Phantheck

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Front Row Education

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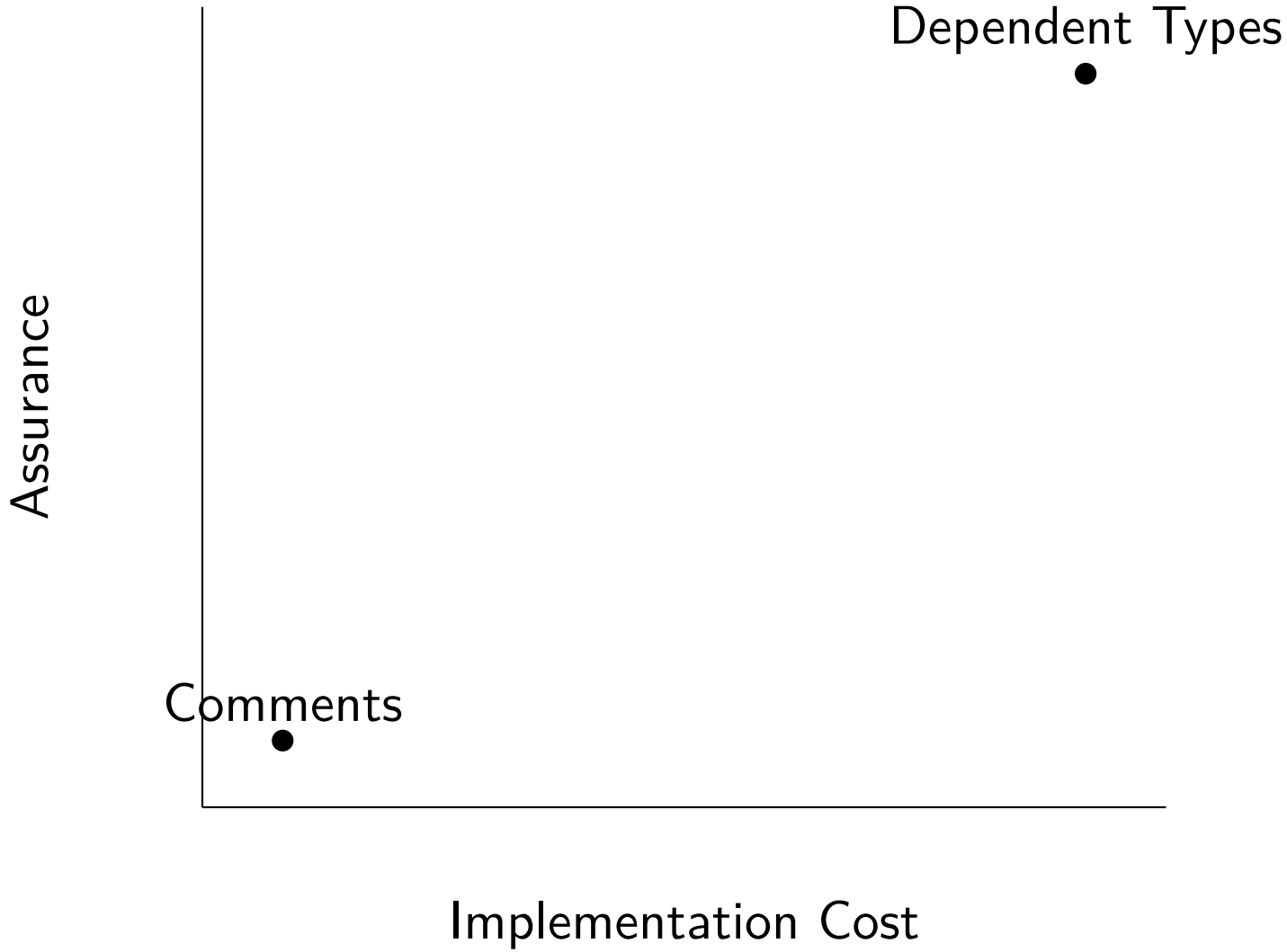
Starting point


```
minimum :: [Int] -> Maybe Int
minimum = listToMaybe . sort
```

Comments


```
-- This function expects to receive
-- a non-empty, sorted list
fastMin :: [Int] -> Int
fastMin = head
```

Tools for correct code



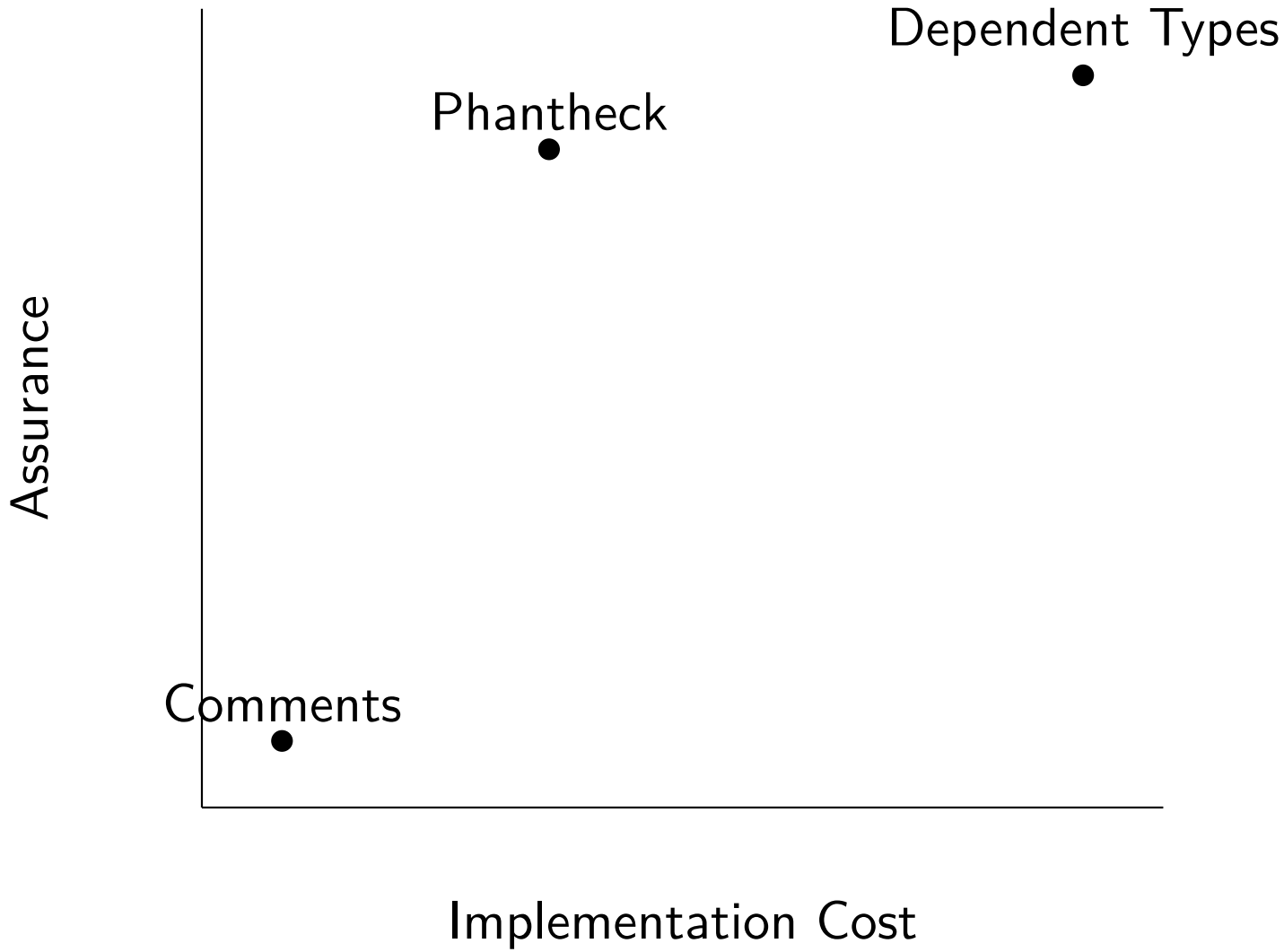
Dependent types


```
ifSingleton : Bool -> Type
ifSingleton True = Nat
ifSingleton False = List Nat

maybeMkSingleton : (x : Bool) -> ifSingleton x
maybeMkSingleton True = 0
maybeMkSingleton False = []
```

Dependent types


```
module Sort {X} {_≈_ _≤_ : Rel X}
            (_≤?_ : Decidable _≤_) (ord : TotalOrder _≈_ _≤_) where
open TotalOrder ord using (total; equivalence)
open Equivalence equivalence using (refl)

data ⊥XT : Set where
  ⊤ ⊥ : ⊥XT
  ⟦_⟧ : X → ⊥XT

data _≲_ : Rel ⊥XT where
  ⊥≲     : ∀ {x} → ⊥ ≲ x
  ≲⊤     : ∀ {x} → x ≲ ⊤
  ≤-lift : ∀ {x y} → x ≤ y → ⟦ x ⟧ ≲ ⟦ y ⟧

data OList (l u : ⊥XT) : Set where
  nil  : l ≲ u → OList l u
  cons : ∀ x (xs : OList ⟦ x ⟧ u) → l ≲ ⟦ x ⟧ → OList l u

toList : ∀ {l u} → OList l u → List X
toList (nil _)        = []
toList (cons x xs _) = x :: toList xs

insert : ∀ {l u} x → OList l u → l ≲ ⟦ x ⟧ → ⟦ x ⟧ ≲ u → OList l u
insert y (nil _)          l≤y y≤u = cons y (nil y≤u) l≤y
insert y (cons x xs l≤x) l≤y y≤u with y ≤? x
insert y (cons x xs l≤x) l≤y y≤u | left  y≤x = cons y (cons x xs (≤-lift y≤x)) l≤y
insert y (cons x xs l≤x) l≤y y≤u | right y>x =
  cons x (insert y xs ([ ≤-lift , (λ y≤x → absurd (y>x y≤x)) ] (total x y)) y≤u) l≤x

isort′ : List X → OList ⊥ ⊤
isort′ = foldr (λ x xs → insert x xs ⊥≲ ≲⊤) (nil ⊥≲)

isort : List X → List X
isort xs = toList (isort′ xs)
```

Tools for correct code



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```
fastMin
  :: ( Precondition 'Ascending ps
     , Precondition 'NonNull ps
     )
  => Prop ps [Int] -> Int
fastMin = head
```

Values, Types, Kinds

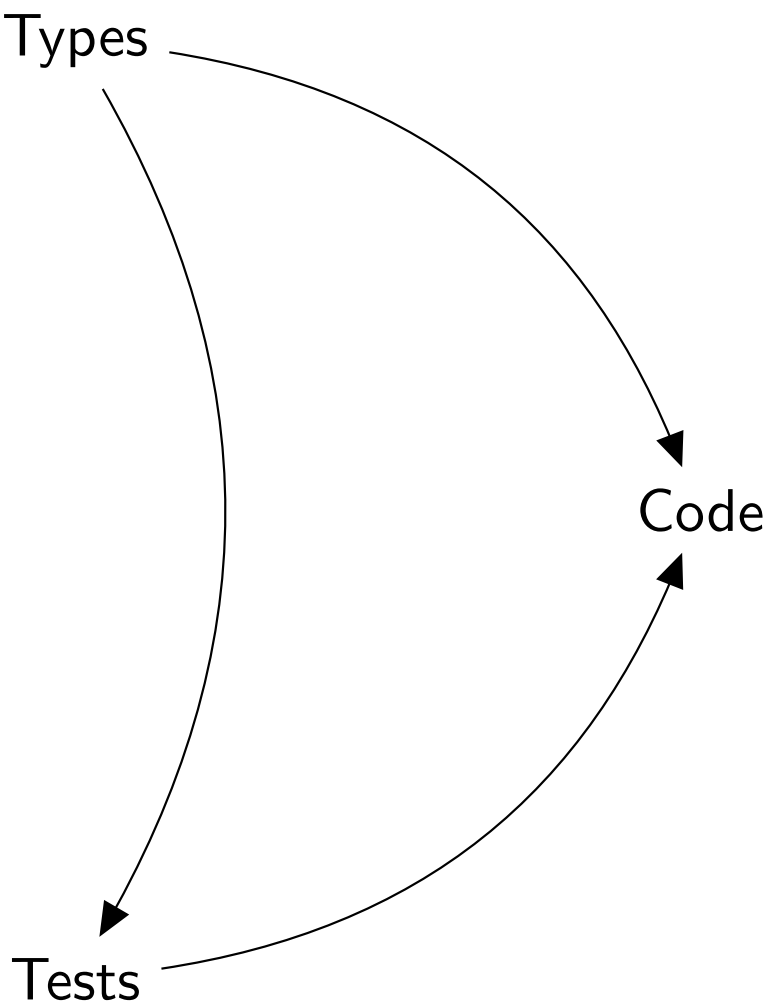

```
:: kinds
:: types
values


data Bool = True | False
-- kind Bool = 'True | 'False

falseAtValueLevel :: Bool
falseAtValueLevel = False

falseAtTypeLevel :: Tagged ('False :: Bool) Int
falseAtTypeLevel = Tagged 0
```

Program metadata
Status quo



Program metadata
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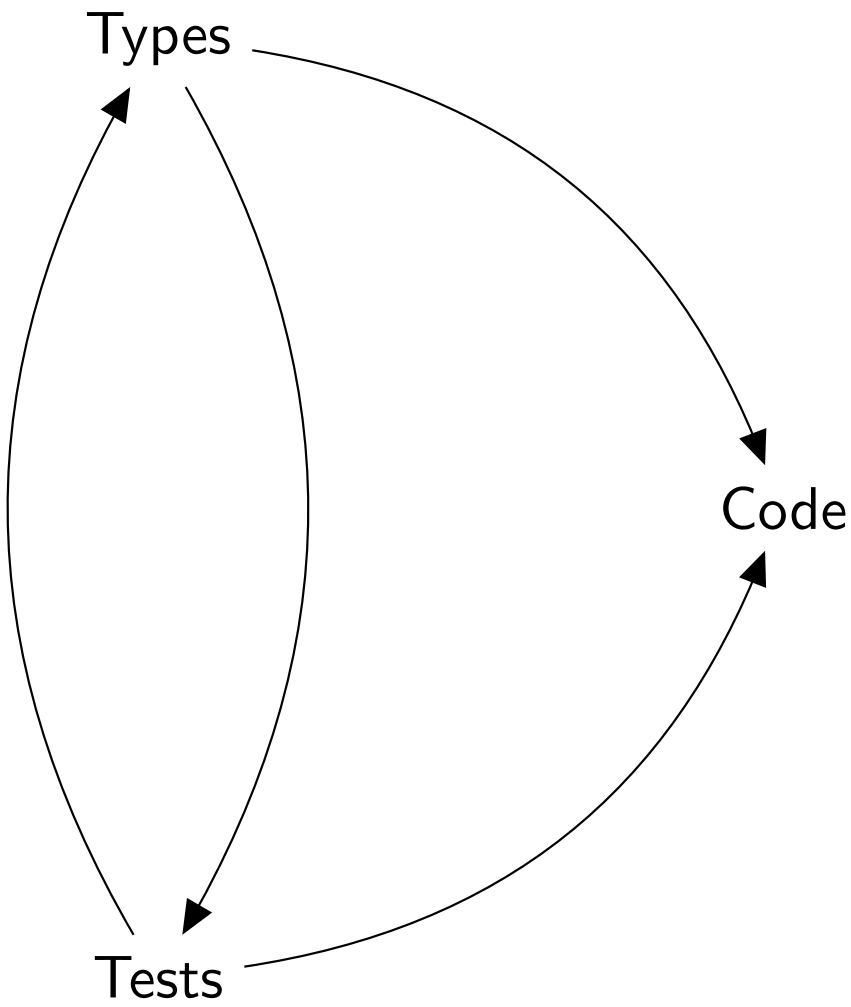

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