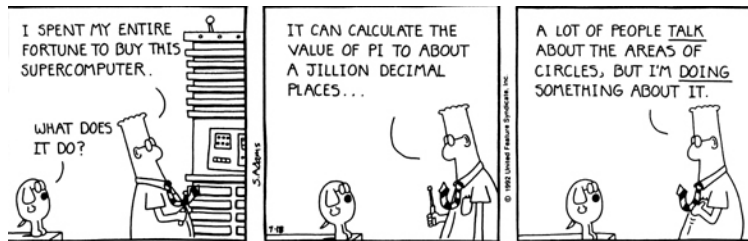# Mth142H Mini-Projects

1. **What are real numbers?**   **Due October 2, 2015**

Why is $\sqrt{2}$ not a rational number? Cauchy sequences and decimal expansions. Completeness and how it allows us to take limits.

2. **Video Game Mathematics**   **Due October 16, 2015**

The worlds of video games, no matter how exotic, are described using mathematics. The same is true for the laws of physics and even magic in these worlds. Find some relatively simple examples of mathematics at work in some of today's more popular video games - be creative!

3. **Space Elevator Math   Due October 16, 2015**

How much work does it take a space elevator to lift a person from the Earth's surface to geostationary orbit and how much does it cost in terms of electricity at today's prices? How strong does the cable need to be in order not to break under its own weight. What if instead we allowed the cable to taper towards the Earth's surface?
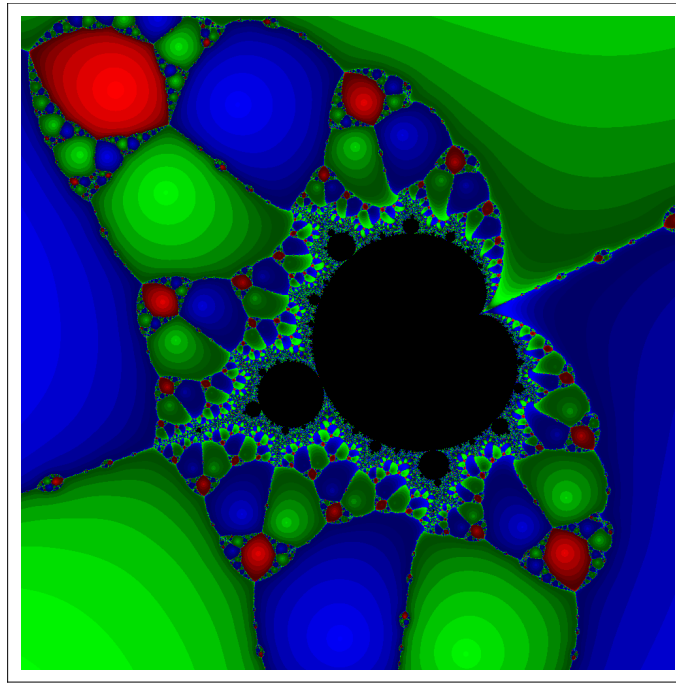
4. **Mathematics and Climate Change   Due October 30, 2015**

Figure 1: Think Big - We Do!

Mathematics is used extensively to study climate using models. Give examples of (simple) climate models and how the predictions of these models influence opinions on the future climate of our planet.

5. **Fractals and the Mandelbrot Set**   **Due November 13, 2015**

Discuss elementary complex arithmetic and show how one can make pictures of the famous Mandelbrot set, sometimes referred to as 'the most complex object in mathematics'. You might like to show one of the many videos on Youtube showing a zoom into the boundary of the Mandelbrot set. Alternatively, you can download the Xaos program and do it yourselves! Xaos can be found at

`http://matek.hu/xaos/doku.php`

6. **The Discrete Logistic Equation**   **Due December 4, 2015**
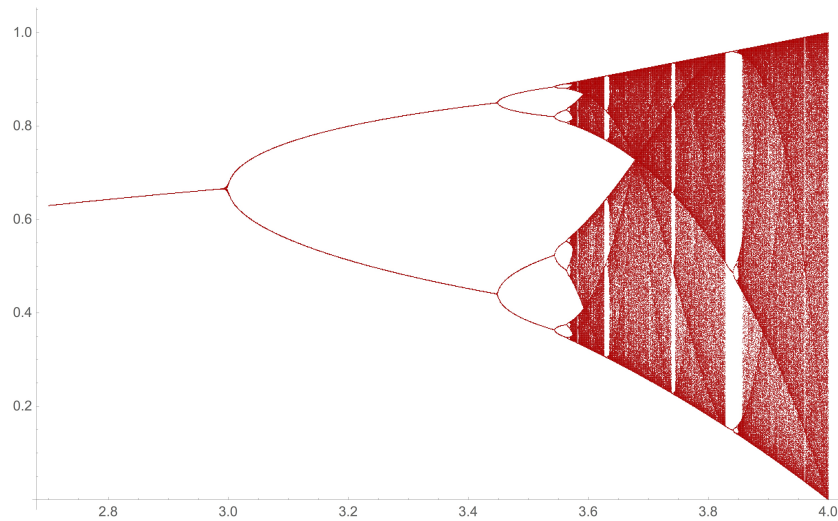
A discrete version of the logistic differential equation we covered in class is given by the formula

$$x_{n+1} = \lambda x_n(1 - x_n)$$

where x_n is the population in year n and λ is the 'fecundity' parameter which measures how fast the individuals in the population reproduce. Show that interesting things happen as λ increases and the behaviour observed is much more chaotic than that for the continuous model discussed in class. Lastly, you should explain what all this has to do with the picture above!

7. **Mathematical Humor   Due December 11, 2015**
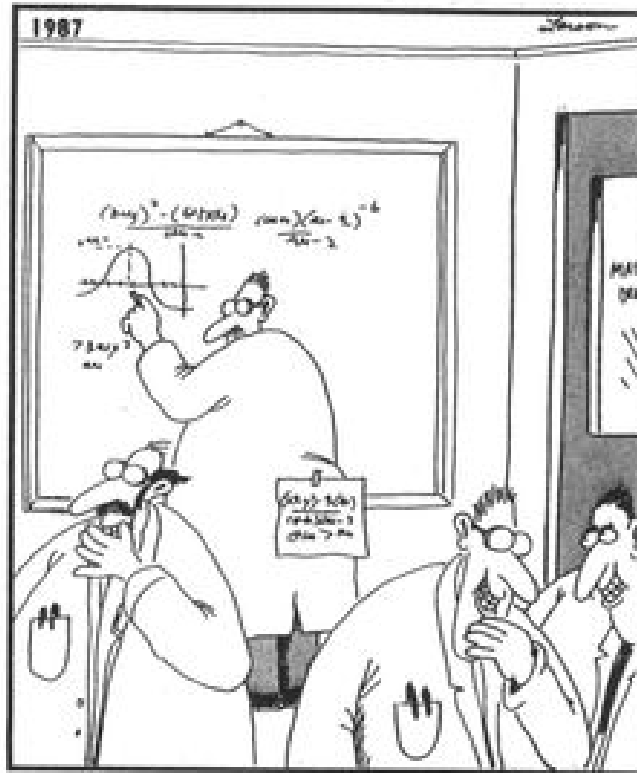
Like all languages, mathematics abounds in humor. Continuing the theme of this year's Honors Colloquium, find examples of humor in mathematics such as in songs (try Tom Lehrer), cartoons (like Gary Larson's above) and above all stories of absent-minded mathematicians and their total inability to deal with the real world.