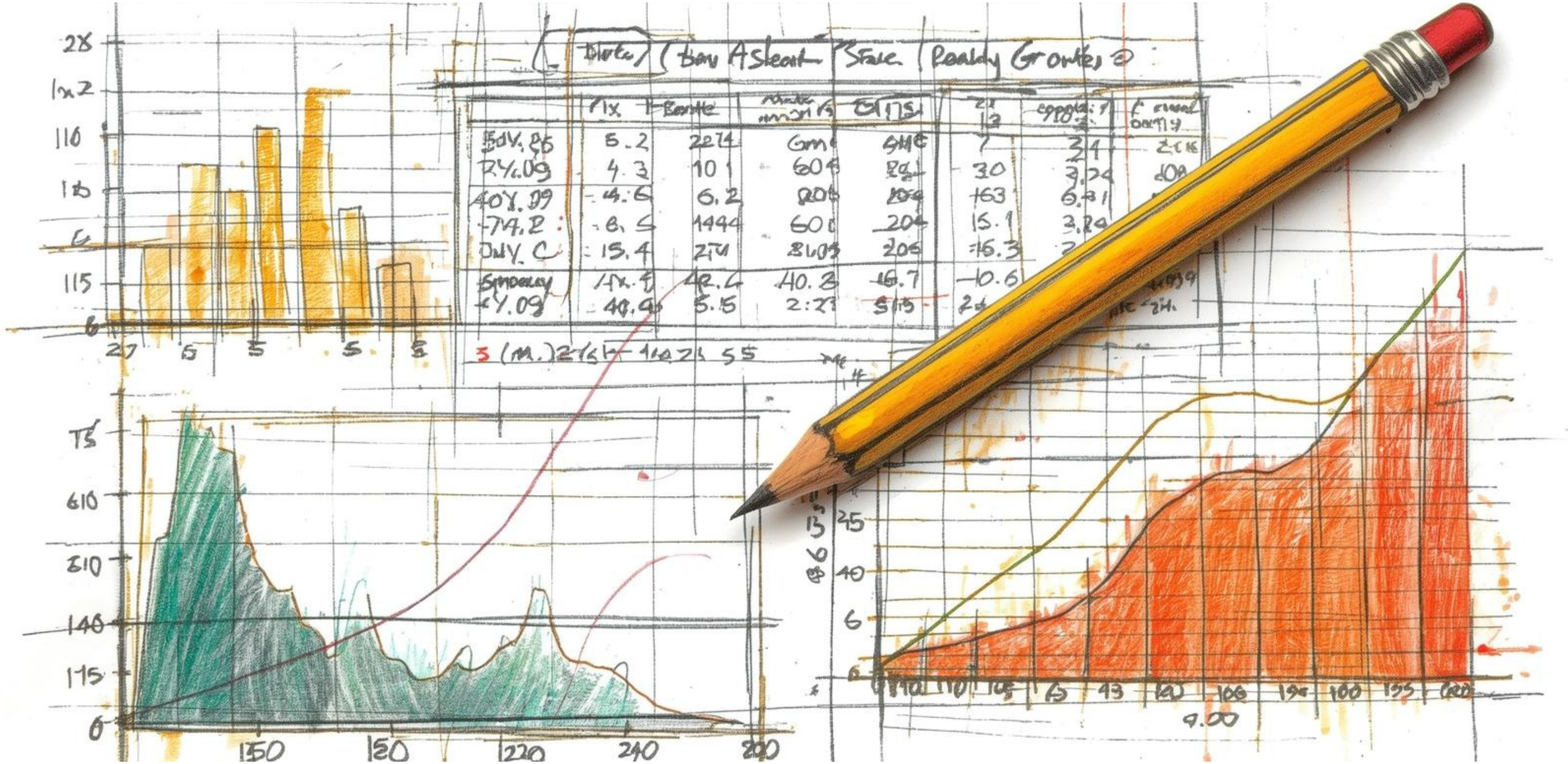


# Measurement, Data, Distributions, Tables, and Graphs

## Statistics

Assoc. Prof. Atanas Kirjakovski

# Grading System

## Course Evaluation

| Term | Percentage |
|---|---|
| Attendance | **15%** |
| Mid-term | **35%** |
| Final | **40%** |
| In-class Project Presentation | **10%** |
| Penalty Exam I | **100%** |
| Penalty Exam II | **100%** |
| MakeUp | **40%** |

### Exams

- Includes mid-term, final, makeup, excuse, upgrade, and penalty exams.
  - **Mid-term Exam:** Covers course content taught before the exam.
  - **Final Exam:** Covers all course content from the entire semester.
  - **Make-up Exam:** Equivalent to the final exam, replaces final exam results.
  - **Excuse Exam:** For students who missed mid-terms due to documented reasons.
  - **Upgrade Exam:** For students with final grades between 30.00 and 49.99, applicable to two courses per semester.
  - **Penalty Exam:** Extra exam for students who fail a course and need to retake it.
- Special provisions are available for graduating students, those with disabilities, and students needing to retake failed courses.

### Grading

- Based on semester activities, midterm, and final exams.
- Minimum 40 points from final exam required to pass a course.
- Minimum 50 points from all required to pass a course.

### Grade Announcements

- Grades are entered into the HELLO system and can be appealed within 48 hours.
- Students can object the grades via online tool in 48 hours after the grades are announced.

# Grade Calculation

| | Percent | Hypothetical Points | Subtotal Points |
|---|---|---|---|
| **Attendance** | 15% | 100 | 15 |
| **Midterm** | 35% | 60 | 21 |
| **Final** | 40% | 85 | 34 |
| **In-class** | 10% | 100 | 10 |
| | | **Total** | **80** |

# https://ibu.kirjakovski.mk

## Prof. Kirjakovski IBU Blog

### 2021

| | | |
|---|---|---|
| Jun 12 | MAKE-UP EXAM: Computer Aided Education | Computer Aided Education (2020/2021) |
| Jun 04 | IMPORTANT: Repeated Final Exam for Some Students | Social Psychology (2020/2021) |
| May 24 | LECTURE 11: Organizational Theory, Dynamics, and Change | Organizational Psychology (2020/2021) |
| May 20 | COURSE EVALUATION: Organizational Psychology | Organizational Psychology (2020/2021) |
| May 20 | FINAL EXAM: Computer Aided Education | Computer Aided Education (2020/2021) |

SCAN ME

**DO NOT RE-UPLOAD THE CONTENT!**

# Academic Calendar

- 7 *Oct 2025, Week 1*
  **DATA, MEASUREMENT, TABLES, AND GRAPHS**
- 14 *Oct 2025, Week 2*
  **CENTRAL TENDENCY AND VARIABILITY**
- 21 *Oct 2025, Week 3*
  **BASICS OF INFERENTIAL STATISTICS**
- 28 *Oct 2025, Week 4*
  **INTRODUCTION TO HYPOTHESIS TESTING**
- 4 *Nov 2025, Week 5*
  **HYPOTHESIS TESTS WITH MEANS OF SAMPLES**
- **MIDTERM EXAMS (10–15 NOV 2025)**
- **EXCUSE EXAMS (24–28 NOV 2025)**
- 18 *Nov 2025, Week 6*
  **STATISTICAL SIGNIFICANCE: DECISION ERRORS, EFFECT SIZE, AND STATISTICAL POWER**
- 25 *Nov 2025, Week 7*
  **INTRODUCTION TO T TESTS: SINGLE SAMPLE AND DEPENDENT MEANS**
- 2 *Dec 2025, Week 8*
  **THE T TEST FOR INDEPENDENT MEANS**
- 9 *Dec 2025, Week 9*
  **INTRODUCTION TO THE ANALYSIS OF VARIANCE**
- 16 *Dec 2025, Week 10*
  **CORRELATION AND REGRESSION**
- 23 *Dec 2025, Week 11*
  **CHI-SQUARE TESTS**
- 30 *Dec 2025, Week 12*
  **NON-PARAMETRIC STATISTICS**
- **WINTER BREAK (31 DEC 2025 – 9 JAN 2026)**
- **FINAL EXAMS (12–17 JANUARY 2026)**
- **MAKEUP EXAMS (19–24 JAN 2026)**

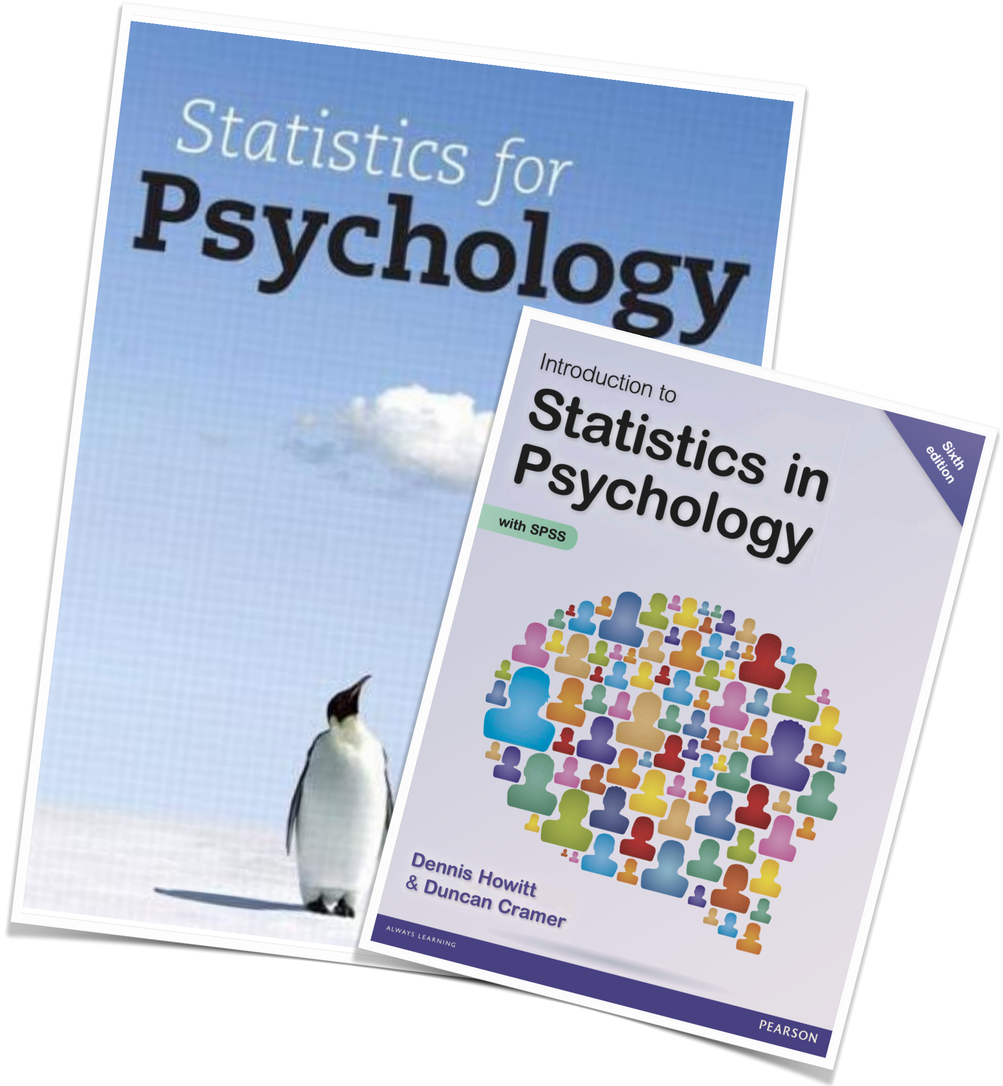
# Textbook and software

- **Main textbook:**
  Aron, A., Coups, E. J., & Aron, E. (2013). *Statistics for psychology* (6th ed). Pearson.

- **Supplementary textbook:**
  Howitt, D., & Cramer, D. (2014). *Introduction to statistics in psychology: With SPSS* (6th Edition). Pearson.

- **<u>Bring your laptops to class!</u>**

- Excel, Jamovi, R, plain text editor (Windows: e.g., Notepad++, macOS: e.g., Textmate)



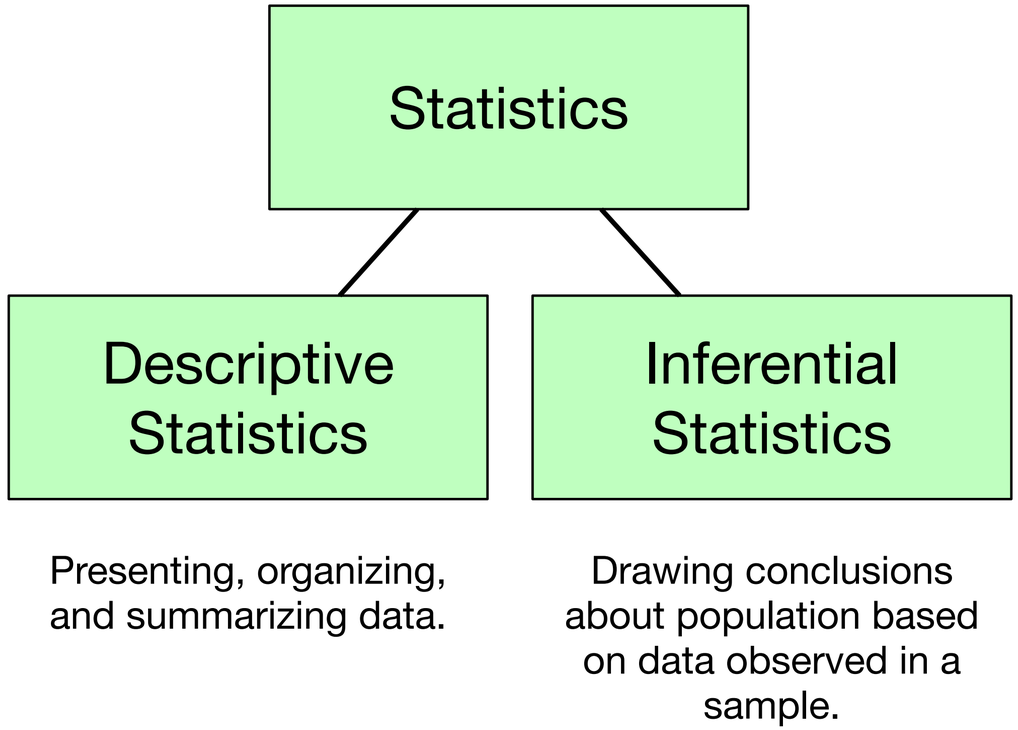
# PLEASE SILENCE YOUR PHONE

# Why Study Statistics?

- To be able to effectively conduct research.
- To be able to read and understand scientific journals.
- To further develop critical and analytic thinking skills.
- To be an informed citizen.
- Statistics is a method of pursuing truth.

# Basic Definitions

- **Statistics is a branch** of mathematics that focuses on organizing, analyzing, and interpreting a group of numbers. **Descriptive statistics summarize** a group of scores or make them more understandable. **Inferential statistics draw** conclusions based on research study scores but go beyond them.



# Data, Variable, Values, Score

- **Data (sing. datum):** Observations or measurements, usually quantified and obtained in the course of research.
- **Quantitative data:** Tests, rating scales, questionnaires, physiological measures, reaction time, accuracy measurements…
- **Qualitative data:** Observations, interviews, case studies, analysis of diaries or written documents…
- **Variable:** Characteristic that can have different values.
- **Values:** Possible number or category that a score can have.
- **Score:** Particular person's value on a variable.
- **Discrete variable:** Variable that has specific values and that cannot have values between these specific values.
- **Continuous variable:** Variable for which, in theory, there are an infinite number of values between any two values.
- **Stacked** (long format) vs **unstacked data** (wide format).

| Stacked Data | | | Unstacked Data |
|---|---|---|---|
| **Country** | **Continent** | | **Africa** |
| Algeria | Africa | | Algeria |
| Angola | Africa | | Angola |
| Benin | Africa | | Benin |
| Botswana | Africa | | Botswana |
| Burkina Faso | Africa | | Burkina Faso |
| Burundi | Africa | | Burundi |
| Cabo Verde/Cape Verde | Africa | | Cabo Verde/Cape Verde |
| Cameroon | Africa | | Cameroon |
| Central African Republic | Africa | | Central African Republic |
| Chad | Africa | | Chad |
| Comoros | Africa | | Comoros |
| Congo/Republic of the Congo | Africa | | Congo/Republic of the Congo |
| Democratic Republic of the Congo | Africa | | Democratic Republic of the Cong |
| Djibouti | Africa | | Djibouti |
| Egypt (transcontinental - generally consid | Africa | | Egypt (transcontinental - general |
| Equatorial Guinea | Africa | | Equatorial Guinea |
| Eritrea | Africa | | Eritrea |
| Eswatini (formerly Swaziland) | Africa | | Eswatini (formerly Swaziland) |
| Ethiopia | Africa | | Ethiopia |
| Gabon | Africa | | Gabon |
| Gambia, The | Africa | | Gambia, The |
| Ghana | Africa | | Ghana |
| Guinea | Africa | | Guinea |
| Guinea-Bissau | Africa | | Guinea-Bissau |
| Ivory Coast/Republic of Côte d'Ivoire | Africa | | Ivory Coast/Republic of Côte d'Iv |
| Kenya | Africa | | Kenya |
| Lesotho | Africa | | Lesotho |

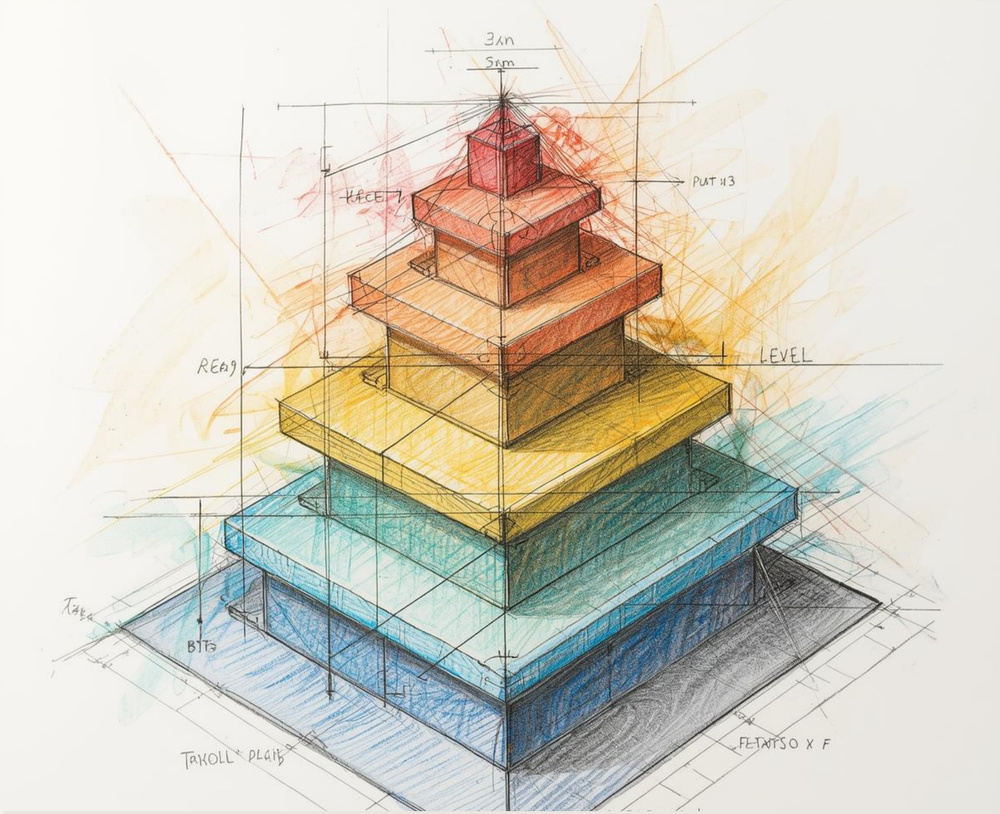
# Levels of Measurement (Types of Variables)

- **Measurement:** “Assignment of numerals to objects or events according to rules” (Stevens, 1946, p. 677). Appraising the extent of something, often expressed as a numerical value.

- **Levels of measurement:** Types of underlying numerical information provided by a measure, such as (equal) interval, rank-order (ordinal), and nominal (categorical).

- **Numeric variable:** Variable whose values are numbers (as opposed to a nominal variable). Also called quantitative variable.

- **Nominal variable:** Variable with values that are categories (that is, they are names rather than numbers). Also called categorical variable.




*Stevens, S. S. (1946). On the theory of scales of measurement. Science, 103(2684), 677–680. https://doi.org/10.1126/science.103.2684.677*

# Levels of Measurement

- **Nominal measures** are used to distinguish categories without any real numerical meaning. Examples include sex, marital status, ethnicity, education, therapy type, etc.

- **Ordinal measures** represent a rank order of properties, such as customer satisfaction, sports performance, symptoms severity, socioeconomic status, education level, or Likert-type scales.

- **Interval measures have** distinctiveness, order, and equal intervals, but no true zero point. Examples include IQ scores, temperature (°C or °F), calendar years, test scores, personality test scores, etc.

- **Ratio measures have all** the properties of interval measures, plus a true zero point that represents the absolute absence of the property. Examples include reaction time, age, height, weight, income, test scores, children, distance traveled, etc.

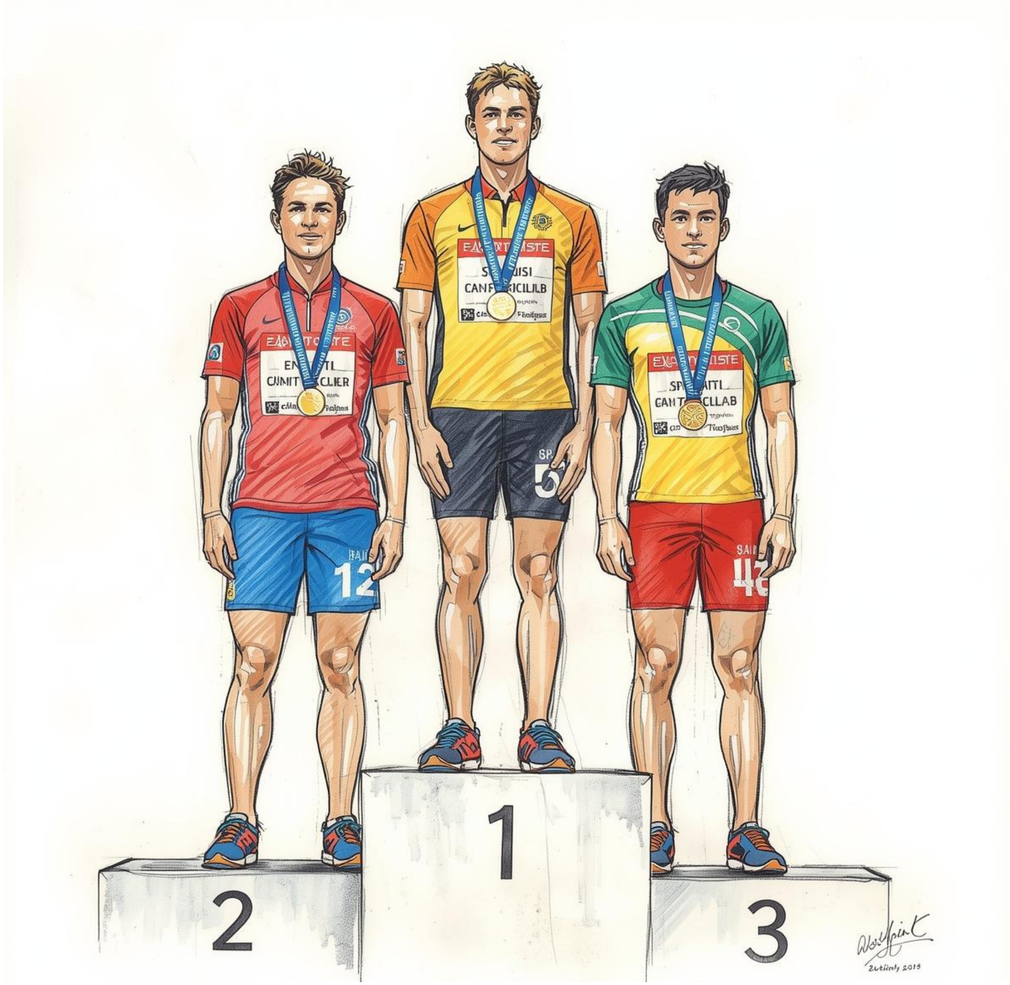
*Stevens, S. S. (1946). On the theory of scales of measurement. Science*, 103(2684), 677–680. https://doi.org/10.1126/science.103.2684.677

# Nominal Level

- Biological sex (male, female)
- Ethnicity (Asian, European, African, etc.)
- Marital status (single, married, divorced, widowed)
- Therapy type (CBT, psychodynamic, behavior therapy)
- Major field of study (psychology, biology, economics)
- Political orientation (liberal, conservative, centrist)
- Smoking status (smoker, nonsmoker)
- Blood type (A, B, AB, O)

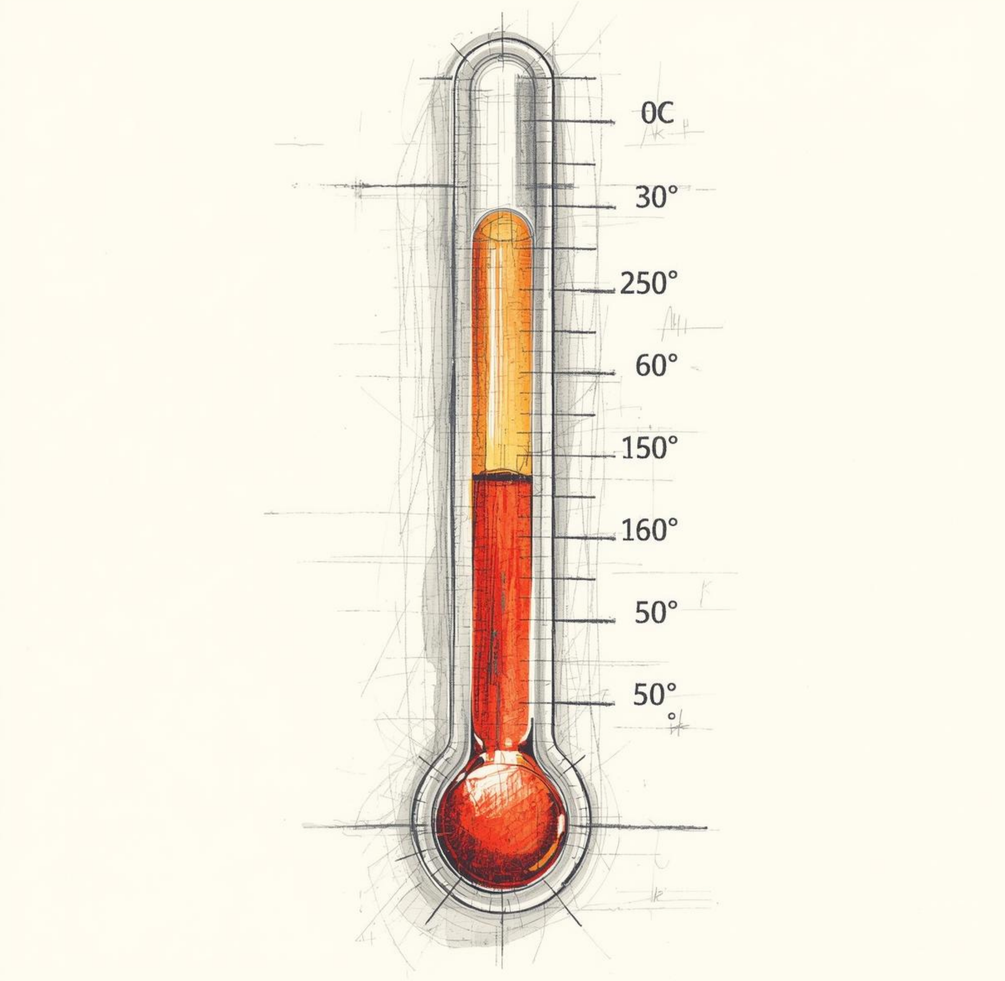
# Ordinal Level

- Educational attainment (primary, secondary, tertiary)
- Socioeconomic status (low, middle, high)
- Symptom severity (mild, moderate, severe)
- Customer satisfaction (unsatisfied to very satisfied)
- Likert-type scale responses (strongly disagree to strongly agree)
- Competition placement (1st, 2nd, 3rd)
- Pain intensity (none, slight, moderate, severe)
- Performance rating (poor, fair, good, excellent)



# Interval Level

- Intelligence quotient (IQ)
- Temperature in °C or °F
- Calendar year (1990, 2000, 2010)
- Psychological test scores without absolute zero (e.g., anxiety or depression scales)
- SAT scores
- Likert-scale total score treated as interval in research
- Time of day (measured on a 12-hour clock)
- Difference scores (e.g., pre–post change score)



# Ratio Level

- Age (years)
- Reaction time (milliseconds)
- Weight (kg, lbs)
- Height (cm, m)
- Distance (meters, kilometers)
- Number of children
- Income (in euros, dollars)
- Time spent studying (minutes, hours)
- Number of errors in a task
- Duration of sleep (hours)

# Frequency Tables

- **Frequency table:** Ordered listing of number of individuals having each of the different values for a particular variable.
- **Grouped frequency table:** Frequency table in which the number of individuals (frequency) is given for each interval of values.
- **Interval:** Range of values in a grouped frequency table that are grouped together.

| Stress Rating |
|---|
| 0 |
| 1 |
| 2 |
| 3 |
| 4 |
| 5 |
| 6 |
| 7 |
| 8 |

**Table 1-7** Grouped Frequency Table for Numbers of Social Interactions During a Week for 94 College Students

| Interval | Frequency | Percent |
|---|---|---|
| 0–4 | 12 | 12.8 |
| 5–9 | 16 | 17.0 |
| 10–14 | 16 | 17.0 |
| 15–19 | 16 | 17.0 |
| 20–24 | 10 | 10.6 |
| 25–29 | 11 | 11.7 |
| 30–34 | 4 | 4.3 |
| 35–39 | 3 | 3.2 |
| 40–44 | 3 | 3.2 |
| 45–49 | 3 | 3.2 |

*Source*: Data from McLaughlin-Volpe et al. (2001).

# Frequency Tables Counts

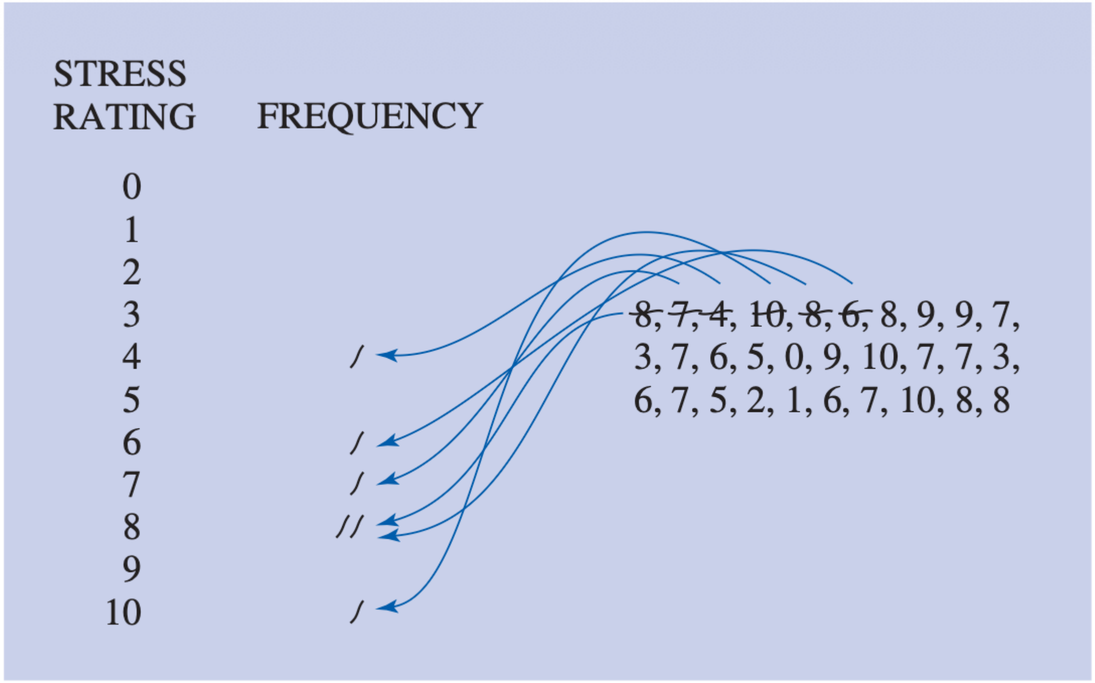



**Figure 1-1** Making a frequency table for the stress ratings scores. (Data based on Aron, Paris, and Aron, 1995.)

| | | |
|---|---|---|
| 0 - | 17 - //// | 34 - |
| 1 - // | 18 - 𝍸 | 35 - // |
| 2 - / | 19 - //// | 36 - |
| 3 - 𝍸 | 20 - | 37 - |
| 4 - //// | 21 - //// | 38 - / |
| 5 - /// | 22 - /// | 39 - |
| 6 - // | 23 - / | 40 - / |
| 7 - // | 24 - // | 41 - / |
| 8 - 𝍸 / | 25 - /// | 42 - |
| 9 - /// | 26 - // | 43 - |
| 10 - 𝍸 / | 27 - / | 44 - / |
| 11 - //// | 28 - / | 45 - |
| 12 - / | 29 - //// | 46 - |
| 13 - // | 30 - // | 47 - // |
| 14 - /// | 31 - | 48 - / |
| 15 - / | 32 - / | |
| 16 - // | 33 - / | |

**Figure 1-2** Making a frequency table of students' social interactions over a week. (Data from McLaughlin-Volpe et al., 2001.)

# Grouped Frequency Tables

**Table 1-3** Frequency Table of Number of Students Rating Each Value of the Stress Scale

| Stress Rating | Frequency | Percent |
|---|---|---|
| 0 | 1 | 3.3 |
| 1 | 1 | 3.3 |
| 2 | 1 | 3.3 |
| 3 | 2 | 6.7 |
| 4 | 1 | 3.3 |
| 5 | 2 | 6.7 |
| 6 | 4 | 13.3 |
| 7 | 7 | 23.3 |
| 8 | 5 | 16.7 |
| 9 | 3 | 10.0 |
| 10 | 3 | 10.0 |

*Source*: Data based on Aron et al. (1995).

**Table 1-6** Grouped Frequency Table for Stress Ratings

| Stress Rating Interval | Frequency | Percent |
|---|---|---|
| 0–1 | 2 | 6.7 |
| 2–3 | 3 | 10.0 |
| 4–5 | 3 | 10.0 |
| 6–7 | 11 | 36.7 |
| 8–9 | 8 | 26.7 |
| 10–11 | 3 | 10.0 |

*Source*: Data based on Aron et al. (1995).

**Frequency Tables for Nominal Variables can be also done.**

**Table 1-4** Frequency Table for a Nominal Variable: Closest Person in Life for 208 Students

| Closest Person | Frequency | Percent |
|---|---|---|
| Family member | 33 | 15.9 |
| Nonromantic friend | 76 | 36.5 |
| Romantic partner | 92 | 44.2 |
| Other | 7 | 3.4 |

*Source*: Data from Aron et al. (1992).

# Grouped Frequency Tables Intervals

- When there are many possible values, data are summarized using intervals (bins), each representing a range of values. For example, instead of individual stress ratings of 8, 9, and 10, you can group them as an interval like 8–9 or 8–10.

- How to select intervals and ranges:

  - The interval size (bin width) should be a round number (like 2, 5, or 10).

  - Aim for about 5 to 15 intervals for the grouped frequency table.

  - Each interval should start with a multiple of the interval size, and the upper end should be just below the start of the next interval (e.g., for size 2: 0–1, 2–3, 4–5, etc.).

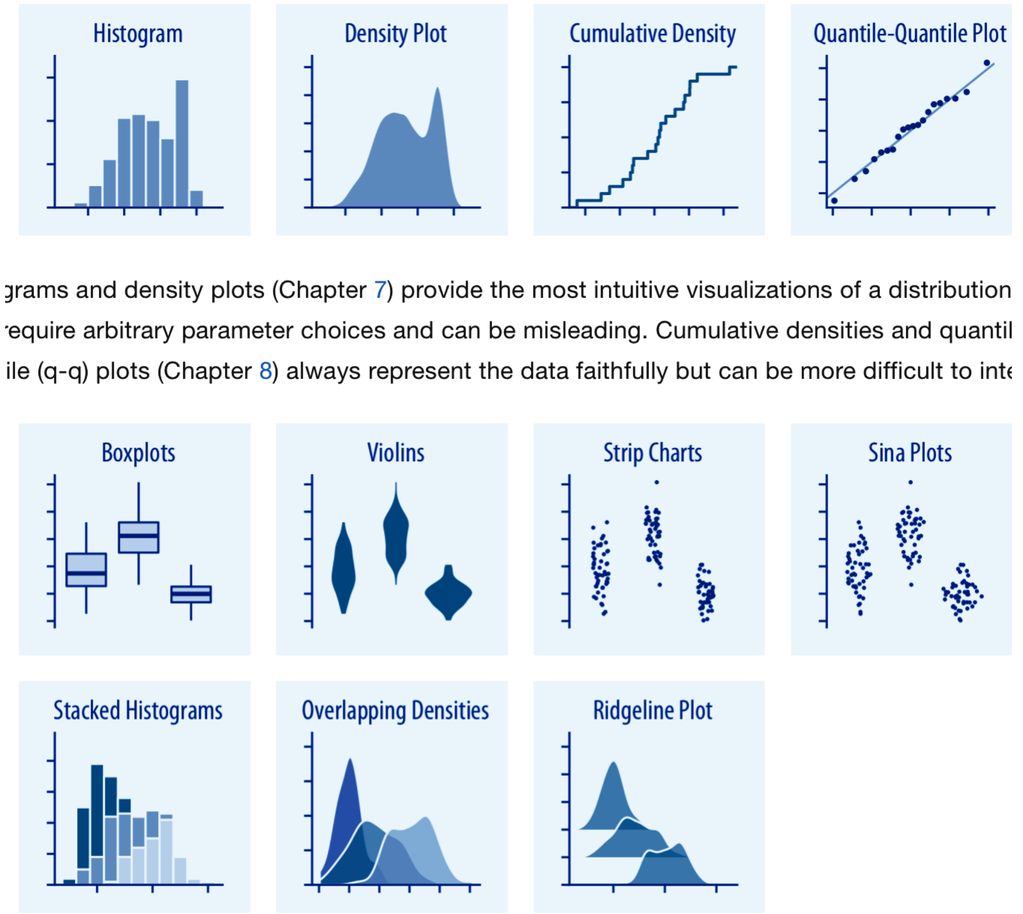
  - For size 5: 0–4, 5–9, 10–14, and so on.

  - The selection of interval size is sometimes experimental: adjust it until you reach intervals that both use round numbers and a manageable number of bins.

# Graphs

- A **graph is a** visual representation of a relationship between numbers or quantities plotted on a drawing with axes at right angles (x-axis and y-axis) and linked by lines, dots, or similar elements. Examples include bar graphs, histograms, and frequency polygons.

- **A histogram is a bar**-like graph of a frequency distribution. The values are plotted along the horizontal axis, and the height of each bar represents the frequency of that value. The bars are usually placed next to each other without spaces, resembling a city skyline.

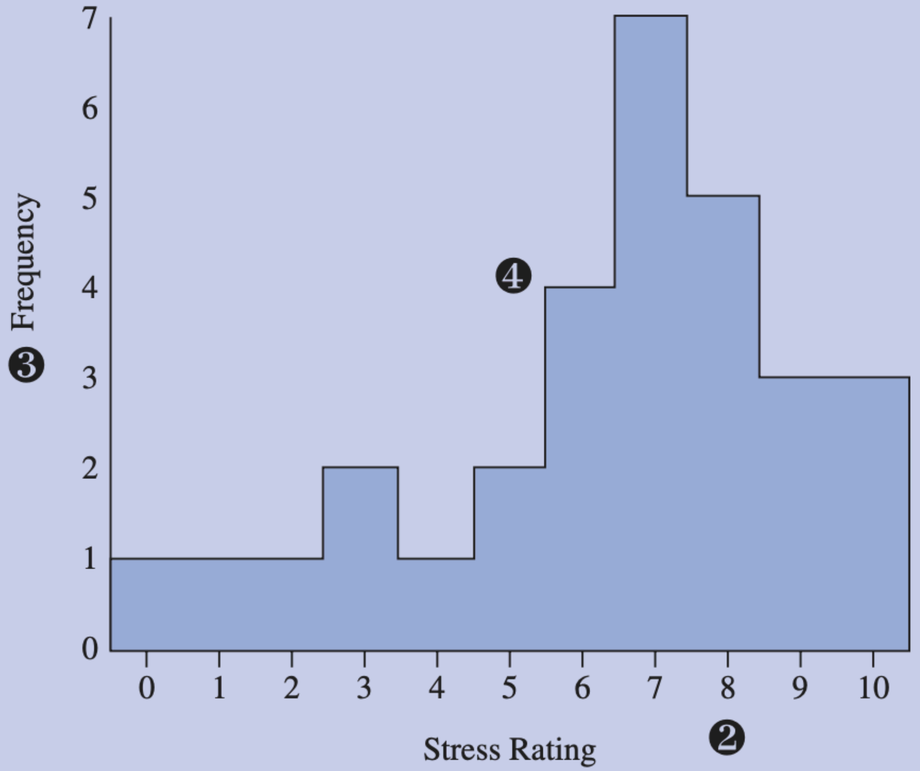


# Histograms

(a) Frequency Table

❶

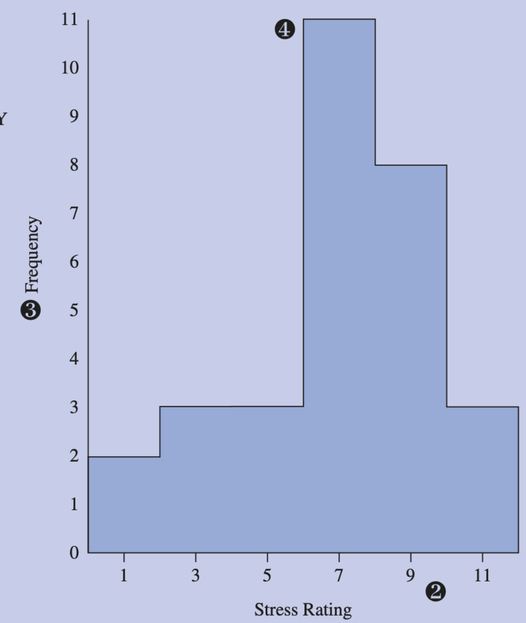
| STRESS RATING | FREQUENCY |
|---|---|
| 0 | 1 |
| 1 | 1 |
| 2 | 1 |
| 3 | 2 |
| 4 | 1 |
| 5 | 2 |
| 6 | 4 |
| 7 | 7 |
| 8 | 5 |
| 9 | 3 |
| 10 | 3 |

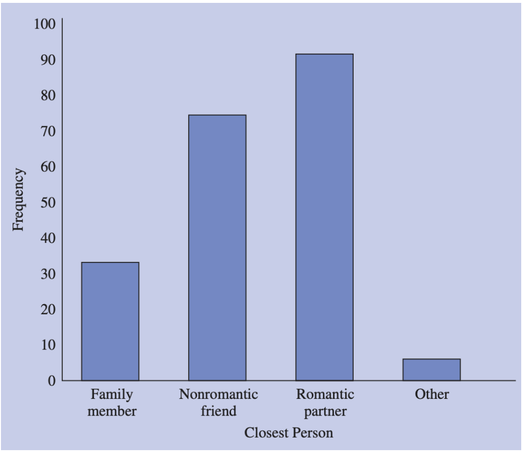



(b) Grouped Frequency Table

❶

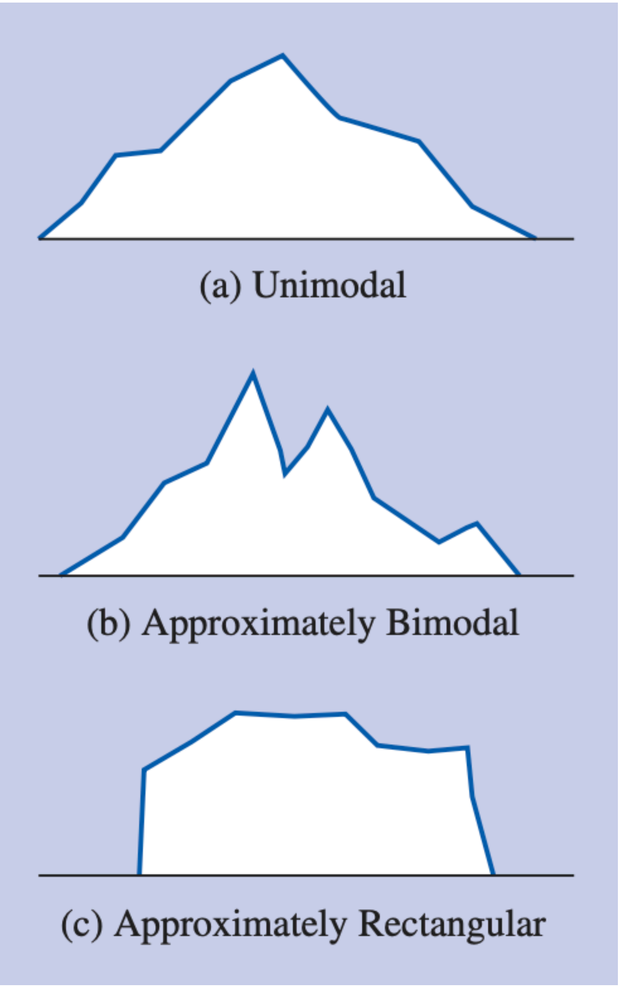
| STRESS RATING INTERVAL | FREQUENCY |
|---|---|
| 0 – 1 | 2 |
| 2 – 3 | 3 |
| 4 – 5 | 3 |
| 6 – 7 | 11 |
| 8 – 9 | 8 |
| 10 – 11 | 3 |



# Frequency Distributions

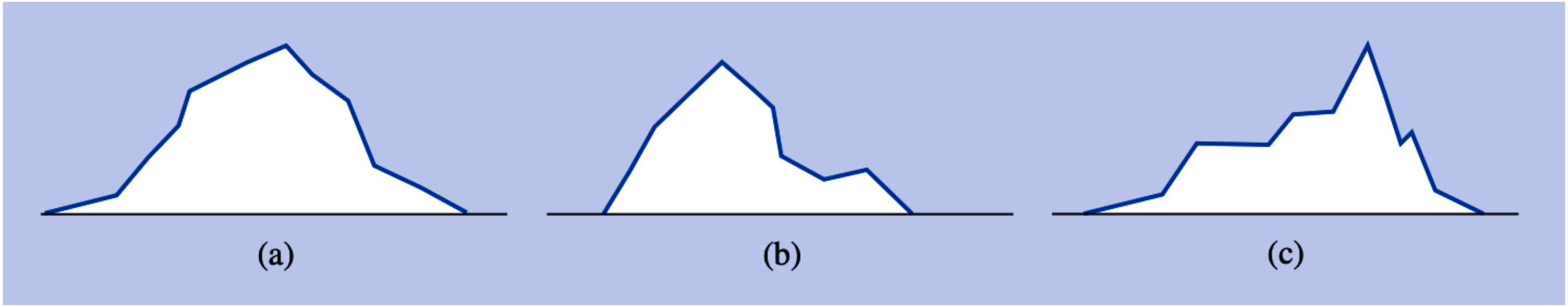
- **Frequency distribution describes the pattern** of frequencies over various values, as shown in frequency tables, histograms, or frequency polygons.
- **Unimodal distribution has** one value with a higher frequency than others. Examples include reaction times, IQ scores, memory recall, and Likert scale responses.
- **Bimodal distribution has** two values with approximately equal frequencies, each higher than the others. Examples include sleep patterns across age groups, test scores with distinct subgroups, perception of ambiguous figures, and response to treatments (placebo vs. active drug).
- **Multimodal distribution has** two or more high frequencies separated by a lower frequency. A bimodal distribution is a special case with two high frequencies. Examples include personality traits across cultures, learning style preferences, attachment styles in adults, and cognitive task performance in different age groups.
- **Uniform distribution (also rectangular distribution) has** all values with approximately the same frequency. Examples include random guessing on multiple-choice tests, random word presentation for memory recall, and random behavioral choices.



# Symmetrical and Skewed Distributions

- **Symmetrical distribution:** Distribution in which the pattern of frequencies on the left and right side are mirror images of each other.

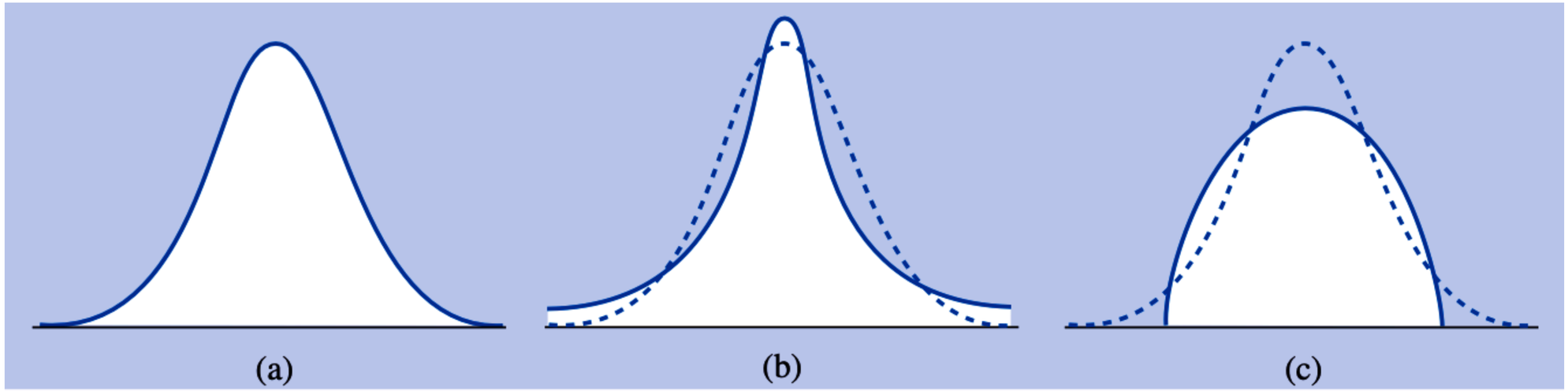
- **Skewed distribution:** Distribution in which the scores pile up on one side of the middle and are spread out on the other side; distribution that is not symmetrical.



# Normal and Kurtotic Distributions

- **Normal curve:** Specific, mathematically defined, bell-shaped frequency distribution that is symmetrical and unimodal; distributions observed in nature and in research commonly approximate it.

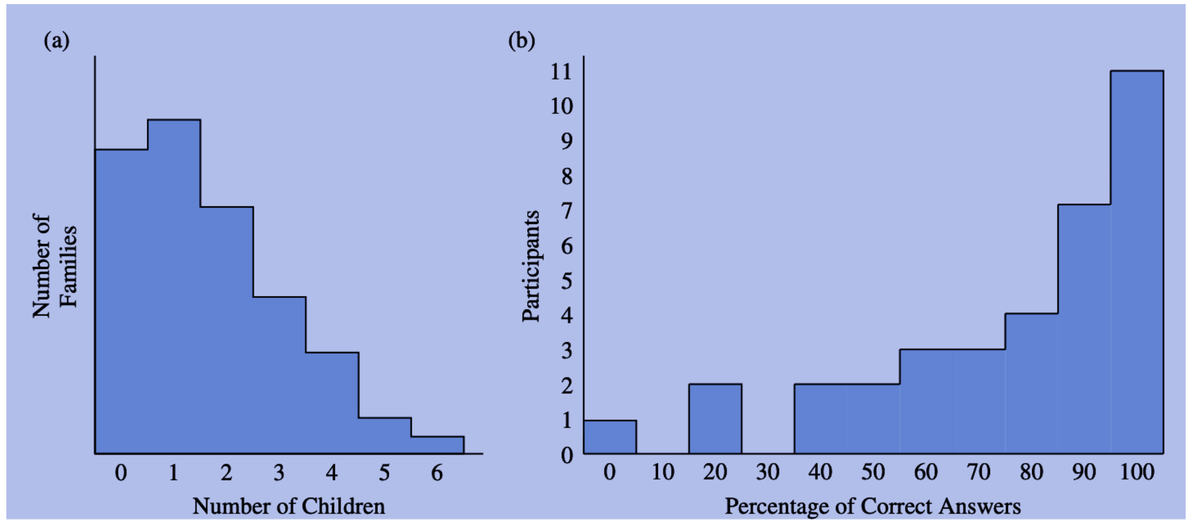
- **Kurtosis:** Extent to which a frequency distribution deviates from a normal curve in terms of whether its curve in the middle is more peaked or flat than the normal curve.



# Floor and Ceiling Effect

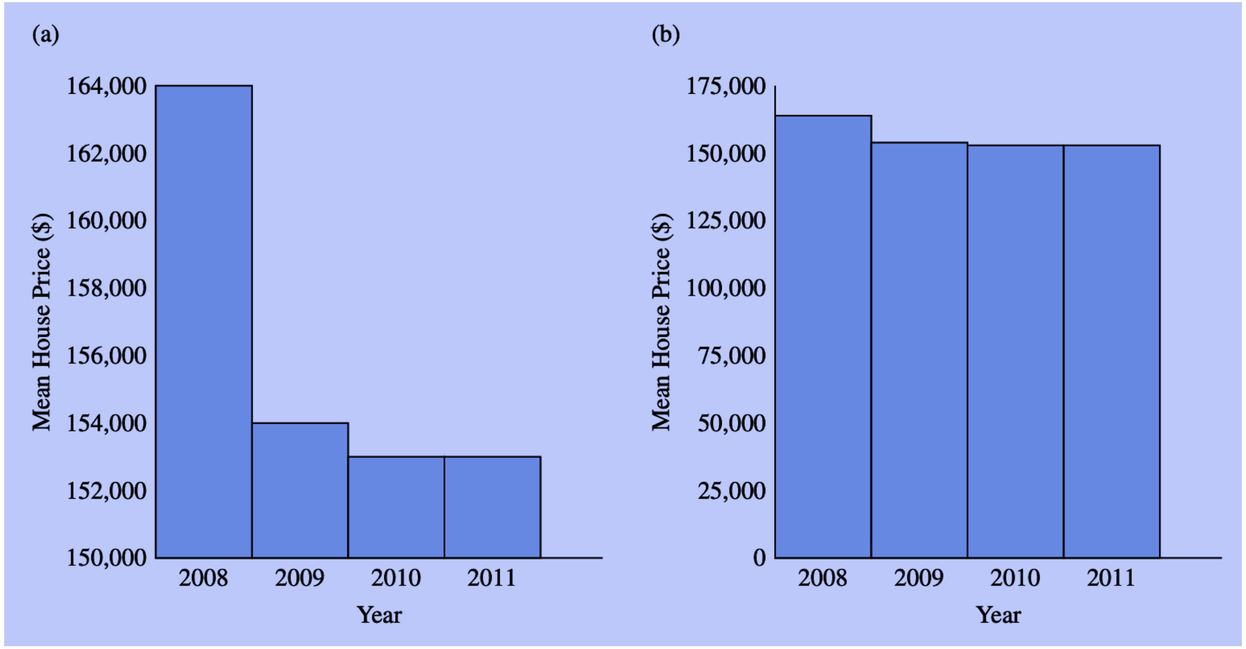
- **Floor effect:** Situation in which many scores pile up at the low end of a distribution (creating skewness to the right) because it is not possible to have any lower score.

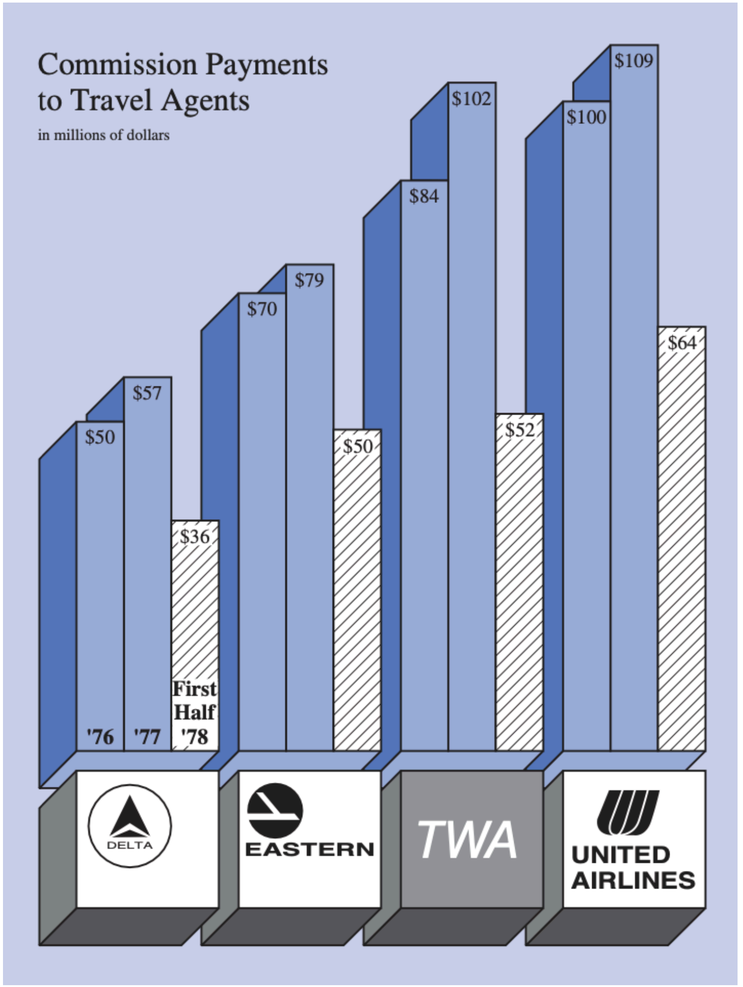
- **Ceiling effect:** Situation in which many scores pile up at the high end of a distribution (creating skewness to the left) because it is not possible to have a higher score.



# Misleading Graphs

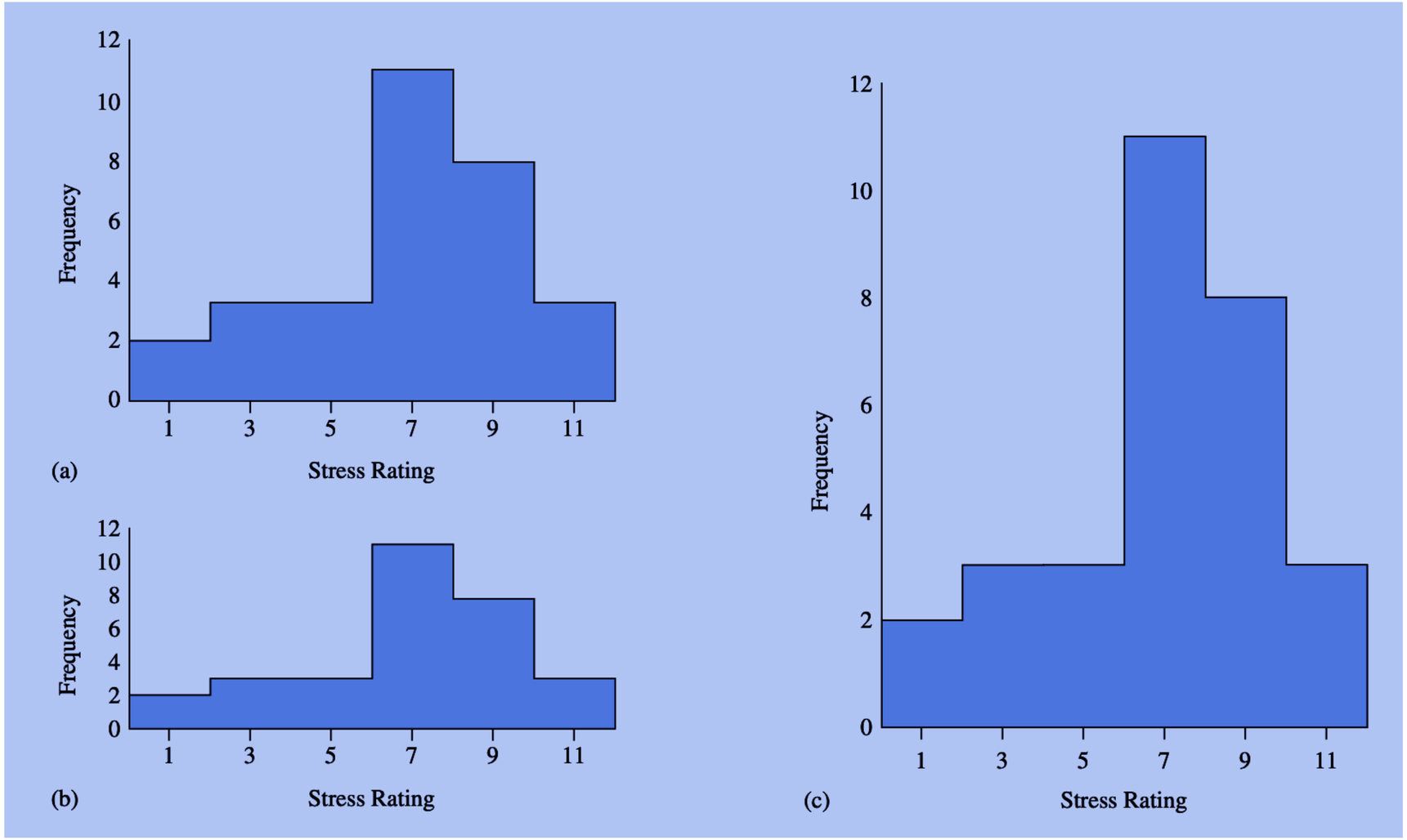
- Exaggeration of proportions when vertical axis doesn't start at 0 .
- Unequal interval sizes.



# Misleading Graphs

**Histogram of students' stress ratings distorted from the standard of width 1 to 1.5 times height.**



# Questions, comments?

# Exercises