UNIVERSITY OF THE FREE STATE
DEPARTMENT OF MATHEMATICAL STATISTICS AND ACTUARIAL SCIENCE
STSM 2634

SEMESTER TEST 2 **29 MAY 2023**
Time: 2h00 Marks: 70

FOLLOW THESE INSTRUCTIONS METICULOUSLY, OTHERWISE MARKS WILL BE SUBTRACTED:

• **You shall submit your answers in Rmarkdown (.rmd) word format. For submissions in any other format, 50% of the marks obtained will be deducted.**

• **The file name of your markdown document should be 'Semester test2' and your student number should be the author name.**

• Install the 'tidyverse', 'neuralnet', 'NeuralNetTools', and 'MASS' package if it is not installed in your computer.

• **You are allowed to use the internet resources, if necessary, except the study materials from Blackboard or social media / email / generative AI.**

• **Your programming (code) and the output must be included in your answers. If either the code or the output is not available, 50% of the marks obtained will be deducted.**

• Please make sure that all **questions are numbered clearly and correctly**.

• Write explanations in support of your analysis as necessary.

• You are free to use any R function you like. You have freedom to write the code in your own way. **To get full marks, your code should be executable and producing the correct output.** 'Partial grading' depends on the amount of your code written correctly.

• You are advised to create regular backups during this test. Save the .rmd file in every 15 minutes. It is your responsibility that your answers are submitted correctly.

• Additional instructions will be given at the test venue as needed, and will be considered binding

Q1. Write a while loop to find the first 10 Fibonacci numbers given by {0, 1, 1, 2, 3, 5, 8, 13, 21, 34}.

[10]

Q2. Write a repeat loop to find the factorial of a given number (let's say 5). If the number is less than 0, it should print an error message.

[10]

Q3. The following code is meant to print the first five even numbers (2, 4, 6, 8, 10), but it contains a mistake. Identify the mistakes in the code and correct them.

```{r}
# count <- 0
# num <- 1
# while (count <= 5) {
#  if (num %% 2 == 0) {
#    print(num)
#  }
#  num <- num + 1
# }
```

[10]

Q4. Write a R code to create an Artificial Neural Network (ANN) model for the mtcars data. The objective variable is 'mpg' and all other variables are input variables. Use the neuralnet and NeuralNetTools package. The ANN model fit should include the following steps:

- First, scale the dataset around mean and standard deviation. This implies subtracting the mean and dividing by the standard deviation for each variable (feature) in the dataset.

- Split the dataset into training and test data in 70:30 ratio.

- Fit an ANN model on the training data with 2 hidden layers with 4 neurons in each layer.

- Measure the accuracy of the predictions by the model.

- Finally, create a graphical display of the ANN model.

[10]

Q5. For the mtcars dataset, fit a generalized linear model (glm) for the mpg dataset. Use gaussian() function for the family of the glm fit. Split the dataset into training and test data in 70:30 ratio and use the training data for the model fitting. Then obtain the predicted values based on the test data, and calculate prediction accuracy in terms of the mean square error (MSE).

[10]

Q6. Write a for loop in R that calculates and prints the remaining balance on a loan each year for 5 years. Assume the loan amount is $5000, the annual interest rate is 5%, and the annual payment is $1000.

The formula for the remaining balance in each year is given by

$$loan\ amount \times\ (1 + interest\ rate) - annual\ payment.$$

Except for the first year, the remaining balance is considered as the loan amount.

[10]

Q7. Write a for loop in R that calculates and prints the balance in a bank account after each year for 10 years. Assume an initial deposit of $1000, an annual interest rate of 2%, and an annual deposit of $500.

The formula for the account balance for the n^{th} year A_n is given by

$$A_n\ =\ A_{\{n-1\}} \times (1 + interest\ rate) + annual\ deposit.$$

[10]

----------End----------