Demystifying Quantitative Data Analysis for Novice Researchers

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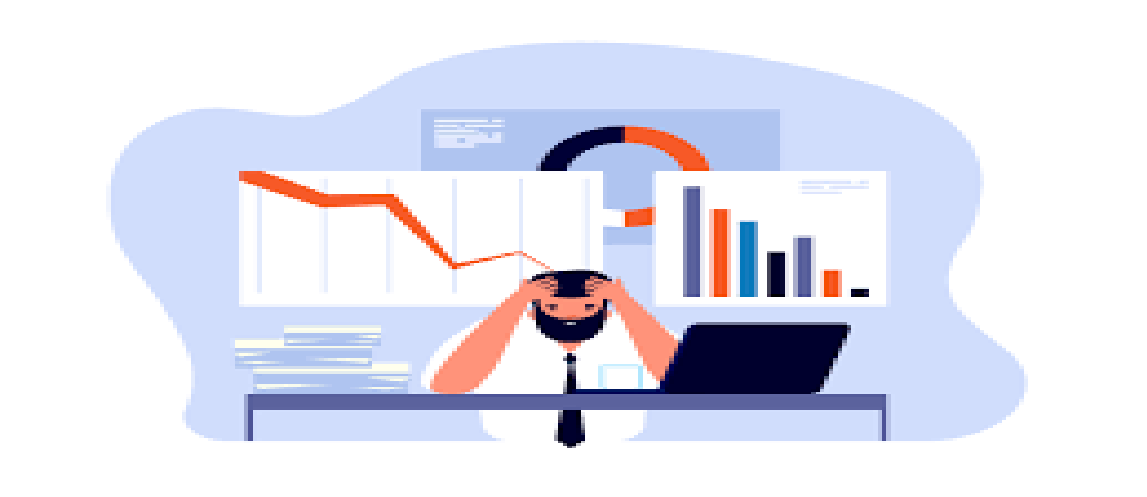


Abstract

Quantitative research seeks to explain phenomena by collecting quantitative data which are then analyzed using statistical methods. Due to the availability of a plethora of quantitative data analysis strategies, novice researchers may find it difficult to discern the appropriate ones to be used in their studies. This communication aims to offer a foundation which enables them to be familiarized with the process of quantitative data analysis within which it takes them through the quantitative data analysis cycle, shares insights and provides tips on how to select the types of analyses that suit the most common types of quantitative designs, including both non-experimental and experimental ones. The inspection of the types of statistics are inherent to the data analysis process ; this involves descriptive statistics followed by inferential statitistics resulting in hypothesis testing which tend to generalize the obtained results from the sample to the population.

Key words: quantitative analysis; novice researchers; non-experimental designs; experimental designs, ; descriptive statistics,; inferential statistics.

Introduction

This participation seeks to demystify quantitative data analysis for novice researchers due to the fact that I noticed that some of them did not choose the quantitative data analysis methods corresponding to their research among the plethora of such kinds of analyses.

So, I decided to clarify this by answering the following questions:

1. What are the most important types of quantitative research/ Designs?
2. What are the most commonly used quantitative data analysis methods?
3. How to choose the appropriate data analysis?

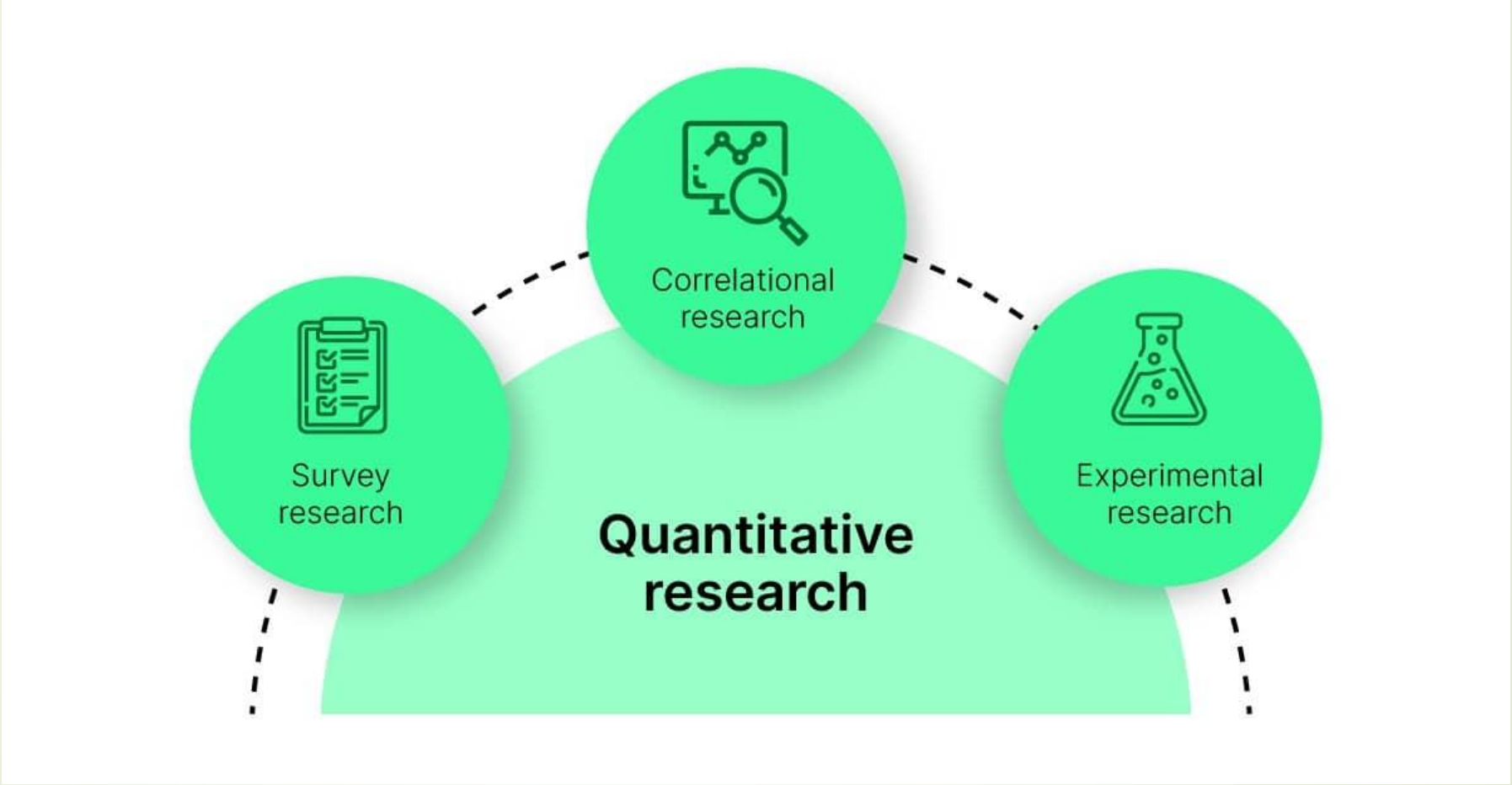
Definition of quantitative research

Quantitative research seeks **to describe situations**, **establish relationships between variables** or tries to **explain causal relationships**. Its purpose is narrow focusing on measurable variables.

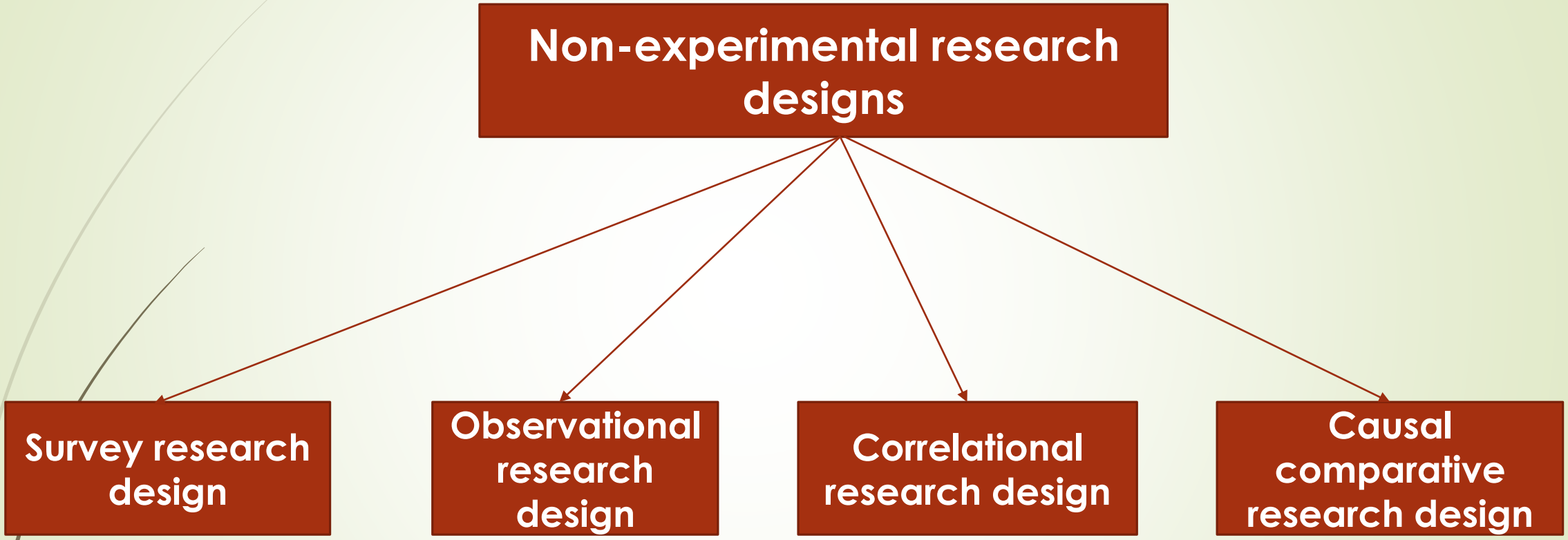
Quantitative research involves data collection procedures that result primarily in **numerical data** which is then analysed primarily using **statistical methods**. Typical example: survey research using a questionnaire, analysed by statistical software such as the SPSS (Dornëy, 2007, p. 24).

Types of quantitative research

The most important types of quantitative research are



The approaches used in quantitative research fall into two categories: Non-experimental research designs and experimental research designs.



Survey research design:descriptive research

- The goal of descriptive research is to describe a phenomenon and its characteristics. This kind of research **does not always require hypotheses**.
- This research is more concerned with **what** rather than how or why. Therefore, observation and survey tools are often used to gather data (Gall,Gall, & Borg, 2007).
- This kind of research may be qualitative, but it is often analyzed quantitatively using frequencies, percentages or statistical analysis to determine relationships.
- Such studies look at individuals, groups, institutions, methods and materials in order **to describe, compare, contrast, classify, analyse and interpret** the entities and the events that constitute their various fields of inquiry (Cohen, 2007, p. 205).
- Surveys are useful mainly for describing patterns **in large groups** rather than in-depth analysis of individual views (Guthrie, 2010 , p. 77).

Observational research

- The distinctive feature of observation as a research process is that it offers an investigator the opportunity to gather 'live' data from naturally occurring social situations (Cohen, 2007, p.396).
- The observation is important in the realm of quatitative research and it is also used to gather quantitative data. The occurrence of the participants behaviour can be counted to determine its frequency.
- A structured observation is very systematic and enables the researcher to generate numerical data from the observation.

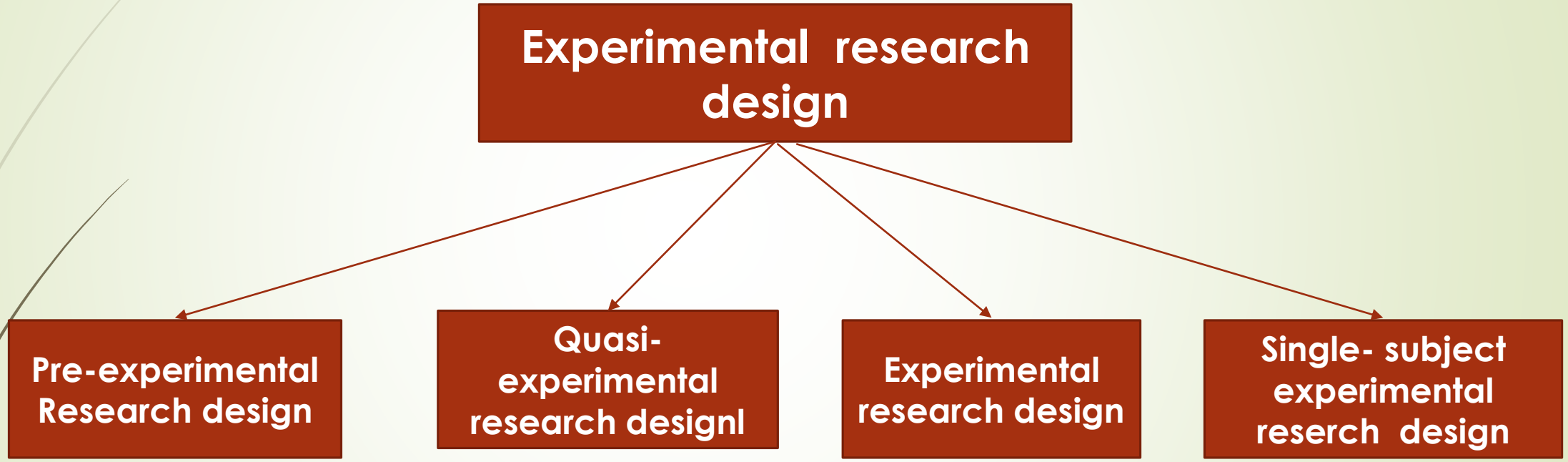
Correlational research

- Correlational research is a quantitative research in which the researcher aims to find out if there is a relationship between variables; its direction (whether it is positive or negative) and its strength.
- Correlational research is carried out for one of two basic purposes—either to help explain important human behaviors or to predict likely outcomes behaviors (Fraenkel, 2012, p. 332).
- This kind of research lacks manipulation.

Causal comparative research/ Ex post facto

A causal-comparative design is a research design that seeks to find relationships between independent and dependent variables after an action or event has already occurred (Salkind, 2010, p.214)

The experimental design consists of a group of techniques during which the researcher uses different treatments to see their effects on the dependent variable.



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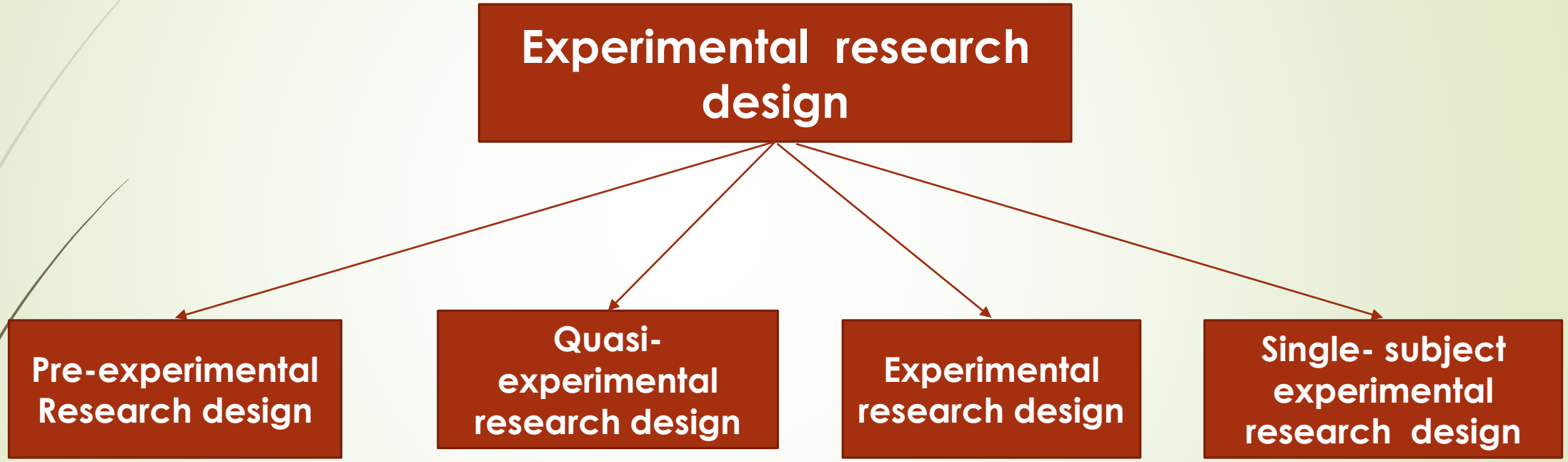
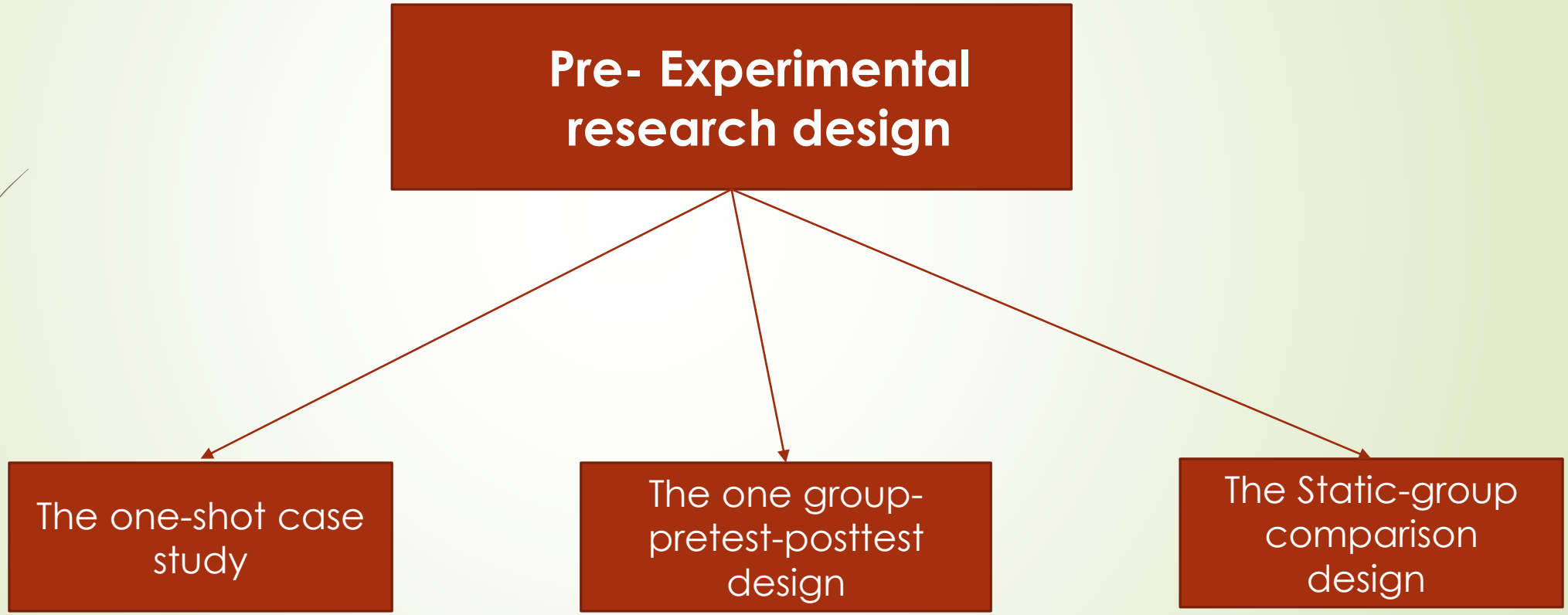


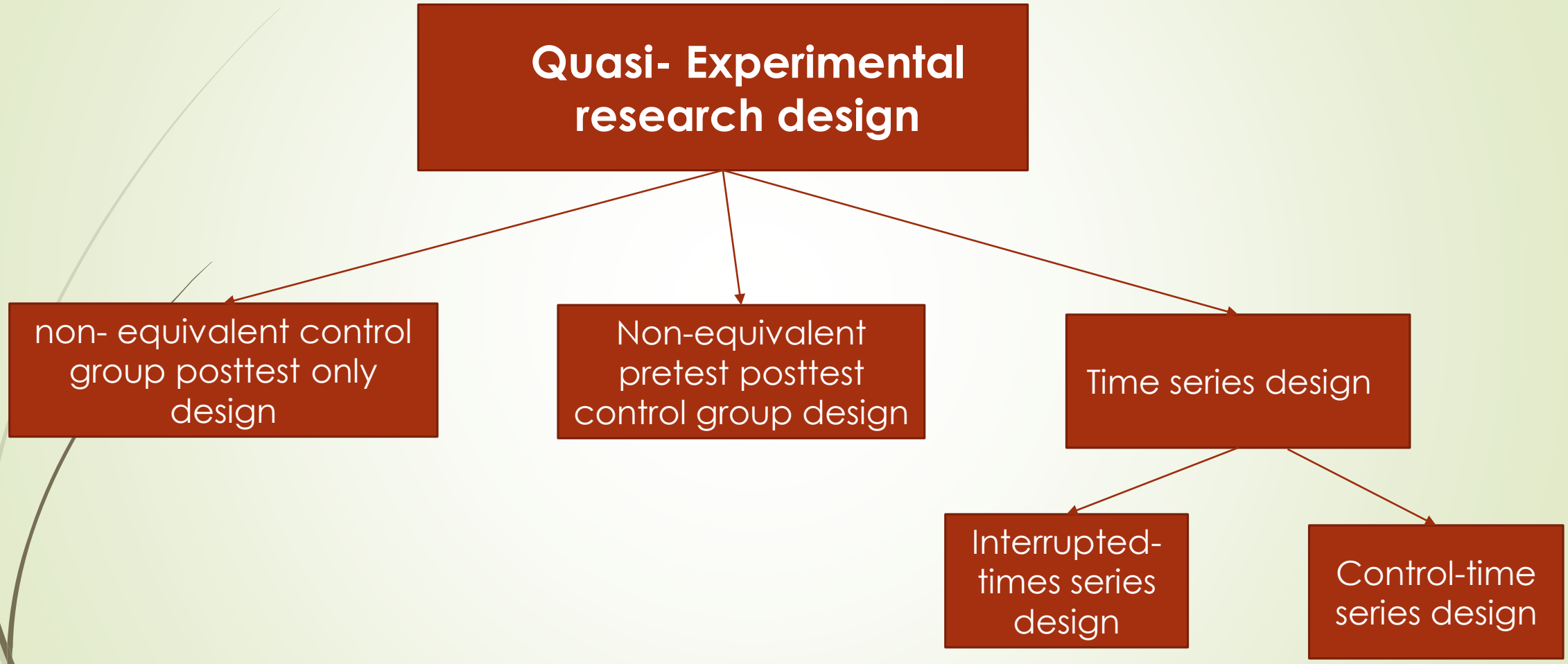
Pre-experimental research design

The pre-experimental research design is the simplest form of experimental research. It is a preliminary investigation of the problem before the main one. It is of three types



Quasi-experimental research design

The quasi-experimental research is similar to the experimental design but lacks randomization.

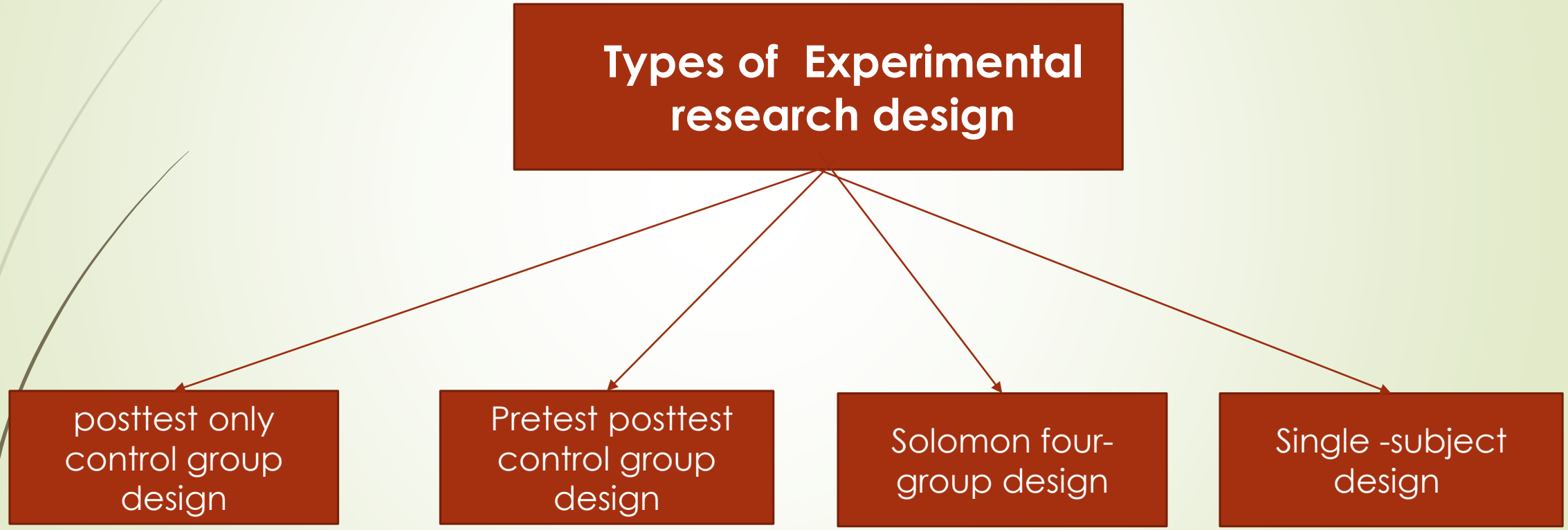


Types of quasi-experimental design

Type of quasi-experimental design	Description
Non-equivalent control group posttest only	Control group (not exposed to a treatment + experimental group (exposed to a treatment) / both posttested
Non-equivalent control group pretest-posttest	A pre-test is added to the first type
Basic -time series design	Observations are made over a period of time before after a treatment (no control group)
Interrupted time- series design	Many observations are made over a period of time before and after a treatment (no control group)
Control series design	A time series design with a non-equivalent control group

Experimental research design

True experimental research design involves choosing the participants randomly. Random assignement is one of the most powerful techniques for controlling extraneous threats to validity (Fraenkel et al, 2012).



- **The posttest- only control group design** : the participants are randomly assigned to the experimental and control group.
- **Pretest-posttest control group** design comprises at least two groups. It is considered the most powerful one
- **The solomon four- group design :** this involves four groups randomly selected. Two groups are pre-tested and two are not. Then, one the pre-tested and one of the non-tested receive the treatment. Finally all the four groups receive the posttest.
- **Single- subject research design** is a design that involves studying in detail the behavior of each of a small number of participants mainly in the field of psychology. It consists of measuring the dependent variable repeatedly over time and changing conditions to assess whether the participant's behaviour improved.

Among its types, the reversal design called ABA sudies the effect of a treatment on a certain behaviour, then it is removed and observations are made to check if the behaviour reverses to the initial phase.

Types of statistical analysis

We have already said that numerical data are statistically analyzed. They can be analyzed by means of: descriptive statistics and inferential statistics.

Descriptive statistics consists of methods for organizing, displaying and descibing data by using tables, graphs and summary methods.

Descriptive statistics are useful, for example, to describe the achievemenof a particular class of learners.

We **can't draw the inference** that girls are better than boys just by descriptive statistics, but to achieve this, we need to employ *inferential statistical procedures.*

Inferential statistics consists of methods that use sample results to help make decisions or prediction about a population (Mann & Lacke, 2010).

They are means by which we test hypotheses.

Inferential statisics is necessary for hypothesis testing

- Inferential statistics involves hypothesis testing.
- Making inferences about the population.

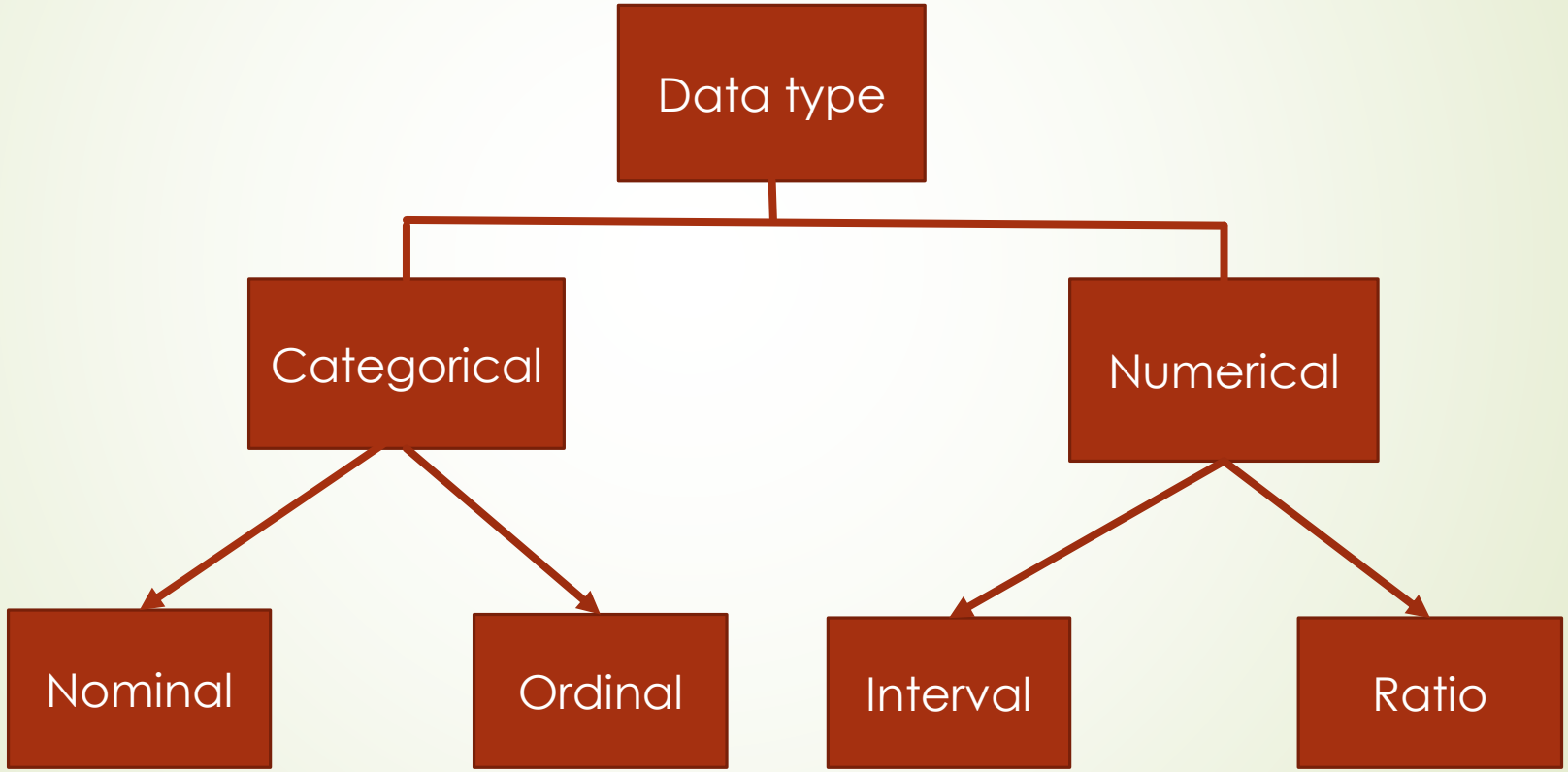
INFERENTIAL STATISTICS

1. Involves
   - Estimation
   - Hypothesis Testing
2. Purpose
   - Make Decisions About Population Characteristics

Inferential statistics

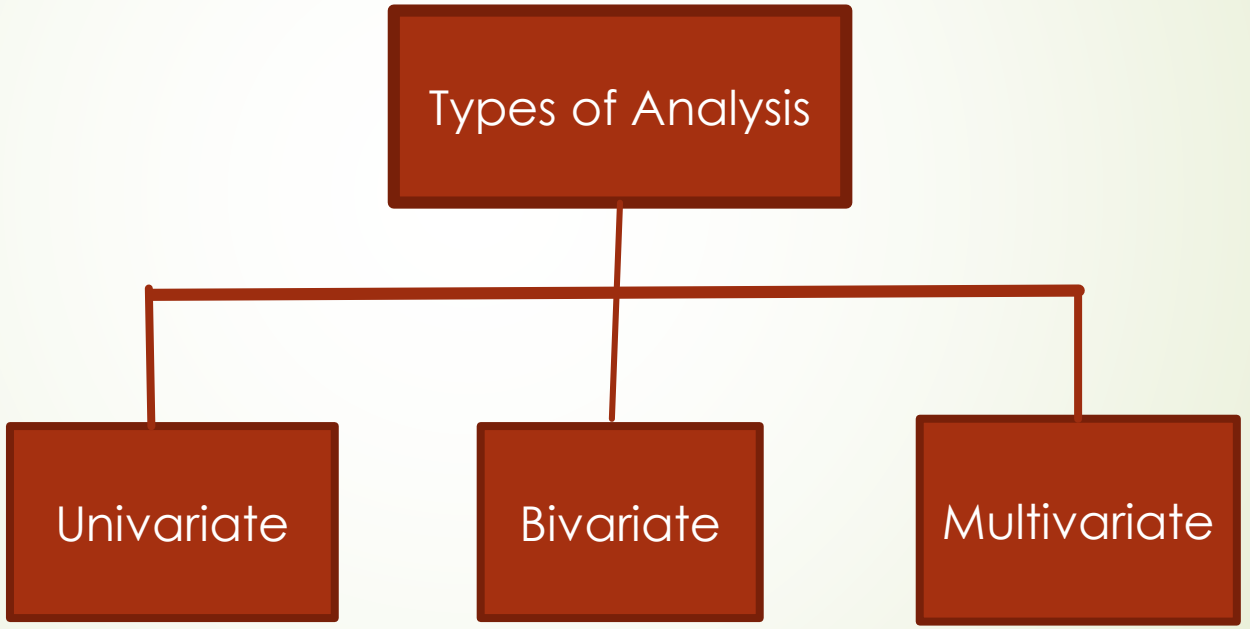
Inferential statistics are used to test hypotheses so as to generalize sample findings to the population.

For this purpose **statistical tests** are used based on the type of data, the number of variables, type of study designed (paired or unpaired)



Follow up

The types of analysis depends on the number of variables



There are three types of analysis depending on the number of variables

- **Univariate descriptive analysis**: a single variable is analyzed and the purpose is to describe central values and distribution of responses.

  It describes one aspect of research. Example: How many students have the average? (mean, median, mode and standard deviation)

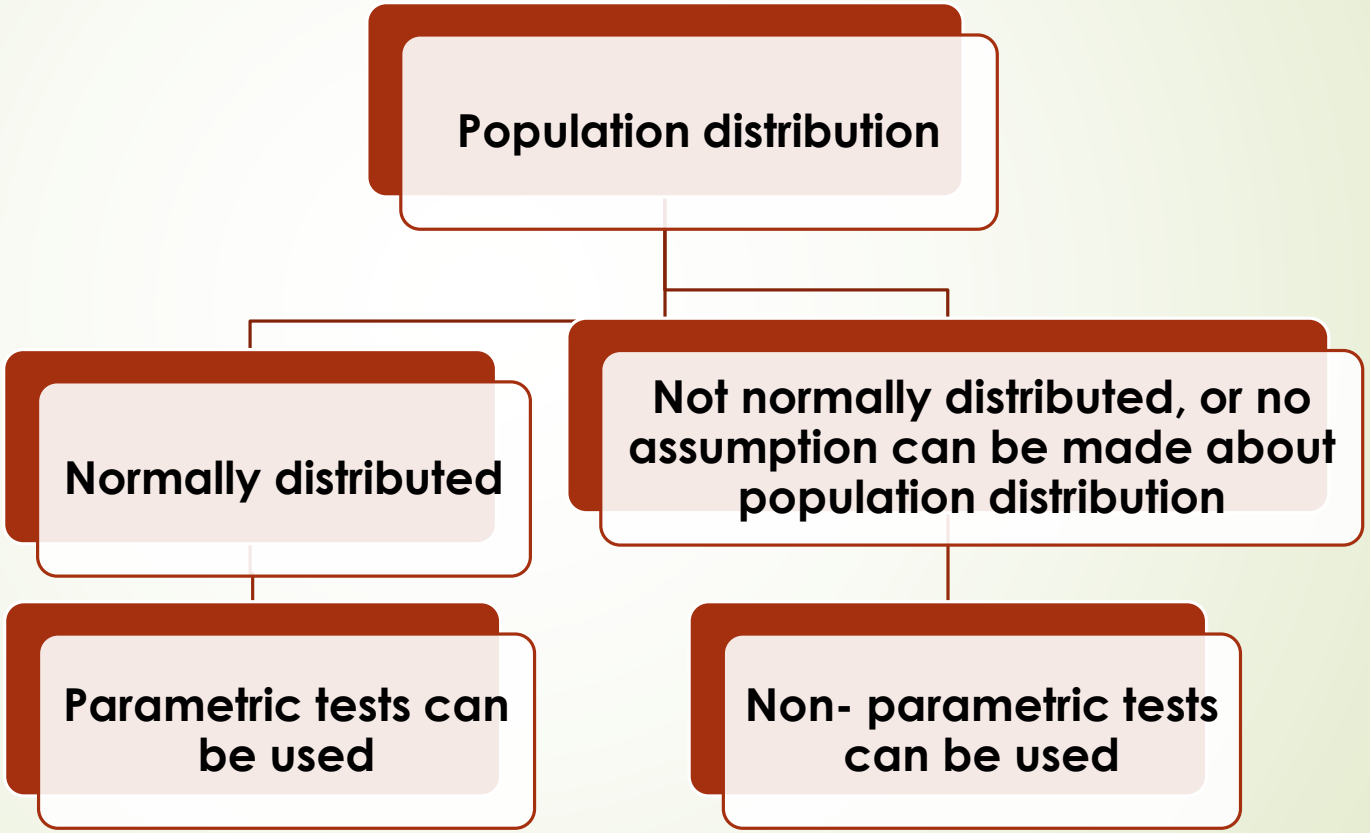
- **Bivariate analysis**: two variables are simultaneously analyzed and the purpose is to test **relational hypotheses** (**causal or associative**), i.e., find relationships between two variables.

- **Multivariate analysis:** more than two variables are analyzed and the purpose is to test relational hypotheses (causal or associative), i.e., find relationships between variables.

The most used in our context is:

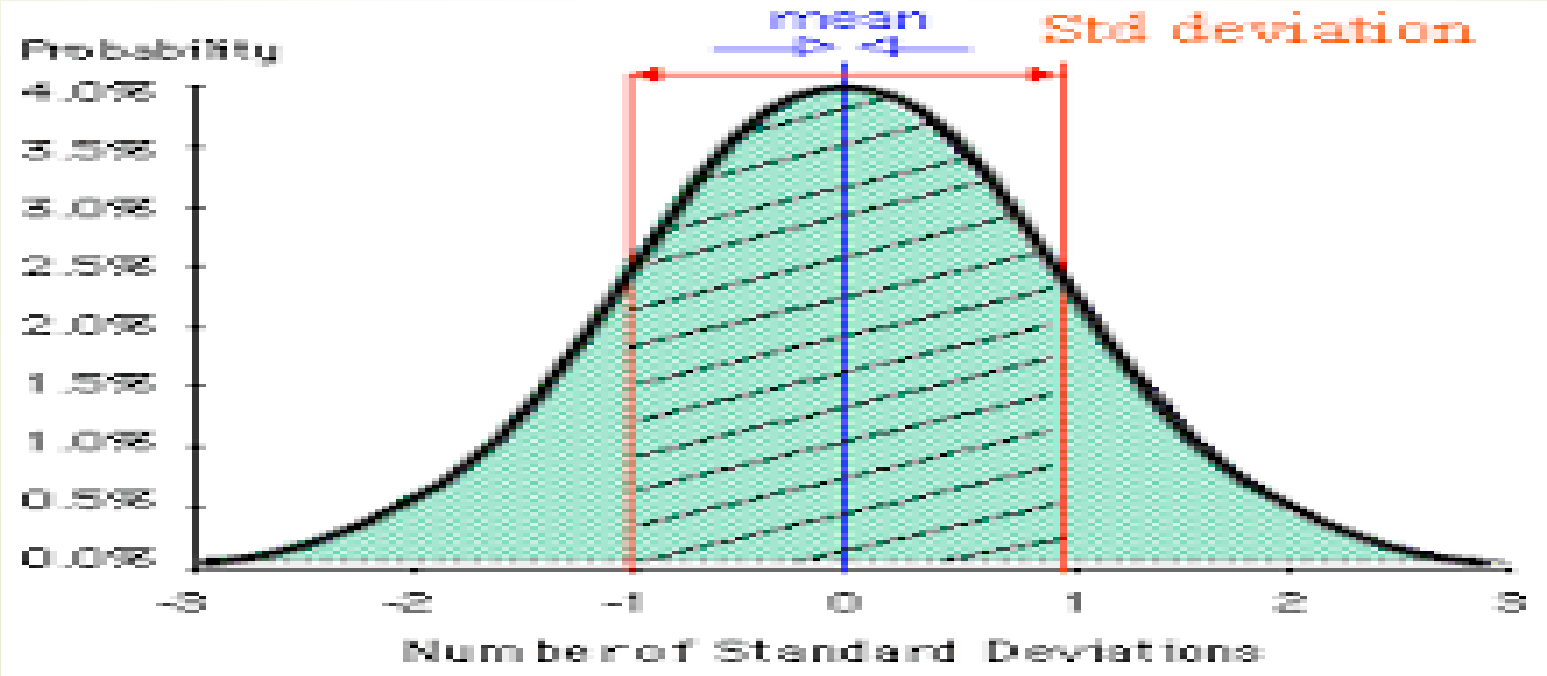
Bivariate analysis which allows, for example**, to test a hypothesis in correlational research or experimental research.**

One of the statistical tests assumptions is normality of data.We can choose either parametric or non-parametric tests depending on whether the population is normally ditributed or not.



Normal distribution is the most important probability in statistics.
It is an arrangement of a data set in which most values cluster around the central peak and the rest taper off symetrically toward either extreme

- The bell-shaped curve indicates that most values fall near the central value , with fewer from the centre and the rest fall symetrically.
- If the sample size is large, it is assumed that the distribution is normal.



Selecting Statistical Tests

Measurement Scale of the Dependent Variable	One Independent Variable				Two Independent Variables	
	Two Levels		More than 2 Levels		Factorial Designs	
	Two Independent Groups	Two Dependent Groups	Multiple Independent Groups	Multiple Dependent Groups	Independent Groups	Dependent Groups
Interval or Ratio	Independent t-test	Dependent t-test	One-Way ANOVA	Repeated Measures ANOVA	Two -Factor ANOVA	Two-Factor ANOVA Repeated Measures
Ordinal	Mann-Whitney U	Wilcoxon	Kruskal-Wallis	Friedman		
Nominal	Chi-Square		Chi-Square		Chi-Square	

Correlation coefficients

Choose Pearson correlation coefficient for continuous data normally distributed (parametric)

Choose Spearman Rank for ordinal data with one or both ordinal variables (non- parametric)

Steps to conduct a statistical test manually

- Calculate the statistical test using the appropriate formula to the one you selected.
- Calculate the degree of freedom.
- Determine the critical value (taking into consideration whether the hypothesis is one-tailed or two-tailed and the significant level 0.05 which is most of the time used.
- Compare the t-test value to the the critical value.

If the value of the t-test is greater than the critical value, the difference is significant so, you reject the null hypothesis.

This can be easily done by a software (like the SPSS), but it's important to know how.

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