

# Functional Programming Concept with

Tutorial for  
Programming Language Laboratory (CS 431)  
September – November 2020



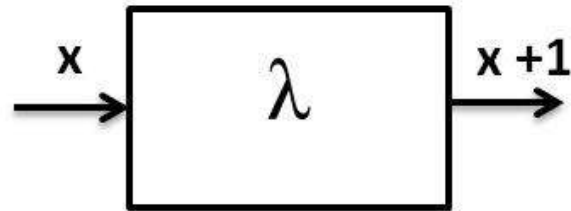
# Functional Programming(FP)

---

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism

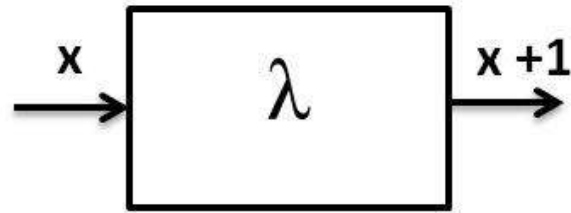
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# Functional Programming(FP)

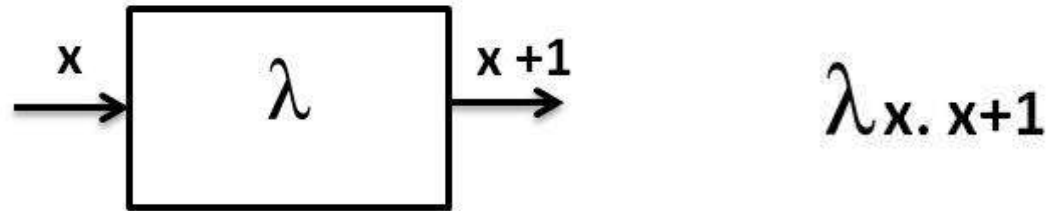
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$\lambda x. x+1$

# Functional Programming(FP)

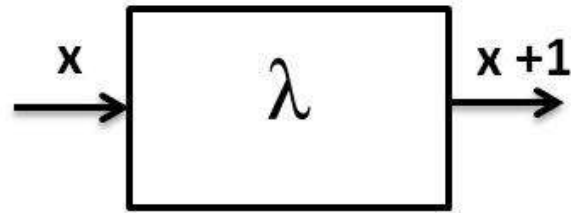
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True:

# Functional Programming(FP)

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism

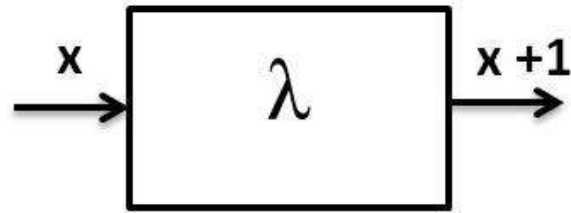


$\lambda x. x+1$

True:  $\lambda x. \lambda y. x$

# Functional Programming(FP)

- Key Idea - computation as 'evaluation of mathematical functions'
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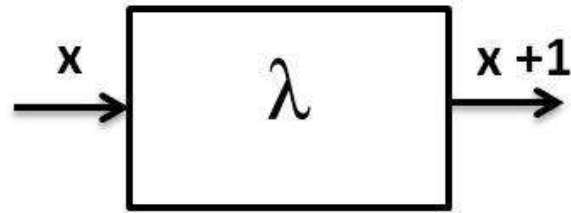
$\lambda x. x+1$

True:  $\lambda x. \lambda y. x$

False:

# Functional Programming(FP)

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism



$\lambda x. x+1$

True:  $\lambda x. \lambda y. x$

False:  $\lambda x. \lambda y. y$



# Functional Programming(FP)

---

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism
- Languages that follow functional programming paradigm
  - Haskell
  - LISP
  - Python
  - Erlang
  - Racket
  - F#
  - Clojure
  - Scala

# Functional Programming

---

- Key Idea - computation as 'evaluation of mathematical functions'
  - Idea originated from Lambda Calculus formalism
- Languages that follow functional programming paradigm
  - **Haskell**
  - LISP
  - Python
  - Erlang
  - Racket
  - F#
  - Clojure
  - Scala

---

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”

# Haskell - Features

---

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

# Purely functional

---

- Every function in Haskell is a function in the mathematical sense (i.e., "pure")
  - The pure function returns the same output every time for the same input
  - In a pure functional language, you can't do anything that has a side effect

# Purely functional

```
function impure(str: string){  
    str = str + "Post";  
    print(str);  
    return(str);  
}
```

State of function  
gets changed

Ex. Impure function

```
function impure(str: string){  
    return(str + "Post");  
}
```

No change in state

Immutable

Ex. Pure function

# Statically Typed

- Every expression in Haskell has a type which compile time is determined at compile time
  - The compiler knows which piece of code is a number, which is a string and so on

haskell\_function = **print** "Hello Haskell learner"

↑  
variable

↑  
function

↑  
String

← Compiler  
automatically detects  
the types

# Statically Typed

- All the types composed together by function application have to match up. If they don't, the program will be rejected by the compiler

➤ Ex. `addMe :: Int -> Int -> Int` ← type signature or function declaration

➤ `addMe x y = x+y` ← function definition

```
*Main> addMe 4 5
9
```

```
*Main> addMe 4 5.5
```

```
<interactive>:23:9: error:
```

- No instance for (Fractional Int) arising from the literal '5.5'
- In the second argument of 'addMe', namely '5.5'
- In the expression: `addMe 4 5.5`
- In an equation for 'it': `it = addMe 4 5.5`



# Type Inference

---

- You don't have to explicitly label every piece of code because the type system can intelligently figure it out

Eg. If we write `a=5+4`

Haskell will automatically infer that `a` is a number

# Lazy

➤ Nothing is evaluated unless it has to be

Eg. Function call :  $f\ 5\ (29^{35792})$

Both the x and y values are evaluated and passed to function f

Non lazy languages like C or Java

Haskell pass the arguments value as it is without doing any actual computation of  $29^{35792}$

Haskell

Saves on CPU usage and user's time!

# Concurrency

---

- Functional programming, by its nature (lack of side effect), is suitable for parallelism
- Concurrency in Haskell is mostly done with Haskell threads
- The Glasgow Haskell Compiler (GHC), comes with concurrency library containing a number of useful concurrency primitives and abstractions technique called Software Transactional Memory (STM)
- STM is an alternative to the lock based synchronization, whose basic objective is to evaluate a set of expression in isolated manner

# Haskell - 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

# Haskell - Application

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# Haskell - Application

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**facebook**

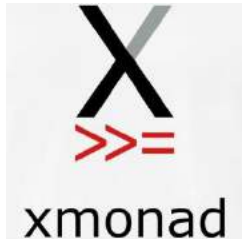
# Haskell - Application

---

- **facebook**  anti-spam programs



# Haskell - Application

- **facebook**  anti-spam programs











# Haskell - Application

-  anti-spam programs
-  a window manager for the X Window System

# Haskell - Application

-  anti-spam programs
-  a window manager for the X Window System  
xmonad
-  **darcs**

# Haskell - Application

-  anti-spam programs
-  a window manager for the X Window System  
xmonad
-  **darcs** revision control system

# Some other FP Applications

---




# Some other FP Applications

---




# Some other FP Applications

---

-  → Scala

# Some other FP Applications

---

-  → Scala



# Some other FP Applications

-  → Scala
-  Erlang



# Some other FP Applications

-  → Scala
-  Erlang
- 

# Some other FP Applications

-  → Scala
-  ? Erlang
-  ? Lisp

# Haskell

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-tutorial.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

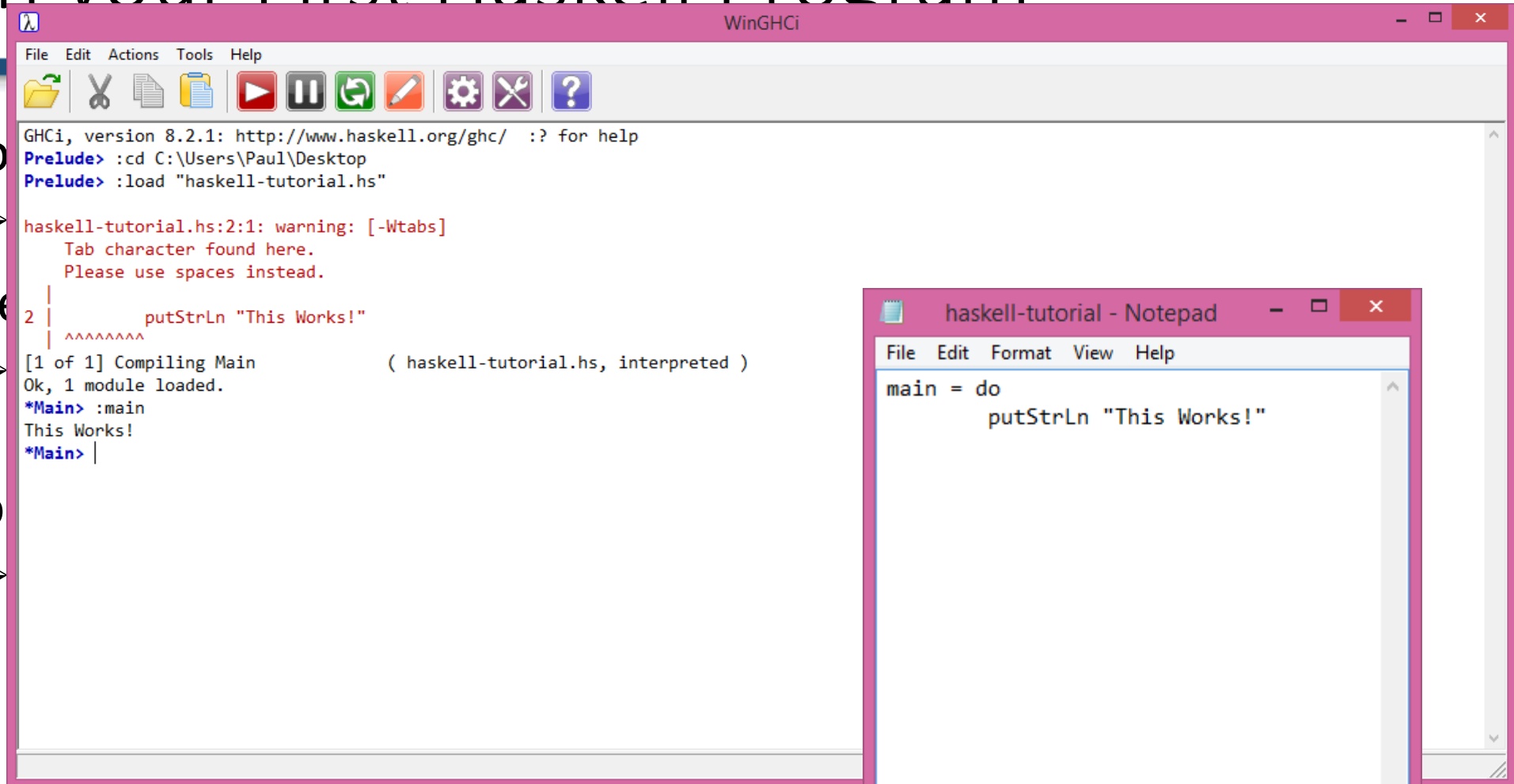
➤ Do



➤ File



➤ Co



The image shows two overlapping windows. The background window is titled 'WinGHCi' and contains the following text:

```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"

haskell-tutorial.hs:2:1: warning: [-Wtabs]
    Tab character found here.
    Please use spaces instead.
2 |         putStrLn "This Works!"
  |         ^^^^^^^^^
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> :main
This Works!
*Main> |
```

The foreground window is titled 'haskell-tutorial - Notepad' and contains the following code:

```
File Edit Format View Help
main = do
    putStrLn "This Works!"
```

# 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-tutorial.hs`)

## ➤ 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

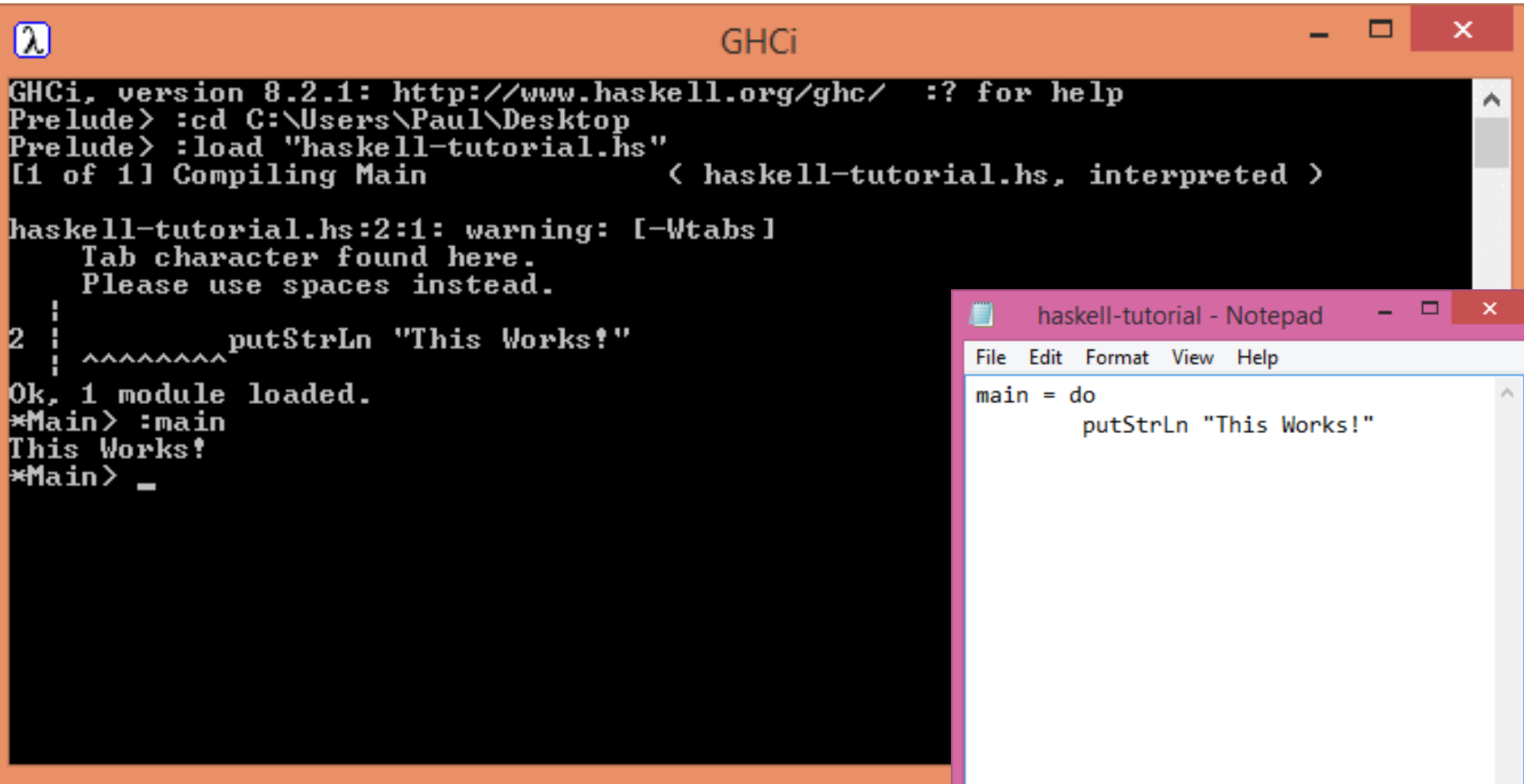
➤

➤ File

➤

➤ Cor

➤



The image shows two overlapping windows. The top window is titled 'GHCi' and contains the following text:

```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )

haskell-tutorial.hs:2:1: warning: [-Wtabs]
    Tab character found here.
    Please use spaces instead.
2  | .....putStrLn "This Works!"
   | .....^
Ok, 1 module loaded.
*Main> :main
This Works!
*Main> _
```

The bottom window is titled 'haskell-tutorial - Notepad' and contains the following text:

```
File Edit Format View Help
main = do
    putStrLn "This Works!"
```

➤ Run the function you want

ion

p)

# 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: Float, Double, Bool, Char, Tuple -- will be discussing with example
  - ```
permanent3 :: Int
```

```
permanent3 = 3
```

 } permanent value for a variable  
--Never Change

# Expressions



The screenshot shows a Windows desktop with two windows open. The window on the left is titled 'WinGHCi' and displays the GHCi prompt. The window on the right is titled 'C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]' and displays a Haskell script.

```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> addExpr
8
*Main> multExpr
15.0
*Main> nextExpr
7.5
*Main> |
```

```
1 import Data.List
2 import System.IO
3
4 sumOfNums = sum[1..100]
5
6 addExpr = 5+3
7 subExpr = 5-3
8 multExpr = 5*3
9 divExpr = 5/3
10
11 nextExpr = multExpr/subExpr
12
13
14
15
```

At the bottom of the Notepad++ window, there is a status bar showing 'Haskell length: 163 lines: 15 Ln: 13 Col: 1 Sel: 0|0 Windows (CR LF) UTF-8 INS'. A watermark 'Activate Windows Go to PC settings to activate Windows.' is visible in the bottom right corner of the Notepad++ window.

# Expressions



The screenshot displays two windows on a Windows desktop. The left window is titled 'WinGHCi' and shows the GHCi prompt with the following commands and output:

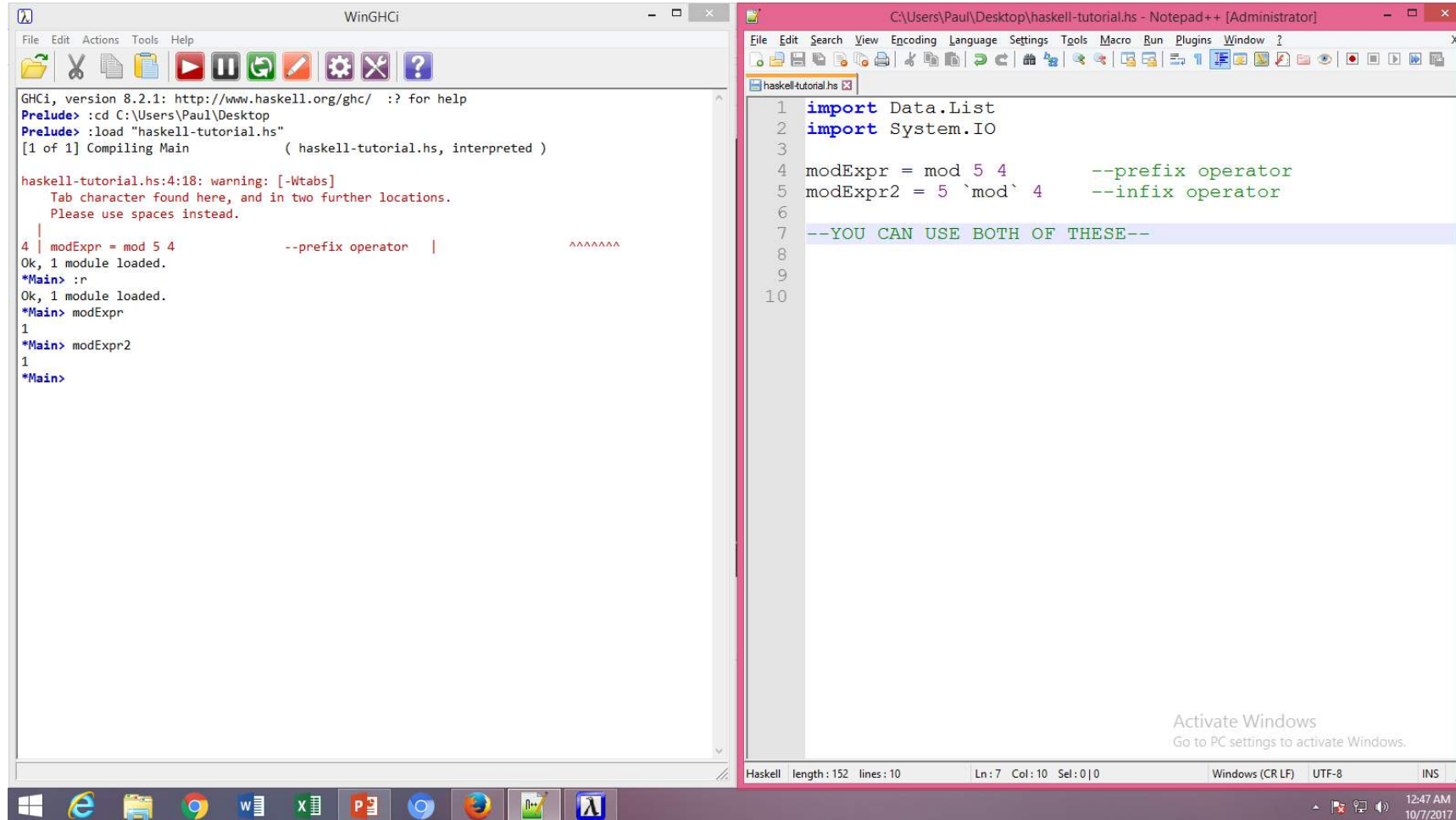
```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> addExpr
8
*Main> multExpr
15.0
*Main> nextExpr
7.5
*Main> sumOfNums
5050
*Main>
*Main>
```

The right window is titled 'C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]' and shows the source code for 'haskell-tutorial.hs':

```
1 import Data.List
2 import System.IO
3
4 sumOfNums = sum[1..100]
5
6 addExpr = 5+3
7 subExpr = 5-3
8 multExpr = 5*3
9 divExpr = 5/3
10
11 nextExpr = multExpr/subExpr
12
13
14
15
```

The status bar at the bottom of the Notepad++ window indicates 'Haskell | length: 163 | lines: 15 | Ln: 13 | Col: 1 | Sel: 0 | 0 | Windows (CR LF) | UTF-8 | INS'. The Windows taskbar at the bottom shows the time as 12:39 AM on 10/7/2017.

# Infix and Prefix Operator



The image shows two windows side-by-side. The left window is WinGHCi, and the right window is Notepad++.

**WinGHCi Window:**

```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main          ( haskell-tutorial.hs, interpreted )

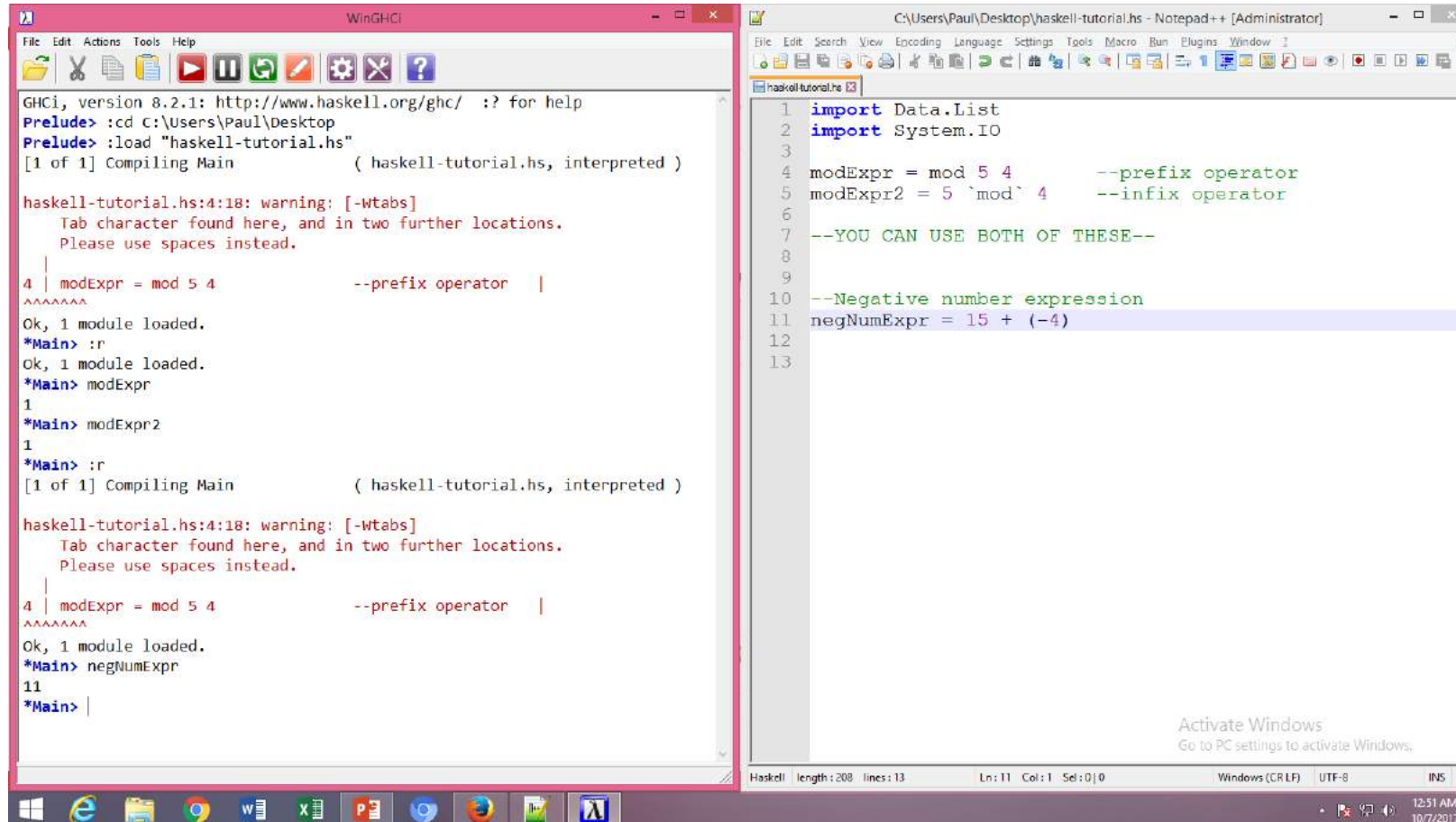
haskell-tutorial.hs:4:18: warning: [-Wtabs]
    Tab character found here, and in two further locations.
    Please use spaces instead.
4 | modExpr = mod 5 4          --prefix operator |
Ok, 1 module loaded.
*Main> :r
Ok, 1 module loaded.
*Main> modExpr
1
*Main> modExpr2
1
*Main>
```

**Notepad++ Window:**

```
C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 modExpr = mod 5 4          --prefix operator
5 modExpr2 = 5 `mod` 4      --infix operator
6
7 --YOU CAN USE BOTH OF THESE--
8
9
10
```

At the bottom of the Notepad++ window, there is a status bar showing: Haskell length: 152 lines: 10 Ln: 7 Col: 10 Sel: 0 | 0 Windows (CR LF) UTF-8 INS

# Negative Number Expression



The image shows a screenshot of a computer screen with two windows. The left window is the GHCi Haskell interpreter, and the right window is a Notepad++ editor showing the source code of the Haskell program.

**Notepad++ Editor (haskell-tutorial.hs):**

```
1 import Data.List
2 import System.IO
3
4 modExpr = mod 5 4      --prefix operator
5 modExpr2 = 5 `mod` 4    --infix operator
6
7 --YOU CAN USE BOTH OF THESE--
8
9
10 --Negative number expression
11 negNumExpr = 15 + (-4)
12
13
```

**GHCi Interpreter:**

```

GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )

haskell-tutorial.hs:4:18: warning: [-Wtabs]
    Tab character found here, and in two further locations.
    Please use spaces instead.
4 | modExpr = mod 5 4      --prefix operator
   ^^^^^^^
Ok, 1 module loaded.
*Main> :r
Ok, 1 module loaded.
*Main> modExpr
1
*Main> modExpr2
1
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )

haskell-tutorial.hs:4:18: warning: [-Wtabs]
    Tab character found here, and in two further locations.
    Please use spaces instead.
4 | modExpr = mod 5 4      --prefix operator
   ^^^^^^^
Ok, 1 module loaded.
*Main> negNumExpr
11
*Main>

```

The status bar at the bottom of the Notepad++ window shows: Haskell length: 208 lines: 13 Ln: 11 Col: 1 Sel: 0|0 Windows (CRLF) UTF-8 INS. The system clock in the bottom right corner shows 12:51 AM on 10/7/2017.

# 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, asin, acos, atan, sinh, cosh, tanh, asinh, acosh, atanh`

# 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, asin, acos, atan, sinh, cosh, tanh, asinh, acosh, atanh`

EXPLORE THESE



# List - Concatenation



The screenshot displays two windows on a Windows desktop. The left window is WinGHCi, showing the execution of Haskell code. The right window is Notepad++, showing the source code for 'haskell-tutorial.hs'.

**WinGHCi Window:**

```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> primeNumber
[3,5,7,11]
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> morePrime
[3,5,7,11,13,17,19,23,29]
*Main> |
```

**Notepad++ Window:**

```
1 import Data.List
2 import System.IO
3
4 primeNumber =[3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
```

Annotations in the Notepad++ window:

- A blue arrow points from the text "Define a list" to the line `primeNumber =[3,5,7,11]`.
- A blue arrow points from the text "Concatenation of two lists" to the line `morePrime = primeNumber ++ [13,17,19,23,29]`.



# List – 'cons' operator

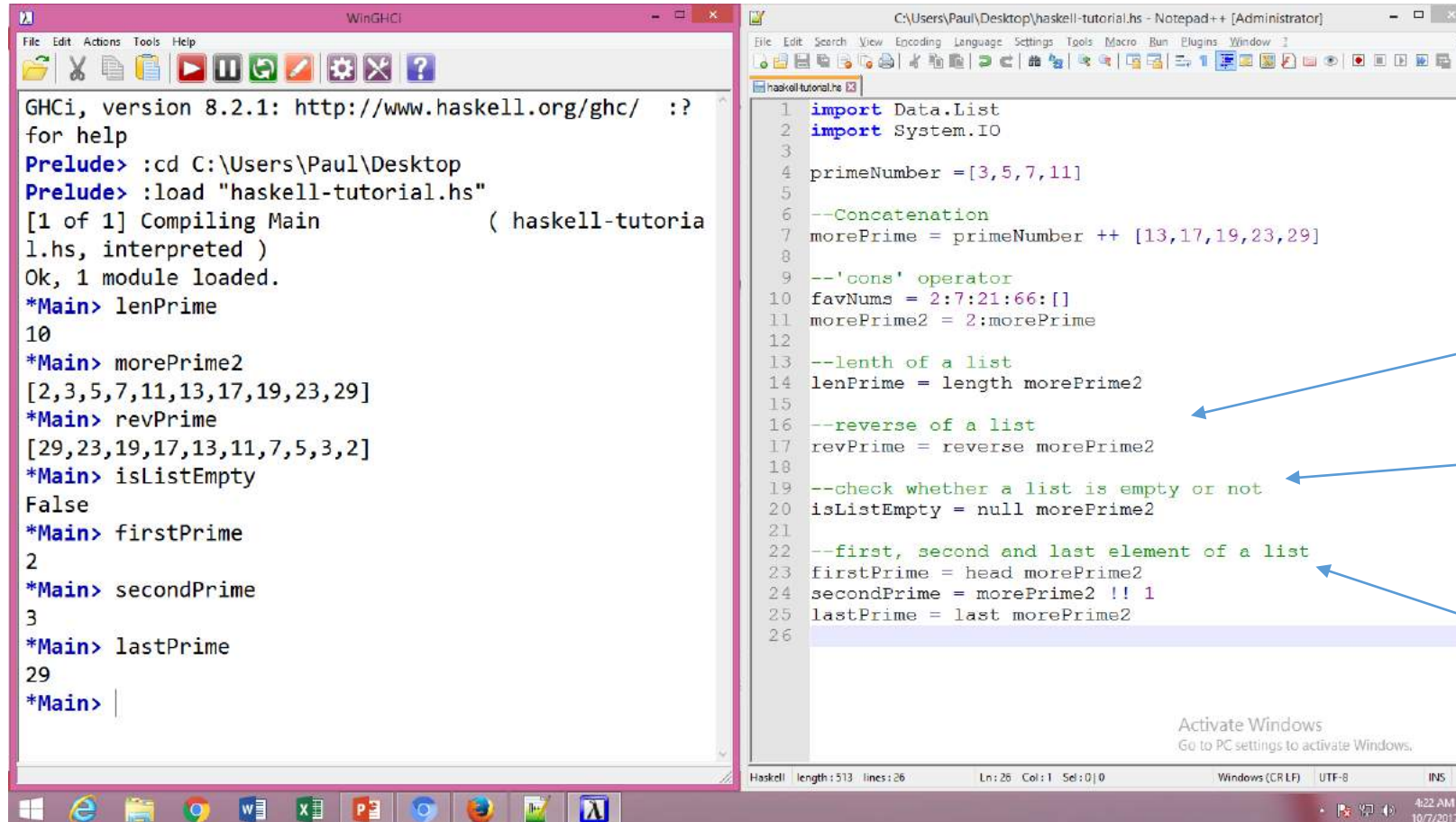


```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> primeNumber
[3,5,7,11]
*Main> :r
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> morePrime
[3,5,7,11,13,17,19,23,29]
*Main> :r
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> favNums
[2,7,21,66]
*Main> :r
[1 of 1] Compiling Main                ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> morePrime2
[2,3,5,7,11,13,17,19,23,29]
*Main> |

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
haskell-tutorial.hs
1  import Data.List
2  import System.IO
3
4  primeNumber = [3,5,7,11]
5
6  --Concatenation
7  morePrime = primeNumber ++ [13,17,19,23,29]
8
9  --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13
14

Haskell length: 202 lines: 14 Ln: 13 Col: 1 Sel: 0|0 Windows (CRLF) UTF-8 INS
4:08 AM 10/7/2017
```

# More Operations on List



The screenshot displays two windows. The left window, WinGHC, shows the execution of Haskell code. The right window, Notepad++, shows the source code for 'haskell-tutorial.hs'.

```
WinGHC
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main          ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> lenPrime
10
*Main> morePrime2
[2,3,5,7,11,13,17,19,23,29]
*Main> revPrime
[29,23,19,17,13,11,7,5,3,2]
*Main> isEmpty
False
*Main> firstPrime
2
*Main> secondPrime
3
*Main> lastPrime
29
*Main> |

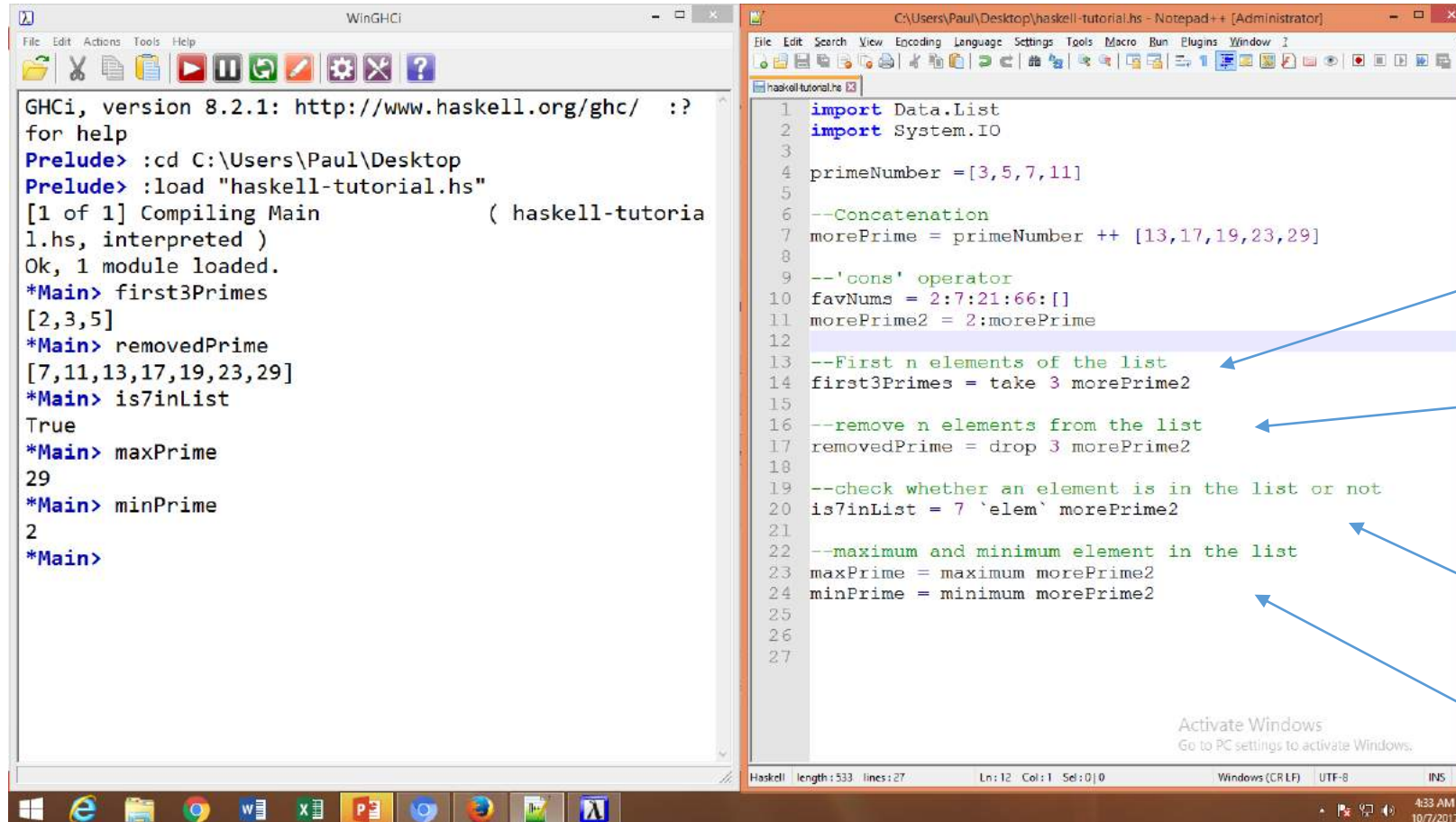
C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --length of a list
14 lenPrime = length morePrime2
15
16 --reverse of a list
17 revPrime = reverse morePrime2
18
19 --check whether a list is empty or not
20 isEmpty = null morePrime2
21
22 --first, second and last element of a list
23 firstPrime = head morePrime2
24 secondPrime = morePrime2 !! 1
25 lastPrime = last morePrime2
26
```

reverse

List empty?

particular element

# More Operations on List



The image shows two windows side-by-side. The left window is WinGHCi, a Haskell interpreter, showing the execution of a Haskell script. The right window is Notepad++ editing a file named 'haskell-tutorial.hs'. The script defines a list of prime numbers and demonstrates various list operations. Blue arrows point from text boxes on the right to specific lines in the code.

```
WinGHCi
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> first3Primes
[2,3,5]
*Main> removedPrime
[7,11,13,17,19,23,29]
*Main> is7inList
True
*Main> maxPrime
29
*Main> minPrime
2
*Main>
```

```
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --First n elements of the list
14 first3Primes = take 3 morePrime2
15
16 --remove n elements from the list
17 removedPrime = drop 3 morePrime2
18
19 --check whether an element is in the list or not
20 is7inList = 7 `elem` morePrime2
21
22 --maximum and minimum element in the list
23 maxPrime = maximum morePrime2
24 minPrime = minimum morePrime2
25
26
27
```

first n element

removing first  
n element

finding an  
element

max and min

# More Operations on List



The screenshot shows two windows side-by-side. The left window is WinGHCi, and the right window is Notepad++.

**WinGHCi Window:**

```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> prodList
60
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> zeroToTen
[0,1,2,3,4,5,6,7,8,9,10]
*Main> evenList
[2,4,6,8,10]
*Main> letterList
"ACEGIKMQSUWY"
*Main> |
```

**Notepad++ Window:**

```
C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --product of elements of a list
14 smallList = [3,4,5]
15 prodList = product smallList
16
17 --generating sequence of elements in list
18 zeroToTen = [0..10]
19 evenList = [2,4..10]
20 letterList = ['A','C'..'Z']
21
22
23
```

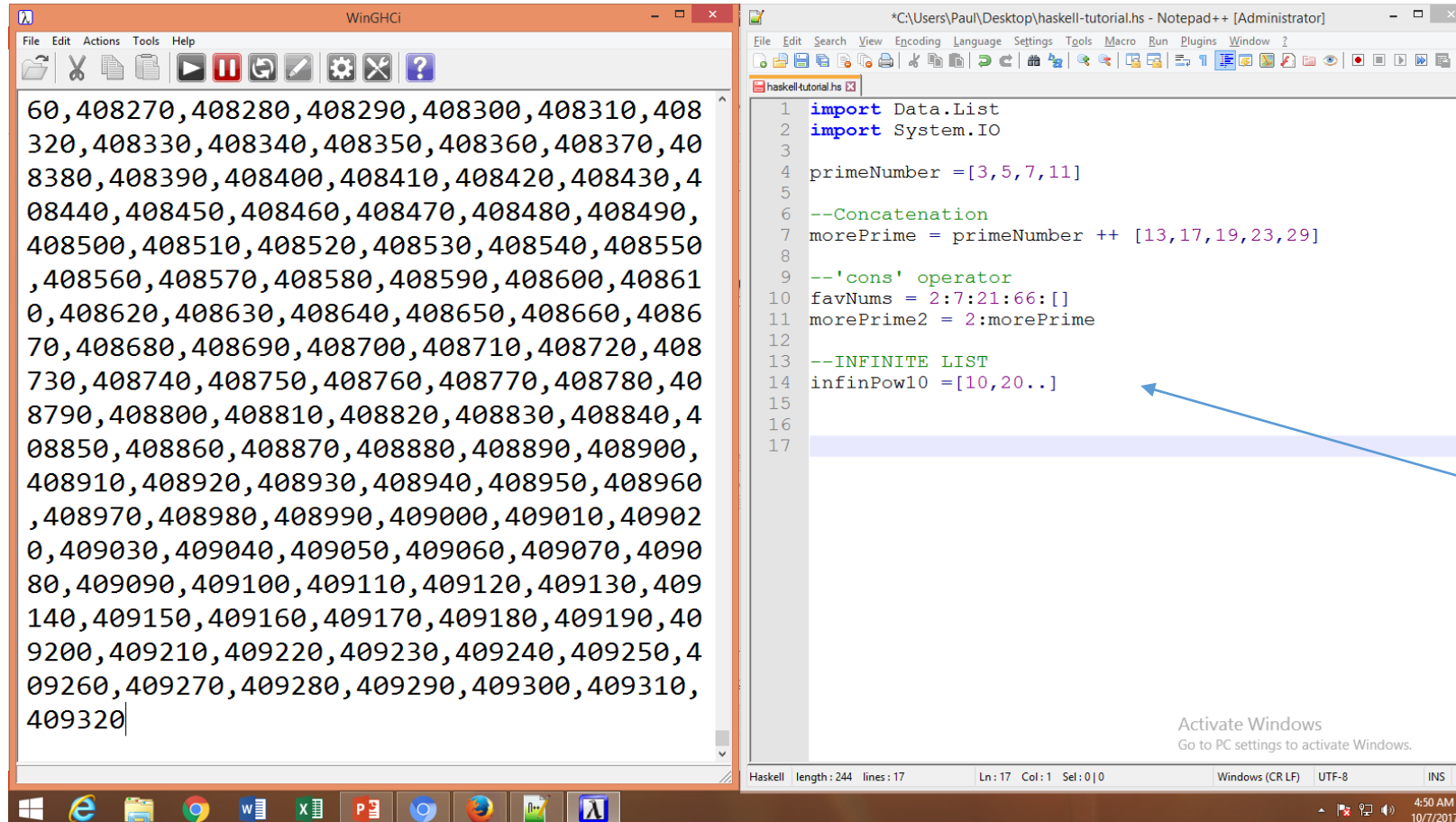
Annotations on the right side of the Notepad++ window:

- A red box labeled "product" with an arrow pointing to line 15: `prodList = product smallList`.
- A red box labeled "sequence" with an arrow pointing to line 20: `letterList = ['A','C'..'Z']`.

At the bottom of the Notepad++ window, it says "Activate Windows Go to PC settings to activate Windows."



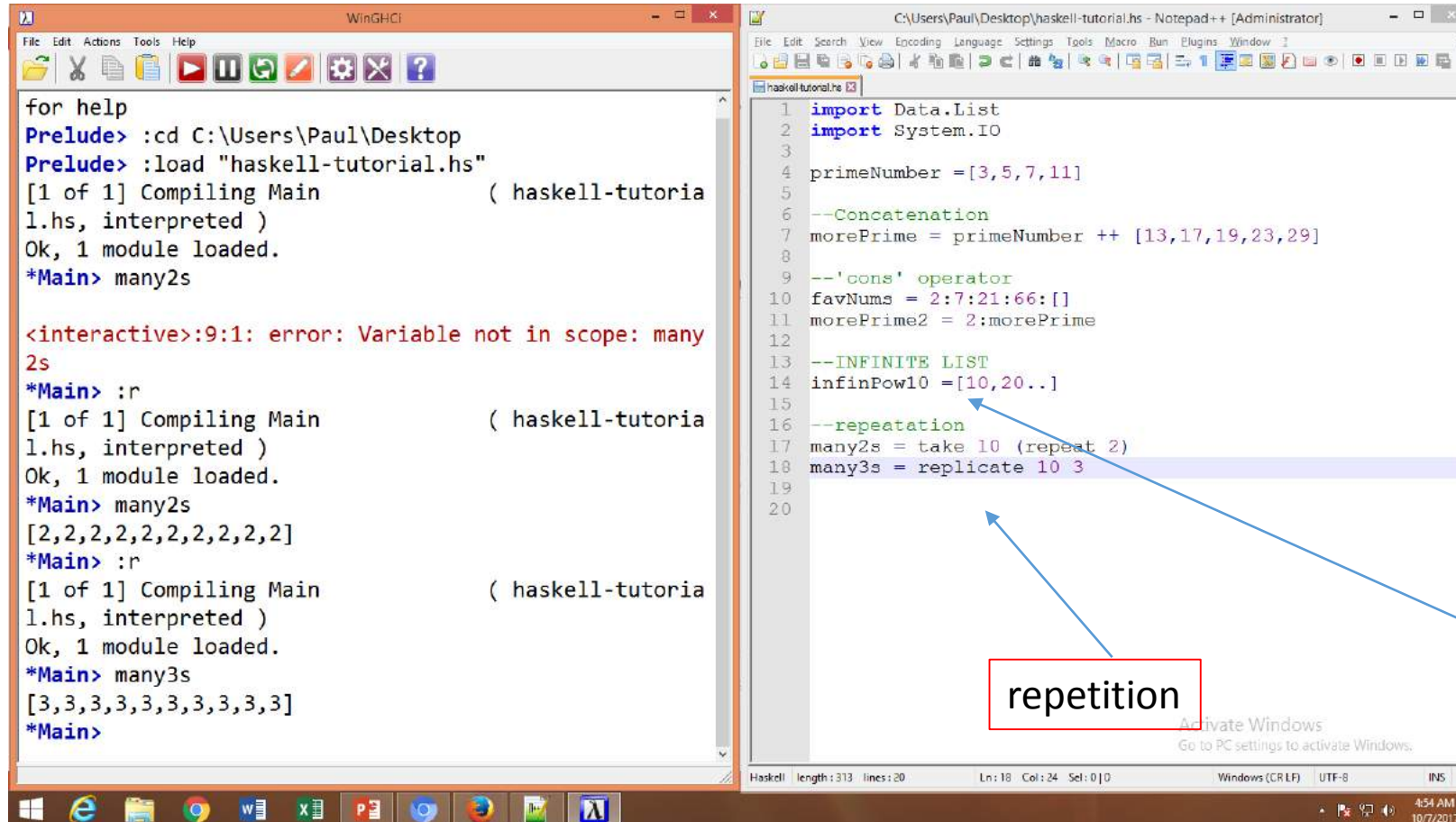
# More Operations on List



The image shows a screenshot of a computer screen with two windows. The left window, titled 'WinGHCi', displays a long list of numbers from 60 to 409320. The right window, titled '\*C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]', shows Haskell code. A blue arrow points from a red-bordered box labeled 'infinite list' to the line 'infinPow10 = [10,20..]' in the code.

```
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --INFINITE LIST
14 infinPow10 = [10,20..]
15
16
17
```

# More Operations on List



The image shows a screenshot of a Haskell tutorial. On the left, the WinGHCi window displays the interactive session. On the right, the Notepad++ window shows the source code for 'haskell-tutorial.hs'.

**WinGHCi Window:**

```
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> many2s

<interactive>:9:1: error: Variable not in scope: many2s
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> many2s
[2,2,2,2,2,2,2,2,2,2]
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> many3s
[3,3,3,3,3,3,3,3,3,3]
*Main>
```

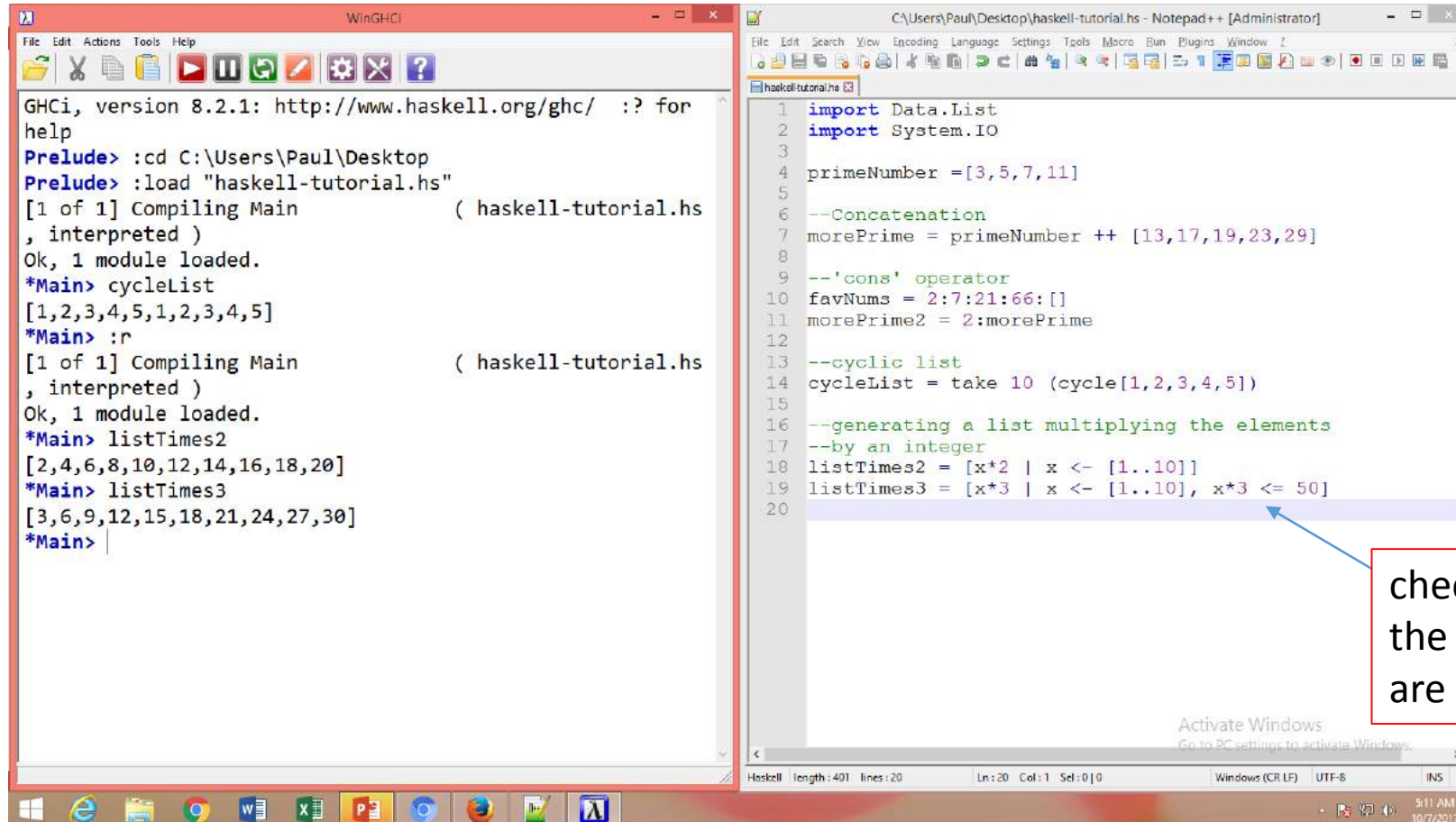
**Notepad++ Window (haskell-tutorial.hs):**

```
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --INFINITE LIST
14 infinPow10 = [10,20..]
15
16 --repeation
17 many2s = take 10 (repeat 2)
18 many3s = replicate 10 3
19
20
```

Arrows point from the text 'repetition' to the `repeat` and `replicate` functions in the code.

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

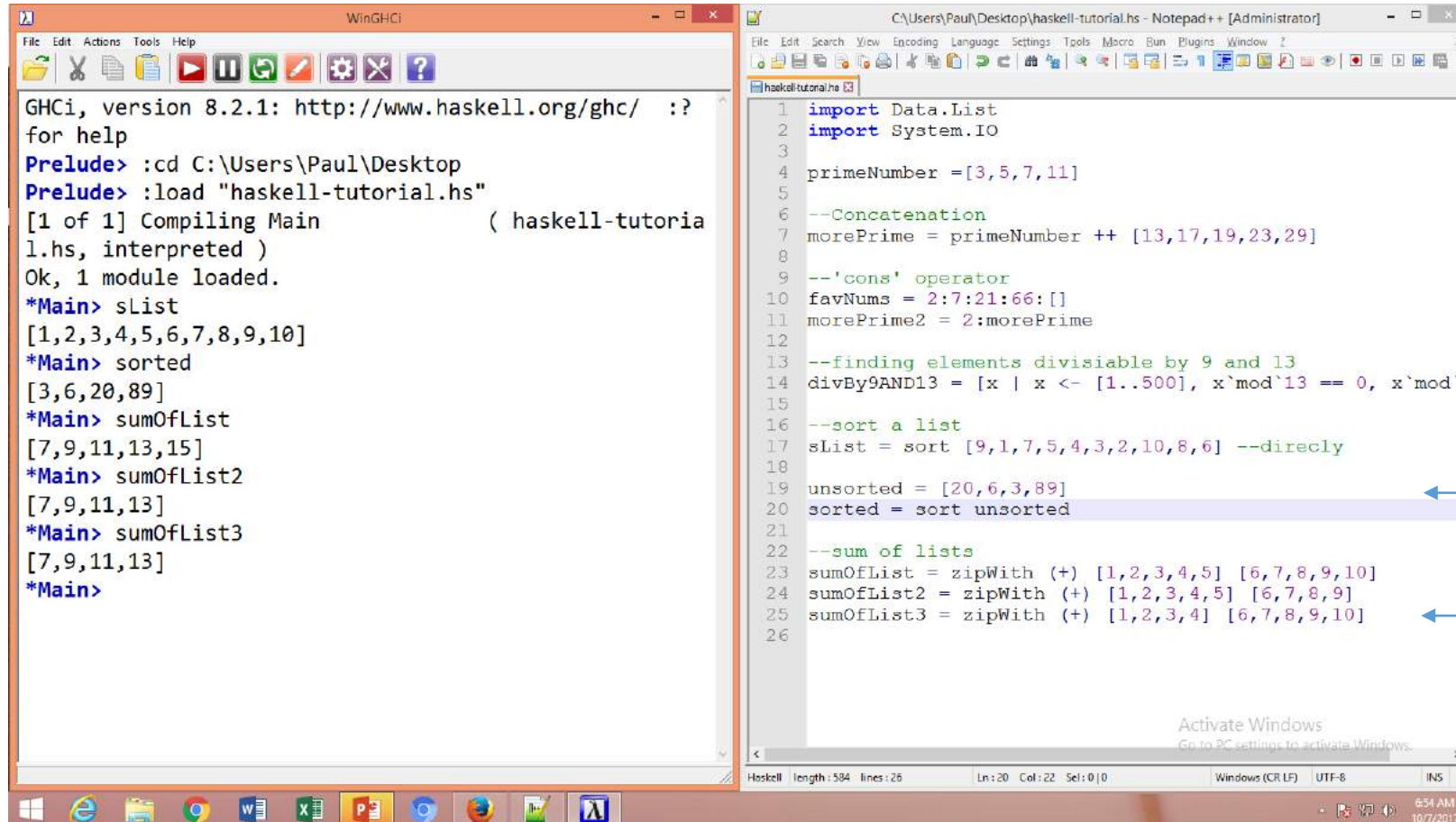


```
WinGHCi
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for
help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main          ( haskell-tutorial.hs
, interpreted )
Ok, 1 module loaded.
*Main> cycleList
[1,2,3,4,5,1,2,3,4,5]
*Main> :r
[1 of 1] Compiling Main          ( haskell-tutorial.hs
, interpreted )
Ok, 1 module loaded.
*Main> listTimes2
[2,4,6,8,10,12,14,16,18,20]
*Main> listTimes3
[3,6,9,12,15,18,21,24,27,30]
*Main>

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
1 import Data.List
2 import System.IO
3
4 primeNumber =[3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --cyclic list
14 cycleList = take 10 (cycle[1,2,3,4,5])
15
16 --generating a list multiplying the elements
17 --by an integer
18 listTimes2 = [x*2 | x <- [1..10]]
19 listTimes3 = [x*3 | x <- [1..10], x*3 <= 50]
20
```

check whether  
the element generated  
are less than 50 or not

# More Operations on List



The image shows two windows side-by-side. The left window is WinGHCi, and the right window is Notepad++.

**WinGHCi window:**

```
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> sList
[1,2,3,4,5,6,7,8,9,10]
*Main> sorted
[3,6,20,89]
*Main> sumOfList
[7,9,11,13,15]
*Main> sumOfList2
[7,9,11,13]
*Main> sumOfList3
[7,9,11,13]
*Main>
```

**Notepad++ window:**

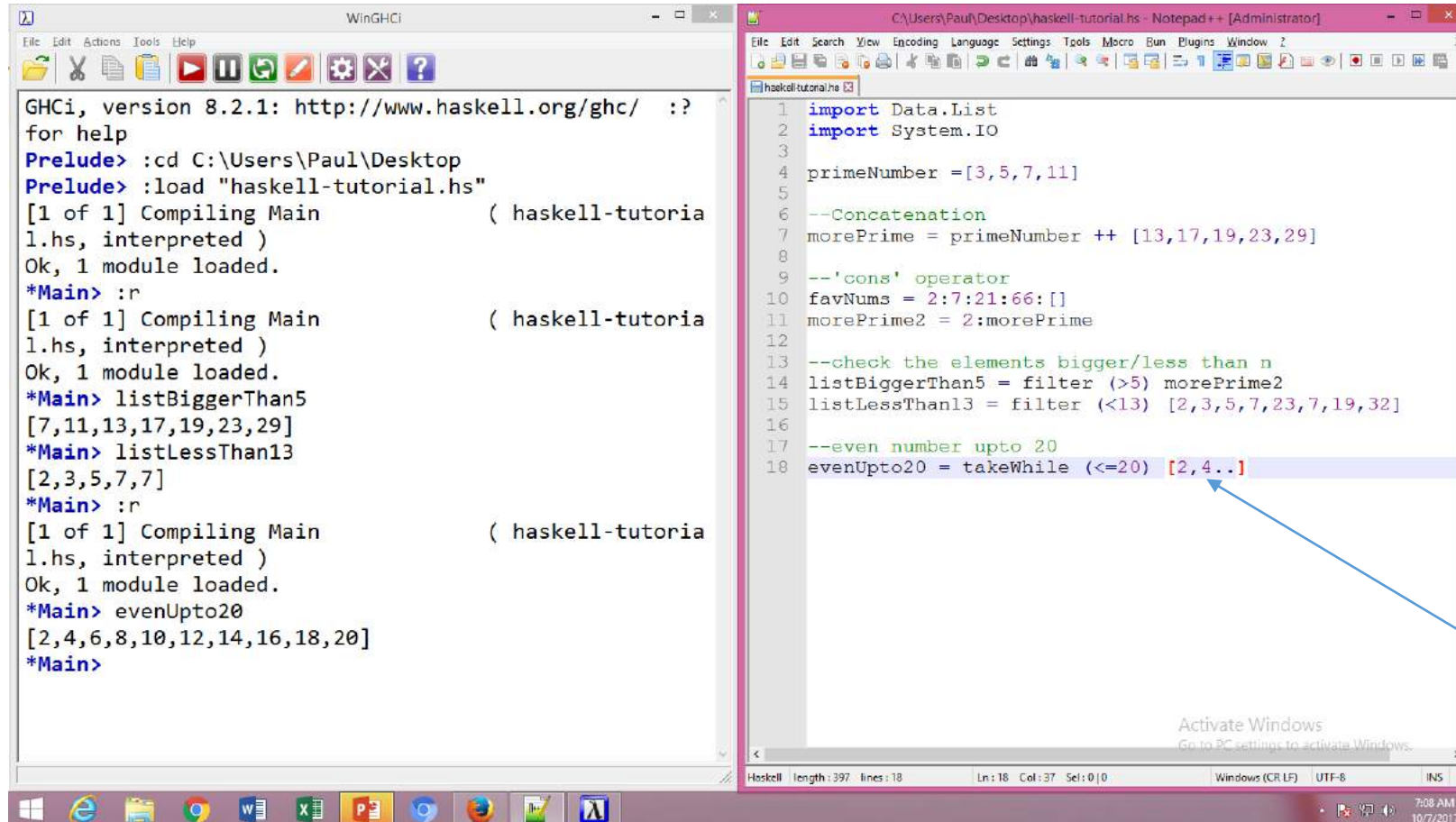
```
1 import Data.List
2 import System.IO
3
4 primeNumber =[3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --finding elements divisible by 9 and 13
14 divBy9AND13 = [x | x <- [1..500], x`mod`13 == 0, x`mod`
15
16 --sort a list
17 sList = sort [9,1,7,5,4,3,2,10,8,6] --directly
18
19 unsorted = [20,6,3,89]
20 sorted = sort unsorted
21
22 --sum of lists
23 sumOfList = zipWith (+) [1,2,3,4,5] [6,7,8,9,10]
24 sumOfList2 = zipWith (+) [1,2,3,4,5] [6,7,8,9]
25 sumOfList3 = zipWith (+) [1,2,3,4] [6,7,8,9,10]
26
```

sorting

summation



# More Operations on List



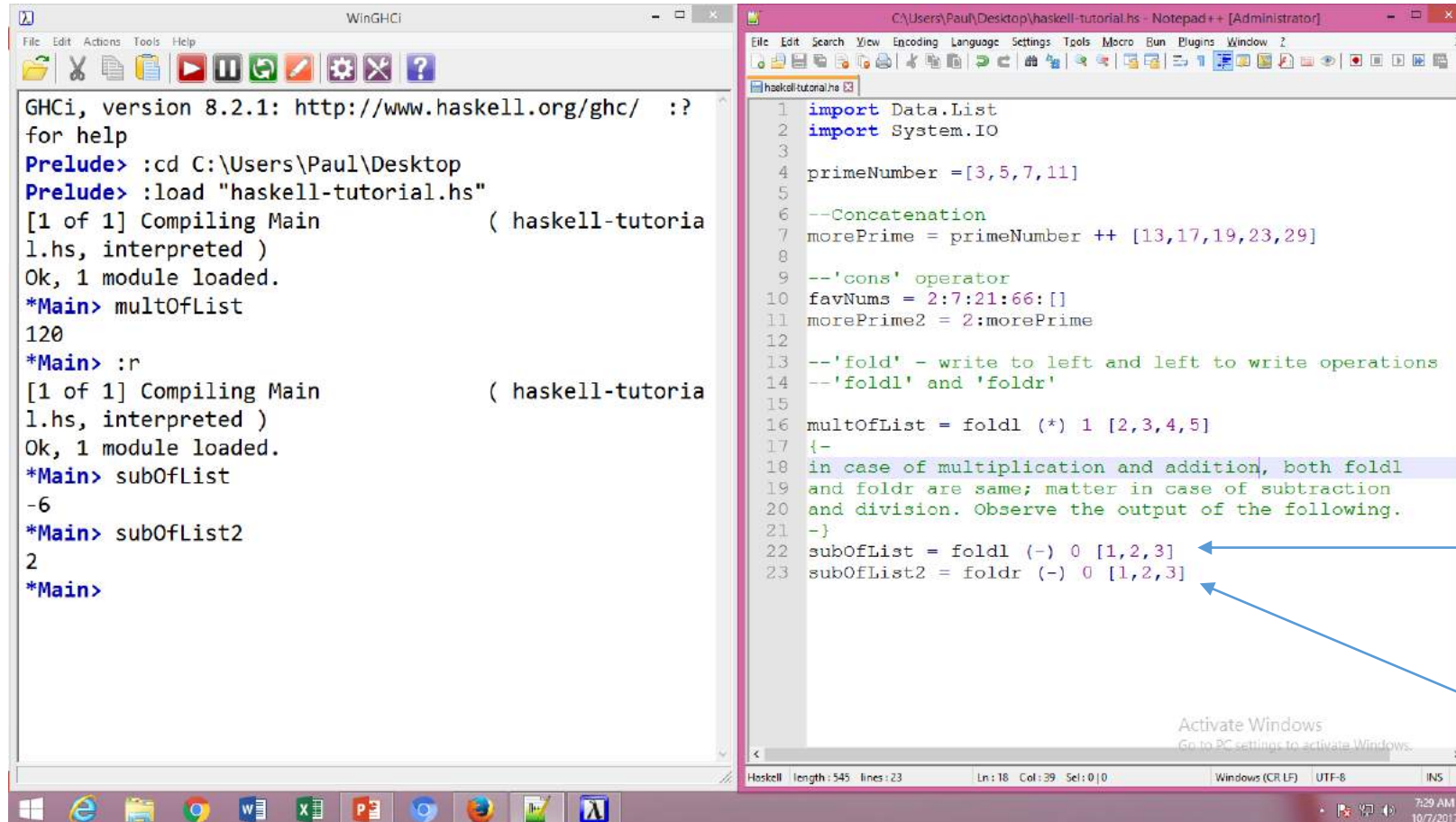
The image shows two windows side-by-side. The left window is WinGHCi, a Haskell interpreter, showing the execution of a Haskell program. The right window is Notepad++, showing the source code of the program. The code defines a list of prime numbers, concatenates it with another list, and uses various list operations like filter and takeWhile to demonstrate laziness.

```
WinGHCi
GHCi, version 8.2.1: http://www.haskell.org/ghc/  :? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> listBiggerThan5
[7,11,13,17,19,23,29]
*Main> listLessThan13
[2,3,5,7,11]
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> evenUpto20
[2,4,6,8,10,12,14,16,18,20]
*Main>
```

```
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --check the elements bigger/less than n
14 listBiggerThan5 = filter (>5) morePrime2
15 listLessThan13 = filter (<13) [2,3,5,7,23,7,19,32]
16
17 --even number upto 20
18 evenUpto20 = takeWhile (<=20) [2,4..]
```

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

# More Operations on List



```
WinGHCi
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> multOfList
120
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> subOfList
-6
*Main> subOfList2
2
*Main>
```

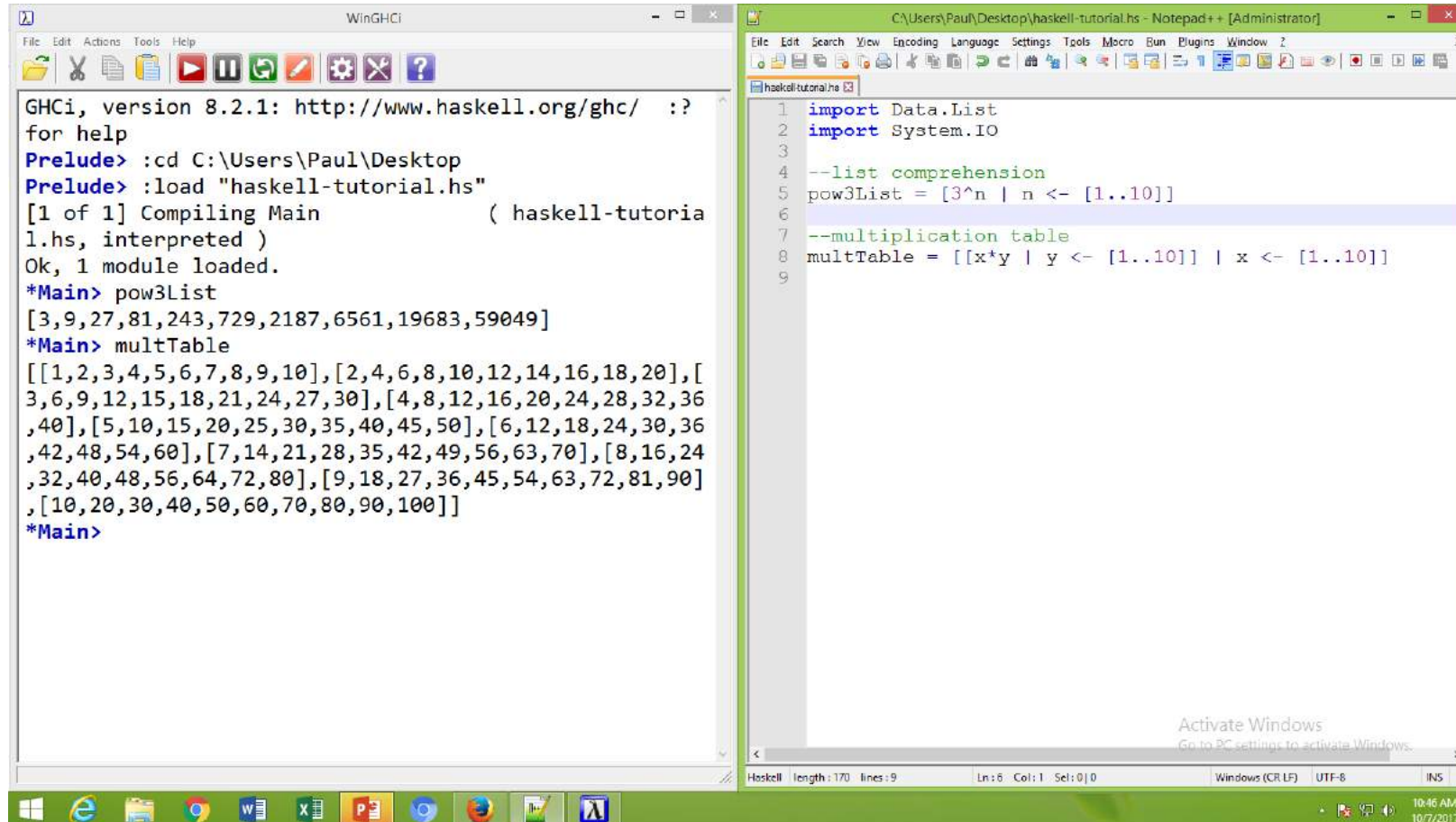
```
C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
1 import Data.List
2 import System.IO
3
4 primeNumber = [3,5,7,11]
5
6 --Concatenation
7 morePrime = primeNumber ++ [13,17,19,23,29]
8
9 --'cons' operator
10 favNums = 2:7:21:66:[]
11 morePrime2 = 2:morePrime
12
13 --'fold' - write to left and left to write operations
14 --'foldl' and 'foldr'
15
16 multOfList = foldl (*) 1 [2,3,4,5]
17 {-
18 in case of multiplication and addition, both foldl
19 and foldr are same; matter in case of subtraction
20 and division. Observe the output of the following.
21 -}
22 subOfList = foldl (-) 0 [1,2,3]
23 subOfList2 = foldr (-) 0 [1,2,3]
```

foldl & foldr

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

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

# More Operations on List



```
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main          ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> pow3List
[3,9,27,81,243,729,2187,6561,19683,59049]
*Main> multTable
[[1,2,3,4,5,6,7,8,9,10],[2,4,6,8,10,12,14,16,18,20],[
3,6,9,12,15,18,21,24,27,30],[4,8,12,16,20,24,28,32,36
,40],[5,10,15,20,25,30,35,40,45,50],[6,12,18,24,30,36
,42,48,54,60],[7,14,21,28,35,42,49,56,63,70],[8,16,24
,32,40,48,56,64,72,80],[9,18,27,36,45,54,63,72,81,90]
,[10,20,30,40,50,60,70,80,90,100]]
*Main>
```

```
1 import Data.List
2 import System.IO
3
4 --list comprehension
5 pow3List = [3^n | n <- [1..10]]
6
7 --multiplication table
8 multTable = [[x*y | y <- [1..10]] | x <- [1..10]]
9
```

Activate Windows  
Go to PC settings to activate Windows.

Haskell | length: 170 | lines: 9 | Ln: 8 | Col: 1 | Sel: 0 | 0 | Windows (CR LF) | UTF-8 | INS | 10:46 AM 10/7/2017

# Multiple Data Type



```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main          ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> bobsName
"Bob Smith"
*Main> bobsAge
52
*Main> |

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window Z
[Icons]
1 import Data.List
2 import System.IO
3
4 --random tuple
5 randTuple = (1, "Random Tuple")
6 bobsSmith = ("Bob Smith", 52)
7 bobsName = fst bobsSmith
8 bobsAge = snd bobsSmith
9
10
11

Haskell | length: 170 | lines: 11 | Ln: 10 | Col: 1 | Sel: 0 | 0 | Windows (CR LF) | UTF-8 | INS | 10:52 AM 10/7/2017
```



# Function Declaration



The screenshot displays two windows on a Windows desktop. The left window is the WinGHC terminal, showing the execution of Haskell code. The right window is a Notepad++ editor showing the source code of 'haskell-tutorial.hs'.

**WinGHC Terminal Output:**

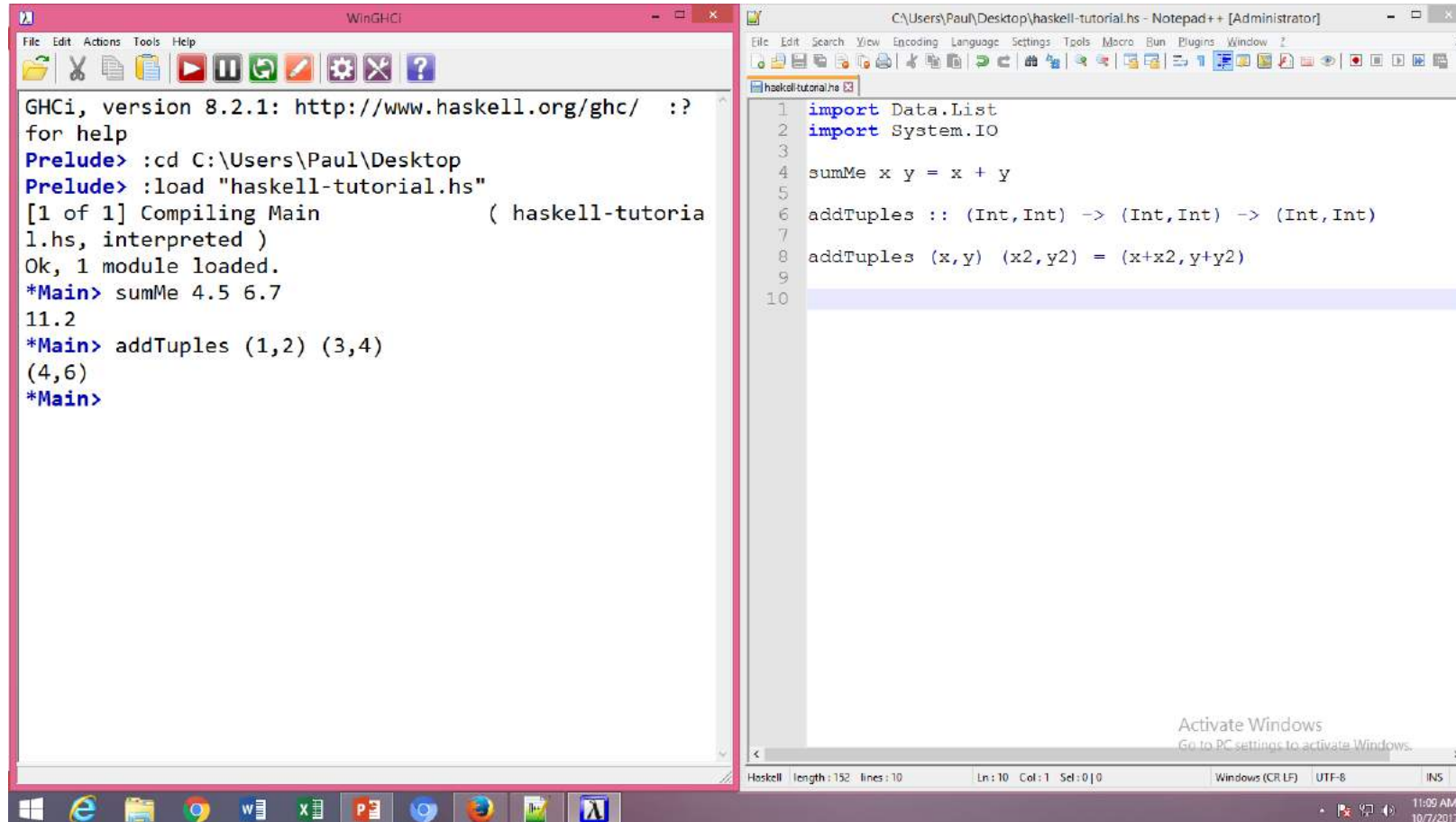
```
GHCi, version 8.2.1: http://www.haskell.org/ghc/
:? for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> :t addMe
addMe :: Int -> Int -> Int
*Main> addMe 56 9999
10055
*Main>
```

**Notepad++ Editor Content (haskell-tutorial.hs):**

```
1 import Data.List
2 import System.IO
3
4 addMe :: Int -> Int -> Int
5 --funcName parameter1 parameter2=operation(return value)
6
7 addMe x y =x+y
```

The status bar at the bottom of the Notepad++ window indicates: Haskell | length: 140 | lines: 7 | Ln: 7 | Col: 15 | Sel: 0 | 0 | Windows (CR LF) | UTF-8 | INS. The system clock shows 11:02 AM on 10/7/2017.

# User Type Declaration



```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> sumMe 4.5 6.7
11.2
*Main> addTuples (1,2) (3,4)
(4,6)
*Main>

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window Z
[Icons]
1 import Data.List
2 import System.IO
3
4 sumMe x y = x + y
5
6 addTuples :: (Int,Int) -> (Int,Int) -> (Int,Int)
7
8 addTuples (x,y) (x2,y2) = (x+x2,y+y2)
9
10

Haskell length: 192 lines: 10 Ln: 10 Col: 1 Sel: 0 | 0 Windows (CR LF) UTF-8 INS
11:05 AM 10/7/2017
```

# User Type Declaration

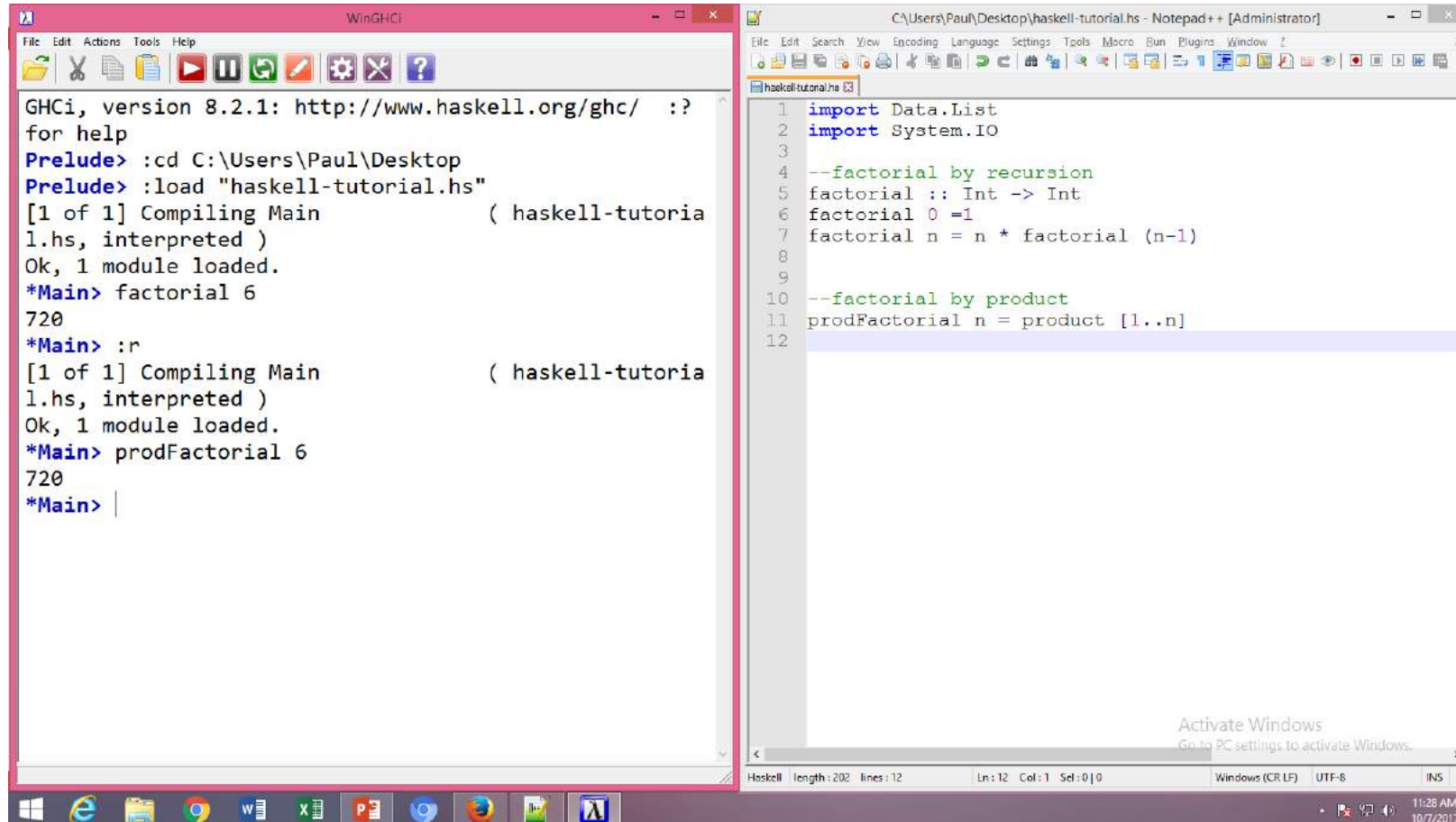


```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> sumMe 4.5 6.7
11.2
*Main> addTuples (1,2) (3,4)
(4,6)
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> whatAge 18
"You Can Vote"
*Main> whatAge 16
"You Can Drive"
*Main> whatAge 67
"Nothing Important"
*Main>

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
[Icons]
1 import Data.List
2 import System.IO
3
4 whatAge :: Int ->String
5
6 whatAge 16 = "You Can Drive"
7 whatAge 18 = "You Can Vote"
8 whatAge 21 = "You are Adult"
9 whatAge x = "Nothing Important"
10
11

Haskell | length: 189 | lines: 11 | Ln: 11 | Col: 1 | Sel: 0 | 0 | Windows (CR LF) | UTF-8 | INS | 11:22 AM 10/7/2017
```

# Factorial (by recursion and by product)

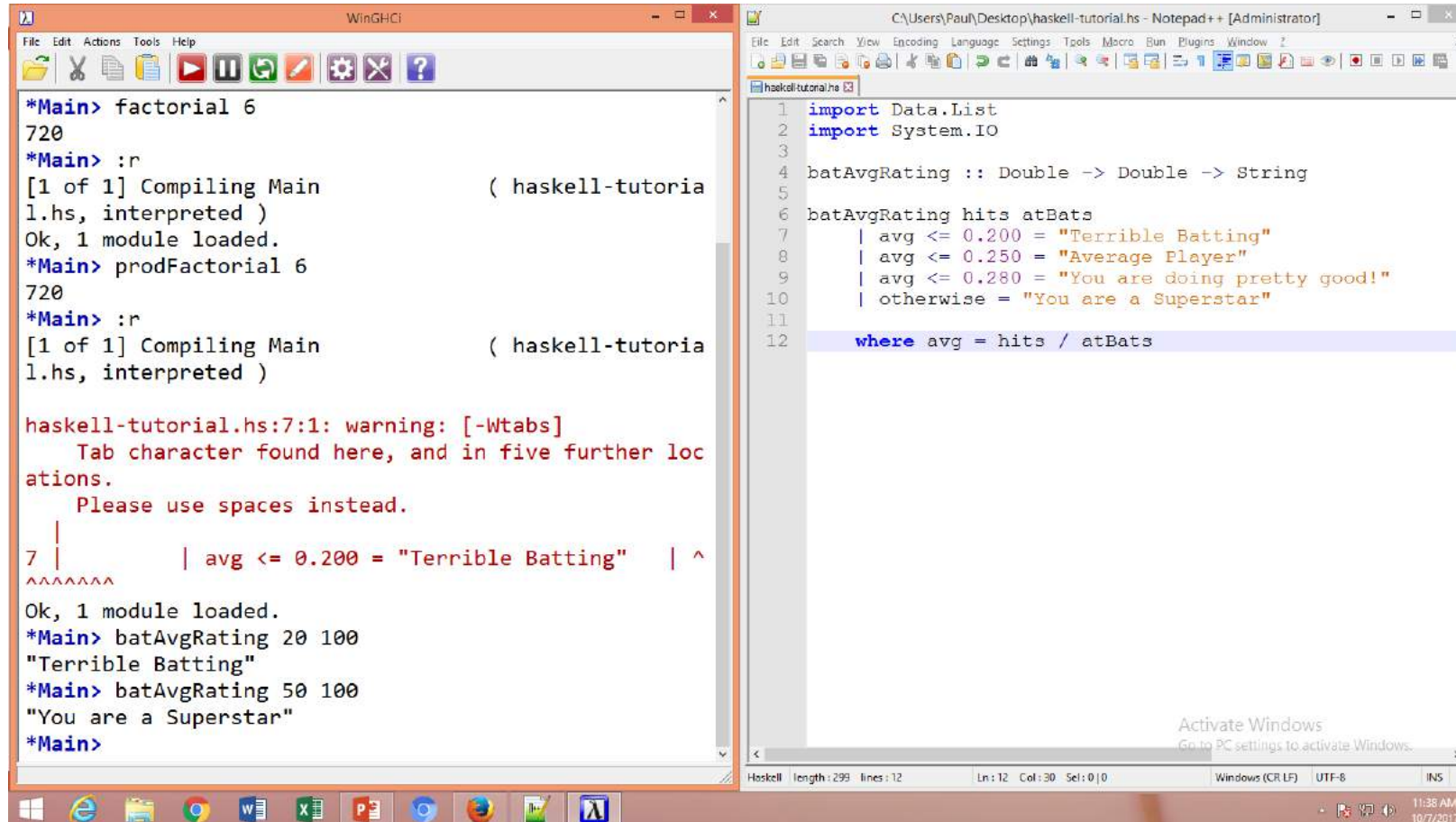


```
WinGHCi
File Edit Actions Tools Help
[Icons]
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> factorial 6
720
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> prodFactorial 6
720
*Main> |

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window Z
[Icons]
1 import Data.List
2 import System.IO
3
4 --factorial by recursion
5 factorial :: Int -> Int
6 factorial 0 = 1
7 factorial n = n * factorial (n-1)
8
9
10 --factorial by product
11 prodFactorial n = product [1..n]
12
```



# Guard (where clause)

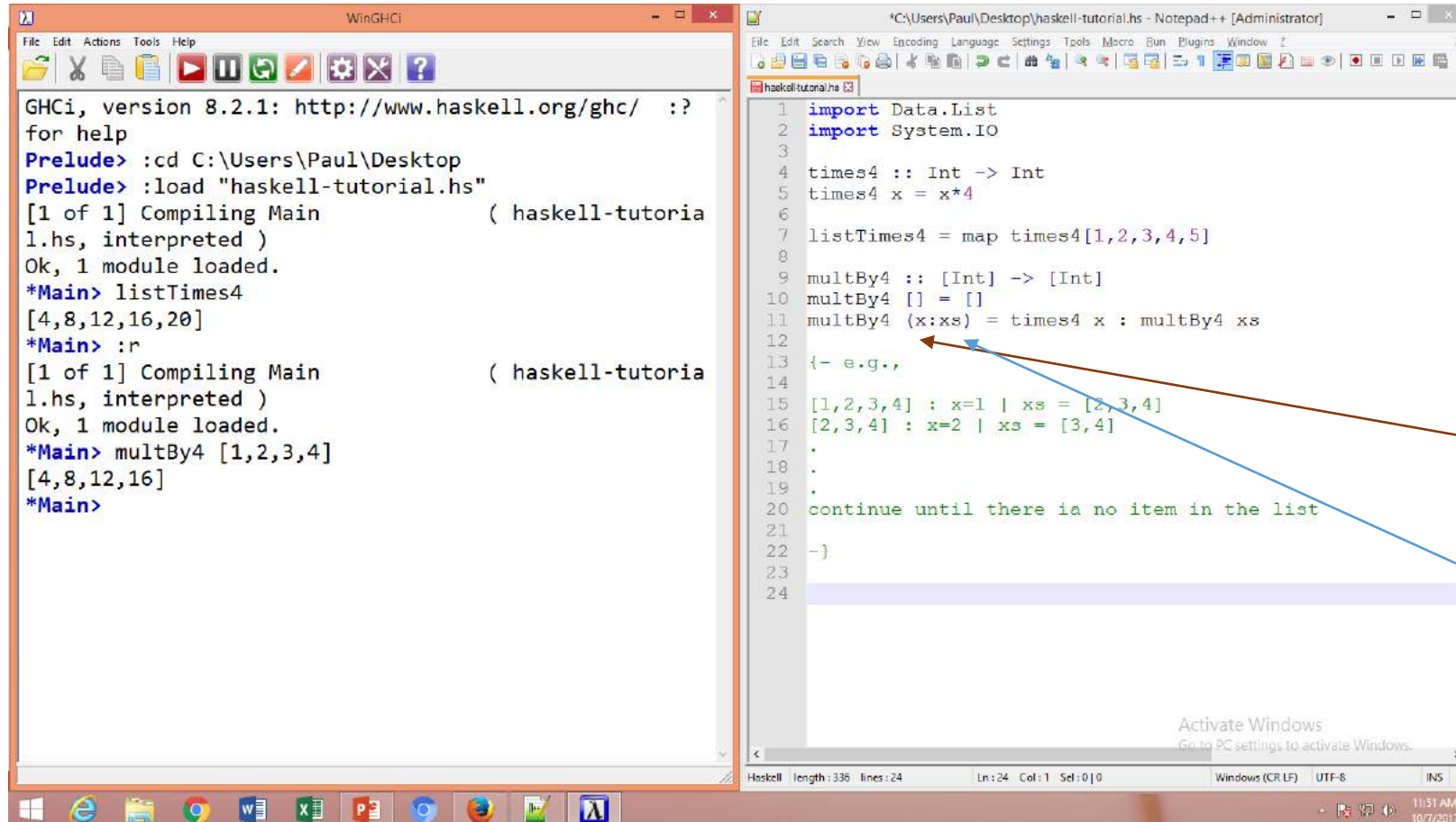


```
*Main> factorial 6
720
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> prodFactorial 6
720
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )

haskell-tutorial.hs:7:1: warning: [-Wtabs]
    Tab character found here, and in five further locations.
    Please use spaces instead.
7 |           | avg <= 0.200 = "Terrible Batting" | ^
  |           ^^^^^^^
Ok, 1 module loaded.
*Main> batAvgRating 20 100
"Terrible Batting"
*Main> batAvgRating 50 100
"You are a Superstar"
*Main>
```

```
1 import Data.List
2 import System.IO
3
4 batAvgRating :: Double -> Double -> String
5
6 batAvgRating hits atBats
7   | avg <= 0.200 = "Terrible Batting"
8   | avg <= 0.250 = "Average Player"
9   | avg <= 0.280 = "You are doing pretty good!"
10  | otherwise = "You are a Superstar"
11
12 where avg = hits / atBats
```

# Higher Order Functions

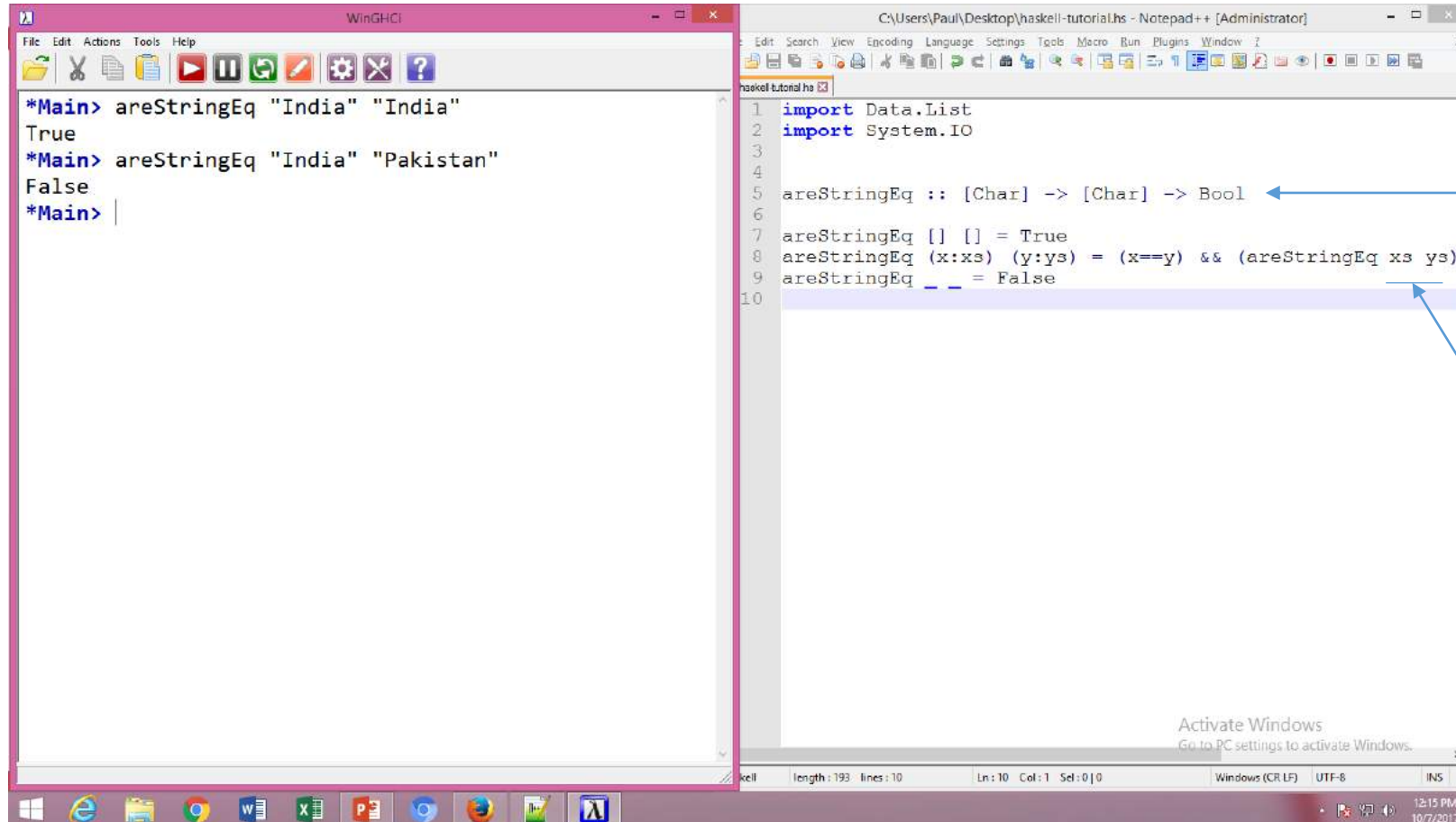


```
WinGHCi
File Edit Actions Tools Help
GHCi, version 8.2.1: http://www.haskell.org/ghc/ :?
for help
Prelude> :cd C:\Users\Paul\Desktop
Prelude> :load "haskell-tutorial.hs"
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> listTimes4
[4,8,12,16,20]
*Main> :r
[1 of 1] Compiling Main             ( haskell-tutorial.hs, interpreted )
Ok, 1 module loaded.
*Main> multBy4 [1,2,3,4]
[4,8,12,16]
*Main>

*C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window Z
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 times4 :: Int -> Int
5 times4 x = x*4
6
7 listTimes4 = map times4 [1,2,3,4,5]
8
9 multBy4 :: [Int] -> [Int]
10 multBy4 [] = []
11 multBy4 (x:xs) = times4 x : multBy4 xs
12
13 {- e.g.,
14 [1,2,3,4] : x=1 | xs = [2,3,4]
15 [2,3,4]  : x=2 | xs = [3,4]
16 .
17 .
18 .
19 .
20 continue until there is no item in the list
21 -}
22
23
24
Haskell length: 336 lines: 24 Ln: 24 Col: 1 Sel: 0 | 0 Windows (CR LF) UTF-8 INS
11:51 AM 10/7/2017
```

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



The screenshot shows two windows. The left window is a WinGHCi terminal with the following text:

```
*Main> areStringEq "India" "India"
True
*Main> areStringEq "India" "Pakistan"
False
*Main> |
```

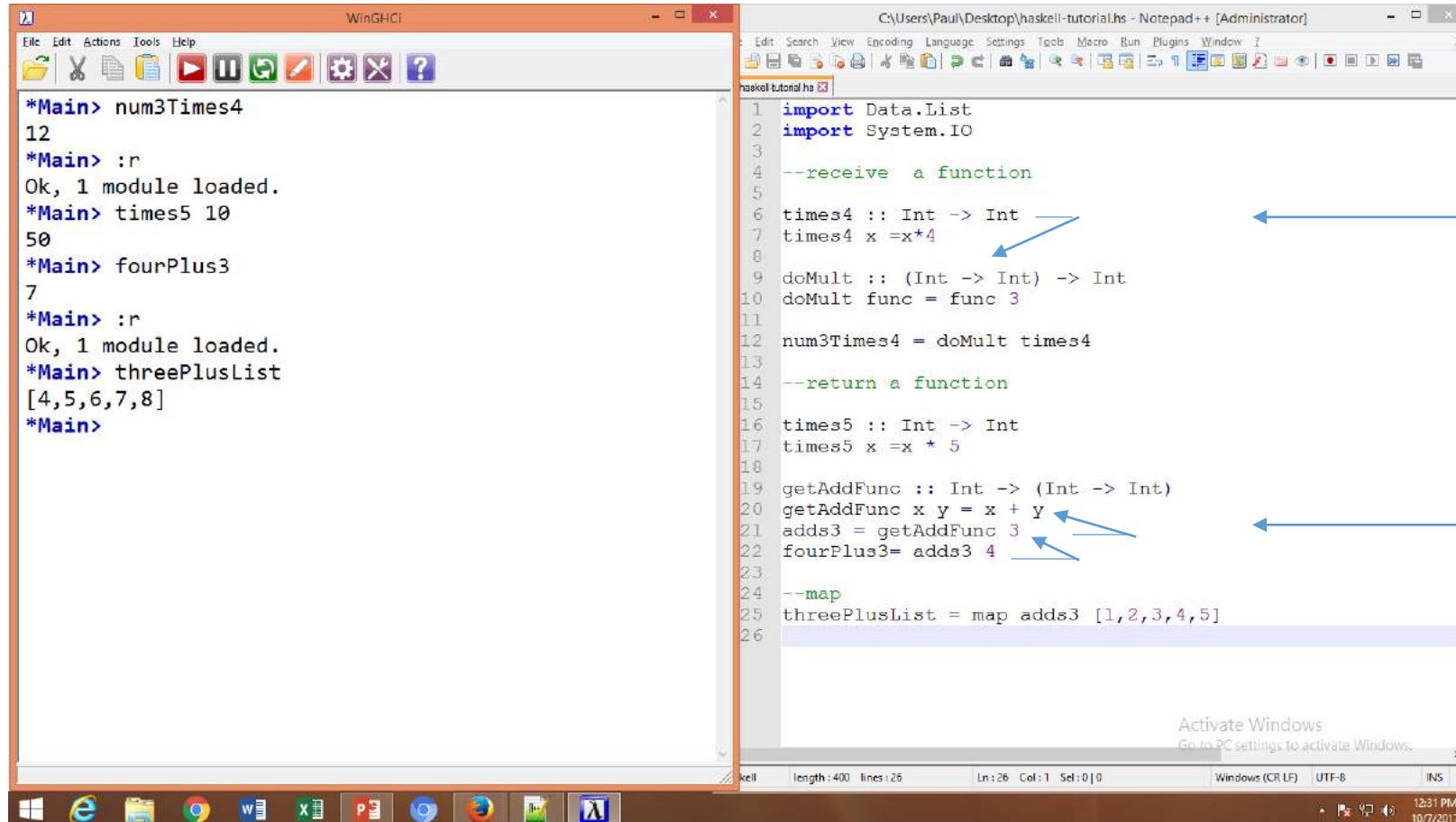
The right window is a Notepad++ editor showing the Haskell code for `areStringEq`:

```
1 import Data.List
2 import System.IO
3
4
5 areStringEq :: [Char] -> [Char] -> Bool
6
7 areStringEq [] [] = True
8 areStringEq (x:xs) (y:ys) = (x==y) && (areStringEq xs ys)
9 areStringEq _ _ = False
10
```

Annotations with blue arrows point from text boxes to the code:

- A box labeled "return type" points to the `Bool` in the function signature on line 5.
- A box labeled "remaining" points to the recursive call `areStringEq xs ys` on line 8.

# Receive and Return a Function



The image shows two windows side-by-side. The left window is WinGHC, a Haskell interpreter, showing the execution of several Haskell expressions. The right window is Notepad++, showing the source code for a Haskell program. Blue arrows point from the code in Notepad++ to the corresponding output in WinGHC. Two red boxes with arrows point to the code in Notepad++: one labeled 'receive' points to the function definition for `times4`, and another labeled 'return' points to the function definition for `getAddFunc`.

```
*Main> num3Times4
12
*Main> :r
Ok, 1 module loaded.
*Main> times5 10
50
*Main> fourPlus3
7
*Main> :r
Ok, 1 module loaded.
*Main> threePlusList
[4,5,6,7,8]
*Main>
```

```
1 import Data.List
2 import System.IO
3
4 --receive a function
5
6 times4 :: Int -> Int
7 times4 x = x*4
8
9 doMult :: (Int -> Int) -> Int
10 doMult func = func 3
11
12 num3Times4 = doMult times4
13
14 --return a function
15
16 times5 :: Int -> Int
17 times5 x = x * 5
18
19 getAddFunc :: Int -> (Int -> Int)
20 getAddFunc x y = x + y
21 adds3 = getAddFunc 3
22 fourPlus3 = adds3 4
23
24 --map
25 threePlusList = map adds3 [1,2,3,4,5]
26
```

# Other Operators

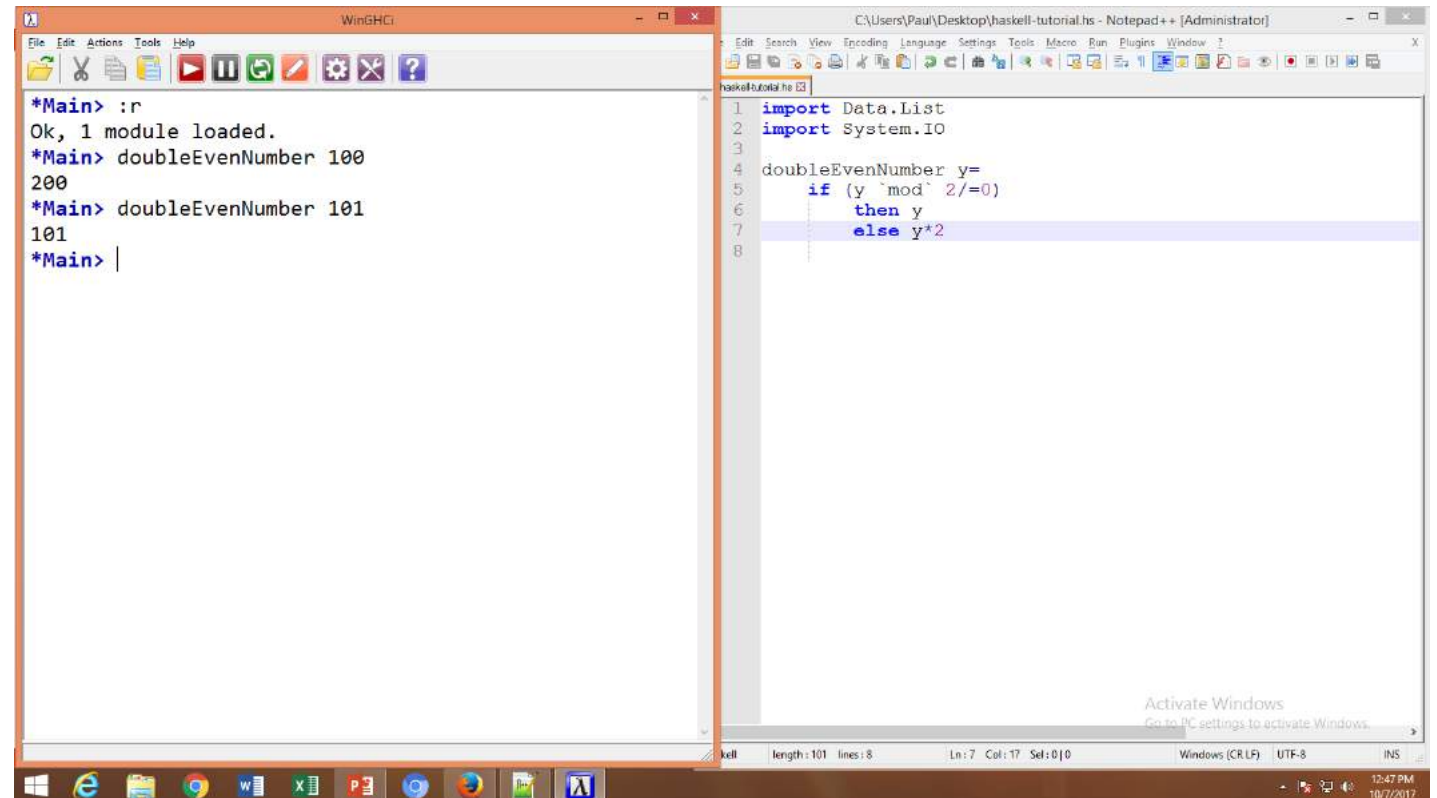
## ➤ Comparison

- < --less than
- > --greater than
- <= --less than equal to
- >= --greater than equal to
- == --equal to

## ➤ Logical

- && --AND
- || --OR
- not --NOT

## Example

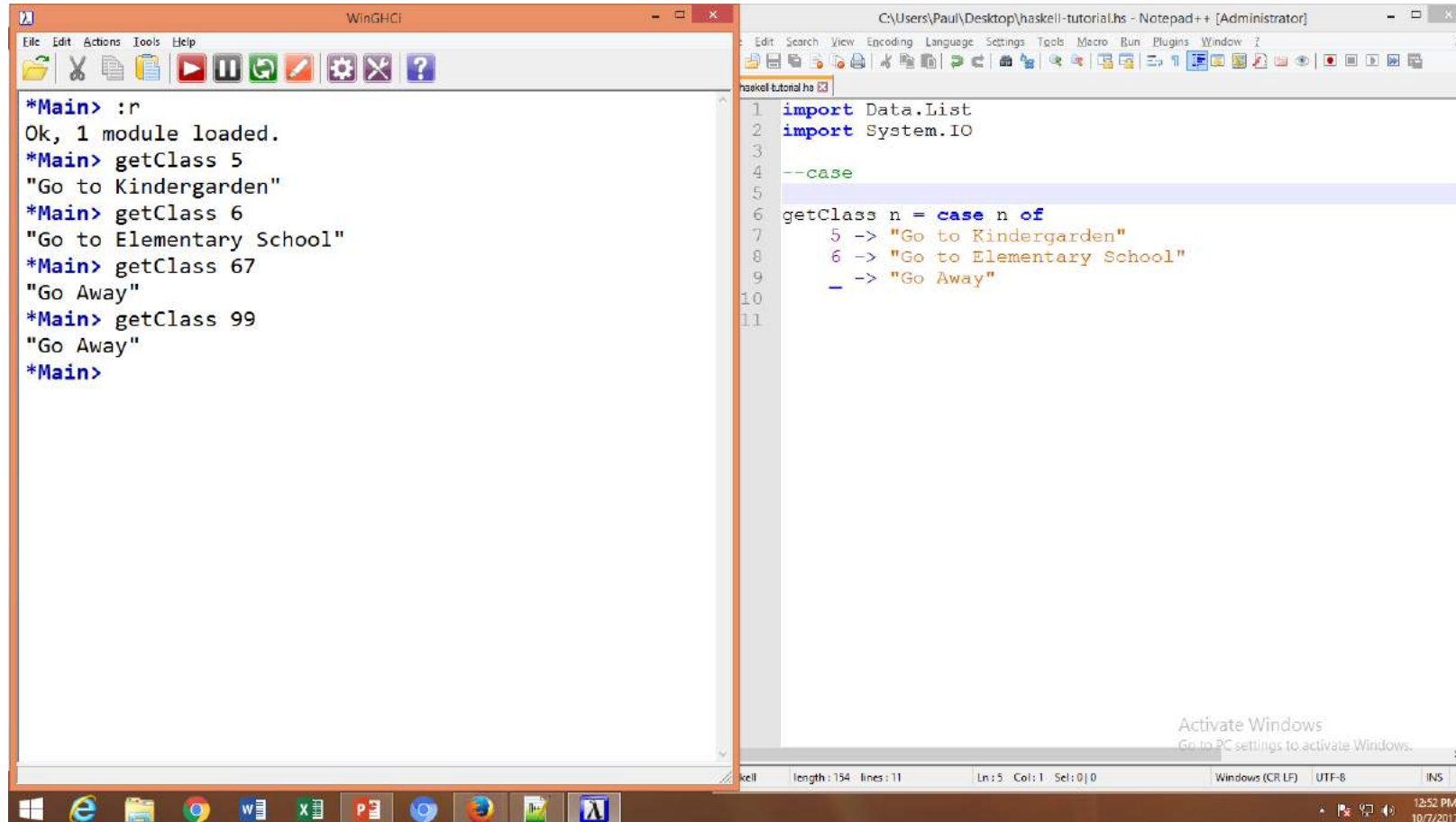


```
*Main> :r
Ok, 1 module loaded.
*Main> doubleEvenNumber 100
200
*Main> doubleEvenNumber 101
101
*Main> |
```

```
1 import Data.List
2 import System.IO
3
4 doubleEvenNumber y=
5     if (y `mod` 2/=0)
6     then y
7     else y*2
8
```



# Case



The screenshot displays two windows side-by-side. The left window, titled 'WinGHCi', shows the GHCi prompt with the following interactions:

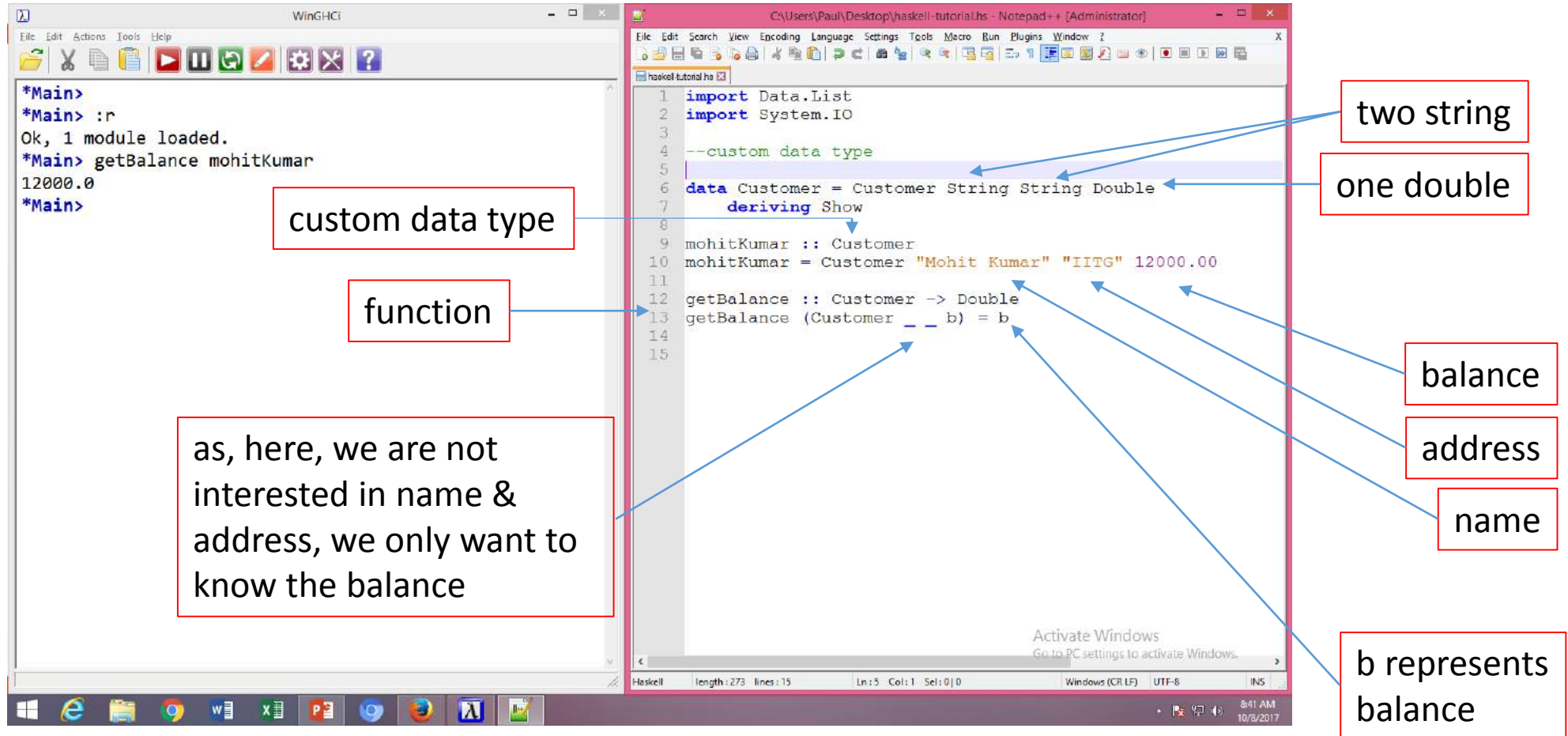
```
*Main> :r
Ok, 1 module loaded.
*Main> getClass 5
"Go to Kindergarden"
*Main> getClass 6
"Go to Elementary School"
*Main> getClass 67
"Go Away"
*Main> getClass 99
"Go Away"
*Main>
```

The right window, titled 'C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]', shows the source code for the tutorial:

```
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
```

The status bar at the bottom of the Notepad++ window indicates the file is 'haskell-tutorial.hs', has a length of 154, 11 lines, and is currently at line 5, column 1. The Windows taskbar at the bottom shows the date and time as 12:52 PM on 10/7/2017.

# Custom Data Type



The image shows a Haskell tutorial with two windows. The left window is a WinGHCi shell, and the right window is a Notepad++ editor showing Haskell code. Annotations explain the code and the shell output.

**WinGHCi Shell Output:**

```
*Main>
*Main> :r
Ok, 1 module loaded.
*Main> getBalance mohitKumar
12000.0
*Main>
```

**Notepad++ Code:**

```
1 import Data.List
2 import System.IO
3
4 --custom data type
5
6 data Customer = Customer String String Double
7   deriving Show
8
9 mohitKumar :: Customer
10 mohitKumar = Customer "Mohit Kumar" "IITG" 12000.00
11
12 getBalance :: Customer -> Double
13 getBalance (Customer _ _ b) = b
14
15
```

**Annotations:**

- custom data type**: Points to the `data Customer` line in the code.
- function**: Points to the `getBalance` function definition.
- as, here, we are not interested in name & address, we only want to know the balance**: Points to the pattern match `(Customer _ _ b)` in the `getBalance` function.
- two string**: Points to the first two `String` arguments in the `Customer` constructor.
- one double**: Points to the `Double` argument in the `Customer` constructor.
- balance**: Points to the `Double` argument in the `Customer` constructor.
- address**: Points to the second `String` argument in the `Customer` constructor.
- name**: Points to the first `String` argument in the `Customer` constructor.
- b represents balance**: Points to the `b` variable in the pattern match.

# Type Classes



```
WinGHCi
File Edit Actions Tools Help
[Icons]
*Main> :r
Ok, 1 module loaded.
*Main> isAnkitDarshit
False
*Main> ankitKumarData
"Employee {name = \"Ankit Kumar\", position = \"Manager\", idNum = 1001}"
*Main> darshitPatelData
"Employee {name = \"Darshit Patel\", position = \"Sales\", idNum = 3001}"
*Main>

C:\Users\Paul\Desktop\haskell-tutorial.hs - Notepad++ [Administrator]
File Edit Search View Encoding Language Settings Tools Macro Run Plugins Window ?
haskell-tutorial.hs
1 import Data.List
2 import System.IO
3
4 --custom data type
5
6 data Employee = Employee {name :: String,
7                             position :: String,
8                             idNum :: Int
9                             } deriving (Eq, Show)
10
11 ankitKumar = Employee{name="Ankit Kumar", position="Manager", idNum=1001}
12 darshitPatel = Employee{name="Darshit Patel", position="Sales", idNum=3001}
13
14 --check whether Ankit and Darshit are same or not
15 isAnkitDarshit = ankitKumar == darshitPatel
16
17 --shows the data of employee
18 ankitKumarData = show ankitKumar
19 darshitPatelData = show darshitPatel
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