Is Case-based Reasoning = Context-aware Reasoning?

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Talk Outline

- Motivation
  - Concept of Context-aware Reasoning (CaR)
  - Concept of Case-based Reasoning (CbR)
- CaR and CbR in Intelligent Environments
- CaR ⇔ CbR (Relationships and Synergies)
- Case Study (POSEIDON)
- Conclusion
The question we want to examine in this research is whether Context-awareness brought something truly new to Intelligent Environments in terms of knowledge representation and reasoning.

(…and if that is the case: How can they complement each other?)
The foremost challenges we identified are:

i. **Lack of methodical description** of why context awareness or case based reasoning is adopted for the implementation of intelligent systems,

ii. **Can we perform the same task** by deploying either of these two methods?, and

iii. **Are there synergies** in between these two approaches where they can supplement each other?
Concept of CaR

- Context-awareness specific information with the deployment of specific services
- The ambition is to embed human-like contextual awareness into systems, to make the interaction with them more natural.

Various definitions:
- Dey and Abowd’s: more focused on the four pillars of location, identity, time and activity.
- Various related concepts before and after their def.
- Recent surveys from:
  - Perera et al. (focus on reasoning)
  - Alegre et al. (focus on Engineering process)
Stages of CaR

- **Acquisition**: where the data considered as context is retrieved from the sources. These sources can be very disparate, including any type of physical, logical or virtual sensors.
- **Abstracting/Modelling**: after the data is acquired, it needs to be modelled, formatting the values from the sensors into something that can be used by an application (e.g., from coordinates to the name of a city).
- **Reasoning**: this data can also be used to create higher level information by Reasoning.
- **Dissemination**: Low and high level context information has to be available to the different applications, through a process known as Dissemination.
Context-reasoning in Intelligent Environments:
  – Ontology based
  – Supervised/Unsupervised learning
  – ECA Rules
  – Probabilistic logic
  – Fuzzy-logic
Concept of CbR

• The overall objective of Case-based Reasoning is to represent and use knowledge.

• Important to the CbR approach is to determine a similarity amongst a set of cases.

• CbR is based on the notion that the similar cases will have similar solutions.
Stages of Building CbR

• Important advantages of CbR is its ability to evolve by accumulating cases and each time a new solution set is emerged from the evolving case base.

• A cyclical process is followed:
  – Retrieve
  – Reuse
  – Revise
  – Retain
Conflicts in CbR

One crucial aspect of reasoning inference is conflict resolution, therefore, there should be a strategy to select one fact from the conflict set. There are different strategies for conflict resolution, for example,

i. Refraction: once the rule has fired it will not be used,
ii. Recency: prefer facts used recently in such situation,
iii. Specificity: use the fact with the more specific contexts,
iv. Priority: ranking factors and selection of highest rank,
v. Parallel: all facts are contributed as a different set of reasoning.
Examples of CaR informing CbR

• **Examples of combined use:**
  – Kofod and Aamondt developed a mobile context aware system where context information is embedded into cases for a situations assessment.
  – Lee developed a music recommendation system where users behaviour, demographics and context details are used for a case base recommendation.
  – Kumar et al. developed an interesting system for e-commerce applications where two distinctive cases are created, i.e., user cases and product cases. These two cases are built upon the context of users and products to incorporate multiple context dimensions to the cases.

• **On a more generic level:** Leake et al. suggested CbR can benefit context-aware system in designing smart homes where users can customise the requirements by building a case and system can gain knowledge from the context of the environment and then match a case.
CaR → CbR (cted.)

Can CaR help with some aspects of CbR?

i. **Acquiring the initial cases**: CaR can support in acquiring data

ii. **Run-time operation**: CaR more suited to operate with minimum resource

iii. **Case classification validity**: CaR can help doublecheck the correctness of the selected case
POSEIDON

PersOnalized Smart Environments to increase Inclusion of people with DOwn's syNdrome

http://www.poseidon-project.org
Infrastructure

Virtual Reality

Interactive table

PC, Tablets, Smartphones
Target areas of support

- Work
- Leisure
- Education
- Safety
- Well-being
- Socialization

[Image of icons representing each area]
Contexts in POSEIDON

• **System contexts:**
  • Battery
  • Connectivity

• **Environment contexts:**
  • Place
  • Time
  • Weather, …

• **User contexts:**
  • Emotional state
  • Assumed knowledge
Can CbR help CaR? (inspired on POSEIDON)

- Some of the contexts...
  - Clothing advice based on weather conditions at planned destination. This can include to wear a coat if it is particularly cold, or take an umbrella if rain is expected. Lastly, we suggest to apply sunblock if the day is especially hot and sunny.
  - Determining when to begin giving navigational instructions based on if they are indoors or outdoors. Instructions should be given when they are required.
  - Offering to call their carer if the system finds they deviate from the route, or are standstill for too long. Deviations requiring the offering of help include large single deviations where rerouting is required, or when the primary user makes small deviations too often.
  - Being standstill for too long can be a sign that they missed a connection service, e.g. a bus, and may require assistance.
But …

- How the system behaves and/or adapts when the meaningful contexts change? Adding contexts will often require developer intervention.

  →

- CbR can increase strengths of CaR on the ability to deal with new situations at runtime, where approaches based on predefined adaptation paths can struggle.
- CbR can also potentially benefit on highlighting:
  - the need to acquire new data from a data source
  - potential context aggregations
A hybrid approach for Intelligent Environments?

Context raw data highly variable: Rule based CaR, as it does not require too many cases to be created.

Dealing with evolving context adaptation: CbR based adaptation, as follows new adaptations strategies to be applied and evolve.

Knowledge based system to assist users in tasks: favor CaR, as it can assist the user in new situations where a particular task guide does not currently exist.

Conflict Resolution: CaR and CbR have developed different strategies which can benefit each other.

Recommendations