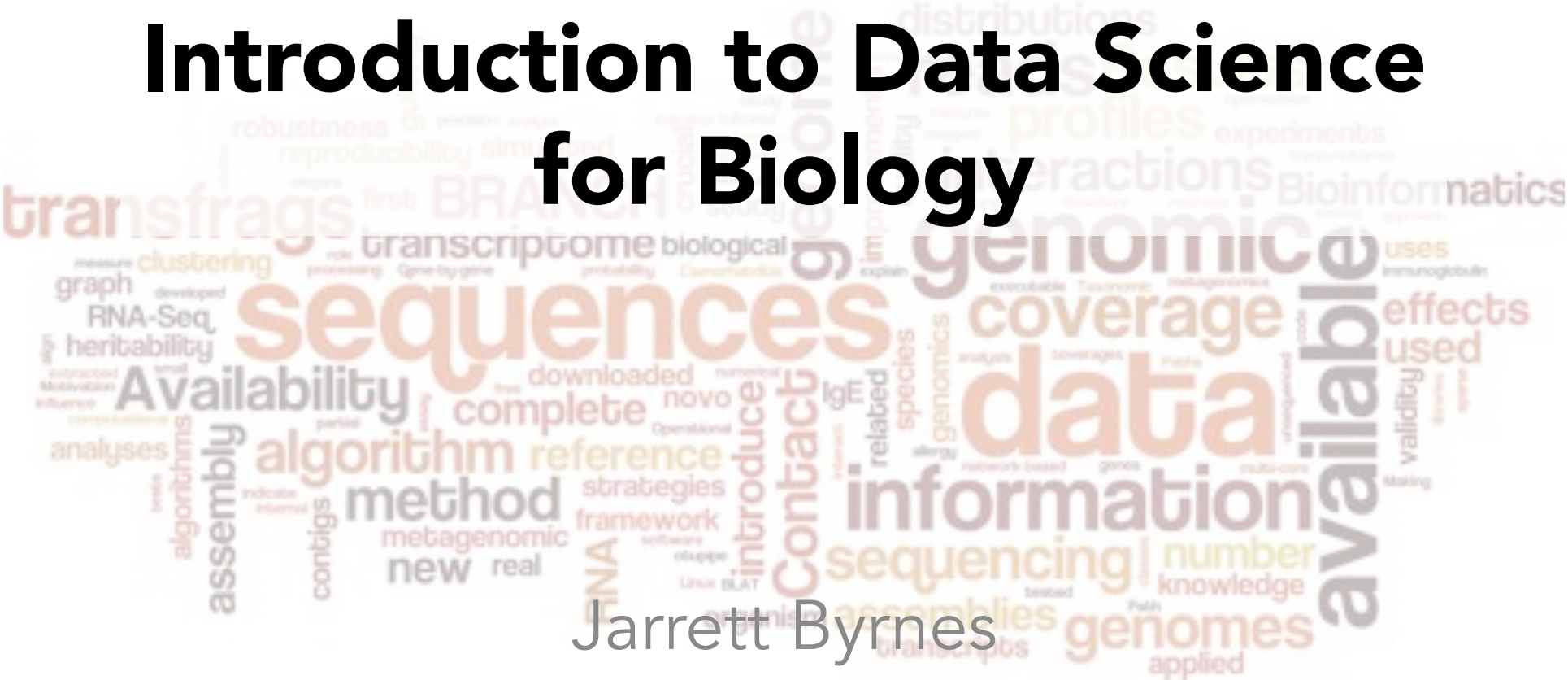
Introduction to Data Science for Biology



Jarrett Byrnes

UMass Boston

Spring 2016

We Are Awash in Data

FiveThirtyEight

Politics Sports Science & Health Economics Culture

First episode: Elections podcast

2016 ELECTION

The Republican Party May Be Failing

By NATE SILVER

TENNIS

THE LATEST

7:00 PM
You'd Have To Be Pretty Dumb To Fix A Tennis Match This Week

5:53 PM
Elections Podcast: One Week To Iowa

4:43 PM
What Do Anti-Abortion Demonstrators Want (Besides An End To Abortion)?

4:39 PM
The Republican Party May Be Failing

3:34 PM
Spurs-Warriors Is The Best Defense-Offense Clash In NBA History

12:56 PM
Tom Brady Couldn't Take The Pressure

INTERACTIVES

Primary Forecasts

UPDATED 4 HOURS AGO

Chance of winning Iowa

	POLLS-ONLY FORECAST	POLLS-PLUS FORECAST
Clinton	67%	80%
Sanders	33%	20%
O'Malley	<1%	<1%

SEE FORECASTS FOR MORE PRIMARIES

NFL Predictions

WEEK 21

UPDATED 1 DAY AGO

Chance of winning the Super Bowl

Carolina	59%
Denver	41%

2016 Primary Forecasts

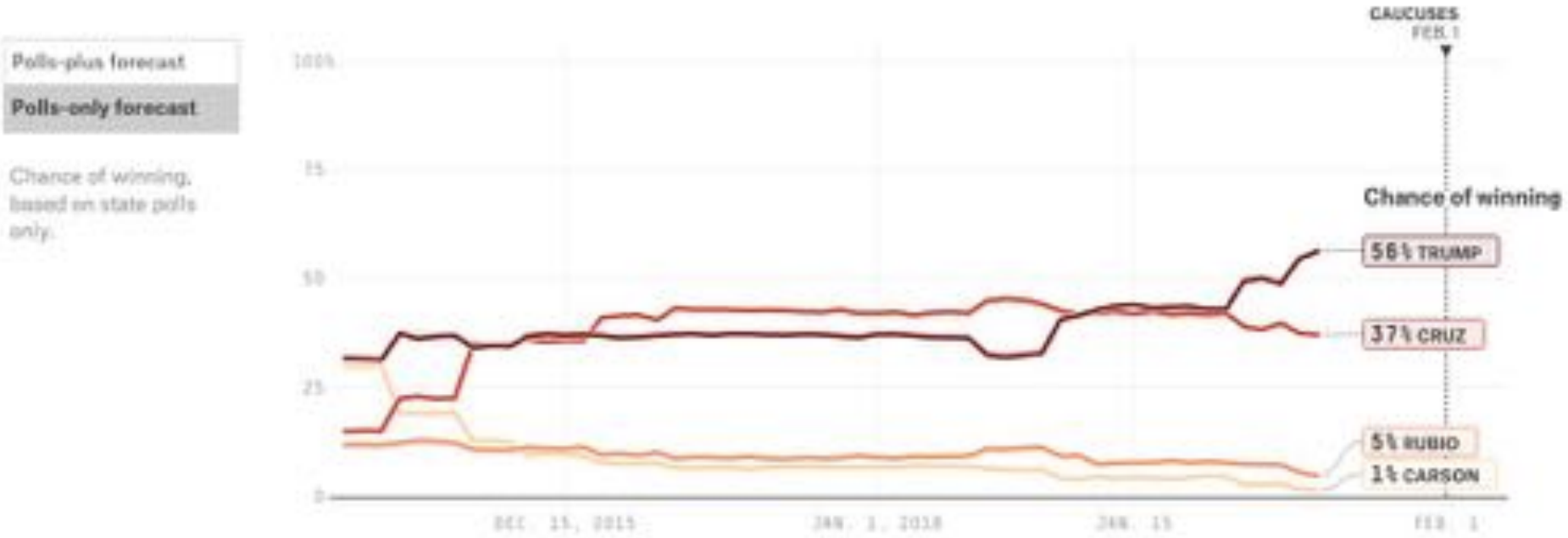
The odds and polls for presidential primaries and caucuses, updated daily.

Read more: How this works »

UPDATED 6:43 PM EST | JAN 25, 2016

Iowa Republican caucuses

According to our latest polls-only forecast, Donald Trump has a 56% chance of winning the Iowa caucuses.



HOME NEWS WEATHER SPORTS BUSINESS ENTERTAINM

Brady's greatness hasn't expired, but Pats ca it forever

PATRIOTS SCOREBOARD

Scoreboard

Sun, Jan 24

AFC Championship

Final	1	2	3	4	Tot
New England	6	3	3	6	18
Denver	7	10	0	3	20

Preview | Box | Gameview | Recap

Leader	New England	Denver
Passing	T. Brady 310	P. Manning 176
Rushing	T. Brady 13	C. Anderson 72
Receiving	R. Gronkowski 144	E. Sanders 62

Leaders

Pass Yds:	T. Brady	4770
Pass TDs:	T. Brady	36
Rush Yds:	L. Blount	703
Rush TDs:	L. Blount	6
Rec Yds:	R. Gronkowski	1176
Rec TDs:	R. Gronkowski	11
Int:	L. Ryan	4
Sacks:	C. Jones	12.5

AFC East Division

Team	W	L	T	Pct
xy-New England	12	4	0	.750
New York	10	6	0	.625
Buffalo	8	8	0	.500
Miami	6	10	0	.375

Full Standings

25 Best Jobs For Work-Life Balance (2015)

Glassdoor Team | October 20, 2015

Maintaining a healthy work-life balance can be tough in today's work environment, but some jobs

1. Data Scientist

- Work-Life Balance Rating: 4.2
- Salary: $114,808
- Number of Job Openings: 1,315

1. Data Scientist

- Work-Life Balance Rating: 4.2
- Salary: $114,808
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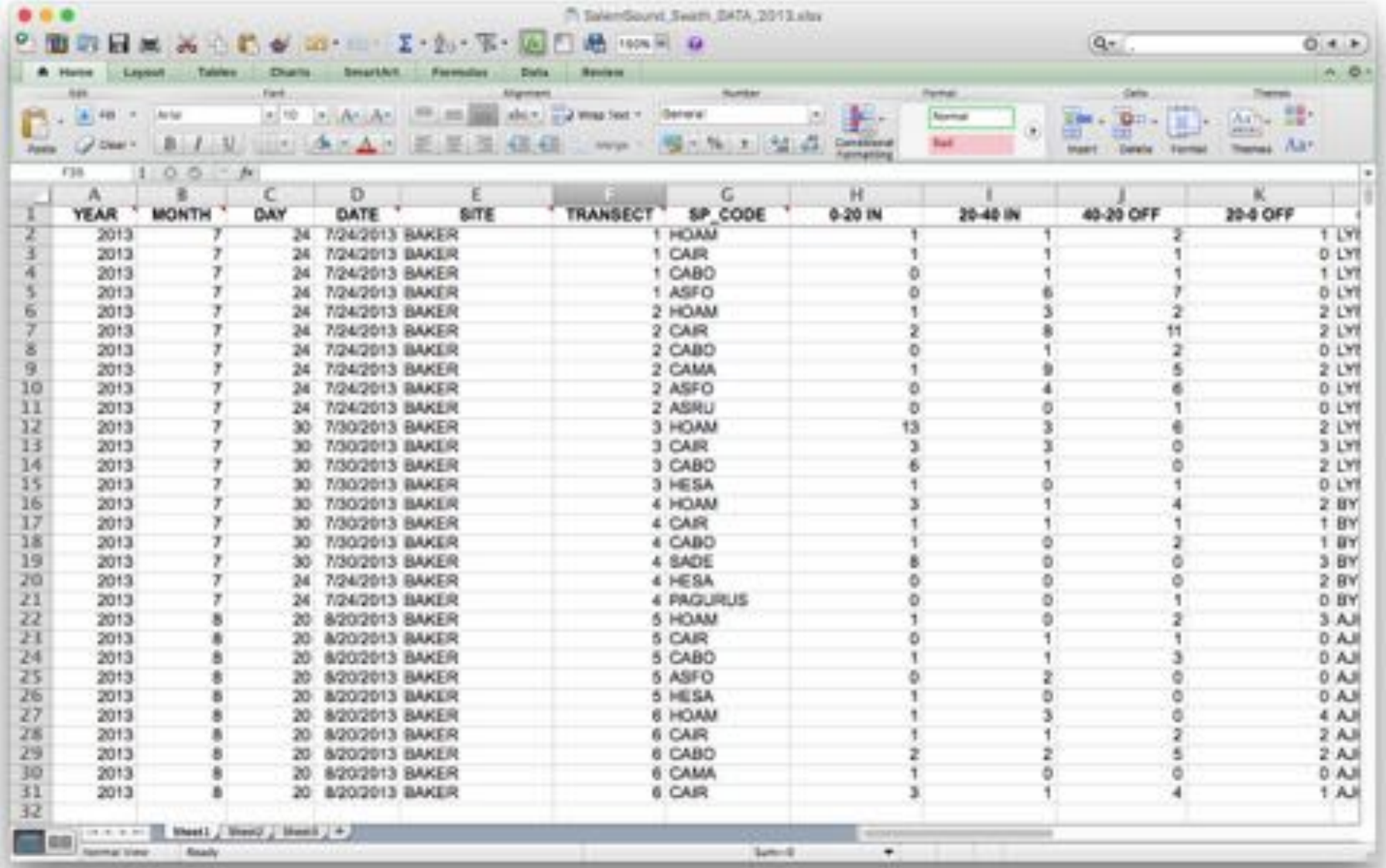

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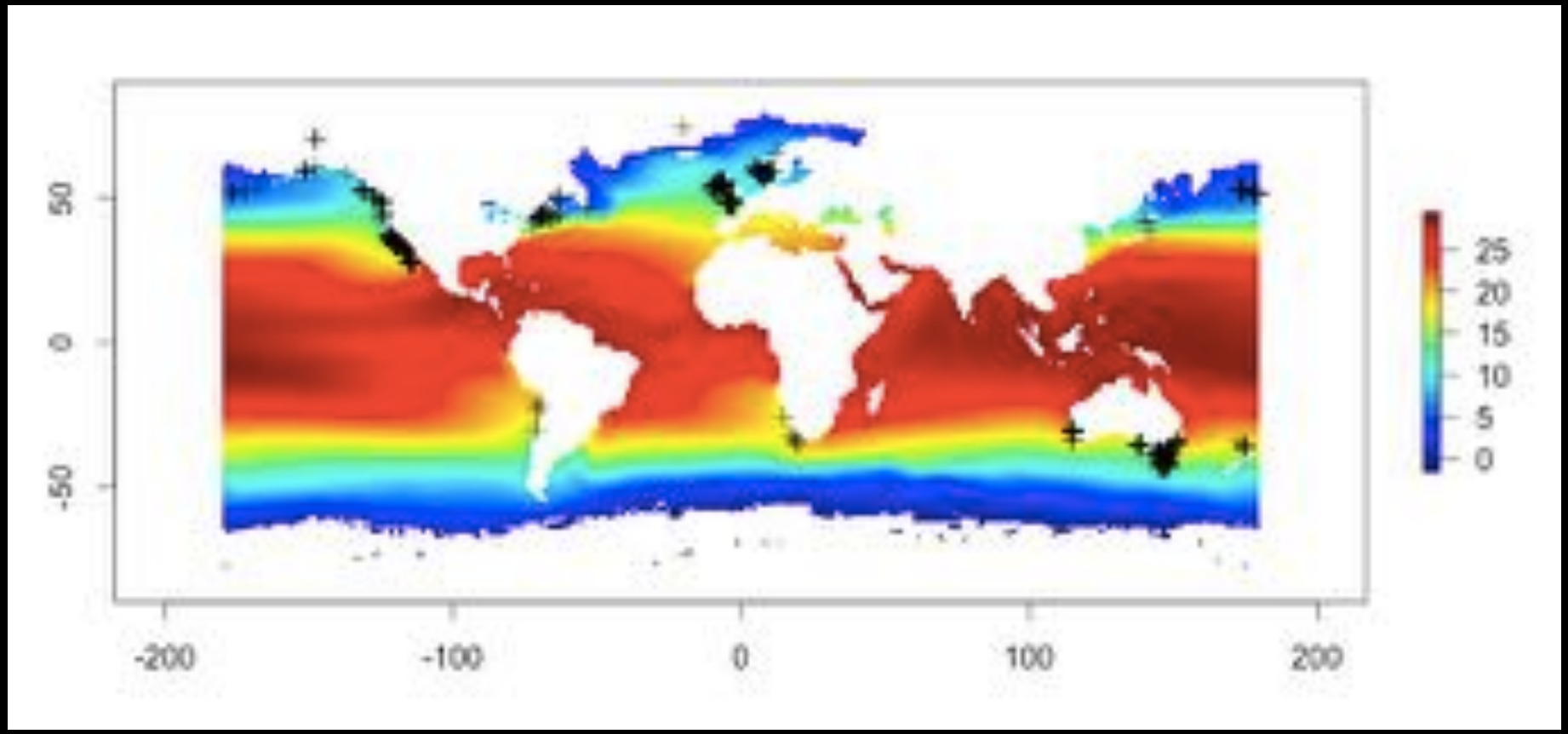
1	YEAR	MONTH	DAY	DATE	SITE	TRANSECT	SP_CODE	0-20 IN	20-40 IN	40-20 OFF	20-0 OFF
2	2013	7	24	7/24/2013	BAKER	1	HOAM	1	1	2	1
3	2013	7	24	7/24/2013	BAKER	1	CAIR	1	1	1	0
4	2013	7	24	7/24/2013	BAKER	1	CABO	0	1	1	1
5	2013	7	24	7/24/2013	BAKER	1	ASFO	0	6	7	0
6	2013	7	24	7/24/2013	BAKER	2	HOAM	1	3	2	2
7	2013	7	24	7/24/2013	BAKER	2	CAIR	2	8	11	2
8	2013	7	24	7/24/2013	BAKER	2	CABO	0	1	2	0
9	2013	7	24	7/24/2013	BAKER	2	CAMA	1	9	5	2
10	2013	7	24	7/24/2013	BAKER	2	ASFO	0	4	6	0
11	2013	7	24	7/24/2013	BAKER	2	ASRU	0	0	1	0
12	2013	7	30	7/30/2013	BAKER	3	HOAM	13	3	6	2
13	2013	7	30	7/30/2013	BAKER	3	CAIR	3	3	0	3
14	2013	7	30	7/30/2013	BAKER	3	CABO	6	1	0	2
15	2013	7	30	7/30/2013	BAKER	3	HESA	1	0	1	0
16	2013	7	30	7/30/2013	BAKER	4	HOAM	3	1	4	2
17	2013	7	30	7/30/2013	BAKER	4	CAIR	1	1	1	1
18	2013	7	30	7/30/2013	BAKER	4	CABO	1	0	2	1
19	2013	7	30	7/30/2013	BAKER	4	SADE	8	0	0	3
20	2013	7	24	7/24/2013	BAKER	4	HESA	0	0	0	2
21	2013	7	24	7/24/2013	BAKER	4	PAGURUS	0	0	1	0
22	2013	8	20	8/20/2013	BAKER	5	HOAM	1	0	2	3
23	2013	8	20	8/20/2013	BAKER	5	CAIR	0	1	1	0
24	2013	8	20	8/20/2013	BAKER	5	CABO	1	1	3	0
25	2013	8	20	8/20/2013	BAKER	5	ASFO	0	2	0	0
26	2013	8	20	8/20/2013	BAKER	5	HESA	1	0	0	0
27	2013	8	20	8/20/2013	BAKER	6	HOAM	1	3	0	4
28	2013	8	20	8/20/2013	BAKER	6	CAIR	1	1	2	2
29	2013	8	20	8/20/2013	BAKER	6	CABO	2	2	5	2
30	2013	8	20	8/20/2013	BAKER	6	CAMA	1	0	0	0
31	2013	8	20	8/20/2013	BAKER	6	CAIR	3	1	4	1
32											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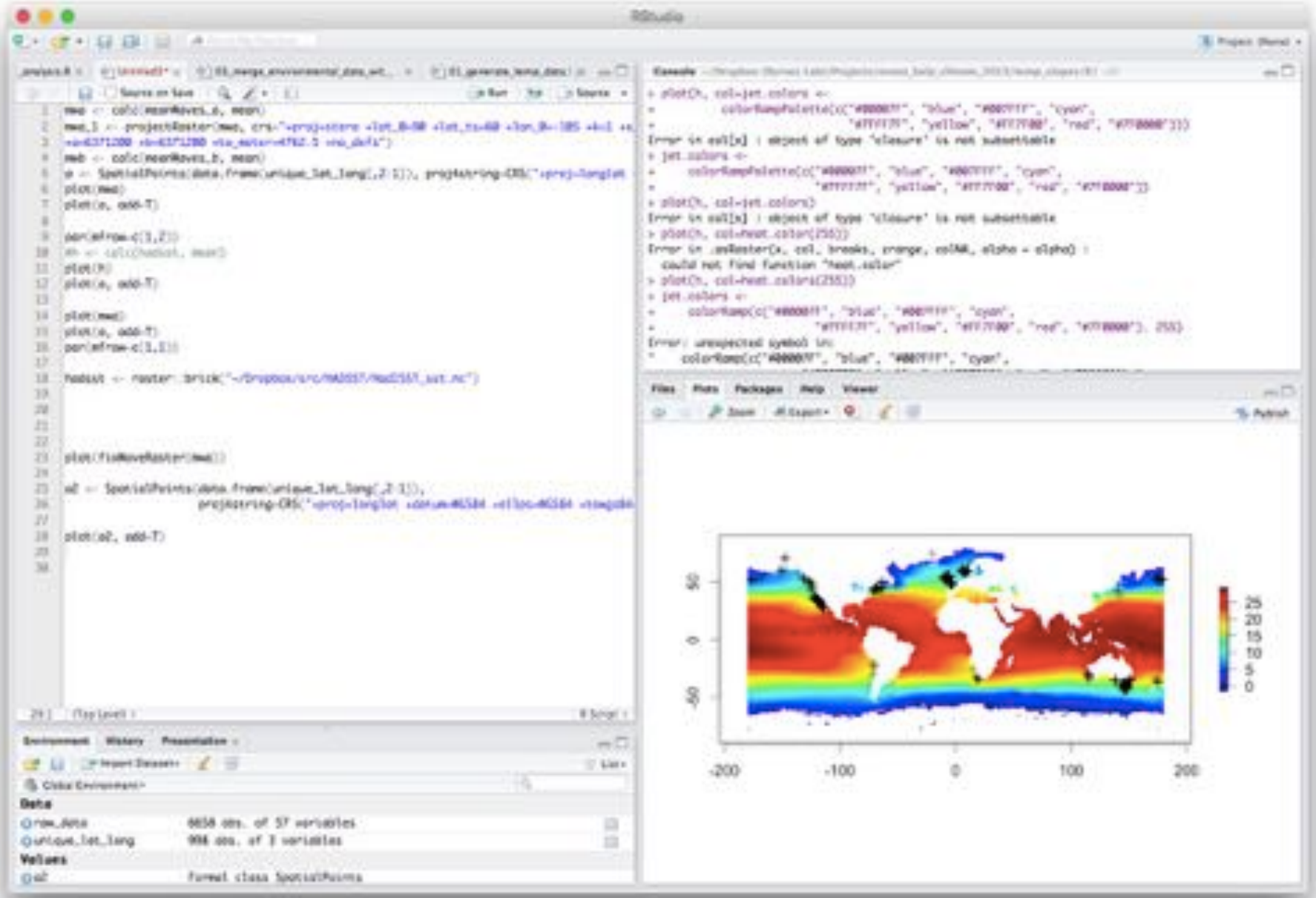
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Console
Files
Plots
Packages
Help
Viewer
Environment
History
Presentation
Data
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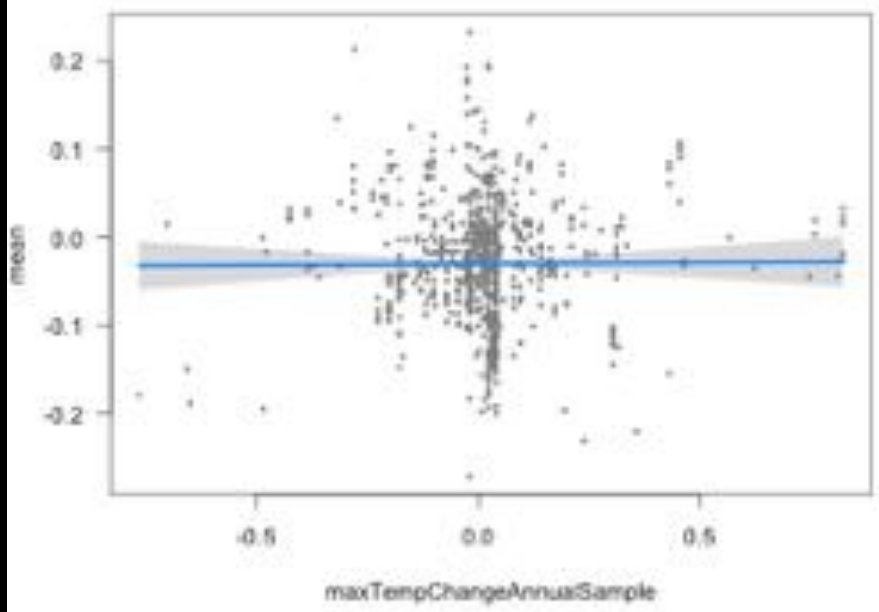
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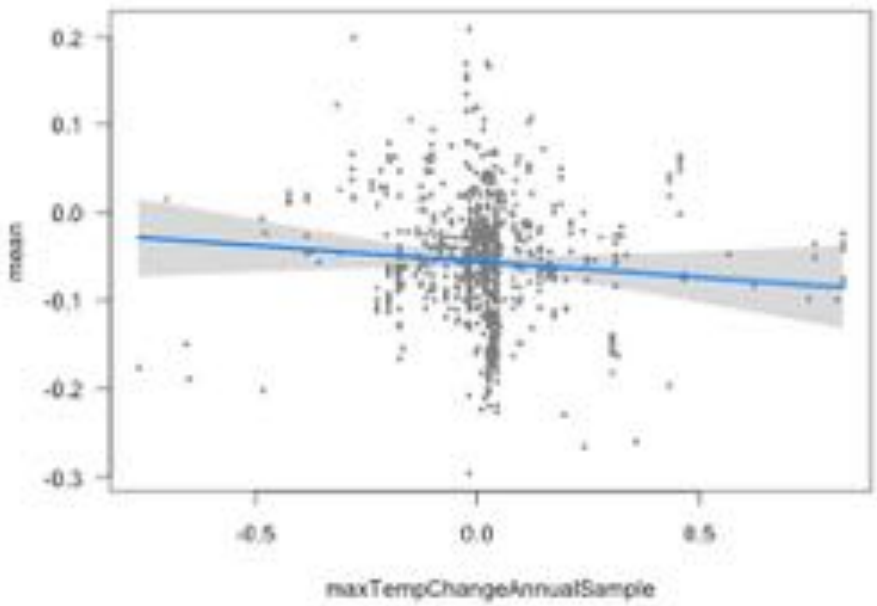
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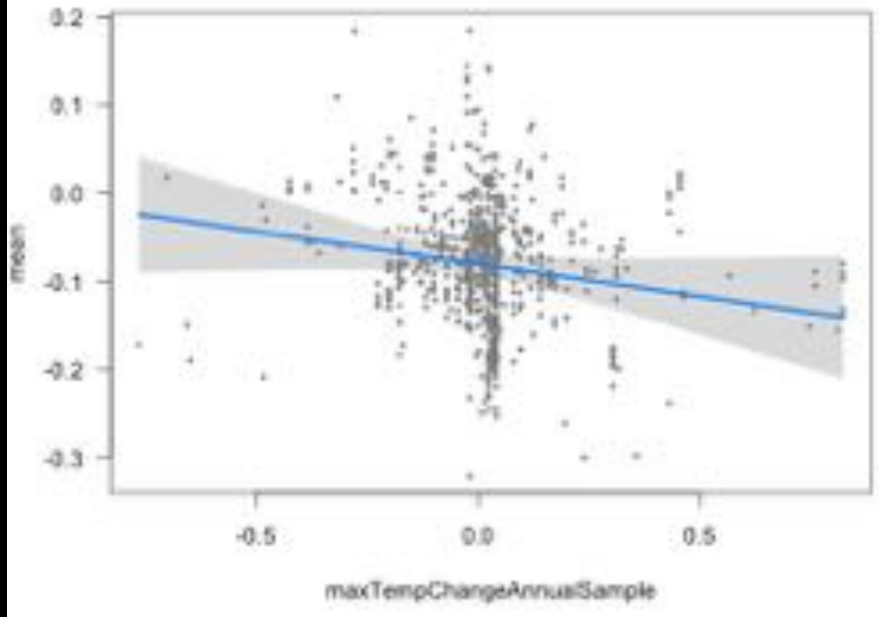
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0.0
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-0.2
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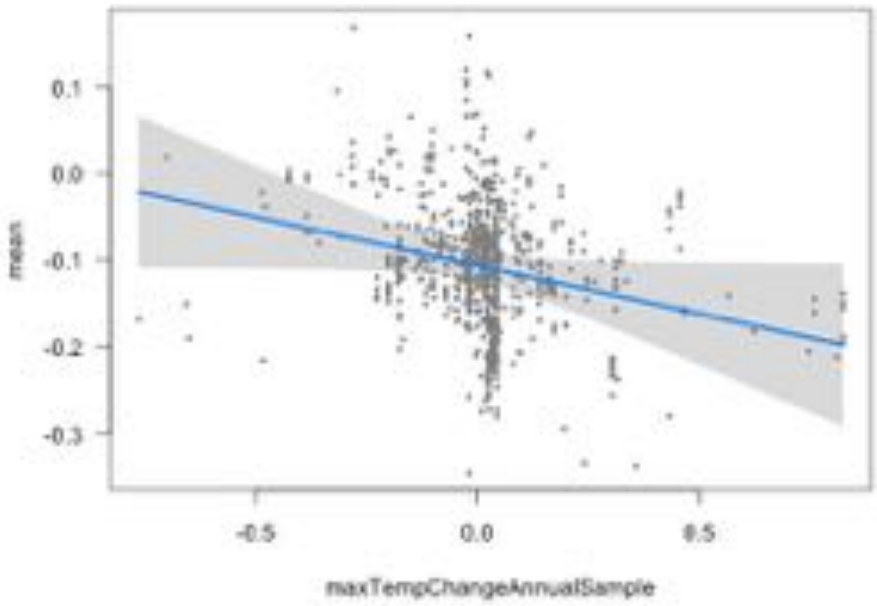
maxTempChangeAnnualSample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0.0
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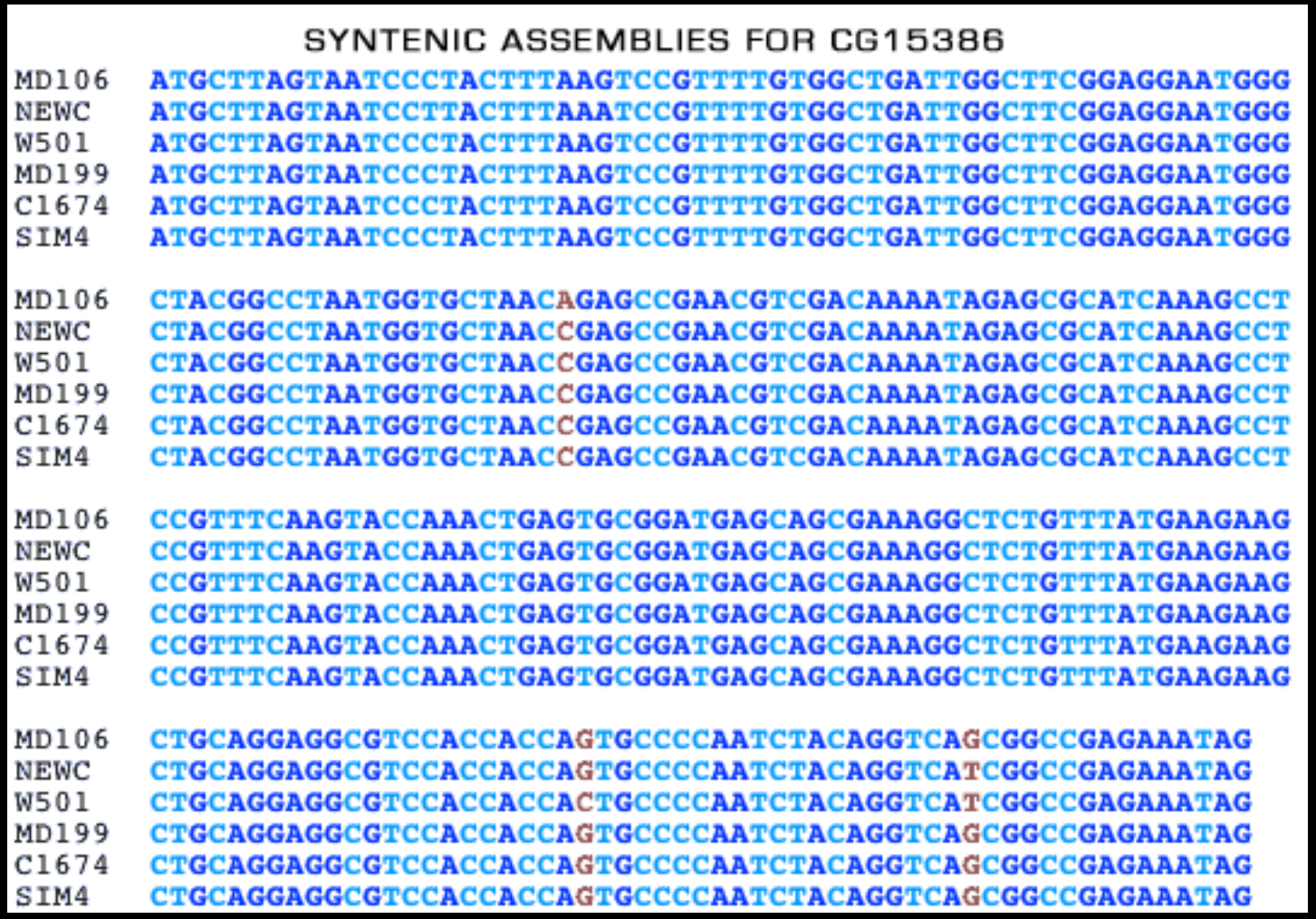
-0.3
-0.5
0.0
0.5
maxTempChangeAnnualSample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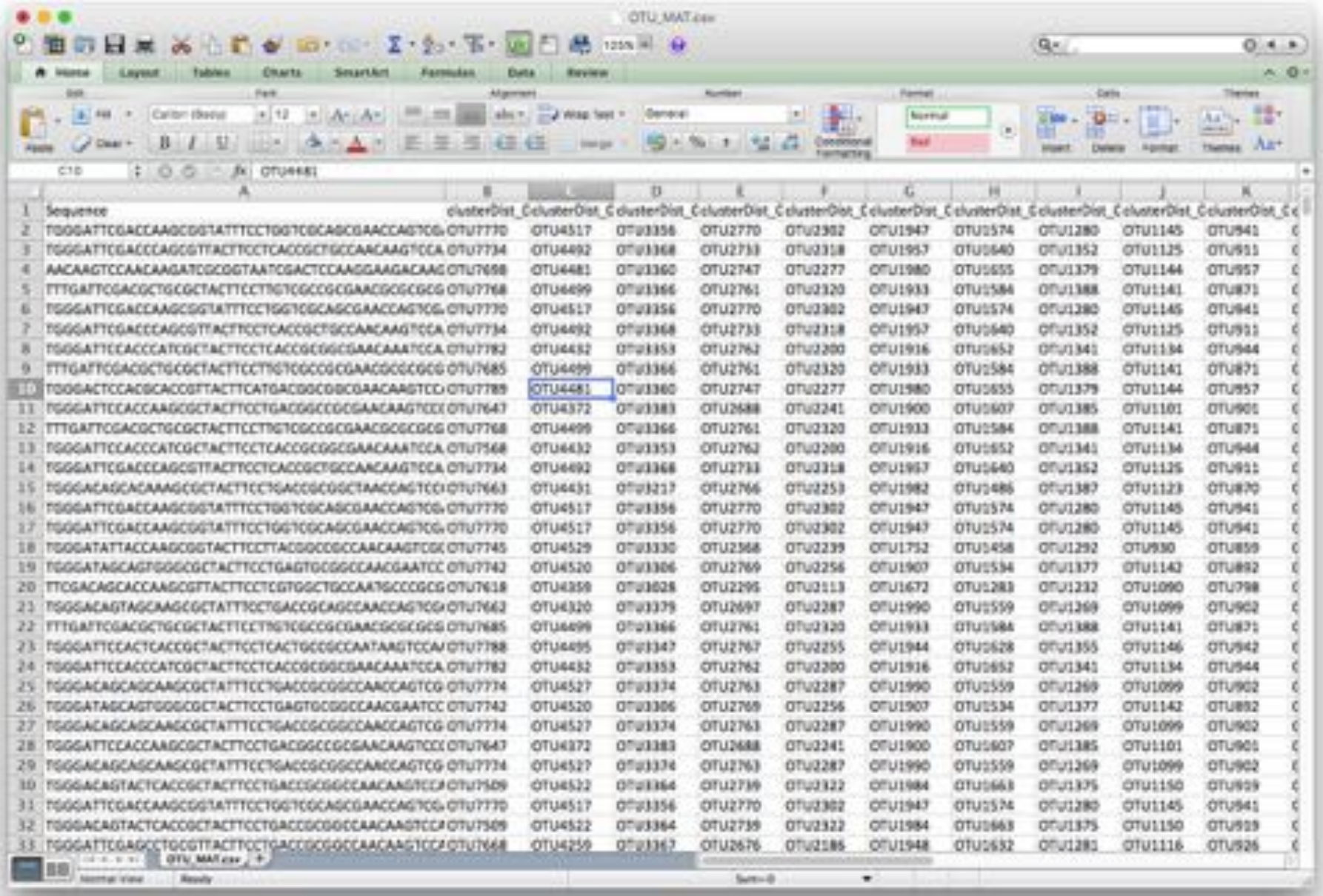
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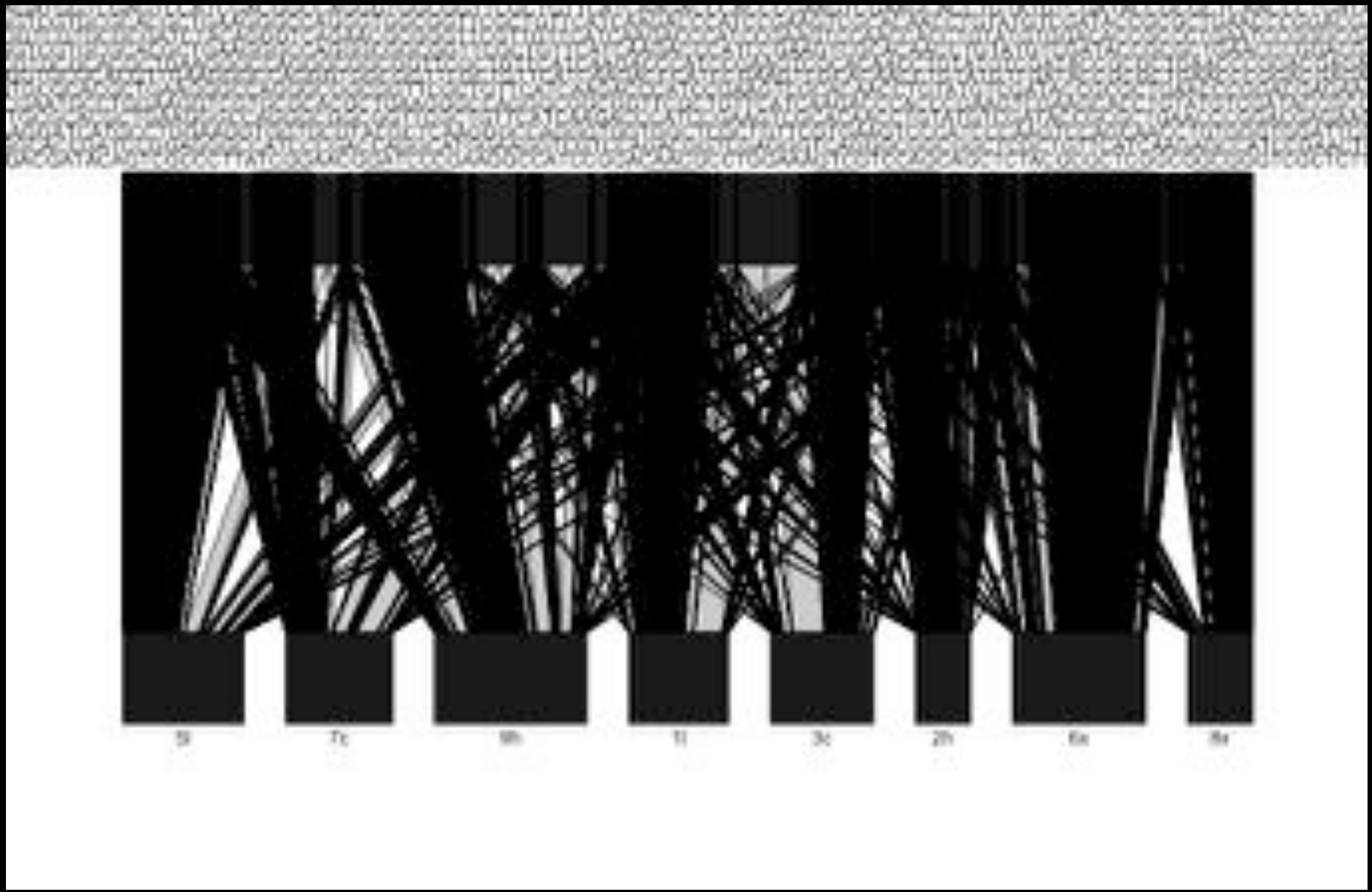

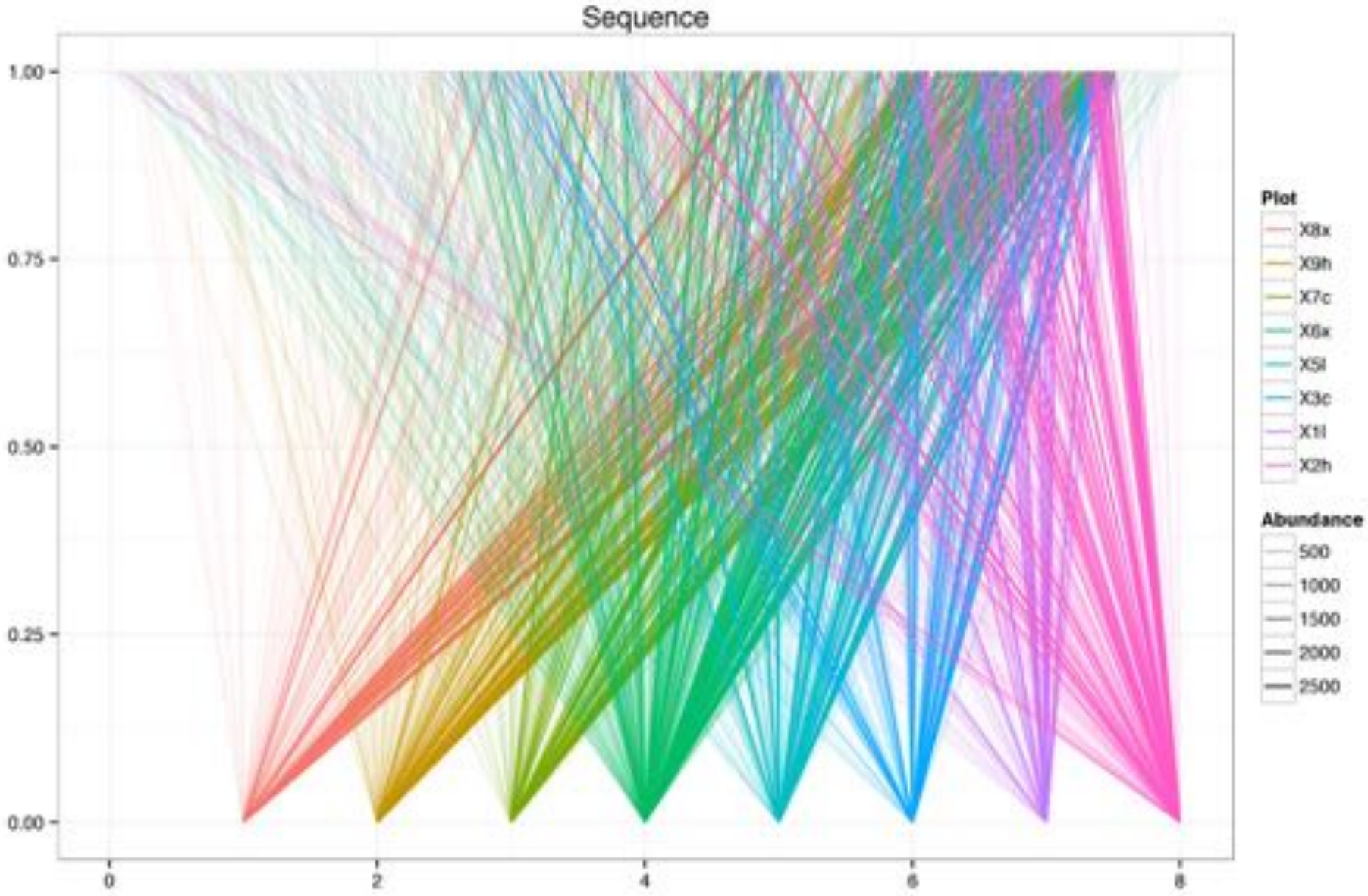
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X2h
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2500

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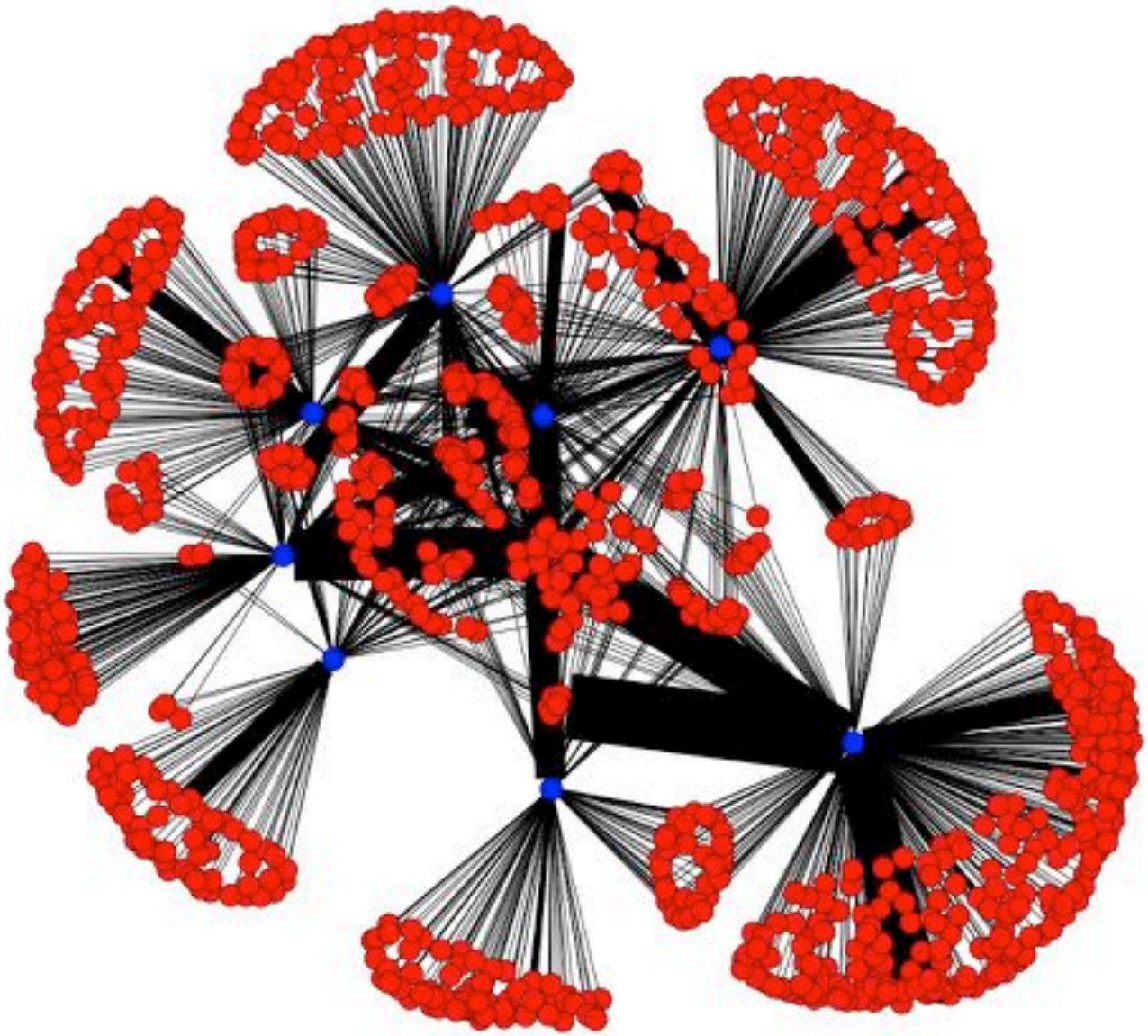
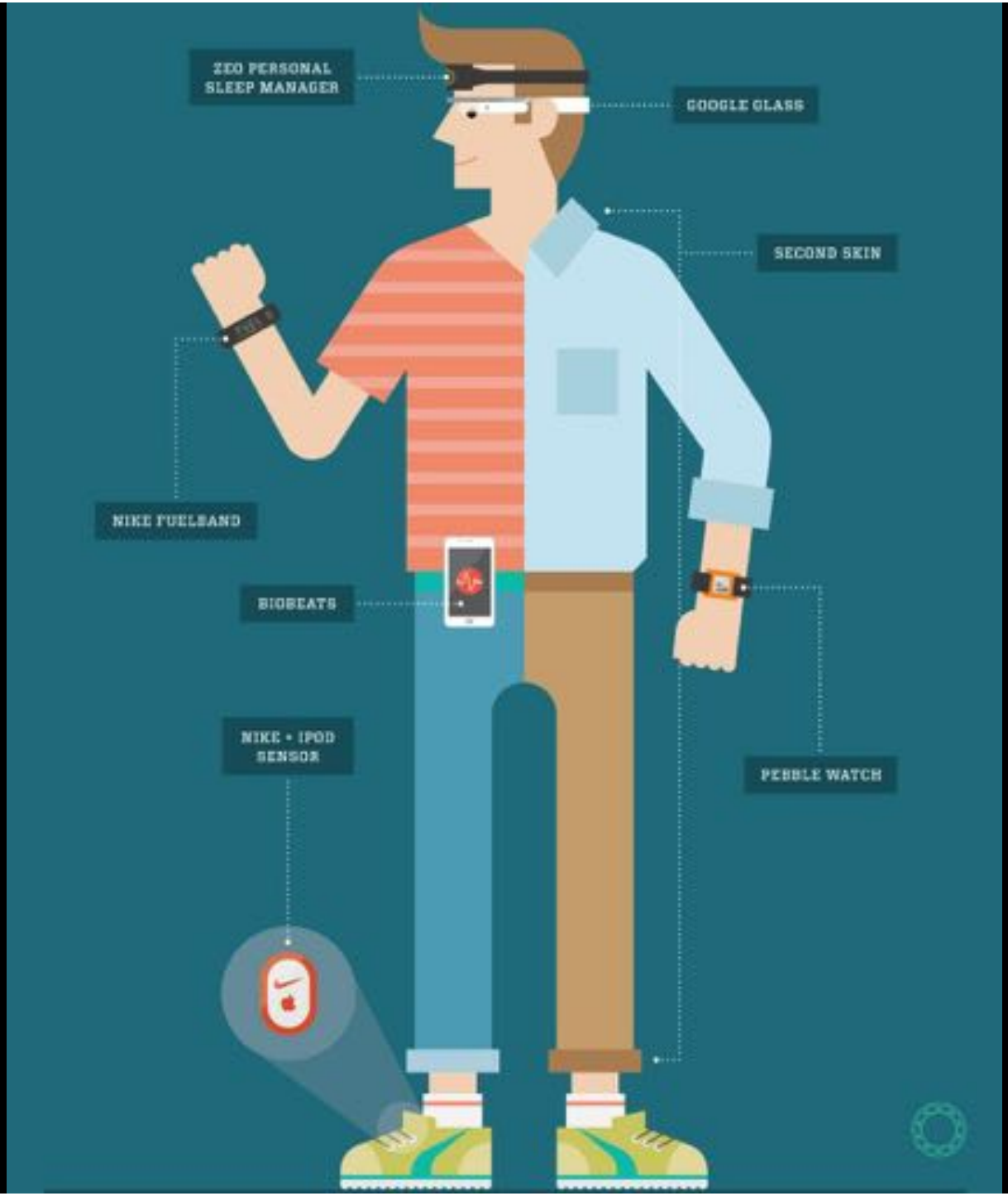
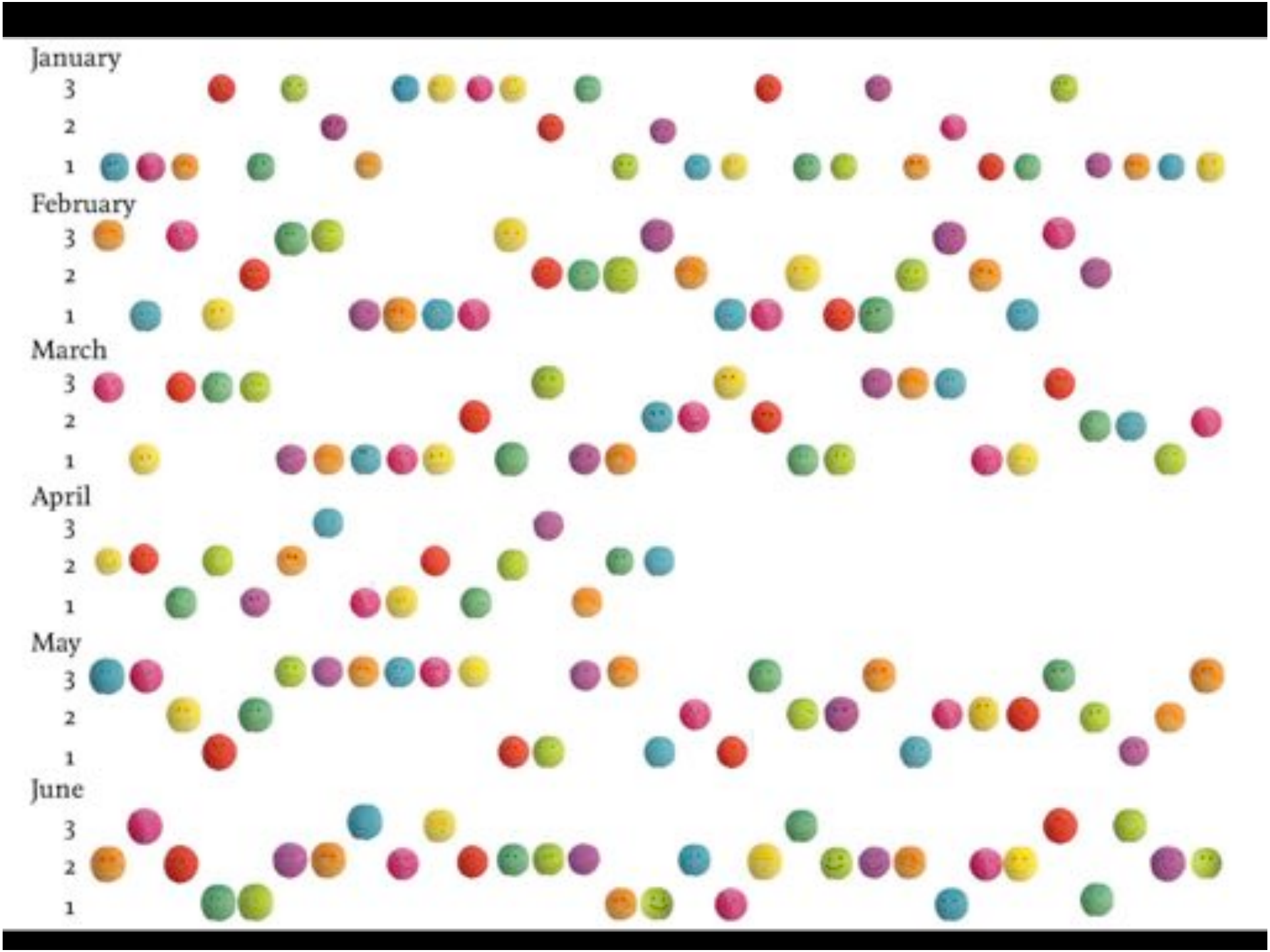



8:44


ZEO PERSONAL SLEEP MANAGER
GOOGLE GLASS
SECOND SKIN
NIKE FUELBAND
BIOBEATS
NIKE + IPOD SENSOR
PEBBLE WATCH


QS
Quantified Self
self knowledge through numbers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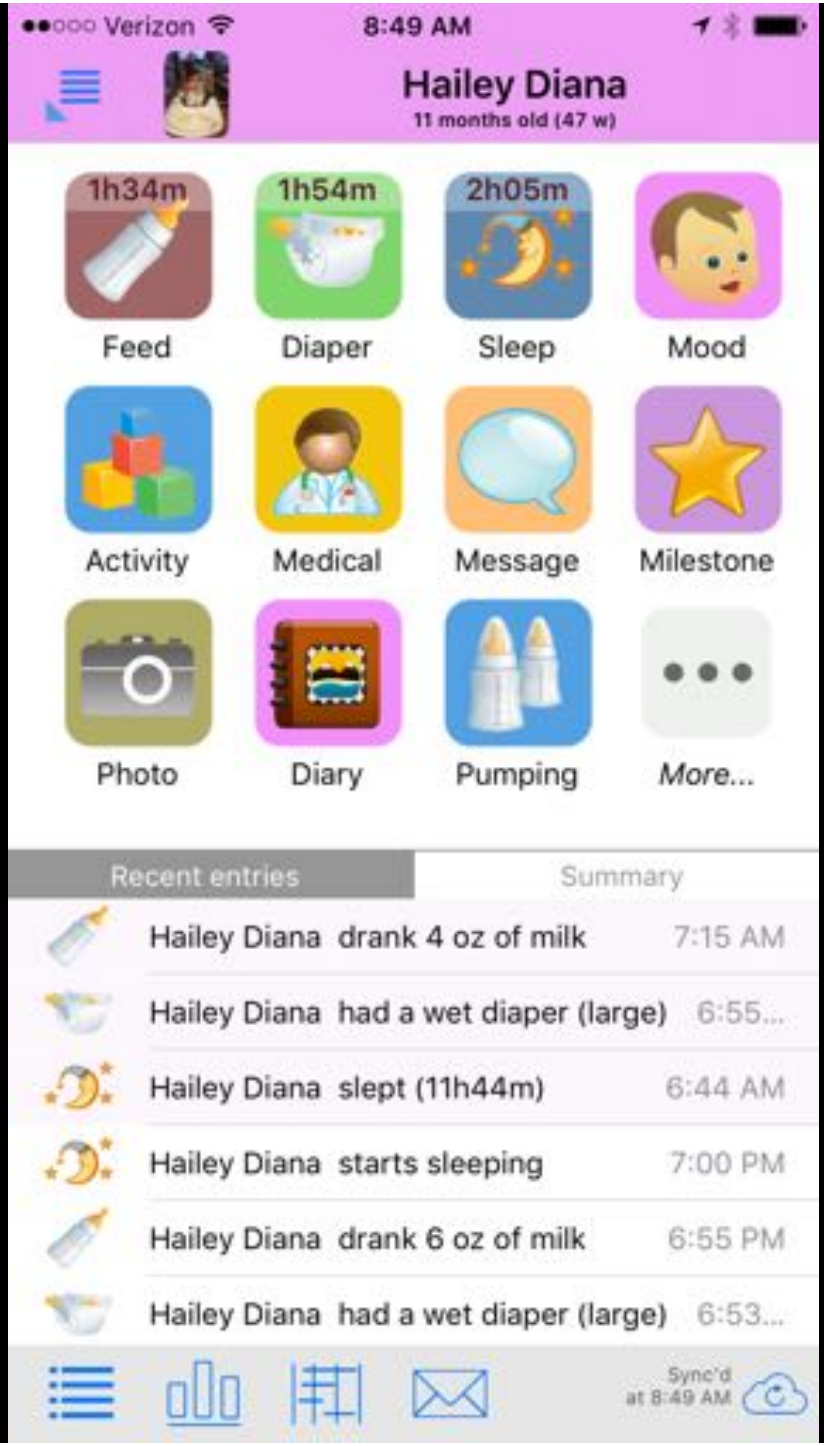
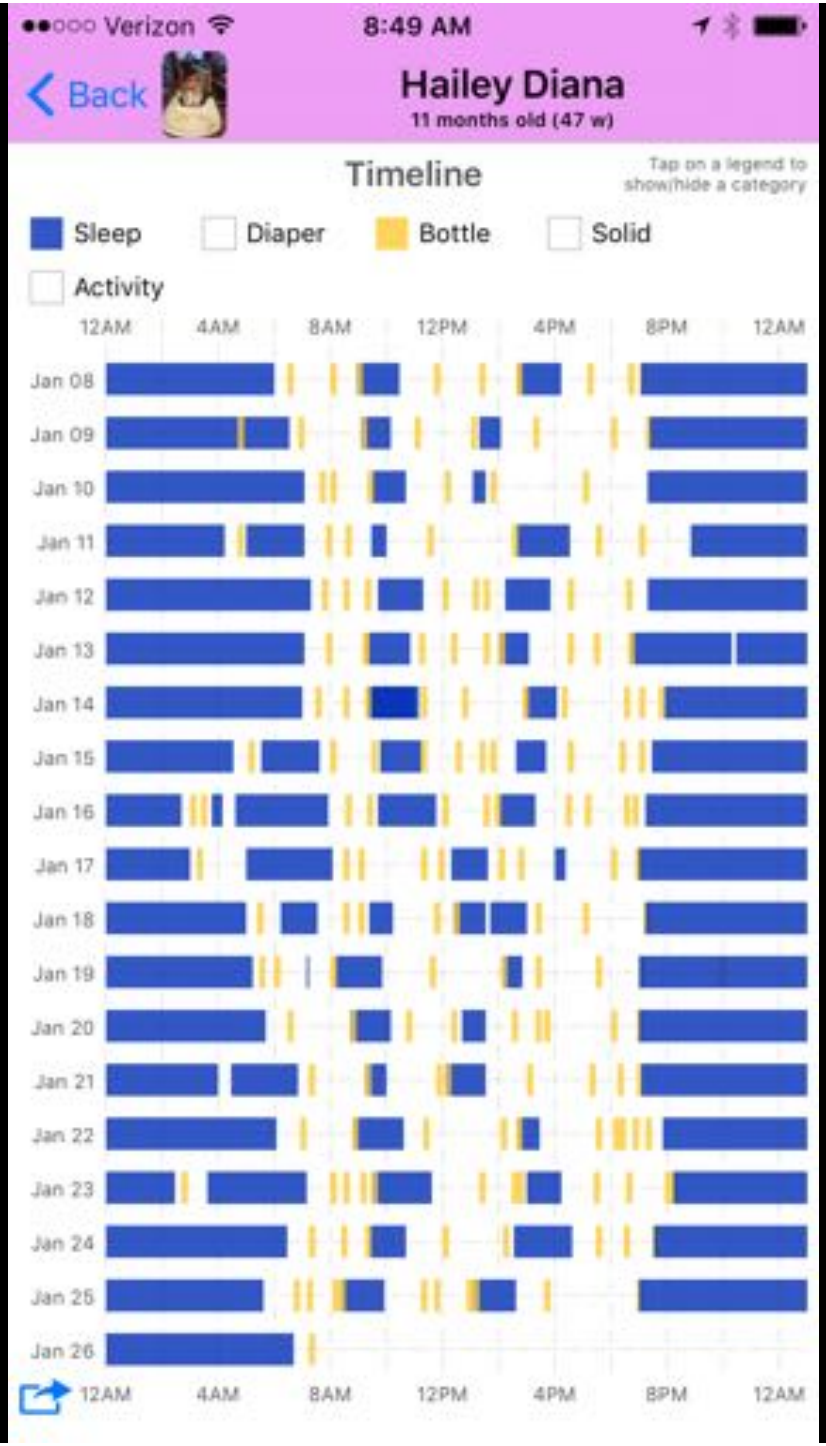
Pepcid


Verizon
8:49 AM
Hailey Diana
11 months old (47 w)
1h34m
1h54m
2h05m
Feed
Diaper
Sleep
Mood
Activity
Medical
Message
Milestone
Photo
Diary
Pumping
More...
Recent entries
Summary
Hailey Diana drank 4 oz of milk 7:15 AM
Hailey Diana had a wet diaper (large) 6:55...
Hailey Diana slept (11h44m) 6:44 AM
Hailey Diana starts sleeping 7:00 PM
Hailey Diana drank 6 oz of milk 6:55 PM
Hailey Diana had a wet diaper (large) 6:53...
Sync'd at 8:49 AM


●●○○○ Verizon
8:49 AM
Back
Hailey Diana
11 months old (47 w)
Timeline
Tap on a legend to show/hide a category
Sleep
Diaper
Bottle
Solid
Activity
12AM
4AM
8AM
12PM
4PM
8PM
12AM
Jan 08
Jan 09
Jan 10
Jan 11
Jan 12
Jan 13
Jan 14
Jan 15
Jan 16
Jan 17
Jan 18
Jan 19
Jan 20
Jan 21
Jan 22
Jan 23
Jan 24
Jan 25
Jan 26
12AM
4AM
8AM
12PM
4PM
8PM
12AM

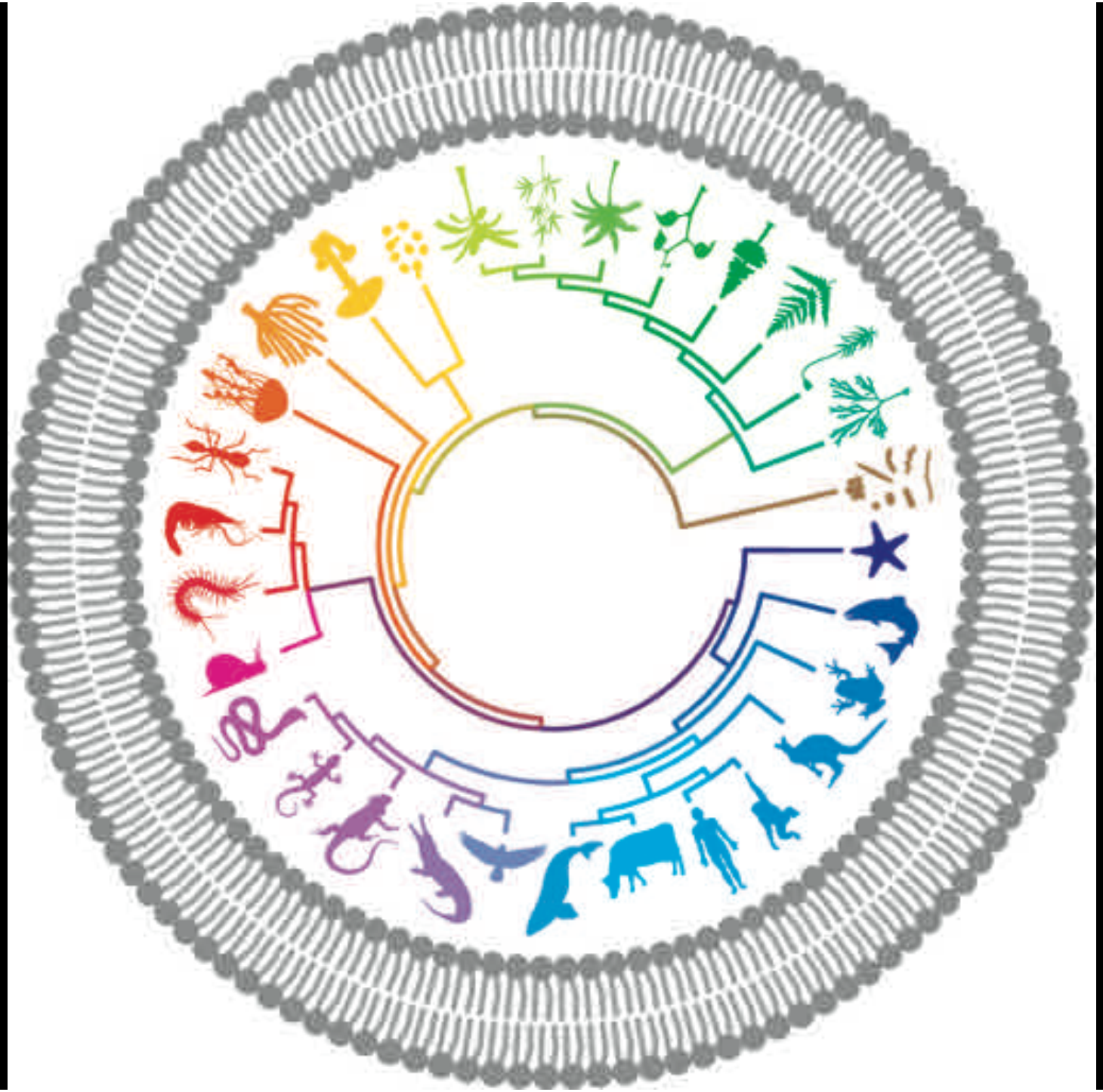
We Are Awash in Data

Data Takes Many Forms

- Athletic performance
- Timeseries of polls
- Sequence Data
- Measurements of physical properties
- Maps (often with many layers) with information
- Timings of events
- Images
- Network descriptions
- Plain text

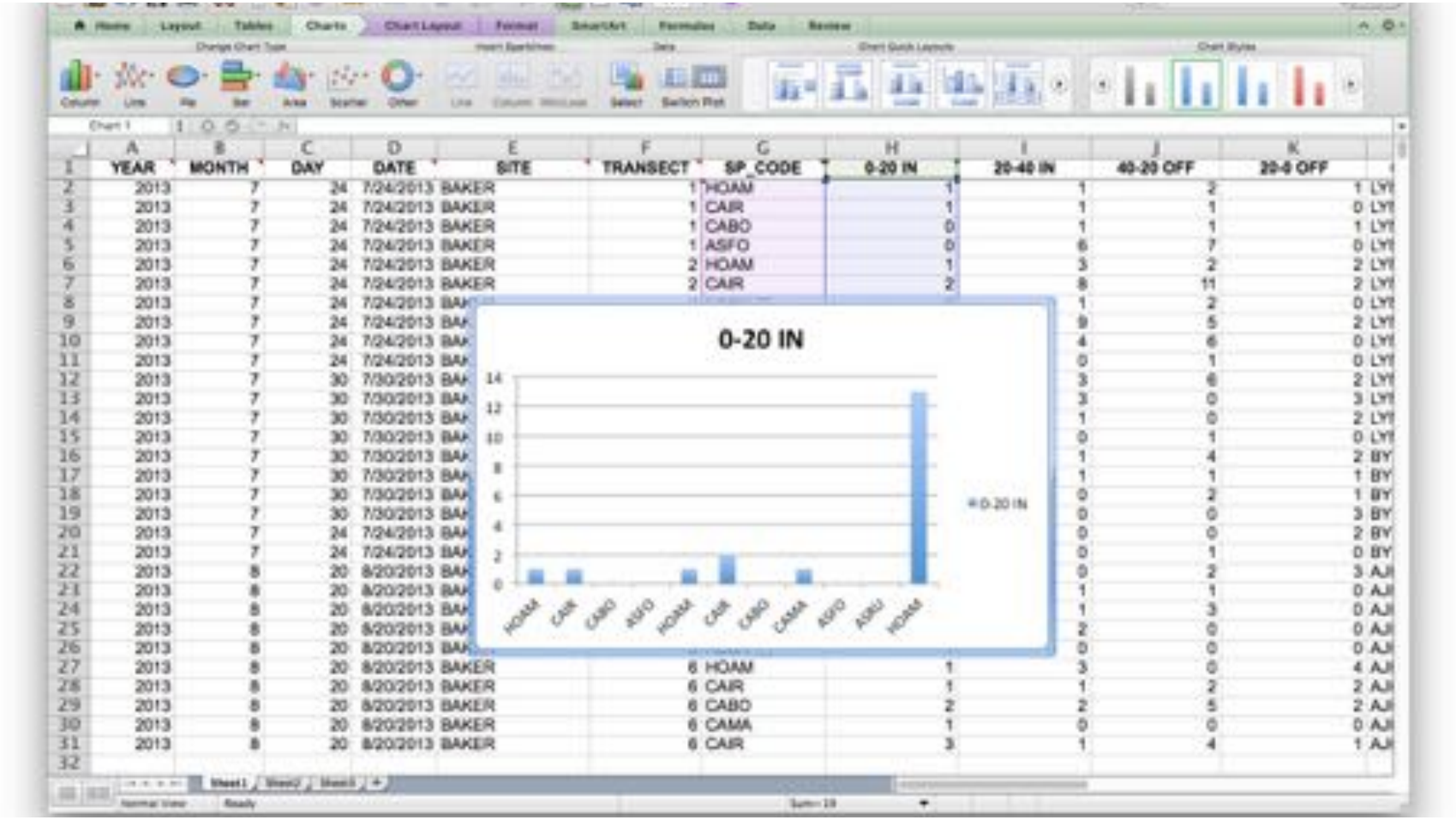
Data is at the Center of Biology


Linked
Different
human
Immune
Critical
Learning
Pipeline
Semantic
translational
Genes
genomic
Prioritization
Cohort
Biomedical
Bioinformatics
neurodegenerative
Health
Repository
model
Screening
Expression
Novel
Framework
Adverse
Modeling
Epistatic
network
Mining
informatics
Proteomics
Cancer
Integrative
Based
Discovery
Multinet
Interactions
analysis
Pharmacokinetics
Disease
Knowledge
Quantifying
Medicine
Preprocessing
Approach
Prediction
Finding
tool
Bioinformatic
risk
Questionnaire
Multiple
bioinformatics
Integrating
Genome
Sources
health
Enhance
Application
Drug
Research
patients
Translational
Data
Factor
data
gene
SNPs
Genomic
Demographics
Cell
Study
using
Base
Omic
Bayesian
Association
Pharmacogenomics
Gene
Free
Young
Identification
Automatic
Automated
American
Towards
expression
Integrated
Integration
Role
Alcohol
Large
Analysis
Using
Model
Sequencing
Frames
Space
Patients
Acute
Genetic
Management
Risk
Interaction
Bootstrapping
Scale
identification
EHR
Genetics
Extraction
Dependence
Network-Based
Clinical
Prediction-based
Generation
Treatment
Potential
SemPoD
Ontology
within
Text
Information-Based
Numerical
Annotation
Method
Question
Vector
Personalized
Networks
clinical
Patient
History
research
HIV
multiple
Response
Heart
Studies




ss Lever
to Start
Fail
sfer
OK
onset
Part No.
U-DTW-1

Classical Tools Not Up to the Task



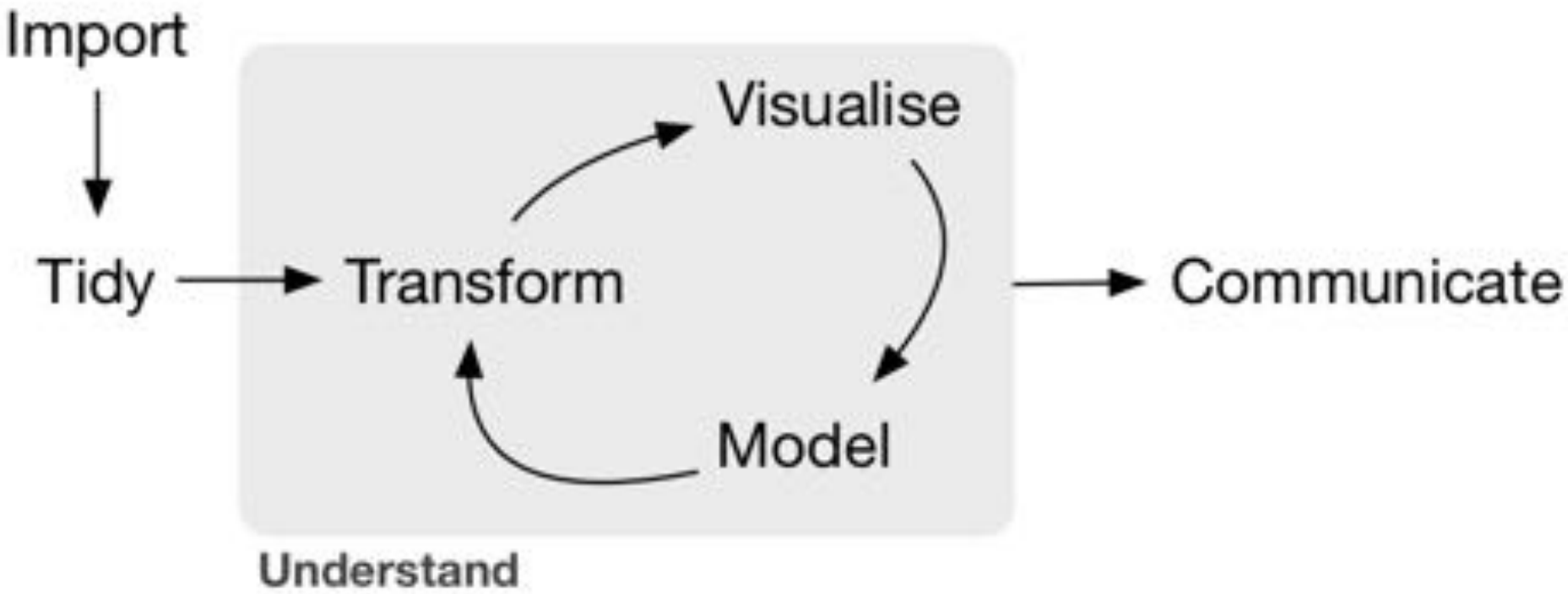
	A	B	C	D	E	F	G	H	I	J	K	
1	YEAR	MONTH	DAY	DATE	SITE	TRANSECT	SP_CODE	0-20 IN	20-40 IN	40-20 OFF	20-0 OFF	
2	2013	7	24	7/24/2013	BAKER	1	HOAM	1	1	2	1	LYI
3	2013	7	24	7/24/2013	BAKER	1	CAIR	1	1	1	0	LYI
4	2013	7	24	7/24/2013	BAKER	1	CABO	0	1	1	1	LYI
5	2013	7	24	7/24/2013	BAKER	1	ASFO	0	6	7	0	LYI
6	2013	7	24	7/24/2013	BAKER	2	HOAM	1	3	2	2	LYI
7	2013	7	24	7/24/2013	BAKER	2	CAIR	2	8	11	2	LYI
8	2013	7	24	7/24/2013	BA				1	2	0	LYI
9	2013	7	24	7/24/2013	BA				9	5	2	LYI
10	2013	7	24	7/24/2013	BA				4	6	0	LYI
11	2013	7	24	7/24/2013	BA				0	1	0	LYI
12	2013	7	30	7/30/2013	BA				3	6	2	LYI
13	2013	7	30	7/30/2013	BA				3	0	3	LYI
14	2013	7	30	7/30/2013	BA				1	0	2	LYI
15	2013	7	30	7/30/2013	BA				0	1	0	LYI
16	2013	7	30	7/30/2013	BA				1	4	2	BY
17	2013	7	30	7/30/2013	BA				1	1	1	BY
18	2013	7	30	7/30/2013	BA				0	2	1	BY
19	2013	7	30	7/30/2013	BA				0	0	3	BY
20	2013	7	24	7/24/2013	BA				0	0	2	BY
21	2013	7	24	7/24/2013	BA				0	1	0	BY
22	2013	8	20	8/20/2013	BA				0	2	3	AJI
23	2013	8	20	8/20/2013	BA				1	1	0	AJI
24	2013	8	20	8/20/2013	BA				1	3	0	AJI
25	2013	8	20	8/20/2013	BA				2	0	0	AJI
26	2013	8	20	8/20/2013	BA				0	0	0	AJI
27	2013	8	20	8/20/2013	BAKER	6	HOAM	1	3	0	4	AJI
28	2013	8	20	8/20/2013	BAKER	6	CAIR	1	1	2	2	AJI
29	2013	8	20	8/20/2013	BAKER	6	CABO	2	2	5	2	AJI
30	2013	8	20	8/20/2013	BAKER	6	CAMA	1	0	0	0	AJI
31	2013	8	20	8/20/2013	BAKER	6	CAIR	3	1	4	1	AJI
32												

Classical Tools Not Up to the Task

Introduction to Data Science for Biology

Who Are You?

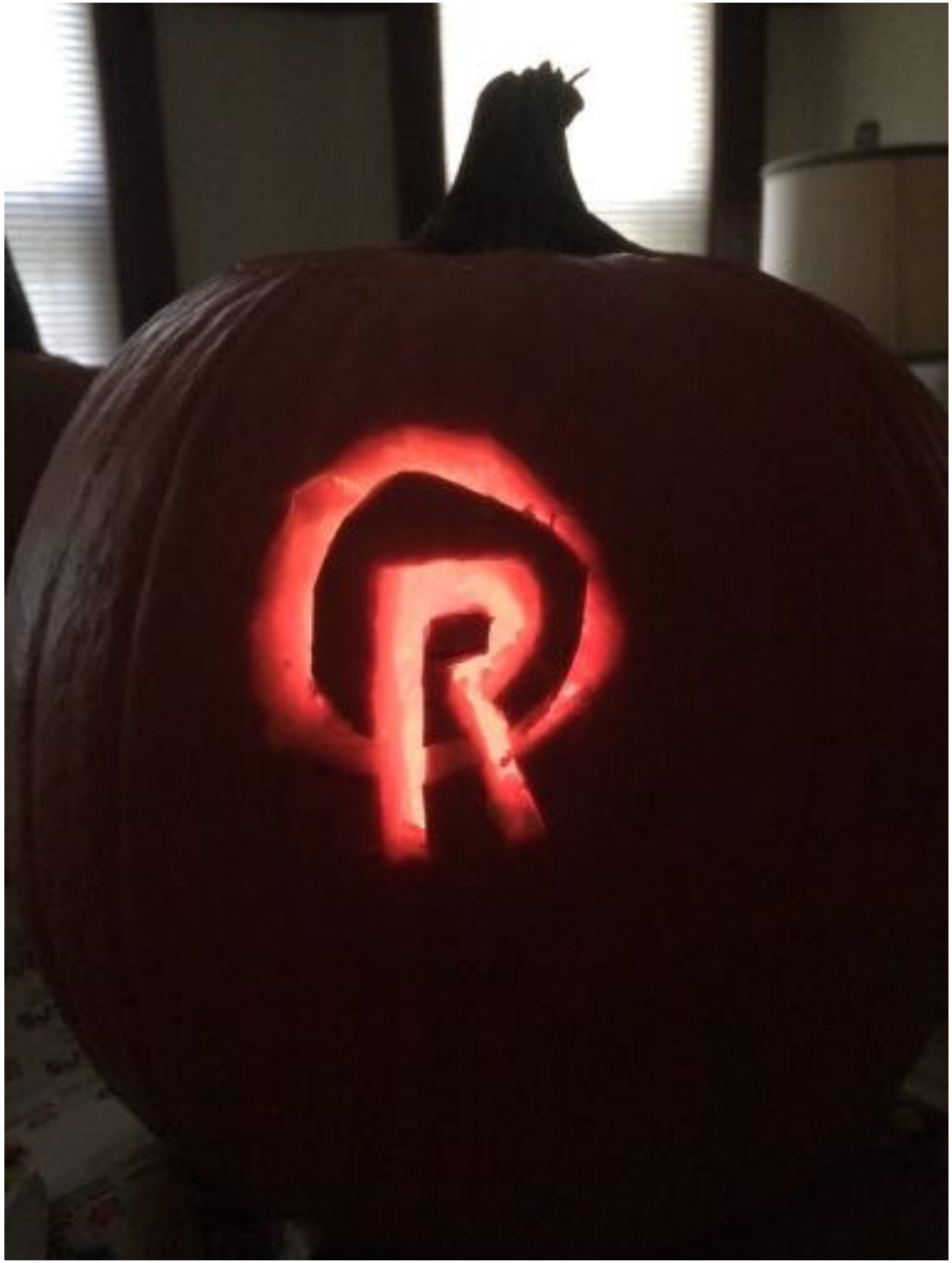
Our Semester


Import
Tidy
Transform
Visualise
Model
Communicate
Understand

Learn how to create efficient understandable datasets for biological research

YEAR	MONTH	DAY	DATE	SITE	TRANSECT	SP_CODE	0-20 IN	20-40 IN	40-20 OFF
2013	7	247/24/2013		BAKER		1HOAM	1	1	2
2013	7	247/24/2013		BAKER		1CAIR	1	1	1
2013	7	247/24/2013		BAKER		1CABO	0	1	1
2013	7	247/24/2013		BAKER		1ASFO	0	6	7
2013	7	247/24/2013		BAKER		2HOAM	1	3	2
2013	7	247/24/2013		BAKER		2CAIR	2	8	11
2013	7	247/24/2013		BAKER		2CABO	0	1	2
2013	7	247/24/2013		BAKER		2CAMA	1	9	5
2013	7	247/24/2013		BAKER		2ASFO	0	4	6
2013	7	247/24/2013		BAKER		2ASRU	0	0	1

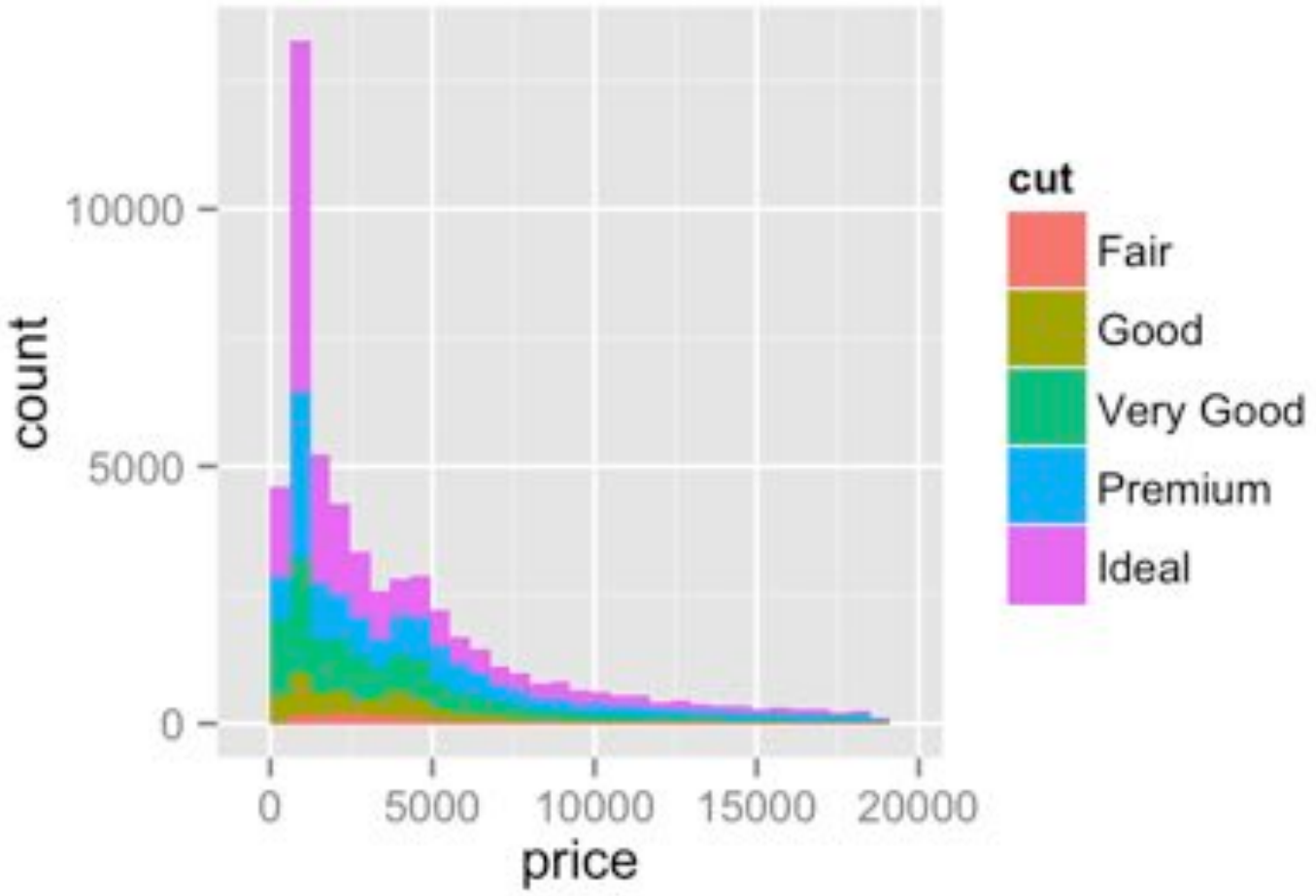
Learn common programming language(s) associated with data science



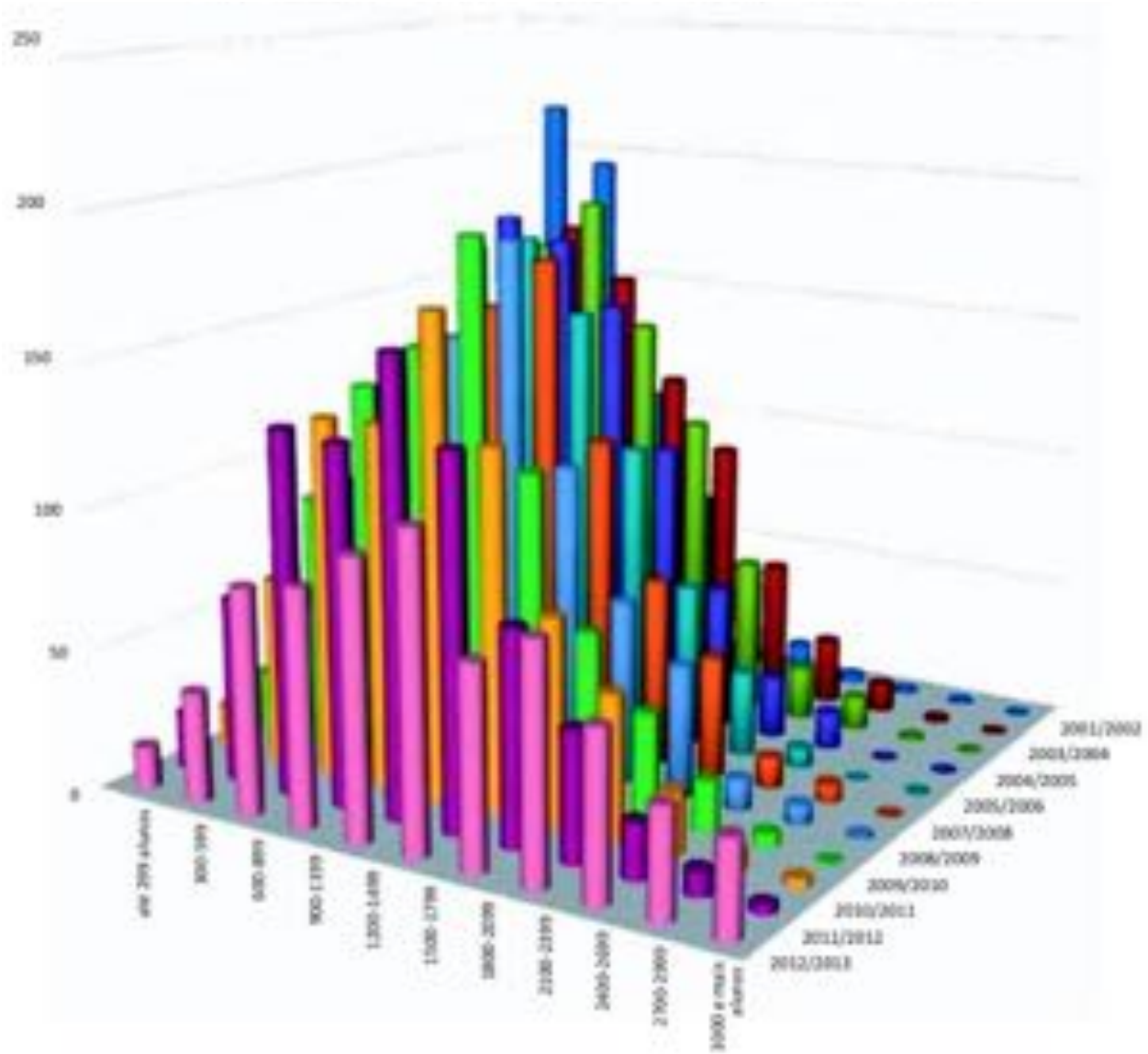

R
4CATS


ONE DOES NOT SIMPLY
PASTE CODE INTO [R]

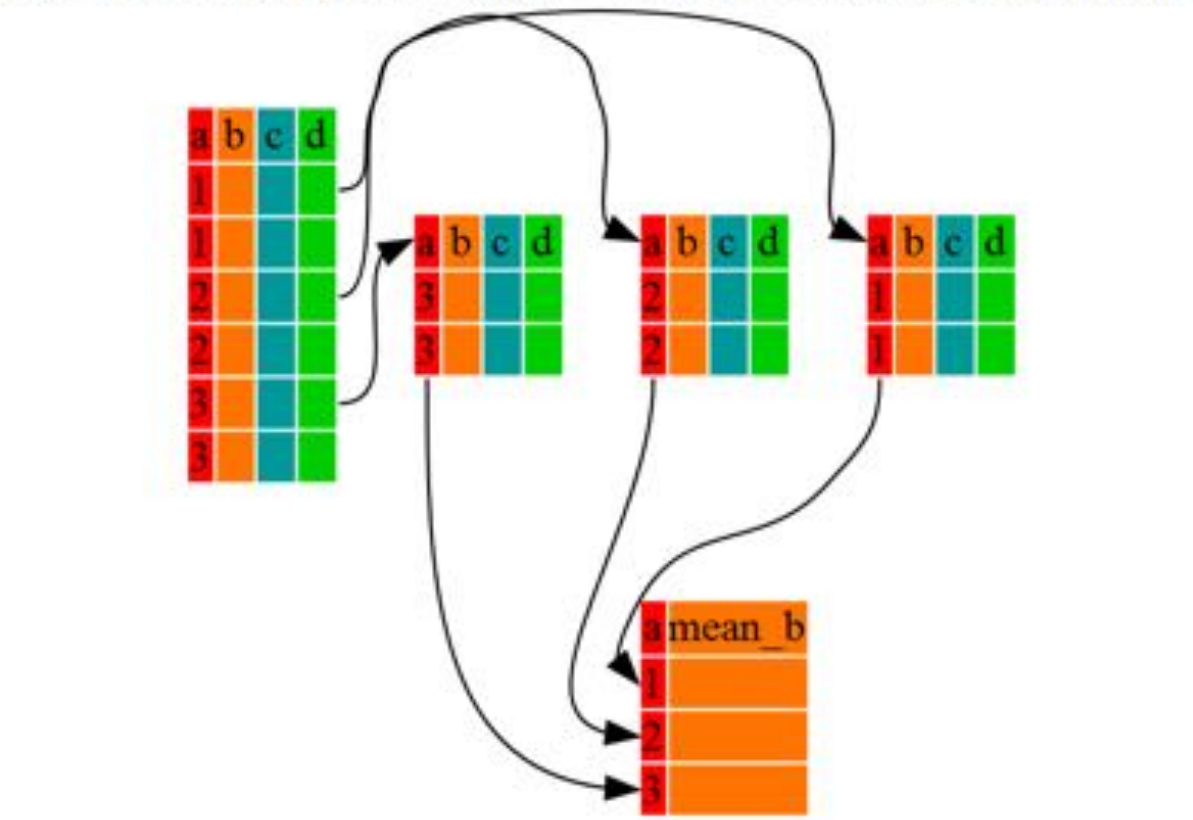
Build a vocabulary of visualization tools that enable students to see what their data means



This is How I Know I Failed You



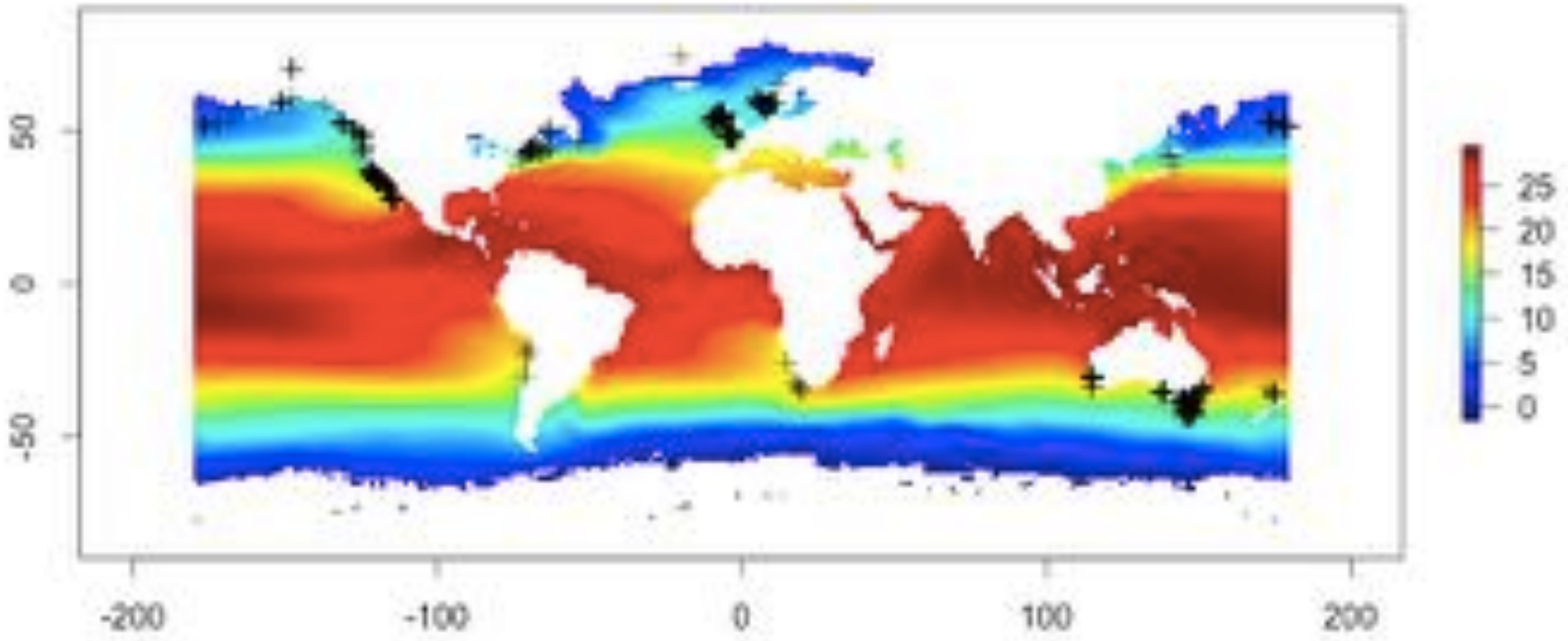
Develop an understanding of how to manipulate data for the purposes of seeing useful patterns



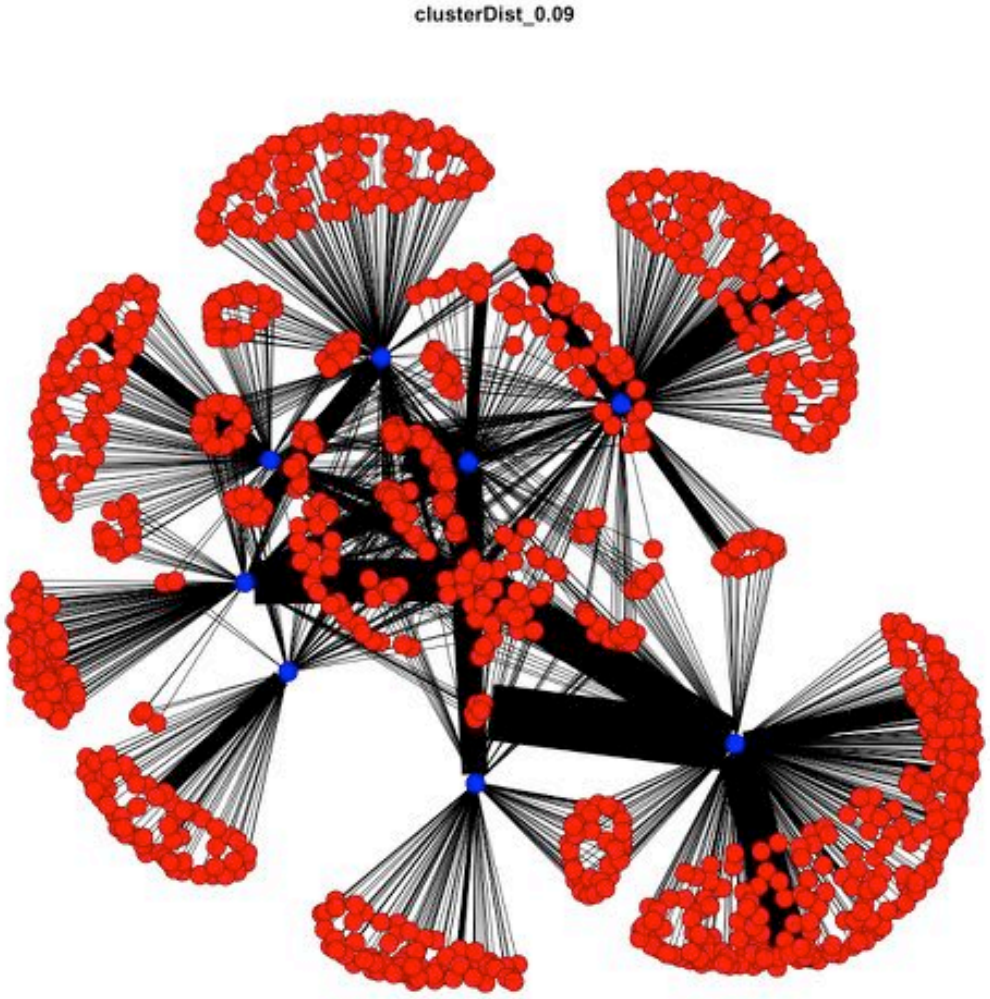
http://swcarpentry.github.io/r-novice-gapminder/


TRIED LEARNING R
DIDN'T INSTALL DPLYR

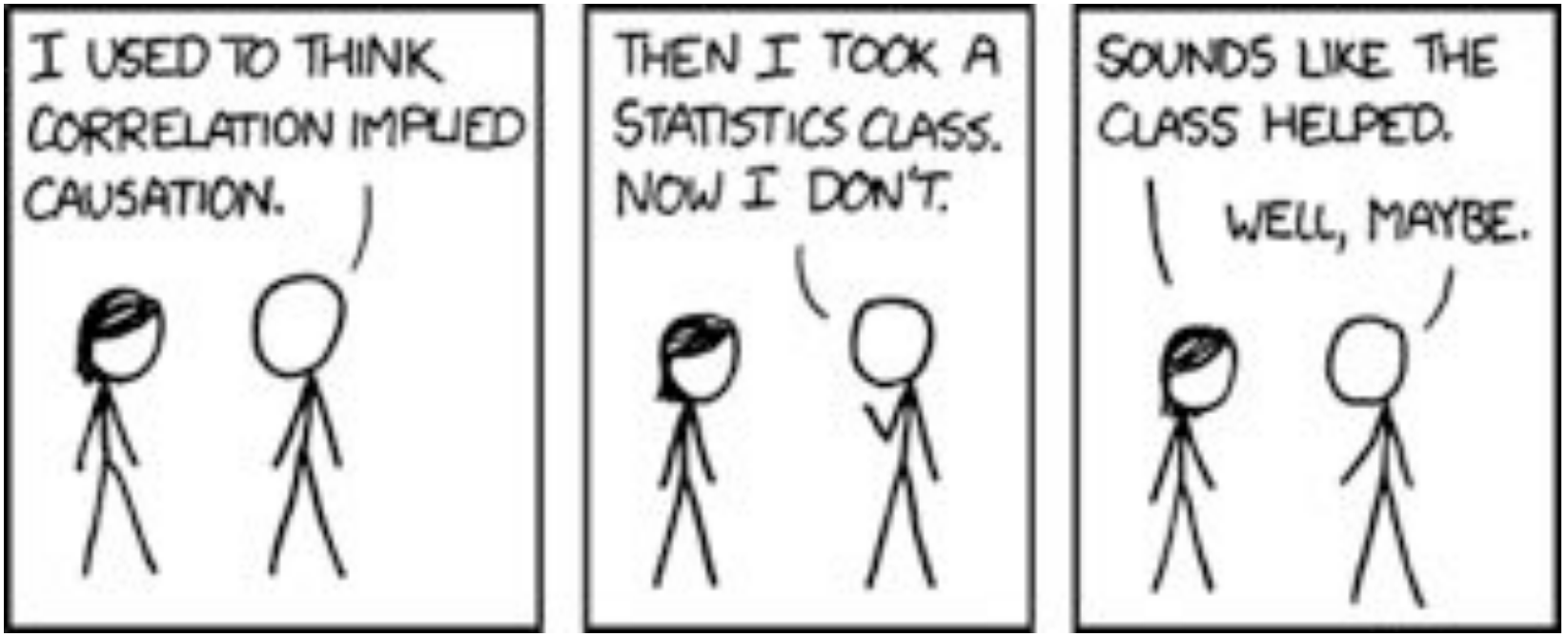
Understand how to unify data from disparate sources to build a larger picture of biological phenomena



Understand how to unify data from disparate sources to build a larger picture of biological phenomena

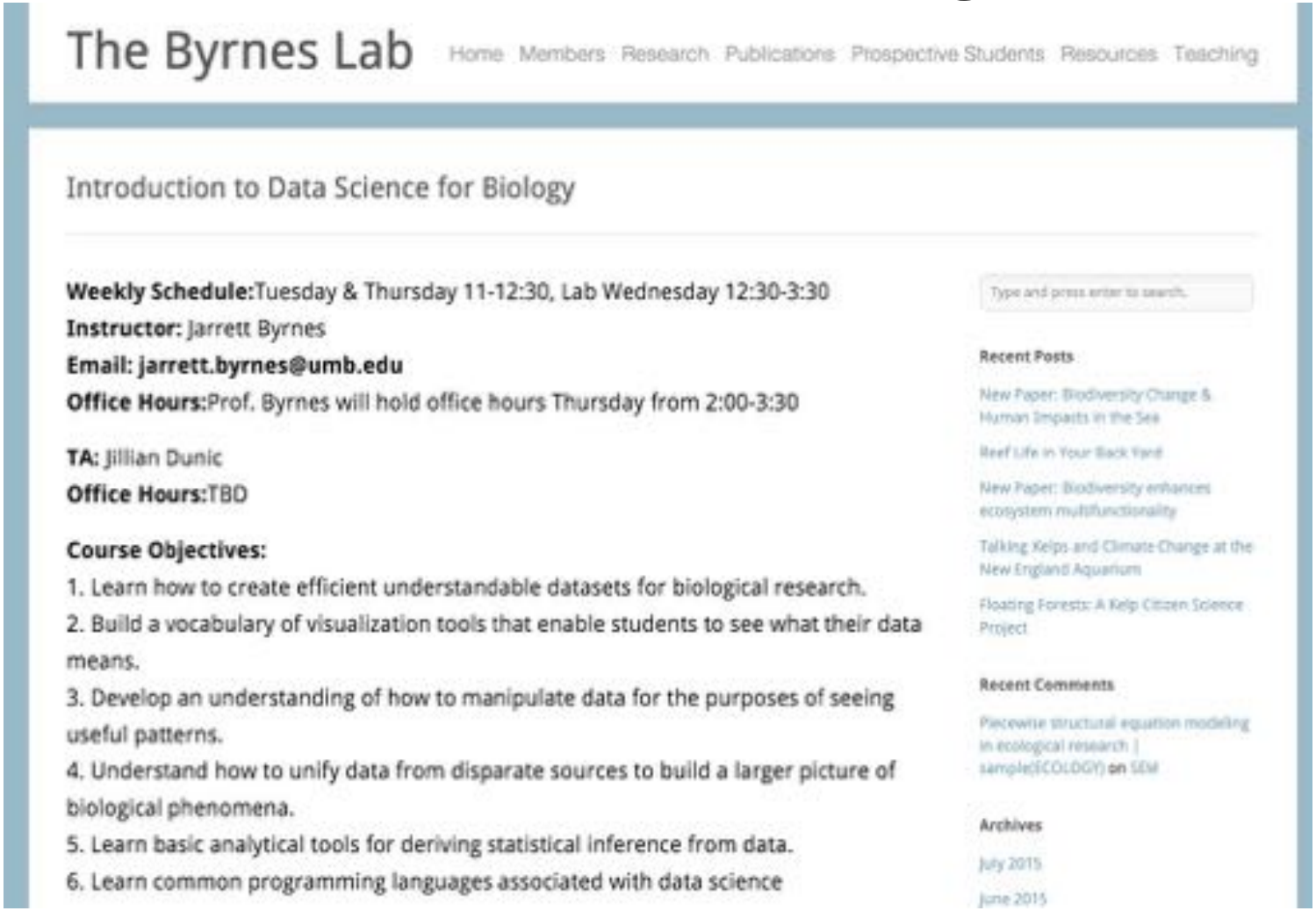


Learn basic analytical tools for deriving statistical inference from data



This Class

Course Web Page



http://byrneslab.net/teaching/data_science/

"Text"book & Weekly Readings

http://r4ds.had.co.nz/

Lab

- Coding!
- TA: Jillian Dunic
- Guided examples and then challenge problems

Assignments

- Weekly problem sets
  - Variable in scope!
  - May involve elements of your final project
- Can be started in lab
  - Will highlight concepts from that week

Final Project

- Analysis of a data set of your choosing
  - From your own work
  - Found data
- Data mashups encouraged!
  - Bring together multiple public sources of data
- Proposals due in two weeks
  - What data will you be using?
  - What question do you want to answer?

Next Time: Data Collection, Entry, and How to Make Your Data Usable

(and have future you avoid wanting to kill now you)

(And listed to the Not So Standard Deviations Podcast)