Homework 1 - Due 1/25/2017

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Introduction

Throughout the semester, you are going to be assigned both theoretical and computational exercises. It is not really possible to hand-write some of the computational exercises that you will be required to do (much less draw plots, etc.), and so we are going to require that the homeworks be generated electronically.

The best way to do this, given that we will be working in R, is to use RMarkdown. This is an augmentation of the extremely simple markup language markdown with features that allow you to render R code and LaTeX. RStudio includes an augmented version of RMarkdown documents that behave very similarly to Jupyter notebooks, allowing you to explore data interactively but also to produce nice, well-formatted documents. These are called R Notebooks.

Part 1: R Notebook Basics

- Download and install R.
- Download and install RStudio.
- Open RStudio and make a new R Notebook file. You can do this by going to `File -> New File -> R Notebook`.
- Read the Markdown Quick Reference found in the `Help` menu to get a sense of how to use Markdown.
- Read the Rstudio R Notebook Guide to get a sense of how to use R notebooks.
- Play around with some text writing. You can render your file by using the `Knit` button found in the RStudio IDE above the source window.

Part 2: LaTeX Basics

In order to write out the theoretical exercises in an electronic format, it will be useful to learn how to use the basics of LaTeX. LaTeX is a general typsetting language that can produce very nice documents, but you will only need to know the subset of the language that lets you render mathematical equations, like

$$\left(\int_0^1 f(x)dx\right) \times \left(\frac{1}{n^{100}}\right)$$

See? Isn't that nice?

LaTeX equations can be rendered directly in RMarkdown by enclosing equations in `$` for inline equations or `$$` for rendering the equations in separate paragraphs.

- Check out this cheat sheet for the basics of LaTeX.
- Try and render some equations.

Part 3: R Basics

Read up on this real-quick-intro to using R.

R code chunks can be rendered in RMarkdown as follows:

```{r}
print("Hi there!")
```

When rendering an RMarkdown document, R variables and functions will be preserved across subsequent chunks (the R chunks are executed in order), so you can have chunks that reference variables that are defined in previous chunks.

Part 4: Assignment

There will be two problems in this assignment. The requirements are as follows:

1. Save this as "homework_1_[NAME]_[ID]", where `NAME` is of the following form: `matthew_pancia` (lowercase underscore concatenation of your first and last name). My file would look like `homework_1_matthew_pancia_B1923912.Rmd`. The title should be `CS 141: Homework 1`, and you should include an `author` field in the YAML header that gives your name and ID. Mine looks like:

```
---
title: "CS 141: Homework 1"
author: "Matthew Pancia - B19239192"
output:
  pdf_document: default
  html_notebook: default
---
```

2. Follow the R Style Guide found here.
3. Do the problems.
4. Submit both the `Rmd` file and the result of knitting the document to PDF. You can use the `Knit` button in the IDE and click on `Knit to PDF`.

Problem 1:

Baby Gauss is famous for frustrating his kindergarten teacher by quickly deriving the formula for the sum of the numbers from 1 to n:

$$\sum_{i=1}^{n} i = \frac{n(n+1)}{2}.$$

Write out an inductive proof of this statement. The solution is an example in the Wikipedia page, which you are welcome to replicate.

Problem 2:

Recall that the Bubble Sort is a really bad way of sorting a list of numbers.

Write an implementation of a bubble sort in R, showing the commented code in RMarkdown chunks, and then show some examples of using it. The format should be something like:

```
[text description of the algorithm]
[documented R code chunks that implement the algorithm]
[some examples of your code being ran]
```