An Intuition for Propagators

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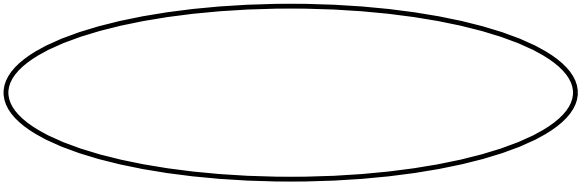
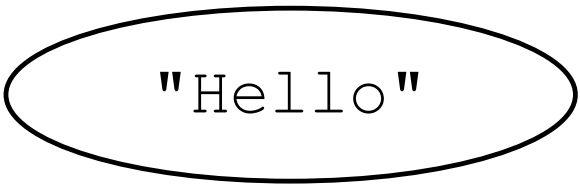
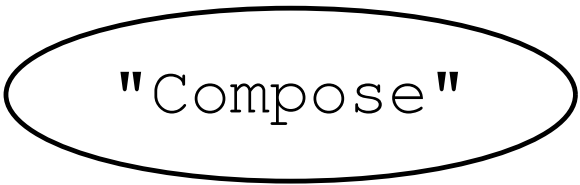
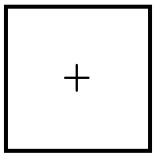
1970s, MIT

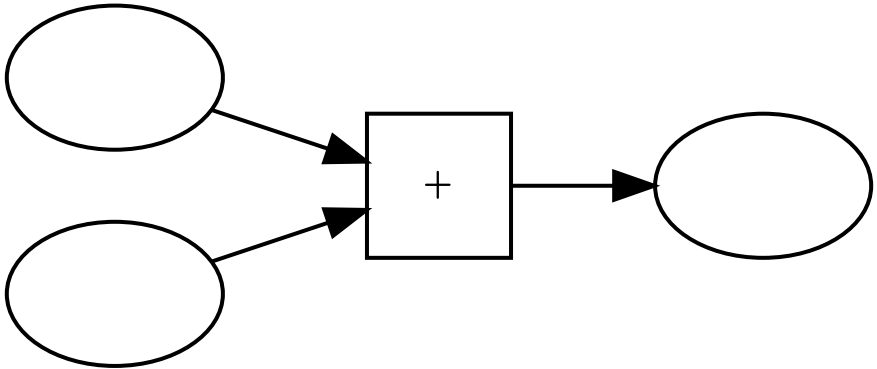
a model of computation for **highly concurrent** machines

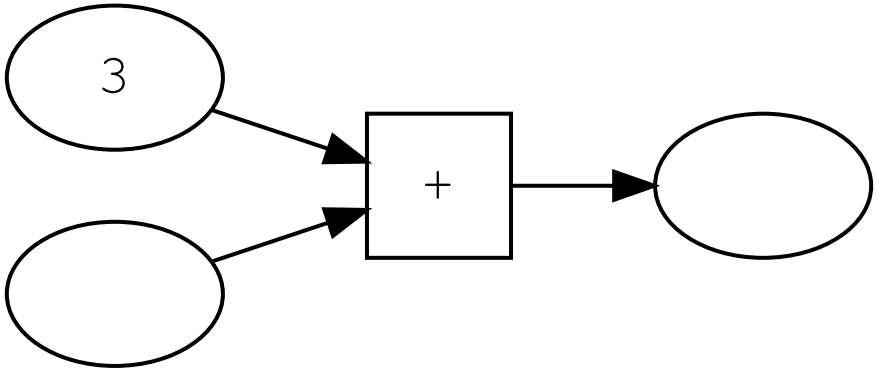



"Hello"


"Compose"



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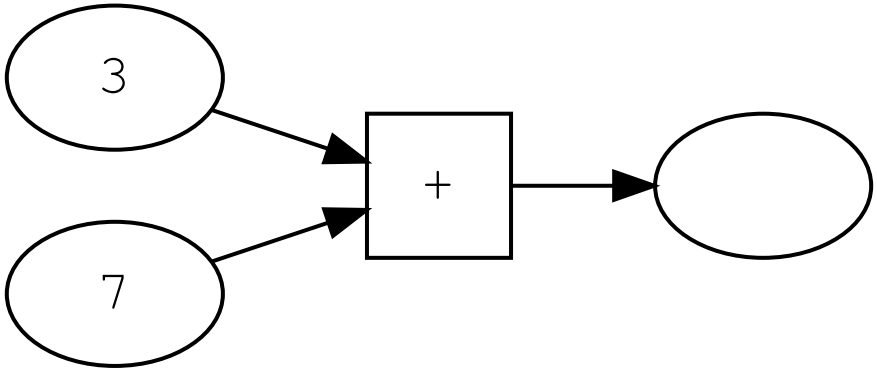
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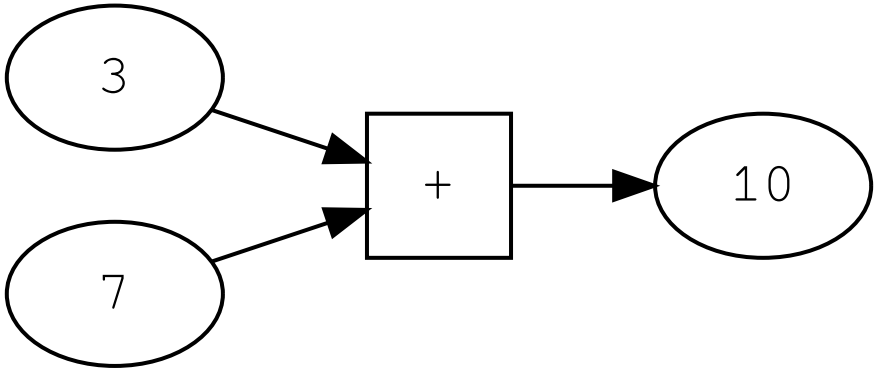
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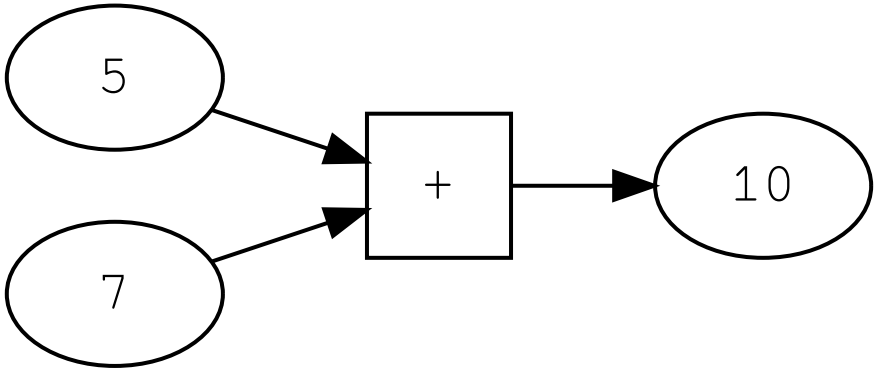
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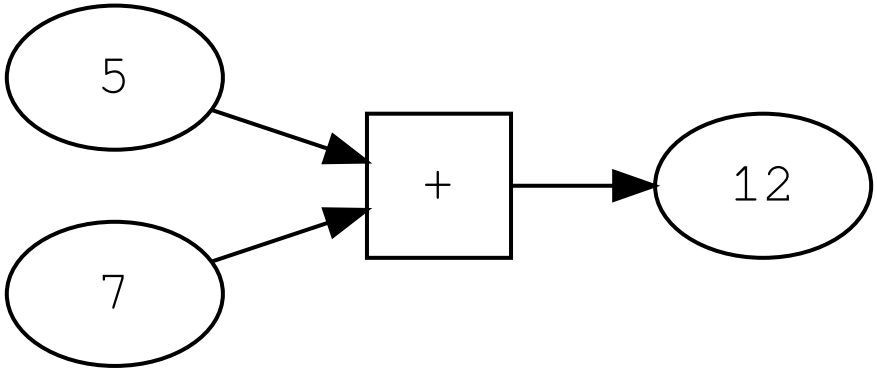
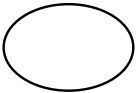

5
7
+
12

```haskell
-- types
data Cell a

data Par a
instance Monad Par
```

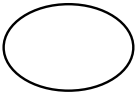
```haskell
-- types
data Cell a

data Par a
instance Monad Par


-- Creating a cell
cell    :: Par (Cell a)
```

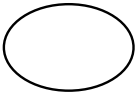
```haskell
-- types
data Cell a

data Par a
instance Monad Par


-- Creating a cell
cell    :: Par (Cell a)


-- Working with Cells
content :: Cell a -> Par (Maybe a)
write   :: Cell a -> a -> Par ()
```

```haskell
-- types
data Cell a

data Par a
instance Monad Par


-- Creating a cell
cell    :: Par (Cell a)


-- Working with Cells
content :: Cell a -> Par (Maybe a)
write   :: Cell a -> a -> Par ()


-- Creating a propagator
watch   :: Cell a -> (a -> Par ()) -> Par ()
```

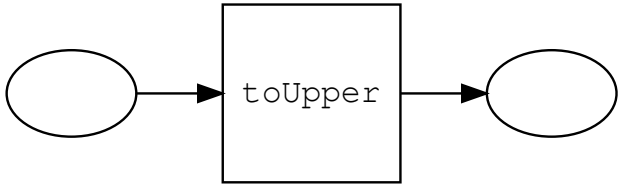


```
do
  input  <- cell
```

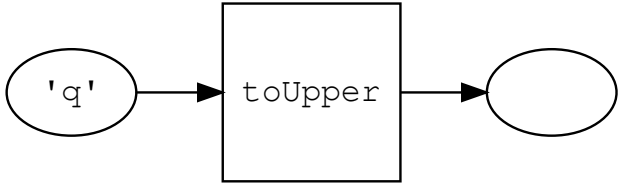




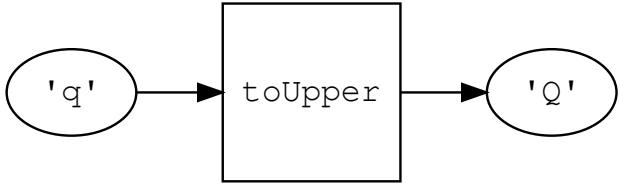
```
do
  input  <- cell
  output <- cell
```




```
do
  input  <- cell
  output <- cell
  watch input (\c ->
    write output (toUpper c))
```

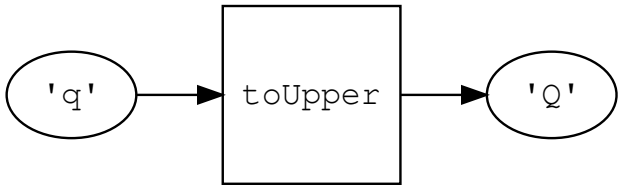



```
do
  input  <- cell
  output <- cell
  watch input (\c ->
    write output (toUpper c))

  write input 'q'
  content output    -- Just 'Q'
```



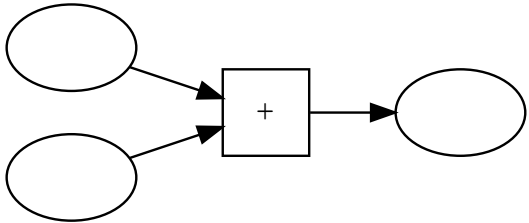

```
do
  input  <- cell
  output <- cell
  watch input (\c ->
    write output (toUpper c))

  write input 'q'
  content output    -- Just 'Q'
```

```
lift :: (a -> b) -> Cell a -> Cell b -> Par ()
lift f input output =
  watch input (\a ->
    write output (f a))
```



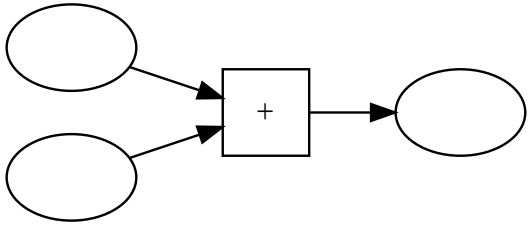

```
do
  input  <- cell
  output <- cell
  lift toUpper input output

  write input 'q'
  content output   -- Just 'Q'
```

```
do  inL  <- cell
    inR  <- cell
    out  <- cell
```




```
do  inL  <- cell
    inR  <- cell
    out  <- cell

  watch inL (\x ->
    do  maybeY <- content inR
        case maybeY of
          Nothing -> pure ()
          Just y  -> write out (x+y)
```

```haskell
with :: Cell a -> (a -> Par ()) -> Par ()
with theCell callback =
  do  maybeA <- content theCell
      case maybeA of
        Nothing -> pure ()
        Just a  -> callback a
```




```
do  inL  <- cell
    inR  <- cell
    out  <- cell

  watch inL (\x ->
    with inR (\y ->
      write out (x+y)
```

```
lift2 :: (a -> b -> c)
      -> Cell a -> Cell b -> Cell c
      -> Par ()
lift2 f inL inR out = do

  watch inL (\a ->
    with inR (\b ->
      write out (f a b)))
  watch inR (\b ->
    with inL (\a ->
      write out (f a b)))
```

Thanks for listening!