Simple R Functions

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1.

(a) Write functions `tmpFn1` and `tmpFn2` such that if `xVec` is the vector $(x_1, x_2, ..., x_n)$, then `tmpFn1(xVec)` returns vector $(x_1, x_2^2, ..., x_n^n)$ and `tmpFn2(xVec)` returns the vector $(x_1, \frac{x_2^2}{2}, ..., \frac{x_n^n}{n})$.

Here is `tmpFn1`

```
tmpFn1 <- function(xVec){
  return(xVec^(1:length(xVec)))
}

## simple example
a <- c(2, 5, 3, 8, 2, 4)

b <- tmpFn1(a)
b
```

```
## [1]    2   25   27 4096   32 4096
```

and now `tmpFn2`

```
tmpFn2 <- function(xVec2){

  n = length(xVec2)

  return(xVec2^(1:n)/(1:n))
}




c <- tmpFn2(a)
c
```

```
## [1]    2.0000   12.5000    9.0000 1024.0000    6.4000  682.6667
```

(b) Now write a fuction `tmpFn3` which takes 2 arguments x and n where x is a single number and n is a strictly positive integer. The function should return the value of

$$1 + \frac{x}{1} + \frac{x^2}{2} + \frac{x^3}{3} + ... + \frac{x^n}{n}$$

```
tmpFn3 <- function(x, n)
{
1 + sum((x^(1:n))/(1:n))
}
```

2. Write a funciton `tmpFn(xVec)` such that if `xVec` is the vector $x = (x_1, ..., x_n)$ then `tmpFn(xVec)` returns the vector of moving averages:

$$\frac{x_1 + x_2 + x_3}{3}, \frac{x_2 + x_3 + x_4}{3}, ..., \frac{x_{n-2} + x_{n-1} + x_n}{3}$$

Try out your function. `tmpFn`(c(1:5,6:1))

```r
tmpFn <- function(xVec)
{
n <- length(xVec)
( xVec[ -c(n-1,n) ] + xVec[ -c(1,n) ] + xVec[ -c(1,2) ] )/3
}
```

now input `tmpFn`(c(1:5,6:1))

```r
tmpFn( c(1:5,6:1) )
```

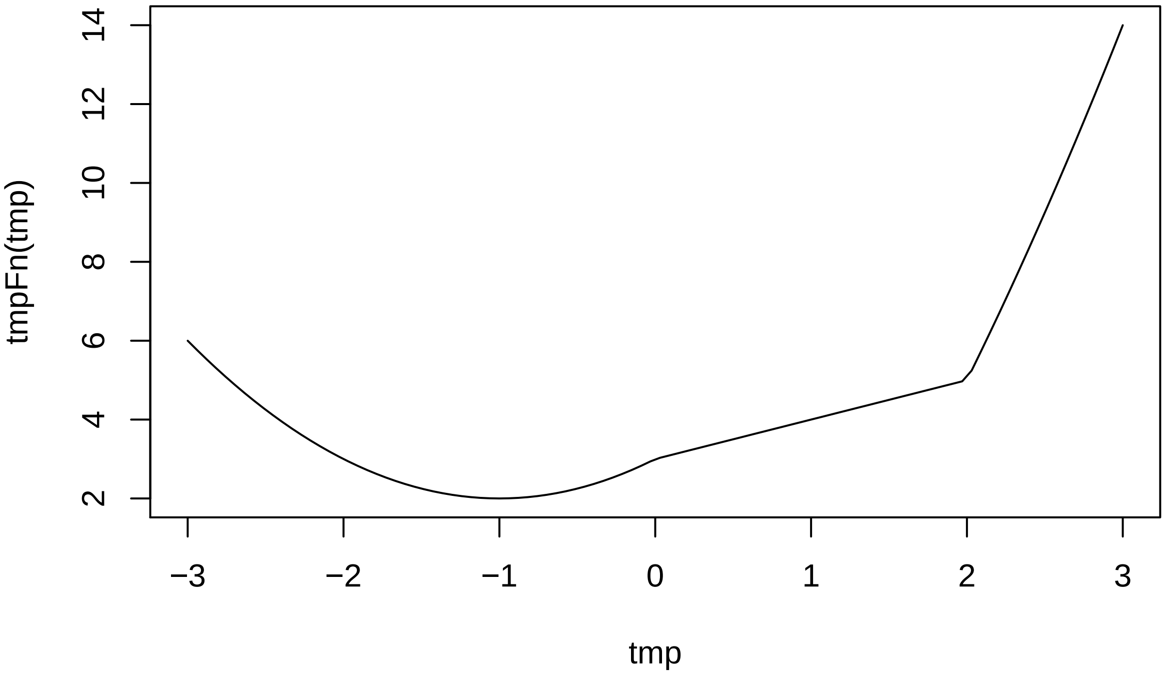
```
## [1] 2.000000 3.000000 4.000000 5.000000 5.333333 5.000000 4.000000 3.000000
## [9] 2.000000
```

3. Consider the continuous function

$$f(x) = \begin{cases} x^2 + 2x + 3 & if \quad x < 0 \\ x + 3 & if \quad 0 \le x < 2 \\ x^2 + 4x - 7 & if \quad 2 \le x \end{cases}$$

Write a function `tmpFn` which takes a single argument `xVec`. the function should return the vector the values of the function $f(x)$ evaluated at the values in `xVec`.
Hence plot the function $f(x)$ for $-3 < x < 3$.

```r
tmpFn <- function(x)
{
ifelse(x < 0, x^2 + 2*x + 3, ifelse(x < 2, x+3, x^2 + 4*x - 7))
}
tmp <- seq(-3, 3, len=100)
plot(tmp, tmpFn(tmp), type="l")
```



4. Write a function which takes a single argument which is a matrix. The function should return a matrix which is the same as the function argument but every odd number is doubled.

Hence the result of using the function on the matrix

$$\begin{bmatrix} 1 & 1 & 3 \\ 5 & 2 & 6 \\ -2 & -1 & -3 \end{bmatrix}$$

should be:

$$\begin{bmatrix} 2 & 2 & 6 \\ 10 & 2 & 6 \\ -2 & -2 & -6 \end{bmatrix}$$

```
tmpFn <- function(mat)
{
mat[mat%%2 == 1] <- 2 * mat[mat%%2 == 1]
mat
}
```

5. Write a function which takes 2 arguements n and k which are positive integers. It should return the nxn matrix:

$$\begin{bmatrix} k & 1 & 0 & 0 & \cdots & 0 & 0 \\ 1 & k & 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & k & 1 & \cdots & 0 & 0 \\ 0 & 0 & 1 & k & \cdots & 0 & 0 \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ 0 & 0 & 0 & 0 & \cdots & k & 1 \\ 0 & 0 & 0 & 0 & \cdots & 1 & k \end{bmatrix}$$

For the specific case of n = 5 and k = 2:

```
tmp <- diag(2, nr = 5)
tmp[abs(row(tmp) - col(tmp)) == 1] <- 1
tmp
```

```
##      [,1] [,2] [,3] [,4] [,5]
## [1,]    2    1    0    0    0
## [2,]    1    2    1    0    0
## [3,]    0    1    2    1    0
## [4,]    0    0    1    2    1
## [5,]    0    0    0    1    2
```

For the general case:

```
tmpFn <- function(n, k)
{
tmp <- diag(k, nr = n)
tmp[abs(row(tmp) - col(tmp)) == 1] <- 1
tmp
}
```

6. Suppose an angle α is given as a positive real number of degrees.

If $0 \leq \alpha < 90$ then it is quadrant 1. If $90 \leq \alpha < 180$ then it is quadrant 2.
if $180 \leq \alpha < 270$ then it is quadrant3. if $270 \leq \alpha < 360$ then it is quadrant 4.
if $360 \leq \alpha < 450$ then it is quadrant 1.
And so on . . .

Write a function `quadrant(alpha)` which returns the quadrant of the angle α.

```
quadrant <- function(alpha)
{
1 + (alpha%%360)%/%90
}
```

example:

```
quadrant(50)
```

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

```
quadrant(92)
```

```
## [1] 2
```

```
quadrant(183)
```

```
## [1] 3
```

```
quadrant(330)
```

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

```
quadrant(390)
```

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

7.

(a) Zeller's congruence is the formula:

$$f = ([2.6m - 0.2] + k + y + [y/4] + [c/4] - 2c) mod 7$$

where $[x]$ denotes the integer part of x; for example $[7.5] = 7$.

Zeller's congruence returns the day of the week f given:

k = the day of the month
y = the year in the century
c = the first 2 digits of the year (the century number)
m = the month number (where January is month 11 of the preceding year, February is month 12 of the preceding year, March is month 1, etc.)
For example, the date 21/07/1‘963 has $m = 5, k = 21, c = 19, y = 63$;
the date 21/2/63 has $m = 12, k = 21, c = 19, andy = 62$.
Write a function `weekday(day,month,year)` which returns the day of the week when given the numerical inputs of the day, month and year.
Note that the value of 1 for f denotes Sunday, 2 denotes Monday, etc.

```
weekday <- function(day, month, year)
{
month <- month - 2
if(month <= 0) {
month <- month + 12
year <- year - 1
}
cc <- year %/% 100
year <- year %% 100
tmp <- floor(2.6*month - 0.2) + day + year + year %/% 4 + cc %/% 4 - 2 * cc
c("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday")[1+tmp%%7]
}
```

example:

```
c( weekday(27,2,1997), weekday(18,2,1940), weekday(21,1,1963) )
```

```
## [1] "Thursday" "Sunday"   "Monday"
```

(b) Does your function work if the input parameters day, month, and year are vectors with the same length and valid entries?

No, *if* statement is not work for vector, but if we write it to a new form:

```
weekday2 <- function(day, month, year)
{
flag <- month <= 2
month <- month - 2 + 12*flag
year <- year - flag
cc <- year %/% 100
year <- year %% 100
tmp <- floor(2.6*month - 0.2) + day + year + year %/% 4 + cc %/% 4 - 2 * cc
c("Sunday","Monday","Tuesday","Wednesday","Thursday","Friday","Saturday")[1+tmp%%7]
}
```

example:

```r
weekday2( c(27,18,21), c(2,2,1), c(1997,1940,1963) )
```

```
## [1] "Thursday" "Sunday"   "Monday"
```