Data

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STAT 226 - Iowa State University

August 22, 2018

Outline

Important terminology/concepts:

- Data
  - Individuals and variables
  - Categorical vs numerical variables
  - Nominal vs ordinal variables
  - Random variables vs observations
- Population vs sample
  - Descriptive vs inferential statistics
  - Parameters vs statistics
- Time series - out of place

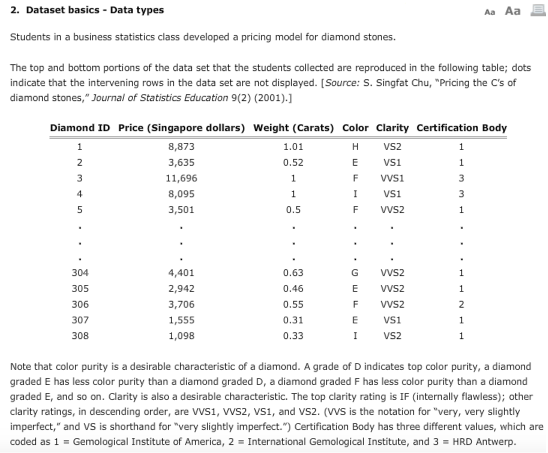
Individuals and Variables

Definition

Individuals are subjects/objects of the population of interest; can be people but also business firms, common stocks or any other object that we want to study.

Definition

A variable is any characteristic of an individual that we are interested in. A variable typically will take on different values for different individuals.



2. Dataset basics - Data types

Students in a business statistics class developed a pricing model for diamond stones.

The top and bottom portions of the data set that the students collected are reproduced in the following table; dots indicate that the intervening rows in the data set are not displayed. [*Source:* S. Singfat Chu, "Pricing the C's of diamond stones," *Journal of Statistics Education* 9(2) (2001).]

Diamond ID	Price (Singapore dollars)	Weight (Carats)	Color	Clarity	Certification Body
1	8,873	1.01	H	VS2	1
2	3,635	0.52	E	VS1	1
3	11,696	1	F	VVS1	3
4	8,095	1	I	VS1	3
5	3,501	0.5	F	VVS2	1
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
304	4,401	0.63	G	VVS2	1
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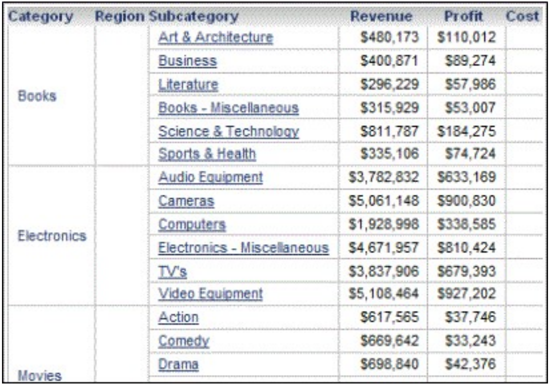
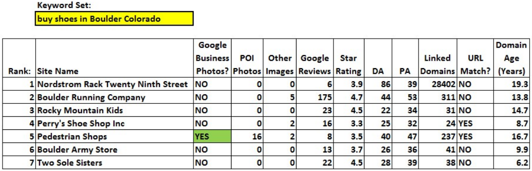
307	1,555	0.31	E	VS1	1
308	1,098	0.33	I	VS2	1

Note that color purity is a desirable characteristic of a diamond. A grade of D indicates top color purity, a diamond graded E has less color purity than a diamond graded D, a diamond graded F has less color purity than a diamond graded E, and so on. Clarity is also a desirable characteristic. The top clarity rating is IF (internally flawless); other clarity ratings, in descending order, are VVS1, VVS2, VS1, and VS2. (VVS is the notation for "very, very slightly imperfect," and VS is shorthand for "very slightly imperfect.") Certification Body has three different values, which are coded as 1 = Gemological Institute of America, 2 = International Gemological Institute, and 3 = HRD Antwerp.



Category	Region	Subcategory	Revenue	Profit	Cost
Books		Art & Architecture	$480,173	$110,012	
		Business	$400,871	$89,274	
		Literature	$296,229	$57,986	
		Books - Miscellaneous	$315,929	$53,007	
		Science & Technology	$811,787	$184,275	
		Sports & Health	$335,106	$74,724	
Electronics		Audio Equipment	$3,782,832	$633,169	
		Cameras	$5,061,148	$900,830	
		Computers	$1,928,998	$338,585	
		Electronics - Miscellaneous	$4,671,957	$810,424	
		TV's	$3,837,906	$679,393	
		Video Equipment	$5,108,464	$927,202	
Movies		Action	$617,565	$37,746	
		Comedy	$669,642	$33,243	
		Drama	$698,840	$42,376	



Keyword Set:

buy shoes in Boulder Colorado

Rank:	Site Name	Google Business Photos?	POI Photos	Other Images	Google Reviews	Star Rating	DA	PA	Linked Domains	URL Match?	Domain Age (Years)
1	Nordstrom Rack Twenty Ninth Street	NO	0	0	6	3.9	86	39	28402	NO	19.3
2	Boulder Running Company	NO	0	5	175	4.7	44	53	311	NO	13.8
3	Rocky Mountain Kids	NO	0	0	23	4.5	22	34	31	NO	14.7
4	Perry's Shoe Shop Inc	NO	0	2	16	3.3	25	32	24	YES	8.7
5	Pedestrian Shops	YES	16	2	8	3.5	40	47	237	YES	16.7
6	Boulder Army Store	NO	0	0	13	3.7	26	36	41	NO	9.9
7	Two Sole Sisters	NO	0	0	22	4.5	28	39	38	NO	6.2

Categorical Variables

Definition

A categorical variable is a variable that can take on one of a limited, and usually fixed number of possible values, assigning each individual to a particular group based on some qualitative property. An ordinal variable is a categorical variable for which the values can be ordered. A nominal variable is a categorical variable that has no ordering.

- Nominal: order not meaningful
  - gender, religion, race
  - type of stock
  - pattern of a carpet
- Ordinal: order may be meaningful
  - grades: A, A-, B+, B, B-, . . .
  - educational degrees
  - Likert scales: disagree, neutral, agree

Numerical variables

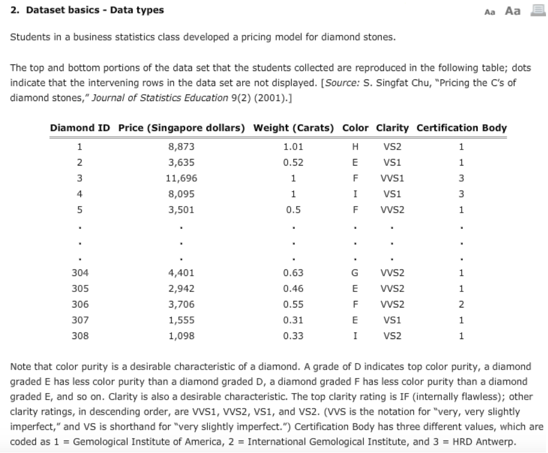
Definition

A numerical, or quantitative, variable take numerical values for which arithmetic operations such as adding and averaging make sense.

Examples:

- height/weight of a person
- temperature
- time it takes to run a mile
- currency exchange rates
- number of webpage hits in an hour

For numerical variables, we also consider whether the variable is a count and whether or not that count has a technical upper limit.



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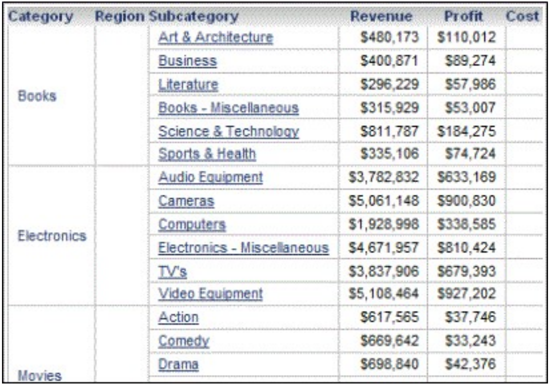

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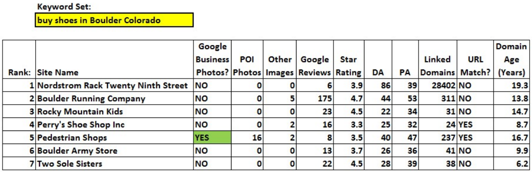

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Random variables

Definition

An observation in a data set refers to the observed value of a variable on a specific individual.

Definition

A random variable is the as yet unknown outcome of some observation. We typically denote random variables with capital Roman letters at the end of the alphabet, e.g. X, Y, or Z.

For example,

- X: monthly unemployment rate
- Y: grade on your next Stat 226 exam, and
- Z: education of customer.

are all examples of random variables.

Observations

Once we “see” an observation, i.e. the outcome of X, Y and Z is determined and no longer unknown, we switch to a lower case letter x, y or z. For example, the corresponding observations could be:

- $x=$ 3.9% (for July 2018),
- $y=$ 95 points, and
- $z=$College graduate

TL;DR Know the difference between a random variable and an observation (data point) and how to distinguish between them in terms of notation!

- upper case letter $\Longrightarrow$ not yet observed
- lower case letter $\Longrightarrow$ observed

Population

Definition

The population is the entire group of individuals that we want to say something about.

Examples:

- all currently enrolled ISU students
- all Starbucks customers nationwide
- all customers banking with Wells Fargo

The population is entirely defined by the target group of interest and the purpose of the study!

Sample

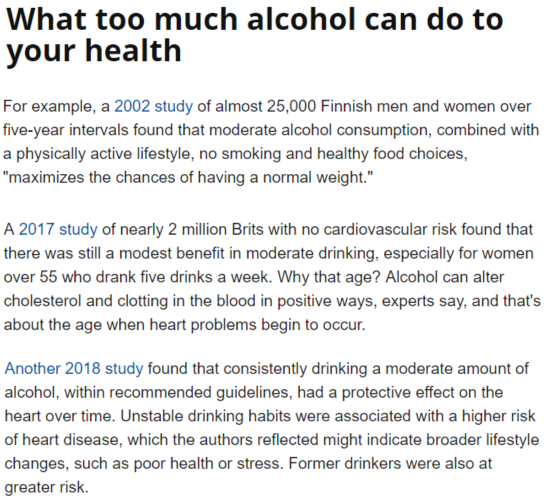
Definition

The subset of the population that you have collected data is called the sample.

Examples (of extremely non-representative) samples:

- students in STAT 226, Section A, Fall 2018 (who came to class)
- Starbucks customers visiting 2302 Lincoln Way, Ames from 11-11:30am today
- Wells Fargo customers visiting 3910 Lincoln Way, Ames, IA 50014 today

https://www.abc15.com/lifestyle/what-too-much-alcohol-can-do-to-your-health:



What too much alcohol can do to your health

For example, a 2002 study of almost 25,000 Finnish men and women over five-year intervals found that moderate alcohol consumption, combined with a physically active lifestyle, no smoking and healthy food choices, "maximizes the chances of having a normal weight."

A 2017 study of nearly 2 million Brits with no cardiovascular risk found that there was still a modest benefit in moderate drinking, especially for women over 55 who drank five drinks a week. Why that age? Alcohol can alter cholesterol and clotting in the blood in positive ways, experts say, and that's about the age when heart problems begin to occur.

Another 2018 study found that consistently drinking a moderate amount of alcohol, within recommended guidelines, had a protective effect on the heart over time. Unstable drinking habits were associated with a higher risk of heart disease, which the authors reflected might indicate broader lifestyle changes, such as poor health or stress. Former drinkers were also at greater risk.

Descriptive versus Inferential Statistics

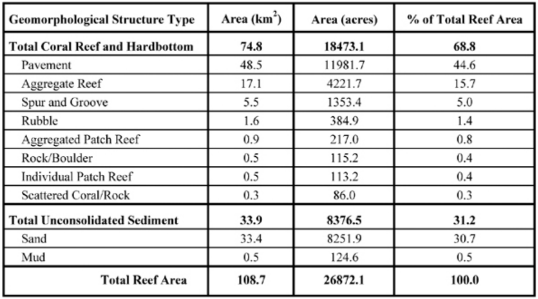
Definition

Descriptive statistics is the collection, presentation and description of data in form of **graphs**, **tables**, and **numerical summaries** that provide meaningful information about the sample.

Goals:

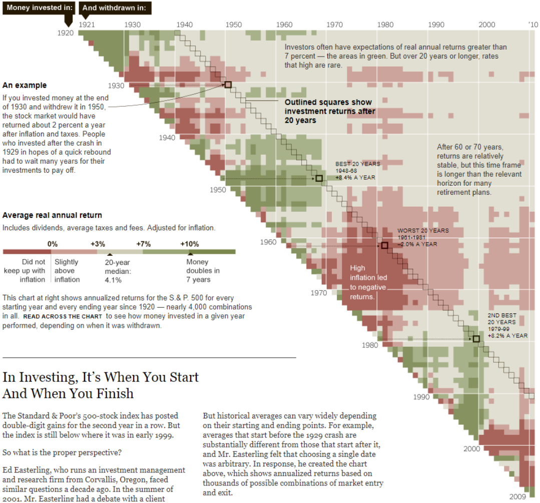
- look for patterns
- summarize and present data

Descriptive statistics focuses on obtaining a better understanding about the **distribution**, **variability**, and **central tendency** that a variable of interest exhibits.



Geomorphological Structure Type	Area (km^2)	Area (acres)	% of Total Reef Area
Total Coral Reef and Hardbottom	**74.8**	**18473.1**	**68.8**
Pavement	48.5	11981.7	44.6
Aggregate Reef	17.1	4221.7	15.7
Spur and Groove	5.5	1353.4	5.0
Rubble	1.6	384.9	1.4
Aggregated Patch Reef	0.9	217.0	0.8
Rock/Boulder	0.5	115.2	0.4
Individual Patch Reef	0.5	113.2	0.4
Scattered Coral/Rock	0.3	86.0	0.3
Total Unconsolidated Sediment	**33.9**	**8376.5**	**31.2**
Sand	33.4	8251.9	30.7
Mud	0.5	124.6	0.5
Total Reef Area	**108.7**	**26872.1**	**100.0**

Table B. Thematic content summary of geomorphological structure



Investors often have expectations of real annual returns greater than 7 percent — the areas in green. But over 20 years or longer, rates that high are rare.

Outlined squares show investment returns after 20 years

BEST 20 YEARS 1948-68 +8.4% A YEAR

After 60 or 70 years, returns are relatively stable, but this time frame is longer than the relevant horizon for many retirement plans.

WORST 20 YEARS 1961-1981 −2.0% A YEAR

High inflation led to negative returns.

2ND BEST 20 YEARS 1979-99 +8.2% A YEAR

An example

If you invested money at the end of 1930 and withdrew it in 1950, the stock market would have returned about 2 percent a year after inflation and taxes. People who invested after the crash in 1929 in hopes of a quick rebound had to wait many years for their investments to pay off.

Average real annual return

Includes dividends, average taxes and fees. Adjusted for inflation.

This chart at right shows annualized returns for the S.& P. 500 for every starting year and every ending year since 1920 — nearly 4,000 combinations in all. READ ACROSS THE CHART to see how money invested in a given year performed, depending on when it was withdrawn.

In Investing, It's When You Start And When You Finish

The Standard & Poor's 500-stock index has posted double-digit gains for the second year in a row. But the index is still below where it was in early 1999.

So what is the proper perspective?

Ed Easterling, who runs an investment management and research firm from Corvallis, Oregon, faced similar questions a decade ago. In the summer of 2001, Mr. Easterling had a debate with a client

But historical averages can vary widely depending on their starting and ending points. For example, averages that start before the 1929 crash are substantially different from those that start after it, and Mr. Easterling felt that choosing a single date was arbitrary. In response, he created the chart above, which shows annualized returns based on thousands of possible combinations of market entry and exit.

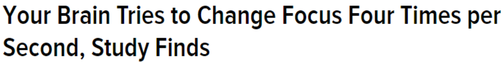
Inferential Statistics

Definition

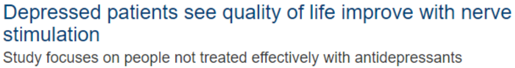
Inferential statistics deals with drawing conclusions and making generalizations based on data for a larger group of subjects (a population).

Goals:

- making statements about the population
- making data-based decisions

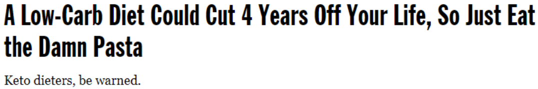


Your Brain Tries to Change Focus Four Times per Second, Study Finds



Depressed patients see quality of life improve with nerve stimulation

Study focuses on people not treated effectively with antidepressants



A Low-Carb Diet Could Cut 4 Years Off Your Life, So Just Eat the Damn Pasta

Keto dieters, be warned.

Statistic

Definition

A (summary or sample) statistic is any function of the data.

Examples:

- Mean, median, mode
- Tables
- Charts, figures

Parameter

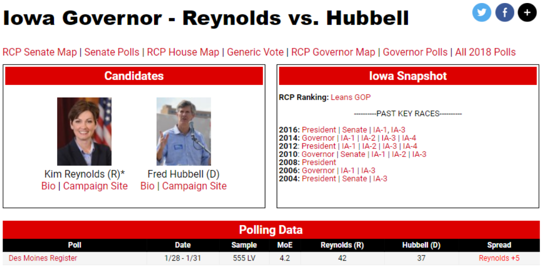
Definition

A (population) parameter is a characteristic of the population.

Examples:

- Mean summary salary of ISU students
- Median expenditure of Starbucks customers
- Standard deviation of savings account dollars of Wells Fargo customers

Numerical statistics are often used to estimate population parameters.



Iowa Governor - Reynolds vs. Hubbell

RCP Senate Map | Senate Polls | RCP House Map | Generic Vote | RCP Governor Map | Governor Polls | All 2018 Polls

Candidates

Kim Reynolds (R)*
Bio | Campaign Site

Fred Hubbell (D)
Bio | Campaign Site

Iowa Snapshot

RCP Ranking: Leans GOP

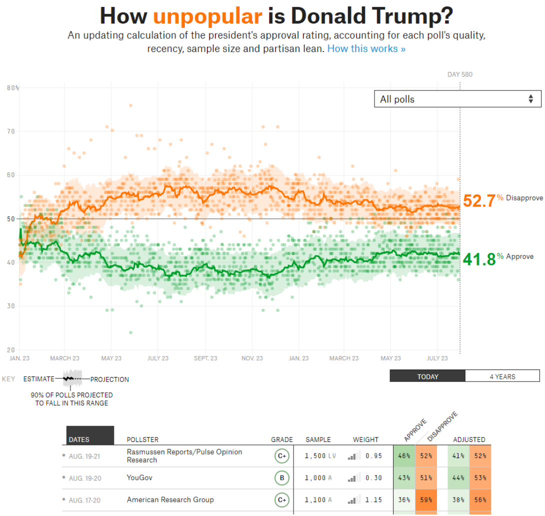
---------PAST KEY RACES---------

2016: President | Senate | IA-1, IA-3
2014: Governor | IA-1 | IA-2 | IA-3 | IA-4
2012: President | IA-1 | IA-2 | IA-3 | IA-4
2010: Governor | Senate | IA-1 | IA-2 | IA-3
2008: President
2006: Governor | IA-1 | IA-3
2004: President | Senate | IA-3

Polling Data

Poll	Date	Sample	MoE	Reynolds (R)	Hubbell (D)	Spread
Des Moines Register	1/28 - 1/31	555 LV	4.2	42	37	Reynolds +5

The proportion of voters who will vote for Reynolds (parameter) is estimated to be 42% (statistic) with a 95% confidence interval of $42\% \pm 4.2\% = (37.8\%, 46\%)$ (statistic).



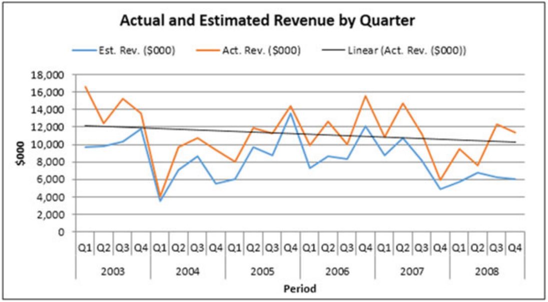
How unpopular is Donald Trump?

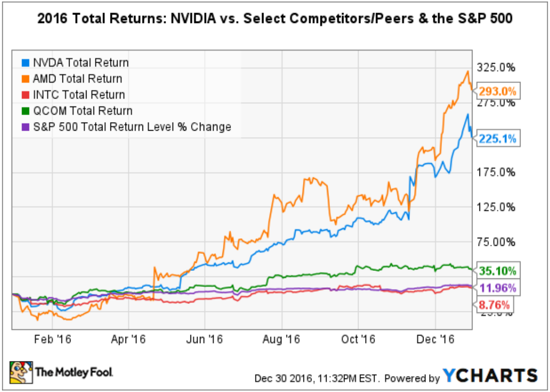
An updating calculation of the president's approval rating, accounting for each poll's quality, recency, sample size and partisan lean. How this works »

DATES	POLLSTER	GRADE	SAMPLE	WEIGHT	APPROVE	DISAPPROVE	ADJUSTED	
AUG. 19-21	Rasmussen Reports/Pulse Opinion Research	C+	1,500 LV	0.95	46%	52%	41%	52%
AUG. 19-20	YouGov	B	1,000 A	0.30	43%	51%	44%	53%
AUG. 17-20	American Research Group	C+	1,100 A	1.15	36%	59%	38%	56%

Time series

Sometimes, variables are **collected over time.** Typically plot these data as a time series where time is on the x-axis.




2016 Total Returns: NVIDIA vs. Select Competitors/Peers & the S&P 500
🟦 NVDA Total Return
🟧 AMD Total Return
🟥 INTC Total Return
🟩 QCOM Total Return
🟪 S&P 500 Total Return Level % Change
325.0%
293.0%
275.0%
225.1%
175.0%
125.0%
75.00%
35.10%
11.96%
8.76%
25.0%
Feb '16
Apr '16
Jun '16
Aug '16
Oct '16
Dec '16
The Motley Fool
Dec 30 2016, 11:32PM EST. Powered by YCHARTS