Introduction to R and RStudio

Part 2: Extended Introduction to R

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Matrices

- Although with most software packages learning about a “matrix” is unnecessary, in R many of the concepts explored while learning about matrices apply to dealing with multiple variables, dataset operations, etc.

- We will start with a brief discussion about matrices before moving more specifically into a discussion about datasets

Matrices

```
> x<-matrix(data=c(1,4,5,2,4,5,6,2),nrow=2, ncol=4)
> x
     [,1] [,2] [,3] [,4]
[1,]    1    5    4    6
[2,]    4    2    5    2

> x[2,4]
[1] 2

> rowSums(x)
[1] 16 13
```

Notice that by default the Matrix was created "by Columns" (1st col, 2nd col, etc.)

x[row,column]

Matrices, cont'd

```
> x<-matrix(data=c(1,4,5,2,4,5,6,2),nrow=2, ncol=4,
  byrow=TRUE)
> x
     [,1] [,2] [,3] [,4]
[1,]    1    4    5    2
[2,]    4    5    6    2

> mean(x[1,])
[1] 3

> var(x[,3])
[1] 0.5
```

This time the data was entered "by row"

When a row or column is blank, all elements are used

Matrices, cont'd

'apply' is also a function

1 = rows
2 = columns

Bind rows together

```
> x<-rbind(x, apply(X=x, MARGIN=2, FUN=mean))
> x
     [,1] [,2] [,3] [,4]
[1,]  1.0  5.0  4.0    6
[2,]  4.0  2.0  5.0    2
[3,]  2.5  3.5  4.5    4

> rownames(x)<-c(1,2,'Mean')
> x
     [,1] [,2] [,3] [,4]
1     1.0  5.0  4.0    6
2     4.0  2.0  5.0    2
Mean  2.5  3.5  4.5    4
```

Matrix Shortcuts

```
a<-matrix(c(2,1,2,4,3,5),nrow=2)
> a
     [,1] [,2] [,3]
[1,]    2    2    3
[2,]    1    4    5

> b<-matrix(c(2,4,6,1,1,3),nrow=3)
> b
     [,1] [,2]
[1,]    2    1
[2,]    4    1
[3,]    6    3
```

When elements are left out of a function, the function uses the defaults or figures out the required number

Defaults to "byrow = FALSE" … defaults can be found in the help file

Figures out that there needs to be 3 columns

Introduction to Matrix Operations

```
> t(a)
     [,1] [,2]
[1,]    2    1
[2,]    2    4
[3,]    3    5
```

Transpose (reverse rows and columns)

```
> a*b
```

* = Scalar multiplication

```
Error in a * b : non-conformable arrays
```

```
> a%*%b
     [,1] [,2]
[1,]   30   13
[2,]   48   20
```

Matrix Multiplication

Datasets

- You can enter your data directly into R

```
> x<-rep(x=c(1,2),each=4)
## same as > x<- c(1,1,1,1,2,2,2,2)
> y<-c(3,4,5,2,6,6,5,4)
> data<-data.frame(x,y)
> data
  x y
1 1 3
2 1 4
3 1 5
4 1 2
5 2 6
6 2 6
7 2 5
8 2 4
```

Repeat

The first column contains the row numbers

What's the Difference between a Dataset and a Matrix?

- The most important difference is that a dataset can contain a mixture of non-numeric and numeric variables, where a matrix cannot (all elements must be of the same form)

```
> mat<-matrix(data=c("a","b","c","d", 1, 2, 3, 5),nrow=1)
> mat
     [,1] [,2] [,3] [,4] [,5] [,6] [,7] [,8]
[1,]  "a"  "b"  "c"  "d"  "1"  "2"  "3"  "5"
```

Numeric elements were converted to character elements

Referencing Variables in Datasets

```
> a<-data.frame(matrix(c(1,3,1,4,2,6,2,8),ncol=2,byrow=TRUE))

> a
  X1 X2
1  1  3
2  1  4
3  2  6
4  2  8
> X1
Error: object 'X1' not found

> a$X1          # variable 'X1' in dataset 'a'
[1] 1 1 2 2
```

The variable names (X1,X2) were automatically assigned

The $ separates the dataset name from the variable name

Relating Variables to Each Other

- You can also relate variables to each other without them being in the same matrix/dataset

```
> iv<-c(1,1,1,1,2,2,2,2)
> dv<-rnorm(8)
> dv
[1]  1.4671261 -1.0878009 -1.0487529 -0.521493
[5]  1.9040232  0.5586128  2.8512241  -1.0348406

> mean(dv[iv==1])
[1] -0.2977303
```

The Problem of "=" and "=="

```
> x<-c(2,5,4,2,8,6)
> y<-c(1,1,1,2,2,2)

> x[y=1]
 [1] 2

> x[y==1]
[1] 2 5 4

> x[y>1]
[1] 2 8 6
```

Note that x[y=1] represents the first instance of x where y=1, whereas x[y==1] represents 'all x where y = 1'

Opening Existing Datasets

- You can also read in external data files
- To read in a dataset from SPSS there are multiple options, here are a couple of the popular options
  - Use the ‘read.spss’ command in the ‘foreign’ package (not recommended as it is very fussy with variable names, formats, and you need to data.frame the dataset after creating it)
  - Convert the SPSS file to a comma separated file (.csv) and then open the file using read.csv(file=” “)
    - This is recommended since it is easy to convert to .csv in SPSS and is very flexible

Opening Existing Datasets

- In general, it is recommended that you convert datasets to .csv before opening them in R
  - Almost all spreadsheet and statistical software packages will let you save your file as a .csv file
- To browse your directories for a file use the 'file.choose()' option (with a read statement)
  - newdata<-read.csv(file.choose())
- Also note that if you are specifying the exact file name, that the slashes are backward to Windows
  - > newdata<-read.csv(file="C:/My Documents/Robs Work/SCS/R Course/testdata2.csv")

Working with Datasets

- Example
  - In this example a researcher is interested in exploring whether sex (male,female) or community size (small, large) relate to the amount of recycling performed by individuals

D10

	A	B	C
1	Sex	Commsize	Recycle
2	male	small	2
3	male	small	4
4	male	large	3
5	male	large	5
6	female	small	6
7	female	small	3
8	female	large	7
9	female	large	4
10			

Working with Datasets, cont'd

```
> newdat<-read.csv(file.choose())
> head(newdat)
     Sex Commsize Recycle
1   male    small       2
2   male    small       4
3   male    large       3
4   male    large       5
5 female    small       6
6 female    small       3
> names(newdat)
[1] "Sex"      "Commsize" "Recycle"
```

After running this line a 'select file' box appears

'head' function gives the first six lines of the dataset

Variable Names

Editing a Dataset

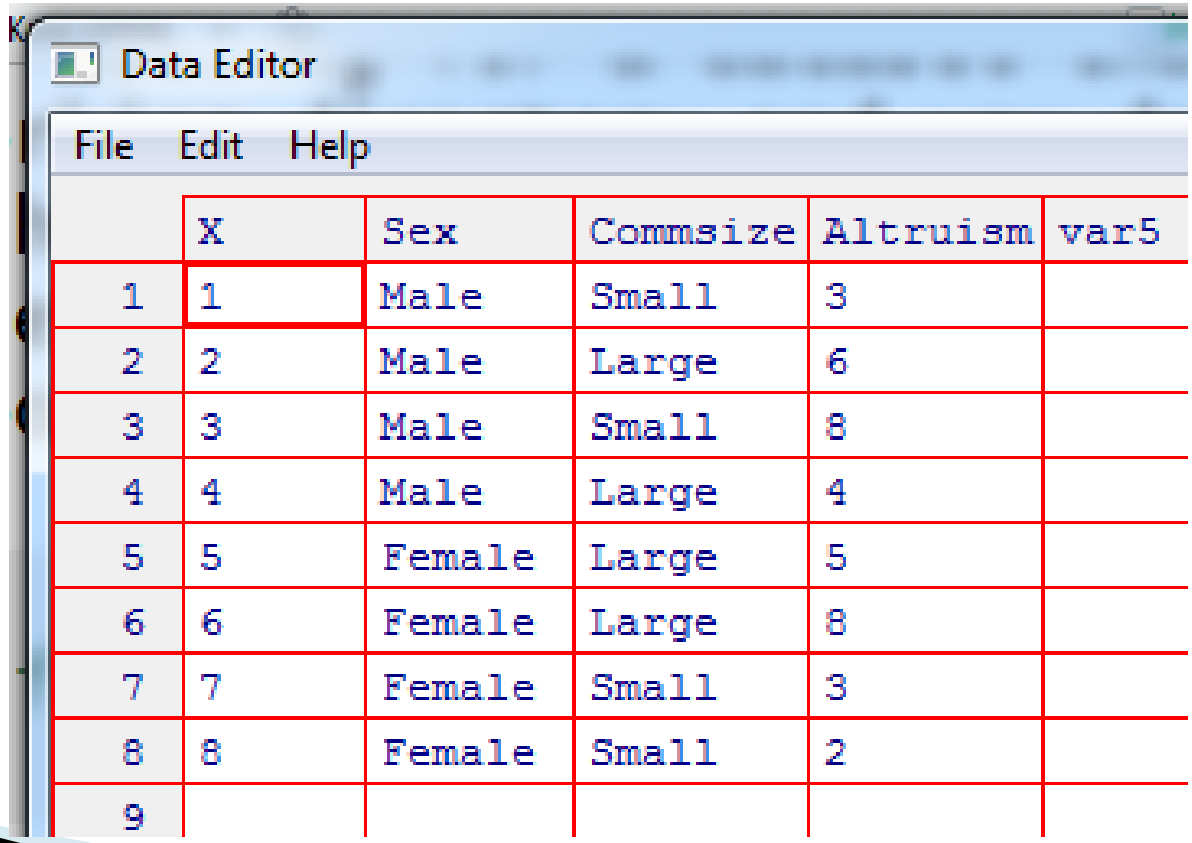
- The following command will pop up a spreadsheet that allows you to change dataset values, variable names, etc.

> edit (dat1)

- However, when you close the spreadsheet nothing is saved because you are not saving (putting, <-) your changes into an object
- In order to save our changes we must specify the name of the dataset that will receive the changes

Editing a Dataset

```
> dat2 <- edit(dat1)
```



	X	Sex	Commsize	Altruism	var5
1	1	Male	Small	3	
2	2	Male	Large	6	
3	3	Male	Small	8	
4	4	Male	Large	4	
5	5	Female	Large	5	
6	6	Female	Large	8	
7	7	Female	Small	3	
8	8	Female	Small	2	
9					

Subsetting a Dataset

- In some instances we want to work with just a subset of the original dataset
  - This could be done with indexing, but subsetting is very straightforward

```
> dat2<-subset(dat1, Sex=='Male')
> dat2
      Sex   Commsize Altruism
1    Male  Small        3
2    Male  Large        6
3    Male  Small        8
4    Male  Large        4
```

Basic Statistics on a Dataset

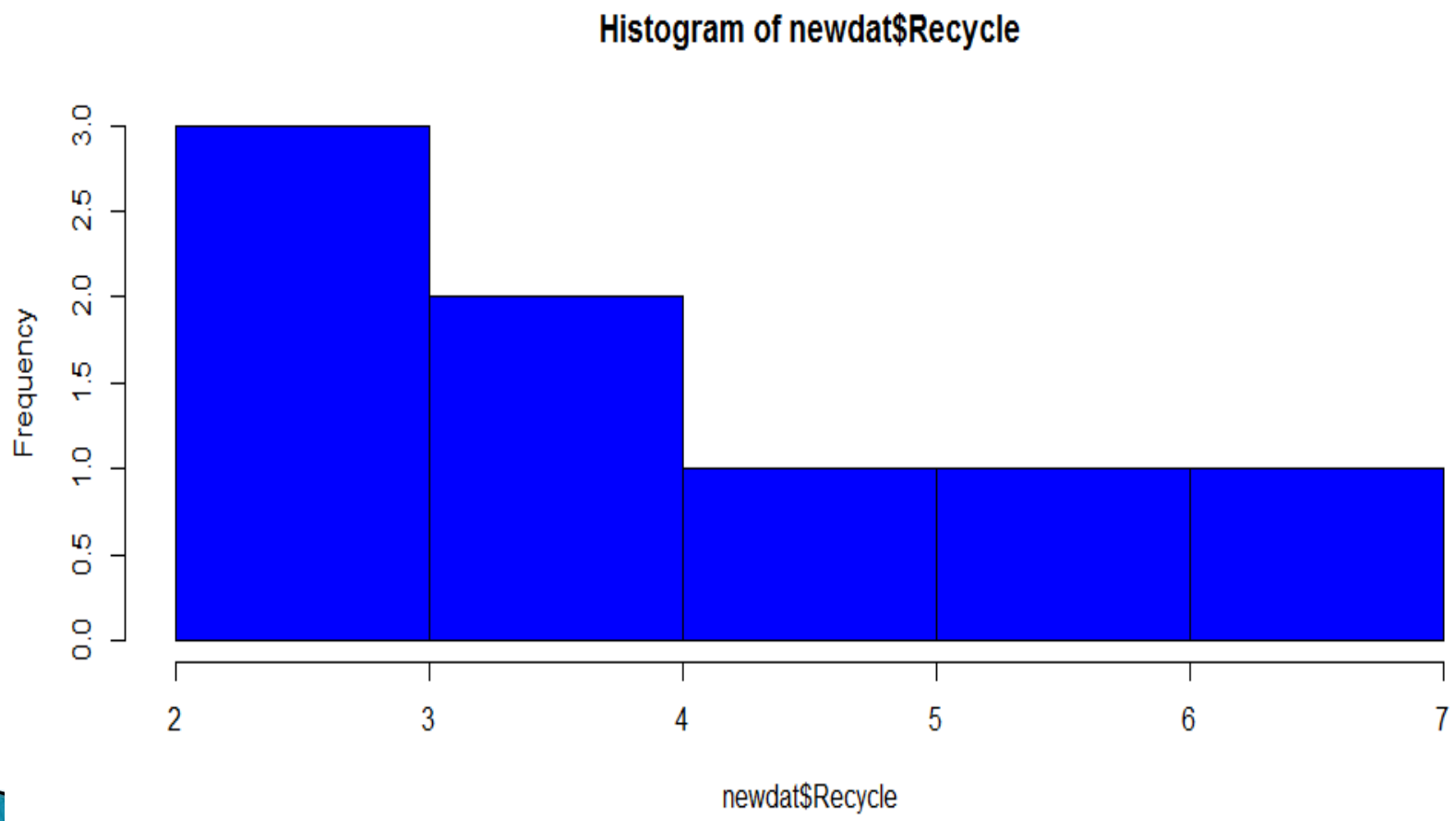
- > mean(newdat$Recycle)
  [1] 4.25

- > mean(newdat$Recycle[newdat$Sex=="male" & newdat$Commsize=="small"])
  [1] 3

- > var(newdat$Recycle[newdat$Sex=="female" & newdat$Commsize=="large"])
  [1] 4.5

Simple Plot

- >hist(newdat$Recycle, col="blue")



Simple Assumption Checks

- Check normality and variance homogeneity assumptions
  - > shapiro.test(newdat$Recycle)

```
 Shapiro-Wilk normality test, data: newdat$Recycle
W = 0.959, p-value = 0.8006
```

  - > library(car)
  - # ‘car’ is a package that I previously installed

  - > leveneTest(newdat$Recycle,newdat$Sex)

```
Levene's Test for Homogeneity of Variance (center = median)
       Df      F value    Pr(>F)
group 1       1.5        0.2666
      6
```

Assumption Checks

- What if we wanted to verify that the distributions in each commsize are normal in shape (this would not make much sense with n=4)
  - > tapply(newdat$Recycle,newdat$Commsize,shapiro.test)

$large
Shapiro-Wilk normality test data: X[[1L]]
W = 0.9714, p-value = 0.85

$small
Shapiro-Wilk normality test data: X[[2L]]
W = 0.9714, p-value = 0.85

'tapply' is very handy any time you need to look at a statistic (e.g., mean) across multiple levels or cells of other variables

Working with Factors

- One of the nice features of R is that when a variable is designated as a “factor”, R performs some operations that are either safeguards or helpful to the user
- A couple examples are:
  - Not permitting numeric operations on factors
    - E.g., mean of factor
  - Automatically assigning dummy variables in regression

Working with Factors

- > is.factor(newdat$Sex)

[1] TRUE

- > levels(newdat$Sex)

[1] "female" "male"

- > cor(newdat$Sex,newdat$Recycle)

Error in cor(newdat$Sex, newdat$Recycle) :
'x' must be numeric

- > library(ltm) #package I installed
- > biserial.cor(y=newdat$Sex, x=newdat$Recycle)

[1] 0.4493585

Saving an R Dataset or Matrix

```
> a
  X1 X2
1  1  3
2  1  4
3  2  6
4  2  8
```

Don't forget the forward slashes (/)

```
> write.csv(a, file='c:/Documents and Settings/Rob/My Documents/RCourse/newdat.csv', row.names=FALSE)
> write.csv(a, file='newdat.csv', row.names=FALSE)
```

If you have already set your working directory

It is important to add row.names=FALSE if you want to open the dataset in other software programs

Writing Functions

- One of the main advantages of R is its flexibility
- For example, R makes it very easy to write your own functions
  - Here is a (completely unnecessary) function to take the mean of a set of observations
    - >robsmean<-function (x) {

      result<-sum(x)/length(x)

      return(result)

      }
  - >robsmean(c(3,2,4))

    [1] 3