STATS 201 Lab Class 1

#Gravity experiment

The rate of acceleration of an object that is dropped varies between $9.76ms^{-2}$ and $9.83ms^{-2}$ depending on location. At Auckland,

$$g = 9.80ms^{-2} \ .$$

The value of g can be estimated in several simple ways, including freefall experiments (https://www.youtube.com/watch?v=uIUtf5ewhOw) pendulum experiments (https://www.youtube.com/watch?v=6WeMbUfH1h8) and projectile experiments (https://www.youtube.com/watch?v=X1-obk6dWx4). (NOTE: Some of these YouTube videos include methods of estimating g. **DO NOT** use these methods - see below for a better approach using the quadratic linear model of Handout 4.)

A group of physics students at the University of Auckland conducted a projectile experiment using an electromagnetic catapult to eject a steel ball in to the air at a fixed speed. At a given time after ejection, a stereo camera would take a photo to measure the height of the ball. A total of 30 trials were conducted.

Each row in **GravityExpt.txt** corresponds to a single trial. The variables are

- **Time**: Seconds after ejection of the steel ball, between 0.2 and 2.
- **Height**: Response variable - the height of the ball in metres.

Theory tells us that the relationship between height and time is quadratic, and that the true value of the coefficient of the quadratic term is $-0.5g = -4.9$.

Conduct a full analysis, and include **Methods and Assumption Checks** along with an **Executive Summary**. In particular, we are interested in addressing a few questions of interest in the **Executive Summary**:

- What is the estimated value of g?
- Is our estimated value of g consistent with the theoretical value of 9.80? [Hint - calculate the 95% confidence for g.]
- Theory also tells us that the true value of the coefficient of the intercept term is zero. Is this consistent with our analysis?
- [Optional] Refit the model without the intercept, and compare the CI for g with the CI you calculated earlier.

Hints

General comments

- Your assignment should be written using R Markdown in RStudio. It should include the code you used and its output, including plots.
- There are many examples of **Methods and Assumption Checks** and **Executive Summaries** in your course book. It is a good idea to find a case study with a similar analysis, and use this to guide you, but remember to write things in your own words. Additionally, each data set may have its own specific questions of interest, so do not only base your answers on examples from other case studies.
- There are some more specific guidelines for the **Methods and Assumption Checks** and **Executive Summaries** below.

Methods and assumption checks

Unless told otherwise, this should include the following:

- A brief comment on any plots of the data.
- A brief description of how you arrived at your final model. For example, if you fitted multiple models, you may comment on what changes you made, and why.
- A brief description of any concerns with the model assumptions. If you have no concerns then it is enough to say "All model assumptions appear to be satisfied."
- The model equation, making sure to define all model terms.
- Reporting the R-square of the model.

Executive Summary

Unless told otherwise, this should include the following:

- A brief statement summarising what your analysis was investigating, and the model that was used.
- Interpretations of the important findings. For example, was there evidence to suggest that your explanatory variables were related to the response variable? Where appropriate, use confidence intervals to express the magnitude of the relationship.
- Answers to any specify research questions.
- This should be written without too much technical detail. An intelligent person who is *not* a statistician should be able to understand what your findings were. Imagine that you are trying to explain the results of your analysis to a friend who is not taking this course.