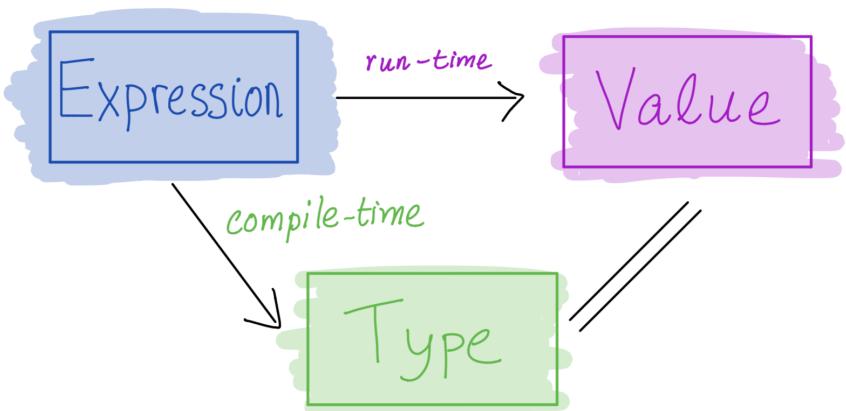
Haskell Crash Course Part II

Recap: Haskell Crash Course II



- Core program element is an **expression**
- Every *valid* expression has a **type** (determined at compile-time)
- Every *valid* expression reduces to a *value* (computed at run-time)

Recap: Haskell

Basic values & operators

- `Int`, `Bool`, `Char`, `Double`
- `+`, `-`, `==`, `/=`

Execution / Function Calls

- Just *substitute equals by equals*

Producing Collections

- Pack data into *tuples* & *lists*

Consuming Collections

- Unpack data via *pattern-matching*

Next: Creating and Using New Data Types

1. **`type`** Synonyms: *Naming* existing types
2. **`data`** types: *Creating* new types

Type Synonyms

Synonyms are just names ("aliases") for existing types

- think `typedef` in `C`

A type to represent `Circle`

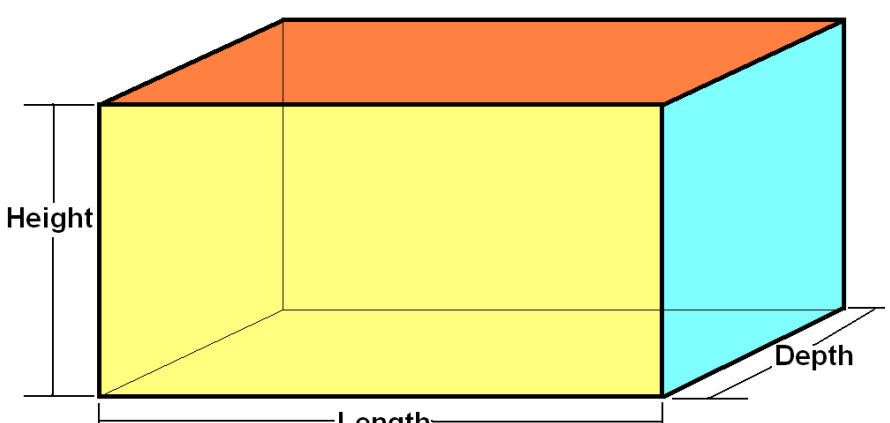
A tuple `(x, y, r)` is a *circle* with center at `(x, y)` and radius `r`

```
type Circle = (Double, Double, Double)
```

A type to represent `Cuboid`

A tuple `(length, depth, height)` is a *cuboid*

```
type Cuboid = (Double, Double, Double)
```



Using Type Synonyms

We can now use synonyms by creating values of the given types

```
circ0 :: Circle
circ0 = (0, 0, 100)  -- ^ circle at "origin" with radius 100

cub0 :: Cuboid
cub0 = (10, 20, 30)  -- ^ cuboid with length=10, depth=20, height=30
```

And we can write functions over synonyms too

```
area :: Circle -> Double
area (x, y, r) = pi * r * r

volume :: Cuboid -> Double
volume (l, d, h) = l * d * h
```

We should get this behavior

```
>>> area circ0
31415.926535897932

>>> volume cub0
6000
```

QUIZ

Suppose we have the definitions

```
type Circle = (Double, Double, Double)
type Cuboid = (Double, Double, Double)

circ0 :: Circle
circ0 = (0, 0, 100)  -- ^ circle at "origin" with radius 100

cub0 :: Cuboid
cub0 = (10, 20, 30)  -- ^ cuboid with length=10, depth=20, height=30

area :: Circle -> Double
area (x, y, r) = pi * r * r

volume :: Cuboid -> Double
volume (l, d, h) = l * d * h
```

What is the result of

```
>>> volume circ0
```

A. `0`

B. Type error

Beware!

Type Synonyms

- Do not *create* new types
- Just *name* existing types

And hence, synonyms

- Do not prevent *confusing* different values

Creating New Data Types

We can avoid mixing up by creating *new* **data** types

```
-- | A new type `CircleT` with constructor `MkCircle`
data CircleT = MkCircle Double Double Double

-- | A new type `CuboidT` with constructor `MkCuboid`
data CuboidT = MkCuboid Double Double Double
```

you choose

Name of new type

*Constructors are the **only way** to create values*

- `MkCircle` creates `CircleT`
- `MkCuboid` creates `CuboidT`

QUIZ

Suppose we create a new type with a **`data`** definition

```
-- | A new type `CircleT` with constructor `MkCircle`
data CircleT = MkCircle Double Double Double
```

What is the **type of** the `MkCircle` *constructor*?

A. `MkCircle :: CircleT`

B. `MkCircle :: Double -> CircleT`

C. `MkCircle :: Double -> Double -> CircleT`

D. `MkCircle :: Double -> Double -> Double -> CircleT`

E. `MkCircle :: (Double, Double, Double) -> CircleT`

Constructing Data

Constructors let us *build* values of the new type

```
circ1 :: CircleT
circ1 = MkCircle 0 0 100  -- ^ circle at "origin" w/ radius 100

cub1 :: Cuboid
cub1 = MkCuboid 10 20 30  -- ^ cuboid w/ len=10, dep=20, ht=30
```

QUIZ

Suppose we have the definitions

```
data CuboidT = MkCuboid Double Double Double

type Cuboid  = (Double, Double, Double)

volume :: Cuboid -> Double
volume (l, d, h) = l * d * h
```

What is the result of

```
>>> volume (MkCuboid 10 20 30)
```

A. `6000`

B. Type error

Deconstructing Data

Constructors let us *build* values of new type ... but how to *use* those values?

How can we implement a function

```
volume :: Cuboid -> Double
volume c = ???
```

such that

```
>>> volume (MkCuboid 10 20 30)
6000
```

Deconstructing Data by Pattern Matching

Haskell lets us *deconstruct* data via pattern-matching

```
volume :: Cuboid -> Double
volume c = case c of
             MkCuboid l d h -> l * d * h
```

`case e of Ctor x y z -> e1` is read as as

IF - `e` evaluates to a value that *matches the pattern* `Ctor vx vy vz`

THEN - evaluate `e1` after naming `x := vx`, `y := vy`, `z := vz`

Pattern matching on Function Inputs

Very common to do matching on function inputs

```
volume :: Cuboid -> Double
volume c = case c of
            MkCuboid l d h -> l * d * h

area :: Circle -> Double
area a  = case a of
            MkCircle x y r -> pi * r * r
```

So Haskell allows a nicer syntax: *patterns in the arguments*

```
volume :: Cuboid -> Double
volume (MkCuboid l d h) = l * d * h

area :: Circle -> Double
area (MkCircle x y r) = pi * r * r
```

Nice syntax *plus* the compiler saves us from *mixing up* values!