

Propagators: An Introduction

George Wilson

Data61/CSIRO

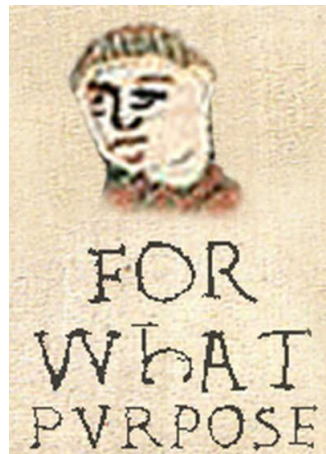
george.wilson@data61.csiro.au

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What?



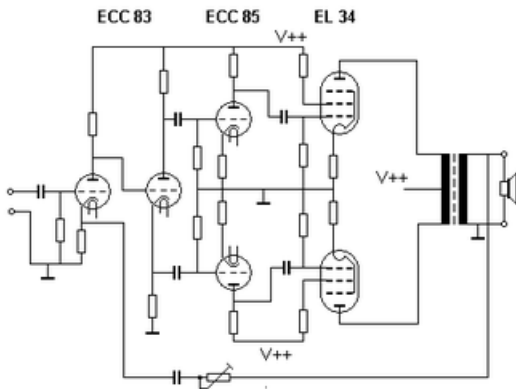
Why?

Roots as early as the 1970's at MIT

- Guy L. Steele Jr.
- Gerald J. Sussman
- Richard Stallman

More recently:

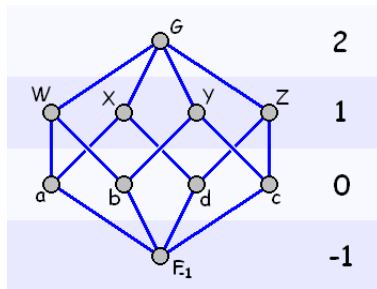
- Alexey Radul



```
(define (map f xs)
  (cond ((null? xs) '())
        (else (cons (f (car xs))
                      (map f (cdr xs)))))))
```

And then

- Edward Kmett



$$x \leq y \implies f(x) \leq f(y)$$

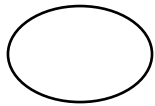
Propagators

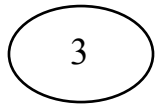
The *propagator model* is a model of computation

We model computations as *propagator networks*

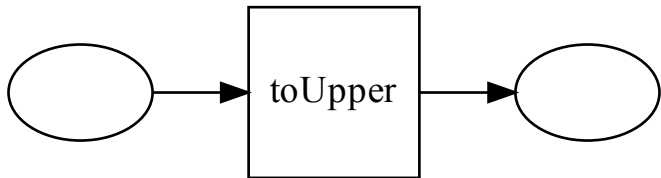
A propagator network comprises

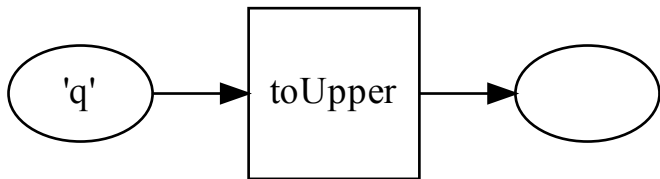
- cells
- propagators
- connections between cells and propagators

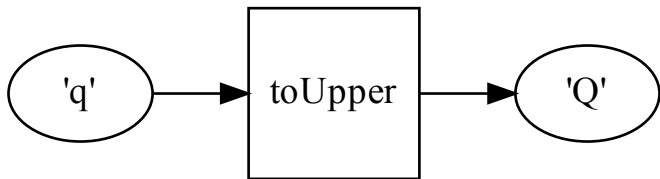


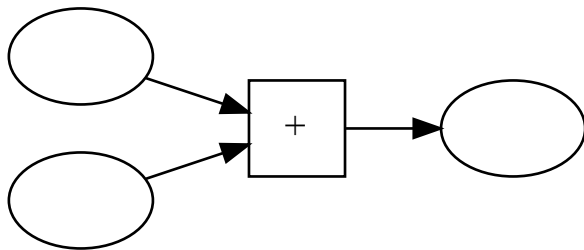


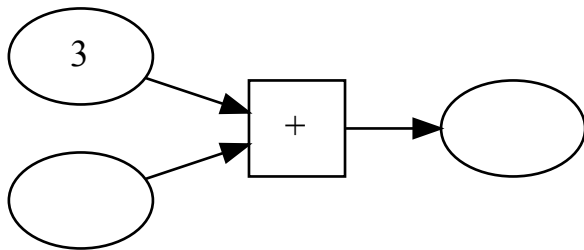
toUpper

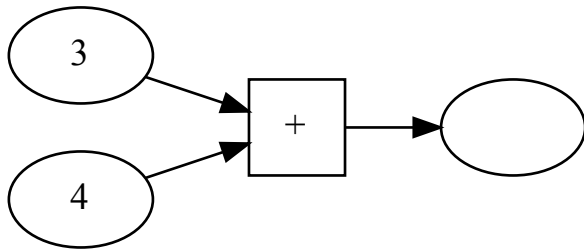


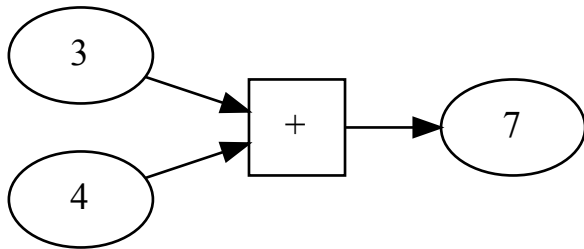












$$z \leftarrow x + y$$

$$z = x + y$$

$$7 = x + 4$$

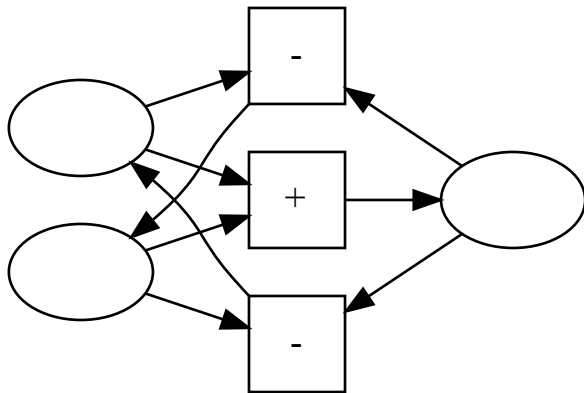
$$7 = 3 + 4$$

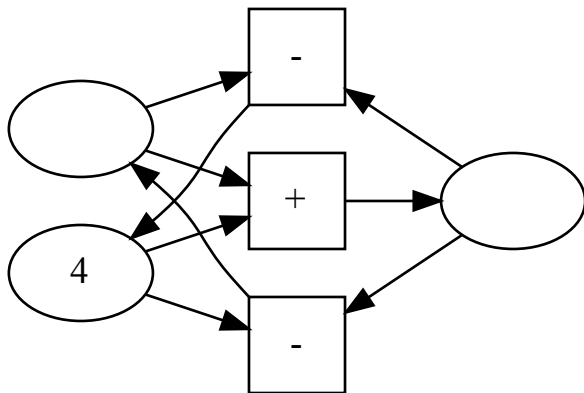
$$z = x + y$$

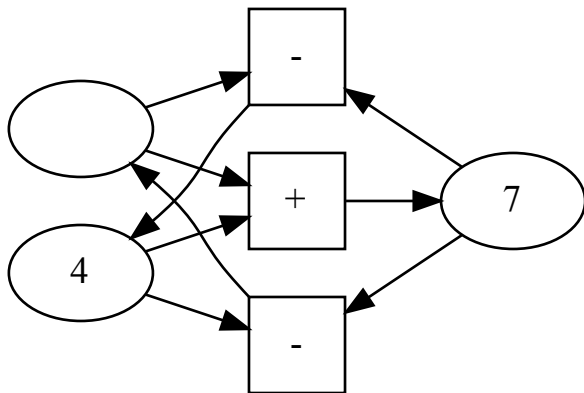
$$z \leftarrow x + y$$

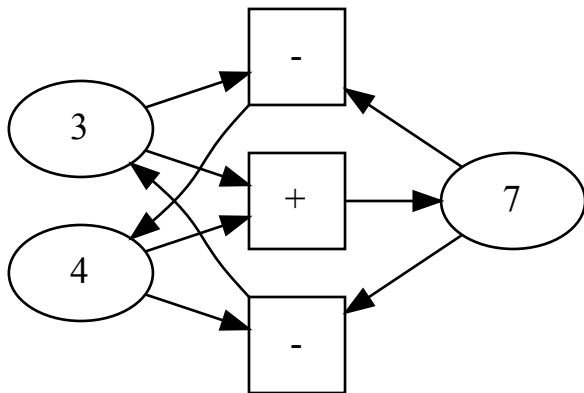
$$x \leftarrow z - y$$

$$y \leftarrow z - x$$



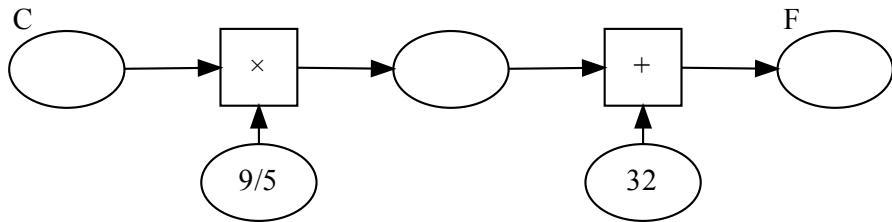




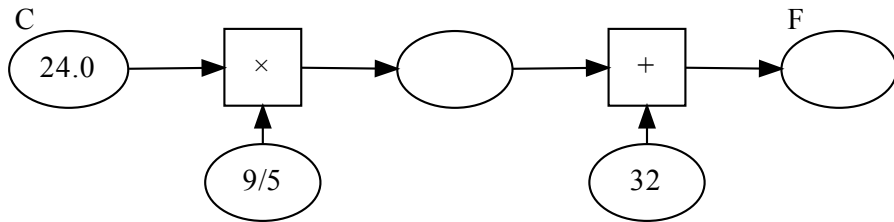


Propagators let us express multidirectional relationships!

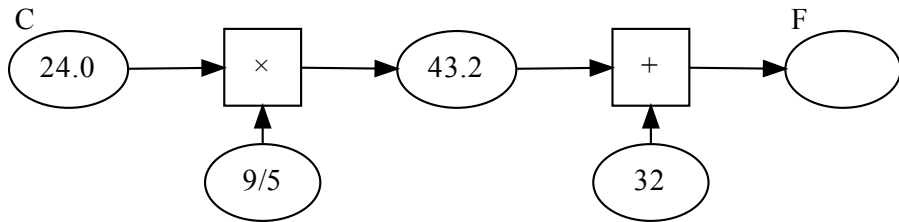
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$



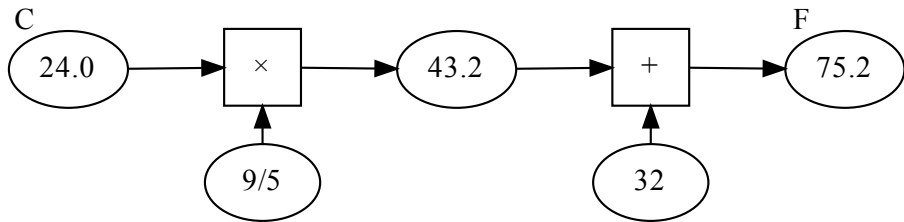
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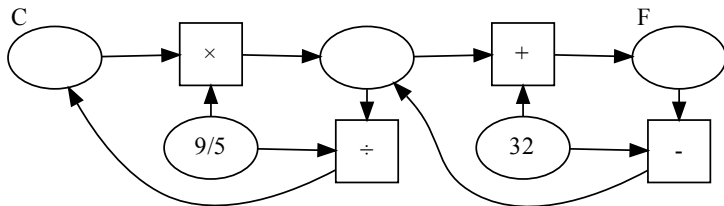


$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$



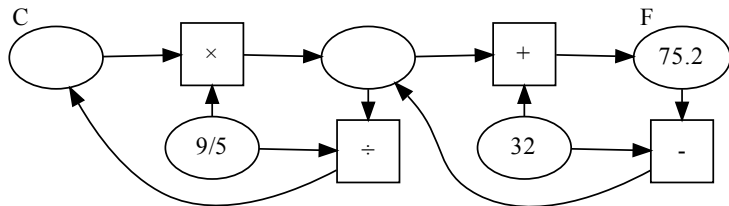
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$



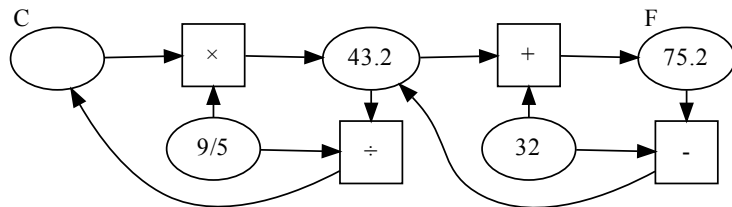
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$



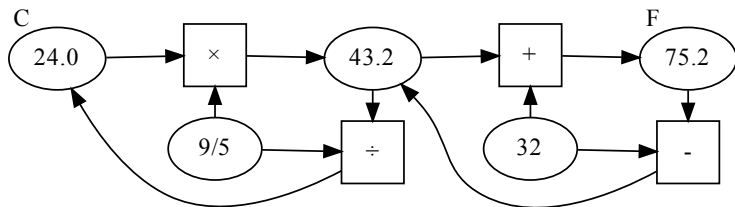
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$



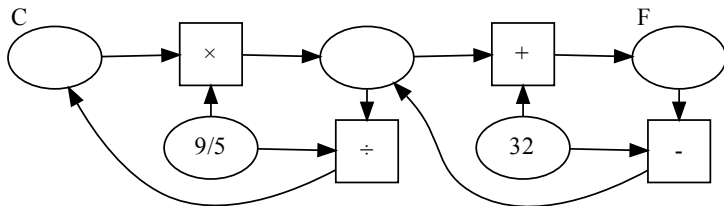
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

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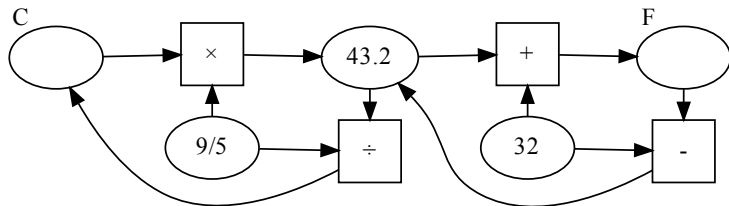
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$



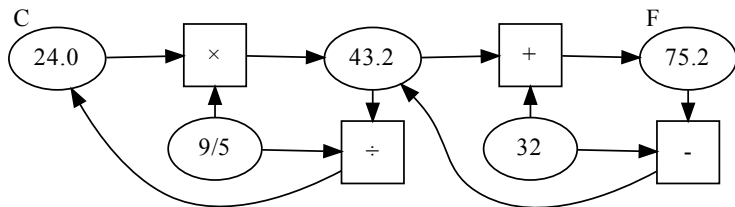
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

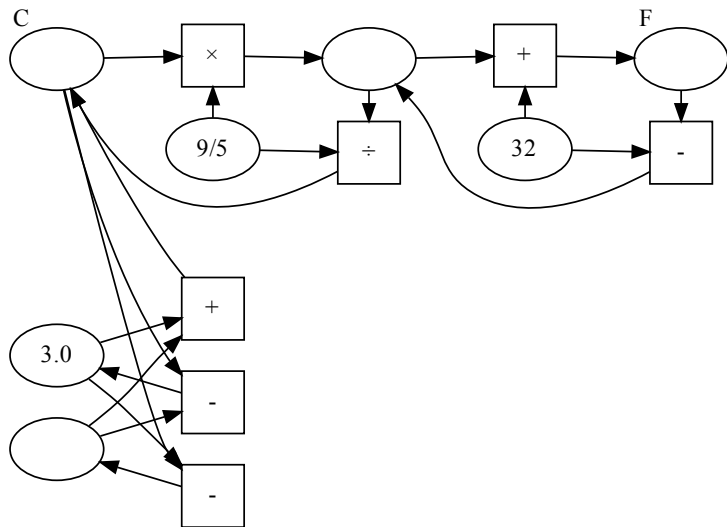
$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$

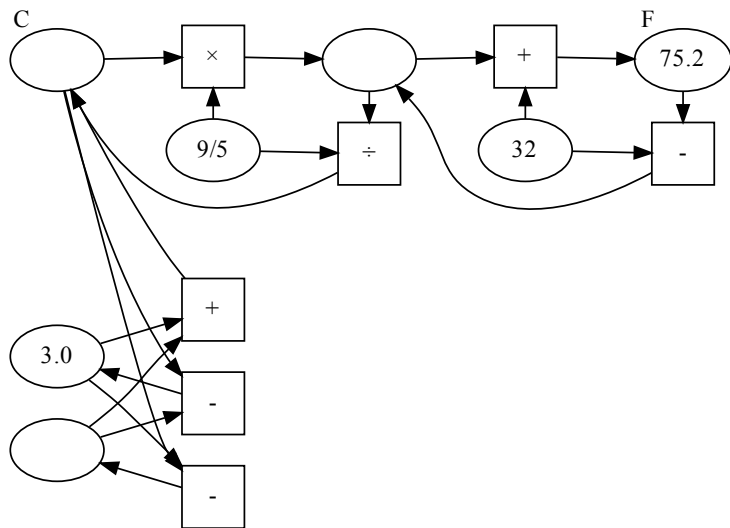


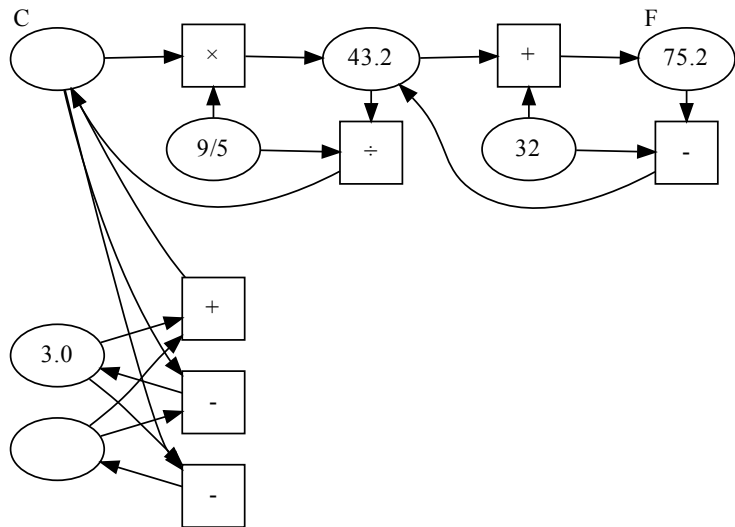
$$^{\circ}F = ^{\circ}C \times \frac{9}{5} + 32$$

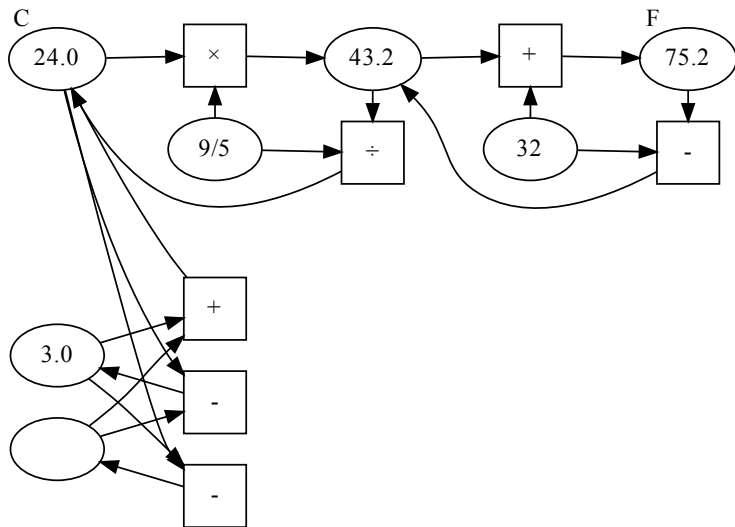
$$^{\circ}C = (^{\circ}F - 32) \div \frac{9}{5}$$

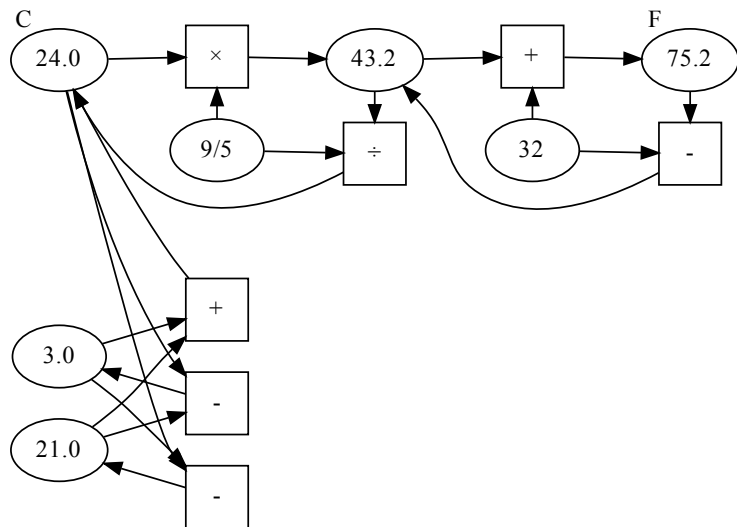








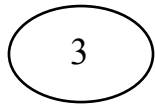


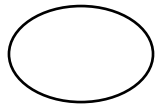


We can combine networks into larger networks!

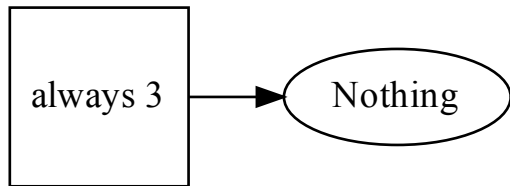
What types are the values of the cells?

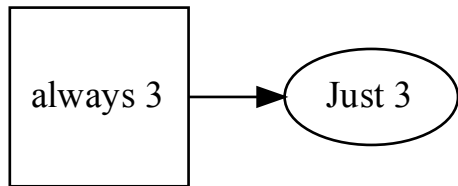
'c'

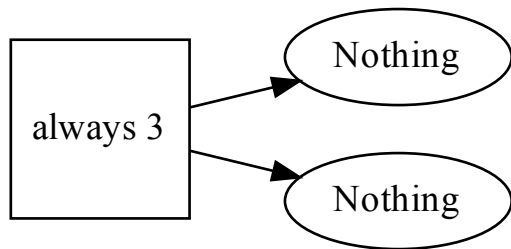


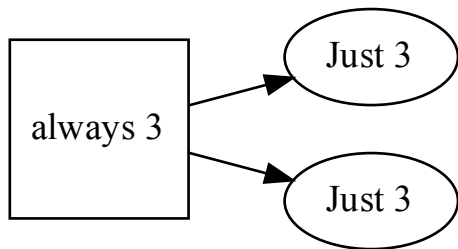


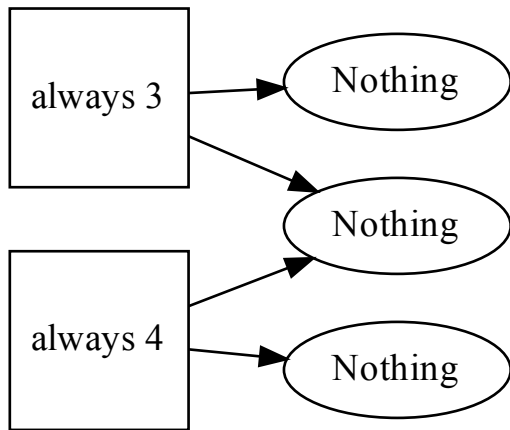
```
data Maybe a = Nothing | Just a
```

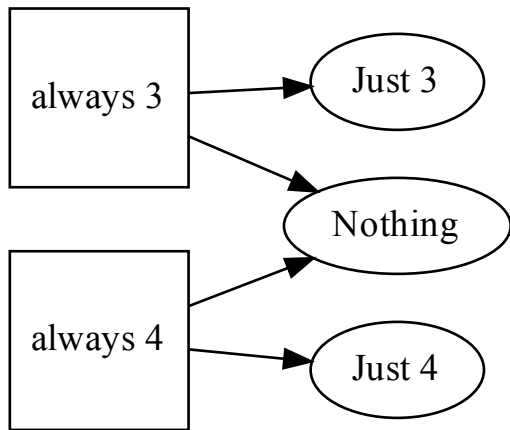


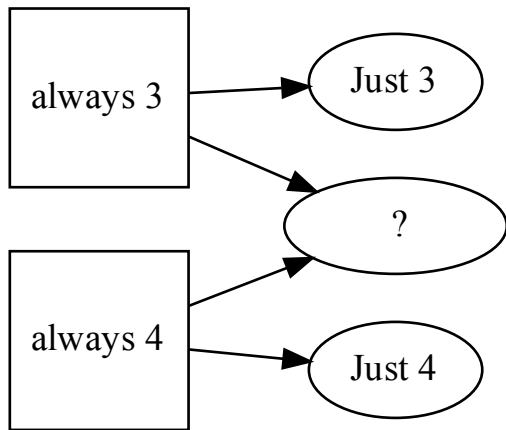












:(

Contradiction

data Perhaps a = Unknown | Known a | Contradiction

```
data Perhaps a = Unknown | Known a | Contradiction
```

```
instance Eq a => Monoid (Perhaps a) where
```

```
  mempty = Unknown
```

```
  mappend Unknown x           = x
```

```
  mappend x      Unknown      = x
```

```
  mappend Contradiction _      = Contradiction
```

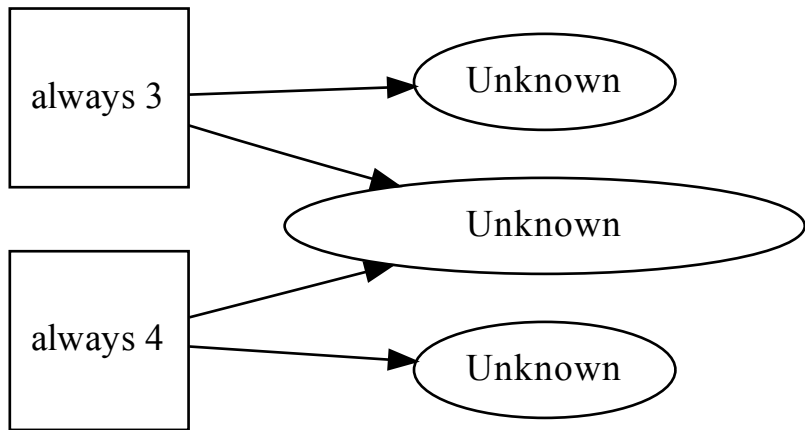
```
  mappend _      Contradiction = Contradiction
```

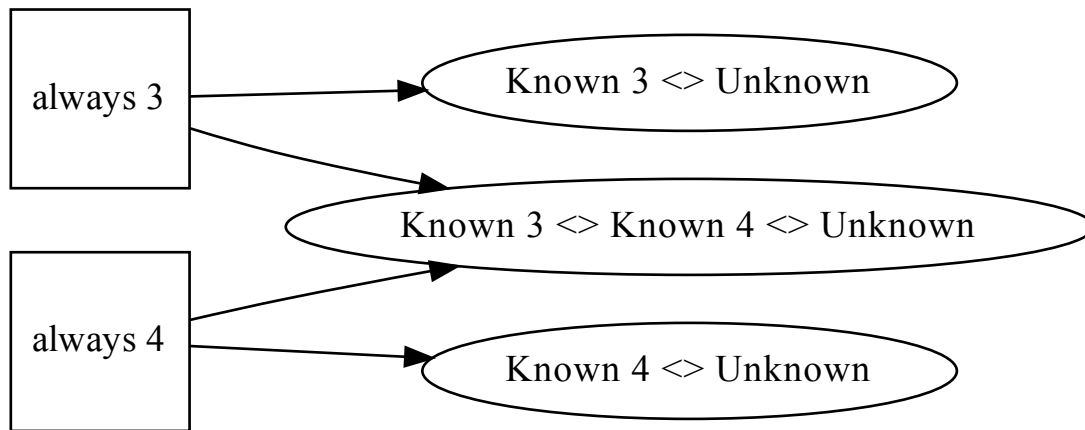
```
  mappend (Known a) (Known b) =
```

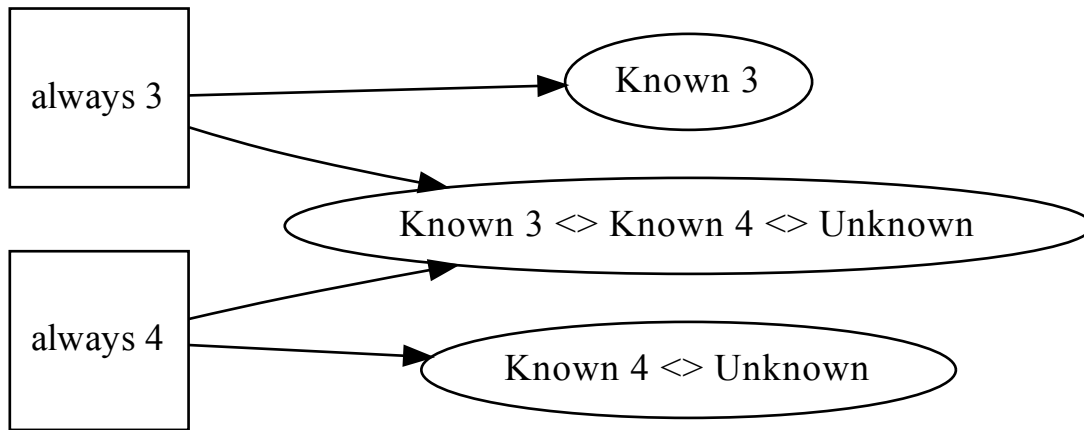
```
    if a == b
```

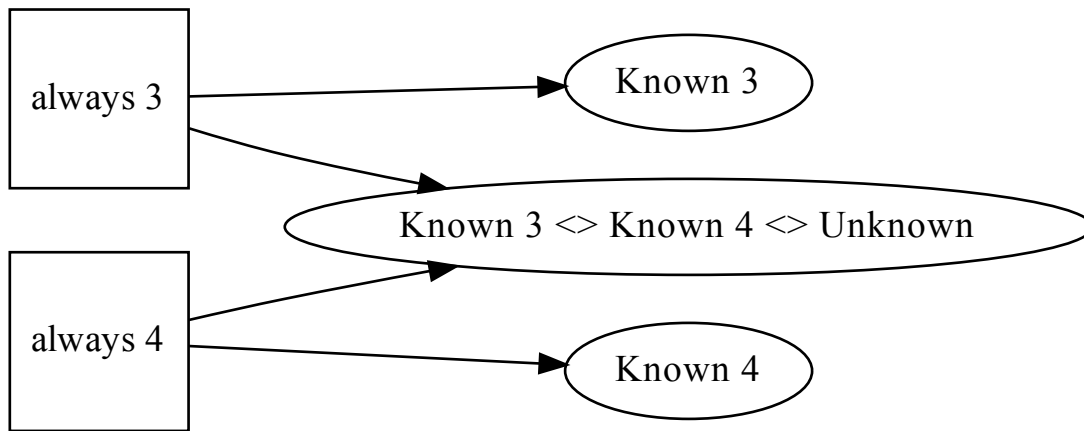
```
      then Known a
```

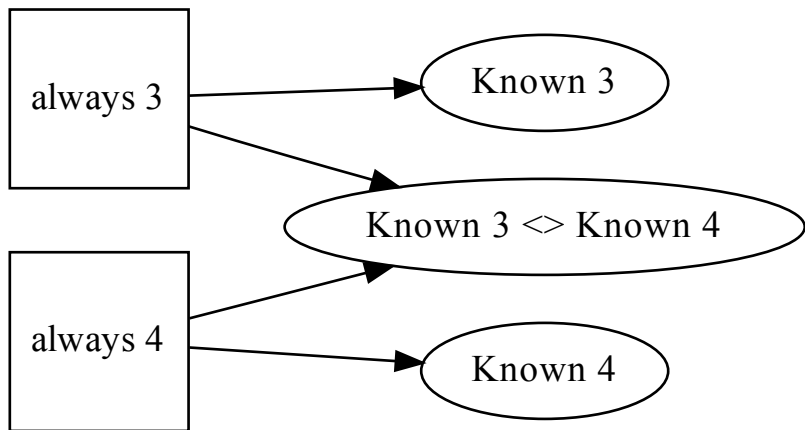
```
      else Contradiction
```

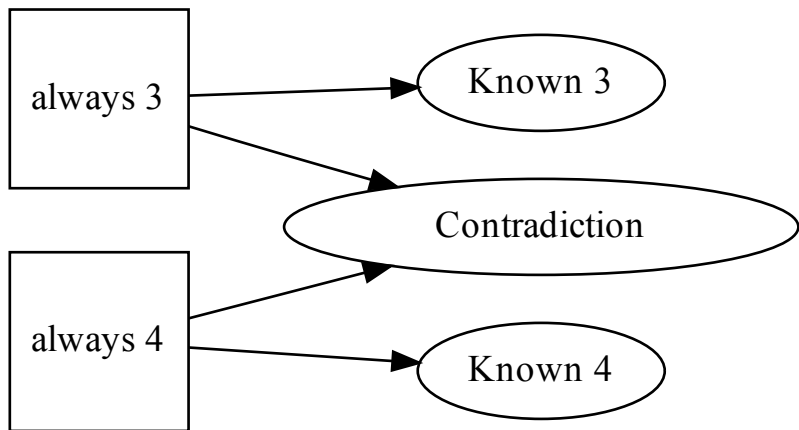












Partial information that supports merging!
But is `Monoid` enough?

Other examples?

$$[1, 5]$$

$$[1, 5] \langle \rangle [2, 7] = [2, 5]$$

$\{True, False\}$

TODO set intersection examples