Case-Based Reasoning

• case used to store description of past experience
• problem encountered and its proposed solution
• may represent a single past case or a generalisation of several single cases
• Case-based reasoning is not the first artificial intelligence method to combine reasoning and learning

Case-Based Reasoning

• contextualised piece of knowledge which teaches the reasoner a lesson
• some areas of artificial intelligence
  – effort first goes into developing a model of how a thought or decision-making processes works
  – then, that model is generally applied to all problem situations involving that particular process
  – the knowledge in the model will be general knowledge

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Case-Based Reasoning

• A Aamodt (1989) paper “Towards Expert Systems that learn from experience”
  – case features categorised as necessary, characteristic, non-characteristic and irrelevant
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  – consider structural features, a functional description, causal explanation of behaviour and qualitative states

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Case-Based Reasoning

• Delaney, Cunningham, Coyle (2004) paper “An Assessment of Case-Based Reasoning for Spam Filtering”
  – The case base can be updated continuously and new training data is immediately available
• McSherry (2004) paper “Maximally Successful Relaxations of Unsuccessful Queries”
  – Presents a mixed initiative approach to recovery from the retrieval failures that occur when there is no case that satisfies all requirements
Case-Based Reasoning

- According to a 1989 panel on CBR, some important questions to ask about case representation include:
  - to what extent should cases be generalised as they are stored?
  - What argument is there for maintaining the distinctness of cases that appear similar?
  - Are cases monolithic structures that are applied individually or are they loosely connected sets of events that are reconstructed at retrieval time?

Case-Based Reasoning

- if dependency structure and causal annotation appear in case representation at all, when should the relevant information be acquired?
  - at storage time, time of modification, use
- CBR has been implemented in many forms
  - decision support systems
  - groups of co-operating application processes sharing information in OO database
  - can be used to support people in tasks

Case-Based Reasoning

- PERSUADER
  - knowledge based system used to model the dynamics of negotiation
  - input is goals of each side and the dispute context
  - CBR generates initial settlement, persuasive arguments and improving rejected proposal
    - responses of negotiating parties will lead to further transformation of solution

Case-Based Reasoning

- ECUE
  - E-mail Classification Using Examples
  - A lazy learning system using CBR
    - Lazy Learning -- the decision of how to generalise beyond training data is deferred until each new unseen instance is considered.

Expert Systems

- developed as specialised problem solvers that emphasised the use of knowledge
  - medical diagnosis
  - mineral prospecting
- designed to reason through knowledge
  - solve problems using methods that humans use
- use heuristic knowledge rather than number to control the process of problem solving

Expert Systems

- have their knowledge encoded and maintained separately from computer program which uses the knowledge
- capable of explaining how a particular conclusion is reached
- use symbolic representation for knowledge
- perform inference through symbolic computations
  - closely resemble manipulations of natural language
Expert Systems

- knowledge engineer extracts knowledge from expert and places it in the knowledge base
- knowledge engineer develops the inference engine
  - sorts through the knowledge in organised manner
- components in expert system
  - knowledge base

Expert Systems

- inference engine
- working memory
  - store user’s input, some rules and other pertinent facts
- I/O interface
- explanation module
  - true expert systems are capable of explaining what they are doing at any point in the process
- editor
  - add or change rules and knowledge base

Expert Systems

- learning module
  - some expert systems can include learning module
  - not common
- each rule in the knowledge base represents small part of knowledge in the domain of expertise
- weaknesses
  - don’t perform well with large number of rules or large search spaces

Expert Systems

- methods developed to cope with this include reasoning by elimination, abstraction, multiple lines of reasoning and least commitment principle
  - elimination
    - discard rules that do not lead to solution or lead to solution of low plausibility
  - abstraction
    - break the problem into sub problems, sub sub problems etc
    - then solve lowest level and work upwards

Expert Systems

- uses guessing when impossible to determine which is the best rule to select at given point
  - if it proves wrong, it must be able to recognise this and try to recover
- multiple lines of reasoning
  - view the problem from different perspectives
  - try to solve and compare solutions
- weaknesses
  - do not present uncertainties very well
  - knowledge may be incomplete, unreliable, imprecise or vague

Expert Systems

- ES tries to take account of quality of knowledge
  - can use probability theory or incidence calculus to deal with uncertainty
  - often make use of commercially available Expert System Shells of which criticisms include
    - not always capable of versatile searching
    - some do not handle uncertainty well
    - some crunch through large collections of data and handle a few simple rules
Expert Systems

- others handle large collections of complex rules, but do not perform well when accessing data
  - many do not learn
  - makes them obsolete within short time of development
  - if needed in foreseeable future, will require maintenance of knowledge base and rest of system
- receives input describing problem in field of expertise
  - uses its inference to extract appropriate information from its KB to produce an answer

Expert Systems

- because expert systems are highly specialised, static systems, they can be extremely brittle when presented with novel problems or situations.
- Expert system shells are environments for creating expert systems
  - wide variety of expert system shells are commercially available, tend to be very expensive.

Expert System Shells

- CLIPS, a shell developed by NASA and written in ANSI C, is available for free at:
  - http://www.ghgcorp.com/clips/download/
- CLIPS
  - complete environment for developing ES
  - C Language Integrated Production System
  - shell - portion of CLIPS which performs inference
  - provides the basic elements of expert system
    - fact list & instance list - global memory for data

Expert System Shells

- knowledge base - provides all the rules
- inference engine - controls overall execution of rules
- program may consist of rules, facts and objects
- CLIPS applications
  - ES for wheelchair selection
  - for people with MS
  - involves examination of number of characteristics
    - ambulation status
    - length of diagnosis

Expert System Shells

- funding sources
- few experts so system developed to aid in process
  - from the therapist’s standpoint
    - environments
    - transport of wheelchair
    - distance to be traversed
    - caregiver status
    - current wheelchairs (consider modification)
  - from the patient’s standpoint
    - cost

Expert System Shells

- Insurance
- Mobility and comfort
- Image
- have Patient database, patient’s needs and constraints
- wheelchair database
- conduct search to provide solution set and explanation
- 3rd Conference on Clips (website)