

MTH208a: Endsem Exam - Part II

Instructions

1. Follow the instructions for each question **exactly**.
2. Make sure you DO NOT have command `rm(list = ls())` in any R Scripts you submit.
3. If your code is not properly commented or horizontal/vertical spacing is missing, points will be deducted.
4. There are four questions and this Part II is overall 80 marks.

Questions

1. Instructions:

- Copy and paste **ONLY** your final function `autoreg_fast` into the file `ans1.R` in your exam repository. **DO NOT PASTE ANY OTHER CODE.**

(20 points) Consider the following function `autoreg` below. (It is your job to figure out what the function does.) Write and submit another R function `autoreg_fast` that is much faster than the above. (You CANNOT use `Rcpp` here.)

```
# n = integer
# rho = number in (-1,1)
autoreg <- function(n, rho)
{
  out <- 0
  for(t in 2:n)
  {
    error <- rnorm(1)
    error <- rho*out[t-1] + error
    out <- c(out, error)
  }
  return(out)
}
```

2. Instructions:

- Upload your final R code to `ans2.R` and the C++ part to `Cans2.cpp` file.
- Be sure to include the code to load the Rcpp library.
- You must also have the `sourceCpp` code to compile and load the code in `Cans2.cpp`.

(25 points) Write an R function called `sel_sums` that does the following tasks in the following order:

- a. Takes an argument `mat` which is a square matrix. You may assume that the user will always input a square matrix. Let the size of `mat` be $p \times p$.
- b. Randomly chooses a number, s , between 1 and p (inclusive), with equal probability.
- c. Calls a C++ function, `sumsC`, that returns the sum of the first s columns of `mat`.
- d. Returns the output obtained from the `sumsC` function.

3. Instructions:

- Copy all and only relevant code and paste in the file `ans3.R`.
- Your final value should be saved in an object called `ans`.

(15 points) Load file `ques3.Rdata`. This object contains a 200×200 matrix `mat`. Write R code that calculates

$$\text{ans} = \frac{[\det(A)]^{1/p} \cdot p! \cdot (2.7)^p}{p^p \cdot \text{trace}(A)}$$

where for a matrix A , the determinant is the product of its eigenvalues and the trace is the sum of its eigenvalues. The final answer should be stored in `ans` and the last line of the code should be

```
ans <- ....
```

HINT: you can use function `eigen(mat, only.values = TRUE)` to calculate the eigenvalues of `mat`.

4. Instructions:

- Copy all and only relevant code and paste in the file `ans4.R`.
- Only paste code required to produce your plots

(20 points) In library `MASS` is the dataset `ships` which contains the dataset of damage caused by waves on various cargo ships. There are 5 variables in the dataset (you can learn more about it using `?ships`). The `type` of ship is listed as a factor with levels “A”, “B”, ..., “E”. Looking at the data I have the following hypothesis:

“Ship type B is the least trustworthy ship as it had the most accidents”

Make a plot or plots to either “prove” or “disprove” my hypothesis. Submit all codes required to make your plots