## 1170:Lab11

November 19th, 2013

## Goals For This Week

In this eleventh lab we will continue practicing our numerical techniques for solving differential equations and definite integrals.

## 1 Recall Euler's method and the Left Hand Sum

Suppose we have a differential equation:

$$
\begin{gather*}
\frac{d f}{d x}=g(x)  \tag{1}\\
f(a)=f_{a} \tag{2}
\end{gather*}
$$

We would like to solve this equation for $f(b)$. In other words, at $x=b$, what is $f(x)$. We have a couple of different interpretations of this problem. First we can think of solving this problem by integration. Then

$$
\begin{array}{r}
\int_{a}^{b} \frac{d f}{d x}=\int_{a}^{b} g(x) \\
f(b)-f(a)=G(b)-G(a) \\
f(b)=G(b)-G(a)+f_{a} \tag{5}
\end{array}
$$

Where $\mathrm{G}(\mathrm{x})$ is the antiderivative of $\mathrm{g}(\mathrm{x})$ and $f_{a}$ is the initial condition If $\mathrm{G}(\mathrm{x})$ is a known function, we are done. However often times there may be no antiderivative of $\mathrm{g}(\mathrm{x})$, as such we can approximate $\int_{a}^{b} g(x) d x$ using the left hand sum.

```
g<-function(t){}
a<-
b<-
n<-
t<-seq(1,n+1)
t[1]<-a
S<-0
delt<-(b-a)/n
for (i in 2:(n+1)) {t[i]<-t[i-1]+delt
S<-g(t[i-1])*delt+S}
S
```

Where $g(x), a, b$, and $n$ need to be filled in.
Alternatively we can solve for $\mathrm{f}(\mathrm{b})$ by using Euler's method until $\mathrm{x}=\mathrm{b}$, starting from $\mathrm{x}=\mathrm{a}, f(a)=f_{a}$

```
g<-function(t){}
a<-
b<-
n<-
t<-seq(1,n)
f<-seq(1,n)
t[1]<-a
f[1]<-
delt<-(b-a)/n
for (i in 2:(n+1)) {t[i]<-t[i-1]+delt
f[i]<-g(t[i-1])*delt+f[i-1]}
plot(t,f,type='l')
```

Where we need to fill in for $\mathrm{a}, \mathrm{b}, \mathrm{n}, \mathrm{g}(\mathrm{x})$, and $f[1]=f_{a}$

## 2 Assignment for this week

1. Problem 53 on page 377 in the text. Growth rates of insects depend on the temperature T. Suppose that the length of an insect follows the differential equation:

$$
\begin{equation*}
\frac{d L}{d t}=0.001 T(t) \tag{6}
\end{equation*}
$$

With $t$ measured in days starting from January 1st and $T$ measured in degrees Celsius. Insects hatch at an initial length of 0.1 cm . If the equation for $T(t)$ is:

$$
\begin{equation*}
T(t)=0.001 t(365-t) \tag{7}
\end{equation*}
$$

then how big will the insect be if it grows for 30 days starting on January 1st? What about if it starts growing on June 1st (day 151)?
2. Now suppose that $T(t)=40-5.0 * 10^{(-6)} t^{2}(365-t)$. Once again how big will the insect be if it grows for 30 days starting on January 1st? What about if it starts growing on June 1st (day 151)?

Solve for problem 1 using Euler's method with an $\mathrm{n}=10000$. Solve problem 2 using the left hand sum with the same n value.

