CS.760

Case-Based Reasoning 2

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- Conversational CBR
- Case Representation
  - Flat
  - OO
- Case Vocabulary
- Similarity

Conversational CBR

- CBR systems that engage in a dialogue (conversation) with users
- Used for shallow diagnosis, product selection, planning.
- Main money earner for CBR
- *CBR-lite*
  - just similarity based retrieval
  - no revision

Conversational CBR

- Pioneer was Inference Corp. with CBR-Express (1993) (*copied* by others)
  - System lets user create a natural language query
  - Query is matched against case descriptions
  - Matching cases retrieved and confirming questions asked of user (conversation)
  - Uses information gain to order questions
  - Conversation stops when a case's confidence passes a threshold value
- Case are "authored" not "programmed"

Conversational CBR

- Demo of Help!CPR from The Haley Enterprise
- www.haley.com

Conversational CBR

- Cases comprise
  - Textual description
  - Set of confirming questions
  - Solution or Action
- Natural language query is matched against case descriptions
  - Uses simple textual comparison
  - Keywords, *trigram* matching
  - Lexicons, thesauruses & concept hierarchies

Trigram matching

- Word are broken into sets of three letters
- paper = [[p,a,p],[a,p,e],[p,e,r]]
- piper = [[p,i,p],[a,p,e],[p,e,r]]
  - approx. similarity = 0.88
- Very good for simple typos
  - Letter transposition

Trigram matching

- A trigram space is constructed from all possible trigram combinations of uppercase letter (26^3)
- A string corresponds to a point in the trigram space where its position along each of the 26^3 dimensions represents a constituent trigram
- A sophisticated indexing technique called "Probably Close" indexing folds this high dimensionality down into an index of lower dimensionality (cf. trigram matching.pdf)

Conversational CBR

- Similar cases are retrieved based upon similar descriptions
- An information gain algorithm calculates which question best discriminates between the cases
- A question's answer alters the confidence (score) of a case
- Questioning continues until a case's confidence exceeds a threshold
- Or all cases have been excluded

Conversational CBR

- Cases are authored not programmed
- Unlike simple rule-based systems diagnostic systems
- Anyone who can use MS Excel can author cases.
- Significant advantage to end-user companies

Conversational CBR

- Advantages over decision trees
  - Questions are not presented in a fixed order
  - Order is dynamically created at query time
  - Questions do not have to be answered
  - Solutions are available at all times (any-time problem solver)
  - Editing & creating cases is simple – they are independent of each other (unlike a decision tree)

Case representation

- Representation depends on:
  - Requirements of domain and task
  - Structure of available case data
- Flat feature-value list (like a database record)
  - Simple case structure is sometimes sufficient for problem solving
  - Easy to store and retrieve in a CBR system
  - Suitable for shallow technical diagnosis, product recommendation

Case representation

- Object-oriented representations
  - Case: collection of objects (instances of classes) in the sense of OO
  - Required for complex and structured objects
- For special tasks:
  - Graph representations: case = set of nodes and arcs
  - Plans: case = (partially) ordered set of actions
  - Predicate logic: case = set of atomic formulas

Case representation

- Flat case representations
- Cases are typically stored in a database
- Two types of case-base
  - Homogenous
  - Heterogenous

Case representation

- Homogenous case-bases:
  - All cases contain the same feature-value pairs (note some values may not be known)
  - ie they share the same record structure
    - Houses in a real estate case-base
    - Cars in a car dealer's case-base
  - Easy to define a full and sufficient set of case features

Case representation

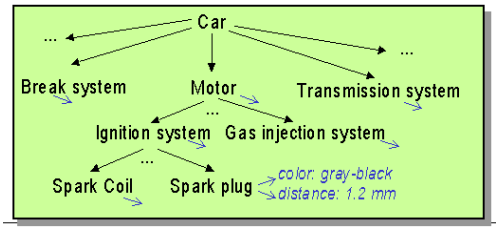
- Heterogenous case-bases:
  - Cases share some feature-value pairs
  - Cases have some different feature-value pairs
  - Difficult/impossible to define a full and sufficient set of case features
    - Medical record: impossible to define all possible symptoms, tests, diseases, treatments, etc…a person may have

Case representation

- OO representation (structural CBR)
  - A case consists of a set of objects
  - Objects described by a set of features
  - Relations between objects (e.g. part-of)
  - Each object belongs to an object-class.
  - Object-classes are organized in a inheritance hierarchy.
  - Case representation language CASUEL (developed by INRECA project)

Case representation

- OO representation (structural CBR)



Case vocabulary

- Case vocabulary means the features that describe a case
- Sometimes called the case index
  - Do NOT confuse with indexing cases for computational efficiency
- Case features (vocab.) should be:
  - Predictive (ie relevant to retrieval)

Case vocabulary

- Case features are:
  - Indexed
  - Unindexed

Patient Ref #: *1024*
Patient Name: *John Doe*
Address: *12 Elm Street*
Next of Kin: *Jane Doe*
Photo:

unindexed features

Age: 53
Sex: Male
Weight: 225 lbs
Height: 5' 11"
Blood Type: A neg.
...

indexed features

Case vocabulary

- Indexed features are:
  - used for retrieval
  - are predictive of the case's solution
- Unindexed feature are:
  - not used for retrieval
  - not predictive of the case's solution
  - provide valuable contextual information and lessons learned
- Features can change status

Similarity ???

- Purpose of similarity, either:
  - Select cases that can be adapted easily to solve the current problem
  - Select cases that have (nearly) the same solution to the current problem
- Basic assumption:
  - similar problems have similar solutions

Similarity ???

- Degree of similarity = utility or reusability of the solution
- Similarity is an a-priori approximation of reusability
- Goal of similarity modelling:
  - provide a good approximation
  - close to real reusability
  - And easy to compute

Similarity ???

- Assumptions
  - 2 similar problem descriptions have similar solution descriptions
  - It is easier to adapt the solution of a similar problem than the solution of a less similar problem

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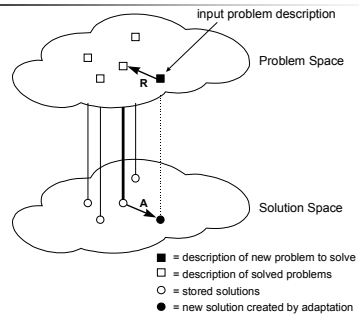
Similarity ???



Modeling similarity

- Different approaches depending on case representation
- Similarity measures (metrics):
  - Functions to compare two cases: $sim(Case_1, Case_2) \rightarrow [0..1]$
  - Local similarity measure: similarity on feature level
  - Global similarity measure: similarity on case or object level
    - combines local similarity measures
    - takes care of different importance of attributes (weights)

The University of Auckland

Modeling similarity

- Different approaches depending on case representation:
  - (Sub-)Graph isomorphism for graph case-representations
  - Logical inferences

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