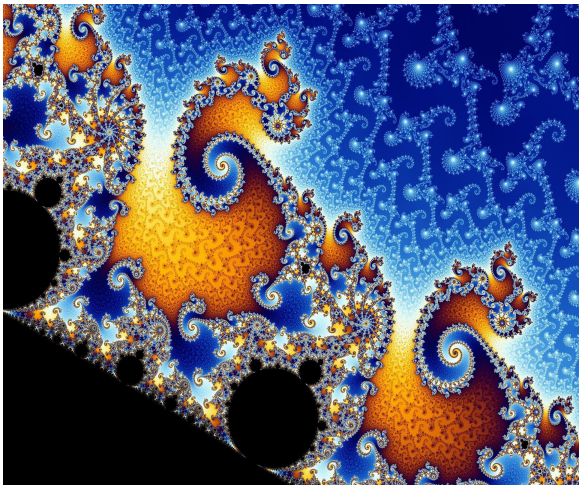
MTH 621/2/3: Advanced Differential Equations (Dynamical Systems) I, II, and III

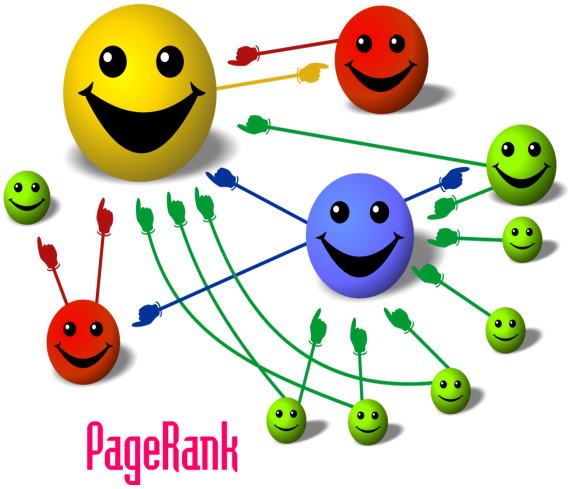
Instructor: J. J. P. Veerman

Term: Fall 2020, Winter and Spring 2021

This is an advanced course in advanced differential equations and their applications. This year we will concentrate on dynamical systems. Rather than a giving a general theory, we will discuss examples from all branches of mathematics and the sciences. We start with a discussion of the simplest nonlinear map from the interval to itself, and show how it leads to very complex behavior, including period-doubling and chaos. We will discuss complex dynamics (Mandelbrot and Julia sets). We will discuss examples of chaotic attractors in low dimensional maps (such as the Smale horsehoe and the Lorenz attractor). Subsequently, we will look in more detail at attractors and their properties such as (fractal) dimension. The study of the Perron Frobenius theorem will permit us to study random walks on graphs, Google's pagerank algorithm, and other network dynamics. We then turn to the Poincare-Bendixson theorem, which in turn will lead us to look at dynamical systems studied in biological evolution.

Towards the end of the year, there will be the possibility of doing small projects counting towards a final grade. Subjects such as applications of number theory in dynamical systems, renormalization, ergodic theory, complex dynamics, fractal dimension, evolutionary dynamics, network dynamics, population dynamics, chemical reaction networks, neural nets, quantum mechanics, and many others can be considered.





Textbooks:
1) S. Sternberg, *Dynamical Systems*, Dover Publications, 2013, New York.
2) Other materials as distributed by instructor.
3) A reference text to be determined later.

Expected preparation: MTH 422/522 or consent of instructor.