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title: "Ch11.2 R Activity"

output:

html\_document: default

word\_document: default

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```{r setup, include=FALSE}

knitr::opts\_chunk$set(echo = TRUE)

```

### Clayton Johnson

- Use R Studio to open this Rmd document from K drive Share folder.

- Fill in your name above.

- Save this Rmd file to your student K drive folder for this class.

### Lesson Plan

Today we will spend time on the computers using R within the R Markdown environment. Referring back to previous RPub lesson slides in the weekly folders (as needed), use this docoument to implement R code for the following problems.

#### Problem 1

In the space below, use R to compute $\sin(\pi/5)$ and $\ln(3)$. Note: R will evaluate your computation when you knit this document (knit to HTML for this activity). To get things going, here is some sample code for a related problem:

```{r}

exp(1)

```

##### Solution

```{r}

sin(pi/5)

```

```{r}

log(3)

```

#### Problem 2

In the space below, write a program `Ch112ExJ` can evaluate

$$J(U) = hA(U-u\_0)$$

for different values of the variable $U$ where $h=5, A=10, u\_0 = 20$. (Hint: Something similar was done recently in the Ch11.2 Slides.)

##### Solution

```{r}

Ch112ExJ <- function(U) {

### Your code here, between the braces {}

### When looking at the example in the Ch11.2 slides,

### note the () around the final term, used for evaluation.

h <- 5 # Convective Cooling Coefficient

A <- 10 # Area of flux

u\_0 <- 20 # Initial temperature

# U is the user-input temperature

return(h\*A\*(U-u\_0))

}

```

#### Problem 3

For your function $J(U)$ in the above problem, evaluate $J(30)$ using R in the space below. Note: As long as you have a working formula for $J(U)$ in the previous problem, R will be able to evaluate your result here when you knit the document. (Ch11.2 slides)

##### Solution

```{r}

Ch112ExJ(30)

```

#### Problem 4

In the space below, write a sequence of commands that plots $f(x) = 2x+1$ over $[0,3]$, using the color blue for the graph. This plot should have one legend item labeled "y = 2x+1", also colored blue. (Ch11.2 Slides)

##### Solution

```{r}

f <- function(x){ ### Your formula here ###

2\*x+1

}

### Your code here, for plotting & labeling curve.###

t\_0 = 0

t\_1 = 3

N <- 1000 # number of nodes within given time

T <- t\_1 # time over which we collect values

h <- T/N # sample density over time

t <- rep(0, N) # zeros

y\_vals <- rep(0, N) # zeros

t[1] <- t-0 # Start at t\_0

for(i in 1:N) {

t[i] <- t[1]+i\*h

y\_vals[i] <- f(t[i])

}

plot(t, y\_vals,

main = "y = 2x + 1",

xlab = "x", #x-axis label

ylab = "y", #y-axis label

type = "l",col="blue", #Line type and color

xlim = c(0,T), #x-axis range vector: c(0,T) = [0,T]

ylim = c( y\_vals[1], y\_vals[N] ) #y-axis range vector: c = "combine"

)

legend("bottomright",

legend = c("y=2x+1"), #Vector of legend items

col = c("blue"), #vector of colors for legend items

lty = c(1)

)

# Better way - Thx dr g

curve(f, main = "y = 2x + 1",

xlab = "x", #x-axis label

ylab = "y", #y-axis label

type = "l",col="blue", #Line type and color

xlim = c(0,T), #x-axis range vector: c(0,T) = [0,T]

ylim = c(1, 7 ) #y-axis range vector: c = "combine"

)

legend("bottomright",

legend = c("y=2x+1"), #Vector of legend items

col = c("blue"), #vector of colors for legend items

lty = c(1)

)

```

#### Problem 5

The position $y$ and velocity $v$ of a whiffle ball thrown vertically satisfies

$$

\begin{aligned}

y' & = v, \,\, y(0) = y\_0 \\

v' & = - g -\frac{c}{m} v , \,\, v(0) = v\_0 \\

\end{aligned}

$$

Here, $c$ is the damping constant (grams/sec), $m$ is the mass (grams), and $g$ the gravitational acceleration value. We will take $c/m = 3/sec, \, g = 9.8 m/sec^2, \, y\_0 = 0$. In the space below, complete the RK4 program `Ch112whiffle` that numerically solves this IVP and plots the solution over the time interval $[0, 2]$ for variable $v0$. After your code is written, run it for $v0 = 15 \, m/sec$. (See HW5 documents, Ch11.2, Ch2.8, etc.)

##### Solution

```{r}

Ch112whiffle <- function(v0) {

#v0 is the initial velocity

N <- 1000 #N is the number of time nodes

T <- 2

h <- T/N #This is the time step size in seconds

#System Parameters

t0 <- 0

y0 <- 0#### Your code here ####

g <- 9.8#### Your code here ####

c <- 3

m <- 1

#Slope functions for ODEs

yp <- function(v) {v}

vp <- function(v) {-g - (c/m)\*v}

#Initialize vectors for time t and temperature U.

t <- rep(0, N) #Vector of N zeros (0 repeated N times)

y <- rep(0, N) #Vector of N zeros (0 repeated N times)

v <- rep(0, N) #Vector of N zeros (0 repeated N times)

t[1] <- t0 #Initial time t0

y[1] <- y0 #Initial temperature

v[1] <- v0 #Initial temperature

#Runge-Kutta Loop (Generate temperature vectors U1 & U2)

for(i in 1:N) {

ay <- h\*yp(v[i]);

av <- h\*vp(v[i]);

by <- h\*yp(v[i]+0.5\*ay);

bv <- h\*vp(v[i]+0.5\*av);

cy <- h\*yp(v[i]+0.5\*by);

cv <- h\*vp(v[i]+0.5\*bv);

dy <- h\*yp(v[i]+cy);

dv <- h\*vp(v[i]+cv);

y[i+1] <- y[i]+(1/6)\*(ay+2\*by+2\*cy+dy); #Next y value

v[i+1] <- v[i]+(1/6)\*(av+2\*bv+2\*cv+dv); #Next v value

t[i+1] <- t[i] + h #Next t value

}

#Plot results

plot(t,y,

main = "Vertical Distance",

xlab = "t (seconds)",

ylab = "Height of Whiffle Ball (m)",

type = "l",col="blue", #Line type and color

xlim = c(0,2), #x-axis range vector: c(0,T) = [0,T]

ylim = c(-4,6) #y-axis range vector: c = "combine"

)

lines(t,v, type="l",col="red")

z <- rep(0, N+1)

lines(t,z, type="l",col="green", lty=2)

legend("topright",

legend = c("Height", "Velocity"), #Vector of legend items

col = c("blue","red"), #vector of colors for legend items

lty = c(1,1) #Vector of line types for legend items

)

}

```

```{r}

#### Your command here for implementing code at v0 = 15. ####

Ch112whiffle(15)

````