Section 3.1

We start with the Pig problem page 6

A pig weighs 200 lb and is **gaining 5 lbs per day**. He costs 45 cents/day to keep. The market price of pork is 65 cents/lb, dropping at 1 cent/day. When should the pig be sold?

The model was \( P = (0.65 - 0.01t)(200 + 5t) - 0.45t; \)

In place of the linear weight gain assumption that \( w(t) = 200 + 5t \) we assume the rate of weight gain is proportional to the current weight \( \frac{dw}{dt} = cw \) with \( w(0) = 200 \). We take \( c = 0.025 \).

Thus \( w(t) = 200e^{ct} \).

```maple
> restart;
> y := (.65 - .01*x)*(200*exp(.025*x))-.45*x;
> plot(y, x=0..12);
> rightend := solve(.65 - .01*x = 0, x);
> plot(y, x=0..rightend);
> dydx := diff(y, x);
> plot(dydx, x=0..50);
```

Use a graph to get global information and a rough idea of the neighborhood of the zero.

```maple
> plot(dydx, x=0..50);
```
Find the zero using Newton's method.

```plaintext
digits := 20;

f := (.65 - .01*x)*(200*exp(c*x)) - .45*x

dfdx := diff(f, x);

F := dfdx;

dFdx := diff(F, x);

c := 0.025; x := 19.5; N := 10;

for n from 1 to N do
    x := evalf(x - F/dFdx);
    od;

evaluate(x - F/dFdx);

evaluate(x);
```
How would we perform sensitivity analysis for $x$ relative to $c$ given that we do not have a formula for $x$ in terms of $c$? Return to the difference quotient definition of Sensitivity. \[ \frac{\Delta x}{\Delta c} \frac{c}{x}. \]

```plaintext
> unassign('x'); unassign('c');
> f:=(.65-.01*x)*(200*exp(c*x))-.45*x;
> dfdx:=diff(f,x);
> F:=dfdx;
> dFdx:=diff(F,x);
```

We try a 1\% increase in $c$ and calculate the new $x$.

```plaintext
> c:=0.02525; x:=19.5; N:=10;
> for n from 1 to N do
x:=evalf(x-F/dFdx);
od;
> x2:=x;
> unassign('x'); x2; x1;
```

And now we have everything we need to approximate $S_{xc}$

```plaintext
> SxcApprox:=(x2-x1)/(0.02525-0.025)*(0.025/x1);
```
A little experimenting with `solve`, `fsolve` et cetera

```maple
> solve(x^2 - 5*x - 2, x);
> evalf(%%);
> fsolve(x^2 - 5*x - 2, x=-1..6);
> solve(x^3 - 1=0, x);
> fsolve(x^10 - 3*x^7 - 1);
> solve( log(x) = x-1.1 , x);
> fsolve( log(x) = x-1.1, x=0.5..3);
```

In general, SOLVE tries to find ALGEBRAIC expressions for ALL roots to an equation. The syntax of the command simply specifies which variable is to be solved for. On the other hand, FSOLVE is used to search for a root in a small interval (for example, where a graphing command has indicated there is a root). To use FSOLVE, note that you must specify the interval to be searched. If you make it large enough that it contains two roots, Maple will find one and stop looking.

An aside about extracting a single root from a list in Maple output:

Suppose I am trying to find the minimum value of \( f(x) = x^3 - 5x \) on \( 0 \leq x < \infty \). When I set \( f(x) = 0 \), I get two solutions, one of which is negative. Here is a way to extract the root we care about without having to retype it or cut and paste.

```maple
> restart: f:= x^3 - 5*x;
> dfdx:=diff(f,x);
> s:=solve(dfdx =0, x);
> secondderiv:=subs(x=s[1], diff(dfdx, x));
> subs(x=s[1], f);
```