CSc 520

Principles of Programming Languages

18: Haskell — Data Types

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User-defined Datatypes

- Haskell allows the definition of new datatypes :

  `data` *Datatype* $a_1 \ldots a_n$ = *constr*$_1$ | . . . | *constr*$_m$

  where

  1. *Datatype* is the name of a new type constructor of arity $n \geq 0$,
  2. a_1, . . . , a_n are distinct type variables representing the arguments of *DatatypeName* and
  3. *constr*$_1$, . . . , *constr*$_m$ $(m \geq 1)$ describe the way in which elements of the new datatype are constructed.

User-defined Datatypes. . .

- Each *constr* can take one of two forms:

  1. *Name type*$_1$ . . . *type*$_r$ where *Name* is a previously unused constructor function name (i.e. an identifier beginning with a capital letter). This declaration introduces *Name* as a new constructor function of type:

     $$\textit{type}_1 \rightarrow \ldots \rightarrow \textit{type}_r \rightarrow \textit{Datatype}\ a_1 \ldots a_n$$

  2. *type*$_1$ $\oplus$ *type*$_2$ where $\oplus$ is a previously unused constructor function operator (i.e. an operator symbol beginning with a colon). This declaration introduces $(\oplus)$ as a new constructor function of type:

     $$\textit{type}_1 \rightarrow \textit{type}_2 \rightarrow \textit{Datatype}\ a_1 \ldots a_n$$

User-defined Datatypes. . .

- The following definition introduces a new type `Day` with elements `Sun`, `Mon`, `Tue`,. . . :

```
data Day = Sun|Mon|Tue|Wed|Thu|Fri|Sat
```

- Simple functions manipulating elements of type `Day` can be defined using pattern matching:

```
what_shall_I_do Sun = "relax"
what_shall_I_do Sat = "go shopping"
what_shall_I_do _   = "go to work"
```

User-defined Datatypes...

- Another example uses a pair of constructors to provide a representation for temperatures which may be given using either of the centigrade or fahrenheit scales:

```
data Temp = Centigrade Float |
            Fahrenheit Float

freezing                  :: Temp -> Bool
freezing (Centigrade temp) = temp <= 0.0
freezing (Fahrenheit temp) = temp <= 32.0
```

User-defined Datatypes...

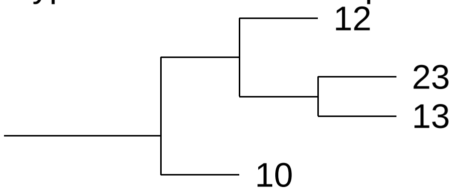
- Datatype definitions may also be recursive.
- The following example defines a type representing binary trees with values of a particular type at their leaves:

```
    data Tree a = Lf a | Tree a :^: Tree a
```

- For example,

```
    (Lf 12 :^: (Lf 23 :^: Lf 13)) :^: Lf 10
```

has type `Tree Int` and represents the binary tree:



User-defined Datatypes...

- Calculate the list of elements at the leaves of a tree traversing the branches of the tree from left to right.

```
leaves  :: Tree a -> [a]
leaves (Lf l)  = [l]
leaves (l:^:r) = leaves l ++ leaves r
```

- Using the binary tree above as an example:

```
? leaves ((Lf 12:^:(Lf 23:^:Lf 13)):^:Lf 10)
[12, 23, 13, 10]
(24 reductions, 73 cells)
```

Acknowledgements

- These slides were derived directly from the Gofer manual.

  Functional programming environment, Version 2.20
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- A copy of the Gofer manual can be found in `/home/cs520/2003/gofer/docs/goferdoc.ps`.