The potential of memorized experiences for creative problem solving and learning

Agnar Aamodt
Norwegian University of Science and Technology (NTNU)
Department of Computer and Information Science
Intelligent Systems Group

An Enriched Artifacts Activity for Supporting Creative Learning: Perspectives for Children with Impairments

Michail N. Giannakos and Letizia Jaccheri
Norwegian University of Science & Technology (NTNU)
Department of Computer and Information Science
{michail.giannakos, letizia}@idi.ntnu.no

Abstract

In this poster we present the results of a creative development program for young students with the name, Our Toys. In our empirical evaluation, a group of researchers and artists designed and implemented two workshop programs of a total of 66 pupils, exploring their experiences with open source software. The workshops were based on Reggio Emilia philosophy of creative reuse and the open-source software Scratch. The results showed that software and hardware intensive activities raise awareness of technology, intensify the experience, and invite students to explore boundaries and increase collaboration and the exchange of views and ideas.

Motivation

- The high importance of creating a felicitous, creative and collaborative environments to facilitate learning, with particular focus on programming.
- Todays technologies not only allow a more active, physical engagement, but also provide the opportunity for novel and collaborative interactions.

Research goal

- To build an understanding of the main interactions between children and the tools in creative activities and to consider improvements on the current processes.

The Field Studies (creative workshops)

WS#	# of Participants	Age (years)	Main Data Collection*
1st	15	12	Semi-structured interviews (on 6 students)
2nd	14	12	Semi-structured interviews (on 5 students)
3rd	12	12	Surveys
4th	10	12	Surveys
5th	15	17	Surveys

** In all workshops observations, photos and short videos were employed.*

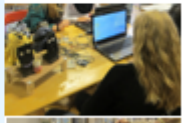
The Physical Phase


Children's worked at ReMida centers according to Reggio Emilia education principles. The main idea is that the initiative for creative actions should spring from the child himself/herself. ReMida centers are creative places with a lot of appealing objects where students start to work without being activated by adults.

The Interactive artifacts


Children's worked in teams (dyads or pentads) and completed and, published in total six interactive works and eleven installations (see example, figures) based on the software/hardware and the recycling materials of the center. Record of the children's activities was kept through photographs

Connecting the Physical with the Digital through Programming



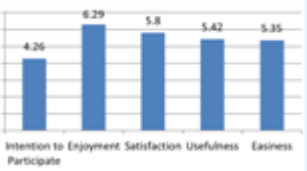

Children engaged in programming languages (i.e., Scratch) and programmable hardware platforms (i.e., Arduino), which enable them to engage in the world of creativity with digital enriched artifacts, like robots and interactive installations

Creativity Revealed

By the end of the workshops children's positive attitude and creative disposal occurred through the activity (Figure) were visible from their responses in the surveys.

Children's Attitudes

The level of enjoyment and satisfaction are high. The level of usefulness and easiness are slightly lower. However, the children's intentions to participate in similar activities are not in at such a high level.



Findings and Remarks

- By analyzing children's responses, the content analysis procedures led us to the conclusion that the creative development activities:

a) raise awareness for technology,

b) make the experience more intense,

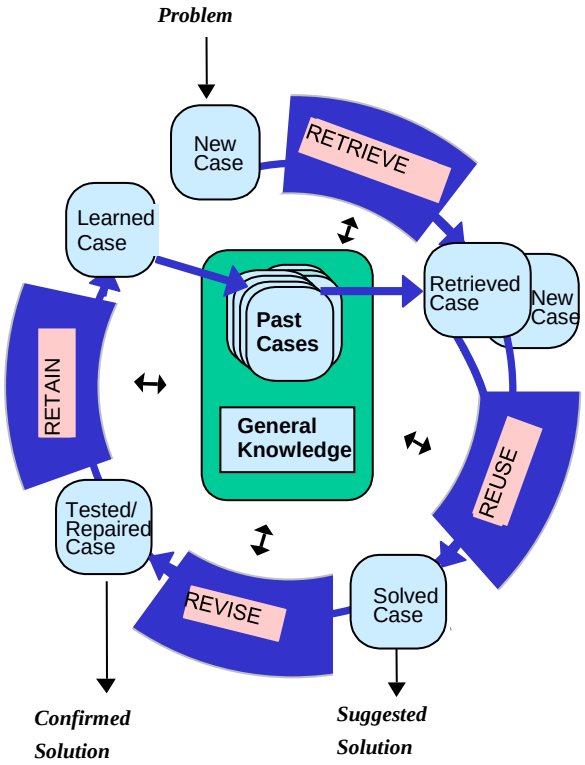
c) invite children to explore boundaries,

d) increase collaboration and the exchange of views and ideas.

- As creative activities are now widely use, a large scale evaluation has become a necessity for further understanding and improvement of such as activities.

Episodic memory
-> Case-based reasoning (CBR)

The core of CBR is the reuse of a similar past solution for solving a new problem



=> **Creativity**??

Towards creative problem solving by CBR

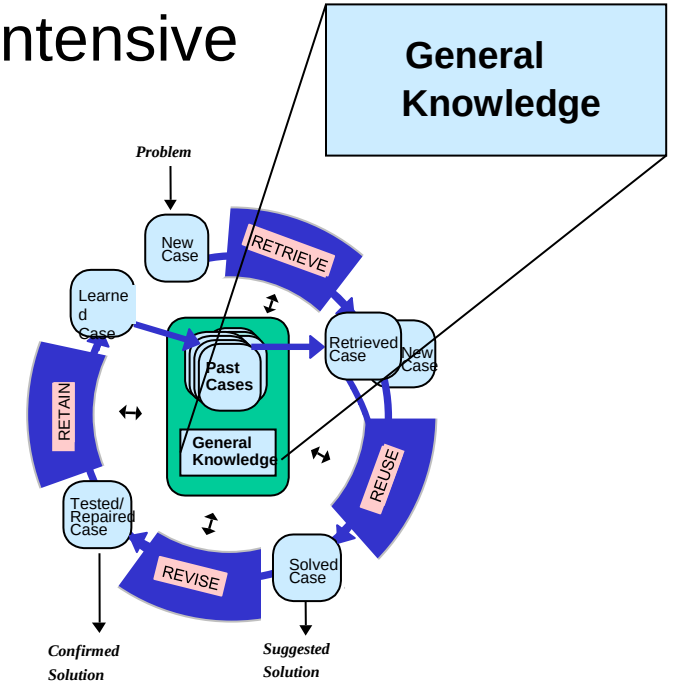
- Specifying a problem a various ways
- Retrieval by identifying a non-obvious starting point in the case space (solution space)
- Reuse by adaptation in non-trivial ways

- Substantial amount of research on creative CBR for design-type problems
- I’m interested in CBR for diagnosis&repair type of tasks – including preventive maintenance

  => Creativity?

- Potential for creativity in data-intensive CBR
  - randomness in retrieval
  - other algorithmic means

- Potential for creativity in knowledge-intensive CBR
  - model-assisted methods
  - explanations!



- The role of explanations in CBR
  - as a justification for the user
  - as an internal reasoning mechanism

- Two early example systems
  - CASEY (Koton, 1988)
  - CREEK (Aamodt, 1994)

CASEY

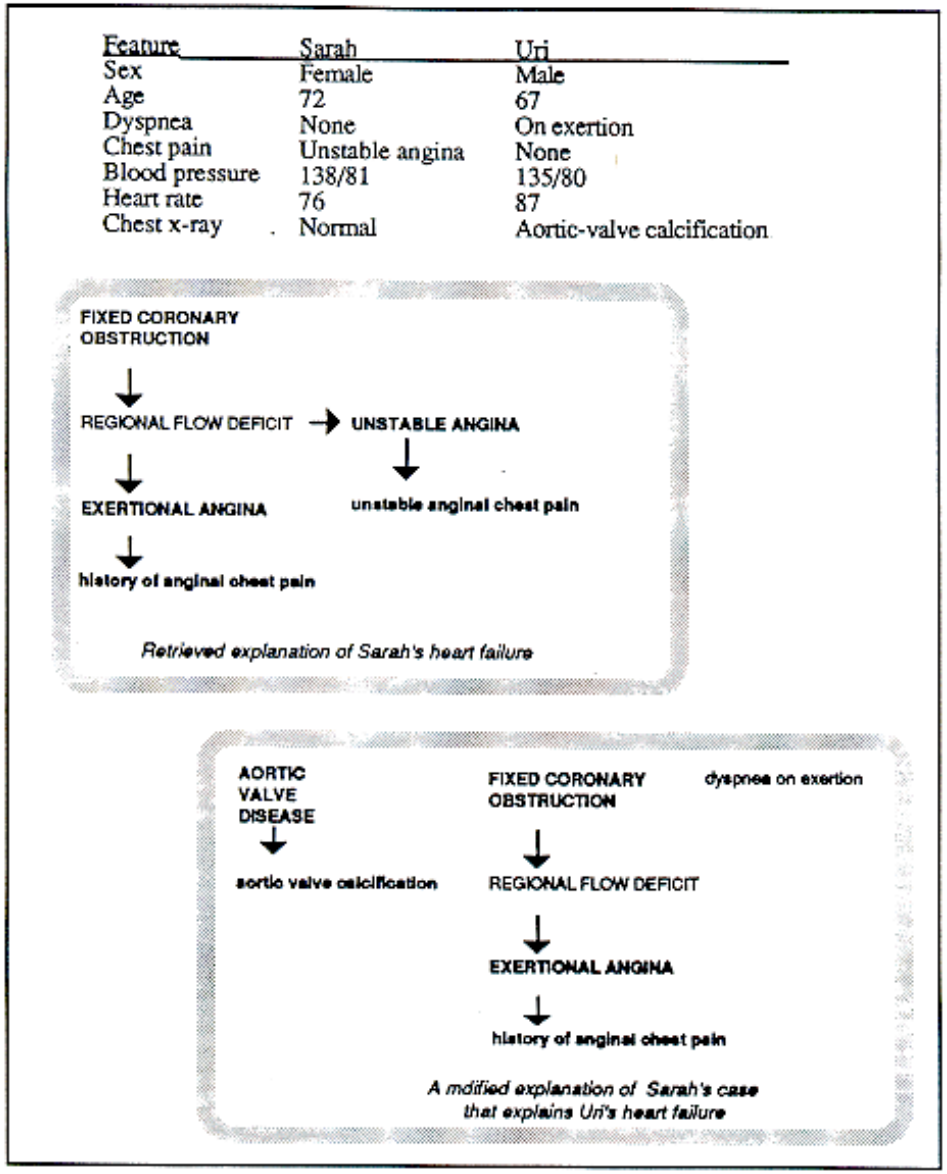
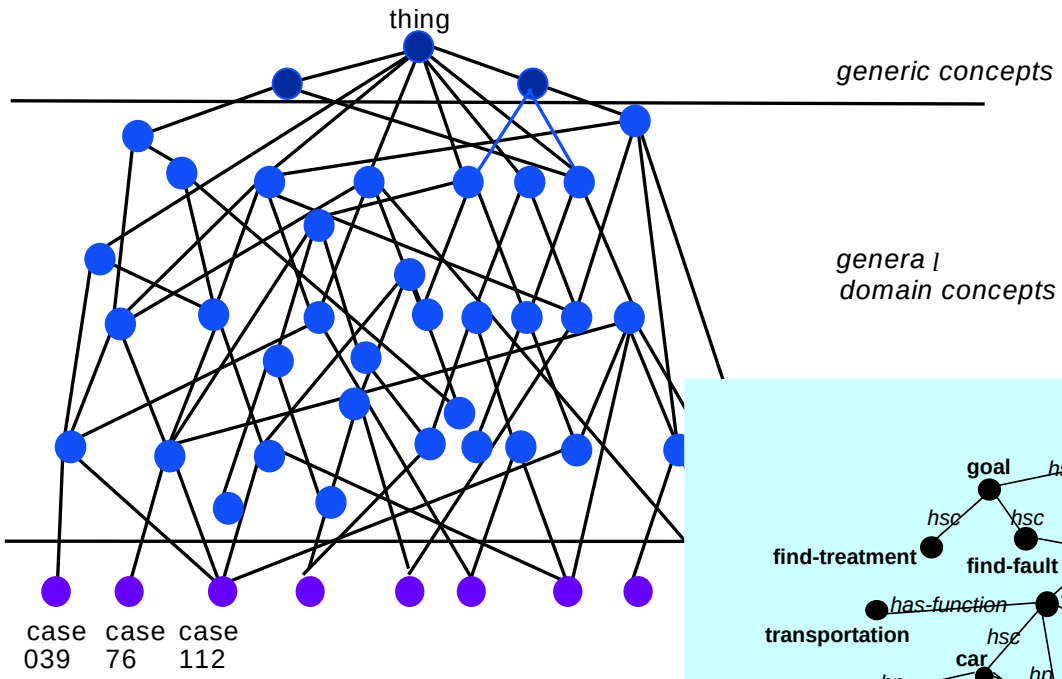
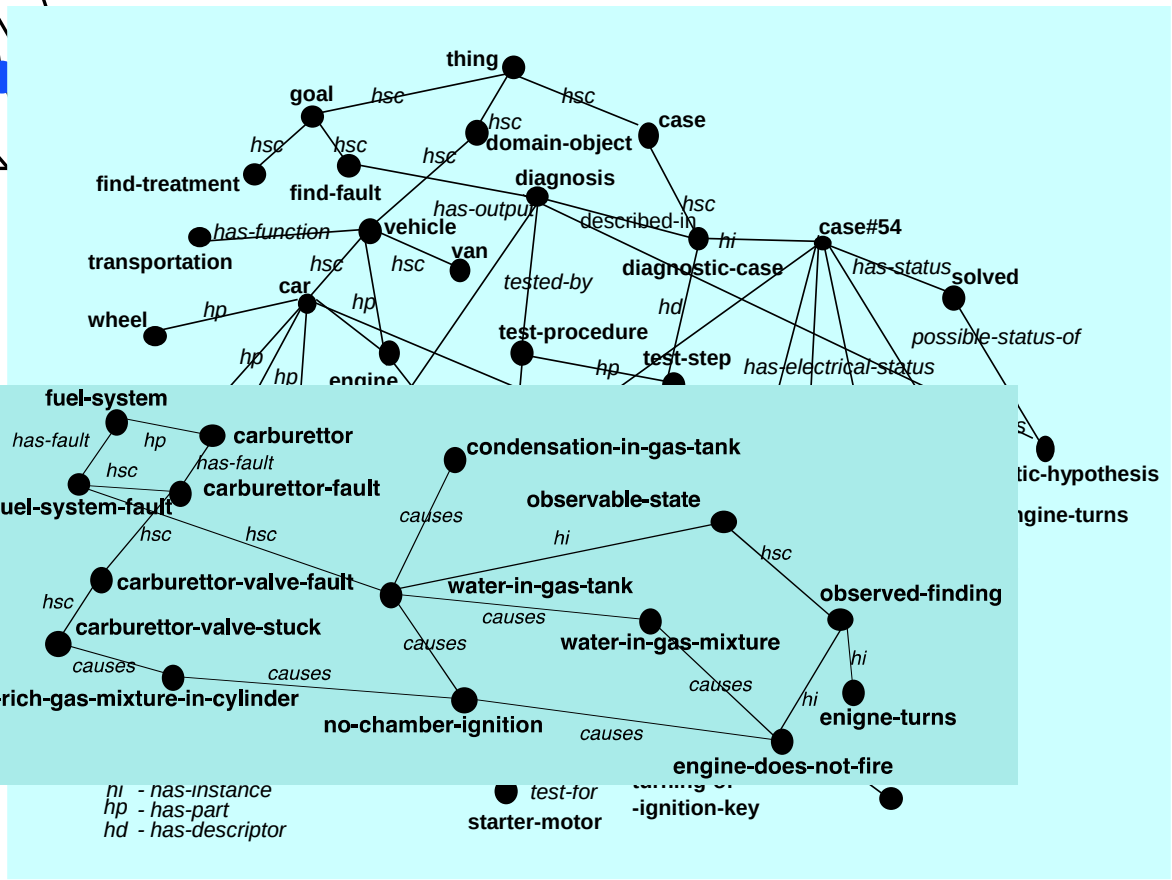


Figure 4.7: An Example of Problem Solving in CASEY
The figure is reproduced from [Koton-89]. Upper case items generally indicate physiological states, while bold items are diagnostic goal states. Lower case items are input features of the problem, and arrows symbolize the *causes* relation. Sarah is a stored case and Uri is the new problem. The upper part of the figure is a table that shows the difference between the cases Sarah and Uri (their similar features are not shown). The middle part is the explanation of Sarah's case, while the resulting modified explanation that fits Uri is shown at the bottom.

CREEK


thing
generic concepts
general
domain concepts
case 039
case 76
case 112


thing
goal
hsc
case
domain-object
find-treatment
find-fault
diagnosis
has-output
described-in
case#54
has-function
vehicle
transportation
van
diagnostic-case
has-status
solved
car
tested-by
wheel
hp
hd
test-procedure
possible-status-of
test-step
has-electrical-status
engine
fuel-system
has-fault
carburettor
carburettor-fault
fuel-system-fault
condensation-in-gas-tank
observable-state
causes
hi
carburettor-valve-fault
water-in-gas-tank
observed-finding
carburettor-valve-stuck
water-in-gas-mixture
too-rich-gas-mixture-in-cylinder
no-chamber-ignition
enigne-turns
engine-does-not-fire
hi - has-instance
hp - has-part
hd - has-descriptor
test-for
starter-motor
-ignition-key

Case-based explanation generation

"In 1984, Swale was the best 3-year-old racehorse, and he was winning all the most important races. A few days after a major victory, he returned from a light morning gallop and collapsed outside his stable. The shocked racing community tried to figure out why. Many hypotheses appeared, but the actual cause was never determined."

- The SWALE project (Schank and Leake, 1989)
  - Capturing and reusing specific explanation patterns
  - A focus on creativity in explanation

Reminding Thinking of other deaths of those in peak physical condition causes the system to be reminded of the death of the runner Jim Fixx, who died when his running over-taxed a hereditary heart defect.
Explanation Swale might have had a heart defect that caused his racing to prompt a heart-attack.

Reminding Thinking about other deaths of young stars, the system is reminded of Janis Joplin's death from a drug overdose.
Explanation 1 The pressure of being a superstar was too much for Swale, and he turned to drugs to escape. He died of an overdose.
Explanation 2 Swale might have been given performance-enhancing drugs by a trainer, and died of an accidental overdose.

Reminding Thinking of folkloric causes of death causes the system to recall the old wives' tale *too much sex will kill you*.
Explanation 1 Although racehorses are prohibited from sex during their racing careers, Swale might have died of a heart-attack from the excitement of just thinking about life on the stud farm.
Explanation 2 Swale might have committed suicide because he became depressed when thinking about sex.
Explanation 3 Swale might have died in an accident when he was distracted by thinking about sex.

Analogy

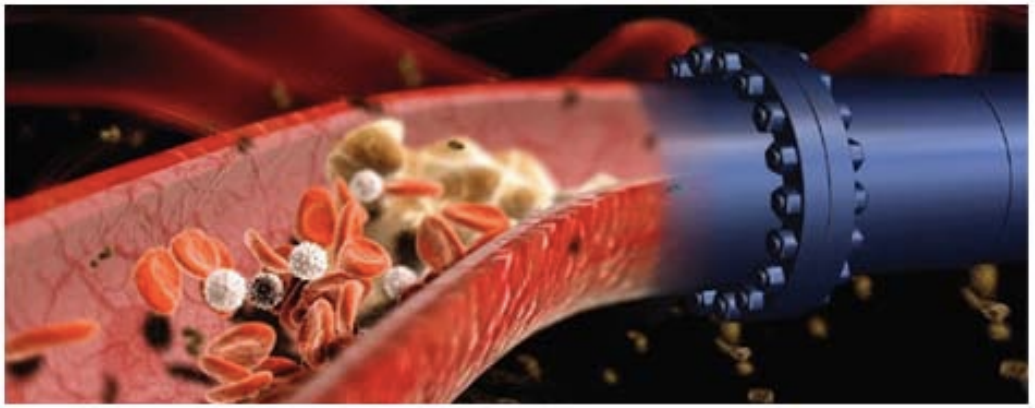
- Cross-domain CBR
- Mapping (reuse, adaptation) of past solution focused, not retrieval
- Strong theoretical support

As an aside – or not?:

  - Spin-off company from our group: 

  - The Pumps & Pipes initiative in Houston, TX

Pumps & Pipes



Two of Houston's major industries - medicine and oil & gas - surprisingly have discovered many similarities in the technologies they use and the challenges they face.

Starting in 2007 it has since spread worldwide (www.pumpsandpipes.com)

Challenges

- Better understanding of

  - how people reuse episodes (cases) creatively in decision making

  - the interplay between case-specific and general domain knowledge in creative problem solving

  - the explanation component in situation understanding, anomaly detection, and anomaly removal

  - how learning facilitates creative problem solving

  - how results from the creative arts transfer to problem solving

  - how computational creativity can support human creative thinking

- References

  - Phyllis Koton (1988): Reasoning about evidence in causal explanations. *Proceedings of AAAI-88.*

  - Agnar Aamodt (1994): Explanation-driven case-based reasoning*.* *Topics in Case-based reasoning, papers from EWCBR-93.*

  - Roger Schank and David Leake (1989): Creativity and learning in a case-based explainer. *Artificial Intelligence* (40) 1989.