Solution  Types and Polymorphism

- Exercises are given every week on the PL page of the SCG website (http://scg.unibe.ch/teaching/pl)
- Solutions to each assignment must be sent to mohammadreza.hazhirpasand@inf.unibe.ch
- The solutions of the assignments are to be delivered before every Thursday at 11 PM. Solutions handed in later than the specified time will not be accepted. In case of serious reasons send an e-mail to mohammadreza.hazhirpasand@inf.unibe.ch

Exercise (6 points)

1. Infer types of the functions factors, isPerfect, mH, and insert and say whether they are monomorphic or polymorphic functions. Please justify your answer. (3 pts)

```haskell
mod :: Int -> Int -> Int
factors n = [x | x <- [1..n-1], mod n x == 0 ]
isPerfect n = sum (factors n) == n

insert _ n [] = [n]
insert 0 n l = n:l
insert i n (x:xs) = x : insert (i-1) n xs

mH (a, b, c) = c
```

**Answer:**

factors :: Int -> [Int]
since both n and x are arguments of the function mod which accepts only the Int arguments

isPerfect :: Int -> Bool
since n is an argument of the function factors which accepts only the Int arguments, and == :: Eq a => a -> a -> Bool

Both functions are monomorphic.

---------------------------------------------------------------

insert :: Int -> a -> [a] -> [a]
since
insert _ n l = [n] => insert :: a->b->c->[b]
isert 0 n l = n:l => insert :: Int->b->[b]->[b]
The insert function is polymorphic.
mH (a, b, c) = c

mH :: (x, y, z) -> z
mH is polymorphic since the three elements a, b, and c may be of any type.
2. Some functions can be used with different argument types, but rarely with any type. Consider the square function, and identify which type is invalid. Please justify your answer. (1 pts)

\[
\begin{align*}
\text{square} & : \text{Int} \to \text{Int} \\
\text{square} & : \text{Float} \to \text{Float} \\
\text{square} & : \text{Char} \to \text{Char} \\
\text{square} & : \text{Double} \to \text{Double}
\end{align*}
\]

**Answer:**

*Invalid type for square is*

\[
\text{square} :: \text{Char} \to \text{Char}
\]

*The compiler doesn’t know how to multiply two Chars.*

*Multiplication is needed to calculate the square.*

3. Define a function to calculate the circumference of a circle and the area of a rectangle. It is required to define a **union type** containing the necessary parameters of a circle and a rectangle. (2 pts)

**Hints:**

- Circumference of a circle : \(2 \times 3.14 \times r\)
- Area of a rectangle : \(l \times w\)

**Answer:**

\[
\begin{align*}
data \text{ Shapes} & = \text{Circle} \text{ Float} \mid \text{Rectangle} \text{ Float} \text{ Float} \\
\text{calit} & :: \text{Shapes} \to \text{Float} \\
\text{calit} \ (\text{Circle} \ r) & = 2 \times \pi \times r \\
\text{calit} \ (\text{Rectangle} \ a \ b) & = a \times b
\end{align*}
\]