State Monad – Methods (6B)

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

This document was produced by using LibreOffice.

Based on

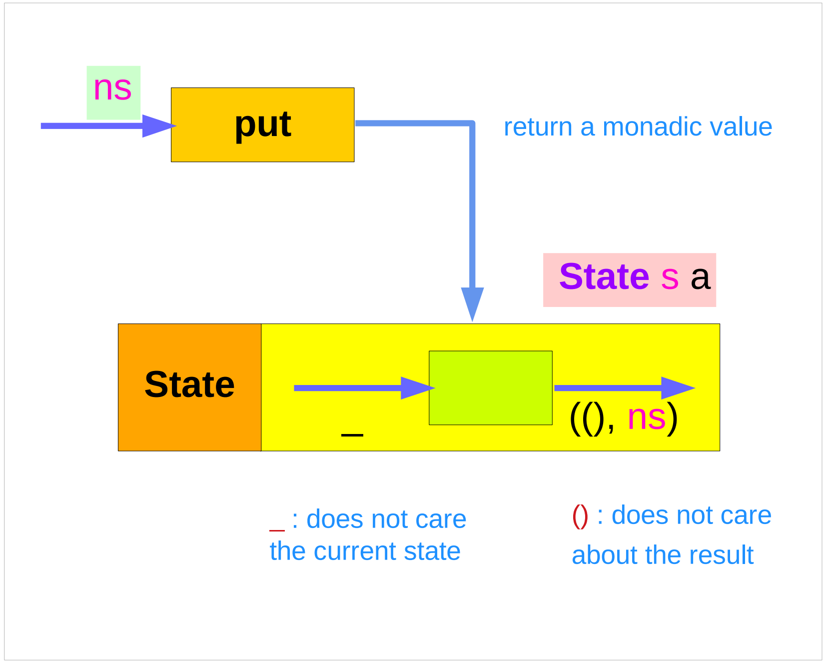
Haskell in 5 steps

https://wiki.haskell.org/Haskell_in_5_steps

put changes the current state

put :: s **->** **State** s a

put ns = **state** **$** _ -> ((), ns)



Given a wanted state new State (ns),

put generates a **state processor**

- ignores whatever the state it receives,
- updates the state to ns
- doesn't care about the result of this processor

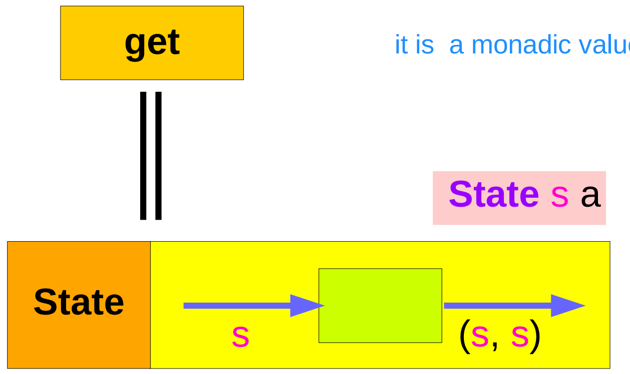
- all we want to do is to change the state
- the tuple will be ((), ns)
- () : the **universal placeholder value**.

https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

get gives the current state :

get :: **State** s s

get = **state** **$** \s -> (s, s)



get generates a **state processor**

- gives back the state s0
- as a result and as an updated state – (s0, s0)

- the state will remain unchanged
- a copy of the state will be made available through the result returned

https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

put returns a monadic value

put :: s **->** **State** s a

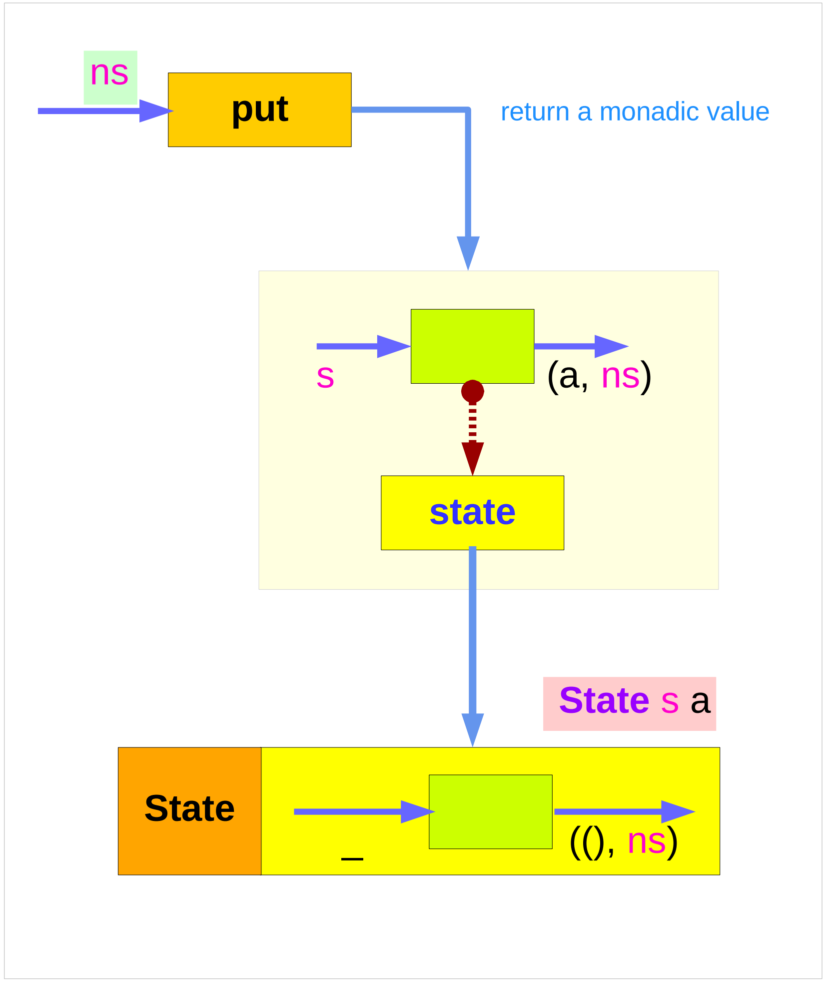
put s **::** **State** s a

put newState = **state $** _ -> ((), newState)

-- setting a state to newState

-- regardless of the old state

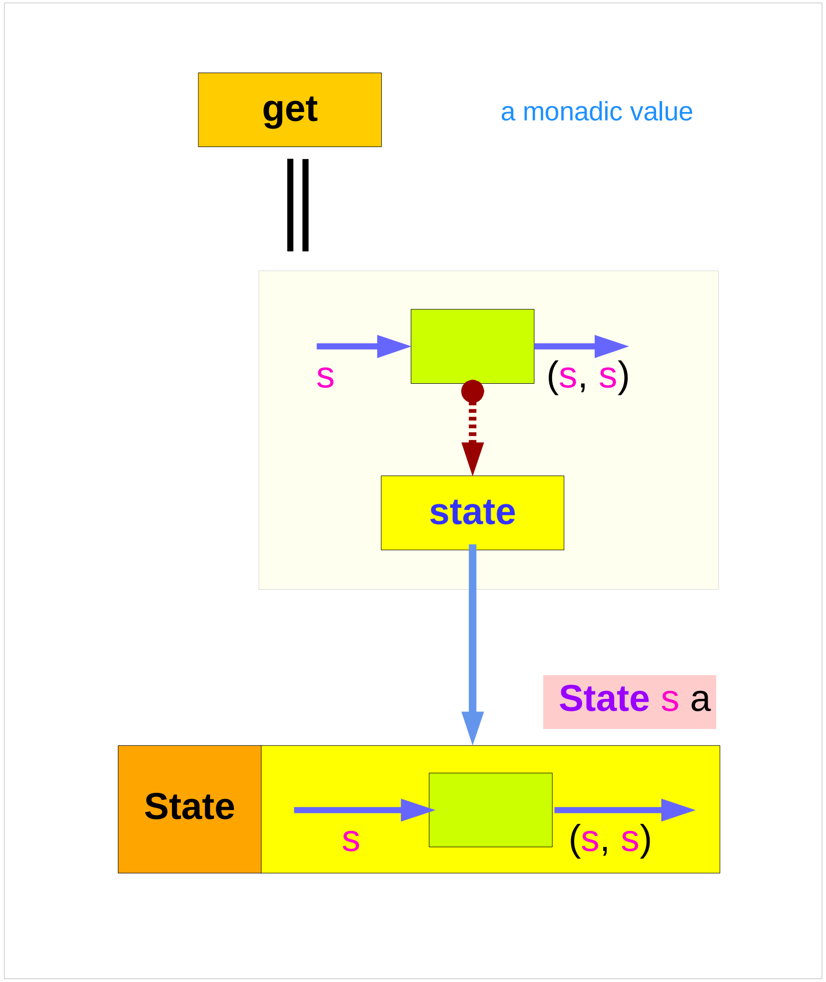
-- setting the result to ()



https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

get is a monadic value

```
get :: State s s

get = state $ \s -> (s, s)

-- getting the current state s
-- also setting the result to s
```



https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

Running **put**

put :: s **->** **State** s a

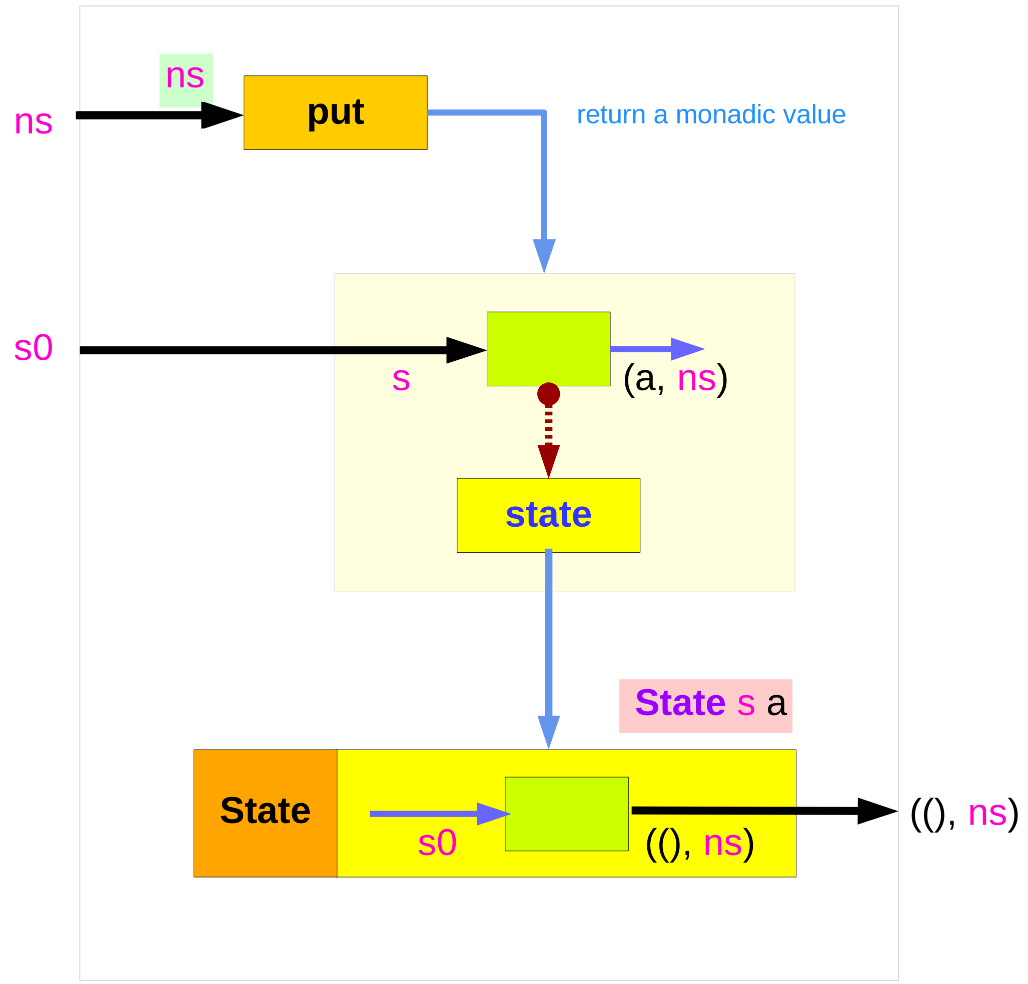
put s **::** **State** s a

put newState = **state $** _ -> ((), newState)

runState **(put** ns**)** **s0**

runState **(put 5)** **1**

((),5)



https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

Running **get**

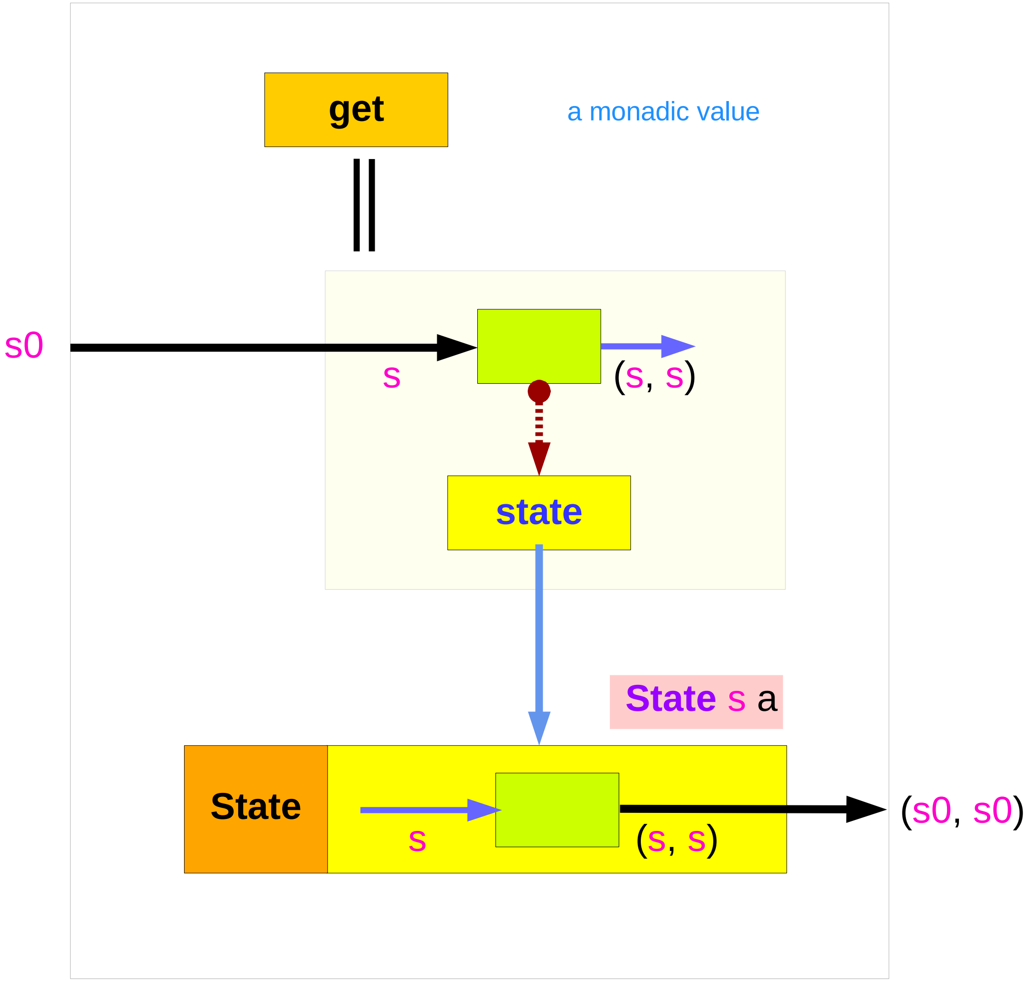
get :: State s s

get = **state $** \s -> (s, s)

runState (get) s0

runState (get) 1

(1,1)



https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

Example codes (1)

```
import Control.Monad.Trans.State

runState get 1
(1,1)
runState (return 'X') 1
('X',1)
runState get 1
(1,1)
runState (put 5) 1
((),5)
```

```
runState (put 1 >> get >> put 2 >> get ) 0
(2,2)

runState (get >>= \n -> put (n+1) >> return n) 0
(0,1)

inc = get >>= \n -> put (n+1) >> return n

runState inc 0
(0,1)
runState (inc >> inc)  0
(1,2)
runState (inc >> inc >> inc)  0
(2,3)
```

https://wiki.haskell.org/State_Monad

Example codes (2)

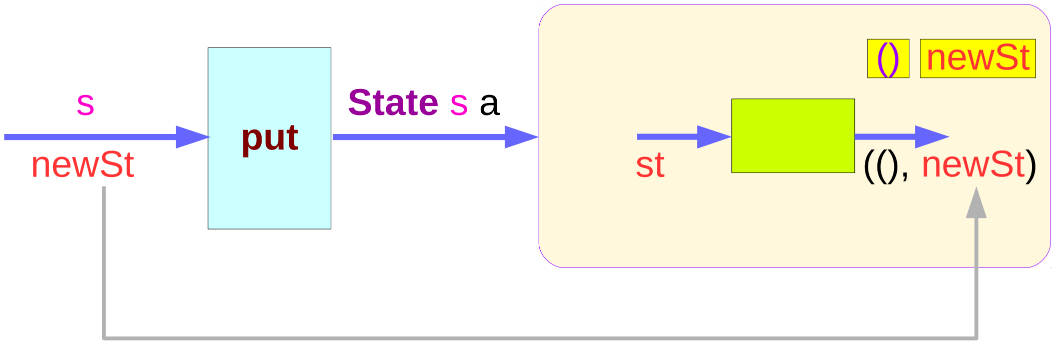
```
import Control.Monad.Trans.State

let postincrement = do { x <- get; put (x+1); return x }
runState postincrement 1
(1,2)

let predecrement = do { x <- get; put (x-1); get }
 runState predecrement 1
(0,0)
```

```
runState (modify (+1)) 1
((),2)
runState (gets (+1)) 1
(2,1)
evalState (gets (+1)) 1
2
execState (gets (+1)) 1
1
```

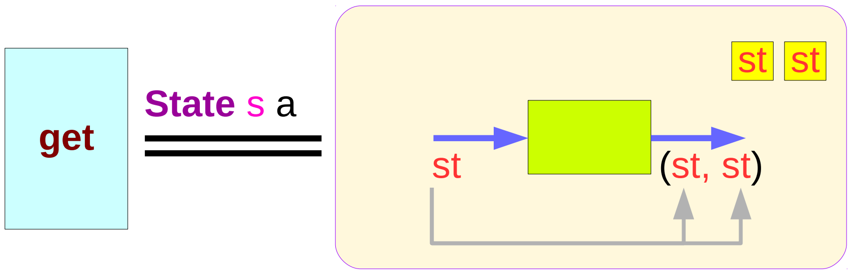
https://wiki.haskell.org/State_Monad

Simple representation of **put** and **get**

```
put :: s -> State s a
put s ::  State s a
put newSt = state $ \_ -> ((), newSt)
```




```
get :: State s s
get = state $ \s -> (s, s)
```



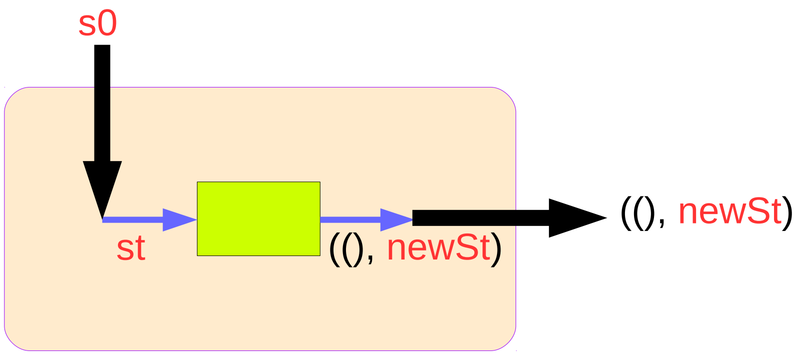
https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

Executing the state processor

put :: s **->** **State** s a

put newSt = **state $** _ -> ((), newSt)

runState (**put** newSt) s0 ➡ ((), newSt)

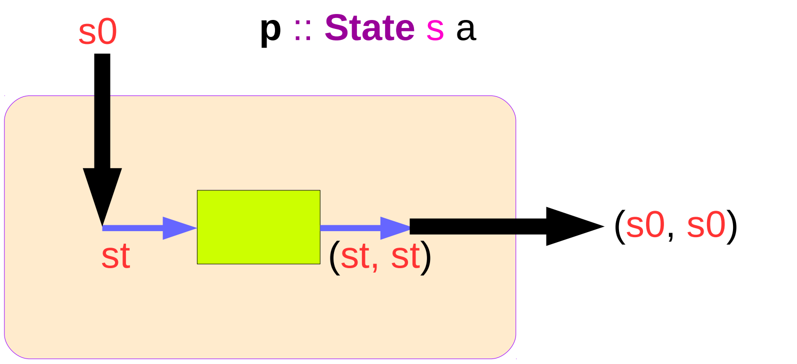


applying the function

get :: **State** s s

get = **state $** \s -> (s, s)

runState (**get**) s0 ➡ (s0, s0)



applying the function

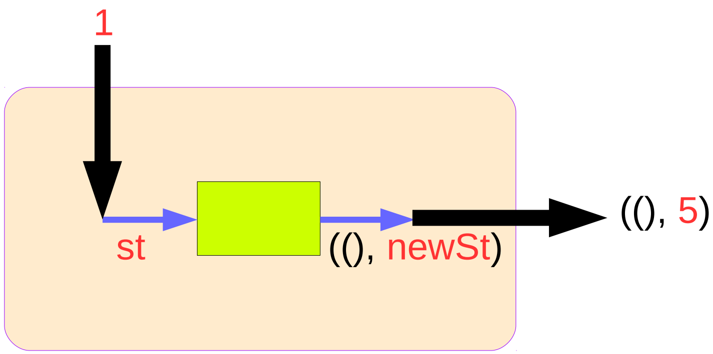
https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

State Monad Examples – put

runState (**put** 5) 1

((),5)

set the result value to () and set the state value.



put 5 :: **State** Int ()

runState (**put** 5) :: Int -> ((),Int)

initial state = 1 :: Int

final value = () :: ()

final state = 5 :: Int

put :: s -> State s a

put newState = **state $** _ -> ((), newState)

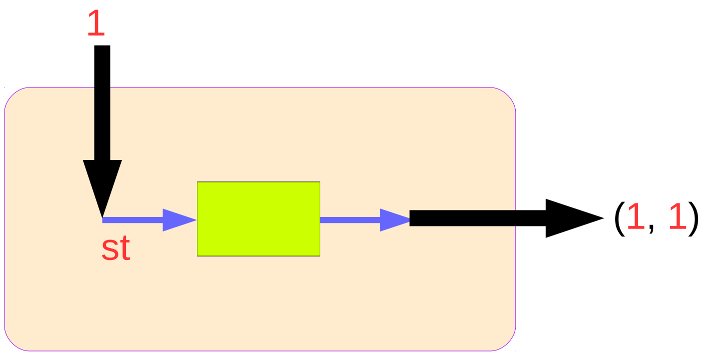
https://wiki.haskell.org/State_Monad

State Monad Examples – get

runState get 1

(1,1)

set the result value to the state and leave the state unchanged.



get :: **State** Int Int

runState get :: Int -> (Int, Int)

initial state = 1 :: Int

final value = 1 :: Int

final state = 1 :: Int

get :: State s s

get = **state $** \s -> (s, s)

https://wiki.haskell.org/State_Monad

Think an unwrapped state processor

```
(return 5)  ⇨   1 -> (5,1)    -- a way of thinking
get         ⇨   1 -> (1,1)    -- a way of thinking
(put 5)     ⇨   1 -> ((),5)   -- a way of thinking
```

a value of type (**State** s a) is

a **function** from initial state s

to final value a and final state s: (a,s).

these are usually wrapped,

but shown here unwrapped for simplicity.

```
(return 5)  ⇨   state( 1 -> (5,1) )     -- an actual way
get         ⇨   state( 1 -> (1,1) )     -- an actual way
(put 5)     ⇨   state( 1 -> ((),5) )    -- an actual way
```

Think an **unwrapped** state processor

wrapping the state processor

https://wiki.haskell.org/State_Monad

State Monad Examples – **return**, **get**, and **put**

Return leaves the state unchanged and sets the result:

-- ie: (**return** 5) ⇨ 1 -> (5,1) -- a way of thinking

runState (**return** 5) 1 ⇨ (5,1)

Get leaves state unchanged and sets the result to the state:

-- ie: **get** ⇨ 1 -> (1,1) -- a way of thinking

runState **get** 1 ⇨ (1,1)

Put sets the result to () and sets the state:

-- ie: (**put** 5) ⇨ 1 -> ((),5) -- a way of thinking

runState (**put** 5) 1 ⇨ ((),5)

https://wiki.haskell.org/State_Monad

State Monad Examples – modify and gets

```
modify :: (s -> s) -> State s ()
modify f = do { x <- get; put (f x) }

gets :: (s -> a) -> State s a
gets f = do { x <- get; return (f x) }
```

```
runState (modify (+1)) 1                (+1) 1 → 2 :: s
⇒ ((),2)

runState (gets (+1)) 1                  (+1) 1 → 2 :: a
⇒ (2,1)
```

```
evalState (gets (+1)) 1                 → :: s state
⇒ 2

execState (gets (+1)) 1                 → :: a result
⇒ 1
```

https://wiki.haskell.org/State_Monad

```
x <- get; put (f x)        - state
x <- get; return (f x)     - result
```

- inside a monad instance
- unwrapped implementations of **modify** and **gets**

Unwrapped Implementation – **return**, **get**, and **put**

Return leaves the state unchanged and sets the result:

-- ie: (**return** 5) ➡ 1 -> (5,1) -- a way of thinking

```
return :: a -> State s a
return x s = (x,s)
```

Get leaves state unchanged and sets the result to the state:

-- ie: **get** ➡ 1 -> (1,1) -- a way of thinking

```
get :: State s s
get s = (s,s)
```

Put sets the result to () and sets the state:

-- ie: (**put** 5) ➡ 1 -> ((),5) -- a way of thinking

```
put :: s -> State s ()
put x s = ((),x)
```

https://wiki.haskell.org/State_Monad

(x,s)

(s,s)

((),x)

- inside a monad instance
- unwrapped implementations of **return**, **get**, and **put**

Counter using State Monad

execState get 0	⇨ 0
set the value of the counter using put:	
execState (put 1) 0	⇨ 1
set the state multiple times:	
execState (do put 1; put 2) 0	⇨ 2
modify the state based on its current value:	
execState (do x <- get; put (x + 1)) 0	⇨ 1
execState (do modify (+ 1)) 0	⇨ 1
execState (do modify (+ 2); modify (* 5)) 0	⇨ 10

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

The Result of a Stateful Computation

a **stateful computation** is a **function** that

takes some **state** and

returns a **value** along with some **new state**.

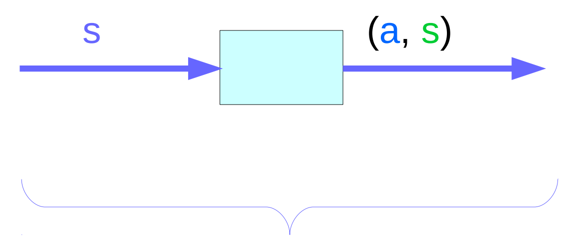
That function would have the following type:

s -> (a,s)

s is the type of the **state** and

a the **result** of the **stateful computation**.

s -> (a, s)



a <u>function</u> is an executable <u>data</u>

when <u>executed</u>, a <u>result</u> is produced

action, execution, result

s -> (a, s)

http://learnyouahaskell.com/for-a-few-monads-more

Stateful Computations inside the State Monad

inside a monad,

when **sc** is a stateful **c**omputation

then the **result** of the stateful computation **sc**

can be assigned to x

```
x <- sc
```

s -> (a, s)

only the result is binded

the **result** type

sc :: State s a

x :: a (the execution result of **sc**)

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

get inside the State Monad

inside the **State** monad,

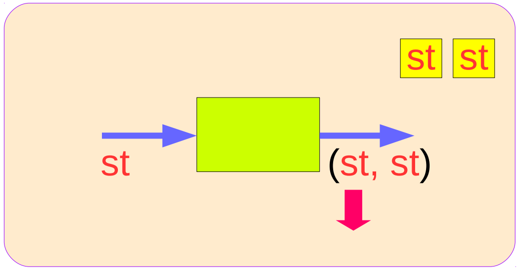
get returns the current monad instance
whose type is **State** s a

```
x <- get
```

the stateful computation is performed
over the current monad instance returned by **get**

the result of the stateful computation is st::s
thus x will get the st

x :: a the execution result of **get**



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Getting the current state inside the State Monad

inside the **State** monad,

get returns the current monad instance
whose type is **State** s a

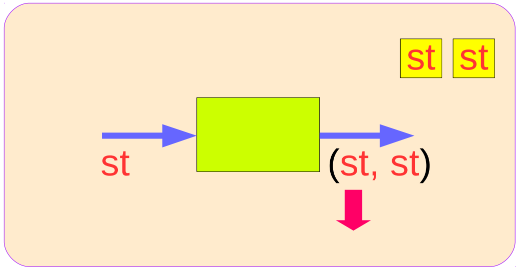
to get the current state st, do

```
s <- get
```

s will have the value of the current state st

this is like **evalState** is called with the current monad instance

- **get**
- **current monad instance**
- **stateful computation**
- **result :: s**

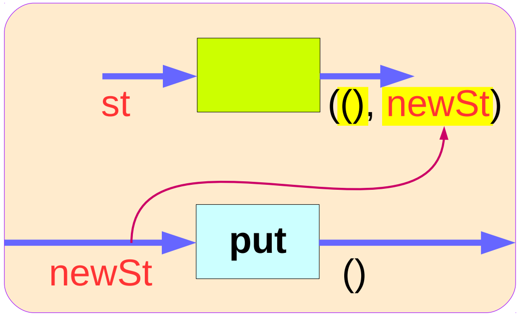


https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

put and get inside State Monad

```
put :: s -> State s a
put newSt = state $ \_ -> ((), newSt)
```

stateful computation of **put**



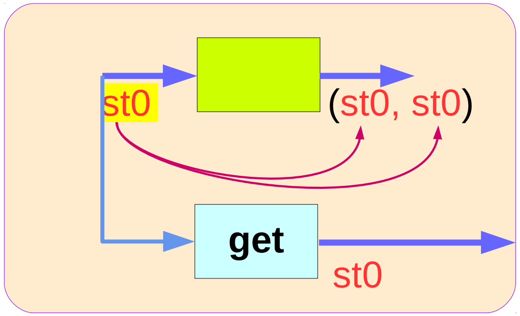
put :: s -> ()

the result type :: ()

-- a way of thinking

```
get :: State s s
get = state $ \s -> (s, s)
```

stateful computation of **get**



get :: s

the result type :: s

-- a way of thinking

-- no such a function

https://en.wikibooks.org/wiki/Haskell/Understanding_monads/State

Inside Functions and runState Functions

Most monads are equipped with some "*run*" functions
such as **runState**, **execState**, and so forth.

But, frequent calling such functions inside the monad
shows that the functionality of the monad does not fully exploited

let p = state (\y -> (y, y+1))

```
s0 <- get                   -- read the state of the current instance
let (a,s1) = runState p s0  -- pass the state to p, get new state
put s1                      -- save new state
```

||

```
a <- p                      -- the stateful computation p updates the state to s1
                            -- the result of the state returned is assigned to a
```

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Redundant computation examples (1)

s0 <- **get**

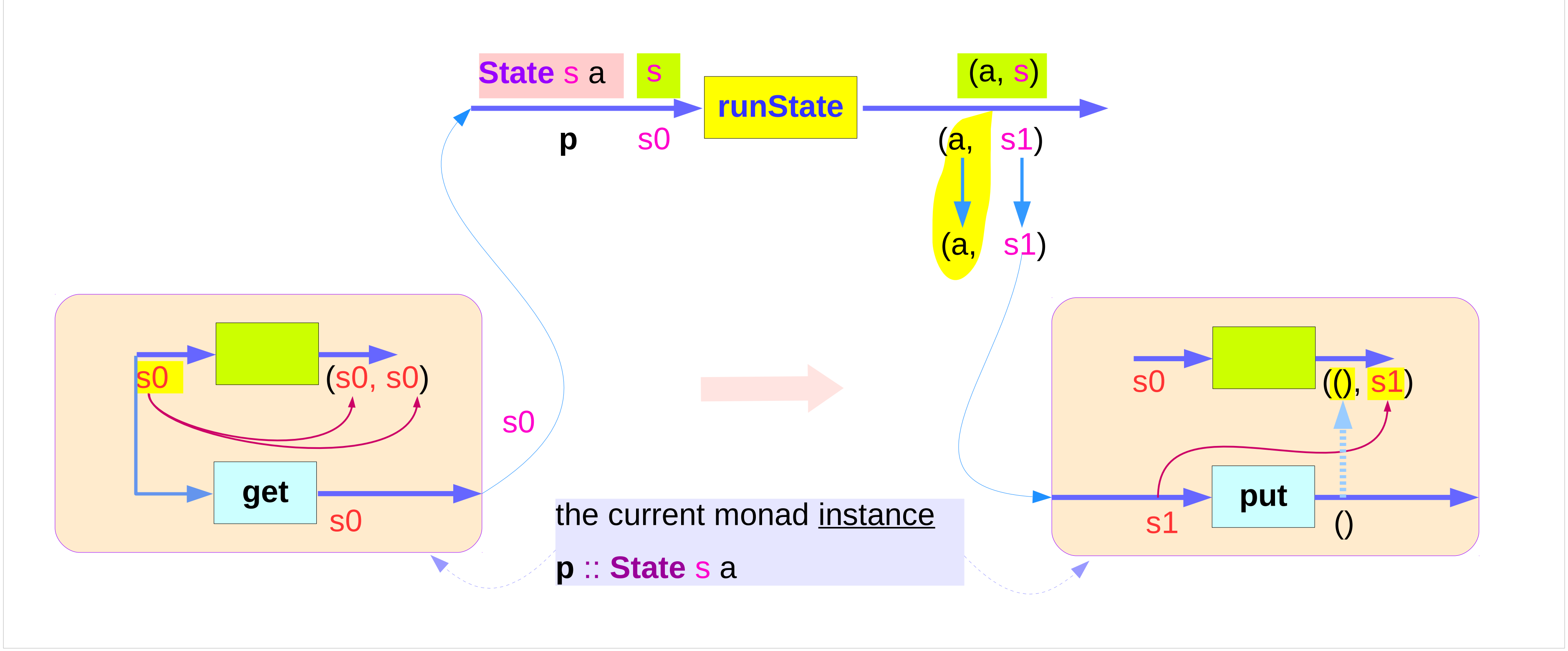
let (a,s1) = **runState p** s0

put s1

the same binding variable a

the same state s1

a <- **p**



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

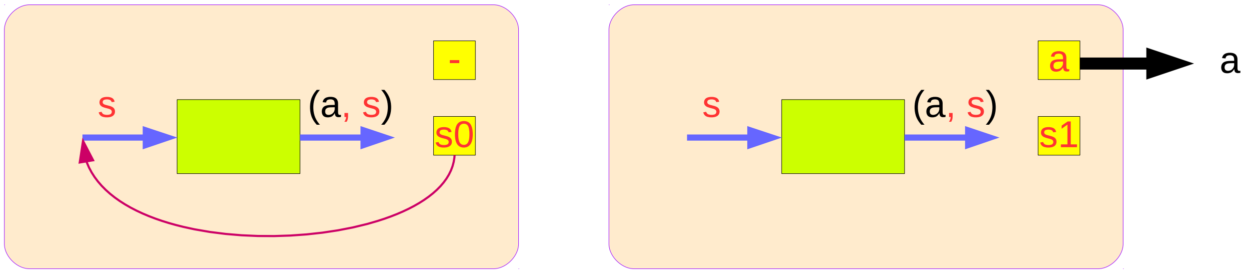
Redundant computation examples (2)

a <- **p**

-- the stateful computation **p** updates the state to s1

-- the result of the state returned is assigned to a

p :: **State** s a



stateful computation **p**

return the result a

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Counter Example

```haskell
import Control.Monad.State.Lazy

tick :: State Int Int
tick = do n <- get
          put (n+1)
          return n

plusOne :: Int -> Int
plusOne n = execState tick n

plus :: Int -> Int -> Int
plus n x = execState (sequence $ replicate n tick) x
```

A function to increment a counter.

tick :

- a monadic value itself

- ~~a function returning a monadic value~~

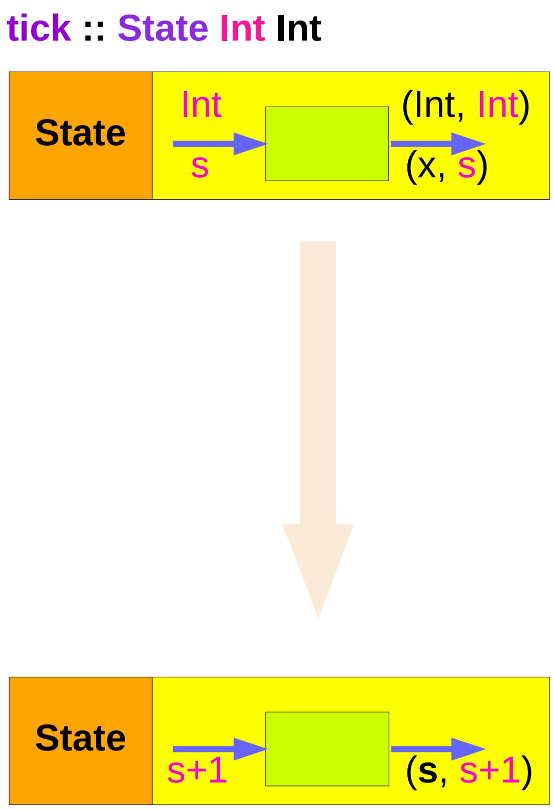
Add one to the given number using the state monad:

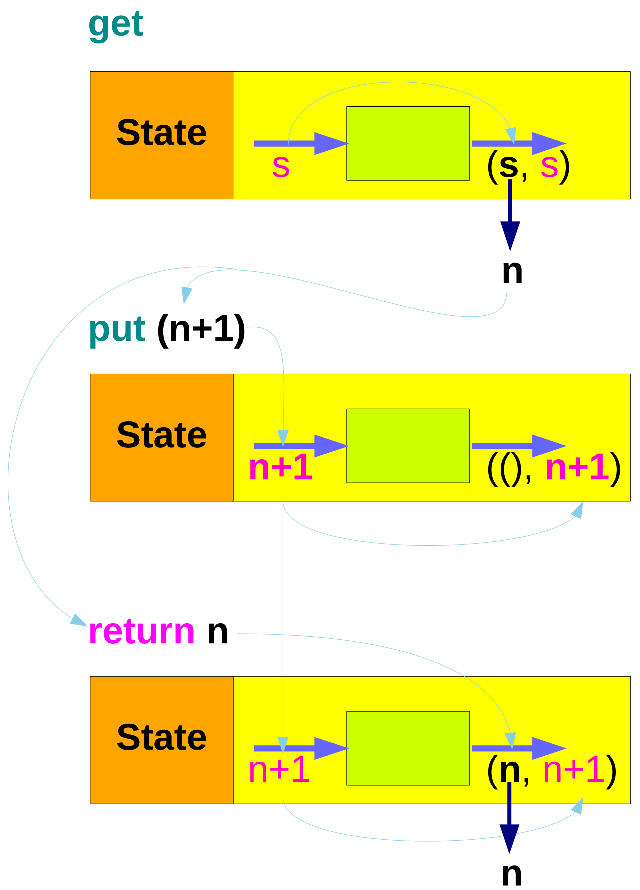
A contrived addition example. Works only with positive numbers:

https://hackage.haskell.org/package/mtl-2.2.2/docs/Control-Monad-State-Lazy.html

Counter Example – tick

```
tick :: State Int Int
tick = do n <- get
          put (n+1)
          return n
```





https://hackage.haskell.org/package/mtl-2.2.2/docs/Control-Monad-State-Lazy.html

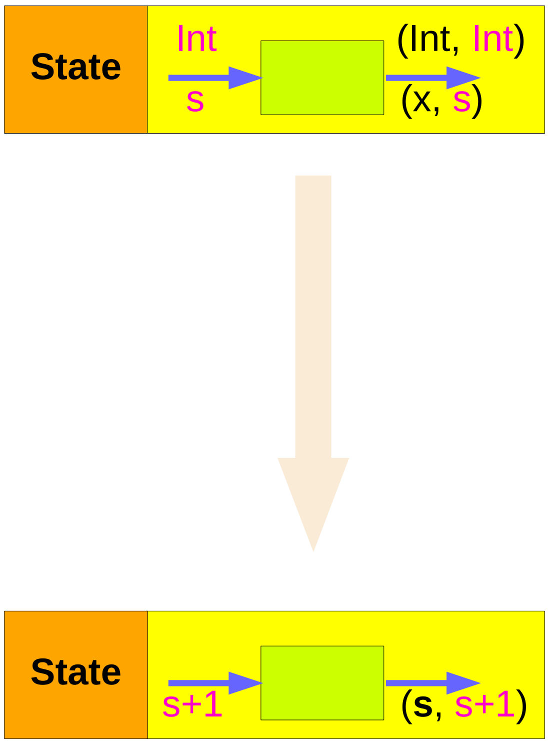
Counter Example – tick without **do**

```
tick :: State Int Int
tick = do n <- get
          put (n+1)
          return n
```

Int cannot receive ()

```
tick = get >>= \n -> put (n+1) >> return n
```

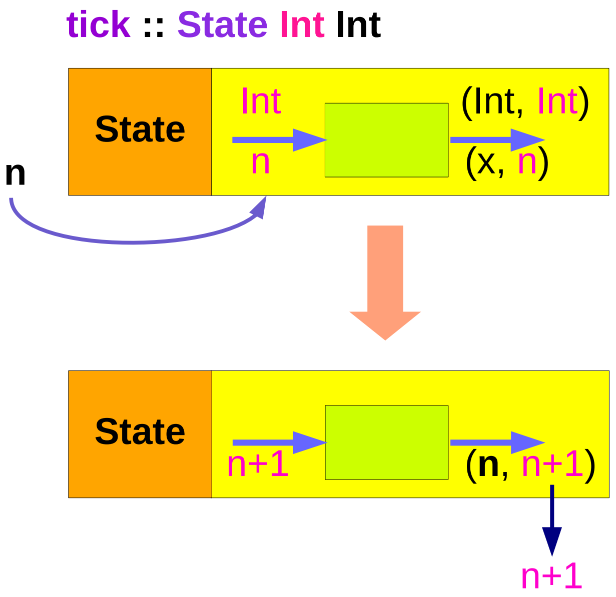
tick :: State Int Int



https://hackage.haskell.org/package/mtl-2.2.2/docs/Control-Monad-State-Lazy.html

Counter Example – incrementing

```
tick :: State Int Int
tick = do n <- get
          put (n+1)
          return n

plusOne :: Int -> Int
plusOne n = execState tick n
```



https://hackage.haskell.org/package/mtl-2.2.2/docs/Control-Monad-State-Lazy.html

Counter Example – using sequence

```
plus :: Int -> Int -> Int
plus n x = execState (sequence $ replicate n tick) x


                  1     2          n
sequence $ [tick, tick, … ,tick]


runState   (sequence $ [tick, tick]) 3          ➡ ([3,4],5)


runState   (sequence $ [tick, tick, tick]) 3    ➡ ([3,4,5],6)
execState  (sequence $ [tick, tick, tick]) 3    ➡ 6
evalState  (sequence $ [tick, tick, tick]) 3    ➡ [3,4,5]
```

https://hackage.haskell.org/package/mtl-2.2.2/docs/Control-Monad-State-Lazy.html

replicate

```
replicate :: Int -> a -> [a]
```

replicate n x is a list of length n with x the value of every element.

```
replicate 3 5
[5,5,5]

replicate 5 "aa"
["aa","aa","aa","aa","aa"]

replicate 5 'a'
"aaaaa"
```

http://zvon.org/other/haskell/Outputprelude/replicate_f.html

sequence

sequence :: Monad m => [m a] -> m [a]

evaluate **each action** in the sequence from left to right,

and collect the **results**.

runState (sequence [get, return 3, return 4]) 1

([1,3,4],1)

runState get 1	**(1,1)**	**result: 1**
runState (return 3) 1	**(3,1)**	**result: 3**
runState (return 4) 1	**(4,1)**	**result: 4**

http://derekwyatt.org/2012/01/25/haskell-sequence-over-functions-explained/

Example of collecting returned values

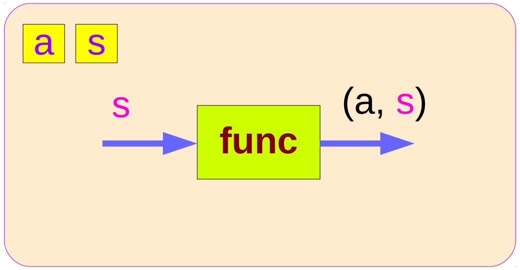
```
collectUntil f comp = do
    st <- get                              -- Get the current state
    if f st  then return [ ]               -- If it satisfies predicate, return
             else do                       -- Otherwise...
                x  <- comp                 -- Perform the computation s
                xs <- collectUntil f comp  -- Perform the rest of the computation
                return (x:xs)              -- Collect the results and return them
```

```
comp :: State s a
st  :: s

x  :: a
xs  :: [a]
```

```
simpleState = state (\x -> (x,x+1))
```

```
*Main> evalState (collectUntil (>10) simpleState) 0
[0,1,2,3,4,5,6,7,8,9,10]
```

simpleState :: State s a



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Example of collecting – stateful computations

```
collectUntil f comp = do
   st <- get
   if f st  then return [ ]
            else do
              x  <- comp
              xs <- collectUntil f comp
              return (x:xs)
```

```
simpleState = state (\x -> (x,x+1))
```

get	st ← 0	comp :	0 → (0, 1)	x ← 0
get	st ← 1	comp :	1 → (1, 2)	x ← 1
get	st ← 2	comp :	2 → (2, 3)	x ← 2
get	st ← 3	comp :	3 → (3, 4)	x ← 3
get	st ← 4	comp :	4 → (4, 5)	x ← 4
get	st ← 5	comp :	5 → (5, 6)	x ← 5
get	st ← 6	comp :	6 → (6, 7)	x ← 6
get	st ← 7	comp :	7 → (7, 8)	x ← 7
get	st ← 8	comp :	8 → (8, 9)	x ← 8
get	st ← 9	comp :	9 → (9, 10)	x ← 9
get	st ← 10	comp :	10 → (10, 11)	x ← 10

```
*Main> evalState (collectUntil (>10) simpleState) 0
[0,1,2,3,4,5,6,7,8,9,10]
```

stateful computation

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Example of collecting – the return type

```
collectUntil f comp = do
   st <- get
   if f st  then return [ ]       –-------------------------------- return State t [a] type
            else do
              x  <- comp   -- stateful computation
              xs <- collectUntil f comp
              return (x:xs)       –-------------------------------- return State t [a] type
```

nesting do statements is possible

if they are within the same monad

enables **branching** within one do block,

as long as both branches of the **if statement**

results in the same monadic type.

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

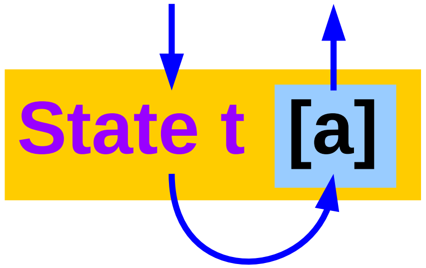
Example of collecting – another stateful compuation

```
collectUntil f comp = do
    st <- get
    if f st  then return [ ]
             else do
               x  <- comp
               xs <- collectUntil f comp
               return (x:xs)
```

```
return :: State t [a] type
collectUntil f comp   :: State t [a]  type
xs <- collectUntil f comp -- stateful computation
xs :: [a]
```

t -> ([a], t)

the result type



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Example of collecting – the function type

Inferred Function Type

collectUntil :: Monad State t m => (t -> Bool) -> m a -> m [a]

m ➡ State t

Specific Function Type

collectUntil :: (t -> Bool) -> State t a -> State t [a]

(>10) :: (t -> Bool)

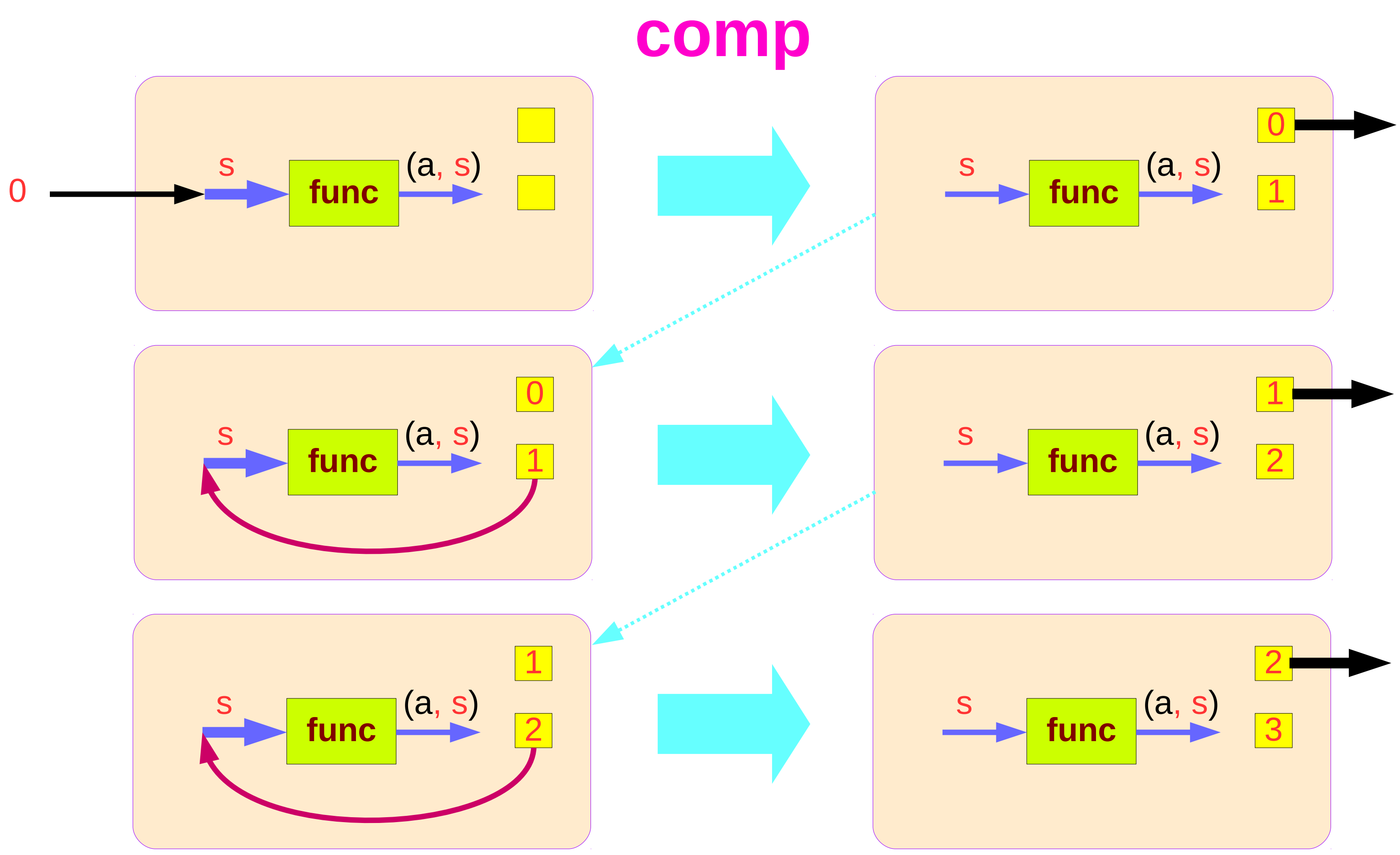
SimpleState :: State t a

*Main> evalState (collectUntil (>10) simpleState) 0

simpleState = state (\x -> (x,x+1))

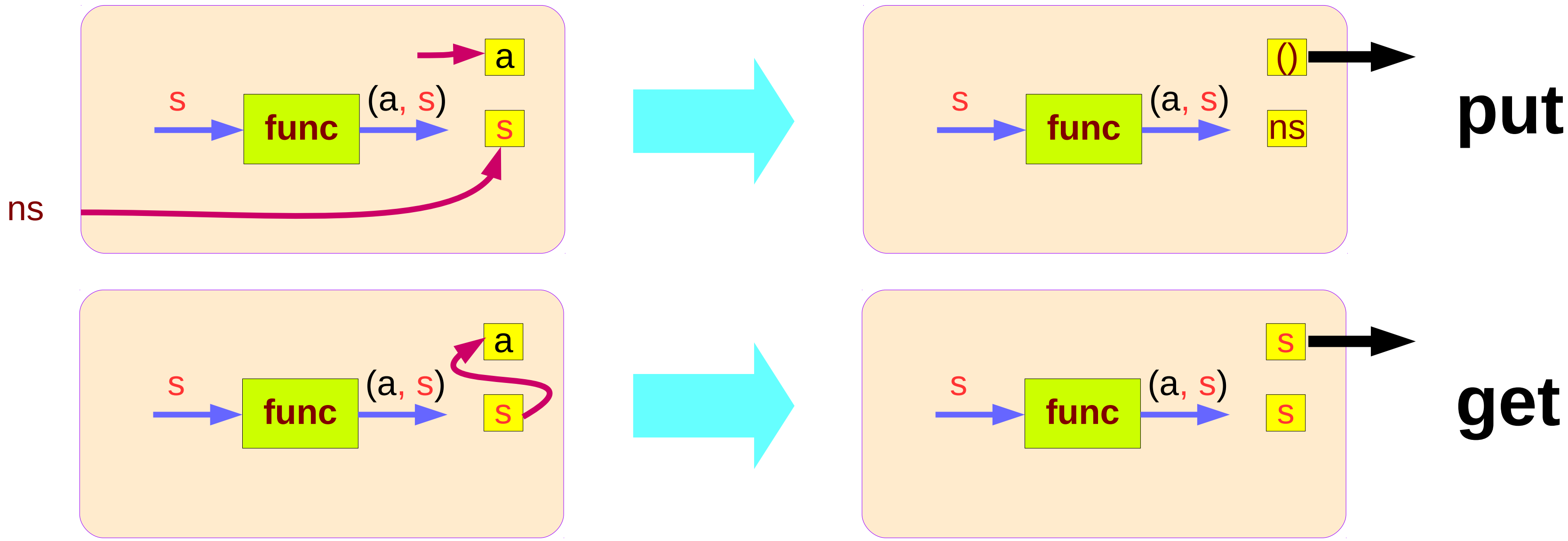
https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Stateful Computation of **comp**



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Stateful Computations of **put** & **get**



https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Another example of collecting returned values

```
collectUntil :: (s -> Bool) -> State s a -> State s [a]
collectUntil f comp = step
  where
    step = do a <- comp                              -- updating stateful computation
              liftM (a : ) continue
    continue = do comp' <- get                       -- current state getting stateful computation
                  if f comp'   then return []
                               else step
```

```
simpleState = state (\x -> (x,x+1))

*Main> evalState (collectUntil (>10) simpleState) 0
[0,1,2,3,4,5,6,7,8,9,10]
```

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Another example – lifting to merge

```
collectUntil :: (s -> Bool) -> State s a -> State s [a]
collectUntil f comp = step
  where
    step = do a <- comp
              liftM (a : ) continue
    continue = do comp' <- get
                  if f comp'  then return []
                              else step
```

```
(:) :: a -> [a] -> [a]
(++) :: [a] -> [a] -> [a]

(:) :: a -> [a] -> [a]
LiftM (:) :: a -> State s [a] -> State s [a]

(a :) ::  [a] -> [a]
LiftM (a :) :: State s [a] -> State s [a]
```

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Another example – the return type

```
collectUntil :: (s -> Bool) -> State s a -> State s [a]
collectUntil f comp = step
  where
    step = do a <- comp                          -- updating stateful computation
              liftM (a : ) continue
    continue = do comp' <- get                   -- current state getting stateful computation
                  if f comp'  then return []
                              else step
```

```
simpleState = state (\x -> (x,x+1))

*Main> evalState (collectUntil (>10) simpleState) 0
[0,1,2,3,4,5,6,7,8,9,10]
```

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Another example – sequence comparison

```
collectUntil :: (s -> Bool) -> State s a -> State s [a]
collectUntil f s = step
  where
    step = do a <- s                          -- update & result return
              liftM (a : ) continue
    continue = do s' <- get                   -- current state check
                  if f s' then return []
                            else step
```

update and **check** the current state

And then **merge**

Since a is part of the result
in both branches of the 'if'

a is the common part of both
'then' part and 'else' part

```
collectUntil f comp = do
    st <- get                                 -- current state check
    if f st then return [ ]
           else do
              x  <- comp                      -- update & result return
              xs <- collectUntil f comp
              return (x:xs)
```

check the current state

then **update** and **merge**

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

Another example – merge comparison

```
collectUntil :: (s -> Bool) -> State s a -> State s [a]
collectUntil f s = step
  where
    step = do a <- s                          -- update & result return
              liftM (a : ) continue
    continue = do s' <- get                   -- current state check
                  if f s' then return []
                          else step
```

update and check the current state

And then merge

Since a is part of the result
in both branches of the 'if'

a is the common part of both
'then' part and 'else' part

```
collectUntil f comp = do
    st <- get                                 -- current state check
    if f st then return [ ]
          else do
            x  <- comp                        -- update & result return
            xs <- collectUntil f comp
            return (x:xs)
```

check the current state

then update and merge

https://stackoverflow.com/questions/11250328/working-with-the-state-monad-in-haskell

liftM and mapM

```
liftM   :: (Monad m) => (a -> b)     -> m a   -> m b
mapM    :: (Monad m) => (a -> m b) -> [a]    -> m [b]
```

liftM lifts a function of type a -> b to a monadic counterpart.

mapM applies a function which yields a monadic value to a list of values, yielding list of results embedded in the monad.

```
> liftM (map toUpper) getLine
Hallo
"HALLO"

> :t mapM return "monad"
mapM return "monad" :: (Monad m) => m [Char]
```

https://stackoverflow.com/questions/5856709/what-is-the-difference-between-liftm-and-mapm-in-haskell

Monad typeclass and Instances

```
class Monad m where
    return :: a -> m a
    (>>=) :: m a -> (a -> m b) -> m b
    (>>) :: m a -> m b -> m b
    fail :: String -> m a
```

m a:
- Maybe a
- IO a
- ST a
- State s a

```
instance Monad Maybe where
        return x = Just x
        Nothing >>= f = Nothing
        Just x >>= f  = f x
        fail _ = Nothing
```

```
instance  Monad IO  where
    m >> k    = m >>= \ _ -> k
    return    = ...
    (>>=)     = ...
    fail s    = ...
```

Default Implementations in MonadState s m

```
class Monad m => MonadState s m | m -> s where
  -- | Return the state from the internals of the monad.
  get :: m s
  get = state (\s -> (s, s))

  -- | Replace the state inside the monad.
  put :: s -> m ()
  put s = state (\_ -> ((), s))

  -- | Embed a simple state action into the monad.
  state :: (s -> (a, s)) -> m a
  state f = do
    s <- get
    let ~(a, s') = f s
    put s'
    return a
```

The mtl package

Control.Monad.State.Class module

https://stackoverflow.com/questions/23149318/get-put-and-state-in-monadstate

No dead loop in the default implementation

the definitions of **get**, **put**,**state** in the **Monad class declaration**

- the default implementations,
- to be overridden in actual **instances** of the class.

the dead loop in the default definition does not happen:

- **put** and **get** in terms of **state**
- **state** in terms of **put** and **get**

* minimal definition is *either* both of **get** and **put** *or* just **state**

```
get :: m s
get = state (\s -> (s, s))

put :: s -> m ()
put s = state (\_ -> ((), s))
```

```
state :: (s -> (a, s)) -> m a
state f = do
  s <- get
  let ~(a, s') = f s
  put s'
  return a
```

https://stackoverflow.com/questions/23149318/get-put-and-state-in-monadstate

Functional Dependency | (vertical bar)

```
class Monad m => MonadState s m | m -> s where …
```

functional dependencies

to constrain the parameters of type classes. — **s** and **m**

s can be determined from **m**, — **m** → **s**

so that **s** can be the return type — **State s** → **s**

but **m** can not be the return type

in a multi-parameter type class,

one of the parameters can be determined from the others,

so that the parameter determined by the others can be the return type

but none of the argument types of some of the methods.

```
class Monad m where
  return :: a -> m a
  (>>=) :: m a -> (a -> m b) -> m b
  (>>) :: m a -> m b -> m b
  fail :: String -> m a
```

m a
- **Maybe a**
- **IO a**
- **ST a**
- **State s a**

https://stackoverflow.com/questions/23149318/get-put-and-state-in-monadstate

Typeclass MonadState s

```
class Monad m => MonadState s m | m -> s where …
```

MonadState s

a typeclass

instance MonadState s MM where …

its type instance itself does not specify values

MonadState s m =>

- can be used as class constraint
- all the **Monad m**

  which supports *state operations* with state of type **s**.

:t get

:t put

s ← m **functional dependencies**

m á State s → s

state operations

defined in the

typeclass definition

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

Types of **get** and **put**

:t get ►	**get :: MonadState s m => m s**

for all **Monad m** which supports *state operations* over state of type **s**,
we have a value of type **m s** - that is,
the monad operation which yields the current state

:t put ►	**put :: MonadState s m => s -> m ()**

a function that takes a value of type **s**
and returns a polymorphic value
representing any **Monad m**
which supports state operations over a state of type **s**

get :: m s

put :: s -> m ()

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

Instances of MonadState s m

class Monad m => MonadState s m | m -> s where

The mtl package

Control.Monad.State.Class module

```
instance Monad m => MonadState s (Lazy.StateT s m) where …
instance Monad m => MonadState s (Strict.StateT s m) where …
instance MonadState s m => MonadState s (ContT r m) where …
instance MonadState s m => MonadState s (ReaderT r m) where …
instance (Monoid w, MonadState s m) => MonadState s (Lazy.WriterT w m) where …
instance (Monoid w, MonadState s m) => MonadState s (Strict.WriterT w m) where …
```

m:
- Lazy.StateT s m
- Strict.StateT s m
- ContT r m
- ReaderT r m
- Lazy.WriterT w m
- Strict.WriterT w m

https://stackoverflow.com/questions/23149318/get-put-and-state-in-monadstate

Instances of the typeclass MonadState s

MonadState s is the class of types that are monads with state.

```
instance MonadState s (State s) where
  get = Control.Monad.Trans.State.get
  put = Control.Monad.Trans.State.put
```

State s is an instance of that typeclass:

```
instance MonadState s (StateT s) where
  get = Control.Monad.Trans.State.get
  put = Control.Monad.Trans.State.put
```

StateT s is an instance of that typeclass:

(the state monad transformer

which adds state to another monad)

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

Overloading get and put

```
instance MonadState s (State s) where
  get = Control.Monad.Trans.State.get
  put = Control.Monad.Trans.State.put
```

This **overloading** was introduced so that

if you're using a stack of monad transformers,

you do not need to explicitly **lift** operations

between different transformers.

If you're not doing that,

you can use the simpler operations from transformers.

The **mtl** package provides **auto-lifting**

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

Typeclass Constrain **MonadState s m** (1)

```
class Monad m => MonadState s m | m -> s where …
```

```
get :: MonadState s m => m s
```

for some monad **m**

storing some state of type **s**,

get is an action in **m**

that returns a value of type **s**.

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

Typeclass Constrain **MonadState s m** (2)

```
class Monad m => MonadState s m | m -> s where …
```

```
put :: MonadState s m => s -> m ()
```

for some monad **m**

put is an action in **m**

storing the given state of type **s**,

but returns nothing **()**.

https://stackoverflow.com/questions/25438575/states-put-and-get-functions

References

[1] ftp://ftp.geoinfo.tuwien.ac.at/navratil/HaskellTutorial.pdf
[2] https://www.umiacs.umd.edu/~hal/docs/daume02yaht.pdf