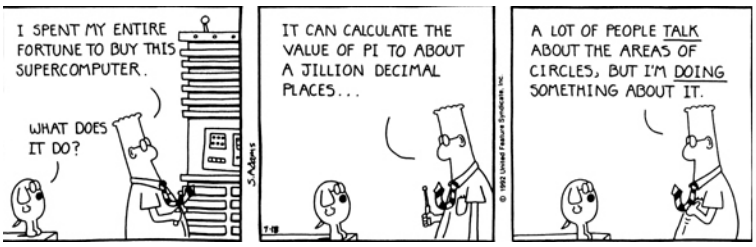
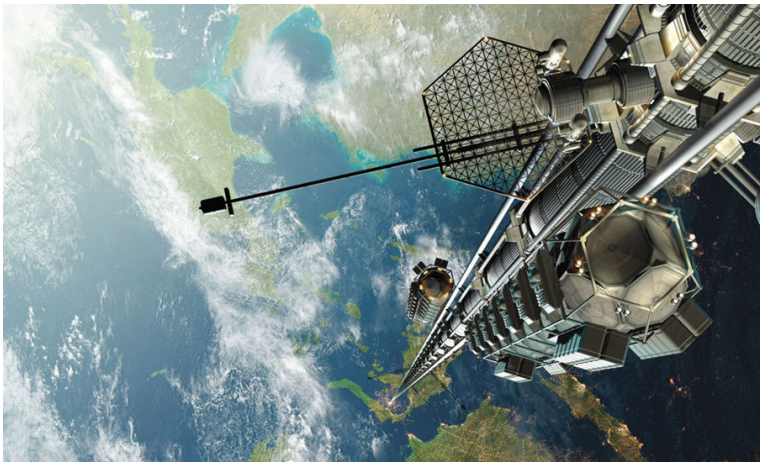
Mth142H Mini-Projects

1. **What are real numbers?** **Due October 4, 2014**



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

2. **Space Elevator Math** **Due October 18, 2014**



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?

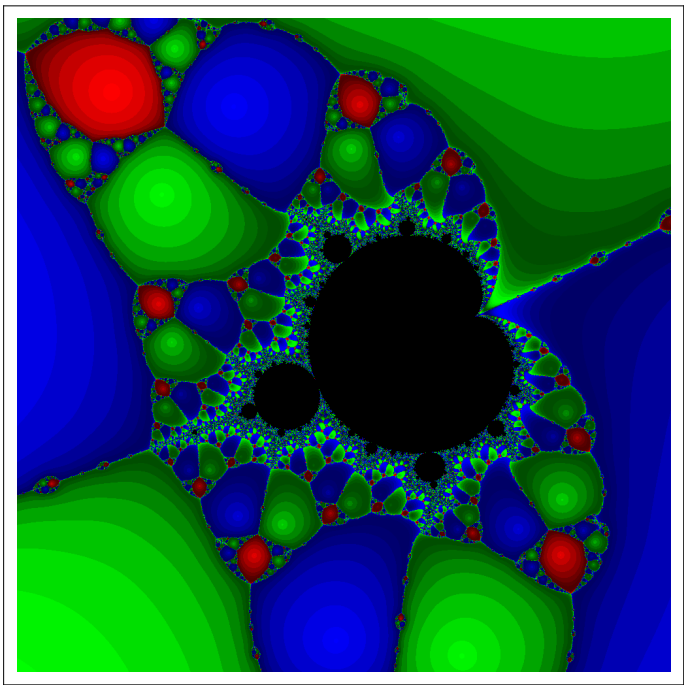
3. **Let's Play Poker** **Due November 1, 2014**

Show how the various poker hands are ranked by determining their probabilities. A good discussion of this can be found in the Wikipedia article at

`http://en.wikipedia.org/wiki/List_of_poker_hands`

In each case, you need to explain how the probability was calculated using permutations and combinations.

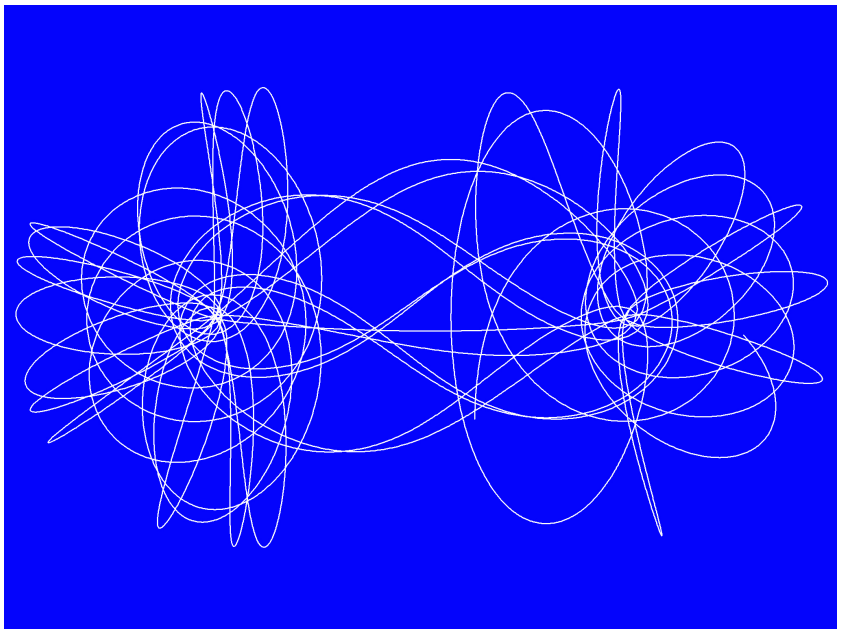
4. **Fractals and the Mandelbrot Set** **Due November 15, 2014**



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

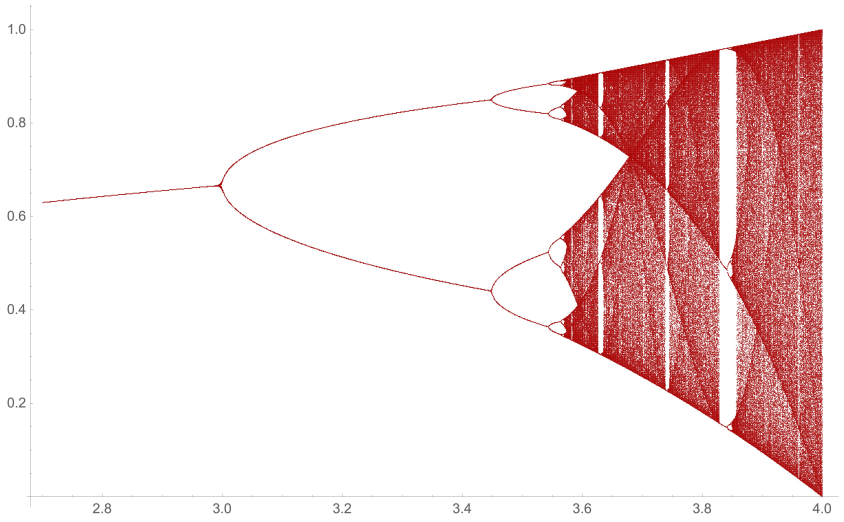
`http://matek.hu/xaos/doku.php`

5. **Orbits and Polar Coordinates** **Due December 5, 2014**



Use polar coordinates and Newton's Law of Gravitation to show how the orbit of a small body around a large one is given by a conic section. Show how this allows us to derive Kepler's famous laws of planetary motion. What does the picture for this project have to do with all this?

6. The Discrete Logistic Equation Due December 5, 2014



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!