Functional Programming Concept with

Tutorial for

Programming Languages Laboratory (CS 431)

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Prelude

- Programming paradigms – broadly two types
  - Imperative
  - Declarative
- Imperative
  - Uses statements to change system state
  - Main concern – HOW to do things
- Declarative
  - Main concern – WHAT to do, not HOW to do things

Prelude

- Declarative paradigm
  - Logic programming – we have already seen it (Prolog); centered on RELATIONS
  - Functional programming – going to discuss in this tutorial

Functional Programming

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism
- Characterized by the absence of "side effects"
  - Doesn't rely on data outside the current function, and doesn't change data that exists outside the current function

Non-functional

```
a = 0
def increment():
    global a
     a += 1
```

Functional

```
def increment(a):
return a + 1
```

Functional Programming

- Languages that follow functional programming paradigm
  - Haskell
  - LISP
  - Python
  - Erlang
  - Racket
  - F#
  - Clojure

Functional Programming

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we are going with Haskell this time

Haskell

- Standardized purely functional programming language
- Named after logician and mathematician Haskell Brooks Curry
- History
  - First version ("Haskell 1.0") was introduced in 1990
  - The latest standard of Haskell is "Haskell 2010"
- Applications example
  - Darcs is a revision control system written in Haskell, with several innovative features, such as more precise control of the patches to be applied
  - Xmonad is a window manager for the X Window System, written fully in Haskell
  - Facebook implements its anti-spam programs in Haskell, as open-source software

Haskell - Features

- Statically typed
- Purely functional
- Type inference
- Lazy
- Concurrent
- Packages

Haskell - Features

- Statically typed
  - Every expression in Haskell has a type which is determined at compile time
  - The compiler knows which piece of code is a number, which is a string and so on, a lot of possible errors are caught at compile time
  - All the types composed together by function application have to match up. If they don't, the program will be rejected by the compiler
  - Types become not only a form of guarantee, but a language for expressing the construction of programs

Haskell - Features

- Purely functional
  - Every function in Haskell is a function in the mathematical sense (i.e., "pure")
  - Even side-effecting IO operations are but a description of what to do, produced by pure code
  - There are no statements or instructions, only expressions which cannot mutate variables (local or global) nor access state like time or random numbers

Haskell - Features

- Type inference
  - You don't have to explicitly label every piece of code with a type because the type system can intelligently figure out a lot about it; if you say a = 5 + 4, you don't have to tell Haskell that a is a number
  - However, you can write out types if you choose, or ask the compiler to write them for you for handy documentation

Haskell - Features

- Lazy
  - Unless specifically told otherwise, Haskell won't execute functions and calculate things until it's really forced to show you a result
  - That goes well with referential transparency and it allows you to think of programs as a series of *transformations on data*

Haskell - Features

- Concurrent
  - Haskell lends itself well to concurrent programming due to its explicit handling of effects
  - Its flagship compiler, GHC, comes with a high-performance parallel garbage collector and light-weight concurrency library containing a number of useful concurrency primitives and abstractions

Haskell - Features

- Packages
  - Open source contribution to Haskell is very active with a wide range of packages available on the public package servers
  - There are 6,954 packages freely available; for instances

bytestring	Binary data	base	Prelude, IO, threads
network	Networking	text	Unicode text
parsec	Parser library	directory	File/directory
hspec	RSpec-like tests	attoparsec	Fast parser
monad-logger	Logging	persistent	Database ORM
template-haskell	Meta-programming	tar	Tar archives

Lets Start

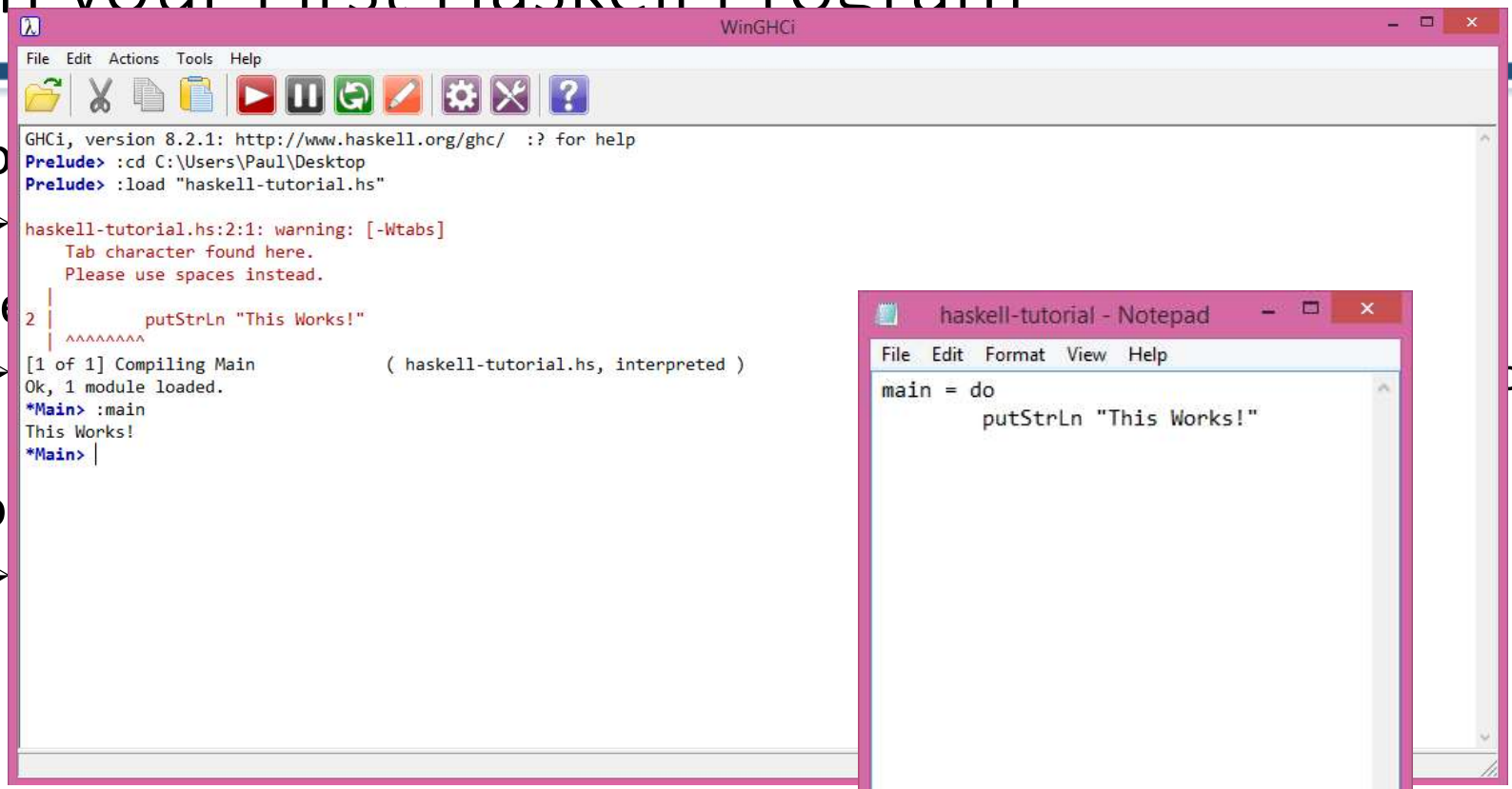
Lets try to understand basic features of Haskell with examples

Run your First Haskell Program

- Download and Install Haskell
  - Download link https://www.haskell.org/downloads
- File extension .hs
  - Open text editor, write your program, save your program with .hs extension (e.g., haskell-tutorail.hs)
- Compilation and Run
  - For Windows OS
    - Open WinGHCi from start menu
    - Load your program (File -> Load..)
    - Run the function you want

Run your First Haskell Program

- Do
  -
- File
  -
- Co
  -



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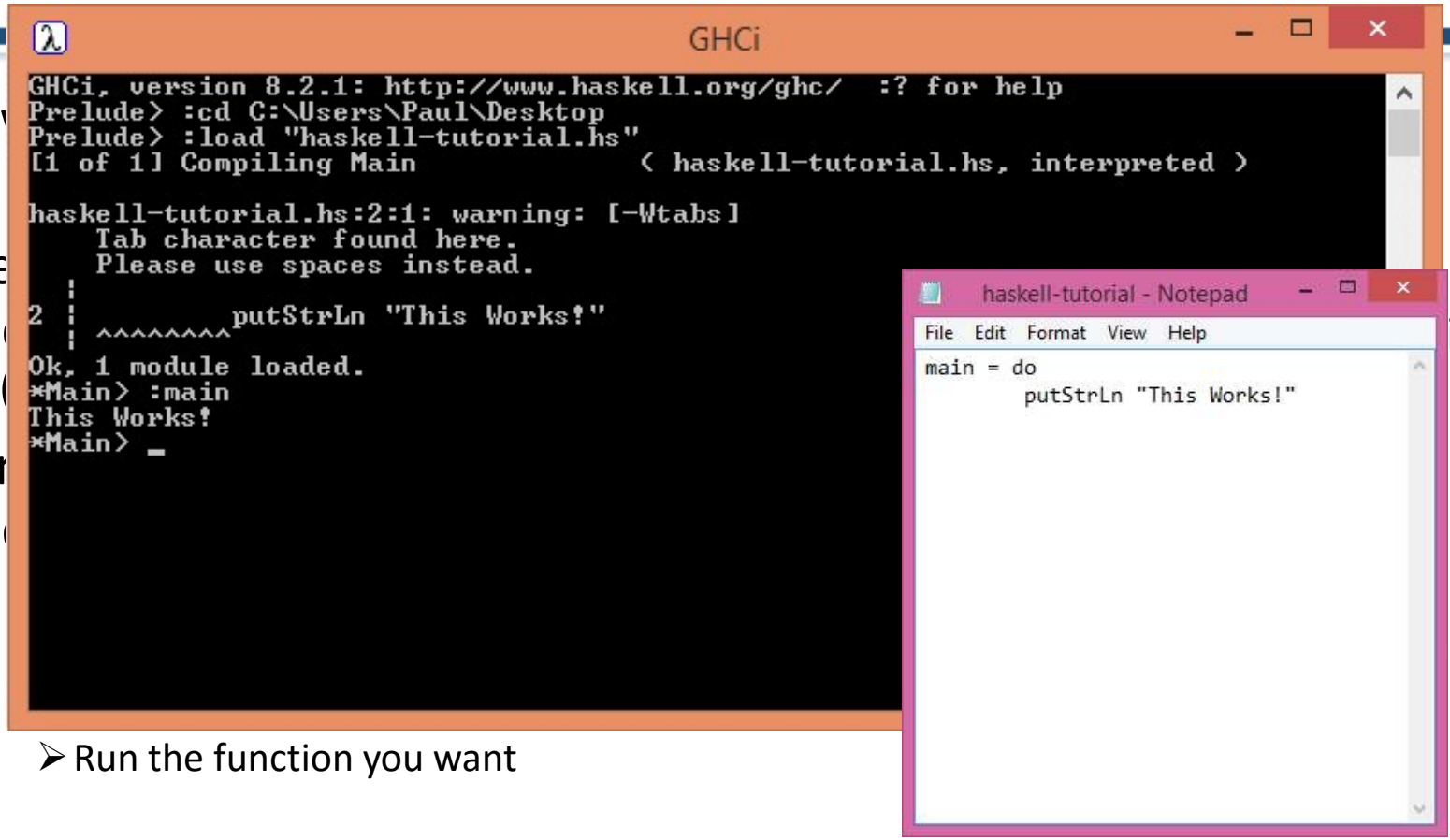
- Compilation and Run
  - Otherwise
    - Open GHCi
    - Enter into directory where you saved your program (:cd C:\Users\Paul\Desktop)
    - Load your program (:load "haskell-tutorial.hs")
    - Run the function you want

Run your First Haskell Program



- Do
  -
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ion

p)

- Run the function you want

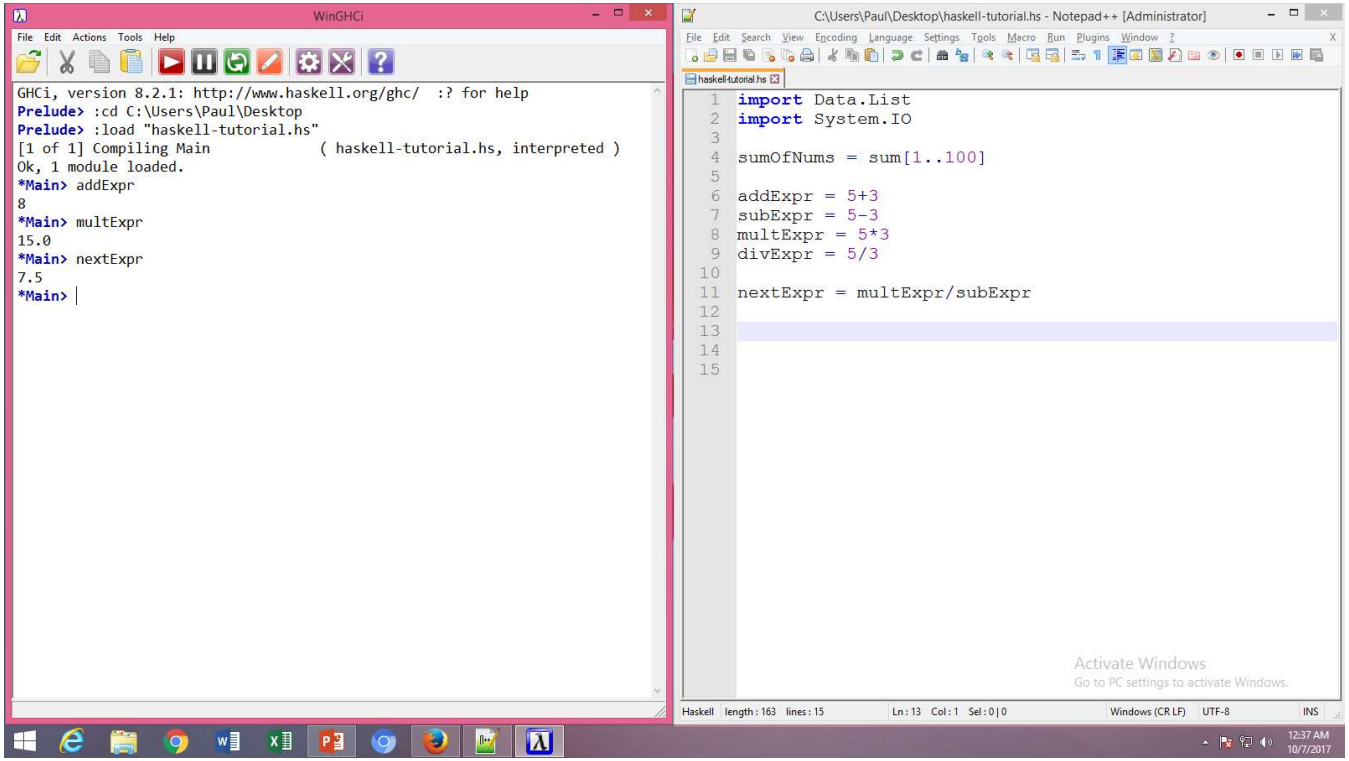
Few things you may keep in mind

- Once you modify your program
  - Save it
  - Before running its function, recompile it - reload (*main> :r)
- Comment Line
  - --Comment
  - {-
    Multiple Comments
    -}
- Clear Screen
  - Ctrl+S

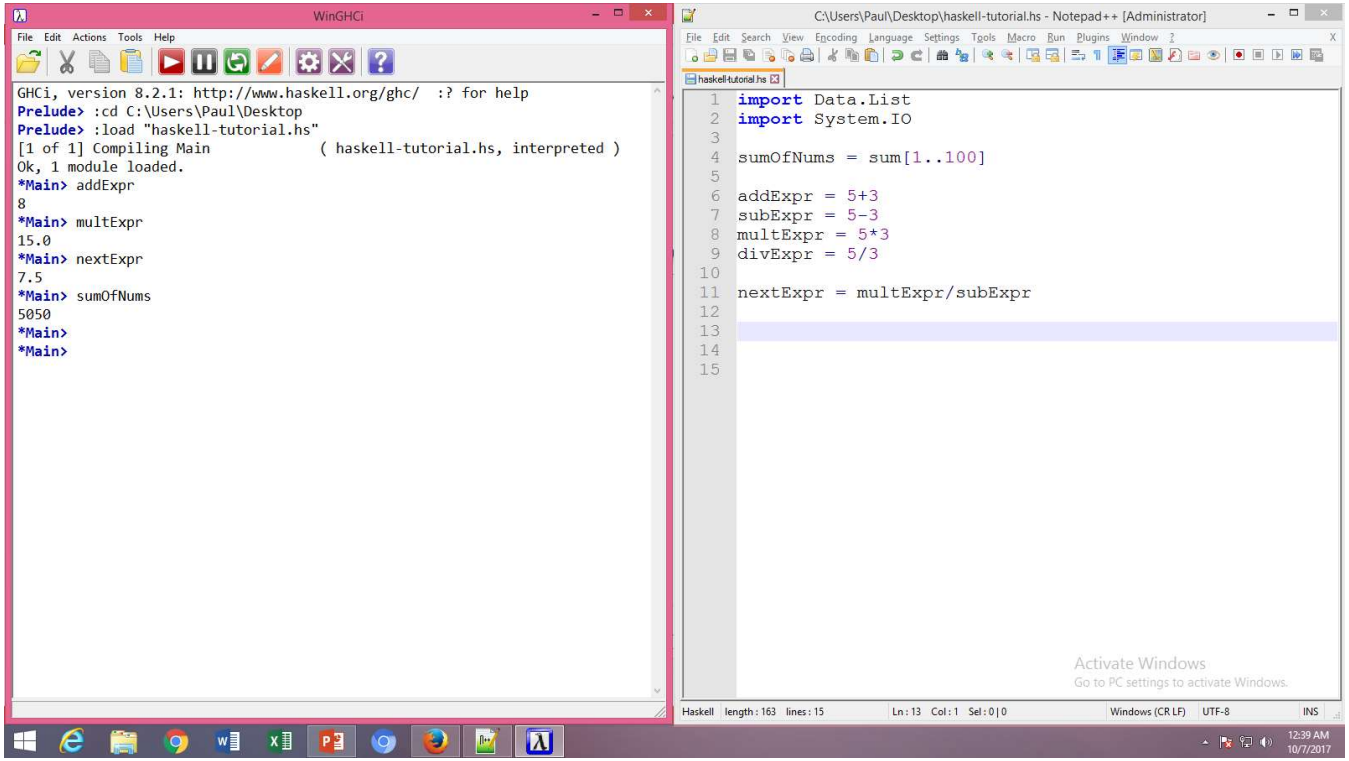
Date Types

- Haskell uses type inference
  - Range of 'Int': -2^63 to 2^63
  - Range of 'Integer': Unbound -- as per the capability of memory of the system
  - Other data types: Double, Bool, Char, Tuple -- will be discussing with example
  - always: always5 :: Int
  - always5 = 5 --Never Change

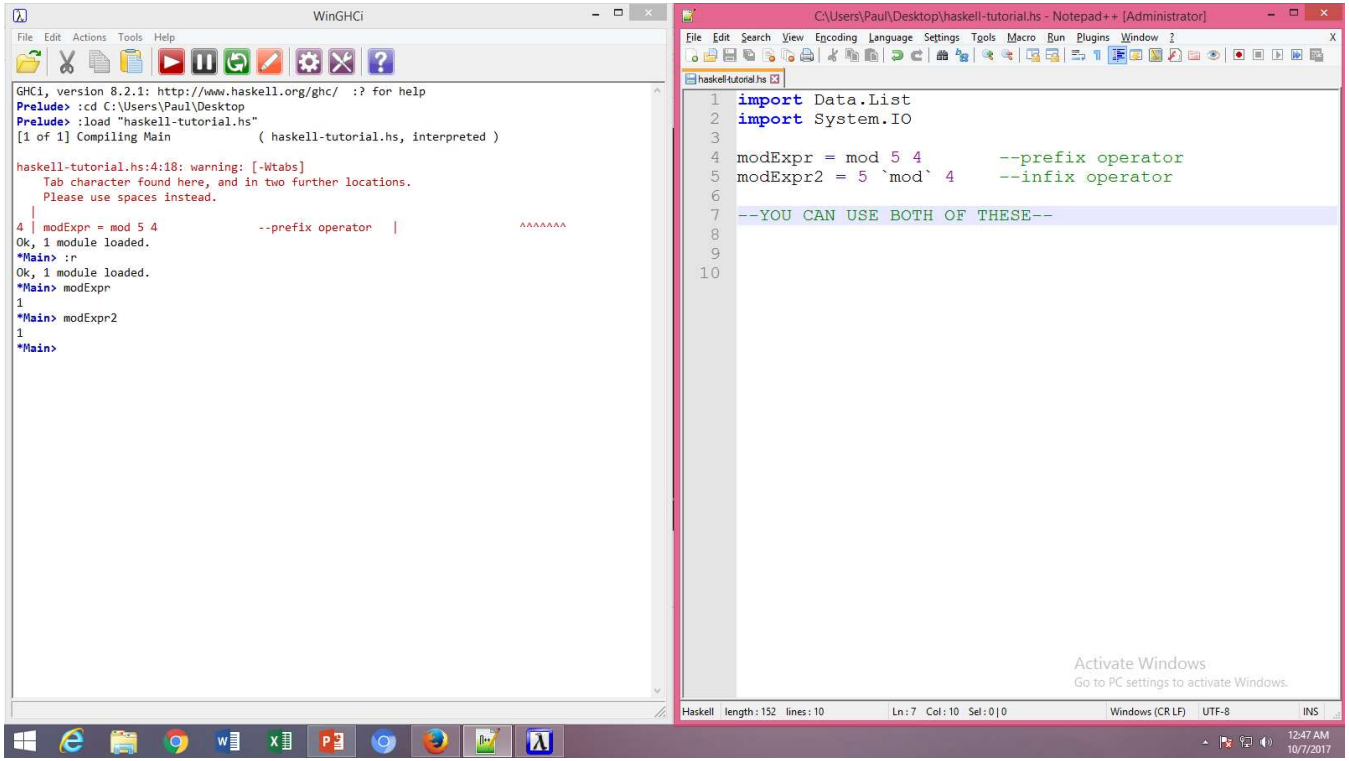
Expressions



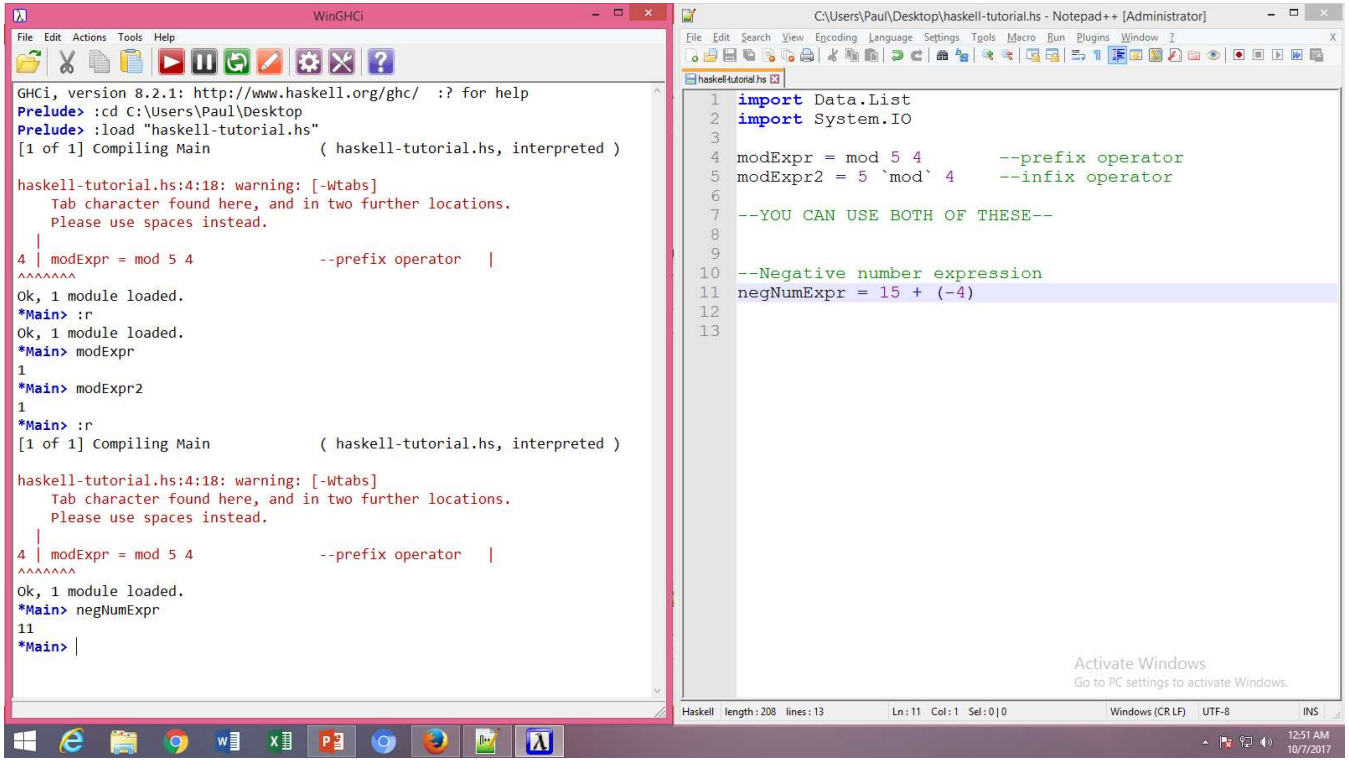
Expressions



Infix and Prefix Operator



Negative Number Expression

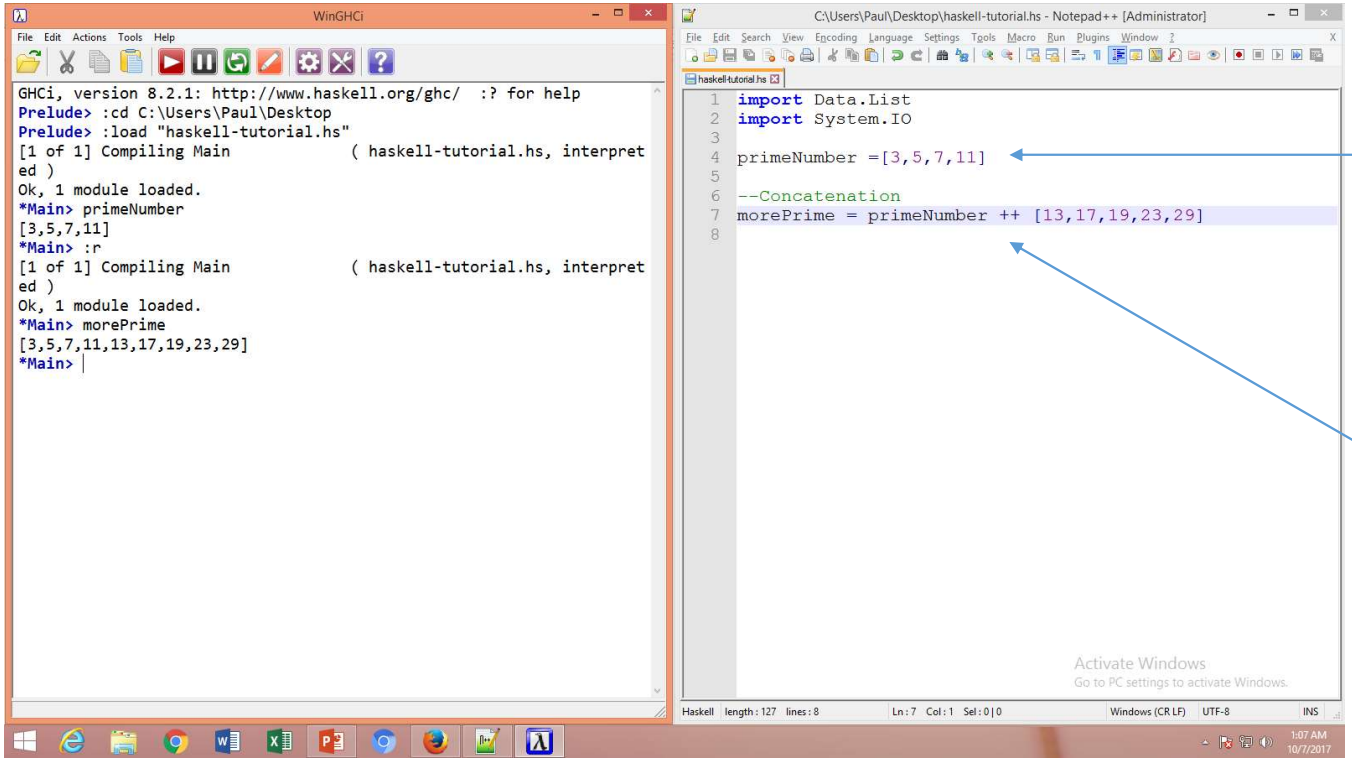


Other built-in Math Function

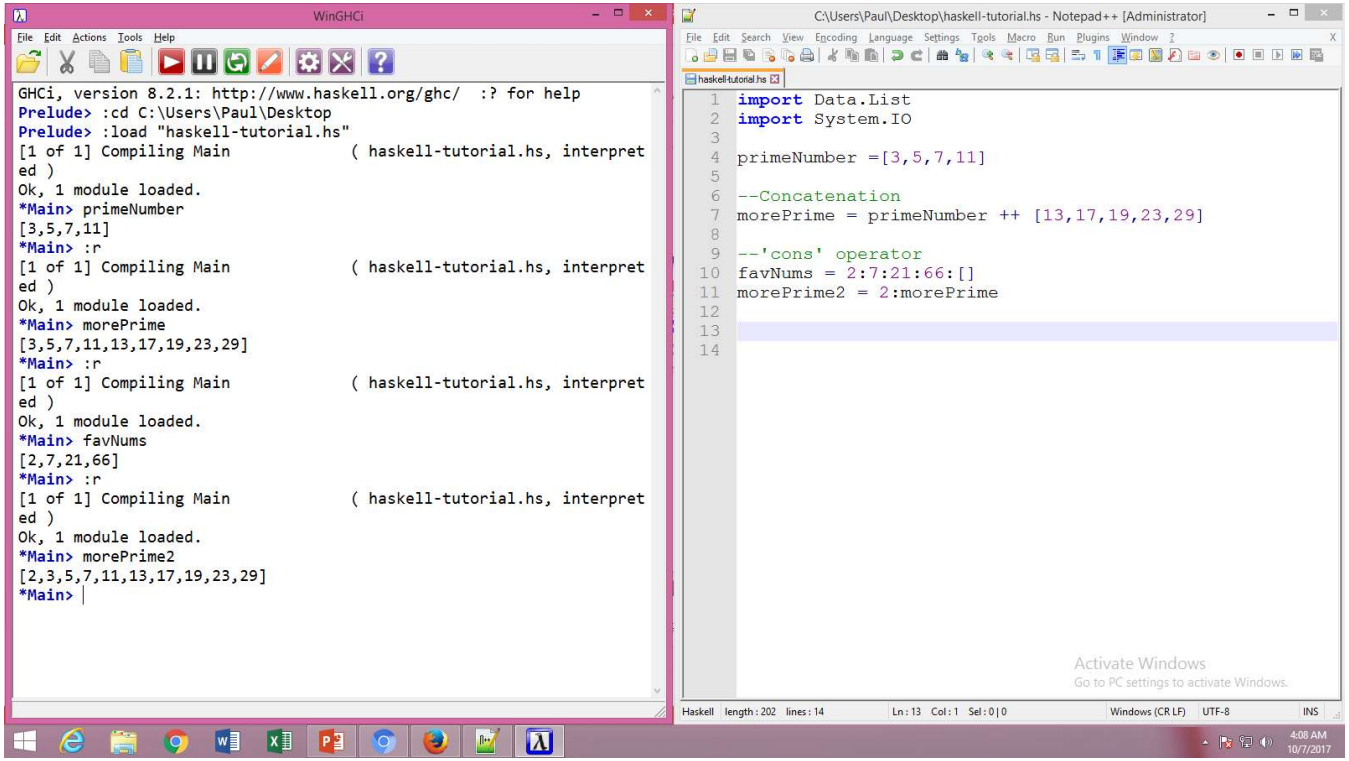
- piVal = pi
- ePow9 = exp 9
- logOf9 = log 9
- Squared9 = 9 ** 2
- truncateVal = truncate 9.999
- roundVal = round 9.999
- ceilingVal = ceiling 9.999
- floorVal = floor 9.999
- Also
  - sin, cos, tan, asign, acos, atan, signh, cosh, tanh, asignh, acosh, atanh

EXPLORE THESE

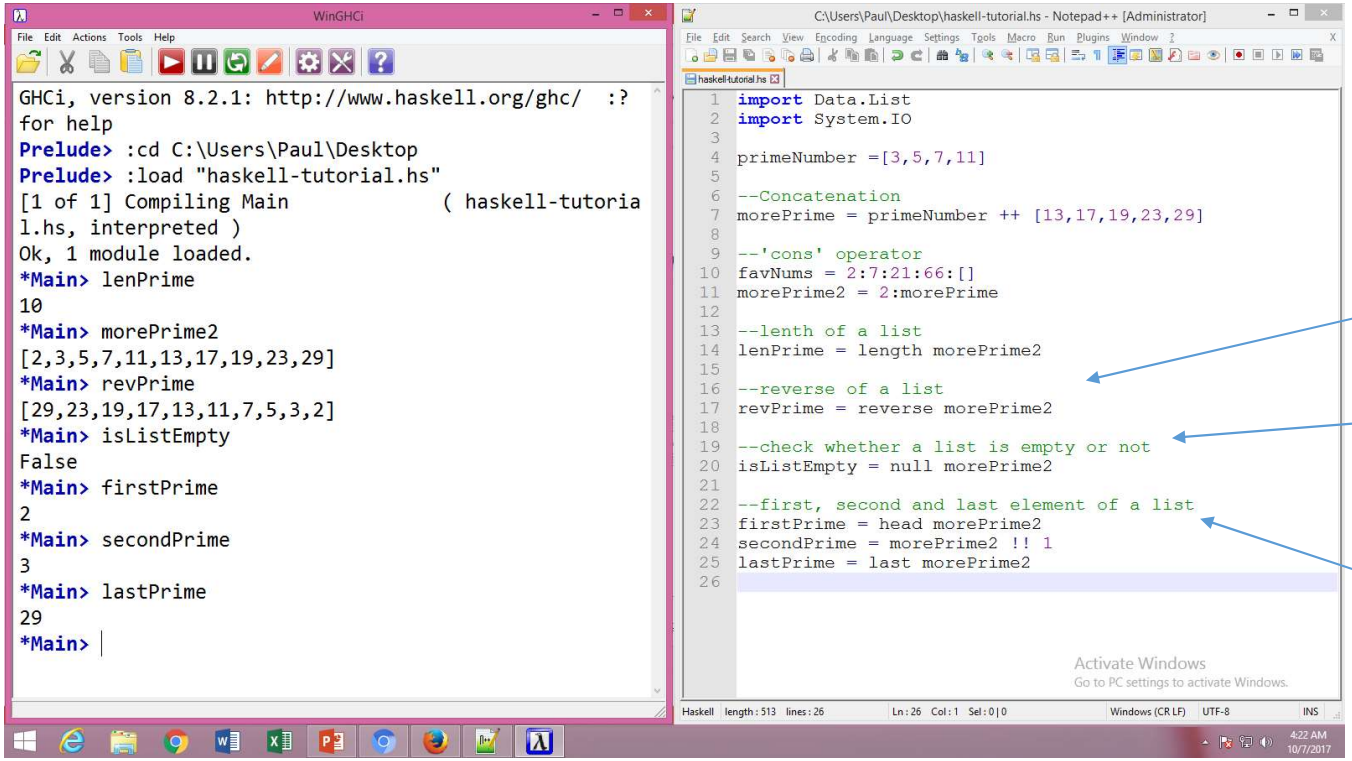
List - Concatenation



List – ‘cons’ operator



More Operations on List



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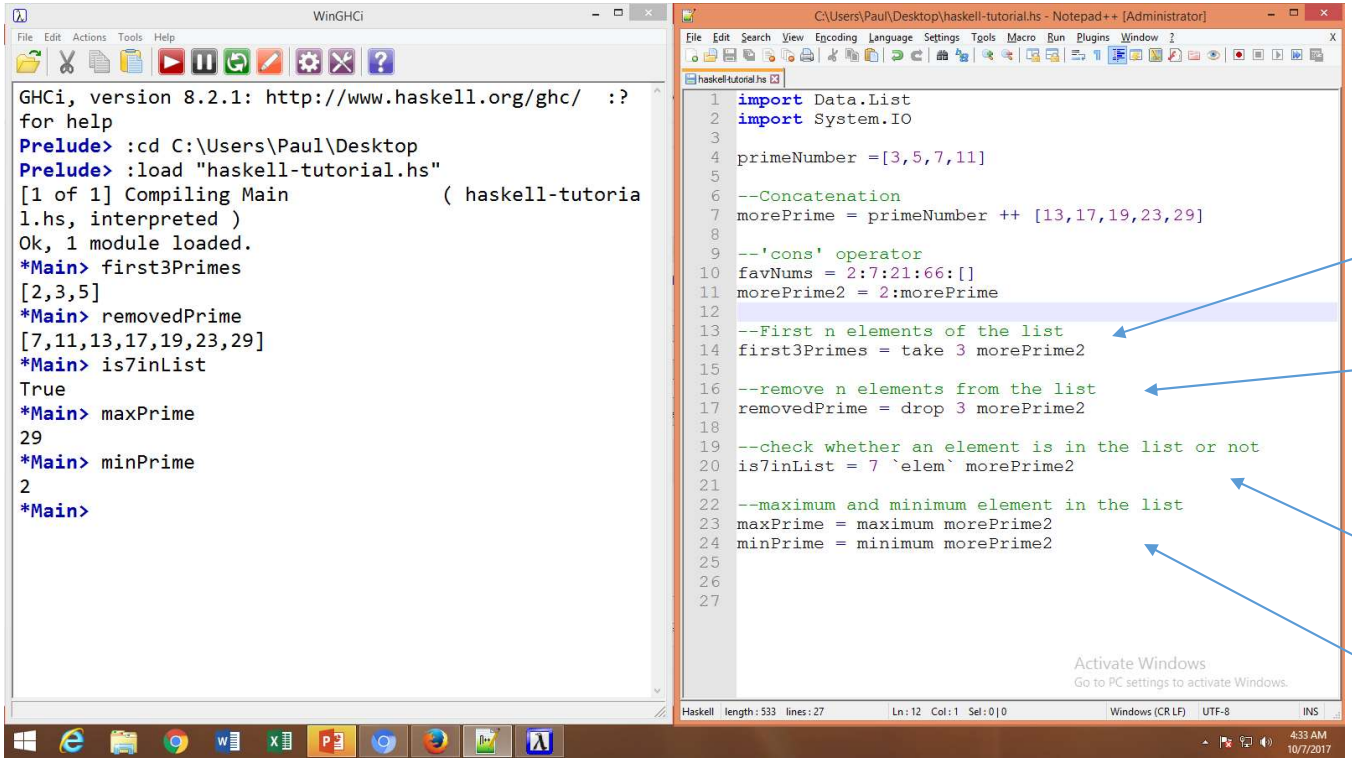

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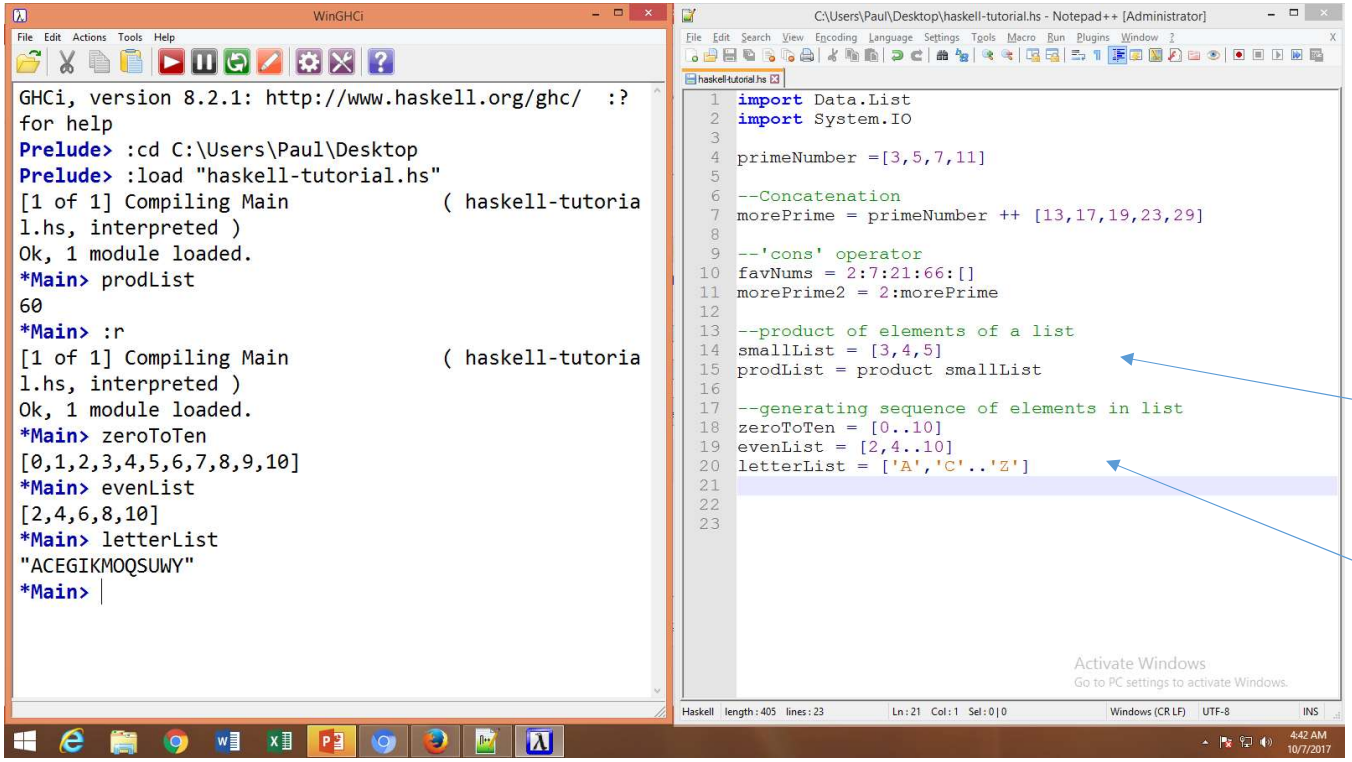

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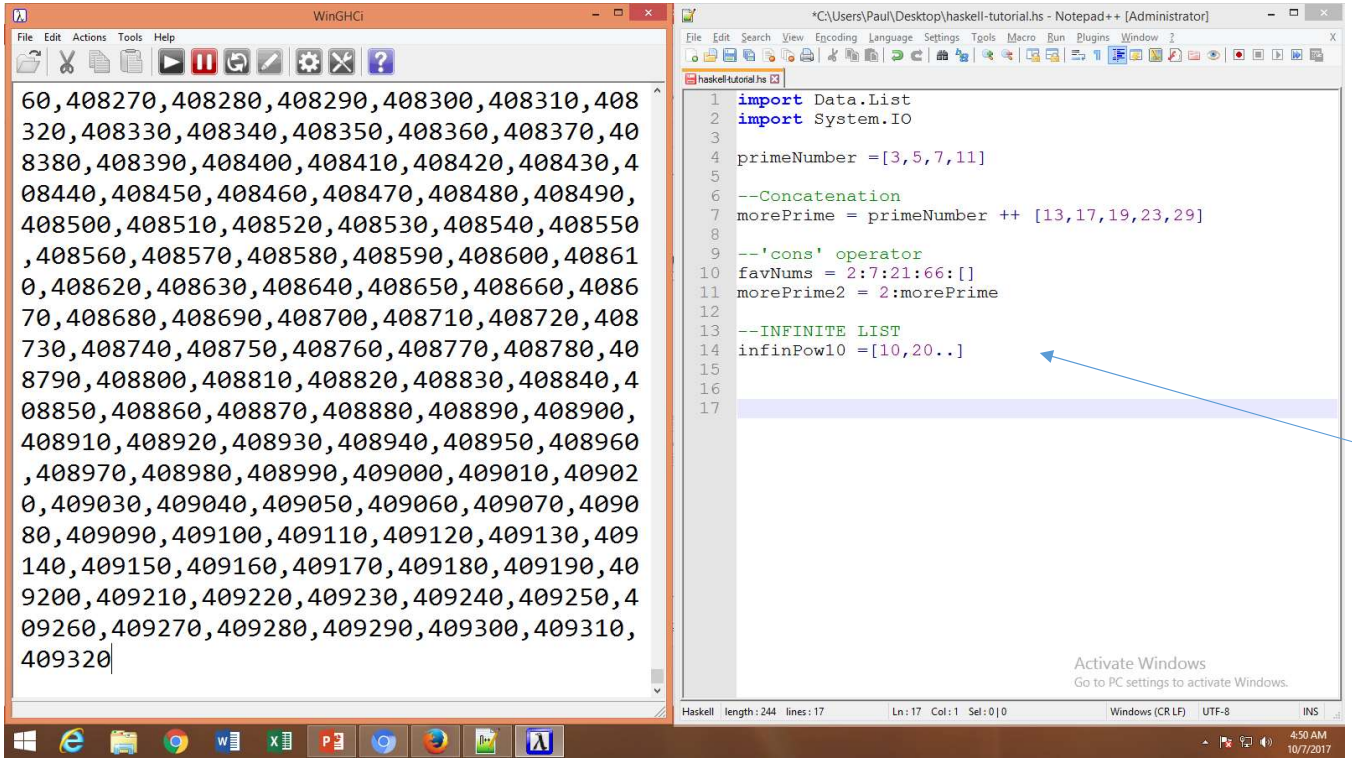
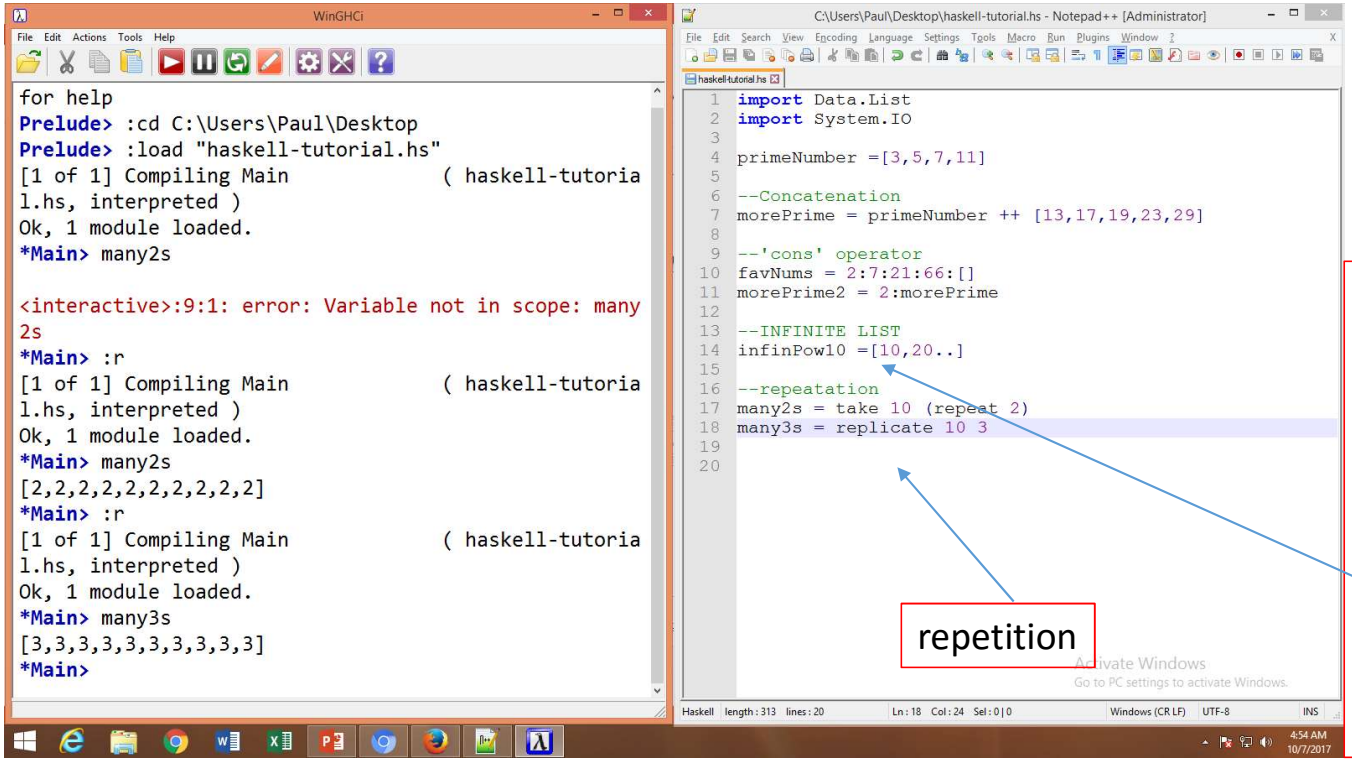
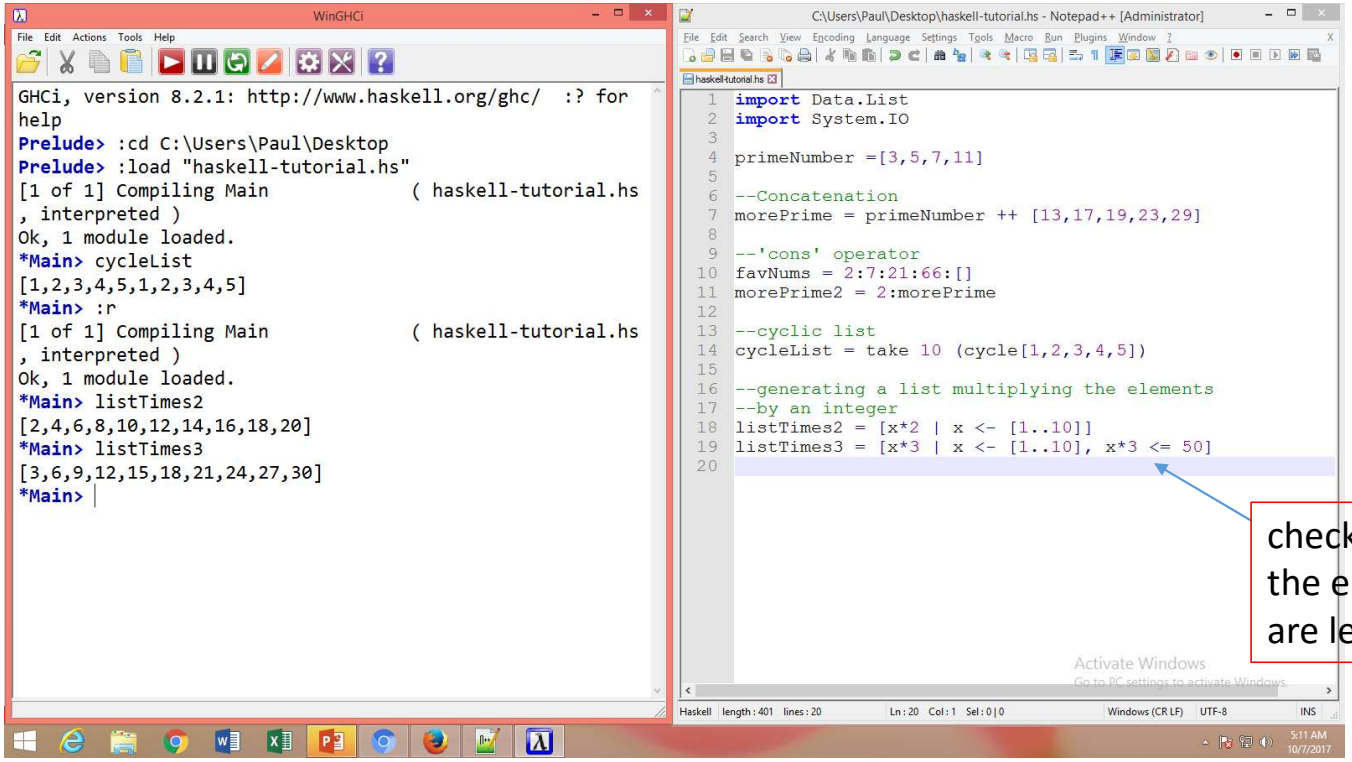


More Operations on List



One of the examples of advantages of laziness property and functional approach: here, the presence of ***infinite list*** does not affect other expressions/ functions in the program

More Operations on List



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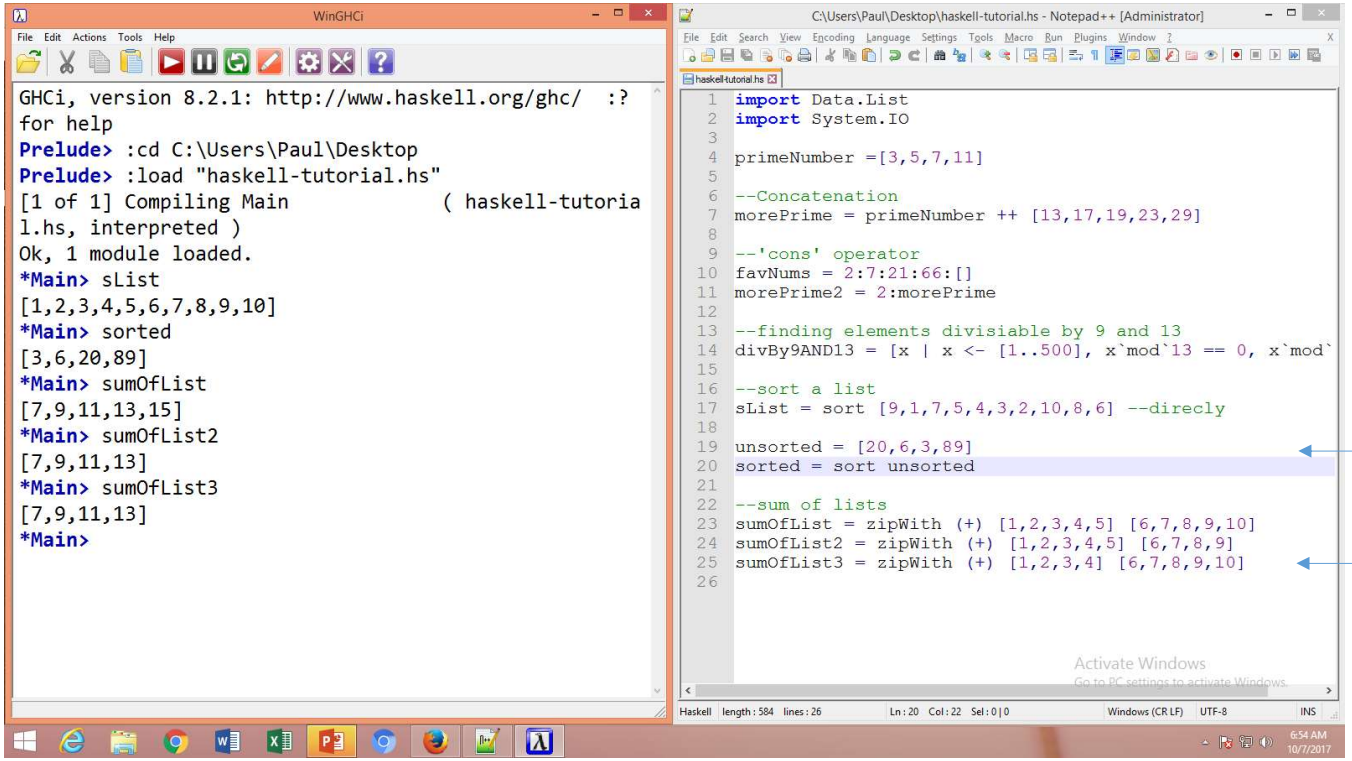
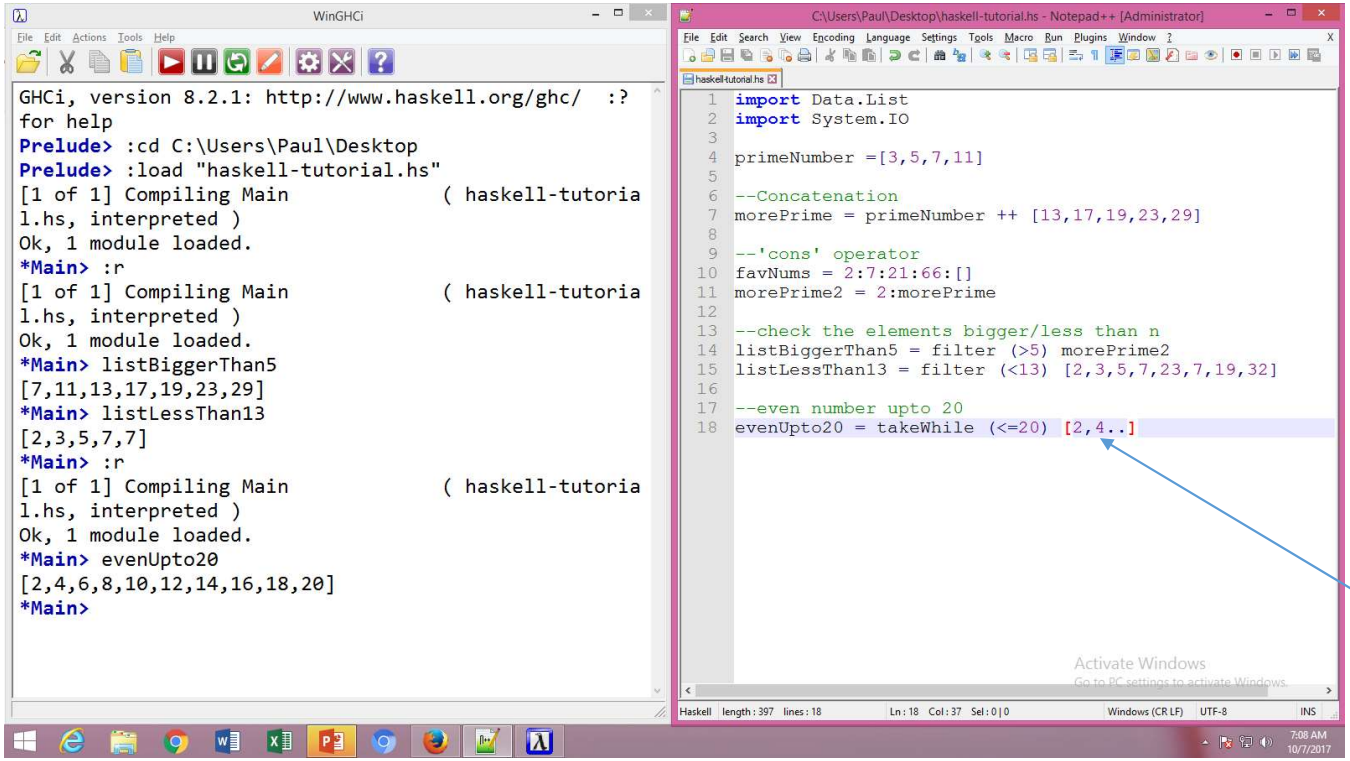
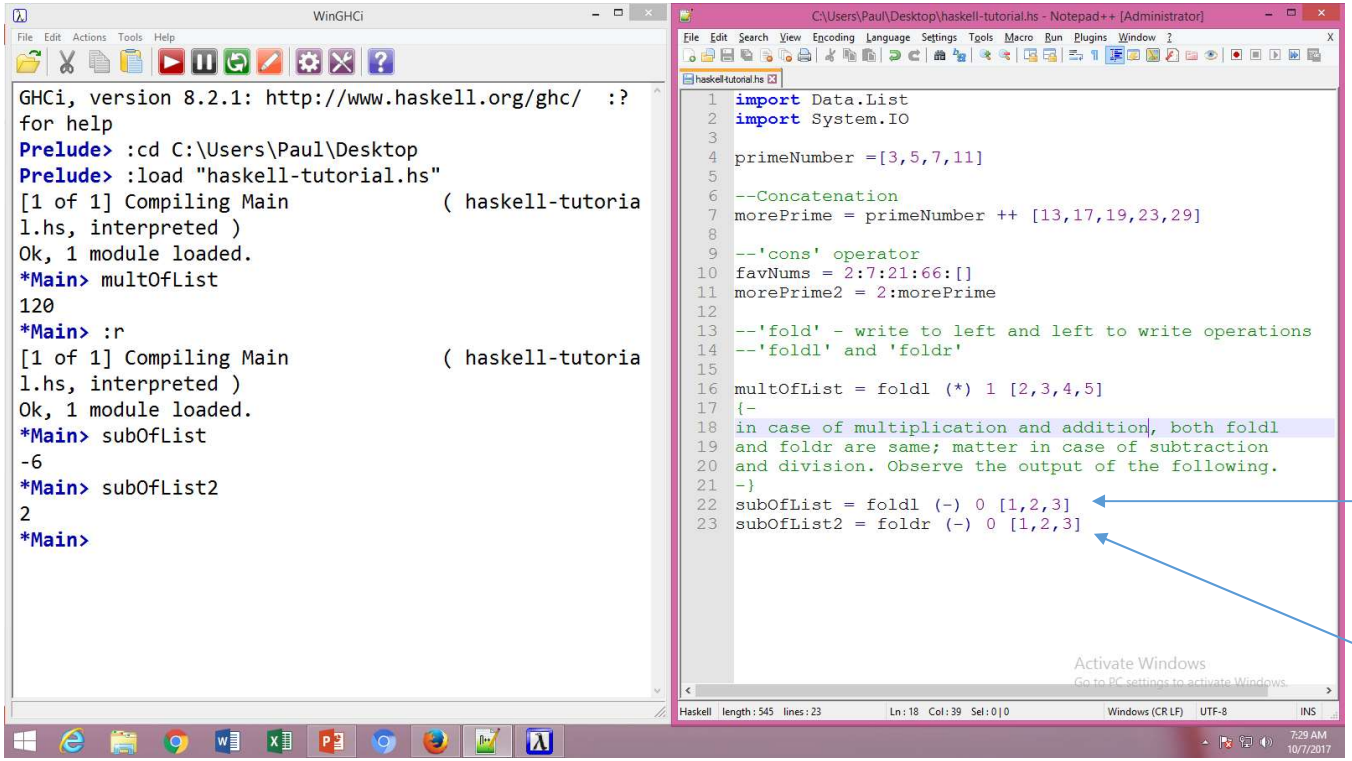


More Operations on List



another example of laziness; although infinite list, check up to 20

More Operations on List

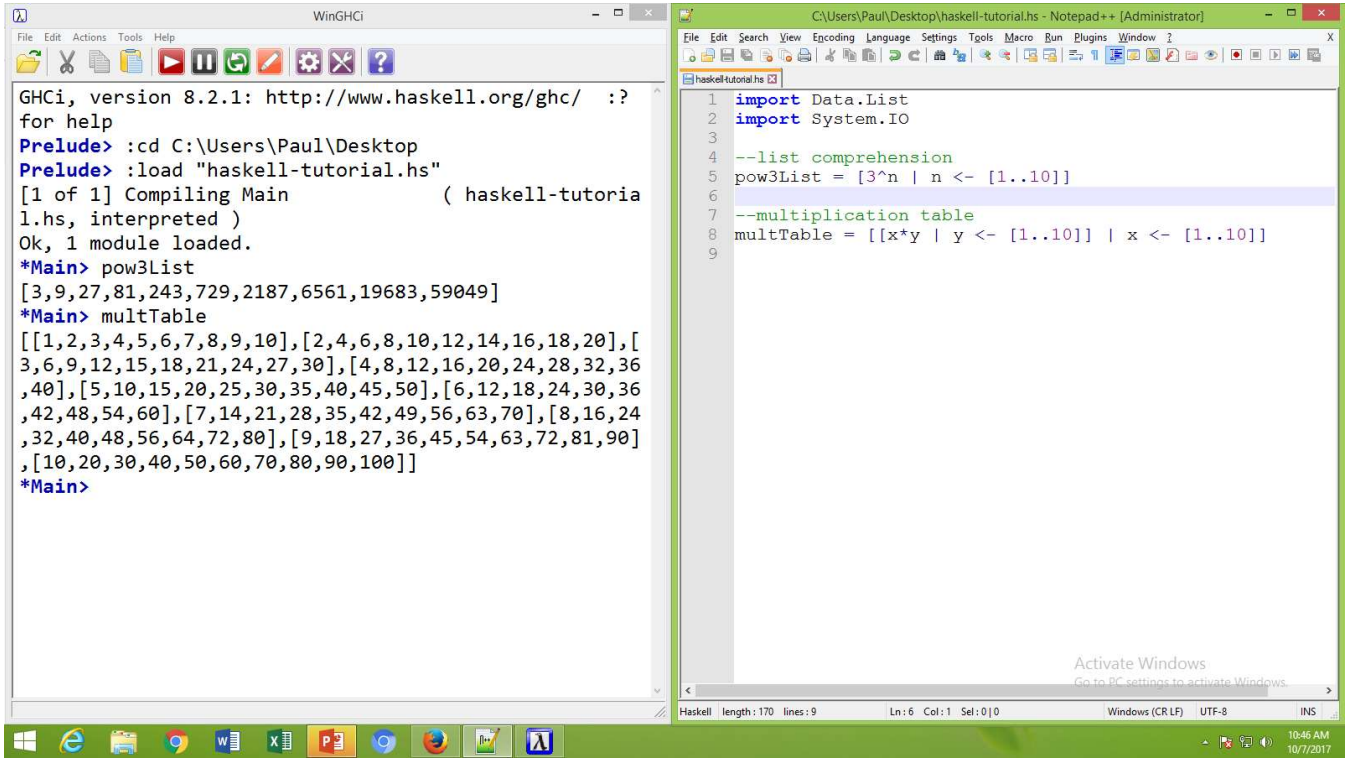


foldl & foldr

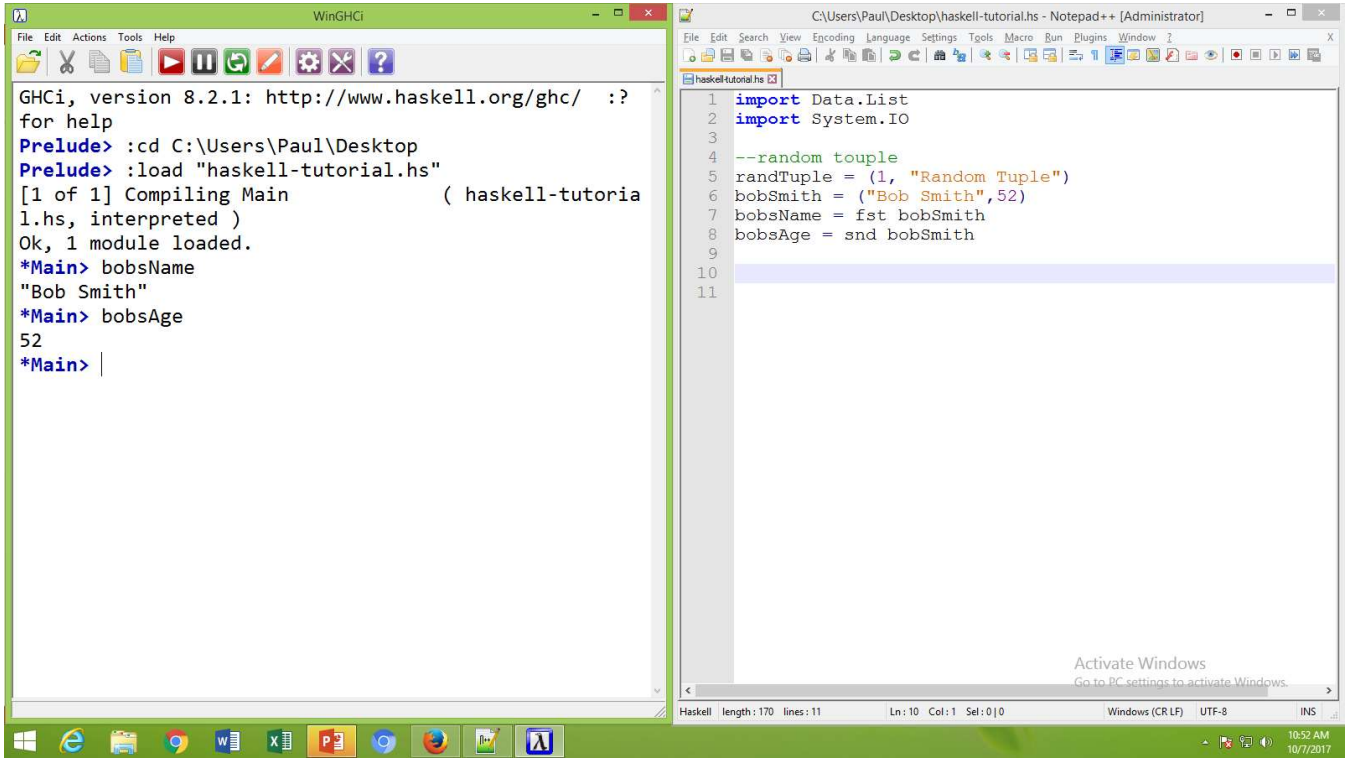
(((0-1)-2)-3)

1-(2-(3-0))

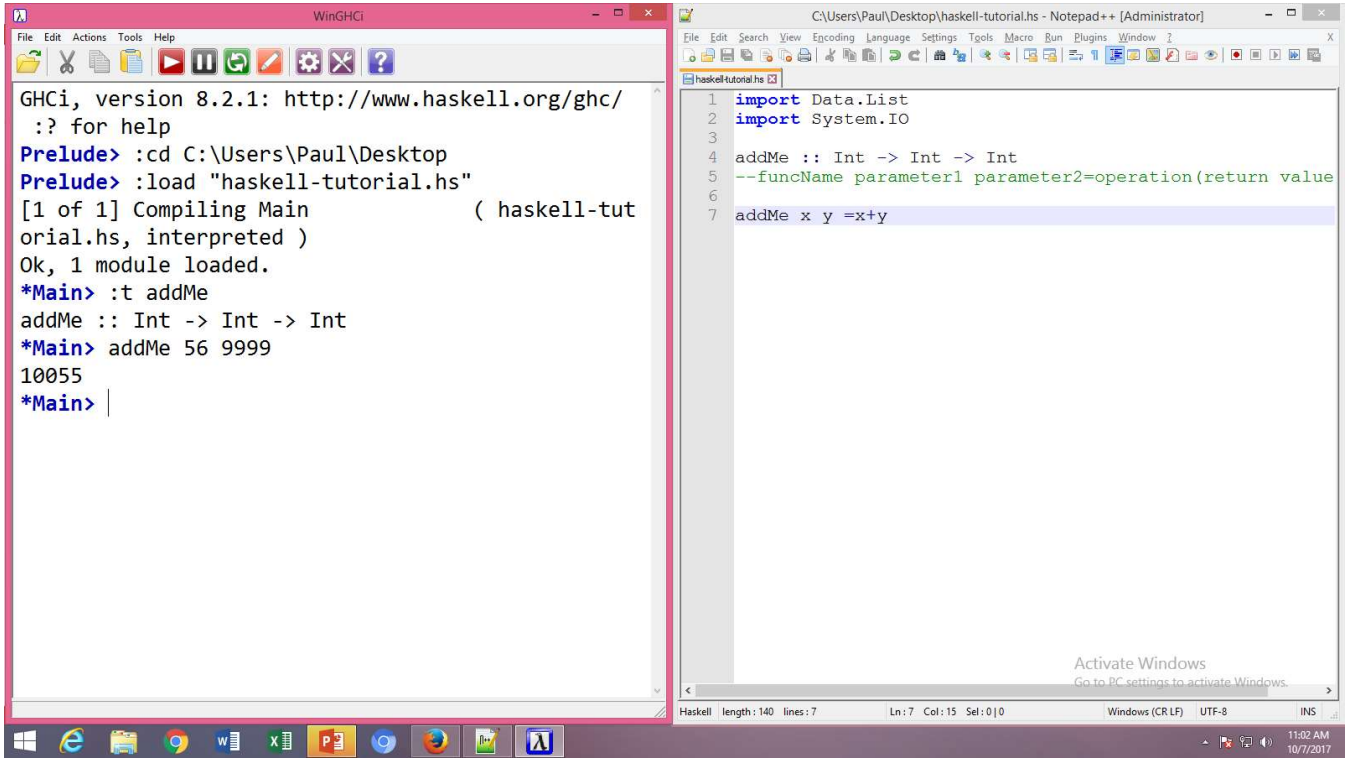
More Operations on List



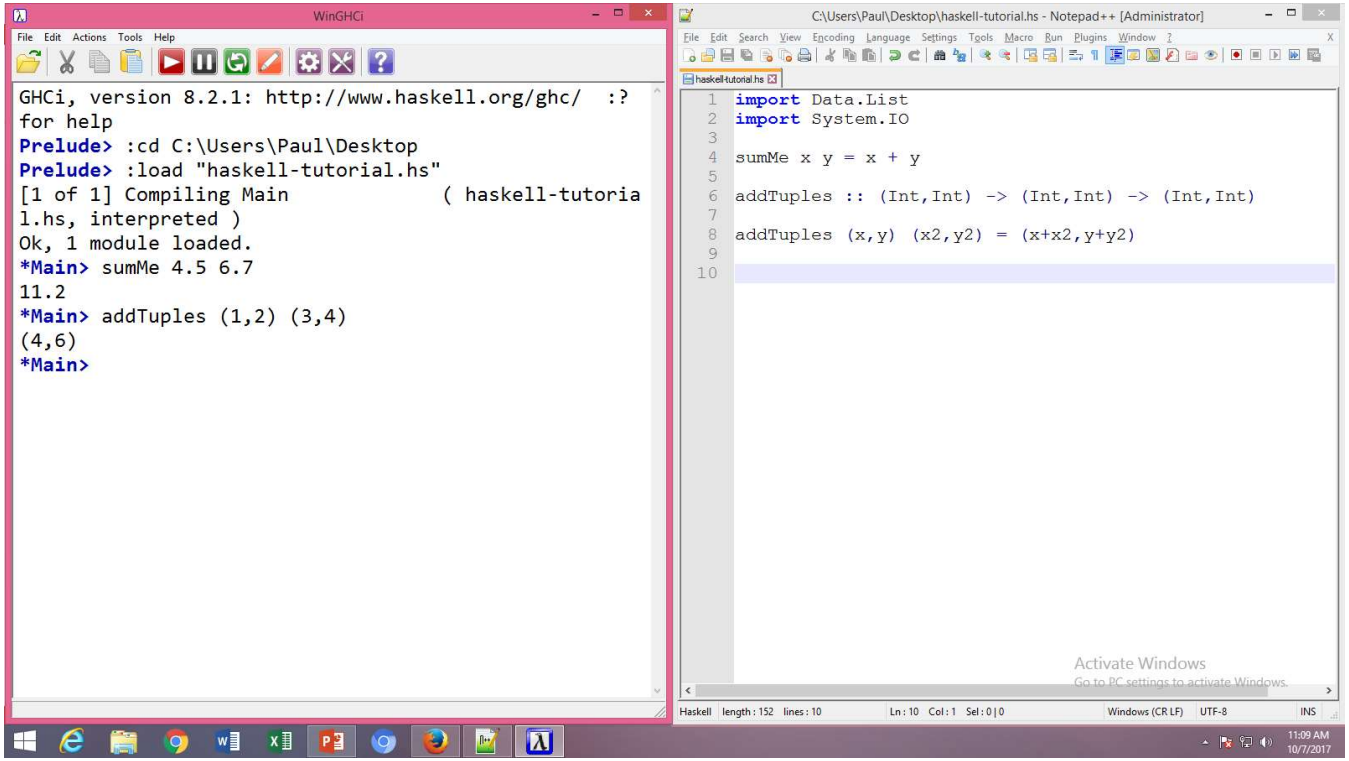
Multiple Data Type



Function Declaration



User Type Declaration



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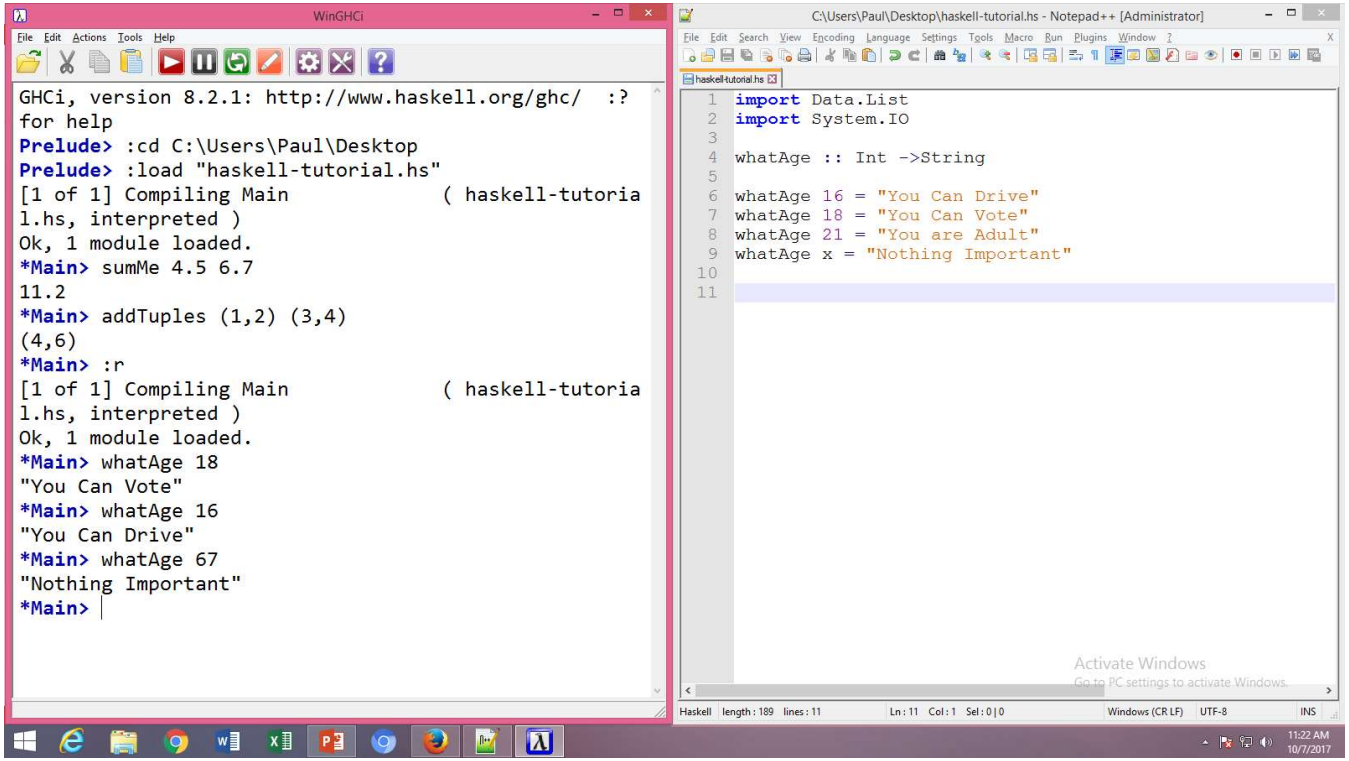
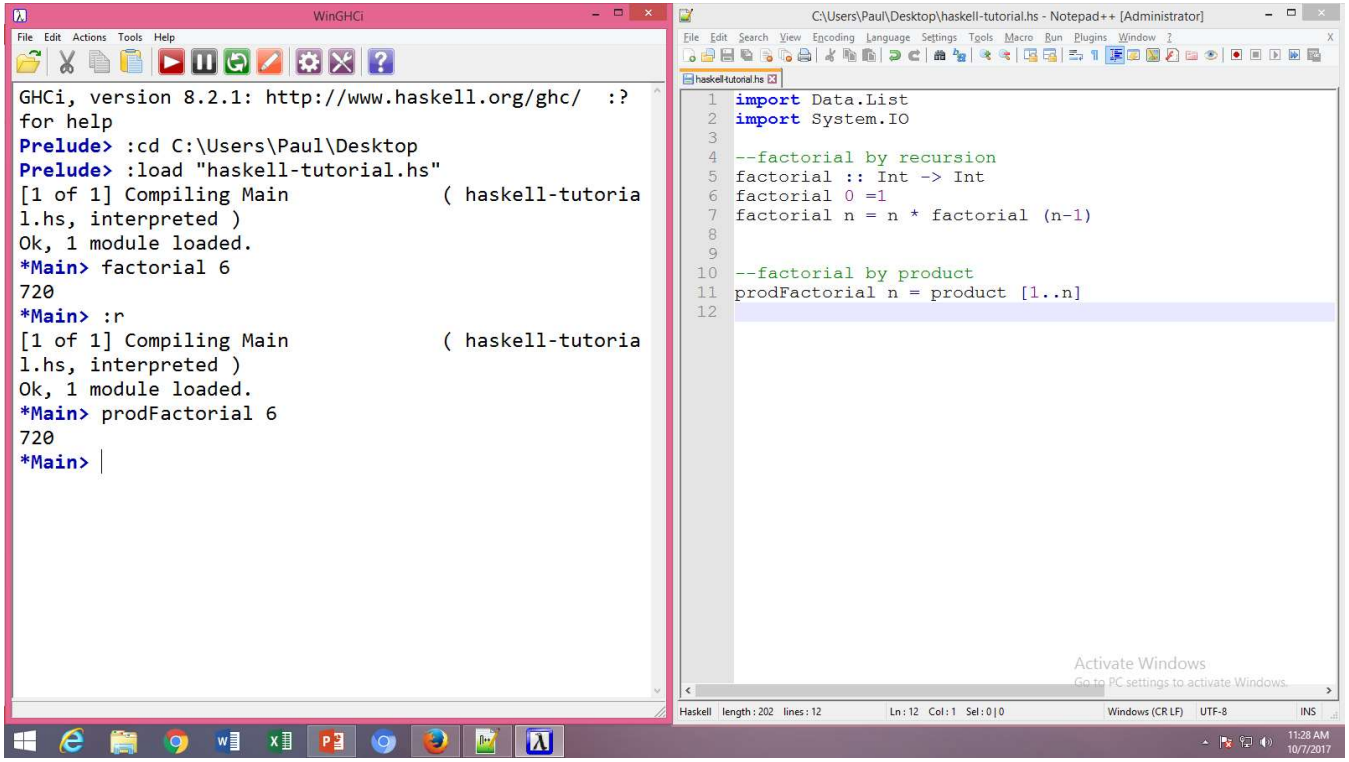
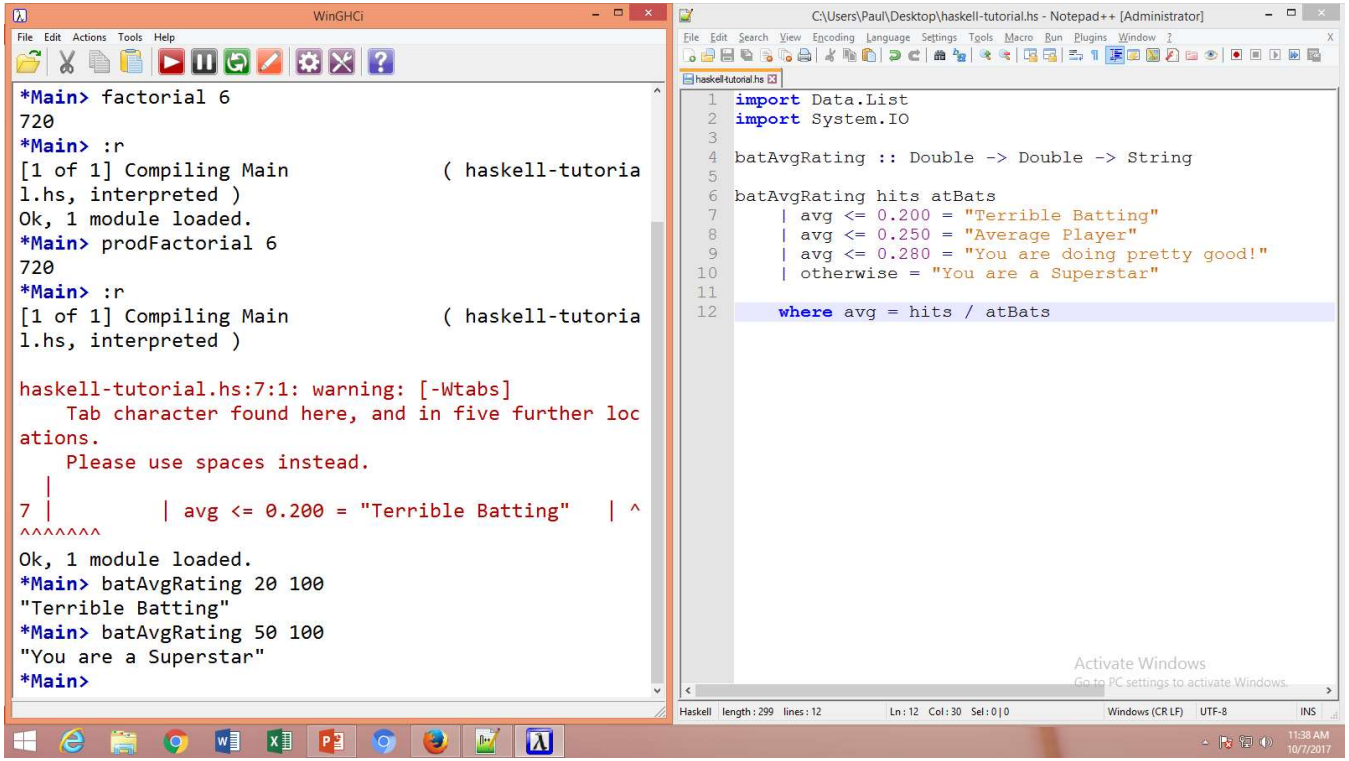


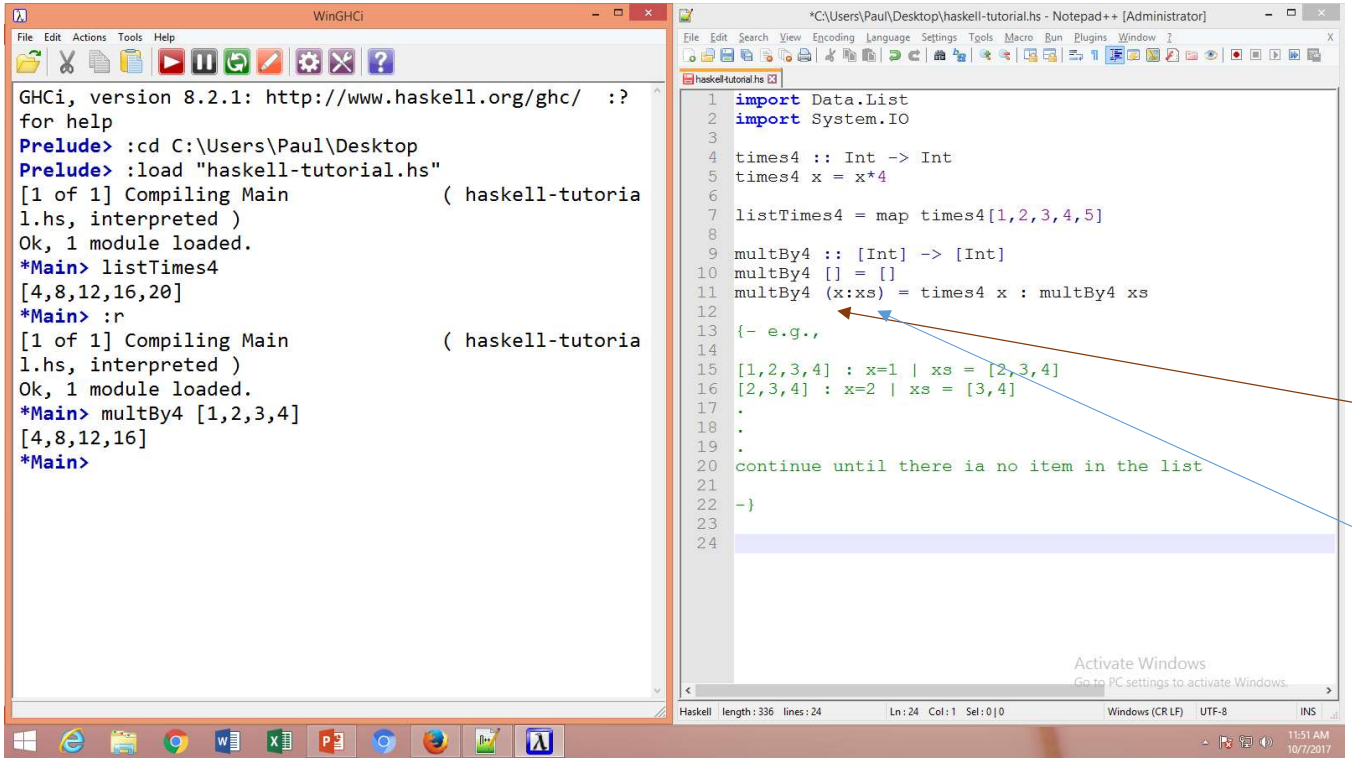
Factorial (by recursion and by product)



Guard (where clause)

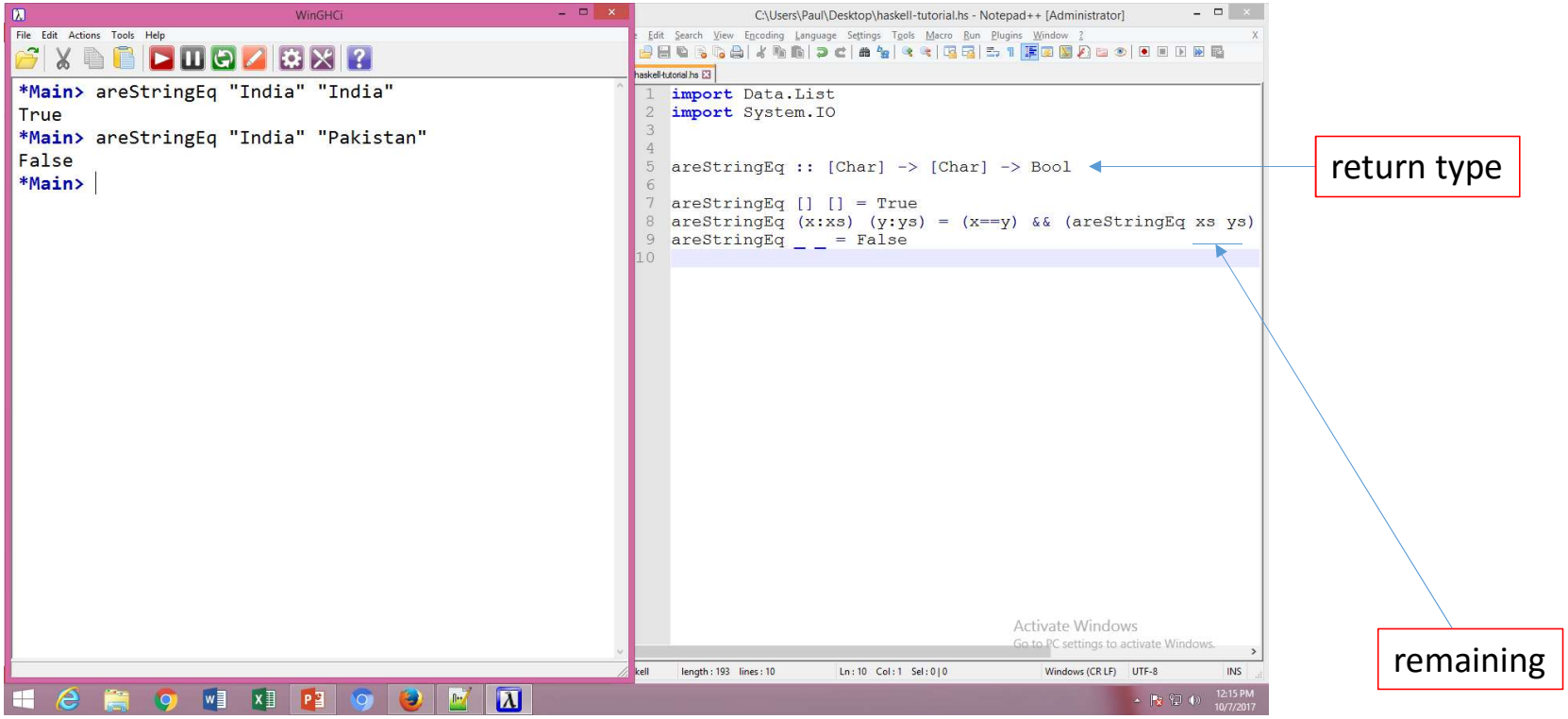


Higher Order Functions

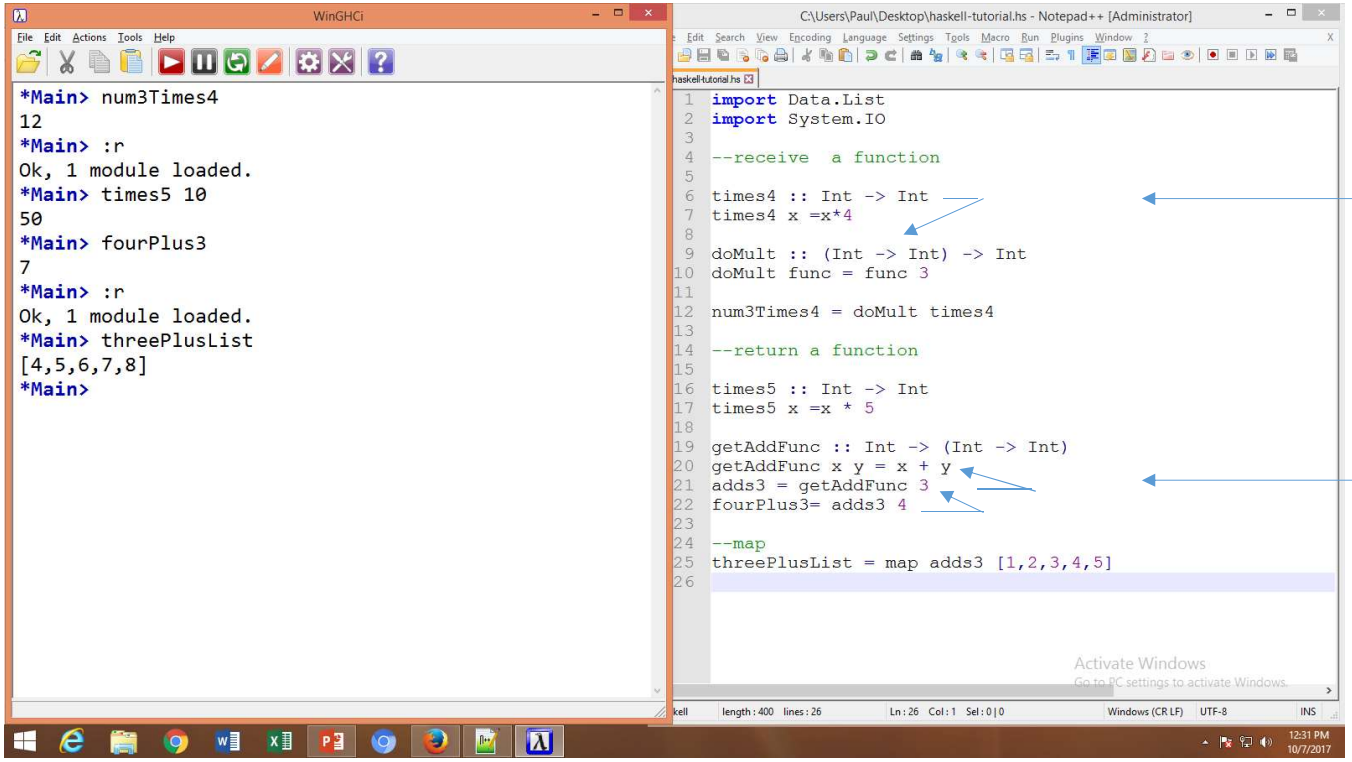


you don't know how many items in the list Beforehand; x represents first element in the list, and xs represents remaining elements of the list

Higher Order Functions



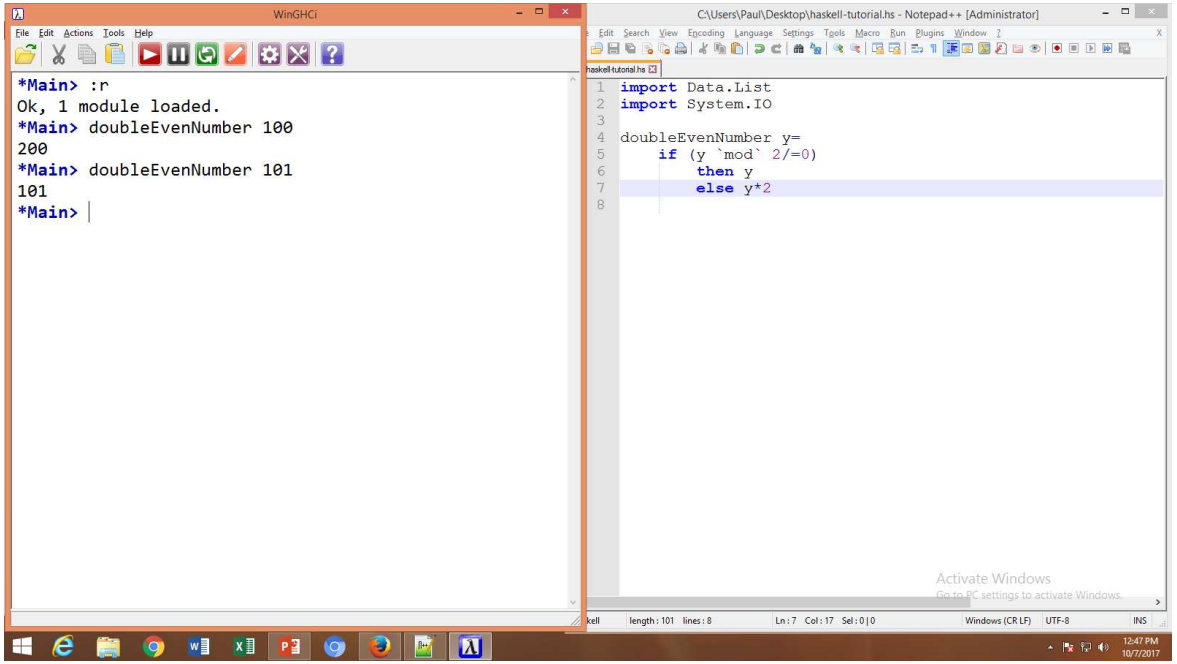
Receive and Return a Function



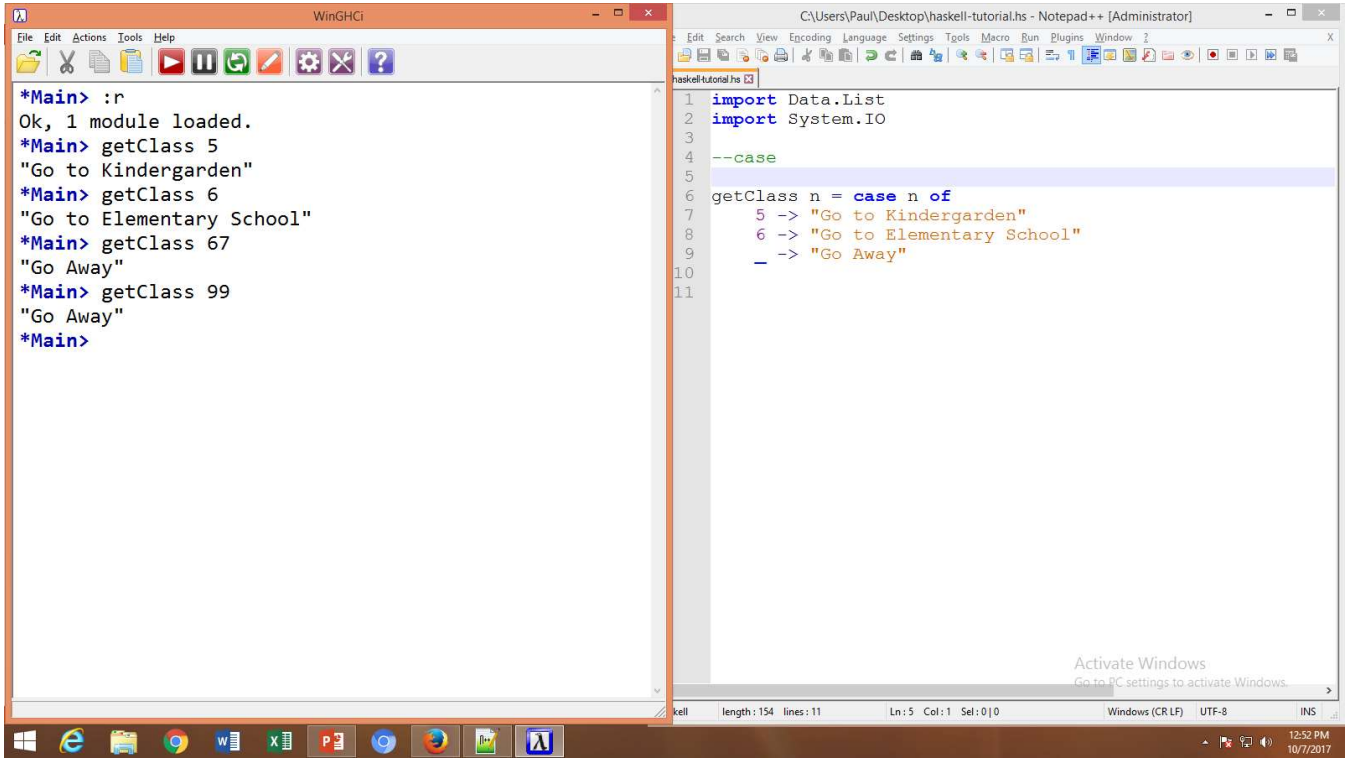
Other Operators

- Comparison
  - `<` --less than
  - `>` --greater than
  - `<=` --less than equal to
  - `>=` --greater than equal to
  - `==` --equal to
- Logical
  - `&&` --AND
  - `||` --OR
  - `not` --NOT

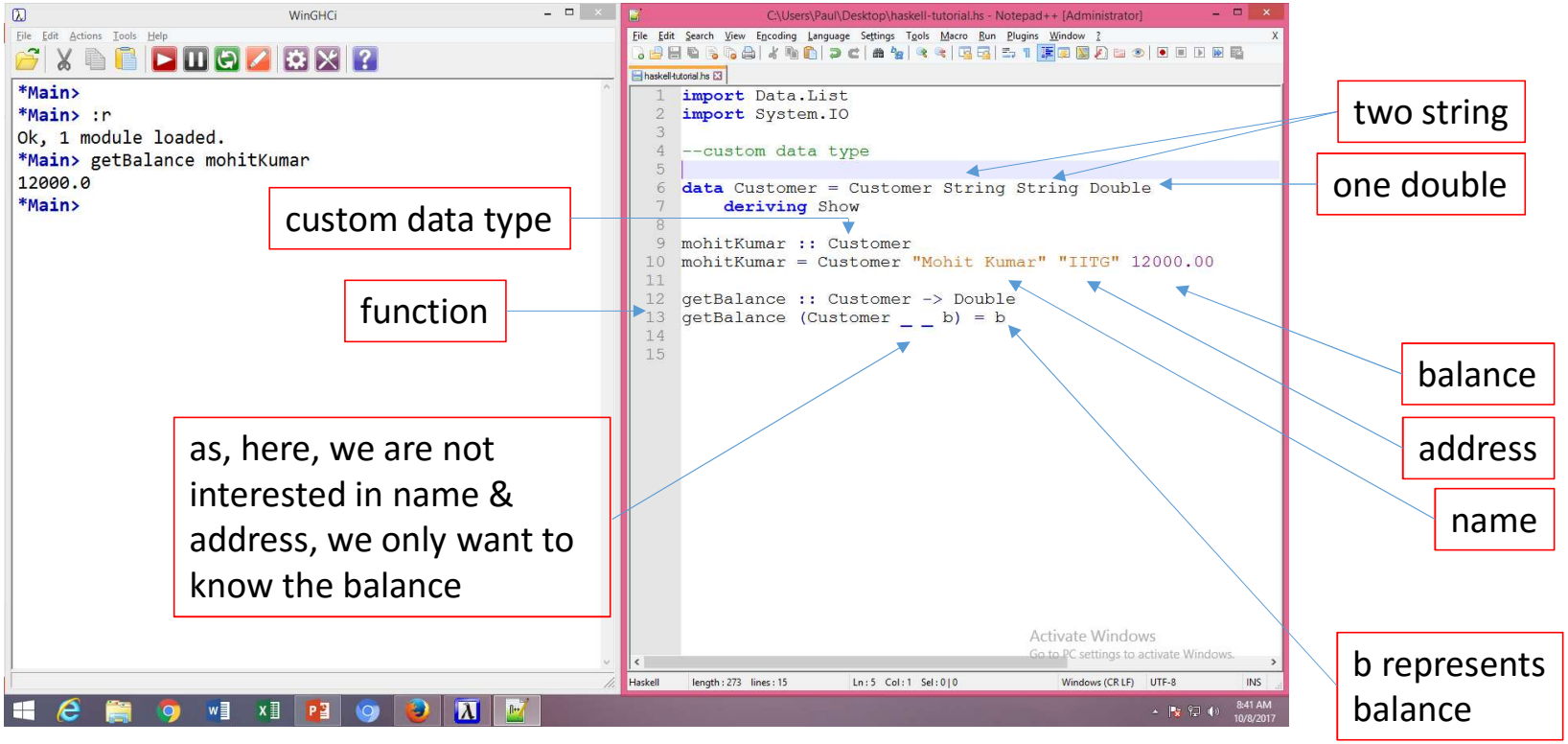
Example



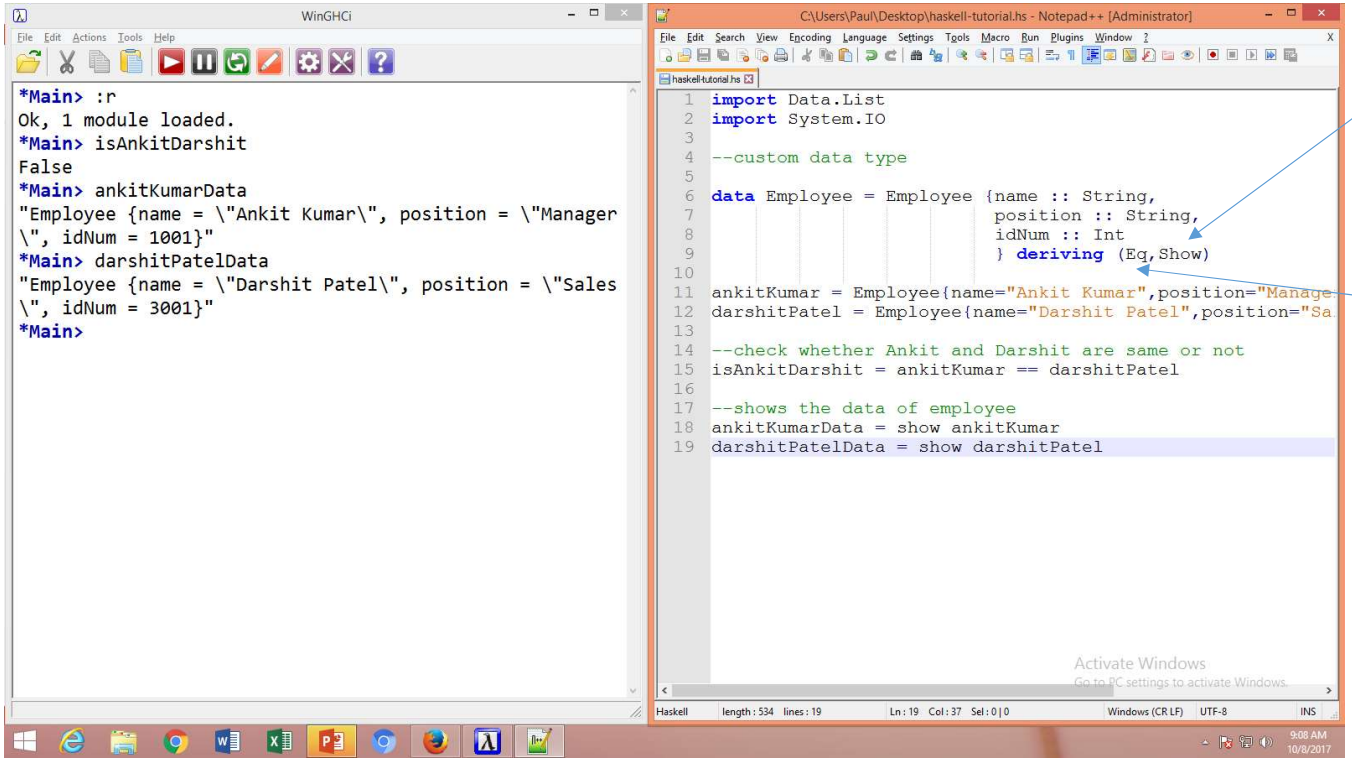
Case


WinGHCi
File Edit Actions Tools Help
*Main> :r
Ok, 1 module loaded.
*Main> getClass 5
"Go to Kindergarden"
*Main> getClass 6
"Go to Elementary School"
*Main> getClass 67
"Go Away"
*Main> getClass 99
"Go Away"
*Main>
C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 --case
5
6 getClass n = case n of
7 5 -> "Go to Kindergarden"
8 6 -> "Go to Elementary School"
9 _ -> "Go Away"
10
11
Activate Windows
Go to PC settings to activate Windows.
length : 154 lines : 11
Ln : 5 Col : 1 Sel : 0 | 0
Windows (CR LF)
UTF-8
INS
12:52 PM
10/7/2017

Custom Data Type



Type Classes



able to show the employee details

able to check for the equality

Assignments

- Only THREE
  - Basic Haskell
  - Food bill generation system
  - Encryption system
- Will get more than ONE month to do (deadline: 30th November)
- Contact head TA (Subrata) for queries

END OF TUTORIAL

YOU MAY EXPLORE

http://www.learnyouahaskell.com

FOR MORE DETAIL