Higher Dimensional Problems

- A differential system may involve more than one *dependent* variables.
  - ◇ These variables may interact with each other, making the problem harder to solve analytically.
  - ◇ Most real-world problems would involve lots of interacting factors.
  - ◇ The way to solve a differential system is exactly the same as solving a single differential equation.
- A predator-prey model:

$$\begin{aligned} \frac{dy_1}{dt} &= ay_1 - by_1y_2 \\ \frac{dy_2}{dt} &= -cy_2 + dy_1y_2. \end{aligned}$$

  - ◇ A MATLAB m-file defining the right-hand side:

```
function [yprime] = predprey(x,y)
global a b c d
yprime(1) = a*y(1)-b*y(1)*y(2);
yprime(2) = -c*y(2)+d*y(1)*y(2);
```

  - ◇ A call from MATLAB of the routine **myeuler**:

```
global a b c d
a=1;b=1;c=0.3;d=0.3;
t0 = 0;                          % initial time
y0=[1,2];                        % initial value
tfinal = 50;                     % final time
N = 500;
[t,y] = myeuler('pred_prey',t0,tfinal,y0,N); % main call
plot(t,y)
plot(y(:,1),y(:,2))              % plotting the phase portrait
```

- A competition model:

$$\begin{aligned} \frac{dy_1}{dt} &= ay_1 - by_1y_2 \\ \frac{dy_2}{dt} &= cy_2 - dy_1y_2. \end{aligned}$$

  - ◇ What is the difference between the competition model and the predator-prey model?
  - ◇ What kind of asymptotic behavior can you predict qualitatively?
  - ◇ Run a numerical test to see the results.