

# 22S:166 Midterm 1, 2014

<Your Name>

<date when you took exam>

## 1 Instructions

Produce a  $\text{\LaTeX}$  document formatted like this one. You do not have to copy any of the instructions into your document. Just make the sections and subsections with the same names and numbers that I have here, as well as retaining any numbered lists. Use labels and references instead of typing in numbers of equations, figures, or sections.

You must work in a Linux environment. Use CSG Linux Desktop to log into one of the computers in 346 SH.

You may either:

- Use Sweave to insert your code and output into your document. In this case, submit your .Rnw file, .bib file, and the final .pdf file into the ICON dropbox. OR
- Copy your R code and output into verbatim environments. In this case, submit your .tex file, .bib file, and the final .pdf file into the ICON dropbox.

If your .Rnw or .tex file will not compile, upload it and a text file containing code and output from running R interactively. I will give partial credit.

Before you leave, check with me to make sure I have received your exam files in ICON.

Type Section 2 exactly as shown below. Use BibTeX to include the citation. Note that you can get the BibTeX entry for R by using the

```
\citation()
```

function in R.

## 2 L<sup>A</sup>T<sub>E</sub>X

The  $l_1$  and  $l_2$  norms of a vector  $x$  may be defined as shown in Equation 1 below.

$$\begin{aligned} \|x\|_1 &= \sum_{i=1}^n |x_i| \\ \|x\|_2 &= \left( \sum_{i=1}^n x_i^2 \right)^{1/2} = \sqrt{x \cdot x} \end{aligned} \quad (1)$$

All computations in this document were carried out in the R software environment (R Core Team, 2013).

## 3 R

You do not have to type any text in this section. Simply number the questions and include the correct R code and output for each.

Carry out the following steps in R. Show your output for each step.

1. Write an R function to compute  $l_1$  and  $l_2$  vector norms as defined in Section 2. Your function should accept two arguments: a numeric vector and a scalar representing the type of norm requested.

If the first argument is not a numeric vector or the second argument is something other than the digit 1 or the digit 2, your function should print an error message and return nothing.

Otherwise, your function should return the  $l_1$  or  $l_2$  norm of the vector depending on the value of the second argument.

Code the calculations in your function yourself (do not use the `norm` function in base R). Write efficient code.

Include the R code for your function in this part of your solutions.

2. Generate a vector of 10 random values from a Poisson distribution with mean 7. Use your function to calculate the  $l_2$  norm of the vector.

Include the R code and output for your function call in this part of your solutions.

3. Call your function with the arguments `c("Alice","Benji")` and 4. Include the code and output.

4. Generate a vector of 1,000,000 random values from a Poisson distribution with mean 7. Use an `R` function to time how long it takes your function to calculate the  $l_1$  norm of this vector.

Include your `R` code and output.

## References

R Core Team (2013). *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Austria.