# Math 53 Chaos!: Homework 6

due Fri Nov 9 . . . but best if do relevant questions after each lecture

This week we jump to continuous time systems, ie ODEs. Sections 7.1-7.3 in the book are review of material from Math 23, so please read this.

T4.9 (see Example 4.5)

T4.11 b only (please make your proof hold water)

4.7 (careful: carpet not gasket)

4.9 (easy)

4.10 [Hint: think about T4.9]

4.12 (isn't this bizarre? Part a is certainly not a fractal)

A. Numerically estimating box-counting dimension of chaotic Hénon attractor. I have given you almost all of the code to do this, so it should not be a hard matlab exercise. Download the code `henon_boxdim_hw6.m` and fill in the first part to fill $N$ iterates of the Hénon attractor with $a = 1.4$ and $b = 0.3$. The second part of the code (which relies on the code `boxcount.m`) estimates the boxdim. You will notice a 'plateau' region in the plot of the slope $\log N(\epsilon)/\log(1/\epsilon)$. You will need to choose $N$ large (eg start with $10^3$ and go up) so that the attractor 'fills in' properly - how large an $N$ did you need so that the plateau region stabilizes? Print out your plot.

[BONUS: generate either a different fractal as a set of points `x`, or use the examples on the boxcount webpage to grab a natural fractal image (choose as high resolution as possible), and estimate its boxdim. Eg coastline, tree, lightning strike. . . ]

B. Numerically estimating correlation dimension of chaotic Hénon attractor. Generate an orbit of length $N = 10000$ (using the above parameters). Now compute for $r = 0.1$ and $r = 0.03$ the values of $C(r)$. Use this to estimate the correlation dimension. Is is close to that claimed in the text? Hint: you only need to write one simple loop, if I give you a command which returns the number of points in the list `x` which are within distance `r` of the $n^{th}$ point `x(:,n)`. That command is

```
numel(find(sum((kron(x(:,n), ones(1,N)) - x).^2, 1) < r^2))
```

It will only work if `x` has exactly the size 2-by-$N$. Your code should take about 30 seconds to run, so please debug if takes much longer.

T7.1 (review)

T7.2 (review)

T7.5

7.3