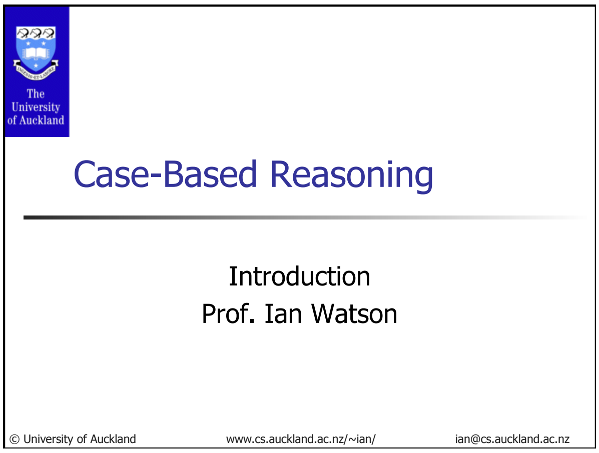
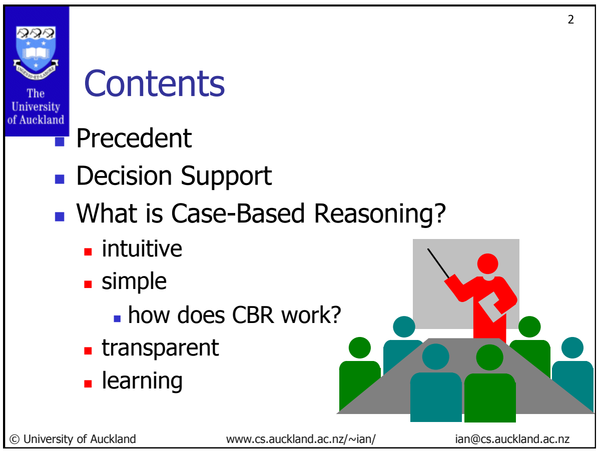


Case-Based Reasoning

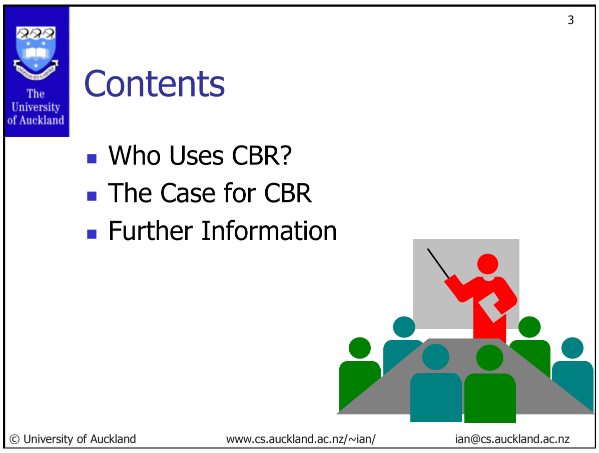
Introduction

Prof. Ian Watson



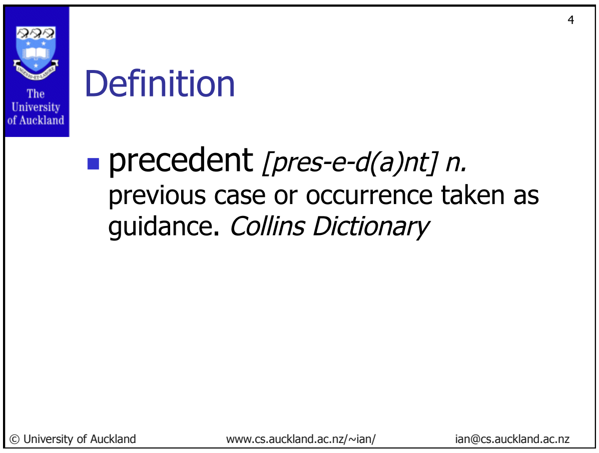
Contents

- Precedent
- Decision Support
- What is Case-Based Reasoning?
  - intuitive
  - simple
    - how does CBR work?
  - transparent
  - learning



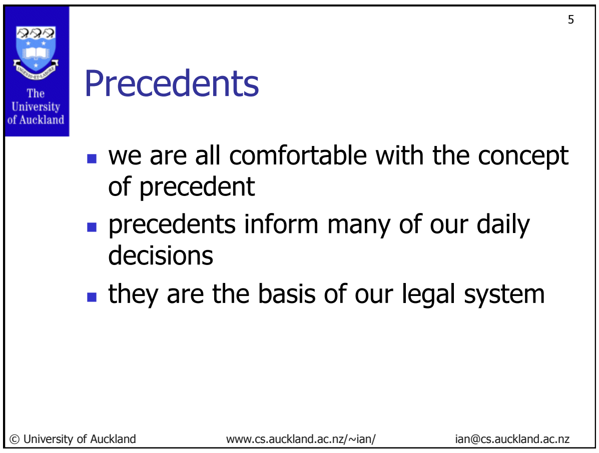
Contents

- Who Uses CBR?
- The Case for CBR
- Further Information



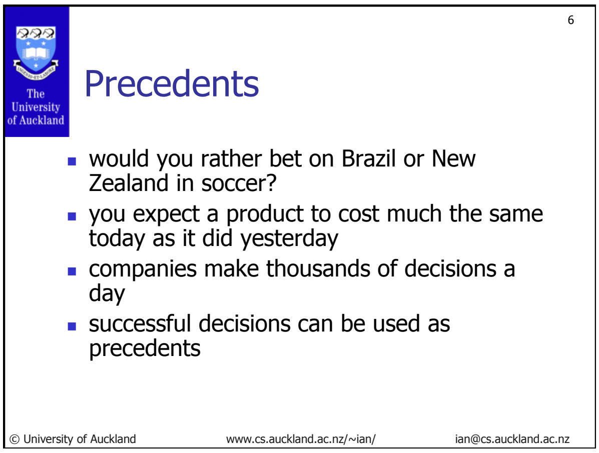
Definition

- precedent *[pres-e-d(a)nt] n.* previous case or occurrence taken as guidance. *Collins Dictionary*



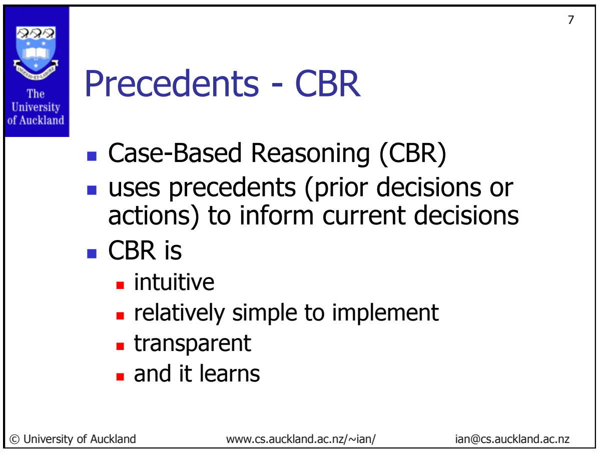
Precedents

- we are all comfortable with the concept of precedent
- precedents inform many of our daily decisions
- they are the basis of our legal system



Precedents

- would you rather bet on Brazil or New Zealand in soccer?
- you expect a product to cost much the same today as it did yesterday
- companies make thousands of decisions a day
- successful decisions can be used as precedents



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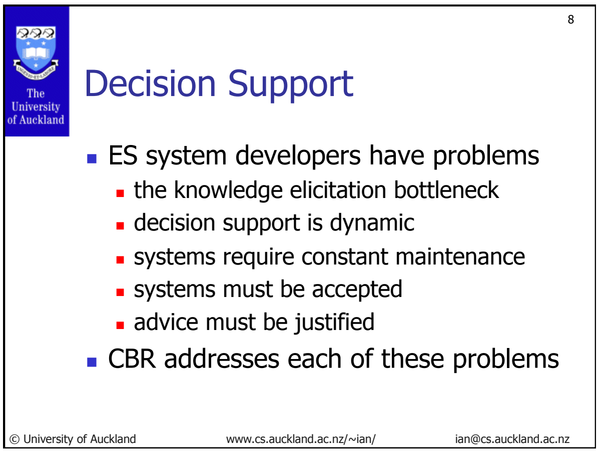
Precedents - CBR

- Case-Based Reasoning (CBR)
- uses precedents (prior decisions or actions) to inform current decisions
- CBR is
  - intuitive
  - relatively simple to implement
  - transparent
  - and it learns



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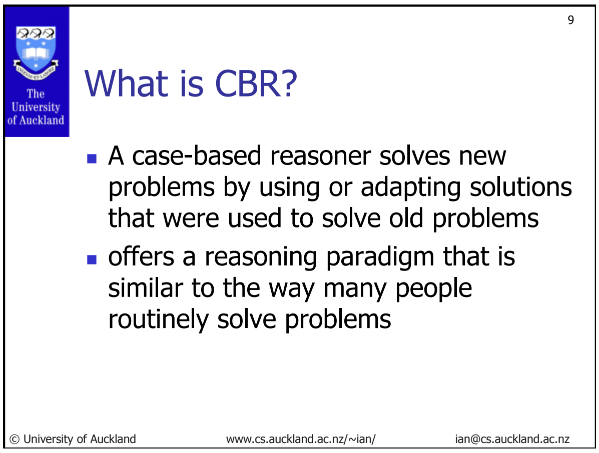
Decision Support

- ES system developers have problems
  - the knowledge elicitation bottleneck
  - decision support is dynamic
  - systems require constant maintenance
  - systems must be accepted
  - advice must be justified
- CBR addresses each of these problems



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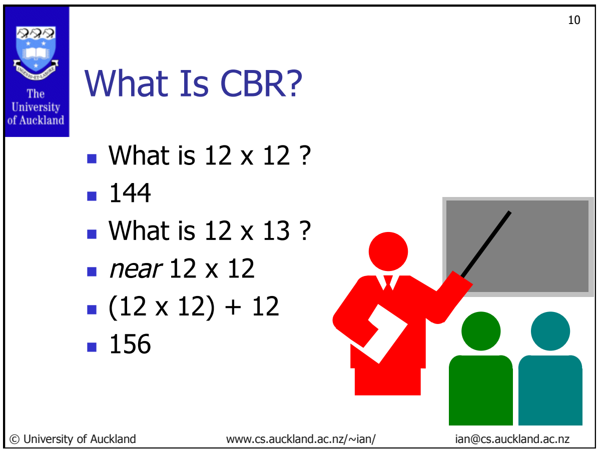
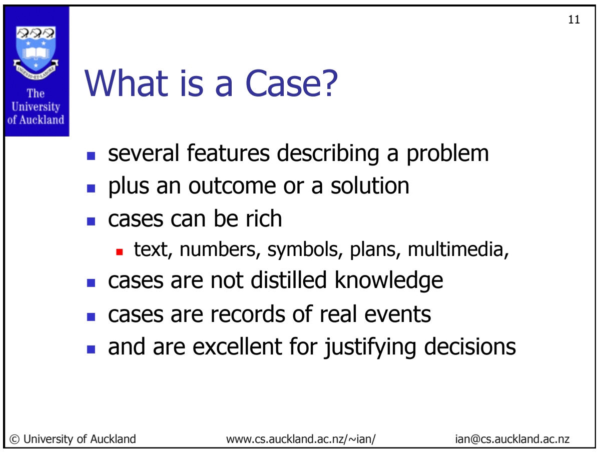
What is CBR?

- A case-based reasoner solves new problems by using or adapting solutions that were used to solve old problems
- offers a reasoning paradigm that is similar to the way many people routinely solve problems



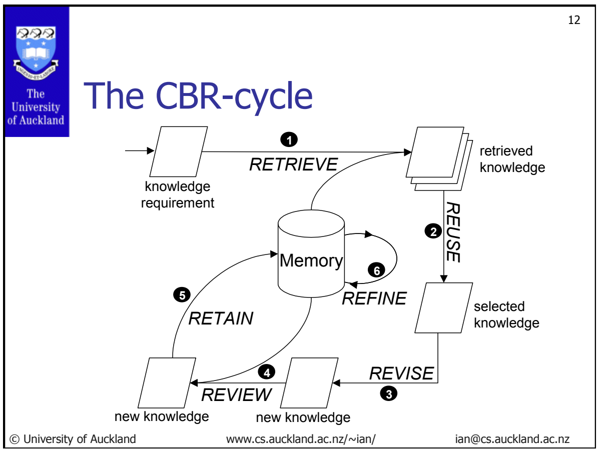
What Is CBR?

- What is 12 x 12 ?
- 144
- What is 12 x 13 ?
- *near* 12 x 12
- (12 x 12) + 12
- 156



What is a Case?

- several features describing a problem
- plus an outcome or a solution
- cases can be rich
  - text, numbers, symbols, plans, multimedia,
- cases are not distilled knowledge
- cases are records of real events
- and are excellent for justifying decisions



The CBR-cycle

knowledge requirement

❶ RETRIEVE

retrieved knowledge

❷ REUSE

selected knowledge

❸ REVISE

new knowledge

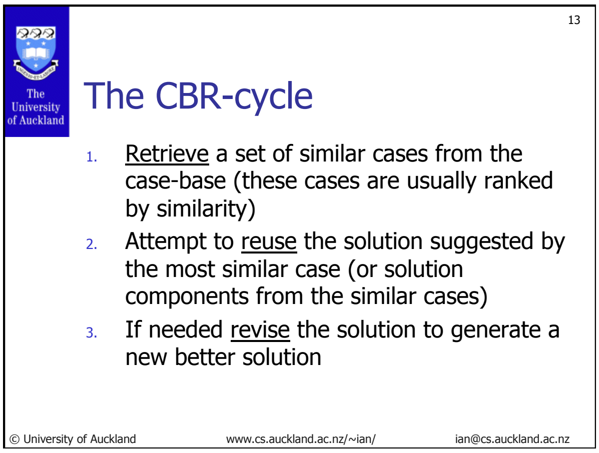
❹ REVIEW

new knowledge

❺ RETAIN

Memory

❻ REFINE



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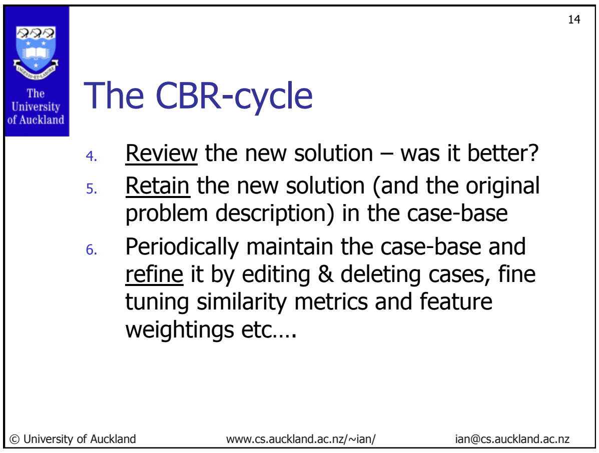
The CBR-cycle

1. Retrieve a set of similar cases from the case-base (these cases are usually ranked by similarity)
2. Attempt to reuse the solution suggested by the most similar case (or solution components from the similar cases)
3. If needed revise the solution to generate a new better solution



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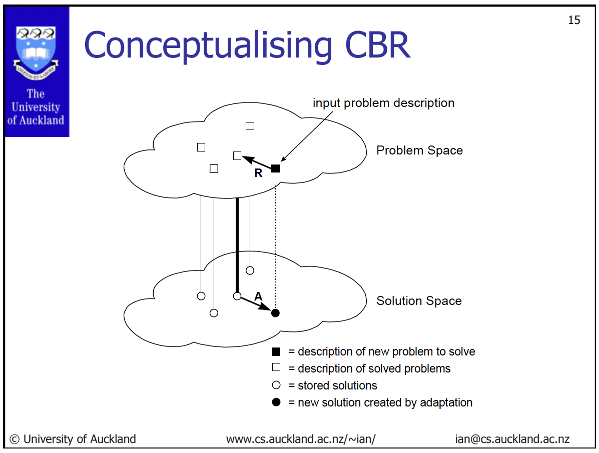
The CBR-cycle

4. Review the new solution – was it better?
5. Retain the new solution (and the original problem description) in the case-base
6. Periodically maintain the case-base and refine it by editing & deleting cases, fine tuning similarity metrics and feature weightings etc….



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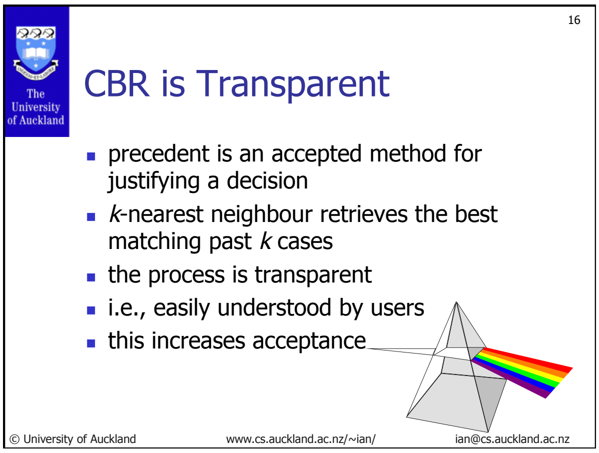
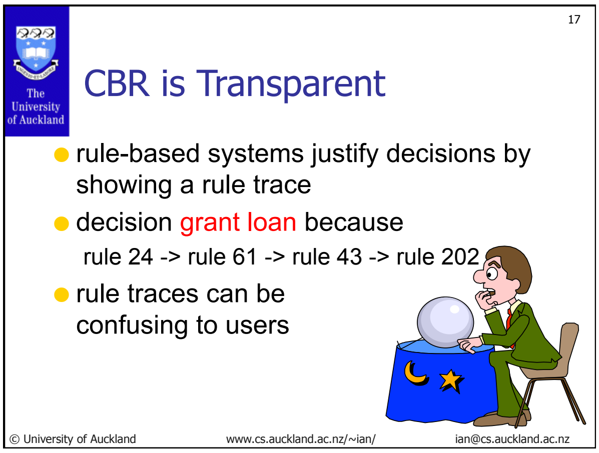
Conceptualising CBR

■ = description of new problem to solve
□ = description of solved problems
○ = stored solutions
● = new solution created by adaptation



CBR is Transparent

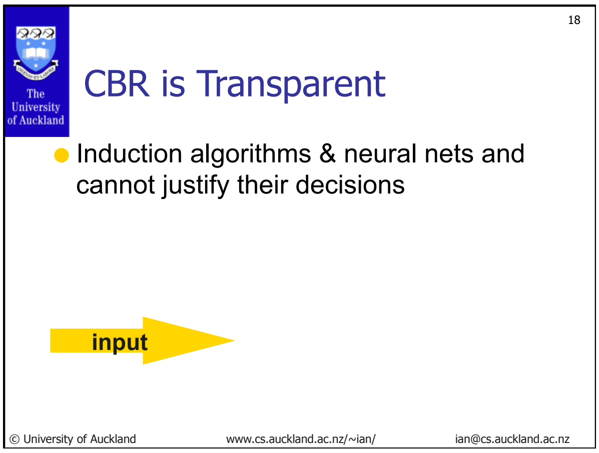
- precedent is an accepted method for justifying a decision
- *k*-nearest neighbour retrieves the best matching past *k* cases
- the process is transparent
- i.e., easily understood by users
- this increases acceptance



CBR is Transparent

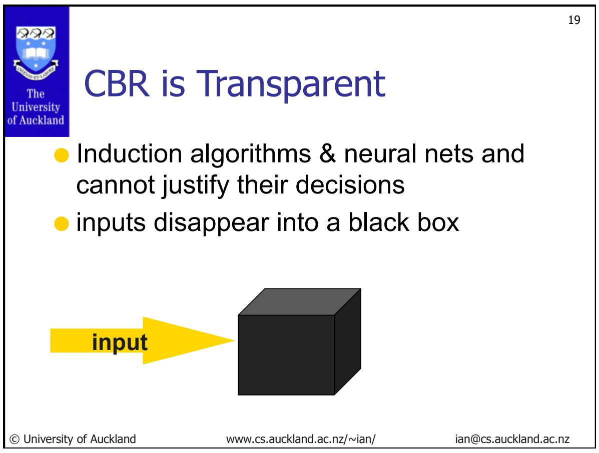
- rule-based systems justify decisions by showing a rule trace
- decision grant loan because

  rule 24 -> rule 61 -> rule 43 -> rule 202
- rule traces can be confusing to users



CBR is Transparent

- Induction algorithms & neural nets and cannot justify their decisions



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CBR is Transparent

- Induction algorithms & neural nets and cannot justify their decisions
- inputs disappear into a black box

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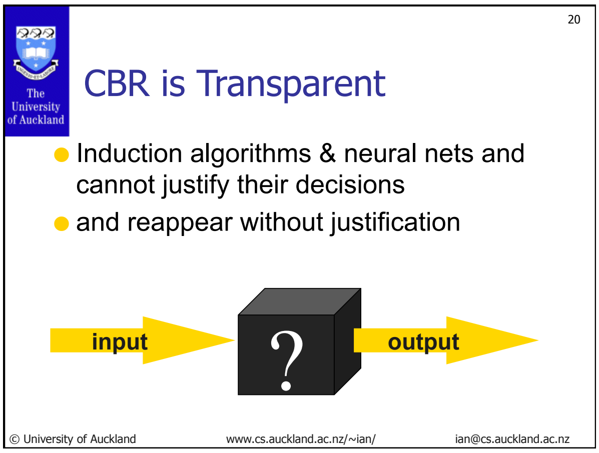

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CBR is Transparent

- Induction algorithms & neural nets and cannot justify their decisions
- and reappear without justification

input
?
output

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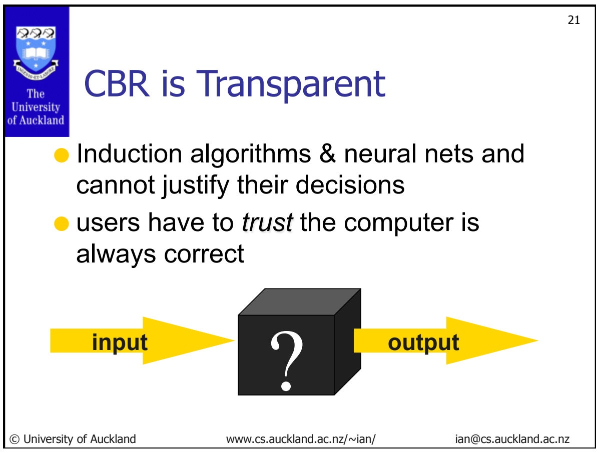

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CBR is Transparent

- Induction algorithms & neural nets and cannot justify their decisions
- users have to *trust* the computer is always correct

input
?
output

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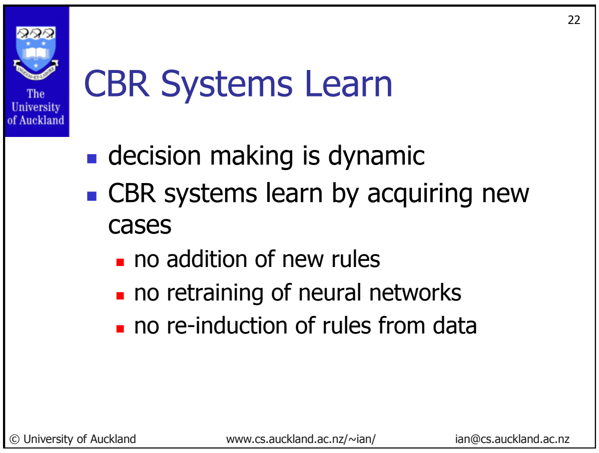
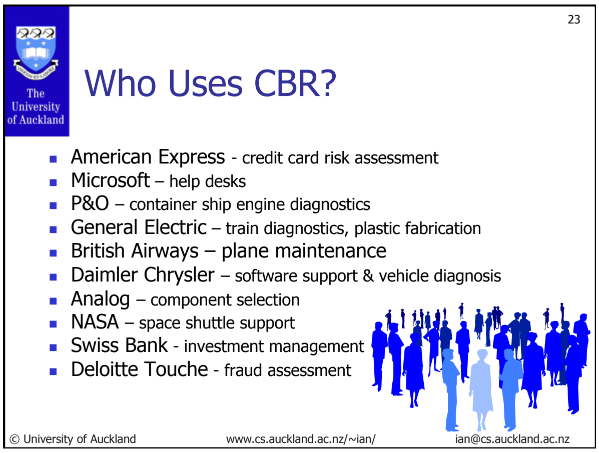


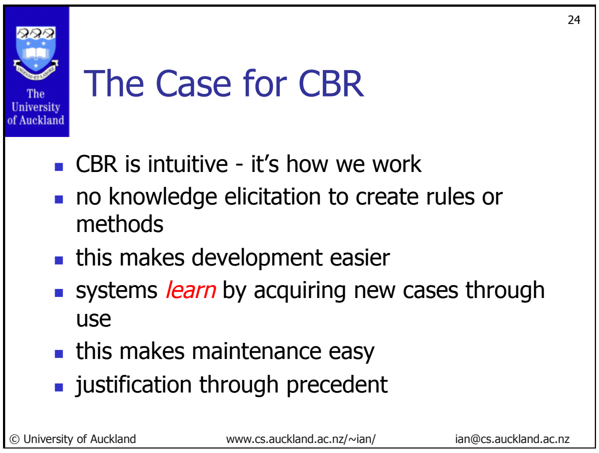
CBR Systems Learn

- decision making is dynamic
- CBR systems learn by acquiring new cases
  - no addition of new rules
  - no retraining of neural networks
  - no re-induction of rules from data



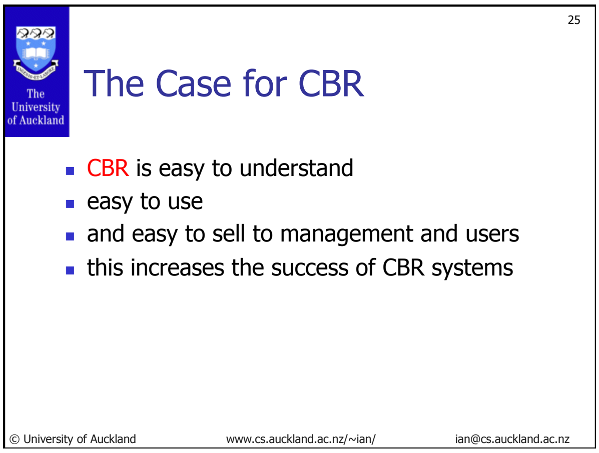
Who Uses CBR?

- American Express - credit card risk assessment
- Microsoft – help desks
- P&O – container ship engine diagnostics
- General Electric – train diagnostics, plastic fabrication
- British Airways – plane maintenance
- Daimler Chrysler – software support & vehicle diagnosis
- Analog – component selection
- NASA – space shuttle support
- Swiss Bank - investment management
- Deloitte Touche - fraud assessment



The Case for CBR

- CBR is intuitive - it's how we work
- no knowledge elicitation to create rules or methods
- this makes development easier
- systems *learn* by acquiring new cases through use
- this makes maintenance easy
- justification through precedent



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The Case for CBR

- CBR is easy to understand
- easy to use
- and easy to sell to management and users
- this increases the success of CBR systems

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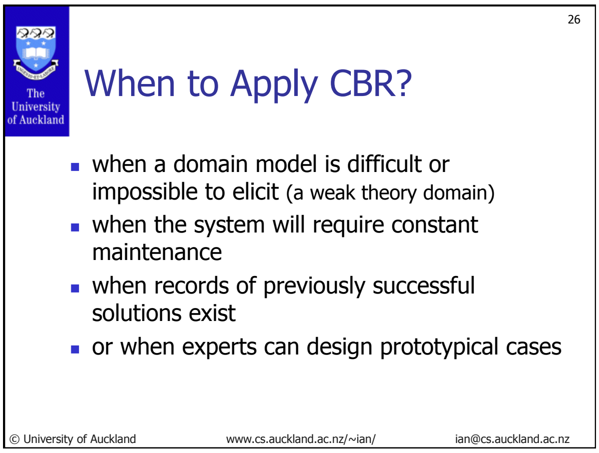

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When to Apply CBR?

- when a domain model is difficult or impossible to elicit (a weak theory domain)
- when the system will require constant maintenance
- when records of previously successful solutions exist
- or when experts can design prototypical cases

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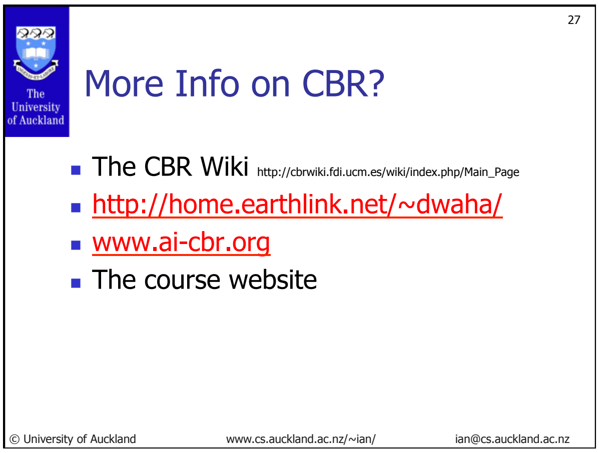

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More Info on CBR?

- The CBR Wiki http://cbrwiki.fdi.ucm.es/wiki/index.php/Main_Page
- http://home.earthlink.net/~dwaha/
- www.ai-cbr.org
- The course website

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