Methods 2 – Portfolio Assignment 2

- *Type:* Individual assignment
- *Due:* 10 April 2022, 23:59
- *Student:* Sara K. Kristensen

1. Square root function

Along the lines of section 6.4.2 (p. 247ff) in Gill's book, write an *R* function that calculates the square root of a given positive number. Your solution should contain:

a. A quick introduction into what the function does and why it works
b. A discussion of the choices you made (e.g., starting point of the algorithm)
c. A range of examples
d. A discussion of what happens when the program is applied to negative numbers

Answer

a. Following Newton-Raphson method the squareroot(x) function has three variables x, what ever number one wants squared, a, start guess of the root, and b, x saved in a new variable. As long as the absolute difference between a and b is bigger than a set margin of answer, because numbers that cannot be written as a fraction has no end to their square root, the function will overwrite a and b until the margin is reached. a is overwritten to the sum of a and b divided by 2, because if a is equal to b, when the equation would give a. b is overwritten to the fraction of x over a, because when a number is divided by its square root it gives the root, in this case a. Therefor b will at one point meet the criteria of being a, in this case with 1e-7 reach of a.

```
squareroot <- function(x){
  a <- 0
  b <- x
  ErrorMargin <- 0.0000001
  if (x<0)
   return ("I only like smiling numbers, choose a positive one!")
  while (abs(a-b)>ErrorMargin){
    a <- (a+b)/2
    b <- x/a
  }
  return(a)
}
```

b. the starting point of the algorithm is 0, because it will then can calculate the square root of any number above 0 (it will still give a number for 0 because of the error margin). The if-statement is for returning a warning message, because the square root of negative numbers does not exist in integers. The while-statement, runs until the difference for a and b hits the error margin of 1e-7 (the desired amount of decimals for the answer).
c. Examples

```
squareroot(16)
```

```
## [1] 4
```

```
squareroot(-12)
```

```
## [1] "I only like smiling numbers, choose a positive one!"
```

```
squareroot(1.2)
```

```
## [1] 1.095445
```

d. there does not exist a real solution for negative integers (excluding the imaginary numbers), because the solution would neither be negative nor positive.

2. Power series derivatives

The power series definitions ($:=$ means "is defined as") of the exponential, sine, and cosine functions are

$$\exp(x) := \sum_{n=0}^{\infty} \frac{x^n}{n!},$$

$$\sin(x) := \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n+1}}{(2n+1)!},$$

$$\cos(x) := \sum_{n=0}^{\infty} \frac{(-1)^n x^{2n}}{(2n)!}.$$

Using these definitions, show that

$$\frac{\mathrm{d}}{\mathrm{d}x} \exp(x) = \exp(x),$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \sin(x) = \cos(x),$$

$$\frac{\mathrm{d}}{\mathrm{d}x} \cos(x) = -\sin(x).$$

You can either use LaTeX (https://www.overleaf.com/learn/latex/Learn_LaTeX_in_30_minutes) or include photos of your (nicely) handwritten equations in the notebook. In any case, write down all intermediate steps.