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## Introduction to Statistics

■ Statistics?


Dad, is this completely safe?

Research in 500 theme parks in 2010 showed that 1 in 10,000 of the carriages were found to be malfunctioning, which can lead to 1 out of 50,000 kids falling out ... So your chances are okay, but there's always a risk, honey ...

People working in statistics are not always the perfect parents

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## Introduction to Statistics

Number of fatal road accidents up in 2016, more than 7,000 lives lost



**KUALA LUMPUR:** In 2016, total of 7,152 people died in road accidents in Malaysia, an alarming jump from 6,706 deaths in the year before, Transport Minister Datuk Seri Liew Tiong Lai announced today.

"Despite the number of campaigns and initiatives conducted by the government, the painful reality is that the accident rate keeps increasing every year.

"It's too late when tragic accidents like the bus crash in Pagoh, which claimed 14 lives, occur. There is no use accusing anyone and finger pointing then," he said at the launch of the Chinese New Year Road Safety campaign in Sunway Pyramid here.

He added that of that number, 62.7 per cent of the deaths involved motorcyclists in 2016.

"In 2016, 6,570 fatal road accidents involving were recorded while in 2015 there were 6,193 of such cases.

Liew said a total of 521,466 accidents were recorded in 2016, an increase from 489,606 in 2015.

"A total of 80.6 per cent of the road accidents are caused by human error.


"I hope that those on the road this festive season do not speed to their destination (just) to arrive early and gamble their lives or that of their loved ones. It's okay to be late as long as you are safe," he advised.

The joint campaign involving the police and other transport authorities like the Road Transport Department will begin on Jan 21 and end on Feb 5.

He also said that there would be increased patrols by authorities at 102 road accident hotspots nationwide.

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## Introduction to Statistics

Department of Statistics Malaysia  
<https://www.dosm.gov.my>

**MARRIAGE & DIVORCE MALAYSIA, 2018**

**2016** **2017**

NUMBER OF MARRIAGE  
200,274 190,532

MARRIAGE CRUDE RATE  
PER 1,000 POPULATION  
6.3 5.9

**2016** **2017**

NUMBER OF DIVORCE  
51,642 49,965

DIVORCE CRUDE RATE  
PER 1,000 POPULATION  
1.6 1.6

**GENERAL MARRIAGE RATE 2017**

GROOM **47.2** BRIDE **44.0**

PER 1,000 UNMARRIED MALES AGED 15 AND OVER PER 1,000 UNMARRIED FEMALES AGED 15 AND OVER

**GENERAL DIVORCE RATE 2017**

MALE **6.5** FEMALE **7.0**

PER 1,000 MARRIED MALES AGED 15 AND OVER PER 1,000 MARRIED FEMALES AGED 15 AND OVER

**MARRIAGE**

AGE 29 26

**DIVORCE**

AGE 37 34

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**facebook** Community Update
4.27.2016



**1.65 Billion**  
on Facebook each month



**1 Billion**  
on WhatsApp each month



**900 Million**  
on Messenger each month



**400 Million**  
on Instagram each month

**LIVE** Live Video  
Launched worldwide

**Connectivity**  
25 million connected via Internet.org

**Artificial Intelligence**  
Access for the blind and visually impaired

**Oculus Rift**  
Shipped with 50+ games and apps

Introduced Reactions









Like
Love
Haha
Wow
Sad
Angry

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Introduction to Statistics

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- Even though you may not have realized it, you probably have made some statistical statements in your everyday conversation or thinking.
- Statements like "I sleep for about eight hours per night on average" and "You are more likely to pass the exam if you start preparing earlier" are actually statistical in nature.

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Introduction to Statistics

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- We encounter data and conclusions based on data every day.
- Statistics is the scientific discipline that provides methods to help us make sense of data.
- Statistical methods are used in business, medicine, agriculture, social sciences, natural sciences, and applied sciences, such as engineering.
- The field of statistics teaches us how to make intelligent judgments and informed decisions in the presence of uncertainty and variation.

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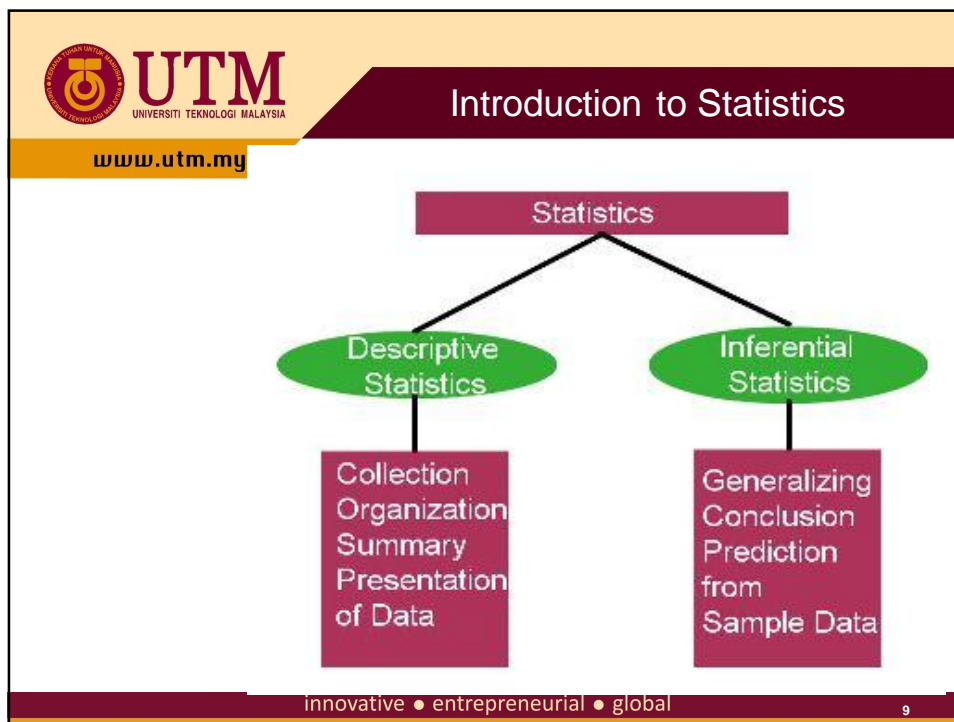
Introduction to Statistics

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- Statistics is the scientific application of mathematical principles to the collection, analysis, and presentation of numerical data.
- Statistics is a discipline which is concerned with:
  - designing experiments and other data collection,
  - summarizing information to aid understanding,
  - drawing conclusions from data, and
  - estimating the present or predicting the future.
- There are 2 main branches of statistics:
  - Descriptive
  - Inferential

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The slide defines descriptive statistics and lists common techniques. It starts with a definition of descriptive statistics, followed by a list of techniques commonly used for data description.

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**Descriptive statistics** are used to describe the basic features of the data gathered from an experimental study in various ways.

The techniques are commonly classified as:

- Graphical description in which we use graphs to summarize data.
- Tabular description in which we use tables to summarize data.
- Parametric description in which we estimate the values of certain parameters which we assume to complete the description of the set of data.

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Descriptive Statistics

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Graphical description

Example:

Graph  
Bar chart  
Pie chart



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Descriptive Statistics

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Tabular description

Example:

Frequency Table

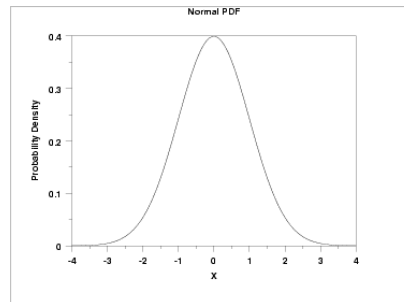
Score	Frequency
0	2
1	5
2	8
3	6
4	4
5	3

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## Descriptive Statistics

### Parametric description

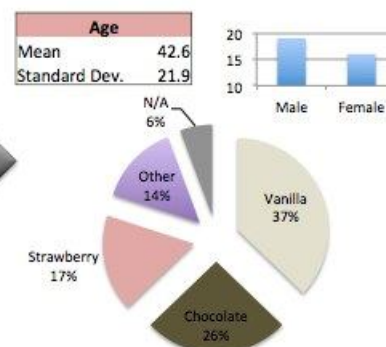
Mean	$\mu$
Median	$\mu$
Mode	$\mu$
Range	Infinity in both directions.
Standard Deviation	$\sigma$
Skewness	0
Kurtosis	3



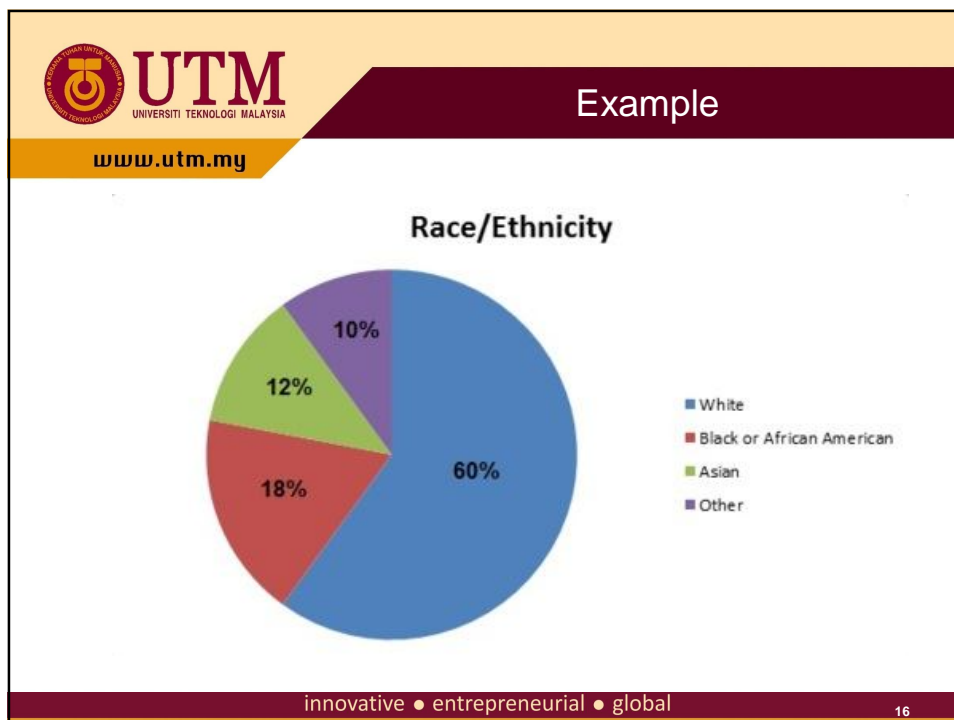
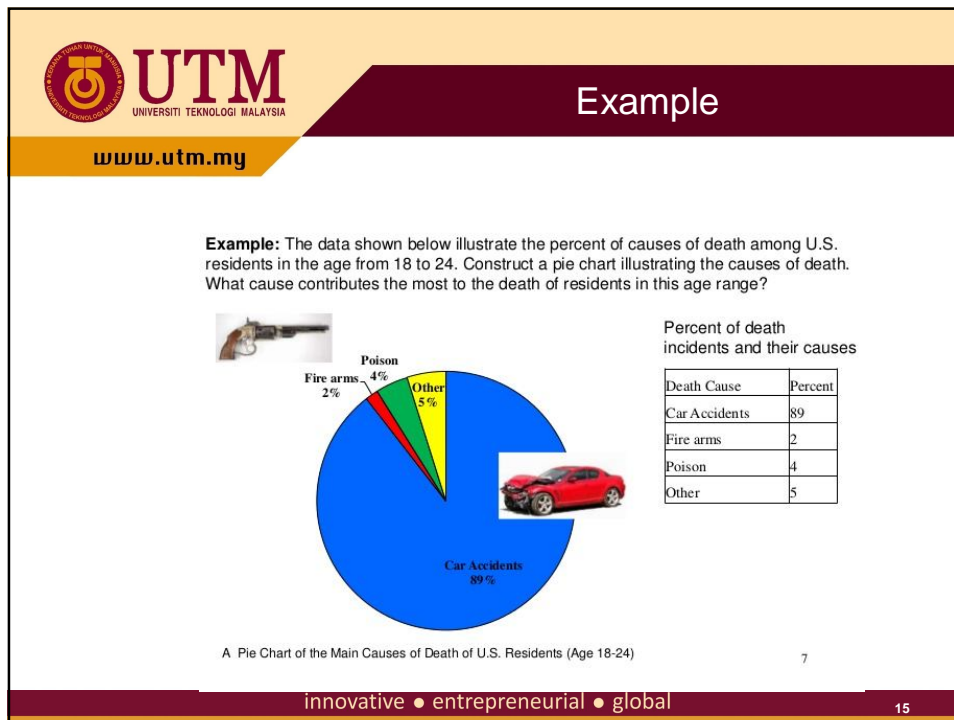
## Example

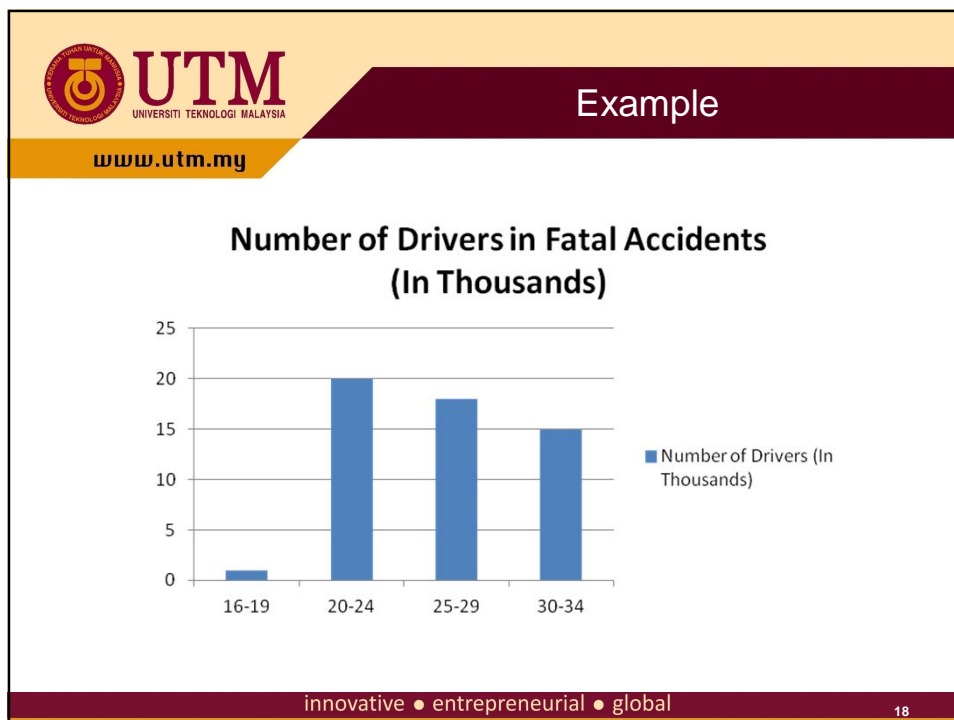
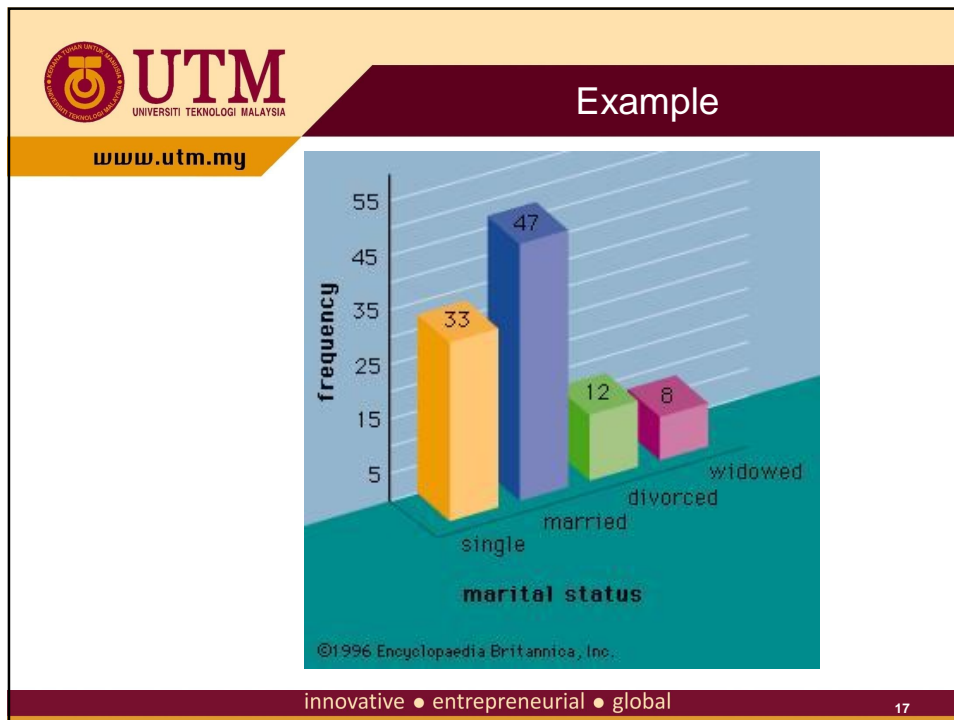
	A	B	C	D
1	Respondent #	Age	Gender	Favorite Ice Cream Flavor
2	1	36	m	Vanilla
3	2	22	f	Chocolate
4	3	61	m	Strawberry
5	4	88	m	Other
6	5	31	m	N/A
7	6	53	m	N/A
8	7	30	f	Chocolate
9	8	64	f	Chocolate
10	9	18	m	Vanilla
11	10	16	f	Vanilla
12	11	83	m	Strawberry
13	12	16	f	Strawberry
14	13	94	m	Strawberry
15	14	55	m	Vanilla
16	15	42	f	Chocolate
17	16	18	f	Vanilla
18	17	61	f	Vanilla

Raw Data

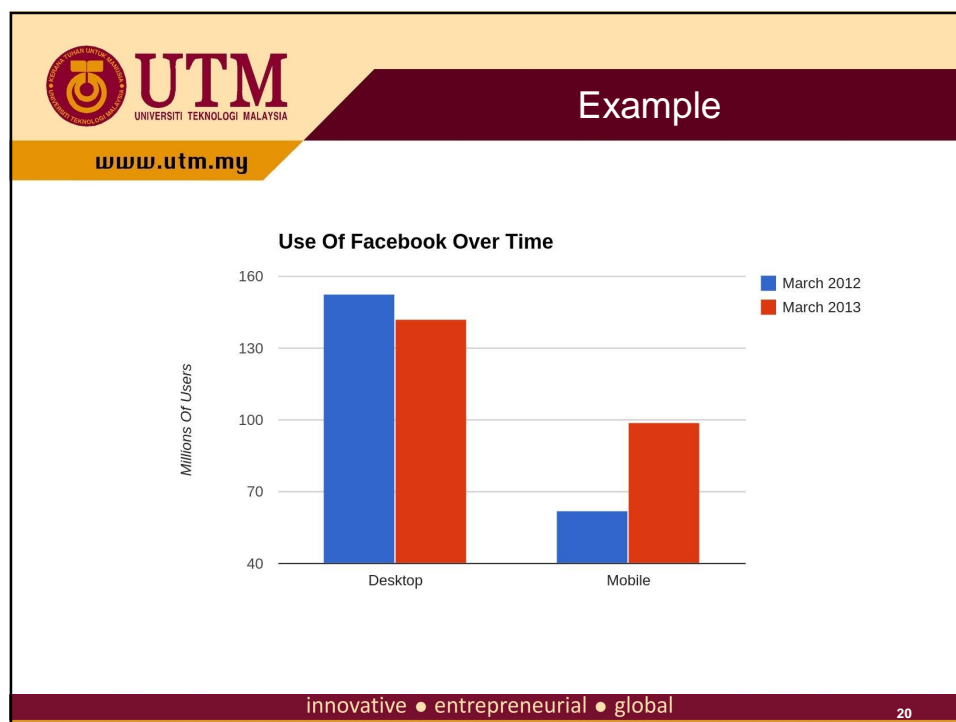
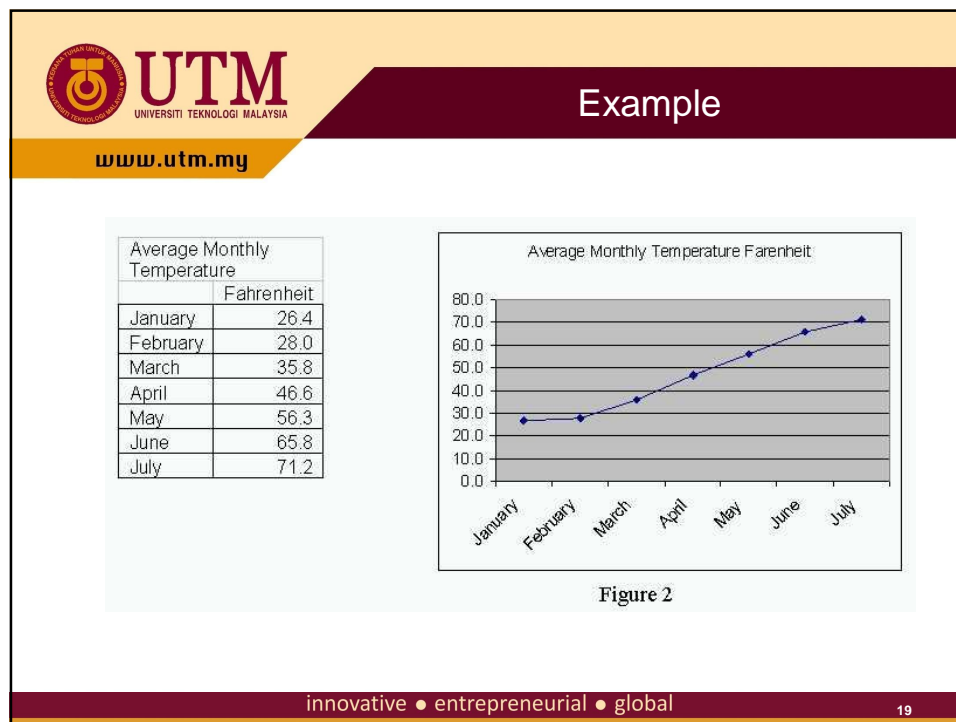


Descriptive Statistics









## Example

	A	B	C	D	E	F	G
5	Sample 1	Sample 2		Sample 1		Sample 2	
6	19	12					
7	41	27		Mean	30.46154	Mean	30.61538
8	29	18		Standard Error	4.673459	Standard Error	5.447345
9	18	23		Median	29	Median	27
10	8	72		Mode	29	Mode	27
11	29	27		Standard Deviation	16.8504	Standard Deviation	19.64068
12	11	27		Sample Variance	283.9359	Sample Variance	385.7564
13	59	53		Kurtosis	-1.15073	Kurtosis	0.062841
14	41	3		Skewness	0.265601	Skewness	0.78698
15	48	45		Range	51	Range	69
16	53	53		Minimum	8	Minimum	3
17	29	13		Maximum	59	Maximum	72
18	11	25		Sum	396	Sum	398
19				Count	13	Count	13

## Example

Table 2 – Clinical and demographic characteristics of patients undergoing pharmacological prophylaxis.				
Variable	n = 357			
	Minimum	Maximum	Average	Standard deviation
Age (years)	24	71	40.35	8.829
Weight (kg)	50	130	71.43	12.211
Height (cm)	148	184	162.75	5.980
BMI (kg/m <sup>2</sup> )	17.93	52.07	26.9731	4.43736
Weight of the flap (g)	650	9200	1422.82	573.049
Surgery time (min)	55	240	135.30	41.267

BMI = body mass index; n = number of patients.

## Example

**TABLE 4**  
 Descriptive statistics of students' attitudes toward statistics

	<i>N</i>	Mode	s.d.	Skewness	Kurtosis
<b>Affect</b>	234	4.6	1.32	-0.45	0.17
<b>Cognitive Competence</b>	232	5.33	1.16	-0.19	-0.62
<b>Value</b>	234	4.88	1.12	-0.62	0.25
<b>Difficulty</b>	233	3.4	1.13	-0.13	-0.65
<b>Interest</b>	231	7	1.26	-1.03	1.09
<b>Effort</b>	235	7	0.98	-2.32	7.85

s.d. = standard deviation  
 Higher value = more positive attitude

## Example

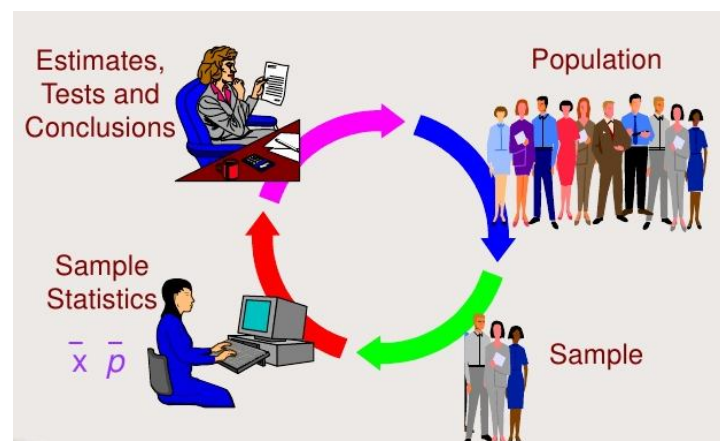
Variable	Mean	Std. Dev	Min	Max
Loans	0.204E + 07	0.234E + 07	0.000	0.178E + 08
Deposits	0.370E + 07	0.430E + 07	0.000	0.368E + 08
Physical capital	0.488E + 07	0.534E + 07	0.000	0.422E + 08

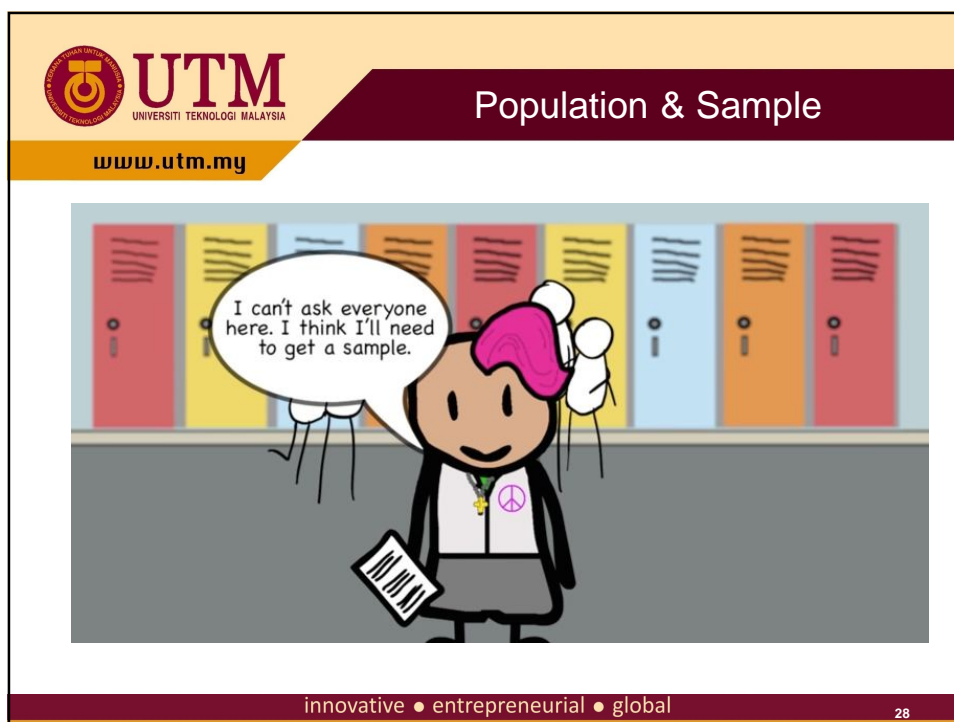
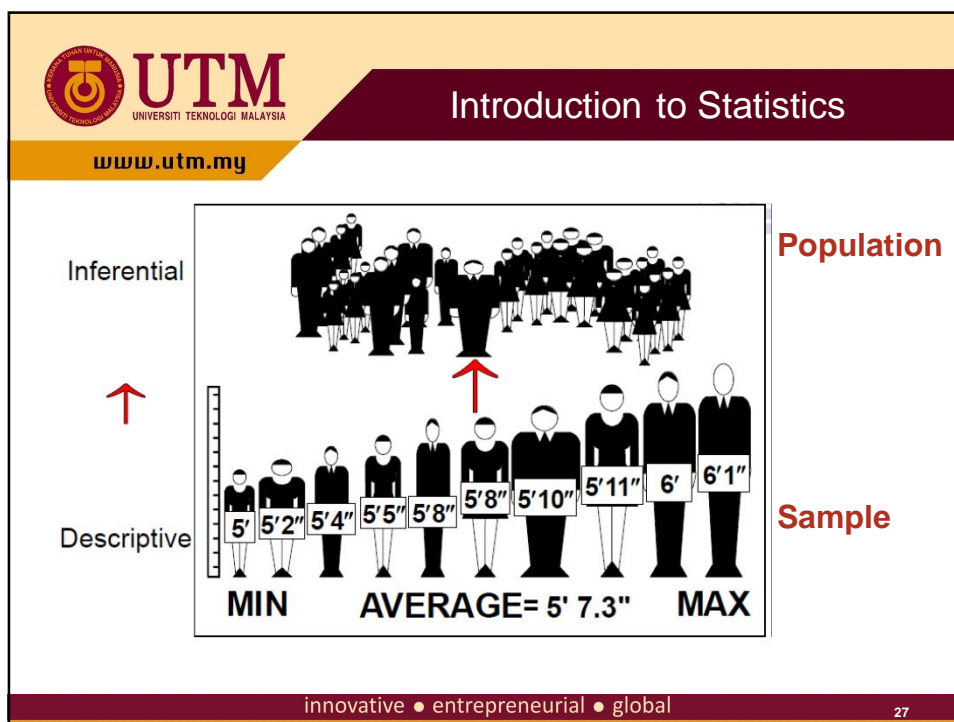
Source: Banking Supervision Department, Bank of Ghana, and the ARB Apex Bank.

## Introduction to Statistics

- **Inferential statistics** are used to draw inferences about a population from a sample.
- It includes:
  - point estimation
  - interval estimation
  - hypothesis testing (or significance testing)
  - prediction

## Inference Process

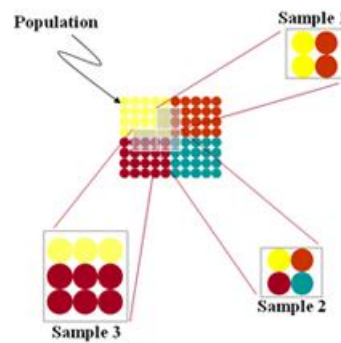




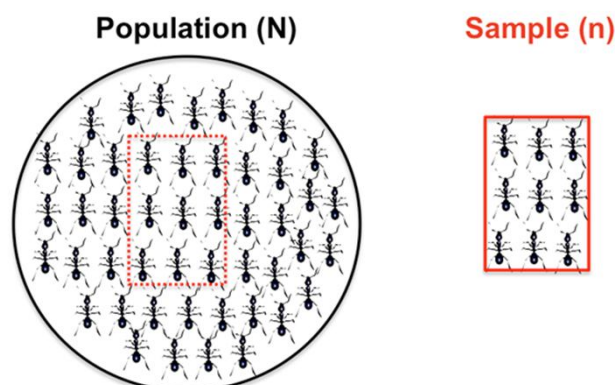


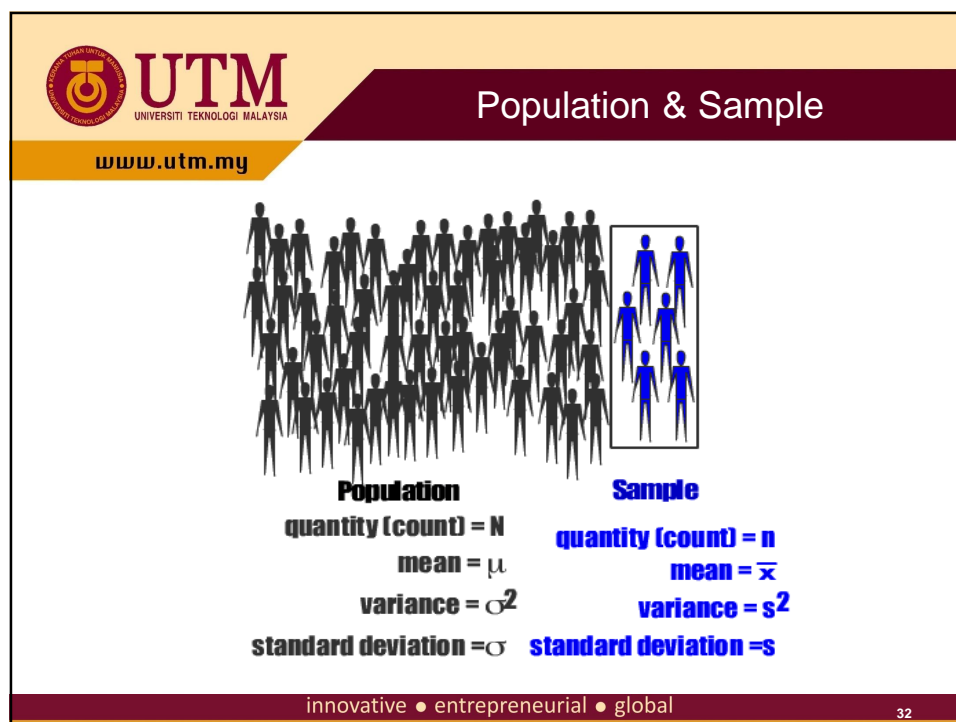
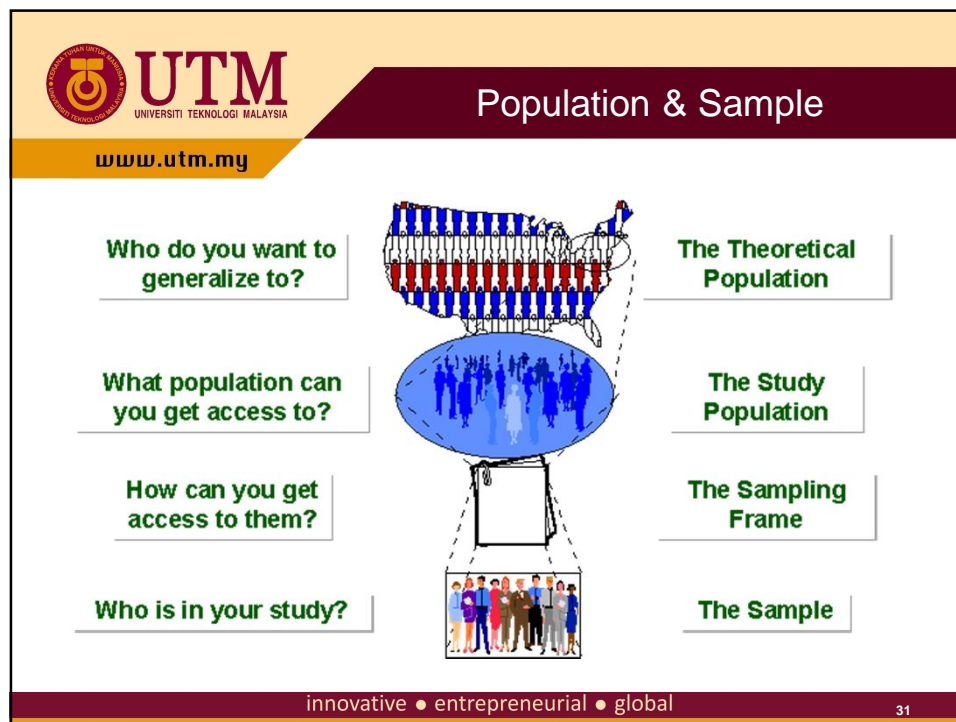
## Population & Sample

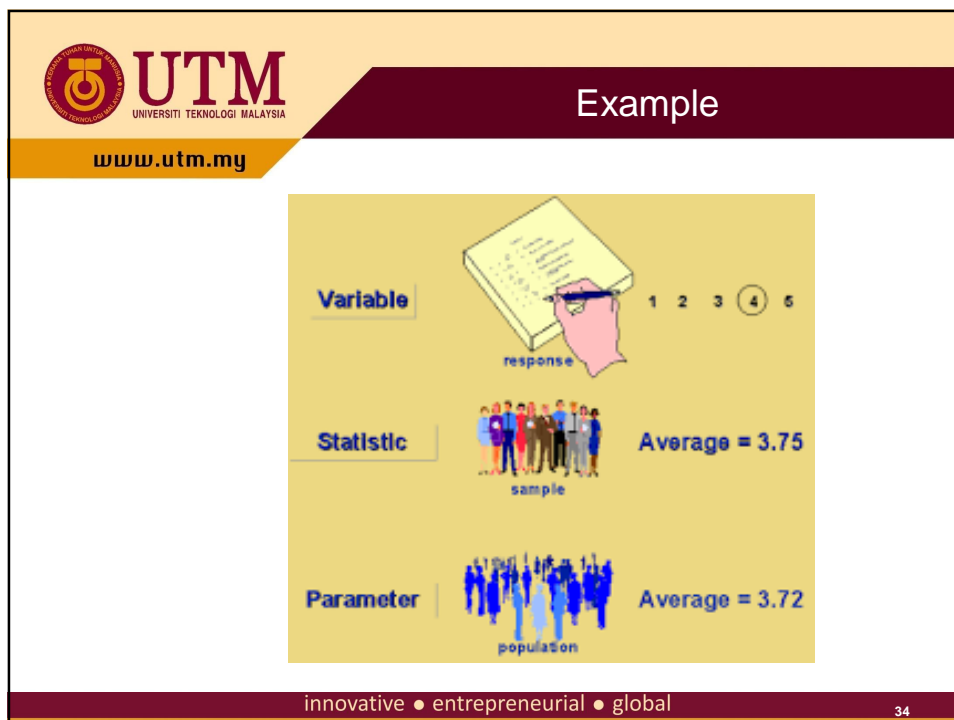
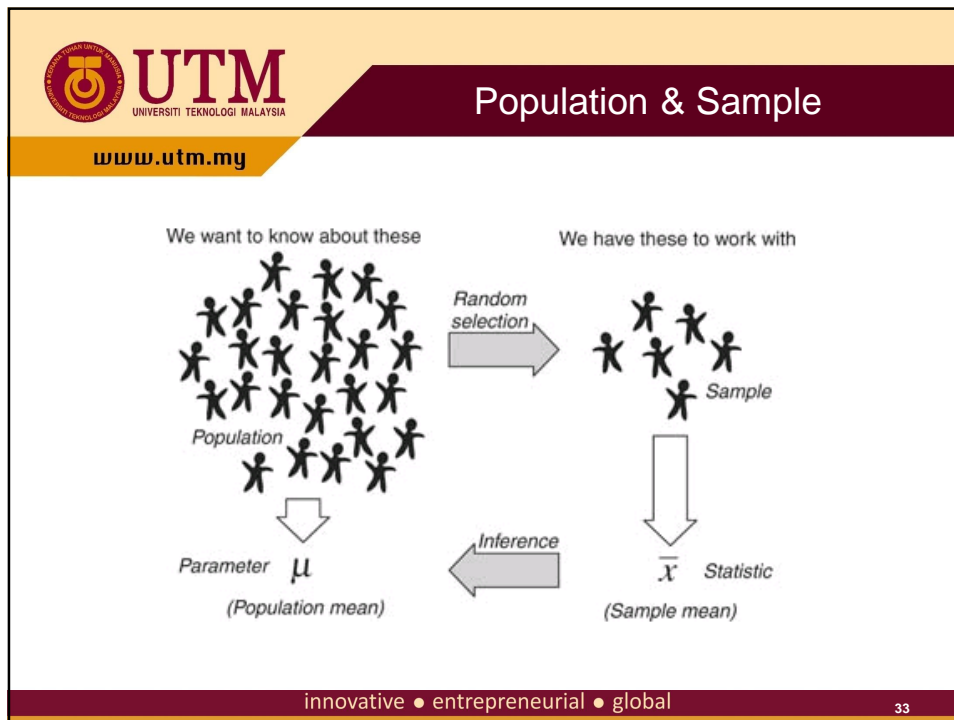
- The entire collection of individuals or object about which information is desired is called the **population** of interest.
- A **sample** is a subset of the population, selected for study in some prescribed manner



## Population & Sample







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### Example

**Population**      **Random Sample**

Mean,  $\mu$ , is unknown

Sample

Mean  $X = 50$

I am 95% confident that  $\mu$  is between 40 & 60.

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### Example

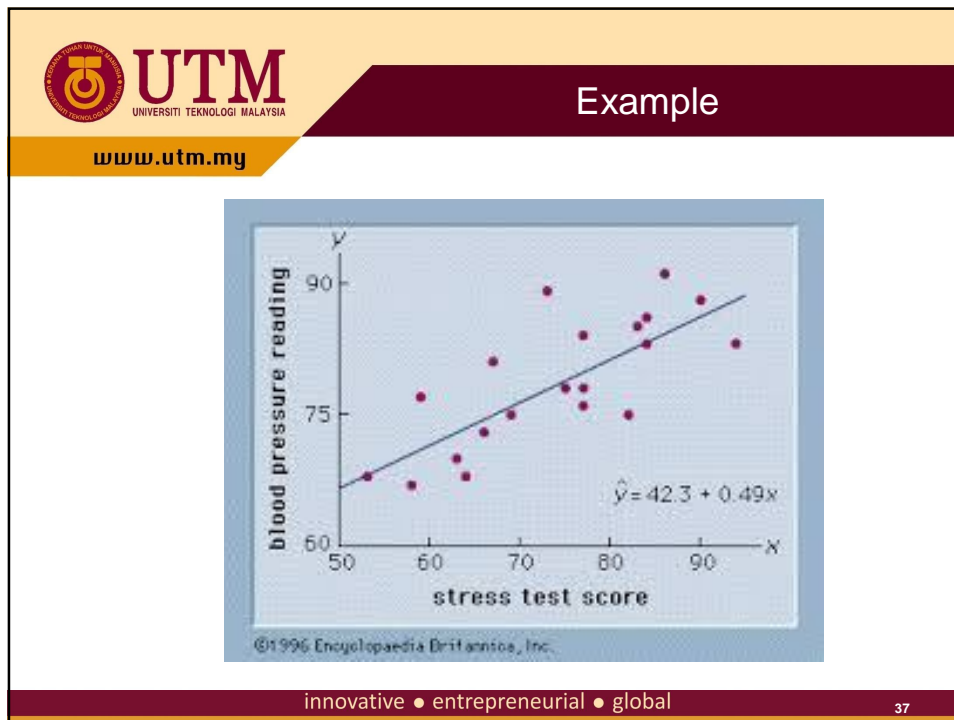
*A new milk formulation designed to improve the psychomotor development of infants was tested on randomly selected infants. Based on the results, it was concluded that the new milk formulation is effective in improving the psychomotor development of infants.*

STATISTICAL RESEARCH & TRAINING CENTRE (SRTC)

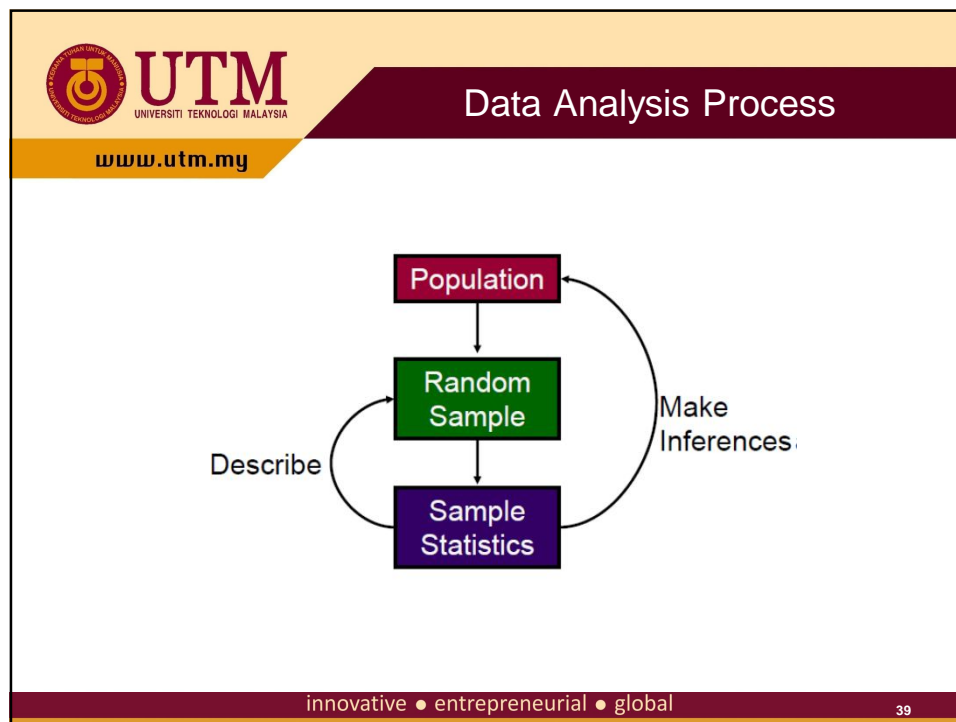
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## Data Analysis Process

- Statistics involves the **collection** and **analysis** of data
- Both task are critical.
- Raw data without analysis are of little value, and even a sophisticated analysis cannot extract meaningful information from data that were not collected in a sensible way.
- The data analysis process can be viewed as a sequence of steps that lead from planning to data collection to informed conclusions based on the resulting data.

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Data Analysis Process

■ 6 steps:

- Understanding the nature of the problem
- Deciding what to measure and how to measure it
- Data collection
- Data summarization and preliminary analysis
- Formal data analysis
- Interpretation of results

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Data Analysis Process

■ Understanding the nature of the problem

- An understanding of the research problem
- Know the goal of the research and what questions we hope to answer
- Have a clear direction before gathering data to lessen the chance of being unable to answer the questions of interest using the data collected.



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## Data Analysis Process

### ■ Deciding what to measure and how to measure it


- In some cases, the choice is obvious, e.g. in a study of the relationship between the weight of a football player and position played, you would need to collect data on player weight and position.



## Data Analysis Process

- but in other cases the choice of information is not as straightforward, e.g. in a study of the relationship between preferred learning style and intelligence, how would you define learning style and measure it and what measure of intelligence would you use?
- It is important to carefully define the variables to be studied and to develop appropriate methods for determining their values.





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Data Analysis Process


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■ **Data collection**

- Decide whether an existing data source is adequate or whether new data must be collected.
- If a decision is made to use existing data (secondary data), it is important to understand how the data were collected and for what purpose.




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Data Analysis Process

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- If new data are to be collected (primary data), a careful plan must be developed.
- The type of analysis that is appropriate and subsequent conclusions that can be drawn depend on how the data are collected.



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## Data Analysis Process


■ **Data summarization and preliminary analysis**

- Summarizing the data graphically and numerically
- This initial analysis provides insight into important characteristics of the data and can provide guidance in selecting appropriate methods for further analysis.



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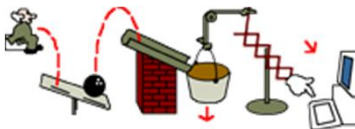
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## Data Analysis Process


■ **Formal data analysis**

- Select and apply the appropriate inferential statistical methods.



■ **Interpretation of results**


- What conclusions can be drawn from the analysis?
- How do the result of the analysis inform us about the stated research problem or question?
- How can our results guide future research?



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## Primary & Secondary Data

- **Secondary data** is data which has been collected by individuals or agencies for purposes other than those of our particular research study.
  - For example, if a government department has conducted a survey of, say, family food expenditures, then a food manufacturer might use this data in the organisation's evaluations of the total potential market for a new product.
  
- **Primary data**, by contrast, are collected by the investigator conducting the research.

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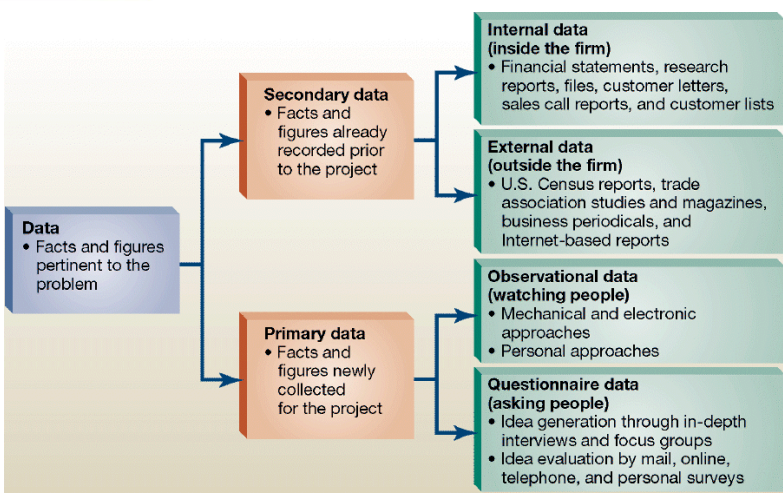
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## Primary & Secondary Data

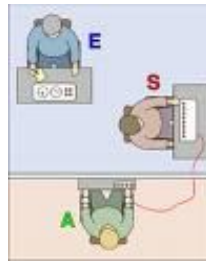
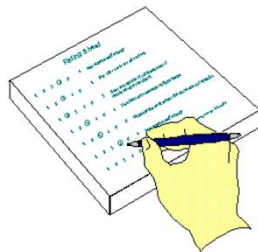



```

graph LR
    A["Data  
• Facts and figures pertinent to the problem"] --> B["Secondary data  
• Facts and figures already recorded prior to the project"]
    A --> C["Primary data  
• Facts and figures newly collected for the project"]
    B --> D["Internal data (inside the firm)  
• Financial statements, research reports, files, customer letters, sales call reports, and customer lists"]
    B --> E["External data (outside the firm)  
• U.S. Census reports, trade association studies and magazines, business periodicals, and Internet-based reports"]
    C --> F["Observational data (watching people)  
• Mechanical and electronic approaches  
• Personal approaches"]
    C --> G["Questionnaire data (asking people)  
• Idea generation through in-depth interviews and focus groups  
• Idea evaluation by mail, online, telephone, and personal surveys"]
            
```

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**Primary data: Experiment****Primary data: Survey (Questionnaire, Interview)**


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Data Sources

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**Secondary data: existing databases, record review**



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Qualitative & Quantitative Data

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Qualitative Data	Quantitative Data
<p><b>Overview:</b></p> <ul style="list-style-type: none"> <li>■ Deals with descriptions.</li> <li>■ Data can be observed but not measured.</li> <li>■ Colors, textures, smells, tastes, appearance, beauty, etc.</li> <li>■ Qualitative → Quality</li> </ul>	<p><b>Overview:</b></p> <ul style="list-style-type: none"> <li>■ Deals with numbers.</li> <li>■ Data which can be measured.</li> <li>■ Length, height, area, volume, weight, speed, time, temperature, humidity, sound levels, cost, members, ages, etc.</li> <li>■ Quantitative → Quantity</li> </ul>

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## Qualitative & Quantitative Data

**Example 1:**


■ *Oil Painting*



<p><b>Qualitative data:</b></p> <ul style="list-style-type: none"> <li>blue/green color, gold frame</li> <li>smells old and musty</li> <li>texture shows brush strokes of oil paint</li> <li>peaceful scene of the country</li> <li>masterful brush strokes</li> </ul>	<p><b>Quantitative data:</b></p> <ul style="list-style-type: none"> <li>picture is 10" by 14"</li> <li>with frame 14" by 18"</li> <li>weighs 8.5 pounds</li> <li>surface area of painting is 140 sq. in.</li> <li>cost \$300</li> </ul>
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## Qualitative & Quantitative Data

**Example 2:**

■ *Latte*



<p><b>Qualitative data:</b></p> <ul style="list-style-type: none"> <li>robust aroma</li> <li>frothy appearance</li> <li>strong taste</li> <li>burgundy cup</li> </ul>	<p><b>Quantitative data:</b></p> <ul style="list-style-type: none"> <li>12 ounces of latte</li> <li>serving temperature 150° F.</li> <li>serving cup 7 inches in height</li> <li>cost \$4.95</li> </ul>
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## Qualitative & Quantitative Data

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## Discrete & Continuous Data

**Discrete** data can only take on certain individual values.

**Continuous** data can take on any value in a certain range.

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## Discrete & Continuous Data

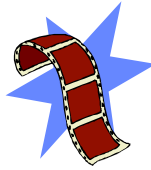
**Example 1**

Number of pages in a book is a **discrete variable**.




**Example 2**

Length of a film is a **continuous variable**.




**Example 3**

Shoe size is a **Discrete variable**. E.g. 5, 5½, 6, 6½ etc. Not in between.



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## Discrete & Continuous Data

**Example 4**


Temperature is a **continuous variable**.

**Example 5**

Number of people in a race is a **discrete variable**.

**Example 6**

Time taken to run a race is a **continuous variable**.



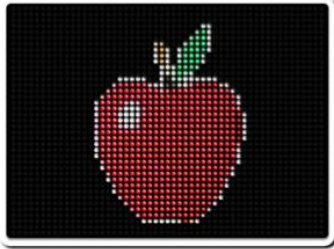
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## Discrete & Continuous Data

### Discrete vs. Continuous



LITE BRITE  
discrete



ETCH-A-SKETCH  
continuous

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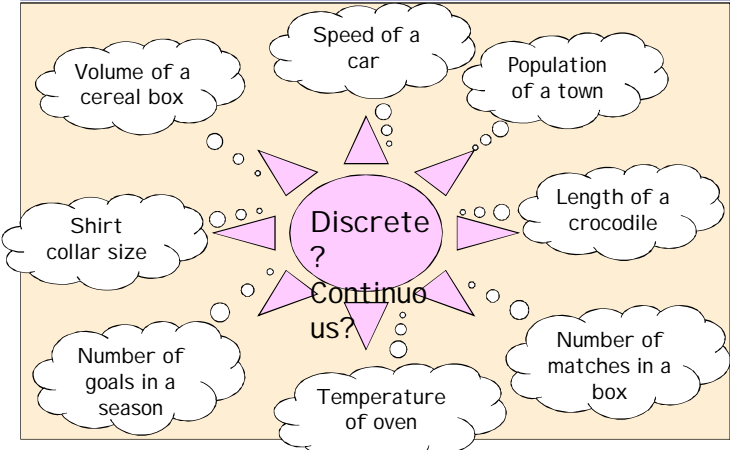
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## Discrete & Continuous Data

Group the following as either discrete or continuous data.

Discrete ?

Continuous ?



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## Discrete & Continuous Data


Discrete	Continuous
<ul style="list-style-type: none"> <li>Population of a town</li> <li>Number of matches in a box</li> <li>Shirt collar size</li> <li>Number of goals in a season</li> </ul>	<ul style="list-style-type: none"> <li>Volume of a cereal box</li> <li>Top speed of a car</li> <li>Length of a crocodile</li> <li>Temperature of oven</li> </ul>

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## Discrete & Continuous Data

■ How about money? Is it a discrete or continuous data?



Discrete!!  
But why?

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Levels of Measurement

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■ There are four levels of data measurement. Ranked from top to bottom in order of complexity and information content these are:

- Nominal scale
- Ordinal scale
- Interval scale
- Ratio scale

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Levels of Measurement

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■ Each level of measurement is characterized by its properties.

- Nominal measurement has just one property: CLASSIFICATION.
- Ordinal measurement has two properties: CLASSIFICATION and ORDER.
- Interval measurement has three properties: CLASSIFICATION, ORDER and EQUAL INTERVALS.
- Ratio data has four properties: CLASSIFICATION, ORDER, EQUAL INTERVALS and TRUE ZERO.

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## Levels of Measurement - Nominal Scales

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- **Properties:** classification
- **Observations reflect:** differences in kind
- **Examples:** gender, ethnic background, major in college
- Nominal measurement is simply concerned with sorting observations into categories.
- Because the single property of nominal data is classification it tells us nothing about differences in degree or amount.

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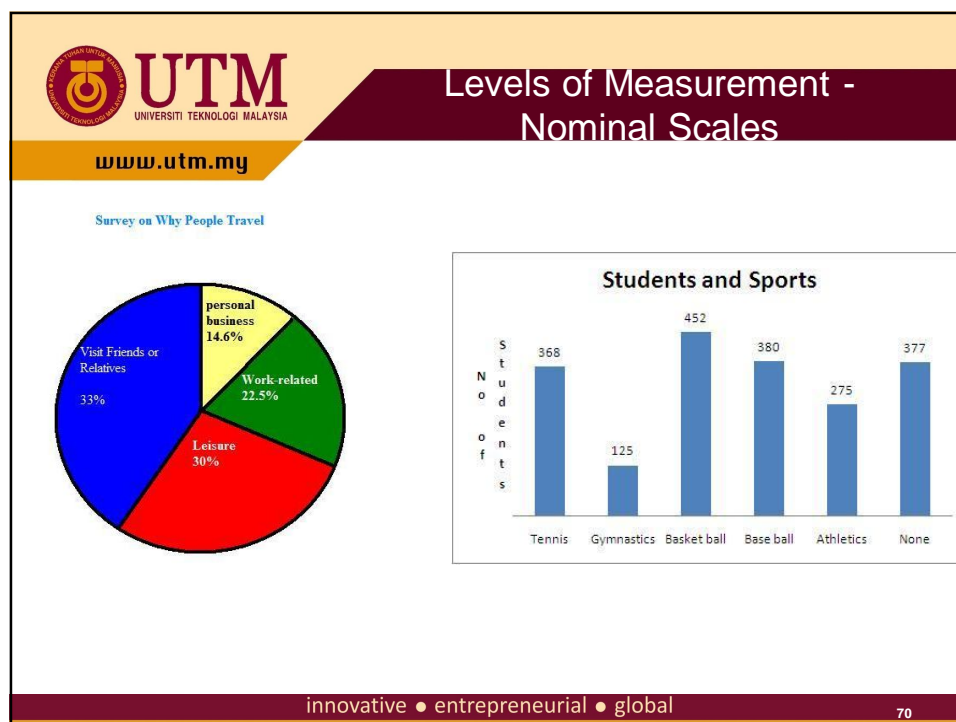
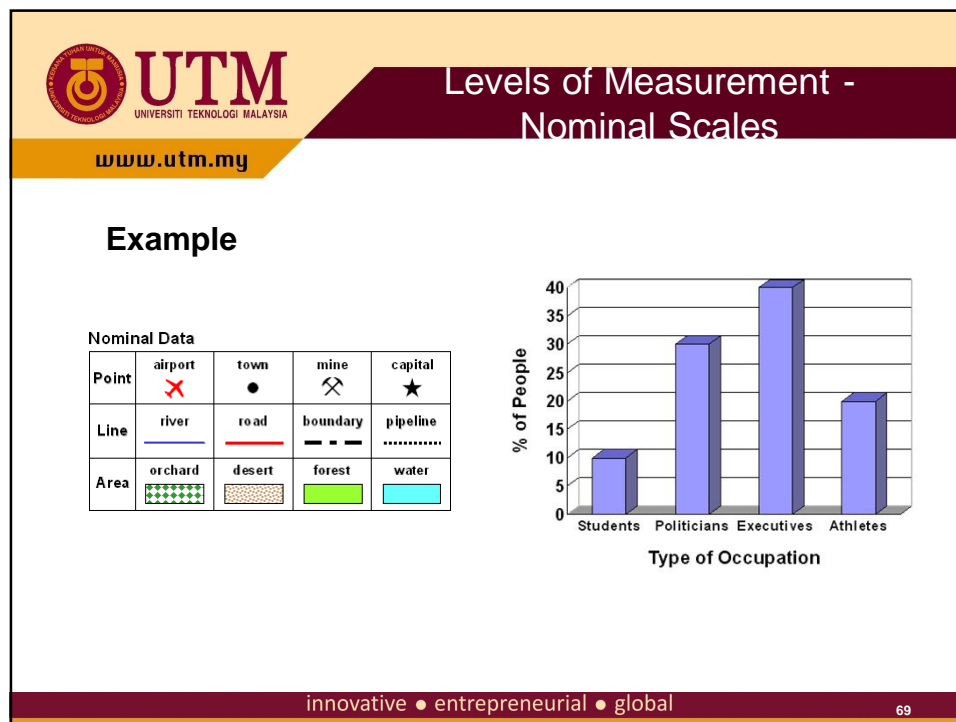

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## Levels of Measurement - Nominal Scales

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- Numbers assigned to categories (as identification codes) have no numeric value (we cannot add, subtract, divide or multiply nominal data) and any ordering of categories is arbitrary.
- This is the most primitive form of measurement. The presence vs. absence of something is a form of nominal measurement (“do you smoke?” YES, NO).
- Although it is considered a form of measurement the collection of nominal data is more easily thought of as a sorting method.

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## Levels of Measurement - Nominal Scales

**What is your gender?**

☒ M – Male

☐ F – Female

**What is your hair color?**

☒ 1 – Brown

☐ 2 – Black

☐ 3 – Blonde

☐ 4 – Gray

☐ 5 – Other

**Where do you live?**

☒ A – North of the equator

☐ B – South of the equator

☐ C – Neither: In the international space station

Sometimes numbers are used to designate category membership


Example:

Country of Origin	
1 = United States	3 = Canada
2 = Mexico	4 = Other

However, in this case, it is important to keep in mind that the numbers do not have intrinsic meaning

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## Levels of Measurement - Ordinal Scales

- **Properties:** classification, order  
**Observations reflect:** differences in degree  
**Examples:** Likert scale categories, rankings, academic letter grade, stages in development
- The distinctive property of ordinal measurement is order.
- On a typical Likert Scale “strongly agree” represents more agreement than “agree”. However, we do not know how much more.

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## Levels of Measurement - Ordinal Scales


### Example: The Likert Scale

	Strongly Agree	Agree	Neither	Disagree	Strongly Disagree
If the price of raw materials fell firms would reduce the price of their food products.	1	2	3	4	5
Without government regulation the firms would exploit the consumer.	1	2	3	4	5
Most food companies are so concerned about making profits they do not care about quality.	1	2	3	4	5
The food industry spends a great deal of money making sure that its manufacturing is hygienic.	1	2	3	4	5
Food companies should charge the same price for their products throughout the country	1	2	3	4	5

## Levels of Measurement - Ordinal Scales

- Similarly if Jozan is ranked 1<sup>st</sup> for funniness, and Nabil is ranked 4<sup>th</sup> we have no way of knowing how much funnier Jozan is than Nabil.
- We cannot assume that they are four times funnier.
- They may be more or less than four times funnier.
- But we do know that they are more funny than Nabil, and more funny than the comedians ranked 2<sup>nd</sup> and 3<sup>rd</sup> places as well.
- We know about order but we have no information about the size of the interval between points.































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## Levels of Measurement - Ordinal Scales


**Example**

**Ordinal Data**

<b>Point</b>	<b>Airports</b>  international  national  regional	<b>Oil well production</b>  high  medium  low	<b>Populated places</b>  large  medium  small
<b>Line</b>	<b>Roads</b>  expressway  major  local	<b>Drainage</b>  river  stream  creek	<b>Boundaries</b>  international  provincial  county
<b>Area</b>	<b>Soil quality</b>  good  fair  poor	<b>Cost of living</b>  high  medium  low	<b>Industrial regions</b>  major  minor

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## Levels of Measurement - Ordinal Scales

**Example**

**An ordinal data example**

How often do you eat cheese for breakfast?


		Code
always		6
usually		5
often		4
sometimes		3
occasionally		2
rarely		1
never		0

"always" is clearly more frequent than "sometimes" but not necessarily twice as frequent, even though 6 = twice 3

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## Levels of Measurement - Ordinal Scales


**Example**



**The " Hot" Scale**

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## Levels of Measurement - Interval Scales

- **Properties:** classification, order, equal intervals  
**Observations reflect:** measurable differences in amount  
**Examples:** IQ scores, degrees of temperature,
- Essentially, interval data are ordinal, but they have an extra property - the ability to meaningfully add and subtract measurements.
- In interval-scaled data, the gaps between the numbers are comparable, unlike with ordinal data.
- Any interval has the same meaning regardless of its location on the scale. "X is five inches longer than Y" has meaning regardless of the values of X and Y.

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## Levels of Measurement - Interval Scales

- However, ratios are meaningless on an interval scale because an interval scale has no true zero.
- Temperature scales are an example of this, so are decibel scales.
- Zero degrees Fahrenheit does not mean the total absence of temperature.
- Zero decibels does not mean there is no sound.

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## Levels of Measurement - Interval Scales

- Furthermore, if it is 80 degrees outside today and it was only 40 degrees outside yesterday we cannot say that today is twice as hot as yesterday.
- Similarly a sound level of 80 dB is not twice as loud as a sound level of 40 dB.
- In short, if the data can be ordered and the arithmetic difference is meaningful, then the data are at least interval data.

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## Levels of Measurement - Ratio Scales

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- **Properties:** classification, order, equal intervals, true zero  
**Observations reflect:** measurable differences in total amount  
**Examples:** weight, income, family size, number of cows in a field
- Ratio data are the highest form of data measurement and the form we are most familiar with.
- For ratio data both differences and ratios are interpretable.
- Ratio data have a natural zero.

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## Levels of Measurement - Ratio Scales

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- Examples of ratio scale data are number of computers you own, weight, height, a bank balance, number of people watching a movie, goals scored by Brazil in the World Cup, etc.
- Ratio data look a lot like interval data.
- However, the zero point has a special meaning in ratio-scaled data: it indicates the absence of whatever property is being measured.

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## Levels of Measurement - Ratio Scales

- Ratio data always have the flavor of counting: when you measure the amount of money that you have, you are counting up coins and bills.
- When you are measuring your height, you are counting the number of inches off the ground to the top of your head.
- Both ratio and interval data make use of a wide range of statistical analysis tools.


## Levels of Measurement

	NOMINAL	ORDINAL	INTERVAL	RATIO
Indicates Difference	X	X	X	X
Indicates Difference & Direction		X	X	X
Indicates Amount of Difference			X	X
Absolute Zero				X


OK to compute....	Nominal	Ordinal	Interval	Ratio
frequency distribution.	Yes	Yes	Yes	Yes
median and percentiles.	No	Yes	Yes	Yes
add or subtract.	No	No	Yes	Yes
mean, standard deviation, standard error of the mean.	No	No	Yes	Yes
ratio, or coefficient of variation.	No	No	No	Yes

				
Level of Measurement	Properties	Examples	Descriptive statistics	Graphs
Nominal / Categorical	Discrete Arbitrary (no order)	Dichotomous <ul style="list-style-type: none"> <li>• Yes / No</li> <li>• Gender</li> </ul> Types / Categories <ul style="list-style-type: none"> <li>• colour</li> <li>• shape</li> </ul>	Frequencies Percentage Mode	Bar Pie
Ordinal / Rank	Ordered categories Ranks	Ranking of favourites Academic grades	Frequencies Mode Median Percentiles	Bar Pie Stem & leaf
Interval	Equal distances between values Discrete (e.g., Likert scale) Metric (e.g., deg. F) Interval scales >5 can usually be treated as ratio	Discrete - Thoughts, behaviours, feelings, etc. on a Likert scale Metric - Deg. C or F	Frequencies (if discrete) Mode (if discrete) Median Mean SD Skewness Kurtosis	Bar (if discrete) Pie (if discrete) Stem & Leaf Boxplot Histogram (if metric)
Ratio	Continuous / Metric / Meaningful 0 allows ratio statements (e.g., A is twice as large as B)	Age Weight VO <sub>2</sub> max Deg. Kelvin	Mean SD Skewness Kurtosis	Histogram Boxplot Stem&Leaf (may need to round leafs)
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Levels of Measurement				
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Statistic	Nominal	Ordinal	Interval	Ratio
Mode	√	√	√	If meaningful
Median	X	√	√	√
Range, Min. Max	X	√	√	√
Mean	X	X	If metric	√
SD	X	X	If metric	√
Graph	Nominal	Ordinal	Interval	Ratio
Bar / Pie	√	√	If discrete	X
Stem & Leaf	X	√	√	√
Boxplot	X	√	√	√
Histogram	X	X	If metric	√
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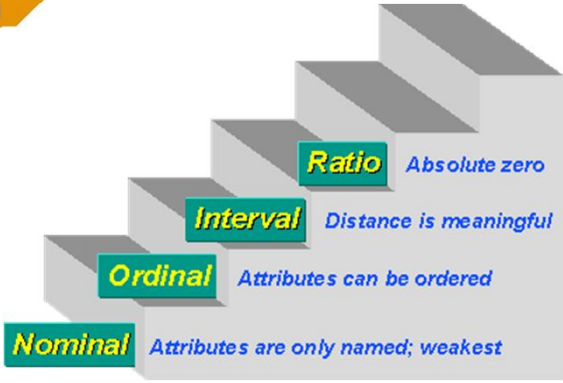
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## Levels of Measurement



"You can have data without information, but you cannot have information without data." —Daniel K. Moran

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## Example

**Scales to classify different measurements**

	Nominal	Ordinal	Interval	Ratio
Sex	x			
Hair colour	x			
Pulse				x
Temp. °C			x	
Team number	x			
Shoe size		x		
Footed-ness	x			

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Exercise

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Identify the following as nominal level, ordinal level, interval level, or ratio level data.

1. Flavours of frozen yogurt
2. Amount of money in savings accounts
3. Students classified by their reading ability: Above average, Below average, Normal
4. Letter grades on an English essay
5. Religions
6. Commuting times to work
7. Ages (in years) of art students
8. Ice cream flavour preference
9. Years of important historical events
10. Instructors classified as: Easy, Difficult or Impossible

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Solution

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Identify the following as nominal level, ordinal level, interval level, or ratio level data.

1. Flavours of frozen yogurt **Nominal**
2. Amount of money in savings accounts **Ratio**
3. Students classified by their reading ability: Above average, Below average, Normal  
**Interval**
4. Letter grades on an English essay **Ordinal**
5. Religions **Nominal**
6. Commuting times to work **Ratio**
7. Ages (in years) of art students **Ratio**
8. Ice cream flavour preference **Ordinal**
9. Years of important historical events **Interval**
10. Instructors classified as: Easy, Difficult or Impossible **Ordinal**

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