

GMBA 7098: Statistics and Data Analysis

Introduction

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Road map

- ▶ **What is statistics?**
- ▶ In-class brainstorming.
- ▶ Basic statistical concepts.

Coffee pricing

- ▶ How to **set the price** p of a cup of coffee?
- ▶ We look for a balance between profit margin and demand volume.
- ▶ Suppose that you know:
 - ▶ The unit cost of making one cup of coffee is 10 NTD.
 - ▶ The demand as a function of the price:

Price (NTD)	40	50	60	70	80
Demand (cup)	300	280	230	200	220

Then simple calculation helps you find a profit-maximizing price.

- ▶ But **how** would you find the demand function?

Coffee pricing

- ▶ The first thing:
Collect **data**!
- ▶ Given this set of data, how would you estimate the demand function?
- ▶ Do you need **more data**?
 - ▶ More records?
 - ▶ More attributes?

Day	Price	Demand	Day	Price	Demand
1	40	312	16	60	198
2	40	307	17	60	239
3	40	267	18	60	271
4	40	287	19	70	165
5	40	343	20	70	178
6	40	331	21	70	194
7	50	276	22	70	202
8	50	290	23	70	188
9	50	275	24	70	210
10	50	300	25	80	240
11	50	243	26	80	233
12	50	266	27	80	167
13	60	212	28	80	198
14	60	234	29	80	179
15	60	256	30	80	225

Measuring unknowns in the world

- ▶ It is always challenging to **measure unknowns** in the world.
- ▶ To help us measure unknowns, people develop the field of **Statistics**.
- ▶ Statistics is the **science** of collecting, analyzing, interpreting, and presenting (**numerical**) data.
 - ▶ For texts: text mining, natural language processing, etc.
 - ▶ For images: image recognition, digital image processing, etc.
- ▶ Mathematics (particularly probability) is helpful.
 - ▶ E.g., to help us model and measure the uncertainty when estimating consumer demands.
- ▶ Ultimate goal (of Business Statistics): to achieve better decision making.

What is Statistics?

- ▶ Many things are unknown...
 - ▶ Consumers' tastes.
 - ▶ Quality of a product.
 - ▶ Stock prices.
 - ▶ The effectiveness of a new way of teaching/training.
- ▶ The study of Statistics includes:
 - ▶ Descriptive Statistics.
 - ▶ Probability.
 - ▶ Inferential Statistics: Estimation.
 - ▶ Inferential Statistics: Hypothesis testing.
 - ▶ Inferential Statistics: Prediction.
- ▶ In summary: To **estimate**, **test**, and **predict** those unknowns.

Road map

- ▶ What is statistics?
- ▶ **In-class brainstorming.**
- ▶ Basic statistical concepts.

Road map

- ▶ What is statistics?
- ▶ Syllabus.
- ▶ In-class brainstorming.
- ▶ **Basic statistical concepts.**

Populations vs. samples

- ▶ A **population** is a collection of persons, objects, or items.
 - ▶ A **census** is to investigate the whole population.
- ▶ A **sample** is a portion of the population.
 - ▶ **Sampling** is to investigate only a subset of the population.
 - ▶ We then use the information contained in the sample to **infer** (“guess”) about the population.
- ▶ What are samples for the following populations?
 - ▶ All students in NTU.
 - ▶ All students in the business school.
 - ▶ All chips made in one factory.
 - ▶ All consumers who have bought iPhone 6.
- ▶ Two important questions:
 - ▶ **Why** sampling?
 - ▶ Is a sample **representative**?

Descriptive vs. inferential statistics

▶ **Descriptive statistics:**

- ▶ Graphical or numerical summaries of data.
- ▶ Describing (visualizing or summarizing) a set of data.

▶ **Inferential statistics:**

- ▶ Making a “scientific guess” on unknowns.
- ▶ Trying to say something about the population.

▶ Which is descriptive and which is inferential?

- ▶ Calculating the average height of 1000 randomly selected NTU students.
- ▶ Using this number to estimate the average height of all NTU students.

▶ Another example (pharmaceutical research):

- ▶ All the potential patients form the population.
- ▶ A group of randomly selected patients is a sample.
- ▶ Use the result on the sample to infer the result on the population.

Parameters vs. statistics

- ▶ A numerical summary of a population is a **parameter**.
 - ▶ The average height of all NTU students.
 - ▶ The expected coffee demand when the price is 50 NTD.
- ▶ A numerical summary of a sample is a **statistic**.
 - ▶ The average height of all NTU male students.
 - ▶ The average coffee demand when the price is 50 NTD in the past 6 days.
- ▶ Almost always people use a statistic to infer a parameter.
 - ▶ Some statistics are “good” while some are “bad.”

Parameters vs. statistics: an example

- ▶ What is the average height of all NTU students?
- ▶ While a census is possible, it is still quite costly.
- ▶ It is natural to:
 - ▶ Sample some NTU students.
 - ▶ Calculate a statistic.
 - ▶ Use that statistic to estimate the average height (the parameter).
- ▶ Some (good or bad) samples and statistics:
 - ▶ The average height of all students in this classroom.
 - ▶ The average height of 100 students randomly drawn from all students.
 - ▶ The maximum height of 100 students randomly drawn from all students.
 - ▶ The sum of heights of 100 students randomly drawn from all students.
 - ▶ The average height of 60 male and 40 female students randomly drawn from the population.

Parameters vs. statistics

- ▶ A parameter is a **fixed number**.
 - ▶ E.g., the average height of all NTU students.
- ▶ A statistic is a **random number** depending on the sample.
 - ▶ Two different random samples typically generate two values of a statistic.
 - ▶ The sampling process matters.

Levels of data measurement

- ▶ Most data we will play with are numerical.
- ▶ Numerical data may be categorized to three levels:
 - ▶ Nominal.
 - ▶ Ordinal.
 - ▶ Quantitative.

Nominal level

- ▶ A **nominal** scale classifies data into categories with **no ranking**.
- ▶ Data are labels or names used to identify an attribute of the element.
- ▶ The label may be numeric or non-numeric label.
- ▶ Examples:

Categorical variables	Values (Categories)
Laptop ownership	Yes / No
Citizenship	Taiwan / Japan / ...
Country code	886 / 86 / 1 / ...

- ▶ Arithmetic operations **cannot** be applied on nominal data.

Ordinal level

- ▶ An **ordinal** scale classifies data into categories with **ranking**.
- ▶ The order or rank of the data is meaningful.
- ▶ However, **differences** between numerical labels do not imply **distances**.
- ▶ Examples:

Categorical variables	Values (Categories)
Product satisfaction	Satisfied, neutral, unsatisfied
Professor rank	Full, associate, assistant
Ranking of scores	1, 2, 3, 4, ...

- ▶ It is still not meaningful to do arithmetic on ordinal data.
 - ▶ Assistant + associate = full?!
 - ▶ The grade difference between no. 1 and no. 5 may not be equal to that between no. 11 and no. 15.

Quantitative (interval and ratio) levels

- ▶ An **quantitative** scale is an ordered scale in which the **difference** between measurements is a meaningful quantity.
 - ▶ Heights, weights, income, prices.
 - ▶ Degrees of temperatures.
 - ▶ Student scores in the 100-point scale.

Some remarks

- ▶ Nominal and ordinal data are called **qualitative data**.
- ▶ Most statistical methods are for **quantitative data**; some are for qualitative data.
 - ▶ Distinguishing nominal and ordinal scales is important.
 - ▶ Distinguishing interval and ratio scales is not.
- ▶ Other names:
 - ▶ Sometimes qualitative data are called **categorical data**.
 - ▶ Sometimes quantitative data are called **numeric data**.

A short summary

- ▶ Understand these terms:
 - ▶ Populations vs. samples.
 - ▶ Parameters vs. statistics.
 - ▶ Inferential statistics vs. descriptive statistics.
- ▶ For each scale of measurement, is it meaningful to calculate the following numbers?

Level	Ranking	Distance
Nominal	No	No
Ordinal	Yes	No
Quantitative	Yes	Yes