

# Survey of CBR Application Areas

Dr. Ian Watson

AI-CBR

University of Salford

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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  $12 \times 12$  ?
- 144
- What is  $12 \times 13$  ?
- *near*  $12 \times 12$
- $(12 \times 12) + 12$
- 156



# What is a Case?

- several features describing a problem
- plus the solution or outcome
- cases can contain:
  - text, numbers, symbols, plans, multimedia,
- cases are not distilled knowledge
- cases are records of real events

# The CBR Cycle

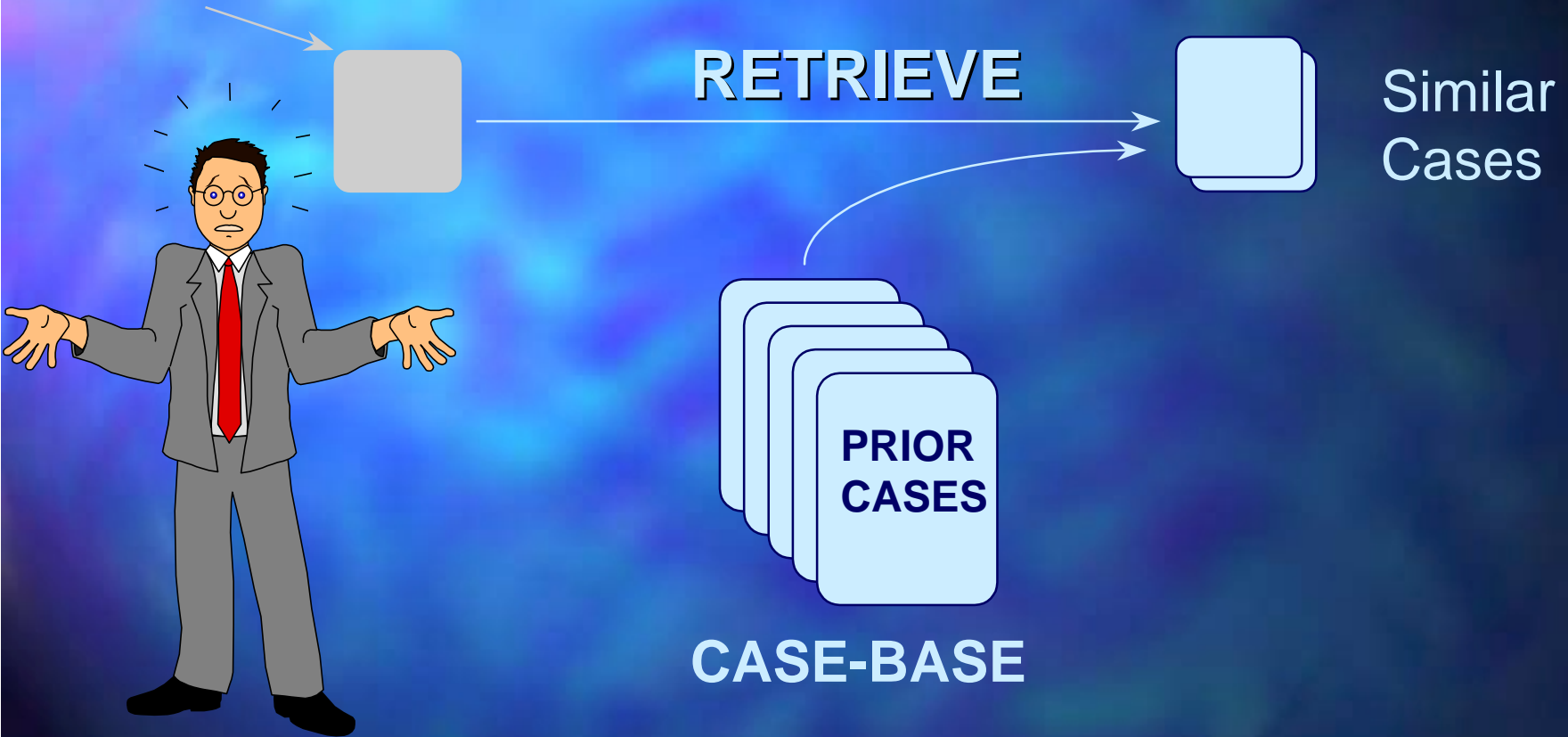
# The CBR Cycle

Problem



# The CBR Cycle

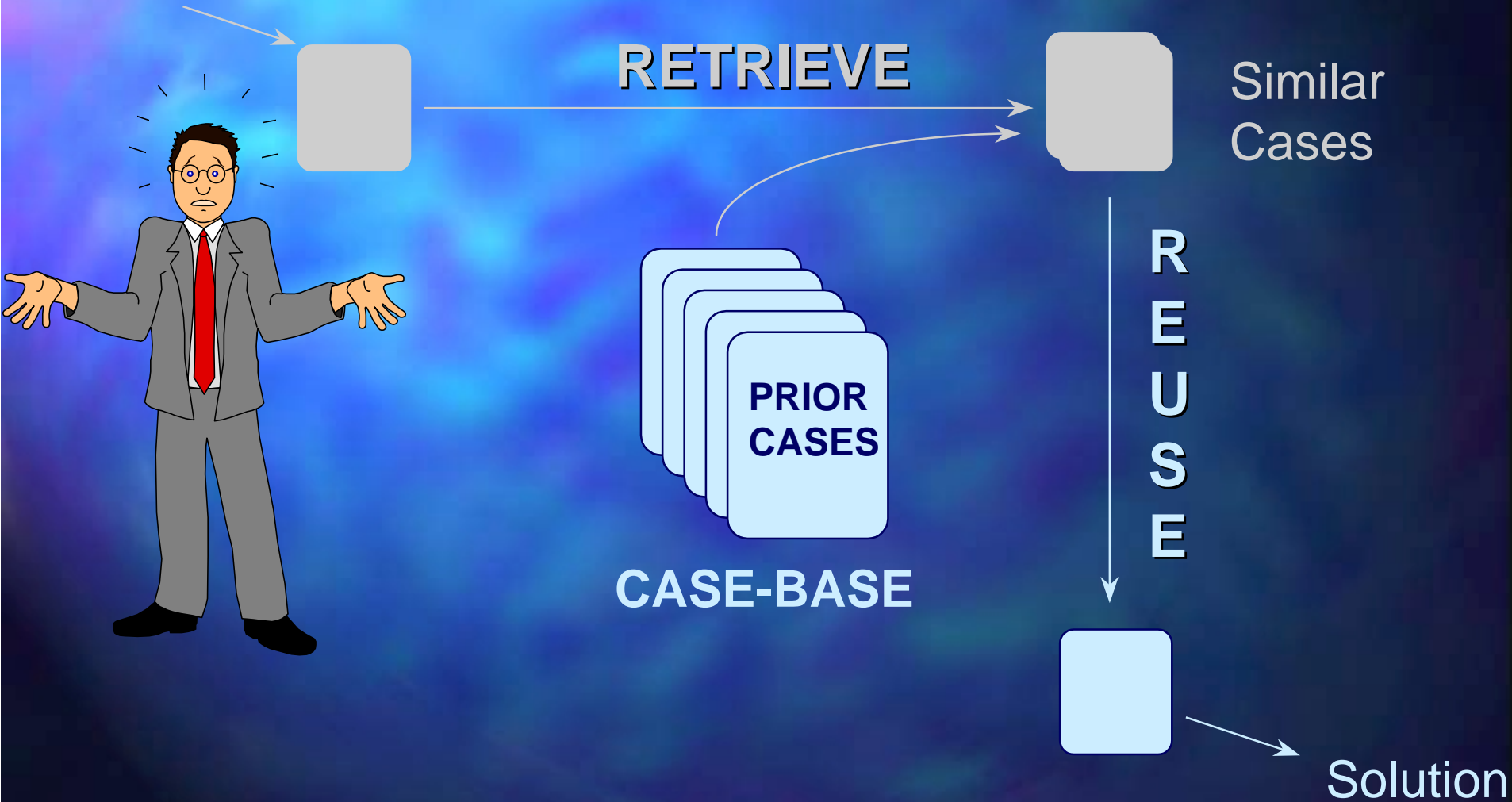
Problem



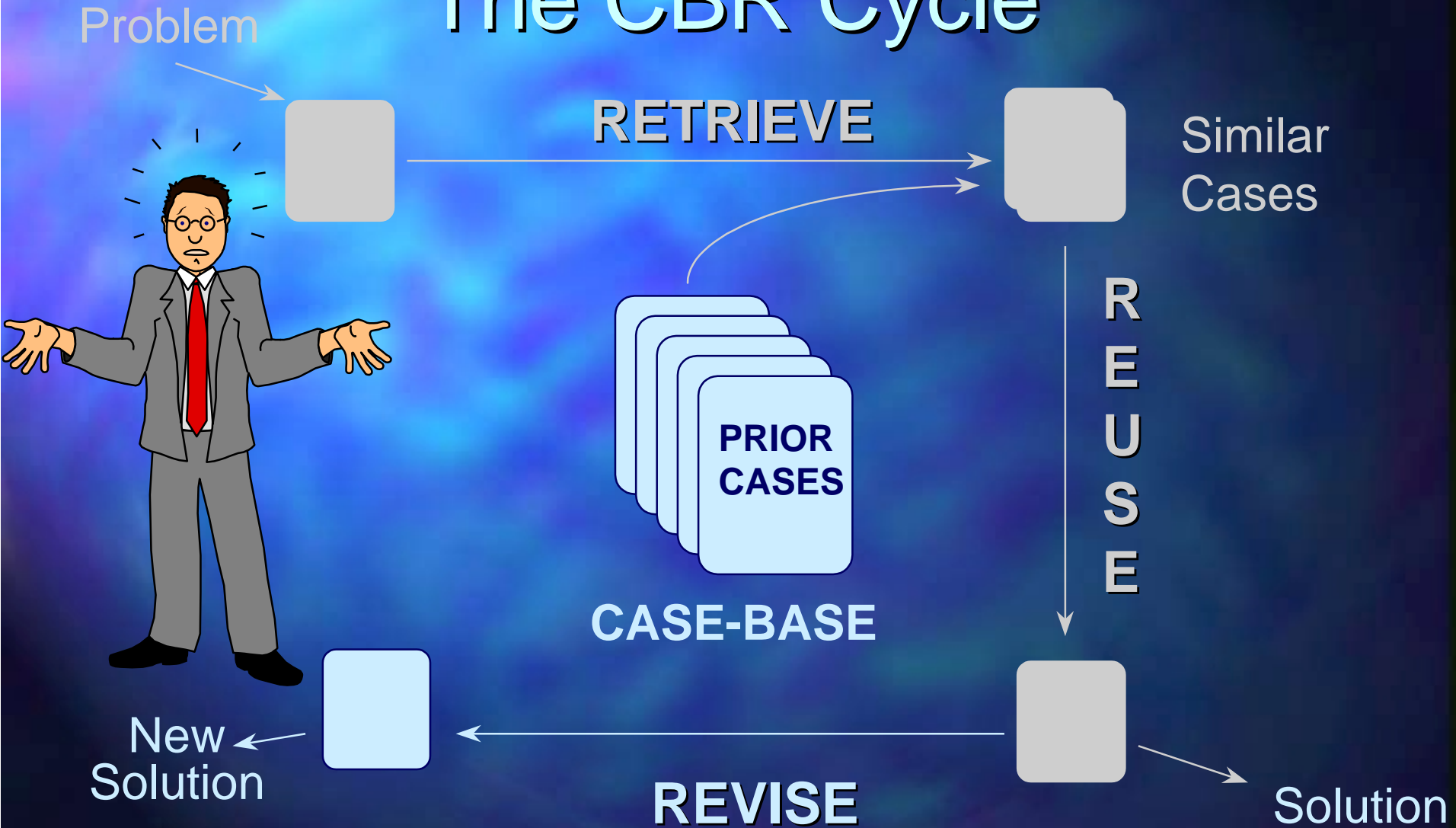


# The CBR Cycle

Problem

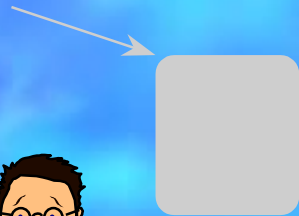


# The CBR Cycle



# The CBR Cycle

Problem



RETRIEVE



Similar Cases



CASE-BASE

REUSE



Solution

REVISE



REVIEW

New Solution



# The CBR Cycle

Problem



RETRIEVE



Similar Cases

RETAIN



PRIOR CASES

CASE-BASE

REUSE



Solution

REVISE

REVIEW



New Solution

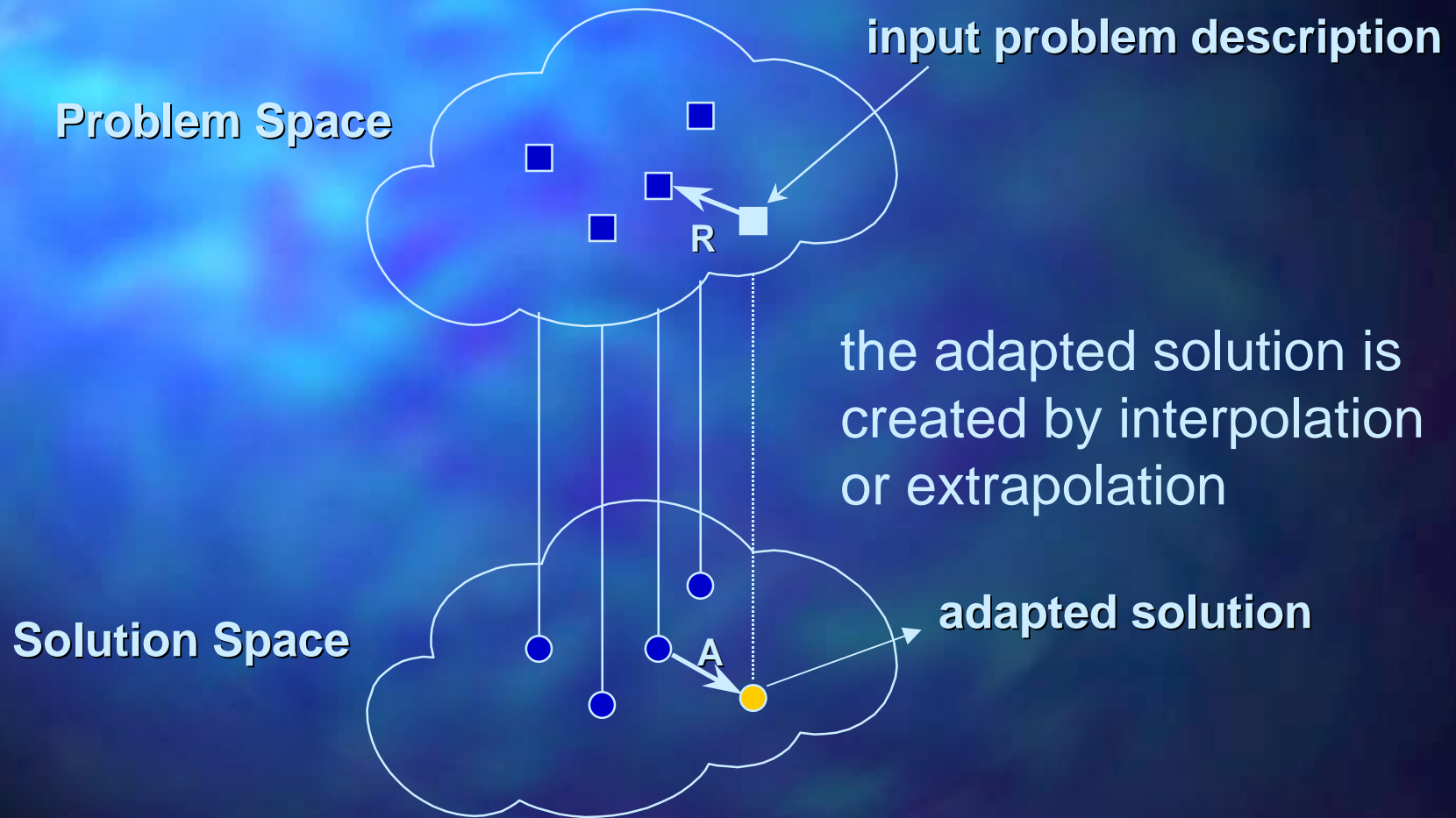


# The CBR Cycle

## ■ The 5 REs

- Retrieve *similar* cases
- Reuse solution from best match
- Revise solution to improve it
- Review new solution
- Retain new problem & solution pair

# Problem & Solution Spaces



# 2 types of case-base

## ■ homogenous cases

- all cases share the same features
- e.g., property cases for an estate agency
- easy to elicit a full set of case features
- no need to learn features in service

## ■ heterogeneous cases

- cases have different features but may share some
- e.g., patient cases from a hospital
- hard to elicit a full set of case features
- will learn features in service

# 2 types of cases

## ■ episodic cases

- are *real* records or *real* events
- e.g., insurance claims, equipment faults, patients
- can be obtained from records
- probably require preprocessing

## ■ prototypical cases

- designed as *typical* examples of events
- e.g., the typical symptoms of flue, a typical tax fraud
- are designed by experts
- requires knowledge elicitation



# 2 types of case features

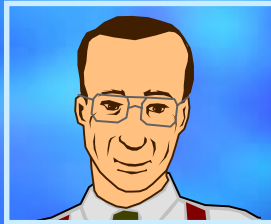
Patient Ref #: 1024

Patient Name: John Doe

Address: 12 Elm Street

Next of Kin: Jane Doe

Photo:



Age: 53

Sex: Male

Weight: 225 lbs

Height: 5' 11"

Blood Type: A neg.

...

## unindexed features

Not predictive & not used for retrieval, they provide background information to users

## indexed features

Predictive and used for retrieval

# 3 Influential Applications

- 3 pioneering CBR applications
  - Lockheed
  - Compaq
  - Broderbund
- proved that CBR could be commercialised
- showed that case-based retrieval was useful without the other REs
- pioneered CBR on the web

# Lockheed

- PROBLEM - how to optimize the loading of an autoclave for curing composite materials
- different materials need different heating & cooling procedures
- materials interact with each other in the autoclave
- mistakes are VERY costly

# Lockheed

- experienced operators relied on plans of previously successful layouts
- new layouts were adapted from old
- if successful they were added to a library
- they wanted to develop a decision support tool to assist experts and to retain expertise as a corporate asset

# Lockheed

- Lockheed had NO model of the autoclave
- nor did the manufacturers
- layouts did not repeat exactly
- materials are constantly changing
- designs constantly change
- elements interact in complex ways



# Lockheed

- their system was implemented in 1990
- CLAVIER started with a few successful layouts
- CLAVIER now has hundreds of successful layouts
- it retrieves a successful layout or adapts one 90% of the time
- acts as a corporate memory
- now sold under license to competitors

# Lessons from Lockheed

- CBR solved a problem that conventional techniques couldn't
- the lazy learning approach works without trying to understand the problem
- involves the engineers in the process (lets them do the hard bit) - they did CBR anyway!
- learns

# Compaq - SMART

- PROBLEM #1 - customers demand better tech support, tech support costs money, profit margins are falling
- PROBLEM #2 - for tech support to be effective staff must be knowledgeable, training is expensive and staff turnover is high - as soon as they are useful they quit!



# Compaq - SMART

- PROBLEM #3 - tech support deals with problems we often don't know about!
- PROBLEM #4 - product life is reducing and product range is increasing this compounds problems 1-3

# Compaq - SMART

## ■ IDEAL SOLUTION

- 0800 number where customers obtain FREE 24 hour tech support
- tech support staff use a KBS so they do not need knowledge of our products
- only *wicked* problems will be passed to technical experts

# Compaq - SMART

- PROBLEM #5...n
- a KBS cannot contain knowledge of problems we don't know about
- on the phone people describe problems differently - noisy, incomplete information
- a KBS would need continual maintenance to keep up with new products and problems

# Compaq - SMART

- SOLUTION a CBR system
- it could deal with incomplete noisy problem descriptions
- could deal with problems similar to a user's problem,
- would be less brittle
- could acquire new problems and their solutions so maintenance would be easier

# Compaq - SMART

## ■ IMPLEMENTATION

- CBR Express from Inference Corp. (now called k-commerce)
- stores problems and their solutions
- allows free form textual descriptions of problems - conversational dialog
- manages *unresolved* cases (the review & retain processes)

# Compaq - SMART

- A stage further...
- include the CBR tool with our products
- people can diagnose many problems before calling us
- reduces our 0800 phone bill
- and we need fewer support staff
- we now provide the *best* customer service at a *lower* cost than our competitors

# Compaq - SMART



- AAAI - Innovative Application in AI Award Winner 1992
- Increased problem resolution from 50% to 95%
- less than two minutes on average to solve a problem

# Lessons from Compaq

- case-based retrieval (CBR-lite) is useful on its own
- mix episodic and prototypical cases in one system
- users can "author" cases
- CBR has become the solution of choice in call centres



# Broderbund

- Make computer games - Myst & Riven
- must provide tech support during Xmas
- were using CBR software in call-centre
- decided to put their support system on the web (1995)
- called the Gizmotapper

# Broderbund

- Gizmotapper was a pioneer of web-based interactive services
- conversational interface to a FAQ
- over Xmas 1995 successfully did the work of 2½ staff

# Lessons from Broderbund

- people like to help themselves
- CBR works on the web
- the web is 24x7

# CBR is everywhere...

- in 1994 there were:
  - 7 CBR tools\*
  - 4 CBR consulting companies
- in 1999 there are:
  - 18 CBR companies selling 30+ tools
  - 1999 there are at least 10 consulting companies

\* these figures are approximate

# CBR is everywhere...

- customer support call-centres
  - the *bread & butter* of CBR
  - handling large distributed global multi-lingual case-bases
  - Xerox - 30,000+ cases, 5 continents, 7 languages
  - increasingly complex diagnostic problems
  - the Daimler-Benz Homer system
  - web enabled is increasingly the norm

# CBR is everywhere...

- financial services sector
  - increasingly combining CBR with datamining techniques
  - CBR can find the specific examples to illustrate an induced rule
  - proving that CBR can handle large (millions of cases)

# CBR is everywhere...

- case-based design
  - a lot of research effort
    - (FABEL, ARCHIE, CADRE, CASECAD...)
  - no “products” yet
  - complex issues
    - high-dimensional cases, creativity, adaptation, constraints

# CBR is everywhere...

- engineering diagnosis
  - fault finding in complex equipment
  - aerospace applications abound
    - NASA, BA, Cfm International, etc...
  - power generating industry (Nuclear and conventional)
  - trains (TGV & Union Pacific Railways)

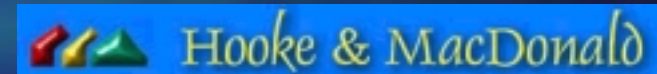


# The future...

- CBR's future is on-line
- e-commerce systems supporting
  - case-based product selection
  - case-based problem resolution
- recognised by:
  - Inference with k-commerce product and strategic partnerships
  - TECINNO with its product range and partnerships
  - WEBSSELL

# The future...is here

- case-based product selection
- unlike a database query you always get the "best" match to your requirements
  - check out tourism, "Innovative Application of AI 1999 Award" at IAAI  
([www.reiseboerse.com](http://www.reiseboerse.com))
  - Hooke & MacDonald - Virtual Letting Agent  
([www.hookemacdonald.ie](http://www.hookemacdonald.ie))



# Information Sources

## ■ ai-cbr

- members mailing list, features, news, bibliography, etc...

[www.ai-cbr.org](http://www.ai-cbr.org)

## ■ the cbr web

- news, projects, publications, etc...

[www.cbr-web.org](http://www.cbr-web.org)

# Information Sources

- *Applying Case-Based Reasoning: Techniques for Enterprise Systems* by Ian Watson. Morgan Kaufmann Publishers Inc., July 1997  
ISBN 1-55860-462-6



# Information Sources

- *Developing Industrial Case-Based Reasoning Applications: the INRECA Methodology*

by Bergmann, R. et al.

Springer, Lecture Notes in Artificial Intelligence 1612, 1999

ISBN 3-540-66182-4

# Information Sources

- *Optimierung der Kundenbeziehung mit CBR-Systemen Intelligente: Systeme für E-Commerce und Support*  
by Markus Stolpmann & Stefan Wess.  
Addison Wesley in the Business & Computing Series. (1998)  
ISBN 3-8273-1436-4



Thank You

questions?

[ian@ai-cbr.org](mailto:ian@ai-cbr.org)