Functional Programming

Overview: Monoid, Foldable, Traversable

Ravi Chugh

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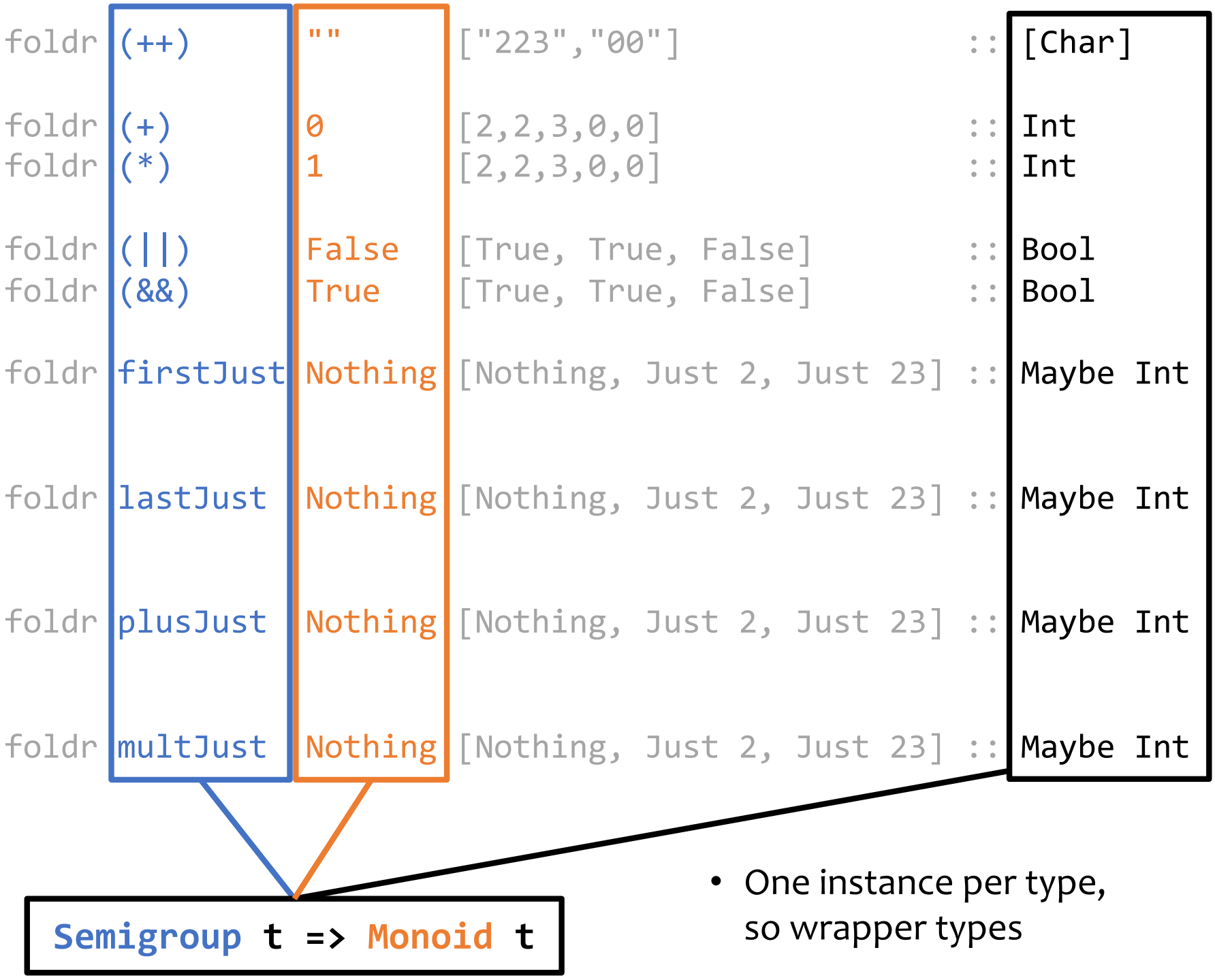
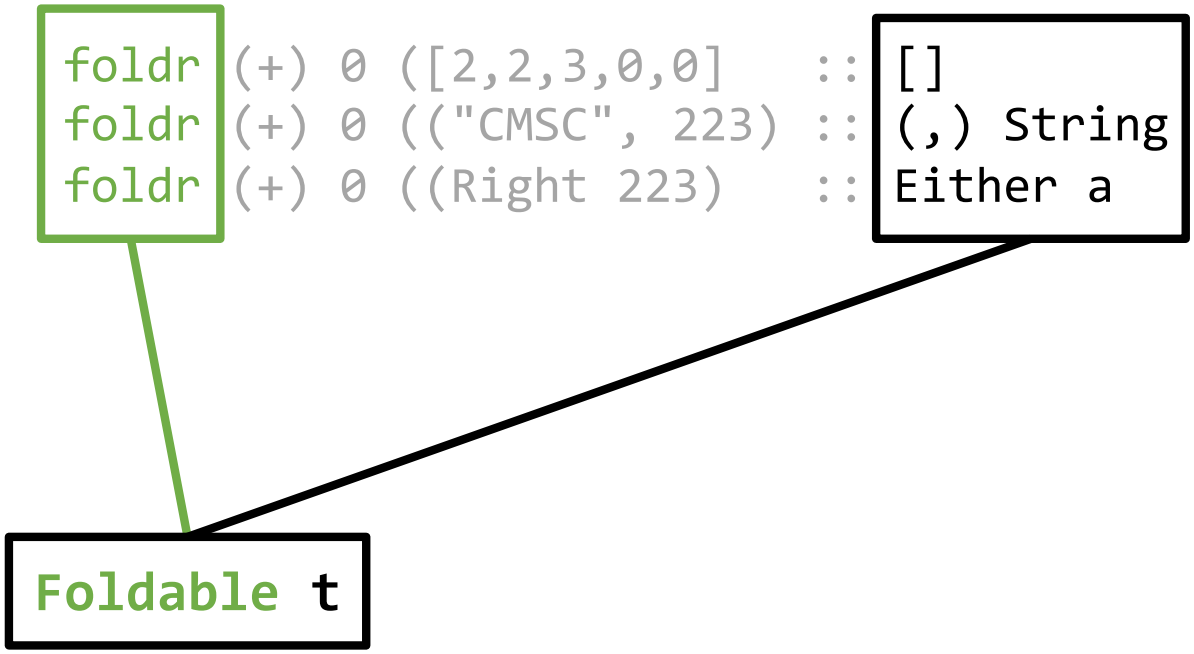
```
foldr (++)      ""      ["223","00"]                :: [Char]

foldr (+)       0       [2,2,3,0,0]                 :: Int
foldr (*)       1       [2,2,3,0,0]                 :: Int

foldr (||)      False   [True, True, False]         :: Bool
foldr (&&)      True    [True, True, False]         :: Bool

foldr firstJust Nothing [Nothing, Just 2, Just 23] :: Maybe Int
  ⇒ Just 2

foldr lastJust  Nothing [Nothing, Just 2, Just 23] :: Maybe Int
  ⇒ Just 23

foldr plusJust  Nothing [Nothing, Just 2, Just 23] :: Maybe Int
  ⇒ Just 25

foldr multJust  Nothing [Nothing, Just 2, Just 23] :: Maybe Int
  ⇒ Just 46
```


foldr (++) "" ["223","00"] :: [Char]
foldr (+) 0 [2,2,3,0,0] :: Int
foldr (*) 1 [2,2,3,0,0] :: Int
foldr (||) False [True, True, False] :: Bool
foldr (&&) True [True, True, False] :: Bool
foldr firstJust Nothing [Nothing, Just 2, Just 23] :: Maybe Int
foldr lastJust Nothing [Nothing, Just 2, Just 23] :: Maybe Int
foldr plusJust Nothing [Nothing, Just 2, Just 23] :: Maybe Int
foldr multJust Nothing [Nothing, Just 2, Just 23] :: Maybe Int
Semigroup t => Monoid t
• One instance per type, so wrapper types

```
foldr (+) 0 ([2,2,3,0,0]   :: []         Int)
foldr (+) 0 (("CMSC", 223) :: (,) String Int)
foldr (+) 0 ((Right 223)   :: Either a   Int)
```




```
  foldr   ::              (a -> b -> b) -> b -> t a -> b
  foldl   ::              (b -> a -> b) -> b -> t a -> b
  fold    :: Monoid m =>                       t m -> m
  foldMap :: Monoid m =>      (a -> m)      -> t a -> m

  elem    :: Eq a     => a -> t  a  -> Bool
( concat  ::                t [a] -> [a]              )

  ...
```

```
sequenceListOfMaybes :: [Maybe a]       -> Maybe [a]

sequenceListOfMaybes :: []    (Maybe a) -> Maybe ([]    a)
sequenceListOfTrees  :: []    (Tree  a) -> Tree  ([]    a)
sequenceTreeOfMaybes :: Tree  (Maybe a) -> Maybe (Tree a)

                        t_outer (t_inner a)   t_inner (t_outer a)
```

Traversable t_outer

```
sequenceA :: Applicative t_inner =>
             t_outer (t_inner a) -> t_inner (t_outer a)

traverse  :: Applicative t_inner =>
             (a -> t_inner b) -> t_outer a -> t_inner (t_outer a)
```

- `traverse` is "effectful `fmap`"
- `Traversable` simultaneously generalizes `Functor` and `Foldable`