Data Analysis Using Spreadsheets

Professor Widom's Instructional Odyssey

www.professorwidom.org

Stanford University

Google

Google Cloud Platform

acm Association for Computing Machinery

Very Large Data Bases Endowment Inc.

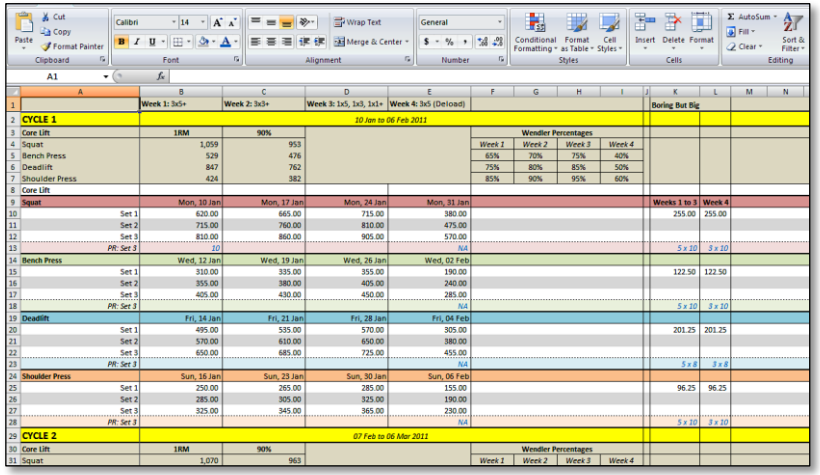
INSTABASE

amazon web services™

Spreadsheets

Most familiar use is for data presentation

Formulas handy for sales, budgets, and other numeric summaries



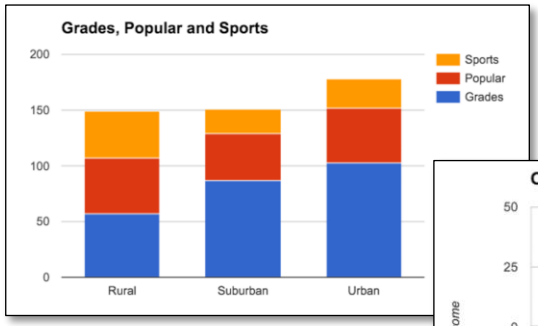
I4 =SUM(B4:H4)

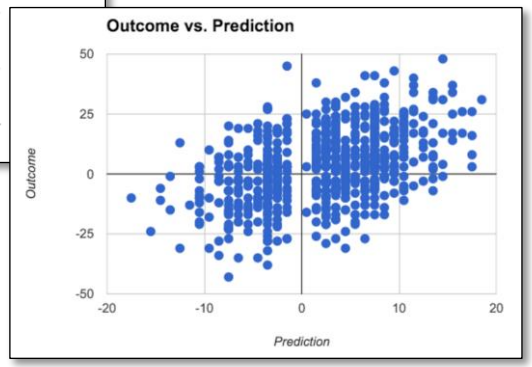
	A	B	C	D	E	F	G	H	I
1									
2									
3		Jan	Feb	Mar	Apr	May	Jun	Jul	Total
4	Person 1	620	768	251	811	664	304	27	3445
5	Person 2	1	928	595	214	317	470	360	2885
6	Person 3	707	481	849	255	548	550	518	3908
7	Person 4	235	110	357	730	739	265	36	2472
8	Person 5	610	508	353	952	643	16	738	3820
9	Person 6	425	648	740	162	865	332	786	3958
10	Person 7	695	751	111	675	736	407	6	3381
11	Person 8	326	449	80	612	779	1000	341	3587
12	Person 9	981	540	509	860	92	631	900	4513
13	**Total**	**4600**	**5183**	**3845**	**5271**	**5383**	**3975**	**3712**	**31969**
14									

Spreadsheets

But also a convenient and powerful tool for analysis of structured data

(And for data visualization)





	A	B	C	D	E	F	G
1	Year	Week	Home	HomeScore	Away	AwayScore	Prediction
2	1998	1	Green_Bay	38	Detroit	19	9.5
3	1998	1	Chicago	23	Jacksonville	24	-8.5
4	1998	1	Minnesota	31	Tampa Bay	7	3.5
5	1998	1	St._Louis	17	New_Orleans	24	3.5
6	1998	1	Cincinnati	14	Tennessee	23	1.5
7	1998	1	Baltimore	13	Pittsburgh	20	-3.5
8	1998	1	Carolina	14	Atlanta	19	4.5
9	1998	1	NY_Giants	31	Washington	24	2.5
10	1998	1	Philadelphia	0	Seattle	38	-3.5
11	1998	1	San_Diego	16	Buffalo	14	1.5
12	1998	1	San_Francisco	36	NY_Jets	30	7.5
13	1998	1	Dallas	38	Arizona	10	5.5
14	1998	1	Indianapolis	15	Miami	24	-3.5
15	1998	1	Kansas_City	28	Oakland	8	7.5
16	1998	1	Denver	27	New_England	21	7.5
17	1998	2	Tennessee	7	San_Diego	13	7.5
18	1998	2	Green_Bay	23	Tampa Bay	15	7.5
19	1998	2	New_Orleans	19	Carolina	14	-3.5
20	1998	2	St._Louis	31	Minnesota	38	-7.5
21	1998	2	Miami	13	Buffalo	7	7.5
22	1998	2	Jacksonville	21	Kansas_City	16	1.5
23	1998	2	NY_Jets	10	Baltimore	24	3.5
24	1998	2	Pittsburgh	17	Chicago	12	11.5
25	1998	2	Atlanta	17	Philadelphia	12	8.5
26	1998	2	Detroit	28	Cincinnati	34	6.5
27	1998	2	Oakland	20	NY_Giants	17	1.5
28	1998	2	Seattle	33	Arizona	14	7.5
29	1998	2	Denver	42	Dallas	23	7.5
30	1998	2	New_England	29	Indianapolis	0	8.5
31	1998	2	Washington	10	San_Francisco	45	-4.5
32	1998	3	Kansas_City	23	San_Diego	7	9.5
33	1998	3	Minnesota	29	Detroit	6	5.5
34	1998	3	Buffalo	33	St._Louis	34	4.5
35	1998	3	Cincinnati	6	Green_Bay	13	-7.5

Spreadsheets

- A surprisingly large fraction of the world's structured data is managed and manipulated in spreadsheets
- Spreadsheets are used by 750 million people — 10% of the world's population

Microsoft Excel is dominant tool
- Many features
- Proprietary and expensive

Google Sheets
- Open and free
- Fewer features, but catching up

This Session

Spreadsheet basics

- Importing and exporting
- Inserting and deleting
- Formulas

Data operations

- Sorting
- Filtering
- Aggregation
- Joining

Even people with significant spreadsheet experience should learn a few new things

Pivot tables

- Restructuring / aggregation / analysis

Data Sets

Europe Temperatures

Cities: city, country, latitude, longitude, temperature

Countries: country, population, EU, coastline

2010 World Cup

Teams: team, ranking, games, wins, draws, losses, goalsFor, goalsAgainst, yellowCards, redCards

Players: surname, team, position, minutes, shots, passes, tackles, saves

Titanic

Titanic: last, first, gender, age, class, fare, embarked, survived

Importing and Exporting

- Structured data in files
  - Comma-separated values (CSV)
  - Tab-separated values (TSV)
- Import into format used by spreadsheet program
- Export from spreadsheet to CSV or TSV (or others)

Cities.csv

```
city,country,latitude,longitude,temperature
Aalborg,Denmark,57.03,9.92,7.52
Aberdeen,United Kingdom,57.17,-2.08,8.10
Abisko,Sweden,63.35,18.83,0.20
Adana,Turkey,36.99,35.32,18.67
Albacete,Spain,39.00,-1.87,12.62
Algeciras,Spain,36.13,-5.47,17.38
Amiens,France,49.90,2.30,10.17
Amsterdam,Netherlands,52.35,4.92,8.93
Ancona,Italy,43.60,13.50,13.52
Andorra,Andorra,42.50,1.52,9.60
Angers,France,47.48,-0.53,10.98
Ankara,Turkey,39.93,32.86,9.86
Antalya,Turkey,36.89,30.70,11.88
Arad,Romania,46.17,21.32,9.32
Athens,Greece,37.98,23.73,17.41
Augsburg,Germany,48.35,10.90,4.54
```

Players.tsv — Edited

surname	team	position	minutes	shots	passes		tackles
Abdoun	Algeria	midfielder	16	0	6	0	0
Belhadj	Algeria	defender	270	1	146	8	0
Boudebouz	Algeria	midfielder	74	3	28	1	0
Bougherra	Algeria	defender	270	1	89	11	0
Chaouchi	Algeria	goalkeeper	90	0	17	0	2
Djebbour	Algeria	forward	123	3	19	1	0
Ghezzal	Algeria	forward	40	3	8	0	0
Guedioura	Algeria	midfielder	38	0	18	1	0
Halliche	Algeria	defender	270	2	94	4	0
Kadir	Algeria	midfielder	262	0	104	3	0
Lacen	Algeria	midfielder	270	0	158	8	0
M'Bolhi	Algeria	goalkeeper	180	0	30	0	12
Matmour	Algeria	midfielder	255	3	68	3	0
Mesbah	Algeria	midfielder	1	0	1	0	0
Saifi	Algeria	forward	15	1	3	0	0
Yahia	Algeria	defender	269	1	79	4	0

Let's Get Started!

- Inserting and deleting rows
- Inserting and deleting columns
- Formulas

Your Turn

1. Add new column to the left of column F called celsius
2. Use formula to compute values from fahrenheit column E

Note: Celsius = (Fahrenheit – 32) * 5/9

Okay to work together!

Okay to ask questions!

Data Operations

- Sorting
- Filtering
- Aggregation
- Grouped aggregation
- Joining

Your Turn

How many cities in Italy?

Note: There are several ways to solve this one!

Data Operations

- Sorting
- Filtering
- Aggregation
- Grouped aggregation
- Joining

Your Turn

What is the average latitude…

1. overall ?
2. for cities with temperature < 10 ?
3. for cities with temperature > 10 ?
4. for cities where both the city name and the country name end in the letter “a” ?

Pivot Tables

For data restructuring, aggregation, general analysis

Convenient and powerful!

Pivot Tables

For data restructuring, aggregation, general analysis

Convenient and powerful!

But pivot tables don't have full spreadsheet functionality – sometimes must copy-paste (special) to new sheet to do further analysis

Your Turn

Use pivot tables to solve these two problems:

1. (easy) Which are warmer on average – cities in the EU or cities not in the EU?
2. (harder) What are the western-most and eastern-most countries with no coastline?

For #2: Define the longitude of a country as the *average* longitude of cities in that country, so find the no-coastline countries with the smallest and largest average longitudes

Explore the features of pivot tables – *you may need additional features to solve this one!* (and you are allowed to scroll ☺)

Data Analysis with Spreadsheets

Convenient and powerful

- Many analyses can be done in "big data" style

No scrolling

A few limitations

- Data size

  Google sheets: 400,000 cells

- Some analyses are difficult

  E.g., two cities closest to each other (easy in SQL)

Data Analysis with Spreadsheets

For help while working with spreadsheets:

- Dropdown tips
- Tutorials and help pages
  (website Course Materials)
- My favorite: web search

World Cup Data Analysis

1. Which team has the highest ratio of goalsFor/goalsAgainst?
2. What is the average number of passes made by forwards? By midfielders?
3. What player on a team with "ia" in the team name played less than 200 minutes and made more than 100 passes?
4. Which team has the highest average number of shots per minute played? ✪
5. How many players who play on a team with ranking <10 played more than 350 minutes?

✪ Reminder: to "join" tables use =xlookup()

Titanic Data Analysis (extra)

1. How many passengers sailed for free (i.e., fare is zero)?
2. How many married women over age 50 embarked in Cherbourg? (Married women's first names begin with "Mrs.")
3. How many passenger ages are missing (blank)? What is the average fare paid by these passengers?
4. What is the most common last name among passengers, and how many passengers have that last name? What is the average number of passengers per last name?
5. What is the average fare paid by passengers in the three classes? What is the average age of passengers in the three classes?
6. What is the survival rate of passengers in the three classes, i.e., what fraction of passengers in each class survived? What is the survival rate of females versus males? ✪✪ Of children (under 18) versus adult (age 18 or over), ignoring passengers whose age is missing?