

Example 3.1. Reconsider the pig problem of Example 1.1, but now take into account the fact that the growth rate of the pig is not constant. Assume that the pig is young, so that the growth rate is increasing. When should we sell the pig for maximum profit?

```

1 md"""
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3 account the fact that the growth rate of the pig is not constant. Assume that
4 the pig is young, so that the growth rate is increasing. When should we sell the
5 pig for maximum profit?
6 """

```

Let  $w(t)$  be the weight of the pig at time  $t$ . Then

$$w(t) = w_0 e^{ct}$$

is the exponential rate of growth we consider here.

```

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3 ``math
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5 ``
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7 """

```

w (generic function with 1 method)

```
1 w(t)=200*exp(c*t)
```

C (generic function with 1 method)

```
1 C(t)=0.45*t
```

p (generic function with 1 method)

```
1 p(t)=0.65-0.01*t
```

R (generic function with 1 method)

```
1 R(t)=w(t)*p(t)
```

P (generic function with 1 method)

```
1 P(t)=R(t)-C(t)
```

```
1 using Symbolics
```

D (generic function with 1 method)

```
1 D(f,x)=expand_derivatives(Differential(x)(f))
```

```
[t, c]
```

```
1 @variables t,c
```

```
dPdt = -0.45 - 2.0exp(c*t) + 200c*(0.65 - 0.01t)*exp(c*t)
```

```
1 dPdt=D(P(t),t)
```

```
parudt = -4.0c*exp(c*t) + 200(c^2)*(0.65 - 0.01t)*exp(c*t)
```

```
1 parudt=D(dPdt,t)
```

```
parudc = 130.0exp(c*t) - 4.0t*exp(c*t) + 130.0c*t*exp(c*t) - 2.0c*(t^2)*exp(c*t)
```

```
1 parudc=expand(D(dPdt,c))
```

```
dtcd =  
(-130.0exp(c*t) + 4.0t*exp(c*t) - 130.0c*t*exp(c*t) + 2.0c*(t^2)*exp(c*t)) / (-4.0c*exp(c*t))
```

```
1 dtcd=-parudc/parudt
```

```
Stc = 2.8746311019686357
```

```
1 Stc=substitute(c/t*dtcd,[c=>1/40,t=>19.46815944415122])
```

The sensitivity is  $S(t, c) \approx 2.8746311019686357$ .

```
1 md"""
```

```
2 The sensitivity is ``S(t,c)\approx 2.8746311019686357``.
```

```
3 """
```