WEEK 11: QUANTITATIVE DATA IN IS: BASIC CONCEPTS

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COMP90044 Research Methods in IS

Week 11 - Aims

- basic concepts of quantitative methods – by carrying out exercises
- positive/critical attitude to quantitative research methods, drawing lessons for all kinds of research
- links to learning more about quantitative research

Week 11 Overview

- Part 1. Measurement: conceptualisation & operationalisation
- Part 2. How good is your measure? validity & reliability

BREAK

- Part 3. Plotting your data meaningfully

- Part 4. Testing hypotheses about your data

Extract from an ethnographic study of an IT development company

- ‘Most of the staff believed the project could not succeed after the demonstration of the prototype to major customers failed to get interest. But most decided to continue with the project to get the value of the experience ...’

Heavy coffee consumption increases death rates in under-55s, study suggests

Scientists claim those in age group who drink average of more than four cups of coffee a day are at 56% greater risk of death from all causes

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Joseph Jebelli
The Guardian, Friday 16 August 2013 03.57 AEST

Jump to comments (121)

Article history

The apparently harmful effects of heavy coffee consumption were not seen in older people. Photograph: David Parker/Alamy

Drinking more than four cups of coffee a day can raise the risk of dying from a host of diseases, scientists claim.

Researchers in the US found that death rates from all causes rose by more than half in people aged under 55 who drank more than 28 cups a

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27 Sep 2011
Coffee may help prevent depression in women

23 Jun 2010
Coffee may protect against head and neck cancers

16 Apr 2008
Vitamin supplements

A note about Statistical software

Statistical Package for the Social Sciences - SPSS
(now = IBM's Predictive Analytics Software PASW)
www.ibm.com/spss/au
Many YouTube tutorials

Minitab

SAS

many others ...

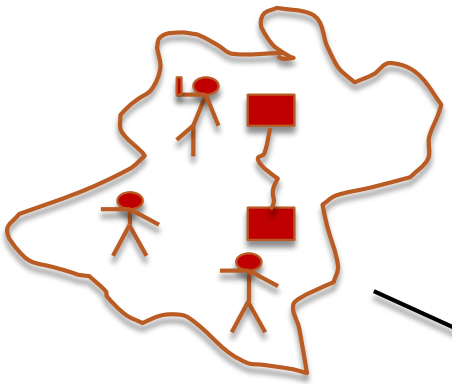
Part 1. Measurement: conceptualisation and operationalisation

A Research Question ...

Are people who are relatively more popular at work likely to be better IT project managers?

The art of measurement

the popularity of people at work



phenomena

the number of friends in people's facebook pages, who work in the same industry

34 3 3 2 5 12 17 4 7 15 8 9 44 21

raw data

mean

13.1

statistical summary (or test result)

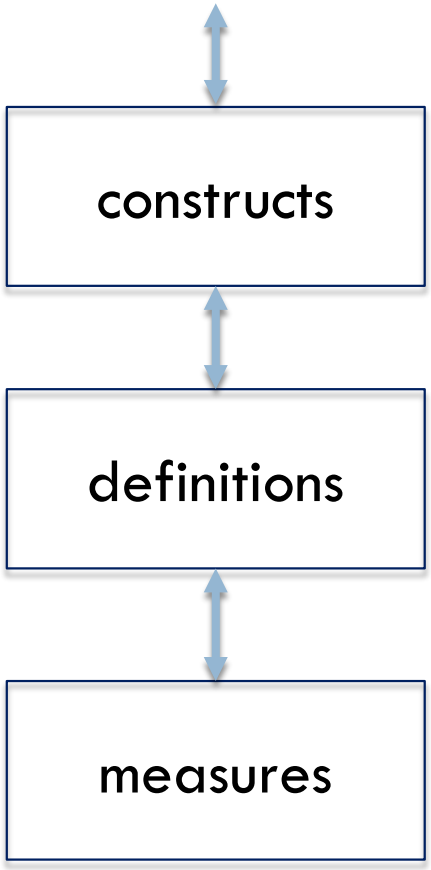
a finding

"People have a mean of 13.1 FaceBook 'friends' in their line of work."

Operationalisation of a RQ

research question

Are people who are relatively more popular at work likely to be better IT project managers?



Theory Level

Empirical Level

Work Popularity

IT Project Management Ability

Number of facebook friends of people in same industry counted by observation of facebook page by researcher.

Peer rating of ability to manage IT projects, collected by anonymous online survey.

Two constructs & measures

Construct: Work Popularity
Measure: Number of facebook friends of people in same industry counted by observation of facebook page by researcher.

Construct: IT Project Management Ability
Measure: Peer rating of ability to manage IT projects, collected by anonymous online survey.

Constructs & Definitions

Construct = a key element in the situation of interest stated at abstract level: e.g., 'work popularity', 'perceived usability', 'technology in use'

Conceptual definition = A clear statement of what each construct means and how it relates to other constructs or the situation of interest.

e.g. 'work popularity' is how well people are liked by others within the community of people that they work with

Operational definition = A way for us to identify what, in practice, counts as an example of the construct.

e.g. 'work popularity' is the strength of friendship networks that a person has within all the people in their industry area that they might be expected to come into contact with

Measures

Measure =

(i) a variable which defines a set of possible data points+

(ii) a procedure and tools for collecting numerical data

A possible measure of work popularity: the number of facebook friends (a whole number from 0 upwards) a person has of people who work in the same industry, as observed and counted directly by a researcher in that person's facebook page.

Examples of measures relevant to information systems

* answer to online survey questions about own beliefs or attitudes towards centralisation of services (attitude report)
* answer to online survey question about the number of help requests sent to tech services in a month (behaviour report)
* answer to paper survey question about managers ability to communicate to a team (other's behaviour report)

Examples of measures relevant to information systems

* observed number of emails sent for clarification within a virtual community over one month, taken from email log. (use log data)
* the number of errors counted by an observer for users of a spreadsheet (field observation)
* the estimated cost of the outsourced parts of software project as recorded in auditor reports
* the estimated profitability of software projects as recorded in auditor reports (public or private sourced data)

Examples of measures relevant to information systems

* the number of calls processed by a call-centre, recorded automatically
* the number of times a website was visited, measured in automatic use logs
* the amount of time users spend in a particular website, taken from use logs

(all user log data)

Work-Life Balance, part 1

A exercise in designing quantitative measurement

Part 2. How good is your measure?
Validity & Reliability

Validity & Reliability (vs Feasibility)

- Validity and Reliability are two ways to assess the value of data measurement in relation to constructs.

- Perfect Validity and Reliability are not possible.

  They are traded off against the Feasibility of the study - mainly the cost, time taken and ethical acceptability.

Validity

- ‘truthfulness’ of a research logic
- The ‘fit between the constructs a researcher uses to describe, theorize, or analyse the social world and what actually occurs in the social world.’ (from Neuman, 6th Ed, p.188)
- The emphasis here is on measurement validity

Types of Validity

- **Face validity** (extent to which the measure is intuitively reasonable)
- **Content validity** (extent to which it covers all aspects of the concept it seeks to represent)
- **Criterion vality** (extent to which it can be judged against an existing standard)
  - concurrent, predictive
- **Construct validity** (extent to which it agrees or disagrees sensibly with other measures being used)
  - convergent, discriminant
- **Ecological validity** (extent to which it reflects the 'real' construct as opposed to an artificial version created by the study)

Reliability

- Is the research logic 'dependable' and 'consistent'?
- Is the measurement process consistent from one situation to another.
- Is the data collected independently of unseen changes in the measurement process.
- Statistical tests are a way of finding out about the reliability of a set of data

(See Neuman, 6th Ed, p188-189)

Types of Reliability

- **Stability reliability** (extent to which a measure produces the equivalent data over time)
- **Representative reliability** (the extent to which a measure produces equivalent data across different groups or sites of collection)
- **Equivalence reliability** (the extent to which a measure gives equivalent data across different indicators of the study; a special case is 'inter-rater reliability')

Work-Life Balance, part 2

Present Back and consider

Validity, Reliability & Feasibility

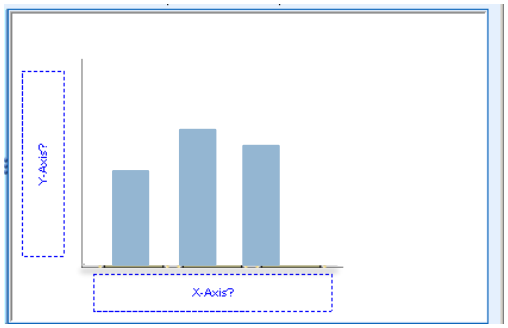
BREAK

Part 3. Plotting Your Data Meaningfully: Making the overall pattern clear to you and clear to others?

The importance of graphs and tables

- Inspecting a set of data through tables and visual plots is a vital part of analysis, for ...
  - checking for errors and anomalies in the data collection process
  - getting an overall sense of the pattern of the findings
  - communicating the data to an audience

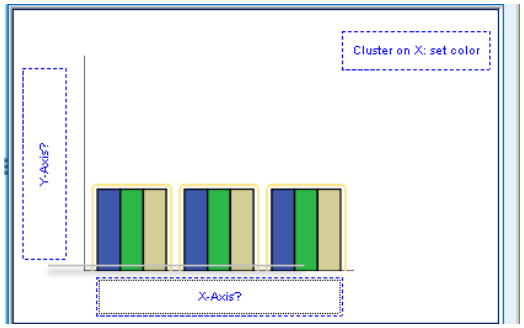
simple
bar chart



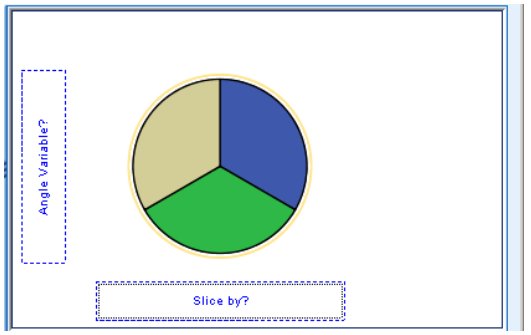
cross-tabulation

y-axis \ x-axis		
	23	67
	153	167

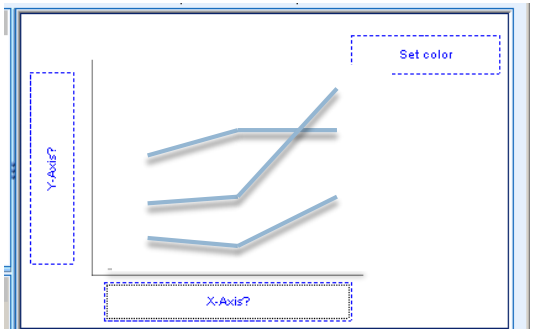
multiple
bar chart



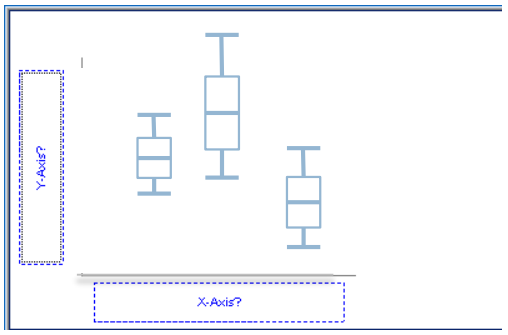
pie chart



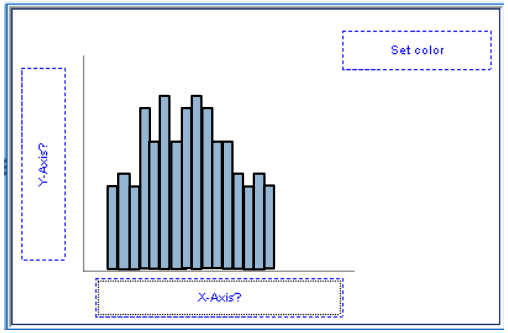
line chart



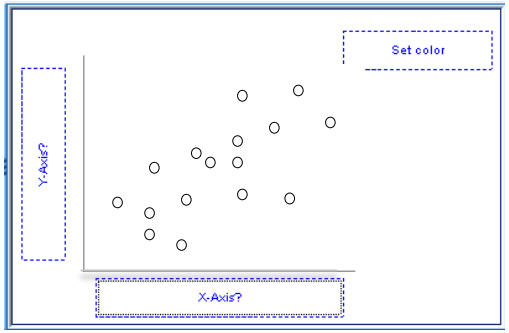
box chart



histogram



scattergram



FaceBookatWork2.sav

	PersonId	Sex	Department	FBFriends	Age
1	1	m	s sales	28	25
2	2	m	s	25	27
3	3	m	s	15	45
4	4	m	t tech support	4	46
5	5	m	t	6	52
6	6	m	t	13	43
7	7	m	s	21	23
8	8	m	s	19	26
9	9	m	t	16	55
10	10	m	t	9	43
11	11	m	t	30	38
12	12	m	s	20	35
13	13	m	t	14	52
14	14	m	s	11	45
15	15	m	s	19	32
16	16	f	s	18	51

How to choose the right plot?

- Choose a data plot based on the following:
  - What level of measurement is involved?
  - Which are the predictor variables and which are the outcome variables
  - What aspects of the data are being shown:
    - single variable: central tendency, dispersion
    - many variables: relationship between data on different variables.

The basics of clear data plotting

- Make sure there are clear labels for:
  - ALL variable names (with units in parentheses)
  - Values - for scale points, separate bars/curves/regions
- Choose a sensible range of values for each variable.
- Remove anything that is unnecessary.
- Add a label with a title e.g. 'Figure 2. The mean number of FaceBook friends for each group'
- Refer to the label in the text of your report e.g. 'Figure 2 shows that ..... '

What's wrong with this graph?

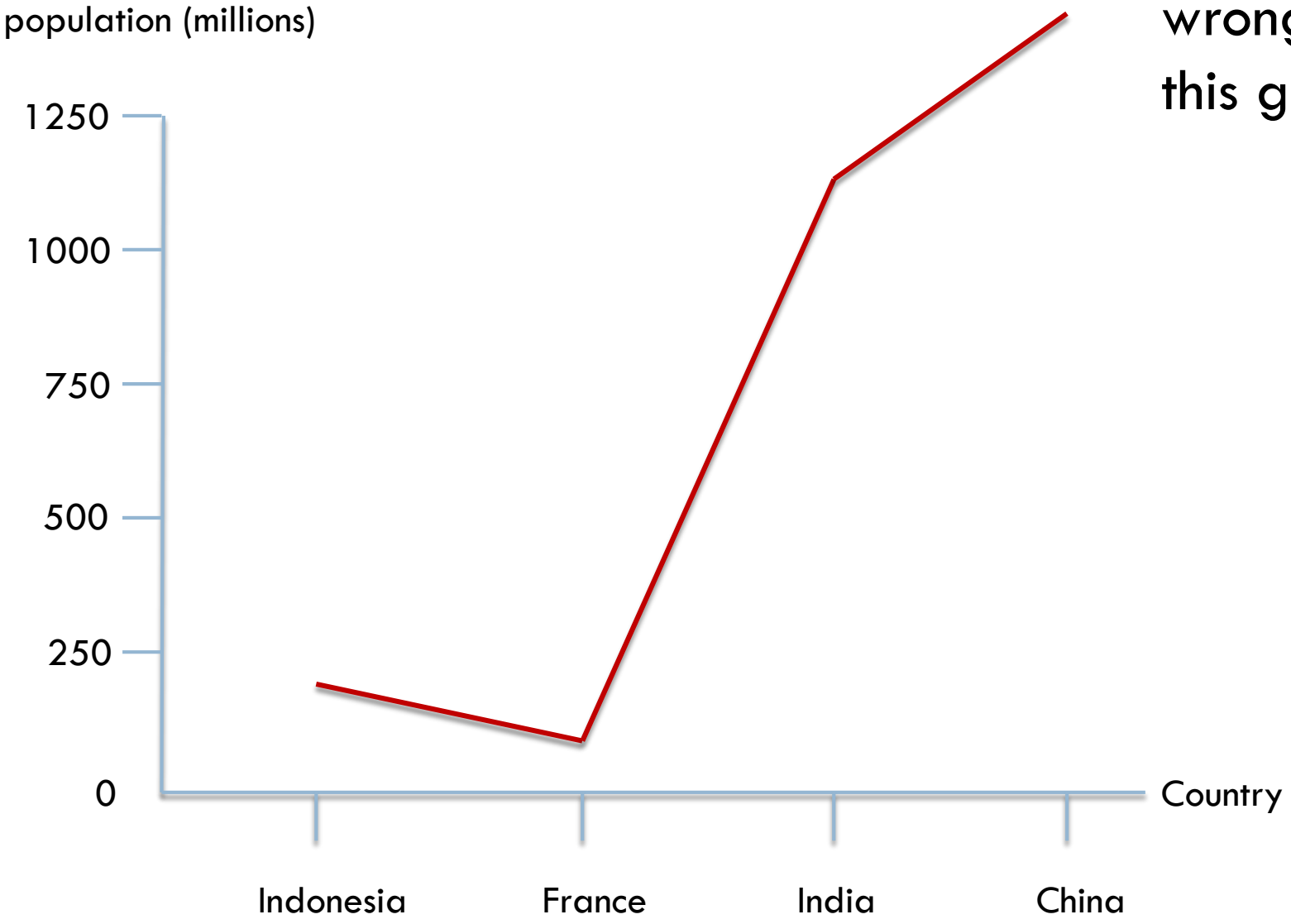


Figure 1. Populations of host countries for study 1.

What's wrong with this graph?

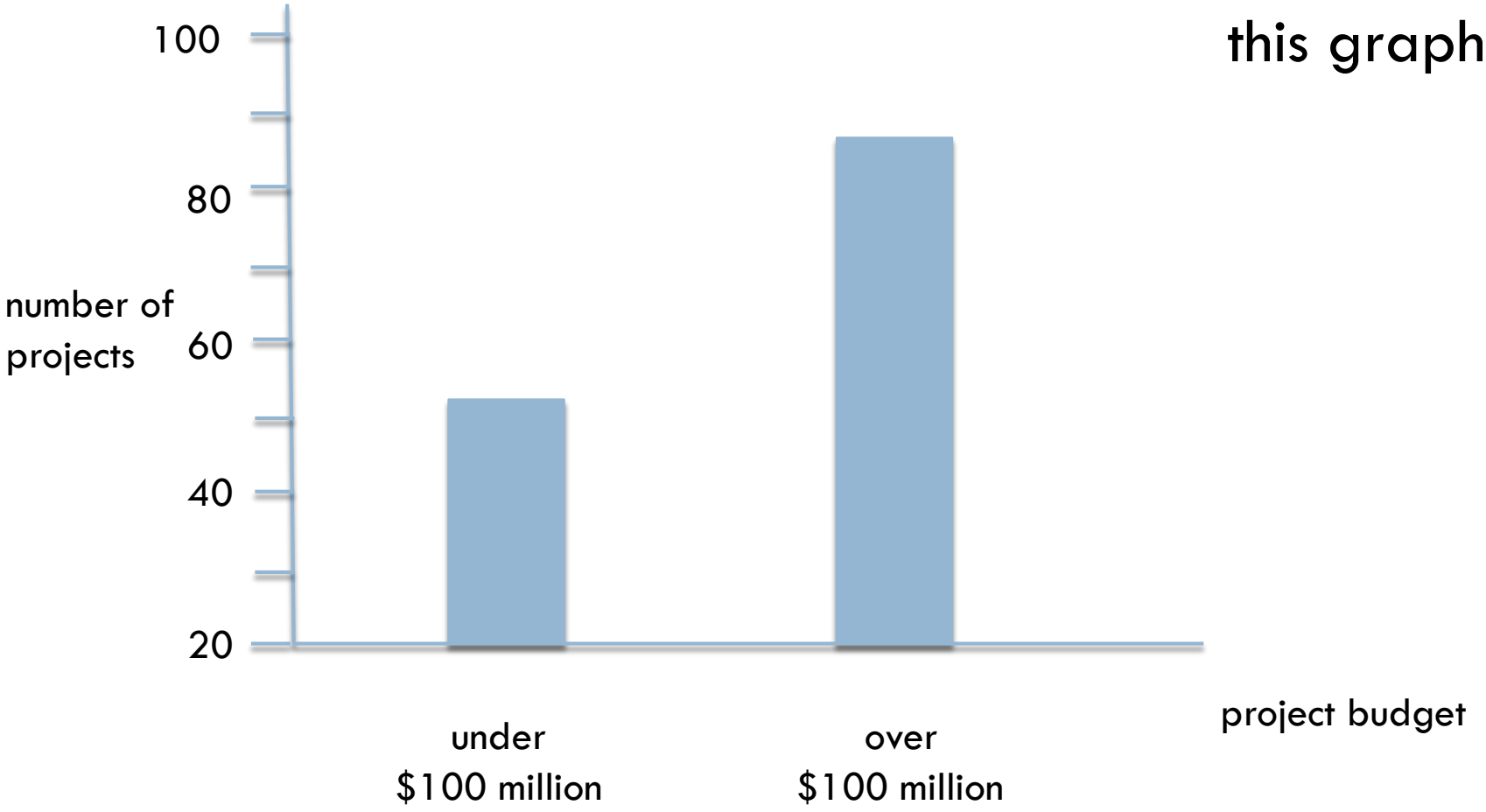


Figure 2. Information Systems projects abandoned before completion in country X, in 2016

Levels of measurement

- nominal - data-points are only names
- ordinal - data-points can be placed in order
- interval - the difference between data-points is meaningful
- ratio - the ratios of data-points are meaningful, ie the measure has a known zero point

Nominal-level measure (lowest)

Gives codes to objects that are only names. (Does not have ordinal, interval or ratio properties.)

'Participants in the study were divided into four groups (1, 2, 3 and 4) where each group took a different role in the game'

Binary measures are a special case - when there are only two categories

'Participants responded "Yes" or "No" to ten questions'

Ordinal-level measure

Gives labels to objects that allow them to be put in a meaningful order. (Does not have interval or ratio properties.)

'Participants in the game study were identified as either

1. 'novices'
2. 'played enough times to know the rules',
3. 'very experienced'.

Interval-level measure

Gives labels to objects that allow them to be put in a meaningful order AND for the difference between the objects to be meaningful. (Does not have ratio properties.)

The player's self-rating on a 10pt scale:

1 (no expertise) to 10 (highest level of expertise)

(Calling this an interval measure means that we are claiming:

Two people who rate themselves as 1 and 2 are closer in expertise than two people who rate themselves as 2 and 9.)

Ratio-level measure (highest)

Gives labels to objects that allows their ratios to be meaningfully compared.

'The time it took for players to beat the first level of the game.'

(Calling this a ratio measure means that we are claiming:

A person with a score of 60 seconds is twice as fast as a person who took120 seconds, and a person who took 20 seconds is four times as fast as a person taking 80 seconds.)

Levels of measurement

The level of a measure relates to the variable that it creates (not to its procedure)

The level of a measure is vitally important because:

- it affects the kind of meaning we can give to the data it produces
- it affects the kind of statistical test or procedure that can be applied to the data

What level are these measures?

1. The number of downloads of The Beatles 'Abbey Road' on iTunes in a given year.
2. The mark that primary school children get in a spelling test out of 20.
3. The make of cars purchased online in a financial year.
4. The time that orchestra members spend on instrument practice each week.
5. Ratings on a five-point scale for how valuable people find YouTube (1 not all - to 5 extremely)
6. Self-report for how much time per week children spend watching TV (0-1hr , 1-2 hrs, 3-4 hrs, 4 -5 hrs, 5-6 hrs, 6-7 hrs, 7-8 hrs, 8-9 hrs, 9-10hrs, more than 10 hrs)
7. The number of Google searches people make each week.
8. The temperatures in centigrade of various working spaces of an industrial plant.
9. The time it takes for mobile phone users to send an acknowledgement in response to a txt message notifying a bush fire risk.
10. The numbers worn by AFL football players committing fouls in a given season.
11. How much a person likes Collingwood football team on a scale of 1 (hate) to 10 (love)
12. The age of people taking part in a survey.

How to choose the right plot?

- Choose a data plot based on the following:
  - What level of measurement is involved?
  - Which are the predictor variables and which are the outcome variables
  - What aspects of the data are being shown:
    - single variable: central tendency, dispersion
    - many variables: relationship between data on different variables.

Predictors and Outcomes

predictor variables - believed to be a cause or driver in the situation of interest (SPSS: 'input variable')

outcome variables – believed to be an outcome or result in the situation of interest (SPSS: 'target variable')

Which is predictor, Which is outcome?

Construct: Work Popularity
Measure: Number of facebook friends of people in same industry counted by observation of facebook page by researcher.

Construct: IT Project Management Skill
Measure: Peer rating on a 10pt-scale of ability to manage IT projects, collected by anonymous online survey.

The aspects of data to describe

- The two most important things to describe about a set of data on a single variable:
  - Central tendency – the 'middle' of the data
  - Dispersion or variability – the extent to which the data points are spread out

Central tendency and dispersion (of data on a single variable)

the number of friends in people's facebook pages, who work in the same industry

mean = 13.1

median = 8

mode = 3

Where is the overall centre?

How spread out are they?

range = 2 - 44

inter quartile range= 4.25 – 16.25

variance = 158

standard deviation = 12.57

Two data sets – which plot?

- Titanic Survivors

- Face-book Friends at Work

For each, Consider

* Which are the Predictor vs Outcome variables
* What is the level of measurement for each variable?
* Which plots from the SPSS range you would use to explore these data?

Titanic Survivors

- How to plot the relationship between:
  - Passenger class (1st, 2nd, 3rd) and Age (0 to 85 yrs)
  - Passenger class (1st, 2nd, 3rd) and Survival (yes or no)

	Name	PClass	Age	Sex	Survived
1	"Allen, Miss Elisabeth Walton"	1st	29	female	1
2	"Allison, Miss Helen Loraine"	1st	2	female	0
3	"Allison, Mr Hudson Joshua Creighton"	1st	30	male	0
4	"Allison, Mrs Hudson JC (Bessie Waldo Daniels)"	1st	25	female	0
5	"Allison, Master Hudson Trevor"	1st	0.92	male	1
6	"Anderson, Mr Harry"	1st	47	male	1
7	"Andrews, Miss Kornelia Theodosia"	1st	63	female	1
8	"Andrews, Mr Thomas, jr"	1st	39	male	0
9	"Appleton, Mrs Edward Dale (Charlotte Lamson)"	1st	58	female	1
10	"Artagaveytia, Mr Ramon"	1st	71	male	0
11	"Astor, Colonel John Jacob"	1st	47	male	0
12	"Astor, Mrs John Jacob (Madeleine Talmadge Force)"	1st	19	female	1
13	"Aubert, Mrs Leontine Pauline"	1st	NA	female	1
14	"Barkworth, Mr Algernon H"	1st	NA	male	1
15	"Baumann, Mr John D"	1st	NA	male	0
16	"Baxter, Mrs James (Helene DeLaudeniere Chaput)"	1st	50	female	1
17	"Baxter, Mr Quigg Edmond"	1st	24	male	0
18	"Beattie, Mr Thomson"	1st	36	male	0
19	"Beckwith, Mr Richard Leonard"	1st	37	male	1
20	"Beckwith, Mrs Richard Leonard (Sallie Monypeny)"	1st	47	female	1
21	"Behr, Mr Karl Howell"	1st	26	male	1
22	"Birnbaum, Mr Jakob"	1st	25	male	0
23	"Bishop, Mr Dickinson H"	1st	25	male	1
24	"Bishop, Mrs Dickinson H (Helen Walton)"	1st	19	female	1
25	"Bjornstrm-Steffansson, Mr Mauritz Hakan"	1st	28	male	1
26	"Blackwell, Mr Stephen Weart"	1st	45	male	0
27	"Blank, Mr Henry"	1st	39	male	1
28	"Bonnell, Miss Caroline"	1st	30	female	1
29	"Bonnell, Miss Elizabeth"	1st	58	female	1
30	"Borebank, Mr John James"	1st	NA	male	0
31	"Bowen, Miss Grace Scott"	1st	45	female	1
32	"Bowerman, Miss Elsie Edith"	1st	22	female	1

titanic.sav [DataSet1] - PASW Statistics Student Version Data Editor

File Edit View Data Transform Analyze Graphs Utilities Window Help

1 : Name "Allen, Miss Elisabeth Walton"

	Name	PClass	Age	Sex	Survived
1295	"Willer, Mr Aaron"	3rd	NA	male	0
1296	"Willey, Mr Edward"	3rd	NA	male	0
1297	"Williams, Mr Howard Hugh"	3rd	NA	male	0
1298	"Williams, Mr Leslie"	3rd	28	male	0
1299	"Windelov, Mr Einar"	3rd	21	male	0
1300	"Wirz, Mr Albert"	3rd	27	male	0
1301	"Wiseman, Mr Phillippe"	3rd	NA	male	0
1302	"Wittevrongel, Mr Camiel"	3rd	36	male	0
1303	"Yalsevac, Mr Ivan"	3rd	NA	male	1
1304	"Yasbeck, Mr Antoni"	3rd	27	male	0
1305	"Yasbeck, Mrs Antoni"	3rd	15	female	1
1306	"Youssef, Mr Gerios"	3rd	NA	male	0
1307	"Zabour, Miss Hileni"	3rd	NA	female	0
1308	"Zabour, Miss Tamini"	3rd	NA	female	0
1309	"Zakarian, Mr Artun"	3rd	27	male	0
1310	"Zakarian, Mr Maprieder"	3rd	26	male	0
1311	"Zenni, Mr Philip"	3rd	22	male	0
1312	"Lievens, Mr Rene"	3rd	24	male	0
1313	"Zimmerman, Leo"	3rd	29	male	0
1314					
1315					

Data View Variable View

Part 4. Testing hypotheses about data

What is a statistical test?

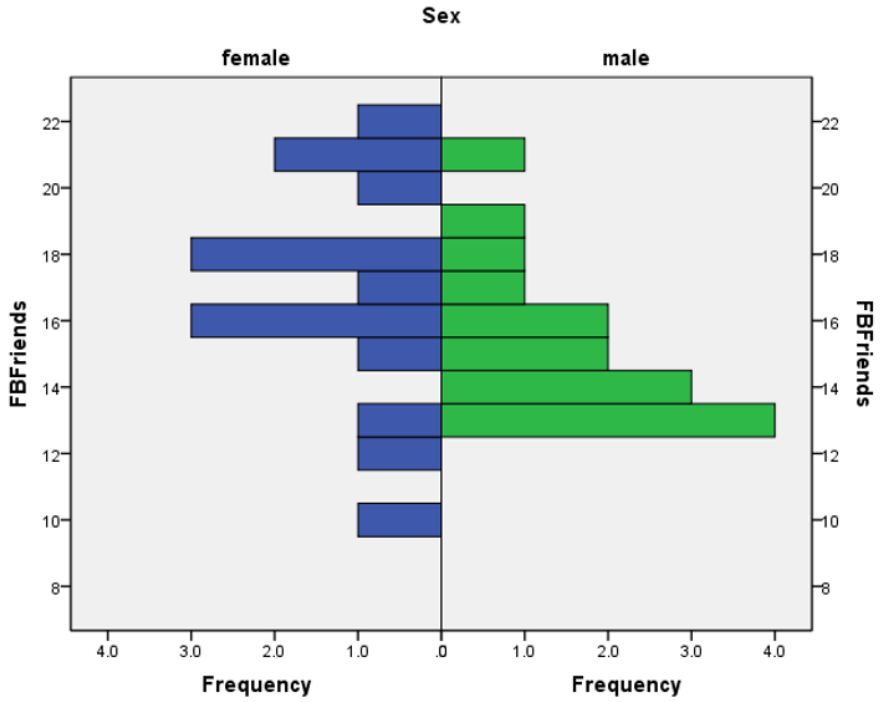
- A statistical test is a procedure for deciding if the data supports a particular hypothesis.
- There are a wide range of statistical tests depending on:
  - The questions asked of the data, including which are predictor and which are outcome variables.
  - The qualities of the data, including the level of measurement used.

FaceBook Friends at Work example

- Questions about the data:
  Is there any difference between men and women for the number of FB friends they have related to work?
- Is there any difference between the sales department and technical support department for the number of FB friends they have related to work?

FaceBookatWork2.sav

	PersonId	Sex	Department	FBFriends	Age
1	1	m	s sales	28	25
2	2	m	s	25	27
3	3	m	s	15	45
4	4	m	t tech support	4	46
5	5	m	t	6	52
6	6	m	t	13	43
7	7	m	s	21	23
8	8	m	s	19	26
9	9	m	t	16	55
10	10	m	t	9	43
11	11	m	t	30	38
12	12	m	s	20	35
13	13	m	t	14	52
14	14	m	s	11	45
15	15	m	s	19	32
16	16	f	s	18	51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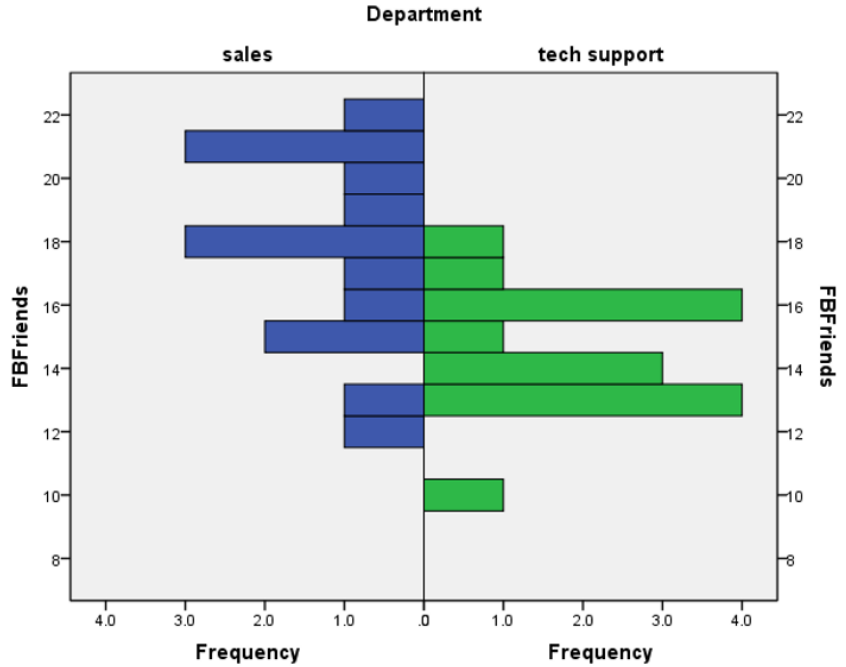
Frequency


Department
sales
tech support
FBFriends
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Frequency

*FaceBookatWork2.sav [DataSet1] - IBM SPSS Statistics Data Editor

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2	Sex	String	8	0		{f, female}...	None	8	Left	Nominal	Input
3	Department	String	8	0		{s, sales}...	None	8	Left	Nominal	Input
4	FBFriends	Numeric	8	0		None	None	8	Right	Scale	Target
5	Age	Numeric	8	0		None	None	8	Right	Scale	Input
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Data View | Variable View

IBM SPSS Statistics Processor is ready

*FaceBookatWork2.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Add-ons Window Help

Visible: 5 of 5 Variables

	PersonId	Sex	Department	FBFriends	Age	var	var	var	var	var	var	var	var	var	var
1	1	m	s	28	25										
2	2	m	s	25	27										
3	3	m	s	15	45										
4	4	m	t	4	46										
5	5	m	t	6	52										
6	6	m	t	13	43										
7	7	m	s	21	23										
8	8	m	s	19	26										
9	9	m	t	16	55										
10	10	m	t	9	43										
11	11	m	t	30	38										
12	12	m	s	20	35										
13	13	m	t	14	52										
14	14	m	s	11	45										
15	15	m	s	19	32										
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21	21	f	s	36	30										
22	22	f	t	16	32										
23	23	f	t	10	46										
24	24	f	t	18	30										
25	25	f	s	25	23										
26	26	f	s	21	45										
27	27	f	t	16	31										
28	28	f	t	17	32										
29	29	f	t	12	45										
30	30	f	t	13	54										
31															
32															
33															
34															
35															

Data View | Variable View

IBM SPSS Statistics Processor is ready

MALE vs FEMALE

Group Statistics

	Sex	N	Mean	Std. Deviation	Std. Error Mean
FBFriends	male	15	15.40	2.444	.631
	female	15	16.87	3.441	.888

t-test result

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
FBFriends	Equal variances assumed	1.311	.262	-1.346	28	.189	-1.467	1.090	-3.699	.765
	Equal variances not assumed			-1.346	25.259	.190	-1.467	1.090	-3.710	.776

SALES DEPARTMENT vs TECH SUPPORT DEPARTMENT

Group Statistics

	Department	N	Mean	Std. Deviation	Std. Error Mean
FBFriends	sales	15	17.73	3.058	.790
	tech support	15	14.53	2.031	.524

t-test result

Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
FBFriends	Equal variances assumed	2.411	.132	3.376	28	.002	3.200	.948	1.258	5.142
	Equal variances not assumed			3.376	24.337	.002	3.200	.948	1.245	5.155

Hypothesis testing

- In asking our first question … we need to think of it as a decision between two competing hypothesis:
  - Null hypothesis: There is no difference between men and women in the number of FB friends they have related to work.
  - Alternative hypothesis: Women will have more work-related FB friends than men. (*There's no basis for this, but imagine a researcher predicted it*!)

Tests and Significance levels

- A t-test can be used to compare the means in the two groups (women, men). A t-test uses the value of interval data to take into account the dispersion of the scores in the two groups.
- The results will be:
  - a t-test score (the t statistic, for a given degrees of freedom which reflects the size of the sample of data.
  - A probability level. If the 'p value' is less than 0.05 then the difference is said to be 'significant'

p-values

- The p-value of the test is the probability that these data would be obtained if the Null hypothesis was true – ie there was no difference between men and women.
- A p-value of 0.05 means that there is only a 1 in 20 chance that these data would have been found if the Null hypothesis was true.
- alpha – is the level of probability that we accept (0.05) – and is entirely arbitrary! (but widely used)

Type I and Type II errors

- For all statistical tests, two errors might be made:
  - A Type I error – that we falsely reject the Null hypothesis (we seem to have found a difference, but in reality there is none). The probability of making a Type I error is alpha.
  - A Type II error – that we falsely accept the Null hypothesis (we seemed to find no difference, but in reality there was a difference). The probability of making a Type II error is beta – generally greater than alpha – and has to be estimated