Chapter 1

# Dynamical Systems and Generalised Modelling

## 1.1 Dynamical Systems Theory

The mathematics of differential equations provides a powerful set of tools for modelling real world phenomena. In particular, we are interested in using the theory of dynamical systems which is the language of how deterministic systems evolve through time. A one-dimensional dynamical system is described by a first-order differential equation of the form,

$$\frac{dx}{dt} = f(x)$$

The archetypal example is the logistic equation which was constructed by Verhulst (cite) to describe population growth,

$$\frac{dN}{dt} = rN\left(1 - \frac{b}{r}N\right)$$

For example, a two dimensional dynamical system is defined by,

$$\frac{dx}{dt} = f(x,y) \tag{1.1}$$
$$\frac{dy}{dt} = g(x,y) \tag{1.2}$$

## 1.2 Bifurcation Theory