BUSINESS STATISTICS

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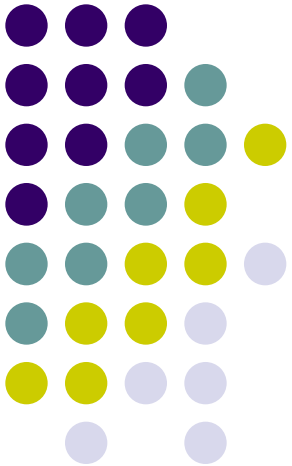

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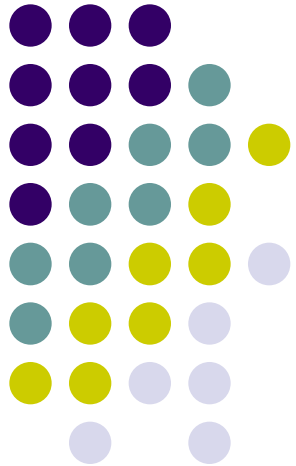
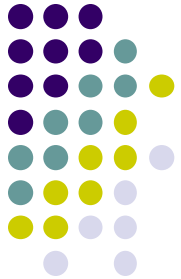
Business Statistics

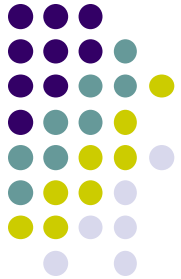
What and Why

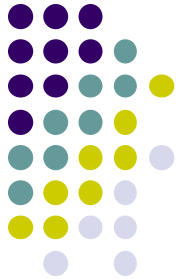




- **Welcome to the world of statistics. This is a world you will want to get comfortable with because you will make better management decisions when you know how to assess the available information and how to ask for additional facts as needed. How else can you expect to manage 12 divisions, 683 products, and 5809 employees?**
- **And even for small business, you will need to understand the larger business environmental of potential customers and competitors it operates within.**

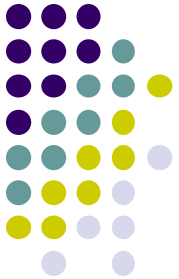
- **The early chapters will introduce you to the role of statistics and data mining in business management to the various types of data sets. Next chapter will show you a good way to see the basic facts about a list of numbers – by looking at a histogram. Fundamental summary numbers (such as average, median, percentiles, etc.) will be explained in the next chapter. One reason statistical methods are so important is that there is so much variability out there that gets in the way of message in the data.**





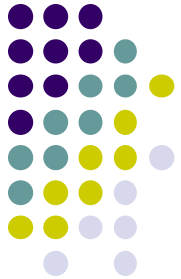
- **Is knowledge of statistics really necessary to be successful in business? Or is it enough to rely on intuition, experience, and hunches? Let's put in another way: Do you really want to ignore much of the vast potentially useful information out there that comes in the form of data?**

- **Is statistics difficult?**
- **Statistics is no more difficult than any other field of study. Naturally, some hard work is needed to achieve understanding of the general ideas and concepts. Although some attention to details and computation is necessary, it is much easier to become an expert *user* of statistics than it is to become an expert statistician trained in all of the fine details. Statistics is easier than it used to be now that personal computers can do the repetitive number-crunching tasks, allowing you to concentrate on interpreting the results and their meaning.**

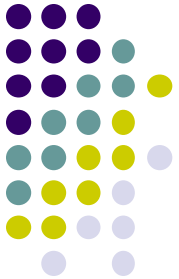


- **Although a few die-hard purists may bemoan the decline of technical detail in statistics teaching, it is good to see that these details are now in their proper place; life is too short for all human being to work out the intricate details of techniques such as long division and matrix inversion.**

- **Does learning statistics decrease your decision-making flexibility?**
- **Knowledge of decisions *enhances* your ability to make good decisions. Statistics is not a rigid, exact science and should not get in the way of your experience and intuition. By learning about data and the basic properties of uncertain events, you will help solidify the information on which your decisions are based, and you will add a new dimension to your intuition.**



- **Think of statistical methods as a component of decision making, but not the whole story. You want to supplement – not replace – business experience, common sense, and intuition.**



Introduction into Business Statistics

CHAPTER QUESTIONS

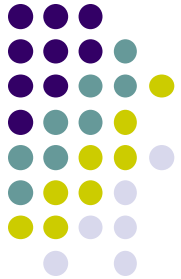
1. Definition of the term ‘statistics’.
2. Statistical Methods
3. Functions of Statistics
4. Key Terms: Data, Population, Parameter, Sample, Variables (Independent and Dependent). Types Of Variables
5. Descriptive and Inferential statistics
6. Data Sources
7. Worthiness Evaluating Survey

Chapter Goals

After completing this chapter, you should be able to:

- Explain how decisions are often based on incomplete information
- Explain key definitions:
  - Population vs. Sample
  - Parameter vs. Statistic
  - Descriptive vs. Inferential Statistics
- Describe random sampling
- Explain the difference between Descriptive and Inferential statistics

Introduction

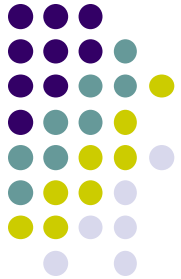


- The word “statistics” is very popularly used in practice. It conveys a variety of meanings to people, many of which are inaccurate or, at the very least, misleading.

- The average persons conceive of “statistics” as column of figures, zigzag graphs or tables like statistics of production, consumption, per capita income, imports, exports, crimes, divorce, share prices, etc.

- Such statistics are quite commonly found in newspapers, journals, reports and one can hear them on radio, television, classroom lectures and so on.

- For example, one may find statements like “the production of food grains is expected to decrease from 192.3 m tones in 1997-98 to 183.2 m tones in 2002-03.



- In addition to meaning numerical facts, “statistics” also refers to a subject, just as ‘mathematics’ as well as symbols, formulae and theorems.

- Thus, the word ‘statistics’ refers either to quantitative information or to a method of dealing with quantitative information.

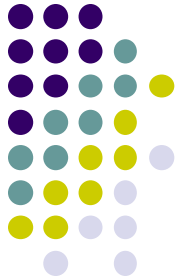
What is statistics?

- **Statistics** is the art and science of collecting and understanding data. Since **data** refers to any kind of recorded information, statistics plays an important role in many human endeavors.

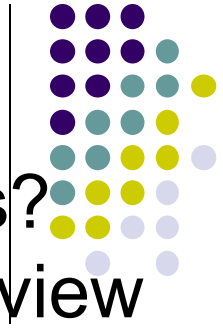
Definition

- There have been many definitions of the term ‘statistics’- indeed scholarly articles have carefully collected together hundreds of definitions, some have defined statistics as statistical data whereas others as statistical methods.
- Croxton and Cowden – “Statistics may be defined as a science of collection, presentation, analysis and interpretation of numerical data.”

- **Statistics Looks at the Big Picture**
- When you have a large, complex assemblage of many small pieces of information, statistics can help you classify and analyze the situation, providing a useful overview and summary of the fundamental features in the data. If you don't yet have the data, then statistics can help you collect them, ensuring that your questions can be answered and that you spend enough (but not too much) effort in the process.



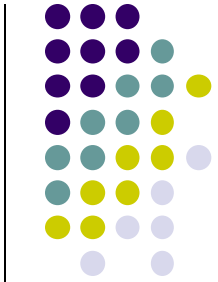
Statistics in Management



- What should a manager know about statistics? Your knowledge should include a broad overview of the basic concepts of statistics, with some details. You should be aware that the world is random and uncertain in many aspects. You should be able to effectively perform two important activities:
- 1. Understand and use the results of statistical analysis as background information in your work.
- 2. Play the appropriate leadership role during the course of a statistical study if you are responsible for the actual data collection and/or analysis.

- To fulfill these roles, you do not need to be able to perform a complex statistical analysis by yourself. However, some experience with actual statistical analysis is essential for you to obtain the perspective that leads to effective interpretation.
- Experience with actual analysis will also help you to lead other to sound results and to understand what they are going through. Moreover, there may be times when it will be most convenient for you to do some analysis on your own. Thus, we will concentrate on the ideas and concepts of statistics, reinforcing these with practical examples.

The five basic activities of statistics

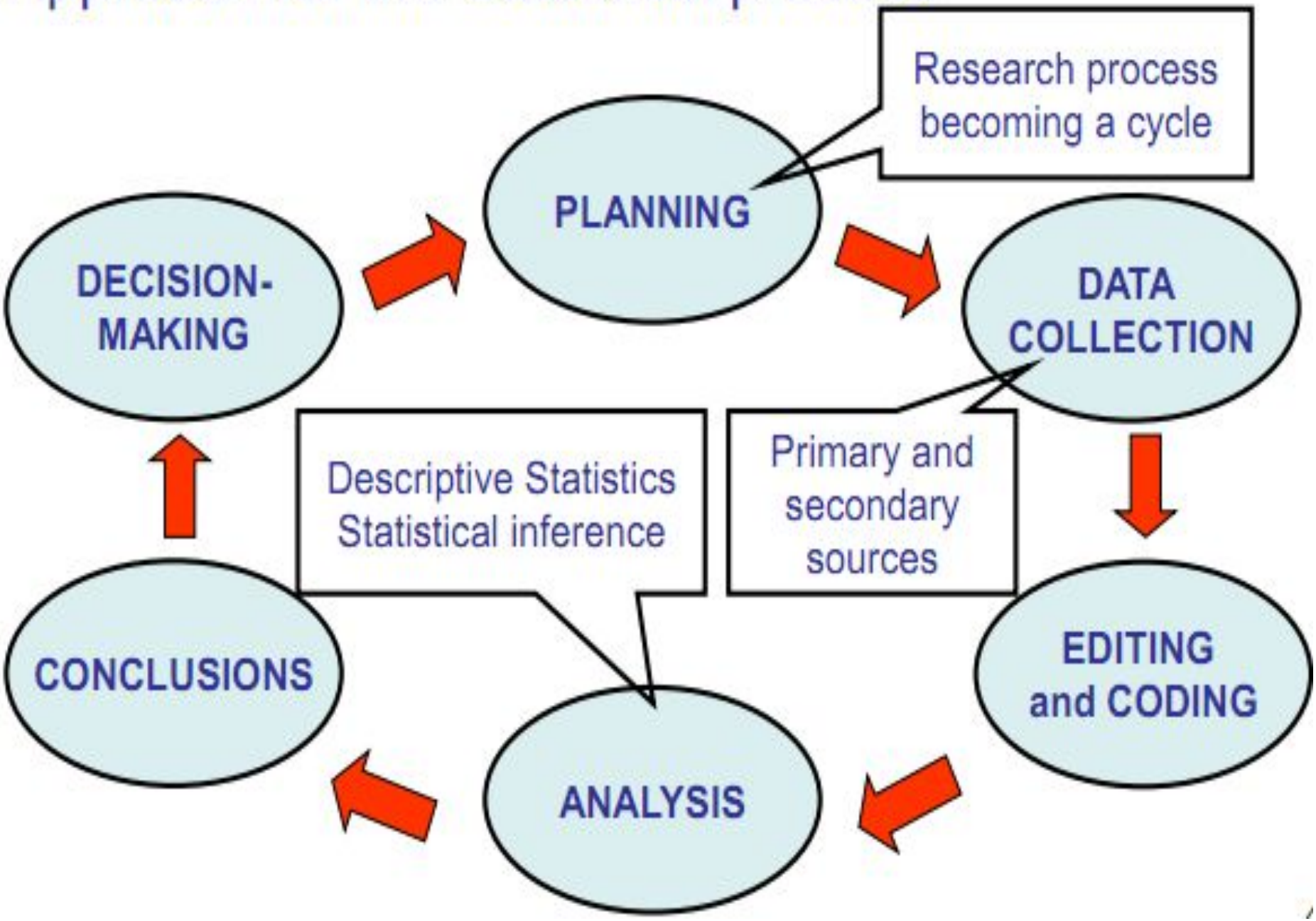


- In the beginning stages of a statistical study, either there are not yet any data or else it has not yet been decided what data to look closely at.
- The ***design*** phase will resolve these issues so that useful data will result.
- Once data are available, an initial inspection is called for, provided by the ***exploratory*** phase.

- In the ***modeling*** phase, a system of assumptions and equations is selected in order to provide a framework for further analysis.
- A numerical summary of an unknown quantity, based on data, is the result of the ***estimation*** process.
- The last of these basic activities is ***hypothesis testing***, which uses the data to help you decide what the world is really like in some respect.

We will now consider these five activities in turn.

Approach for the Statistical process

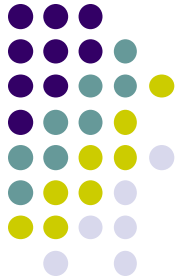


Designing a Plan for Data Collection -

might be called *sample survey design* for a marketing study or *experimental design* for a chemical manufacturing process optimization study. This phase of ***designing the study*** involves planning the details of data gathering. A careful design can avoid the cost and disappointment of finding out – too late – that the data collected are not adequate to answer the important questions. A good design will also collect just the right amount the data: enough to be useful, but not so much as to be wasteful. Thus, by planning ahead, you can help ensure that the analysis phase will go smoothly and hold down the cost of the project.

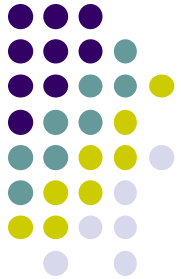
- Statistics is particularly useful when you have a large group of people, firms, or other items (the *population*) that you would like to know about but can't reasonable afford to investigate completely. Instead, to achieve a useful but imperfect understanding of this population, you select a smaller group (the *sample*) consisting of some – but not all – of the items in the population. The process of generalizing from the observed sample to the larger population is known as *statistical inference*.

- The ***random sample*** is one of the best ways to select a practical sample, to be studied in detail, from a population that is too large to be examined in its entirety. By selecting randomly, you accomplish two goals:



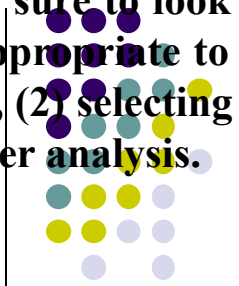
- 1. You are guaranteed that the selection process is fair and proceeds without bias; that is, all items have an equal chance of being selected. This assures you that, on average, samples will be representative of the population (although each particular random sample is usually only approximately, and not perfectly, representative).
- 2. The randomness, introduced in a controlled way during the design phase of the project, will help ensure validity of the statistical inferences drawn later.

Exploring the Data



- As soon as you have a set of data, you will want to check it out. Exploring the data involves looking at your data set from many angles, describing it, and summarizing it. In this way you will be able to make sure that the data are really what they are claimed to be and that there are no obvious problems. But good exploration also prepares you for the formal analysis in either of two ways:

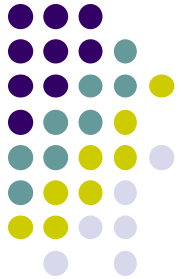
that the data set is "well behaved". Whenever possible, examine the data directly to make sure to look OK: That is, there are no large errors, and the relationships observable in the data are appropriate to the kind of analysis to be performed. This phase can help in (1) editing the data for errors, (2) selecting an appropriate analysis, (3) validating the statistical techniques that are to be used in further analysis.



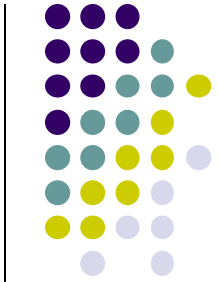
- 1. By verifying that the expected relationships actually exist in the data, thereby validating the planned techniques of analysis.
- 2. By finding some unexpected structure in the data that must be taken into account, thereby suggesting some changes in the planned analysis.

- **Exploration is the first phase once you have data to look at. It is often not enough to rely on a formal, automated analysis, which can be only as good as the data that go into the computer and which assumes that the data set is "well behaved". Whenever possible, examine the data directly to make sure to look OK: That is, there are no large errors, and the relationships observable in the data are appropriate to the kind of analysis to be performed. This phase can help in (1) editing the data for errors, (2) selecting an appropriate analysis, (3) validating the statistical techniques that are to be used in further analysis.**

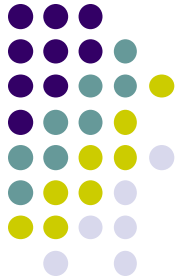
Modeling the Data



- In statistics, a ***model*** is a system of assumption and equations that can generate artificial data similar to the data you are interested in, so that you can work with a few numbers (called *parameters*) that represent the important aspects of the data. A model can be a very effective system within which questions about large-scale properties of the data can be answered.

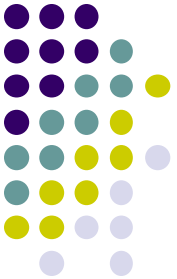


- Here are some models that can be useful in analyzing data. Notice that each model generates data with the general approach “data equals structure plus noise”, specifying the structure in different ways. In selecting a model, it can be very useful to consider what you have learned by exploring the data.



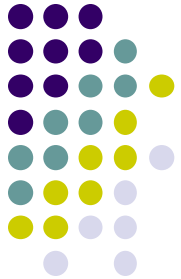
- 1. Consider a simple model that generates artificial data consisting of a *single number* plus noise. Follows we explore how to extract information about the single number and how to describe the noise.
- 2. Consider a model that generates *pairs* of artificial noisy data values that are related to each other. Next we'll show some useful models for describing the nature and extent of the relationship and the noise.
- 3. Consider a model that generates a *series* of noisy data values where the next one is related to the previous one.

Estimating an Unknown Quantity



- produces the best educated guess possible based on the available data. We all want estimates of things that are just plan impossible to know exactly. Here are some examples of unknowns to be estimated:

Estimating an Unknown Quantity

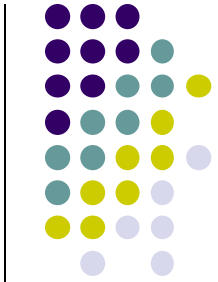


1. Next period (quarter's) sales.
2. What the government will do next to our tax rates.
3. How the population of region will react to a new product.
4. How your portfolio of investment will fare next year.
5. The productivity gains of a change in strategy.
6. The defect rate in a manufacturing process.

- Statistics can shed light on some of these situations by producing a good, educated guess when reliable data are available. Keep in mind that all statistical estimates are just guesses and are, consequently, often wrong. However, they will serve their purpose when they are close enough to the unknown truth to be useful. If you knew how accurate these estimates were (approximately), you could decide how much attention to give them.

- **Statistical estimation also provides an indication of the amount of uncertainty or error involved in the guess, accounting for the consequences of random selection of a sample from a large population. The *confidence interval* gives probable upper and lower bounds on the unknown quantity being estimated, as if to say, I'm not sure exactly what the answer is, but I'm quite confident it's between these two number.**

Hypothesis testing

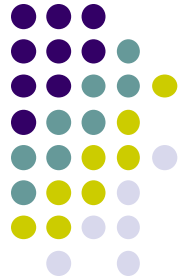


- Statistical **hypothesis testing** is the use of data in deciding between two (or more) different possibilities in order to resolve an issue in an ambiguous situation. **Hypothesis testing** produces a definite decision about which of the possibilities is correct, based on data. The procedure is to collect data that will help decide among the possibilities and to use careful statistical analysis for extra power when the answer is not obvious from just glancing at the data.

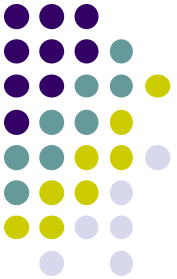
Here are some examples of hypothesis that might be tested using data:

1. The average New Yorker plans to spend at least 10$ on your product next month.
2. You will win tomorrow's election.
3. A new medical treatment is safe and effective.
4. Brand X produces a whiter, brighter wash.
5. The error in a financial statement is smaller than some material amount.
6. It is possible to predict the stock market based on careful analysis of the past.
7. The manufacturing defect rate is below that expected by customers.

- Note that each **hypothesis** makes a definite statement, and it may be either true or false. The result of a statistical hypothesis test is the conclusion that either the data support the hypothesis or they don’t.



What is “Statistics”?



- ***Statistics is the science of data that involves:***
- Collecting
- Classifying
- Summarizing
- Organizing and
- Interpretation

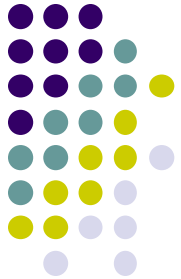
Statistical Methods

- The methods by which statistical data are analyzed are called statistical methods.
- Statistical methods are applicable to a very large number of fields- economics, sociology, anthropology, business, agriculture, psychology, medicine and education.
- Statistical methods are used by governmental bodies, private business firms, and research agencies as an indispensable aid in i) forecasting ii) controlling and iii) exploring.

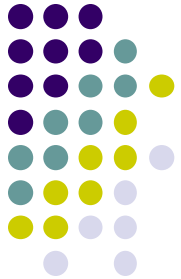
Statistical Methods

- There are five stages in a statistical investigation:

1. **Collection**: Utmost care must be exercised in collecting data because they form the foundation of statistical analysis. If data are faulty, the conclusion drawn can never be reliable. The data may be available from existing published or unpublished sources or else may be collected by investigator himself.

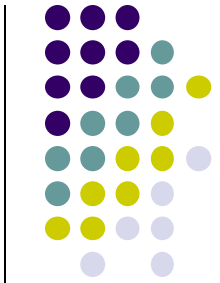


2. **Organization:** Data from published sources are generally in organized form. Data from survey needs organization. The first step is data editing so that the omissions, inconsistencies, irrelevant answers and wrong computation in the returns may be corrected or adjusted. The second step is to classify data and the last step is tabulation of data-arrange data in rows and columns.



3. **Presentation:** After the data have been collected and organized, they are ready for presentation. It facilitates statistical analysis.

4. **Analysis:** Data are analyzed mostly in tabular form. Methods used are numerous ranging from simple observation of data to complicated, sophisticated and highly mathematical techniques.

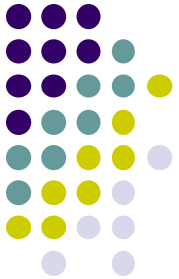


5. **Interpretation:** Drawing conclusions from the data collected and analyzed. It is a difficult task and necessitates a high degree of skills and experience. Correct interpretation will lead to a valid conclusion of the study and thus can aid in decision-making.

Statistics: Science or Art

- Whether statistics is a science or an art is often a subject of debate. Science refers to a systematized body of knowledge. It studies cause and effect relationship and attempts to make generalizations in the form of scientific principles or laws. It describes facts objectively and avoids vague judgments as good as bad.

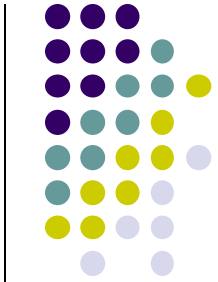
- Science, in short, is like a lighthouse that gives light to the ships to find out their own way but does not indicate the direction in which they should go.



- Art, on the other hand, refers to the skill of handling facts so as to achieve a given objective. It is concerned with ways and means of presenting and handling data, making inferences logically and drawing relevant conclusions.

- If science is knowledge, the art is action.

Functions of Statistics



- **Definiteness:** To present general statements in a precise and definite form. The sex ratio (i.e. number of females per 1000males) is going up in Belarus.

  The sex ratio has gone up from 927 in 1991 to 933 in 2001.

- **Condensation**: It simplifies mass of data into a few significant figures.

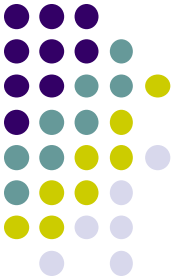
- **Comparison:** It facilitates comparison.

- Formulating and testing Hypothesis: Statistical methods are extremely useful in formulating and testing hypothesis and to develop new theories.

- Prediction: Statistical methods provide helpful means of forecasting future events.

- Formulation of policies: Statistics provide the basic material for framing suitable policies. How much oil a nation should import in 2005.

Dealing with Uncertainty



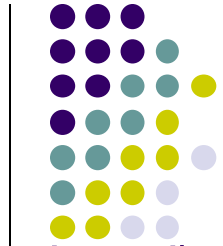
Everyday decisions are based on incomplete information

Consider:

- The price of IBM stock *will* be higher in six months than it is now.

- If the federal budget deficit is as high as predicted, interest rates *will* remain high for the rest of the year.

Dealing with Uncertainty

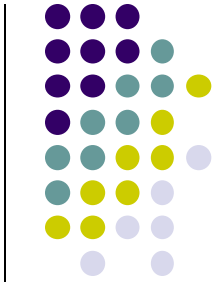


(continued)

Because of uncertainty, the statements should be modified:

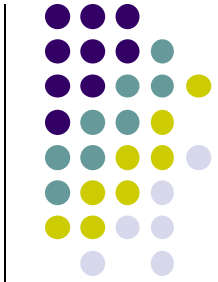
- The price of IBM stock is *likely* to be higher in six months than it is now.
- If the federal budget deficit is as high as predicted, it is *probable* that interest rates will remain high for the rest of the year.

Basic concepts of Statistics



- **Parameter**
  - Computed from the universe.
- **Statistic**
  - Computed from the subset taken from the universe.
- **Variable**
  - Characteristic of the item being observed or measured.
- **Data**
  - Collection of observations on one or more variable.

Basic concepts of Statistics



– **Population**

• Entire group we want information about.

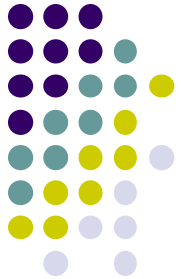
– **Sample**

• The proportion of the population we actually examine.

• Representative and not biased.

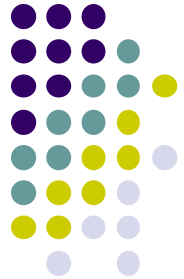
• Random sampling.

Basic concepts of Statistics

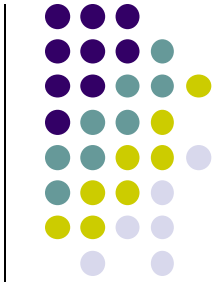


– **Census**

- Investigate the whole population
- Expensive
- Time consuming
- Sections of population is inaccessible
- Units are destroyed
- Inaccurate



Key Definitions



- What is **Data**?

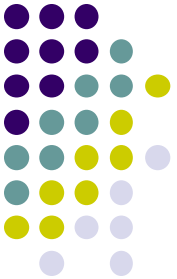
  facts or information that is relevant or appropriate to a decision maker

- A **population** is the collection of all items of interest or under investigation
  - N represents the population size
- A **sample** is an observed subset of the population
  - n represents the sample size

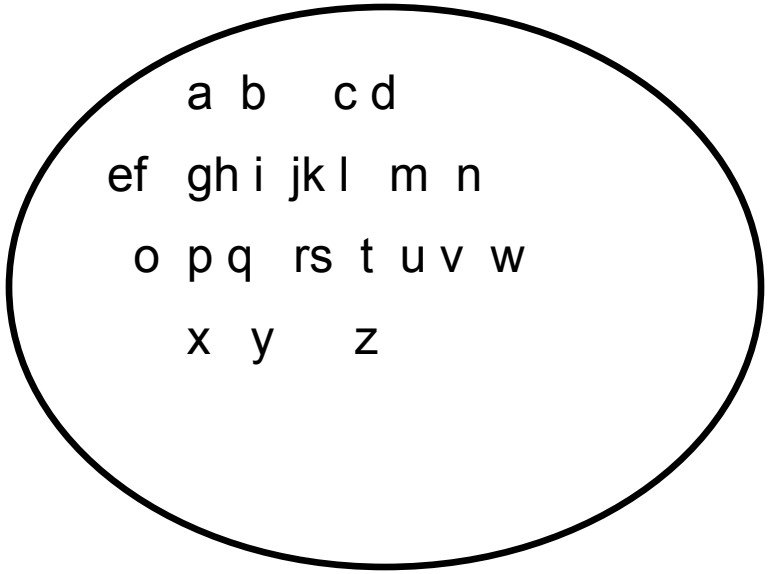
Key Definitions

- A **parameter** is a specific characteristic of a population
- A **statistic** is a specific characteristic of a sample

Population vs. Sample

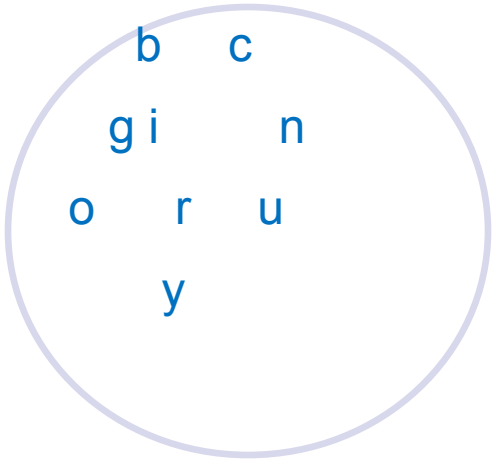


Population



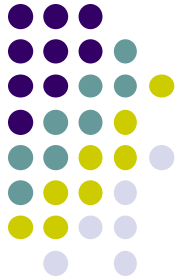
Values calculated using population data are called parameters

Sample



Values computed from sample data are called statistics

Examples of Populations



- Names of all registered voters in the United States
- Incomes of all families living in Belarus
- Annual returns of all stocks traded on the New York Stock Exchange
- Grade point averages of all the students in your university

Random Sampling

Simple random sampling is a procedure in which

each member of the population is chosen strictly by chance,

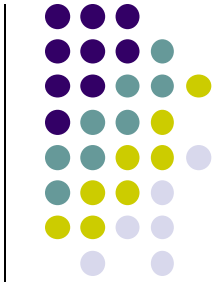
- each member of the population is equally likely to be chosen,

and

- every possible sample of n objects is equally likely to be chosen

The resulting sample is called a random sample

Variables



- Traits or characteristics that can change values from case to case.
- A variable is what is measured or manipulated in an experiment

•Examples:

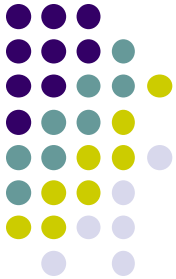
•Age

•Gender

•Income

•Social class

Types Of Variables



- **In causal relationships**:
- CAUSE =>EFFECT

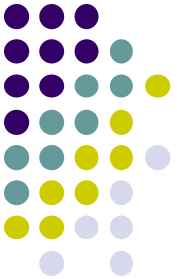
independent variable & dependent variable

•**Independent variable: is a variable that can be controlled or manipulated.**

An independent variable is the variable you have control over (dose of drug)

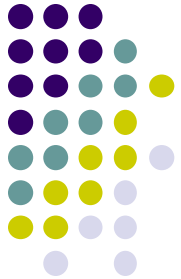
•**Dependent variable: is a variable that cannot be controlled or manipulated. Its values are predicted from the independent variable (effect on the condition)**

Types Of Variables



- Discrete variables are measured in units that cannot be subdivided. Example: Number of children
- Continuous variables are measured in a unit that can be subdivided infinitely. Example: Height

Descriptive and Inferential Statistics



Two branches of statistics:

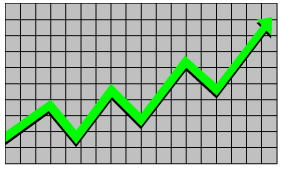
- Descriptive statistics
  - Collecting, summarizing, and processing data to transform data into information
- Inferential statistics
  - provide the bases for predictions, forecasts, and estimates that are used to transform information into knowledge

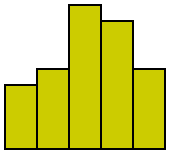
Descriptive Statistics

- **Collect data**
  - e.g., Survey

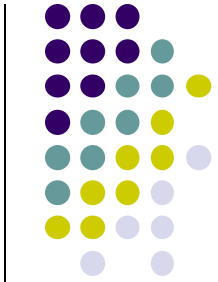
Gives us the overall picture about data

- **Presents data** in the form of tables, charts and graphs





Descriptive Statistics



- **Summarize data**
  - e.g., Sample mean = $\frac{\sum X_i}{n}$

•Avoids inferences

Examples:

•Measures of central location

Mean, median, mode and midrange

•Measures of Variation

•Variance, Standard Deviation, z-scores

Inferential Statistics

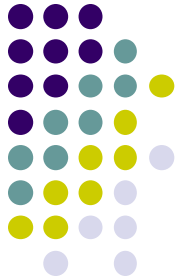
- Take **decision** on overall population using a sample
- "Sampled" data are incomplete but can still be representative of the population
- Permits the making of generalizations (inferences) about the data
- ***Probability theory is a major tool used to analyze sampled data***

Inferential Statistics

- **Estimation**
  - e.g., Estimate the population mean weight using the sample mean weight
- **Hypothesis testing**
  - e.g., Test the claim that the population mean weight is 120 pounds

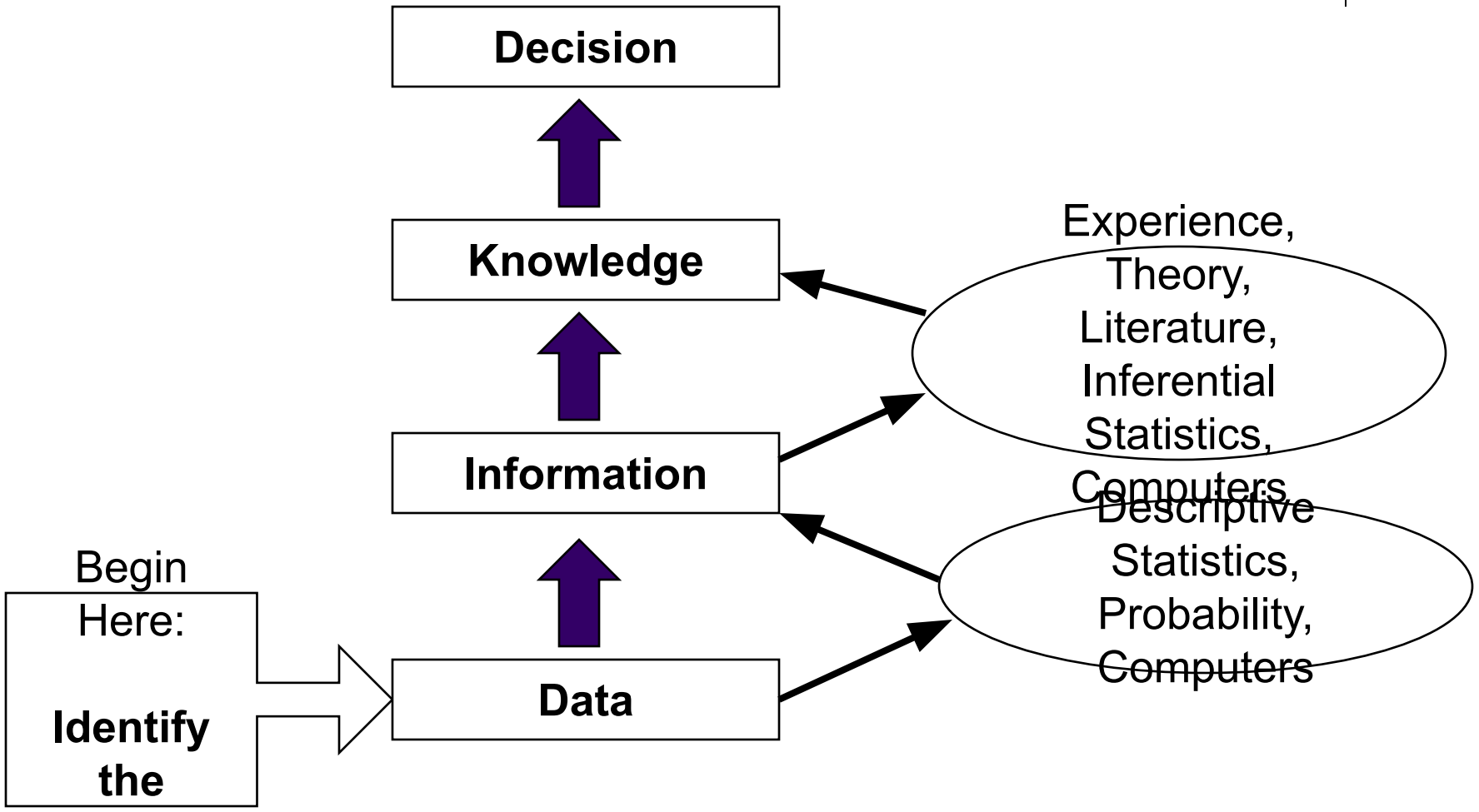
Inference is the process of drawing conclusions or making decisions about a population based on sample results

Predictive Modeling

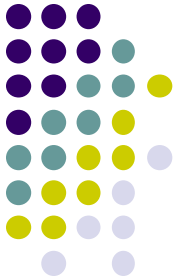


- The science of predicting future outcomes based on historical events.
- Model Building: “Developing set of equations or mathematical formulation to forecast future behaviors based on current or historical data.”
- Regression, logistic Regression, time series analysis etc.

The Decision Making Process



Why We Need Data



- To provide input to survey
- To provide input to study
- To measure performance of service or production process
- To evaluate conformance to standards
- To assist in formulating alternative courses of action
- To satisfy curiosity

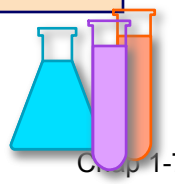
Data Sources

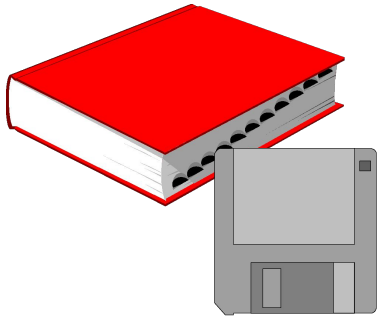
Primary
Data Collection

- Observation
- Survey
- Experimentation

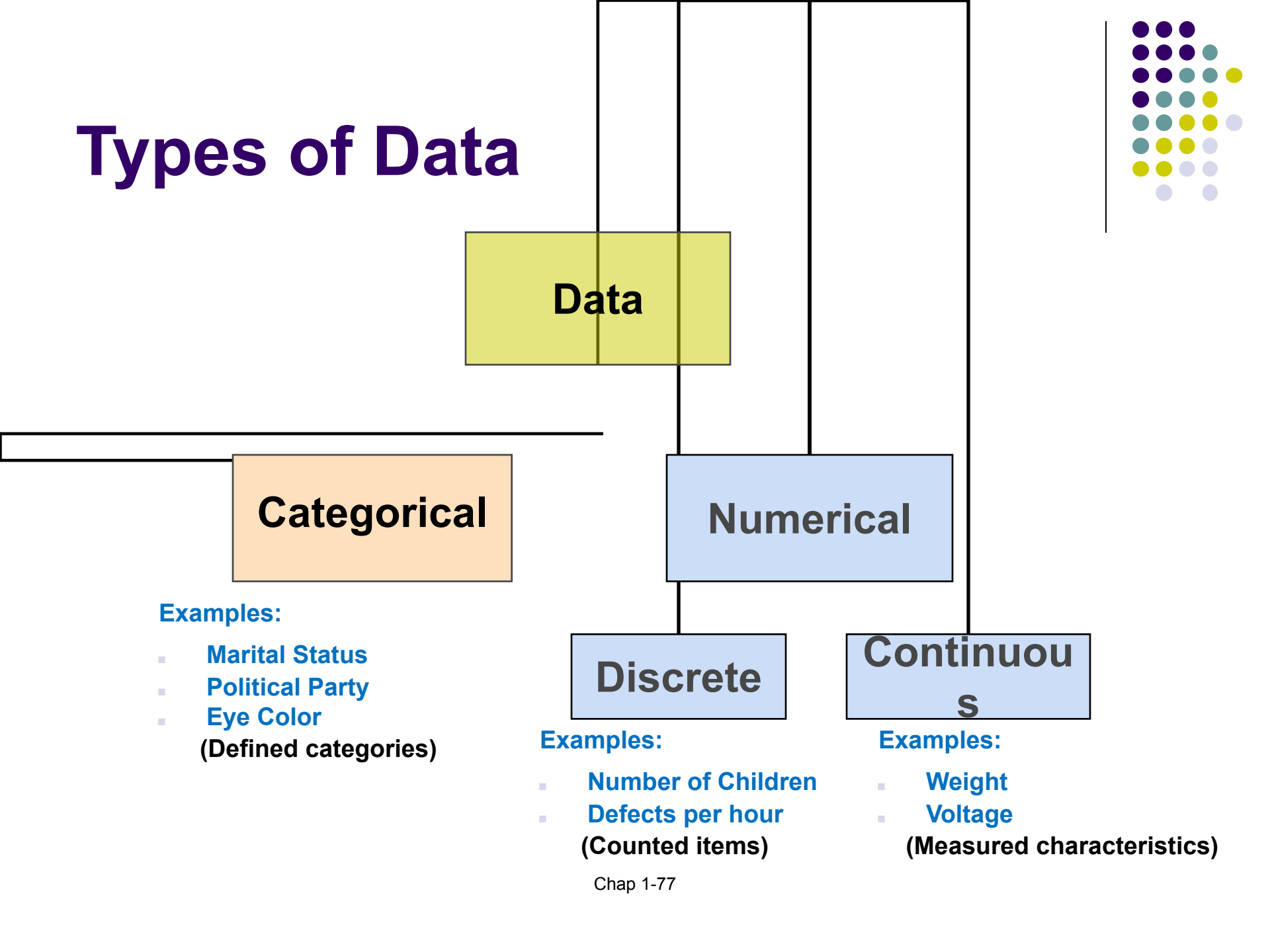
Secondary
Data Compilation

- Print or Electronic





Types of Data



Examples:

- Marital Status
- Political Party
- Eye Color

(Defined categories)

Examples:

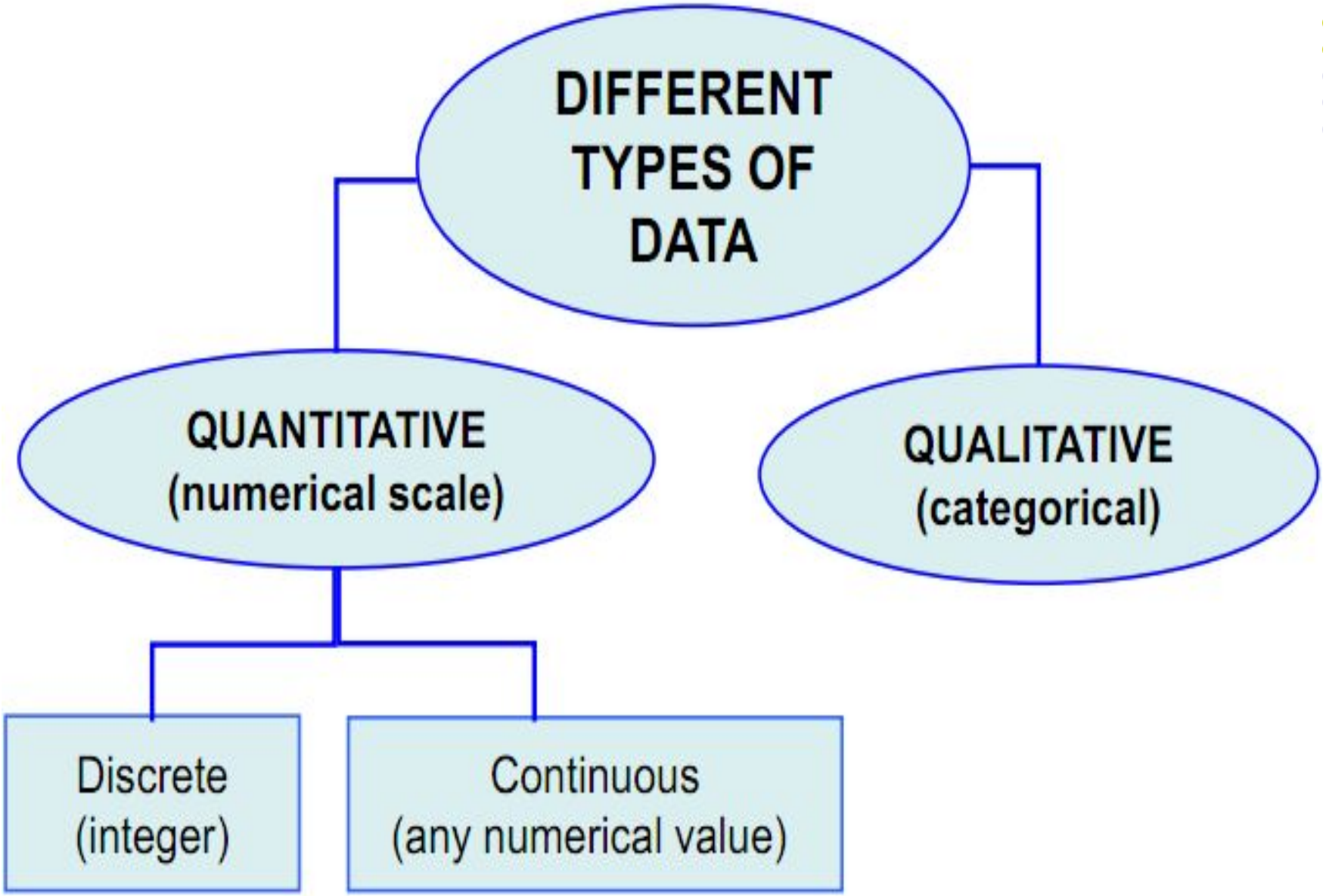
- Number of Children
- Defects per hour

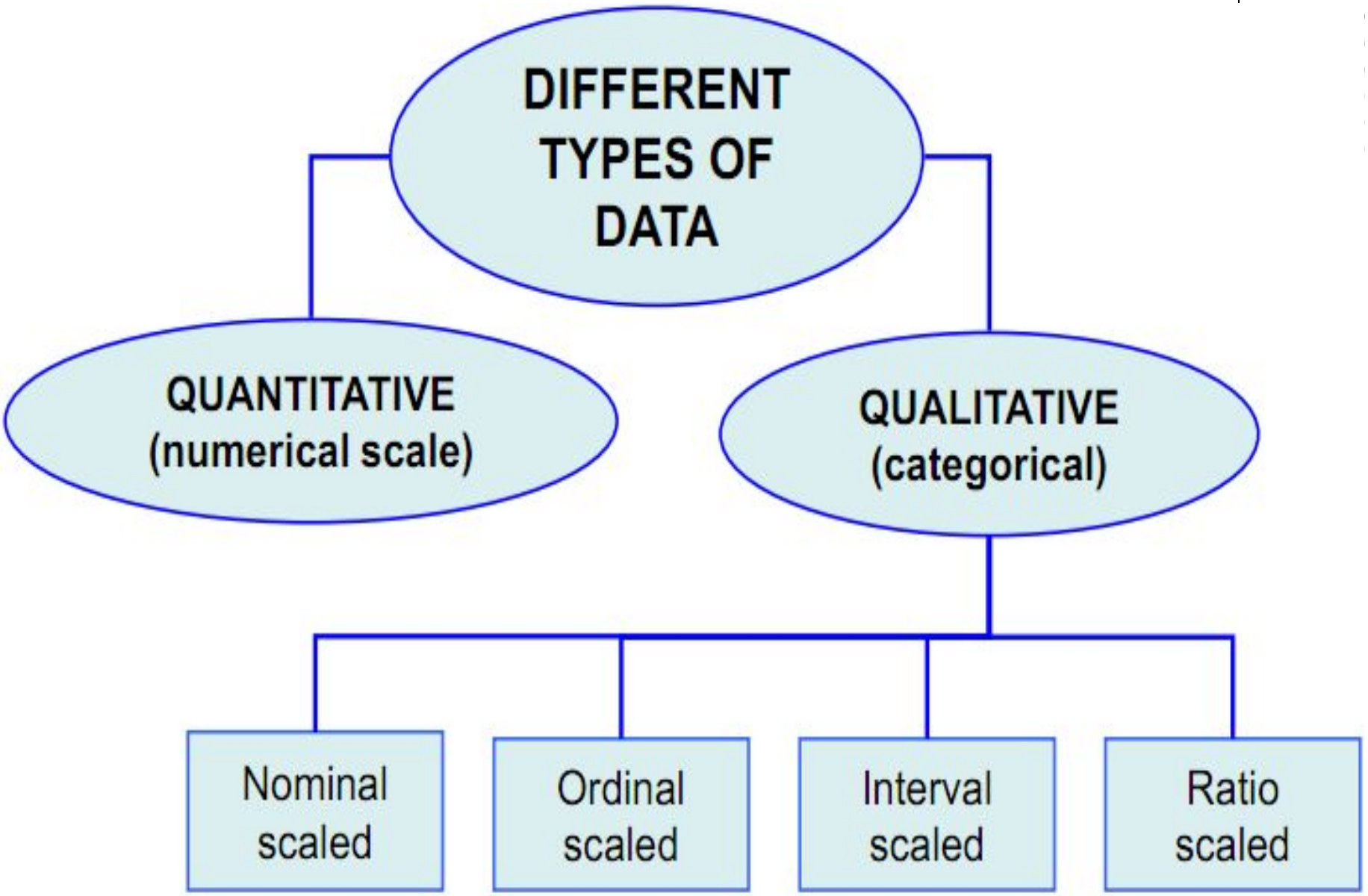
(Counted items)

Examples:

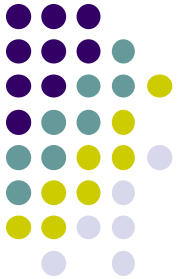
- Weight
- Voltage

(Measured characteristics)


DIFFERENT TYPES OF DATA
QUANTITATIVE (numerical scale)
QUALITATIVE (categorical)
Discrete (integer)
Continuous (any numerical value)


DIFFERENT TYPES OF DATA
QUANTITATIVE (numerical scale)
QUALITATIVE (categorical)
Nominal scaled
Ordinal scaled
Interval scaled
Ratio scaled

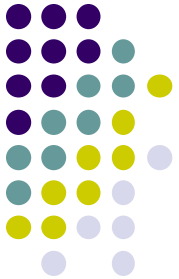
- Problems associated with the collection
- of data:
- – Characteristics have to be measured.
- – Measurements can be complicated.
- – Measurements must be valid and accurate.
- – Secondary data not easy to validate.
- – Data can be incomplete, typographical errors, small sample.
- – Biased or misleading responses.



Problems associated with the collection of data:

– Make sure of the following:

- Who conducted the study?
- What data was collected?
- What sampling method was used?
- Sample size?
- Chance of bias?
- Is data relevant to the problem at hand?



- ***How to design a questionnaire***

– **Questions should:**

- Be simply stated.
- Have no suggestion of a specific answer.
- Be specific and address only one issue.
- Carefully word sensitive issues.
- Not require calculations or a study to be answered.

– **Types of questions**:

- Closed
- Open
- Combined

- ***Appearance and layout of a questionnaire***

– Attractive look.
– Coloured paper.
– Clear instructions on how to complete.
– Reasonably short.
– Enough space to complete questions.
– Mother-tongue language.
– Interesting questions first.
– Simple questions first, controversial questions later.
– Complete one topic before starting the next.
– Important information first.

- **Interview**

– Fieldworker completed questionnaire

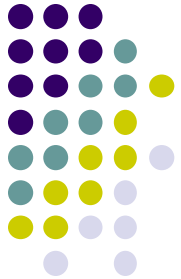
- Higher response rate and data collection is immediate.

– **Mailed questionnaires**

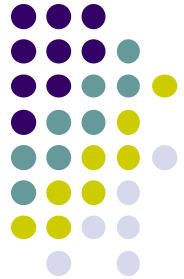
- When population is large or dispersed.
- Low response rate.
- Time consuming.

– **Telephone interview**

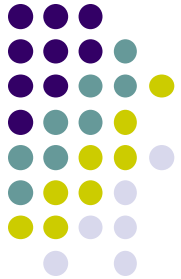
- Lower costs.
- Quicker contact with geographically dispersed respondents.

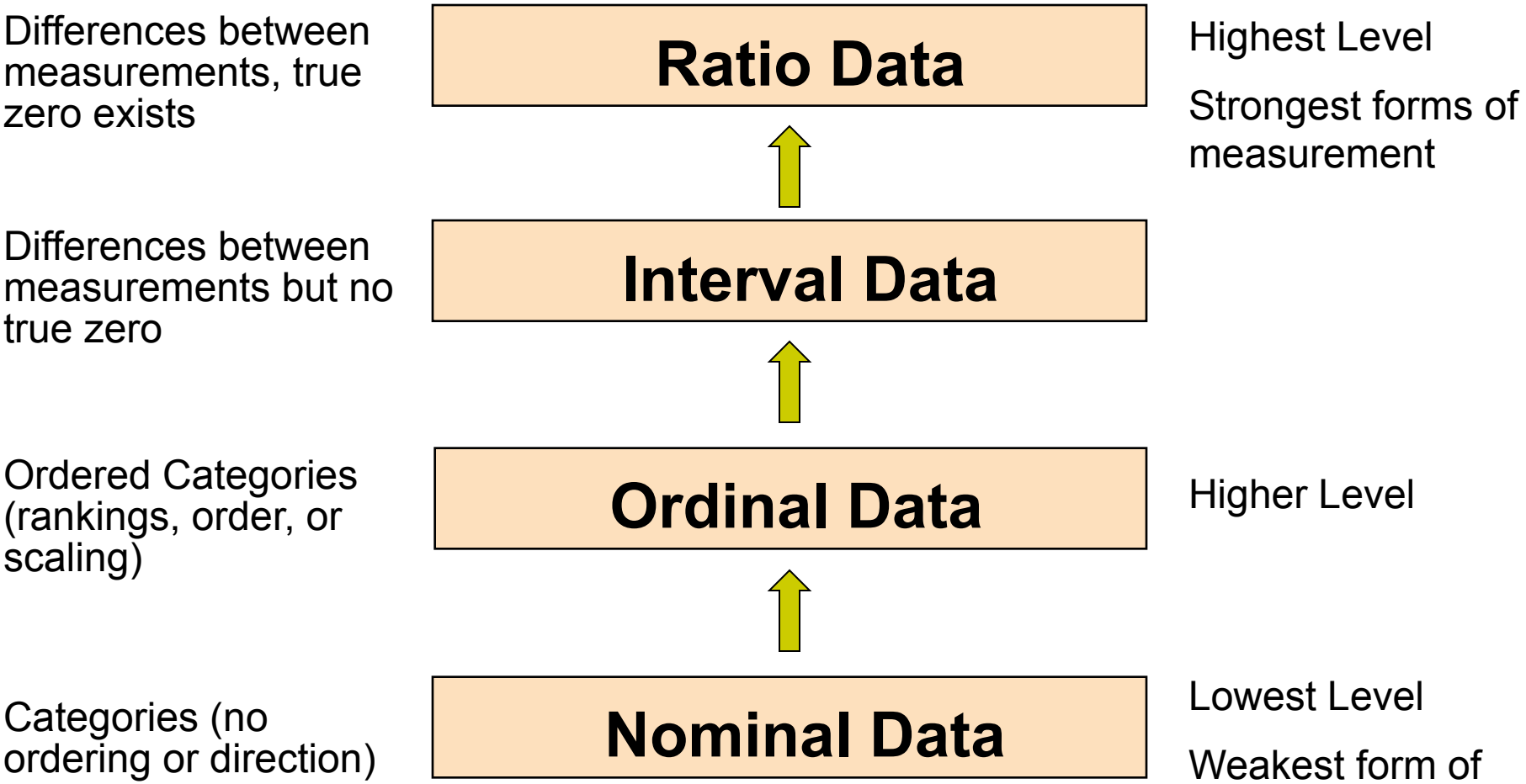


- **Editing the data**
  - Obvious errors should be eliminated.
  - Eliminate questionnaires that are incomplete and unreliable.
  - Questionnaires should be pre-tested on a small group of people.

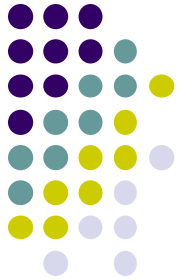


Levels of Measurement and Measurement Scales



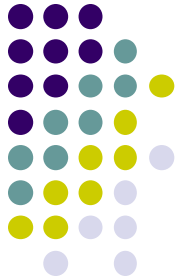


Evaluating Survey Worthiness



- What is the purpose of the survey?
- Is the survey based on a probability sample?
- Coverage error – appropriate frame?
- Non-response error – follow up
- Measurement error – good questions elicit good responses
- Sampling error – always exists

Types of Survey Errors



- Coverage error or selection bias
  - Exists if some groups are excluded from the frame and have no chance of being selected
- Non response error or bias
  - People who do not respond may be different from those who do respond
- Sampling error
  - Variation from sample to sample will always exist
- Measurement error
  - Due to weaknesses in question design, respondent error, and interviewer's effects on the respondent

Types of Survey Errors

(continued)

- Coverage error

Excluded from frame

- Non response error

Follow up on nonresponses

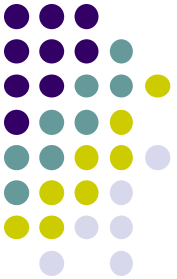
- Sampling error

Random differences from sample to sample

- Measurement error

Bad or leading question

What do we expect from the statistical analysis?



- To find out whether there is a statistically significant difference between **our sample** and **general population**