Practice 3.2

Practice sheets are not assessed. The intention is to use material from lectures in preparation for Competence tests and Assignments. You are encouraged to use `thing.[TAB]` and `thing?` in IPython.

Coupled differential equations

Any n^{th} order Ordinary Differential Equation can be expressed as n coupled first order ODEs.

Some differential equations are naturally expressed as coupled first order ODEs. For example, the following represents predator–prey population dynamics (e.g. foxes and rabbits):

$$\dot{x} = ax - bxy \text{ and } \dot{y} = cxy - dy.$$

The file `solvers.py` (embedded in this PDF and available on the course website) contains code from lectures which implements various methods, including Euler and Runge–Kutta 4th order. Please use it like so:

```
from solvers import rkscipy # similar for euler, rk4, etc
```

Solve the above coupled ODEs, using the following parameters, and plot $x(t)$ and $y(t)$ for $0 \leq t \leq 20$.

$$a = 2; b = 5; c = 1; d = 1$$

with initial conditions

$$x(0) = 1; y(0) = 3.$$

Try with `euler`, `rk4`, `rkscipy`. What timestep is appropriate for each method?

A plot of $x(t), y(t)$ should look something like the following: