Data Science: Lets All Be Ninjas

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Data Science

1. Means lots of things...
2. Data: Collection, curation, exploration, prediction.
3. Rewards programming skills.
4. Yay for outside options!

Skills

1. Data management.
   - Funky data, many sources, replicability.
2. Working at large scale and high speed.
   - Approximate methods, HPC, resource management.
3. Description and interpretation.
   - Visualization, summarization, causal inference.
4. Collaboration and open source.
   - Fluency, Extensibility, distributability.

What We Will Cover

1. Scientific Programming in R.
2. Remote Access – cluster resources.
3. Bash, RStudio, Github.
4. High Performance Computing – parallelization and performant programming.
5. Big Data – Memory management.
6. Hardware.
7. R and C++.
8. Web Scraping.
9. Package Development.

Overview

1. General Programming in R.
2. Super Friends!
3. Super Tools!

1. General Programming in R.

Motivation – The Gardener

- How many plants to water?
- Which plants to water?

Overview

- `for( )` and `while( )` loops.
- `if( )` statements.
- Nested loops
- Lists

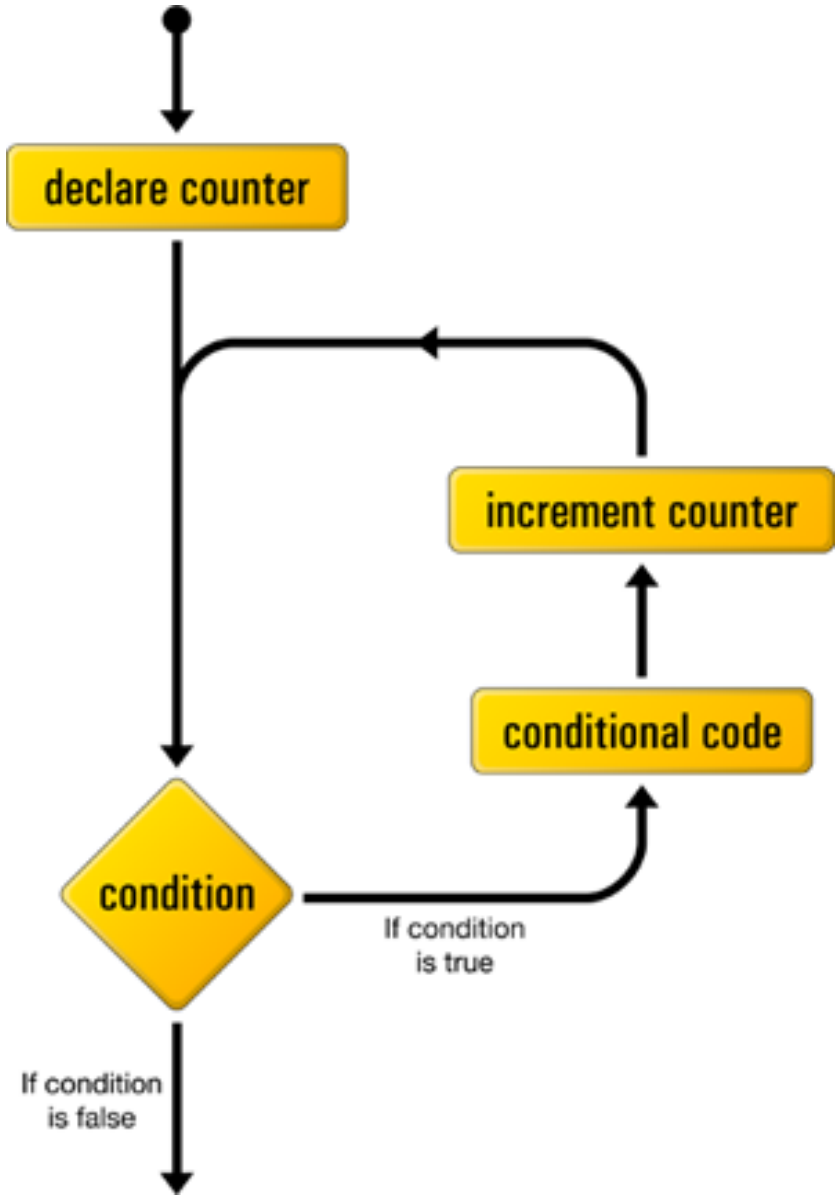
Preliminaries

```
# create a vector
my_vector <- c(1:10)
print(my_vector)

# get the length of the vector
length(my_vector)

# comparison operators
5 < 6
5 > 6
5 == 5
5 != 6
5 <= 5
```

The `for( )` Loop


declare counter
increment counter
conditional code
condition
If condition
is true
If condition
is false

The for( ) Loop

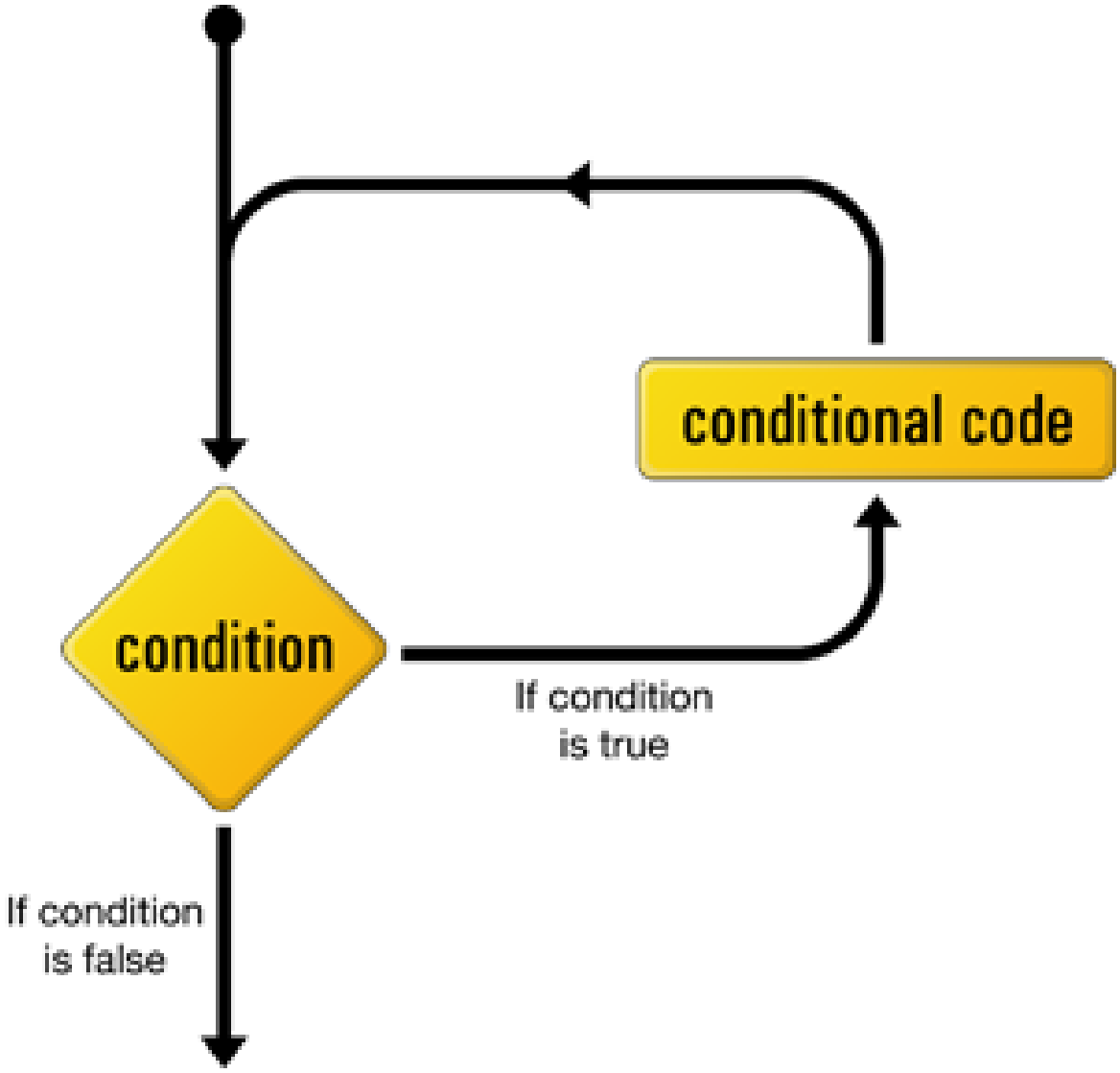
- Do something N times.

```
my_vector <- c(20:30)
for(i in 1:length(my_vector)){
    my_vector[i] <- sqrt(my_vector[i])
}

my_vector

[1] 4.472136 4.582576 4.690416 4.795832 4.898979
[6] 5.000000 5.099020 5.196152 5.291503 5.385165
[11] 5.477226
```

The `while( )` Loop



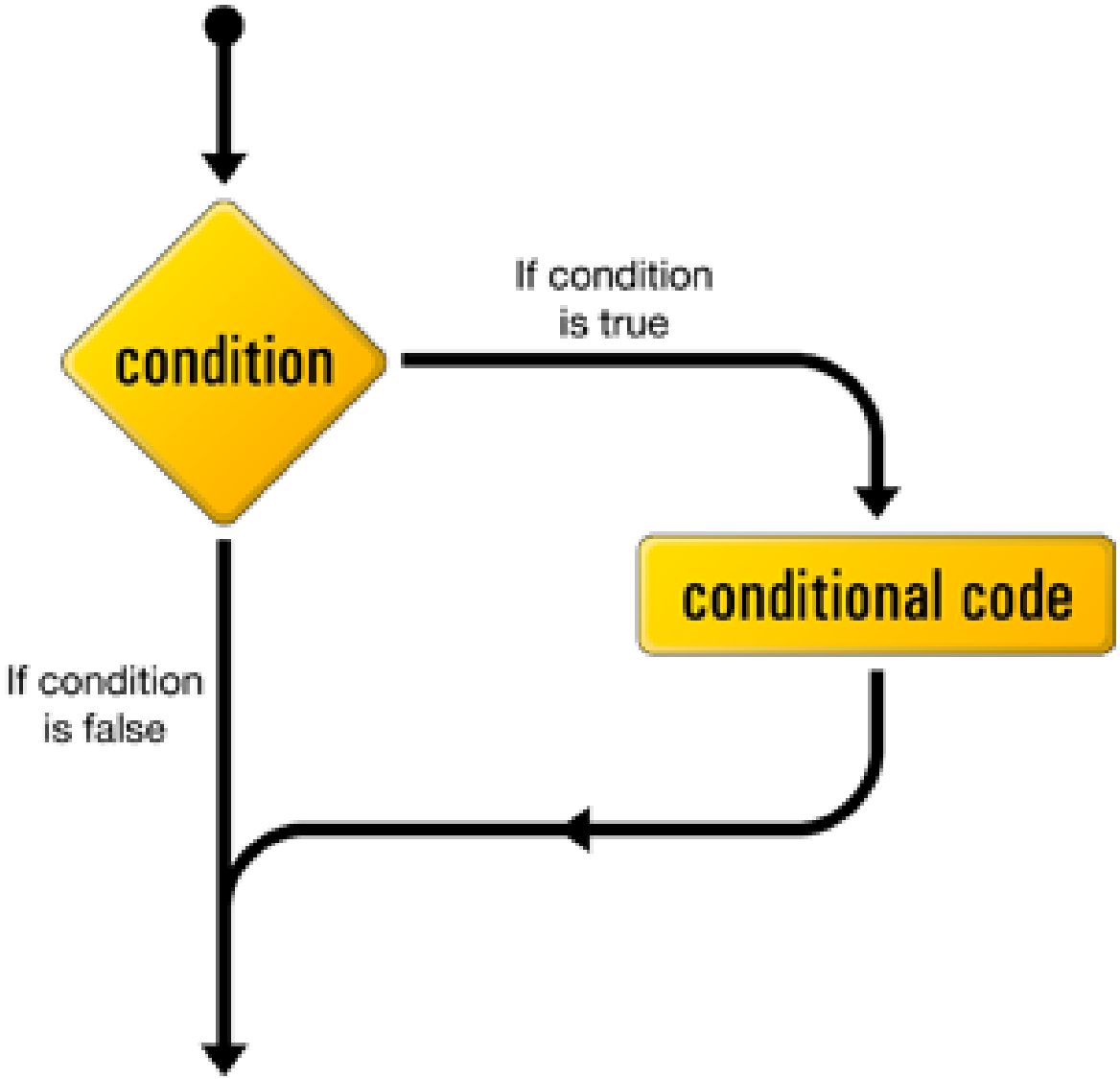
The `while( )` Loop

- Do something until a condition is met.
- Useful if you do not know the number of iterations ahead of time.

```
my_vector <- c(20:30)
counter <- 1
while(counter <= length(my_vector)){
    my_vector[counter] <- sqrt(my_vector[counter])
    counter <- counter + 1
}

my_vector
```

The `if( )` Statement



The if( ) Statement

- Do something if some condition is met.
- Can be built into a loop.

```
my_vector <- c(20:30)

for(i in 1:length(my_vector)){
    if(my_vector[i] == 25){
        print("The square root of 25 is 5!")
    }
}
```

The `else` Statement

- Do something if some condition is not met.

```
my_vector <- c(20:30)

for(i in 1:length(my_vector)){
    if(my_vector[i] == 25){
        print("I am 25!")
    }else{
        print("I am not 25!")
    }
}
```

Traversing A Matrix

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

Nested Loops

- Can loop over entries in higher dimensional data structures.

```
my_matrix <- matrix(1:100,ncol=10,nrow=10)

for(i in 1:length(my_matrix[,1])){
    for(j in 1:length(my_matrix[1,])){
        if(my_matrix[i,j] %% 2 == 0){
            my_matrix[i,j] <- 0
        }
    }
}

my_matrix
```

Lists

- Flexible, can store any kind of data including another list.
- Good for keeping results together.

```
# Create an empty list
my_list <- vector("list", length = 10)

# Create a list from objects
my_list <- list(10, "dog",c(1:10))

# Add a sublist to a list
my_list <- append(my_list, list(list(27,14,"cat")))
```

List Contents

```
> my_list
[[1]]
[1] 10

[[2]]
[1] "dog"

[[3]]
 [1]  1  2  3  4  5  6  7  8  9 10

[[4]]
[[4]][[1]]
[1] 27

[[4]][[2]]
[1] 14

[[4]][[3]]
[1] "cat"
```

2. Super Friends!

Overview

- `bash` is a command line terminal.
  - Linux and OS X (Cygwin for Windows).
- `VPN`: access campus network.
- `ssh/PuTTY` (Windows) for remote access.
- `ftp`: for file transfer.

Bash Commands

- `cd`: change the current directory.
- `ls` prints contents of current directory.
- `edit/vi/emacs` opens a text editor.

```
0587377979:Desktop matthewjdenny$ cd RA_Projects/
0587377979:RA_Projects matthewjdenny$ ls
Example          Jerry Epstein   Jerry Friedman
0587377979:RA_Projects matthewjdenny$ cd Example/
0587377979:Example matthewjdenny$ ls
Example.R
0587377979:Example matthewjdenny$ edit Example.R
```

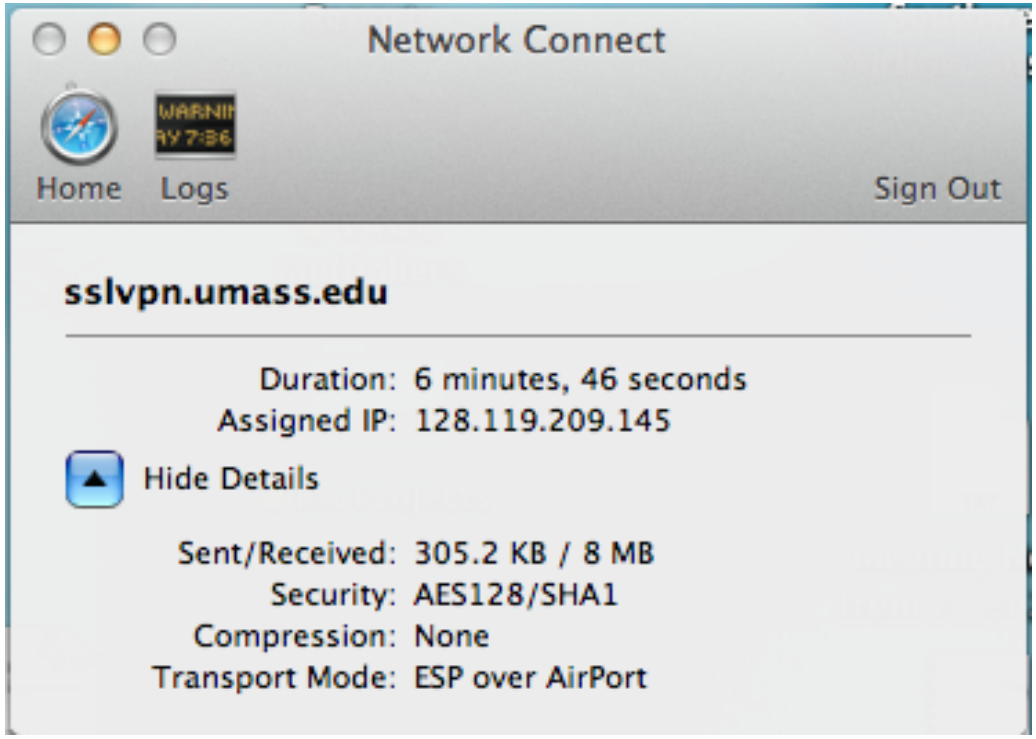
Bash Commands – Continued

- `python` opens python console.
- `R` opens standard R console.
- `cd ..` moves us back up a level in the directory structure.

```
0587377979:Example matthewjdenny$ cd ..
0587377979:RA_Projects matthewjdenny$ cd ..
0587377979:Desktop matthewjdenny$
```

Using VPN

- Provided by university/organization.
- For login to local campus resources.
- Routes all trafic through campus servers

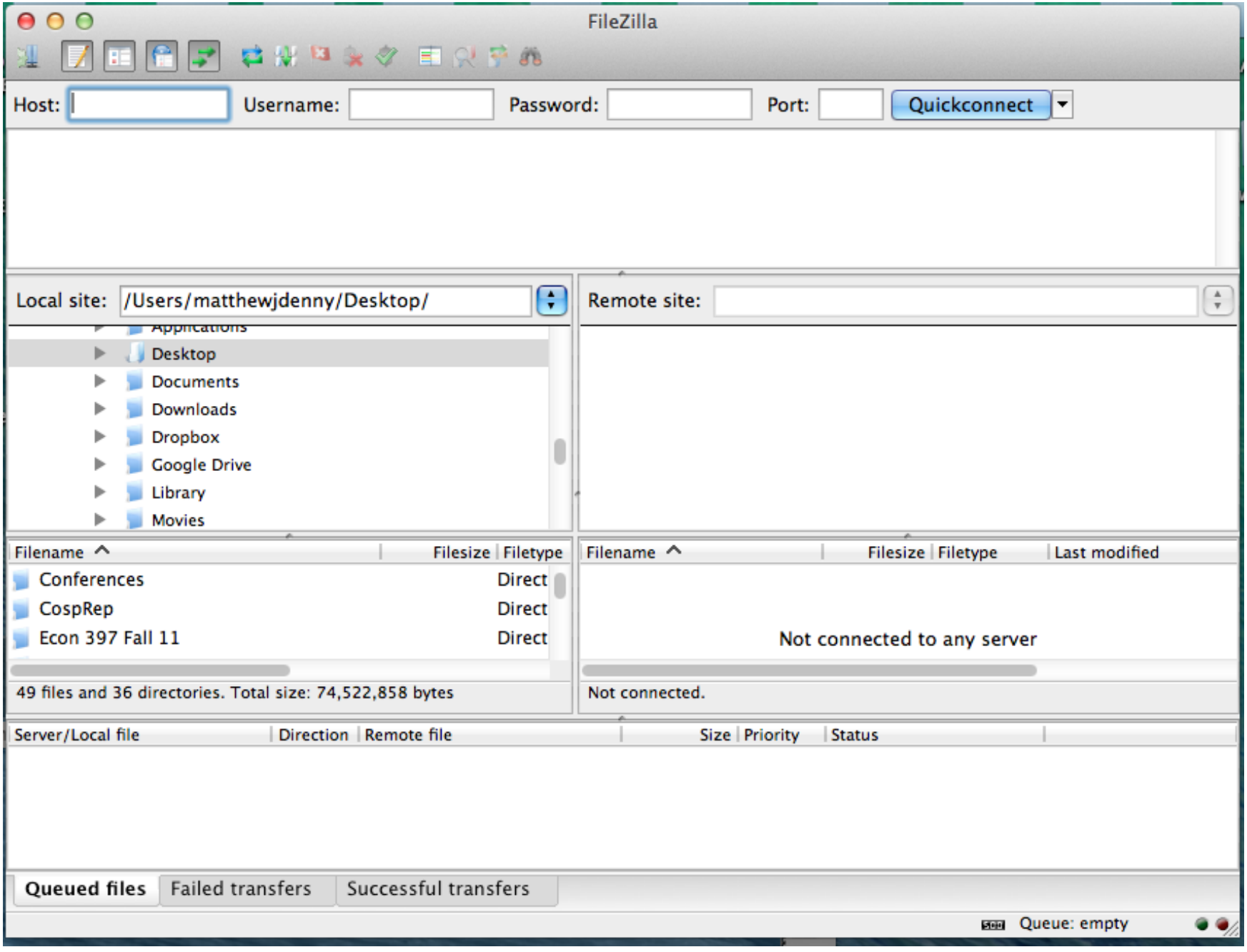


Using SSH

- Must have account on remote machine.
- ssh username@ipaddress
  - static ip: 128.114.64.8
  - dynamic: somedomain.dyndns.com
- prompt to enter password

```
Last login: Sun Jul 27 20:38:03 on ttys000
umass-vpn-145:~ matthewjdenny$ ssh [redacted]
[redacted] password:
Last login: Sun Jul 27 20:42:39 2014 from umass-vpn-145.vpn.umass.edu
[Denny@mattdenny ~]$ ls
Desktop     Dropbox     Pictures  rstudio-server-0.98.501-x86_64.rpm
Documents   GridEngine  Public    Templates
Downloads   Music       R         Videos
[Denny@mattdenny ~]$ R
```

FTP Using FileZilla



Putting It All Together

1. Connect to campus network using `VPN`
2. `ssh` into remote computing resource
3. Transfer files to/from machine using `ftp`
4. Navigate directories using `bash` and run analysis in `R` or `Python`.

3. Super Tools!

Overview

- Version Control
  - Git or Subversion.
  - Make an account on Github.
- RStudio
  - Lots of setup options.
  - Version control integration.

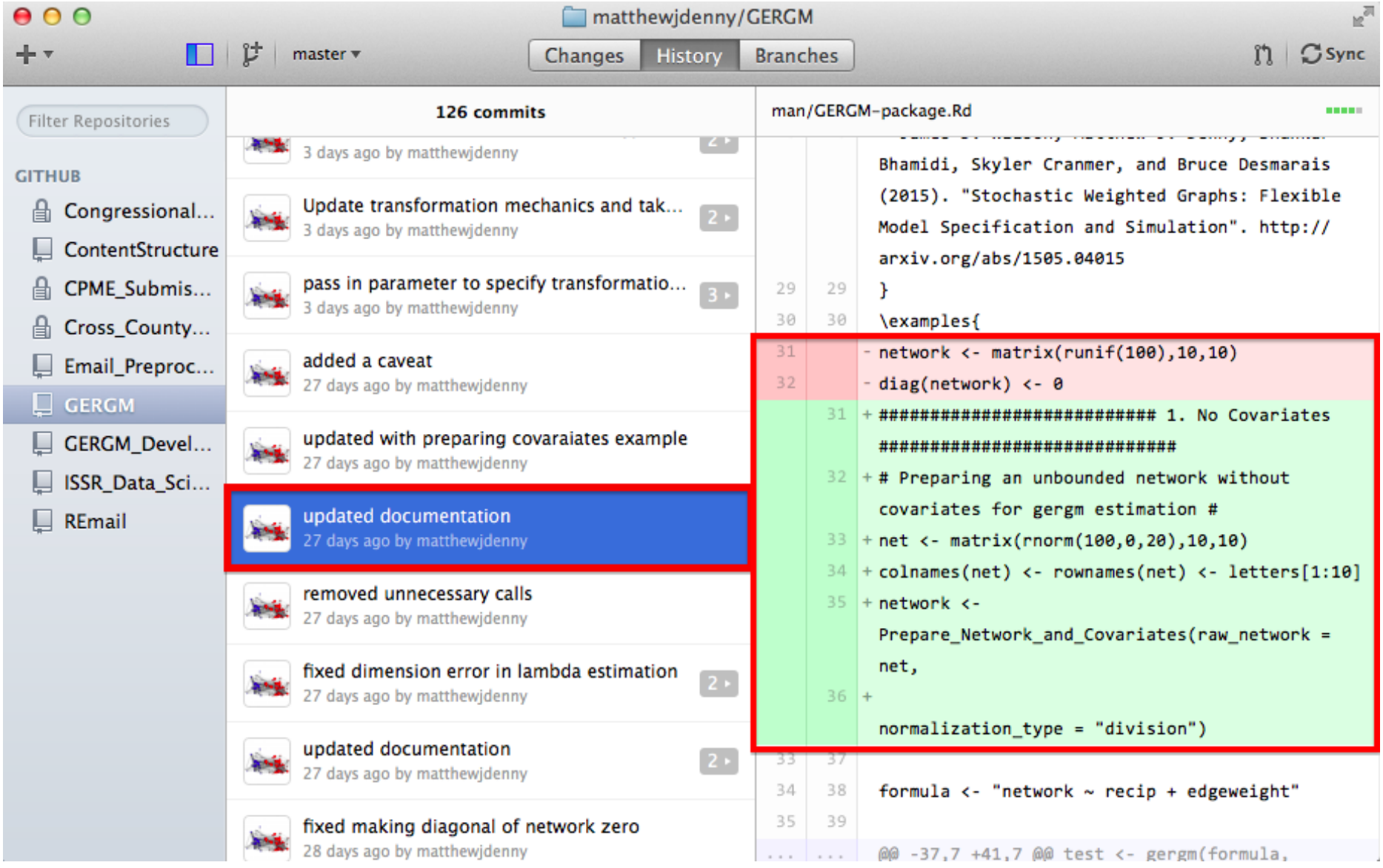
Version Control

- System for tracking changes to documents.
- Resolving conflicts.
- Reverting changes.
- Sharing your work.
- Highly motivating!

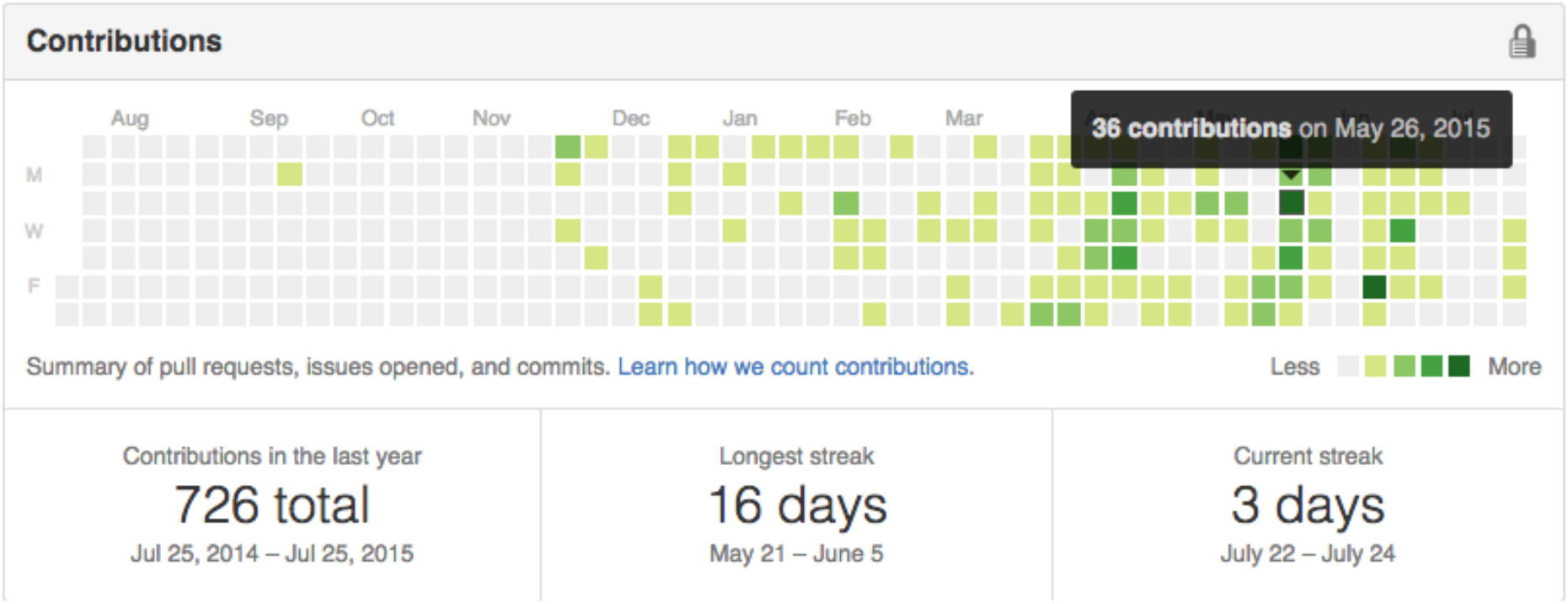
Git/Github

- Start by going to: github.com – make an account.
- Then windows.github.com – or – mac.github.com.
- Check out a tutorial.
- RStudio also has Git integration.

Git Tracks Changes



Motivation


Contributions
Aug
Sep
Oct
Nov
Dec
Jan
Feb
Mar
36 contributions on May 26, 2015
M
W
F
Summary of pull requests, issues opened, and commits. Learn how we count contributions.
Less
More
Contributions in the last year
726 total
Jul 25, 2014 – Jul 25, 2015
Longest streak
16 days
May 21 – June 5
Current streak
3 days
July 22 – July 24

RStudio

- Make sure you have the latest version of R.
- Then go to: rstudio.com – free academic download.
- Check out a tutorial.
- Spend time getting to know the interface.

Hands-On Tutorial

www.mjdenny.com/Data_Science_Tools.html