Un livre de Wikilivres.

Mathc gnuplot

Une version à jour et éditable de ce livre est disponible sur Wikilivres,
une bibliothèque de livres pédagogiques, à l'URL :
http://fr.wikibooks.org/wiki/Mathc_gnuplot

Introduction

Préambule

Le livre montre les liens que l'on peut créer entre les mathématiques, le langage C et gnuplot. Une approche expérimentale exigerait un passage continu entre un exemple simple et un autre plus complexe. Dans ce livre, on sautera les étapes.

L'étude de ce livre devrait pouvoir commencer après une initiation d'un mois au langage C.

Le groupe Yahoo "Mathc" vous permettra de récupérer les fichiers sources de ce travail, et 300 vidéos sur ce travail en utilisation libre (voir dans Dailymotion les playlists)[1].

En pratique

Pour **le langage C** :

- Certains exemples sont fournis sous la forme de fichiers "*.c" et "*.h".
- Sauvez tous les fichiers "*.h" dans votre répertoire de travail.
- Chaque fichier "*.c" est un exemple.
- Compilez-le directement.

Pour **gnuplot** :

- **Linux** :
  - Pour sélectionner le bon répertoire sous Linux tapez :
  - cd '/home/bernard/Documents/c'
  - En choisissant les noms de vos répertoires personnels
  - Après ou avant avoir lancé gnuplot.
- **Windows** :
  - Pour sélectionner le bon répertoire sous Windows
  - Choisissez l'icône ChDir (change directory)
  - Puis l'icône Open pour sélectionner un fichier de commande de gnuplot.
- **Animation** :
  - Tapotez sur l'icône **replot** de gnuplot. (Windows et Linux)
- **Mémoire** :
  - Gnuplot a de la mémoire.
  - Cela pose des problèmes de compatibilité entre les graphiques.
  - Taper la commande **reset** pour effacer les commandes en mémoire.

Les **logiciels** :

- Pour Gnuplot avec Wikipedia pour Linux et Windows
- Pour le langage c Code::Blocks avec Wikipedia pour Linux et Windows.

Références

1. https://groups.yahoo.com/neo/groups/mathc/info

Fichiers pour gnuplot

Préambule

Quelques fonctions à connaitre :

```
f_p=fopen("a.txt","w");//(write)  Créer un fichier en écriture.
f_p=fopen("a.txt","r");//(read)   0uvrir un fichier en lecture.
f_p=fopen("a.txt","a");//(append) 0uvrir un fichier en écriture.
                       //         Rajouter le texte en fin de fichier.

 printf(    "%d",i);   // Imprimer sur l'écran.
fprintf(f_p,"%d",i);   // Imprimer dans le fichier *f_p
sprintf(  s,"%d",i);   // Imprimer dans la chaine de caractères s.
```

Éviter les lettres accentuées dans les fichiers sources (*.c,*.h), cela pose des problèmes pour échanger les fichiers entre Windows et Linux ou à l'international.

Voir l'introduction pour installer gnuplot dans votre répertoire de travail.

Premiers fichiers

Un fichier list.txt

1. Copier cet exemple dans votre éditeur.
2. Sauvez-le sous le nom "c01.c"
3. Compilez et exécutez-le.
4. Éditer le fichier "list.txt"

c01.c
Un fichier list.txt

```
/* ------------------------------ */
/* Save as c01.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
double f(double x){return(pow(x,2.));}
/* ------------------------------ */
int main(void)
{
FILE   *fp;                  /*Déclarer un pointeur de fichier.    */
double   a;
                             /*Ouvrir le fichier en mode écriture.*/
 fp = fopen("list.txt","w"); /*fp est un pointeur de fichier       */
                             /*qui pointe sur "list.txt"           */
 for(a = -5.0; a <= 5.0; a++)
  fprintf(fp," %6.3f %6.3f\n",/*Imprimer dans le fichier           */
                 a,   f(a));
 fclose(fp);                 /*Fermer le fichier                   */
```

```
printf("\n\n Ouvrir le fichier list.txt "
       "\n\n Press return to continue.  ");
getchar();
return 0;}
```

Un fichier de données pour Gnuplot

Nous ne mettrons pas d'extension pour les fichiers de données avec gnuplot.

1. Compilez et exécutez-ce fichier.
2. Éditer le fichier "data"
3. Dans gnuplot tapez : plot "data"

c02.c
Un fichier de données pour Gnuplot

```
/* ----------------------------- */
/* Save as c02.c                 */
/* ----------------------------- */
#include    <stdio.h>
#include     <math.h>
/* ----------------------------- */
double f(double x){return(pow(x,2.));}
/* ----------------------------- */
int main(void)
{
FILE *fp = fopen("data","w");
double a = -5.0;

  for(; a <= 5.0; a+=.2)
     fprintf(fp," %6.3f   %6.3f\n",a,f(a));
  fclose(fp);

 printf(" Dans gnuplot -> plot \"data\" \n\n"
        " Press return to continue.     \n\n");
 getchar();

 return 0;
}
```

Un fichier de commande pour Gnuplot

L'extension des fichiers de commande de gnuplot est "*.plt" Ici on dessine deux chaines de caractères.

1. Compilez et exécutez-ce fichier.
2. Éditer le fichier "a_main.plt"
3. Dans gnuplot tapez : load "a_main.plt"

c03.c
Un fichier de commande pour Gnuplot

```
/* ----------------------------- */
/* Save as c03.c                 */
/* ----------------------------- */
#include    <stdio.h>
#include     <math.h>
/* ----------------------------- */
char  heq[] = "sin(x)";
char  geq[] = "cos(x)";
/* ----------------------------- */
int main(void)
{
FILE   *fp = fopen("a_main.plt","w");

fprintf(fp,"# Fichier de commande pour Gnuplot          \n"
           "# En ligne de commande : load \"a_main.plt\"\n"
           "#\n"
           " set zeroaxis\n"
           " plot %s,\\\n"
           " %s \n\n"
           " reset", geq, heq);
 fclose(fp);

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue.        ");
 getchar();

 return 0;
}
```

Cela donne dans le fichier "a_main.plt" :

```
# Fichier de commande pour Gnuplot
# En ligne de commande : load "a_main.plt"
#
 set zeroaxis
 plot cos(x),\
 sin(x)
 reset
```

On peut remarquer que chaque fonction est sur une ligne différente. Important si l'on veut dessiner quatre ou cinq fonctions.

Dessiner une liste et une chaîne de caractères

On associe les deux méthodes vues précédemment.

1. Compilez et exécutez-ce fichier.
2. Éditer le fichier "a_main.plt"
3. Dans gnuplot tapez : load "a_main.plt"

c04.c
Dessiner une liste et une chaîne de caractères

```
/* ----------------------------- */
```

```c
/* Save as c04.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
double f(double x){return(cos(x));}
/* ------------------------------ */
char   feq[] =           "cos(x)";
/* ------------------------------ */
int main(void)
{
FILE *fp;
double a = -5.0;

   fp = fopen("data","w");
   for(; a <= 5.0; a+=.2)
        fprintf(fp," %6.3f   %6.3f\n",   a, f(a));
   fclose(fp);

   fp = fopen("a_main.plt","w");
   fprintf(fp,"# Fichier de commande pour Gnuplot          \n"
              "# En ligne de commande : load \"a_main.plt\"\n"
              "#\n"
              " set zeroaxis\n"
              " plot \"data\",\\\n"
              " %s\n"
              " reset",feq);
   fclose(fp);

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue.        ");
 getchar();

 return 0;
}
```

Cela donne dans le fichier "a_main.plt" :

```
# Fichier de commande pour Gnuplot
# En ligne de commande : load "a_main.plt"
#
set zeroaxis
plot "data",\
cos(x)
reset
```

Une fonction graphique

On met simplement le contenu de la fonction main() dans G_plot().

1. Compilez et exécutez-ce fichier..
2. Éditer le fichier "a_main.plt"
3. Dans gnuplot tapez : load "a_main.plt"

c05.c
Une fonction graphique

```
//* ------------------------------ */
/* Save as c05.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
double f(double x){return(cos(x));}
char   feq[] = "cos(x)";
/* ------------------------------ */
int G_plot(void)
{
FILE *fp;
double a = -5.0;

   fp = fopen("data","w");
   for(; a <= 5.0; a+=.2)
        fprintf(fp," %6.3f   %6.3f\n",a,f(a));
  fclose(fp);

  fp = fopen("a_main.plt","w");
   fprintf(fp,"# Fichier de commande pour Gnuplot          \n"
              "# En ligne de commande : load \"a_main.plt\"\n"
              "#\n"
              " set zeroaxis\n"
              " plot \"data\",\\\n"
              " %s\n"
              " reset",feq);
  fclose(fp);

return 0;
}
/* ------------------------------ */
int main(void)
{
 G_plot();

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue.        ");
 getchar();

 return 0;
}
```

Cela donne dans le fichier "a_main.plt" :

```
# Fichier de commande pour Gnuplot
# En ligne de commande : load "a_main.plt"
#
set zeroaxis
plot "data",\
cos(x)
reset
```

Les ennuis commencent

À partir des fichiers précédents, essayer de dessiner la fonction g, sans modifier G_plot() ?

```
/* ------------------------------ */
```

```
double g(double x){return(sin(x));}
char   geq[] = "sin(x)";
/* ---------------------------- */
```

La solution : Les pointeurs de fonctions (voir le chapitre suivant).

Conclusion

Nous avons dessiné des fonctions sous forme de chaines de caractères et sous la forme de liste de points.

Un problème est apparu : Rendre les fonctions graphiques indépendantes de la fonction utilisée.

Une solution va être proposée : Les pointeurs de fonctions.

Pointeurs de fonctions

Préambule

En langage C, le nom d'une fonction est un pointeur. On peut l'utiliser comme **argument** dans l'appel d'une fonction. Exemple : `G_plot(f);` (`f()` étant une fonction)

Un pointeur de fonction doit avoir le même prototype que la fonction pointée.

- Pour la fonction f(x) :

```
double f     (double x)            {return( pow(x,2.));}
double (*P_f)(double x)
```

- Pour la fonction g(x,y) :

```
double g     (double x,double y)   {return(x*y;}
double (*P_g)(double x,double y)
```

Pour appeler la fonction, nous utiliserons cette méthode :

- Pour la fonction f(x) :

```
((*P_f)(a)) /* corresponds à un appel de fonction de forme f(a). */
```

- Pour la fonction g(x,y) :

```
((*P_g)(a,b)) /* corresponds à un appel de fonction de forme g(a,b). */
```

Remarque :

- f et g sont des pointeurs et f() et g() sont des fonctions.

- `double (*P_f)(double x)` c'est une déclaration de pointeur de fonction.
- `P_f` c'est le pointeur.
- `((*P_f)())` c'est un appel à une fonction.

Exemples graphiques (avec gnuplot)

Dessiner deux fonctions successivement

La fonction Gplt() dessine f(x) et g(x).

c01.c
Dessiner deux fonctions successivement

```
/* ------------------------------ */
/* Save as c01.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
double f(double x){return(  pow(x,2.));}
double g(double x){return(2.0*x + 3.0);}
/* ------------------------------ */
void G_plt(
double (*P_f)(double x)
)
{
FILE  *fp = fopen("data","w");
double  a = -5.0;

 for(; a <= 5.0; a += 0.3)
   fprintf(fp," %6.3f  %6.3f\n",a,((*P_f)(a)));
 fclose(fp);
}
/* ------------------------------ */
int main(void)
{
 printf(" Type: plot \"data\" ");
    G_plt(f);
 getchar();

 printf(" Type: plot \"data\" ");
    G_plt(g);

 printf("\n\n Press return to continue.\n");
 getchar();

 return 0;
}
```

Solution pour le chapitre précédent

La fonction G_plot() dessine la fonction (data) et la chaîne de caractères.

c02.c
Solution pour le chapitre précédent

```
/* ------------------------------ */
/* Save as c02.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
double f(double x){return(cos(x));}
char   feq[] = "cos(x)";
/* ------------------------------ */
double g(double x){return(sin(x));}
```

```
char   geq[] = "sin(x)";
/* ------------------------------ */
int G_plot(
double (*P_f)(double x),
char   Feq[])
{
FILE *fp;
double a = -5.0;

 fp = fopen("data","w");
 for(; a <= 5.0; a+=.2)
   fprintf(fp," %6.3f %6.3f\n",a,((*P_f)(a)));
 fclose(fp);

 fp = fopen("a_main.plt","w");
 fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n"
            " set zeroaxis\n"
            " plot \"data\",\\\n"
            " %s\n"
            " reset",Feq);
 fclose(fp);

return 0;
}
/* ------------------------------ */
int main(void)
{
 printf(" load \"a_main.plt\" with gnuplot ");
    G_plot(f,feq);
 getchar();

 printf(" load \"a_main.plt\" with gnuplot ");
    G_plot(g,geq);

 printf("\n\n Press return to continue.\n");
 getchar();

 return 0;
}
```

Résultat après le premier appel de G_plot() :

```
# Gnuplot file : load "a_main.plt"
set zeroaxis
plot "data",\
cos(x)
reset
```

Résultat après le deuxième appel de G_plot() :

```
# Gnuplot file : load "a_main.plt"
set zeroaxis
plot "data",\
sin(x)
reset
```

Exemple numérique

Passer des pointeurs de fonctions à une fonction.

Les fonctions f‘ et f“

Calculer la dérivée première et seconde d'une fonction.

c03.c
Les fonctions f‘ et f“

```c
/* ------------------------------ */
/* Save as c03.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------ Fonction f ------------ */
double f(double x){return( pow(x,2.));}
/* ------------------------------ */
char  feq[] = "x**2";
/* ------ Fonction g ------------ */
double g(double x){return(
 pow(cos(x),2.)+sin(x)+x-3);}
/* ------------------------------ */
char  geq[] = "cos(x)**2+sin(x)+x-3";
/* ------------------------------
 f'(a) = f(a+h) - f(a-h)
          -------------
              2h
   ------------------------------ */
double Dx_1(
double (*P_f)(double x),/* Declaration de pointeur de fonction */
double a,
double h
)
{
 return( ( ((*P_f)(a+h))-((*P_f)(a-h)) ) / (2.*h) );
}
/* ------------------------------
 f''(a) = f(a+h) - 2 f(a) + f(a-h)
           ----------------------
                     h**2
   ------------------------------ */
double Dx_2(
double (*P_f)(double x),/* Declaration de pointeur de fonction */
double a,
double h
)
{
 return( (((*P_f)(a+h))-2*((*P_f)(a))+((*P_f)(a-h))) / (h*h) );
}
/* ------------------------------ */
int main(void)
{
double x = 2.;
double h = 0.001;

printf("\n\n");

printf("  f(%.3f) = %.3f  \n",x,f(x)       );
printf(" f'(%.3f) = %.3f  \n",x,Dx_1(f,x,h));
```

```
printf("f''(%.3f) = %.3f  \n",x,Dx_2(f,x,h));

printf("\n\n");

printf("  g(%.3f) = %.3f \n",x,g(x)       );
printf(" g'(%.3f) = %.3f \n",x,Dx_1(g,x,h));
printf("g''(%.3f) = %.3f \n",x,Dx_2(g,x,h));

    printf("\n\n Press return to continue.");

 getchar();

 return 0;
}
```

Résultat :

```
  f(2.000) = 4.000
 f‘(2.000) = 4.000
f‘‘(2.000) = 2.000
.
  g(2.000) = 0.082
 g‘(2.000) = 1.341
g‘‘(2.000) = 0.398
.
Press return to continue.
```

La fonction FoG

Ici on passe les deux fonctions f et g à la fonction FoG().

La même fonction peut calculer gof, fog et fof...

c04.c
La fonction FoG

```
/* ------------------------------ */
/* Save as c04.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------ Fonction f ------------ */
double f(double x){return( pow(x,2.));}
/* ------------------------------ */
char  feq[] = "x**2";
/* ------ Fonction g ------------ */
double g(double x){return(2.0*x + 3.0);}
/* ------------------------------ */
char  geq[] = "2.0*x + 3.0";
/* - Fonction FoG (g suivie de f)-*/
double FoG(
double (*P_F)(double x),/* Pointeur pour la premiere fonction */
double (*P_G)(double x),/* Pointeur pour la deuxieme fonction */
double a
)
```

```
{
 return((*P_F)( ((*P_G)(a))) );
}
/* ------------------------------ */
int main(void)
{
double a = 2.0;

 printf(" f : x-> %s\n", feq);
 printf(" g : x-> %s\n", geq);
 printf(" \n\n");

   printf(" f(g(%.0f)) = %6.1f\n", a, FoG(f,g,a));
   printf(" g(f(%.0f)) = %6.1f\n", a, FoG(g,f,a));
   printf(" f(f(%.0f)) = %6.1f\n", a, FoG(f,f,a));

 printf("\n\n Press return to continue.\n");
 getchar();

 return 0;
}
```

Résultat :

```
f : x-> x**2
g : x-> 2.0*x + 3.0
.
f(g(2)) = 49.0
g(f(2)) = 11.0
f(f(2)) = 16.0
.
Press return to continue.
```

Tableau de pointeurs de fonctions

Préambule

Nous avons des fonctions semblables. Nous voulons les associer pour pouvoir les manipuler dans des boucles. Nous allons créer un **tableau de pointeurs de fonctions**.

Le tableau de pointeurs de fonctions doit être déclaré avec un prototype de la même forme que celui des fonctions.

Tableau de pointeurs de fonctions

Les fonctions trigonométriques

Nous allons utiliser les fonctions trigonométriques du C.

Déclaration du tableau

```
double (*TrigF[6])(double x) = {cos,sin,tan,atan,asin,acos};
```

- Toutes les fonctions ont la même forme : `double` *`fonction`*`(double)`.
- Le tableau à la même forme que les fonctions : `double` *`tableau`*`(double)`.
- Il y a six fonctions : cos, sin, tan, atan, asin, acos.

Exemple d'un appel

```
  cos(.5) == TrigF[0](.5)
```

Exemple à tester

c01.c
Exemple à tester

```
/* ------------------------------ */
/* Save as c01.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
```

```
/* ------------------------------ */
int main(void)
{
double (*TrigF[6])(double x) = {cos,sin,tan,atan,asin,acos};

double x= .5;
int    i=  0;

 printf(" Nous avons declare un tableau "
        " de pointeurs de fonctions.\n  "
        " J'ai utilise ici les fonctions predefinie du c.\n");


  printf("       cos(%.1f)  = %.3f  \n",  x,     cos(x));
  printf(" TrigF[%d](%.1f)) = %.3f\n\n",i,x,TrigF[i](x));

 printf(" Press return to continue");
 getchar();

 return 0;
}
```

Application

- Créer un tableau de valeurs des fonctions trigonométriques.
- Imprimer le résultat dans cette ordre (sin,cos,tan,acos,asin,atan)
- Pour .1 <= x <+ .5

Avec le résultat dans un fichier

c02.c
Avec le résultat dans un fichier

```
/* ------------------------------ */
/* Save as c02.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
int main(void)
{
FILE   *fp = fopen("list.txt","w");

double (*TrigF[6])(double x) = {atan,asin,acos,tan,cos,sin};

int    i= 6;
double x= .1;

fprintf(fp,"   x || sin    cos    tan    acos   asin   atan \n");

     for(;x<=.5;x+=.1)
        {
         fprintf(fp," %.1f ||",x);
         for(i=6;i;)
            fprintf(fp," %.3f ",TrigF[--i](x));
```

```
        fprintf(fp,"\n");
       }

 fclose(fp);

 printf("\n\n Ouvrir le fichier list.txt\n");
 getchar();

 return 0;
}
```

Le résultat :

```
  x || sin    cos    tan    acos   asin   atan
0.1 || 0.100  0.995  0.100  1.471  0.100  0.100
0.2 || 0.199  0.980  0.203  1.369  0.201  0.197
0.3 || 0.296  0.955  0.309  1.266  0.305  0.291
0.4 || 0.389  0.921  0.423  1.159  0.412  0.381
0.5 || 0.479  0.878  0.546  1.047  0.524  0.464
```

Remarques :

- Attention à l'ordre des fonctions dans la déclaration du tableau.
- double (*TrigF[6])(double x) = {**atan,asin,acos,tan,cos,sin**};

Au démarrage :

- La décrémentation ce fait dans le tableau. **TrigF[--i](x)**
- Il entre 6 dans le tableau.
- 6 est décrémenté -> 5 (avant l'appel de la fonction **--i**)
- La sixième fonctions est appelé (Sin).
- La numéro cinq. :)

Au final :

- Il entre **UN** dans le tableau.
- **UN** est décrémenté -> 0
- La première fonctions est appelé (atan).
- La numéro zéro. :))

- i est égal à zéro en rentrant dans la boucle.
- Le cycle est cassé. :(

Avec le résultat à l'écran

c03.c
Avec le résultat à l'écran

```
/* ------------------------------ */
/* Save as c03.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
int main(void)
{
double (*TrigF[6])(double x) = {atan,asin,acos,tan,cos,sin};

int    i= 6;
double x= .1;

     for(;x<=.5;x+=.1)
       {
         printf("\n");
         for(i=6;i;) printf(" %.3f ",TrigF[--i](x));
       }

 printf("\n\n Press return to continue.\n");
 getchar();

 return 0;
}
```

Les fonctions f‘ et f“

Nous voulons créer la fonction **Derivate** pour calculer la dérivé première et seconde d'une fonction en utilisant un **tableau de pointeurs de fonctions**.

Voir listing en fin de page.

Déclaration du tableau

```
double (*Derivate[3])(double (*P_f)(double x),double a,double h) = {fx,Df_x,Df_xx};
```

- Toutes les fonctions (fx,Df_x,Df_xx) ont la même forme : `double` *`fonction`*`(double (*P_f)(double x) double double)`.
- Le tableau à la même forme que les fonctions : `double` *`tableau`*`(double (*P_f)(double x) double double)`.

Il y a trois fonctions. (0,1,2)= {fx, Df_x, Df_xx}. La fonction fx donne f.

- Supprimer cette fonction et travailler sur deux fonctions.
- Réfléchissez.

Exemple d'un appel

```
    f(x) == Derivate[0](f,x,0.)
```

- Derivate[0] donne f(x).
- Voir la fonction fx() la première fonction du tableau.
- h = 0 dans cet appel parce qu'il n'est pas utilisé (voir code de fx())

Exemple à tester

c04.c
Exemple à tester

```c
/* ------------------------------ */
/* Save as c04.c                  */
/* ------------------------------ */
#include    <stdio.h>
#include     <math.h>
/* ------------------------------ */
/* ------------------------------ */
double f(double x){return( pow(x,2.));}
/* ------------------------------ */
char  feq[] = "x**2";
/* ------------------------------ */
/* ------------------------------ */
double g(double x){return(
 pow(cos(x),2.)+sin(x)+x-3);}
/* ------------------------------ */
char  geq[] = "cos(x)**2+sin(x)+x-3";
/* ------------------------------ */
/* ------------------------------ */
double fx(
double (*P_f)(double x),
double a,
double h
)
{
 return( ((*P_f)(a)) );
}
/* ------------------------------
 f'(a) = f(a+h) - f(a-h)
           -------------
               2h
   ------------------------------ */
double Df_x(
double (*P_f)(double x),
double a,
double h
)
{
 return( ( ((*P_f)(a+h))-((*P_f)(a-h)) ) / (2.*h) );
}
/* ----------------------------
 f''(a) = f(a+h) - 2 f(a) + f(a-h)
```

```
          ----------------------
                    h**2
   ------------------------------ */
double Df_xx(
double (*P_f)(double x),
double a,
double h
)
{
 return( (((*P_f)(a+h))-2*((*P_f)(a))+((*P_f)(a-h))) / (h*h) );
}
/* ------------------------------ */
int main(void)
{
double (*Derivate[3])(double (*P_f)(double x),
                      double a,
                      double h) = {fx,Df_x,Df_xx};
double a = 2;
double h = 0.001;

printf("\n\n");

printf("  f(%.3f) = %.3f = %.3f \n",a,      f(a),  Derivate[0](f,a,0));
printf(" f'(%.3f) = %.3f = %.3f \n",a,Df_x (f,a,h),Derivate[1](f,a,h));
printf("f''(%.3f) = %.3f = %.3f \n",a,Df_xx(f,a,h),Derivate[2](f,a,h));

printf("\n\n");

printf("  g(%.3f) = %.3f = %.3f \n",a,      g(a),  Derivate[0](g,a,0));
printf(" g'(%.3f) = %.3f = %.3f \n",a,Df_x (g,a,h),Derivate[1](g,a,h));
printf("g''(%.3f) = %.3f = %.3f \n",a,Df_xx(g,a,h),Derivate[2](g,a,h));

 printf("\n\n Press return to continue.");
 getchar();

 return 0;
}
```

Fichiers h : Fichiers h partagés

Préambule

Vous trouverez dans cette section une suite de fichiers h. Installer ces fichiers dans votre répertoire de travail. Ils seront appelés par le fichier "x_ahfile.h" de chaque exemple.

Ces fichiers ne sont pas utilisés pour la géométrie de la tortue.

En pratique

- xdef.h

  `PI`
  : Déclaration de pi.

  `clrscrn();`
  : Effacer la fenêtre du terminal Dos.

  `Pause();`
  : Une pause d'une seconde pour les animations.

  `NewName();`
  : Créer une liste de noms de fichiers.

- xplt.h

  `i_WGnuplot();`
  : Contrôler la fenêtre de gnuplot 2d.

  `i_WsGnuplot();`
  : Contrôler la fenêtre de gnuplot 3d.

  `i_VGnuplot();`
  : Contrôler la vue de la fonction 3d.

- xspv.h

  `i_point2d();`
  : Initialiser un point en 2d.

  `i_point3d();`
  : Initialiser un point en 3d.

  `i_vector2d();`
  : Initialiser un vecteur en 2d.

  `i_vector3d();`
  : Initialiser un vecteur en 3d.

- xfx_x.h

  Dérivées de f(x);

- xfxy_x.h

  Dérivées partielles de f(x,y);

- xfxyz_x.h

  Dérivées partielles de f(x,y,z);

Fichiers h : xdef

Préambule

Installer ce fichier dans votre répertoire de travail.

xdef.h
Définitions générales

```
/* ---------------------------------- */
/*  Save as :   xdef.h                */
/* ---------------------------------- */
#ifndef PI
#define PI               3.14159265359
#endif
/* ---------------------------------- */
void clrscrn(void)
{
  printf("\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n");
}
/* ---------------------------------- */
void Pause(void)
{
int i=300;
int j;

  while(--i){j=600000;while(--j);}
}
/* ---------------------------------- */
/* First file name :                  */
/*                                    */
/* char fname[]= "a_paaa";            */
/* ---------------------------------- */
char *NewName(
char *name
)
{
            if(name[5]<'z')

               ++name[5];

       else if(name[4]<'z')
              {
                 name[5]='a';
               ++name[4];
              }
       else if(name[3]<'z')
              {
                 name[5]='a';
                 name[4]='a';
               ++name[3];
              }

 return(name);
}
```

Fichiers h : xplt

Préambule

Installer ce fichier dans votre répertoire de travail.

xplt.h
Définition d'intervalles pour le tracé

```
/* ---------------------------------- */
/*  Save as :   xplt.h                */
/* ---------------------------------- */
typedef struct
{
 double xmini;  double xmaxi;
 double ymini;  double ymaxi;

}W_Ctrl, *PW_Ctrl;
/* ---------------------------------- */
W_Ctrl i_WGnuplot(
 double xmini,  double xmaxi,
 double ymini,  double ymaxi
)
{
W_Ctrl w = {xmini,xmaxi,ymini,ymaxi};

return (w);}
/* ---------------------------------- */
typedef struct
{
 double xmini;  double xmaxi;
 double ymini;  double ymaxi;
 double zmini;  double zmaxi;

}Ws_Ctrl, *PWs_Ctrl;
/* ---------------------------------- */
Ws_Ctrl i_WsGnuplot(
 double xmini,  double xmaxi,
 double ymini,  double ymaxi,
 double zmini,  double zmaxi
)
{
Ws_Ctrl w = {xmini,xmaxi,ymini,ymaxi,zmini,zmaxi};

return (w);}
/* ---------------------------------- */
typedef struct
{
 double rot_x;  double rot_z;
 double scale;  double scale_z;

}View_Ctrl, *PView_Ctrl;
/* ---------------------------------- */
View_Ctrl i_VGnuplot(
 double rot_x,  double rot_z,
 double scale,  double scale_z
)
{
```

```
View_Ctrl V = {rot_x,rot_z,scale_z,scale_z};

return (V);}
/* ---------------------------------- */
typedef struct
{
 double mini;  double maxi;
 double step;

}t_Ctrl, *Pt_Ctrl;
/* ---------------------------------- */
t_Ctrl i_time(
 double mini,  double maxi,
 double step
)
{
t_Ctrl t = {mini,maxi,step};

return (t);}
```

Fichiers h : xspv

Préambule

Installer ce fichier dans votre répertoire de travail.

xspv.h
Définition des types de points et de vecteurs

```
/* ---------------------------------- */
/*  Save as :   xspv.h                */
/* ---------------------------------- */
typedef struct
{
 double x;  double y;

}point2d, *Ppoint2d;
/* ---------------------------------- */
point2d i_point2d(
 double x,  double y
)
{
point2d p = {x,y};

return (p);}
/* ---------------------------------- */
typedef struct
{
 double x;  double y;  double z;

}point3d, *Ppoint3d;
/* ---------------------------------- */
point3d i_point3d(
double x,  double y,  double z
)
{
point3d p = {x,y,z};

return (p);}
/* ---------------------------------- */
typedef struct
{
 double i;  double j;

}vector2d, *Pvector2d;
/* ---------------------------------- */
vector2d i_vector2d(
 double i,  double j
)
{
vector2d v = {i,j};

return (v);}
/* ---------------------------------- */
typedef struct
{
 double i;  double j;  double k;
```

```
}vector3d, *Pvector3d;
/* ---------------------------------- */
vector3d i_vector3d(
 double i,  double j,  double k
)
{
vector3d v = {i,j,k};

return (v);}
```

Fichiers h : xfx_x

Préambule

Installer ce fichier dans votre répertoire de travail.

xfx_x.h
Dérivation de fonctions df(x)/dx

```
/* ------------------------------------ */
/*  Save as :   xfx_x.h                 */
/* ------------------------------------
 f'(a) = f(a+h) - f(a-h)
          -------------
              2h
   ---------------------------------  */
double fx_x(
double (*P_f)(double x),
double a,
double h
)
{
 return( ( ((*P_f)(a+h))-((*P_f)(a-h)) ) / (2.*h) );
}
/* ------------------------------------
 f''(a) = f(a+h) - 2 f(a) + f(a-h)
           ----------------------
                    h**2
   ---------------------------------  */
double fx_xx(
double (*P_f)(double x),
double a,
double h
)
{
 return( (((*P_f)(a+h))-2*((*P_f)(a))+((*P_f)(a-h))) / (h*h) );
}
```

Fichiers h : xfxy_x

Préambule

Installer ce fichier dans votre répertoire de travail.

xfxy_x.h
Dérivation de fonction df(x,y)/dx

```
/* ---------------------------------- */
/*  Save as :   xfxy_x.h              */
/* ---------------------------------- */
double fxy_x(
double (*P_f)(double x, double y),
double   h,
point2d  p
)
{
double tplsh;
double tmnsh;

 tplsh = ((*P_f)(p.x+h,p.y));
 tmnsh = ((*P_f)(p.x-h,p.y));

 return(( tplsh-tmnsh)/(2.*h) );
}
/* ---------------------------------- */
double fxy_y(
double (*P_f)(double x, double y),
double   h,
point2d  p
)
{
double tplsh;
double tmnsh;

 tplsh = ((*P_f)(p.x,p.y+h));
 tmnsh = ((*P_f)(p.x,p.y-h));

 return(( tplsh-tmnsh)/(2.*h) );
}
/* ---------------------------------- */
double fxy_xx(
double (*P_f)(double x, double y),
double   h,
point2d  p
)
{
double t;
double tplsh;
double tmnsh;

 t     = ((*P_f)(p.x  , p.y));
 tplsh = ((*P_f)(p.x+h, p.y));
 tmnsh = ((*P_f)(p.x-h, p.y));

 return( (tplsh-2*t+tmnsh)/(h*h) );
}
```

```c
/* ---------------------------------- */
double fxy_yy(
double (*P_f)(double x, double y),
double   h,
point2d  p
)
{
double t;
double tplsh;
double tmnsh;

 t     = ((*P_f)(p.x, p.y  ));
 tplsh = ((*P_f)(p.x, p.y+h));
 tmnsh = ((*P_f)(p.x, p.y-h));

 return( (tplsh-2*t+tmnsh)/(h*h) );
}
```

Fichiers h : xfxyz x

Préambule

Installer ce fichier dans votre répertoire de travail.

xfxyz_x.h
Dérivation de fonction df(x,y,z)/dx

```
/* ------------------------------------ */
/*  Save as :   xfxyz_x.h               */
/* ------------------------------------ */
double fxyz_x(
double (*P_f)(double x, double y, double z),
double   h,
point3d  p
)
{
double tplsh;
double tmnsh;

 tplsh = ((*P_f)(p.x+h,p.y,p.z));
 tmnsh = ((*P_f)(p.x-h,p.y,p.z));

 return(( tplsh-tmnsh)/(2.*h) );
}
/* ------------------------------------ */
double fxyz_y(
double (*P_f)(double x, double y, double z),
double   h,
point3d  p
)
{
double tplsh;
double tmnsh;

 tplsh = ((*P_f)(p.x,p.y+h,p.z));
 tmnsh = ((*P_f)(p.x,p.y-h,p.z));

 return(( tplsh-tmnsh)/(2.*h) );
}
/* ------------------------------------ */
double fxyz_z(
double (*P_f)(double x, double y, double z),
double   h,
point3d  p
)
{
double tplsh;
double tmnsh;

 tplsh = ((*P_f)(p.x,p.y,p.z+h));
 tmnsh = ((*P_f)(p.x,p.y,p.z-h));

 return(( tplsh-tmnsh)/(2.*h) );
}
```

Application : Fonction Heaviside

Préambule

La fonction Heaviside dans Wikipedia.

La fonction Heaviside

$$\forall x \in \mathbb{R},\ H(x) = \begin{cases} 1 & \text{si} \quad x > 0 \\ \text{sinon} & 0 \end{cases}$$

Présentation

Voici une possibilité pour la déclaration de la fonction Heaviside.

```
/* ---------------------------------- */
double H(
double x)
{
       if(x>0.)return(1.);
       else    return(0.);
}
/* ---------------------------------- */
```

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

c01.c
La fonction

```
/* ---------------------------------- */
/*  Save as :  c01.c                  */
/* ---------------------------------- */
#include "x_ahfile.h"
/* ---------------------------------- */
int main(void)
{
 printf(" H : if(x>0) 1 else 0 \n");

      G_plot(i_WGnuplot(-2.,20.,-1.,2.),
             i_time(-2.,20.,0.001),
             H);

 printf("\n  load \"a_main.plt\" with gnuplot."
        "\n  Press return to continue         ");
 getchar();

 return 0;
}
```

Une application

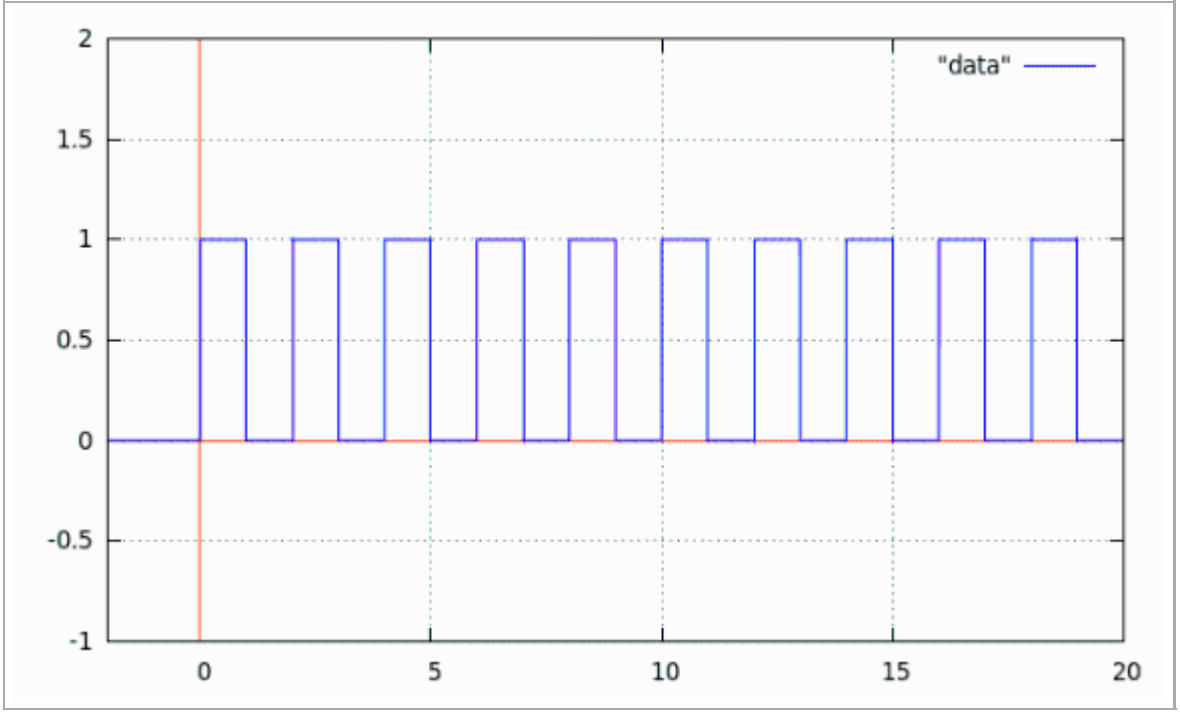
Nous allons simplement appeler la fonction Heaviside dans une boucle for.

Pour obtenir une somme : Sum((-1)^n*H(x-n),n=0..20)

c02.c
Une application

```
/* ---------------------------------- */
/*  Save as :  c02.c                  */
/* ---------------------------------- */
#include "x_ahfile.h"
/* ---------------------------------- */
double v(
double x)
{
double n=0, r=0;

 for(;n<20;++n) r += pow(-1,n)*H(x-n);

 return(r);
}
char veq[] = "Sum((-1)^n*H(x-n),n=0..20)";
/* ---------------------------------- */
int main(void)
{
 printf(" H : if(x>0) 1 else 0 \n\n"
        " v : x-> %s           \n\n",veq);

      G_plot(i_WGnuplot(-2.,20.,-1.,2.),
             i_time(-2.,20.,0.001),
             v);

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue         ");
 getchar();

 return 0;
}
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/*  Save as :   x_ahfile.h              */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include "xdef.h"
#include "xplt.h"
/* ---------------------------------- */
#include   "fh.h"
#include  "g_f.h"
```

fh.h
La fonction Heaviside

```
/* ---------------------------------- */
/*  Save as :  fh.h                   */
/* ---------------------------------- */
double H(
double x)
```

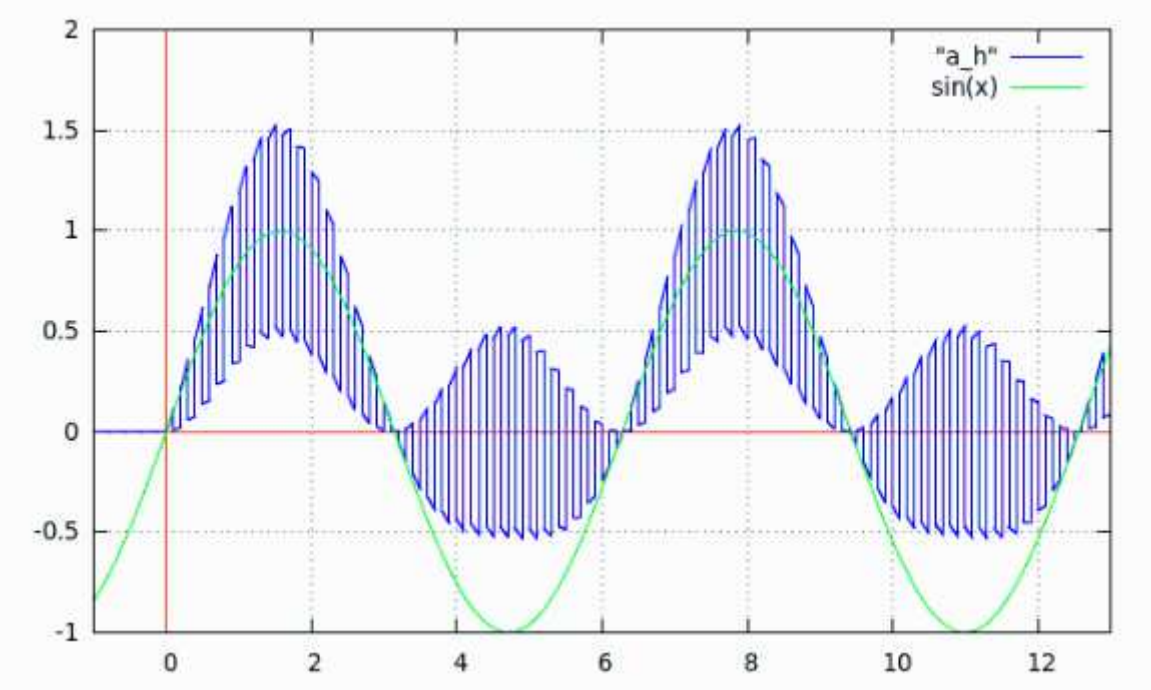
```
{
       if(x>0.)return(1.);
       else    return(0.);
}
/* ------------------------------------ */
```

g_f.h
La fonction graphique

```
/* ------------------------------------ */
/*  Save as :   g_f.h                   */
/* ------------------------------------ */
void G_plot(
W_Ctrl W,
t_Ctrl T,
double (*P_f1)(double x)
)
{
FILE  *fp;
double  t;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
           " set zeroaxis lt 8\n"
           " set grid\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"data\" with line lt 3\n"
           " reset",
             W.xmini,W.xmaxi,W.ymini,W.ymaxi);
 fclose(fp);

        fp = fopen("data","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.3f   %6.3f\n",t,(*P_f1)(t));
 fclose(fp);
}
```

Conclusion

Certains résultats sont vraiment surprenants en associant la fonction heaviside et la fonction sinus.


"a_h"
sin(x)
2
1.5
1
0.5
0
-0.5
-1
0
2
4
6
8
10
12

Application : Tangente

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner la tangente

c01.c
Dessiner la tangente

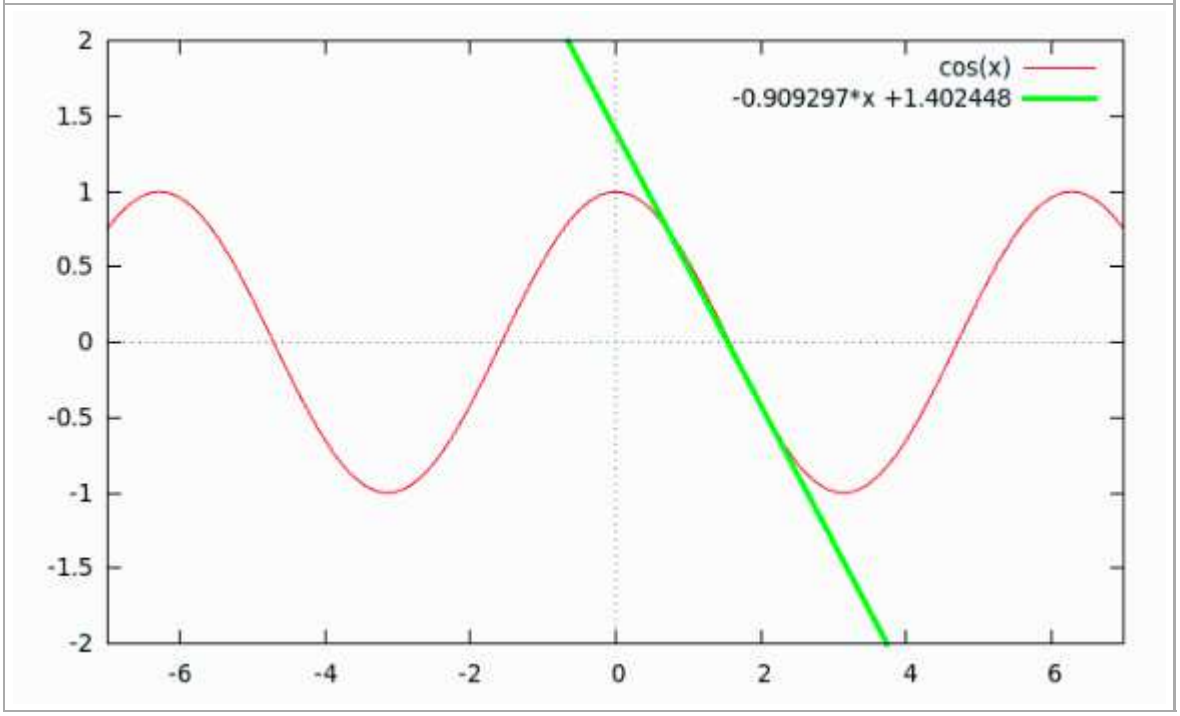
```c
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "f2.h"
/* ------------------------------------ */
int main(void)
{
double c = 2;

 printf("  f : x-> %s\n\n",   feq);
 printf("  f': x-> %s\n\n\n",Dfeq);

 printf(" With c = %0.3f, the equation of the tangent is :",c);
 printf("\n\n    y = f'(c) (x-c) + f(c) =");
 eq_Tan(c,f,Df);

 G_Tan(i_WGnuplot(-7, 7,-2,2),
       c,
       feq,
       f,
       Df);

 printf(" load \"a_main.plt\" with gnuplot.\n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
 f : x->  cos(x)
 f': x->  (-sin(x))
.
With c = 2.000, the equation of the tangent is :
.
   y = f'(c) (x-c) + f(c) = -0.909*x +1.402
```

```
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
#include    "k_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ------------ f -------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' ------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

k_tan.h

Equation de la tangente

```
/* ---------------------------------- */
/*  Save as :    k_tan.h              */
/* ---------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]


   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=c
   a = f'(c)
   b = f(c) - f'(c)c
   ---------------------------------- */
void eq_Tan(
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
 printf(" %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
/* ---------------------------------- */
void eq_Tanf(
FILE *fp,
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
fprintf(fp," %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_Tan(
W_Ctrl w,
double c,
  char    fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE *fp = fopen("a_main.plt","w");

fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
           " set zeroaxis\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s, \\\n"
           " %0.6f*x %+0.6f lw 3\n"
           " reset",
            w.xmini,w.xmaxi,w.ymini,w.ymaxi,
            fEQ,
            (*PDf)(c),
            (-(*PDf)(c)* c + (*P_f)(c)));

 fclose(fp);
}
```

Exemple avec la sortie dans le fichier "a_out.txt"

c01f.c
Sortie dans un fichier

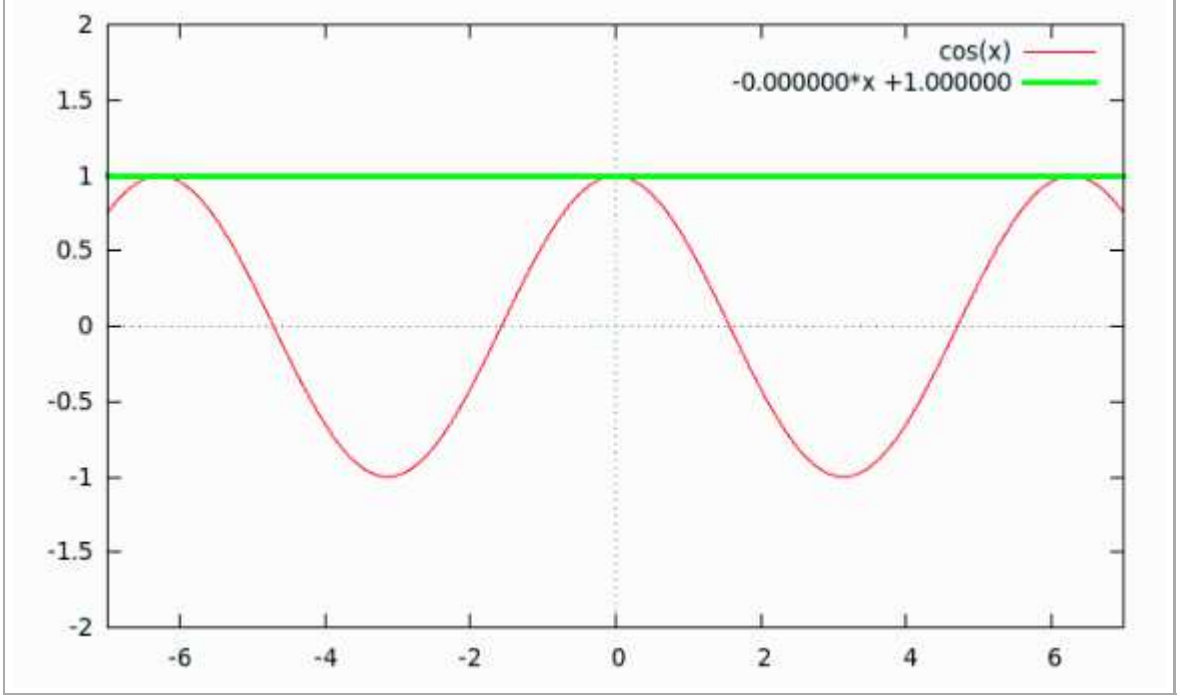
```
/* ---------------------------------- */
/*  Save as :   c01f.c                */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ---------------------------------- */
int main(void)
{
FILE *fp = fopen("a_out.txt","w");
double c = 0;

fprintf(fp,"  f : x-> %s\n\n",   feq);
fprintf(fp,"  f': x-> %s\n\n\n",Dfeq);

fprintf(fp," With c = %0.3f, the equation of the tangent is :",c);
fprintf(fp,"\n\n    y = f'(c) (x-c) + f(c) =");
eq_Tanf(fp,c,f,Df);

G_Tan(i_WGnuplot(-7, 7,-2,2),c,feq,f,Df);

fprintf(fp," load \"a_main.plt\" with gnuplot.");
```

```
 fclose(fp);

 printf(" Read \"a_out.txt\".\n"
        " Press return to continue");

  getchar();

 return 0;
}
```

Le résultat dans le fichiers "a_out.txt"

```
 f : x->  cos(x)
 f': x->  (-sin(x))
 .
With c = 0.000, the equation of the tangent is :
.
   y = f'(c) (x-c) + f(c) = -0.000*x +1.000
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Application : Champ de tangentes

Préambule

La tangente dans Wikipedia.

Présentation

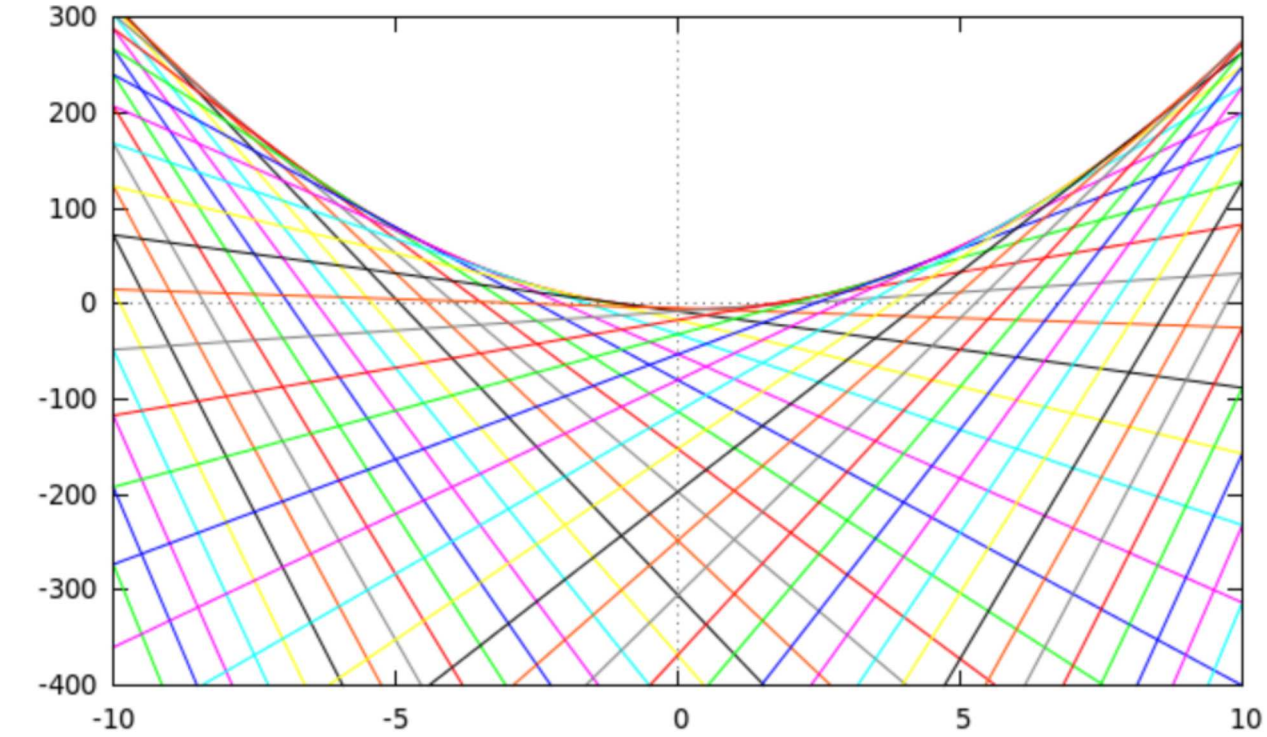
N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner un champ de tangentes 1

c01.c
Dessiner la tangente

```c
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "f1.h"
/* ------------------------------------ */
int main(void)
{
 printf("  f : x-> %s  \n", feq);
 printf("  f': x-> %s\n\n",Dfeq);

 printf(" The equation of the tangent is : \n\n");
 printf("       y = f'(c) (x-c) + f(c)     \n\n");

  G_TanA(i_WGnuplot(-10,10,-400,300),
         i_time(-24.,24.,1),
         feq,
         f,
         Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Résultat dans gnuplot

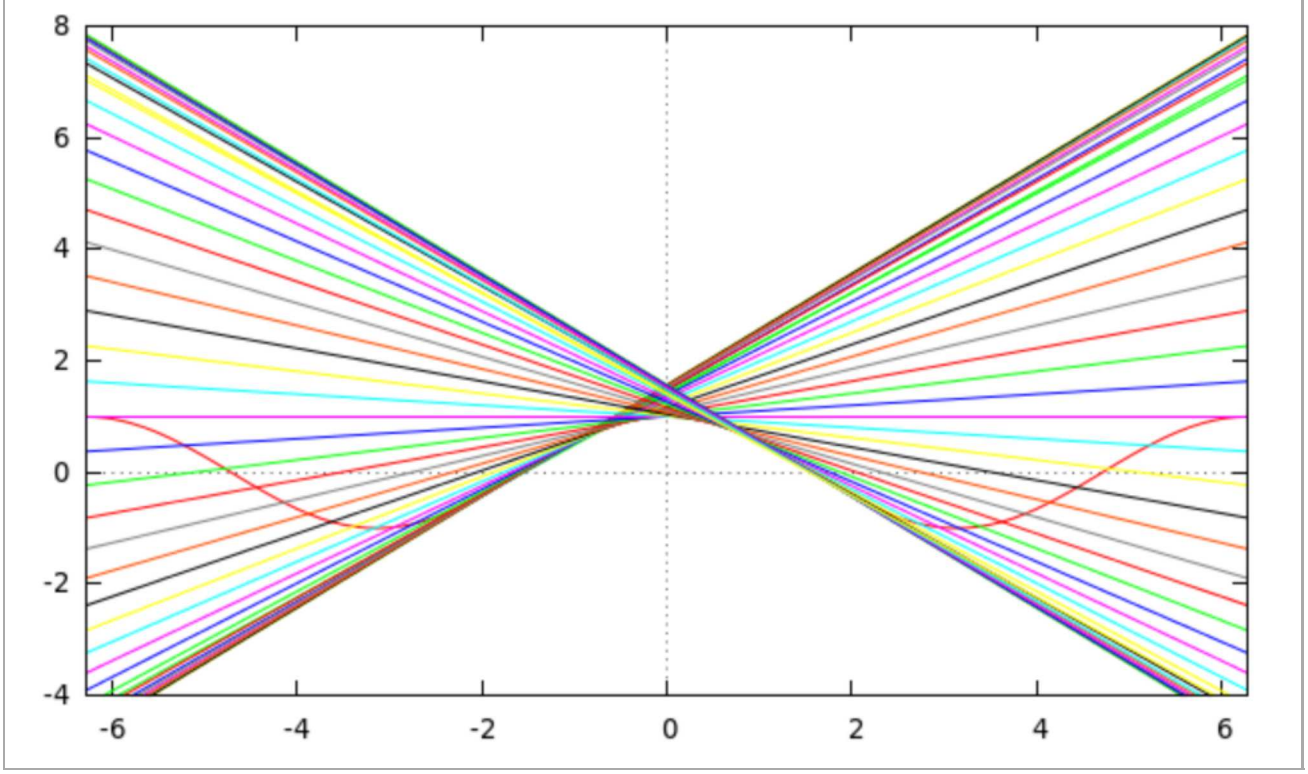


Dessiner un champ de tangentes 2

c02.c
Dessiner la tangente

```
/* ---------------------------------- */
/*  Save as :   c02.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ---------------------------------- */
int main(void)
{
 printf("  f : x-> %s  \n", feq);
 printf("  f': x-> %s\n\n",Dfeq);

 printf(" The equation of the tangent is : \n\n");
 printf("       y = f'(c) (x-c) + f(c)     \n\n");

  G_TanA(i_WGnuplot(-2*PI, 2*PI,-4,8),
         i_time(-2.,2.,.1),
         feq,
         f,
         Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Résultat dans gnuplot



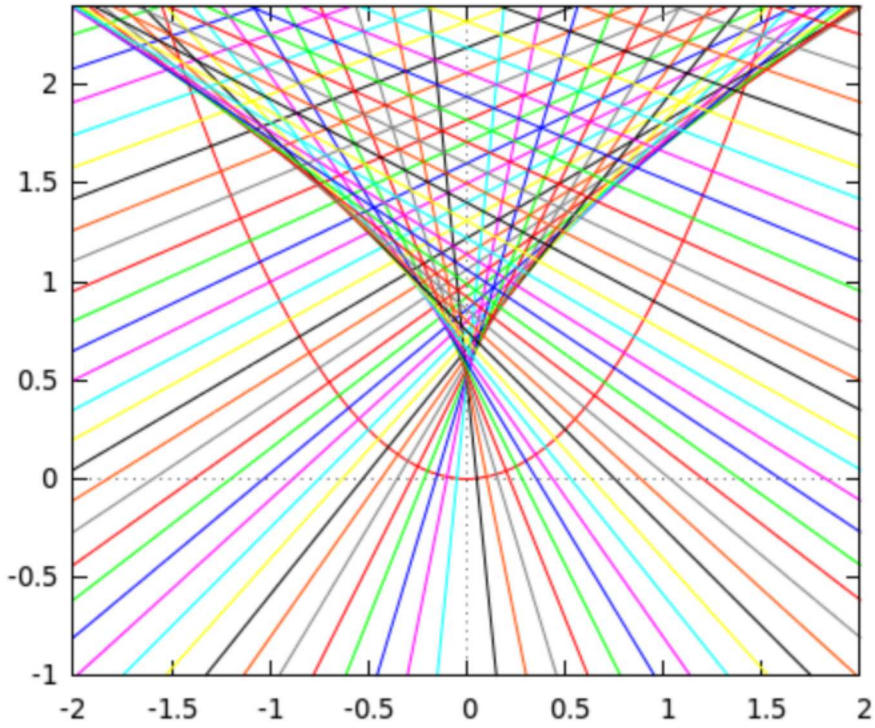
Dessiner un champ de normales 3

c03.c
Dessiner un champ de normales 3

```
/* ------------------------------------ */
/*  Save as :   c03.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "f3.h"
/* ------------------------------------ */
int main(void)
{
 printf("  f : x-> %s  \n", feq);
 printf("  f': x-> %s\n\n",Dfeq);

 printf(" The equation of the tangent is : \n\n");
 printf("       y = f'(c) (x-c) + f(c)     \n\n");

  G_NorA(i_WGnuplot(-2,2,-1,2.4),
         i_time(-2,2,.05),
         feq,
         f,
         Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();
```

```
 return 0;
}
```

Résultat dans gnuplot



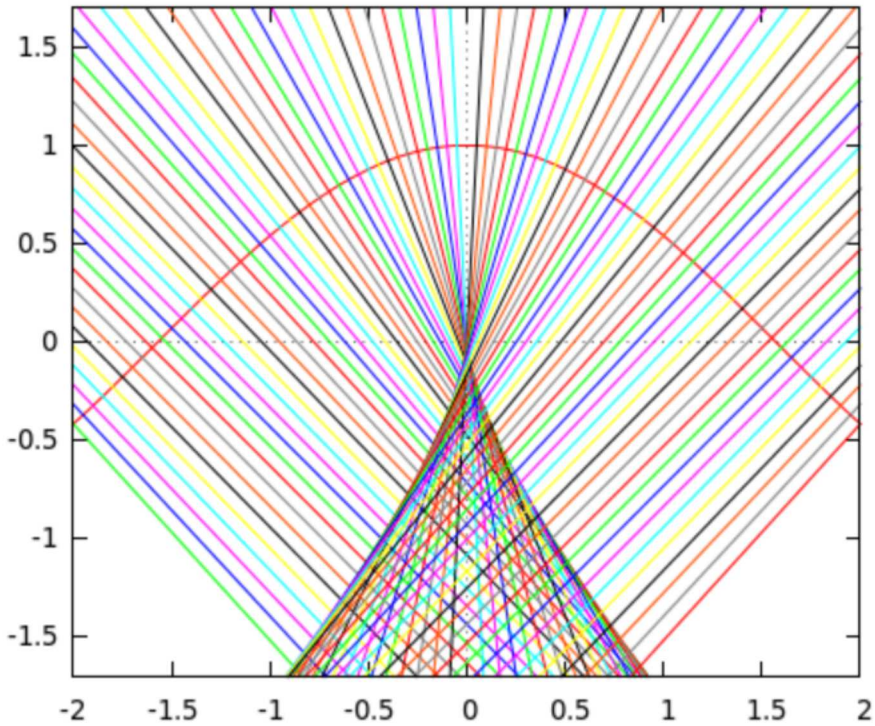
Dessiner un champ de normales 4

c04.c
Dessiner un champ de normales 4

```
/* ---------------------------------- */
/*  Save as :   c04.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "f1.h"
/* ---------------------------------- */
int main(void)
{
 printf("  f : x-> %s  \n", feq);
 printf("  f': x-> %s\n\n",Dfeq);

 printf(" The equation of the tangent is : \n\n");
 printf("       y = f'(c) (x-c) + f(c)     \n\n");

  G_NorA(i_WGnuplot(-2, 2,-1.7,1.7),
         i_time(-2.,2.,.05),
         feq,
         f,
         Df);
```

```
 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
#include     "xdef.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

f1.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f1.h                  */
/* ---------- f --------------------- */
double f(
double x)
{
 return(       3*x*x-2*x-5);
}
char  feq[] = " 3*x**2-2*x-5";
/* ------------ f' -------------------- */
double Df(
double x)
{
 return(        6*x-2 );
}
char Dfeq[] = " 6*x-2 ";
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ---------- f --------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' -------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

f3.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f3.h                  */
/* ---------- f --------------------- */
double f(
double x)
{
 return(        x*x);
}
char  feq[] = " x**2";
```

```
/* ------------ f' -------------------- */
double Df(
double x)
{
 return(        2*x );
}
char Dfeq[] = " 2*x ";
```

kg_tan.h
Les fonctions graphiques

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_TanA(
W_Ctrl w,
t_Ctrl Pic,
  char    fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE *fp = fopen("a_main.plt","w");
double p = Pic.mini;

fprintf(fp,"# Gnuplot file : load \"a_main.plt\"\n"
           " set zeroaxis\n"
           " unset key\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s, \\\n",
                w.xmini,w.xmaxi,w.ymini,w.ymaxi,
                fEQ);

for(;p<Pic.maxi;p+=Pic.step)
    fprintf(fp," %0.6f*x %+0.6f, \\\n",
           (*PDf)(p), (-(*PDf)(p)*p+(*P_f)(p)) );

     fprintf(fp," %0.6f*x %+0.6f\n",
           (*PDf)(p), (-(*PDf)(p)*p+(*P_f)(p)) );

fprintf(fp," reset");
 fclose(fp);
}
/* ---------------------------------- */
void G_NorA(
W_Ctrl w,
t_Ctrl Pic,
  char    fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE *fp = fopen("a_main.plt","w");
double p = Pic.mini;

fprintf(fp,"# Gnuplot file : load \"a_main.plt\"\n"
           " set size ratio -1\n"
           " set zeroaxis\n\n"
           " unset key\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
```

```
          " %s, \\\n",
                w.xmini,w.xmaxi,w.ymini,w.ymaxi,
                fEQ);

for(;p<Pic.maxi;p+=Pic.step)
    fprintf(fp," %0.6f*x %+0.6f, \\\n",
          (-1/(*PDf)(p)), (1/(*PDf)(p)*p+(*P_f)(p)) );

     fprintf(fp," %0.6f*x %+0.6f\n",
          (-1/(*PDf)(p)), (1/(*PDf)(p)*p+(*P_f)(p)) );

fprintf(fp," reset");
 fclose(fp);
}
```

Application : Tangente et axes x-y

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

c01.c
Dessiner les points d'intersection de la tangente avec les axes x/y

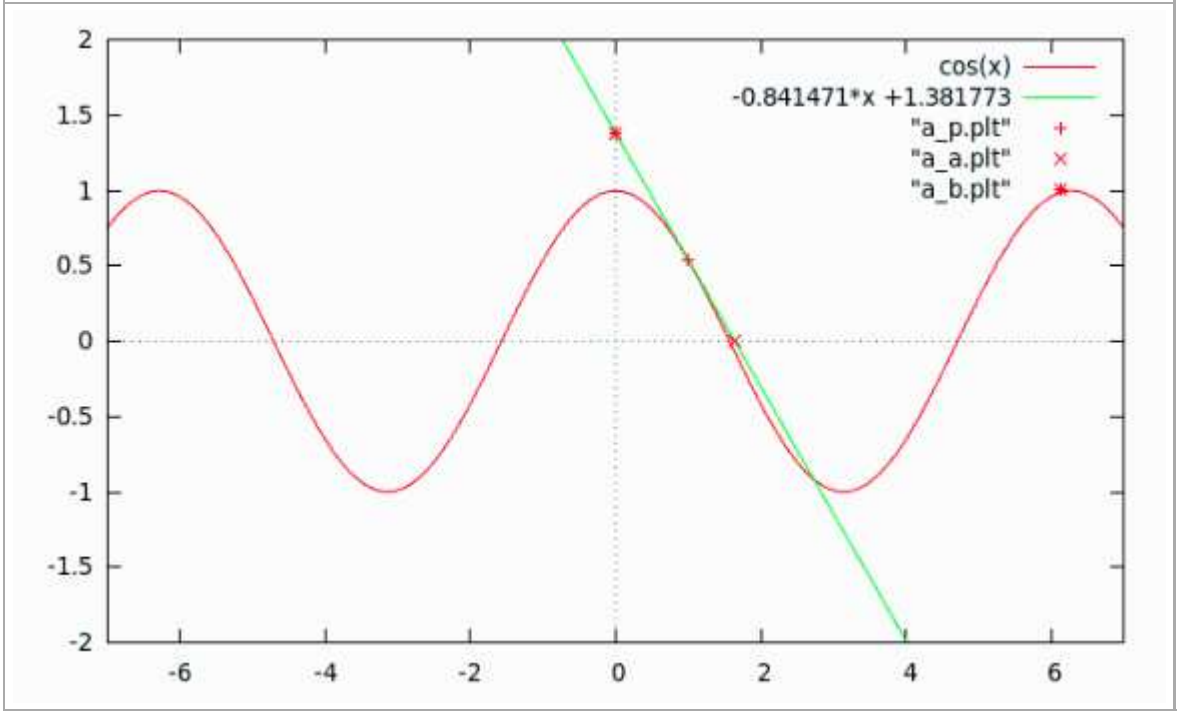
```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ----------------------------------- */
int main(void)
{
double c = 1;

 printf("  f : x-> %s  \n", feq);
 printf(" Df : x-> %s\n\n",Dfeq);

 printf(" With c = %0.3f, the equation of"
          " the tangent is :\n\n"
          "      y =  Df(c) (x-c) + f(c) = ",c);
eq_Tan(c,f,Df);

 printf(" Find at c = %0.3f\n\n"
        " the intersection points of the"
        " tangent with the x-y axis.\n\n",c);

 printf(" P(%5.3f, %5.3f)     P(c, f(c))\n",
        c,f(c));

 printf(" A(%5.3f, 0.000)     A(c-f(c)/Df(c), 0)\n",
        c-(f(c))/(Df(c)));

 printf(" B(    0, %5.3f)     B(0, f(c)-c Df(c))\n",
        f(c)-((Df(c))*c));

 G_Tan_xy(i_WGnuplot(-7,7,-2,2),
          c,
          feq,
          f,Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();
```

```
 return 0;
}
```

Le résultat.

```
 f : x->  cos(x)
Df : x->  (-sin(x))
.
With c = 1.000, the equation of the tangent is :
.
     y =  Df(c) (x-c) + f(c) =  -0.841*x +1.382
.
.
Find at c = 1.000
.
the intersection points of the tangent with the x-y axis.
.
P(1.000, 0.540)     P(c, f(c))
A(1.642, 0.000)     A(c-f(c)/Df(c), 0)
B(    0, 1.382)     B(0, f(c)-c Df(c))
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
```

```
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
#include    "k_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ------------ f --------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' ------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

k_tan.h
Equation de la tangente

```
/* ---------------------------------- */
/*  Save as :    k_tan.h              */
/* ----------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]

   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=c
   a = f'(c)
   b = f(c) - f'(c)c
   ---------------------------------- */
void eq_Tan(
double    c,
double (*P_f)(double x),
```

```
double (*PDf)(double x)
)
{
 printf(" %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
/* ---------------------------------- */
void eq_Tanf(
FILE *fp,
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
fprintf(fp," %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

kg_tan.h

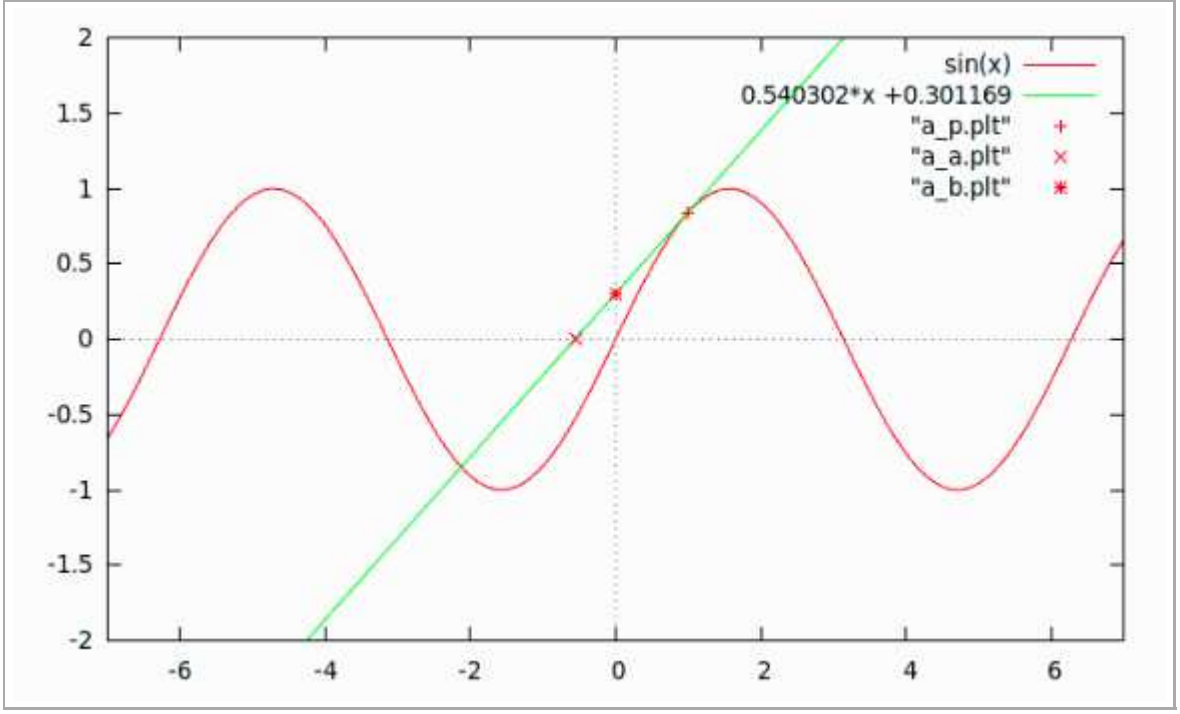
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_Tan_xy(
W_Ctrl w,
double c,
  char fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE   *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
           " set zeroaxis \n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] "
           " %s,\\\n"
           " %0.6f*x %+0.6f,\\\n"
           " \"a_p.plt\" lt 1,\\\n"
           " \"a_a.plt\" lt 1,\\\n"
           " \"a_b.plt\" lt 1\n"
           " reset",
            w.xmini,w.xmaxi,w.ymini,w.ymaxi,
            fEQ,
  ((*PDf)(c)),  (-((*PDf)(c))*c+((*P_f)(c))) );
 fclose(fp);

       *fp = fopen(   "a_p.plt","w");
fprintf(fp," %0.6f   %0.6f",
             c, ((*P_f)(c)));
 fclose(fp);

        fp = fopen(   "a_a.plt","w");
fprintf(fp," %0.6f   0.",
c-((*P_f)(c))/((*PDf)(c)));
 fclose(fp);

        fp = fopen(   "a_b.plt","w");
```

```
fprintf(fp," 0.   %0.6f",
((*P_f)(c))-(((*PDf)(c))*c));
 fclose(fp);
}
```

Un exemple avec la fonction sin.

Résultat dans gnuplot



Application : Tangente de P à l'axes des x

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

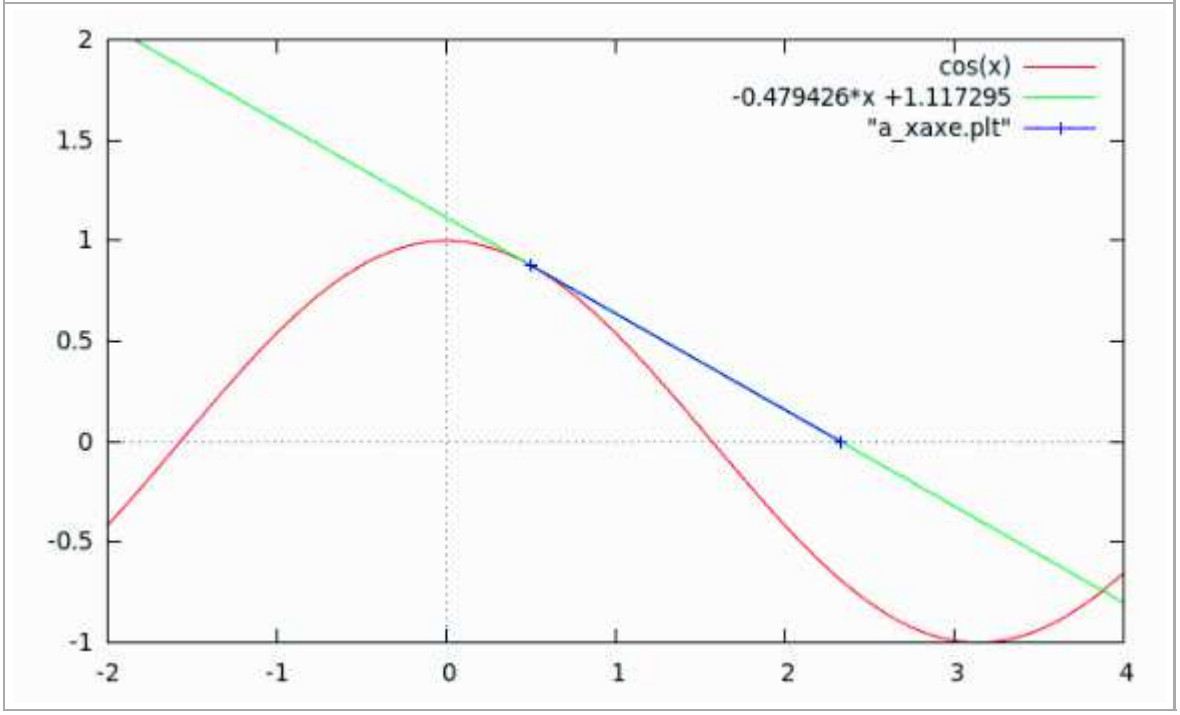
c01.c
Calculer la longeur de P(c,f(c) à l'axe de x.

```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "f2.h"
/* ------------------------------------ */
int main(void)
{
double c = .5;

 printf("  f : x-> %s  \n", feq);
 printf("  Df: x-> %s\n\n",Dfeq);

 printf(" With c = %0.3f, the equation of the tangent is :\n\n"
        "       y =  Df(c) (x-c) + f(c) = ",c);
 eq_Tan(c,f,Df);

 printf(" Find PA, the length of the tangent from P to the x axis.\n\n");

 printf(" P(%5.3f, %5.3f)           P(c, f(c))       \n",
        c,f(c));

 printf(" A(%5.3f, 0.000)           A(c-f(c)/Df(c), 0)\n\n\n",
          c-(f(c)/Df(c)));

 printf(" PA =  sqrt(f(c)**2*(1 +(1/Df(c)**2))) = %6.3f\n\n\n",
        sqrt(pow(f(c),2)*(1+(1/pow(Df(c),2)))));

 G_TanPx      (i_WGnuplot(-2,4,-1,2),
               c,
               feq,f,Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
 f : x->  cos(x)
 Df: x->  (-sin(x))
.
With c = 0.500, the equation of the tangent is :
.
     y =  Df(c) (x-c) + f(c) =  -0.479*x +1.117
.
Find PA, the length of the tangent from P to the x axis.
.
P(0.500, 0.878)           P(c, f(c))
A(2.330, 0.000)           A(c-f(c)/Df(c), 0)
.
PA =  sqrt(f(c)**2*(1 +(1/Df(c)**2))) =  2.030
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
```

```
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
#include    "k_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ------------ f -------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' ------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

k_tan.h
Equation de la tangente

```
/* ---------------------------------- */
/*  Save as :    k_tan.h               */
/* ---------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]


   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=c
   a = f'(c)
   b = f(c) - f'(c)c
   ---------------------------------- */
void eq_Tan(
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
 printf(" %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
```

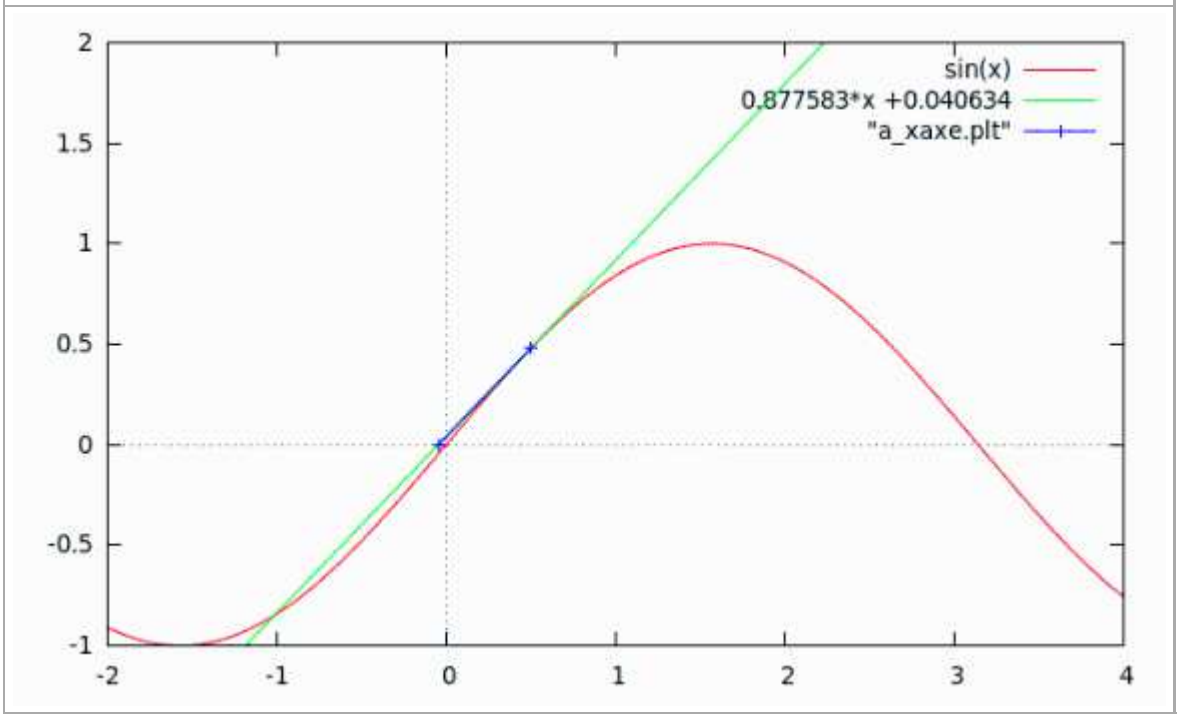
```
}
/* ---------------------------------- */
void eq_Tanf(
FILE *fp,
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
fprintf(fp," %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_TanPx(
W_Ctrl w,
double c,
  char    fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE   *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
           " set zeroaxis \n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s,\\\n"
           " %0.6f*x %+0.6f,\\\n"
           " \"a_xaxe.plt\" with linesp lt 3 \n"
           " reset",
             w.xmini,w.xmaxi,w.ymini,w.ymaxi,
            fEQ,
       (*PDf)(c),-(*PDf)(c)*c+(*P_f)(c) );
 fclose(fp);

        fp = fopen("a_xaxe.plt","w");
fprintf(fp," %0.6f   %0.6f\n",c,(*P_f)(c) );
fprintf(fp," %0.6f   0.   \n",
c-((*P_f)(c)/(*PDf)(c)));
 fclose(fp);
}
```

Même exemple avec la fonction sin.

Résultat dans gnuplot



Application : Tangente de P à l'axes des y

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

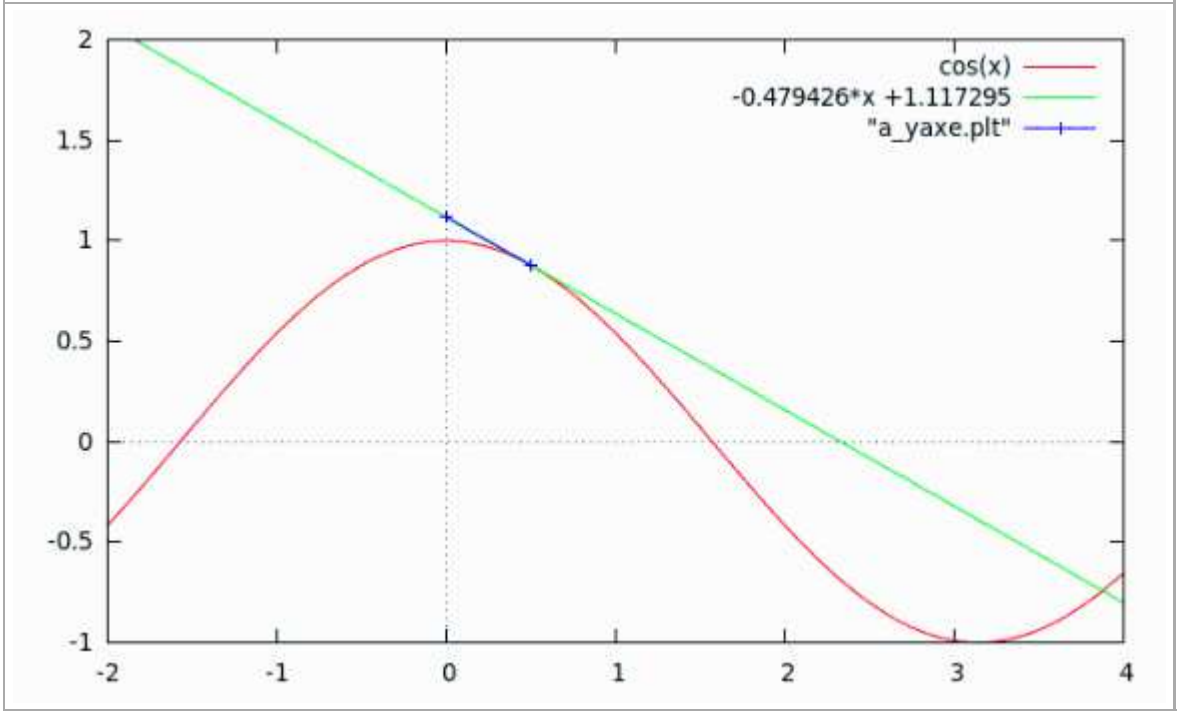
c01.c
Calculer la longeur de P(c,f(c) à l'axe de y.

```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "f2.h"
/* ------------------------------------ */
int main(void)
{
double c = .5;

 printf("  f : x-> %s  \n", feq);
 printf("  Df: x-> %s\n\n",Dfeq);

 printf(" With c = %0.3f, the equation of the tangent is :\n\n"
        "       y =  Df(c) (x-c) + f(c) = ",c);
 eq_Tan(c,f,Df);

 printf(" Find PB, the length of the tangent from P to the y axis.\n\n");

 printf(" P(%5.3f,  %5.3f)    P(c, f(c))          \n",
        c, f(c));

 printf(" B(0.000,  %5.3f)    B(0, f(c)-c*Df(c))\n\n",
        f(c)-c*Df(c));

 printf(" PB = sqrt(c**2*(1+Df(c)**2)) = %6.3f \n\n",
 sqrt(c*c*(1+pow(Df(c),2))));

 G_TanPy      (i_WGnuplot(-2,4,-1,2),
               c,
               feq,f,Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
 f : x->  cos(x)
 Df: x->  (-sin(x))
.
With c = 0.500, the equation of the tangent is :
.
     y =  Df(c) (x-c) + f(c) =  -0.479*x +1.117
.
Find PB, the length of the tangent from P to the y axis.
.
P(0.500,  0.878)    P(c, f(c))
B(0.000,  1.117)    B(0, f(c)-c*Df(c))
.
PB = sqrt(c**2*(1+Df(c)**2)) =  0.554
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
```

```
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
#include    "k_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ------------ f -------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' ------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

k_tan.h
Equation de la tangente

```
/* ---------------------------------- */
/*  Save as :    k_tan.h              */
/* ---------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]

   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=c
   a = f'(c)
   b = f(c) - f'(c)c
   ---------------------------------- */
void eq_Tan(
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
 printf(" %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

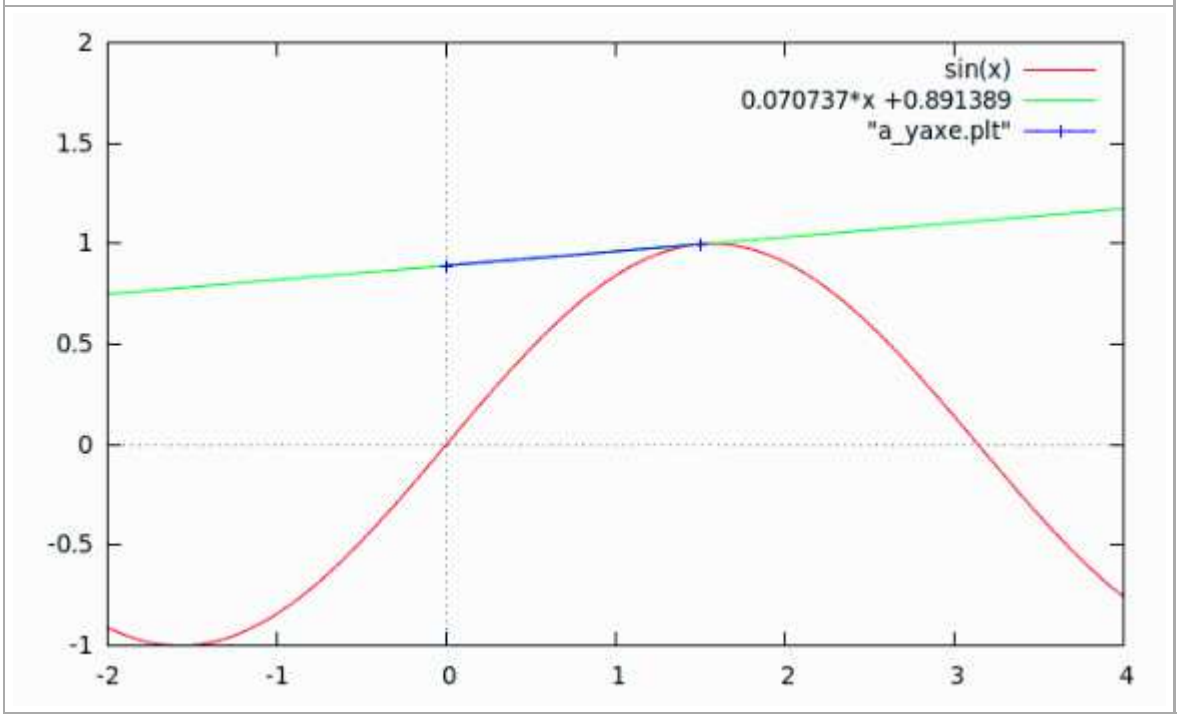
```
/* ---------------------------------- */
void eq_Tanf(
FILE *fp,
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
fprintf(fp," %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_TanPy(
W_Ctrl w,
double c,
  char fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE   *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s, \\\n"
           " %0.6f*x %+0.6f, \\\n"
           " \"a_yaxe.plt\" with linesp lt 3\n"
           " reset",
             w.xmini,w.xmaxi,w.ymini,w.ymaxi,
             fEQ,
    ((*PDf)(c)) ,(-((*PDf)(c))* c + ((*P_f)(c))));
 fclose(fp);

        fp = fopen("a_yaxe.plt","w");
fprintf(fp," %0.5f   %0.5f\n",c,((*P_f)(c)));
fprintf(fp," 0.000   %0.5f",
((*P_f)(c))-(((*PDf)(c))*c));
 fclose(fp);
}
```

Même exemple avec la fonction sin.

Résultat dans gnuplot



Application : Sous tangente

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

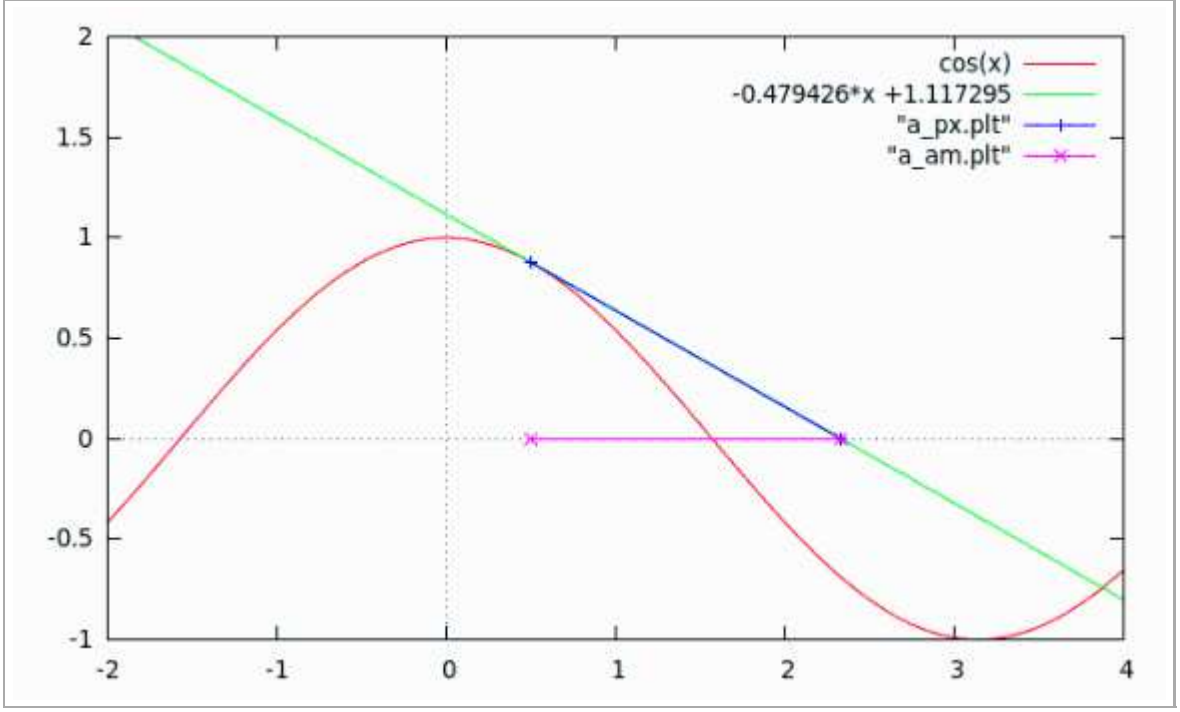
c01.c
Calculer la longeur de la sous tangente.

```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ---------------------------------- */
int main(void)
{
double c = .5;

 printf("  f : x-> %s  \n", feq);
 printf("  Df: x-> %s\n\n",Dfeq);

 printf(" With c = %0.3f, the equation of the tangent is :\n\n"
        "       y =  Df(c) (x-c) + f(c) = ",c);
 eq_Tan(c,f,Df);

 printf(" Find AM, the length of the under tangent.\n\n");

 printf(" P(%5.3f, %5.3f)         P(c, f(c))    \n",
        c, f(c));

 printf(" A(%5.3f, 0.000)         A(c-f(c)/Df(c), 0)\n",
        c-(f(c)/Df(c)));
 printf(" M(%5.3f, 0.000)         M( c, 0)\n\n\n", c);

 printf(" AM = sqrt((f(c)**2)/(Df(c)**2)) = %6.3f\n\n\n",
         sqrt(f(c)*f(c)*(1/(Df(c)*Df(c)))));

  G_TanxM    (i_WGnuplot(-2,4,-1,2),
                 c,
               feq,f,Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
 f : x->  sin(x)
 Df: x->  (cos(x))
.
With c = 0.500, the equation of the tangent is :
.
     y =  Df(c) (x-c) + f(c) =  0.878*x +0.041
.
Find AM, the length of the under tangent.
.
P(0.500, 0.479)         P(c, f(c))
A(-0.046, 0.000)         A(c-f(c)/Df(c), 0)
M(0.500, 0.000)         M( c, 0)
.
AM = sqrt((f(c)**2)/(Df(c)**2)) =  0.546
.
load "a_main.plt" with gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
```

```
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
#include    "k_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ------------ f -------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' ------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

k_tan.h
Equation de la tangente

```
/* ---------------------------------- */
/*  Save as :    k_tan.h              */
/* ----------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]


   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=c
   a = f'(c)
   b = f(c) - f'(c)c
   ---------------------------------- */
void eq_Tan(
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
 printf(" %0.3f*x %+0.3f\n\n\n",
```

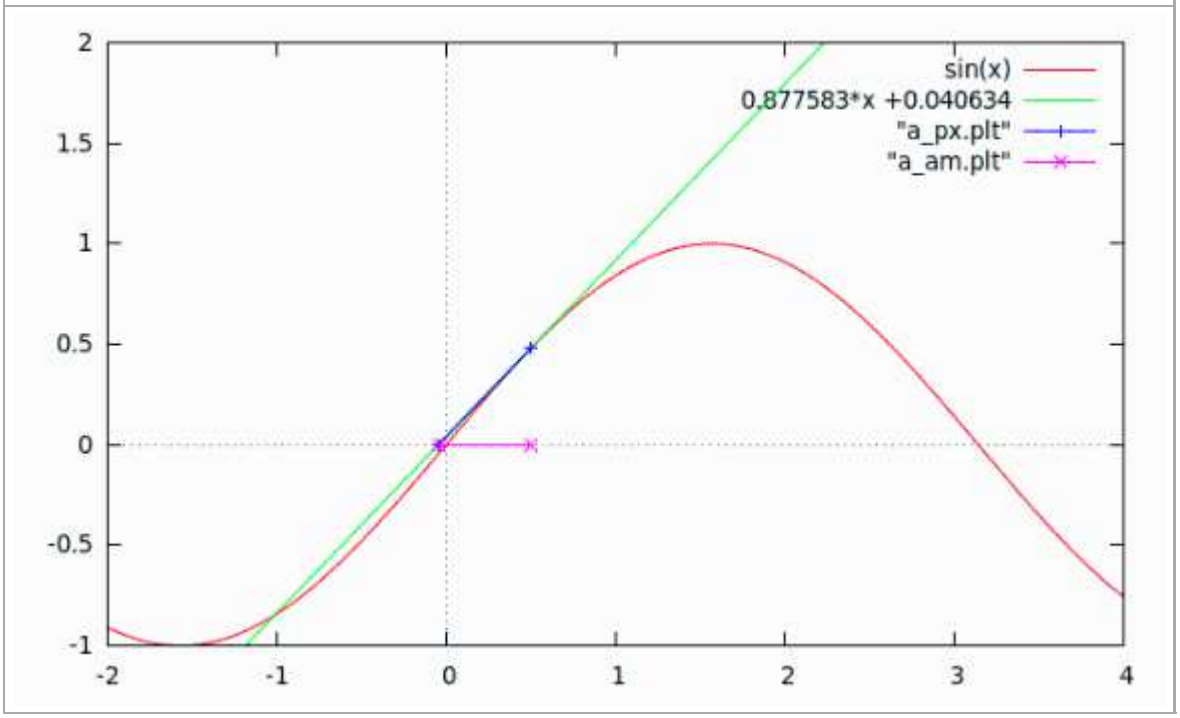
```
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
/* ------------------------------------ */
void eq_Tanf(
FILE *fp,
double    c,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
fprintf(fp," %0.3f*x %+0.3f\n\n\n",
 (*PDf)(c), (*P_f)(c) - (*PDf)(c)*c );
}
```

kg_tan.h
La fonction graphique

```
/* ------------------------------------ */
/*  Save as :   kg_tan.h                */
/* ------------------------------------ */
void G_TanxM(
W_Ctrl w,
double c,
  char   fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE   *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis \n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " %s,\\\n"
           " %0.6f*x %+0.6f,\\\n"
           " \"a_px.plt\" with linesp lt 3,\\\n"
           " \"a_am.plt\" with linesp lt 4 \n"
           " reset",
             w.xmini,w.xmaxi,w.ymini,w.ymaxi,fEQ,
        ((*PDf)(c)),(-(*PDf)(c)*c+(*P_f)(c)));
 fclose(fp);

        fp = fopen("a_px.plt",  "w");
fprintf(fp," %0.6f   %0.6f\n", c,((*P_f)(c)));
fprintf(fp," %0.6f   0.",
 c-(((*P_f)(c))/((*PDf)(c))) );
 fclose(fp);

        fp = fopen("a_am.plt",  "w");
fprintf(fp," %0.6f   0.\n",
c-(((*P_f)(c))/((*PDf)(c))));
fprintf(fp," %0.6f   0.", c);
 fclose(fp);
}
```

Même exemple avec la fonction sin.

Résultat dans gnuplot



Application : Cercle de courbure

Préambule

Le cercle de courbure dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

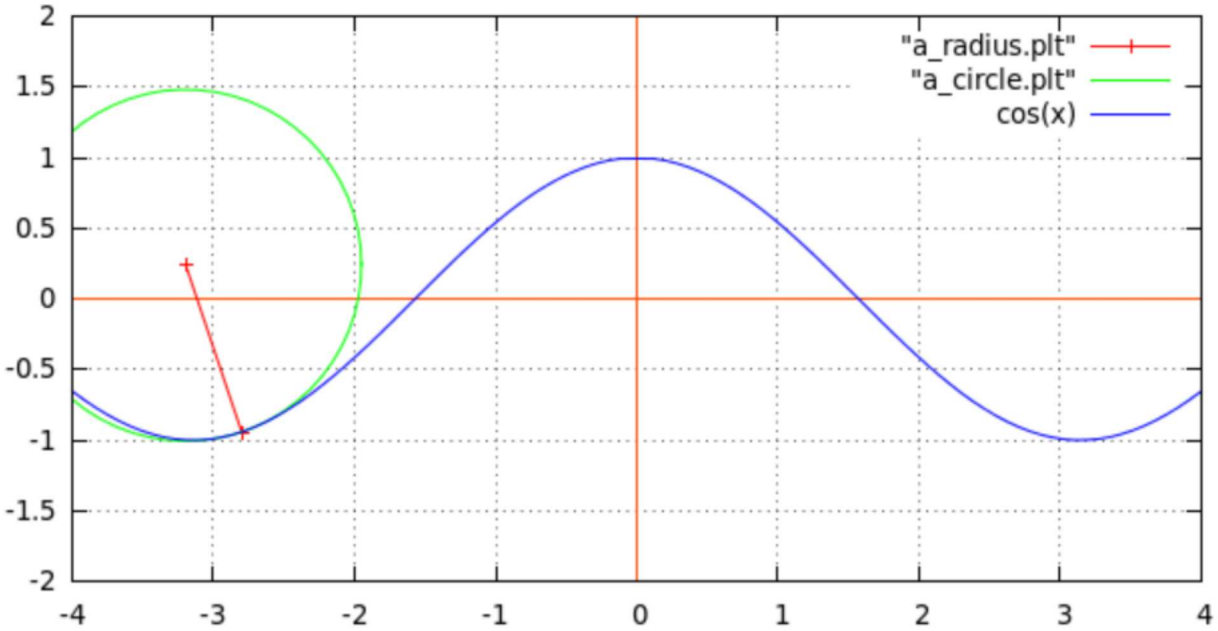
c01.c
Dessiner un cercle de courbure pour une fonction f(x).

```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "fb.h"
/* ------------------------------------ */
int main(void)
{
double x = 0.;
double e = .001;

   circle("a_circle.plt",
          1./K_y_2d(f,x,e),
          h_y_2d(f,x,e),
          k_y_2d(f,x,e));

   G_C_2d(i_WGnuplot(-4.,4.,-2.,2.),
          f,x,e,
          feq);

 clrscrn();

 printf(" If a smooth curve C is the graph of y = f(x),\n"
        " then the curvature K at P(x,y) is\n\n\n"
        " K = |y''| / [1 + y'^2]^(3/2)     \n\n\n"

        " If P(x,y) is a point on the graph "
        "of y = f(x)  \n"
        " at which K != 0. The point M(h,k)"
        " is the center\n"
        " of the cuvature for P if   \n\n\n"
        " h = x - y'[1 + y'^2] / y''     \n"
        " k = y +   [1 + y'^2] / y'' \n\n\n"

        " The radius is r = 1/K \n\n\n"

        " Open the file \"a_main.plt\" with Gnuplot.\n\n");

 printf("\n Press return to continue");
 getchar();
```

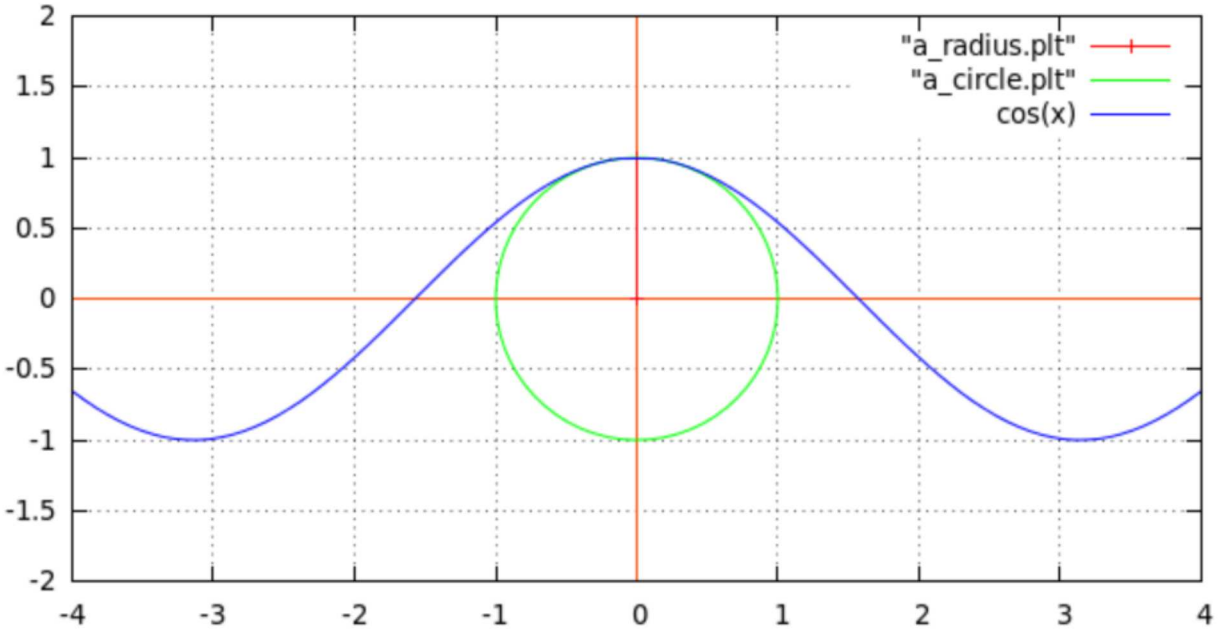
```
 return 0;
}
```

Le résultat.

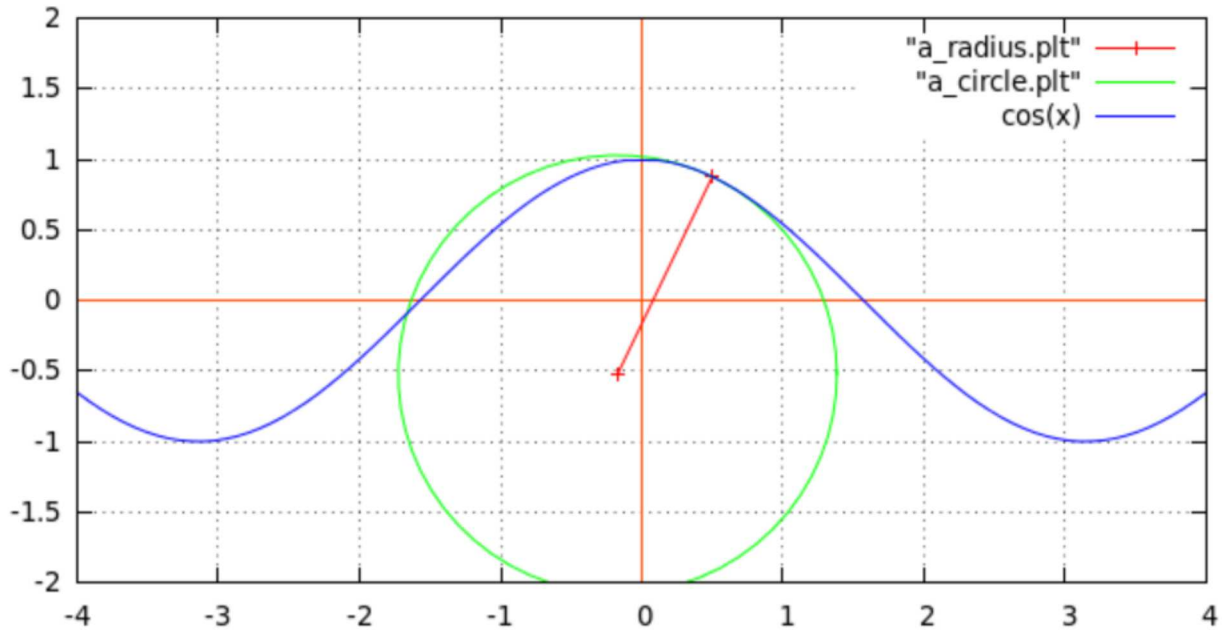
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include    "xfx_x.h"
/* ---------------------------------- */
#include  "kradius.h"
#include     "kg_c.h"
#include  "kcircle.h"
```

kradius.h
Coordonnées du cercle

```
/* ---------------------------------- */
/*  Save as :   kradius.h             */
/* ---------------------------------- */
double K_y_2d(
double (*P_f)(double x),
double x,
double e
)
{
double a = fx_x((*P_f),x,e);

 return(fabs(fx_xx((*P_f),x,e))
                  /
             pow(1+a*a,3./2.));
}
/* ---------------------------------- */
double h_y_2d(
double (*P_f)(double x),
double x,
double e
)
{
double a = fx_x((*P_f),x,e);

 return(x - ( ( a*(1+a*a) )
               /
        fx_xx((*P_f),x,e)));
}
/* ---------------------------------- */
double k_y_2d(
double (*P_f)(double x),
double x,
double e
)
{
double a = fx_x((*P_f),x,e);

 return((*P_f)(x) + (    (1+a*a)
                  /
           fx_xx((*P_f),x,e)));
}
```

fb.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fb.h                  */
/* ---------------------------------- */
double f(
double x)
{
        return( cos(x));
}
char  feq[] =  "cos(x)";
```

kg_c.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_c.h                */
/* ---------------------------------- */
void G_C_2d(
W_Ctrl W,
double (*P_f)(double x),
double x,
double e,
char   feq[]
)
{
FILE   *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
           " set size ratio -1\n"
           " set grid\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"a_radius.plt\" with linespoints,\\\n"
           " \"a_circle.plt\" with line,\\\n"
           " %s with line\n",
    W.xmini,W.xmaxi,W.ymini,W.ymaxi,feq);
 fclose(fp);

        fp = fopen("a_radius.plt","w");
fprintf(fp," %6.5f   %6.5f\n",h_y_2d((*P_f),x,e),
                              k_y_2d((*P_f),x,e));
fprintf(fp," %6.5f   %6.5f\n",x,(*P_f)(x));
 fclose(fp);

 Pause();
}
```

kcircle.h
Le cercle

```
/* ---------------------------------- */
/*  Save as :   kcircle.h             */
/* ---------------------------------- */
void circle(
char   Name[FILENAME_MAX],
double r,
double x,
double y
)
{
FILE   *fp = fopen(Name,"w");
double   t = 0.;

for(;t<2.01*PI;t+=.1)
fprintf(fp," %6.5f %6.5f\n",r*cos(t)+x,r*sin(t)+y);
 fclose(fp);
}
```

Application : Méthode de Newton

Préambule

Méthode de Newton dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

c01.c
Calculer le point d'intersection entre g et h.

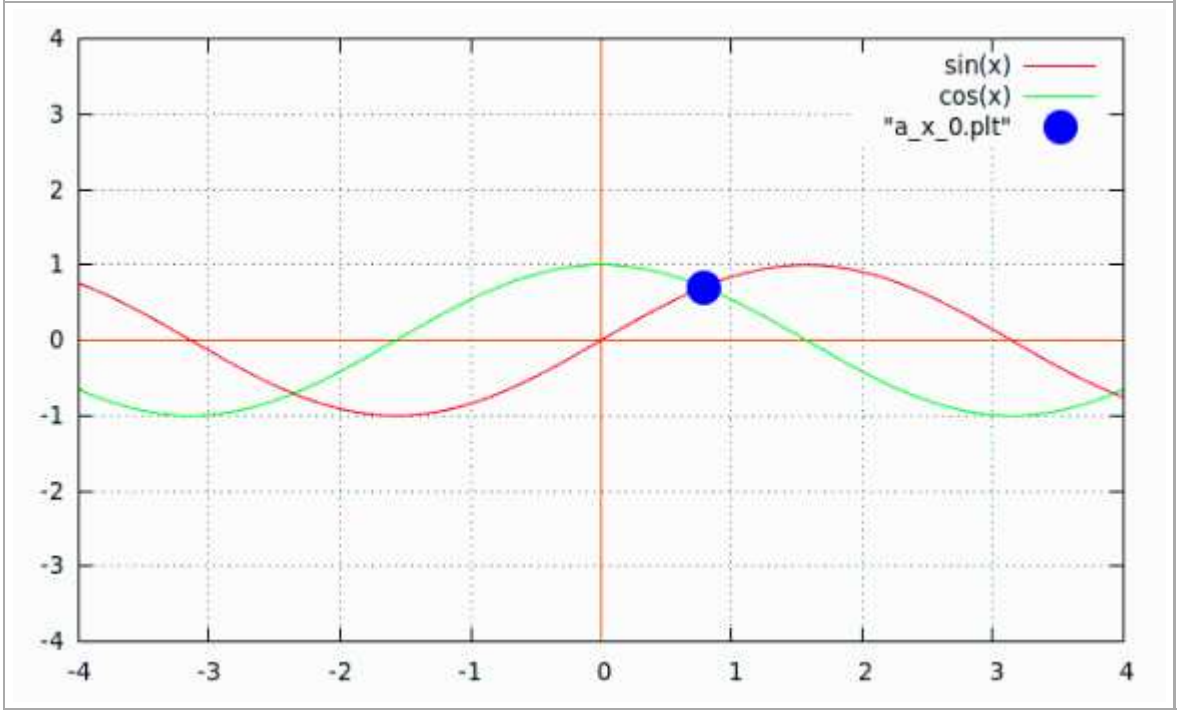
```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ----------------------------------- */
int main(void)
{
int         n = 5;
double FirstA = 0.5;

 clrscrn();
 printf(" Use Newton's method to approximate"
        " the intersection point of :\n\n");
 printf(" g : x-> %s\n\n", geq);
 printf(" and\n\n");
 printf(" h : x-> %s\n\n", heq);

 G_gh(i_WGnuplot(-4,4,-4,4), geq,heq);

 printf(" To see the graphs of g and h, open the"
        " file \"a_main.plt\" with Gnuplot.\n\n"
        " You can see that, the intersection"
        " point is between 0.0 and 1.0.\n\n"
        " Choose x = %.1f as a first approximation.\n\n",FirstA);
 getchar();

 clrscrn();
 printf(" In fact we want find sin(x) = cos(x)"
        " or sin(x) - cos(x) = 0.\n\n"
        " We want find a root of\n\n"
        " f : x-> %s\n\n", feq);
 getchar();

 clrscrn();
 printf(" As a first approximation x = %.1f \n\n"
        " The Newton's method give :        \n\n",FirstA);

     G_gh_x_0(i_WGnuplot(-4,4,-4,4),
              geq,
```

```
                heq,
                  g,
                Newton_s_Method(FirstA,n,f,Df));

 printf("\n\n load \"a_main.plt\" with gnuplot. "
        "\n\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
Use Newton's method to approximate the intersection point of :
g : x-> sin(x)
and
h : x-> cos(x)
.
To see the graphs of g and h, open the file "a_main.plt" with Gnuplot.
.
You can see that, the intersection point is between 0.0 and 1.0.
Choose x = 0.5 as a first approximation.
In fact we want find sin(x) = cos(x) or sin(x) - cos(x) = 0.
We want find a root of
.
f : x-> sin(x) - cos(x)
.
As a first approximation x = 0.5
.
The Newton's method give :
.
x[1] = 0.500000000000000
x[2] = 0.793407993026023
x[3] = 0.785397992096516
x[4] = 0.785398163397448
x[5] = 0.785398163397448
.
load "a_main.plt" with gnuplot.
```

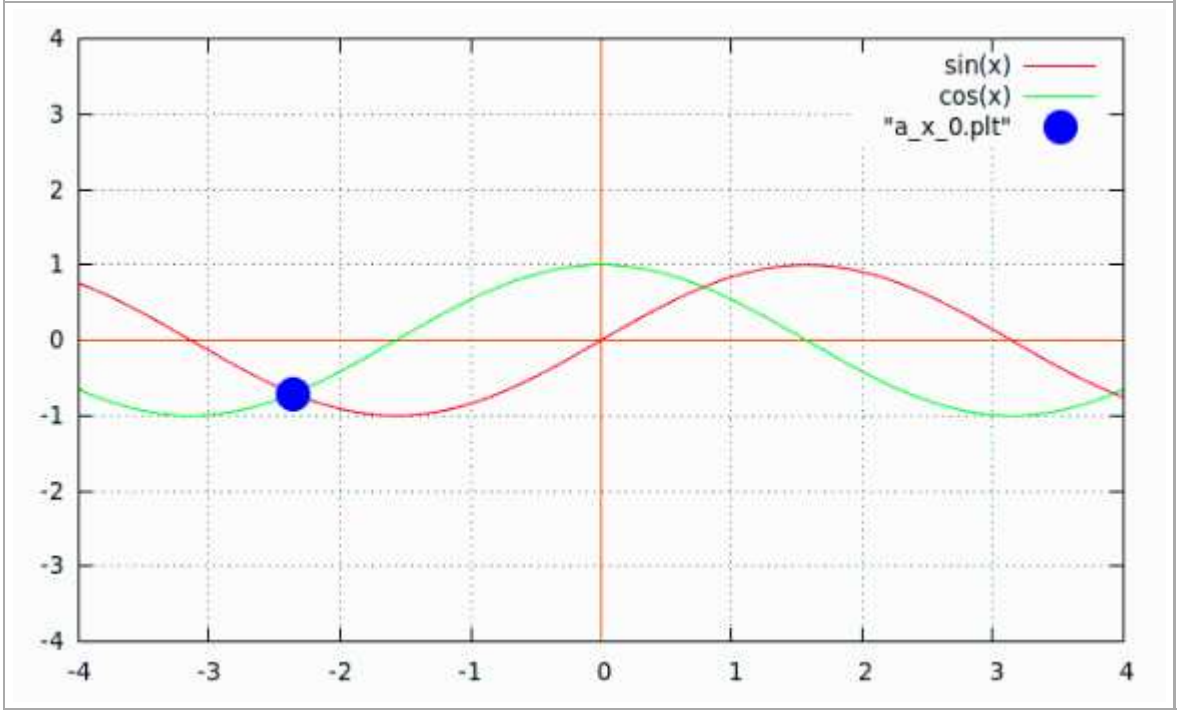
Résultat dans gnuplot



Un autre exemple avec :

```
As a first approximation x = -2.5
.
The Newton's method give :
.
x[1] = -2.500000000000000
x[2] = -2.355194920430497
x[3] = -2.356194490525248
x[4] = -2.356194490192345
x[5] = -2.356194490192345
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h             */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include  "knewton.h"
#include    "kg_gh.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ---------------------------------- */
double g(
```

```
double x)
{
        return(sin(x));
}
char  geq [] = "sin(x)";
/* ---------------------------------- */
double Dg(
double x)
{
          return(cos(x));
}
char  Dgeq [] = "cos(x)";
/* ---------------------------------- */
/* ---------------------------------- */
double h(
double x)
{
        return(cos(x));
}
char  heq [] = "cos(x)";
/* ---------------------------------- */
double Dh(
double x)
{
          return(- sin(x));
}
char  Dheq [] = "- sin(x)";
/* ---------------------------------- */
/* ---------------------------------- */
double f(
double x)
{
         return(sin(x) - cos(x));
}
char  feq [] = "sin(x) - cos(x)";
/* ---------------------------------- */
double Df(
double x)
{
          return(cos(x) + sin(x));
}
char  Dfeq [] = "cos(x) + sin(x)";
```

knewton.h
Méthode de Newton

```
/* ---------------------------------- */
/*  Save as :   knewton.h             */
/* ----------------------------------
   x_n+1 = x_n -  f(x_n)
                  ------
                  f'(x_n)
  ---------------------------------- */
double Newton_s_Method(
double x,
   int imax,
double (*P_f)(double x),
double (*PDf)(double x)
)
{
```

```
int i=1;

   for(;i<=imax;i++)
      {
       printf(" x[%d] = %.15f\n",i,x);
       x -= ((*P_f)(x))/((*PDf)(x));
      }
return(x);
}
```

kg_gh.h
Fonctions graphiques

```
/* ------------------------------------ */
/*  Save as :   kg_gh.h                 */
/* ------------------------------------ */
void G_gh(
W_Ctrl w,
  char geq[],
  char heq[]
)
{
FILE   *fp = fopen("a_main.plt","w");

fprintf(fp," set zeroaxis lt 8\n"
           " set grid\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s, \\\n"
           " %s  \n"
           " reset",
          w.xmini,w.xmaxi,w.ymini,w.ymaxi,
          geq,heq);

 fclose(fp);
}
/* ------------------------------------ */
void G_gh_x_0(
W_Ctrl  w,
  char  geq[],
  char  heq[],
double (*P_g)(double x),
double  x_0
)
{
FILE   *fp = fopen("a_main.plt","w");
FILE   *fq = fopen( "a_x_0.plt","w");

fprintf(fp," set zeroaxis lt 8\n"
           " set grid\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " %s, \\\n"
           " %s, \\\n"
           " \"a_x_0.plt\" pt 7 ps 3 \n"
           " reset",
          w.xmini,w.xmaxi,w.ymini,w.ymaxi,
          geq,heq);
 fclose(fp);

fprintf(fq," %0.6f   %0.6f", x_0,(*P_g)(x_0));
 fclose(fq);
```

```
}
```

Application : Tangente d'une courbe

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

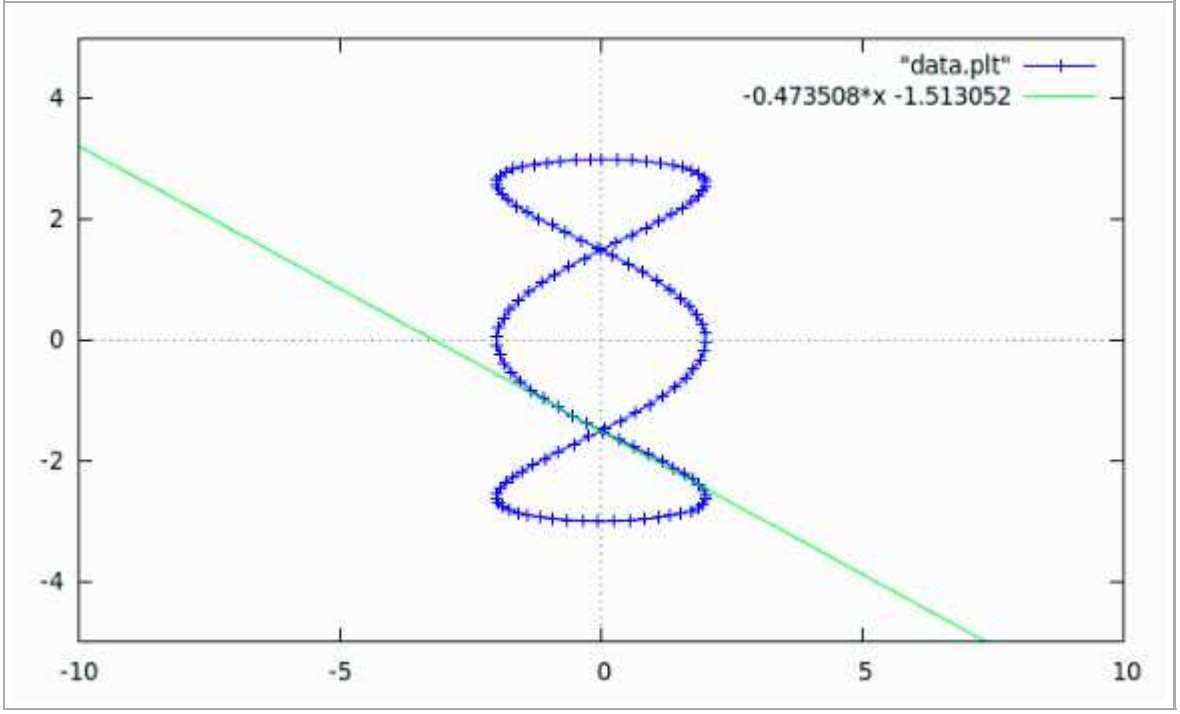
Dessiner la tangente d'une courbe

c01.c
Dessiner la tangente d'une courbe

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fe.h"
/* ---------------------------------- */
int main(void)
{
 printf(" Let C be the curve consisting of all"
        " ordered pairs (f(t),g(t)).\n\n"
        " With\n\n"
        " f : t-> %s\n\n"
        " g : t-> %s\n\n", feq, geq);

     G_Tan( i_WGnuplot(-10.,10.,-5.,5.),
            i_time(0,2.*PI,.05),
            2.,
            f,g,DgDf);

 printf(" To see the curve C, open the file \"a_main.plt\""
        " with Gnuplot.\n\n"
        "\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

fe.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fe.h                  */
/* ---------------------------------- */
double f(
double t)
```

```
{
double a=2;
double k1=3;

        return( a*sin(k1*t) );
}
char  feq[] =  "a*sin(k1*t)";
/* ---------------------------------- */
double Df(
double t)
{
double a=2;
double k1=3;

        return( a*cos(k1*t)*k1);
}
char  Dfeq[] =  "a*cos(k1*t)*k1";
/* ---------------------------------- */
double g(
double t)
{
double b =3;
double k2=1;
        return( b*cos(k2*t) );
}
char  geq[] =  "b*cos(k2*t)";
/* ---------------------------------- */
double Dg(
double t)
{
double b =3;
double k2=1;
        return(  -b*sin(k2*t)*k2 );
}
char  Dgeq[] =  "-b*sin(k2*t)*k2";
/* ---------------------------------- */
double DgDf(
double t)
{
        return(Dg(t)/Df(t));
}
```

kg_tan.h

La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_Tan(
W_Ctrl W,
t_Ctrl T,
double c,
double (*P_f) (double t),
double (*P_g) (double t),
double (*PDgDf)(double t)
)
{
FILE   *fp;
double t;
```

```
        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"data.plt\" with linesp lt 3 pt 1,\\\n"
           " %0.6f*x %+0.6f\n"
           " reset",
             W.xmini,W.xmaxi,W.ymini,W.ymaxi,
             (*PDgDf)(c),
             (-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
 fclose(fp);

             fp = fopen("data.plt","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.6f   %6.6f\n",(*P_f)(t),(*P_g)(t));
      fclose(fp);
}
```

Application : Tangente et axes x-y d'une courbe

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

c01.c
Dessiner les points d'intersection de la tangente avec les axes x/y

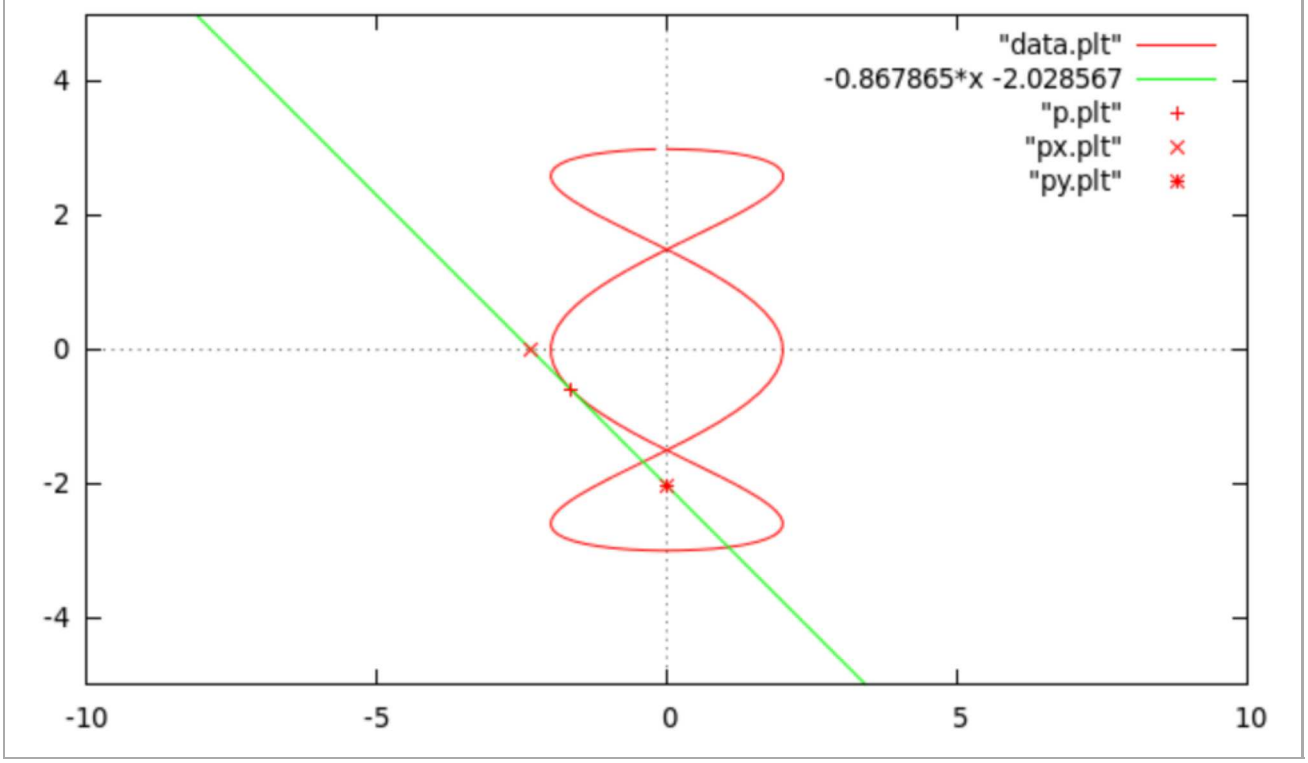
```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fe.h"
/* ---------------------------------- */
int main(void)
{
double c = PI/2.+.2;

 printf(" Let C be the curve consisting of all"
        " ordered pairs (f(t),g(t)).\n\n"
        " With\n\n"
        " f : t-> %s\n\n"
        " g : t-> %s\n\n", feq, geq);

 printf(" Find at c = %0.3f\n\n"
        " the intersection points of "
        "the tangent with the x-y axis.\n\n\n",c);

 printf(" P(%6.3f, %6.3f) P(c, f(c))\n\n",
        c, f(c));

 printf(" A(%6.3f, 0)     A(f(c)-g(c)/DgDf(c), 0)\n\n",
        f(c)-g(c)/DgDf(c));

 printf(" B( 0, %6.3f)    B(0, g(c)-f(c)*DgDf(c))\n\n\n",
        g(c)-f(c)*DgDf(c));

     G_Tanxy(i_WGnuplot(-10.,10.,-5.,5.),
             i_time(0,2.*PI,.05),
             c,
             f,g,DgDf);

 printf(" To see the curve C, open the file \"a_main.plt\""
        " with Gnuplot.\n\n"
        "\n Press return to continue");
 getchar();

 return 0;
```

```
}
```

Le résultat.

```
Let C be the curve consisting of all ordered pairs (f(t),g(t)).
With
f : t-> a*sin(k1*t)
g : t-> b*cos(k2*t)
.
Find at c = 1.771
the intersection points of the tangent with the x-y axis.
.
P( 1.771, -1.651)     P(c, f(c))
A(-2.337, 0)          A(f(c)-g(c)/DgDf(c), 0)
B( 0, -2.029)         B(0, g(c)-f(c)*DgDf(c))
.
To see the curve C, open the file "a_main.plt" with Gnuplot.
Press return to continue
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
```

```
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

fe.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fe.h                  */
/* ---------------------------------- */
double f(
double t)
{
double a=2;
double k1=3;

        return( a*sin(k1*t) );
}
char  feq[] =  "a*sin(k1*t)";
/* ---------------------------------- */
double Df(
double t)
{
double a=2;
double k1=3;

        return( a*cos(k1*t)*k1);
}
char  Dfeq[] =  "a*cos(k1*t)*k1";
/* ---------------------------------- */
double g(
double t)
{
double b =3;
double k2=1;
        return( b*cos(k2*t) );
}
char  geq[] =  "b*cos(k2*t)";
/* ---------------------------------- */
double Dg(
double t)
{
double b =3;
double k2=1;
        return(  -b*sin(k2*t)*k2 );
}
char  Dgeq[] =  "-b*sin(k2*t)*k2";
/* ---------------------------------- */
double DgDf(
double t)
{
        return(Dg(t)/Df(t));
}
```

kg_tan.h

La fonction graphique

```
/* ----------------------------------- */
/*  Save as :   kg_tan.h               */
/* ----------------------------------- */
void G_Tanxy(
W_Ctrl W,
t_Ctrl T,
double c,
double (*P_f) (double t),
double (*P_g) (double t),
double (*PDgDf)(double t)
)
{
FILE *fp;
double t;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"data.plt\" with line lt 1,\\\n"
           " %0.6f*x %+0.6f, \\\n"
           " \"p.plt\" lt 1, \\\n"
           " \"px.plt\" lt 1,\\\n"
           " \"py.plt\" lt 1   \n"
           " reset",
        W.xmini,W.xmaxi,W.ymini,W.ymaxi,
(*PDgDf)(c),(-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
 fclose(fp);

        fp = fopen("data.plt","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.6f   %6.6f\n",(*P_f)(t),(*P_g)(t)  );
             fclose(fp);

        fp = fopen("p.plt","w");
     fprintf(fp," %0.6f   %0.6f", (*P_f)(c), (*P_g)(c)  );
             fclose(fp);

        fp = fopen("px.plt","w");
     fprintf(fp," %0.6f  0.",
             ((*P_f)(c))-((*P_g)(c))/((*PDgDf)(c))      );
             fclose(fp);

        fp = fopen("py.plt","w");
     fprintf(fp," 0.   %0.6f",
             ((*P_g)(c))- (((*PDgDf)(c))*((*P_f)(c)))   );
             fclose(fp);
}
```

Application : Tangente de P à l'axes des x d'une courbe

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

c01.c
Calculer la longeur de P(f(c),g(c) à l'axe de x.

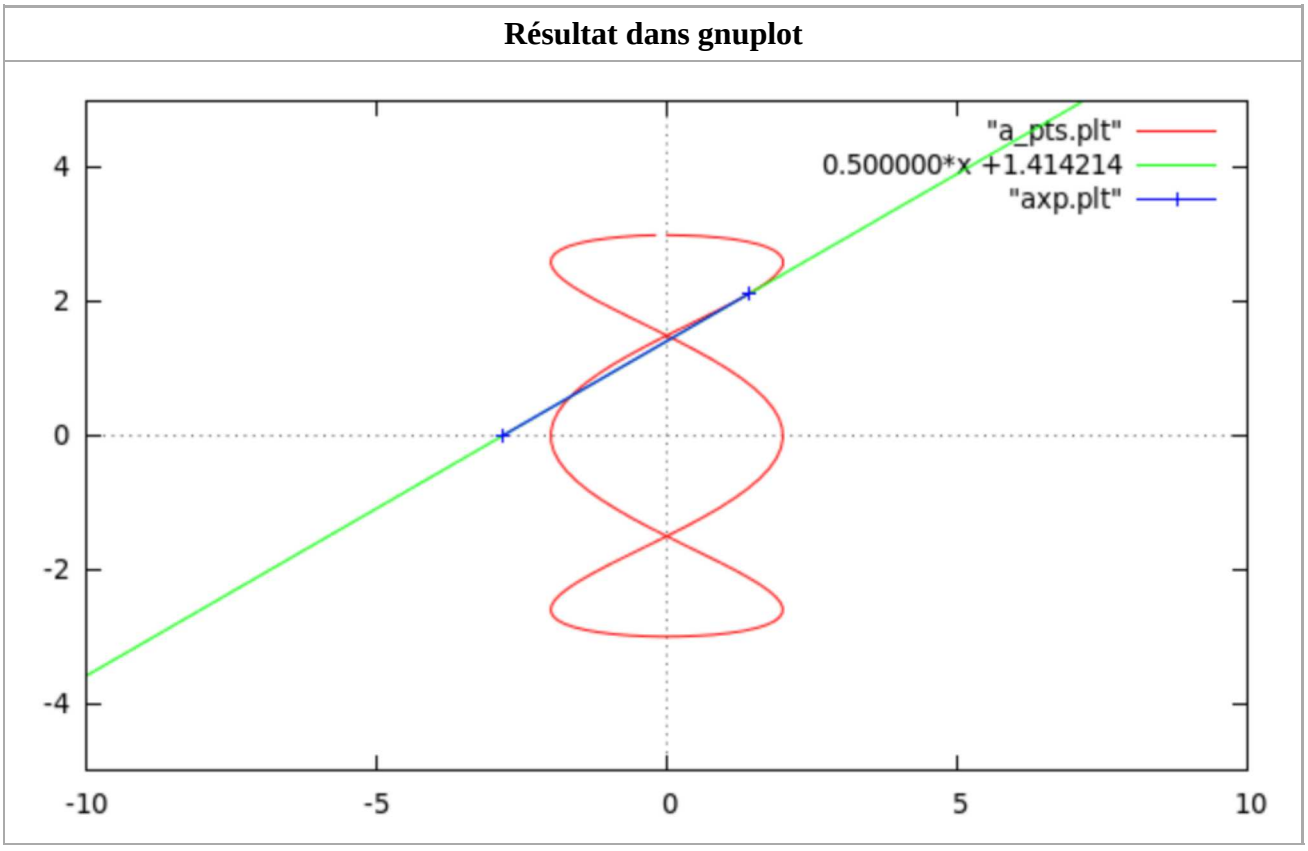
```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "fe.h"
/* ------------------------------------ */
int main(void)
{
double c = PI/4;

 printf(" Let C be the curve consisting of all"
        " ordered pairs (f(t),g(t)).\n\n"
        " With\n\n"
        " f : t-> %s\n\n"
        " g : t-> %s\n\n", feq, geq);

 printf(" With c = %0.3f, the equation of the tangent is :\n\n"
        " y =  ((Dg/Dy)(c))(x-f(c))+g(c) = ",c);
 eq_Tan(f,g,DgDf,c);

 printf("\n\n\n");

 printf(" Find PA, the length of the tangent from P to the x axis.\n\n");

 printf(" P(%6.3f, %6.3f)    P(f(c), g(c))                \n",
        f(c),g(c));

 printf(" A(%6.3f,  0.000)    A(f(c)-g(c)/(DgDf)(c), 0)\n\n\n",
          f(c)-g(c)/(DgDf)(c));

 printf(" PA =  sqrt(g(c)**2*(1+(DgDf(c)**2))/(DgDf(c)**2))\n"
        "    = %6.3f\n\n",
       sqrt(pow(g(c),2)*(1/pow(DgDf(c),2)+1)) );

     G_TanLx(i_WGnuplot(-10.,10.,-5.,5.),
             i_time(0,2.*PI,.05),
             c,
```

```
            f,g,DgDf);

 printf(" To see the curve C, open the file \"a_main.plt\""
        " with Gnuplot.\n\n"
        "\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
Let C be the curve consisting of all ordered pairs (f(t),g(t)).
.
With
.
f : t-> a*sin(k1*t)
g : t-> b*cos(k2*t)
.
With c = 0.785, the equation of the tangent is :
y =  ((Dg/Dy)(c))(x-f(c))+g(c) =  0.500*x +1.414
.
Find PA, the length of the tangent from P to the x axis.
P( 1.414,  2.121)    P(f(c), g(c))
A(-2.828,  0.000)    A(f(c)-g(c)/(DgDf)(c), 0)
.
PA =  sqrt(g(c)**2*(1+(DgDf(c)**2))/(DgDf(c)**2))
   =  4.743
.
To see the curve C, open the file "a_main.plt" with Gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

fe.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fe.h                  */
/* ---------------------------------- */
double f(
double t)
{
double a=2;
double k1=3;

        return( a*sin(k1*t) );
}
char  feq[] =  "a*sin(k1*t)";
/* ---------------------------------- */
double Df(
double t)
{
double a=2;
double k1=3;

        return( a*cos(k1*t)*k1);
}
char  Dfeq[] =  "a*cos(k1*t)*k1";
/* ---------------------------------- */
double g(
double t)
{
double b =3;
double k2=1;
        return( b*cos(k2*t) );
}
char  geq[] =  "b*cos(k2*t)";
/* ---------------------------------- */
double Dg(
```

```
double t)
{
double b =3;
double k2=1;
        return(  -b*sin(k2*t)*k2 );
}
char  Dgeq[] =  "-b*sin(k2*t)*k2";
/* ---------------------------------- */
double DgDf(
double t)
{
        return(Dg(t)/Df(t));
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void eq_Tan(
double (*P_f)  (double t),
double (*P_g)  (double t),
double (*PDgDf)(double t),
double c
)
{
  printf(" %0.3f*x %+0.3f",
(*PDgDf)(c),(-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
}
/* ---------------------------------- */
void G_TanLx(
W_Ctrl W,
t_Ctrl T,
double c,
double (*P_f)  (double t),
double (*P_g)  (double t),
double (*PDgDf)(double t)
)
{
FILE *fp;
double t;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"a_pts.plt\" with line lt 1,   \\\n"
           " %0.6f*x %+0.6f,                 \\\n"
           " \"axp.plt\" with linesp lt 3      \n"
           " reset",
        W.xmini,W.xmaxi,W.ymini,W.ymaxi,
(*PDgDf)(c),(-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
 fclose(fp);

        fp = fopen("a_pts.plt","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.6f %6.6f\n",(*P_f)(t),(*P_g)(t));
 fclose(fp);

        fp = fopen("axp.plt","w");
```

```
    fprintf(fp," %0.6f %0.6f\n",(*P_f)(c),(*P_g)(c));
    fprintf(fp," %0.6f  0.  \n",
                (*P_f)(c)-(*P_g)(c)/(*PDgDf)(c));
    fclose(fp);
}
```

Application : Tangente de P à l'axes des y d'une courbe

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

c01.c
Calculer la longeur de P(f(c),g(c) à l'axe de y.

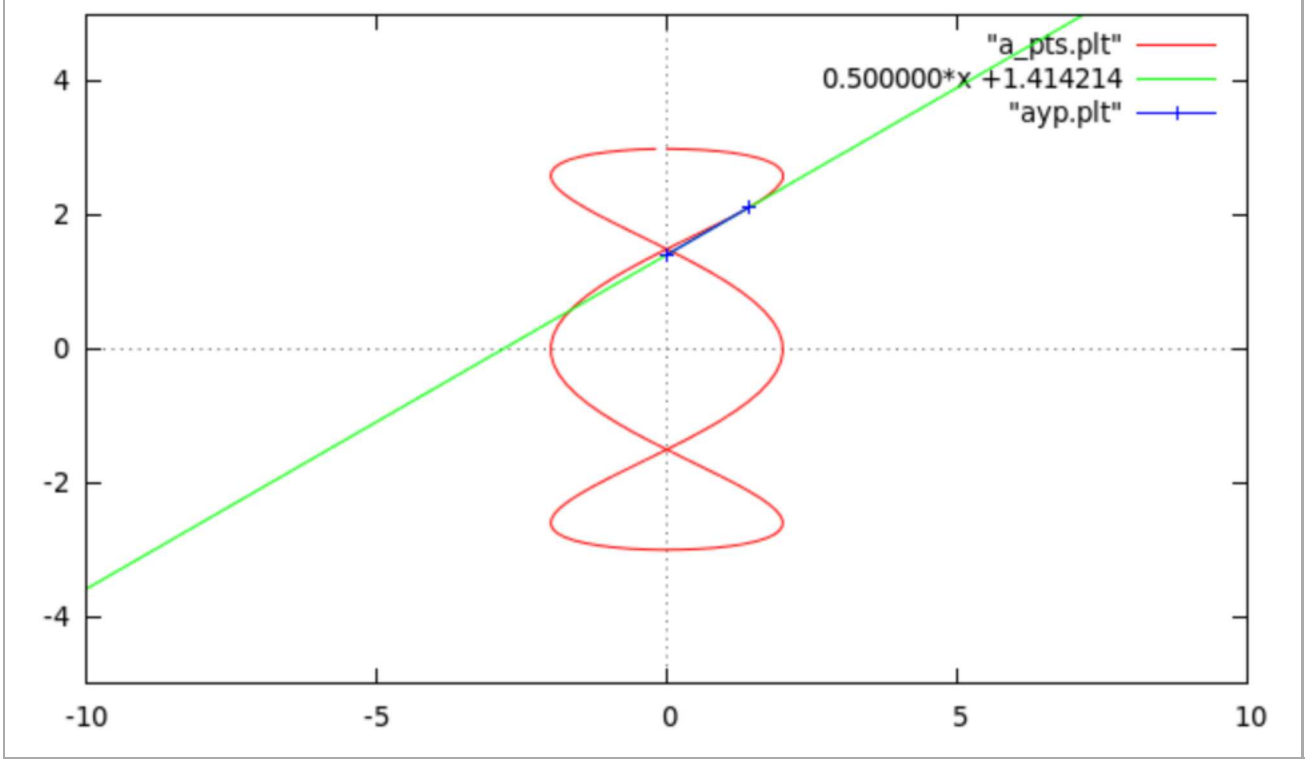
```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "fe.h"
/* ------------------------------------ */
int main(void)
{
double c = PI/4.;

printf(" Let C be the curve consisting of all"
        " ordered pairs (f(t),g(t)).\n\n"
        " With\n\n"
        " f : t-> %s\n\n"
        " g : t-> %s\n\n", feq, geq);

 printf(" With c = %0.3f, the equation of the tangent is :\n\n"
        " y =  ((Dg/Dy)(c))(x-f(c))+g(c) = ",c);
 eq_Tan(f,g,DgDf,c);

 printf("\n\n\n");

 printf(" Find PB, the length of the tangent from P to the y axis.\n\n");

 printf(" P(%6.3f, %6.3f)    P(f(c), g(c))                \n",
        f(c),g(c));

 printf(" B(+0.000, %6.3f)    B(0, g(c)-f(c)*DgDf(c))\n\n\n",
           g(c)-DgDf(c)*f(c));

 printf(" PB =  sqrt(f(c)**2*(1+DgDf(c)**2))\n"
        "    = %6.3f\n\n",
       sqrt(pow(f(c),2)*(1+pow(DgDf(c),2))));

     G_TanLy(i_WGnuplot(-10.,10.,-5.,5.),
             i_time(0,2.*PI,.05),
             c,
```

```
            f,g,DgDf);

 printf(" To see the curve C, open the file \"a_main.plt\""
        " with Gnuplot.\n\n"
        "\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
Let C be the curve consisting of all ordered pairs (f(t),g(t)).
.
With
.
f : t-> a*sin(k1*t)
g : t-> b*cos(k2*t)
.
With c = 0.785, the equation of the tangent
y =  ((Dg/Dy)(c))(x-f(c))+g(c) =  0.500*x +1.414
.
Find PB, the length of the tangent from P to the y axis.
.
P( 1.414,  2.121)    P(f(c), g(c))
B(+0.000,  1.414)    B(0, g(c)-f(c)*DgDf(c))
.
PB =  sqrt(f(c)**2*(1+DgDf(c)**2))
   =  1.581
.
To see the curve C, open the file "a_main.plt" with Gnuplot.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

fe.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fe.h                  */
/* ---------------------------------- */
double f(
double t)
{
double a=2;
double k1=3;

        return( a*sin(k1*t) );
}
char  feq[] =  "a*sin(k1*t)";
/* ---------------------------------- */
double Df(
double t)
{
double a=2;
double k1=3;

        return( a*cos(k1*t)*k1);
}
char  Dfeq[] =  "a*cos(k1*t)*k1";
/* ---------------------------------- */
double g(
double t)
{
double b =3;
double k2=1;
        return( b*cos(k2*t) );
}
char  geq[] =  "b*cos(k2*t)";
```

```
/* ---------------------------------- */
double Dg(
double t)
{
double b =3;
double k2=1;
        return(  -b*sin(k2*t)*k2 );
}
char  Dgeq[] =  "-b*sin(k2*t)*k2";
/* ---------------------------------- */
double DgDf(
double t)
{
        return(Dg(t)/Df(t));
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void eq_Tan(
double (*P_f)  (double t),
double (*P_g)  (double t),
double (*PDgDf)(double t),
double c
)
{
 printf(" %0.3f*x %+0.3f",
(*PDgDf)(c),(-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
}
/* ---------------------------------- */
void G_TanLy(
W_Ctrl W,
t_Ctrl T,
double c,
double (*P_f) (double t),
double (*P_g) (double t),
double (*PDgDf)(double t)
)
{
FILE *fp;
double t;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_pts.plt\" with line lt 1,\\\n"
           " %0.6f*x %+0.6f,\\\n"
           " \"ayp.plt\" with linesp lt 3\n"
           " reset",
        W.xmini,W.xmaxi,W.ymini,W.ymaxi,
(*PDgDf)(c),(-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)));
 fclose(fp);

        fp = fopen("a_pts.plt","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.6f %6.6f\n",(*P_f)(t),(*P_g)(t));
             fclose(fp);
```

```
        fp = fopen("ayp.plt","w");
     fprintf(fp," %0.6f %0.6f\n",(*P_f)(c),(*P_g)(c));
     fprintf(fp,"    0. %0.6f \n",
     (*P_g)(c)- (*PDgDf)(c)*(*P_f)(c));
             fclose(fp);
}
```

Application : Cercle de courbure d'une courbe

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner

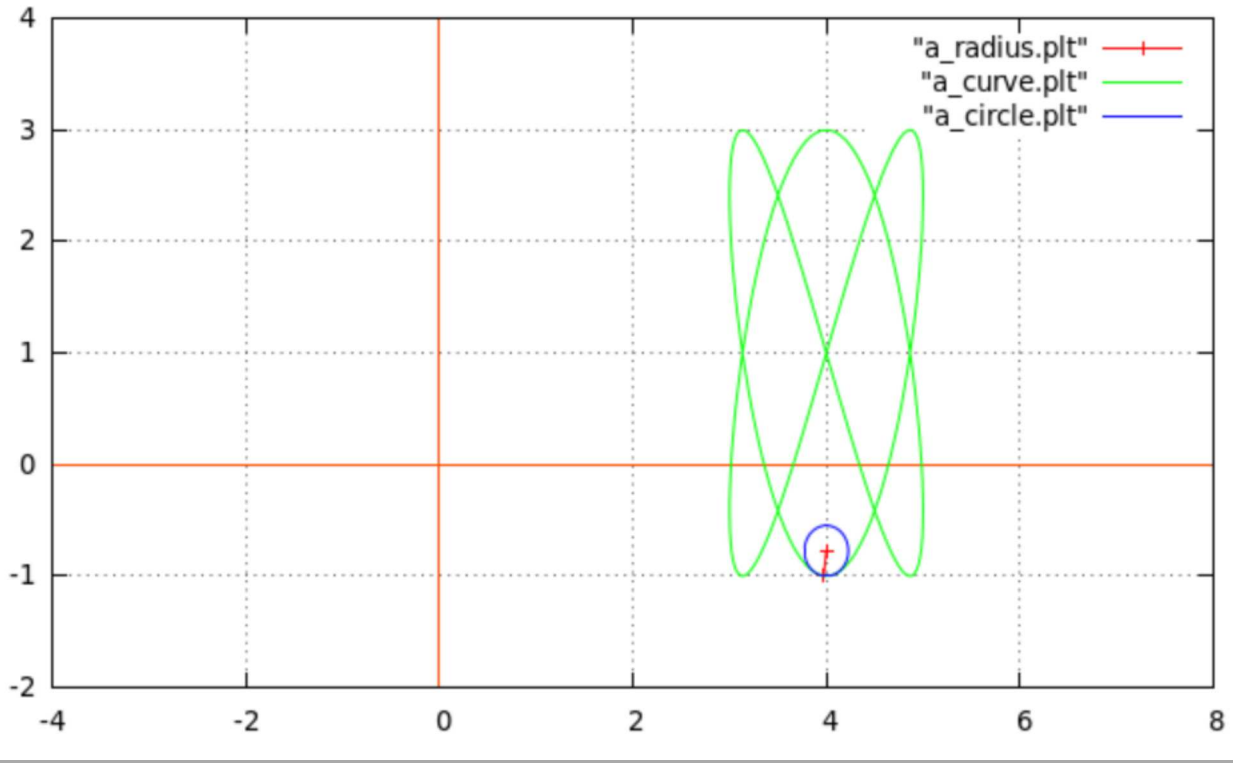
c01.c
Dessiner un cercle de courbure pour une fonction (f(t),g(t))

```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "fb.h"
/* ----------------------------------- */
int main(void)
{
double t = PI;
double e = .001;

     circle("a_circle.plt",
               1./fabs(Kt_2d(f,g,t,e)),
                  cx_2d(f,g,t,e),
                  cy_2d(f,g,t,e));

     G_C_2d(i_WGnuplot(-4,8,-2,4),
            i_time(0.,2*PI,.03),
             f,g,t,
             e);

 printf(" The curvature K of a smooth parametric"
        " curve C is :\n\n\n"

        " K = |f' g'' - g' f''| / "
        "[ (f')^2 - (g')^2 ]^(3/2)\n\n"

        " If P(f(t),g(t)) is a point on the curve  \n"
        " at which K != 0. The point M(h,k)"
        " is the center\n"
        " of the cuvature for P if   \n\n\n"
        " h = f - g'[f'^2 + g'^2] / [f'g''-f''g']\n"
        " k = g + f'[f'^2 + g'^2] / [f'g''-f''g']\n\n\n"

        " The radius is r = 1/|K| \n\n\n"

        " Open the file \"a_main.plt\" with Gnuplot.\n\n");

 printf("\n Press return to continue");
 getchar();

 return 0;
```

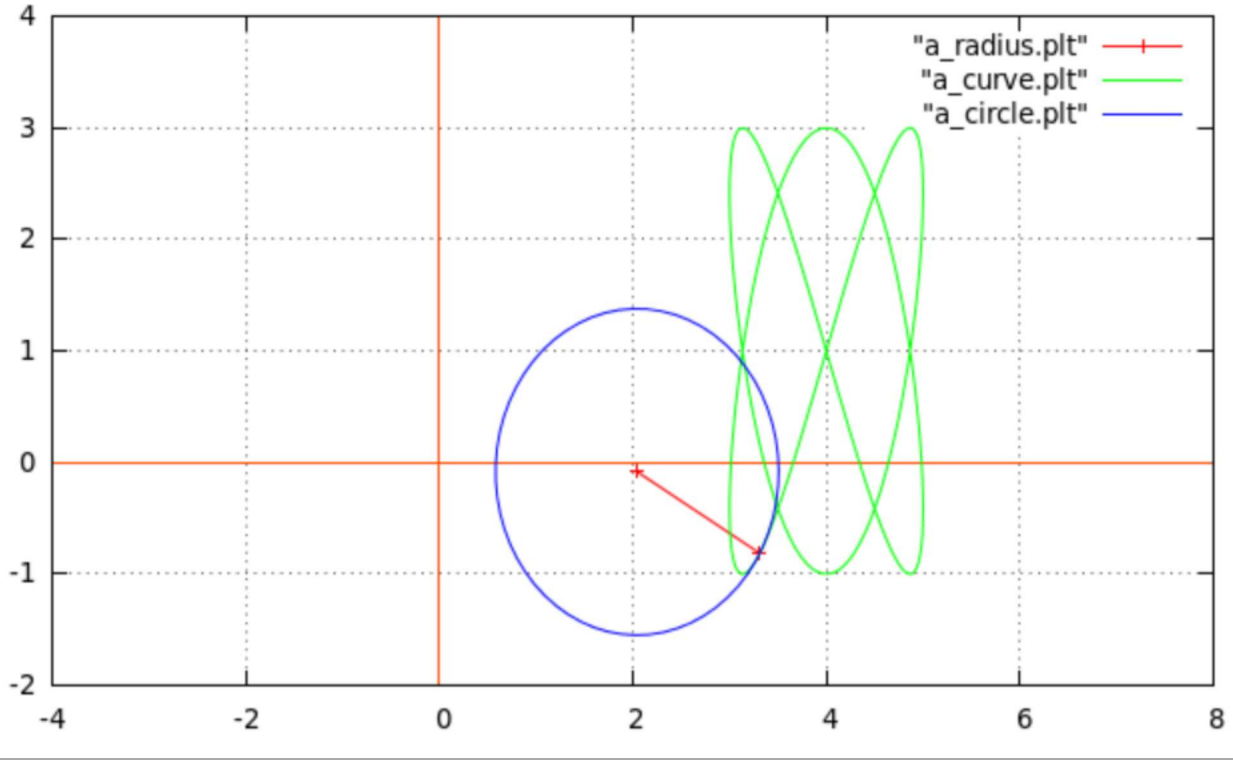
```
}
```

Le résultat.

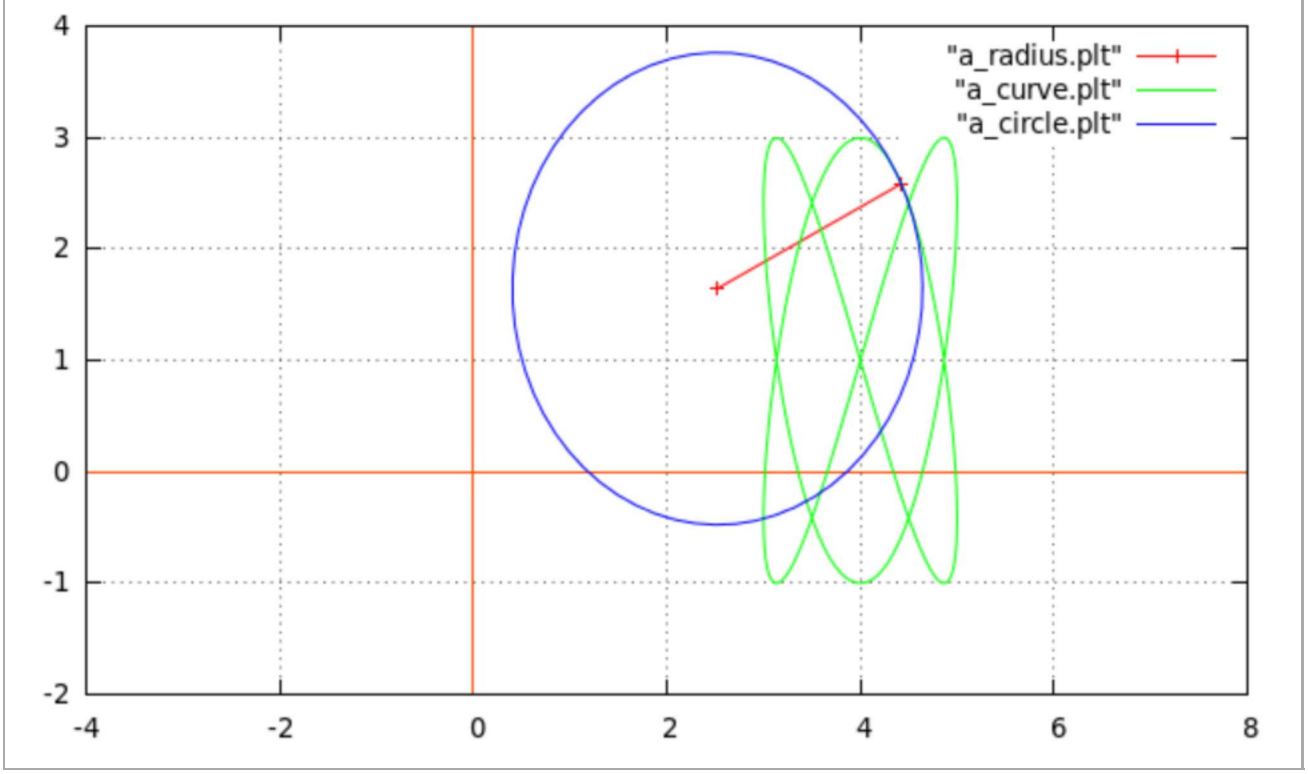
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include    "xfx_x.h"
/* ---------------------------------- */
#include  "kradius.h"
#include     "kg_c.h"
#include  "kcircle.h"
```

kradius.h
Coordonnées du cercle

```
/* ---------------------------------- */
/*  Save as :   kradius.h             */
/* ---------------------------------- */
double Kt_2d(
double (*P_f)(double t),
double (*P_g)(double t),
double t,
double e
)
{
double K;
double a;
double b;

a = fx_x((*P_f),t,e);
b = fx_x((*P_g),t,e);

K = fabs(a*fx_xx((*P_g),t,e)-b*fx_xx((*P_f),t,e))
                 /
     pow(a*a+b*b,3./2.);

 return(K);
}
/* ---------------------------------- */
double cx_2d(
double (*P_f)(double t),
double (*P_g)(double t),
double t,
double e
)
{
double Num,Den;

 Num =( pow(fx_x((*P_f),t,e),2)
       +pow(fx_x((*P_g),t,e),2)
      )
      *fx_x((*P_g),t,e);

 Den = fx_x((*P_f),t,e)*fx_xx((*P_g),t,e)-
       fx_x((*P_g),t,e)*fx_xx((*P_f),t,e);

 return((*P_f)(t)-Num/Den);
}
/* ---------------------------------- */
double cy_2d(
double (*P_f)(double t),
double (*P_g)(double t),
double t,
double e
)
{
double Num,Den;

 Num =( pow(fx_x((*P_f),t,e),2)
       +pow(fx_x((*P_g),t,e),2)
      )
      *fx_x((*P_f),t,e);

 Den = fx_x((*P_f),t,e)*fx_xx((*P_g),t,e)-
       fx_x((*P_g),t,e)*fx_xx((*P_f),t,e);

 return((*P_g)(t)+Num/Den);
}
```

fb.h

La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fb.h                  */
/* ---------------------------------- */
double f(
double t)
{
        return( 4+sin(2*t) );
}
char  feq[] =  "4+sin(2*t)";
/* ---------------------------------- */
double g(
double t)
{
        return( 1-2*cos(3*t) );
}
char  geq[] =  "1-2*cos(3*t)";
```

kg_c.h

La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_c.h                */
/* ---------------------------------- */
void G_C_2d(
W_Ctrl W,
t_Ctrl T,
double (*P_f)(double x),
double (*P_g)(double x),
double x,
double e
)
{
FILE *fp;
double i;

        fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
           " set size ratio -1\n"
           " set grid\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"a_radius.plt\" with linespoints,\\\n"
           " \"a_curve.plt\" with line,\\\n"
           " \"a_circle.plt\" with line\n",
          W.xmini,W.xmaxi,W.ymini,W.ymaxi);
 fclose(fp);

        fp = fopen("a_curve.plt","w");
for(i=T.mini; i<=T.maxi; i+=T.step)
fprintf(fp," %6.3f  %6.3f\n",(*P_f)(i),(*P_g)(i));
fclose(fp);
```

```
        fp = fopen("a_radius.plt","w");
fprintf(fp," %6.5f   %6.5f\n",cx_2d((*P_f),(*P_g),x,e),
                              cy_2d((*P_f),(*P_g),x,e));
fprintf(fp," %6.5f   %6.5f\n",(*P_f)(x),(*P_g)(x));
             fclose(fp);

 Pause();
}
```

kcircle.h
Le cercle

```
/* ---------------------------------- */
/*  Save as :   kcircle.h             */
/* ---------------------------------- */
void circle(
char   Name[FILENAME_MAX],
double r,
double x,
double y
)
{
FILE   *fp = fopen(Name,"w");
double   t = 0.;

for(;t<2.01*PI;t+=.1)
fprintf(fp," %6.5f %6.5f\n",r*cos(t)+x,r*sin(t)+y);
 fclose(fp);
}
```

Application : Courbe de Bézier

Préambule

Les courbes de Béziers dans Wikipedia.

Courbe de Béziers

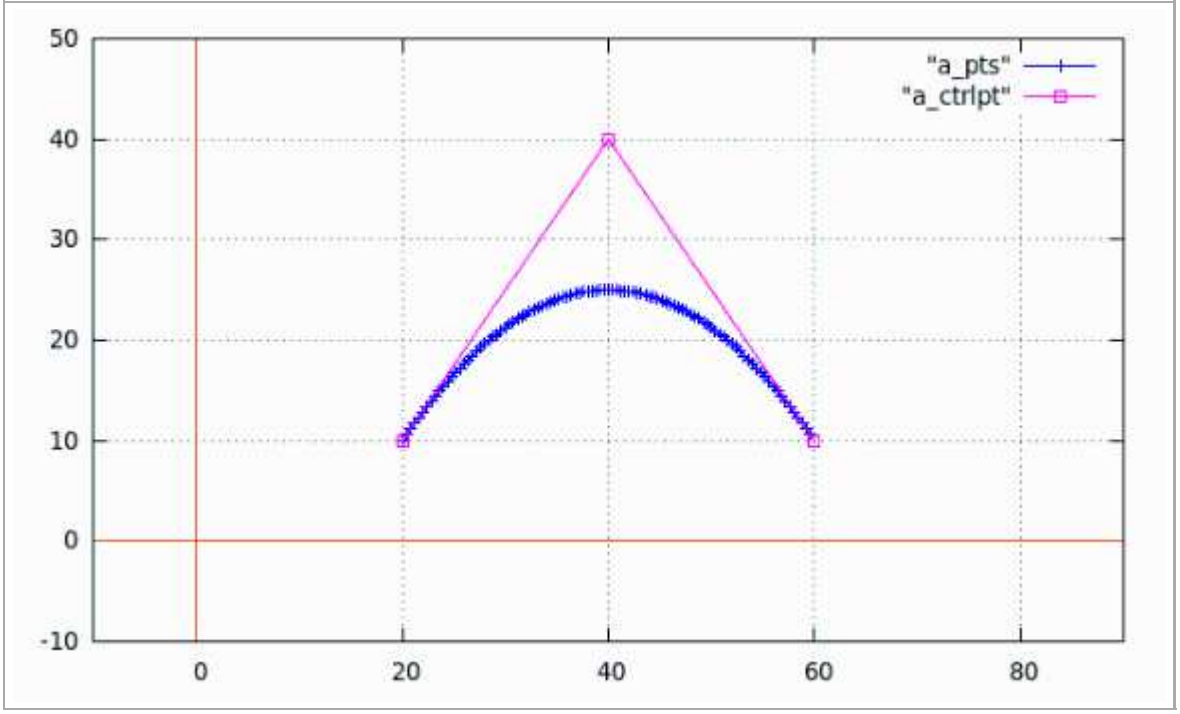
Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

c01.c
Exemple à tester

```c
/* ----------------------------------- */
/*  Save as :  c01.c                   */
/* ----------------------------------- */
#include "x_ahfile.h"
/* ----------------------------------- */
int main(void)
{
 printf(" Une courbe de Bezier.\n\n");

    G_quadratic_Bezier_lp_2d(
              i_WGnuplot(-10,90,-10,50),
              i_point2d(20.,10.),
              i_point2d(40.,40.),
              i_point2d(60.,10.) );

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue");

 return 0;
}
```

Résultat dans gnuplot



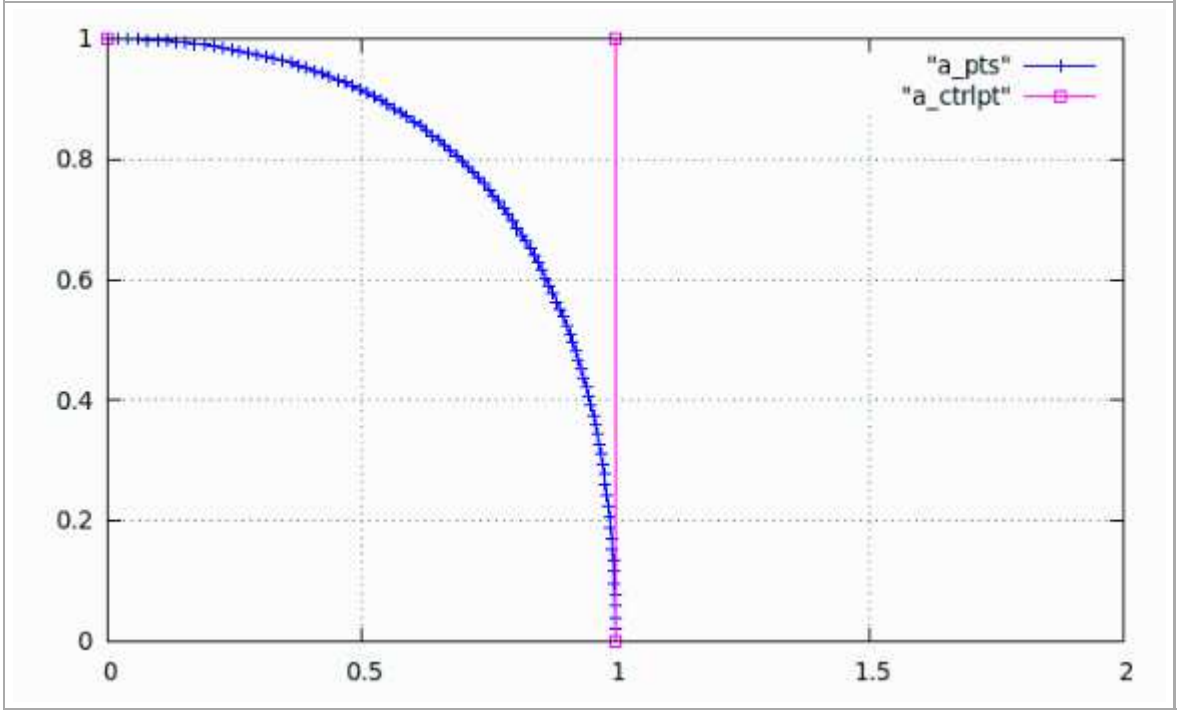
Une application

Nous avons essayé de recouvrir un quart de cercle avec une courbe de Béziers. Nous savons que c'est impossible (voir théorie)

c02.c
Exemple à tester

```
/* ----------------------------------- */
/*  Save as :  c02.c                   */
/* ----------------------------------- */
#include "x_ahfile.h"
/* ----------------------------------- */
int main(void)
{
 printf(" Une courbe de Bezier.\n\n");

    G_quadratic_Bezier_lp_2d(
             i_WGnuplot(-0,2,-0,1),
             i_point2d(0.,1.),
             i_point2d(1.,1.),
             i_point2d(1.,0.)  );

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue");

 return 0;
}
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :  x_ahfile.h             */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include     "xspv.h"
/* ---------------------------------- */
#include    "kpoly.h"
#include  "kbezier.h"
```

Cette partie ne peut être vue que dans wikiversité.

kpoly.h
Les équations de la courbe

```
/* ---------------------------------- */
/*  Save as :    kpoly.h              */
/* ---------------------------------- */
double quadratic_Bezier_x_2d(
double   t,
point2d P0,
point2d P1,
point2d P2
)
{
return(
    P0.x * pow((1-t),2) * pow(t,0) +
2 * P1.x * pow((1-t),1) * pow(t,1) +
    P2.x * pow((1-t),0) * pow(t,2)
);
}
/* ---------------------------------- */
double quadratic_Bezier_y_2d(
double   t,
point2d P0,
point2d P1,
point2d P2)
{
return(
    P0.y * pow((1-t),2) * pow(t,0) +
2 * P1.y * pow((1-t),1) * pow(t,1) +
    P2.y * pow((1-t),0) * pow(t,2)
);
}
/* ---------------------------------- */
```

kbezier.h
La fonction graphique

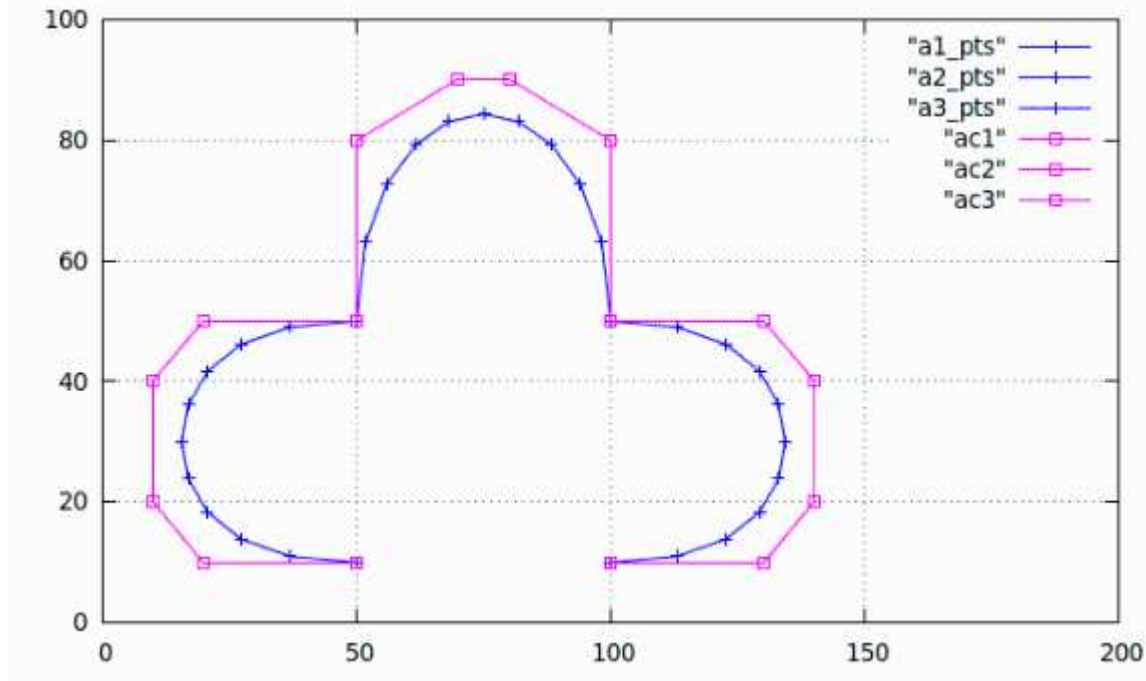
```
/* ---------------------------------- */
/*  Save as :  kbezier.h              */
/* ---------------------------------- */
void G_quadratic_Bezier_lp_2d(
W_Ctrl   w,
point2d P0,
point2d P1,
point2d P2
)
{
FILE   *fp;

double  mini = 0.;
double  maxi = 1.;
double  step =  .01;
double     t = mini;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis lt 8\n"
           " set grid \n\n"
           " set size ratio -1\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_pts\" with linesp lt 3 pt 1, \\\n"
           " \"a_ctrlpt\" with linesp lt 4 pt 4 \\\n\n"
           " reset",w.xmini,w.xmaxi,w.ymini,w.ymaxi);
```

```
 fclose(fp);

            fp = fopen("a_pts","w");
 for(t=mini; t<=maxi; t+=step)
     fprintf(fp," %6.5f   %6.5f\n",quadratic_Bezier_x_2d(t,P0,P1,P2),
                                   quadratic_Bezier_y_2d(t,P0,P1,P2));
      fclose(fp);

            fp = fopen("a_ctrlpt","w");
     fprintf(fp," %6.5f   %6.5f\n",P0.x,P0.y);
     fprintf(fp," %6.5f   %6.5f\n",P1.x,P1.y);
     fprintf(fp," %6.5f   %6.5f\n",P2.x,P2.y);
      fclose(fp);

 Pause();
}
```

Conclusion

Nous avons utilisé dans les exemples trois points de contrôles. Ici un exemple avec trois courbes et cinq points de contrôles.

Résultat dans gnuplot



Application : Courbe de Bézier rationnelle

Préambule

Les courbes de Béziers dans Wikipedia.

Courbes de Béziers rationelles (cubiques)

La seule chose qui change avec le chapitre précédent, c'est le fichier "kpoly.h".

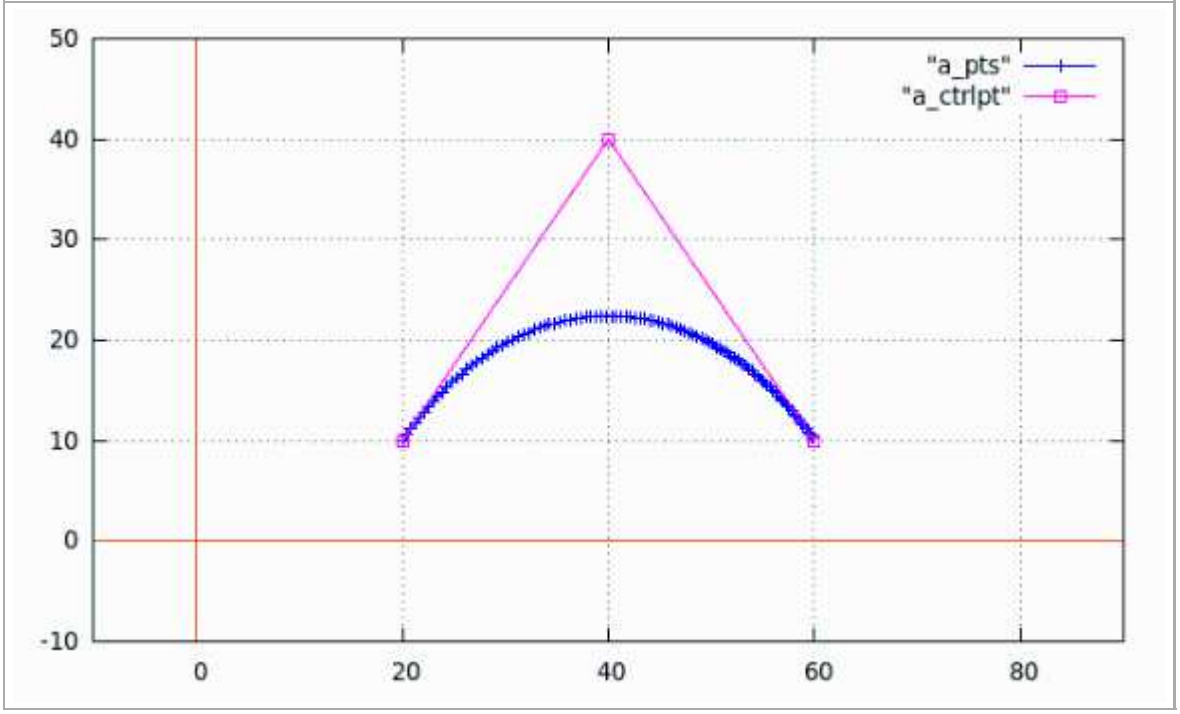
Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

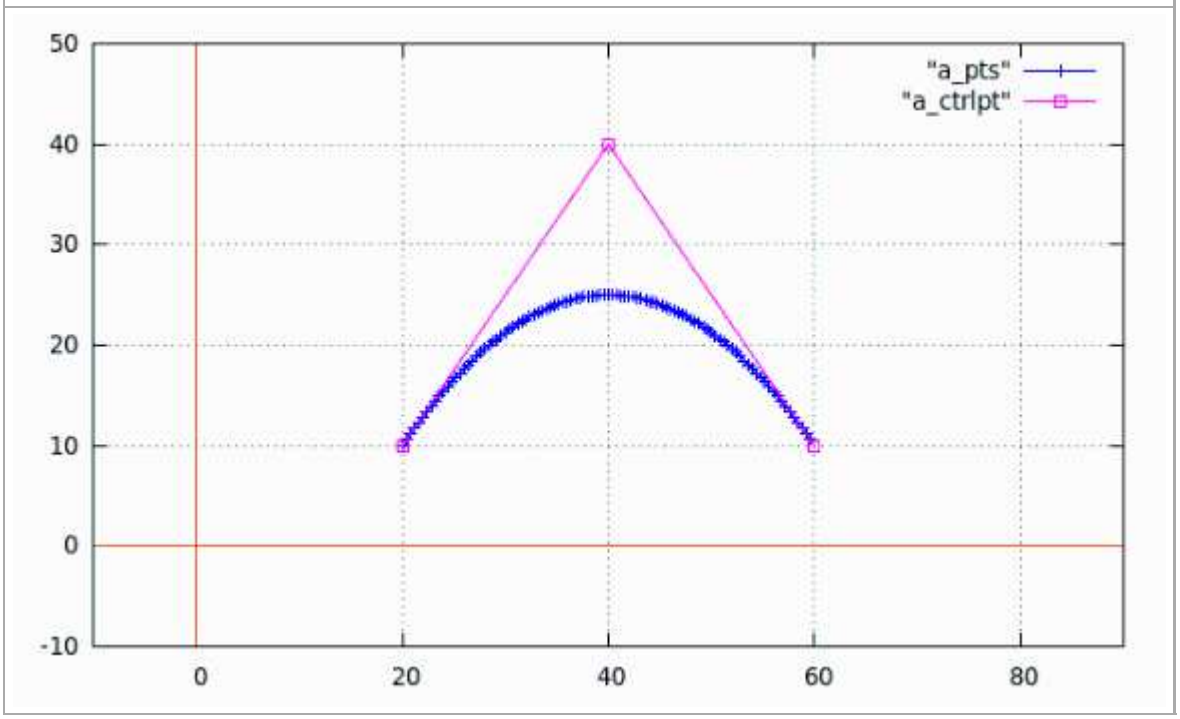
c01.c
Exemple à tester

```c
/* ---------------------------------- */
/*  Save as :  c01.c                  */
/* ---------------------------------- */
#include "x_ahfile.h"
/* ---------------------------------- */
int main(void)
{

 printf(" Une courbe de Bezier.\n\n");

    G_quadratic_Bezier_lp_2d(
             i_WGnuplot(-10,90,-10,50),
             i_point2d(20.,10.),
             i_point2d(40.,40.),
             i_point2d(60.,10.)
             );

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue");

 return 0;
}
```

Résultat dans gnuplot



Courbe du chapitre précédent



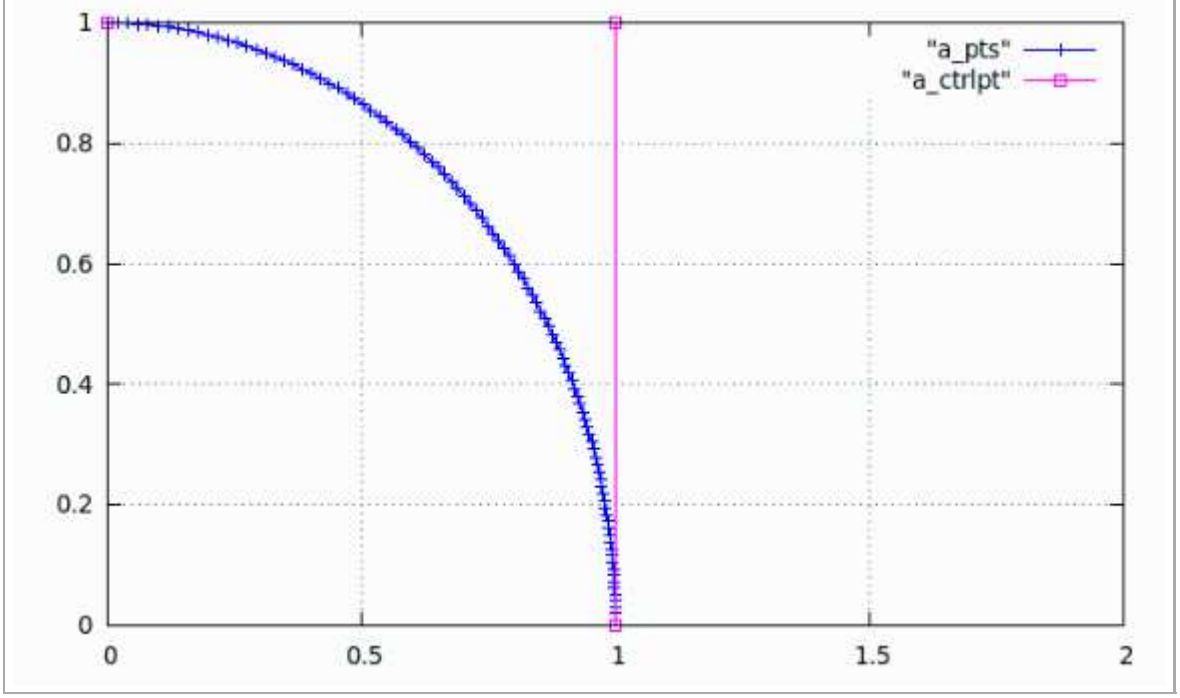
Une application

Nous avons essayé de recouvrir un quart de cercle avec une courbe de Béziers. En théorie cela est possible avec les courbes de Béziers rationelles (cubiques).

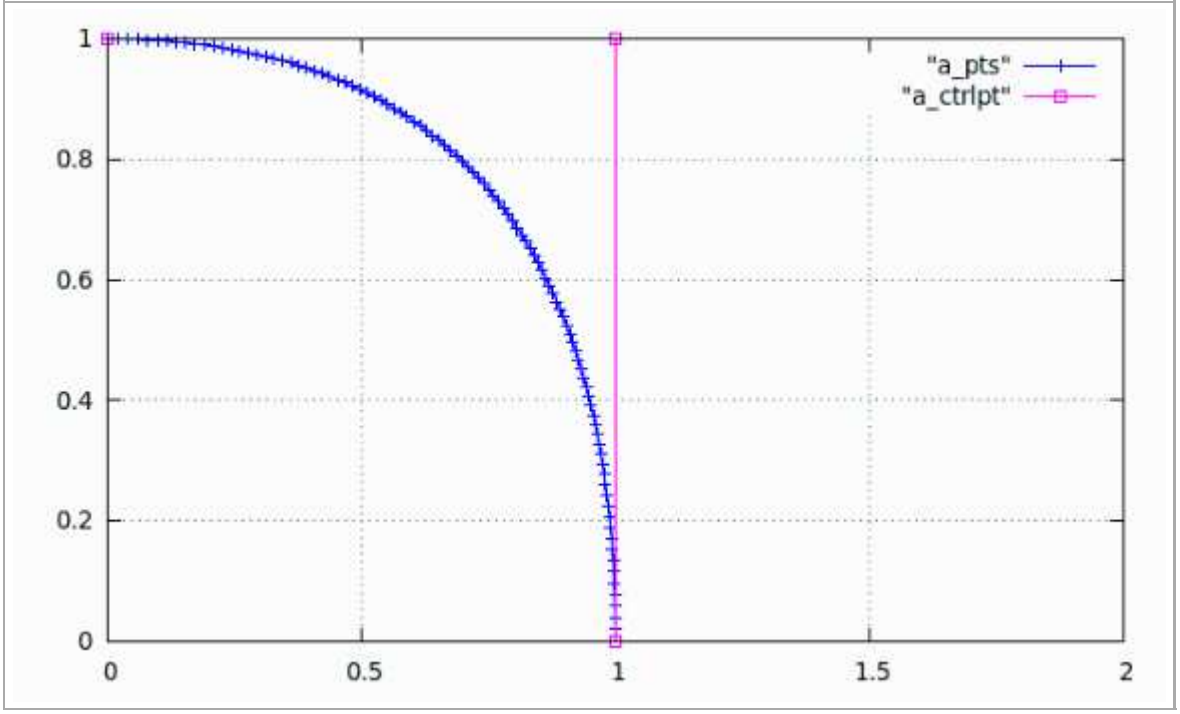
c02.c
Exemple à tester

```
/* ---------------------------------- */
/*  Save as :  c02.c                  */
/* ---------------------------------- */
#include "x_ahfile.h"
/* ---------------------------------- */
int main(void)
{

 printf(" Une courbe de Bezier.\n\n");

    G_quadratic_Bezier_lp_2d(
             i_WGnuplot(-0,2,-0,1),
             i_point2d(0.,1.),
             i_point2d(1.,1.),
             i_point2d(1.,0.)
             );

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Press return to continue");

 return 0;
}
```

Résultat dans gnuplot



Courbe du chapitre précédent



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :  x_ahfile.h             */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include     "xspv.h"
/* ---------------------------------- */
#include    "kpoly.h"
#include  "kbezier.h"
```

Cette partie ne peut être vue que dans wikiversité.

kpoly.h
Les équations de la courbe

```
/* ---------------------------------- */
/*  Save as :    kpoly.h               */
/* ---------------------------------- */
double quadratic_Bezier_x_2d(
double   t,
point2d P0,
point2d P1,
point2d P2
)
{
return(

(
    P0.x * pow((1-t),2) * pow(t,0) +
2 * P1.x * pow((1-t),1) * pow(t,1) +
2 * P2.x * pow((1-t),0) * pow(t,2)
)
/
(
     pow((1-t),2) * pow(t,0) +
2 *  pow((1-t),1) * pow(t,1) +
2 *  pow((1-t),0) * pow(t,2)
)

);
}
/* ---------------------------------- */
double quadratic_Bezier_y_2d(
double   t,
point2d P0,
point2d P1,
point2d P2)
{
return(

(
    P0.y * pow((1-t),2) * pow(t,0) +
2 * P1.y * pow((1-t),1) * pow(t,1) +
2 * P2.y * pow((1-t),0) * pow(t,2)
)
/
(
     pow((1-t),2) * pow(t,0) +
2 *  pow((1-t),1) * pow(t,1) +
2 *  pow((1-t),0) * pow(t,2)
)

);
}
/* ---------------------------------- */
```

kbezier.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :  kbezier.h               */
/* ---------------------------------- */
void G_quadratic_Bezier_lp_2d(
W_Ctrl   w,
```

```
point2d P0,
point2d P1,
point2d P2
)
{
FILE   *fp;

double  mini = 0.;
double  maxi = 1.;
double  step =  .01;
double     t = mini;

        fp = fopen("a_main.plt","w");
fprintf(fp," set zeroaxis lt 8\n"
           " set grid \n\n"
           " set size ratio -1\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_pts\" with linesp lt 3 pt 1, \\\n"
           " \"a_ctrlpt\" with linesp lt 4 pt 4 \\\n\n"
           " reset",w.xmini,w.xmaxi,w.ymini,w.ymaxi);
 fclose(fp);

        fp = fopen("a_pts","w");
 for(t=mini; t<=maxi; t+=step)
     fprintf(fp," %6.5f   %6.5f\n",quadratic_Bezier_x_2d(t,P0,P1,P2),
                                   quadratic_Bezier_y_2d(t,P0,P1,P2));
 fclose(fp);

        fp = fopen("a_ctrlpt","w");
     fprintf(fp," %6.5f   %6.5f\n",P0.x,P0.y);
     fprintf(fp," %6.5f   %6.5f\n",P1.x,P1.y);
     fprintf(fp," %6.5f   %6.5f\n",P2.x,P2.y);
 fclose(fp);

 Pause();
}
```

Application : Fonction vectorielle 3D

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

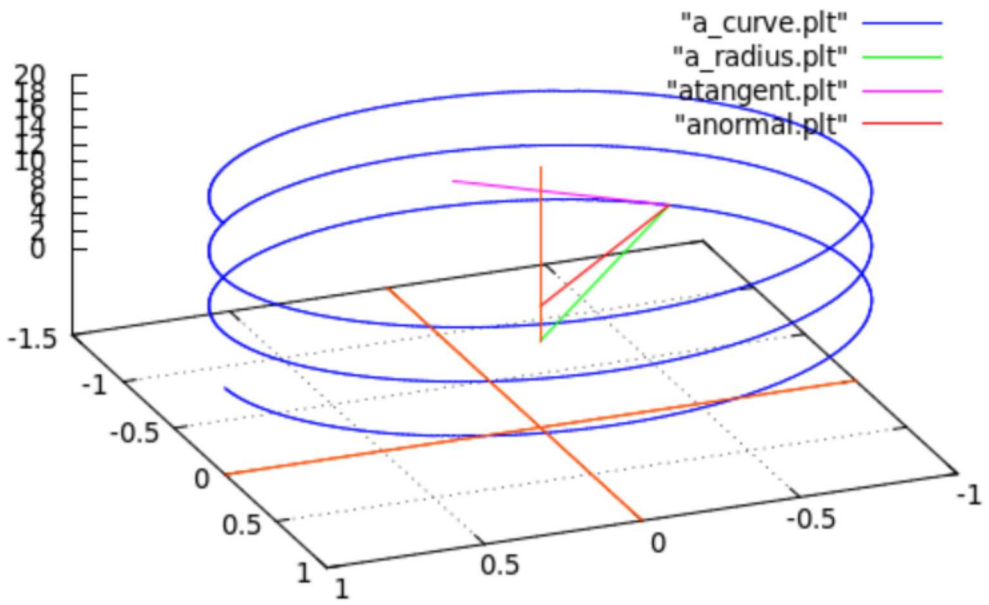
Dessiner

c01.c
Dessiner un vecteur tangent et normales unitaire.

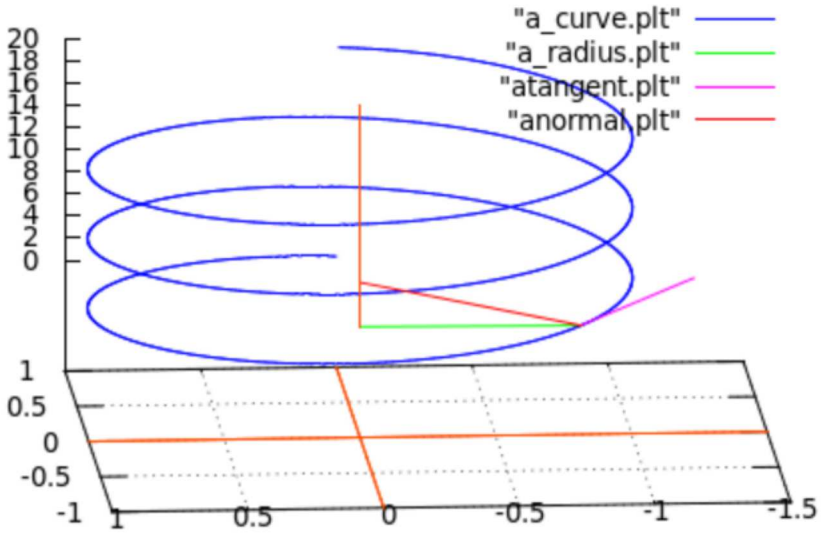
```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
double t     =  4.;

 printf(" r(t) = f(t)i + g(t)j + h(t)k \n\n");
 printf(" With \n\n");
 printf(" f : t-> %s  \n", feq);
 printf(" g : t-> %s  \n", geq);
 printf(" h : t-> %s\n\n", heq);
 printf(" t = %+.2f \n\n",   t);

     G_Curve_3d(i_time(0.,6.*PI,.01),
                f,g,h,
                Tf,Tg,Th,
                t);

 printf(" Draw the velocity and accelerator vectors"
        " at the point P(f(t),g(t)),                \n\n"
        " open the file \"a_main.plt\" with Gnuplot.\n\n");

 printf("\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Résultat dans gnuplot



Les fichiers h de ce chapitre

`x_ahfile.h`
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include    "xfx_x.h"
/* ---------------------------------- */
#include   "knfx_x.h"
#include "kg_ctan1.h"
```

knfx_x.h
Normalisé

```
/* ---------------------------------- */
/*  Save as :   knfx_x.h               */
/* ---------------------------------- */
double fx_x_Normalize(
double (*P_f)(double x),
double (*P_g)(double x),
double (*P_h)(double x),
double t,
double e
)
{
double Df=fx_x((*P_f),t,e);
double Dg=fx_x((*P_g),t,e);
double Dh=fx_x((*P_h),t,e);

 return(Df/sqrt(Df*Df+Dg*Dg+Dh*Dh));
}
```

fa.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fa.h                  */
/* ---------------------------------- */
double f(
double t)
{
        return( cos(t));
}
char  feq[] =  "cos(t)";
/* ---------------------------------- */
double g(
double t)
```

```
{
        return( sin(t));
}
char  geq[] =  "sin(t)";
/* ---------------------------------- */
double h(
double t)
{
        return( t);
}
char  heq[] =  "t";
/* ---------------------------------- */
double Tf(
double t)
{
        return(
        -(sin(t)/sqrt(2))
        );
}
/* ---------------------------------- */
double Tg(
double t)
{
        return(
        cos(t)/sqrt(2)
        );
}
/* ---------------------------------- */
double Th(
double t)
{
        return(
        1/sqrt(2)
        );
}
```

kg_ctan1.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_ctan1.h            */
/* ---------------------------------- */
void G_Curve_3d(
t_Ctrl T,
double (*P_f)(double t),
double (*P_g)(double t),
double (*P_h)(double t),
double (*P_Tf)(double t),
double (*P_Tg)(double t),
double (*P_Th)(double t),
double t
)
{
FILE *fp;
double i;
double e = .001;

fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
```

```
           " set grid\n\n"
           " splot \\\n"
           " \"a_curve.plt\" with line lt 3,\\\n"
           " \"a_radius.plt\" with line lt 2,\\\n"
           " \"atangent.plt\" with line lt 4,\\\n"
           " \"anormal.plt\" with line lt 1 ");
fclose(fp);

        fp = fopen("a_curve.plt","w");
for(i=T.mini; i<=T.maxi; i+=T.step)
fprintf(fp," %6.3f  %6.3f  %6.3f\n",
       (*P_f)(i),
       (*P_g)(i),
       (*P_h)(i));
 fclose(fp);

        fp = fopen("a_radius.plt","w");
fprintf(fp,"  0  0  0   \n %6.5f  %6.5f  %6.5f  \n",
       (*P_f)(t),
       (*P_g)(t),
       (*P_h)(t));
 fclose(fp);

        fp = fopen("atangent.plt","w");
fprintf(fp,"  %6.5f  %6.5f  %6.5f \n"
           "  %6.5f  %6.5f  %6.5f \n",
       (*P_f)(t),
       (*P_g)(t),
       (*P_h)(t),
       (*P_f)(t)+fx_x_Normalize((*P_f),(*P_g),(*P_h),t,e),
       (*P_g)(t)+fx_x_Normalize((*P_g),(*P_f),(*P_h),t,e),
       (*P_h)(t)+fx_x_Normalize((*P_h),(*P_f),(*P_g),t,e) );
 fclose(fp);

        fp = fopen("anormal.plt","w");
fprintf(fp,"  %6.5f  %6.5f  %6.5f \n"
           "  %6.5f  %6.5f  %6.5f \n",
       (*P_f)(t),
       (*P_g)(t),
       (*P_h)(t),
       (*P_f)(t)+fx_x_Normalize((*P_Tf),(*P_Tg),(*P_Th),t,e),
       (*P_g)(t)+fx_x_Normalize((*P_Tg),(*P_Tf),(*P_Th),t,e),
       (*P_h)(t)+fx_x_Normalize((*P_Th),(*P_Tf),(*P_Tg),t,e));
 fclose(fp);

 Pause();
}
```

Algorithme

```
r(t) = f(t) i + g(t) j + h(t) k
T(t) = r'(t) / ||r'(t)||
N(t) = T'(t) / ||T'(t)||
```

Application : Tangente de f(x,y)

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner la tangente

- La méthode consiste à poser :
  - x = i (ici i=1).
  - D'utiliser la dérivée partielle par rapport à y.
  - Puis écrire l'équation de la tangente d'une fonction en y.

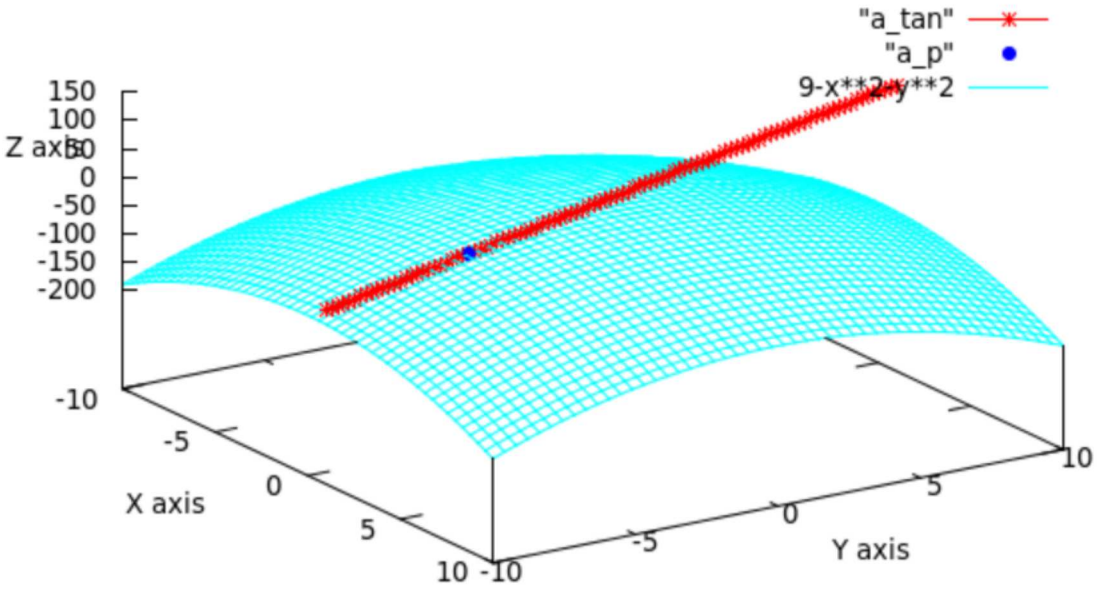
c01.c
Dessiner la tangente

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
point2d p = i_point2d(1,2);
double  h = .001;

 printf(" Draw the equation of the tangent\n\n");
 printf(" at the point P(%.0f,%.0f),\n\n",p.x,p.y);
 printf(" on the plan x = %.0f for f(x,y).\n\n\n",p.x);
 printf(" f : (x,y)-> %s\n\n\n", feq);

 printf(" Cartesian form :\n\n"
        " z = %f y %+f\n\n",
        fxy_y(f,h,p),
        f(p.x,p.y)-fxy_y(f,h,p)*p.y);

       G_3d_p(i_WGnuplot(-10.,10.,-10.,10.),
              i_VGnuplot( 55.,57.,  1., 1.),
              feq,f,
              p);

 printf(" Open the file \"a_main.plt\" with gnuplot.\n");

 getchar();

 return 0;
```

```
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xspv.h"
#include     "xplt.h"
#include   "xfxy_x.h"
/* ---------------------------------- */
#include    "kg_3d.h"
```

fa.h

La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fa.h                  */
/* ---------------------------------- */
double f(
double x,
double y)
{
 return( (9-x*x-y*y) );
}
char  feq[] = "9-x**2-y**2";
```

kg_3d.h

La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_3d.h                */
/* ---------------------------------- */
void G_3d_p(
W_Ctrl W,
View_Ctrl V,
  char feq[],
double (*P_f)(double x, double y),
point2d p
)
{
FILE   *fp;
double a,b;
double    h = .001;
double step = 0.2;

        fp = fopen("a_main.plt","w");
fprintf(fp,"set isosamples 50\n"
           "set hidden3d\n"
           "set xlabel \"X axis\"\n"
           "set ylabel \"Y axis\"\n"
           "set zlabel \"Z axis\" offset 1, 0\n"
           "set view %0.3f, %0.3f, %0.3f, %0.3f \n"
           "splot[%0.3f:%0.3f][%0.3f:%0.3f]\\\n"
           "\"a_tan.plt\" with linesp lt 1 pt 3,\\\n"
           "\"a_p.plt\" pt 20,\\\n"
           "%s \n\n",
        V.rot_x,V.rot_z,V.scale,V.scale_z,
        W.xmini,W.xmaxi,W.ymini,W.ymaxi, feq);
 fclose(fp);

         fp = fopen("a_p.plt","w");
 fprintf(fp," %6.3f %6.3f %6.3f\n",
          p.x,p.y, (*P_f)(p.x,p.y));
  fclose(fp);

  a=fxy_y((*P_f),h,p);
  b=((*P_f)(p.x,p.y)-fxy_y((*P_f),h,p)*p.y);

  fp = fopen("a_tan.plt","w");
    for(p.y=W.ymini; p.y<W.ymaxi;p.y+=step)
```

```
      fprintf(fp," %6.3f %6.3f %6.3f\n",
              p.x,p.y, a*p.y+b);
 fclose(fp);

  Pause();
}
```

Application : Gradient

Préambule

Le gradient dans Wikipedia.

Présentation

Dessiner la courbe de niveau C de f qui contient P et dessiner le gradient au point P.

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Dessiner le gradient au point P

c01.c
Dessiner le gradient au point P

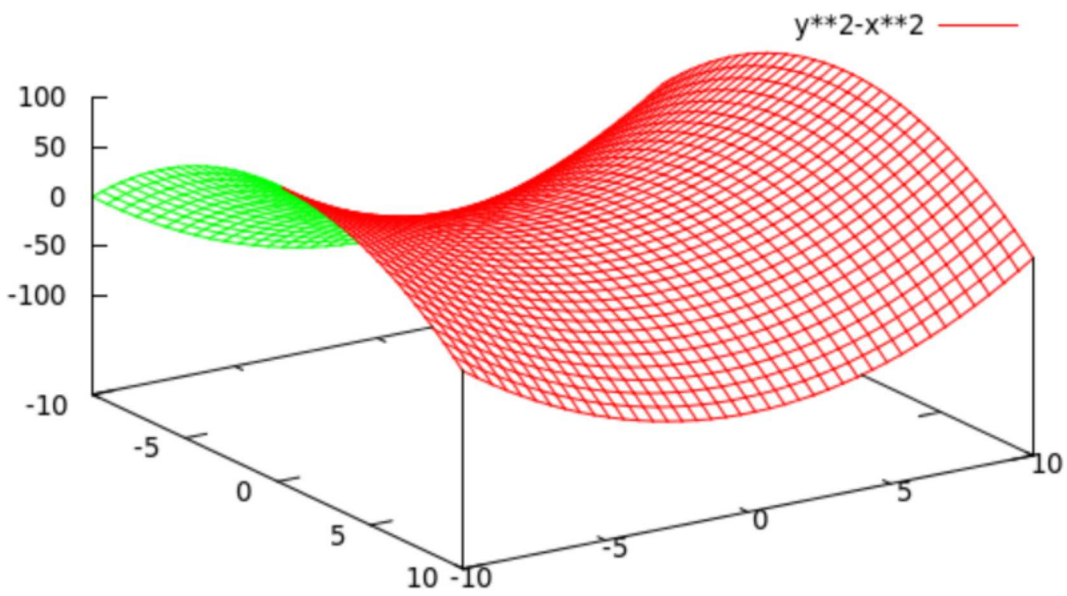
```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
double   h  = .0001;
 point2d p  = i_point2d(2,1);
vector2d u  = grad_fxy(g,h,p);

 clrscrn();
 printf(" Sketch both the level curve C of f "
        "that contains P and grad(P)   \n\n");
 printf(" f : (x,y)-> %s\n\n", feq);
 printf(" with p(%+.3f,%+.3f) \n\n",p.x,p.y);

  printf(" In first sketch the graph of f(x,y) = 0\n\n");

     G_3d_eq(i_WsGnuplot(-10,10,-10,10,-100,100),
             i_VGnuplot( 55.,57.,1.,1.),
             feq);

 printf(" Open the file \"a_main.plt\" with gnuplot.\n");
 getchar();

 clrscrn();
 printf(" The level curves have the form f(x,y) = k \n");
 printf(" with p(%+.3f,%+.3f) k = %+.3f \n\n",
          p.x,p.y,f(p.x,p.y));

 printf(" The new function is :\n");
 printf(" g : (x,y)-> %s\n\n", geq);

  printf(" grad(g)]p = %+.3fi  %+.3fj\n",u.i,u.j);
  printf(" is a vector normal to the function\n");
```

```
  printf(" g : (x,y)-> %s\n", geq);
  printf(" at the point p(%+.3f,%+.3f)\n\n", p.x,p.y);

  G_3d_levelcurvegradfxy(i_WsGnuplot(-6,6,-6,6,
                                     g(p.x,p.y),
                                     g(p.x,p.y)+.1),
                         g,geq,
                         p);

 printf(" Open the file \"a_main.plt\" with gnuplot.\n"
        " Press return to continue.\n");

 getchar();

 return 0;
}
```

Le résultat.

```
Sketch both the level curve C of f  that contains P and grad(P)
.
f : (x,y)->  y**2-x**2
.
with p(+2.000,+1.000)
.
In first sketch the graph of f(x,y) = 0
.
Open the file "a_main.plt" with gnuplot.
```

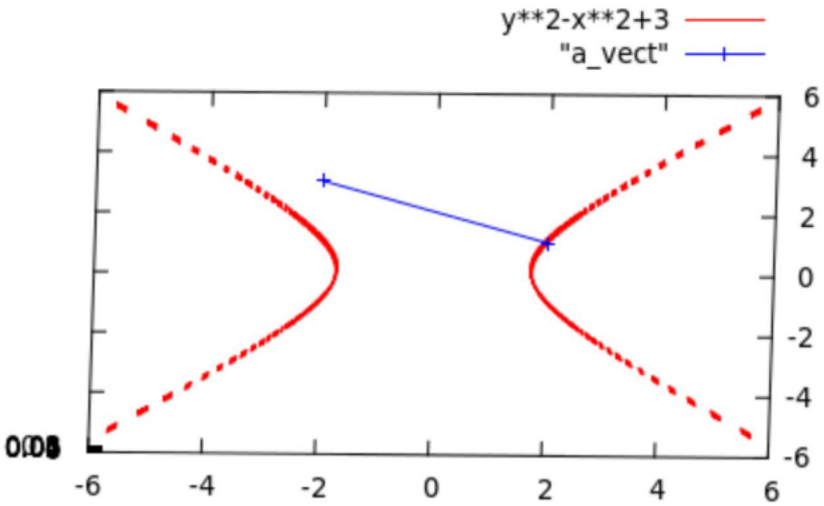
Résultat dans gnuplot




```
The level curves have the form f(x,y) = k
with p(+2.000,+1.000) k = -3.000
```

```
.
The new function is :
g : (x,y)->  y**2-x**2+3
.
grad(g)]p = -4.000i  +2.000j
is a vector normal to the function
g : (x,y)->  y**2-x**2+3
at the point p(+2.000,+1.000)
.
Open the file "a_main.plt" with gnuplot.
Press return to continue.
```

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xspv.h"
#include     "xplt.h"
```

```
#include   "xfxy_x.h"
/* ---------------------------------- */
#include    "kgrad.h"
#include    "kg_3d.h"
#include  "kg_grad.h"
```

fa.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fa.h                  */
/* ---------------------------------- */
double f(
double x,
double y)
{
 return( ( y*y-x*x) );
}
char  feq[] = " y**2-x**2";
/* ---------------------------------- */
double g(
double x,
double y)
{
 return( ( y*y-x*x+3) );
}
char  geq[] = " y**2-x**2+3";
/* ---------------------------------- */
```

kgrad.h
Le gradient

```
/* ---------------------------------- */
/*  Save as :   kgrad.h               */
/* ---------------------------------- */
vector2d grad_fxy(
double (*P_f)(double x,double y),
double   h,
point2d  p
)
{
vector2d   u;

       u.i = fxy_x((*P_f),h,p);
       u.j = fxy_y((*P_f),h,p);

 return(u);
}
```

kg_3d.h

La fonction graphique (1)

```
/* ---------------------------------- */
/*  Save as :   kg_3d.h               */
/* ---------------------------------- */
void G_3d_eq(
   Ws_Ctrl W,
View_Ctrl V,
char      feq[]
)
{
FILE   *fp = fopen("a_main.plt","w");
fprintf(fp,"reset\n"
           "set    samples 40\n"
           "set isosamples 40\n"
           "set hidden3d\n"
           "set view %0.3f, %0.3f, %0.3f, %0.3f \n"
           "splot[%0.3f:%0.3f][%0.3f:%0.3f][%0.3f:%0.3f]\\\n"
           "%s",
            V.rot_x,V.rot_z,V.scale,V.scale_z,
            W.xmini,W.xmaxi,W.ymini,W.ymaxi,W.zmini,W.zmaxi,
            feq);
 fclose(fp);
}
```

kg_grad.h

Dessiner la courbe de niveau qui contient P et le gradient au point P

```
/* ---------------------------------- */
/*  Save as :   kg_grad.h             */
/* ---------------------------------- */
void G_3d_levelcurvegradfxy(
Ws_Ctrl W,
double (*P_f)(double x, double y),
char    feq[],
point2d   p
)
{
FILE   *fp;
double   h  = .0001;

        fp = fopen("a_main.plt","w");
fprintf(fp,"reset\n"
           "set    samples 400\n"
           "set isosamples 400\n"
           "set view 1.000, 1.000, 1.000, 1.000 \n"
           "splot[%0.3f:%0.3f][%0.3f:%0.3f][%0.3f:%0.3f]\\\n"
           "%s,\\\n"
           "\"a_vect\" with linesp lt 3\n",
           W.xmini,W.xmaxi,W.ymini,W.ymaxi,W.zmini,W.zmaxi,
           feq);
 fclose(fp);

         fp = fopen("a_vect","w");
 fprintf(fp," %6.3f   %6.3f   %6.3f\n",
             p.x, p.y, ((*P_f)(p.x,p.y)) );
 fprintf(fp," %6.3f   %6.3f   %6.3f\n",
```

```
            p.x+fxy_x((*P_f),h,p),
            p.y+fxy_y((*P_f),h,p),
            (*P_f)(p.x,p.y) );
  fclose(fp);
}
```

Application : Vecteur normal

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

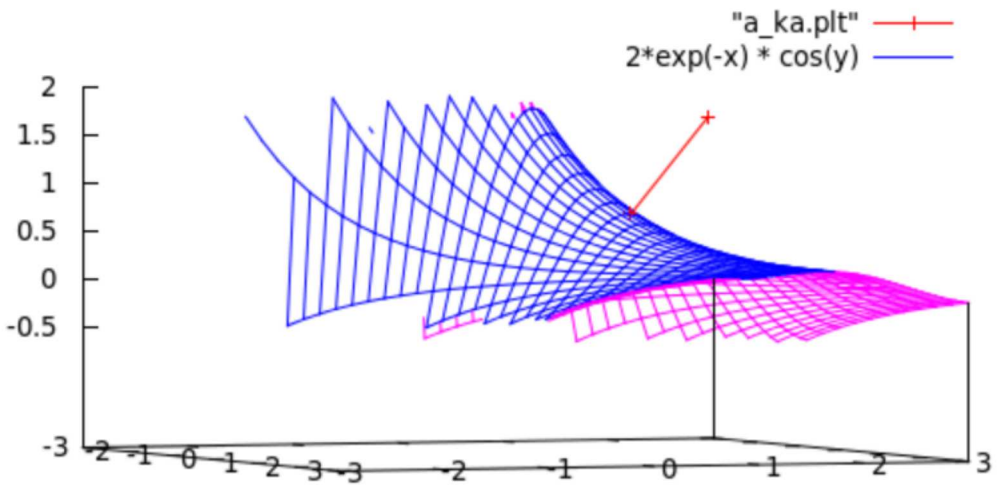
Dessiner le vecteur normale au point P

c01.c
Dessiner le vecteur normale au point P

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
   printf(" Draw the normal vector at the point P.\n\n"
          " f : (x,y)-> %s\n\n", feq);

     G_3d_v(i_WsGnuplot(-3,3,-3,3,-.5,2),
            i_VGnuplot( 94.,22.,1.,1.),
            feq,f,f_z,
            i_point2d(1,0.));

 printf(" Open the file \"a_main.plt\" with gnuplot.\n"
        " Press return to continue.\n");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ----------------------------------- */
/*  Save as :   x_ahfile.h             */
/* ----------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ----------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include     "xspv.h"
#include  "xfxyz_x.h"
/* ----------------------------------- */
#include   "kg_3dv.h"
```

fa.h
La fonction à dessiner

```
/* ----------------------------------- */
/*  Save as :  fa.h                    */
/* ----------------------------------- */
```

```
double f(
double x,
double y)
{
 return(      (2*exp(-x) * cos(y)) );
}
char  feq[] = "2*exp(-x) * cos(y)";
/* ---------------------------------- */
double f_z(
double x,
double y,
double z)
{
 return(      (2*exp(-x) * cos(y) - z) );
}
char  f_zeq[] = "2*exp(-x) * cos(y) - z";
```

kg_3dv.h

La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_3dv.h              */
/* ---------------------------------- */
void G_3d_v(
  Ws_Ctrl W,
View_Ctrl V,
  char feq[],
double (*P_f) (double x, double y),
double (*P_fz)(double x, double y, double z),
point2d p
)
{
FILE   *fp;
point3d p3d = i_point3d(p.x,p.y,(*P_f)(p.x,p.y));

        fp = fopen("a_main.plt","w");
fprintf(fp,"reset\n"
           "set    samples 40\n"
           "set isosamples 40\n"
           "set hidden3d\n"
           "set view %0.3f, %0.3f, %0.3f, %0.3f \n"
           "splot[%0.3f:%0.3f][%0.3f:%0.3f][%0.3f:%0.3f]\\\n"
           "\"a_ka.plt\" with linespoints,\\\n"
           "%s ",
            V.rot_x,V.rot_z,V.scale,V.scale_z,
            W.xmini,W.xmaxi,W.ymini,W.ymaxi,W.zmini,W.zmaxi,
            feq);
 fclose(fp);

 fp = fopen("a_ka.plt","w");
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x, p.y, ((*P_f)(p.x,p.y)) );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x-fxyz_x((*P_fz),0.0001,p3d),
              p.y-fxyz_y((*P_fz),0.0001,p3d),
((*P_f)(p.x,p.y))-fxyz_z((*P_fz),0.0001,p3d));
 fclose(fp);

Pause();
}
```

Application : Plan tangent

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

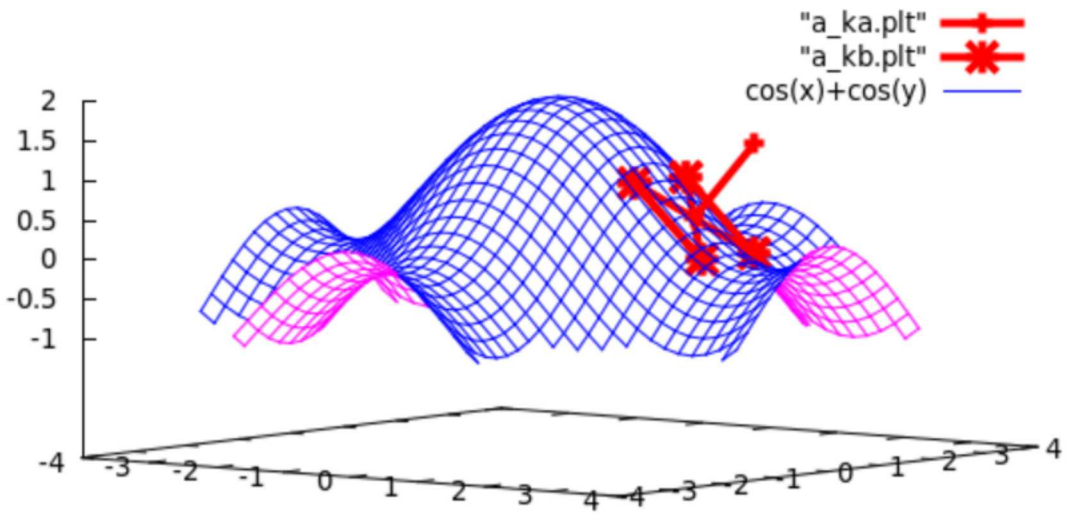
Dessiner le plan tangent au point P

c01.c
Dessiner le plan tangent au point P

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{

 printf(" Draw the Tangent plane.\n\n"
        " f : (x,y)-> %s\n\n", feq);

     G_3d_v( i_WsGnuplot(-4,4,-4,4,-1,2),
             i_VGnuplot( 80.,38.,1.,1.),
             feq,f,f_z,
             i_point2d(2,0.));

 printf(" Open the file \"a_main.plt\" with gnuplot.\n"
        " Press return to continue.\n");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xspv.h"
#include     "xplt.h"
#include  "xfxy_x.h"
#include  "xfxyz_x.h"
/* ---------------------------------- */
#include    "kg_3d.h"
```

fa.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fa.h                  */
/* ---------------------------------- */
double f(
double x,
double y)
{
 return(       cos(x)+cos(y) );
}
char  feq[] = "cos(x)+cos(y)";
/* ---------------------------------- */
double f_z(
double x,
double y,
double z)
{
 return(         cos(x)+cos(y)-z );
}
char  f_zeq[] = "cos(x)+cos(y)-z";
```

fa.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_3d.h               */
/* ---------------------------------- */
void G_3d_v(
  Ws_Ctrl W,
View_Ctrl V,
  char feq[],
double (*P_f) (double x, double y),
double (*P_fz)(double x, double y, double z),
point2d p
)
{
FILE      *fp;
point3d   P3D = i_point3d(p.x,p.y,(*P_f)(p.x,p.y));
double radius = .5;

        fp = fopen("a_main.plt","w");
fprintf(fp,"reset\n"
           "set size ratio -1\n"
           "set    samples 40\n"
           "set isosamples 40\n"
           "set hidden3d\n"
           "set view %0.3f, %0.3f, %0.3f, %0.3f \n"
           "splot[%0.3f:%0.3f][%0.3f:%0.3f][%0.3f:%0.3f]\\\n"
           " \"a_ka.plt\" with linesp lt 1 lw 4,\\\n"
           " \"a_kb.plt\" with linesp lt 1 lw 4 ps 2,\\\n"
           "%s lt 3",
            V.rot_x,V.rot_z,V.scale,V.scale_z,
            W.xmini,W.xmaxi,W.ymini,W.ymaxi,W.zmini,W.zmaxi,
            feq);
 fclose(fp);

 fp = fopen("a_ka.plt","w");
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x, p.y, (*P_f)(p.x,p.y) );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
```

```
             p.x-fxyz_x((*P_fz),0.0001,P3D),
             p.y-fxyz_y((*P_fz),0.0001,P3D),
((*P_f)(p.x,p.y))-fxyz_z((*P_fz),0.0001,P3D));
 fclose(fp);

 fp = fopen("a_kb.plt","w");
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x+radius,
              p.y+radius,
              fxy_x((*P_f),0.0001,p)*(+radius)+
              fxy_y((*P_f),0.0001,p)*(+radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x-radius,
              p.y+radius,
              fxy_x((*P_f),0.0001,p)*(-radius)+
              fxy_y((*P_f),0.0001,p)*(+radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x-radius,
              p.y-radius,
              fxy_x((*P_f),0.0001,p)*(-radius)+
              fxy_y((*P_f),0.0001,p)*(-radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x+radius,
              p.y-radius,
              fxy_x((*P_f),0.0001,p)*(+radius)+
              fxy_y((*P_f),0.0001,p)*(-radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x+radius,
              p.y+radius,
              fxy_x((*P_f),0.0001,p)*(+radius)+
              fxy_y((*P_f),0.0001,p)*(+radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x-radius,
              p.y-radius,
              fxy_x((*P_f),0.0001,p)*(-radius)+
              fxy_y((*P_f),0.0001,p)*(-radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x+radius,
              p.y-radius,
              fxy_x((*P_f),0.0001,p)*(+radius)+
              fxy_y((*P_f),0.0001,p)*(-radius)+
              (*P_f)(p.x,p.y)
              );
         fprintf(fp," %6.3f   %6.3f   %6.3f\n",
              p.x-radius,
              p.y+radius,
              fxy_x((*P_f),0.0001,p)*(-radius)+
              fxy_y((*P_f),0.0001,p)*(+radius)+
              (*P_f)(p.x,p.y)
              );
 fclose(fp);

 Pause();
}
```

Commande pause 1

Préambule

Créer une animation avec la commande "pause 1" de gnuplot. Ces exemples dans cette page présentent le code sans animation. Pour le troisième exemple voir le chapitre Animation Tangente Pour un autre exemple, voir le chapitre Tangente d'une courbe

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Le cadre

c01.c
Créer une liste de commande.

```c
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include  "kg_tan1.h"
/* ------------------------------------ */
int main(void)
{
t_Ctrl Pic = {0,5,1};

  G_TanA(Pic);

 printf(" Read \"a_main.plt\".\n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
# Gnuplot file : load "a_main.plt"

set zeroaxis

pause 1

pause 1

pause 1

pause 1

pause 1
```

```
reset
```

Dessiner

- Dessiner une chaîne de caractères.

```
/* ---------------------------------- */
/*  Save as :   c02.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include  "kg_tan2.h"
#include       "f2.h"
/* ---------------------------------- */
int main(void)
{
 printf("  f : x-> %s  \n", feq);

  G_TanA(i_WGnuplot(-7, 7,-2,2),
         i_time(0,5,1),
         feq);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat.

```
# Gnuplot file : load "a_main.plt"

set zeroaxis

plot [-7.000:7.000] [-2.000:2.000]   cos(x)
pause 1

plot [-7.000:7.000] [-2.000:2.000]   cos(x)
pause 1

plot [-7.000:7.000] [-2.000:2.000]   cos(x)
pause 1

plot [-7.000:7.000] [-2.000:2.000]   cos(x)
pause 1

plot [-7.000:7.000] [-2.000:2.000]   cos(x)
pause 1

reset
```

Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ----------- f --------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
```

kg_tan1.h
La fonction graphique pour c01.c

```
/* ---------------------------------- */
/*  Save as :   kg_tan1.h             */
/* ---------------------------------- */
void G_TanA(
t_Ctrl Pic
)
{
FILE *fp = fopen("a_main.plt","w");
double p;

    fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
               " set zeroaxis\n\n");

for(p=Pic.mini; p<Pic.maxi; p+=Pic.step)

    fprintf(fp," pause 1\n\n");

    fprintf(fp," reset");
     fclose(fp);
}
```

kg_tan2.h

La fonction graphique pour c02.c

```
/* ---------------------------------- */
/*  Save as :   kg_tan2.h              */
/* ---------------------------------- */
void G_TanA(
W_Ctrl w,
t_Ctrl Pic,
char   fEQ[]
)
{
FILE *fp = fopen("a_main.plt","w");
double p ;

    fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
               " set zeroaxis\n\n");

for(p = Pic.mini; p<Pic.maxi; p+=Pic.step)

    fprintf(fp," plot [%0.3f:%0.3f] [%0.3f:%0.3f] "
               " %s\n"
               " pause 1\n\n",
                 w.xmini,w.xmaxi,w.ymini,w.ymaxi,
                 fEQ);

    fprintf(fp," reset");
     fclose(fp);
}
```

Animer un point

Préambule

Créer une animation avec la commande "pause 1" de gnuplot. La position du point est dans les fichiers a_p***. Dans cet exemple la commande "pause 1" a été oublié.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

L'animation

c01.c
Créer une liste de commande

```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include        "f.h"
/* ---------------------------------- */
int main(void)
{
    G_plt(i_WGnuplot(-5,5, -1,10),
          i_time(-3.,5., .01),
          feq,f);

 printf(" open the file \"a_main.plt\" with Gnuplot.\n\n"
        " Press return to continue\n");
 getchar();

 return 0;
}
```

Le résultat.

```
# Gnuplot file : load "a_main.plt"

reset
plot[-5.000:5.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paab" pt 7 ps 3
reset
plot[-5.000:5.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paac" pt 7 ps 3
reset
plot[-5.000:5.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paad" pt 7 ps 3
reset
```

```
plot[-5.000:5.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paae" pt 7 ps 3
reset
plot[-5.000:5.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paaf" pt 7 ps 3
```

Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include     "kg_f.h"
```

f.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f.h                   */
/* ---------------------------------- */
double f(
double x)
{
 return(       -0.5*x*x  + 1.0*x + 8.0);
}
char  feq[] = "-0.5*x**2 + 1.0*x + 8.0";
```

kg_f.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_f.h                */
/* ---------------------------------- */
```

```
void G_plt(
W_Ctrl w,
t_Ctrl Pic,
char feq[],
double (*P_f)(double x)
)
{
FILE   *fp1;
FILE   *fp2;
double    p;
char files[]= "a_paaa";

         fp1 = fopen("a_main.plt","w");
 fprintf(fp1,"# Gnuplot file : load \"a_main.plt\" \n\n");

for(p=Pic.mini; p<Pic.maxi; p+=Pic.step)
{
 fprintf(fp1," reset\n"
            " plot[%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
            " %s lt 13,\\\n"
            " \"%s\" pt 7 ps 3 \n",
         w.xmini,w.xmaxi,w.ymini,w.ymaxi,
         feq,
         NewName(files));

         fp2 = fopen(files,"w");
 fprintf(fp2," %+0.6f %+0.6f",p,(*P_f)(p));
  fclose(fp2);
}
  fclose(fp1);
}
```

Animer deux points

Préambule

Créer une animation avec la commande "pause 1" de gnuplot. La position des deux points sont dans les fichiers a_p***

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

L'animation

c01.c
Créer une liste de commande.

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include        "f.h"
/* ---------------------------------- */
int main(void)
{
    G_plt(i_WGnuplot(-5,5, -1,10),
          i_time(-3.,5., .01),
          feq,f);

 printf(" open the file \"a_main.plt\" with Gnuplot.\n\n"
        " Press return to continue\n");
 getchar();

 return 0;
}
```

Le résultat.

```
# Gnuplot file : load "a_main.plt"

reset
plot[-4.000:6.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paab"  pt 7 ps 3

reset
plot[-4.000:6.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paac"  pt 7 ps 3

reset
plot[-4.000:6.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
```

```
"a_paad"  pt 7 ps 3

reset
plot[-4.000:6.000] [-1.000:10.000]\
-0.5*x**2 + 1.0*x + 8.0 lt 13,\
"a_paae"  pt 7 ps 3
```

Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include     "kg_f.h"
```

f.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f.h                   */
/* ---------------------------------- */
double f(
double x)
{
 return(       -0.5*x*x  + 1.0*x + 8.0);
}
char  feq[] = "-0.5*x**2 + 1.0*x + 8.0";
```

xg_f.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   xg_f.h                */
/* ---------------------------------- */
void  G_plt(
```

```
W_Ctrl w,
t_Ctrl Pic,
char feq[],
double (*P_f)(double x)
)
{
FILE   *fp1;
FILE   *fp2;
double  p,q;
char files[] = "a_paaa";

        fp1 = fopen("a_main.plt","w");
fprintf(fp1,"# Gnuplot file : load \"a_main.plt\" \n\n");

for(p=q=Pic.mini; p<Pic.maxi; p+=Pic.step)
{
 fprintf(fp1," reset\n"
             " plot[%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
             " %s lt 13,\\\n"
             " \"%s\"  pt 7 ps 3 \n",
             w.xmini,w.xmaxi,w.ymini,w.ymaxi,
             feq,
             NewName(files));

         fp2 = fopen(files,"w");
 fprintf(fp2," %+0.6f %+0.6f\n",p,(*P_f)(p));
 fprintf(fp2," %+0.6f %+0.6f\n",q,(*P_f)(p));
  fclose(fp2);
}
 fclose(fp1);
}
```

Animation : Tangente

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Animer la tangente

Nous utilisons ici la méthode avec la commande "pause 1" de gnuplot.

c01.c
Animer la tangente

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "f2.h"
/* ---------------------------------- */
int main(void)
{
 printf("  f : x-> %s  \n", feq);
 printf("  f': x-> %s\n\n",Dfeq);

 printf(" The equation of the tangent is : \n\n");
 printf("       y = f'(c) (x-c) + f(c)     \n\n");

  G_TanA(i_WGnuplot(-7, 7,-2,2),
         i_time(-1.5,2,.2),
         feq,
         f,
         Df);

 printf(" load \"a_main.plt\" with gnuplot. \n\n"
        " Press return to continue");
 getchar();

 return 0;
}
```

Le résultat dans a_main.plt

```
# Gnuplot file : load "a_main.plt"
set zeroaxis
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.997495*x +1.566980
pause 1
```

```
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.963558*x +1.520124
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.891207*x +1.433924
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.783327*x +1.326604
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.644218*x +1.215795
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.479426*x +1.117295
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.295520*x +1.043993
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  0.099833*x +1.004988
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.099833*x +1.004988
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.295520*x +1.043993
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.479426*x +1.117295
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.644218*x +1.215795
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.783327*x +1.326604
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.891207*x +1.433924
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.963558*x +1.520124
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.997495*x +1.566980
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.991665*x +1.556986
pause 1
plot [-7.000:7.000] [-2.000:2.000]  cos(x),  -0.946300*x +1.474681
pause 1
reset
```

Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

f2.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   f2.h                  */
/* ---------- f --------------------- */
double f(
double x)
{
 return(       cos(x));
}
char  feq[] = " cos(x)";
/* ------------ f' -------------------- */
double Df(
double x)
{
 return(  (-sin(x)) );
}
char Dfeq[] = " (-sin(x)) ";
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ----------------------------------
   y = ax + b    [P(xp,yp);(y-yp)=a(x-xp)]

   a = f'(x)

   b = y - ax
   b = y - f'(x)x
   b = f(x) - f'(x)x

   x=p
   a = f'(p)
   b = f(p) - f'(p)p
   ---------------------------------- */
void G_TanA(
W_Ctrl w,
t_Ctrl Pic,
  char    fEQ[],
double (*P_f)(double x),
double (*PDf)(double x)
)
{
FILE *fp = fopen("a_main.plt","w");
double p = Pic.mini;

fprintf(fp,"# Gnuplot file : load \"a_main.plt\"\n"
           " set zeroaxis\n\n");

for(;p<Pic.maxi;p+=Pic.step)
    fprintf(fp," plot [%0.3f:%0.3f] [%0.3f:%0.3f] "
               "%s, "
               " %0.6f*x %+0.6f \n"
               " pause 1\n\n",
                 w.xmini,w.xmaxi,w.ymini,w.ymaxi,
```

```
                fEQ,
           (*PDf)(p), (-(*PDf)(p)*p+(*P_f)(p)) );

fprintf(fp," reset");
 fclose(fp);
}
```

Animation : Cercle de courbure

Préambule

Cercle de courbure dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et récupérer aussi ceux du chapitre Dessiner :Cercle de courbure.

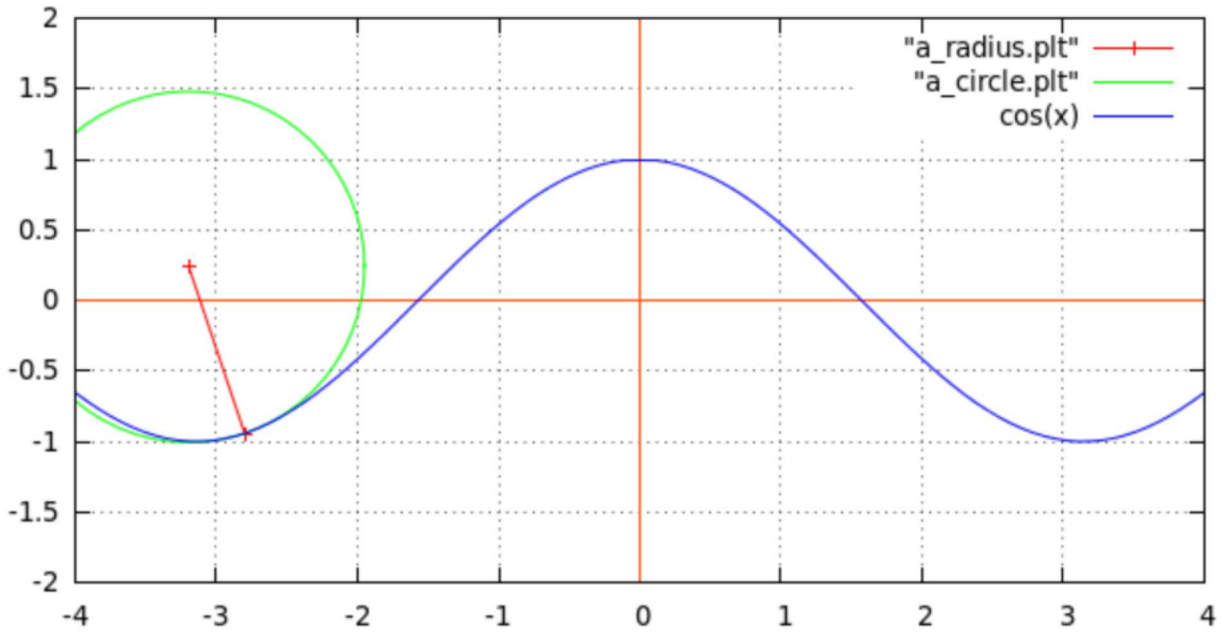
Animer

c01.c
Animer le cercle de courbure pour une fonction f(x)

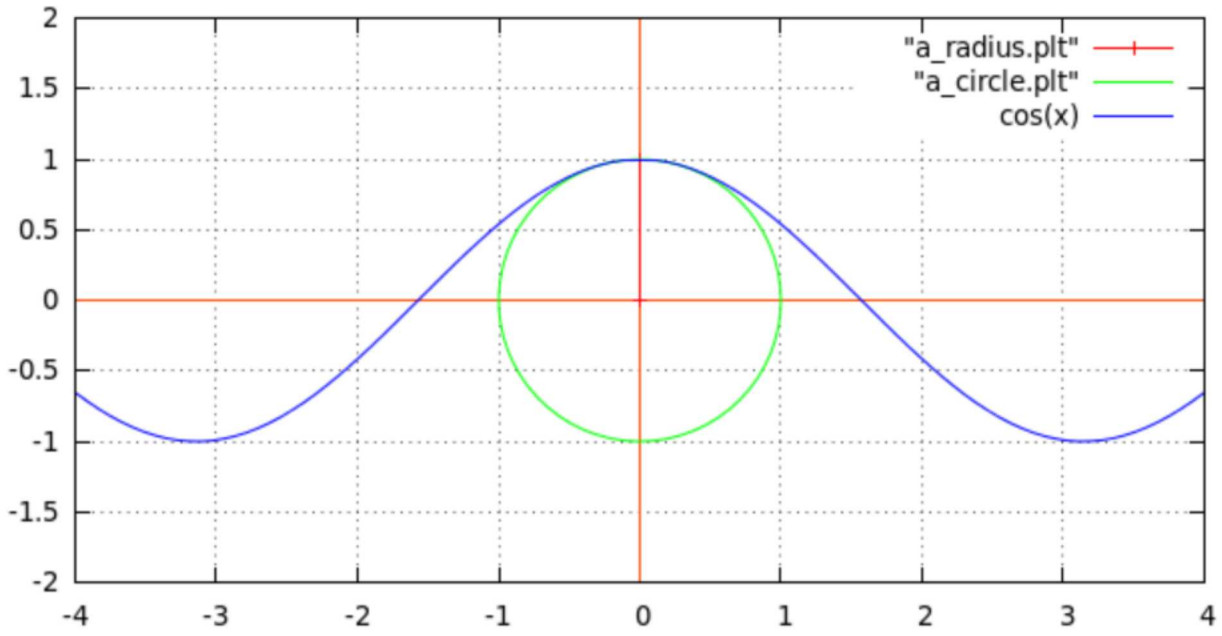
```
/* ------------------------------------ */
/*  Save as :   c01.c                   */
/* ------------------------------------ */
#include "x_ahfile.h"
#include       "fb.h"
/* ------------------------------------ */
int main(void)
{
double x = -3.5;
double e = .001;

 for(;x<3.5;x+=.1)
    {
   circle("a_circle.plt",
          1./K_y_2d(f,x,e),
          h_y_2d(f,x,e),
          k_y_2d(f,x,e));

     G_C_2d(i_WGnuplot(-4.,4.,-2.,2.),
            f,x,e,
            feq);}

 printf(" open the file \"a_main.plt\" with Gnuplot.\n\n"
        " Use the command replot of gnuplot         \n\n");

 return 0;
}
```

Le résultat.

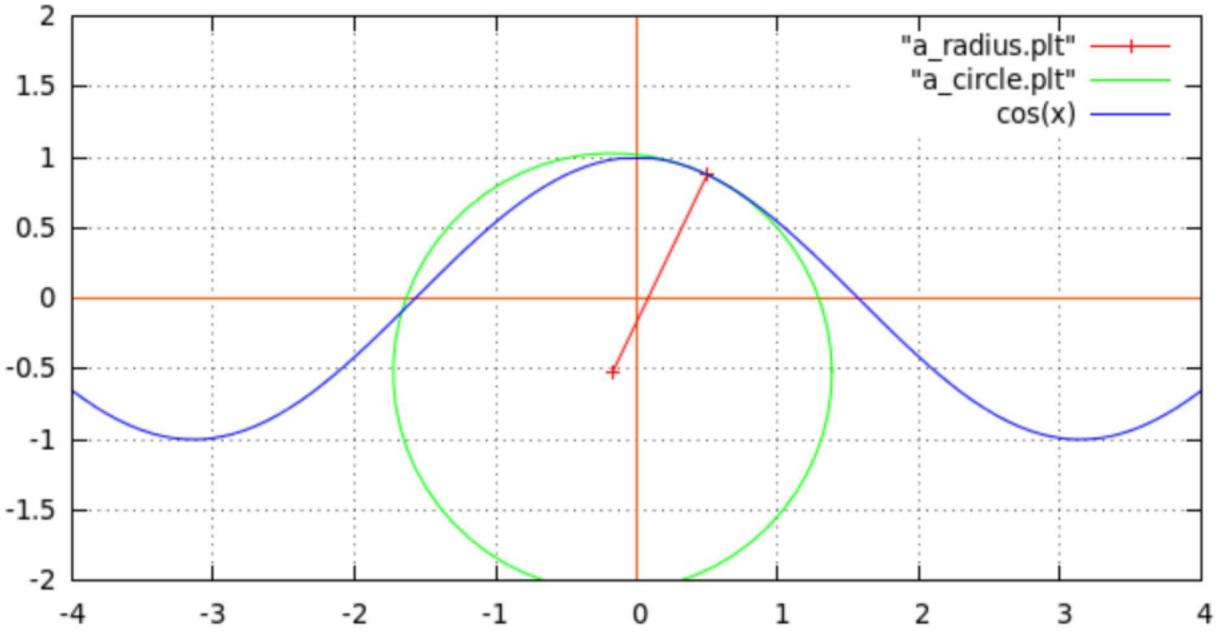
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Animation : Tangente d'une courbe

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

Animer la tangente

Nous utilisons ici la méthode avec la commande "pause 1" de gnuplot.

c01.c
Animer la tangente

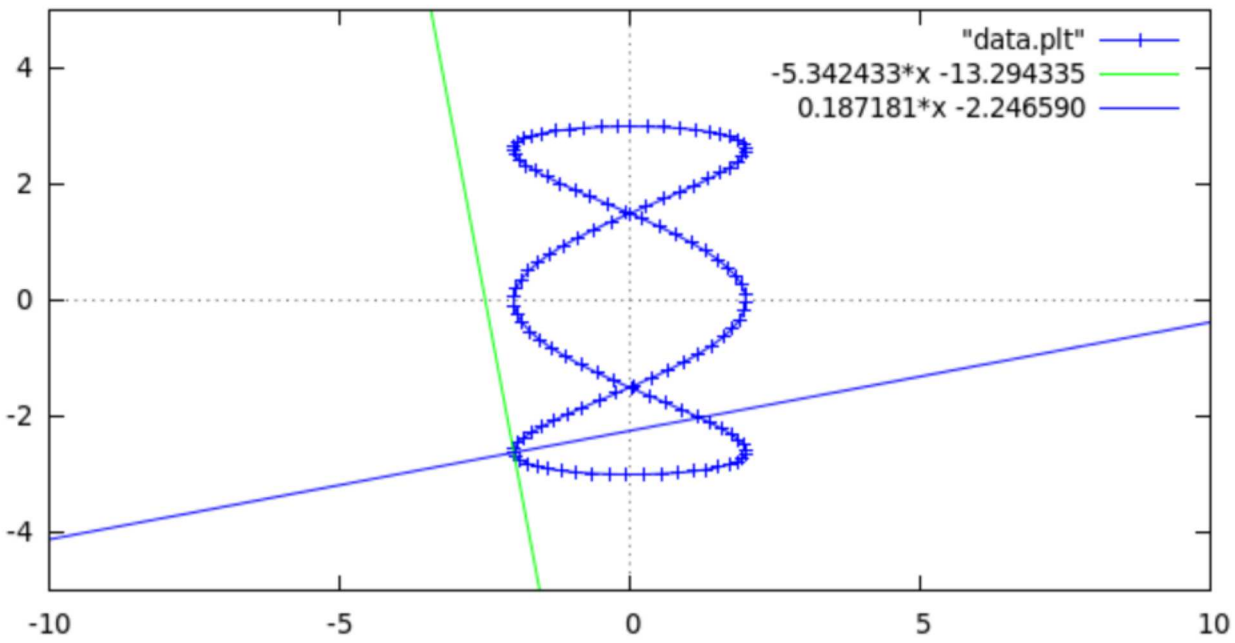
```c
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "fe.h"
/* ----------------------------------- */
int main(void)
{

 printf(" Let C be the curve consisting of all"
        " ordered pairs (f(t),g(t)).\n\n"
        " With\n\n"
        " f : t-> %s\n\n"
        " g : t-> %s\n\n", feq, geq);

  G_NormalA( i_WGnuplot(-10.,10.,-5.,5.),
             i_time( .1,2.*PI,.05),
             i_time(0.0,2.*PI,.05),
             f,
             g,
           DgDf);

 printf(" To see the curve C, open the file \"a_main.plt\""
        " with Gnuplot.\n\n"
        "\n Press return to continue");
 getchar();

 return 0;
}
```

Le résultat dans a_main.plt

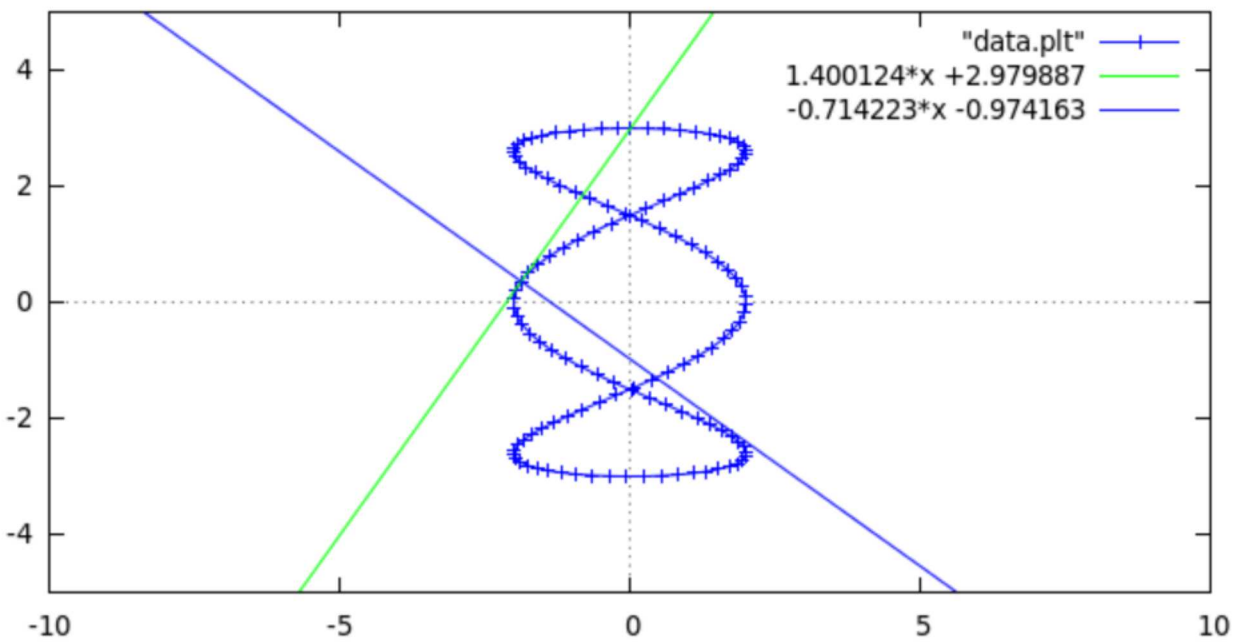
```
# Gnuplot file : load "a_main.plt"
```

```
set zeroaxis
set size ratio -1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.052250*x +3.015895, 19.138612*x -8.326680
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.082980*x +3.038500, 12.051102*x -7.517315
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.120357*x +3.076117, 8.308636*x -6.442618
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.169064*x +3.137218, 5.914933*x -5.156957
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.237705*x +3.238412, 4.206886*x -3.724725
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.344572*x +3.415897, 2.902154*x -2.216673
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.537340*x +3.764826, 1.861020*x -0.705905
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-0.993042*x +4.639209, 1.007007*x +0.736221
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
-3.388779*x +9.393329, 0.295092*x +2.044043
pause 1
plot [-10.000:10.000] [-5.000:5.000]\
"data.plt" with linesp lt 3 pt 1,\
3.303093*x -4.027901, -0.302747*x +3.161169
pause 1
reset
```

Résultat dans gnuplot



Résultat dans gnuplot



Les fichiers h de ce chapitre

`x_ahfile.h`
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include   "kg_tan.h"
```

fe.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fe.h                  */
/* ---------------------------------- */
double f(
double t)
{
double a=2;
double k1=3;

        return( a*sin(k1*t) );
}
char  feq[] =  "a*sin(k1*t)";
/* ---------------------------------- */
double Df(
double t)
{
double a=2;
double k1=3;

        return( a*cos(k1*t)*k1);
}
char  Dfeq[] =  "a*cos(k1*t)*k1";
/* ---------------------------------- */
double g(
double t)
{
double b =3;
double k2=1;
        return( b*cos(k2*t) );
}
char  geq[] =  "b*cos(k2*t)";
/* ---------------------------------- */
double Dg(
double t)
{
double b =3;
double k2=1;
        return(  -b*sin(k2*t)*k2 );
}
char  Dgeq[] =  "-b*sin(k2*t)*k2";
/* ---------------------------------- */
```

```
double DgDf(
double t)
{
        return(Dg(t)/Df(t));
}
```

kg_tan.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_tan.h              */
/* ---------------------------------- */
void G_NormalA(
W_Ctrl W,
t_Ctrl C,
t_Ctrl T,
double (*P_f)  (double t),
double (*P_g)  (double t),
double (*PDgDf)(double t)
)
{
FILE   *fp;
double c;
double t;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n\n"
           " set zeroaxis\n"
           " set size ratio -1\n");

for(c=C.mini; c<C.maxi; c+=C.step)
{
fprintf(fp," plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"data.plt\" with linesp lt 3 pt 1,\\\n"
           " %0.6f*x %+0.6f,"
           " %0.6f*x %+0.6f\n"
           " pause 1\n",
        W.xmini,W.xmaxi,W.ymini,W.ymaxi,
    (*PDgDf)(c),
            (-(*PDgDf)(c)*(*P_f)(c)+(*P_g)(c)),
-1./(*PDgDf)(c),
        -1./(-(*PDgDf)(c))*(*P_f)(c)+(*P_g)(c));
}
fprintf(fp," reset");
 fclose(fp);

        fp = fopen("data.plt","w");
 for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.6f   %6.6f\n",
                (*P_f)(t),(*P_g)(t));
 fclose(fp);
}
```

Animation : Cercle de courbure d'une courbe

Préambule

Cercle de courbure dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et de recuperer aussi ceux du chapitre Dessiner : Cercle de courbure d'une courbe.

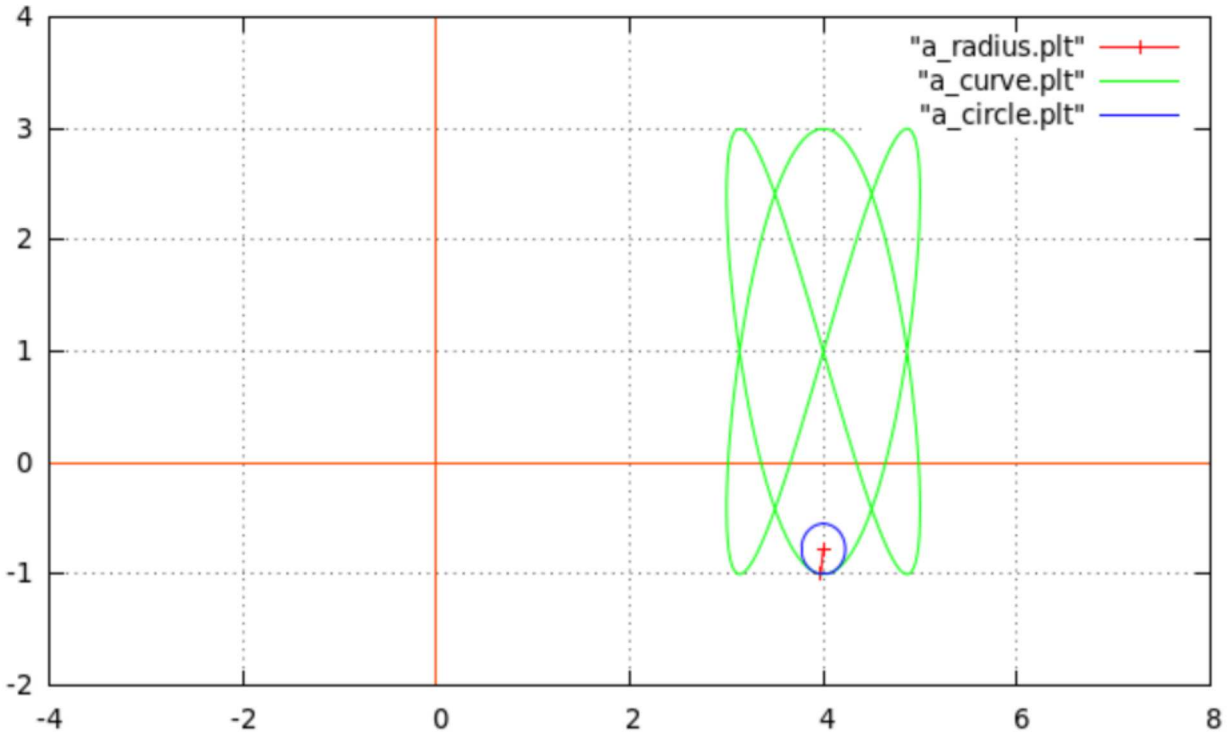
Animer

c01.c
Animer le cercle de courbure pour une fonction (f(t),g(t)).

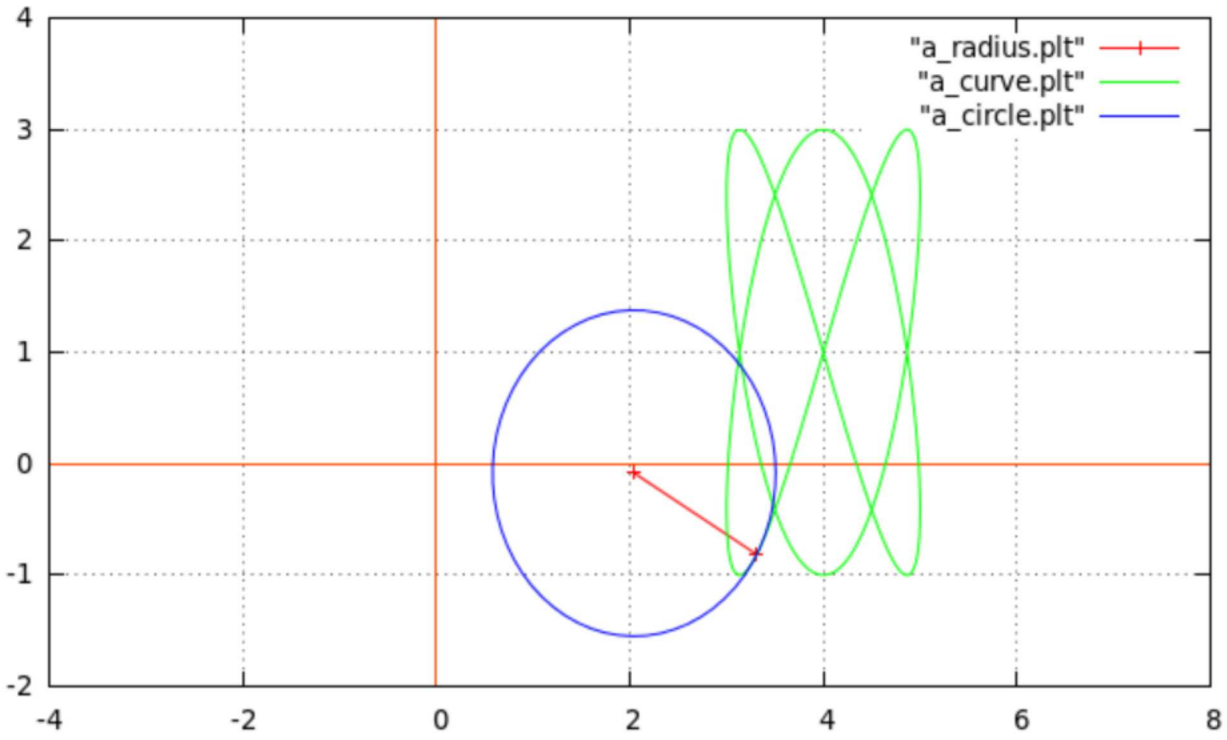
```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "fb.h"
/* ----------------------------------- */
int main(void)
{
double t = 0.;
double e = .001;

 for(;t<2*PI;t+=.03)
    {
     circle("a_circle.plt",
               1./fabs(Kt_2d(f,g,t,e)),
                  cx_2d(f,g,t,e),
                  cy_2d(f,g,t,e));

     G_C_2d(i_WGnuplot(-4,8,-2,4),
            i_time(0.,2*PI,.03),
             f,g,t,
             e);
    }

 printf(" open the file \"a_main.plt\" with Gnuplot.\n\n"
        " Use the command replot of gnuplot         \n\n");

 return 0;
}
```

Le résultat.

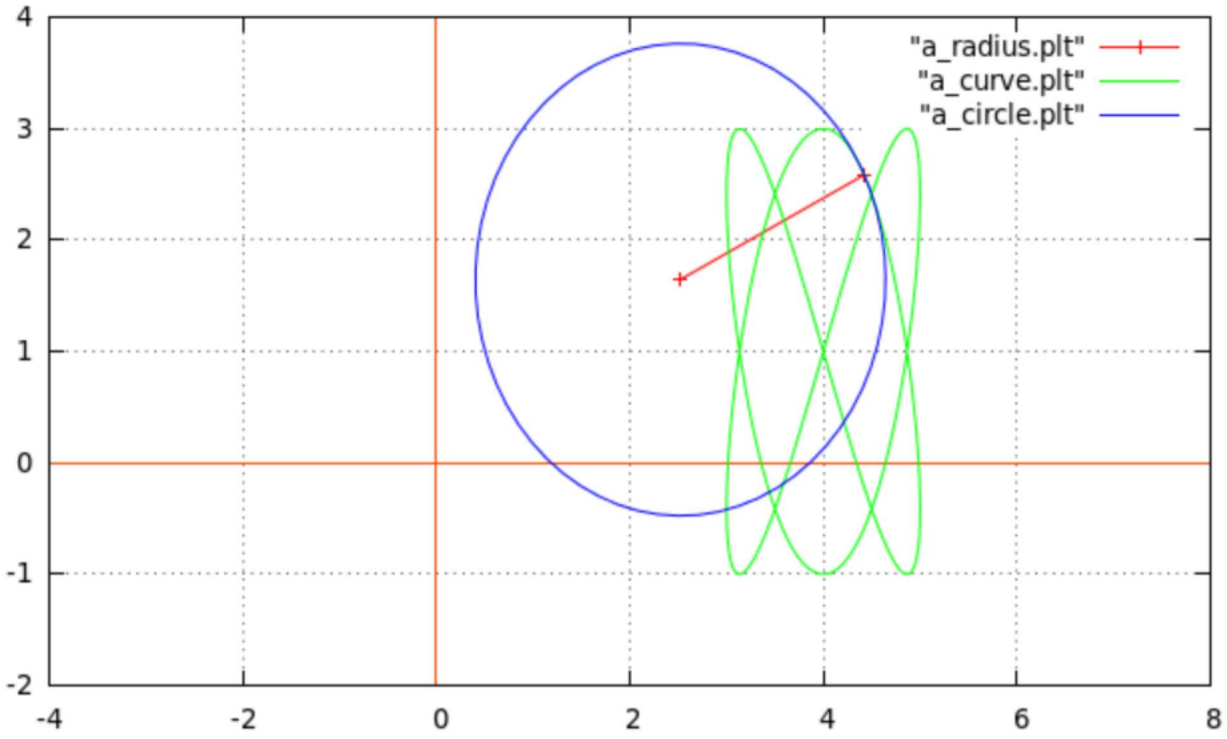
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Animation : Cycloïde

Préambule

La cycloïde dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

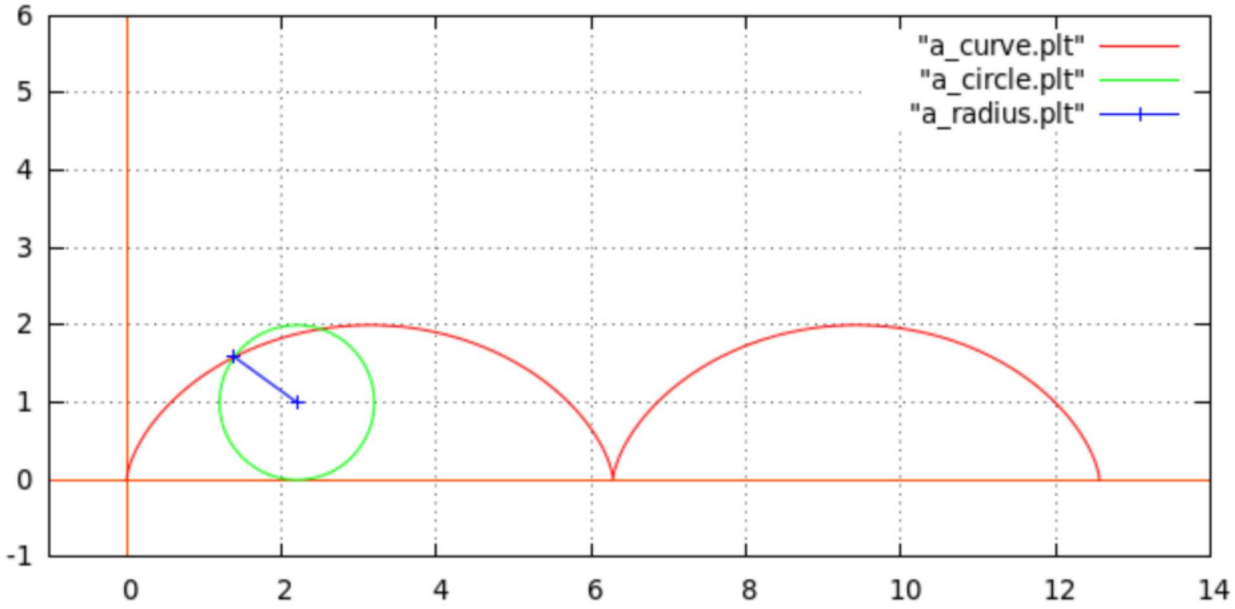
Animer

c01.c
Animer une cycloide

```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
/* ----------------------------------- */
int main(void)
{
double x=0;

 printf(" Let C be the curve consisting of all ordered \n"
        " pairs (f(t),g(t)) \n\n"
        " f : t-> %s\n"
        " g : t-> %s\n",feq,feq);

printf("\n\n Open the file \"a_main.plt\" with Gnuplot."
       "\n\n Use the \"replot\" command of gnuplot.\n\n");

 for(;x<4*PI;x+=.1)

   G_CurveA(i_WGnuplot(-1.,14,-1.,6.),
            i_time(0.,4.*PI,.01),
            f,g,
            x);

 printf(" Press return to continue\n");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include    "curve.h"
#include "kg_curve.h"
```

curve.h
La fonction à dessiner

```
/* ---------------------------------- */
```

```
/*  Save as :   curve.h                  */
/* ---------------------------------- */
double f(
double t)
{
        return(1*t-sin(t));
}
char  feq[] = "1*t-sin(t)";
/* ---------------------------------- */
double g(
double t)
{
        return(1-cos(t));
}
char  geq[] = "1-cos(t)";
/* ---------------------------------- */
```

kg_curve.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_curve.h              */
/* ---------------------------------- */
void G_CurveA(
W_Ctrl W,
t_Ctrl T,
double (*P_f)(double t),
double (*P_g)(double t),
double x
)
{
FILE   *fp;
double  t;

        fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
           " set size ratio -1\n"
           " set grid\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_curve.plt\" with line, \\\n"
           " \"a_circle.plt\" with line,\\\n"
           " \"a_radius.plt\" with linesp",
     W.xmini,W.xmaxi,W.ymini,W.ymaxi);
 fclose(fp);

        fp = fopen("a_curve.plt","w");
  for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.5f   %6.5f\n",(*P_f)(t),(*P_g)(t));
  fclose(fp);

        fp = fopen("a_radius.plt","w");
  fprintf(fp," %6.5f   1.000\n",x);
  fprintf(fp," %6.5f   %6.5f\n",(*P_f)(x),(*P_g)(x));
  fclose(fp);

        fp = fopen("a_circle.plt","w");
  for(t=0;t<2.01*PI;t+=.1)
     fprintf(fp," %6.5f %6.5f\n",cos(t)+x,sin(t)+1);
  fclose(fp);
```

```
  Pause();
}
```

Animation : Cardioïde

Préambule

La cardioïde dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

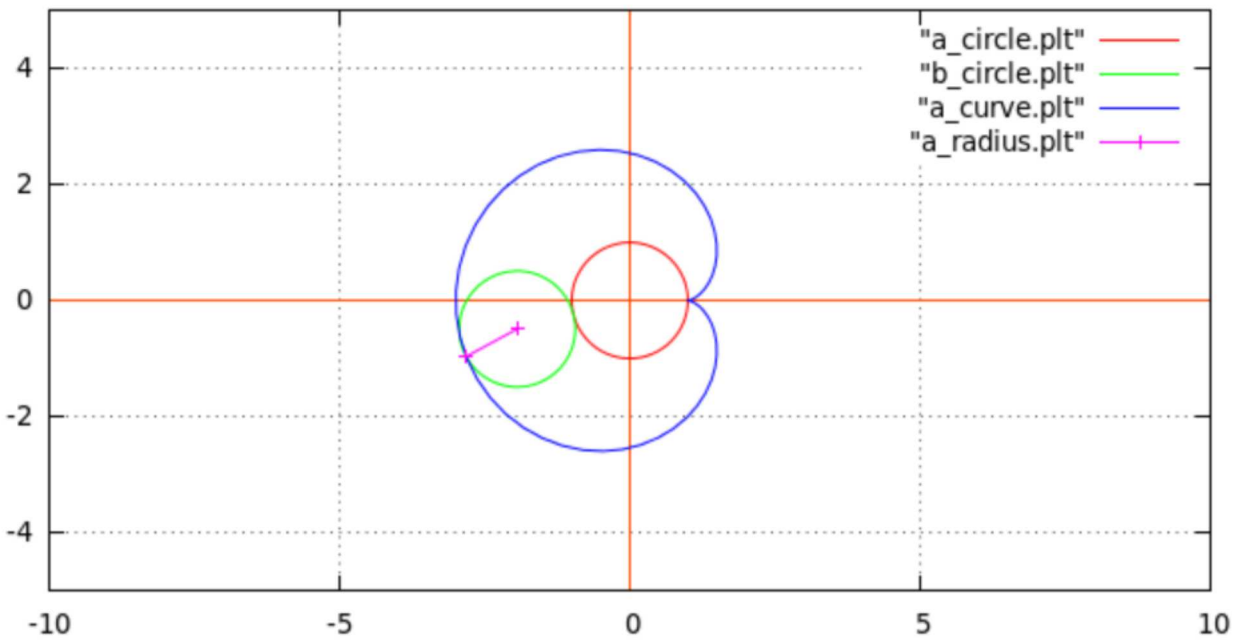
Animer

c01.c
Animer une cardioïde

```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
/* ----------------------------------- */
int main(void)
{
double x;

 printf(" Let C be the curve consisting of all ordered \n"
        " pairs (f(t),g(t)) \n\n"
        " f : t-> %s\n"
        " g : t-> %s\n",feq,feq);

printf("\n\n Open the file \"a_main.plt\" with Gnuplot."
       "\n\n Use the \"replot\" command of gnuplot.\n\n");

 for(x=0;x<2.01*PI;x+=.03)

     G_C_2d(i_WGnuplot(-10.,10,-5.,5.),
            i_time(0.,2.*PI,.1),
            f,g,x);

 printf(" Press return to continue\n");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h de ce chapitre

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include    "curve.h"
#include "kg_curve.h"
```

curve.h
La fonction à dessiner

```
/* ---------------------------------- */
```

```
/*  Save as :   curve.h                 */
/* ---------------------------------- */
double f(
double t)
{
double a=1;

        return( a*(2*cos(t)-cos(2*t)));
}
char  feq[] =  "a*(2*cos(t)-cos(2*t))";
/* ---------------------------------- */
double g(
double t)
{
double a=1.;

        return( a*(2*sin(t)-sin(2*t)));
}
char  geq[] =  "a*(2*sin(t)-sin(2*t))";
```

kg_curve.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_curve.h             */
/* ---------------------------------- */
void G_C_2d(
W_Ctrl W,
t_Ctrl T,
double (*P_f)(double t),
double (*P_g)(double t),
double x
)
{
FILE   *fp;
double  t;

        fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
           " set size ratio -1\n"
           " set grid\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_circle.plt\" with line,\\\n"
           " \"b_circle.plt\" with line,\\\n"
           " \"a_curve.plt\" with line, \\\n"
           " \"a_radius.plt\" with linesp",
        W.xmini,W.xmaxi,W.ymini,W.ymaxi);
 fclose(fp);

          fp = fopen("a_curve.plt","w");
for(t=T.mini; t<=T.maxi; t+=T.step)
  fprintf(fp," %6.5f %6.5f\n",(*P_f)(t),(*P_g)(t));
   fclose(fp);

         fp = fopen("a_radius.plt","w");
 fprintf(fp," %6.5f  %6.5f\n",2*cos(x)+0,2*sin(x)+0);
 fprintf(fp," %6.5f  %6.5f\n",(*P_f)(x),(*P_g)(x));
  fclose(fp);
```

```
        fp = fopen("a_circle.plt","w");
for(t=0;t<2.01*PI;t+=.1)
  fprintf(fp," %6.5f %6.5f\n",cos(t)+0,sin(t)+0);
   fclose(fp);

         fp = fopen("b_circle.plt","w");
for(t=0;t<2.01*PI;t+=.1)
   fprintf(fp," %6.5f %6.5f\n",
          cos(t)+2*cos(x),sin(t)+2*sin(x));
   fclose(fp);

  Pause();
}
```

Animation : Rosace

Préambule

Coordonnées polaires dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

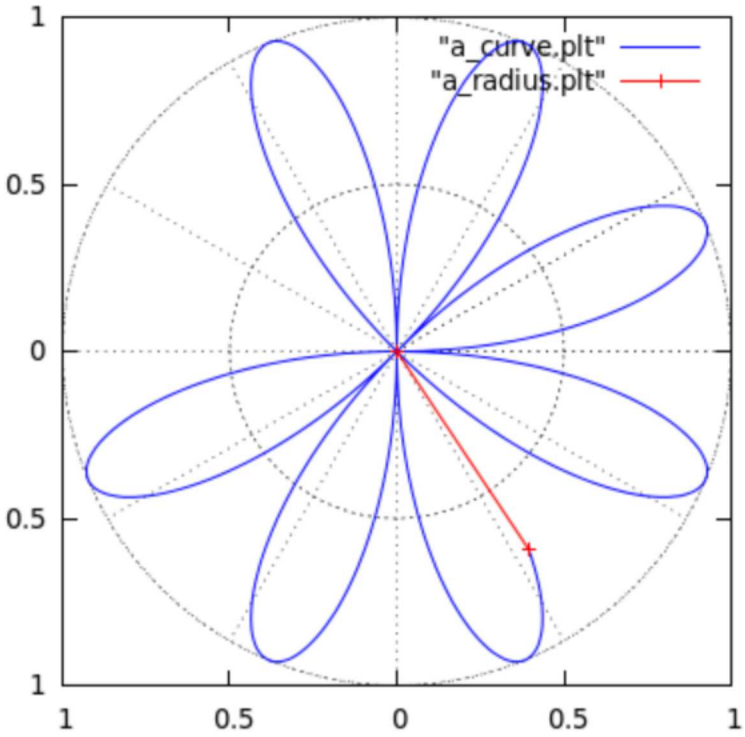
Animer

c01.c
Animer une rosace

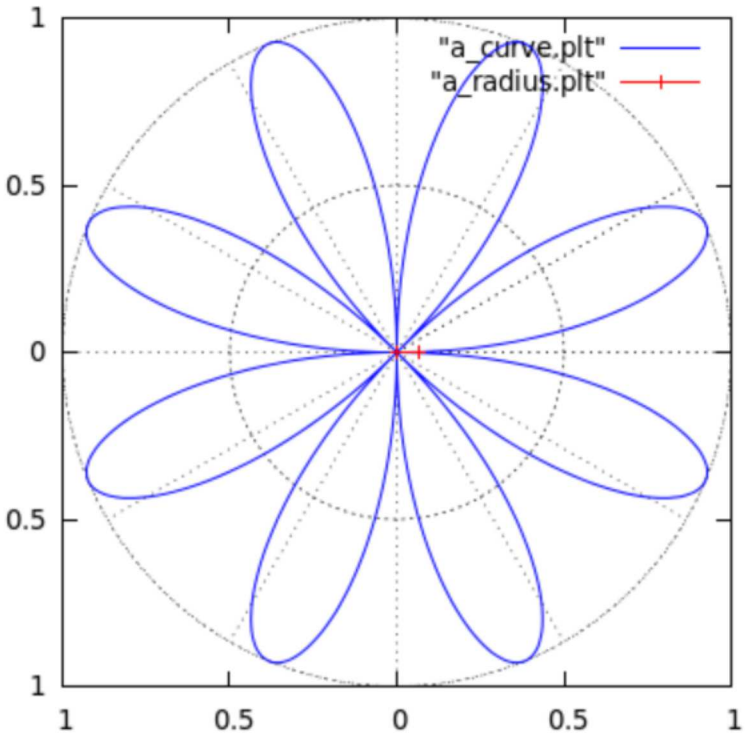
```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fr.h"
/* ---------------------------------- */
int main(void)
{
double maxi;

 printf(" r : t-> %s\n\n", req);

 printf("\n\n Open the file \"a_main.plt\" with Gnuplot."
        "\n\n Use the \"replot\" command of gnuplot.\n\n");

 for(maxi=0;maxi<=2.*PI+.1;maxi+=.1)

     G_polar(i_WGnuplot(-1.,1.,-1.,1.),
             i_time(0,maxi,0.01),
             r);

 printf("\n Press return to continue");
 getchar();
 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Résultat dans gnuplot



Les fichiers h de ce chapitre

`x_ahfile.h`
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
/* ---------------------------------- */
#include "kg_polar.h"
```

fr.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fr.h                  */
/* ---------------------------------- */
double r(
double t)
{
double n=4;

        return( sin(n*t));
}
char  req[] =  "sin(n*t)";
```

kg_polar.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_polar.h            */
/* ---------------------------------- */
void G_polar(
W_Ctrl W,
t_Ctrl T,
double (*P_r)(double k)
)
{
FILE   *fp;
double  t;

        fp = fopen("a_main.plt","w");
fprintf(fp," set size ratio -1\n"
           " set polar\n"
           " set grid polar\n\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           " \"a_curve.plt\" with line lt 3, \\\n"
           " \"a_radius.plt\" with linesp lt 1 pt 1",
           0., 2.*PI,W.xmini,W.xmaxi,W.ymini,W.ymaxi);
```

```
 fclose(fp);

        fp = fopen("a_curve.plt","w");
  for(t=T.mini; t<=T.maxi; t+=T.step)
     fprintf(fp," %6.3f   %6.3f\n",t,(*P_r)(t));
 fclose(fp);

          fp = fopen("a_radius.plt","w");
  fprintf(fp," 0.  0. \n  %6.3f  %6.3f\n",
            t-T.step,(*P_r)(t-T.step));
 fclose(fp);

    Pause();
}
```

Animation : Vecteur unitaire

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés et ceux de ce chapitre.

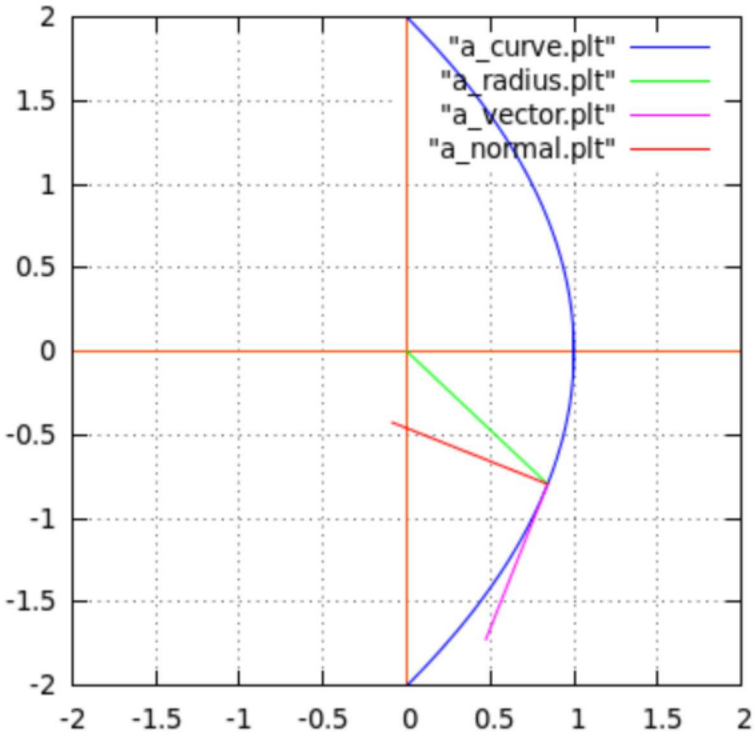
Animer

c01.c
Animer a un vecteur normale unitaire et un vecteur tangent unitaire.

```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fb.h"
/* ---------------------------------- */
int main(void)
{
double t=0.;

 printf(" r(t) = f(t)i + g(t)j \n\n"
        " With \n\n"
        " f : t-> %s  \n"
        " g : t-> %s\n\n",feq,geq);

printf("\n\n Open the file \"a_main.plt\" with Gnuplot."
       "\n\n Use the \"replot\" command of gnuplot.\n\n");

 for(;t<4.*PI;t+=.05)

     G_Curve_2d(i_WGnuplot(-2,2,-2,2),
                i_time( 0.,4.*PI,.05),
                f,g,Tf,Tg,
                t);

 printf(" Press return to continue\n");
 getchar();

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Les fichiers h partagés

x_ahfile.h
Appel des fichiers

```
/* ---------------------------------- */
/*  Save as :   x_ahfile.h            */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
#include   <string.h>
/* ---------------------------------- */
#include     "xdef.h"
#include     "xplt.h"
#include    "xfx_x.h"
/* ---------------------------------- */
#include   "knfx_x.h"
#include "kg_ctan1.h"
```

knfx_x.h
Normalisé

```
/* ---------------------------------- */
```

```
/*  Save as :   knfx_x.h                  */
/* ---------------------------------- */
double fx_x_Normalize(
double (*P_f)(double x),
double (*P_g)(double x),
double t,
double e
)
{
double Df=fx_x((*P_f),t,e);
double Dg=fx_x((*P_g),t,e);

 return(Df/sqrt(Df*Df+Dg*Dg));
}
```

fb.h
La fonction à dessiner

```
/* ---------------------------------- */
/*  Save as :   fb.h                  */
/* ---------------------------------- */
double f(
double t)
{
        return( cos(t)*cos(t));
}
char  feq[] =  "cos(t)**2";
/* ---------------------------------- */
double g(
double t)
{
        return( 2*sin(t));
}
char  geq[] =  "2*sin(t)";
/* ---------------------------------- */
double Tf(
double t)
{
return(
 (-cos(t)*sin(t))
      /
 sqrt(pow(cos(t),2)*pow(sin(t),2)+pow(cos(t),2)));
}
/* ---------------------------------- */
double Tg(
double t)
{
return(
 cos(t)
    /
 sqrt(pow(cos(t),2)*pow(sin(t),2)+pow(cos(t),2)));
}
/* ---------------------------------- */
```

kg_ctan1.h
La fonction graphique

```
/* ---------------------------------- */
/*  Save as :   kg_ctan1.h            */
/* ---------------------------------- */
void G_Curve_2d(
W_Ctrl W,
t_Ctrl T,
double (*P_f)(double t),
double (*P_g)(double t),
double (*P_Tf)(double t),
double (*P_Tg)(double t),
double t
)
{
FILE  *fp;
double  i;
double  e=.001;

fp = fopen("a_main.plt","w");
fprintf(fp," reset\n"
           " set zeroaxis lt 8\n"
           " set grid\n\n"
           " set size ratio -1\n"
           " plot [%0.3f:%0.3f] [%0.3f:%0.3f]\\\n"
           " \"a_curve.plt\" with line lt 3,\\\n"
           " \"a_radius.plt\" with line lt 2,\\\n"
           " \"a_vector.plt\" with line lt 4,\\\n"
           " \"a_normal.plt\" with line lt 1 \n",
          W.xmini,W.xmaxi,W.ymini,W.ymaxi);
fclose(fp);

            fp = fopen("a_curve.plt","w");
for(i=T.mini; i<=T.maxi+T.step; i+=T.step)
    fprintf(fp," %6.3f  %6.3f\n",(*P_f)(i),(*P_g)(i));
     fclose(fp);

        fp = fopen("a_radius.plt","w");
fprintf(fp,"  0  0   \n %6.5f  %6.5f  \n",
          (*P_f)(t),(*P_g)(t));
 fclose(fp);

        fp = fopen("a_vector.plt","w");
fprintf(fp,"  %6.5f  %6.5f \n  %6.5f  %6.5f \n",
       (*P_f)(t),
       (*P_g)(t),
       (*P_f)(t)+fx_x_Normalize((*P_f),(*P_g),t,e),
       (*P_g)(t)+fx_x_Normalize((*P_g),(*P_f),t,e) );
 fclose(fp);

        fp = fopen("a_normal.plt","w");
fprintf(fp,"  %6.5f  %6.5f \n  %6.5f  %6.5f \n",
       (*P_f)(t),
       (*P_g)(t),
       (*P_f)(t)+fx_x_Normalize((*P_Tf),(*P_Tg),t,e),
       (*P_g)(t)+fx_x_Normalize((*P_Tg),(*P_Tf),t,e) );
 fclose(fp);

 Pause();
}
```

Animation : Courbe de Bézier

Préambule

Les courbes de Béziers dans Wikipedia.

Courbes de Béziers cubiques (normale ou rationnelle)

L'animation

N'oubliez pas les fichiers *.h partagés et les fichiers *.h dans les chapitres Courbe de Bézier ou Courbe de Bézier rationnelle.

Cet exemple fonctionne pour les deux types de courbes (normale,rationnelle).

c01.c
Courbe de béziers

```c
/* ---------------------------------- */
/*  Save as :  c01.c                  */
/* ---------------------------------- */
#include "x_ahfile.h"
/* ---------------------------------- */
int main(void)
{
int Pic=80;

 printf("\n\n load \"a_main.plt\" with gnuplot."
        "\n\n Use replot to see the animation  "
        "\n\n Press return to continue         ");

 while(Pic--)

    G_quadratic_Bezier_lp_2d(
             i_WGnuplot(-10,90,-10,50),
             i_point2d(Pic,10.),
             i_point2d(40.,40.),
             i_point2d(60.,10.));

 return 0;
}
```

Animation : Fonction vectorielle 3D

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés. Recuperer aussi ceux du chapitre Dessiner : Fonction vectorielle 3D.

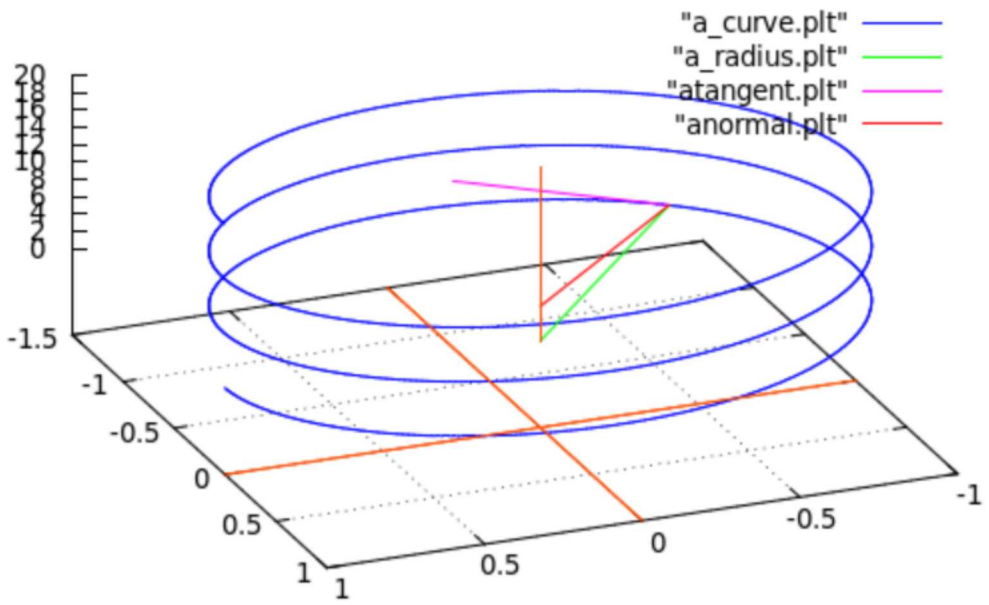
Animer

c01.c
Animer un vecteur tangent et normales unitaire

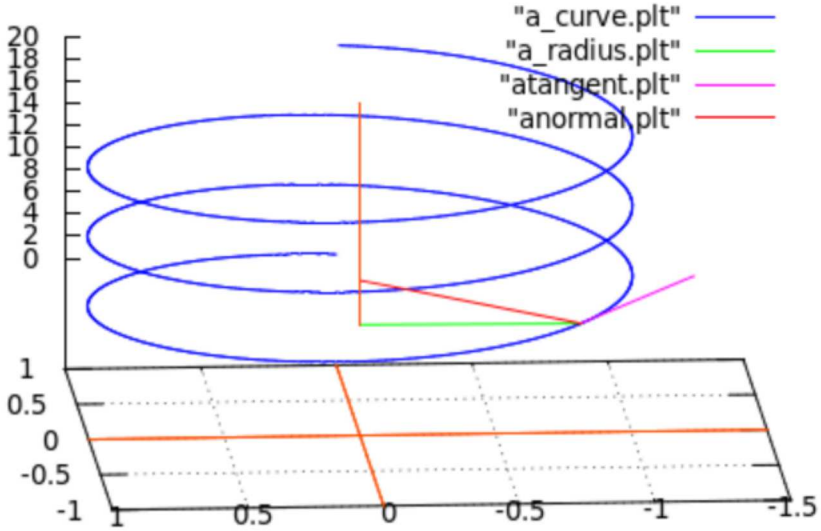
```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
 main(void)
{
double t=0;

 printf(" r(t) = f(t)i + g(t)j + h(t)k \n\n");
 printf(" With \n\n");
 printf(" f : t-> %s  \n", feq);
 printf(" g : t-> %s  \n", geq);
 printf(" h : t-> %s\n\n", heq);

printf("\n\n Open the file \"a_main.plt\" with Gnuplot."
       "\n\n Use the \"replot\" command of gnuplot.\n\n");

 for(;t<6.*PI;t+=.05)

     G_Curve_3d(i_time(0.,6.*PI,.01),
                f,g,h,
                Tf,Tg,Th,
                t);

 printf(" open the file \"a_main.plt\" with Gnuplot.\n\n"
        " Use the command replot of gnuplot         \n\n");

 return 0;
}
```

Le résultat.

Résultat dans gnuplot



Résultat dans gnuplot



Animation : Tangente de f(x,y)

Préambule

La tangente dans Wikipedia.

Présentation

N'oubliez pas les fichiers *.h partagés. Recuperer aussi ceux du chapitre Dessiner : Tangente de f(x,y).

Dessiner la tangente

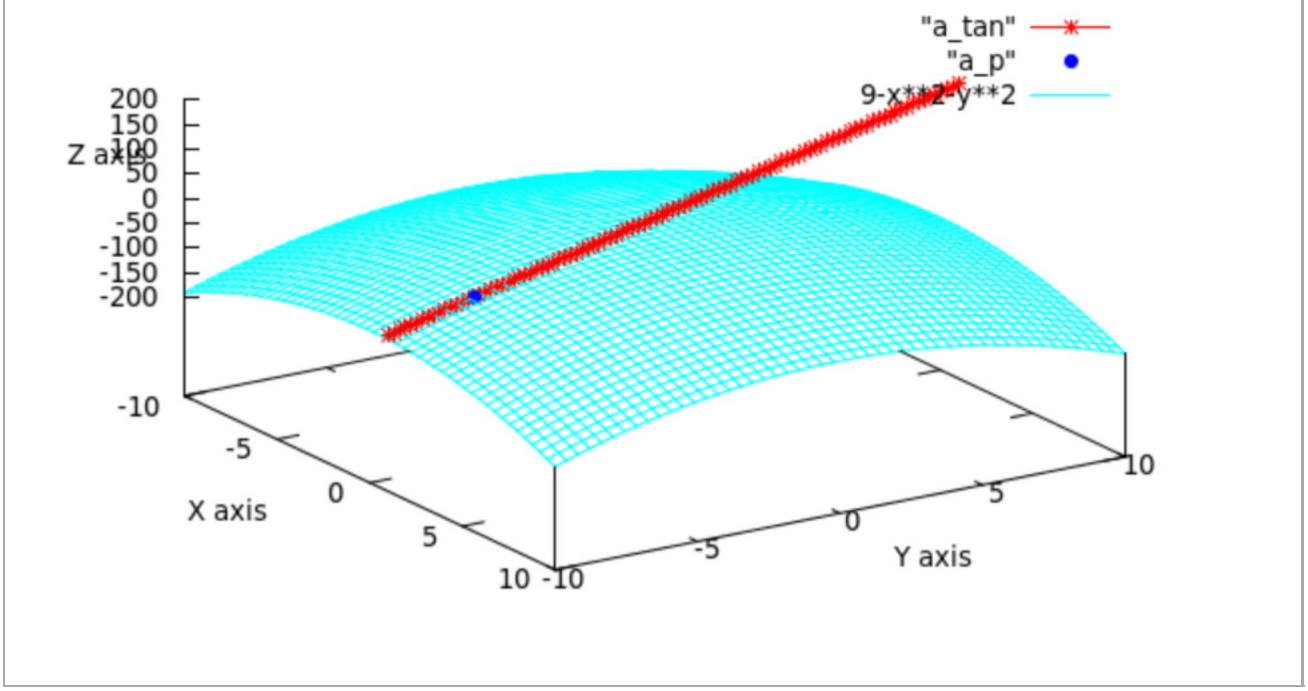
- La méthode consiste à poser :
  - x = i (ici i=1).
  - D'utiliser la dérivée partielle par rapport à y.
  - Puis écrire l'équation de la tangente d'une fonction en y.

c01.c
Dessiner la tangente

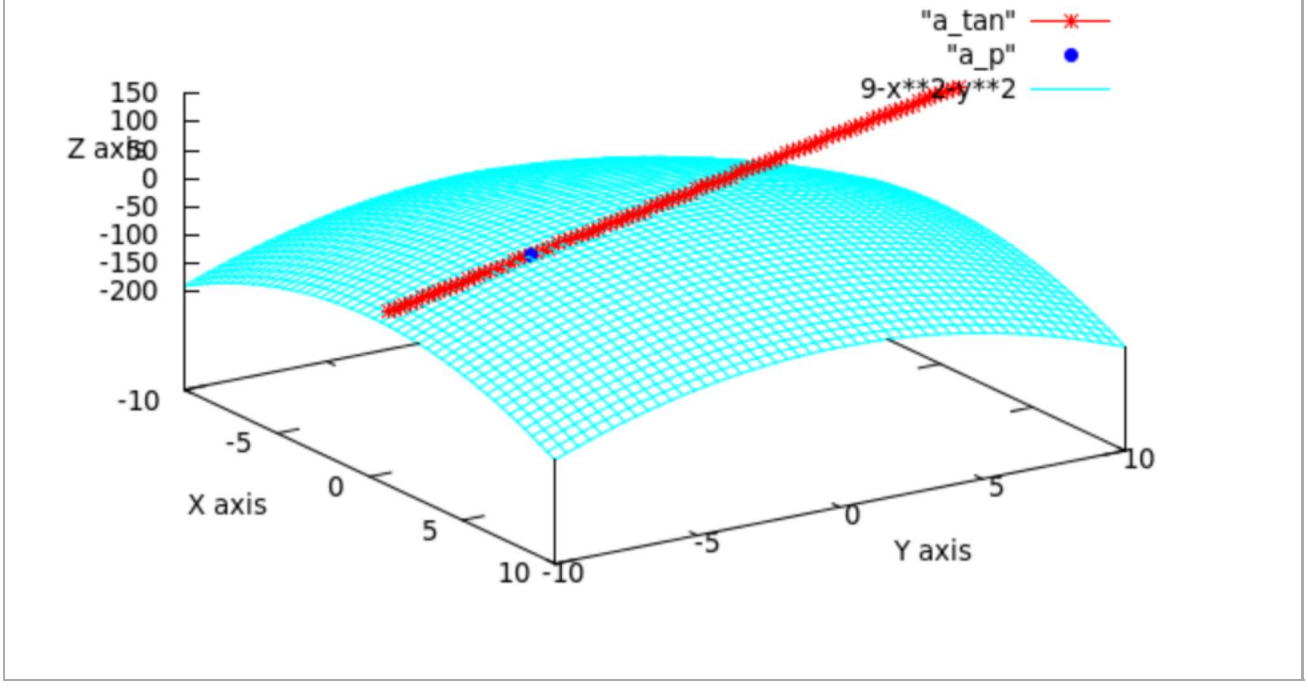
```
/* ----------------------------------- */
/*  Save as :   c01.c                  */
/* ----------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ----------------------------------- */
int main(void)
{
double n = -10;

 while((n+=.2)<10)

     G_3d_p( i_WGnuplot(-10.,10.,-10.,10.),
             i_VGnuplot( 55.,57.,  1., 1.),
             feq,f,
             i_point2d(1,n));

printf(" Open the file \"a_main.plt\" with Gnuplot.\n\n"
       " Use the \"replot\" command of gnuplot.    \n\n"
       " Press return to continue.                 \n\n");

 return 0;
}
```

Le résultat.

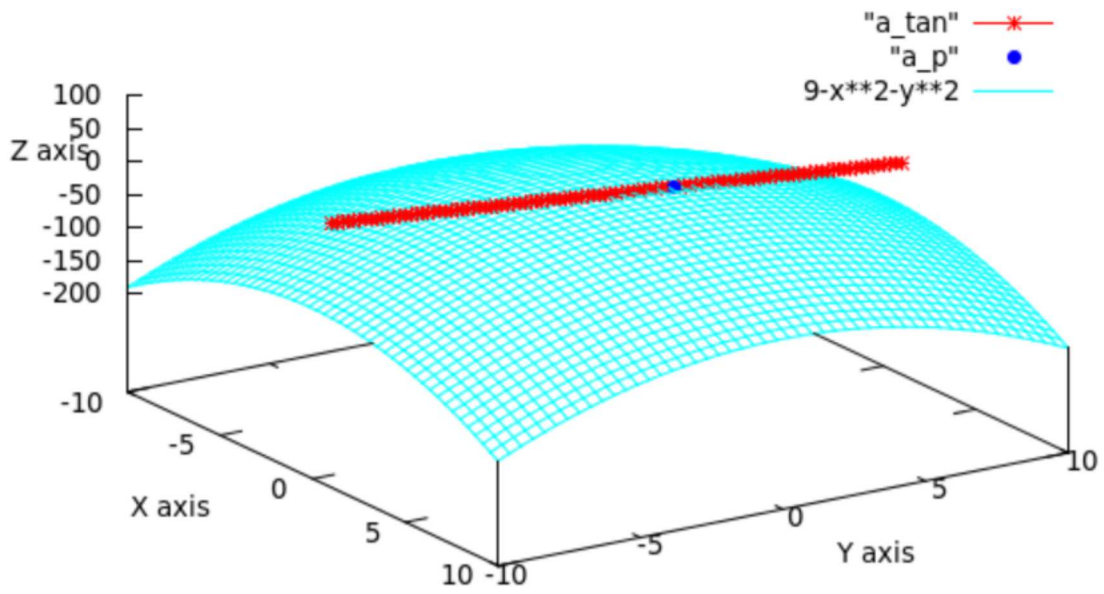
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Animation : Vecteur normal

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés. Récupérer aussi ceux du chapitre Dessiner : Vecteur normal.

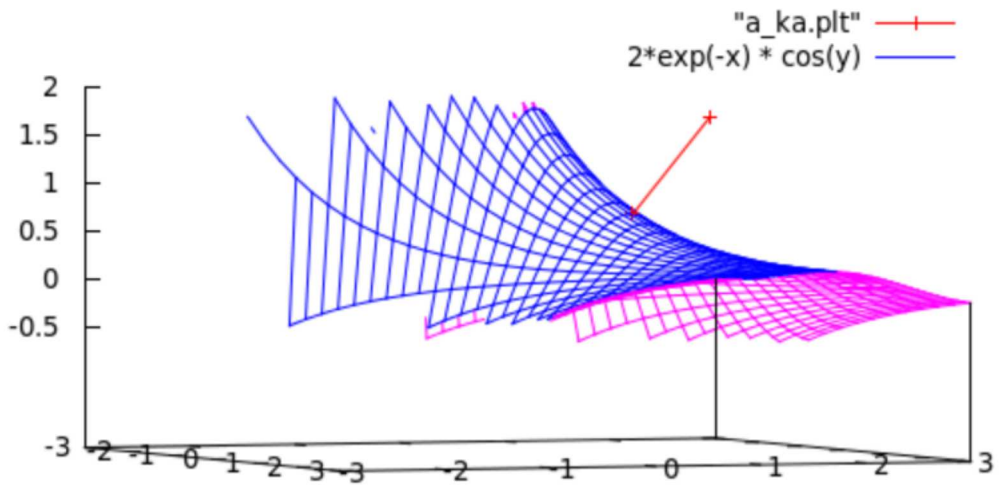
Dessiner le vecteur normale au point P

c01.c
Dessiner le vecteur normale au point P

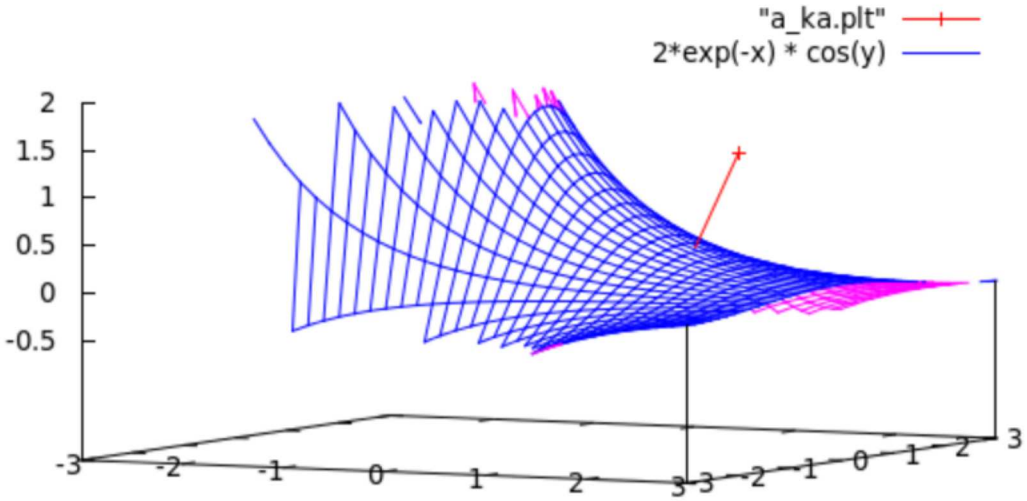
```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
double n = 0;

   printf(" Draw the normal vector at the point P.\n\n"
          " f : (x,y)-> %s\n\n", feq);

 while((n+=.05)<2.8)

     G_3d_v(i_WsGnuplot(-3,3,-3,3,-.5,2),
            i_VGnuplot( 94.,22.,1.,1.),
            feq,f,f_z,
            i_point2d(n,0.));

printf(" Open the file \"a_main.plt\" with Gnuplot.\n\n"
       " Use the \"replot\" command of gnuplot.    \n\n"
       " Press return to continue.                 \n\n");

 getchar();

 return 0;
}
```

Le résultat.

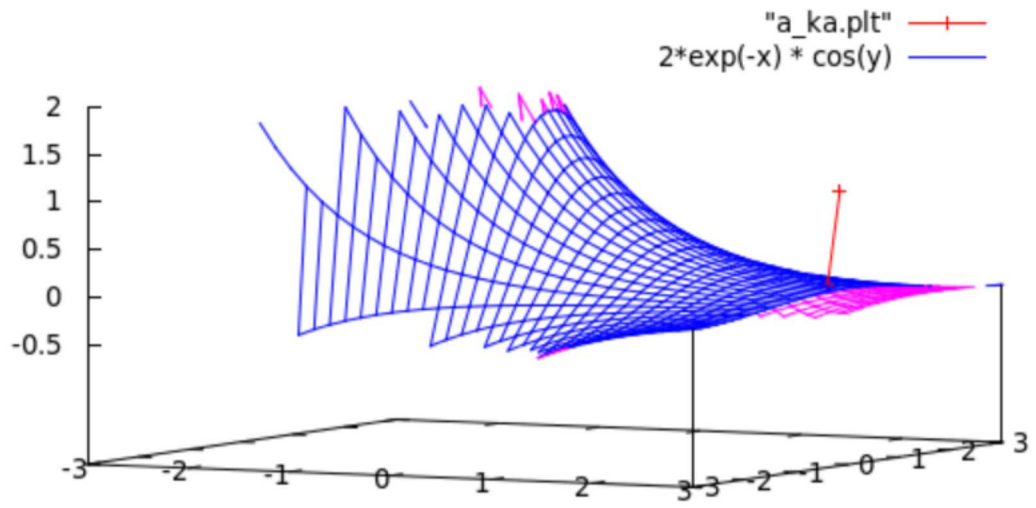
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Animation : Plan tangent

Préambule

Présentation

N'oubliez pas les fichiers *.h partagés. Récupérer aussi ceux du chapitre Dessiner : Plan tangent'.

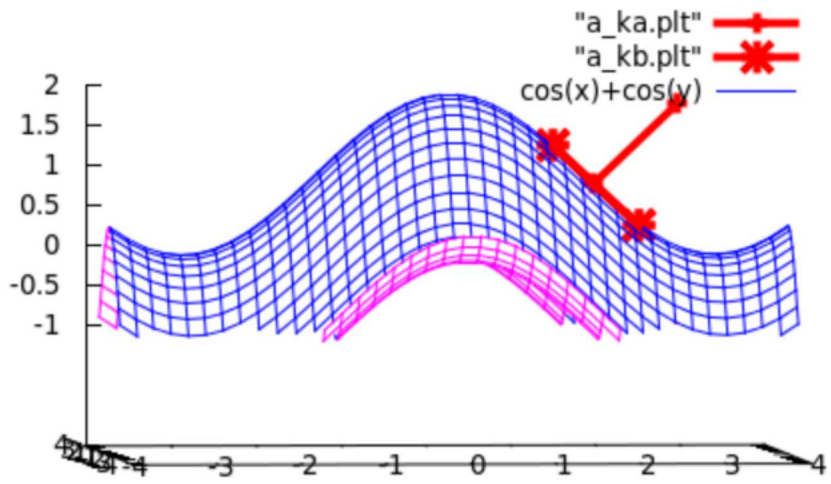
Animer le plan tangent au point P

c01.c
Animer le plan tangent au point P

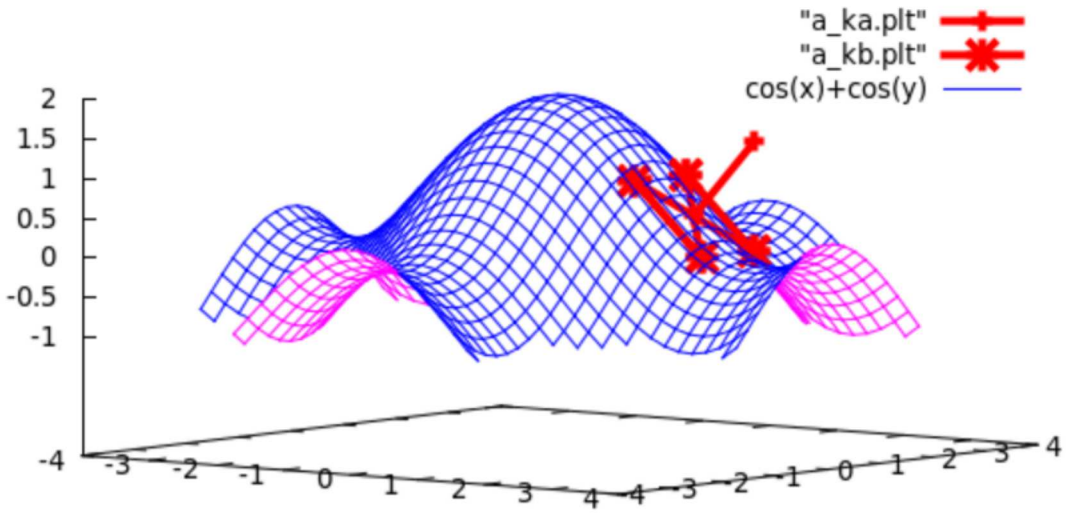
```c
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "x_ahfile.h"
#include       "fa.h"
/* ---------------------------------- */
int main(void)
{
double n = 0;

 printf(" Draw the Tangent plane.\n\n"
        " f : (x,y)-> %s\n\n", feq);

 while((n+=.05)<3.8)

     G_3d_v( i_WsGnuplot(-4,4,-4,4,-1,2),
             i_VGnuplot( 80.,38.,1.,1.),
             feq,f,f_z,
             i_point2d(n,0.));

printf(" Open the file \"a_main.plt\" with Gnuplot.\n\n"
       " Use the \"replot\" command of gnuplot.    \n\n"
       " Press return to continue.                 \n\n");

 getchar();

 return 0;
}
```

Le résultat.

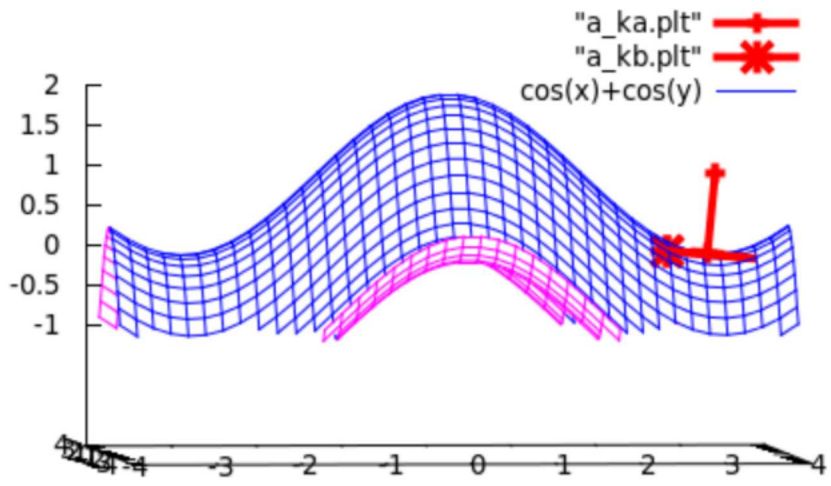
Résultat dans gnuplot



Résultat dans gnuplot



Résultat dans gnuplot



Présentation de la librairie

Préambule

La géométrie de la tortue dans Wikipedia.

Dans ce chapitre, nous présenterons un exemple (c01.c) et la librairie (*.h). Le code des fonctions de la librairie ne sont pas à étudier. Dans un premier temps, amusez-vous simplement avec ces fonctions.

Présentation

- Les commandes d'initialisation :
  - **U = GINIT(-10.,10.,-10.,10.);
    - création de la matrice.
    - initialisation de la fenêtre de gnuplot
  - F_mR(U); Destruction de la matrice.
- Les commandes de déplacement :
  - SETUP(U,angle,x,y); Positionner la tortue.
  - GO(U,+P); Avancer de P pas.
  - GO(U,-P); Reculer de P pas.
  - TU(U,+D); Tourner de D degrés sur la droite.
  - TU(U,-D); Tourner de D degrés sur la gauche.
- La direction:
  - Les angles positifs tournent dans le sens des aiguilles d'une montre.
    - L'angle 0 est le nord.
  - La direction est mémorisée.

Dessiner

c01.c
Dessiner un carré

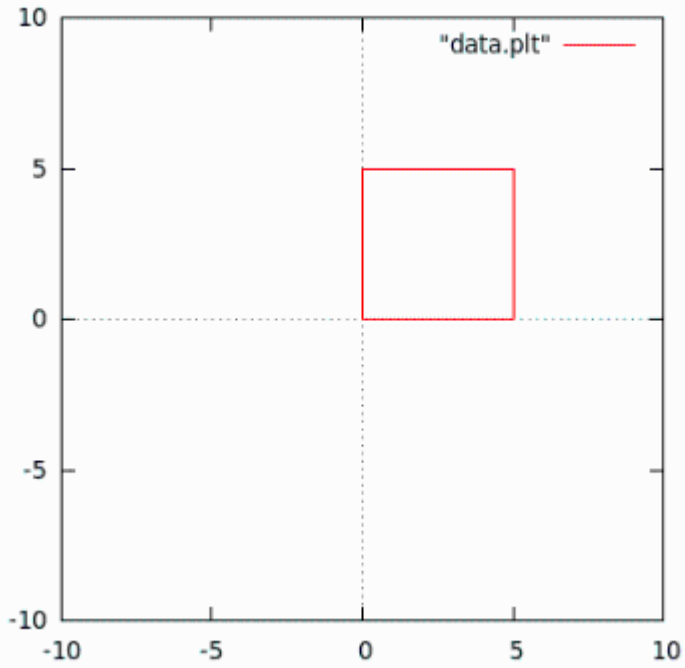
```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);
int      i = 4;

   clrscrn();

   for(;i--;)
```

```
      {GO(U,5.);TU(U,90.);}

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Le résultat :

```
# Gnuplot file : load "a_main.plt"
set zeroaxis
set size ratio -1
plot [-10.000:10.000] [-10.000:10.000] \
"data.plt" with linesp pt 0
```

Résultat dans gnuplot



Les fichiers h partagés

v_a.h
Appel des fichiers

```
/* ------------------------------------ */
/*      Save as :  v_a.h                */
/* ------------------------------------ */
#include    <stdio.h>
#include   <stdlib.h>
#include   <stddef.h>
#include    <ctype.h>
```

```
#include     <time.h>
#include     <math.h>
/* ---------------------------------- */
#include  "vdefine.h"
#include  "vmatini.h"
#include  "vmatbas.h"
#include  "vmatcop.h"
#include  "vmatrot.h"
```

vdefine.h
Déclaration des defines

```
/* ---------------------------------- */
/*      Save as : vdefine.h           */
/* ---------------------------------- */
#define C0               0
#define C1               1
#define C2               2
#define C3               3
#define C4               4
#define C5               5

#define R0               0
#define R1               1
#define R2               2
#define R3               3
#define R4               4
#define R5               5

#define OF               0

#define R_SIZE           0
#define C_SIZE           1
#define C_SIZE_A         2
#define FIRST            1

#ifndef PI
#define PI               3.14159265359
#endif

#define MAX(A,B) ((A)>(B) ? (A):(B) )

void clrscrn(void)
{
  printf("\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n");
}
```

L'étude sur les matrices fait partie d'un autre livre.

vmatini.h
Création et destruction d'une matrice

```
/* ---------------------------------- */
/*      Save as : vmatini.h           */
/* ----------------------------------*/
double **I_mR(
int      r,
int      c
)
{
int      i = R0;
int     ar = r + C1;
int     ac = c + C1;
double **A = malloc(ar * sizeof(*A));

     for(; i<ar; i++)
      A[i] = malloc(ac * sizeof(**A));

    A[R_SIZE][OF] = ar;
    A[C_SIZE][OF] = ac;

return(A);
}
/* ---------------------------------- */
void F_mR(
double **A
)
{
int i=R0;
int r=A[R_SIZE][OF];

 if(A) for(;i<r;i++) free(A[i]);

 free(A);
}
```

vmatbas.h

Additionner et multiplier des matrices

```
/* ---------------------------------- */
/*      Save as : vmatbas.h           */
/* ---------------------------------- */
double **add_mR(
double **A,
double **B,
double **AplsB
)
{
int r;
int c;

for (r=FIRST;r<A[R_SIZE][OF];r++)
 for(c=FIRST;c<A[C_SIZE][OF];c++)
     AplsB[r][c]=A[r][c]+B[r][c];
 return(AplsB);
}
/* ---------------------------------- */
double **mul_mR(
double **A,
double **B,
double **AB
```

```
)
{
int i,j,k;

for  (k=FIRST;           k<A[R_SIZE][OF];k++)
 for (j=FIRST;           j<B[C_SIZE][OF];j++)
  for(i=FIRST,AB[k][j]=0;i<A[C_SIZE][OF];i++)
      AB[k][j]+=A[k][i]*B[i][j];

 return(AB);
}
```

vmatcop.h
Copier une matrice

```
/* ---------------------------------- */
/*      Save as : vmatcop.h           */
/* ---------------------------------- */
double ** c_mR(
double **A,
double **B
)
{
int r;
int c;

for( r=FIRST;r<A[R_SIZE][OF];r++)
 for(c=FIRST;c<A[C_SIZE][OF];c++)
     B[r][c]=A[r][c];

return(B);
}
/* ---------------------------------- */
double  **c_a_A_mR(
double  a[],
double  **A
)
{
int r;
int c;
int i=0;

for( r=FIRST; r<A[R_SIZE][OF]; r++)
 for(c=FIRST; c<A[C_SIZE][OF]; c++)
     A[r][c] = a[i++];

return(A);
}
```

vmatrot.h
Matrice de rotation

```
/* ---------------------------------- */
/*      Save as : vmatrot.h           */
```

```
/* ---------------------------------- */
double **rot2D_mR(
double  **A,
double alpha
)
{
 A[1][1]=cos(alpha);A[1][2]=-sin(alpha);
 A[2][1]=sin(alpha);A[2][2]= cos(alpha);

return(A);
}
```

y_o.h
La librairie de géométrie de la tortue standard

```
/* ---------------------------------- */
/*      Save as : y_o.h               */
/* ---------------------------------- */
void PD(
double **A
)
{
FILE * fp = fopen("data.plt","a");

fprintf(fp,"  %+.3f  %+.3f \n",
           A[R1][C1],A[R2][C1]);
 fclose(fp);
}
/* ---------------------------------- */
void PU(
double **A
)
{
FILE *fp = fopen("data.plt","a");

fprintf(fp,"\n  %+.3f  %+.3f \n",
           A[R1][C1],A[R2][C1]);
 fclose(fp);
}
/* ---------------------------------- */
double **Ginit(
double **U,
double xmin,
double xmax,
double ymin,
double ymax
)
{
FILE *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n"
           "set zeroaxis\n"
           "set size ratio -1\n"
           "plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           "\"data.plt\" with linesp pt 0\n"
           ,xmin,xmax,ymin,ymax);
 fclose(fp);

        fp = fopen("data.plt","w");
```

```
 fclose(fp);

        U[R0][C1] = 0.;/* angle */
        U[R1][C1] = 0.;/* x     */
        U[R2][C1] = 0.;/* y     */

        PD(U);

return(U);
}
/* ---------------------------------- */
double **GINIT(
double xmin,
double xmax,
double ymin,
double ymax
)
{
return( Ginit(I_mR(R2,C1),xmin,xmax,ymin,ymax) );
}
/* ---------------------------------- */
void SET(
double **U,
double angle,
double x,
double y
)
{
   U[R0][C1] = angle;
   U[R1][C1] = x;
   U[R2][C1] = y;

   PD(U);
}
/* ---------------------------------- */
void SETUP(
double **U,
double angle,
double x,
double y
)
{
   U[R0][C1] = angle;
   U[R1][C1] = x;
   U[R2][C1] = y;

   PU(U);
}
/* ---------------------------------- */
void GO(
double **U,
double Step
)
{
double **T = I_mR(R2,C2);
double **B = I_mR(R2,C1);
double **C = I_mR(R2,C1);

double angle=U[R0][C1];

   B[R1][C1] = 0.;
   B[R2][C1] = Step;

   rot2D_mR(T,PI/180.*(-angle));
   mul_mR(T,B,C);
   c_mR(U,B);
```

```
   add_mR(B,C,U);

   PD(U);

F_mR(C);
F_mR(B);
F_mR(T);
}
/* ---------------------------------- */
void GU(
double **U,
double Step
)
{
double **T = I_mR(R2,C2);
double **B = I_mR(R2,C1);
double **C = I_mR(R2,C1);

double angle=U[R0][C1];

   B[R1][C1] = 0.;
   B[R2][C1] = Step;

   rot2D_mR(T,PI/180.*(-angle));
   mul_mR(T,B,C);
   c_mR(U,B);
   add_mR(B,C,U);

   PU(U);

F_mR(C);
F_mR(B);
F_mR(T);
}
/* ---------------------------------- */
void TU(
double **U,
double angle
)
{
  U[R0][C1]+=angle;
}
```

Application : Quelques exemples

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples.

Dessiner

Petits drapeaux

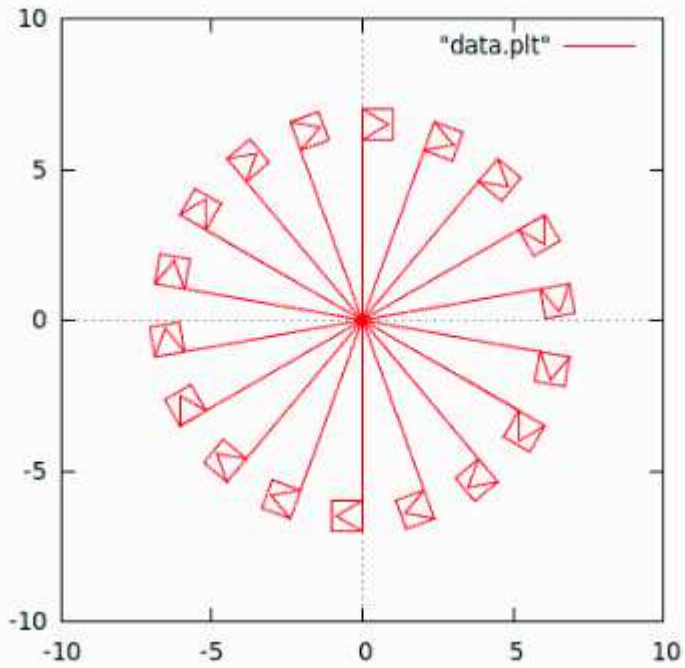
N'oubliez pas les fichiers h de la librairie.

c01.c
Petits drapeaux

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include  "v_a.h"
#include  "y_o.h"
/* ---------------------------------- */
void shape(
double **U,
double step,
int    side
)
{
double angle=360./side;

   for(;side--;)
      {GO(U,step);TU(U,angle);}
}
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    a=20;
int    i=360/a;

  for(;i--;)
    {
     GO(U, step);

     shape(U,1,4);
     shape(U,1,3);
```

```
     GO(U,-step);
     TU(U,  1*a);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

    fun(U,6.);
   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Petit jeux sur les rectangles

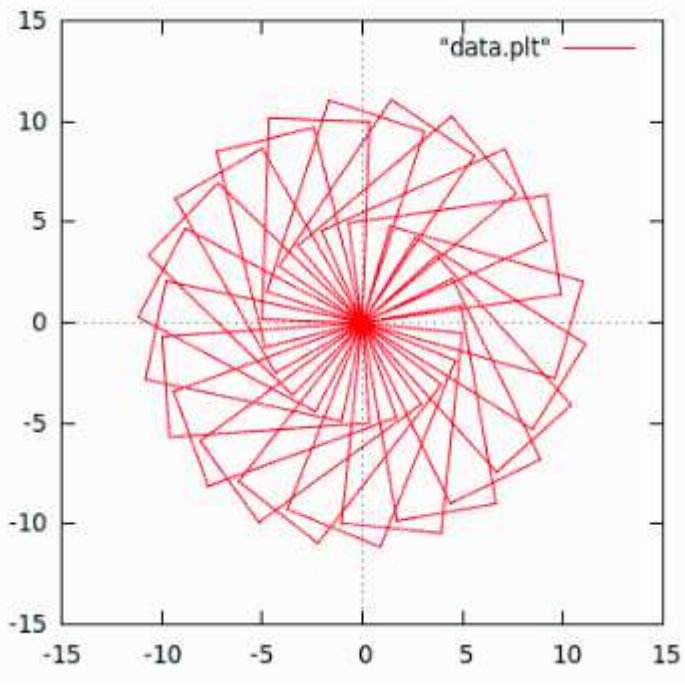
N'oubliez pas les fichiers h de la librairie.

c02.c
Petit jeux sur les rectangles

```
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void side(
double **U,
```

```
double size
)
{
      GO(U,size);TU(U,90.);
}
/* ---------------------------------- */
void rectangle(
double **U,
double size1,
double size2
)
{
int i=2;

   for(;i--;)
      {
       side(U,size1);
       side(U,size2);
       }
}
/* ---------------------------------- */
int main(void)
{
double   i = 360.;
double   n = 16.;
double **U = GINIT(-15.,15.,-15.,15.);

   for(;(i-=n)>=0.;)
      {
       TU(U,n);rectangle(U,5.,10.);
      }

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  fflush(stdout);

  return 0;
}
```

Résultat dans gnuplot



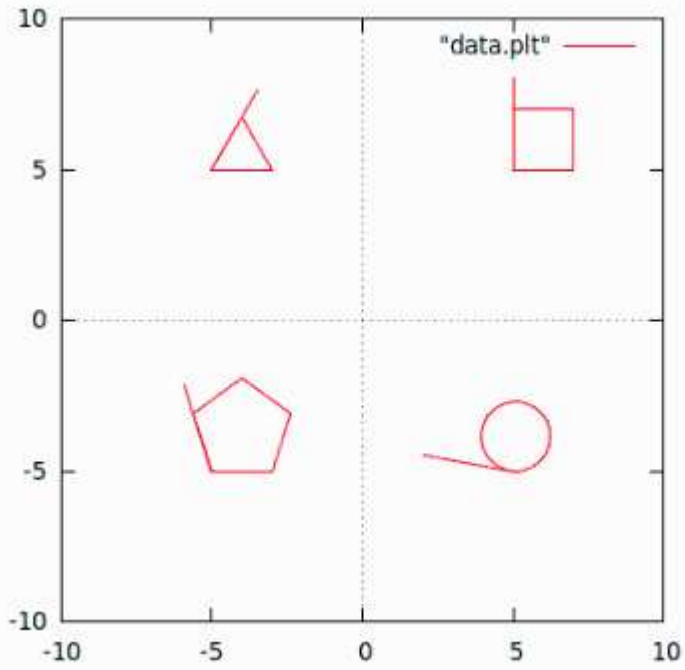
Petit jeux sur les formes

N'oubliez pas les fichiers h de la librairie.

c03.c
Petit jeux sur les formes

```c
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void shape(
double **U,
double step,
int    side
)
{
double angle=360./side;

   for(;side--;)
      {GO(U,step);TU(U,angle);}
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   SETUP(U,30,-5,5);
   shape(U,2,3);
      GO(U,3.);

   SETUP(U, 0, 5,5);
   shape(U,2,4);
      GO(U,3.);

   SETUP(U,72.-90.,-5,-5);
   shape(U,2,5);
      GO(U,3.);

   SETUP(U,10-90, 5,-5);
   shape(U,.2,36);
      GO(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Résultat dans gnuplot



Application : Soleil 1

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples.

Dessiner

Soleils 0

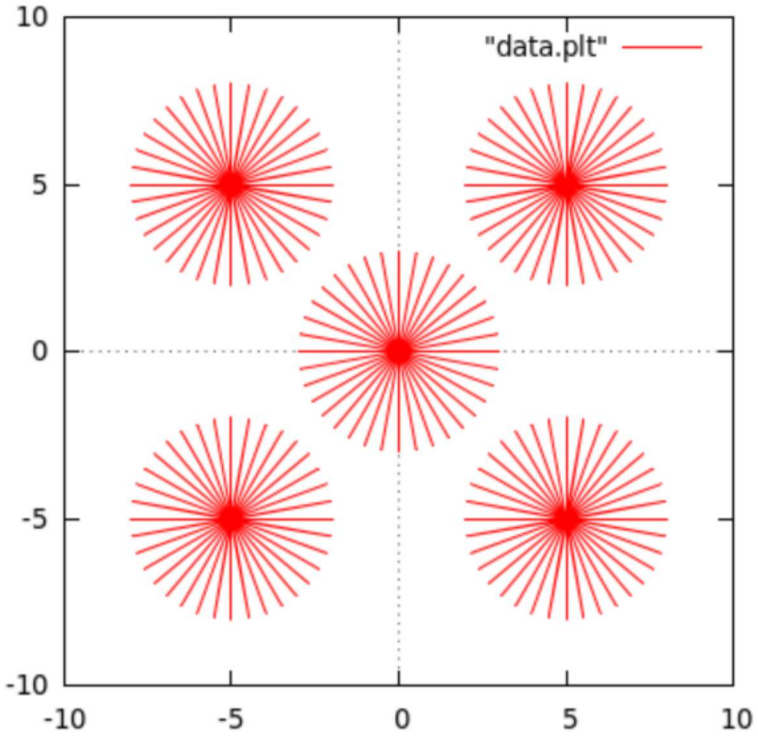
N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 0

```
/* ---------------------------------- */
/*  Save as : c00.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int i=360/10;

  for(;i--;)
    {
     GO(U, step);
     GO(U,-step);
     TU(U,  10.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

   SETUP(U,0.,-5, 5);fun(U,3.);
   SETUP(U,0., 5, 5);fun(U,3.);
   SETUP(U,0.,-5,-5);fun(U,3.);
   SETUP(U,0., 5,-5);fun(U,3.);
   SETUP(U,0., 0,-0);fun(U,3.);
```

```
   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Résultat dans gnuplot



Soleil 1

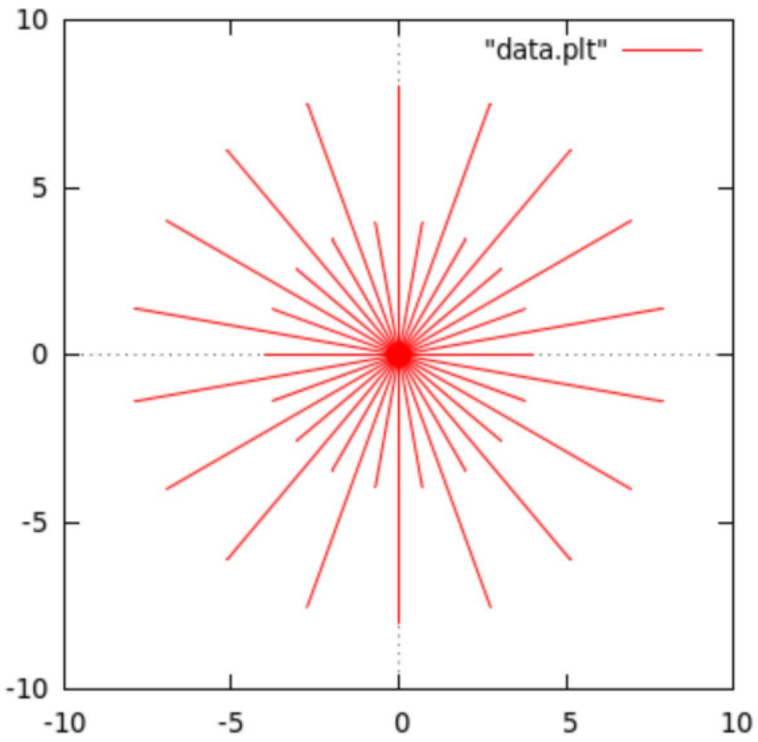
N'oubliez pas les fichiers h de la librairie.

c01.c
Soleil 1

```
/* ---------------------------------- */
/*  Save as : c01.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int i=360/10;
int a=1;

  for(;i--;)
    {
     a= (a==1)?2:1;
```

```
     GO(U, a*step);
     GO(U,-a*step);
     TU(U,  10.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

   fun(U,4.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Résultat dans gnuplot



Soleil 2

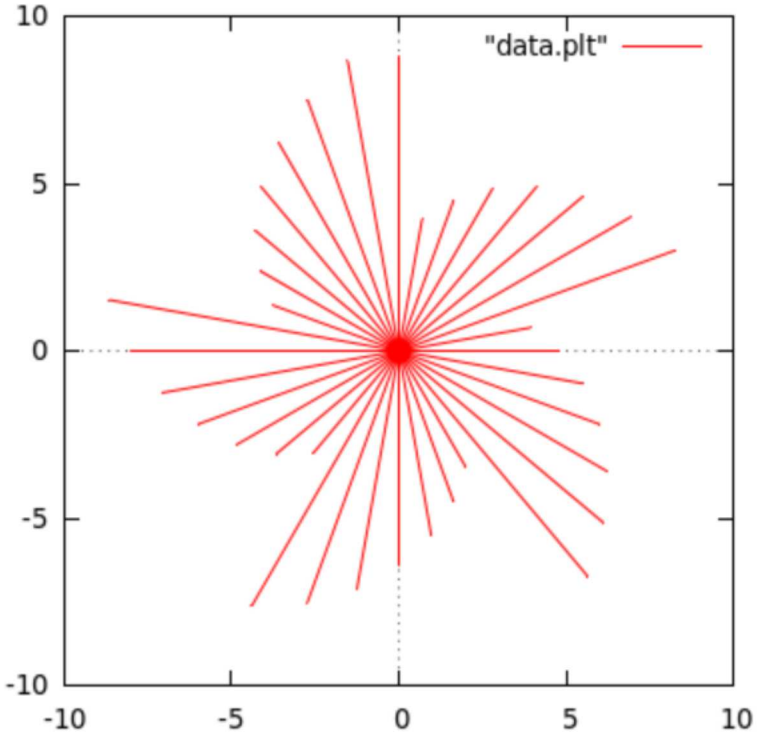
N'oubliez pas les fichiers h de la librairie.

c01.c
Soleil 2

```
/* ---------------------------------- */
```

```c
/*  Save as : c02.c                          */
/* ---------------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------------- */
void fun(
double **U,
double step
)
{
int    i=360/10;
double a=2.;

  for(;i--;)
    {
     (a>2.) ?  (a=1.):(a+=0.2);
     GO(U, a*step);
     GO(U,-a*step);
     TU(U,  10.);
    }
}
/* ---------------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

   fun(U,4.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Résultat dans gnuplot



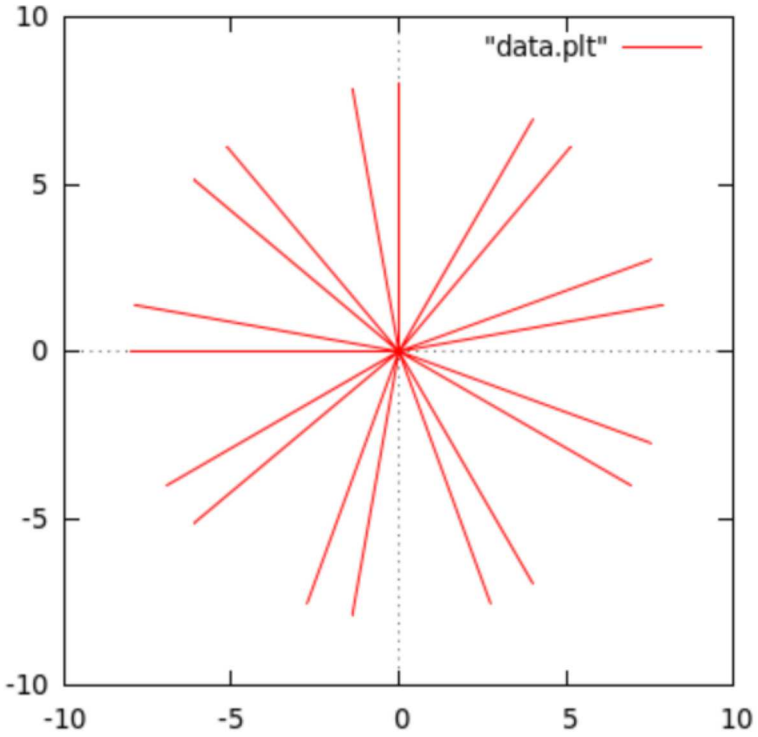
Soleil 3

N'oubliez pas les fichiers h de la librairie.

c01.c
Soleil 3

```
/* ---------------------------------- */
/*  Save as : c03.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int i=18;
int a=1;

  for(;i--;)
    {
     a= (a==1)?3:1;
     GO(U, step);
     GO(U,-step);
     TU(U, a*10.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

   fun(U,8.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  getchar();

  return 0;
}
```

Résultat dans gnuplot



Soleil 4

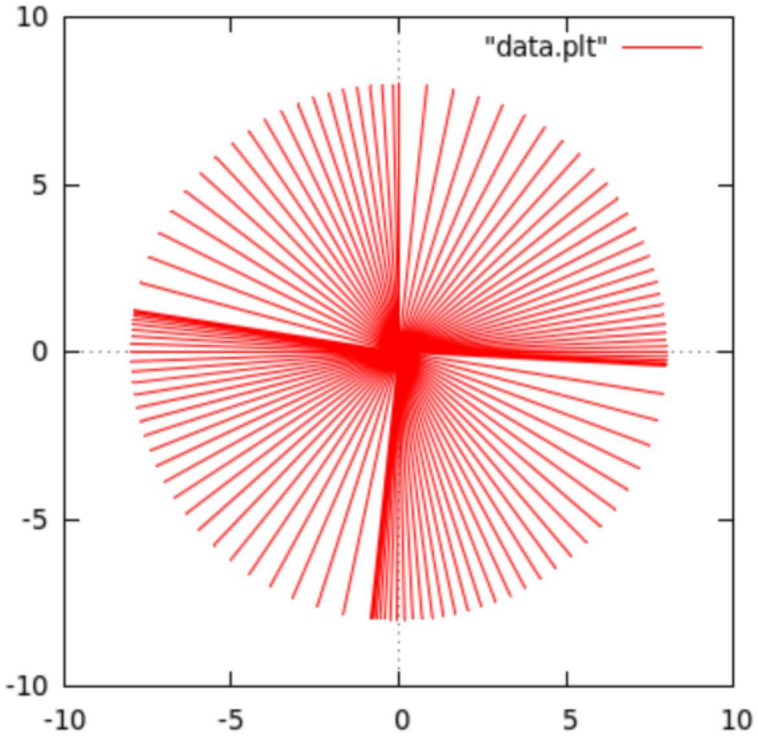
N'oubliez pas les fichiers h de la librairie.

c01.c
Soleil 4

```
/* ---------------------------------- */
/*  Save as : c04.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int i=113;
int a=0;

  for(;i--;)
    {
     (a) ? (a-=2):(a=60);
     GO(U, step);
     GO(U,-step);
     TU(U, a*.1);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);
```

```
   clrscrn();

   fun(U,8.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");
  fflush(stdout);
  getchar();

  return 0;
}
```

Résultat dans gnuplot



Application : Soleil 2

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples.

Dessiner

Soleils 0

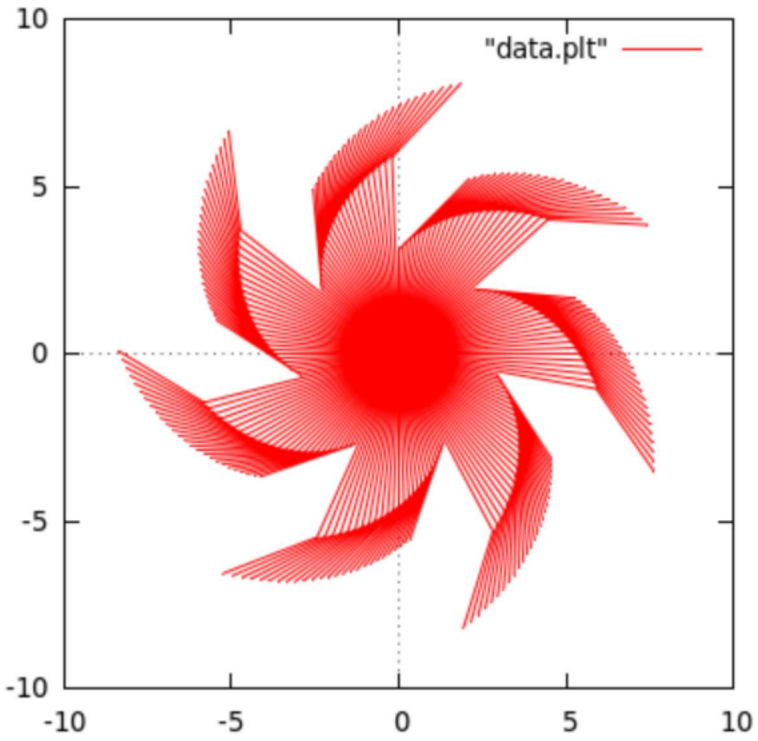
N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 0

```
/* ---------------------------------- */
/*  Save as : c00.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    i=180;
double a=1.;

  for(;i--;)
    {
     (a>2.) ? (a=1.):(a+=0.04);
     GO(U, a*step);

     TU(U,    45.);
     GO(U,   step);
     GO(U,-  step);
     TU(U,   -45.);

     GO(U,-a*step);
     TU(U,     2.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);
```

```
   clrscrn();

   fun(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Soleils 1

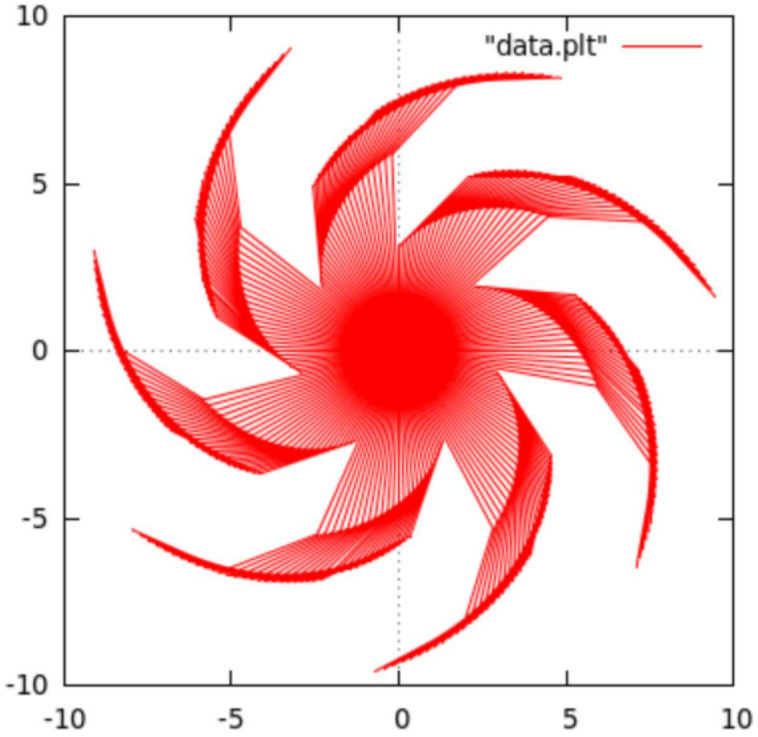
N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 1

```
/* ---------------------------------- */
/*  Save as : c01.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    i=180;
```

```
double a=1.;

  for(;i--;)
    {
     (a>2.) ? (a=1.):(a+=0.04);
     GO(U, a*step);

     TU(U,    45.);
     GO(U,   step);

     TU(U,    45.);
     GO(U,   step);
     GO(U,-  step);
     TU(U,   -45.);

     GO(U,-  step);
     TU(U,   -45.);

     GO(U,-a*step);
     TU(U,     2.);
    }
}
/* ------------------------------------ */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

   fun(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



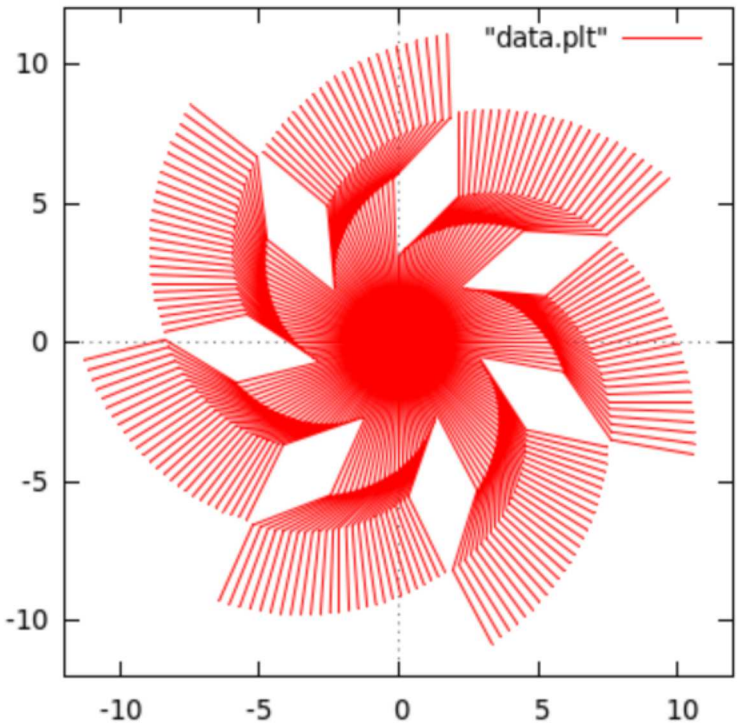
Soleils 2

N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 2

```
/* ---------------------------------- */
/*  Save as : c02.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    i=180;
double a=1.;

  for(;i--;)
    {
     (a>2.) ? (a=1.):(a+=0.04);
     GO(U, a*step);

     TU(U,    45.);
     GO(U,   step);

     TU(U,   -45.);
     GO(U,   step);
     GO(U,-  step);
     TU(U,    45.);

     GO(U,-  step);
     TU(U,   -45.);

     GO(U,-a*step);
     TU(U,     2.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-12.,12.,-12.,12.);

   clrscrn();

   fun(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Soleils 3

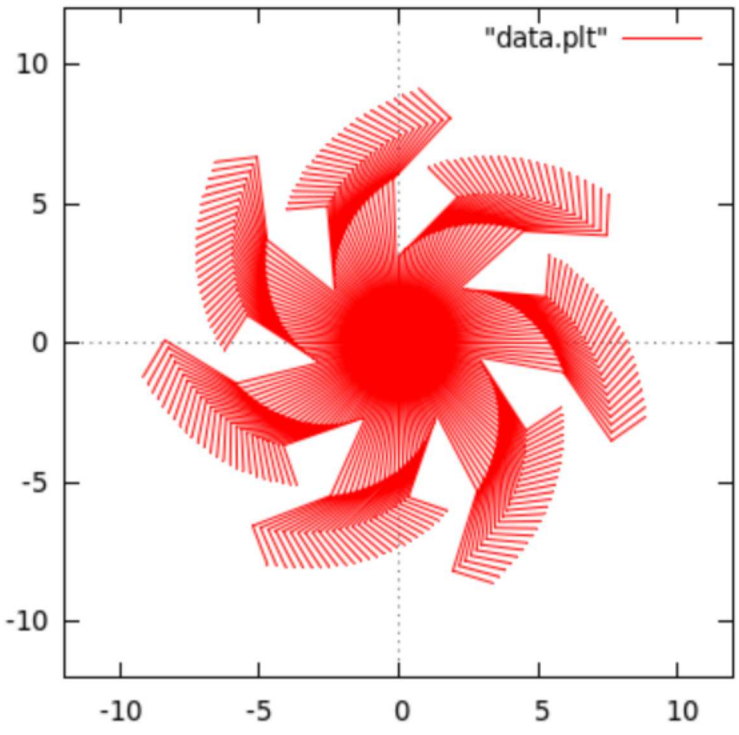
N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 3

```
/* ---------------------------------- */
/*  Save as : c03.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    i=180;
double a=1.;

  for(;i--;)
    {
     (a>2.) ? (a=1.):(a+=0.04);
     GO(U, a*step);

     TU(U,    45.);
     GO(U,   step);

     TU(U,   -90.);
     GO(U,   step/2.);
```

```
     GO(U,-  step/2.);
     TU(U,    90.);

     GO(U,-  step);
     TU(U,   -45.);

     GO(U,-a*step);
     TU(U,     2.);
    }
}
/* ------------------------------------ */
int main(void)
{
double **U = GINIT(-12.,12.,-12.,12.);

   clrscrn();

   fun(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



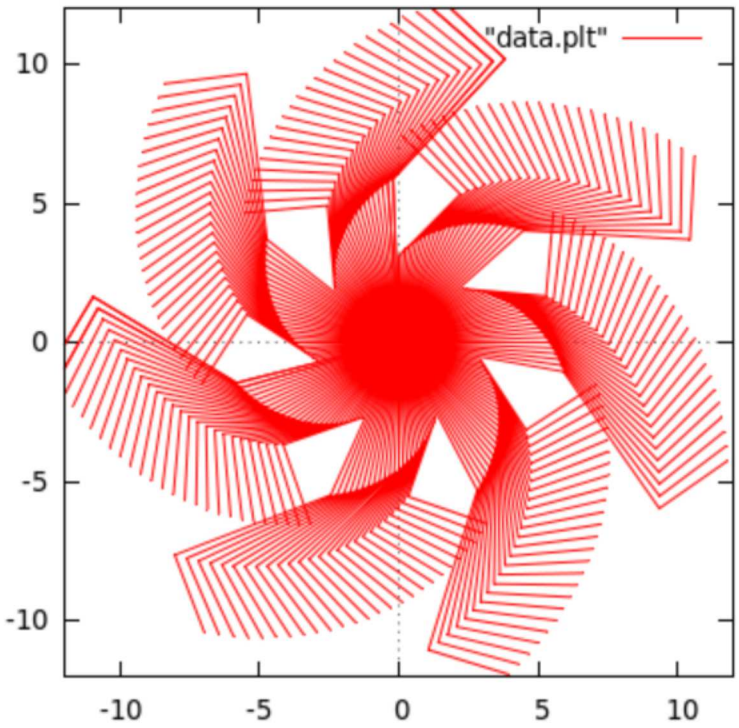
Soleils 4

N'oubliez pas les fichiers h de la librairie.

c00.c
Soleils 4

```c
/* ---------------------------------- */
/*  Save as : c04.c                   */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void fun(
double **U,
double step
)
{
int    i=180;
double a=1.;

  for(;i--;)
    {
     (a>2.) ? (a=1.):(a+=0.04);
     GO(U, a*step);

     TU(U,    45.);
     GO(U, a*step);

     TU(U,   -90.);
     GO(U,   step);
     GO(U,  -step);
     TU(U,    90.);

     GO(U,-a*step);
     TU(U,   -45.);

     GO(U,-a*step);
     TU(U,     2.);
    }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-12.,12.,-12.,12.);

   clrscrn();

   fun(U,3.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Application : Quelques polygones

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples.

Dessiner

Jeux sur les polygones 1

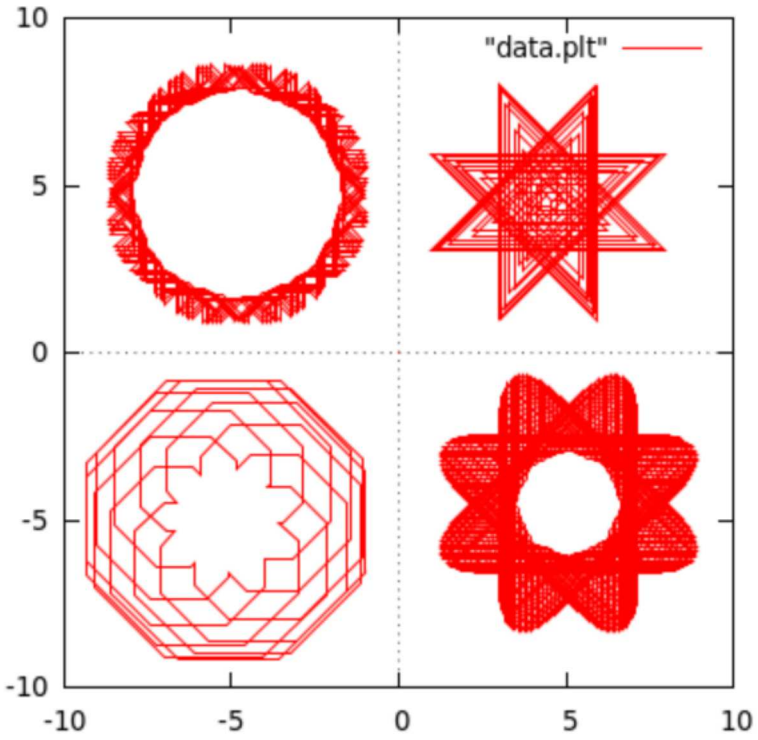
N'oubliez pas les fichiers h de la librairie.

c01.c
Jeux sur les polygones 1

```
/* ---------------------------------- */
/*  Save as :   c01.c                 */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void poly(
double **U,
double d,
double a,
double phasechange,
double n
)
{
double phase=0.;

  for(;n-->0;)
     {
      GO(U,d*cos(phase));
      TU(U,-a);
      phase+=phasechange;
     }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

          /* poly(U, d,   a,   phasechange, n) */

   SETUP(U,0.,-8, 4  );poly(U, 1.5, 45., 1.,500.);
```

```
   SETUP(U,0., 3, 1  );poly(U, 7. , 45., 3.,100.);
   SETUP(U,0.,-1,-6.5);poly(U, 3. , 45., 6.,100.);
   SETUP(U,0., 3,-7  );poly(U, 5. , 45., 8.,500.);
   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Jeux sur les polygones 2

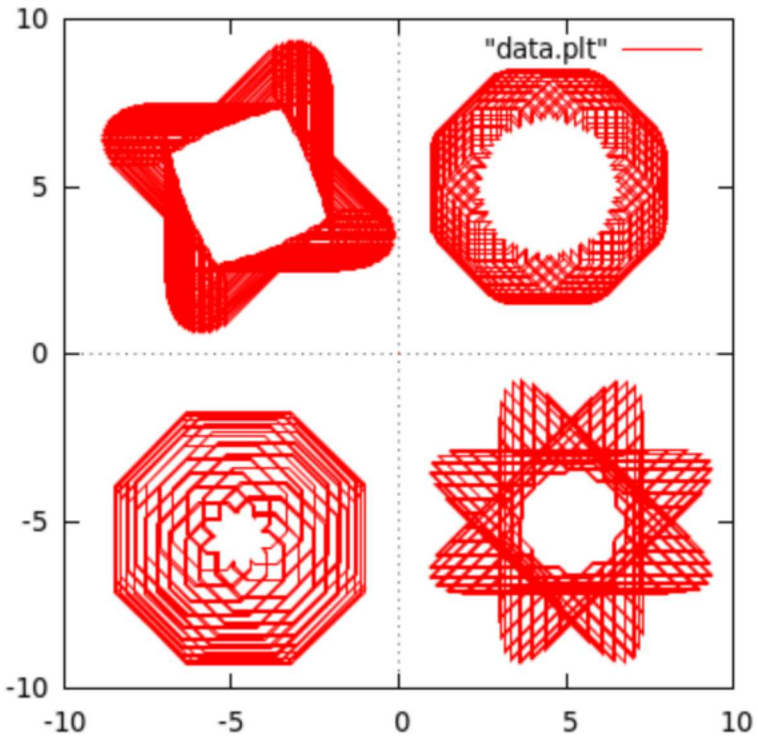
N'oubliez pas les fichiers h de la librairie.

c02.c
Jeux sur les polygones 2

```
/* ---------------------------------- */
/*  Save as :   c02.c                 */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void poly(
double **U,
double d,
double a,
double phasechange,
double n
)
```

```
{
double phase=0.;

  for(;n-->0;)
     {
      GO(U,d*cos(phase));
      TU(U,-a);
      phase+=phasechange;
     }
}
/* ------------------------------------ */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);


   clrscrn();

 /*  poly(U, d,   a,   phasechange, n) */
   SETUP(U,0.,-7., 2.5);poly(U, 5. , 45., 11.,300.);
   SETUP(U,0., 8., 4. );poly(U, 2. , 45., 13.,500.);
   SETUP(U,0.,-1.,-7. );poly(U, 3. , 45., 19.,500.);
   SETUP(U,0., 3.,-8. );poly(U, 6. , 45., 17.,500.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



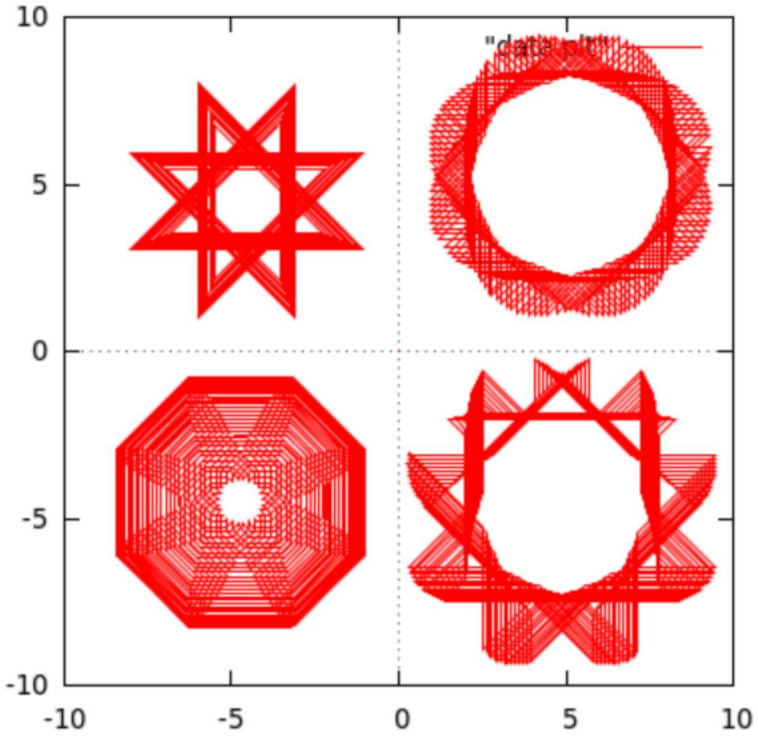
Jeux sur les polygones 3

N'oubliez pas les fichiers h de la librairie.

c03.c
Jeux sur les polygones 3

```
/* ---------------------------------- */
/*  Save as :   c03.c                 */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void poly(
double **U,
double d,
double a,
double phasechange,
double n
)
{
double phase=0.;

  for(;n-->0;)
     {
      GO(U,d*cos(phase));
      TU(U,-a);
      phase+=phasechange;
     }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-10.,10.,-10.,10.);

   clrscrn();

 /*  poly(U, d,   a,   phasechange, n) */
   SETUP(U,0.,-6., 1. );poly(U,7. , 45., 22.,100.);
   SETUP(U,0., 2., 4. );poly(U,2.5, 45., 24.,400.);
   SETUP(U,0.,-1.,-6. );poly(U,3. , 45., 25.,600.);
   SETUP(U,0., 2.,-7. );poly(U,4.5, 45., 30.,290.);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Application : Dessiner en pointillés

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples en pointillés.

- Les commandes :
  - GO(U,+P); Avancer de P pas.
  - GO(U,-P); Reculer de P pas.
  - GU(U,+P); Avancer de P pas sans laisser de trace.
  - GU(U,-P); Reculer de P pas sans laisser de trace.

Dessiner

Premier exemple

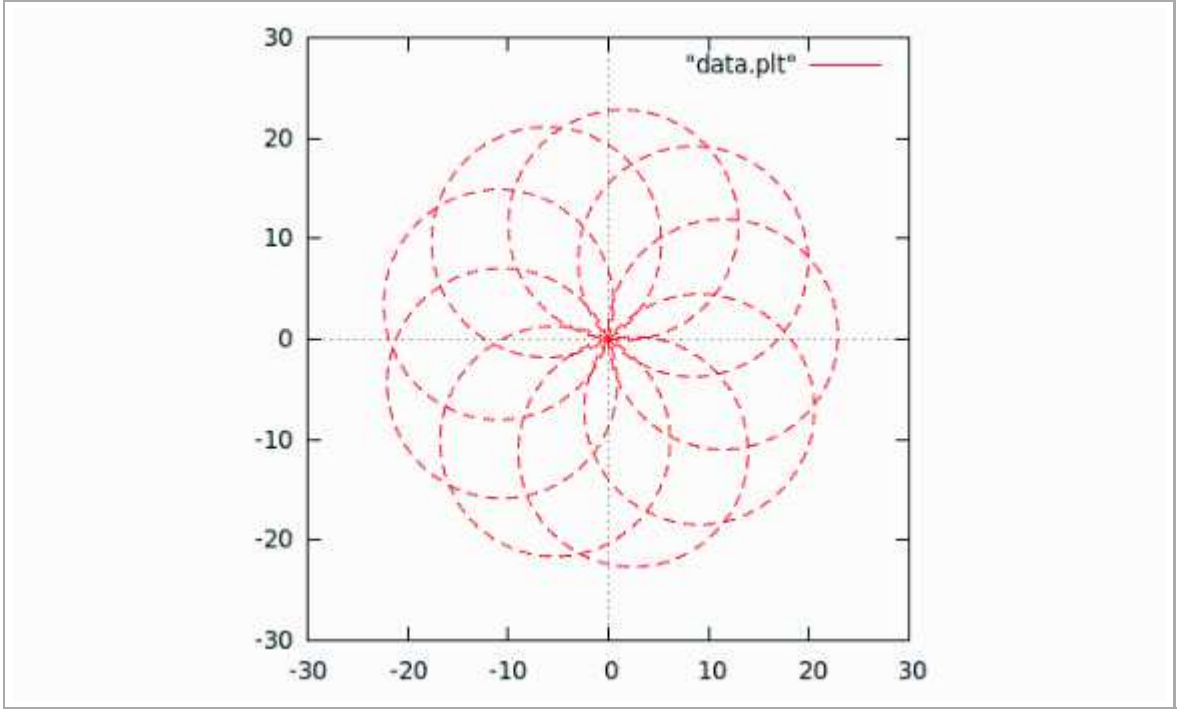
N'oubliez pas les fichiers h de la librairie.

c01.c
Premier exemple

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void circle(
double **U,
double r,
double deg
)
{
double i=360;
int    j=1;

  for(;(i-=deg)>=0;)
     {
      if((j*=-1)>0)GO(U,r);
      else         GU(U,r);

      TU(U,deg);
     }
}
/* ---------------------------------- */
void circleS(
```

```
double **U
)
{
int i=9;

  for(;i--;)
     {
      circle(U,1.,5.);
      TU(U,40.);
     }
}
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-30.,30.,-30.,30.);

  clrscrn();
  circleS(U);
     F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Deuxième exemple

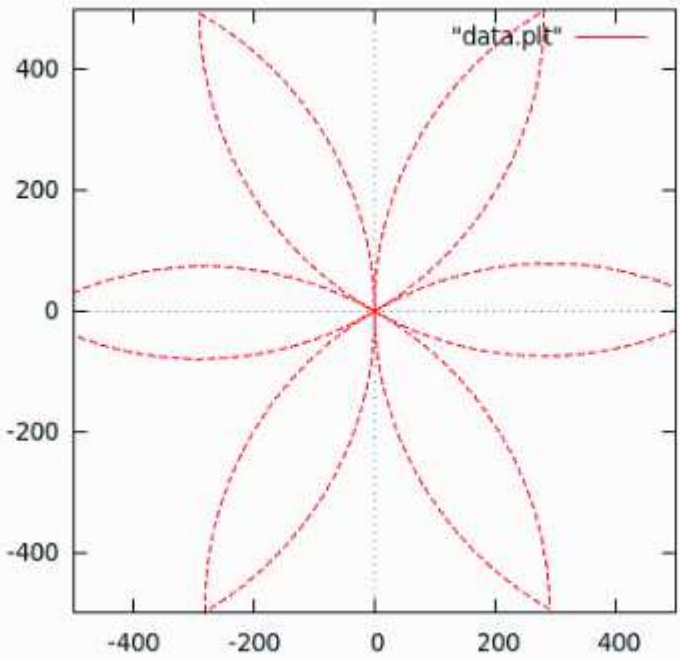
N'oubliez pas les fichiers h de la librairie.

c02.c
Deuxième exemple

```
/* ---------------------------------- */
```

```
/* save as : c02.c                          */
/* ---------------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------------- */
void arcR(
double **U,
double r,
double deg
)
{
int i=0;

  for(;i++<deg;)
     {
      if(fmod(i,2))GO(U,r);
      else         GU(U,r);

      TU(U,1.);
     }
}
/* ---------------------------------------- */
void petal(
double **U,
double size
)
{
      arcR(U,size,60.);
      TU(U,120.);
      arcR(U,size,60.);
      TU(U,120.);
}
/* ---------------------------------------- */
void flower(
double **U,
double size

)
{
int i=6;

  for(;i--;)
     {
      petal(U,size);
      TU(U,60.);
     }
}
/* ---------------------------------------- */
int main(void)
{
double **U = GINIT(-500.,500.,-500.,500.);

   clrscrn();
   flower(U,10.);
     F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Troisième exemple

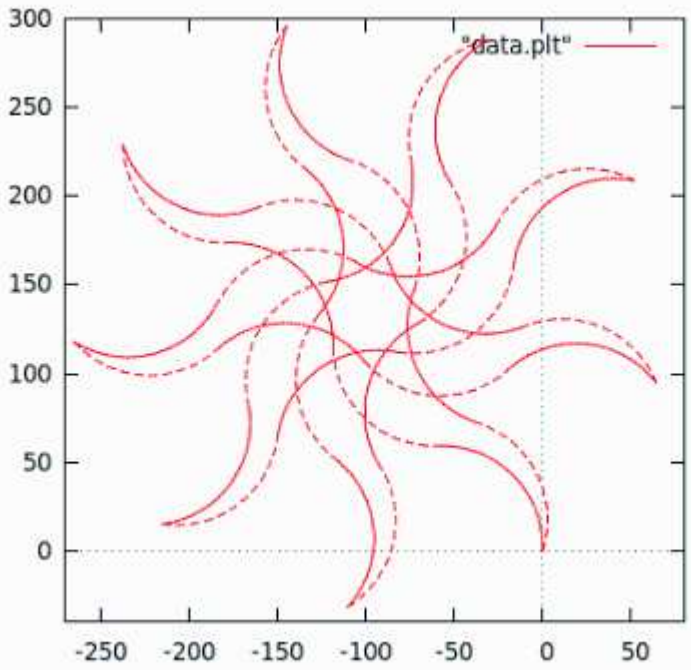
N'oubliez pas les fichiers h de la librairie.

c03.c
Troisième exemple

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
void arcR(
double **U,
double r,
double deg

)
{
int i=0;

  for(;i++<deg;)
     {
      if(fmod(i,2))GO(U,r);
      else         GU(U,r);

      TU(U,4.);
     }
}
/* ---------------------------------- */
void arcL(
double **U,
```

```
double r,
double deg
)
{
  for(;deg-->=0;)
     {
      GO(U,r);
      TU(U,-4.);
     }
}
/* ------------------------------------ */
void ray(
double **U,
double r
)
{
int i=2;

  for(;i--;)
     {
      arcL(U,r,45./2.);
      arcR(U,r,45./2.);
     }
}
/* ------------------------------------ */
void sun(
double **U,
double size

)
{
int i=9;

  for(;i--;)
     {
      ray(U,size);
      TU(U,160.);
     }
}
/* ------------------------------------ */
int main(void)
{
double **U = GINIT(-270.,80.,-40.,300.);

    sun(U,4.);
   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Application : Fonctions récursives

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

- F_mR(tree(U,50.));
  - Cette méthode est utilisée ici pour montrer la sortie finale des fonctions.
  - C'est à dire return(U);

Dessiner

Un arbre

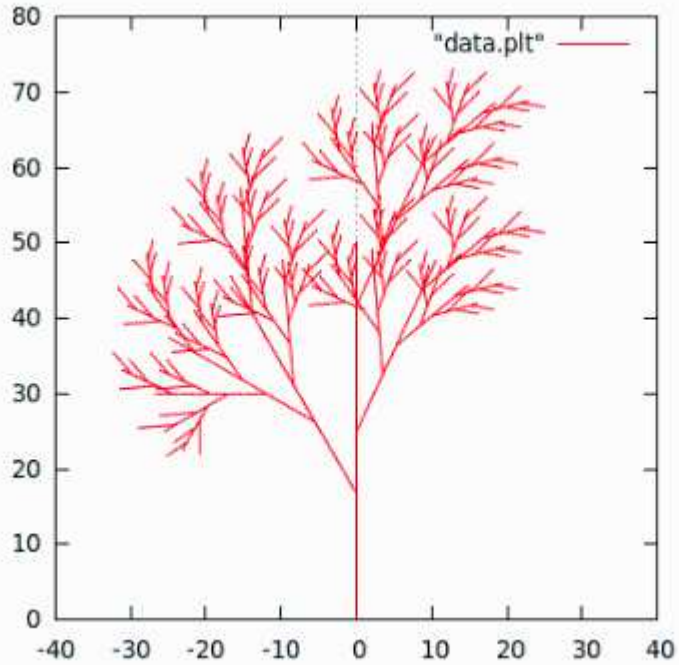
N'oubliez pas les fichiers h de la librairie.

c01.c
Un arbre

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **tree( double **U,double size);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-40.,40.,-0.,80.);

  F_mR(tree(U,50.));

  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **tree(
double **U,
double size
)
{
if(size<5.){GO(U,size);GO(U,-size);return(0);}

GO(U,size/3.);TU(U,-30.);
tree(U,size*2./3.);
TU(U,30.);GO(U,size/6.);TU(U,25.);
tree(U,size/2.);
```

```
TU(U,-25.);GO(U,size/3.);TU(U,25.);
tree(U,size/2.);
TU(U,-25.);GO(U,size/6.);GO(U,-size);

return(U);
}
```

Résultat dans gnuplot



Petit jeux sur les triangles

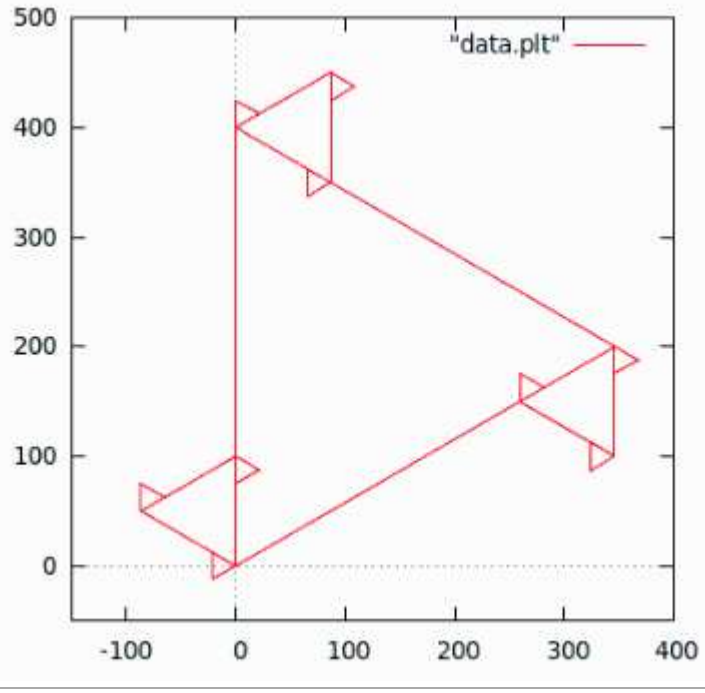
N'oubliez pas les fichiers h de la librairie.

c02.c
Petit jeux sur les triangles

```c
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **sqr(double **U,double size);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-150.,400.,-50.,500.);

  F_mR(sqr(U,400.));

  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
```

```
/* ---------------------------------- */
double **sqr(
double **U,
double size
)
{
int i=3;

 if(size<10.) return(0);

 for(;i--;)
  {
   TU(U,-60.);

   sqr(U,size/4.);

   TU(U,60.);GO(U,size);TU(U,120.);
 }
 return(U);
}
```

Résultat dans gnuplot



Petit jeux sur les carrés

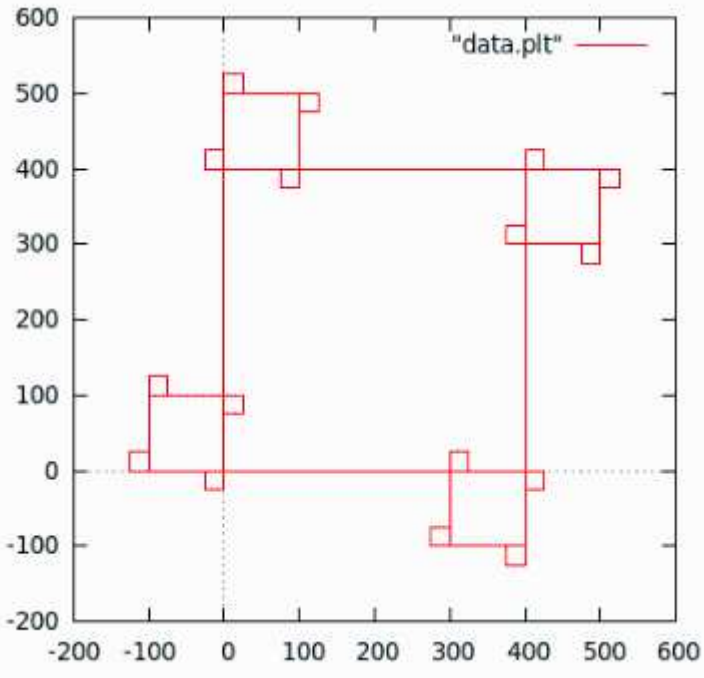
N'oubliez pas les fichiers h de la librairie.

c03.c
Petit jeux sur les carrés

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
```

```
#include "y_o.h"
/* ---------------------------------- */
double **sqr(double **U,double size);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-200.,600.,-200.,600.);

  F_mR(sqr(U,400.));
  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **sqr(
double **U,
double size
)
{
int i=4;

 if(size<10.) return(0);

 for(;i--;)
  {
   TU(U,-90.);

   sqr(U,size/4.);

   TU(U,90.);GO(U,size);TU(U,90.);
 }
 return(U);
}
```

Résultat dans gnuplot



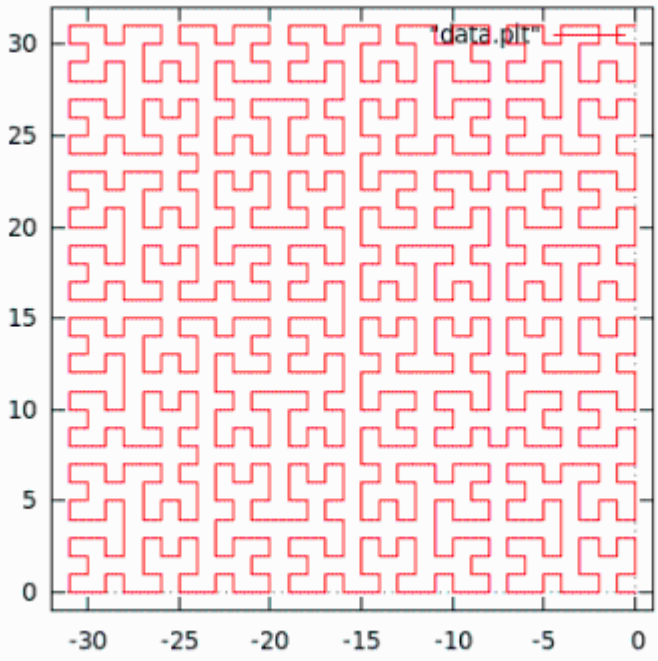
Courbe de Hilbert

N'oubliez pas les fichiers h de la librairie.

c04.c
Courbe de Hilbert

```
/* ---------------------------------- */
/* save as : c04.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **hilbert(double **U,double size,
           double level,double parity);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-32., 1.,-1.,32.);

  F_mR(hilbert(U,1.,5.,1.));
  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **hilbert(
double **U,
double size,
double level,
double parity
)
{
 if(--level<0.)return(0);

 TU(U,parity*(-90));
 hilbert(U,size,level,-parity);
 GO(U,size);TU(U,parity*90);
 hilbert(U,size,level,parity);
 GO(U,size);
 hilbert(U,size,level,parity);
 TU(U,parity*90);GO(U,size);
 hilbert(U,size,level,-parity);
 TU(U,parity*(-90));

return(U);
}
```

Résultat dans gnuplot



Application : Triangles

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Quelques exemples avec des fonctions récursives. Petits jeux sur les triangles.

Dessiner des triangles

Exemple 1

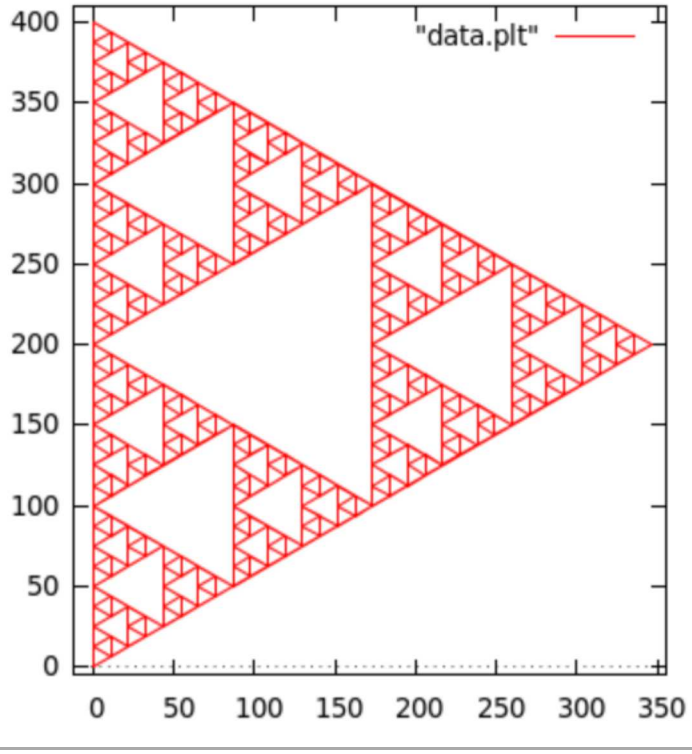
N'oubliez pas les fichiers h de la librairie.

c01.c
Exemple 1

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **triangle(double **U,double size);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-12.,355.,-5.,410.);

  F_mR(triangle(U,400.));
  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **triangle(
double **U,
double size
)
{
int i=3;

 if(size<10.) return(0);

 for(;i--;)
  {
   triangle(U,size/2.);
   GO(U,size);TU(U,120.);
  }
 return(U);
```

```
}
```

Résultat dans gnuplot



Exemple 2

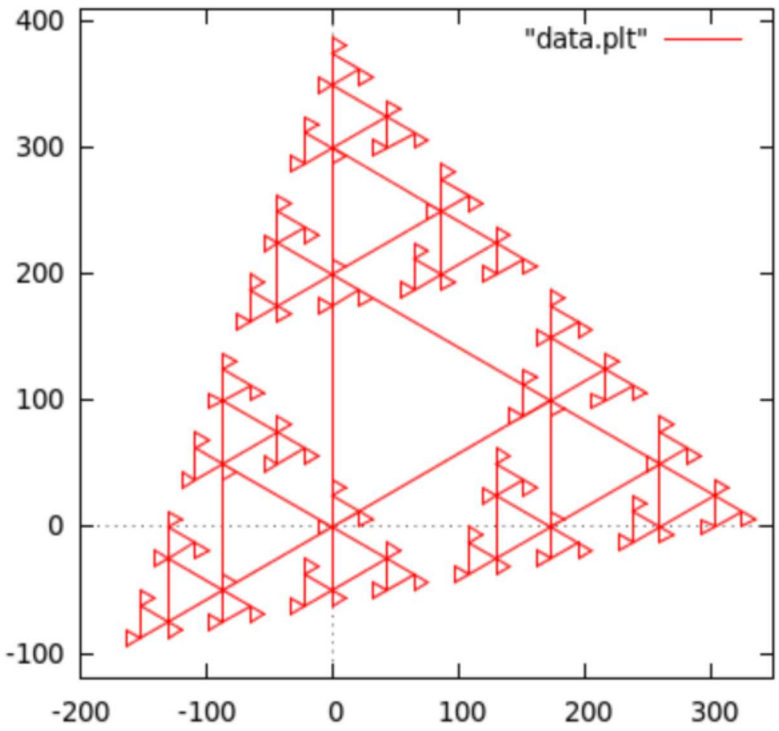
N'oubliez pas les fichiers h de la librairie.

c02.c
Exemple 2

```
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **triangle(double **U,double size);
/* ---------------------------------- */
int main(void)
{
double **U = GINIT(-200.,350.,-120.,410.);

   F_mR(triangle(U,200.));
   printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **triangle(
double **U,
double size
```

```
)
{
int i=3;

 if(size<10.) return(0);

 for(;i--;)
  {
   GO(U,size);
   triangle(U,size/2.);
   TU(U,120.);
 }
 return(U);
}
```

Résultat dans gnuplot



Exemple 3

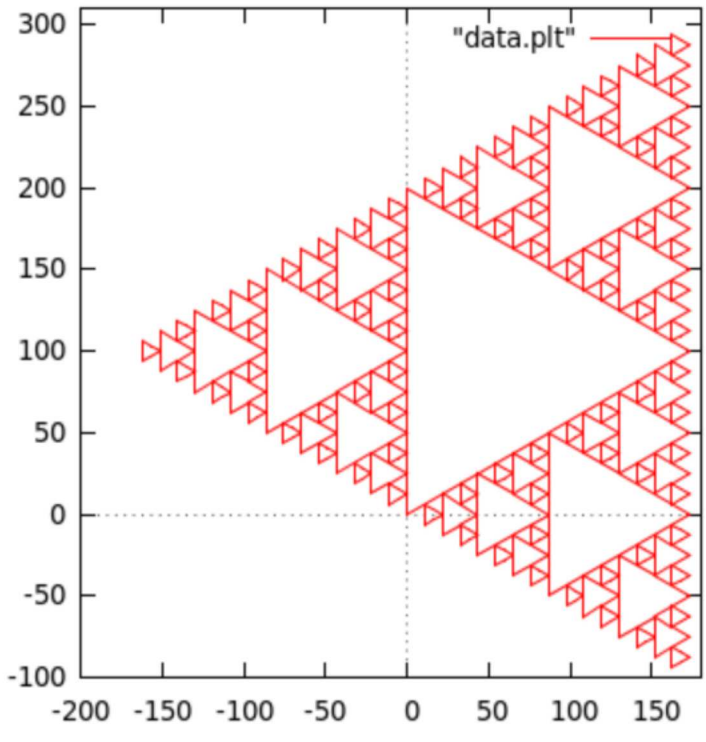
N'oubliez pas les fichiers h de la librairie.

c03.c
Exemple 3

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_o.h"
/* ---------------------------------- */
double **triangle(double **U,double size);
/* ---------------------------------- */
```

```
int main(void)
{
double **U = GINIT(-200.,180.,-100.,310.);

  F_mR(triangle(U,200.));
  printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **triangle(
double **U,
double size
)
{
int i=3;

 if(size<10.) return(0);

 for(;i--;)
  {
   GO(U,size/2.);TU(U,-120.);

   triangle(U,size/2.);

   TU(U,120.);GO(U,size/2.);

   TU(U,120.);
 }
 return(U);
}
```

Résultat dans gnuplot



Présentation de la librairie vectorielle

Préambule

La géométrie de la tortue dans Wikipedia.

Dans ce chapitre, nous présenterons un exemple (c01.c) et la librairie (*.h). Les fonctions de la librairie ne sont pas à étudier. Dans un premier temps, amusez-vous simplement avec ces fonctions.

Présentation

Les commandes d'initialisation :

- **U = G_main(-10.,10.,-10.,10.);
  - création de la matrice.
  - Initialisation de la fenêtre de gnuplot
- F_mR(U); Destruction de la matrice.

Les commandes de déplacement :

- SETUP(U,angle,x,y); Positionner la tortue.
- vo(U,0,+P); Avancer de P unités.
- vo(U,0,-P); Reculer de P unités.
- vo(U,D,0); Contrôler la "D"irection.

La direction :

- Suit les règles du cercle trigonométrique mais en degrés. Les angles positifs sont mesurés dans le sens inverse des aiguilles d'une montre, à partir de l'axe des x positifs.
- À chaque déplacement il faut lui indiquer une direction.

Dessiner

Dessiner un carré.

c01.c
Dessiner un carré.

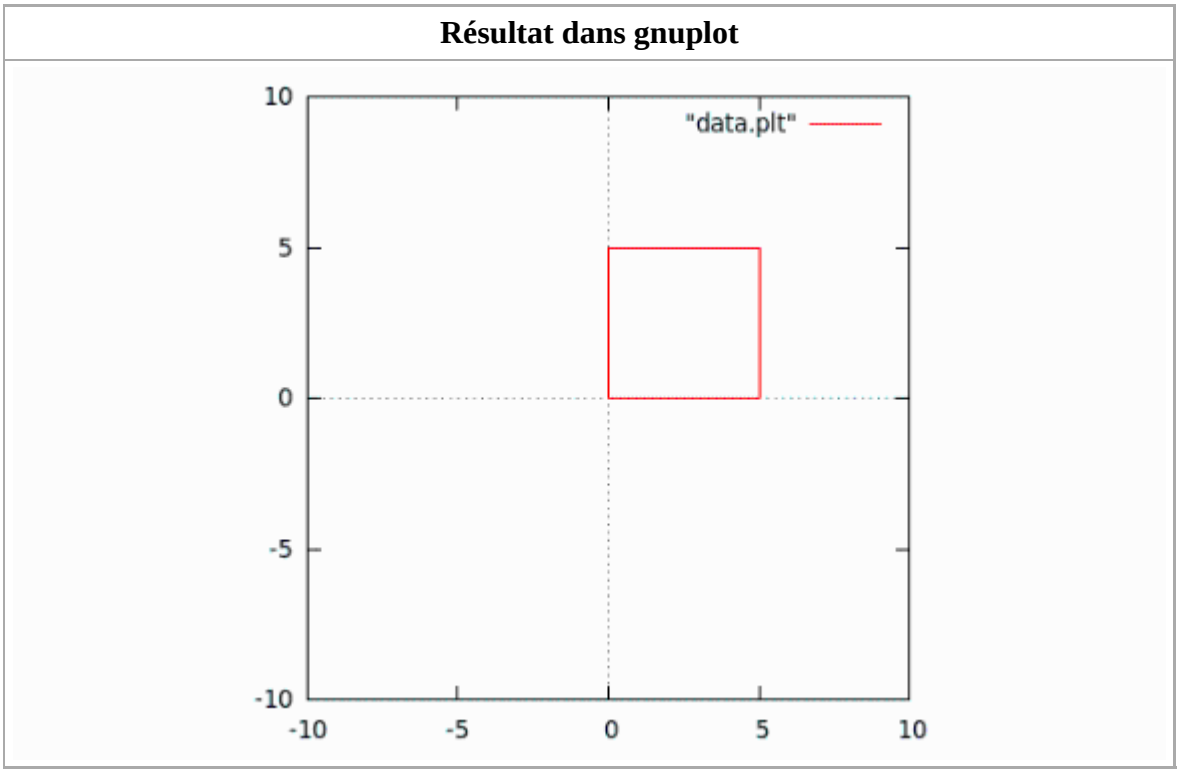
```c
/* ---------------------------------- */
/* Save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
int main(void)
{
double **U   = G_main(-10.,10.,-10.,10.);
double angle = 0.;
double  side = 5.;

   for(;angle<360;angle+=90)
```

```
      vo(U,angle,side);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n");

  return 0;
}
```

Le résultat :

```
# Gnuplot file : load "a_main.plt"

set zeroaxis
set size ratio -1
plot [-10.000:10.000] [-10.000:10.000] \
"data.plt" with linesp pt 0
```

Résultat dans gnuplot



Les fichiers h partagés

v_a.h
Appel des fichiers

```
/* ---------------------------------- */
/*      Save as :  v_a.h              */
/* ---------------------------------- */
#include    <stdio.h>
#include   <stdlib.h>
#include   <stddef.h>
```

```
#include    <ctype.h>
#include     <time.h>
#include     <math.h>
/* ---------------------------------- */
#include  "vdefine.h"
#include  "vmatini.h"
#include  "vmatbas.h"
#include  "vmatcop.h"
#include  "vmatrot.h"
```

vdefine.h
Déclaration des defines

```
/* ---------------------------------- */
/*      Save as : vdefine.h           */
/* ---------------------------------- */
#define C0              0
#define C1              1
#define C2              2
#define C3              3
#define C4              4
#define C5              5

#define R0              0
#define R1              1
#define R2              2
#define R3              3
#define R4              4
#define R5              5

#define OF              0

#define R_SIZE          0
#define C_SIZE          1
#define C_SIZE_A        2
#define FIRST           1

#ifndef PI
#define PI              3.14159265359
#endif

#define MAX(A,B) ((A)>(B) ? (A):(B) )

void clrscrn(void)
{
  printf("\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n"
         "\n\n\n\n\n\n\n\n\n\n\n\n");
}
```

L'étude sur les matrices fait partie d'un autre livre.

vmatini.h
Création et destruction d'une matrice

```
/* ---------------------------------- */
/*      Save as : vmatini.h           */
/* ----------------------------------*/
double **I_mR(
int      r,
int      c
)
{
int      i = R0;
int     ar = r + C1;
int     ac = c + C1;
double **A = malloc(ar * sizeof(*A));

     for(; i<ar; i++)
      A[i] = malloc(ac * sizeof(**A));

    A[R_SIZE][OF] = ar;
    A[C_SIZE][OF] = ac;

return(A);
}
/* ---------------------------------- */
void F_mR(
double **A
)
{
int i=R0;
int r=A[R_SIZE][OF];

 if(A) for(;i<r;i++) free(A[i]);

 free(A);
}
```

vmatbas.h

Additionner et multiplier des matrices

```
/* ---------------------------------- */
/*      Save as : vmatbas.h           */
/* ---------------------------------- */
double **add_mR(
double **A,
double **B,
double **AplsB
)
{
int r;
int c;

for (r=FIRST;r<A[R_SIZE][OF];r++)
 for(c=FIRST;c<A[C_SIZE][OF];c++)
     AplsB[r][c]=A[r][c]+B[r][c];
 return(AplsB);
}
/* ---------------------------------- */
double **mul_mR(
double **A,
double **B,
double **AB
```

```
)
{
int i,j,k;

for  (k=FIRST;           k<A[R_SIZE][OF];k++)
 for (j=FIRST;           j<B[C_SIZE][OF];j++)
  for(i=FIRST,AB[k][j]=0;i<A[C_SIZE][OF];i++)
      AB[k][j]+=A[k][i]*B[i][j];

 return(AB);
}
```

vmatcop.h
Copier une matrice

```
/* ---------------------------------- */
/*      Save as : vmatcop.h           */
/* ---------------------------------- */
double ** c_mR(
double **A,
double **B
)
{
int r;
int c;

for( r=FIRST;r<A[R_SIZE][OF];r++)
 for(c=FIRST;c<A[C_SIZE][OF];c++)
     B[r][c]=A[r][c];

return(B);
}
/* ---------------------------------- */
double  **c_a_A_mR(
double  a[],
double  **A
)
{
int r;
int c;
int i=0;

for( r=FIRST; r<A[R_SIZE][OF]; r++)
 for(c=FIRST; c<A[C_SIZE][OF]; c++)
     A[r][c] = a[i++];

return(A);
}
```

vmatrot.h
Matrice de rotation

```
/*      Save as : vmatrot.h           */
/* ---------------------------------- */
```

```
double **rot2D_mR(
double  **A,
double alpha
)
{
 A[1][1]=cos(alpha);A[1][2]=-sin(alpha);
 A[2][1]=sin(alpha);A[2][2]= cos(alpha);

return(A);
}
```

y_r.h
La librairie de géométrie de la tortue vectorielle

```
/* ---------------------------------- */
/*      Save as : y_r.h               */
/* ---------------------------------- */
void pd(
double **A
)
{
FILE   *fp = fopen("data.plt","a");

fprintf(fp," %+.3f %+.3f\n",A[R1][C1],A[R2][C1]);
 fclose(fp);
}
/* ---------------------------------- */
void pu(
double **A
)
{
FILE   *fp = fopen("data.plt","a");

fprintf(fp,"\n %+.3f %+.3f\n",A[R1][C1],A[R2][C1]);
 fclose(fp);
}
/* ---------------------------------- */
double **g_main(
double **A,
double xmin,
double xmax,
double ymin,
double ymax
)
{
FILE *fp;

        fp = fopen("a_main.plt","w");
fprintf(fp,"# Gnuplot file : load \"a_main.plt\" \n"
           "set zeroaxis\n"
           "set size ratio -1\n"
           "plot [%0.3f:%0.3f] [%0.3f:%0.3f] \\\n"
           "\"data.plt\" with linesp pt 0\n"
           ,xmin,xmax,ymin,ymax);
 fclose(fp);

        fp = fopen("data.plt","w");
 fclose(fp);

       A[R1][C1] = 0.;
```

```
        A[R2][C1] = 0.;

        pd(A);

return(A);
}
/* ---------------------------------- */
double **G_main(
double xmin,
double xmax,
double ymin,
double ymax
)
{
 return(g_main(I_mR(R2,C1),xmin,xmax,ymin,ymax));
}
/* ---------------------------------- */
void set(
double **A,
double x,
double y
)
{
   A[R1][C1] = x;
   A[R2][C1] = y;

   pd(A);
}
/* ---------------------------------- */
void setup(
double **A,
double x,
double y
)
{
   A[R1][C1] = x;
   A[R2][C1] = y;

   pu(A);
}
/* ---------------------------------- */
void vo(
double **A,
double alpha,
double side
)
{
double **T = I_mR(R2,C2);
double **B = I_mR(R2,C1);
double **C = I_mR(R2,C1);

   B[R1][C1] = side;
   B[R2][C1] = 0.;

   rot2D_mR(T,PI/180.*(alpha));
     mul_mR(T,B,C);
       c_mR(A,B);
     add_mR(B,C,A);

   pd(A);

F_mR(C);
F_mR(B);
F_mR(T);
}
/* ---------------------------------- */
```

```
void vu(
double **A,
double alpha,
double side
)
{
double **T = I_mR(R2,C2);
double **B = I_mR(R2,C1);
double **C = I_mR(R2,C1);

   B[R1][C1] = side;
   B[R2][C1] = 0.;

   rot2D_mR(T,PI/180.*(alpha));
     mul_mR(T,B,C);
       c_mR(A,B);
     add_mR(B,C,A);

   pu(A);

F_mR(C);
F_mR(B);
F_mR(T);
}
```

Vectorielle : Quelques exemples

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

- Quelques exemples .

Dessiner

Petits jeux sur les pentagones

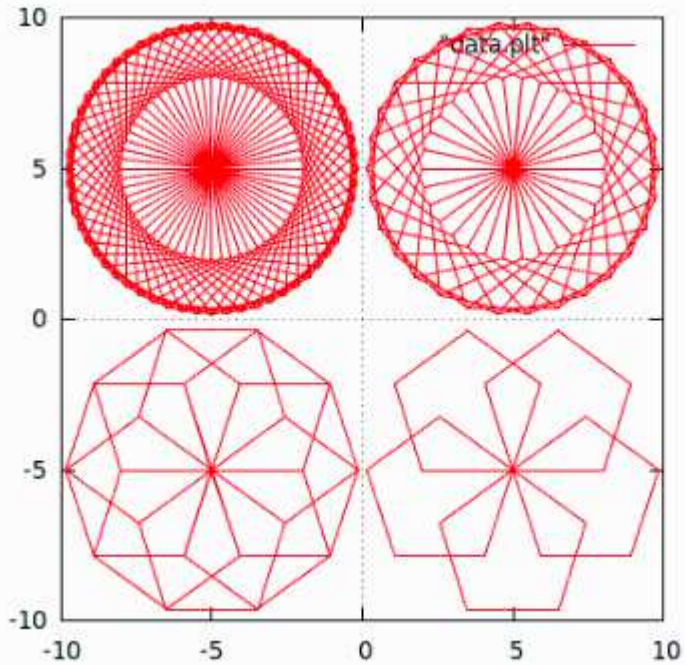
N'oubliez pas les fichiers h de la librairie.

c01.c
Petits jeux sur les pentagones

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void shape(
double **U,
double side,
int  nbside,
double angle0
)
{
double i=nbside;
double shapeangle=360./nbside;

   for(;i--;angle0+=shapeangle)

       vo(U,angle0,side);
}
/* ---------------------------------- */
int main(void)
{
double    side = 3.;
double  nbside = 5.;
double   angle = 0.;
double     **U = G_main(-10.,10.,-10.,10.);

   setup(U,-5,5);
   for(angle=0; angle<360; angle+=6)
       shape(U,side,nbside,angle);

   setup(U,5.,5.);
```

```
   for(angle=0; angle<360; angle+=12)
       shape(U,side,nbside,angle);

   setup(U,-5.,-5.);
   for(angle=0; angle<360; angle+=36)
       shape(U,side,nbside,angle);

   setup(U,5.,-5.);
   for(angle=0; angle<360; angle+=72)
       shape(U,side,nbside,angle);

   F_mR(U);

  printf("  * open the file main.plt with Gnuplot.\n\n\n\n\n\n");

  return 0;
}
```

Résultat dans gnuplot



Une feuille

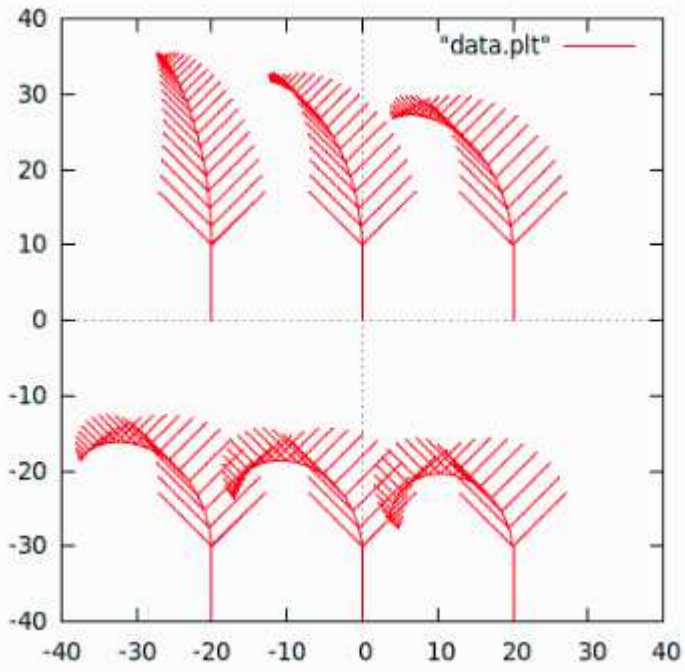
N'oubliez pas les fichiers h de la librairie.

c02.c
Une feuille

```
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
double **tree(
```

```
double **U,
double brancheangle,
double branchelength,
double branchebranche,
double step,
double angletrunc
)
{
double j=angletrunc;
double i=branchelength;

  vo(U,+90.,branchelength);

  for(;i>0;i-=step,j+=angletrunc)
     {
       vo(U, brancheangle+90.,   i);
       vo(U, brancheangle+90.,  -i);
       vo(U,-brancheangle+90.,   i);
       vo(U,-brancheangle+90.,  -i);
       vo(U,            j+90.,   i/branchebranche);
     }

return(U);
}
/* ------------------------------------ */
int main(void)
{
double **U = G_main(-40.,40.,-40.,40.);

double  branchebranche =  4.;
double   branchelength =  10.;
double    brancheangle = -45.;
double      angletrunc = -0.;
double            step =  .5;

  setup(U,-20.,0.);
  tree(U,brancheangle,branchelength,branchebranche,step,2);

  setup(U,0.,0.);
  tree(U,brancheangle,branchelength,branchebranche,step,4);

  setup(U,20.,0.);
  tree(U,brancheangle,branchelength,branchebranche,step,6);

  setup(U,-20.,-40.);
  tree(U,brancheangle,branchelength,branchebranche,step,8);

  setup(U,0.,-40.);
  tree(U,brancheangle,branchelength,branchebranche,step,10);

  setup(U,20.,-40.);
  tree(U,brancheangle,branchelength,branchebranche,step,12);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



Petit jeux sur les polygones 1

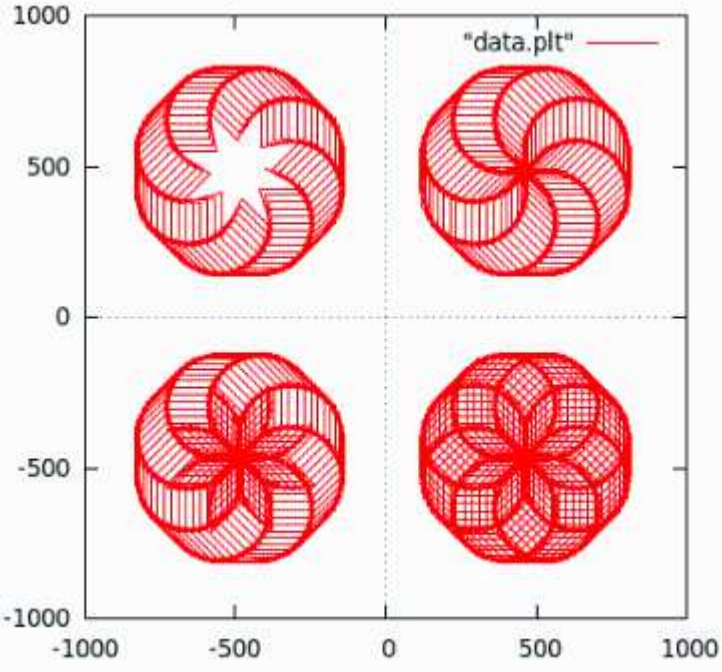
N'oubliez pas les fichiers h de la librairie.

c03.c
Petit jeux sur les polygones 1

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void duopoly(
double **U,
double **Sides,
double **Angles,
double alpha,
int    n
)
{
int i=1;
int c;

   for(;i++<n;)

      for(c=C1;c<Angles[C_SIZE][OF];c++)

        vo(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
}
/* ---------------------------------- */
int main(void)
{
```

```
double alpha  =-0;

double a[2]   ={  45.,  46.};
double s[2]   ={ 140., 140.};

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C2));
double **S = c_a_A_mR(s,I_mR(R1,C2));

   setup(U,-150, 350.);
   duopoly(U,S,A,alpha,152);

   setup(U, 800, 350.);
   duopoly(U,S,A,alpha,200);

   setup(U,-150,-600.);
   duopoly(U,S,A,alpha,275);

   setup(U, 800,-600.);
   duopoly(U,S,A,alpha,400);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



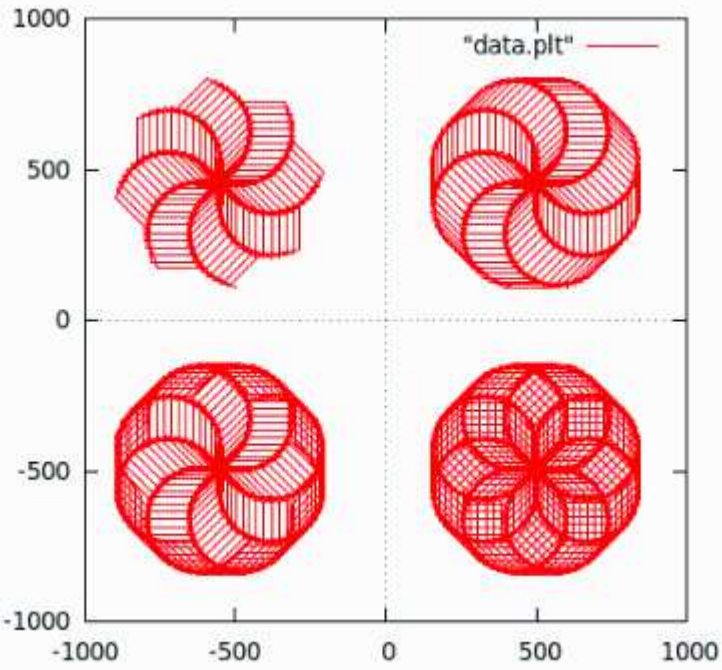
Petit jeux sur les polygones 2

N'oubliez pas les fichiers h de la librairie.

c04.c
Petit jeux sur les polygones 2

```
/* ---------------------------------- */
/* save as : c04.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void duopoly(
double **U,
double **Sides,
double **Angles,
double alpha,
int    n
)
{
int i=1;
int c;

   for(;i++<n;)

      for(c=C1;c<Angles[C_SIZE][OF];c++)

        vo(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
}
/* ---------------------------------- */
int main(void)
{
double alpha  =-0;

double a[2]   ={  45.,  46.};
double s[2]   ={  140., -140.};

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C2));
double **S = c_a_A_mR(s,I_mR(R1,C2));

   setup(U,-550, 450.);
   duopoly(U,S,A,alpha,152);

   setup(U, 500, 450.);
   duopoly(U,S,A,alpha,200);

   setup(U,-550,-500.);
   duopoly(U,S,A,alpha,275);

   setup(U, 500,-500.);
   duopoly(U,S,A,alpha,400);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



Petit jeux sur les polygones 3

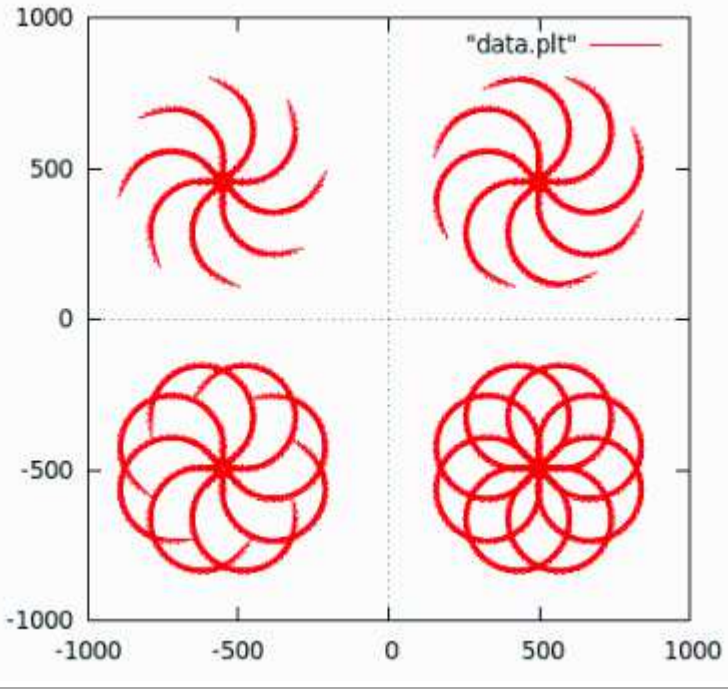
N'oubliez pas les fichiers h de la librairie.

c05.c
Petit jeux sur les polygones 3

```
/* ---------------------------------- */
/* save as : c05.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void duopoly(
double **U,
double **Sides,
double **Angles,
double alpha,
int    n
)
{
int a=1;
int i=1;
int c;

for(;i++<n;)
  for(c=C1;c<Angles[C_SIZE][OF];c++)
    if(a)
     {vu(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
      a=0;}
    else
      {vo(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
       a=1;}
```

```
}
/* ---------------------------------- */
int main(void)
{
double alpha  =-0;

double a[2]   ={  45.,  46.};
double s[2]   ={  140., -140.};

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C2));
double **S = c_a_A_mR(s,I_mR(R1,C2));

   setup(U,-550, 450.);
   duopoly(U,S,A,alpha,152);

   setup(U, 500, 450.);
   duopoly(U,S,A,alpha,200);

   setup(U,-550,-500.);
   duopoly(U,S,A,alpha,275);

   setup(U, 500,-500.);
   duopoly(U,S,A,alpha,400);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



Vectorielle : Quelques exemples 2

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

- Quelques exemples .

Dessiner

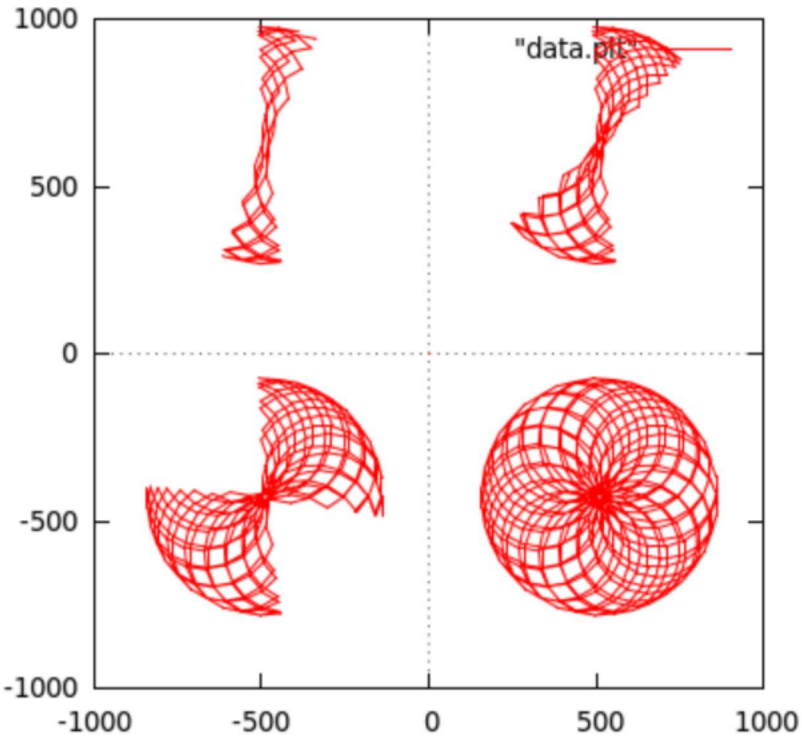
N'oubliez pas les fichiers h de la librairie.

c01.c
Petits jeux sur les polygones

```
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void poly(
double **U,
double **Sides,
double **Angles,
double alpha,
int    n
)
{
int i=1;
int c;

   for(;i++<n;)

      for(c=C1;c<Angles[C_SIZE][OF];c++)

        vo(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
}
/* ---------------------------------- */
int main(void)
{
double a[2]   ={ 19.,-20.};
double s[2]   ={ 60., 60.};
double alpha  =-90;

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C2));
double **S = c_a_A_mR(s,I_mR(R1,C2));
```

```
   setup(U,-500,450.);
   poly(U,S,A,alpha,50);

   setup(U, 500,450.);
   poly(U,S,A,alpha,100);

   setup(U, -500,-600.);
   poly(U,S,A,alpha,200);

   setup(U,500,-600.);
   poly(U,S,A,alpha,400);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



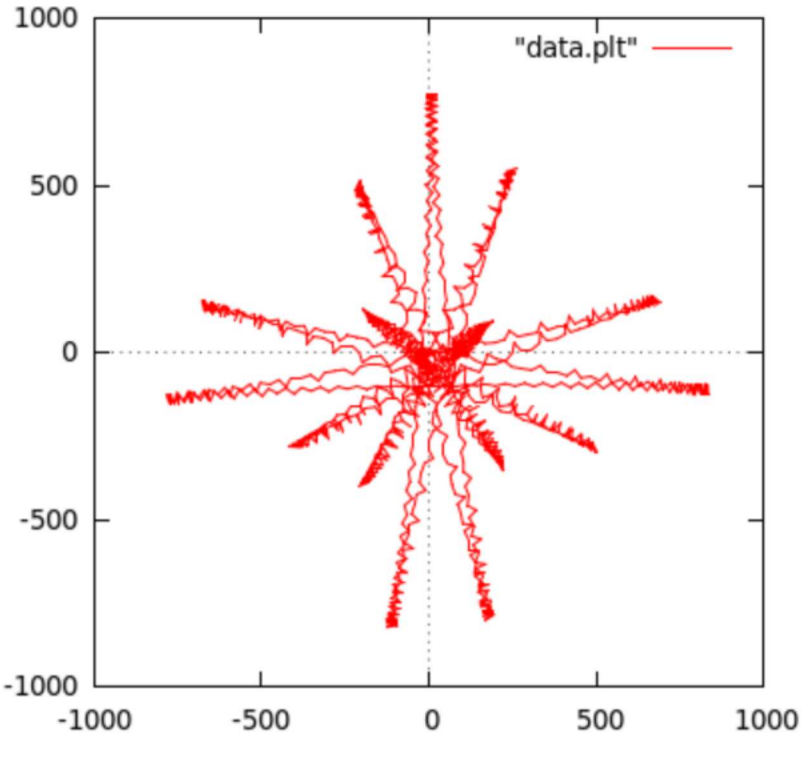
N'oubliez pas les fichiers h de la librairie.

c02.c
Une étoiles

```
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void poly(
double **U,
```

```
double **Sides,
double **Angles,
double alpha,
int    n
)
{
int i=1;
int c;

   for(;i++<n;)

      for(c=C1;c<Angles[C_SIZE][OF];c++)

        vo(U,i*(Angles[R1][c])+alpha,Sides[R1][c]);
}
/* ------------------------------------ */
int main(void)
{
double a[4]   ={ 7.,  -8.,  9., -10.};
double s[4]   ={ 30., 30., 30.,  30.};

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C4));
double **S = c_a_A_mR(s,I_mR(R1,C4));

   setup(U, 200,-100.);
   poly(U,S,A,-0.,400.);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



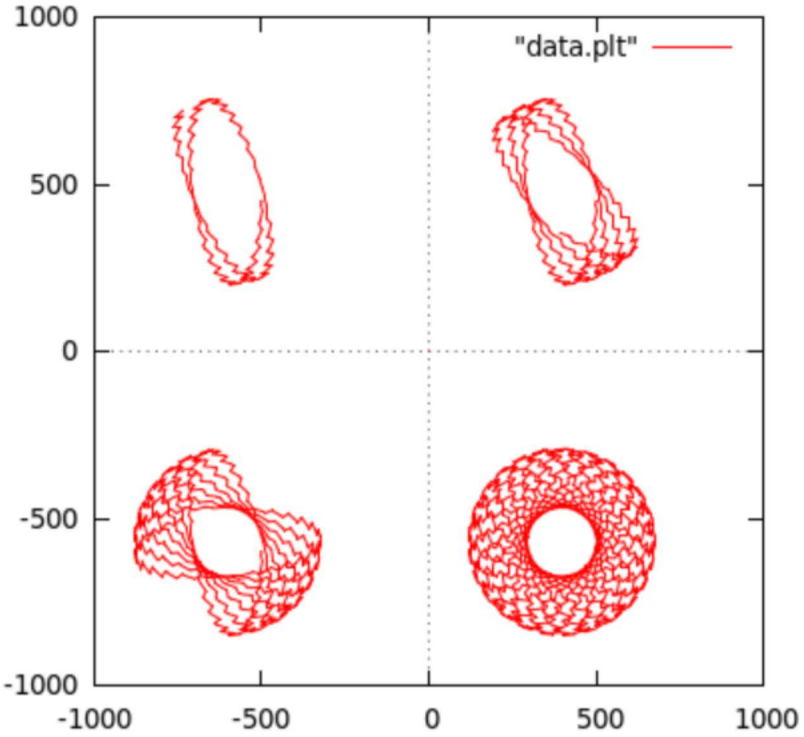
N'oubliez pas les fichiers h de la librairie.

c03.c

Petit jeux sur les polygones

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
void poly(
double **U,
double **Sides,
double **Angles,
double alpha,
double n
)
{
int i;
int c;

   for(i=1;i<n;++i)
      for(c=FIRST; c<Angles[C_SIZE][OF]; c++)
        vo(U,i*(Angles[FIRST][c])+alpha,Sides[FIRST][c]);
}
/* ---------------------------------- */
int main(void)
{
double alpha  =-90;

double a[3]   ={ -12., 13.,-12.};
double s[3]   ={  10., 20., 30.};

double **U = G_main(-1000.,1000.,-1000.,1000.);
double **A = c_a_A_mR(a,I_mR(R1,C3));
double **S = c_a_A_mR(s,I_mR(R1,C3));

   setup(U,-500,450.);
   poly(U,S,A,alpha,50);

   setup(U, 500,450.);
   poly(U,S,A,alpha,100);

   setup(U, -500,-600.);
   poly(U,S,A,alpha,200);

   setup(U,  500,-600.);
   poly(U,S,A,alpha,400);

   F_mR(U);

  return 0;
}
```

Résultat dans gnuplot



Vectorielle : Fonctions récursives

Préambule

La géométrie de la tortue dans Wikipedia.

Présentation

Les fonctions récursives.

Dessiner

Un arbre

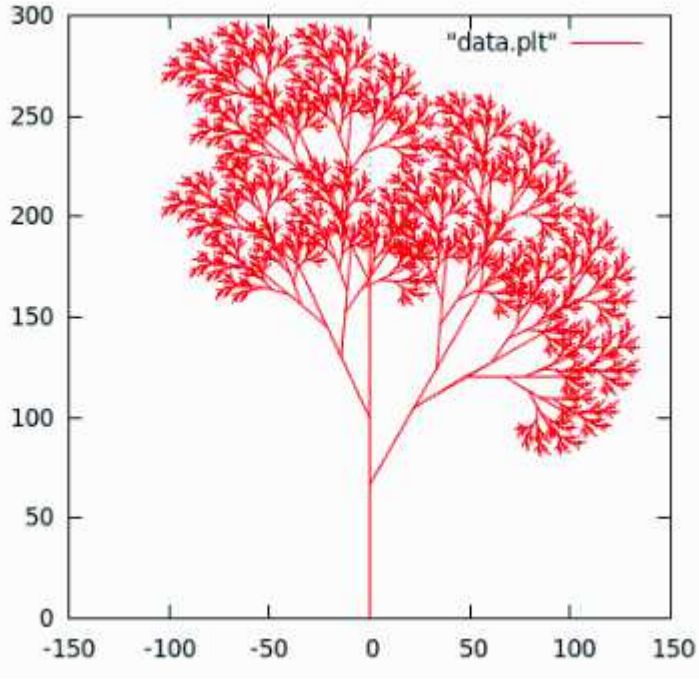
N'oubliez pas les fichiers h de la librairie.

c01.c
Un arbre

```c
/* ---------------------------------- */
/* save as : c01.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
double **fun(double **U,double side,double angle);
/* ---------------------------------- */
int main(void)
{
double angle     =  90.;
double  side     =  200.;

double **U = G_main(-150.,150.,-0.,300.);

   F_mR(fun(U,angle,side));

   printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **fun(
double **U,
double angle,
double side
)
{
 if(side<5)
   {
    vo(U,angle, side);
    vo(U,angle,-side);
    return(0);
```

```
  }

vo(U,angle, side/3.);

angle+=-30;
fun(U,angle,side*2./3.);

angle+= 30;
vo(U,angle, side/6.);

angle+= 25;
fun(U,angle,side/2.);

angle+=-25;
vo(U,angle, side/3.);

angle+= 25;
fun(U,angle,side/2.);

angle+=-25;
vo(U,angle, side/6.);
vo(U,angle, -side);

return(U);
}
```

Résultat dans gnuplot



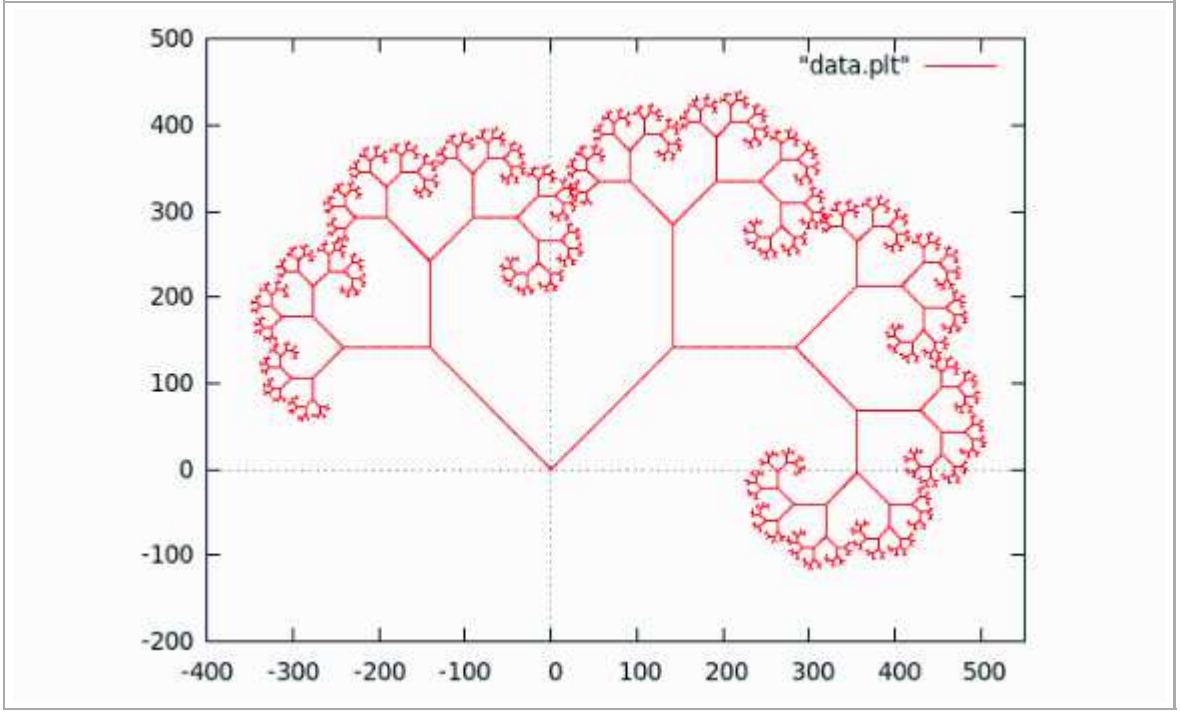
Un arbre (2)

N'oubliez pas les fichiers h de la librairie.

c02.c
Un arbre (2)

```
/* ---------------------------------- */
/* save as : c02.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
double **fun(double **U,
double side,double angle,double tangle);
/* ---------------------------------- */
int main(void)
{
double angle     =  90.;
double  side     = 200.;
double tangle    =  90.;

double **U = G_main(-400.,550.,-200.,500.);

   F_mR(fun(U,angle,side,tangle));

   printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
double **fun(
double **U,
double angle,
double side,
double tangle
)
{
 if(side<2) return(0);

 angle+=-tangle/2.;
 vo(U,angle, side);

 fun(U,angle,side/1.4,tangle);

 vo(U,angle,-side);
 angle+=tangle;
 vo(U,angle, side);

 fun(U,angle,side/2.,tangle);

 vo(U,angle,-side);
 angle+=-tangle/2.;

 return(U);
}
```

Résultat dans gnuplot



Un flocon

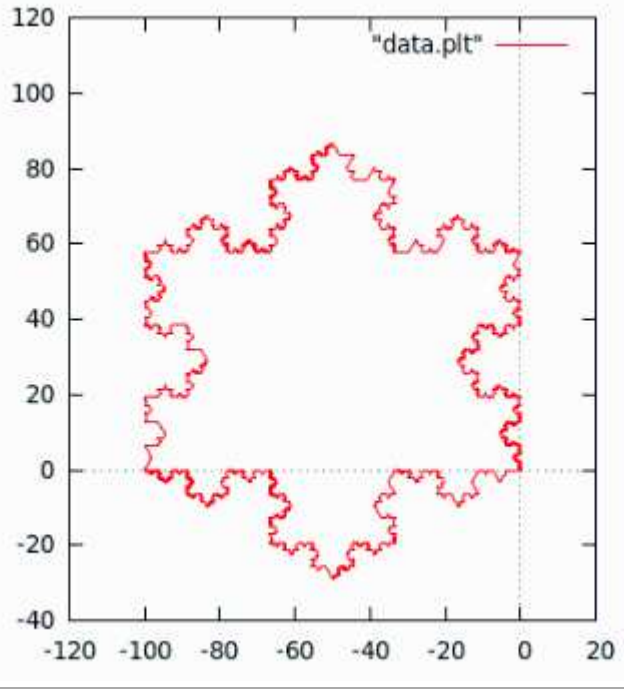
N'oubliez pas les fichiers h de la librairie.

c03.c
Un flocon

```
/* ---------------------------------- */
/* save as : c03.c                    */
/* ---------------------------------- */
#include "v_a.h"
#include "y_r.h"
/* ---------------------------------- */
double **fun2(double **U,
double angle,double side,double i);
int fun(double **U,
double angle,double side,double i);
/* ---------------------------------- */
int main(void)
{
double angle     =  0.;
double  side     = 100.;
double     i     =  10.;

double **U = G_main(-120.,20.,-40.,120.);

   F_mR(fun2(U,angle,side,i));

   printf("  * open the file main.plt with Gnuplot.");

  return 0;
}
/* ---------------------------------- */
```

```
int fun(
double **U,
double angle,
double side,
double i
)
{
 if(i<1)
   {
    vo(U,angle,side);
    return (0);
   }

 fun(U,angle,side/3.,--i);angle+=-60;
 fun(U,angle,side/3.,--i);angle+=120;
 fun(U,angle,side/3.,--i);angle+=-60;
 fun(U,angle,side/3.,--i);
}
/* ---------------------------------- */
double **fun2(
double **U,
double angle,
double side,
double i
)
{
int j;

  for(j=3; j>0; --j)
     {
      angle+=120;fun(U,angle,side,i);
     }

 return(U);
}
```

Résultat dans gnuplot



Conclusion

Préambule

La suite de ce travail pourrait être l'étude des matrices (L'étude des doubles pointeurs de doubles).

En pratique

Liste des cours disponibles avec vidéos, voir l'introduction

Fonction :

- fonction Heaviside

Limite :

- Asymptotes obliques

Dérivé :

- Tangente|Tangente
- Normale|Normale

Intégrale :

- Méthode des trapèzes
- Méthode de Simpson

Application de l'intégrale définie :

- Aires
- Longueur d'arc

Forme indéterminées et intégrales impropres :

- Intégrales impropres

Courbes planes et coordonnées polaires :

- Tangente
- Normale
- Cycloide
- Polaire
- Courbes de béziers

Fonctions vectorielles :

- Fonctions vectorielles
- Longueur de la courbe
- Tangente
- Cinématiques
- Courbures

Dérivations partielles :

- Dessiner f(x,y)
- Limite
- Tangente
- Méthode de Newton

Intégrales multiples :

- Intégrales doubles
- Intégrales doubles triples

Algèbre linéaire :

- Les coefficients d'un polynôme (Gauss/Jordan)
- Les coefficients d'un polynôme (Déterminant)
- Transformation linéaire (2d_3x3)

Géométrie de la tortue standard :

Géométrie de la tortue vectorielle :

Annexe : Commandes de bases (gnuplot)

Préambule

Dans ce chapitre, nous voyons les premières commandes pour dessiner des fonctions de la forme f(x).

En pratique

test

Cet exemple donne les informations de base.

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#
test
reset
# ---------------------
```

Le passage à la ligne

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  \n ->   \
#
plot cos(x)\
     sin(x)\
         .4\
        -.4
reset
# ---------------------
```

Chaine de caractères

linetype | lt <0..15>

Chaque nombre correspond à une couleur différente. (voir test)

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>
#
plot cos(x) lt 1,\
     sin(x) lt 2,\
        .4  lt 3,\
       -.4  lt 3
reset
# ---------------------
```

linewidth | lw <1.. 6>

Chaque nombre correspond à une épaisseur différente.

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  #  linewidth | lw <1.. 6>
#
plot cos(x) lt 1 lw 1,\
     sin(x) lt 2 lw 3,\
        .4  lt 3 lw 4,\
       -.4  lt 3 lw 6
reset
# ---------------------
```

Liste de points

plot "data"

Dessiner une liste de points.

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#
plot "data"
reset
# ---------------------
```

Créer un fichier "data" avec ces données :

```
-5 25
-4 16
-3 9
-2 4
-1 1
0 0
1 1
2 4
3 9
4 16
5 25
```

pointtype | pt <0..15>

Chaque nombre correspond à un dessin différent de points. (voir test)

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  pointtype | pt <0..15>
#
plot "data" pt 10
reset
# ---------------------
```

pointsize | ps <1.. >

Chaque nombre correspond taille de points différents. (voir test)

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
```

```
#  pointsize | ps <1..  >
#
plot "data" pt 10  ps 3
reset
# ---------------------
```

with linesp

Les points sont réliés par des segments.

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>   (color)
#  linewidth | lw <1.. 6>   (size)
#  pointsize | ps <1..  >   (size)
#
plot "data" with linesp lt 3 lw 3 ps 3
reset
# ---------------------
```

pt 0

Sans les points.

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>   (color)
#  linewidth | lw <1.. 6>   (size)
#  pointsize | ps <1..  >   (size)
#
plot "data" with linesp lt 3 lw 3 ps 3 pt 0
reset
# ---------------------
```

Commandes générales

set zeroaxis lt 8 lw 3

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>   (color)
#  linewidth | lw <1.. 6>   (size)
#
set zeroaxis lt 8 lw 3
plot sin(x),\
     cos(x)
reset
# ---------------------
```

set grid lt 8 lw 3

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>   (color)
#  linewidth | lw <1.. 6>   (size)
#  pointsize | ps <1..  >   (size)
#
set grid lt 8 lw 3
plot sin(x),\
     cos(x)
reset
# ---------------------
```

complet

```
# ---------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
#  linetype  | lt <0..15>   (color)
#  linewidth | lw <1.. 6>   (size)
#  pointsize | ps <1..  >   (size)
#
set zeroaxis lt 8 lw 3
set grid
plot [-6.:6.] [-1.4:1.4]\
     sin(x),\
     cos(x)
reset
# ---------------------
```

Annexe : Commandes de bases 3d (gnuplot)

Préambule

Dans ce chapitre, nous voyons les premières commandes pour dessiner des fonctions en 3d.

En pratique

splot[x][y][z] (La fonction)

```
# --------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
reset
splot [0:2*pi][0:2*pi][-1:1]\
cos(x)*cos(y)
# --------------------
```

set hidden (Faces cachées)

```
# --------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
reset
set hidden
splot [0:2*pi][0:2*pi][-1:1]\
cos(x)*cos(y)
# --------------------
```

set view rot_x, rot_z, scale, scale_z (Imposer une vue)

```
# --------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
reset
set hidden
set view 55.,57.,  1., 1.
splot [0:2*pi][0:2*pi][-1:1]\
cos(x)*cos(y)
# --------------------
```

set xlabel "X axis" (Nommer les axes)

```
# --------------------
# save this file as : a_main.plt
# Then into gnuplot : load "a_main.plt"
#
reset
```

```
set hidden
set xlabel "X axis"
set ylabel "Y axis"
set view 55.,57.,  1., 1.
splot [0:2*pi][0:2*pi][-1:1]\
cos(x)*cos(y)
# ---------------------
```

Mathc_gnuplot

Cette page est le livre d'or du livre Mathc gnuplot.

N'hésitez pas à faire vos remarques ici, indiquez des fautes, proposez des améliorations, ...

Utilisez le modèle suivant pour noter le livre :

```
{{RemarqueNotée|note=de 0 à 10|titre=titre de la critique|votre remarque ici}}
```

L'auteur.

Note : ★★★★☆	**L'auteur.**
Le meilleur livre que j'ai écrit sur Wikibook ;)	