St. Louis Hadoop User Group

December 16, 2014

1. Introduction to R
2. About Hue

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What is R?

- Language for statistical computing
- Re-implementation of the S programming language
- Open source (GNU license)
- A pirate's favorite language?

Getting R

- Cross-platform (Windows, Linux, Mac OS X, ...)
- Source and binaries available from `r-project.org`
- It's even easier on Debian or Ubuntu Linux:

```
$ sudo apt-get install r-base
```

- There are also IDEs for R, but we'll skip these for now

Starting R in Interactive Mode

- To run R interactively, execute the R command

```
$ R
```

- You can then enter R statements at the prompt
  - R is an interpreted language, so there's no compile step

```
> print("hello world")
[1] "hello world"
```

NOTE: I'll show the R prompt and R statements in blue to help distinguish them from the output that these statements produce

Exiting Interactive Mode

- This is harder than you think!

```
> exit
Error: object 'exit' not found
> quit
function (save = "default", status = 0, runLast = TRUE)
.Internal(quit(save, status, runLast))
<bytecode: 0x1a84b98>
<environment: namespace:base>
>
```

- OK, so how *do* you exit then?

Exiting Interactive Mode, Part II

- Use the `quit()` function, or its short equivalent, `q()`
  - Alternatively, you can hit Ctrl-d

```
> quit()
Error: object 'exit' not found
> Save workspace image? [y/n/c]: n
$
```

- You can avoid this prompt by starting R thusly

```
$ R --no-save
```

Running R Scripts

- It's a hassle to type your entire program every time
  - You can save your R statements to a text file
  - Anything following a **#** on a line is ignored (comments)
- Use the `source()` function to load and execute them

```
> source("my_program.R")
```

- You can also run them non-interactively (batch mode)

```
$ R --no-save < my_program.R
```

R Packages and CRAN

- Packages are another benefit of R
- The best code is the code you don't have to write
- CRAN=**C**omprehensive **R** **A**rchive **N**etwork

```
> install.packages("lubridate")
```

Assignment and Types

- You assign variables using less-than and minus signs
  - Using equals also works (mostly), but is discouraged

```
> answer <- 42
> body_temp <- 98.6
> name <- "Tom"
```

- R has data types, but they are determined dynamically

```
> typeof(body_temp)
[1] "double"
> typeof(name)
[1] "character"
```

Why the [1] in the Output?

- The print() function displays the value of a variable

```
> print(name)
[1] "Tom"
```

- You may wonder why R keeps prepending [1]
  - It's because the output fits on one line
  - You'll see something like this when it does not

```
> x <- 1:25
[1]  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15
[16] 16 17 18 19 20 21 22 23 24 25
```

Vectors

- The **`1:25`** notation generated a sequence of numbers
  - These are stored in a data structure called a *vector*
  - Sort of like an array in C or Java (all of same type)
- Use subscripts to refer to a specific element
  - In order to annoy me, R uses 1-based indexing

```
> x <- 1:25
> print(x[1])
[1] 1
```

In many languages, this would refer to the **second** element

Vectors Abound!

- Surprise: our variables are not single (scalar) values
  - They may just *happen* to contain a single value
  - They're really vectors

```
> print(name)
[1] "Tom"

> print(name[1])
[1] "Tom"
```

Creating Vectors

- Use the `c()` function to create a multi-element vector

```
> dogs <- c("Fido", "Spot", "Buster")
> print(dogs[1])
[1] "Fido"
> print(dogs[2])
[1] "Spot"
```

- You can create a new vector from a subset of another

```
> two_dogs <- dogs[2:3]
> print(two_dogs[1])
[1] "Spot"
```

Displaying Vectors

- The `print()` function can display a vector
  - Prints elements (strings are quoted), followed by newline

```
> print(dogs)
[1] "Fido" "Spot"  "Buster"
> print(dogs[2:3])
[1] "Fido" "Spot"
```

- The `cat()` function omits any such formatting

```
> cat(dogs)
Fido Spot Buster>
```

Generating Random Numbers

- You saw earlier how to generate a sequence of numbers
  - R can also generate random numbers
- The `rnorm()` function generates `N` random numbers
  - Based on the *normal distribution* (AKA "bell curve")
  - Values are centered about zero

```
> z <- rnorm(8)
> print (z)
[1] -0.6935897 -2.1828442  1.7268656  0.1267711
[5] -0.3590410 -0.8488329 -1.7032515 -0.6952838
```

Some Built-In Functions (1)

- The `sum()` function adds up all numbers in a vector

```
> print(sum(2:5))
[1] 14
```

- `min()` returns smallest value; `max()` returns the largest

```
> n <- c(3, 5, 199, -2, 17, 4, 0)
> print(min(n))
[1] -2
> print(max(n))
[1] 199
```

Some Built-In Functions (2)

- The `range()` function shows the bounds of a vector
  - It creates a two-element vector with min and max values

```
> x <- 10:500
> range(x)
[1] 10 500
```

- `mean()` returns the average value

```
> n <- c(5, 7, 2, 3, 4, 8, 6, 9, 2, 1, 5)
> print(mean(n))
[1] 4.727273
```

Some Built-In Functions (3)

- The `quantile()` function calculates values at intervals
  - Imagine you had populated a vector with household incomes

```
> quantile(household_incomes)
    0%     25%     50%     75%    100% 
  7033   23427   44298   87513  979261 
```

- `sample()` returns N values selected at random

```
> s <- sample(household_incomes, 3)
> print(s)
[1] 50962 29168 43227
```

Creating Functions

- This example shows how to create and call a function
  - R shows a plus sign to denote line continuation
  - The parentheses following `return` are required

```
> quadruple <- function(x) {
+    return (x * 4)
+ }
> print(quadruple(3))
[1] 12
```

Applying Functions to Vectors

- Use `sapply` to call a function on each element
    - Result is a new vector
    - R has many "apply" variations

```
> n <- 3:7
> print(n)
[1] 3 4 5 6 7
> quadrupled_n <- sapply(n, quadruple)
> print(quadrupled_n)
[1] 12 16 20 24 28
```

Lists

- All data in a vector must be of the same type
  - Lists can contain data of any type (including vectors)
- Create these with the `list()` function
  - Access elements with weird multi-dimensional notation

```
> names <- c("Alice", "Bob", "Carol", "David")
> ages <- c(29, 37, 35, 41)
> people <- list(names, ages)
> print(people[[2]][3])
35
```

Data Frames

- This is an important data structure in R
  - It's a list of vectors all having the same length
  - You can name each element when creating the vector
- Create using the `data.frame()` function

```
> height <- c(Abe=71, Betty=64, Chuck=75)
> weight <- c(Abe=170, Betty=125, Chuck=190)
> children = data.frame(height, weight)
> print(children)
        height weight
Abe       71    170
Betty     64    125
Chuck     75    190
```

Data Frame Element Access

- You can access elements by name or index number

```
> print(children['Abe','weight'])
[1] 170
> print(children$weight[1])
[1] 170
```

- The latter form is widely used with functions

```
> print(children$weight)
[1] 170 125 190
> print(mean(children$weight))
[1] 161.6667
```

Reading Data from CSV

- Imagine `foo.csv` contains this comma-separated data

```
name,age,salary
Arno,52,75000
Burt,61,87250
Cleo,47,91000
Dave,23,42875
Earl,39,56500
```

- Read it into a data frame and show its range:

```
> foo <- read.csv(file="foo.csv",head=TRUE,sep=",")
> range(foo$salary)
[1] 42875 91000
```

Getting Help in R

- R has extensive built-in help
  - To get help on using help (like `man man` in UNIX)

```
> ? help
```

  - To view help for a specific function:

```
> ? read.csv
```

  - To search for a topic (like `man -k` in UNIX)

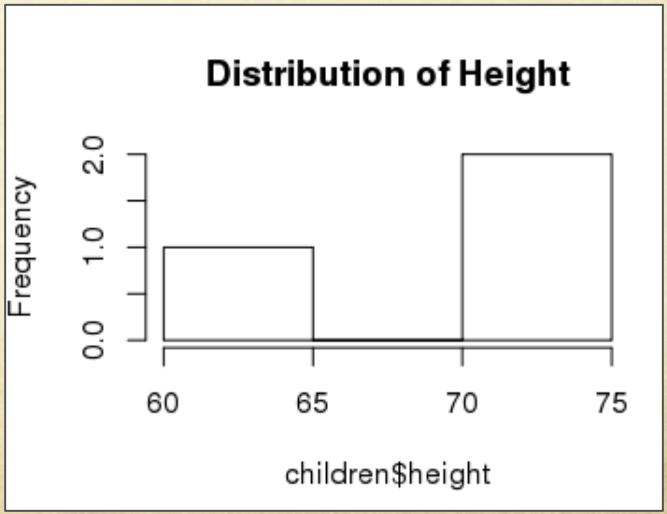
```
> ?? average
```

Graphics

- R has built-in support for creating charts and graphs
  - Add-on packages like "ggplot" makes this even better
- This example creates a histogram data frame's column

```
> hist(children$height, main="Distribution of Height")
```

- Shown on-screen, but it's easy to save them as PNG or PDF
- Run `demo(graphics)` or `demo(persp)` for examples



That's It for R...

- Any questions?
- Let's move on to some demos of Hue!

NOTE: The "Hue" presentation featured live demonstrations of Hue, a Web-based front end for Hadoop and related tools such as Pig, Hive, Impala, HBase, Solr, and Spark.

Cloudera's Quickstart VM provides a ready-to-use installation of all of these tools running in a virtual machine (VMWare, VirtualBox, and more). It's perfect for experimenting, and you can download a free copy of the VM from here:

http://tiny.cloudera.com/quickstart

You can watch several short videos demonstrating various features in Hue here:

http://gethue.com/tutorials/