SWE3053
Human Computer Interaction

Lecture 22

Data analysis

Assignment #8 – Coming up with a Research Question

Submit on iCampus before **(Monday) May 9 <u>23:59 pm</u>**.

Attention Tunnel

- Augmented Reality Application
- Research Question:
  - How to direct user’s attention in an omni-directional workspace?
- Directional Cue:
  - Up, down, left, right, front, back, …
- Visual Highlight
- Problems?
- How to solve these problems?

- https://www.researchgate.net/profile/Frank_Biocca/publication/221516708_Attention_funnel_Omnidirectional_3D_cursor_for_mobile_Augmented_Reality_platforms/links/0deec520ed67a989c9000000/Attention-funnel-Omnidirectional-3D-cursor-for-mobile-Augmented-Reality-platforms.pdf

What if you have categorical variables?

- T-test and ANOVA are for numerical variables
- What about categorical variables?
  - Male vs. Female
  - Yes vs. No
  - Always vs. Sometimes vs. Never
  - Once a month vs. 2-3 times a month vs. 4-7 times a month vs. more than 7 times a month

Consider the following scenario..

We want to explore if there is any preference to the type of mobile phone: iPhone vs. Android

You recruit 1000 subjects, and you ask them the question:

- Do you like the iPhone or Android phone?

If there is no preference, what is the expected frequency?

If you run the experiment and receive the following data:

- Android: 500; iPhone: 500

You can come up with the conclusion that there is no preference

- i.e. You reject the Null Hypothesis.

What about Android: 350; iPhone: 650?
What about Android: 450; iPhone: 550?
What about Android: 499; iPhone: 501?
Where do you draw the line???

Chi-Square Analysis

We want to explore if there is any preference to the type of mobile phone: iPhone vs. Android

You recruit 1000 subjects, and you ask them the question:

- Do you like the iPhone or Android phone?

If there is no preference, what is the expected frequency?

Android	iPhone
500	500

If you run the experiment and receive the following data:

Android	iPhone
532	468

How do you analyze the data and come up with a proper scientific conclusion?

NHST using Chi-Square

1. State the Null Hypothesis H_0 and Alternative Hypothesis H_1.

   Null Hypothesis N_0: The collected data would have the same natural distribution of 50/50

   Alternative Hypothesis N_1: The collected data would not have the same natural distribution of 50/50

2. Select the appropriate statistical method.

Chi-Square

3. Select a level of significance.

.05

4. Calculate the statistic.

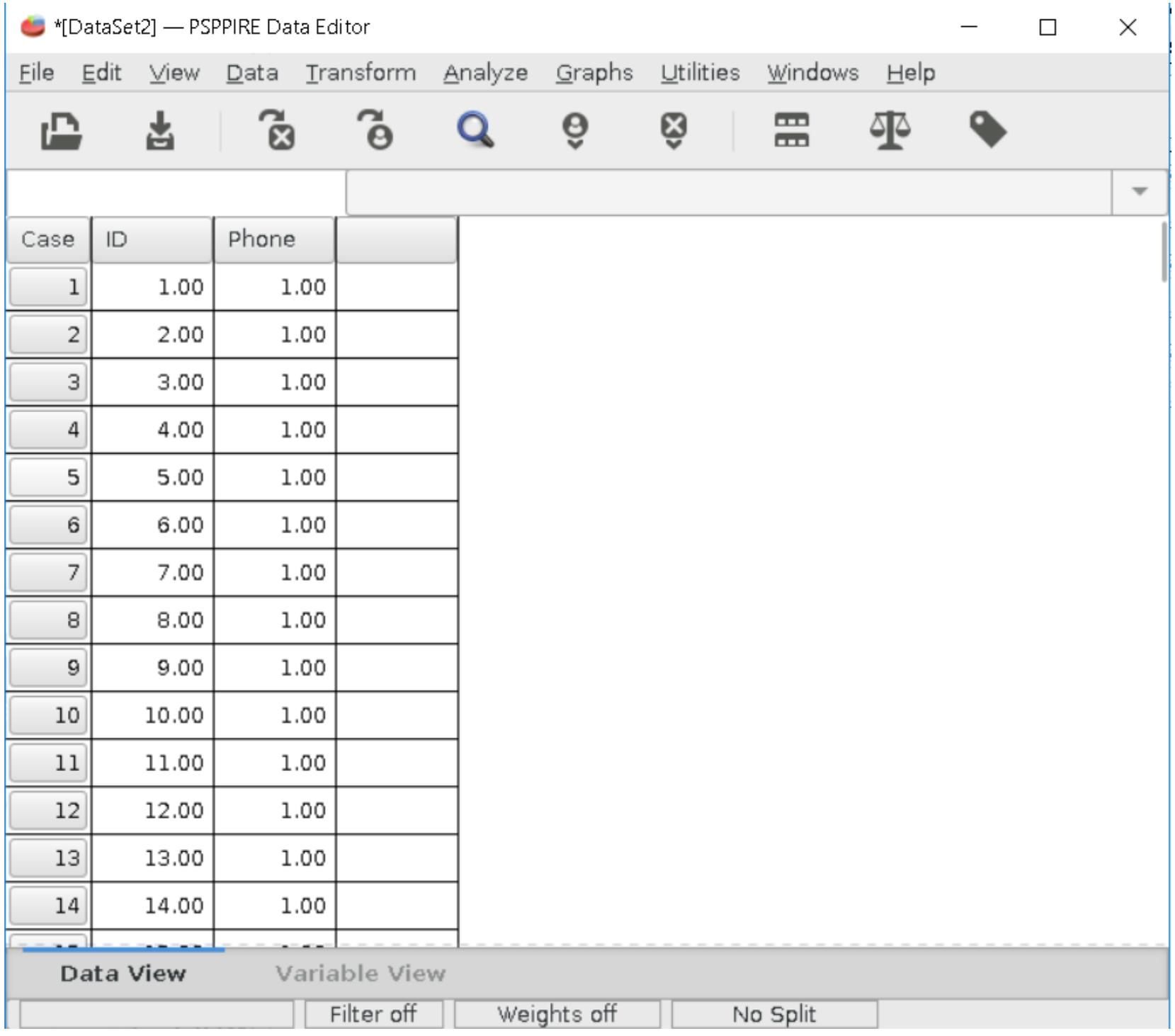
I am skipping the maths and stats for this course……

Let's go directly into SPSS and let the computer do the calculations!

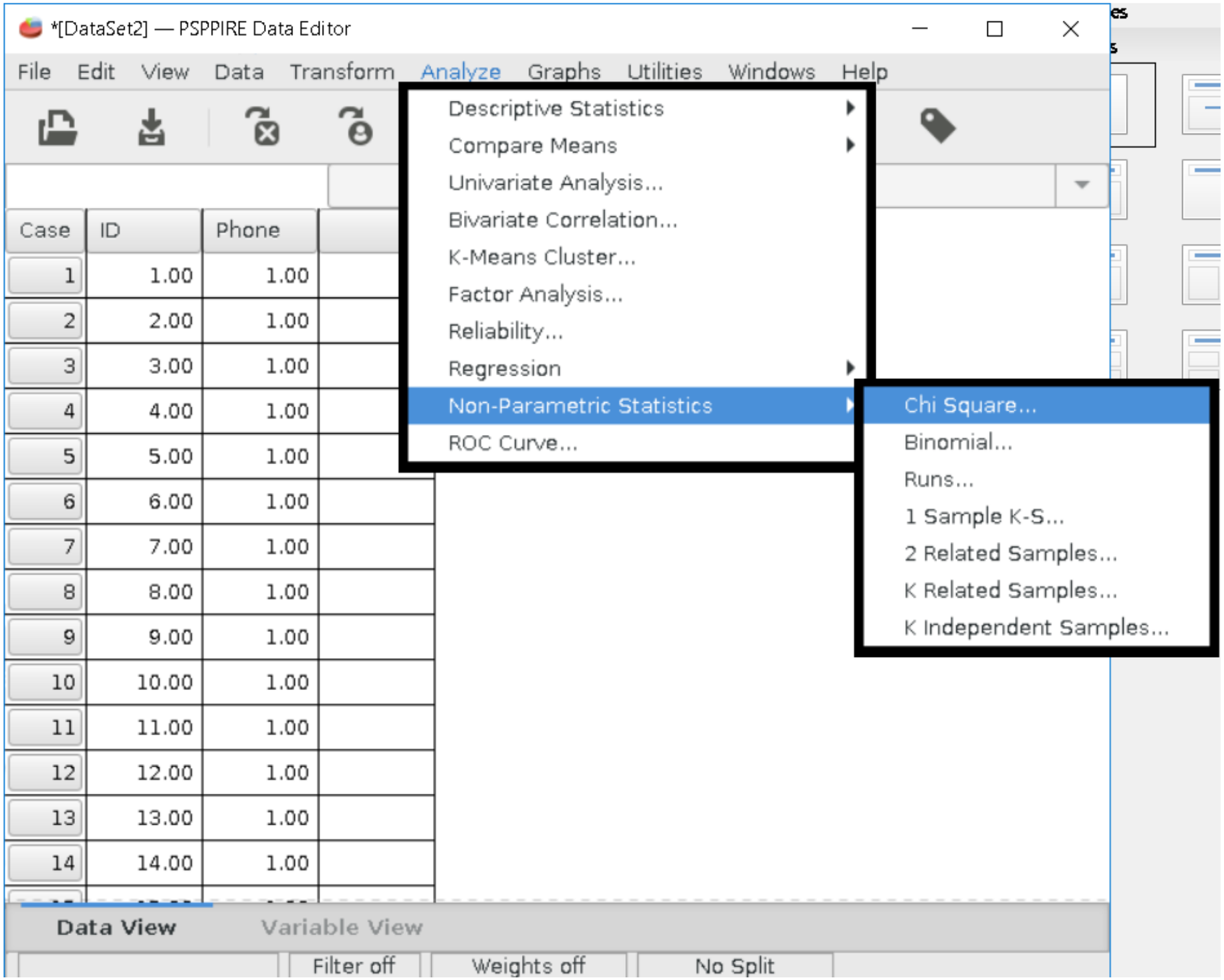
5. Make the decision.

How to do it in PSPP

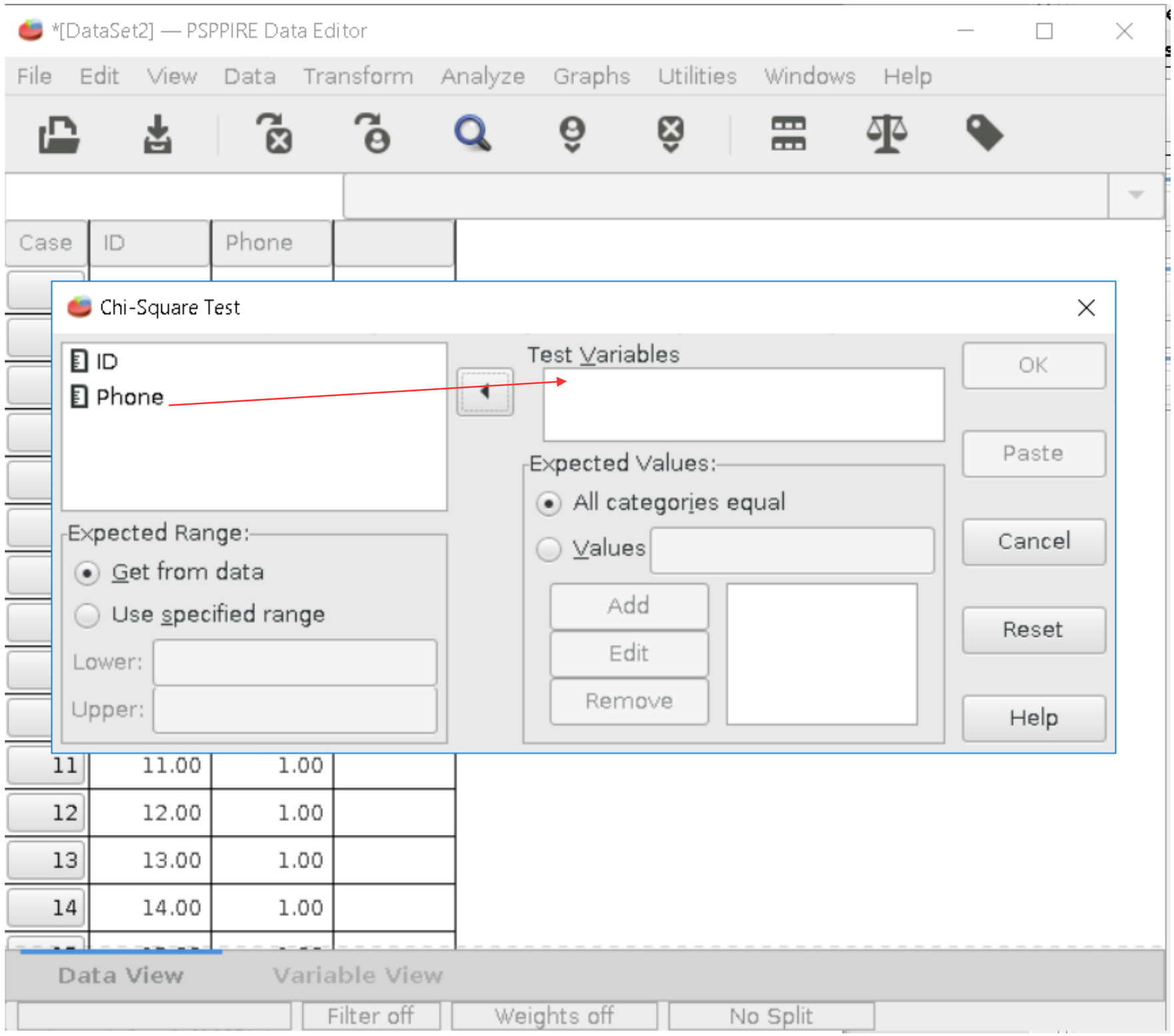
You have 1000 data samples



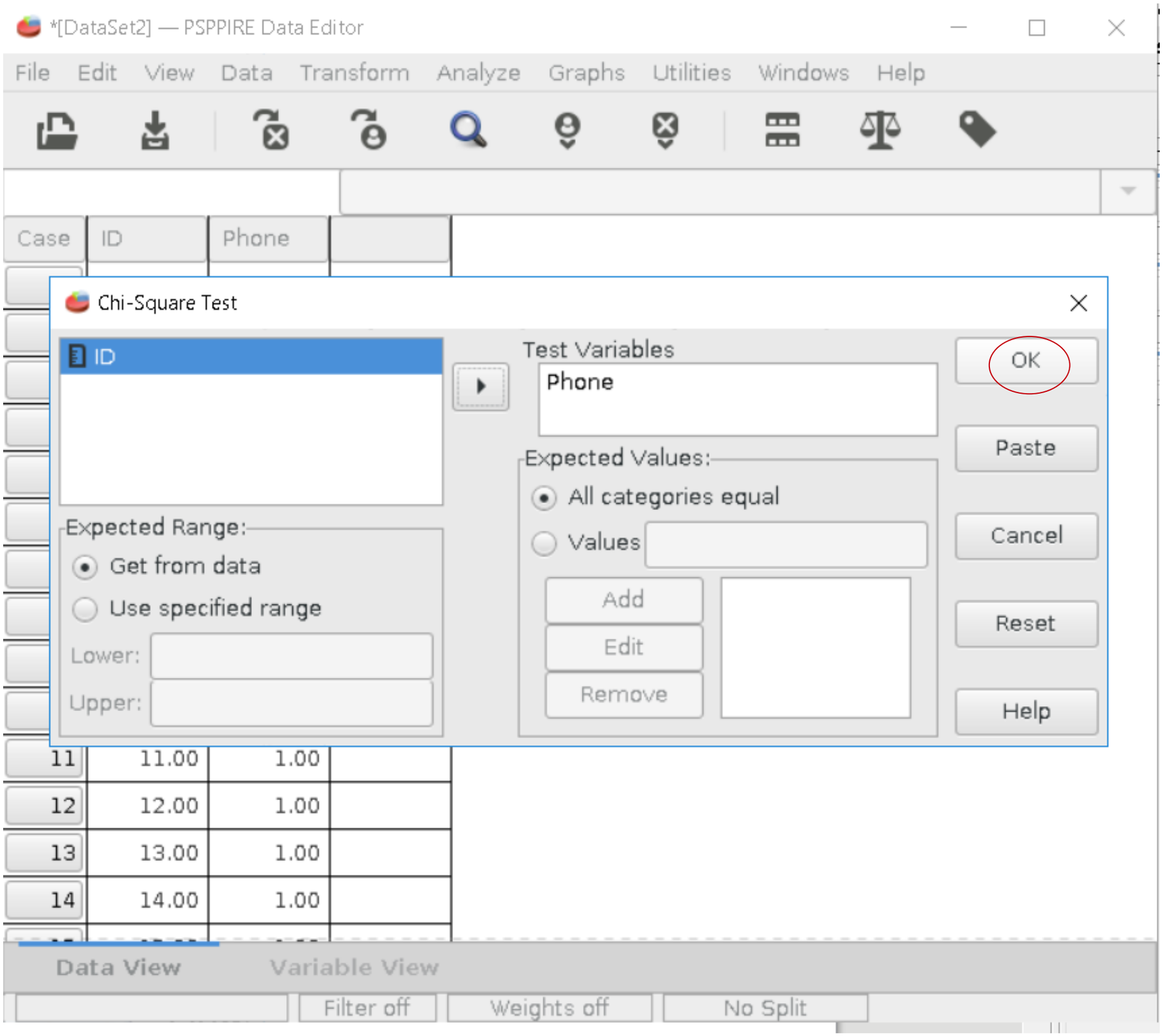
How to do it in PSPP



How to do it in PSPP



How to do it in PSPP



How to do it in PSPP

```
NPAR TESTS

NPAR TEST
        /CHISQUARE= Phone.
```

Phone

	Observed N	Expected N	Residual
1.00	532	500.00	32.00
2.00	468	500.00	-32.00
Total	1000		

Test Statistics

	Phone
Chi-Square	4.10
df	1
Asymp. Sig.	.043

NHST using Chi-Square

1. State the Null Hypothesis H_0 and Alternative Hypothesis H_1.

Null Hypothesis N_0: The collected data would have the same natural distribution of 50/50

Alternative Hypothesis N_1: The collected data would not have the same natural distribution of 50/50

2. Select the appropriate statistical method.

Chi-Square

3. Select a level of significance.

.05

4. Calculate the statistic.

I am skipping the maths and stats for this course……

Let's go directly into SPSS and let the computer do the calculations!

5. Make the decision.

H0 is rejected. People do have a significant preference!

Comparison to a known distribution

Last year, we conducted a customer satisfaction survey of our software interface, and the result is as follow:

Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
10	20	26	12

This year, we came up with a new version of the software interface, and conducted another survey with the following result:

Very Satisfied	Satisfied	Dissatisfied	Very Dissatisfied
19	22	25	9

NHST using Chi-Square

1. State the Null Hypothesis H_0 and Alternative Hypothesis H_1.

Null Hypothesis N_0: The collected data would have the same distribution of last yaer (10:20:26:12)

Alternative Hypothesis N_1: The collected data would not have the same natural distribution of last year.

2. Select the appropriate statistical method.

Chi-Square

3. Select a level of significance.

.05

4. Calculate the statistic.

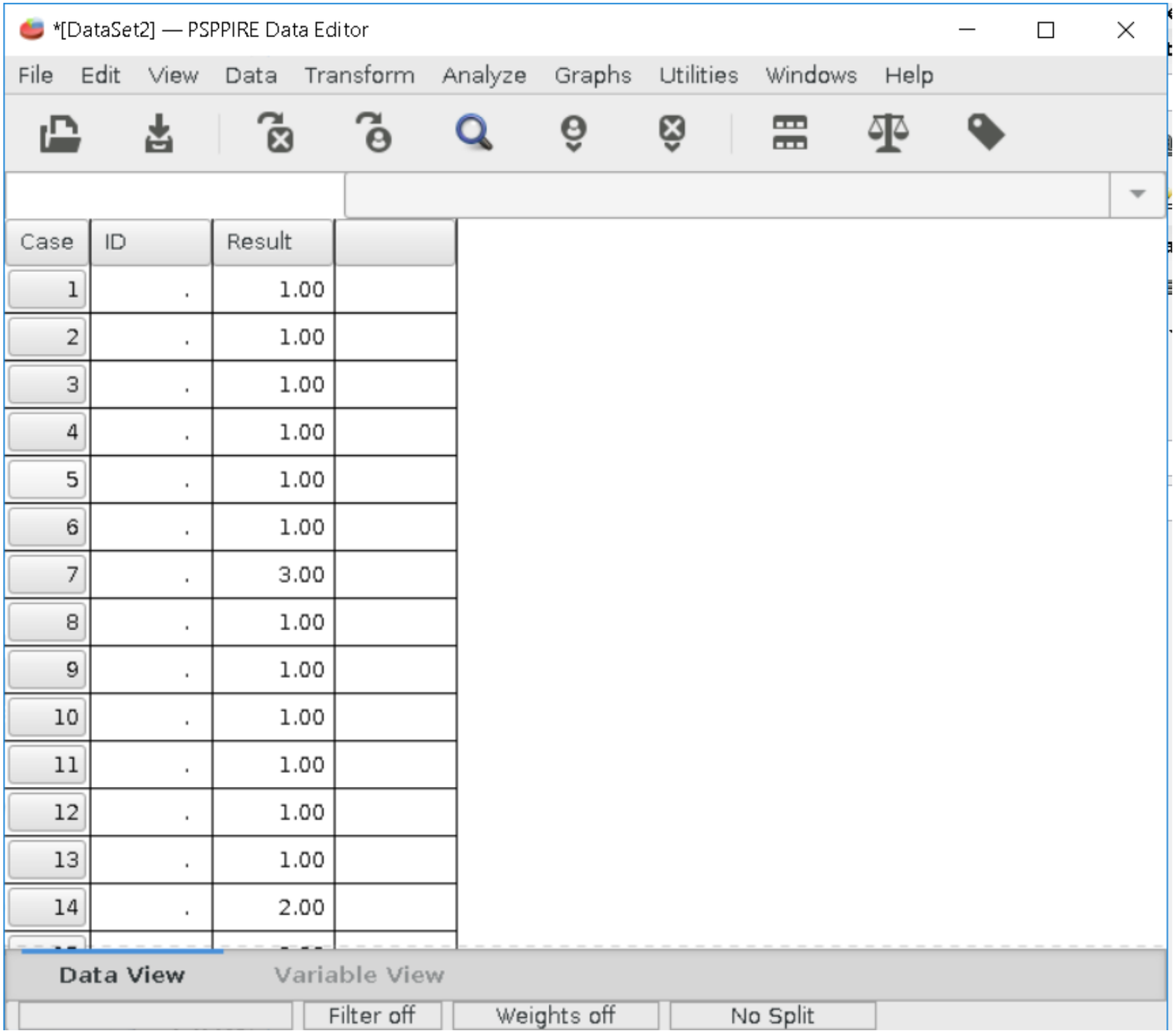
I am skipping the maths and stats for this course……

Let's go directly into SPSS and let the computer do the calculations!

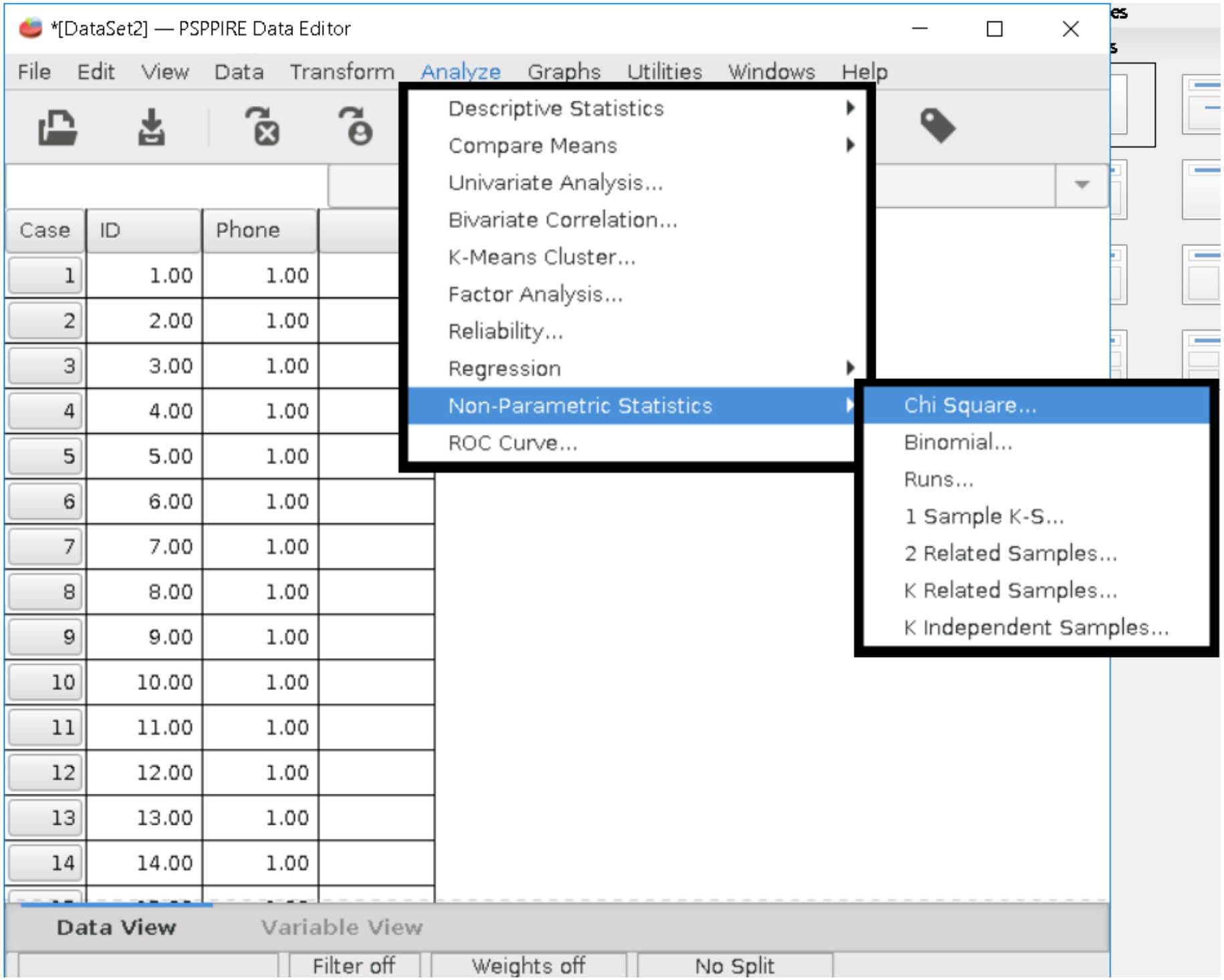
5. Make the decision.

How to do it in PSPP

Data samples



How to do it in PSPP



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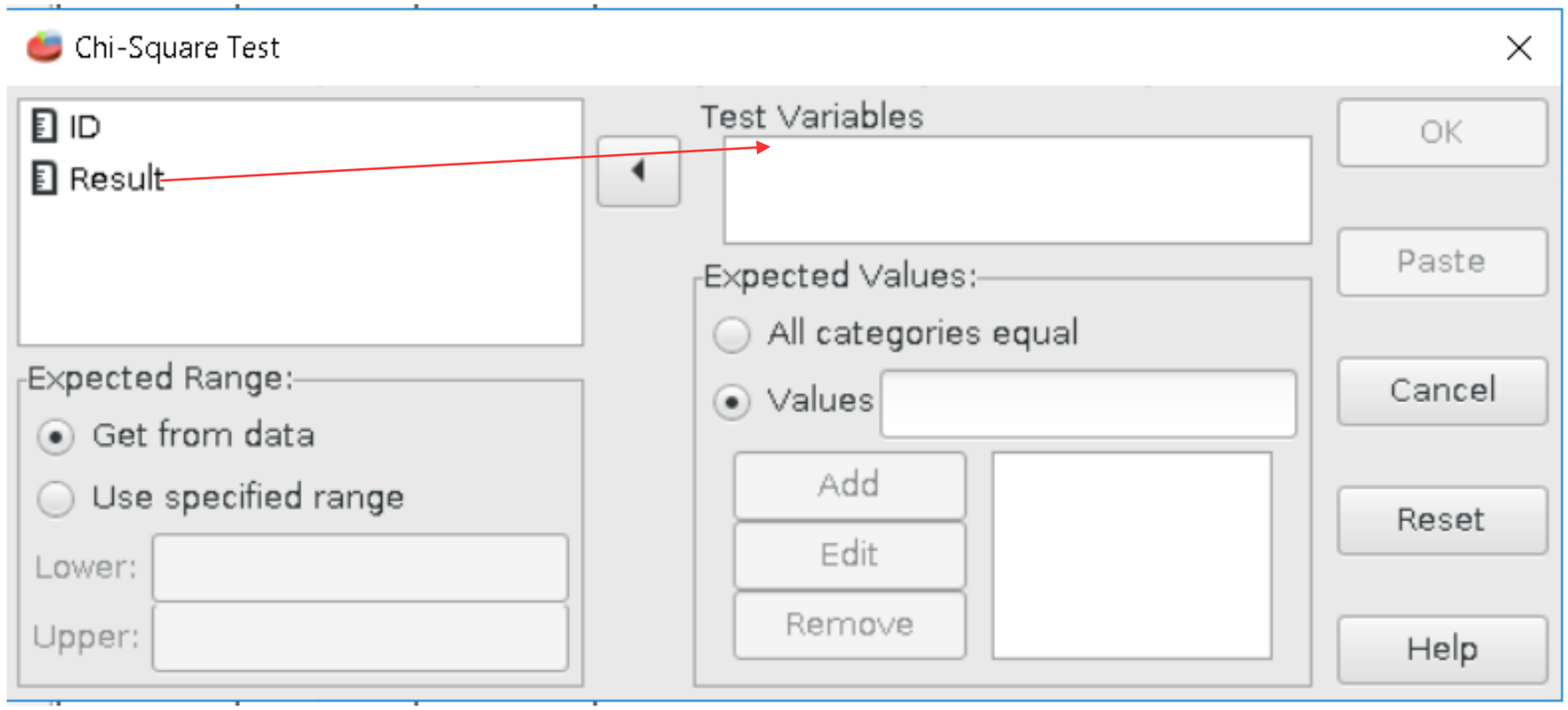
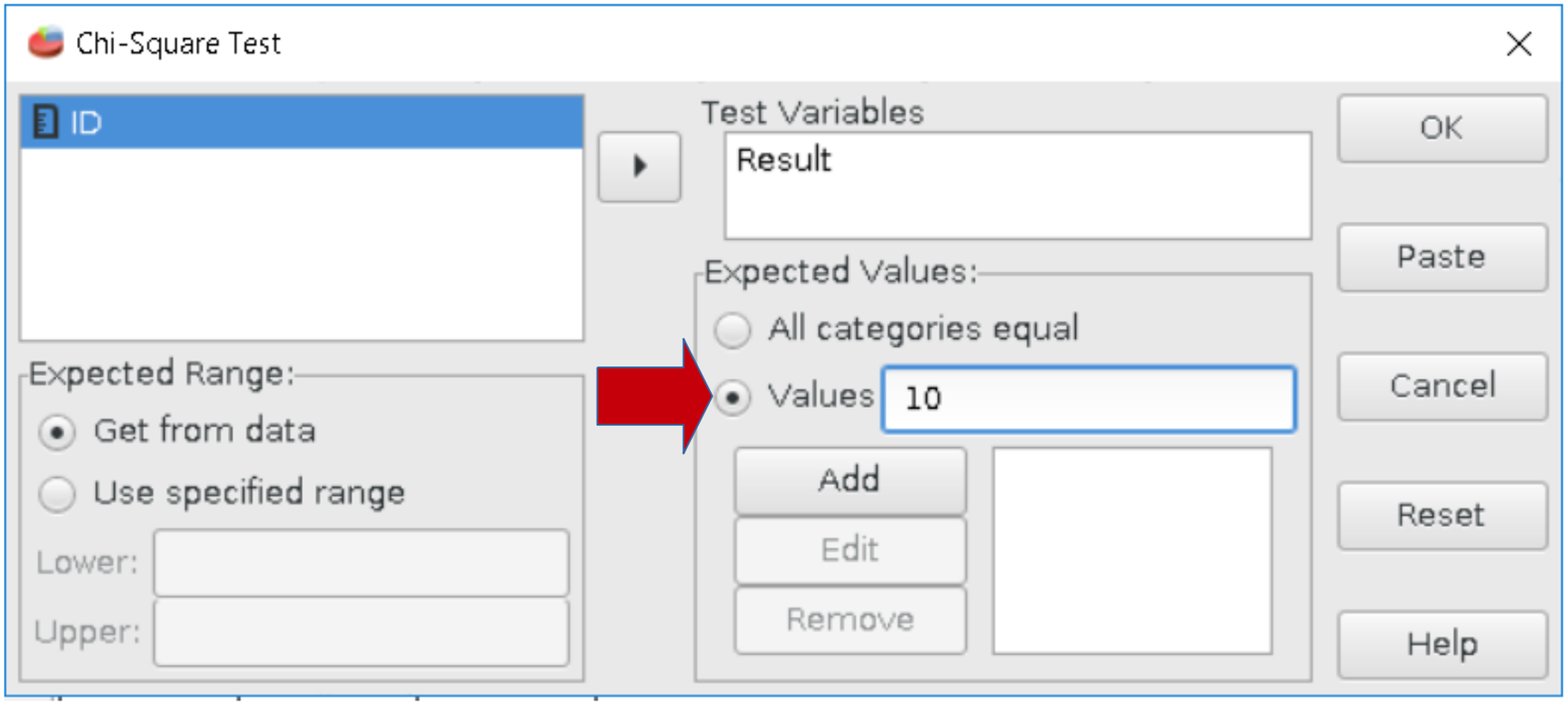
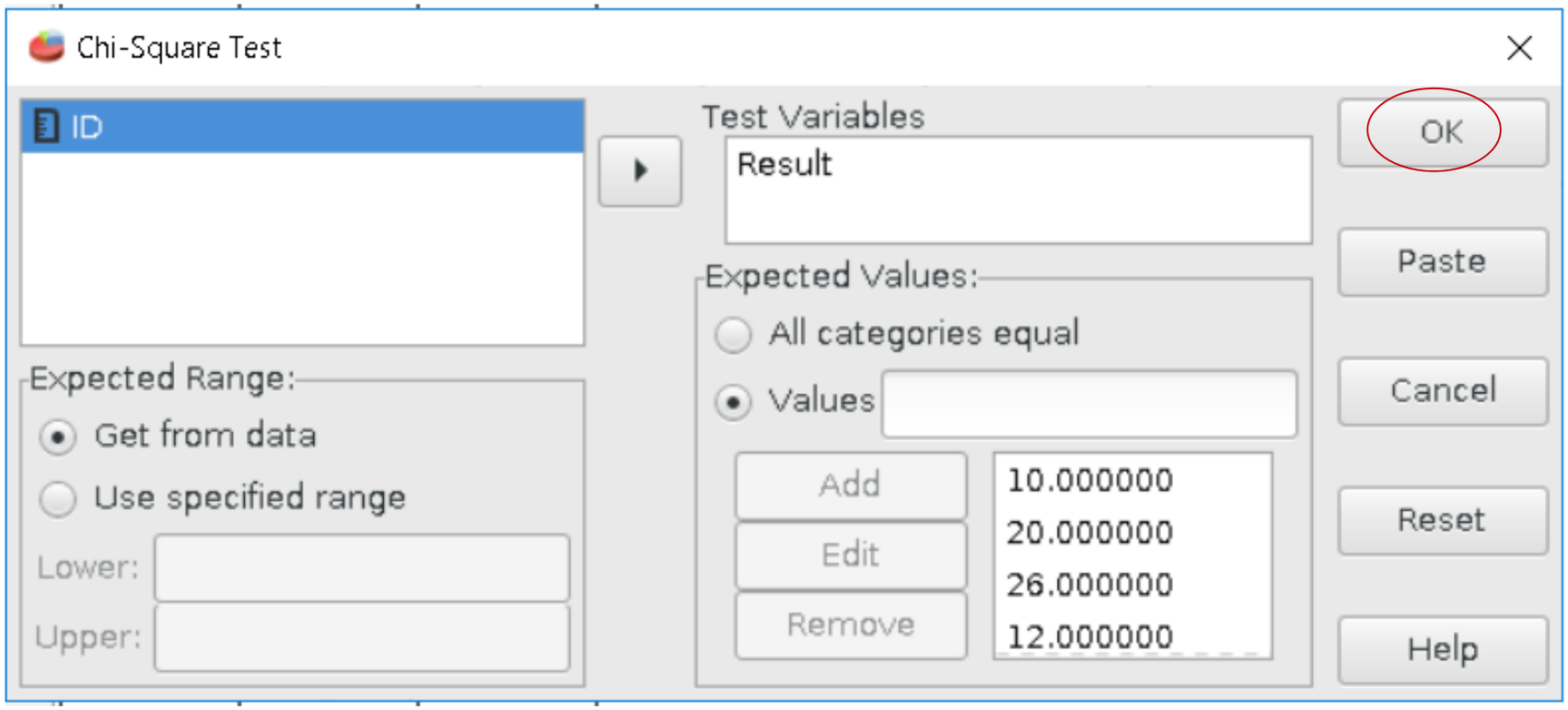


How to do it in PSPP



Enter: 10 => Add
Enter: 20 => Add
Enter: 26 => Add
Enter: 12 => Add

How to do it in PSPP



Result

```
NPAR TESTS

NPAR TEST
        /CHISQUARE= Result
        /EXPECTED =  10 20 26 12.
```

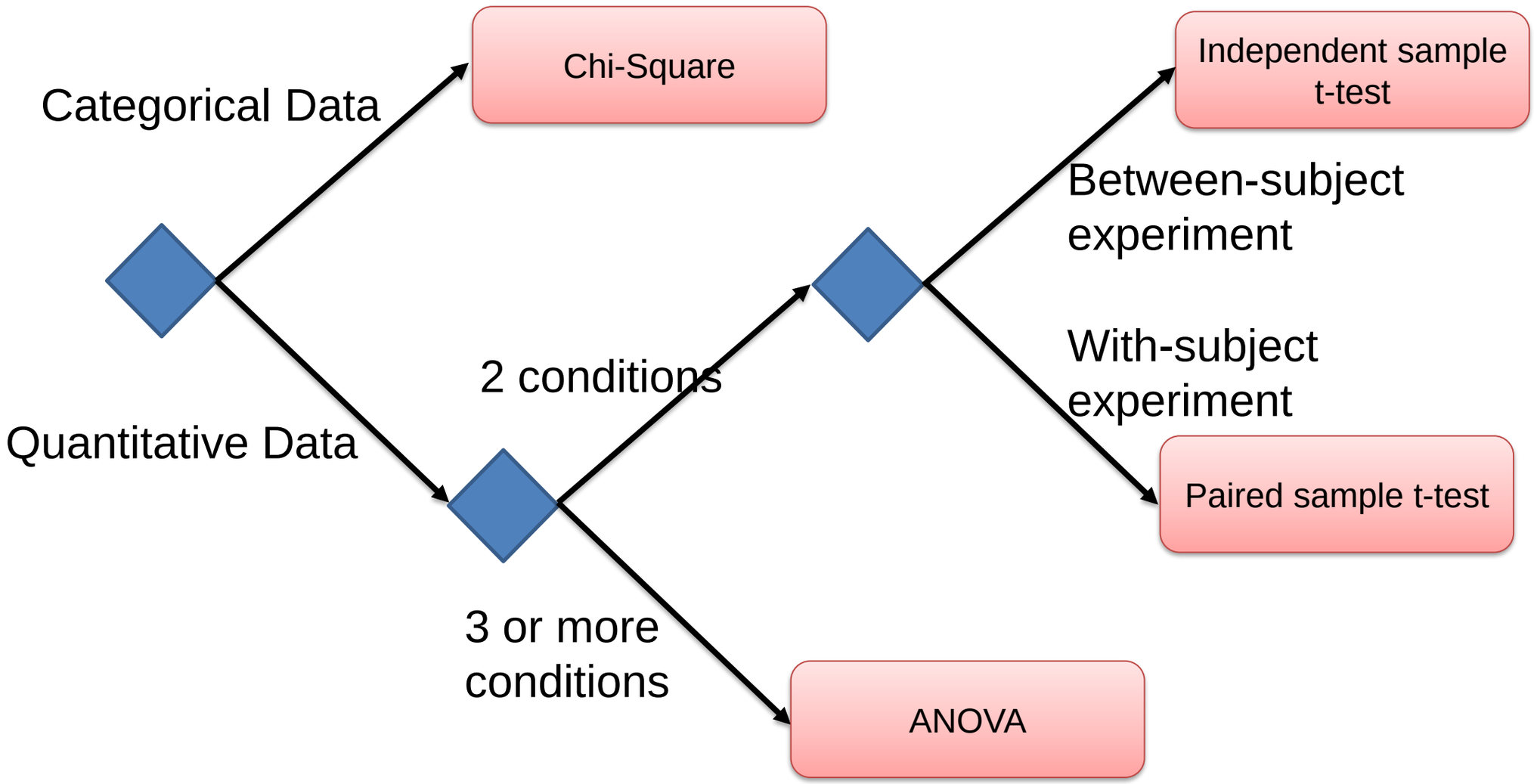
Result

	Observed N	Expected N	Residual
1.00	19	11.03	7.97
2.00	22	22.06	-.06
3.00	25	28.68	-3.68
4.00	9	13.24	-4.24
Total	75		

Test Statistics

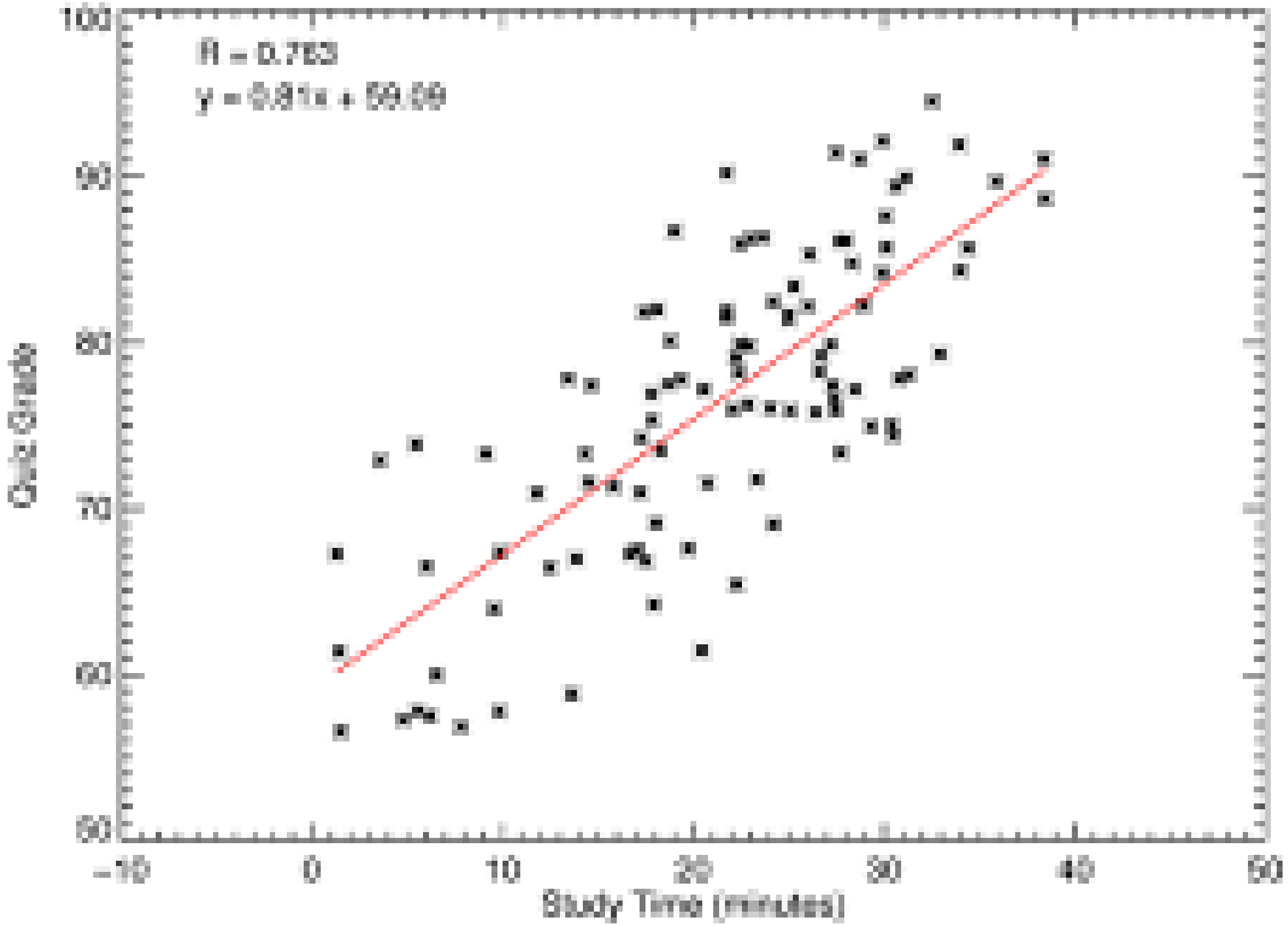
	Result
Chi-Square	7.59
df	3
Asymp. Sig.	.055

The respond pattern did not differ significantly from last year’s result.


Categorical Data
Chi-Square
Quantitative Data
2 conditions
Independent sample t-test
Between-subject experiment
With-subject experiment
Paired sample t-test
3 or more conditions
ANOVA

Correlational Studies

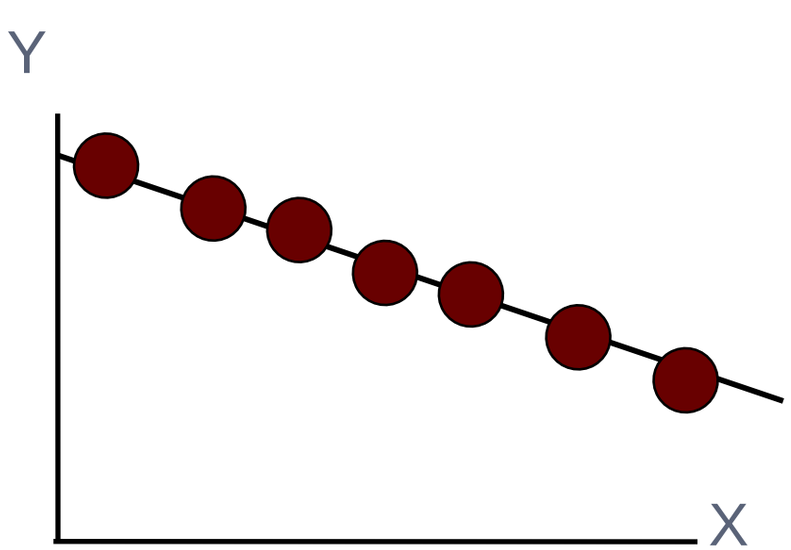
- Correlation:
  - when two (or more) variables vary together
    - that is, when scores on one variable co-vary with scores on another variable
- Scatterplot
  - When two variables are linearly correlated, their data points tend to fit on a straight line
  - You can generate a scatterplot using PSPP
    - Click “Graph => Scatterplot”; select the two variables and click OK


R = 0.763
y = 0.81x + 59.09
100
90
80
70
60
50
Quiz Grade
−10
0
10
20
30
40
50
Study Time [minutes]

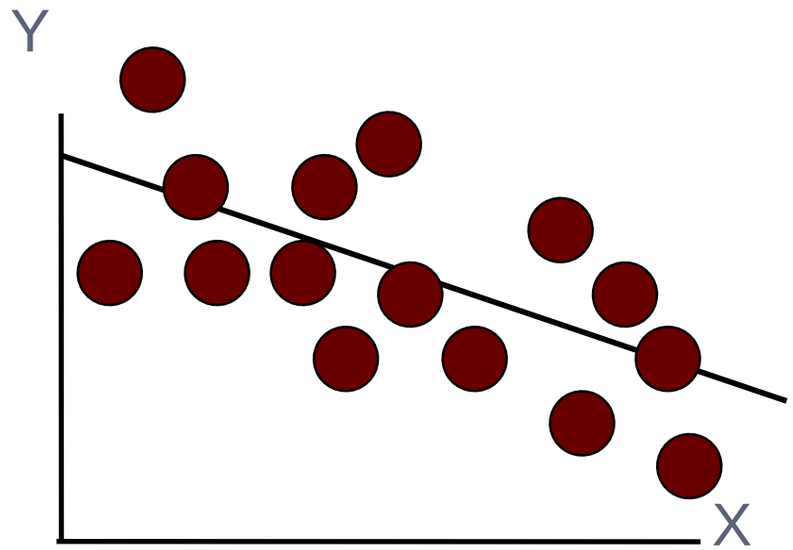
Pearson’s Correlation Coefficient

- Correlation coefficient
  - Pearson’s Correlation Coefficient
    - Standardized (unitless) measurement of correlation of 2 variables
      In the range of +1.0 to -1.0
      -1.0 : a perfect negative relationship
      0.0 : no relationship
      +1.0 : a perfect positive relationship
    - Magnitude
      - zero indicates no relationship, strength of relationship increases as coefficient approaches | 1.0 |
    - Direction
      - sign of correlation indicates direction of relationship, negative (−) or positive (+)

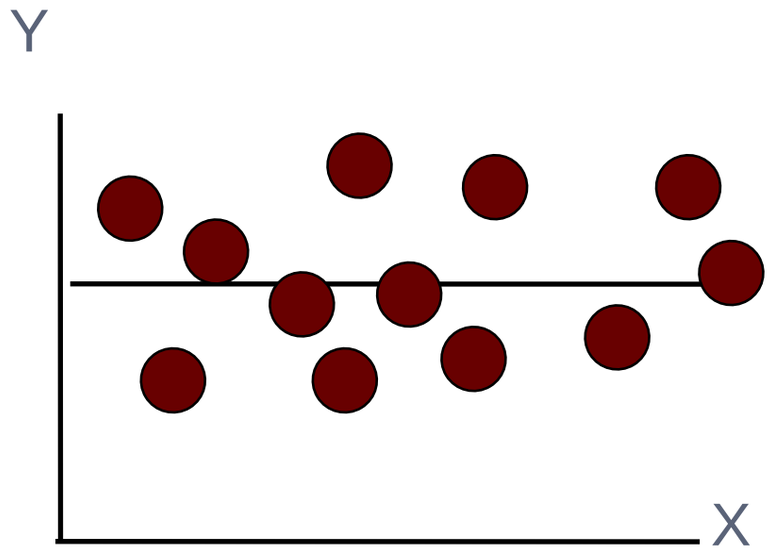
Scatterplot of data with various correlation coefficient



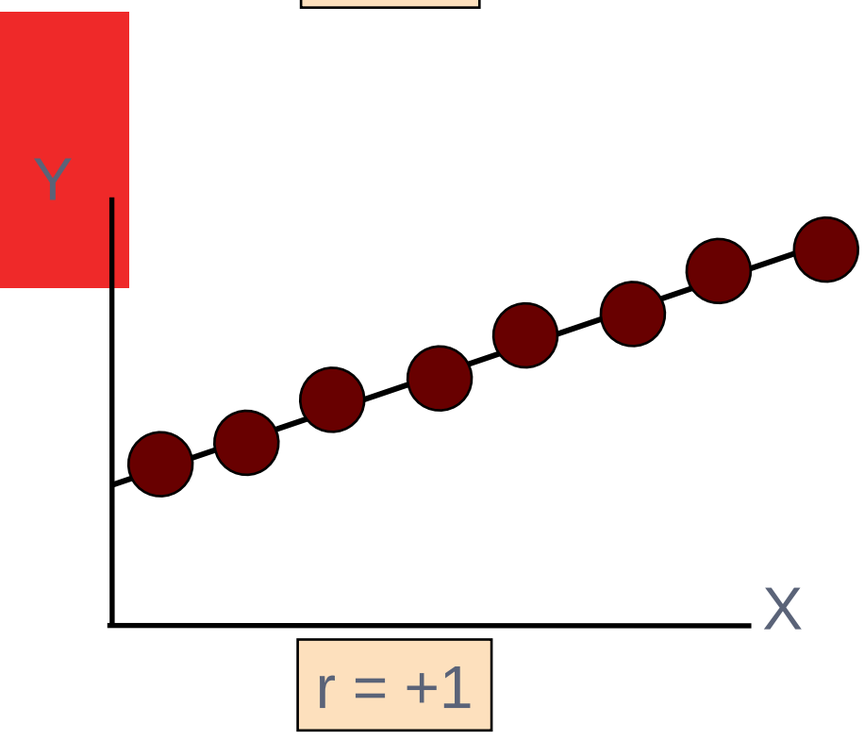
r = -1



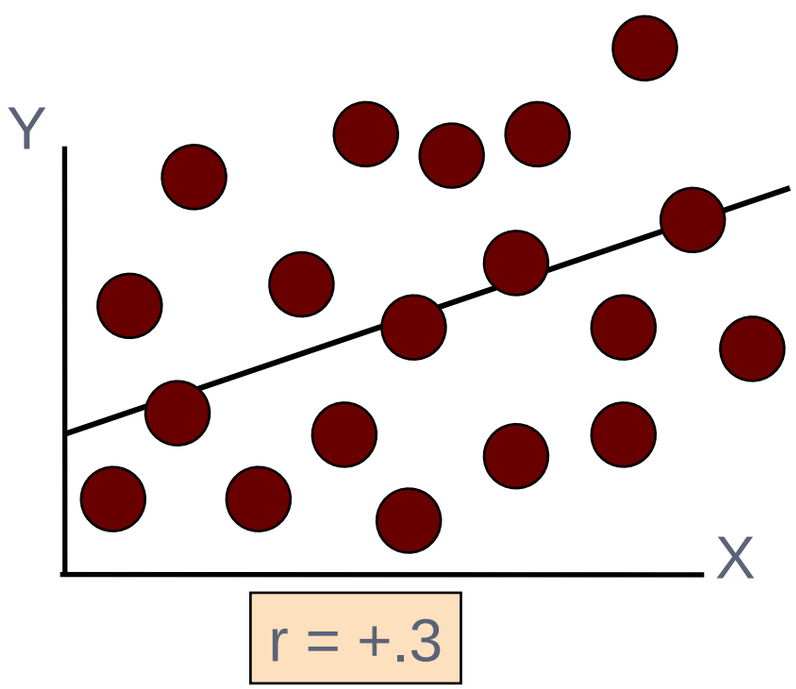
r = -.6



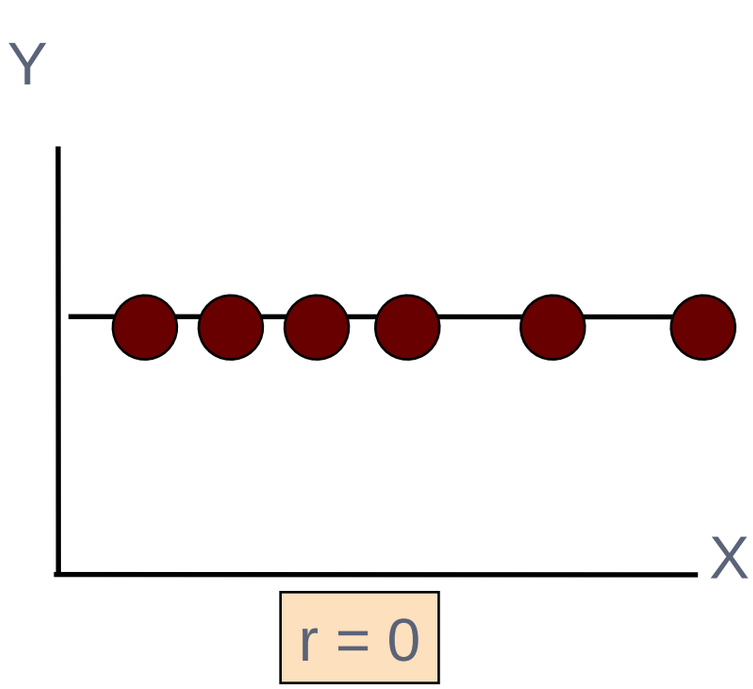
r = 0



r = +1



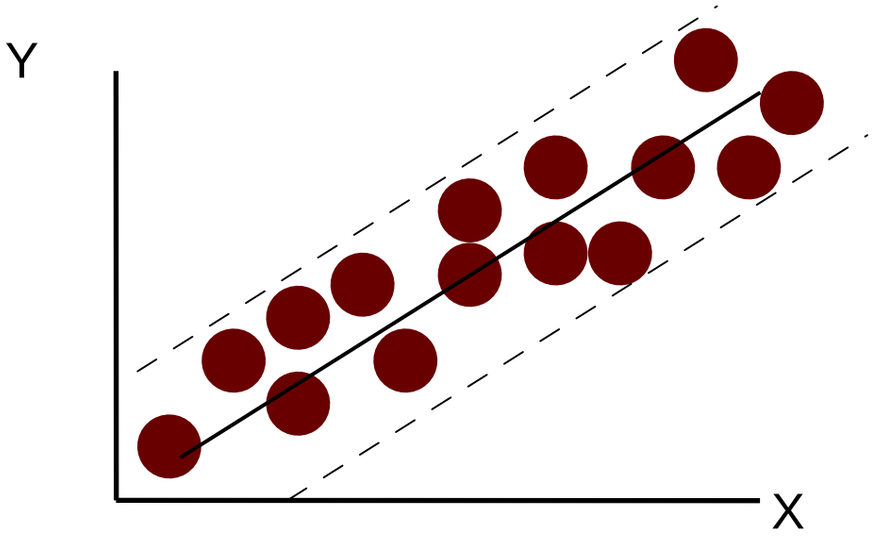
r = +.3

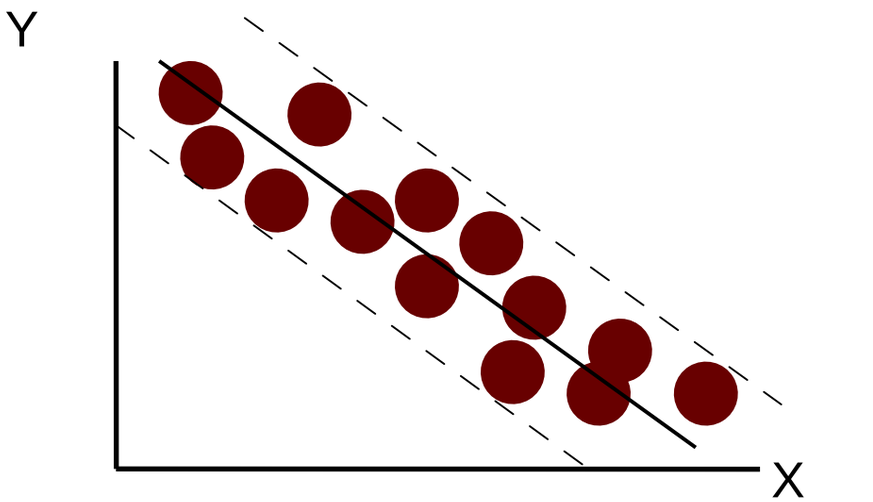


r = 0

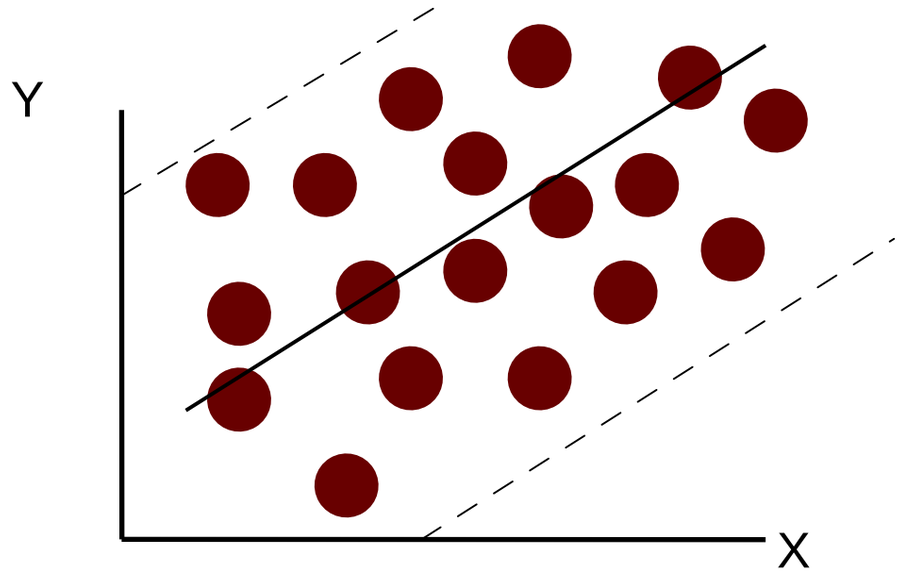
Strong vs. weak correlation

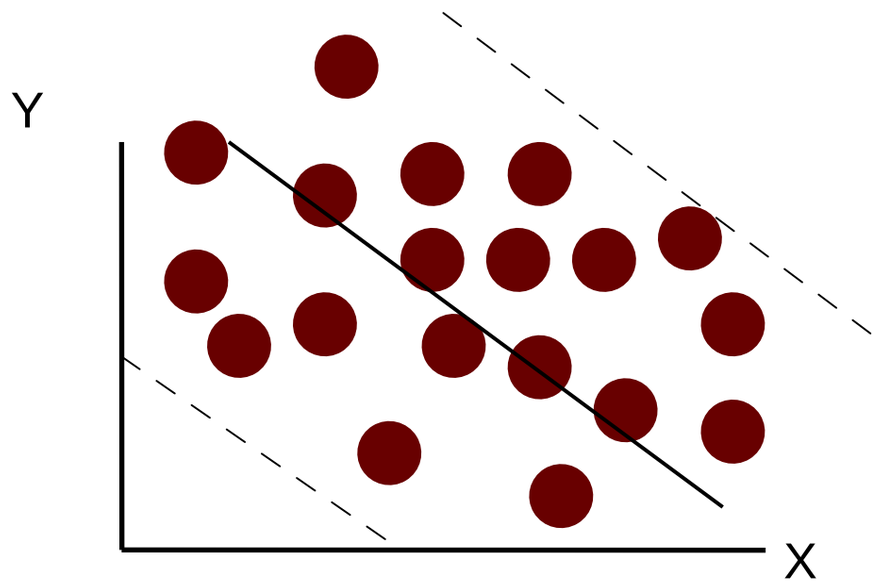
Strong relationships





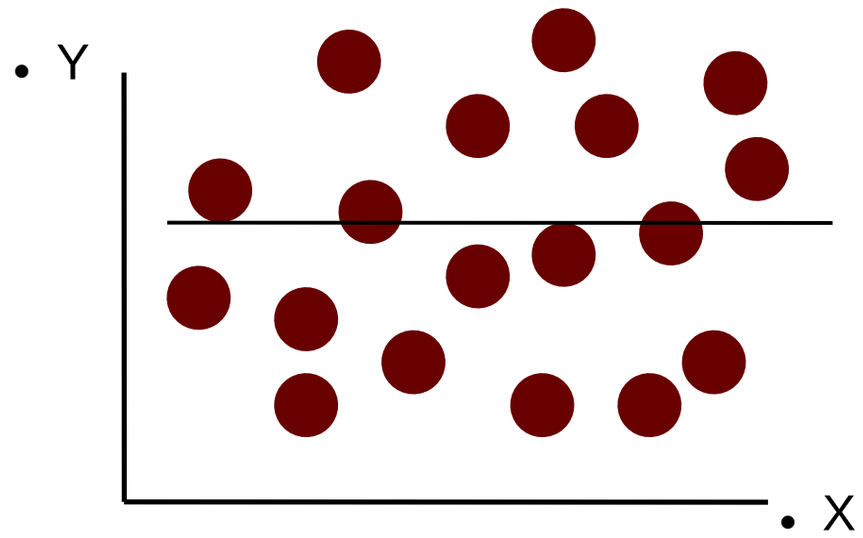
Weak relationships

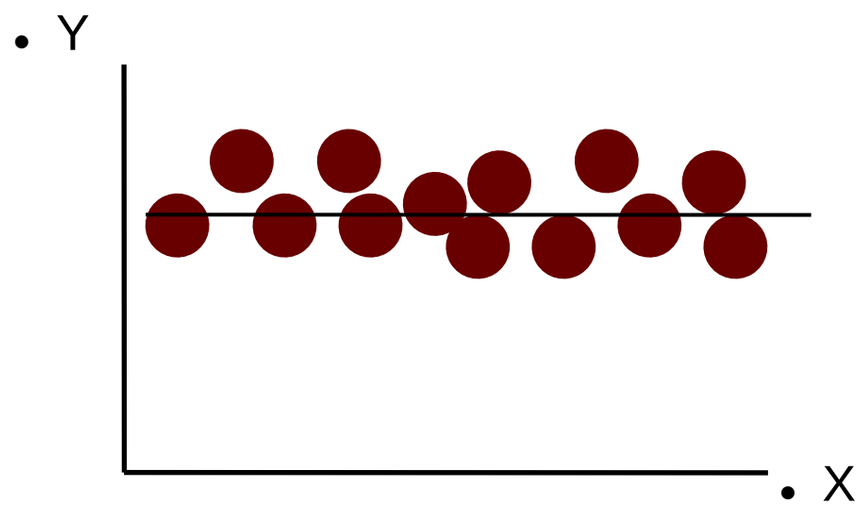




No Correlation

- No relationship





Interpreting correlations

Interpreting correlations

When two variables are correlated, we can make predictions for each variables
if we know score for X, we can predict score for Y;
and vice versa

We cannot make causal statements
"correlation does not imply causation"
"spurious relationship"

http://www.tylervigen.com/spurious-correlations

Correlation in PSPP

You can do pairwise bivariate correlation analysis in PSPP

- Click “Analyze → Bivariate Correlations”
- Select two or more variables
- If more than 2 variables are selected, pairwise comparison will be performed
  - i.e. Var1 vs. Var2, Var2 vs. Var3, Var2 vs. Var3, etc

```
CORRELATIONS

CORRELATION
        /VARIABLES = v1 v2
        /PRINT = TWOTAIL NOSIG.
```

Correlations

		v1	v2
v1	*Pearson Correlation*	1.00	-.43
	Sig. (2-tailed)		.047
	N	22	22
v2	*Pearson Correlation*	-.43	1.00
	Sig. (2-tailed)	.047	
	N	22	22

SWE3053 – Human Computer Interaction

1. Theories, Principles and Guidelines
   - Conceptualizing Interaction
   - Sensational and Perceptual Aspect
   - Anthropometric Aspect
   - Cognitive Aspect
   - Emotional and Social Aspect
   - Interface Design Principles and Guidelines

2. Academic Research
   - Research Ethics
   - Research Methodology
   - Gathering Data
   - Data Analysis, Interpretation and Presentation

3. Design and Evaluation
   - Design Lifecycle
   - Establishing Requirements
   - Design, Prototyping and Construction
   - Evaluating Design

What is involved in Interaction Design?

- It is a process:
  - a goal-directed problem solving activity informed by intended use, target domain, materials, cost, and feasibility
  - a creative activity
  - a decision-making activity to balance trade-offs
- Generating alternatives and choosing between them is key

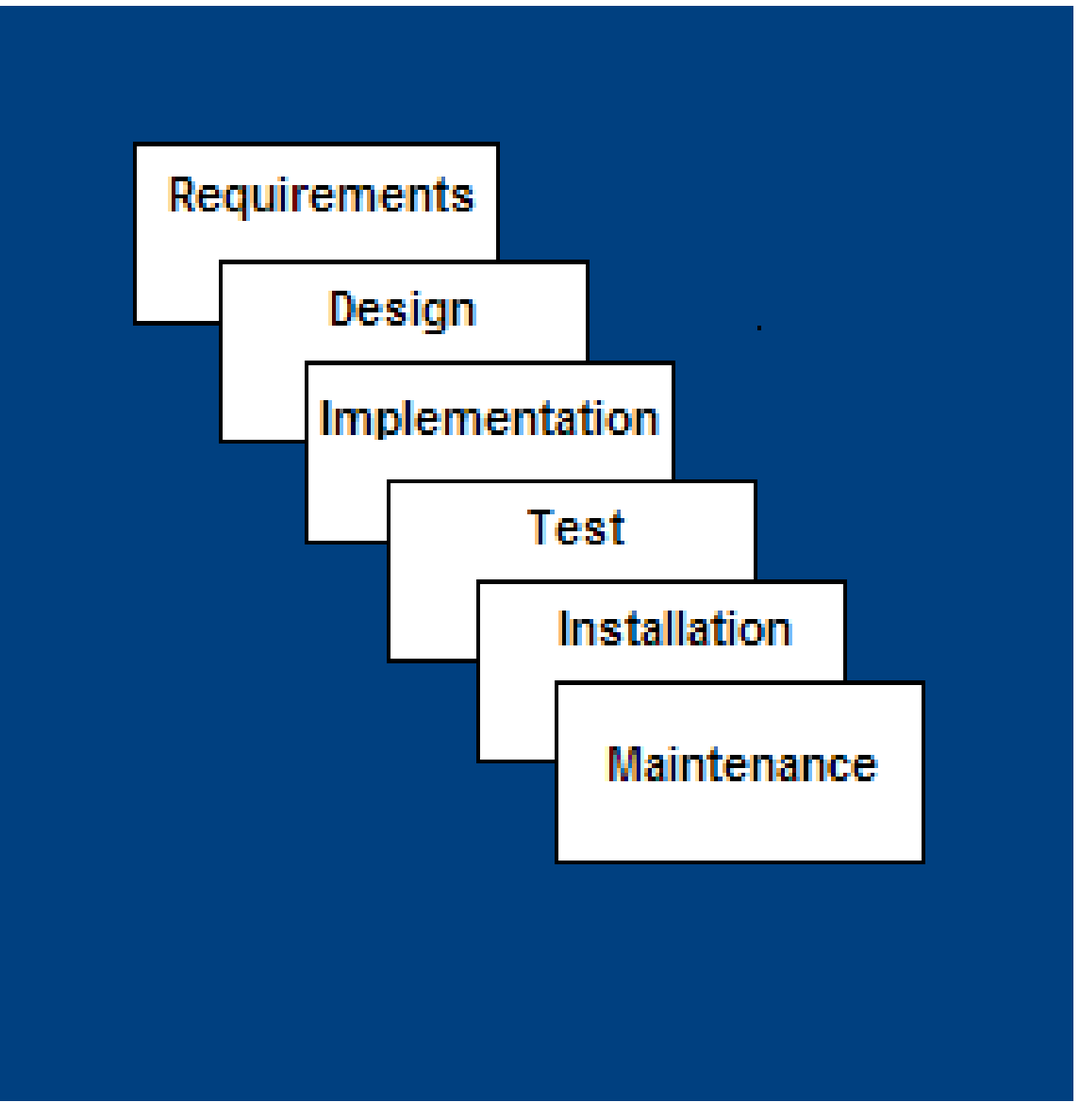
Importance of involving users

- Expectation management
  - Realistic expectations
  - No surprises, no disappointments
  - Timely training
  - Communication, but no hype
- Ownership
  - Make the users active stakeholders
  - More likely to forgive or accept problems
  - Can make a big difference to acceptance and success of product

The design lifecycle

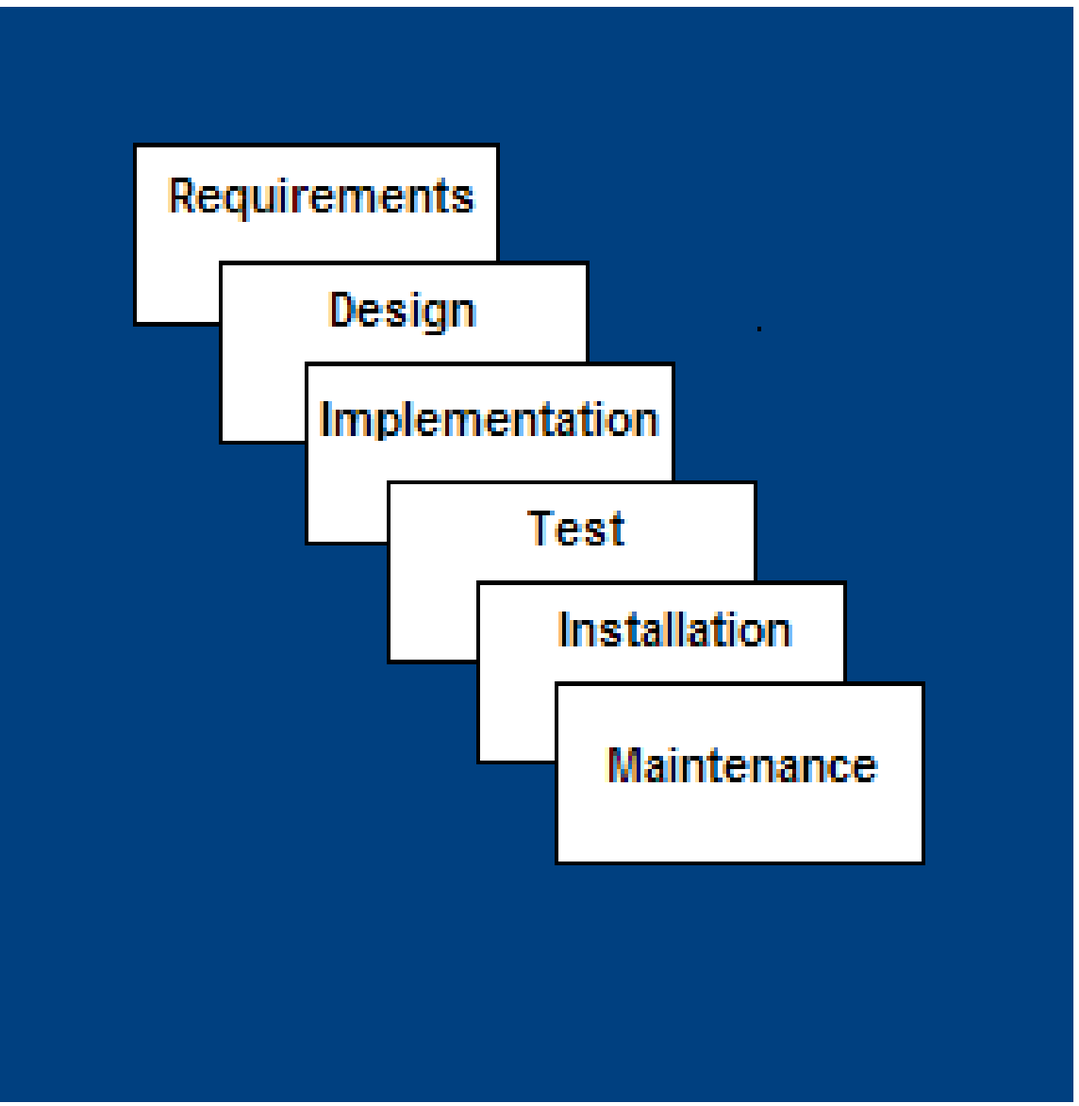
- Understanding of the design process
- A framework that describes the activities performed at each stage of a design project.
- Designing for usability occurs at all stages of the life cycle, not as a single isolated activity
- There are many models of the design life cycle we will look at some of the more popular.
  - Waterfall, V-shaped, Iterative Prototyping
- In reality most software development is somewhere between these two extremes

The Waterfall Model



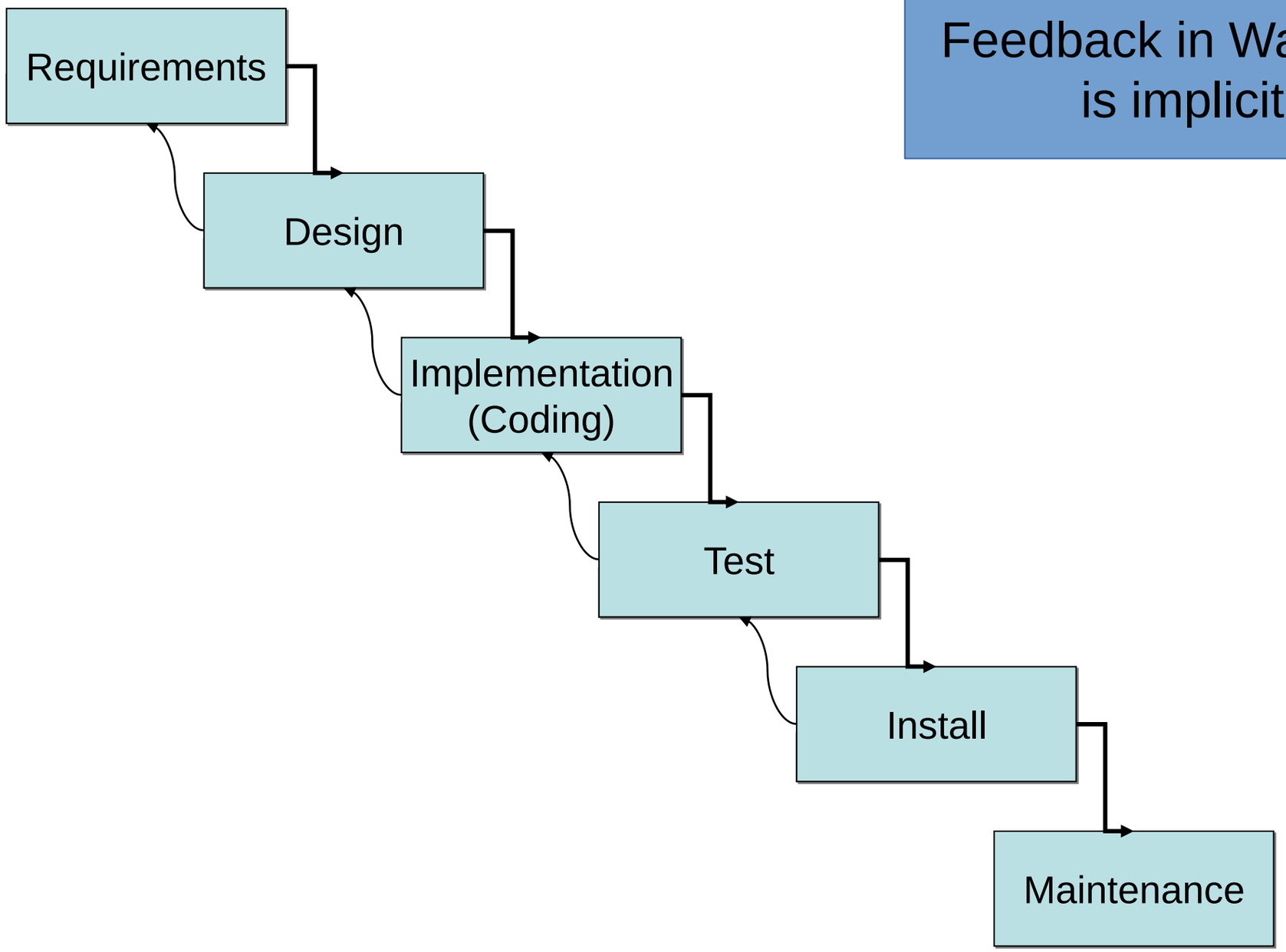
- One of the earliest design process developed
- Before the Waterfall, software developers tended to just dig in and write codes
  - Promoting “Think first, write second”
  - Develop all requirements before writing the first line of code
- Many variants exist, but they are similar
- Design process as a sequence of stages
- Linear and sequential
- Each stage produces a concrete product to be used in the next stage

Waterfall Model



- **Requirements** – defines needed information, function, behavior, performance and interfaces.
- **Design** – data structures, software architecture, interface representations, algorithmic details.
- **Implementation** – source code, database, user documentation.
- **Test** – testing for problems and issues.
- **Installation** – deployment for use.
- **Maintenance** – support, patches.

The life cycle for interactive systems



Feedback in Waterfall is implicit

Waterfall Strengths

- Easy to understand, easy to use
- Provides structure to inexperienced staff
- Milestones are well understood
- Sets requirements stability
- Good for management control (plan, staff, track)
- Works well when quality is more important than cost or schedule

Waterfall Deficiencies

- All requirements must be known upfront
- Deliverables created for each phase are considered frozen – inhibits flexibility
- Can give a false impression of progress
- Does not reflect problem-solving nature of software development – iterations of phases
- Validation is not sufficient
- Integration is one big bang at the end
  - – Infant mortality
- Problems may be missed until the next stage
  - – e.g. The design cannot be implemented in the coding stage
  - – And a cascading effect: Problems in Coding Stage affect the Design, and consequentially affect the Requirements
- Little opportunity for customer to preview the system (until it may be too late)
  - – Problems may not be revealed until the testing stage!
  - – e.g. Missing a requirement may not be revealed until the testing stage!
-

When to use the Waterfall Model

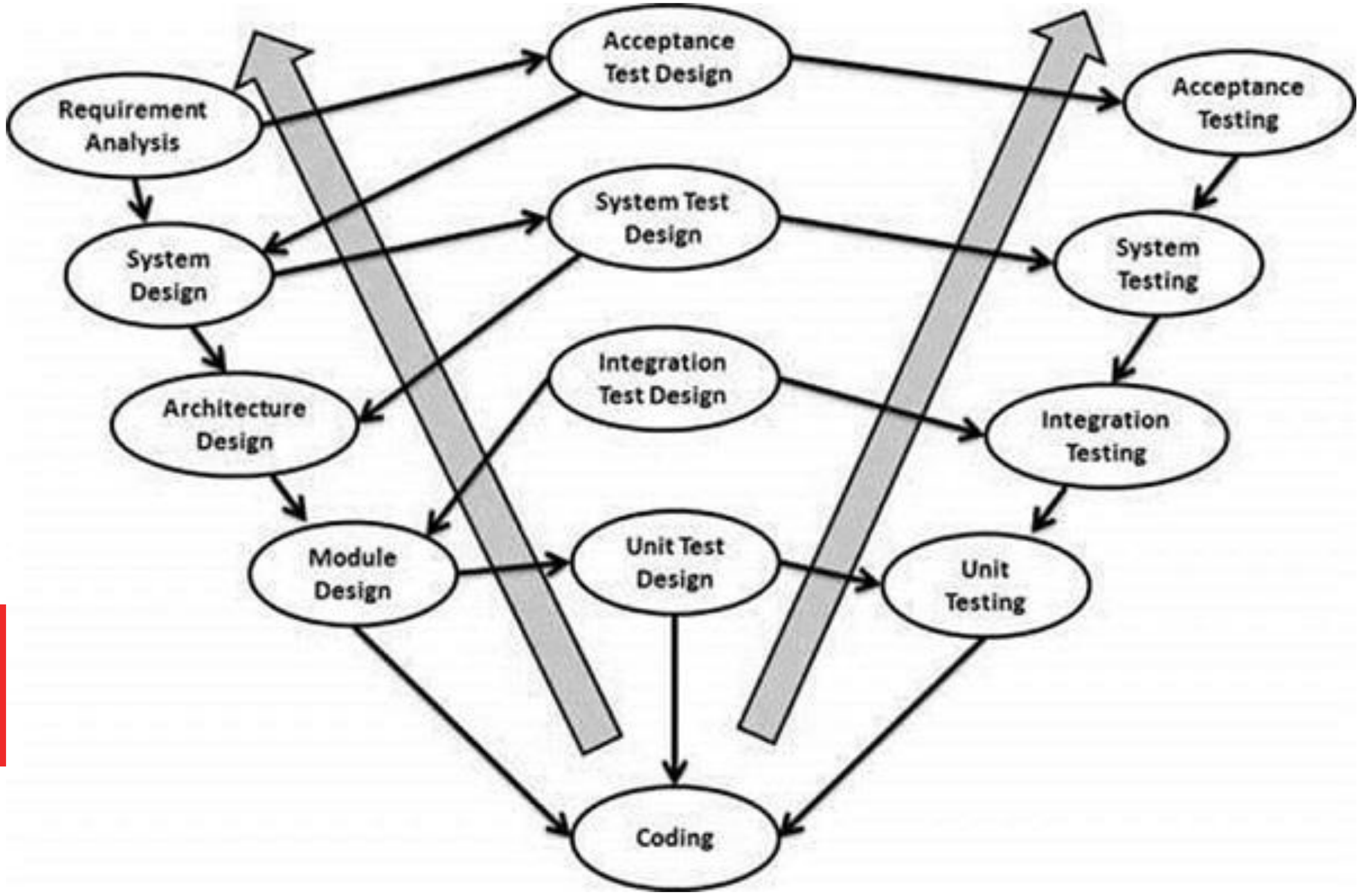
- Requirements are very well known
- Product definition is stable
- Technology is understood
- New version of an existing product
- Porting an existing product to a new platform.
-

Critics of the Waterfall

- Applicability of Waterfall to Interaction Design is poor
  - It is for Software development
- Interface design is always “risky”
  - It is unlikely the we can come up with a good design in the first shot!
  - Good designs evolve from mistakes
- End users were involved only in 2 stages: Requirement and Test
- Interface problems often causes changes in requirement and design
  - Wasted efforts at the Design and Implementation stages

V-Shaped Model

- A variant (or extension) of the Waterfall that emphasizes the verification and validation of the product.
- Association of a testing phase for each corresponding development stage
- Testing of the product is planned in parallel with a corresponding phase of development
- Next phase starts only after completion of the previous phase
-


Requirement Analysis
Acceptance Test Design
Acceptance Testing
System Design
System Test Design
System Testing
Architecture Design
Integration Test Design
Integration Testing
Module Design
Unit Test Design
Unit Testing
Coding

V-Shaped Steps

- Requirement Analysis / Acceptance Testing
  - Development User Requirements
  - Establish Acceptance Criteria

- System Design / System Testing
  - Overall system design
  - System test plan (functionality test) is developed based on the system design

- Architecture Design / Integration Testing
  - High-level architectural design
  - System is also broken down into modules
  - Integration tests are developed

- Module Design / Unit Testing
  - Detailed low-level design for individual modules
  - Unit tests for each module are developed

- Coding
  Start writing the first line of code!
-

V-Shaped Strengths

- Emphasize planning for verification and validation of the product in early stages of product development
- Each deliverable must be testable
- Project management can track progress by milestones
- Easy to use

V-Shaped Weaknesses

- Does not easily handle concurrent events
- Does not handle iterations or phases
- Does not easily handle dynamic changes in requirements
- Does not contain risk analysis activities

When to use the V-Shaped Model

- Excellent choice for systems requiring high reliability – hospital patient control applications
- All requirements are known up-front
- When it can be modified to handle changing requirements beyond analysis phase
- Solution and technology are known