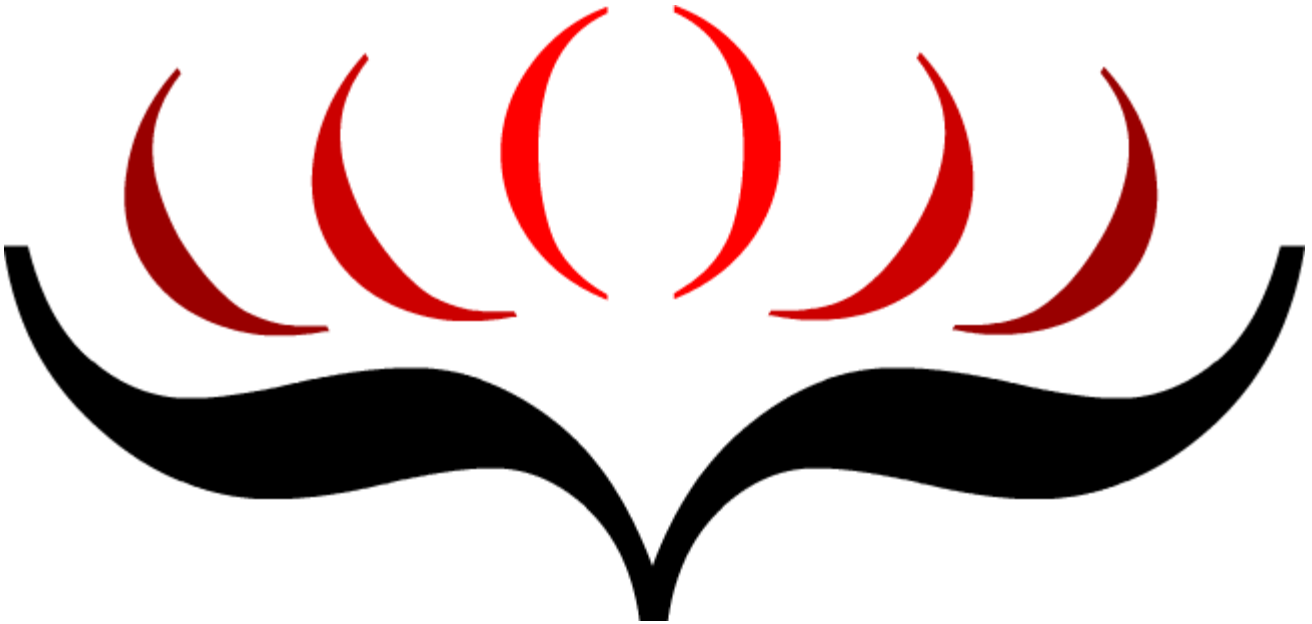
The first steps in Haskell



Vladimir Alekseichenko

Agenda

- Your Haskell environment
- Getting started with ghc*
- Basic types and definitions
- Types and functions
- A first Haskell program

The first steps…

http://cutebabystyles.com/?p=11

Your Haskell environment

Haskell is a language with many implementations, two of which are widely used:

- Hugs
- GHC

Hugs

Haskell User's Gofer System
Hugs

http://www.haskell.org/hugs/

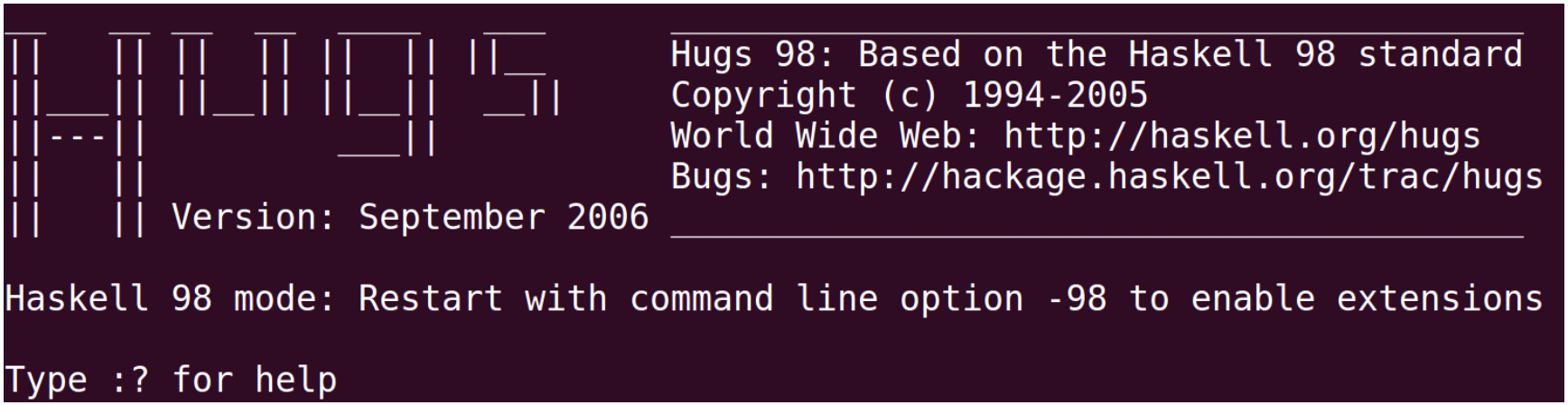
Hugs 98

It’s a functional programming system based on Haskell 98, the de facto standard for non-strict functional programming languages.

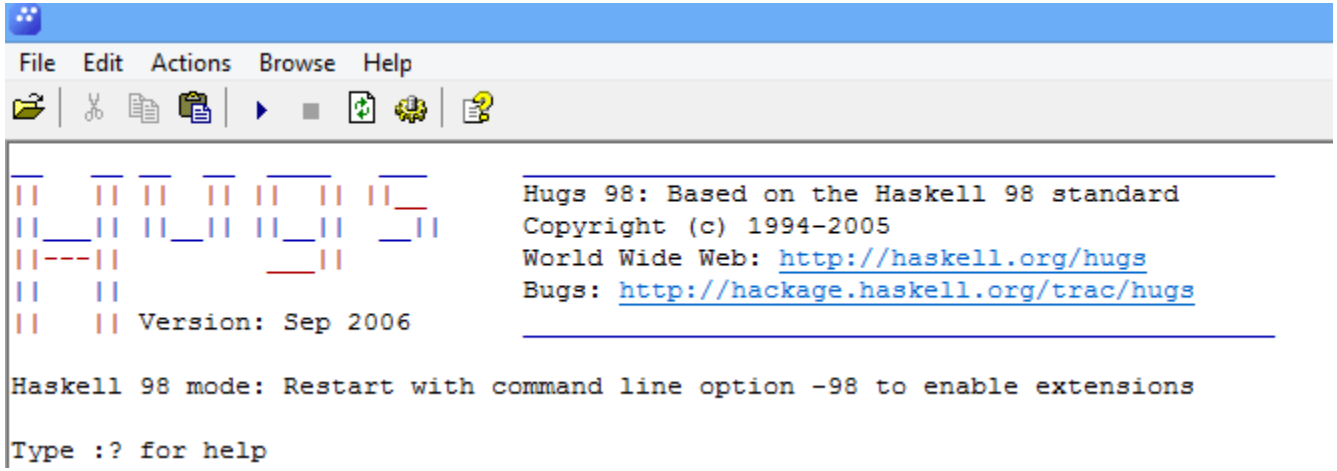
Hugs 98 provides an almost complete implementation of Haskell 98

http://www.haskell.org/hugs/

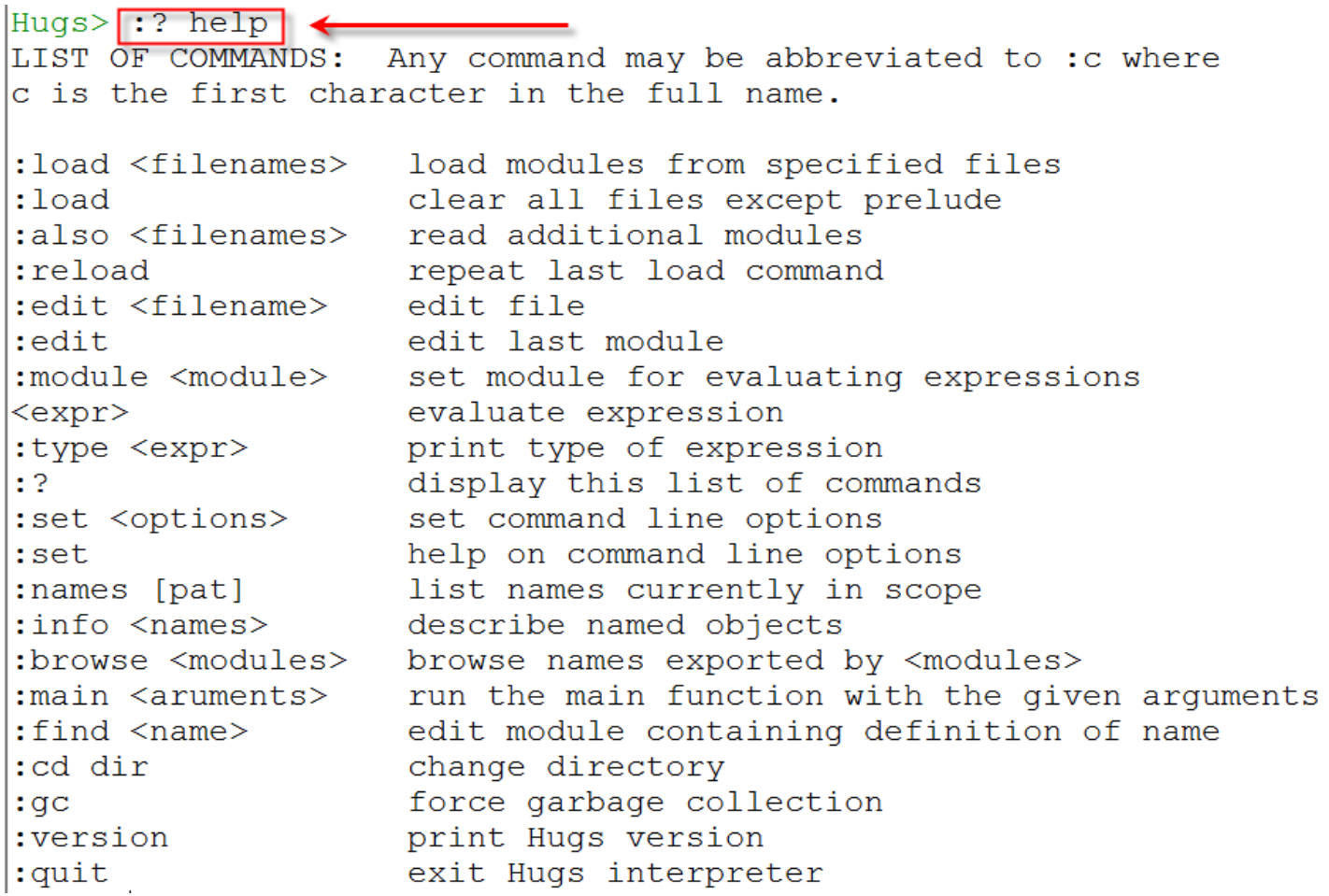
Hugs


Hugs 98: Based on the Haskell 98 standard
Copyright (c) 1994-2005
World Wide Web: http://haskell.org/hugs
Bugs: http://hackage.haskell.org/trac/hugs
Version: September 2006
Haskell 98 mode: Restart with command line option -98 to enable extensions
Type :? for help

WinHugs (0)


File Edit Actions Browse Help
Hugs 98: Based on the Haskell 98 standard
Copyright (c) 1994-2005
World Wide Web: http://haskell.org/hugs
Bugs: http://hackage.haskell.org/trac/hugs
Version: Sep 2006
Haskell 98 mode: Restart with command line option -98 to enable extensions
Type :? for help

WinHugs (1)


Hugs> :? help
LIST OF COMMANDS: Any command may be abbreviated to :c where
c is the first character in the full name.
:load <filenames> load modules from specified files
:load clear all files except prelude
:also <filenames> read additional modules
:reload repeat last load command
:edit <filename> edit file
:edit edit last module
:module <module> set module for evaluating expressions
<expr> evaluate expression
:type <expr> print type of expression
:? display this list of commands
:set <options> set command line options
:set help on command line options
:names [pat] list names currently in scope
:info <names> describe named objects
:browse <modules> browse names exported by <modules>
:main <aruments> run the main function with the given arguments
:find <name> edit module containing definition of name
:cd dir change directory
:gc force garbage collection
:version print Hugs version
:quit exit Hugs interpreter

WinHugs (2)

```
Hugs> 1
1
Hugs> :set +t
Hugs> 1
1 :: Integer
Hugs> :set -t
Hugs> 1
1
```

GHC

http://www.greydogsoftware.com/forum/showthread.php?p=1906885

The Glorious Glasgow Haskell Compilation System

It’s an open source native code compiler for the functional programming language Haskell.

More commonly known as the Glasgow Haskell Compiler or GHC.

http://en.wikipedia.org/wiki/Glasgow_Haskell_Compiler

GHC has three main components

- ghc - an optimizing compiler that generates fast native code.
- ghci - an interactive interpreter and debugger.
- runghc - a program for running Haskell programs as scripts, without needing to compile them first.

The Haskell Platform


Windows


Mac


Linux

Comprehensive

The Haskell Platform is the easiest way to get started with programming Haskell. It comes with all you need to get up and running. Think of it as "Haskell: batteries included". Learn more...

Robust

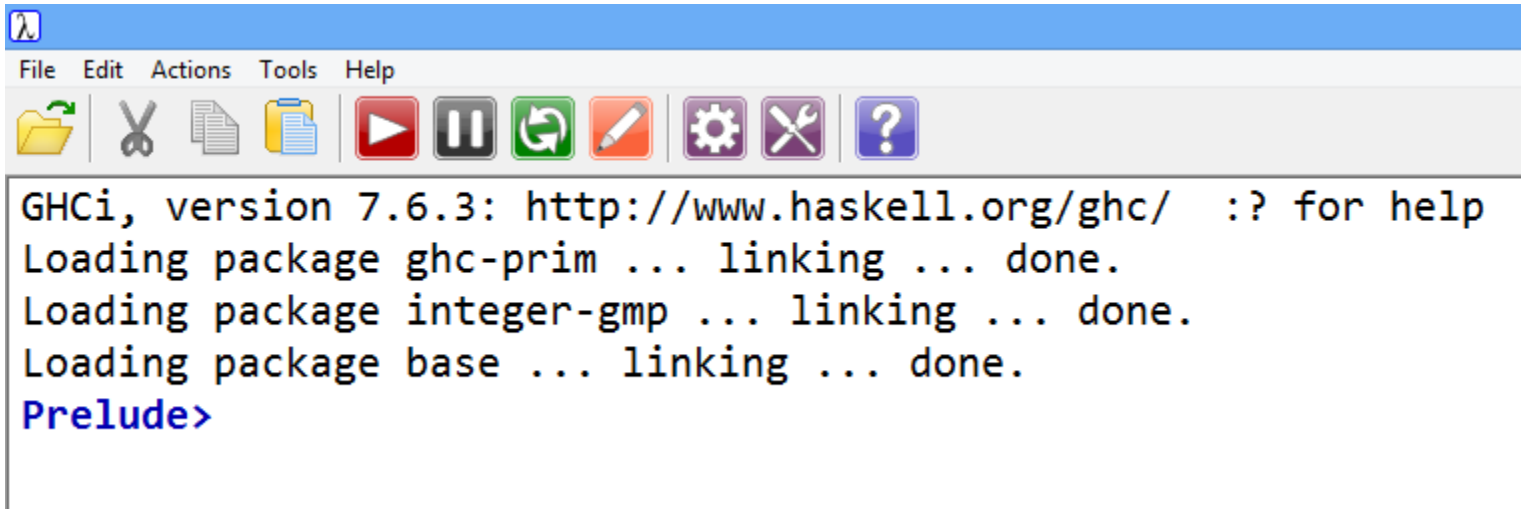
The Haskell Platform contains only stable and widely-used tools and libraries, drawn from a pool of thousands of Haskell packages, ensuring you get the best from what is on offer.

Cutting Edge

The Haskell Platform ships with advanced features such as multicore parallelism, thread sparks and transactional memory, along with many other technologies, to help you get work done.

http://www.haskell.org/platform/

WinGHCi (0)


File Edit Actions Tools Help
GHCi, version 7.6.3: http://www.haskell.org/ghc/ :? for help
Loading package ghc-prim ... linking ... done.
Loading package integer-gmp ... linking ... done.
Loading package base ... linking ... done.
Prelude>

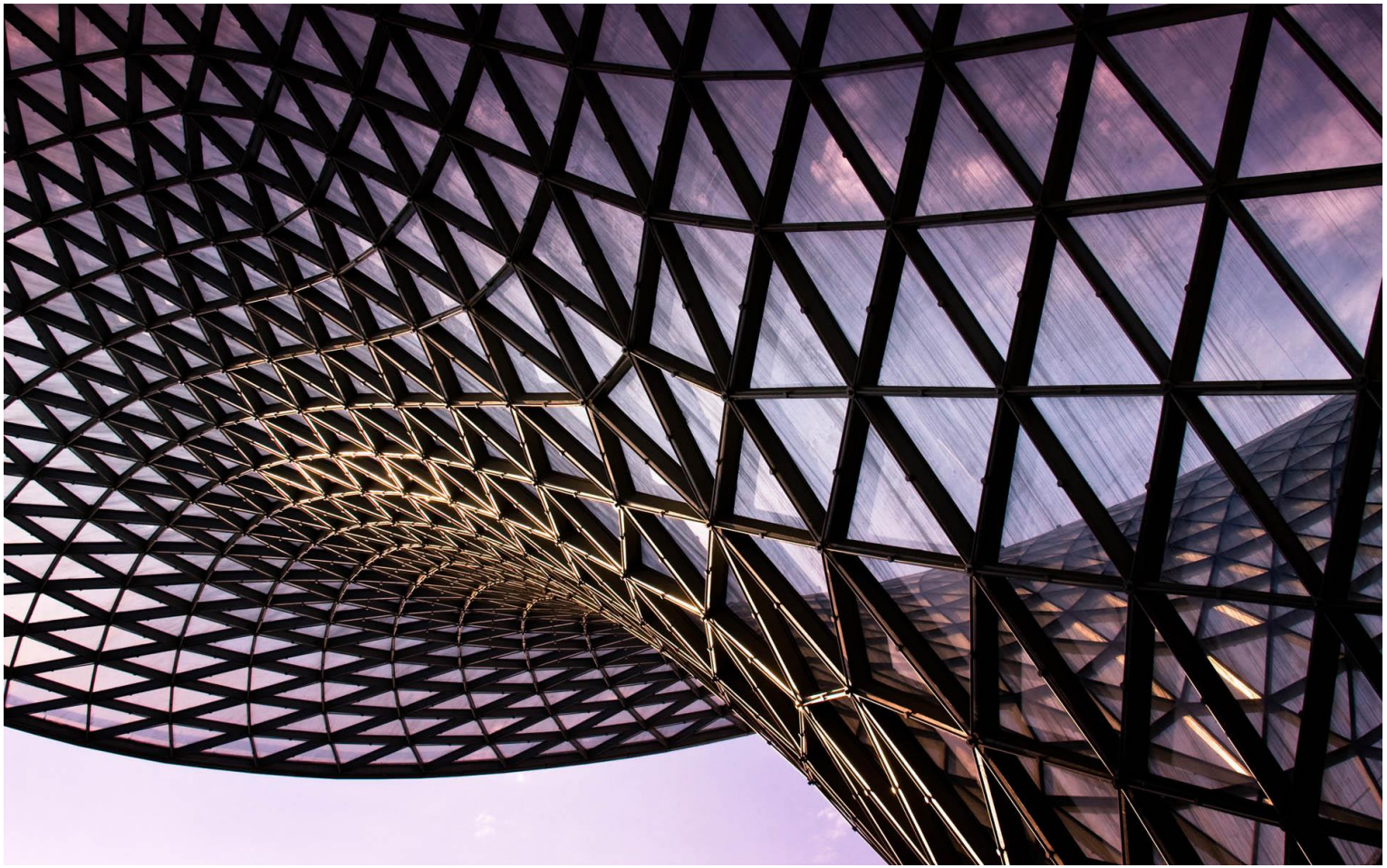
WinGHCi (1)

```
Prelude> :? help
 Commands available from the prompt:

   <statement>                 evaluate/run <statement>
   :                           repeat last command
   :{\n ..lines.. \n:}\n       multiline command
   :add [*]<module> ...        add module(s) to the current target set
   :browse[!] [[*]<mod>]       display the names defined by module <mod>
                               (!: more details; *: all top-level names)
   :cd <dir>                   change directory to <dir>
   :cmd <expr>                 run the commands returned by <expr>::IO String
   :ctags[!] [<file>]          create tags file for Vi (default: "tags")
                               (!: use regex instead of line number)
   :def <cmd> <expr>           define command :<cmd> (later defined command has
                               precedence, ::<cmd> is always a builtin command)
   :edit <file>                edit file
```

WinGHCi (2)

```
Prelude> :i Int
data Int = GHC.Types.I# GHC.Prim.Int#    -- Defined in `GHC.Types'
instance Bounded Int -- Defined in `GHC.Enum'
instance Enum Int -- Defined in `GHC.Enum'
instance Eq Int -- Defined in `GHC.Classes'
instance Integral Int -- Defined in `GHC.Real'
instance Num Int -- Defined in `GHC.Num'
instance Ord Int -- Defined in `GHC.Classes'
instance Read Int -- Defined in `GHC.Read'
instance Real Int -- Defined in `GHC.Real'
instance Show Int -- Defined in `GHC.Show'
```

The basic elements



http://www.tione.ru/photo/cities/konstrukcija_iz_metala_i_stekla/29-0-1607

Lists

- []
- [1, 2, 3]
- 1 : [2, 3]
- 1 : (2: (3 : []))
- [1..n]
- [2, 4..20]

Bad lists

- 1 : „two” : []
- [1::Int, 1::Integer]
- [1, 2, „third”]
- [1, 5, 9..100]
- [1,2..10,20..100]
- [(1, ‚a’), (‚b’, 2)]
- [[1, 2, 3], [‚a’, ‚b’, ‚c’]]

Tuples

- (1,2)
- (1,2,3)
- …
- (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15)
- („a”, 1)
- („a”, [], [„a”, „b”], 1)
- ((1, 2), (‚a’, ‚b’, ‚c’), ([1], [2]))

Bad tuples

- (1) – it’s not tuple
- (1, (2)) - it’s not tuple
- (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16)

Types of lists

- [Int]
- [Integer]
- [Char]
- [(Integer, Char)]
- [[Integer]]

Types of lists

```
Prelude> [1, 2, 3]::[Int]
[1,2,3]
it :: [Int]
Prelude> [1, 2, 3]
[1,2,3]
it :: [Integer]
Prelude> ['a', 'b', 'c']
"abc"
it :: [Char]
Prelude> [(1, 'a')]
[(1,'a')]
it :: [(Integer, Char)]
Prelude> [[], [1], [1..4]]
[[],[1],[1,2,3,4]]
it :: [[Integer]]
```

Types of tuples

- (Integer, Integer)
- (Char, Integer)
- (Char, [Integer])
- (Char, (Integer, Integer), [[Integer]])

Types of tuples

```
Prelude> (1, 2)
(1,2)
it :: (Integer, Integer)
Prelude> ('a', 56)
('a',56)
it :: (Char, Integer)
Prelude> ('a', [1, 2, 3])
('a',[1,2,3])
it :: (Char, [Integer])
Prelude> ('a', (5, 7, 9), [[], [1], [1..3]])
('a',(5,7,9),[[],[1],[1,2,3]])
it :: (Char, (Integer, Integer, Integer), [[Integer]])
```

Type

Every expression and function in Haskell has a *type*.

For example, the value True has the type Bool, while the value "foo" has the type String.

Some common basic **types**

- Char
- Bool
- Int
- Integer
- Double

Some common basic **types**

```
Prelude> :type 'a'
'a' :: Char
Prelude> :t True
True :: Bool
Prelude> :set +t
Prelude> 1.1
1.1
it :: Double
```

New types

We've seen two ways to introduce new types:

- **data**
- **type**

Type synonyms

Creates an alias for an existing type, with no overhead.

Type synonyms

```haskell
module Distance where

type Coord   = (Double, Double)
type Pair a  = (a, a)
type Complex = Pair Double

distance :: Coord -> Coord -> Double
distance (x0, y0) (x1, y1) = sqrt( (x1-x0)^2 + (y1-y0)^2)
```

Both **Coord** and **Complex** are **(Double, Double)**!

Distance

```
Prelude> :l "Distance.hs"
[1 of 1] Compiling Distance         ( Distance.hs, interpreted )
Ok, modules loaded: Distance.
*Distance> distance (1.0, 2.0) (2.0, 3.0)
1.4142135623730951
it :: Double
```

Data.String

```
type String = [Char]
```

```
Prelude> :t ""
"" :: [Char]
Prelude> ['a', 'b', 'c'] == "abc"
True
it :: Bool
```

Data types

Creates a new (boxed) type, adding overhead of a Val wrapper.

MagicType

```haskell
module MagicType where

data MagicType = AbraKadabra Int Int Int | SimSalabim Int Int

magicFun :: MagicType -> Int
magicFun (AbraKadabra a b c) = a + b + c
magicFun (SimSalabim a b) = a + b
```

MagicType

```
Prelude> :l "MagicType.hs"
[1 of 1] Compiling MagicType        ( MagicType.hs, interpreted )
Ok, modules loaded: MagicType.
*MagicType> magicFun (AbraKadabra 1 2 3)
6
it :: Int
*MagicType> magicFun (SimSalabim 1 2)
3
it :: Int
```

Distance (0)

```haskell
module Distance where

data Coord    = Coord Double Double
data Pair a   = Couple a a
data Complex = Pair Double

distance :: Coord -> Coord -> Double
distance (Coord x0 y0) (Coord x1 y1) = sqrt( (x1-x0)^2 + (y1-y0)^2)
```

Distance (1)

```
*Distance> :l "Distance.hs"
[1 of 1] Compiling Distance         ( Distance.hs, interpreted )
Ok, modules loaded: Distance.
*Distance> distance (Coord 1.0 2.0) (Coord 2.0 3.0)
1.4142135623730951
it :: Double
*Distance> distance (Complex 1.0 2.0) (Complex 2.0 3.0)

<interactive>:246:11:
    Not in scope: data constructor `Complex'
    Perhaps you meant `Couple' (line 4)

<interactive>:246:29:
    Not in scope: data constructor `Complex'
    Perhaps you meant `Couple' (line 4)
```

Date (0)

```haskell
module Date where

data Date = Date Year Month Day

data Year = Year Int

data Month = January | February | March | April
           | May | June | July | August
           | September | October | November | December

```

Date (1)

```
11 data Day = Day Int
12
13 data Week = Monday | Tuesday | Wednesday
14           | Thursday | Friday | Saturday
15           | Sunday
16
17 data Time = Time Hour Minute Second
18 data Hour = Hour Int
19 data Minute = Minute Int
20 data Second = Second Int
```

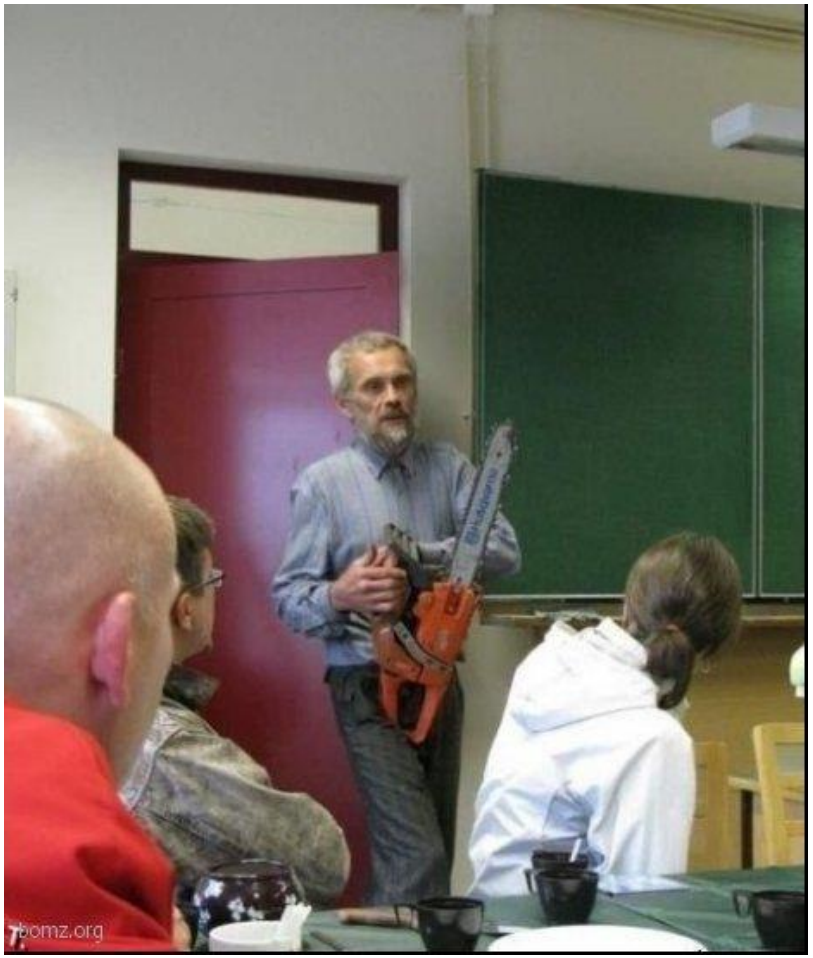
Weekend

```
22 weekend :: Week -> Bool
23 weekend Saturday = True
24 weekend Sunday   = True
25 weekend _        = False
```

Weekend

```
*Date> :l "Date.hs"
[1 of 1] Compiling Date                ( Date.hs, interpreted )
Ok, modules loaded: Date.
*Date> weekend Monday
False
it :: Bool
*Date> weekend Sunday
True
it :: Bool
*Date> weekend Saturday
True
it :: Bool
```

Write first program



http://bomz.org/demotivators/demotivation.php?demotivator=15068

Types of programs

Haskell programs are of two types:

- executable
- library

Five rules

1. The program consists of modules.
2. One module - one single file.
3. The module name is the file name.
4. The module name begins with a capital letter.
5. File has the extension **.hs**.

Notepad

```
Prelude Fibonacci> :edit "Fibonacci.hs"
```

http://en.wikipedia.org/wiki/File:Notepad.png

Notepad++

http://www.reviversoft.com/blog/2013/04/text-editin-showdown/

Change the WinGHCi editor

```
Prelude Fibonacci> :set editor "C:\\Program Files (x86)\Notepad++\notepad++.exe"
Prelude Fibonacci> :e " Fibonacci.hs"
'C:\\Program' is not recognized as an internal or external command,
operable program or batch file.
Prelude Fibonacci> :set editor "C:\\"Program Files (x86)"\Notepad++\notepad++.exe"
Prelude Fibonacci> :e " Fibonacci.hs"
Ok, modules loaded: Fibonacci.
```

Fibonacci number

In mathematical terms, the sequence Fn of Fibonacci numbers is defined by the recurrence relations:

$$F_n = F_{n-1} + F_{n-2},$$

with seed values:

$$F_0 = 0,\ F_1 = 1.$$

http://en.wikipedia.org/wiki/Fibonacci_number

Fibonacci numer (0)

```
1 module Fibonacci where
2
3 fibonacci   :: Integer -> Integer
4
5 fibonacci 0 = 0
6 fibonacci 1 = 1
7 fibonacci n = fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (0)

```
1  module Fibonacci where
2
3  fibonacci    :: Integer -> Integer
4
5  fibonacci 0 = 0
6  fibonacci 1 = 1
7  fibonacci n = fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (1)

```haskell
module Fibonacci where

fibonacci   :: Integer -> Integer
fibonacci n = case n of
                0 -> 0
                1 -> 1
                _ -> fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (1)

```haskell
module Fibonacci where

fibonacci   :: Integer -> Integer
fibonacci n = case n of
                0 -> 0
                1 -> 1
                _ -> fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (2)

```haskell
module Fibonacci where

fibonacci    :: Integer -> Integer

fibonacci n | n == 0 = 0
            | n == 1 = 1
            | n > 1  = fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (2)

```
1  module Fibonacci where
2
3  fibonacci     :: Integer -> Integer
4
5  fibonacci n | n == 0 = 0
6              | n == 1 = 1
7              | n > 1  = fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (3)

```haskell
module Fibonacci where

fibonacci   :: Integer -> Integer

fibonacci n =
    if n == 0
        then 0
        else if n == 1
            then 1
            else fibonacci(n-1) + fibonacci(n-2)
```

Fibonacci numer (3)

```
1  module Fibonacci where
2
3  fibonacci    :: Integer -> Integer
4
5  fibonacci n =
6      if n == 0
7          then 0
8          else if n == 1
9              then 1
10             else fibonacci(n-1) + fibonacci(n-2)
```

Loading source files

```
Prelude> :cd D:\src\haskell
Prelude> :load "Fibonacci.hs"
[1 of 1] Compiling Fibonacci         ( Fibonacci.hs, interpreted )
Ok, modules loaded: Fibonacci.
*Fibonacci>
```

Running the program

```
Prelude> :l "Fibonacci.hs"
[1 of 1] Compiling Fibonacci         ( Fibonacci.hs, interpreted )
Ok, modules loaded: Fibonacci.
*Fibonacci> fibonacci 10
55
it :: Integer
```

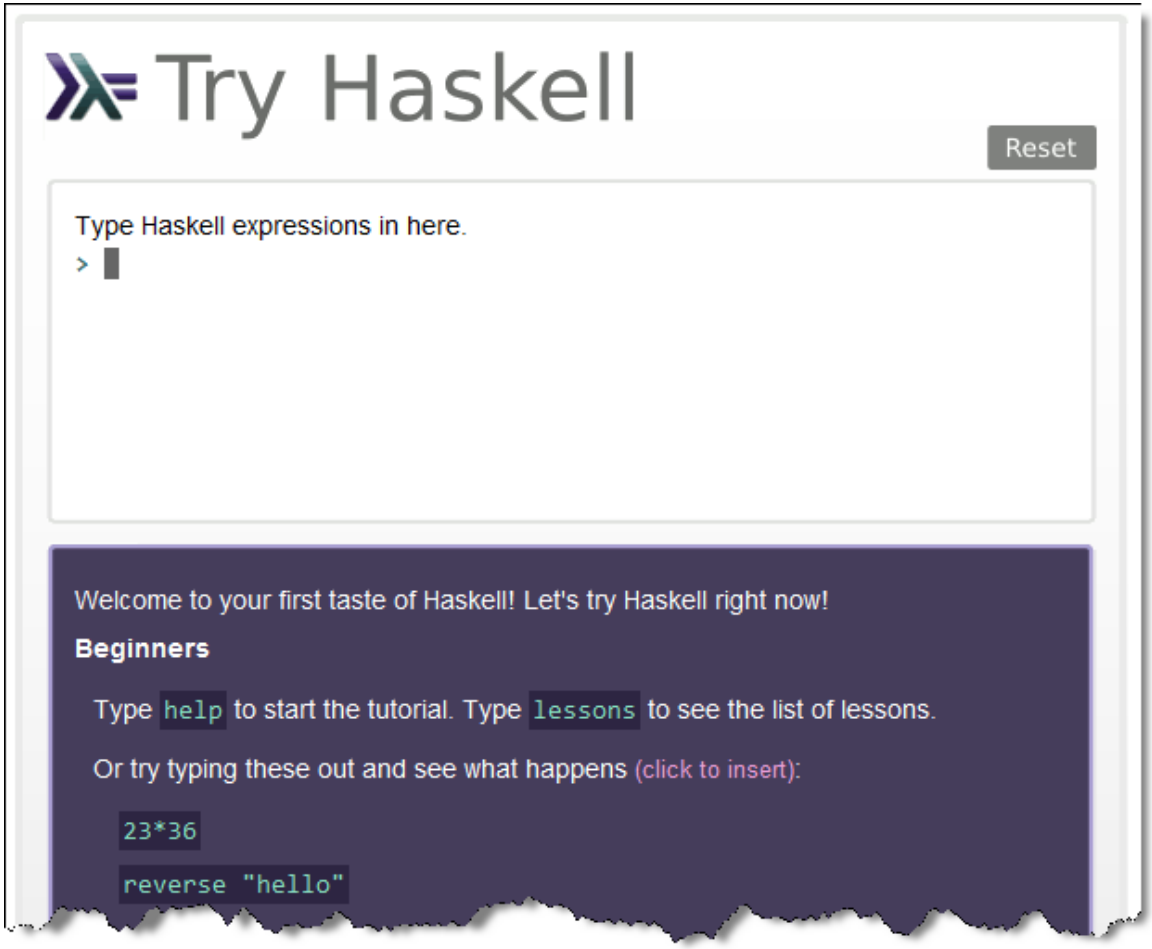
Working with lists

```
head          :: [a] -> a
head (x:_)    = x
head []       = error "head: empty list"

tail          :: [a] -> [a]
tail (x:xs)   = xs
tail []       = error "tail : empty list"

length        :: [a] -> Int
length (x:xs)= 1 + length xs
length []     = 0

null          :: [a] -> Bool
null []       = True
null _        = False
```

Working with lists

```
Prelude> head [1, 2, 3]
1
it :: Integer
Prelude> tail [1, 2, 3]
[2,3]
it :: [Integer]
Prelude> length [1, 2, 3]
3
it :: Int
Prelude> null [1, 2, 3]
False
it :: Bool
```

TryHaskell.org



Books

- **Real World Haskell** by *Bryan O'Sullivan, Don Stewart, John Goerzen.*
- **Learn You a Haskell for Great Good!** by *Miran Lipovača.*
- **Haskell: The Craft of Functional Programming** by *Simon Thompson*.