

<http://xkcd.com/1312/>



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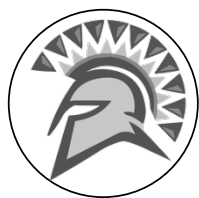
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CS 252:  
*Advanced Programming Language Principles*



## Introduction to Haskell

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Key traits of Haskell

1. Purely functional
2. Lazy
3. Statically typed
4. Type inference
5. Fully curried functions

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## Interactive Haskell

```
$ ghci
GHCi, version 7.6.3
...
Prelude> 3 + 4
7
Prelude> let f x = x + 1
Prelude> f 3
4
Prelude>
```

Needed in ghci,  
but not in a  
script

## Running Haskell from Unix command line

```
$ cat helloWorld.hs
main :: IO ()
main = do
    putStrLn "Hello World"
$ runhaskell helloWorld.hs
Hello World
$
```

## Haskell Base Types

- Int – bounded integers
- Integer – unbounded
- Float
- Double
- Bool
- Char

### Lists

- Comma separated, as in Java.
- Some useful operators:
  - ++ concatenation
  - : prepend an item
  - !! get an element at the given index
  - head first item
  - tail rest of the list
  - last last item
  - init the beginning part of the list

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### List examples

```
Prelude> "I hate the homeless" ++
  "ness problem that plagues our city"
"I hate the homelessness problem that
plagues our city"
Prelude> let s = "bra" in
  s !! 2 : s ++ 'c' : last s : 'd' : s
"abracadbra"
Prelude>
```

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### Ranges

```
Prelude> [1..15]
[1,2,3,4,5,6,7,8,9,10,11,12,13,14,15]
Prelude> ['a'..'z']
"abcdefghijklmnopqrstuvwxyz"
Prelude> [1,3..27]
[1,3,5,7,9,11,13,15,17,19,21,23,25,27]
Prelude> let evens = [2, 4..]
Prelude> take 5 evens
[2,4,6,8,10]
```

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## List Comprehensions

- Based on set notation:

$$S = \{ 2 \cdot x \mid x \in \mathbb{N}, x \leq 10 \}$$

- The equivalent in Haskell is:

```
[2*x | x <- 10]
```

- What does this give us?

```
[(a,b,c) | a<-[1..10],
           b<-[1..10],
           c<-[1..10],
           a^2 + b^2 == c^2 ]
```

A "tuple"

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## A Simple Function

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```
> let inc x = x + 1
> inc 5
6
> inc 'c'
```

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```
<interactive>:9:1:
  No instance for (Num Char)
  arising from a use of `inc'
  Possible fix: add an instance
  declaration for (Num Char)
  In the expression: inc 'c'
  In an equation for `it': it =
  inc 'c'
```

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```
> inc 2.5
3.5
```

Is this the  
behavior that  
we want?

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Adding a *type signature*.

```
inc :: Int -> Int
inc x = x + 1
```

Now we will get a  
compilation error  
on `inc 2.5`

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```
> inc (-5)
```

```
-4
```

Note the parens:  
inc -5  
would be a syntax  
error

Is *this* the behavior  
that we want?

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Using *pattern matching*.

```
inc :: Int -> Int
```

```
inc x | x < 0 =
```

```
    error "no negative nums"
```

```
inc x = x + 1
```

This is a *guard condition*

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Can't reassign variables in Haskell

*"If you say that a is 5, you can't say  
it's something else later because  
you just said it was 5.*

*What are you, some kind of liar?"*

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### Recursion

- Base case
  - tells us when to stop
- Recursive step
  - calls the function with a *smaller version* of the same problem

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### Recursive Example

```
addNums :: [Integer] -> Integer
addNums [] = 0
addNums (x:xs) = x + addNums xs
```

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### Lab: parts 1 & 2 (groups of 2-3)

Starter code:

<http://cs.sjsu.edu/~austin/cs252-spring16/labs/lab1/>. Implement:

1. maxNum
2. "fizzbuzz" game

```
> fizzbuzz 15
"1 2 fizz 4 buzz fizz 7 8
fizz buzz 11 fizz 13 14
fizzbuzz"
```

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## Types

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### Haskell Types

- `:t` type tells you the types for different values.
- `:t` is a shortcut.

```
Prelude>:t 'A'
```

```
'A' :: Char
```

'A' is a Char

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### What is the Type?

```
Prelude>:t "Hello"
```

```
"Hello" :: [Char]
```

"Hello" is an array of  
Chars (i.e. a String)

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## What is the Type?

```
Prelude>:t head
```

```
head :: [a] -> (a)
```

What is a?  
Is a a type?

a is a *type variable*;  
it stands in place of  
other types.

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## What is the Type?

```
Prelude>:t (==)
```

```
(==) :: Eq a => a -> a -> Bool
```

This symbol indicates  
that Eq is a typeclass

Eq a indicates that a  
may be any type,  
provided that it satisfies  
the expected behavior.  
(Think of Java interfaces)

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## Some Typeclasses

- **Eq** – Support equality testing
- **Ord** – Can be ordered
- **Show** – Representable as strings
- **Read** – Buildable from a string representation
- **Enum** – Sequentially ordered
- **Bounded** – Upper and lower bound

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JSON example  
(in class)

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Lab 1, part 3: JSON pretty printer

Download JSON.hs and  
jsonDriver.hs

In JSON.hs, implement the JObject  
case in toString

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HW1: implement a BigNum module

HW1 explores how you might support big  
numbers in Haskell if it did *not* support them.

- Use a list of 'blocks' of digits, least significant  
block first. So 9,073,201 is stored as:  
[201,73,9]
- Starter code is available on the course website.  
**NOTE: YOU MAY NOT CHANGE THE  
TYPE SIGNATURES.**

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