ICT158

Introduction to Information Systems

Topic 5

Decisions and decision making

Learning objectives

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After completing this topic you should be able to:

- Explain why individuals and organisations need to make decisions and identify the main themes involved in decision-making
- Distinguish between rational and intuitive aspects of decisions
- Explain how uncertainty and risk, framing and biases affect decision-making
- Distinguish between structured, unstructured and semi-structured decisions, and give examples of each for an organisation
- Briefly explain the difference between classical decision theory and behavioural approaches
- Use multi-criteria decision-making to evaluate alternatives with conflicting priorities
- Use decision tables and decision trees to represent the logic of structured decisions

Readings

- Belanger, F. & Van Slyke, C. (2012) Chapter 6: Analysing information for business decision-making. In *Information Systems for Business: An Experiential Approach*. Wiley. Available through MyUnitReadings
- Some of the material in this lecture is from Gammack, J, Hobbs, V, & Pigott, D. (2007). *The Book of Informatics*. Melbourne: Cengage Learning Australia Pty Ltd. Chapter 7 – some pages will be available through MyUnitReadings

Overview

- How individuals make decisions
- Decisions and organisations
- Representing decision logic
- Group decision-making

5.1 How individuals make decisions

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5.1.1 What is a decision?

5.1.2 The nature of decision-making

- Rational versus intuitive
- Bias and the effect on decision-making
- Uncertainty and risk

What did you have for breakfast this morning?

What influenced your decision?

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What else did you decide today?

- Whether to get out of bed…
- What to wear…
- Whether to come to this lecture…
- Whether to try and get a close parking spot…
- Whether to throw out or recycle the drink cans…
- Which mobile phone to buy…
- Who to vote for in the guild/council election…
- Where to go on holiday…
- Whether to take that job you were offered…

What factors affected your decision-making?

Intuition

Competing values

Emotion

Uncertainty

Risk

Calculation

Morals

Ethics

Other people

…

What is a decision?

A choice made between alternative courses of action in a situation of uncertainty

What decisions might be made at a university?

How many textbooks to reorder for a unit

Who teaches what next semester

How to determine who can graduate

Whether to put on a new unit/course

How to brand/advertise

Whether to open a new campus

What information would be needed for each of these?

Recap

A decision is a choice between alternatives, in a situation of uncertainty, and is influenced by factors such as intuition, other people, risk, amongst others.

How individuals make decisions

The nature of decision making

How does a person make a decision?

Decisions may:

- Be based on reason or emotion
- Involve personal styles and preferences
- Involve personal values and principles
- Be based on faulty reasoning or biases
- Involve uncertainty
- Be affected by risk perception and framing

Rational decision – a decision that is based on the available information, weighing advantages and disadvantages in a logical manner

The large size coffee tin is better value, but if I buy that I won't have enough money for cheese

I can't really afford those shoes but they make me feel great!

Intuitive decision – a decision that is predominantly based on feelings or values rather than being made rationally

Values – individual moral and social beliefs and principles

I won't buy genetically modified food products

Rational versus intuitive

- **Rational** decisions are arrived at through reasoning and logic
- **Intuitive** may be spontaneous emotional decisions, maybe subconscious
- In practice, most decisions are likely to be a mixture of both emotion and reason, or at least validated against the other mode
- Often a decision is made because it ‘feels right’ and only later is rationalised

Rational versus intuitive

- Intuition can also draw on **expertise** – when an expert knows a field so well they 'just know' the answer without apparently reasoning through it

--- However, they are actually likely to be drawing on extensive previous experience and recognised patterns, and simply applying a shortcut or **heuristic**

- Thus the ability to memorise and recognise familiar patterns, recognise the relevance of new information and to make connections can help increase decision quality

Cognitive biases

Human thinking is prone to **bias** which can directly affect the quality of decision making

- Biases are 'short cuts' (heuristics) in thinking that lead to the wrong place
- It's important to be aware of the possibility of cognitive bias in your (or someone else's) thinking

The classic work on cognitive bias was done by Amos Tversky and Daniel Kahneman (where these examples are taken from):

'The framing of decisions and the psychology of choice' Science, 1981. 211: 453-8 [available through MyUnitReadings]

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"Linda is 31 years old, single, outspoken and bright. She majored in philosophy. As a student she was deeply concerned with issues of discrimination and social justice, and also participated in antinuclear demonstrations."

Which is most likely?

A: Linda is a programmer

B : Linda is a programmer and an eco-warrior

?

(after Tversky & Kahneman, 1982)

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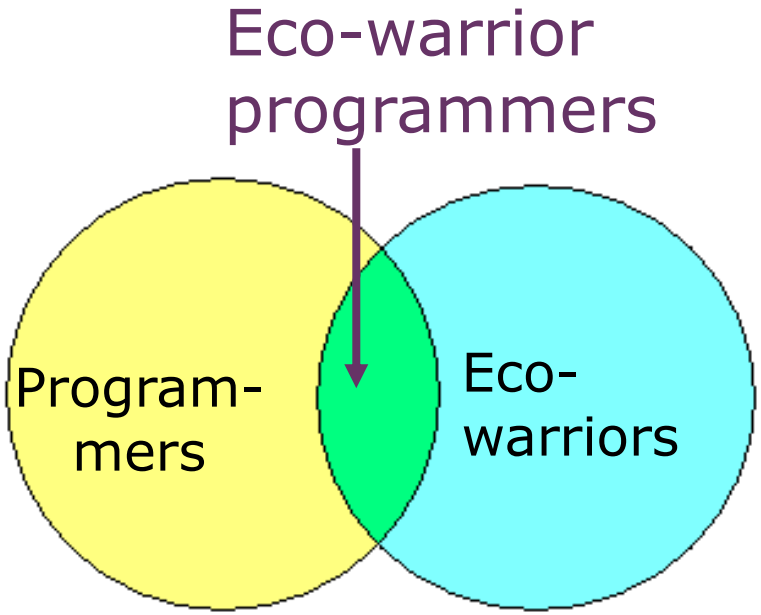
A programmer and eco-warrior can't be more likely than just "a programmer"!

This is an example of **representativeness bias**

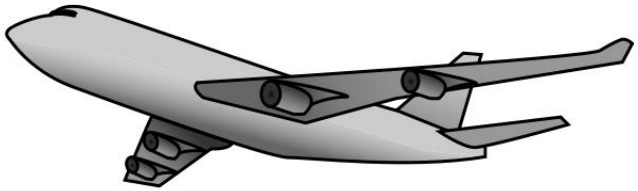
(Also called conjunction fallacy)

- where the probability of something is estimated erroneously, because it is based on a preconceived idea of its representativeness of a particular category



Availability bias

- Which is a more likely cause of death in the United States - being killed by falling aeroplane parts or by a shark?



?

Availability bias

- In the USA, the chances of dying from falling aeroplane parts is *30 times greater** than dying from a shark attack
- However shark attacks are easier to imagine and receive more publicity

  - the information is more ***available***

  - more people rated shark attacks as the more likely cause of death

*from Scott Plous, S (1993) *The Psychology of Judgment and Decision Making*

Gambler's fallacy

A fair coin is flipped five times – HHHHH

You have to bet $100 on next outcome.

H or T – why?

?

Gambler's fallacy

- No preference is correct
- ***T*** was thought of as more likely due to run
- Assumption that chance sequences must be locally representative – wrong!

Cognitive biases affecting decision making

- Cognitive biases introduce unpredictability and irrationality into human decision-making
- This can have significant implications, e.g. decisions on funding:

  More shark nets or more research on diabetes?

Lots of examples here:

http://en.wikipedia.org/wiki/List_of_cognitive_biases

Some cognitive biases affecting decision making

Negativity bias – giving more weight to negative than positive information

Confirmation bias – searching for information that supports preconceptions

Loss aversion – making losses more important than equal gains

Bandwagon – tendency to do/believe something because others do

Gambler's fallacy – believing that random events are influenced by previous random events

Source: Belanger (2012) p95

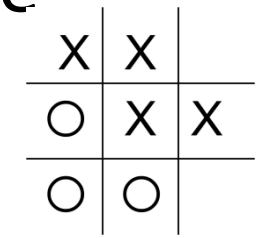
Recap

*Biases are 'short cuts' (**heuristics**) in thinking that lead to the wrong place*

*Cognitive biases (such as **representativeness**; **availability**; **gambler's fallacy**) introduce unpredictability and irrationality into human decision-making*

Uncertainty and risk

- In a *closed world* situation the complete set of choices and their relative probability is known
- In these situations the risk of each alternative can be estimated statistically and decisions based on this
- However where we don't have complete information, we have **uncertainty**



Uncertainty and risk

Risk associated with uncertainty can be reduced by taking *extra information* into account

th?

We know that ‘the’ is a much more common word than ‘thy’ in English - guessing that the next letter is E is a lower risk strategy

How many textbooks to order?

Relevant information might include…

- Projected number of students in the unit
- Whether the book is required or optional
- Whether it was used last year
- Whether it will be used again next year
- Whether there are other bookshops nearby
- Whether it's available online
- What it costs

…

Risk perception

- Taking risks is a personal preference and rests on an individual's emotional comfort with a choice and their relative optimism, pessimism or realism
- Risks may be perceived differently by different people (and even by the same person under different conditions)
- This means that individuals will vary in their assessment of the likelihood of outcomes and behave accordingly

You are in charge of a hospital, preparing to combat a disease expected to kill 600 people

- If program **A** is adopted:

  200 people will be saved

- If program **B** is adopted:

  There is a 33% probability that 600 people will be saved
  and a 67% probability that no people will be saved

WHICH DO YOU CHOOSE?

You are in charge of a hospital, preparing to combat a disease expected to kill 600 people

- If program **C** is adopted:

  400 people will die

- If program **D** is adopted:

  There is a 33% probability that nobody will die and a 67% probability that 600 people will die

WHICH DO YOU CHOOSE?

Framing

- In this example, programs A and C, and B and D, are identical – just *framed* differently
- However when this dilemma was given to real doctors, they made different choices, depending on which version they read:
- In the first version, most (72 per cent) chose program A.

  This is a conservative, low risk choice.
- In the second version though, 78 per cent chose D, the higher risk option!

Framing and risk perception

- This example was used by Tversky and Kahneman in their work on **prospect theory**
- Prospect theory addresses the finding that people have different attitudes to the same risk whether it is **framed** in terms of loss or gain

- This is significant, as it means that decision-makers may behave inconstantly or irrationally

Framing and risk perception

- You are about to buy petrol for $1.20 a litre (you need 50 litres to fill your car). You remember that you saw a petrol station 5 minutes away that was selling it for $1.00 a litre.
  - **Would you make the trip?**

- You are about to buy a mobile phone for $300. The salesman tells you that the mobile phone you want to buy is on sale at the other branch of the store, 5 minutes drive away, for $290.
  - **Would you make the trip?**

Recap

Risks may be perceived differently by different people, and the same risk may be perceived differently according to how it is ***framed***

Uncertainty is often associated with risk: extra information can reduce uncertainty

5.2 Decisions and organisations

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5.2.1 Problem-solving and decision-making

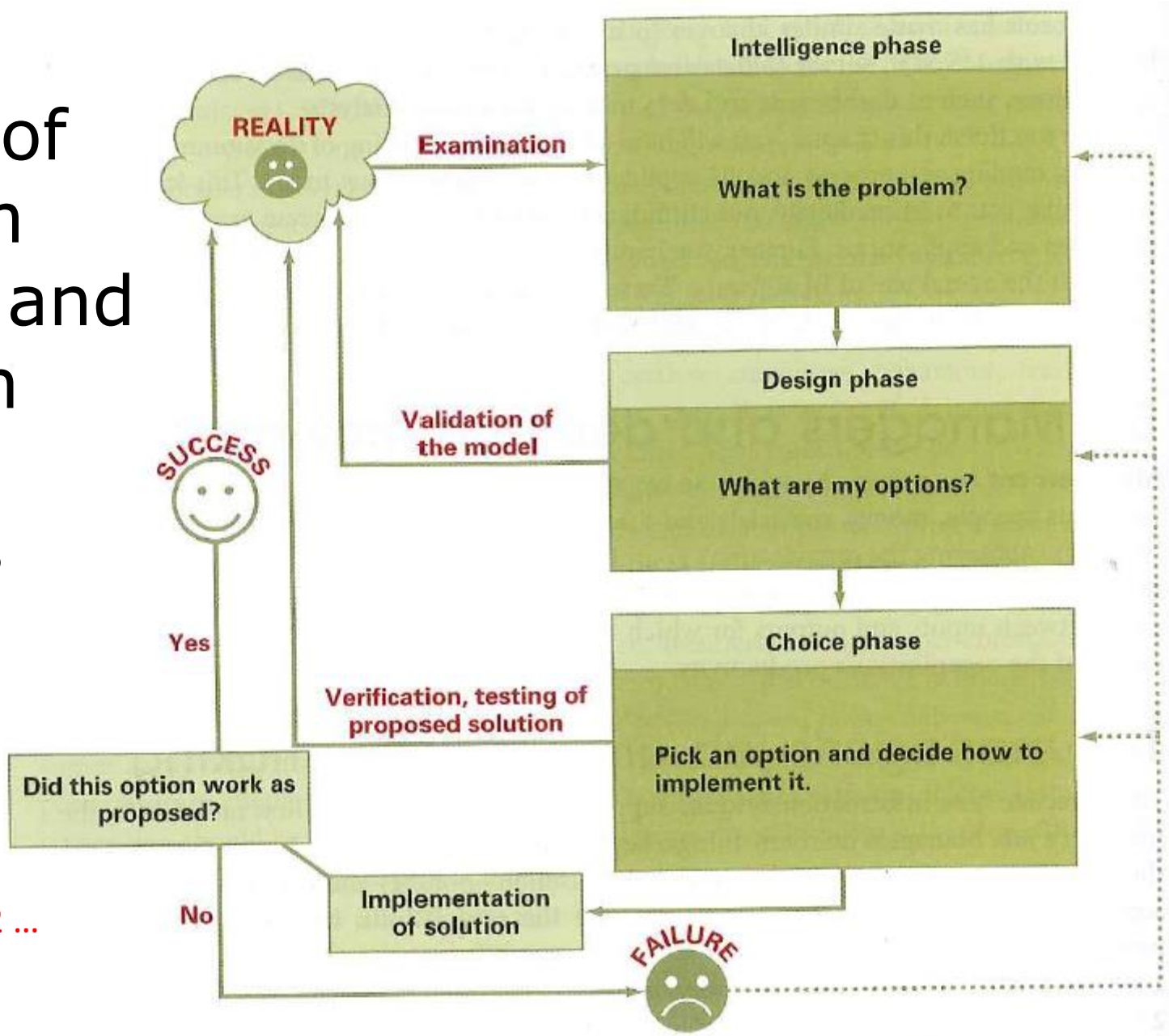
5.2.1 Types of decisions

- Structured
- Semi-structured
- Unstructured

5.2.3 Ethics of decision-making

5.2.4 Theories of decision making in organisations

Stages of problem solving and decision making process



Recap from Topic 2 …

Source: Gray et al (2015)

Problem solving and decision making

- Once potential solutions have been identified, a **decision** can be made about which to choose
- May be straightforward or may involve some judgement
- There may be some **risk** associated with the solution (losing time, money, effort)
- Risks can be identified and quantified in terms of risk/reward ratio, and reduced by testing the solution in a limited manner
- Organisations and individuals will also differ in how 'risk averse' they are

Recap from Topic 2 …

Information and decisions

Information is needed to:

- Understand the objectives of a decision
- Understand the constraints that limit the number of alternatives
- Identify the alternatives themselves
- Forecast the potential outcomes from each alternative
- Compare and select among the alternatives

Source: Belanger (2012) p94

Information and decisions

- Business rules and procedures
- Basic information about how the business is/has been operating – sales, subscriptions, salaries, profits, etc….
- ‘Profiling’ information about customers/context, based on statistics (BI)
- Information on customer decision-making behaviour
- Projections based on current data and assumptions
- Information about what competitors are doing/planning
- Research on new innovations in the field

Types of decisions

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Structured (programmable) decision – a decision which is routine: it usually occurs frequently, its structure is clear, and the way to handle it is known. Corresponds to a *structured* problem.

Semi-structured decision – a decision where some aspects are programmable, but others required judgment

Unstructured (non-programmable) decision – a decision which corresponds to an *unstructured* or infrequent problem. There no well-known set of procedures to handle the decision and the situation needs to be treated as a one-off.

Who makes which decisions?

Table 6.1 Gorry and Scott-Morton's Information Systems Framework

	Operational control	Managerial control	Strategic planning
Structured	Accounting systems (accounts payable/ receivable), order processing, inventory control, order processing	Human resources reporting, short-term forecasting	Investment analysis, distribution system analysis
Semi-structured	Production planning	Budget variance analysis	Compensation planning
Unstructured	Cash management, project management	Budget preparation, sales planning	New product planning, social responsibility planning

Source: Adapted from Gorry & Scott-Morton (1971), Rainer & Turban (2008)

Source: Belanger (2012) p96

Levels of management and types of decision making

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Different decisions are typically made at different levels in the organisation:

- Routine, **structured** decisions are made at the lower, operational level – or may even be automated
- **Semi-structured** decisions requiring some level of judgement are made by middle level managers
- **Unstructured**, strategic and long range decisions requiring a high level of judgement are made by top level managers/executives

Where IS can provide support for problem solution/decision making

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	Operational control	Management control	Strategic planning	IS support
Structured	Accounts receivable, order entry 1	Budget analysis, short-term forecasting, personnel reports, make-or-buy analysis 2	3	MIS, statistical models (management science, financial, etc.)
Semistructured	Production scheduling, inventory control 4	Credit evaluation, budget preparation, plant layout, project scheduling, reward systems design 5	Building a new plant, mergers and acquisitions, planning (product, quality assurance, compensation, etc.) 6	Decision support systems, business intelligence
Unstructured	7	Negotiating, recruiting an executive, buying hardware, lobbying 8	New technology development, product R&D, social responsibility planning 9	Decision support systems, expert systems, enterprise resource planning, neural networks, business intelligence, big data

Source: Gray et al (2015)

Bad decisions...

- Poor decision making skills
- Time pressures
- Relying too much on intuition, rather than being systematic
- Being overconfident
- Going with the group (groupthink)
- Addressing the wrong objective (solving the wrong problem)
- Cognitive biases

Google 'worst ever business decisions' for some examples!

Source: Belanger (2012) p95

Ethics and decision-making

- **Ethics** in professional decision-making is very important and it addresses issues that usually cannot be quantified, nor are they simple personality variables
- 'Ethics is not about doing what is legal and avoiding what is illegal; it is about the motives and principles which guide problem solving and decision-making in the grey areas where an action may be legal, but may not be right.'

Source: Harrison (2001)

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Theories of decision making in organisation

Classical decision theory

The **classical** approach to decision-making assumes an ideal situation:

- there is no uncertainty
- all the information is available
- consequences are known
- there is a clear criterion to evaluate the choices

The theory assumes **perfect rationality**, so any objective decision maker would make the same choice consistently

Behavioural theories

- **Behavioural theories** of decision-making describe how people actually make decisions, which is not always in line with the idealised cases in the classical theories
- Examples include:

  Simon's concept of bounded rationality

  Cohen et al's 'garbage can' model

Bounded rationality

Simon proposed that practical decision making was actually bound by

- Incomplete information
- Uncertainty regarding courses of action and their constraints

Concept of **bounded rationality:**

- A decision needs only to be ‘good enough’
- Given limited time, resources and information, models that make realistic assumptions are of more practical use
- Similar to the concept of satisficing in problem solving – the solution isn’t perfect, but good enough

Garbage can model

Cohen et al's model emphasises the situated context and general messiness of real life organisational decision making:

- Decisions are made in specific contexts of time and place
- With whatever information is available
- And participation from whoever happens to be there
- Decision goals may be ambiguous or unclear
- And people may disagree about how to get there

No mathematically optimal solution – just 'muddling through'

Recap

Classical decision theory *assumes an ideal situation of complete information and no uncertainty, with perfect rationality.*

In contrast, ***behavioural theories*** *seek to represent how decisions are actually made in practice*

5.3 Representing decision logic

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5.3.1 Structured decisions

- Decision trees
- Decision tables

5.3.2 Multi-criteria decision matrix

5.3.4 What-if analysis

A decision tree

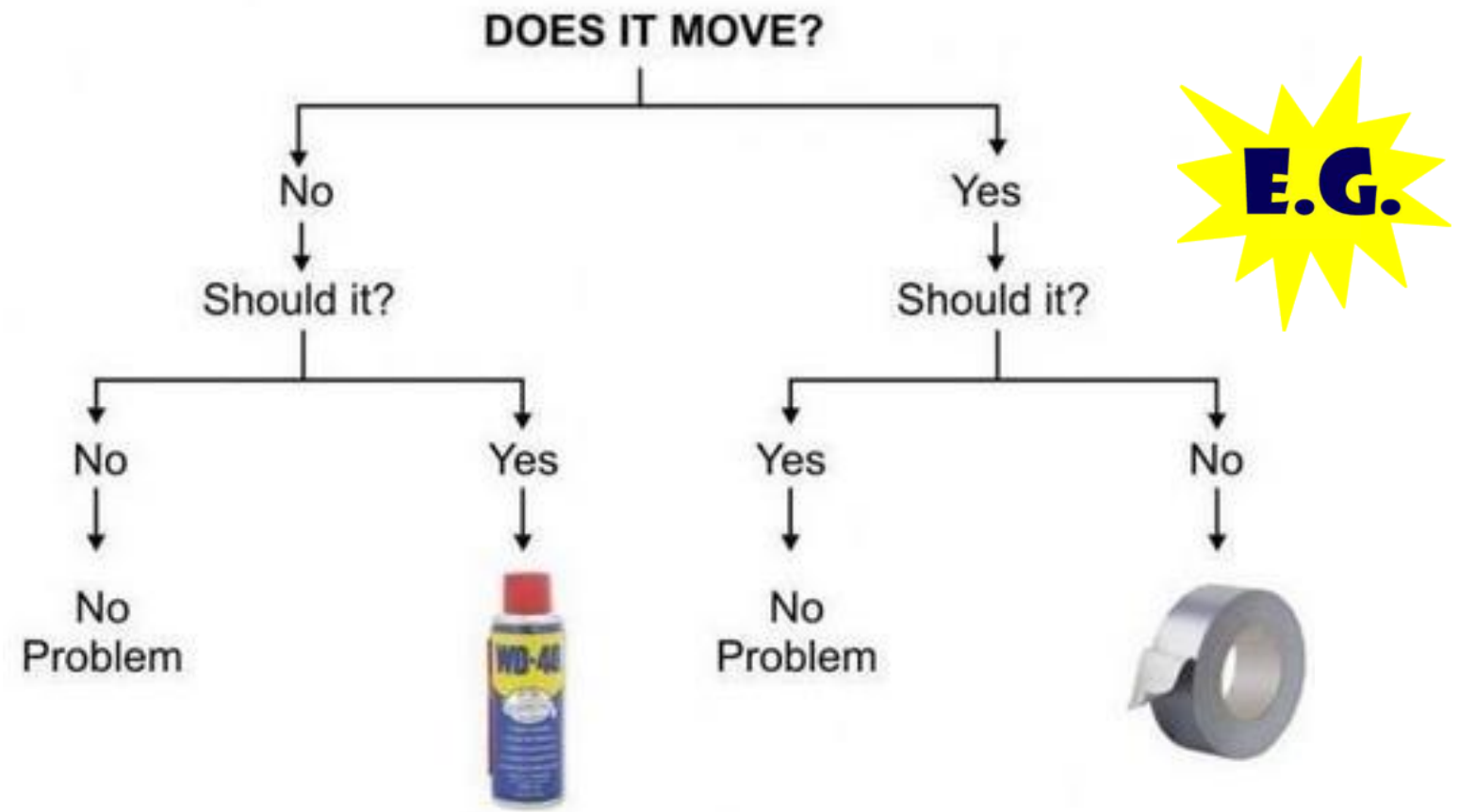

Image from https://www.flickr.com/photos/dullhunk/7214525854/in/photostream/

A decision table

Conditions	Moves	Y	Y	N	N
	Should move	Y	N	Y	N
Actions	WD-40			X	
	Gaffer Tape		X		
	No problem	X			X

Decision tables and decision trees

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- A simple way of representing complicated *condition-action pairs*, such as those found in regulations
- Decision tables and decision trees are very common structures in information systems, especially for representing business rules

How to create a decision table

1. Identify the **conditions** that apply – these are the possible states, each of which can be True (Yes) or False (No)

   e.g. Final score over 50? --- answer can be either Yes or No

2. Write out **all possible combinations** of conditions

   1 condition = 2 combinations (rules)

   2 conditions = 4 combinations (2^2)

   3 conditions = 8 combinations (2^3)

3. State the possible outcome (**action**) for each rule. There should be only one action per rule

How to create a decision table

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4. Simplify the table by indicating any “don’t care” conditions where it makes no difference whether a condition is True or False:

Conditions	Has PhD?	Yes	Yes	No	No
	Has relevant experience?	Yes	No	Yes	No
Actions	Shortlist	X			
	Reject		X	X	X

Simplifies to:

Conditions	Has PhD?	Yes	Yes	No
	Has relevant experience?	Yes	No	-
Actions	Shortlist	X		
	Reject		X	X

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Students must have paid all their due fees to the university in order to receive a grade for the courses in which they are enrolled. Any failure to pay fees to the university will result in a grade of ‘result withheld’ being awarded. Furthermore, for a student to be eligible to be awarded a grade, that student must be recorded as being enrolled in the relevant subject prior to the end of semester and regardless of the attendance record and academic performance in the assessed components o f that subject. A failure to enrol in the subject will result in a grade of ‘result withheld’.

What conditions and actions can be identified here?

Students must have **paid all their due fees to the university in order to receive a grade** for the courses in which they are enrolled. **Any failure to pay fees to the university will result in a grade of 'result withheld'** being awarded.

Condition: PAID FEES or NOT PAID FEES

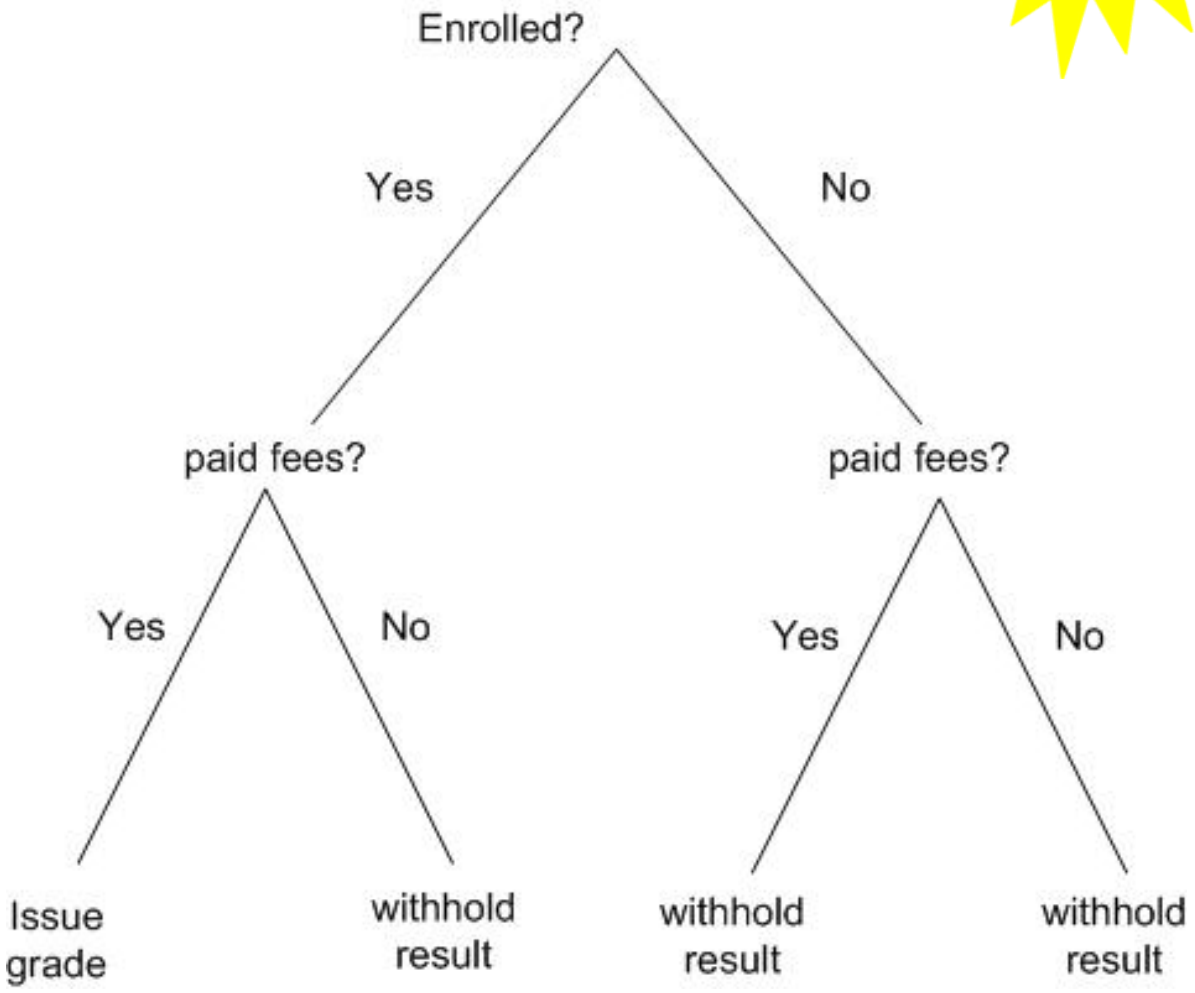
Actions: ISSUE GRADE or WITHHOLD RESULT

… Furthermore, **for a student to be eligible to be awarded a grade, that student must be recorded as being enrolled** in the relevant subject prior to the end of semester and regardless of the attendance record and academic performance in the assessed components o f that subject. **A failure to enrol in the subject will result in a grade of 'result withheld'**.

Condition: ENROLLED or NOT ENROLLED

Actions: ISSUE GRADE or WITHHOLD RESULT

Decision tree



The tree could also be drawn with the first branch being 'Paid fees?'

Decision table

Exactly the same information can be shown as a decision table:

	1	2	3	4
Enrolled?	Y	Y	N	N
Paid fees?	Y	N	Y	N
Withhold result		X	X	X
Issue grade	X			

Decision table

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	1	2	3	4
Enrolled?	Y	Y	N	N
Paid fees?	Y	N	Y	N
Withhold result		X	X	X
Issue grade	X			

Rules can be generated from the table

There are four rules here, eg:

Rule 1: IF Enrolled AND Paid Fees THEN Issue Grade

Recap

Decision tables and decision trees can be used to represent the logic of a ***structured*** *decision*

Multi-criteria decision-making

When a decision needs to be made based on *many* different criteria

Think about how you will buy your next computer – how do you balance:

- Price?
- Weight?
- Software?
- Processor?
- Touch screen?
- Battery life?
- …

See for example http://smallbiztrends.com/2014/11/tablet-versus-a-laptop.html (image from article)

Should I walk? Cycle? Take the car?

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E.G.

Journey Summary

From: The Rookery - Preston Road, Brighton » view location
To: Nevill Playing Field - Eridge Road, Hove » view location
Departing: Monday, 5th October at 20:41

Results: Click on a travel option below to view a map of the route with directions.

	distance	duration	calories burnt	cost	carbon footprint
map	2.04 miles 3.28 km 4104 steps	41 min	194 calories	£ 0	0 kg
map	2 miles 3.22 km	13 min	135 calories	£ 0	0 kg
map	2.21 miles 3.56 km	9 min	0 calories	£ 1.55	0.71 kg

Which car?

	Toytown Yappy	Hyena Git	Holdem Barista
Cost ($)	16 000	15 500	14 500
0–100 km (s)	16.4	13.6	13
Height (mm)	1530	1495	1495
Fuel economy (litres/100km)	6.5	6.2	6.9

- The Barista is cheapest…
- … and the fastest acceleration
- But the Yappy is tallest…
- And the Git is most fuel efficient…

Which of these attributes is most *important* to you?

Which car?

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		Toytown Yappy	Hyena Git	Holdem Barista
Cost	(40)	3	2	1
0-100km	(20)	3	2	1
Height	(10)	1	2	2
Fuel economy	(30)	2	1	3

- RANK the attributes instead of using their absolute values (1 best, 3 worst)
- Next, WEIGHT the attributes according to which is most important to you
  - Here cost is most important, rated at 40%, height is relatively unimportant at 10%

Which car?

		Toytown Yappy	Hyena Git	Holdem Barista
Cost	(40)	120	80	40
0-100km	(20)	60	40	20
Height	(10)	10	20	20
Fuel economy	(30)	60	30	90
		250	**170**	**170**

- The weighted score can now be calculated
- This shows the Yappy is worst overall (highest score) and can be ruled out

Multi-criteria decision-making

- Multi-criteria decision-making (MCDM) is widely used in information systems for evaluating alternatives (**evaluation matrix**)
- There are various methods for MCDM, based on how the criteria are scored (here we used a simple ranking) and how the weightings are allocated (here we used percentages)
- Spreadsheets can be used to automate
- Different results will be obtained from different stakeholders if they have different priorities

What-if analysis

What-if analysis can be used to evaluate different **scenarios** based on different assumptions or projections

Goal seeking can provide the parameters for a desired outcome

Spreadsheets (e.g. Excel) are typically used for what-if analysis, and have many built-in features

Recap

Multi-criteria decision-making involves comparing options on many different and often competing criteria. A MCD (evaluation) matrix enables a comparison using weighted criteria to indicate priorities

5.4 Group decision making

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5.4.1 Techniques

- Voting
- Nominal group
- Delphi

Some techniques for group decision making

Voting systems

- individuals make decisions that are then aggregated in some way to give a single outcome

Nominal group technique

- A group of people is chosen to address a problem and generate ideas and alternatives
- Individuals list ideas and vote to rank/rate them
- Aim is to avoid dynamics of interacting groups

Delphi

- A panel of experts each make an anonymous, individual assessment on an issue
- The assessments are collected and averaged
- Experts again give an opinion, until they converge

Recap

There are many techniques that can be used by groups to make decisions. Each is designed to improve the decision-making process in some way

Topic summary

- Decision-making is an integral part of everyday life, and essential to all businesses
- Decision-making involves many human and psychological factors
- Risk, uncertainty, cognitive bias and framing affect how a decision is perceived
- Different types of decisions are made in different part of the organisation
- Decisions can be categorised into structured, semi-structured and unstructured decisions
- Many methods for decision representation and evaluation exist, including decision tables, decision trees, multi-criteria decision matrices, and what-if analysis

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