Example 2

Copyright (c) 2010 - 2017 Young W. Lim.

Permission is granted to copy, distribute and/or modify this document under the terms of the GNU Free Documentation License, Version 1.2 or any later version published by the Free Software Foundation; with no Invariant Sections, no Front-Cover Texts, and no Back-Cover Texts. A copy of the license is included in the section entitled "GNU Free Documentation License".

Please send corrections (or suggestions) to youngwlim@hotmail.com.

This document was produced by using OpenOffice.

Young Won Lim
11/21/17

Using 2-d Arrays

```
#include <stdio.h>
#include <stdlib.h>
#define SIZE 10
```

avg3() definition

```
//-------------------------------------------------
// Calculating the average of three numbers
//-------------------------------------------------
double avg3(int x, int y, int z)
{
  return (x+y+z) / 3.;
}
```

init_arrays() definition

```
//-------------------------------------------------
// Initialize X[4][SIZE] arrays
// by assigning random number grade
//-------------------------------------------------
void init_arrays (int X[][SIZE], double A[])
{
  int i;

  // srand(7) makes rand() generate
  // the same random sequence
  // --> easy to debug a program
  srand(7);

  for (i=0; i<SIZE; ++i) {
    X[0][i] = i+1 + 201600; // I
    X[1][i] = rand() % 101; // K
    X[2][i] = rand() % 101; // E
    X[3][i] = rand() % 101; // M
    A[i] = avg3(X[1][i], X[2][i], X[3][i]);
  }
}
```

pr_table() definition

```
//-------------------------------------------------
// Print the original table
//-------------------------------------------------
void pr_table (int X[][SIZE], double A[])
{
   int i;

   printf("%10s %10s %10s %10s %10s \n", "StID",
          "Korean", "Enlgish", "Math", "Average");

   for (i=0; i<SIZE; ++i) {
     printf("%10d %10d %10d %10d %10.2f \n",
       X[0][i], X[1][i], X[2][i], X[3][i], A[i]);

   }
}
```

DbubbleSort() definition

```
//-------------------------------------------------
// Bubble Sort Double Array
//-------------------------------------------------
void DbubbleSort(double a[], int size)
{
  int    p, j;
  double tmp;

  for (p=1; p< size; ++p) {
    for (j=0; j< size-1; ++j) {
      if ( a[j] < a[j+1] )  {
        tmp    = a[j];
        a[j]   = a[j+1];
        a[j+1] = tmp;
      }
    }
  }
}
```

pr_sorted_table() definition

```
//-------------------------------------------------
// Print the Sorted Table
//-------------------------------------------------
void pr_sorted_table (int X[][SIZE], double A[])
{
   int i, j;
   double B[SIZE];  // Backup Array for Sorting

   for (i=0; i<SIZE; ++i)  B[i] = A[i];

   //.....................
   DbubbleSort(B, SIZE);
   //.....................

   printf("\n\nSorted on a student's average\n\n");
   printf("%10s %10s %10s %10s %10s \n", "StID",
          "Korean", "Enlgish", "Math", "Average");

   for (i=0; i<SIZE; ++i) {
     for (j=0; j<SIZE; ++j) if (B[i] == A[j]) break;

     printf("%10d %10d %10d %10d %10.2f \n",
       X[0][j], X[1][j], X[2][j], X[3][j], A[j]);
   }
}
```

Avg() definition

```
//-----------------------------------------------
// Average over Integer Array
//-----------------------------------------------
double Avg(int M[], int n) {
  int i; double S=0.0;

  for (i=0; i<n; ++i) S+= M[i];
  return S/n;
}
```

DAvg() definition

```
//-------------------------------------------------
// Average over Doubl Array
//-------------------------------------------------
double DAvg(double N[], int n) {
  int i; double S=0.0;

  for (i=0; i<n; ++i) S+= N[i];
  return S/n;
}
```

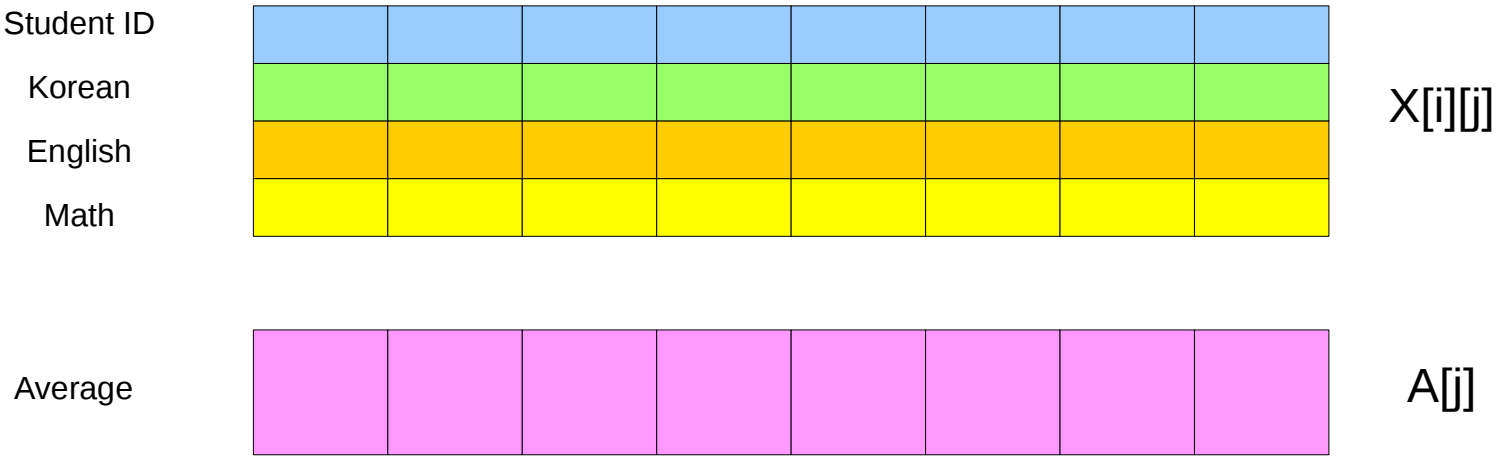
pr_average definition

```
//-------------------------------------------------
// Print the Averages
//-------------------------------------------------
void pr_averages(int X[][SIZE], double A[]) {
  double A1 =  Avg(X[1], SIZE);
  double A2 =  Avg(X[2], SIZE);
  double A3 =  Avg(X[3], SIZE);
  double A4 = DAvg(A, SIZE);

  printf("%10s %10.2f %10.2f %10.2f %10.2f \n",
         "Average", A1, A2, A3, A4);
}
```

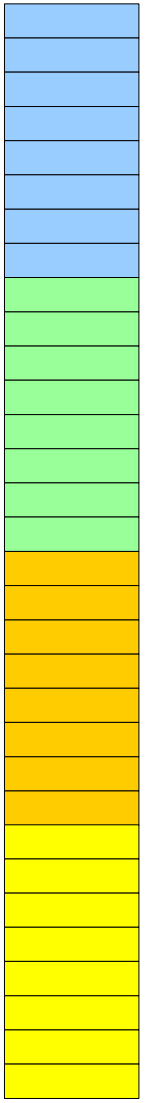
main() definition

```
//=================================================
// main
//=================================================
int main(void) {
  // X[0][SIZE] -->  I[SIZE];  // ID of a student
  // X[1][SIZE] -->  K[SIZE];  // Grade of Korean
  // X[2][SIZE] -->  E[SIZE];  // Grade of English
  // X[3][SIZE] -->  M[SIZE];  // Grade of Math

  int X[4][SIZE];
  double A[SIZE];  // Average of a student

  init_arrays(X, A);

  pr_table(X, A);

  pr_sorted_table(X, A);

  pr_averages(X, A);
}
```

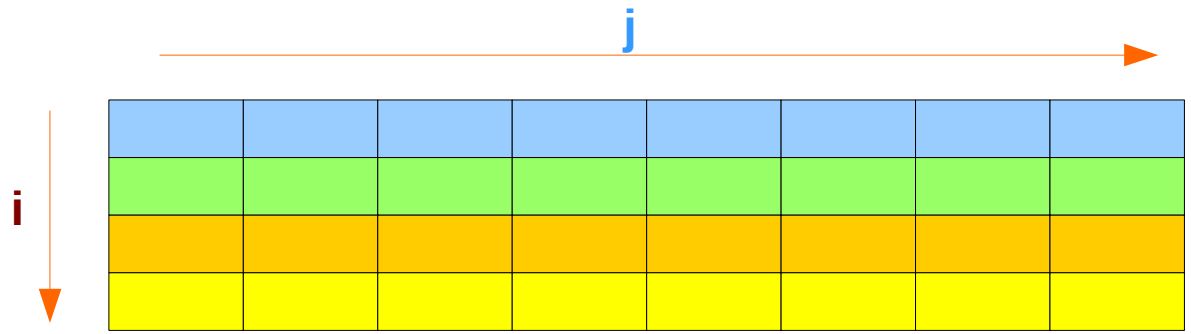
2-d Array Definition



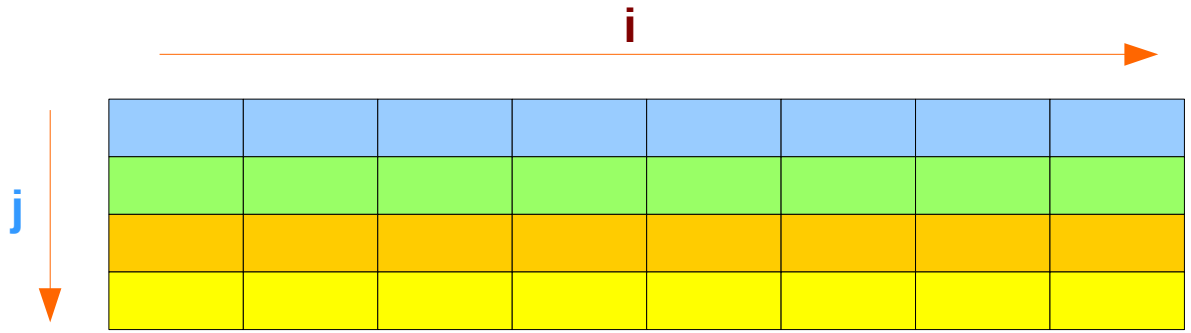
Row-by-Row : Row Major Ordering



Row and Column Index

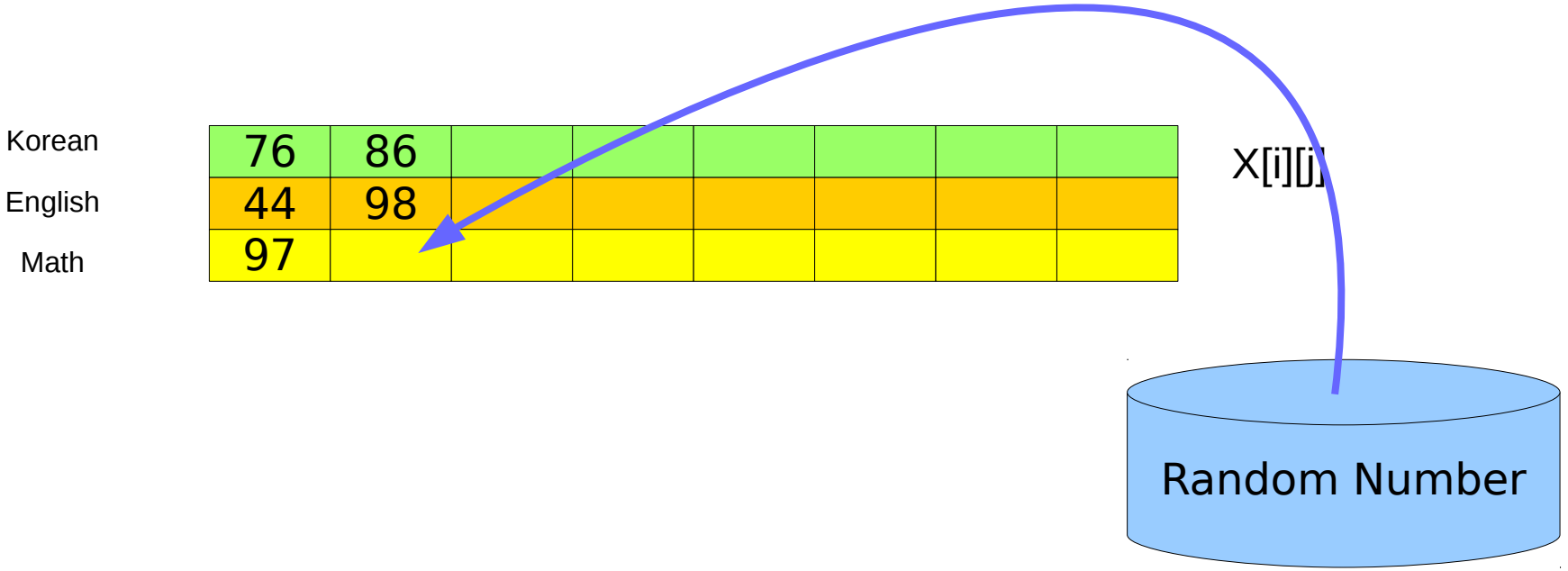


X[i][j]

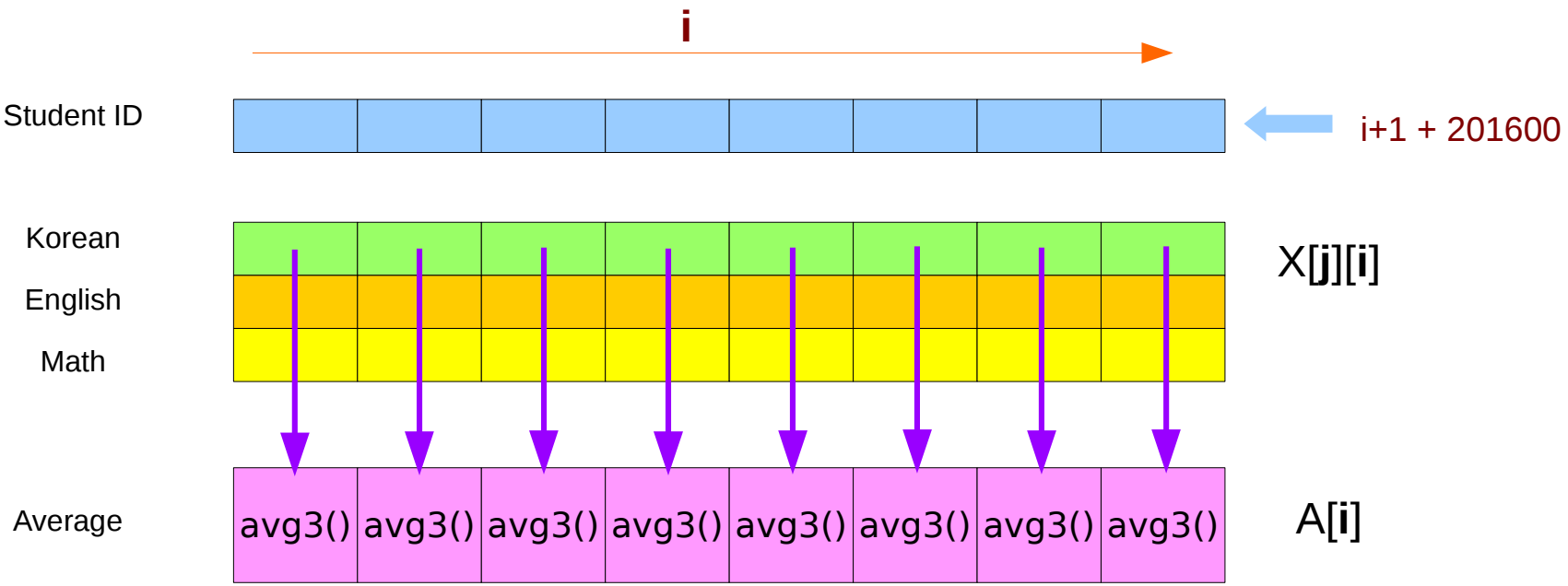


X[j][i]

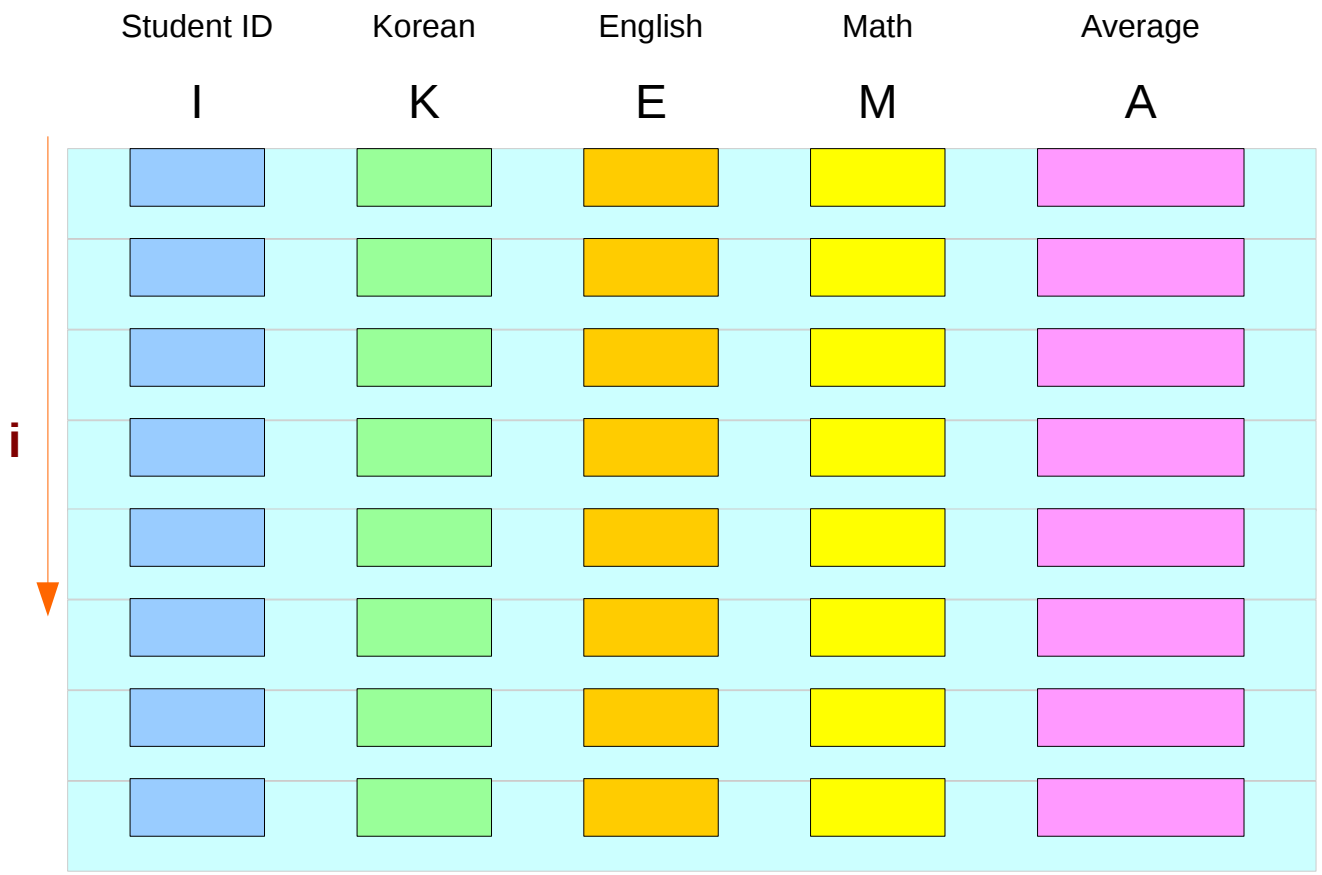
init_arrays() - filling grades



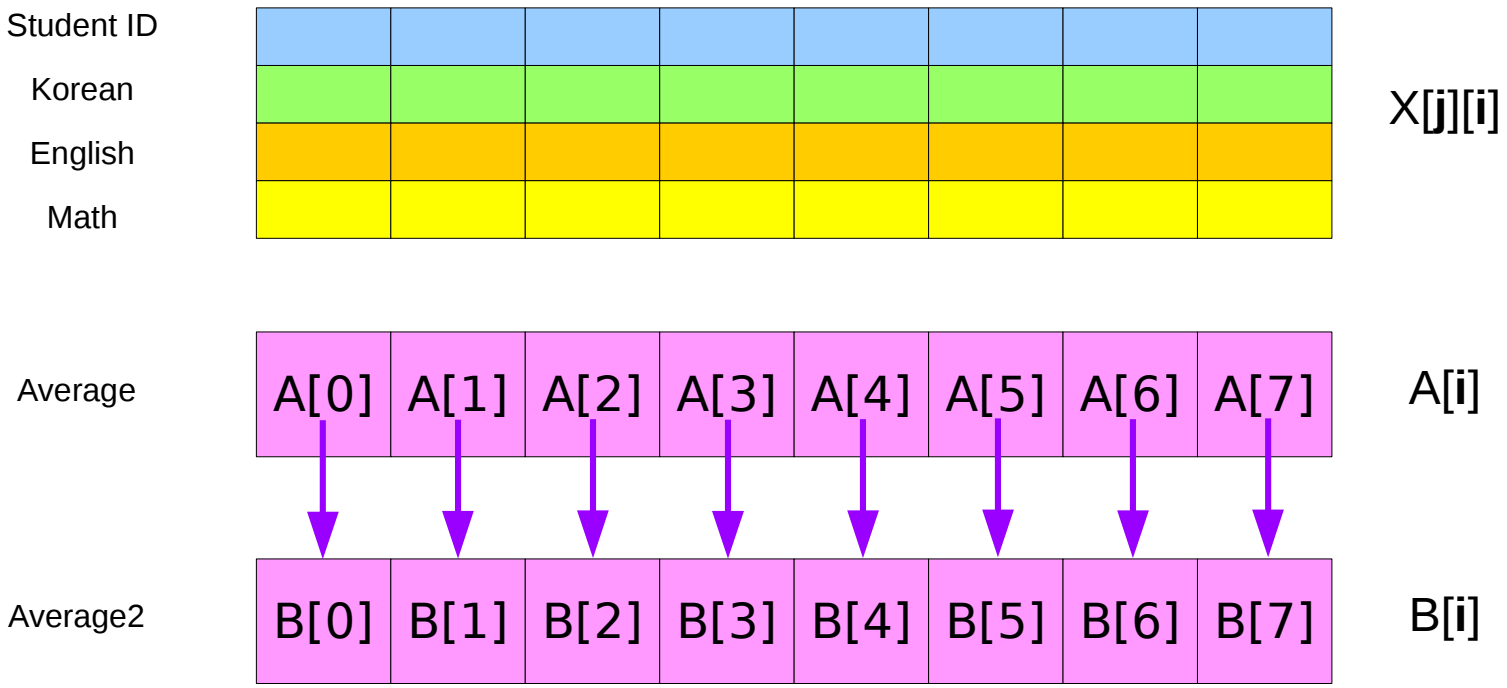
init_arrays() - computing averages



pr_table()

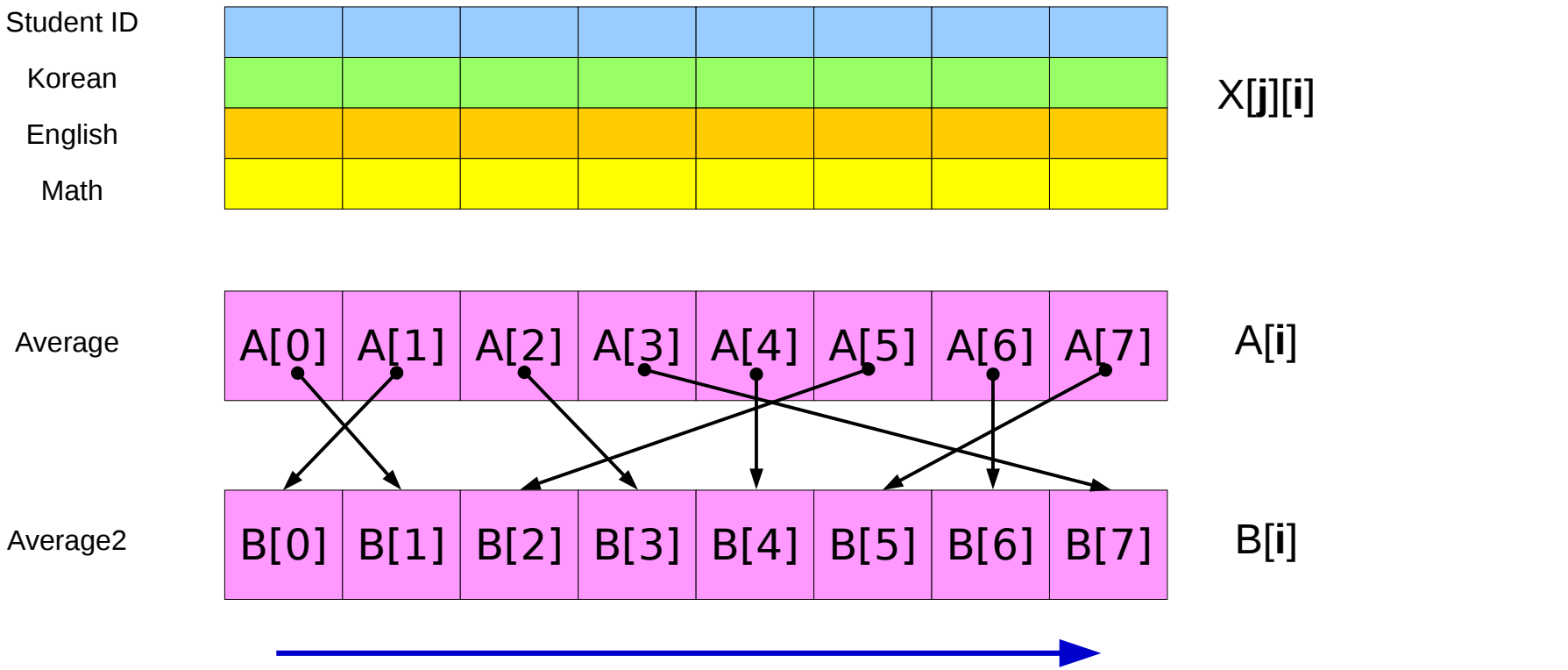


pr_sorted_table – copying A to B



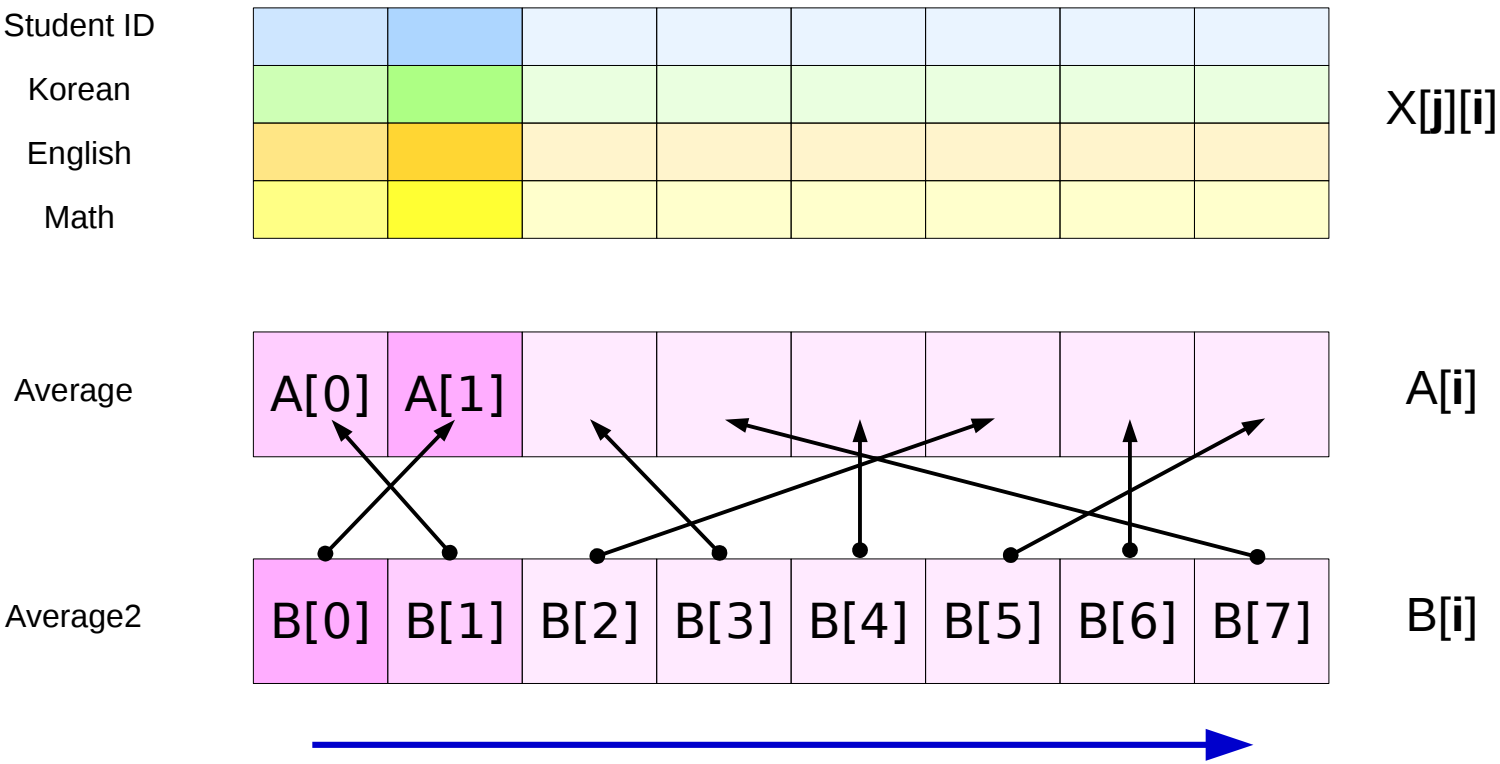
First, copy
A[i] into B[i]

pr_sorted_table – sorting B



after DbubbleSort()
B[j] > B[j]
A, B: different order

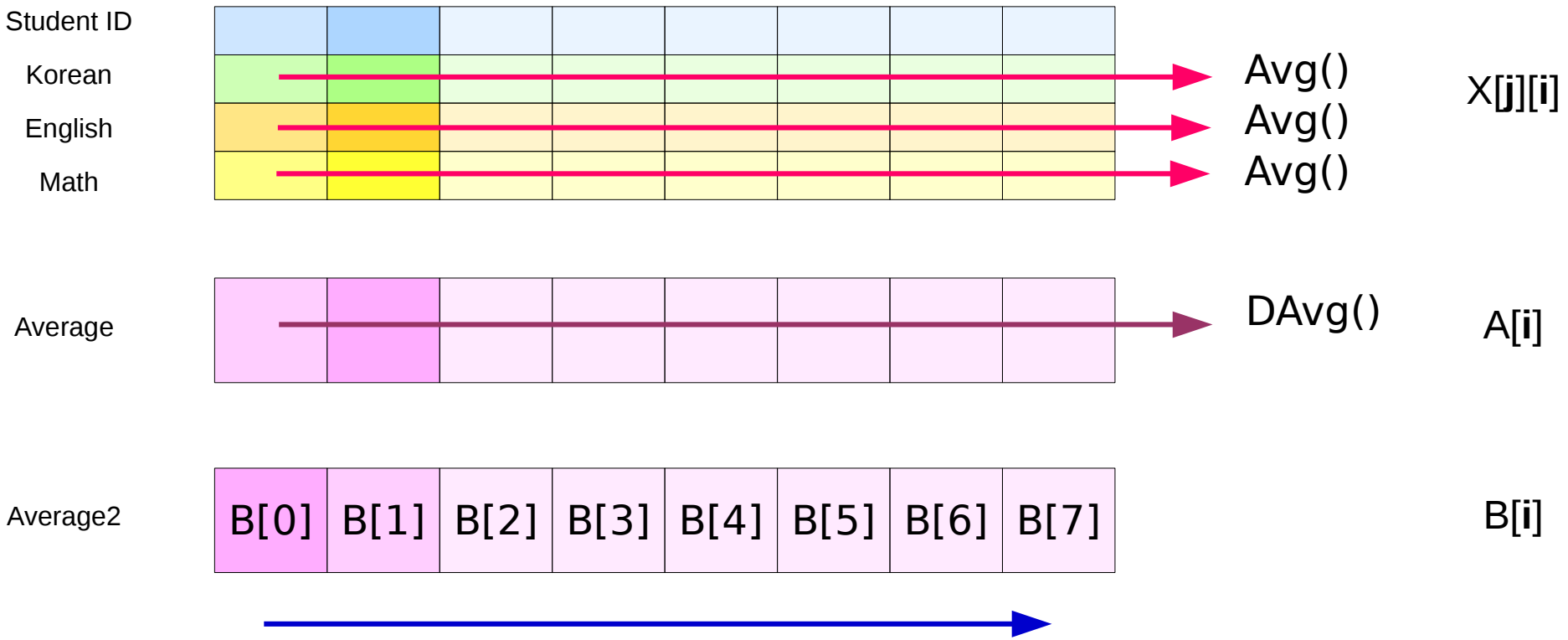
pr_sorted_table – printing by B



Search A[j] = B[i]

Assume that two averages have always different values

pr_averages


Student ID
Korean
English
Math
Avg()
Avg()
Avg()
X[j][i]
Average
DAvg()
A[i]
Average2
B[0]
B[1]
B[2]
B[3]
B[4]
B[5]
B[6]
B[7]
B[i]

Function Prototypes and Function Calls

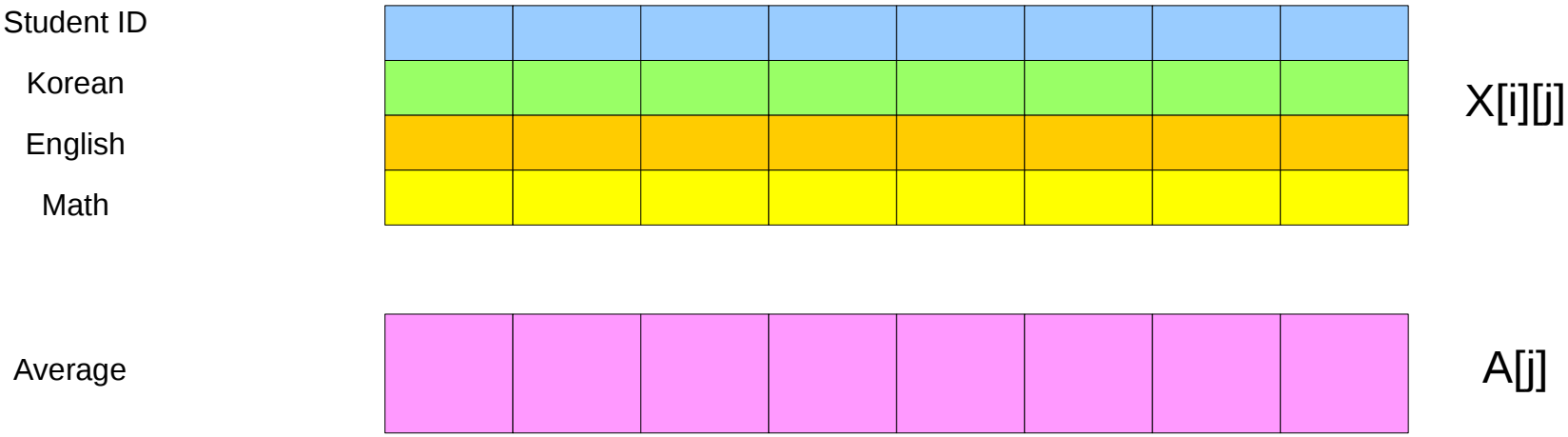
```
double    avg3          (int x, int y, int z) ;
void      init_arrays   (int X[][SIZE], double A[]);
void      pr_table      (int X[][SIZE], double A[]);
void      DbubbleSort   (double a[], int size);
void      pr_sorted_table (int X[][SIZE], double A[]);
double    Avg           (int X[], int n);
double    Davg          (double Y[], int n);
void      pr_averages   (int X[][SIZE], double A[]);
```

```
init_arrays(X, A); ……..  in main()
    A[i] = avg3(K[i], E[i], M[i]); ……..  in init_arrays()

pr_table(X, A); ……..  in main()

pr_sorted_table(X, A); ……..  in main()
    DbubbleSort(B, SIZE);  ……..  in pr_sorted_table()

pr_averages(X, A); ……..  in main()
    double A1 =  Avg(X[1], SIZE); ……..  in pr_averages()
    double A2 =  Avg(X[2], SIZE); ……..  in pr_averages()
    double A3 =  Avg(X[3], SIZE); ……..  in pr_averages()
    double A4 = DAvg(A, SIZE); ……..  in pr_averages()
```

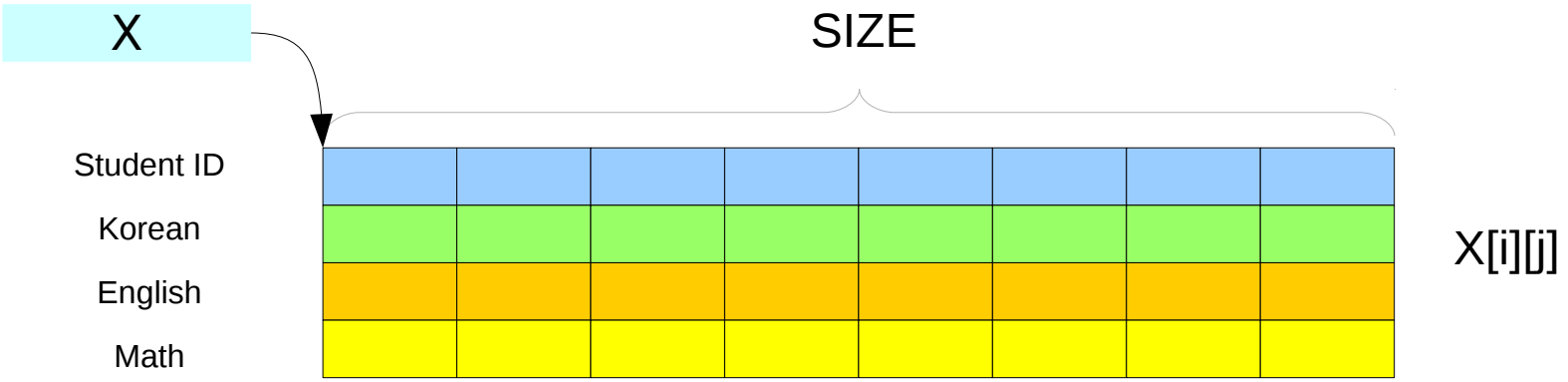
2-d Array Definitions

```
int main(void) {
  // X[0][SIZE] -->  I[SIZE];  // ID of a student
  // X[1][SIZE] -->  K[SIZE];  // Grade of Korean
  // X[2][SIZE] -->  E[SIZE];  // Grade of English
  // X[3][SIZE] -->  M[SIZE];  // Grade of Math

  int X[4][SIZE];
  double A[SIZE];  // Average of a student

  init_arrays(X, A);

  pr_table(X, A);

  pr_sorted_table(X, A);

  pr_averages(X, A);
}
```

2-d Array Definition



int X[ ][SIZE] : Formal Parameter

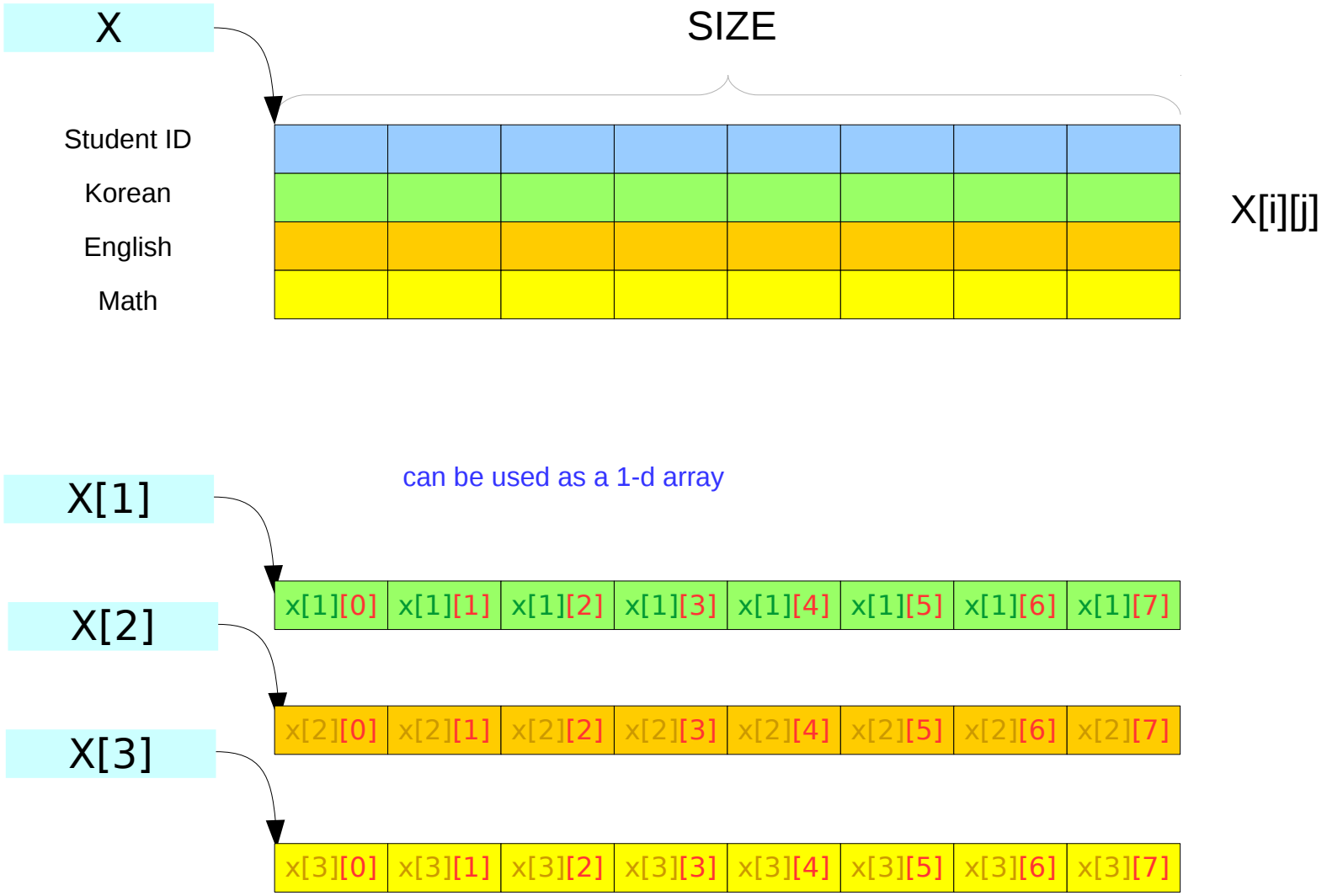


int X[4][SIZE];

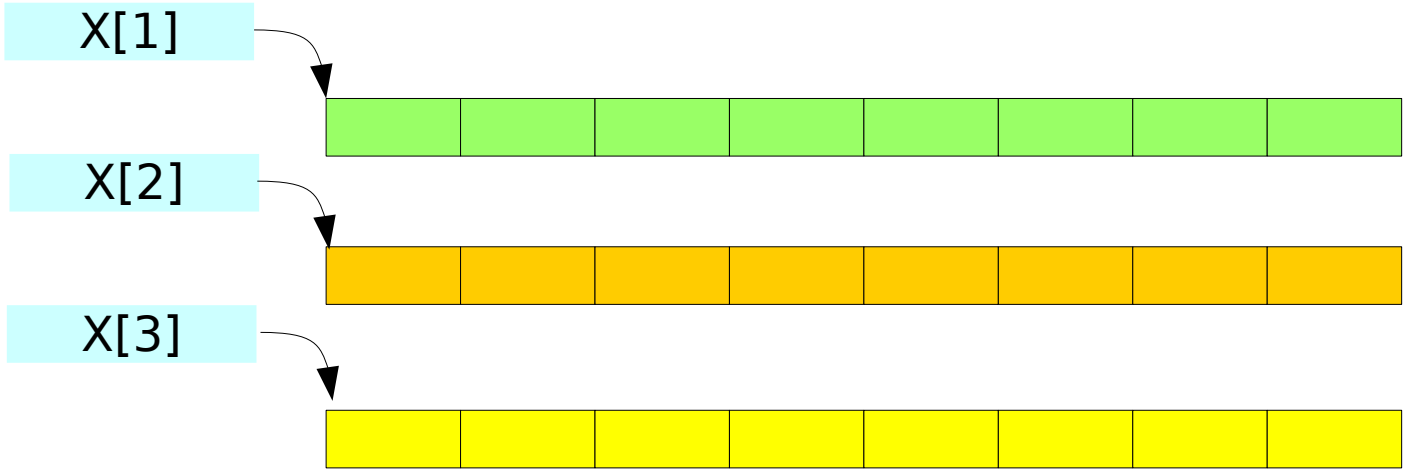
X

Init_arrays(int X[ ][SIZE], ...)
pr_table(int X[ ][SIZE], ...)
pr_sorted_table(int X[ ][SIZE], ...)
pr_averages(int X[ ][SIZE], ...)

X[1], X[2], X[3] : 2nd, 3rd , 4th rows



int X[ ] : Formal Parameter

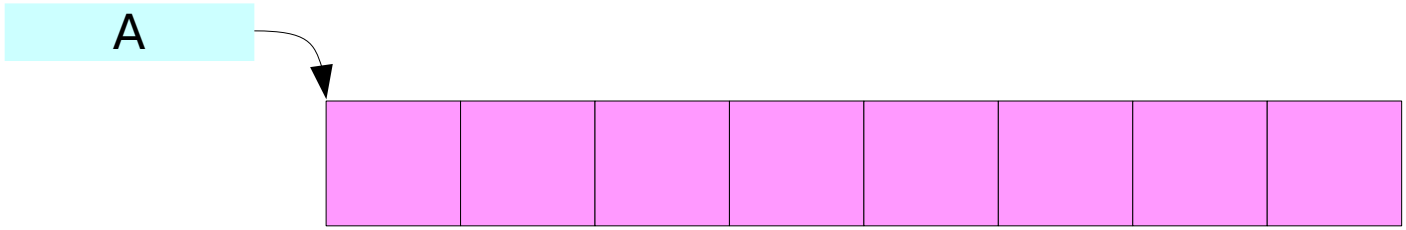


int X[4][SIZE];

X[1]
X[2]
X[3]

Avg(int X[ ], ...)

double Y[ ] : Formal Parameter



int A[SIZE];

A

DAvg(double Y[ ], ...)

References

[1] Essential C, Nick Parlante
[2] Efficient C Programming, Mark A. Weiss
[3] C A Reference Manual, Samuel P. Harbison & Guy L. Steele Jr.
[4] C Language Express, I. K. Chun
[5] cprogramex.wordpress.com