MY472 – Day 1: Overview and Fundamentals

Pablo Barberá & Akitaka Matsuo

MY 472: Data for Data Scientists

October 2, 2018

Course website: lse-my472.github.io


Data is everywhere


243.26
TOMACCO
JUICE


Rx

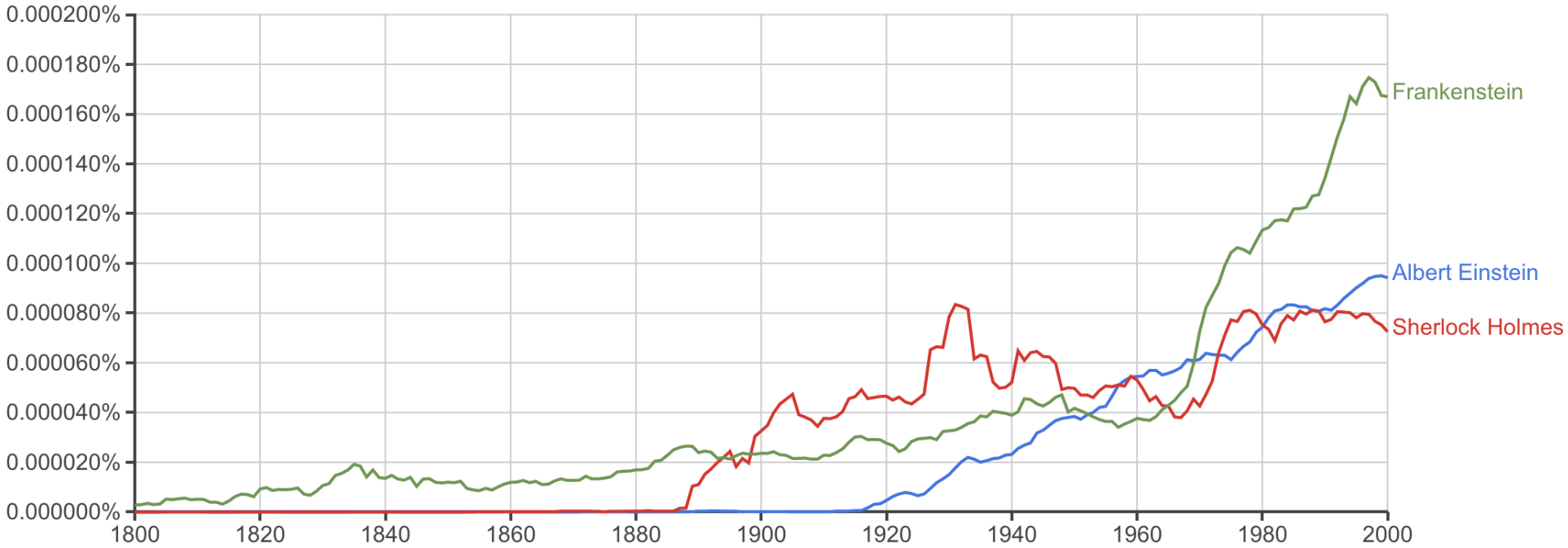
NBC/Instagram


Gefällt mir
Instagram
Pinterest
twitter
LinkedIn
facebook
flickr
skype
YouTube
XING

Google Books Ngram Viewer

Graph these comma-separated phrases: Albert Einstein,Sherlock Holmes,Frankenstein case-insensitive

between 1800 and 2000 from the corpus English with smoothing of 3. Search lots of books




Strongly agree
Agree
Disagree
ly disagree

The Data revolution in election campaigns

CNN Tech » Gadgets | Cyber Security | Innovation Nation Live TV U.S. Edition + menu

How Obama's data crunchers helped him win

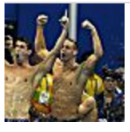
By Michael Scherer

Updated 11:45 AM ET, Thu November 8, 2012

President Obama's campaign manager hired an analytics department five times as large as that of the 2008 operation.

Top stories

Top US commander warns Russia, Syria



Is NBC's Olympics coverage really that bad?

The Data revolution in election campaigns

Data Analyst

APPLY FOR THIS JOB

BROOKLYN, NY ANALYTICS FULL-TIME

We are looking for Data Analysts, at both the junior and senior levels, to join our team at our Brooklyn, NY headquarters. The Analyst will play a pivotal role in developing data-driven strategies for key primary and battleground states. They will be responsible for designing and building tools to guide strategies at all levels of the campaign. By utilizing their statistical expertise, our Analysts will dissect large datasets, synthesize results and present findings to team leaders.

2016

Trump's secret data reversal

Having once dismissed the importance of campaign tech, the mogul is now rushing to catch up with Clinton.

By **KENNETH P. VOGEL** and **DARREN SAMUELSOHN** | 06/28/16 05:22 AM EDT

Donald Trump has dismissed political data operations as "overrated," but his campaign is now bolstering its online fundraising and digital outreach by turning to GOP tech specialists who previously tried to stop him from winning the party's nomination.

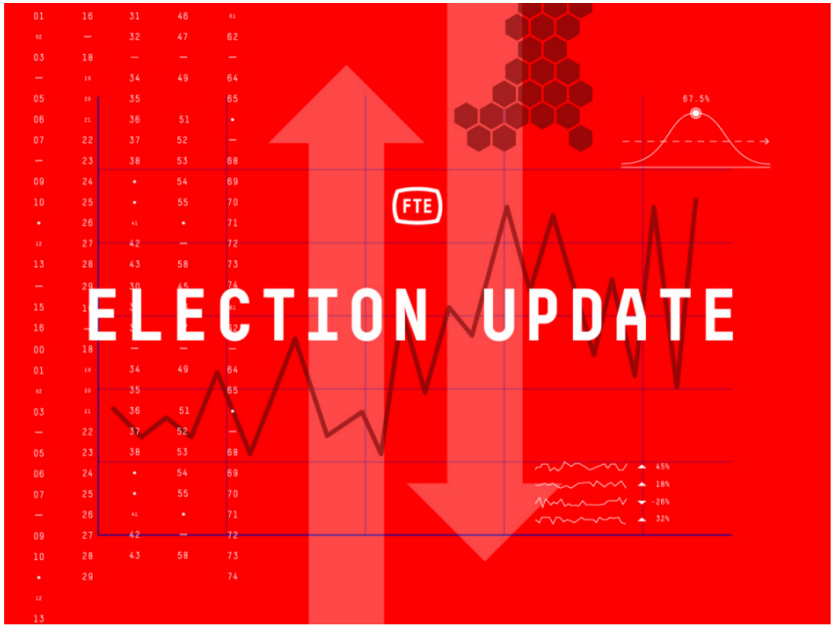
Data Journalism

FiveThirtyEight

ESPN

Politics Sports Science & Health Economics Culture

All week: Rio 2016 coverage



2016 ELECTION

National Polls Show The Race Tightening — But State Polls Don't

By Nate Silver

THE LATEST

8:55 AM
Significant Digits For Monday, Aug. 22, 2016

AUG 21
Election Update: National Polls Show The Race Tightening — But State Polls Don't

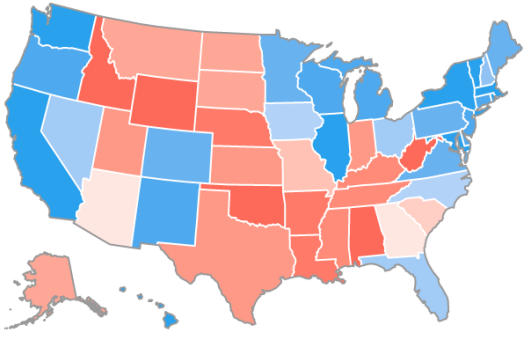
AUG 19
Winning An Olympic Gold Medal Hasn't Been This Difficult Since 1896

AUG 19
Let Caster Run! We Should Celebrate Semenya's Extraordinary Talent

INTERACTIVES

2016 Election Forecast

UPDATED 4 HOURS AGO



See polls and forecasts

MLB Predictions

UPDATED 15 HOURS AGO

Upcoming games

Nationals def. Orioles	50%
Pirates def. Astros	56%

Non-profit sector

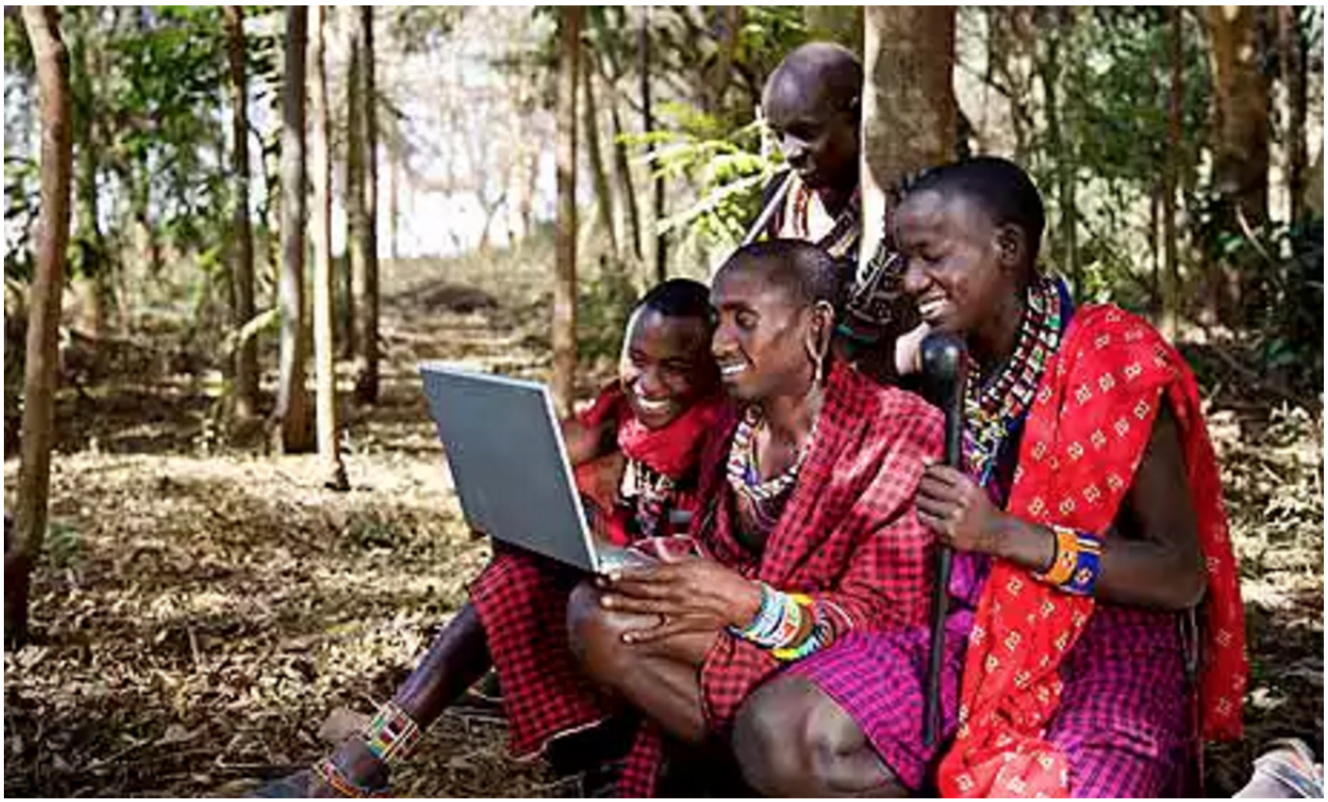
Development data
Datablog

Data without borders: why I want to change the world

Data scientist **Jake Porway** wants to hook up developers with charities and the developing world. Here he explains why

Jake Porway

Thursday 23 June 2011
11.10 EDT



Data without borders: Men on the Samburu National Reserve, Kenya, using a laptop Photograph: Scott Stulberg/Corbis

Data Scientist:

The Sexiest Job of the 21st Century

Meet the people who can coax treasure out of messy, unstructured data.

by Thomas H. Davenport and D.J. Patil

When Jonathan Goldman arrived for work in June 2006 at LinkedIn, the business networking site, the place still felt like a start-up. The company had just under 8 million accounts, and the number was growing quickly as existing members invited their friends and colleagues to join. But users weren't seeking out connections with the people who were already on the site at the rate executives had expected. Something was apparently missing in the social experience. As one LinkedIn manager put it, "It was like arriving at a conference reception and realizing you don't know anyone. So you just stand in the corner sipping your drink—and you probably leave early."

How can we analyze *(Big) data* to answer social science questions?

The 80/20 rule of data science:
80% data manipulation, 20% data analysis

This course is about the 80%

Plan for today

- Administration and logistics
- A brief history of data and the origins of databases
- Data types and storage units
- Introduction to R
- Markdown in brief
- git and Github for version control

Why you should take this course

It provides "data science literacy":

- what is data?
  - basic data types and structures
- how to collect data?
  - how to scrape data from the Internet
  - how to work with APIs
- how to clean data?
  - how to format, organize, and reshape data
  - the use of git and GitHub
- how to store and query data?
  - how to create and use databases
  - how to create and manage (online) databases

Course outline

1. Introduction to data
2. The shape of data
3. Cloud computing
4. Basics of HTML and CSS
5. Using data from the internet
6. (Reading week)
7. Working with APIs
8. Creating and managing databases
9. Interacting with online databases
10. Exploratory data analysis
11. Parallel computing

Prerequisites and software

- Introductory course – no prerequisites (but familiarity with R will be useful!)
- Lab computers are available, but we strongly recommend bringing your own laptop
- Software:
  - R 3.5.1 – Install from https://www.r-project.org/
  - RStudio – Install from https://www.rstudio.com/products/rstudio/download-server/
  - GitHub Desktop – Install from https://desktop.github.com/

  → *Please install before lab session this week*
- Mirrors similar tool usage and learning in other Methodology courses

About me: Pablo Barberá

- Assistant Professor of Computational Social Science at the London School of Economics
  - Previously Assistant Prof. at Univ. of Southern California
  - PhD in Politics, New York University (2015)
  - Data Science Fellow at NYU, 2015–2016
- My research:
  - Social media and politics, comparative electoral behavior
  - Text as data methods, social network analysis, Bayesian statistics
  - Author of R packages to analyze data from social media
- Contact:
  - P.Barbera@lse.ac.uk
  - www.pablobarbera.com
  - @p_barbera

Your turn!

1. Name?
2. MSc/PhD Programme?
3. Previous experience with R?
4. Why are you interested in this course?

Course philosophy

How to learn the techniques in this course?

- Lecture approach: not ideal for learning how to code
- You can only learn by doing.

→ We will cover each concept three times during each week

1. Introduction to the topic in lecture
2. Guided coding session in lecture and lab
3. Course assignments

- Warning! We will move fast.

Readings

- Mixed set of readings, very specific to each week.
  - For instance, Week 1's readings
  - Often available electronically, otherwise, available for purchase from Amazon (often in Kindle versions)
- Sometimes linked to Internet sources
  - Some books are available online and in print, and the online version may be more recent
- Please do the readings!

Course meetings

- Ten two-hour lectures: Tuesday 09:00–11:00 in 32L.LG.03
- Ten 1.5-hour classes ("labs")
  - Group 1: Thursdays 09:30–11:00 in TW2.4.03
  - Group 2: Fridays 15:00–16:30 in STC.S018
- No lecture/class in Week 6
- Office hours (book via LSE For You)
  - Pablo: Fridays 12:30–14:30, COL 7.10
  - Aki: Tuesdays 11:30–12:30, COL 8.02 (only weeks 3, 4, 5, 9)

Assessment

- 5 problem sets will be assessed (50%).
  - Submitted via GitHub (more in lab)
  - Only compiled assignments will be accepted
  - At least one will be collaborative; rest will be individual submissions.
- Take-home exam (50%)
  - Work with a dataset to answer a series of question
  - More open-ended format than problem sets
  - Deadline: January 18, 23:59

A note on collaboration

- All assignments are individual unless we instruct you otherwise
- For individual assignments:
  - You can discuss solutions with peers
  - However, you are not allowed to copy-paste code you need to write the code yourself
  - Submissions with identical code (where we shouldn't expect to see it) will be considered plagiarism
- You can use online resources but always give credit in comments if you borrow code/solutions

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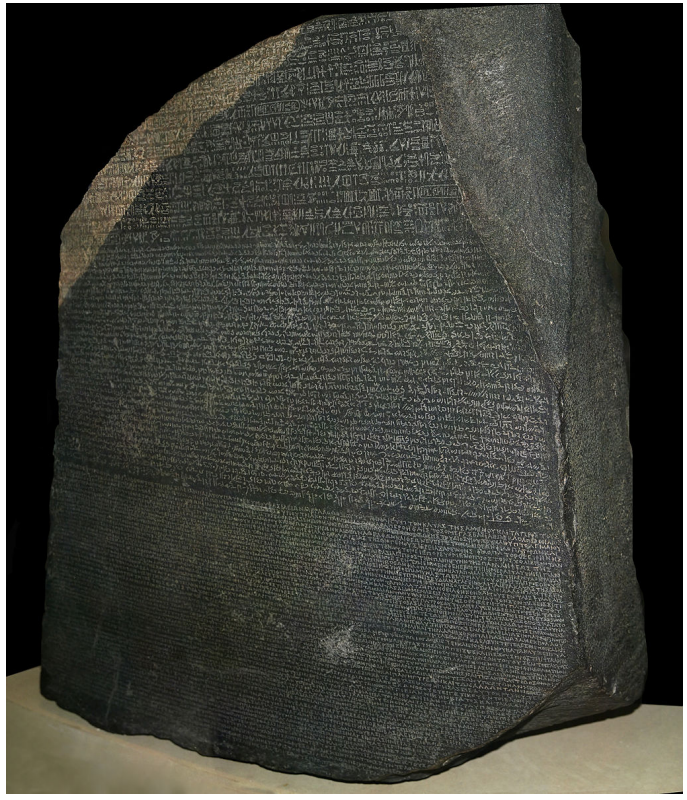
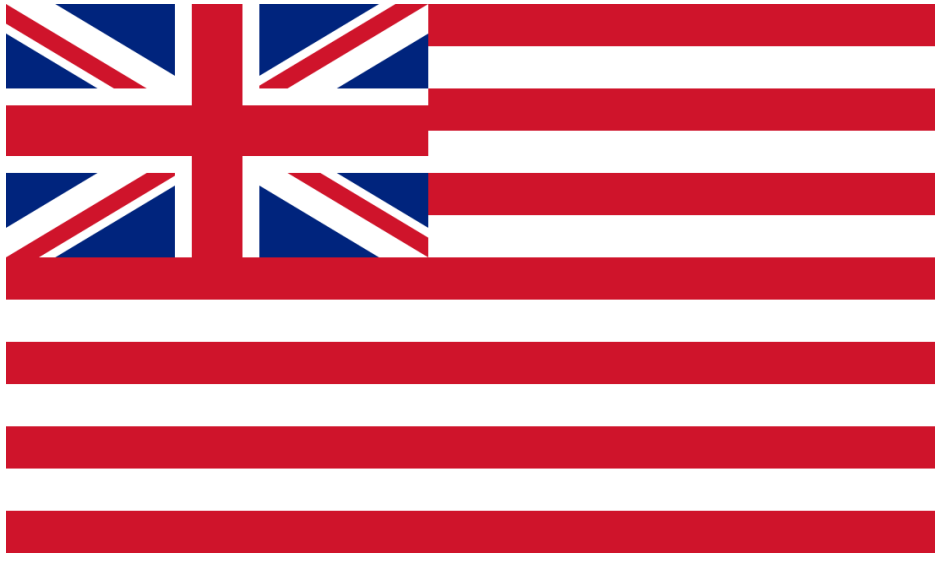
A brief history of data



Rosetta stone, British Museum

- Earliest example of database are likely government records: who is paying taxes and how much, census of citizens...

Early examples of distributed databases



Flag of East India Company

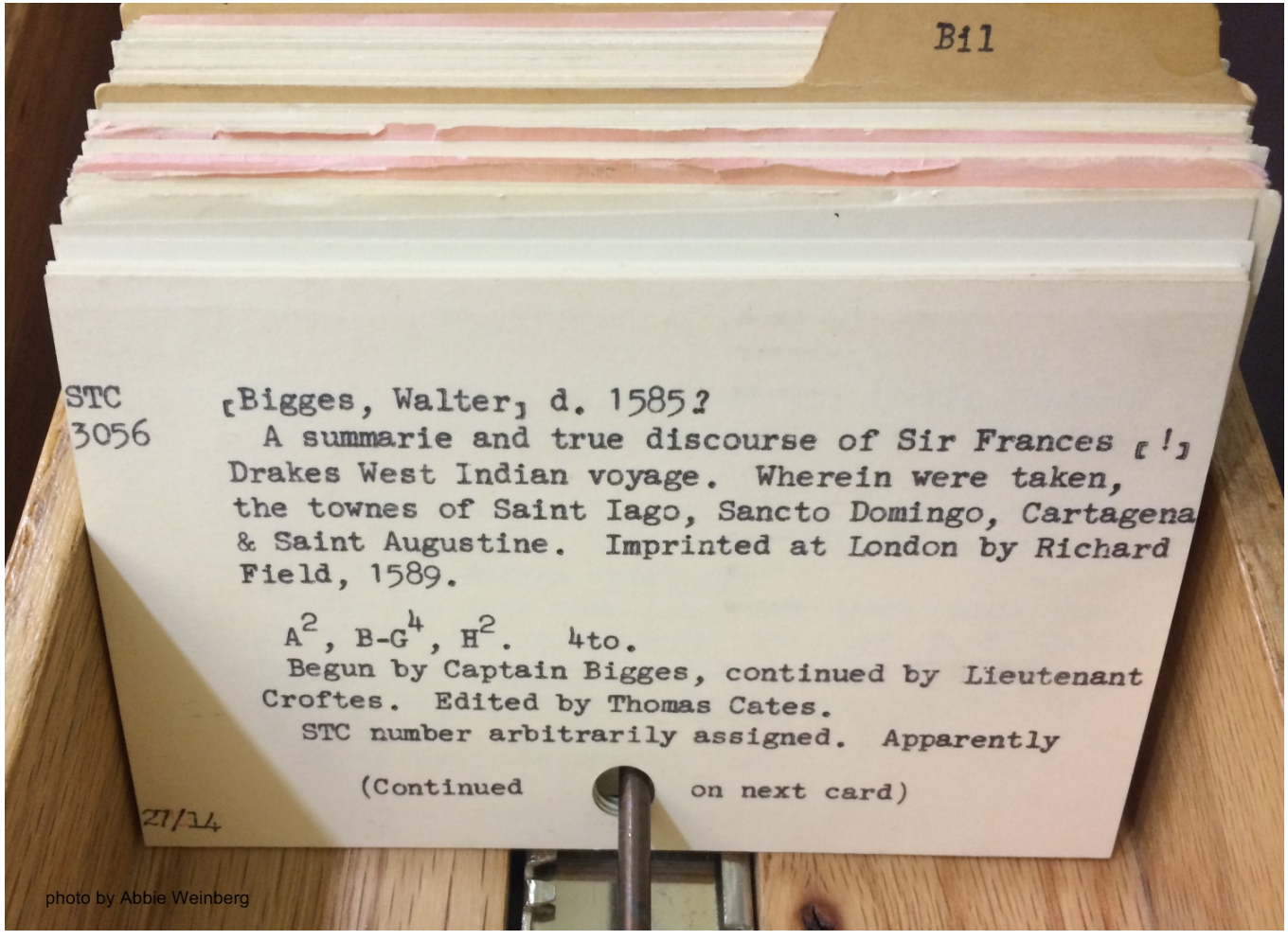
- Massive scale of company led to innovations in data storage

Early example of a database index

Index cards used in a library to catalog books

- Initially developed to catalog species by botanist Carl Linnaeus (19th century)
- Each piece of information is a field; units (species, books) are a record; records are *indexed* using a specific reference / sorting system.

Each record looked like this:

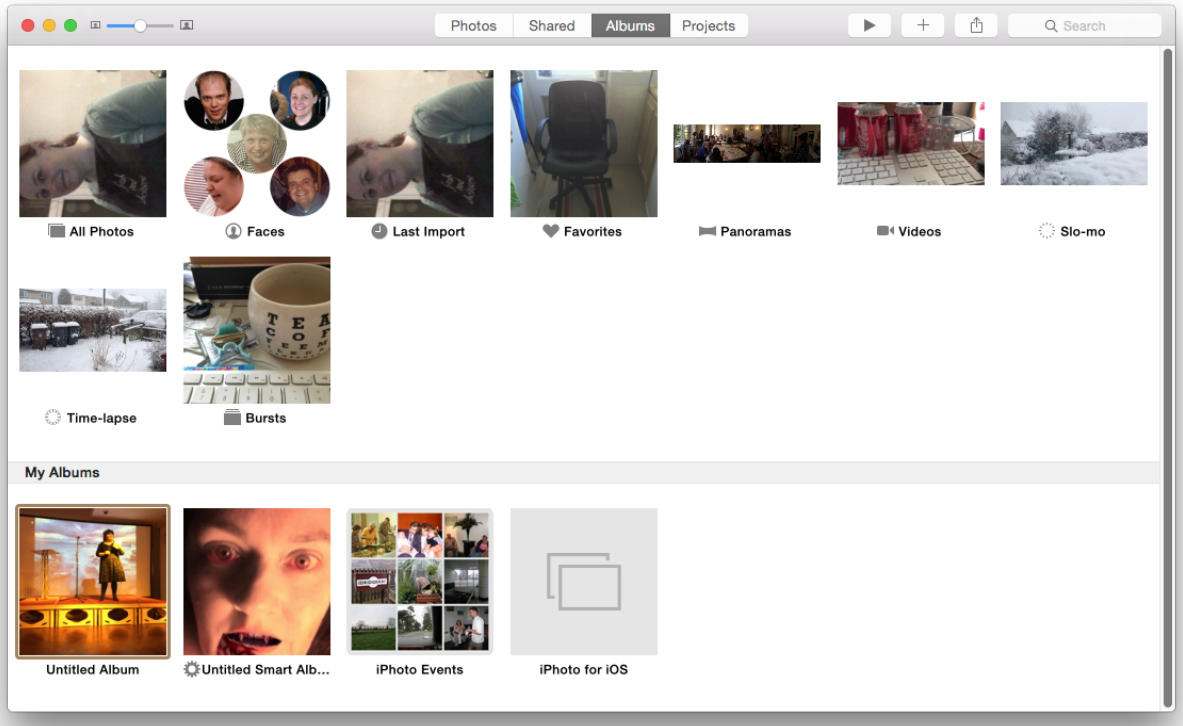


Dewey decimal system

- A proprietary library classification system first published in the United States by Melvil Dewey in 1876
- Scheme is made up of ten classes, each divided into ten divisions, each having ten sections
- The system's notation uses Arabic numbers, with three whole numbers making up the main classes and sub-classes and decimals creating further divisions
- Example:

```
500 Natural sciences and mathematics
   510 Mathematics
      516 Geometry
         516.3 Analytic geometries
            516.37 Metric differential geometries
               516.375 Finsler Geometry
```

- Problem: cards can only be sorted one way. Re-referencing was literally a manual operation
- Contrast with the idea of electronic indexes, where assets are stored once and many indexing and referencing systems can be applied



Modern database managers

- Codd, E.F. (1970) "A Relational Model of Data for Large Shared Data Banks." *Communications of the ACM*.

School Table

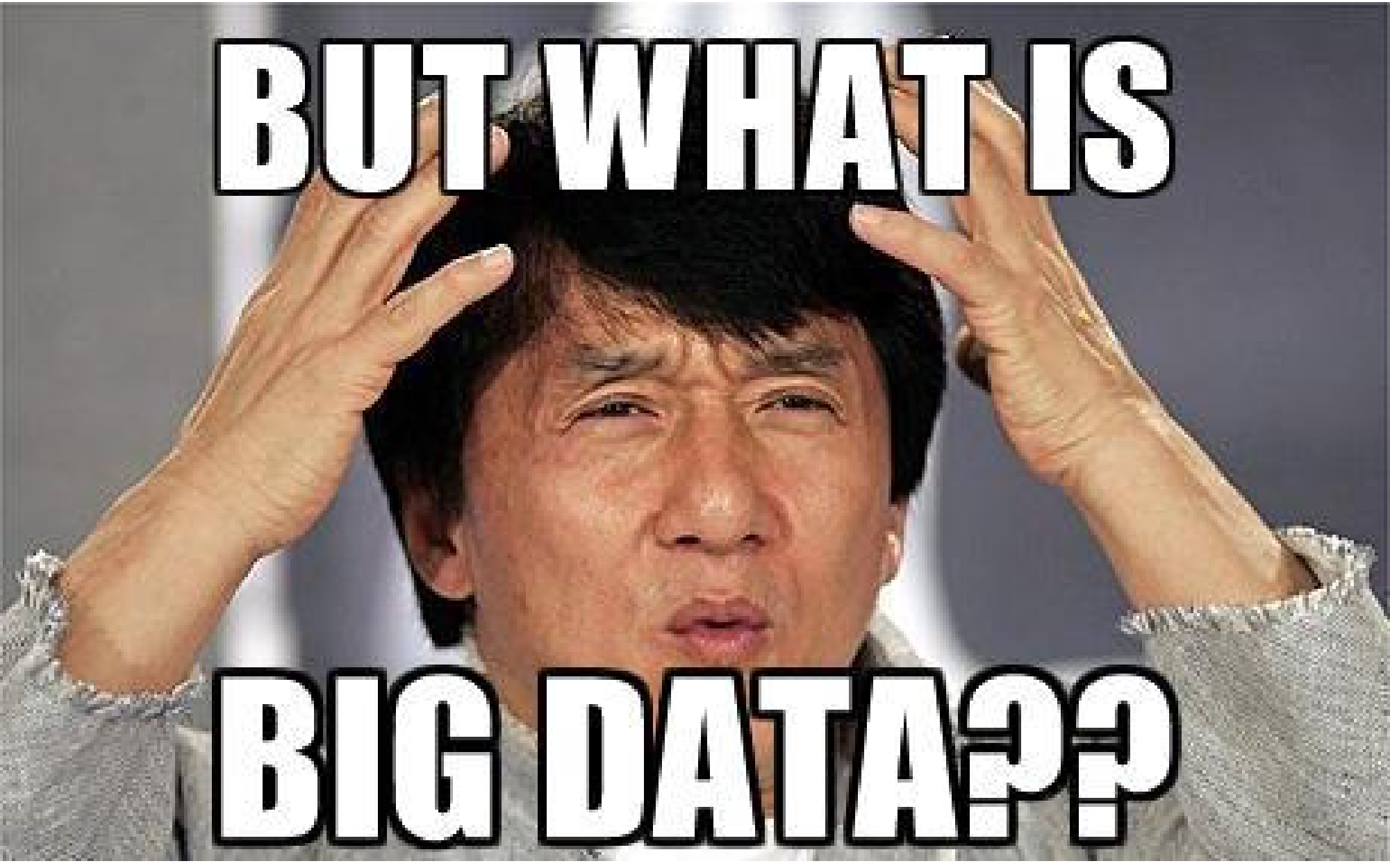
ID	Name
S001	University of Technology
S002	University of Applied Science

Student Table

School ID	ID	Name	DOB
S001	UT-1000	Tommy	05/06/1995
S001	UT-1000	Better	16/04/1995
S002	UAS-1000	Linda	02/09/1995
S002	UAS-1000	Jonathan	22/06/1995

Recent developments in data storage/management

- **NoSQL**: beyond relational structure; flexible; more scalable & compatible with distributed cloud storage (Big Data)


BUT WHAT IS
BIG DATA???

The Three V's of Big Data

Dumbill (2012), Monroe (2013):

1. Volume: 6 billion mobile phones, 1+ billion Facebook users, 500+ million tweets per day...
2. Velocity: personal, spatial and temporal granularity.
3. Variability: images, networks, long and short text, geographic coordinates, streaming...

Big data: data that are so large, complex, and/or variable that the tools required to understand them must first be invented.

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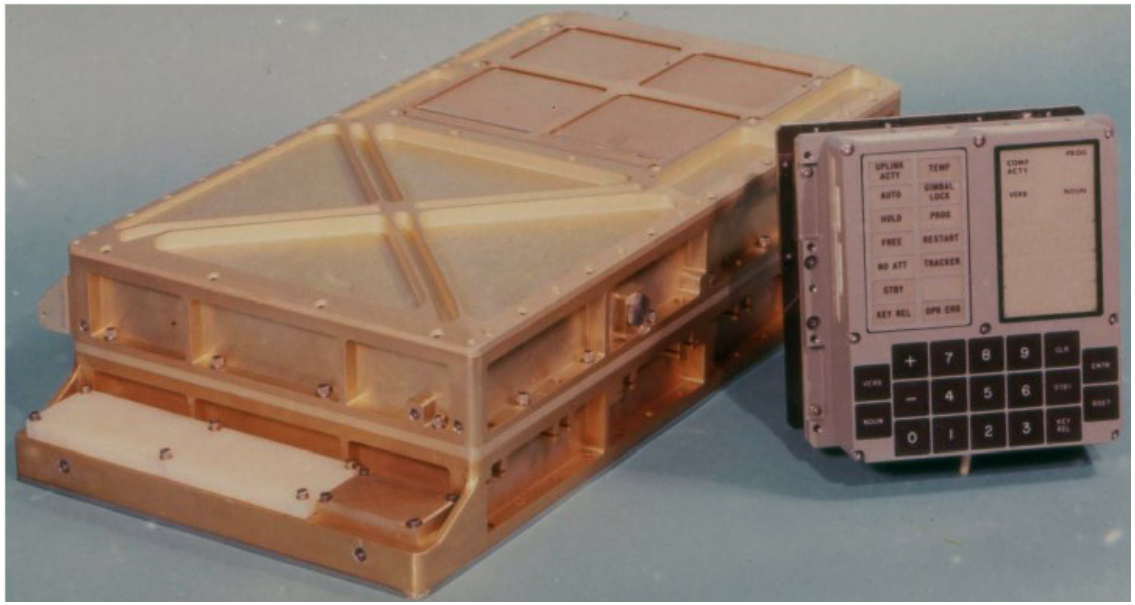
Changes in the world of data

- Volume of data in the modern world: 90% of the world's data has been generated in the last *two years*
- Facebook processes 500+ terabytes of data each day
- Square Kilometer Array (SKA) telescope
  - Southern hemisphere radio telescope with a total of 1km^2 of data sensors
  - Will generate 1 exabyte *daily* $= 1 \times 10^18$ bytes

- Compare this with the Apollo Guidance Computer (1966), which guided the first humans to the moon:
  - Magnetic core memory: 16-bit word length, 2048 words RAM = 4KB
  - Core rope memory: 36,864 words. 73KB



Basic units of data

- Bits
  - Smallest unit of storage; a 0 or 1
  - With n bits, can store 2^n patterns
- Bytes
  - 8 bits = 1 byte (why 1 byte can store 256 patterns)
  - "eight bit encoding" - used to represent characters, such as `A` represented as 65 = 01000001

Dec	Hx	Oct	Char	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr	Dec	Hx	Oct	Html	Chr
0	0	000	NUL (null)	32	20	040		Space	64	40	100	@	@	96	60	140	`	`
1	1	001	SOH (start of heading)	33	21	041	!	!	65	41	101	A	A	97	61	141	a	a
2	2	002	STX (start of text)	34	22	042	"	"	66	42	102	B	B	98	62	142	b	b
3	3	003	ETX (end of text)	35	23	043	#	#	67	43	103	C	C	99	63	143	c	c
4	4	004	EOT (end of transmission)	36	24	044	$	$	68	44	104	D	D	100	64	144	d	d
5	5	005	ENQ (enquiry)	37	25	045	%	%	69	45	105	E	E	101	65	145	e	e
6	6	006	ACK (acknowledge)	38	26	046	&	&	70	46	106	F	F	102	66	146	f	f
7	7	007	BEL (bell)	39	27	047	'	'	71	47	107	G	G	103	67	147	g	g
8	8	010	BS (backspace)	40	28	050	(	(	72	48	110	H	H	104	68	150	h	h
9	9	011	TAB (horizontal tab)	41	29	051	)	)	73	49	111	I	I	105	69	151	i	i
10	A	012	LF (NL line feed, new line)	42	2A	052	*	*	74	4A	112	J	J	106	6A	152	j	j
11	B	013	VT (vertical tab)	43	2B	053	+	+	75	4B	113	K	K	107	6B	153	k	k
12	C	014	FF (NP form feed, new page)	44	2C	054	,	,	76	4C	114	L	L	108	6C	154	l	l
13	D	015	CR (carriage return)	45	2D	055	-	-	77	4D	115	M	M	109	6D	155	m	m
14	E	016	SO (shift out)	46	2E	056	.	.	78	4E	116	N	N	110	6E	156	n	n
15	F	017	SI (shift in)	47	2F	057	/	/	79	4F	117	O	O	111	6F	157	o	o
16	10	020	DLE (data link escape)	48	30	060	0	0	80	50	120	P	P	112	70	160	p	p
17	11	021	DC1 (device control 1)	49	31	061	1	1	81	51	121	Q	Q	113	71	161	q	q
18	12	022	DC2 (device control 2)	50	32	062	2	2	82	52	122	R	R	114	72	162	r	r
19	13	023	DC3 (device control 3)	51	33	063	3	3	83	53	123	S	S	115	73	163	s	s
20	14	024	DC4 (device control 4)	52	34	064	4	4	84	54	124	T	T	116	74	164	t	t
21	15	025	NAK (negative acknowledge)	53	35	065	5	5	85	55	125	U	U	117	75	165	u	u
22	16	026	SYN (synchronous idle)	54	36	066	6	6	86	56	126	V	V	118	76	166	v	v
23	17	027	ETB (end of trans. block)	55	37	067	7	7	87	57	127	W	W	119	77	167	w	w
24	18	030	CAN (cancel)	56	38	070	8	8	88	58	130	X	X	120	78	170	x	x
25	19	031	EM (end of medium)	57	39	071	9	9	89	59	131	Y	Y	121	79	171	y	y
26	1A	032	SUB (substitute)	58	3A	072	:	:	90	5A	132	Z	Z	122	7A	172	z	z
27	1B	033	ESC (escape)	59	3B	073	;	;	91	5B	133	[	[	123	7B	173	{	{
28	1C	034	FS (file separator)	60	3C	074	<	<	92	5C	134	\	\	124	7C	174			|
29	1D	035	GS (group separator)	61	3D	075	=	=	93	5D	135	]	]	125	7D	175	}	}
30	1E	036	RS (record separator)	62	3E	076	>	>	94	5E	136	^	^	126	7E	176	~	~
31	1F	037	US (unit separator)	63	3F	077	?	?	95	5F	137	_	_	127	7F	177	&#127;	DEL

Source: www.LookupTables.com

Basic units of data

Multi-byte units:

unit	abbreviation	total bytes	nearest decimal equivalent
kilobyte	KB	1,024^1	1000^1
megabyte	MB	1,024^2	1000^2
gigabyte	GB	1,024^3	1000^3
terabyte	TB	1,024^4	1000^4
petabyte	PB	1,024^5	1000^5
exabyte	EB	1,024^6	1000^6
zettabyte	ZB	1,024^7	1000^7
yottabyte	YB	1,024^8	1000^8

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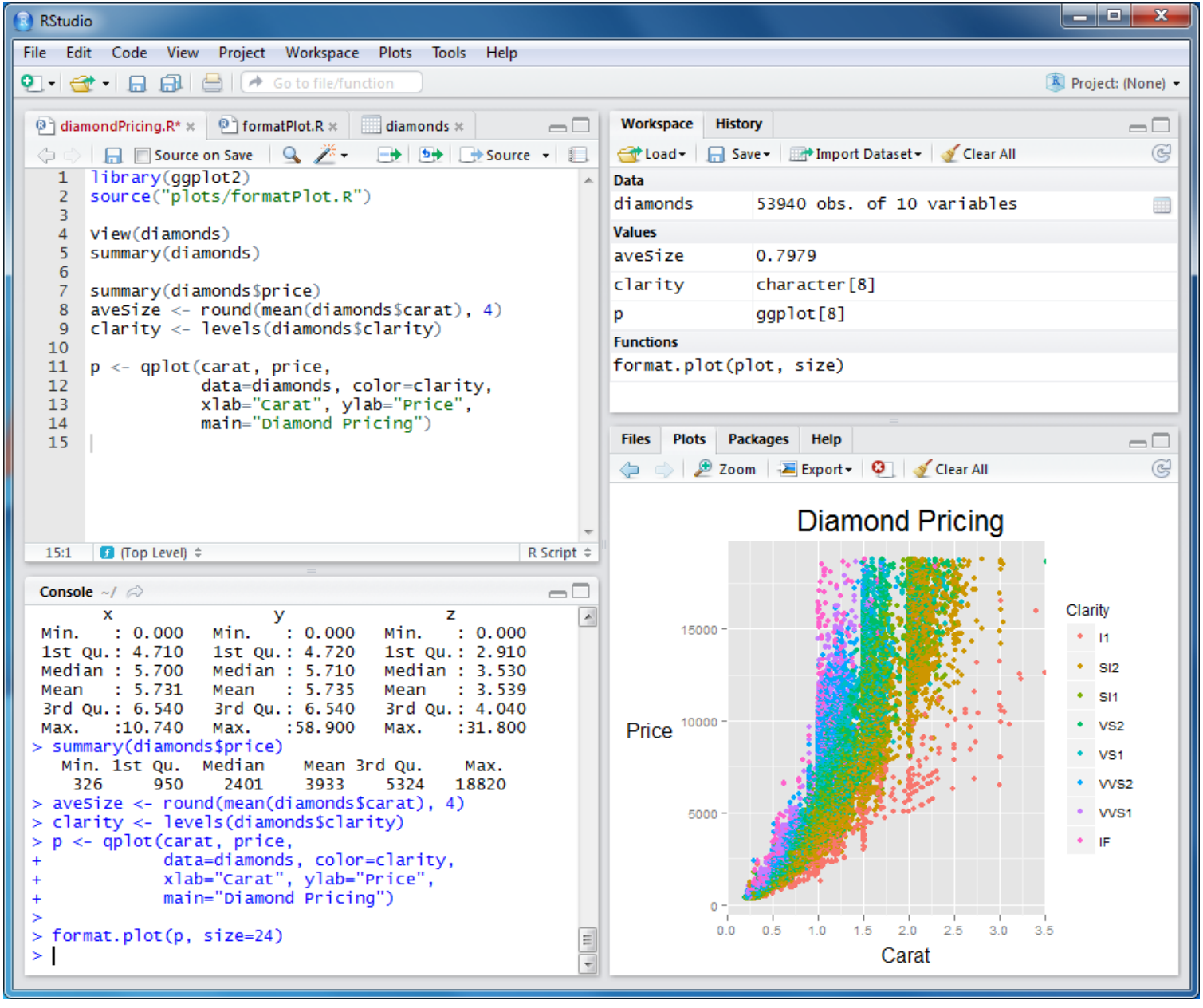
Why we're using R

- Becoming *lingua franca* of statistical analysis in academia
- What employers in private sector demand
- It's free and open-source
- Flexible and extensible through *packages* (over 10,000 and counting!)
- Powerful tool to conduct automated text analysis, social network analysis, and data visualization, with packages such as quanteda, igraph or ggplot2.
- Command-line interface and scripts favors reproducibility.
- Excellent documentation and online help resources.

R is also a full programming language; once you understand how to use it, you can learn other languages too.

RStudio


RStudio
File Edit Code View Project Workspace Plots Tools Help
Go to file/function
Project: (None)
diamondPricing.R*
formatPlot.R
diamonds
Source on Save
Source
1 library(ggplot2)
2 source("plots/formatPlot.R")
3
4 View(diamonds)
5 summary(diamonds)
6
7 summary(diamonds$price)
8 aveSize <- round(mean(diamonds$carat), 4)
9 clarity <- levels(diamonds$clarity)
10
11 p <- qplot(carat, price,
12 data=diamonds, color=clarity,
13 xlab="Carat", ylab="Price",
14 main="Diamond Pricing")
15
15:1 (Top Level) R Script
Console ~/
x y z
Min. : 0.000 Min. : 0.000 Min. : 0.000
1st Qu.: 4.710 1st Qu.: 4.720 1st Qu.: 2.910
Median : 5.700 Median : 5.710 Median : 3.530
Mean : 5.731 Mean : 5.735 Mean : 3.539
3rd Qu.: 6.540 3rd Qu.: 6.540 3rd Qu.: 4.040
Max. :10.740 Max. :58.900 Max. :31.800
> summary(diamonds$price)
Min. 1st Qu. Median Mean 3rd Qu. Max.
326 950 2401 3933 5324 18820
> aveSize <- round(mean(diamonds$carat), 4)
> clarity <- levels(diamonds$clarity)
> p <- qplot(carat, price,
+ data=diamonds, color=clarity,
+ xlab="Carat", ylab="Price",
+ main="Diamond Pricing")
>
> format.plot(p, size=24)
>
Workspace History
Load Save Import Dataset Clear All
Data
diamonds 53940 obs. of 10 variables
Values
aveSize 0.7979
clarity character[8]
p ggplot[8]
Functions
format.plot(plot, size)
Files Plots Packages Help
Zoom Export Clear All
Diamond Pricing
Price
Carat
Clarity
I1
SI2
SI1
VS2
VS1
VVS2
VVS1
IF
0
5000
10000
15000
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5

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Guided coding session

`01-RMarkdown.Rmd`

`02-intro-to-R.Rmd`

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