Stat 704 Data Analysis I
Lecture 2: Introduction to Computing Tools

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The New York Times

Business Computing

Data Analysts Captivated by R's Power

Left, Stuart Isett for The New York Times; right, Kieran Scott for The New York Times

R first appeared in 1996, when the statistics professors Robert Gentleman, left, and Ross Ihaka released the code as a free software package.

By ASHLEE VANCE
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To some people R is just the 18th letter of the alphabet. To others, it's the rating on racy movies, a measure of an attic's insulation or what pirates in movies say.

Related

R is also the name of a popular

R computing & graphics package

- R is a powerful, free statistical computing and graphics package.
- Popular with many researchers due to contributed packages: R functions to do specialized, advanced, & often complex statistical analysis.
- R can also do many important, routine calculations, analysis, and provide common graphical displays used in this course.
- Installed in several of the computing labs across campus, e.g. Sloan 108 & 109, Gambrell 003.
- You can download it and install it from CRAN: `http://cran.r-project.org/`

R: Pros and Cons

Pros

+ Free
+ Available for all major platforms
+ Powerful graphics
+ Comprehensive
+ Easy interface with other languages (such as C, Fortran)
+ Well-designed programming language (object-oriented)
+ Unlimited extensibility
+ Widely used by statisticians
+ Increasingly used for genomic analyses (Bioconductor)

Cons

- No dedicated support
- Complex Syntax
- Not point-and-click
- No warranty
- Relatively slow

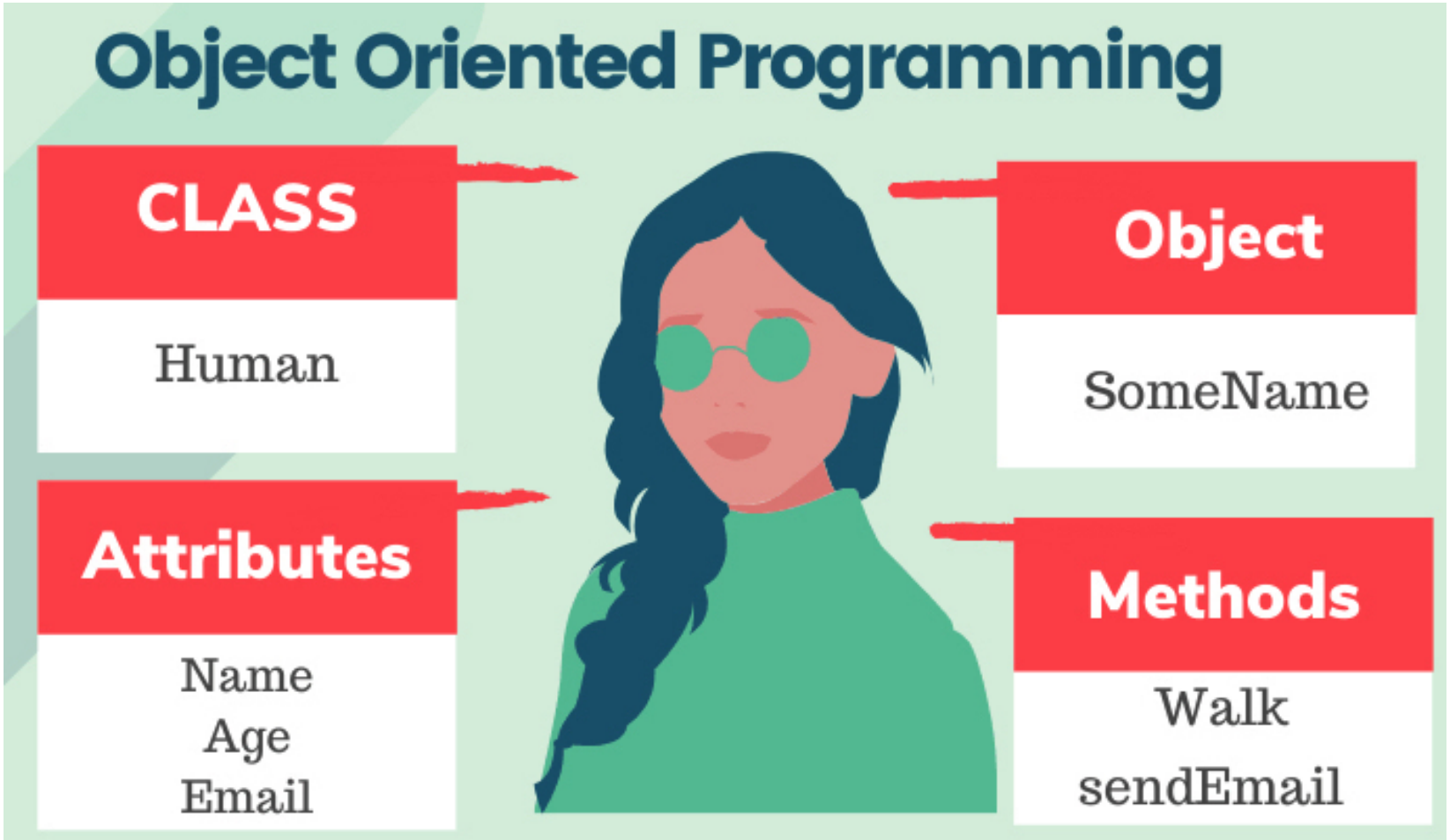
SAS: Pros and Cons

Pros

+ Dedicated support
+ Excels in handling large datasets
+ Easy syntax
+ Industrial standard
+ Widely used by statisticians
+ New routines for mixed effect model
+ New routines for MCMC

Cons

- Expensive
- Window & Unix only
- Not point-and-click
- New routines developed later than R
- Less flexible
- Not so nice graphics


Object Oriented Programming
CLASS
Human
Object
SomeName
Attributes
Name
Age
Email
Methods
Walk
sendEmail

R Topics Outline

- Get Started
- R as a calculator
- Vectors
- Matrices, Arrays, Factors, List, Data Frame
- Import/Export Data
- R Graphics
- Random number generating
- Writing R function
- for loops
- rep, seq, which, match

Get Started

- Installation
  - google R $\rightarrow$ The R project for Statistical Computing
  - R64 bits (large datasets) vs. R32 bits
- Getting help with R
  - At the command prompt, type, for example ?read.table or help(read.table)
  - At the command prompt, type, for example, help.search("read") or apropos("read").
  - Within R, use the menu bar: Help: R help.
  - Quititng R. q()
  - How to save work space

R Resources

John Verzani's SimpleR notes
R Reference Card
CRAN (Document/Manuals)

Note: To run some of the example in John Verzani's notes, run:
> install.packages("UsingR")
> library(UsingR)

R as a calculator

```
> 3 + 2
[1]5
> 7/2
[1]3.5
> 3 * 5
[1]15
> 2 ^ 3
[1]8
> 7%% 3 ## answer 1, modulo reduction
> log(1 : 4)
> log 2(1 : 4)
> log(1 : 4, base = 3)
> exp(1)
[1]2.718282
> abs(-3)
> sqrt(3)
> sin(0.5)
```

Vectors

Vectors contain elements of just 1 type, either numeric, integer, logical, or character (complex and raw are rare).

- Accessing elements in a vector: [ ]. (Very important)
- Use **c** to create a vector

```
> x<- 3
> x # print x
>x<-4
>x
### Creating simple vectors
> x<- c(1,3.5,-28.4,10) #numerical vector
> y<-c("cat","dog","mouse","monkey") #character
> z<-c(TRUE,TRUE,TRUE,FALSE,FALSE) #logical vector
> x<-1:10
> seq(1, 10, by=1)
> seq(3,9, by=3)
> rep(2,10)
> log(seq(1,2,by=0.1))
>x <- c(1,5,10,NA,15)
> sum(x)
> sum(x,na.rm=TRUE)
> prod(x,na.rm=TRUE)
> mean(x,na.rm=TRUE)
```

Accessing Elements in a Vector

```
>y <- c(8,32,15,-7, 2,19)
> length(y)
>y[3:5] ##position in vector as positive integer
> y[-c(1,5,6)] ## exclude:  use negative integers
>y< 15
> y[y<15]
> which(y==32)
> x <- 1:10
> match(y, x)
> colors <- c(``red", ``blue", ``pink", ``yellow")
> which(colors == ``yellow")
> x < −c(1,5,10,NA,15)
> which(is.na(x))
> which(!is.na(x))
> rep(c(1,2,3), 10)
> rep(c(1,2,3), each=10)
> rep(c(1,2,3), c(10, 9, 8))
```

&, |

```
>x<-c(T, T, F, F)
>y<-c(T, F, T, F)
>mat<-cbind(x,y)
>mat
>and<- x & y
>or<-x | y
>and
>or
```

Factors

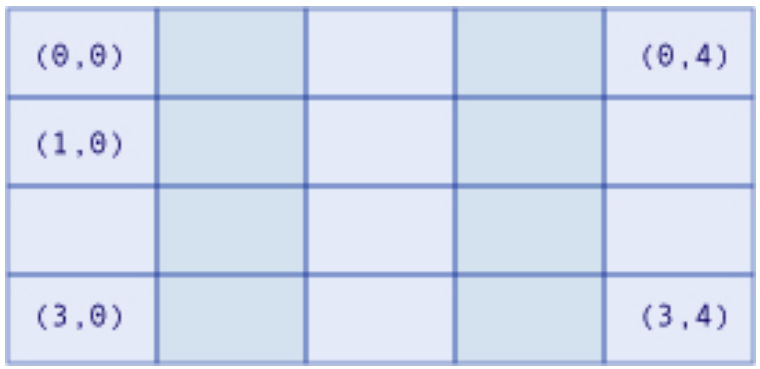
Factors: vectors with levels. Handy for regression modeling.

Example:

```
> colors <- c(1, 1, 2, 3)
> colors <-
factor(colors, label=c("red","green","blue"))
> table(colors)
colors
red green blue
2       1     1
```

Matrices

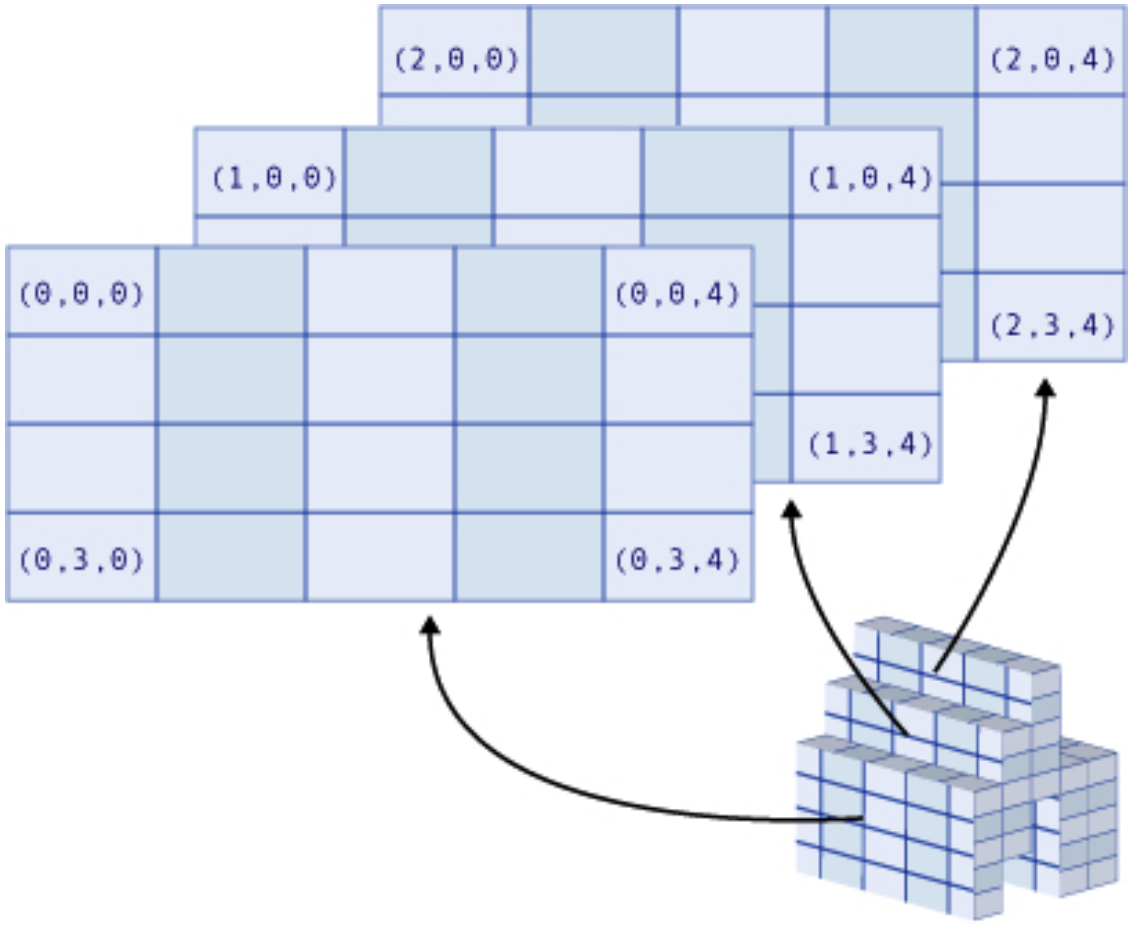
- Dimension: Row by column.
- Accessing elements in a matrix: [row, column].
- create a matrix



```
> help(cbind)
>y <- c(8,32,15,-7, 2,19)
> x <- 1:6
> mat<- cbind(x,y)
> help(rbind)
> dim(mat) ## check dimension
> ncol(mat) ## the number of columns of a matrix
> nrow(mat) ## the number of rows of a matrix
> mat[2,3] # the value in the 2nd row and the 3rd column
> mat[1:3,] ## the first three row of mat
> mat[,2] ## the 2nd column of mat
> mat[-1,] ## exclude the first row
> newmat<-matrix(1:9, nrow=3) ## create new matrix
> newmat
> m<-matrix(1:9, nrow=3, byrow=T) ## fill row first
> colnames(m) <- c("a", "b", "c") ## label column name
> rownames(m) <- c("r1", "r2", "r3")
> vect<-as.vector(newmat)
```

Arrays

- Dimension: Row by column by height.



```
> myarray<-array(1:64, dim=c(4,4,4))
> myarray
> myarray[1,2,3]
```

Data Frames

Data Frame: like matrices, but each column can be a different data type.

>str(mydata)
'data.frame': 10 obs. of 3 variables:
 $ y : num 24.2 26.6 23.9 23.6 23.6 ...
 $ x1: num 3.02 2.43 3.35 3.86 3.7 É
 $ x2: Factor w/ 2 levels "F","M": 2 2 2 2 2 2 1 1 1 1

Lists

List: a bag contains different things (vectors, matrices, data frames, É)

- Accessing components in a list: [[ ]].
- Accessing to elements within components.

Lists

```
> x <- list(one=c(18:36),two=c("AK","AL","AZ"),
            three=c(T,T,F,T),four=matrix(1:12,3,4))
> str(x)
List of 4
$ one :  int [1:19] 18 19 20 21 22 23 24 25 26 27 É
$ two :  chr [1:3] "AK" "AL" "AZ"
$ three:  logi [1:4] TRUE TRUE FALSE TRUE
$ four :  int [1:3, 1:4] 1 2 3 4 5 6 7 8 9 10 ...
> x[[1]]
> x$one
> y <- unlist(x)
```

For loops

```
for(i in 1:100){
    d <- Sys.time()
    print(paste("Now is", d, sep=" "))
    print(i)
}
```

R Topics Outline

- Import Data
- Export Data
- Generate random sample
- Sample
- R Graphics
- Writing R function
- for loops
- rep, seq, which, match

R Reference Card