Generic Deriving of Generic Traversals

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Fighting boilerplate

- Template Haskell (2002)
- Scrap Your Boilerplate (2003)
- GHC.Generics (2011)

Fighting boilerplate

	High-level	**Efficient**
• Template Haskell (2002)		✓
• Scrap Your Boilerplate (2003)		
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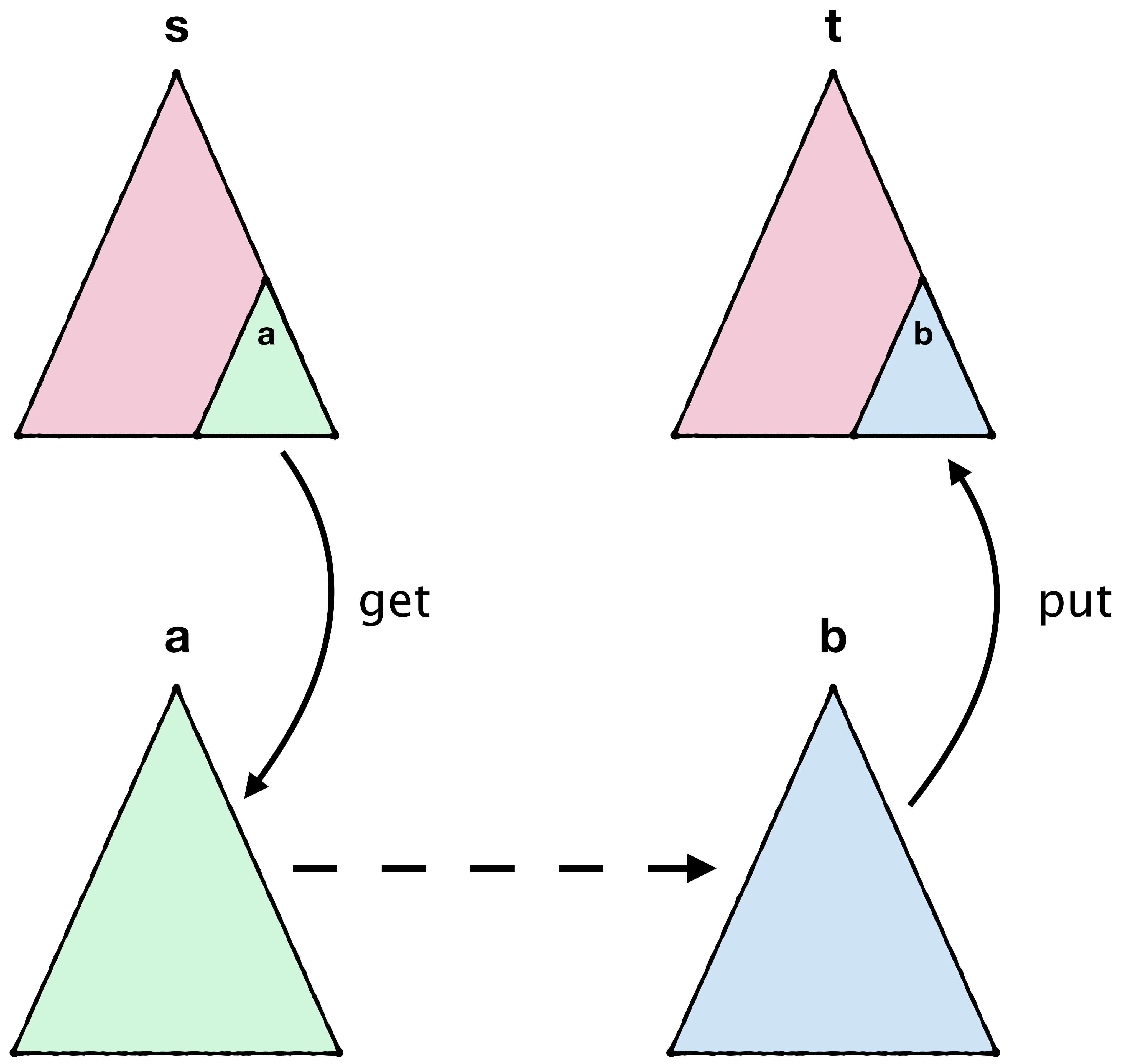
• Template Haskell (2002)		✓
• Scrap Your Boilerplate (2003)	✓	
• GHC.Generics (2011)		✓
• generic-lens (2018)	✓	✓

Lenses

Lenses

```
type Lens s t a b
```

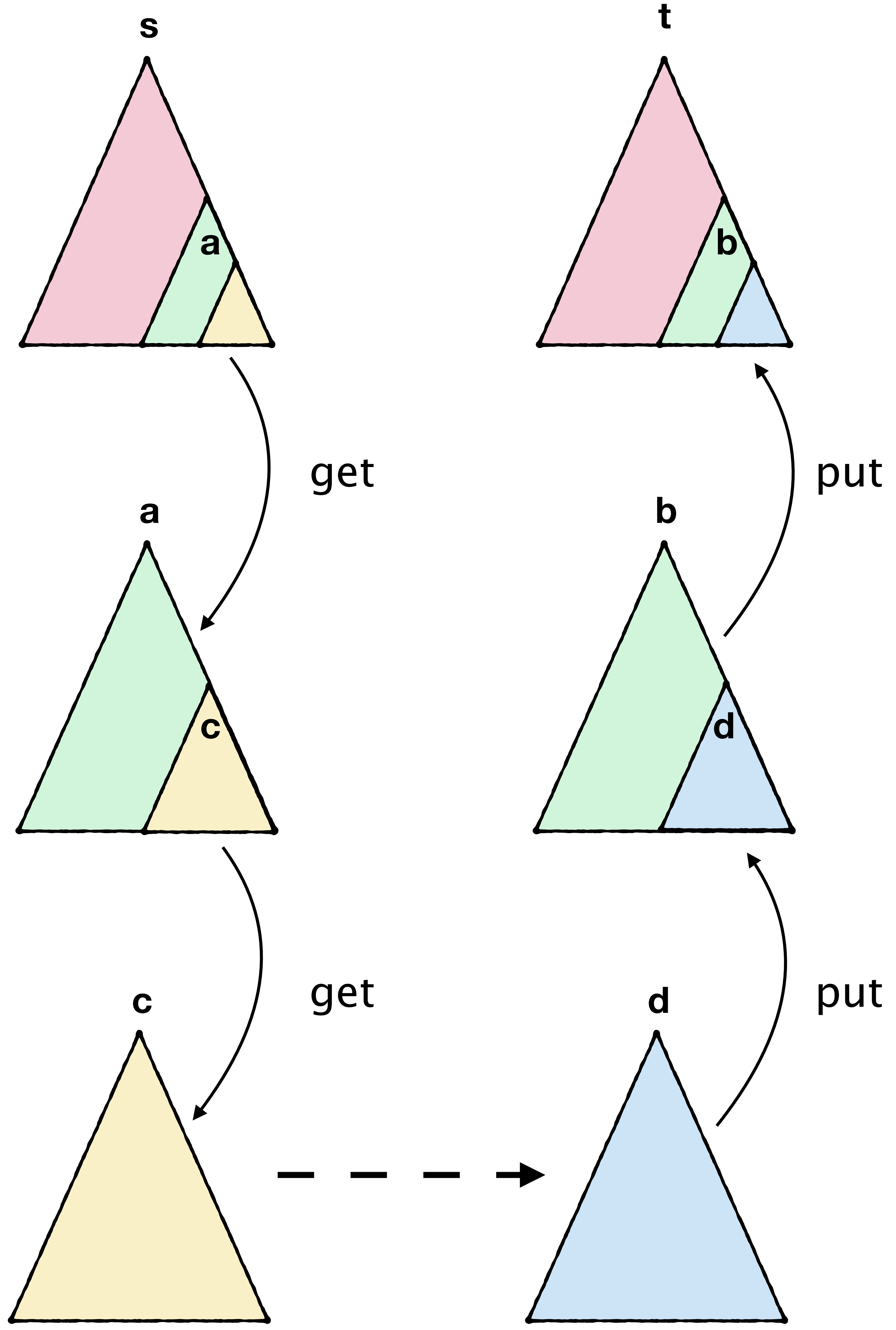


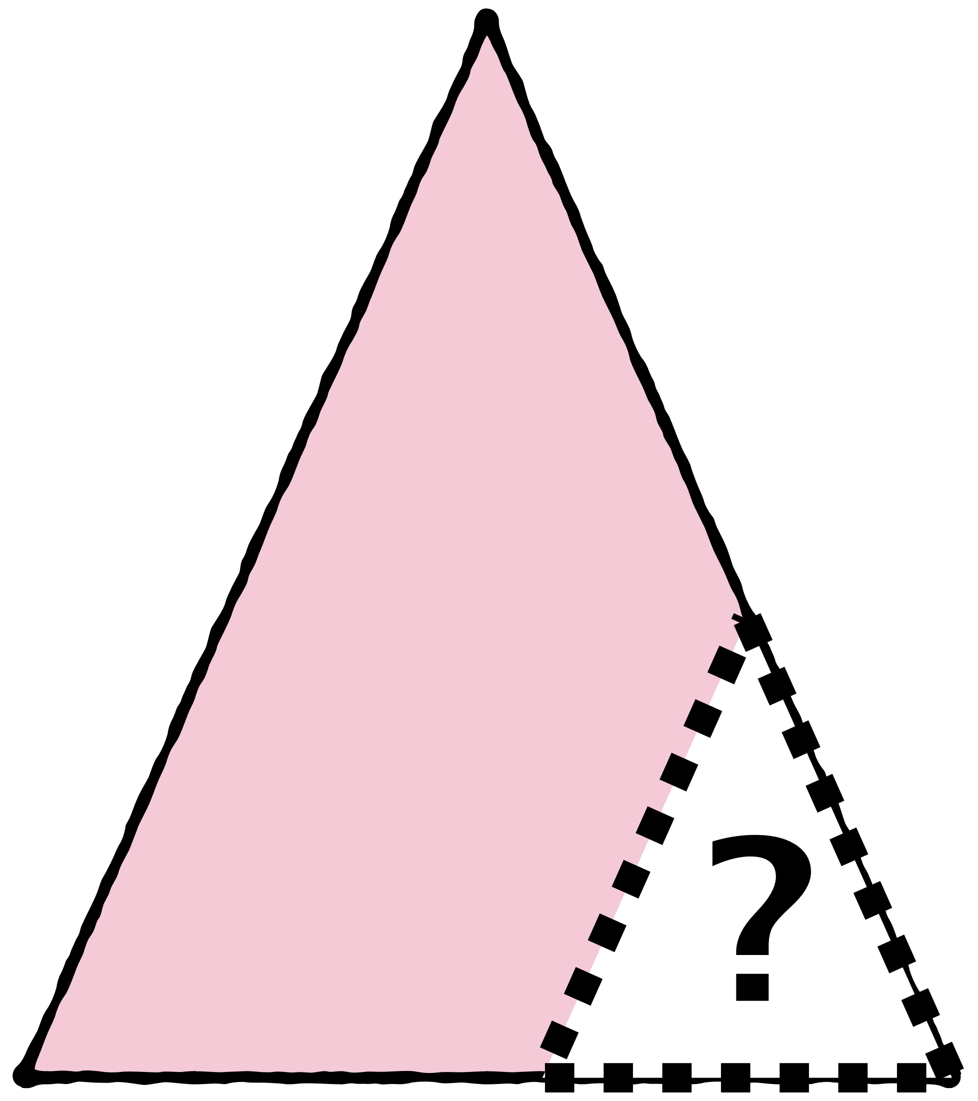
Composition

```
type Lens s t c d
```

```
Lens s t
     a b
```

```
Lens a b
     c d
```





```haskell
data Person = Person
 { name   :: String
 , age    :: Int
 , height :: Int
 }
```

```haskell
data Person = Person
  { name   :: String
  , age    :: Int
  , height :: Int
  }

  view (typed @String)
```

```haskell
data Person = Person
  { name   :: String
  , age    :: Int
  , height :: Int
  }

   view (field @"age")
```

```haskell
data Person = Person
 { name   :: String
 , age    :: Int
 , height :: Int
 }
```

```haskell
view (position @3)
```

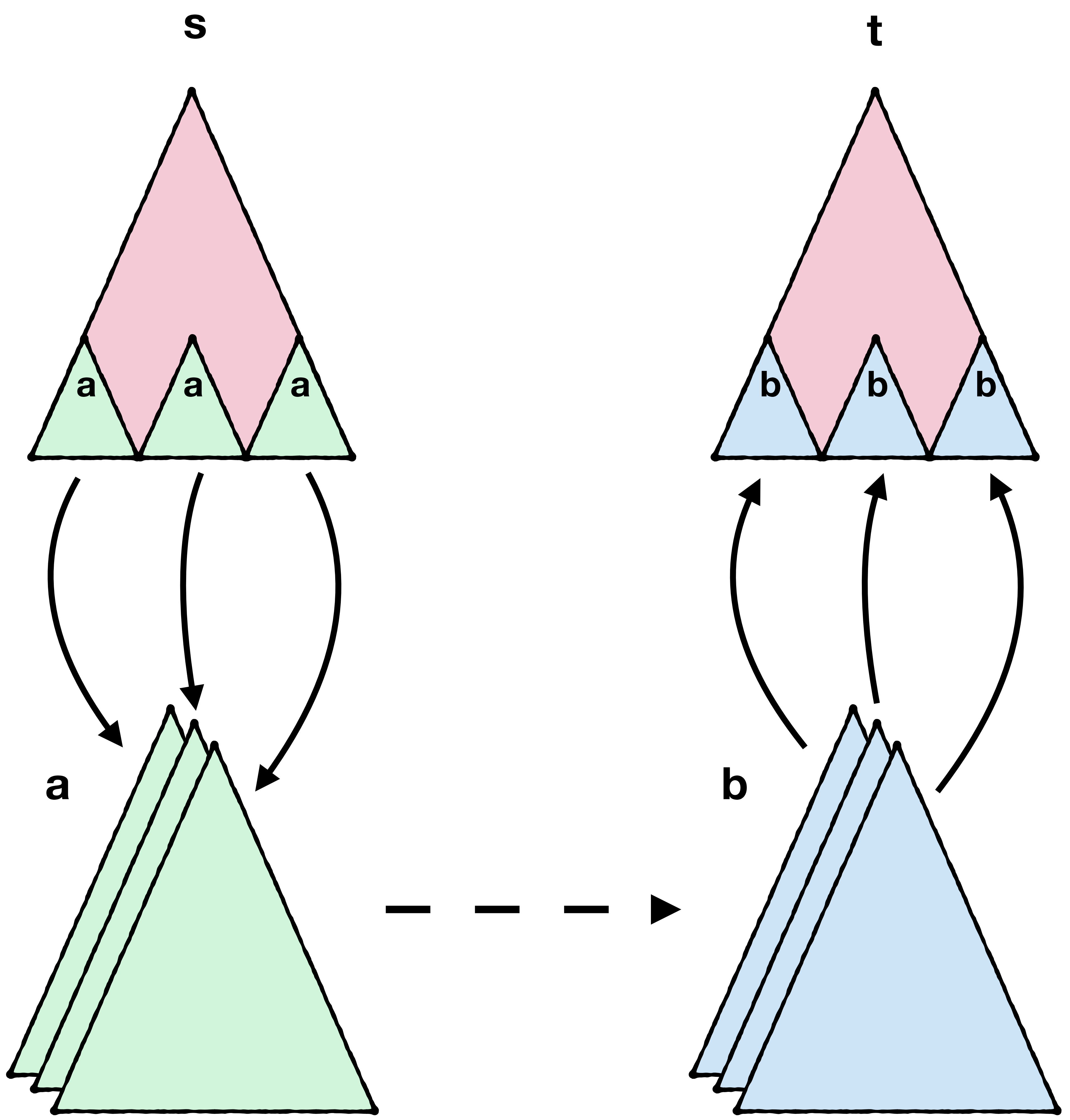
```haskell
data Person = Person
  { name   :: String
  , age    :: Int
  , height :: Int
  }
```

```haskell
view (typed @Int)
```

Traversals

Traversals

```
type Traversal s t a b
```



Composition

```
type Traversal s t c d
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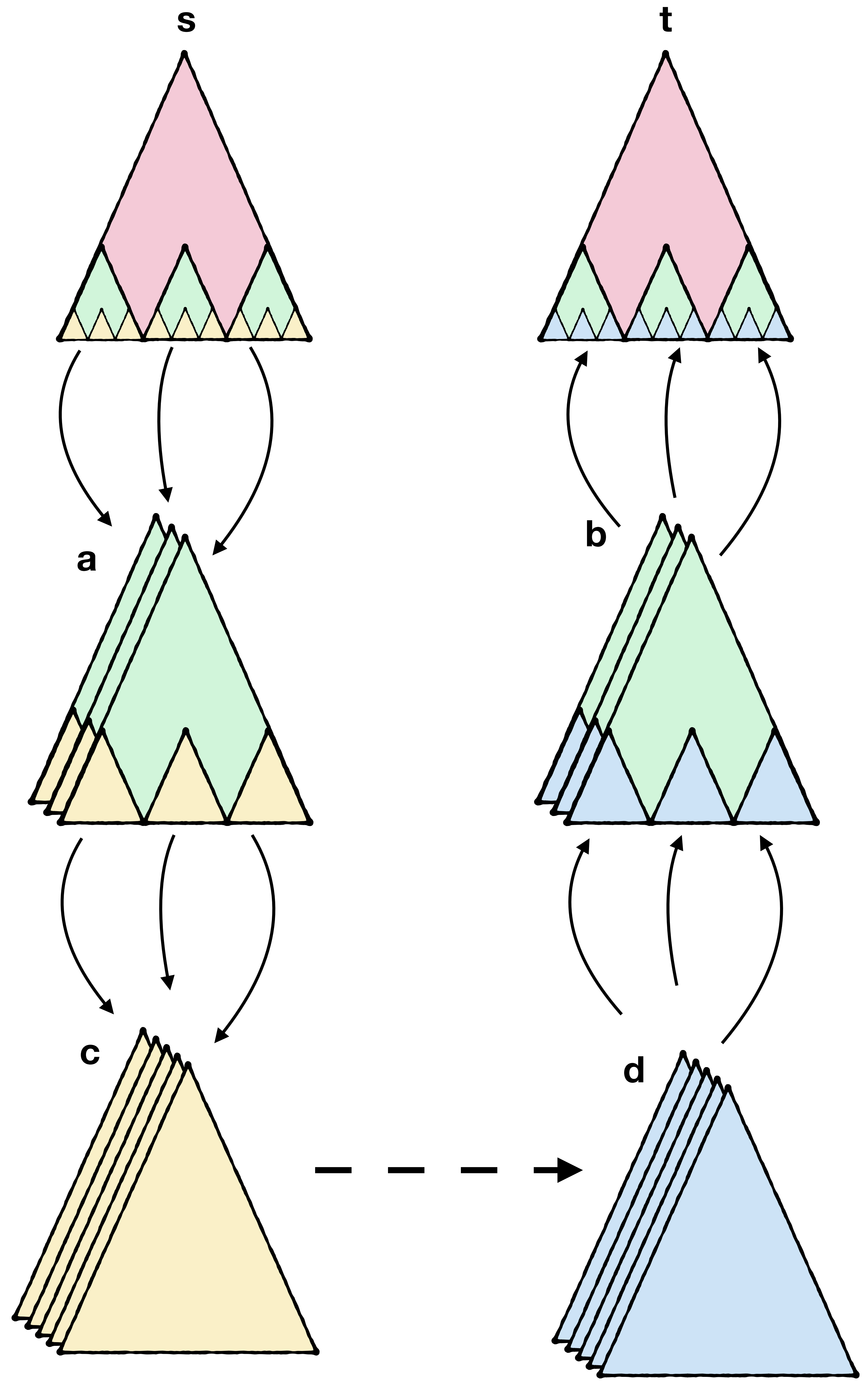


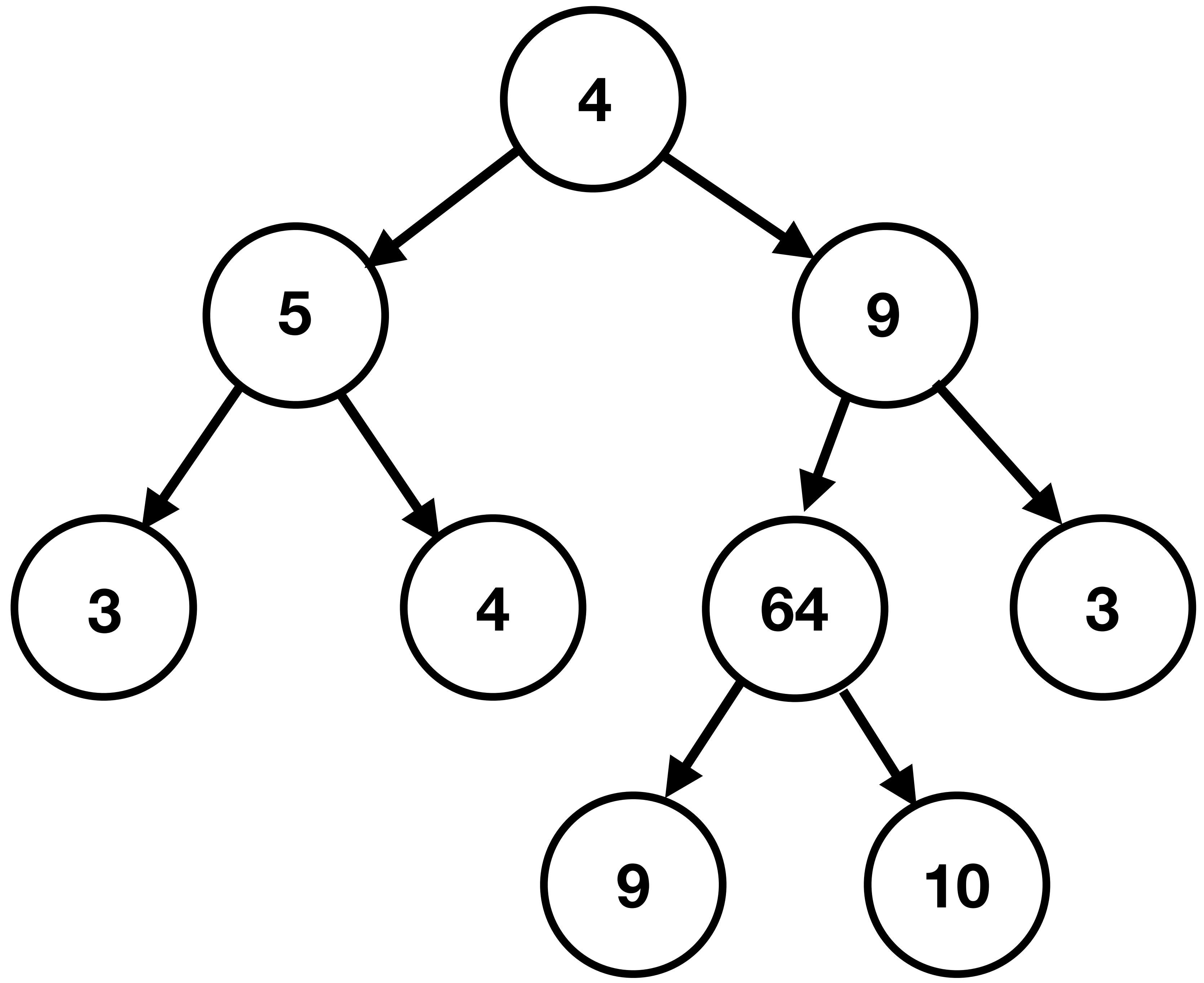
```
Traversal s t
          a b
```

```
Traversal a b
          c d
```

Example

Type-directed traversal

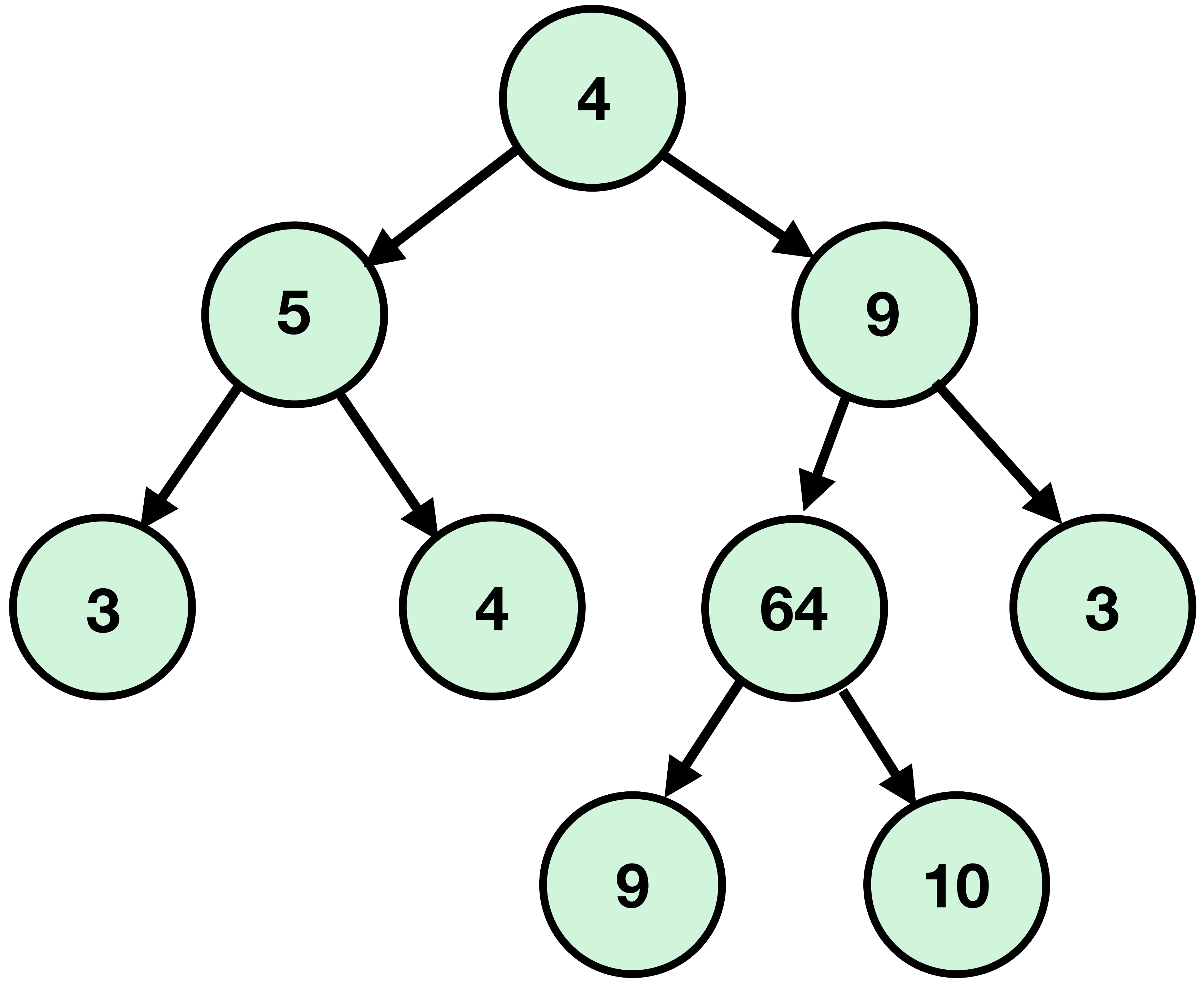
```
data Tree a w
  = Leaf a
  | Node w (Tree a w) (Tree a w)
```



`Tree Int Int`

Type-directed traversal

```
data Tree a w
  = Leaf a
  | Node w (Tree a w) (Tree a w)
```



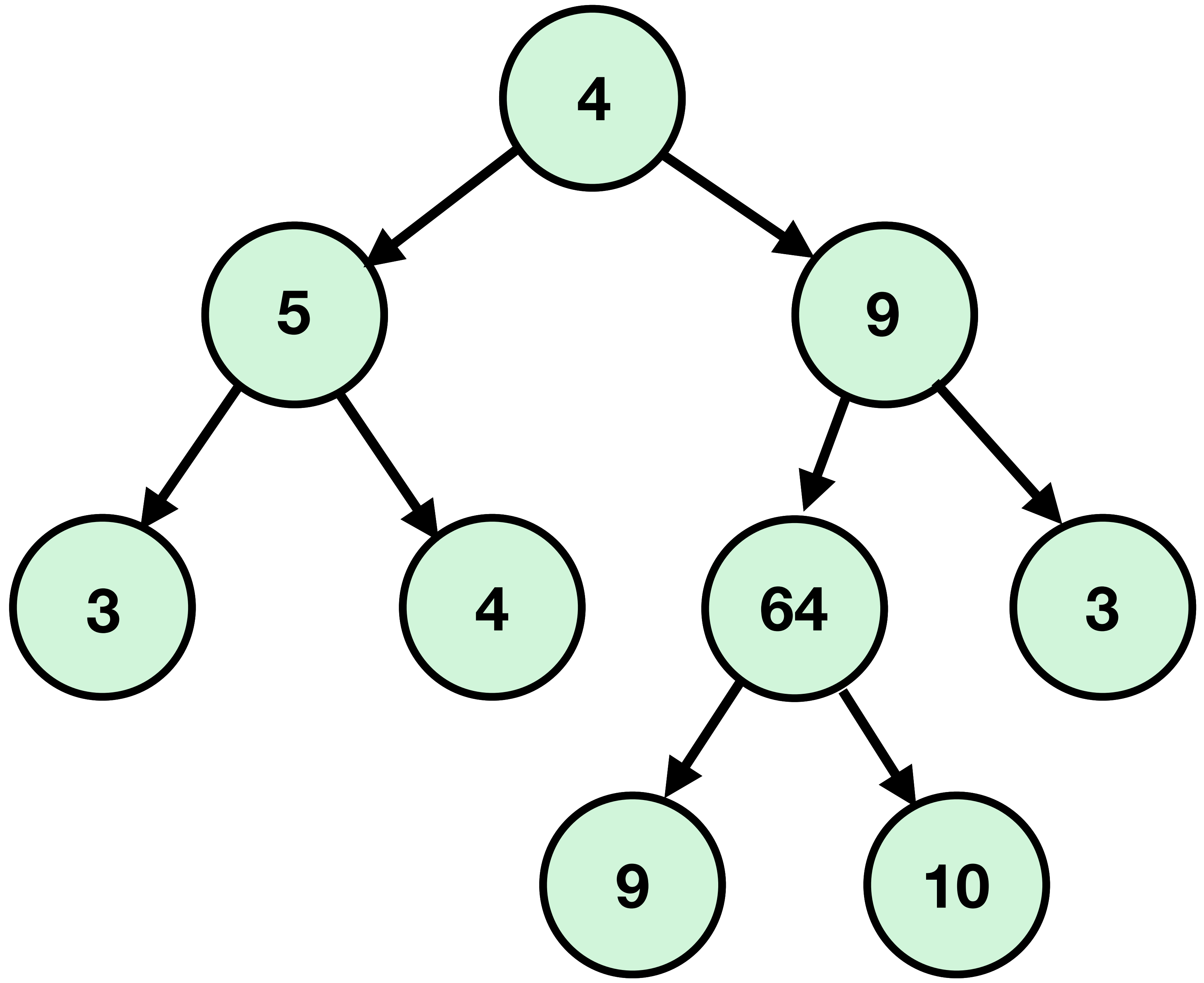
```
types @Int
```

```
Tree Int Int
```

Type-directed traversal

```haskell
data Tree a w
  = Leaf a
  | Node w (Tree a w) (Tree a w)
```

```
[4,5,3,4,9,64,9,10,3]
```

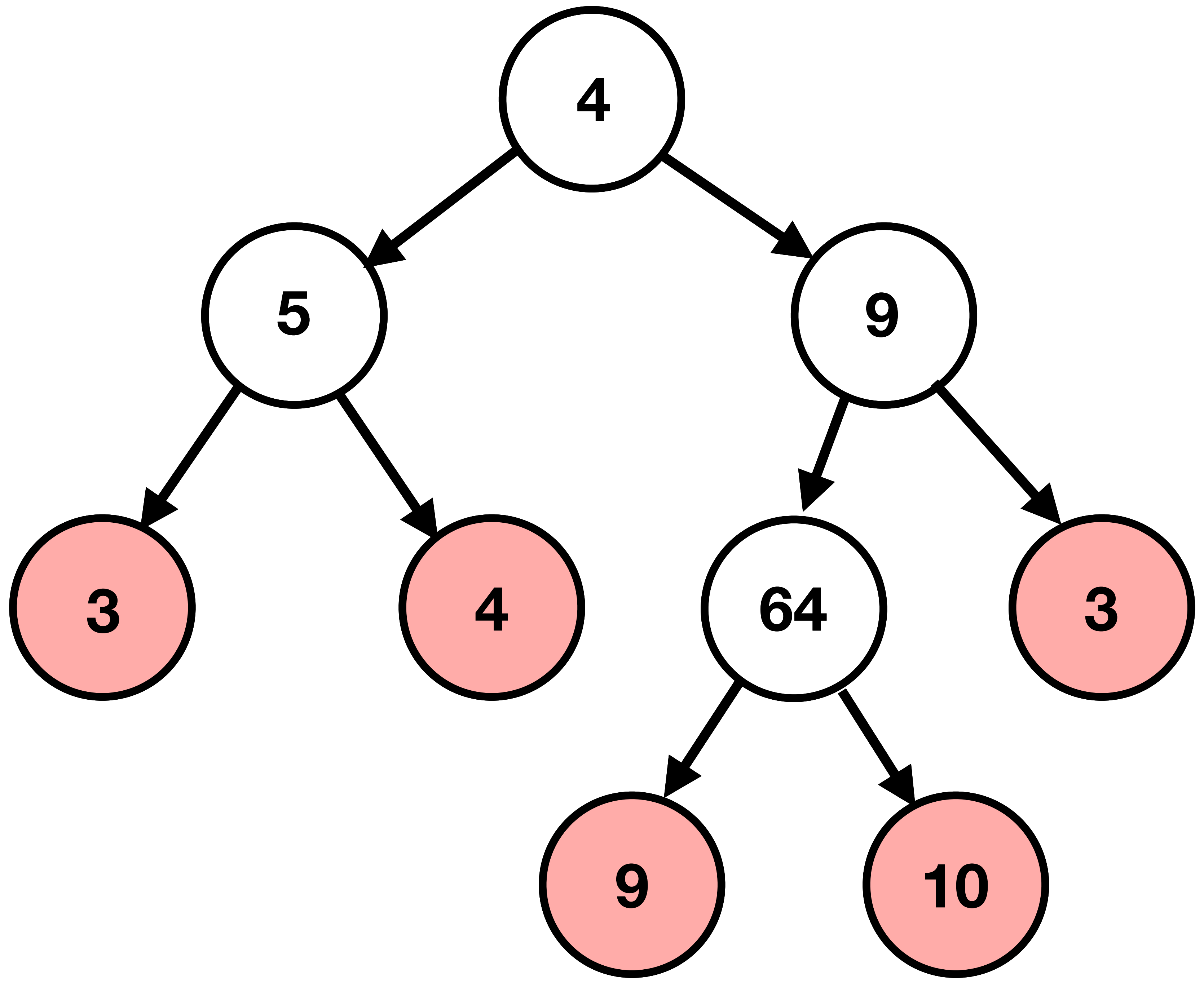


```haskell
toListOf (types @Int )
```

```haskell
Tree Int Int
```

Polymorphic traversals

```
data Tree a w
  = Leaf a
  | Node w (Tree a w) (Tree a w)
```

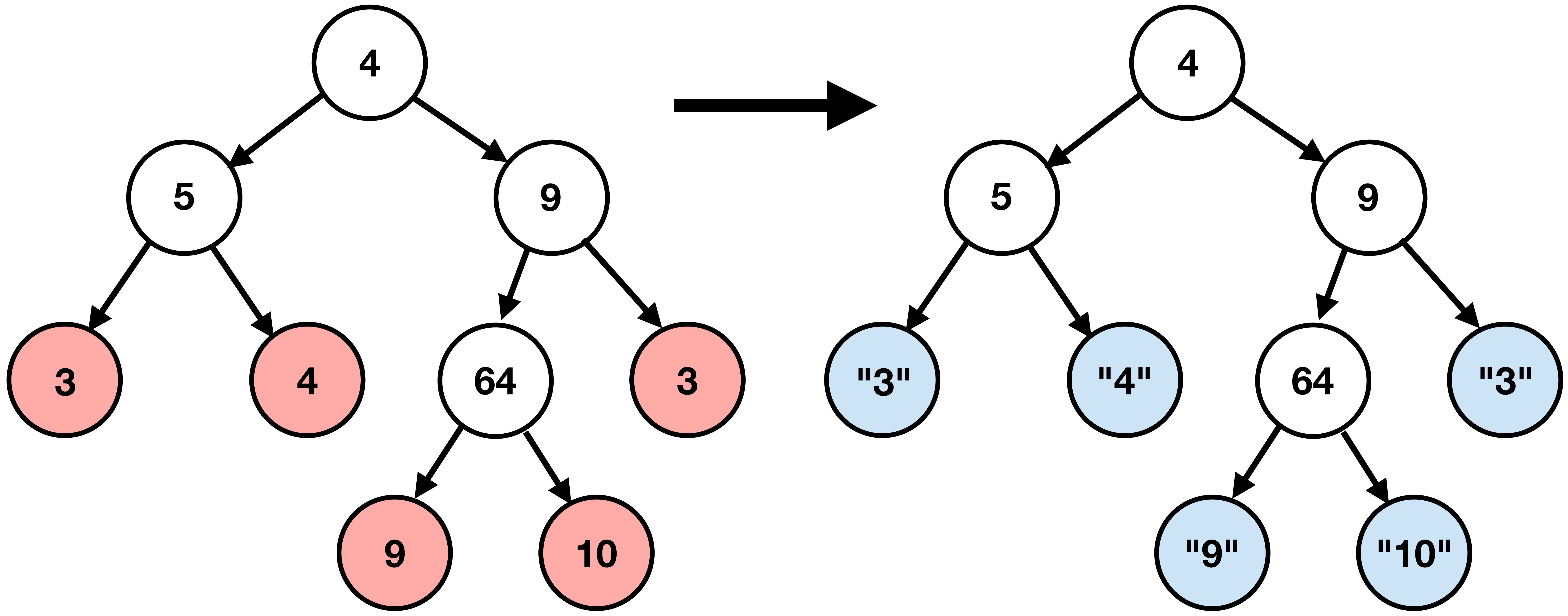


`param @1`

`Tree Int Int`

Polymorphic traversals

```
Traversal (Tree Int Int) (Tree String Int) Int String
```



```
over ( param @1 ) show
```

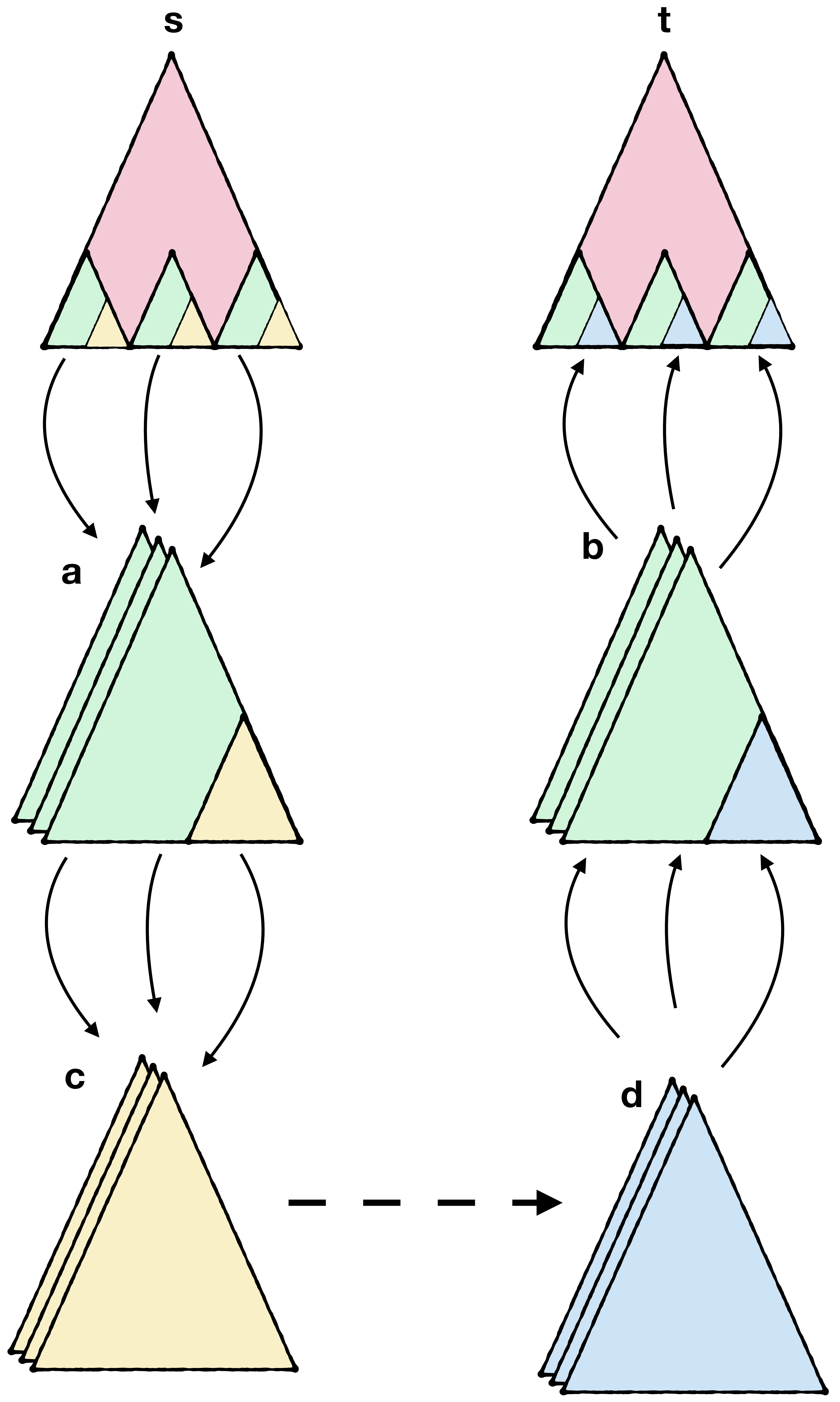
```
Tree String Int
```

Lenses are Traversals

Composition

```
Traversal s t
          a b
```

```
     Lens a b
          c d
```



Example

```haskell
data Class = Class
  { teachers :: [Person]
  , students :: [Person]
  }
```

```haskell
toListOf ( field @"teachers"
         . types @Person
         . field @"name" )
```

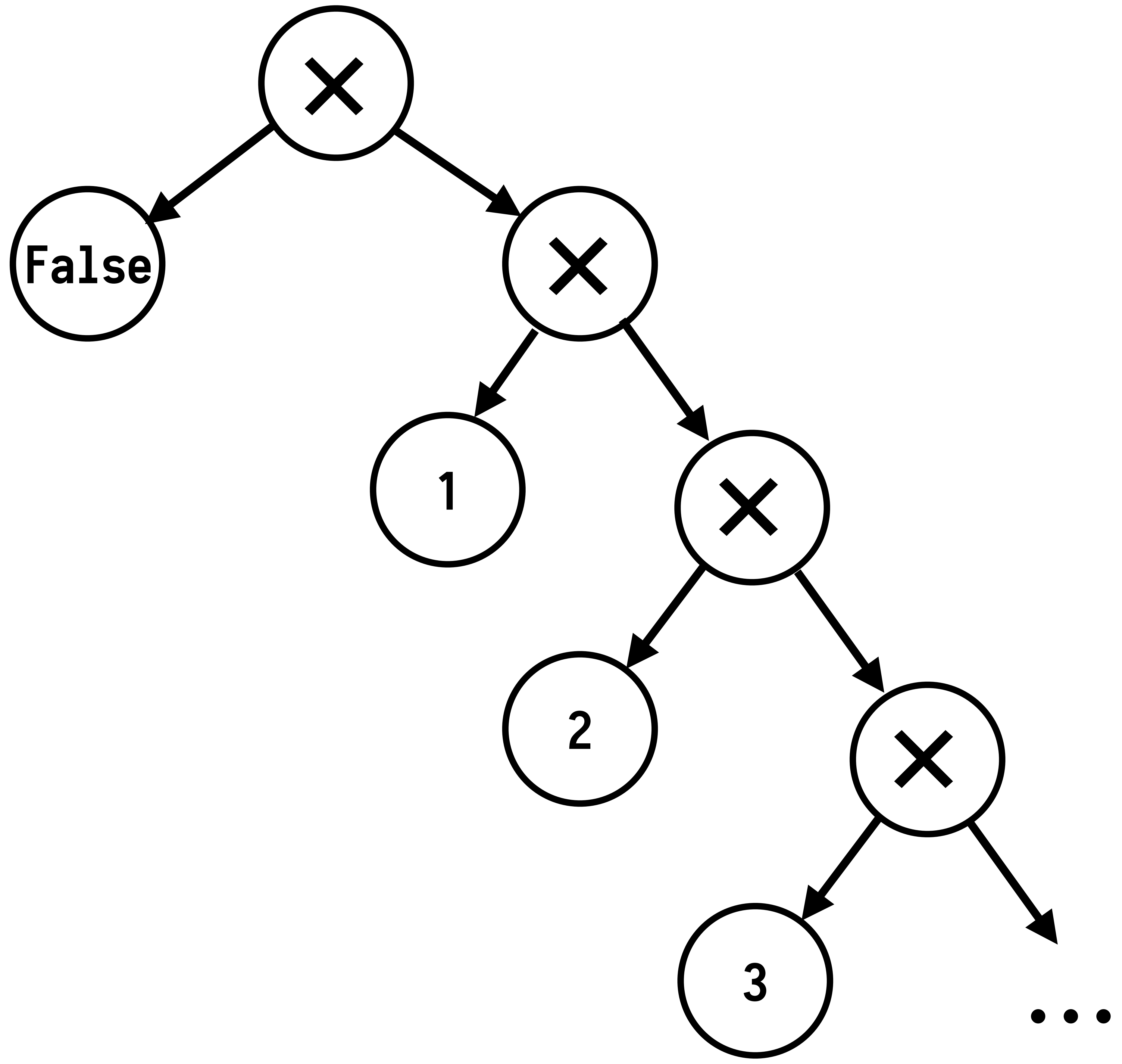
```
Class [john, peter] [gleb, ash] ----► ["John", "Peter"]
```

Locating values

Generic universe

Sums	`data f :+: g = L f | R g`
Products	`data f :×: g = f :×: g`
Constants	`newtype K a = K a`
Unit	`data U = U`
Void	`data V`

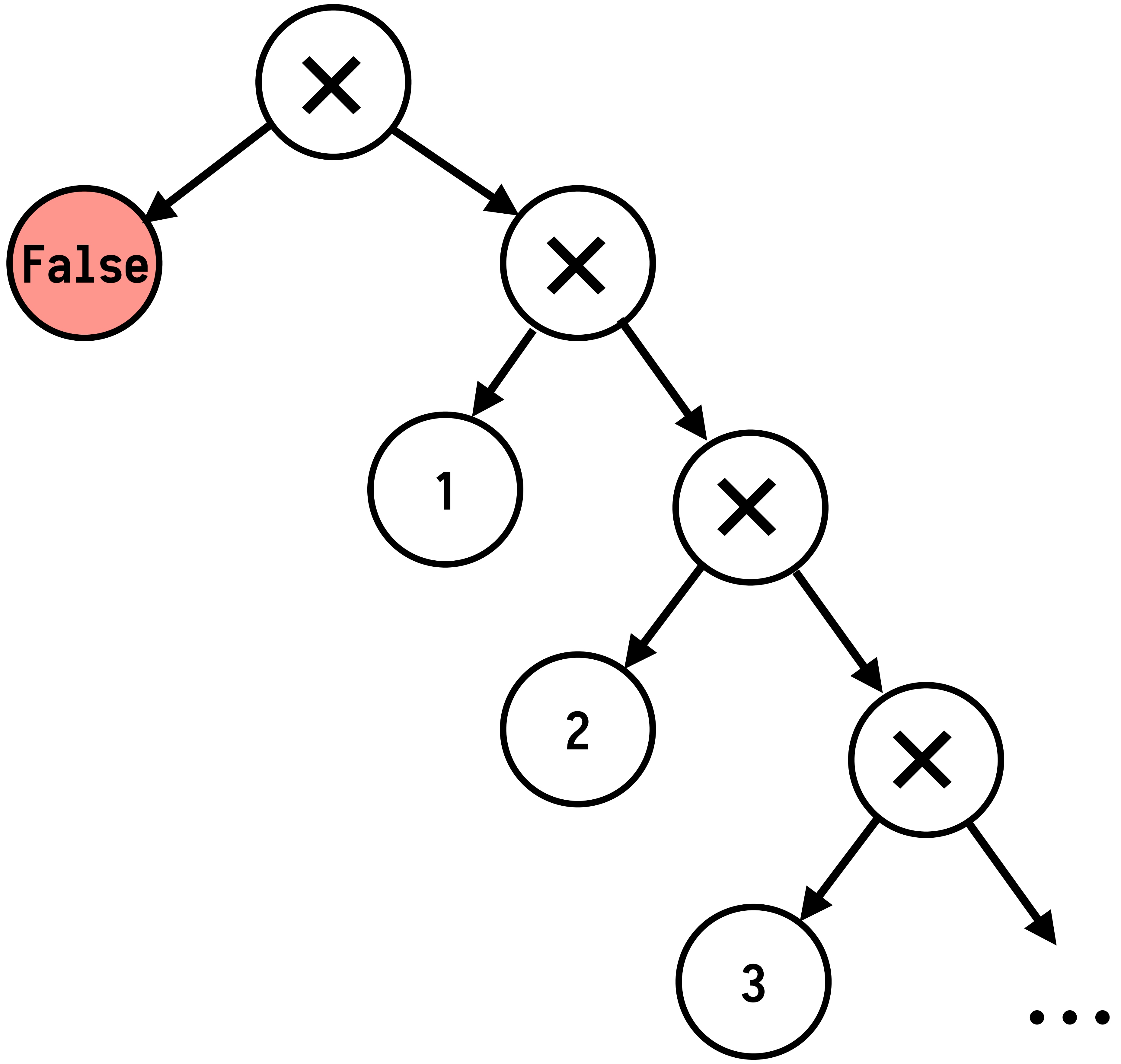
```
(False, [1, 2, 3, 4, 5, 6, 7]) :: (Bool, [Int])
```



Value structure

```
(False, [1, 2, 3, 4, 5, 6, 7]) :: (Bool, [Int])
```

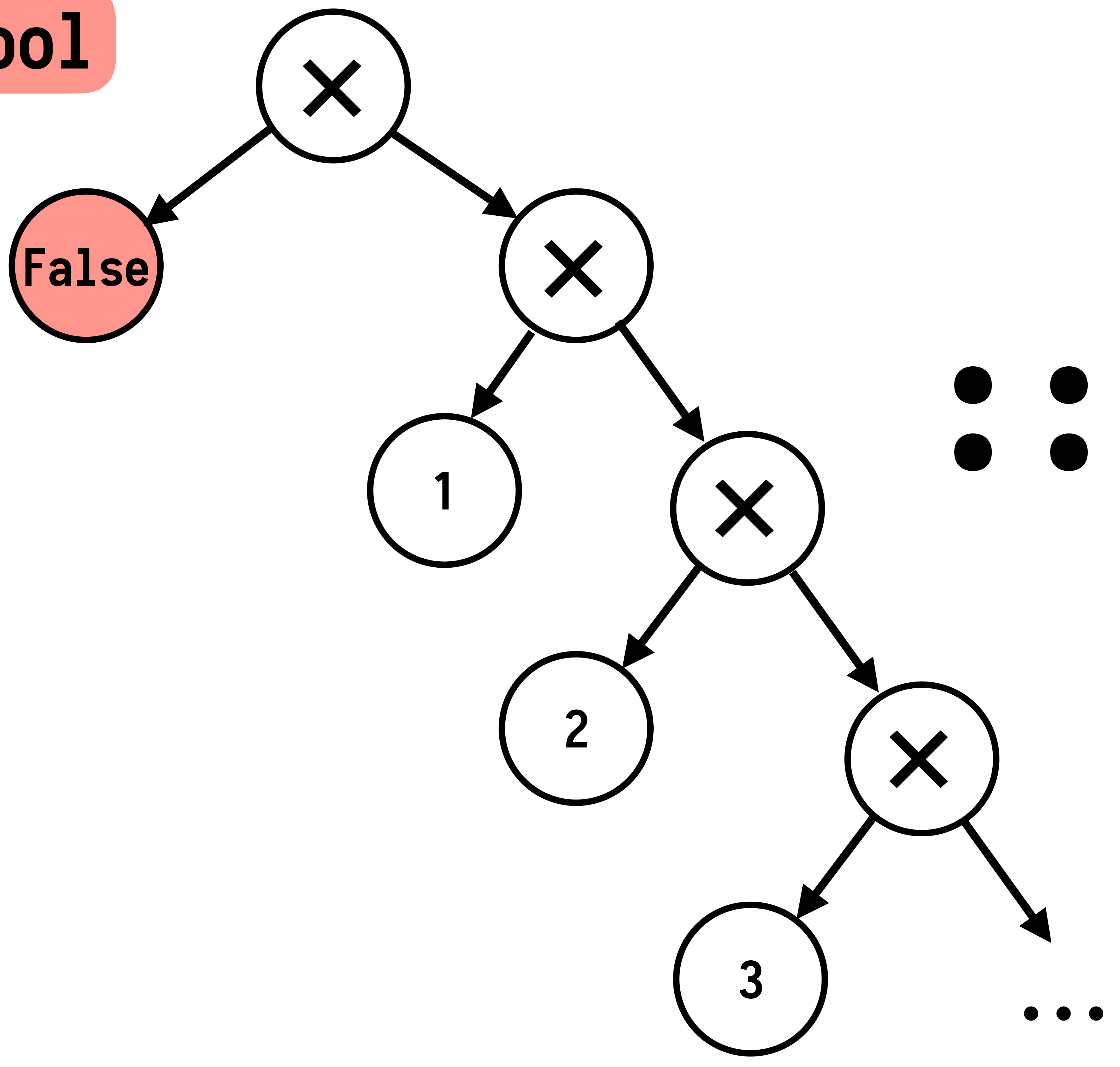
```
types @Bool
```



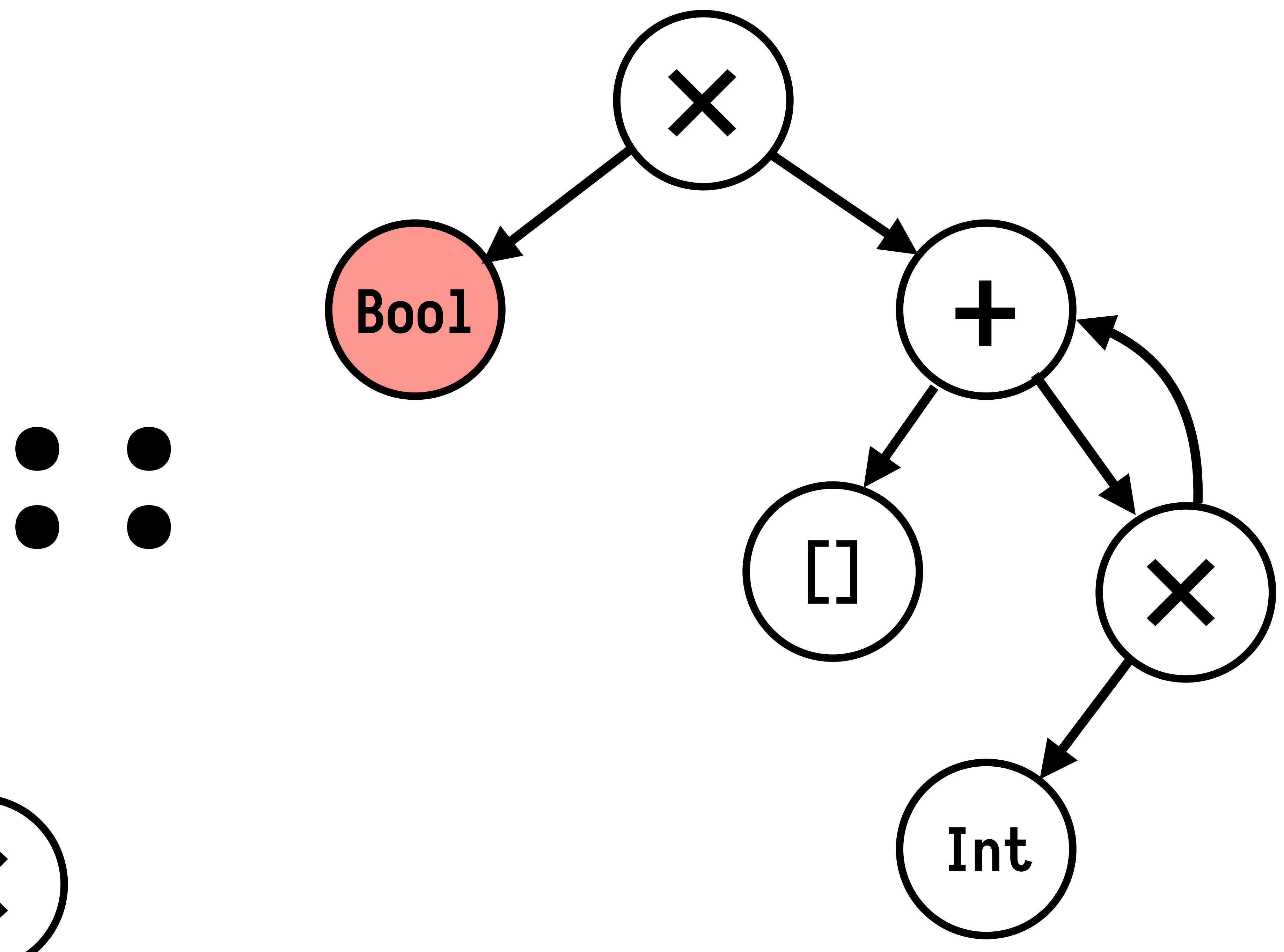
Value structure

`(False, [1, 2, 3, 4, 5, 6, 7]) :: (Bool, [Int])`

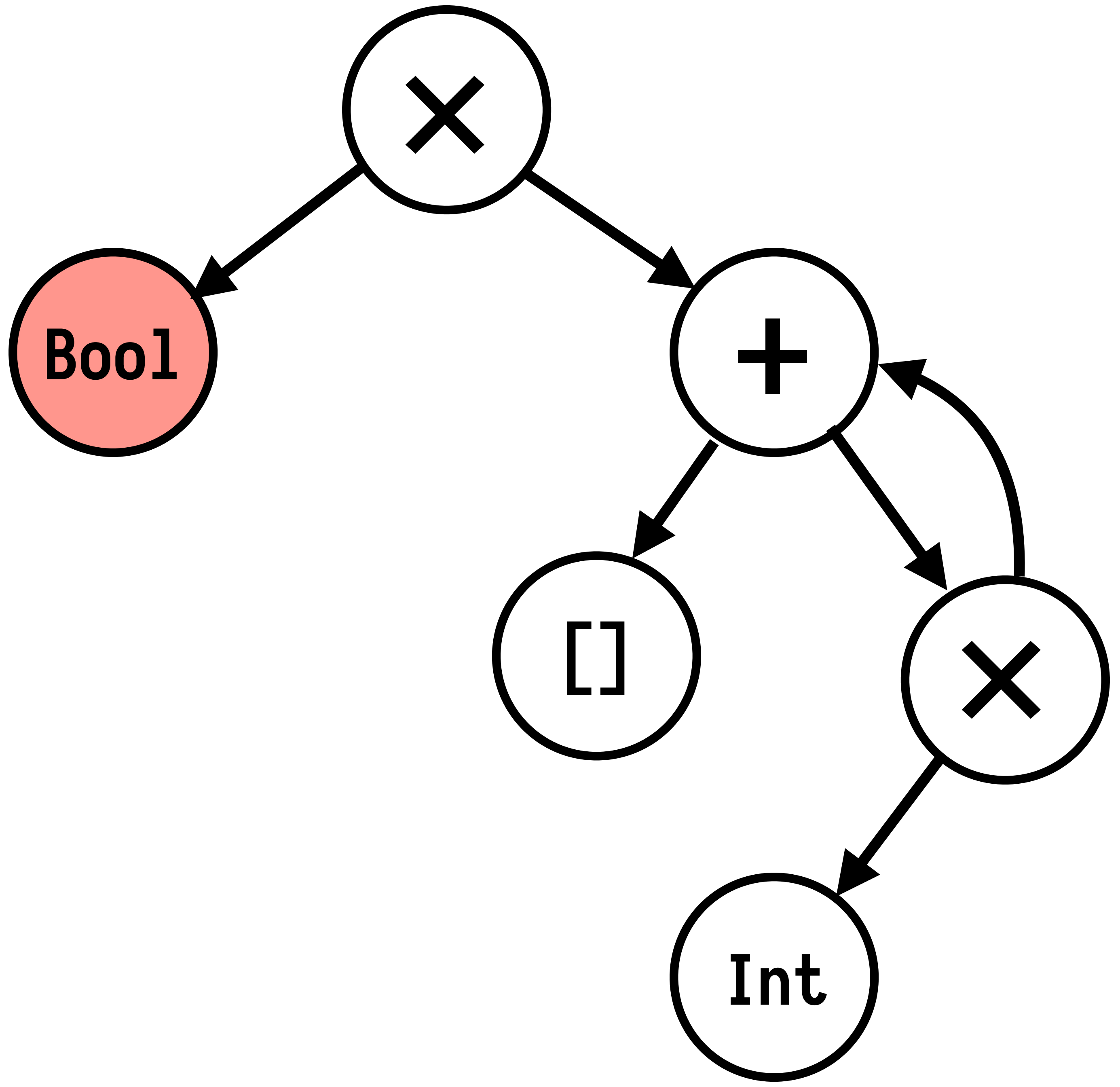
`types @Bool`



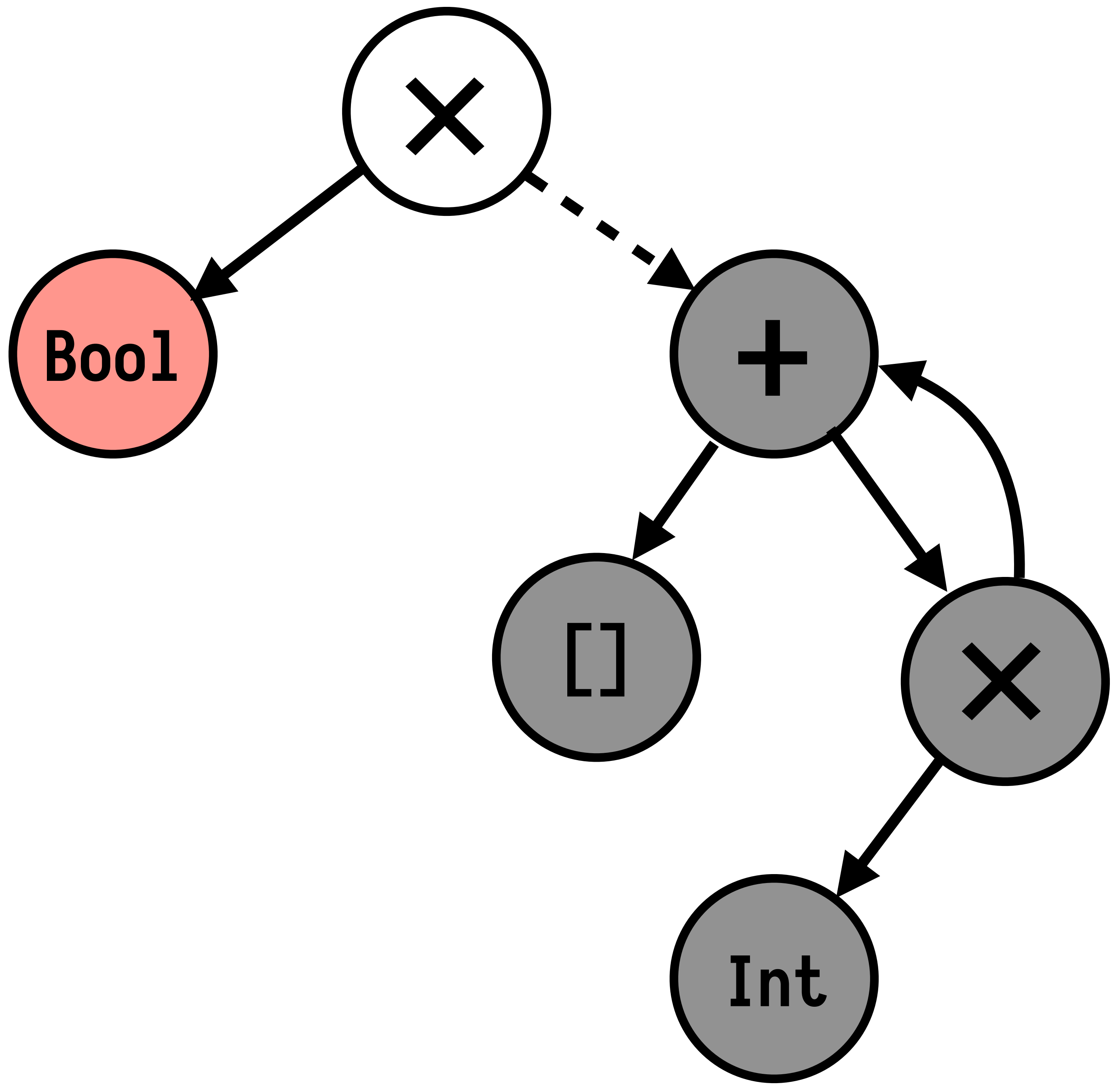
Value structure



Type structure



Type structure

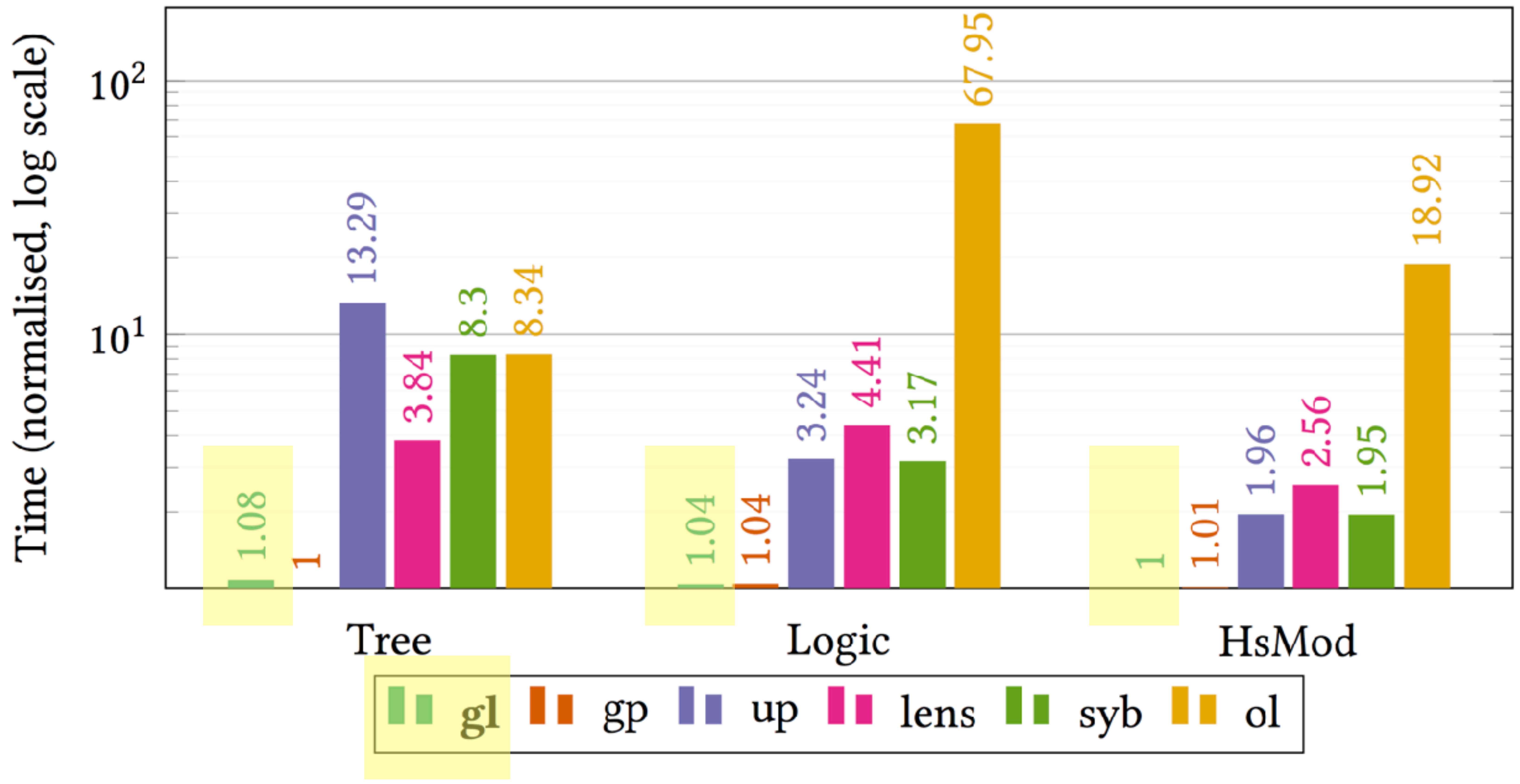


Type structure

```
type family Interesting (rep :: ⋆) (a :: ⋆) (seen :: [⋆]) :: Bool where
 Interesting (l :+: r) t seen = Interesting l t seen ∨ Interesting r t seen
 Interesting (l :×: r) t seen = Interesting l t seen ∨ Interesting r t seen
 Interesting (K t)     t seen = 'True
 Interesting (K r)     t seen = If (Elem r seen)
                                     'False
                                    (Interesting (Rep r) t (r ': seen))
 Interesting U t seen = 'False
 Interesting V t seen = 'False
```

Performance

Benchmarks



Execution time normalised as a factor of hand-written code

More!

- Lenses (by position, type, or field name)
- Prisms (by constructor name, or type)
- Type-inference of polymorphic traversals
- Custom type-errors
- Case study of inlining and specialisation (+ inspection testing)

Hackage: generic-lens

https://github.com/kcsongor/generic-lens

Thank you!