Technische Universität Berlin, Department of Psychology and Ergonomics,
Chair of Cognitive Modeling in Human-Machine Systems

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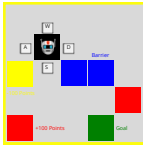

Lessons Learned From Modelling Situated Cognitive Agents Interacting With a Dynamic Environment

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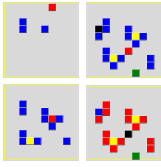
Background: What *cognitive mechanisms* are central for a cognitive agent to achieve its goals *within a dynamic and incompletely known environment*?

Answering this question may reveal more information about the complex cognitive processes dealing with information processing, decision making, problem solving and action planning (Funke, 2010). The study of knowledge representations and reasoning problems faced by a cognitive agent is thus also relevant to cognitive robotics and related fields (Levesque and Reiter, 1998).
In a student project of about two months, we used the cognitive architecture ACT-R (Anderson, 2000) to develop four cognitive agents for a simple task environment. These can support other researchers faced with similar task requirements by exploring a wide range of possible implementations and contributing some information on how situated cognition can be realized with a cognitive architecture.

Task Environment



- goal: move onto green goal tile quickly and with high score
- agent starts on top row (agent color unknown)
- goal is below the agent, in lower half of the grid
- possible movements: left, right, up, down (inside yellow box)
- movements towards colored tile can have three different consequences: blocked movement, pass, win points, lose points
- effects of object colors are randomized each trial
- fog of war: only objects in immediate surroundings are shown

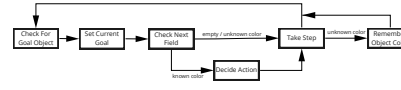
Agent Requirements

1. find colour + position of agent object
2. search for goal to be approached
3. find out effect of colored objects, infer the best way towards the goal
4. cope with constantly appearing and disappearing objects, make decisions based on mental representation of the environment

Cognitive Models

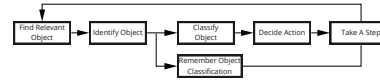
Speedy

Follows a path of sub goals including center, bottom-left and bottom-right corner. Objects on its path are evaluated and decisions are made according to the remembered meaning. In crucial situations, predefined heuristics are resorted to. The highest goal is to reach the goal.



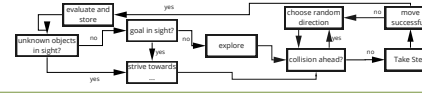
Forest

Uses a one tile visual representation which is selected by the desired direction the agent wants to move. When encountering a blocked tile the agent will try to identify and classify it. Depending on this process the tile is moved onto or evaded.



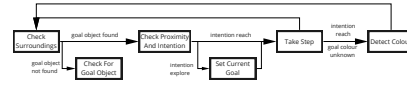
Ms. Captain Curious

The agent is curious and "on the go": Simple heuristics help it to get moving without planning. It aims to identify every unknown object, it only ever looks just one step ahead, and it uses random moves instead of reasoning when it is in an ambiguous situation.



Intell-Agent

Uses a 12 tile diamond-shaped visual representation for reasoning which is updated at every step. Intentions determine goal pursuit behaviour. The highest valued intention is to collect visible bonus points followed by reaching the goal.



Discussion

The main lessons learned were (1) to develop a better understanding of what cognitive plausible mechanisms really are and where difficulties lie in seperating computational and cognitive aspects. (2) The second lesson learned was to realize how important it is to use detailed task analysis and visualizations of model structure for group communication while modelling. (3) The third point was that pre-attentive visual processes are sometimes sufficient for simple localization and checking purposes of the agent.

Challenge Results

Agent	# of productions	Completed /15	Avg. # of Moves	Avg. Time (s)	Avg. Score
Speedy	41	12	62.75	14.184	1145
Forest	53	4	24.10	29.50	80
Ms. Cap. Curious	83	13	39.46	39.78	1180
Intell-agent	226	13	26.61	62.04	1177

References

Anderson, J. R. (2000). Learning and memory: An integrated approach (2nd ed.). Wiley.
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Levesque, H., & Reiter, R. (1998, March). High-level robotic control: Beyond planning. A position paper. In AIII 1998 Spring Symposium: Integrating Robotics Research: Taking the Next Big Leap.