Problem Set 1 (UPDATED)

Notification:

1. Please make sure you use the assign name for every question to ensure get the full credit from the Gradescope. Other variable names are not allow in this Problem Set.

2. Plagiarism are not tolerance for every assignment, homework and other kind of coding problem.

3. Please make sure your file name is `problemSet_1.R`.

4. Enter your name as a string under `myName`.

4. The due day for PS1 is **September 19, 2022 11:59 pm**.

Vector

1. Create the following vector:
(a) (1,2,3,...,19,20), Name `v1`;
(b) (20,19,18,...,2,1), Name `v2`;
(c) (1,3,5,...,17,19), Name `v3`;
(d) (3,7,11,3,7,11,...,3,7,11) where there are 10 occurrences of 3, Name `v4`;
(e) (3,7,11,3,7,11,...,3) where there are 11 occurrences of 3, 10 occurrences of 7 and 10 occurrences of 11, Name `v5`.

2. Create a vector of the values of $e^x sin(x)$ at x = 3.0,3.1,3.2,...,6.0 Name `x1`

3. Calculate the following:

$$\sum_{i=10}^{100} (i^3 + 4i^2)$$

Name `sum1`

4. Use the function `paste` to create the following character vectors of length 30:
(a). ("label 1", "label 2", ..., "label 30"). Notice: there is a single space between 'label' and number following, Name `str1`.
(b). ("function1", "function2", ..., "function30"). In this case, there is no space between 'function' and number following, Name `str2`.

5. Print the vector, "c(1,'function',NA, seq(1,5,2), 0.125)", as a string, using `paste() or paste0()` Name `vs`.

Matrix

6. Create a 3x3 matrix **A** from 1 to 9, and find A^3, Name `m1_ans`

7. Create a matrix B with 17 rows:

$$\begin{bmatrix} 12 & -12 & 12 \\ 12 & -12 & 12 \\ ... & ... & ... \\ 12 & -12 & 12 \end{bmatrix}$$

Calculate the 3 x 3 matrix $B^T B$ Name `m2_ans`.

8. Solve the following system of linear equations in five unknowns

$$\begin{aligned} x_1 + 2x_2 + 3x_3 + 4x_4 + 5x_5 &= 7 \\ 2x_1 + x_2 + 2x_3 + 3x_4 + 4x_5 &= -1 \\ 3x_1 + 2x_2 + x_3 + 2x_4 + 3x_5 &= -3 \\ 4x_1 + 3x_2 + 2x_3 + x_4 + 2x_5 &= 5 \\ 5x_1 + 4x_2 + 3x_3 + 2x_4 + x_5 &= 17 \end{aligned}$$

by considering an appropriate matrix equation $Ax = y$.
Make use of the special form of the matrix A. The method used for the solution should easily generalise to a larger set of equations where the matrix A has the same structure; hence the solution should not involve typing in every number of A, Name: `m3_ans`. Hint: Use `solve` function.

Function

9. Create two functions `function1` and `function2`,

(a). function1(xv) return the vector $(x_1, x_2^2, ..., x_n^n)$, calculate vector $xv = (0.0, 0.1, ..., 0.8, 0.9, 1.0)$ Name: `func1_ans`

(b). function2(xv) return $(x_1, \frac{x_2^2}{2}, \frac{x_3^3}{3}, ..., \frac{x_n^n}{n})$, calculate vector $xv = (0.0, 0.1, ..., 0.8, 0.9, 1.0)$ Name: `func2_ans`.

(c). Write a function `function3` 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

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

then calculate vector $xv = (0.0, 0.1, ..., 0.8, 0.9, 1.0)$
Name the variable: `func3_ans`

10. Create two functions to covert the temperature between Celsius and Fahrenheit. For Celsius to Fahrenheit Name: `cel_to_far`, from Fahrenheit to Celsius Name: `far_to_cel`.

11. Using function to list the odd number in 1,2,3,…,1998,1999,2000, Name: `odd_ans`.

12. Create a function which takes a single argument r and calculates

$$\sum_{s=1}^{r} \frac{s^{0.5}}{11 + 3.5r^{1.2}}$$

Then write a function which uses `sapply` to calculate the sum when $r = 10$, Name: `sum_ans`.

For the following problems compose your functions such that the name and inputs match.

13. Write a function that receives two inputs, a number x, and another number y, the function should return x or the next largest number divisible by y. *hint: use the modulo operator* `%%`.

Name: `modNumber(x,y)`.

ex: `modNumber(50,16)` *should return* `[1] 64` *and* `modNumber(64,16)` *should also return* `[1] 64`

Your supplied `modNumber(x,y)` *should return* `[1] 64` *and* `modNumber(64,16)` *should also return* `[1] 64`.

Your function will be accessed by the autograder and tested with some inputs against another version of the function, s.t. `autoGraderModNumber(500,6) == 504 == modNumber(500,6)`.

14. Write a function using `switch` that returns the number of wheels of a vehicle on the following vehicles: - unicycle - bike - car - truck - tricycle - motorcycle Your function should use these as possible input strings. Name: `numberOfWheels`

15. Write a function called `myFactorial` that returns the factorial of a given natural number.

Your results should be equivalent to the base R function `factorial()`.

16. Write a function called `myCustomFactorial(x,y)` that returns the product of the sequence of natural numbers between inputs x and y.

Your function should return equivalent values to `factorial(y)` *for inputs* `myCustomFactorial(1,y)`.

17. Write a function called `customRiverMean` that returns the average length of rivers in the vector `rivers` shorter than an given maximum length.

ex: `customRiverMean(400) == 300.125`

Loops and Apply

18. Write a for loop that populates a vector with the Length(`ToothGrowth\$len`) of the `ToothGrowth` dataset. Your vector should only include observations of teeth 15 units or longer. Name your vector `longTeeth`.

19. Use the apply family of functions to create a list of the average values of each column in MT Cars, use the list to assign values to `averageHorsePower` and `averageWeight` detailing the mean value of the horsepower and weight of the included cars.

20. *(Extra)* A function that uses `sapply` where given a vector $(x_1, ..., x_n)$ and a vector $(y_1, ..., y_m)$ and returns the vector $(z_1, ..., z_n)$ where $z_1 = \text{number}(y_j < x_1)$, $z_2 = \text{number}(y_j < x_2)$, … , $z_n = \text{number}(y_j < x_n)$