GPCO 453: Quantitative Methods I

Sec 03: Exploratory Data Analysis

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Contact Information

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The teaching staff is a team!

Professor Garg	Tu	1300-1500 (RBC 1303)
Shane Xuan	M	1100-1200 (SSB 332)
	M	1530-1630 (SSB 332)
Joanna Valle-luna	Tu	1700-1800 (RBC 3131)
	Th	1300-1400 (RBC 3131)
Daniel Rust	F	1100-1230 (RBC 3213)

Roadmap

In this section, we cover the basics for exploratory data analysis:

- Data structure

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- Variance and standard deviation
- Percentiles

Data Structure

- Time-series data track the same sample at different points in time
  - Marry-2002
  - Marry-2003

    $\vdots$
  - Marry-2008

Data Structure

- Time-series data track the same sample at different points in time
  - Marry-2002
  - Marry-2003

    $\vdots$
  - Marry-2008
- Cross sectional data observe different subjects at the same point of time
  - Marry-2002
  - Jake-2002

    $\vdots$
  - Dan-2002

Variable Types

- Nominal (categorical)

  i.e. Hillary, Donald, Gary, Jill

- Ordinal (can rank)

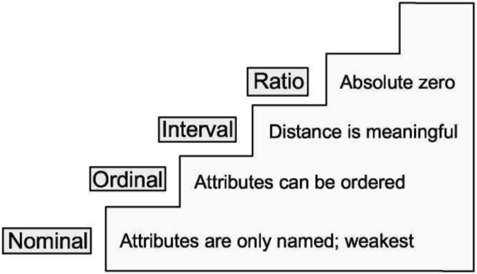
  i.e. strongly agree > agree > neutral > disagree > strongly disagree

- Interval (different by how much?)

  i.e. grade in school, happiness index, election fraud index

Variable Types

Figure: Hierarchy of measurement levels (Trochim & Donnelly 2006)



Variable Types: Examples

Table: Variable Types

Variable	**Type**
Celsius	Interval
Kelvin	Ratio
GDP	Ratio
Country	Nominal
Gender	Nominal
Age	Ratio
Distance	Ratio
Happiness index	Interval

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  - a collection of information about states
- One way to think: What is my unit of analysis $\rightarrow$ what items do I want to compare?

Dispersion

Positive Skew: Mean $>$ Median

Dispersion

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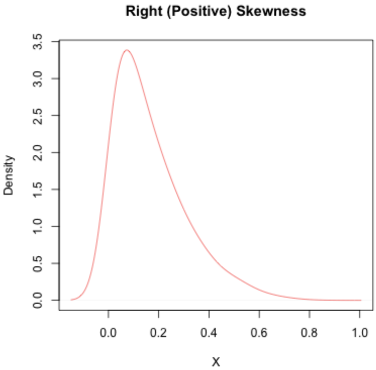
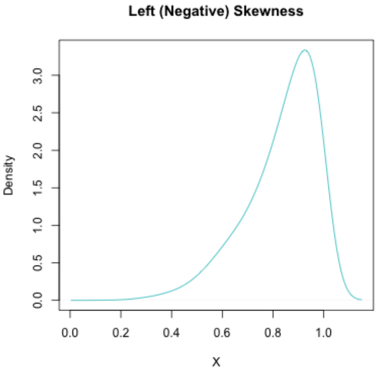
Negative Skew: Mean $<$ Median

Positive Skew: Mean $>$ Median

Negative Skew: Mean $<$ Median





Conditional Probability

- Students taking the GMAT were asked about their undergraduate major and intent to pursue MBA as a full time or part time student:

	Business	Engineering	Other	Total
Full time	352	197	251	800
Part time	150	161	194	505
Total	502	358	445	1305

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  Since $\Pr(F|B) \neq \Pr(F)$, we know F and B are not independent.

Geometric Mean

- The geometric mean is a type of average, and it is commonly used for growth rates (i.e. population growth, or interest rates)

$$\left(\prod_{i}^{n} x_i\right)^{1/n} = \sqrt[n]{x_1 x_2 \cdots x_n} \tag{1}$$

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- One way to calculate is $(90000)(1.5)(1.2)(1.9)$
- Another way to calculate is to use the geometric mean:

$$(90000)\overbrace{\left(\underbrace{\left[\sqrt[3]{(1.5)(1.2)(1.9)}\right]}_{\text{geometric mean}}\right)^{3}}^{\text{compounding by 3 years}} \tag{2}$$

Variance and Standard Deviation

- Variance for a sample is defined as

$$\sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \overline{X})^2}{n-1}$$

Standard deviation is defined as

$$\begin{aligned} \sigma &\equiv \sqrt{\sigma^2} \\ &= \sqrt{\frac{\sum_{i=1}^{n}(x_i - \overline{X})^2}{n-1}} \end{aligned}$$

Variance and Standard Deviation

- Example

x_i	$x_i - \overline{X}$	$(x_i - \overline{X})^2$
1		
2		
3		
4		
5		

Find the mean

$$\overline{X} = \frac{1+2+3+4+5}{5} = 3$$

Variance and Standard Deviation

- Example

x_i	$x_i - \overline{X}$	$(x_i - \overline{X})^2$
1	-2	
2	-1	
3	0	
4	1	
5	2	

Calculate the 2^{nd} column

$$x_1 - \overline{X} = 1 - 3 = -2$$
$$x_2 - \overline{X} = 2 - 3 = -1$$
$$\vdots$$
$$x_5 - \overline{X} = 5 - 3 = 2$$

Variance and Standard Deviation

- Example

x_i	$x_i - \overline{X}$	$(x_i - \overline{X})^2$
1	-2	4
2	-1	1
3	0	0
4	1	1
5	2	4

Square the 2^{nd} column

$$(x_1 - \overline{X})^2 = (-2)^2 = 4$$
$$(x_2 - \overline{X})^2 = (-1)^2 = 1$$
$$\vdots$$
$$(x_5 - \overline{X})^2 = 2^2 = 4$$

Variance and Standard Deviation

- Example

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2	-1	1
3	0	0
4	1	1
5	2	4

Let me remind you of the formula

$$\sigma^2 = \frac{\sum_{i=1}^{n}(x_i - \overline{X})^2}{n-1}$$

$$= \frac{4+1+0+1+4}{5-1}$$

$$= 2.5$$

$$\sigma = \sqrt{2.5}$$

Percentiles

- Location of the p-th percentile is

$$L_p = \frac{p}{100}(n+1) \tag{3}$$

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- We arrange the following numbers in ascending order:

	3710	3755	3850	3880	3880	3890	3920	3940	3950	4050	4130	4325
Position	1	2	3	4	5	6	7	8	9	10	11	12

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- The location of the 80th percentile is

$$L_{80} = \left(\frac{80}{100}\right)(12+1) = 10.4 \tag{4}$$

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- The 80th percentile is the value in position 10 (4050) plus 0.4 times the difference between the value in position 11 (4130) and the value in position 10 (4050):

$$4050 + 0.4(4130 - 4050) = 4082 \tag{5}$$