INTELLIGENT SYSTEMS QUALIFIER

Spring 2010

Each IS student has two specialty areas. Answer 2 of the 3 questions in each of your specialty area as well as 2 of the 3 Core questions below.

You will be assigned an identifying number and are required to hand in printed or written copies of your answers with each page identified only by that number. This process enables us to grade your answers anonymously. You should NOT identify yourself explicitly by name on your answer sheets or implicitly by referring in the first person to your work (my project on ABC).

Please answer each question starting on a new page, with your answer following the text of the question.

Place any relevant references that you cite in an answer at the end of that answer, NOT in a separate section at the end of the whole exam.

If you have any questions or feel it necessary to make any assumptions in your answers, do not seek clarification from faculty or staff. Simply record your assumptions as part of your answer.

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All IS students must answer 2 of the 3 Core questions:

Core AI #1

According to the Intelligent Agent view described in Russell & Norvig’s AI textbook, intelligence is a function that maps percepts into actions:

f: P* → A

where the asterisk on P indicates a history of percepts. Given this view, explain why classification is ubiquitous in intelligence. You may want to consider illustrative scenarios such as a frog extending its limbs to reach an edible insect or a robot pressing on the brakes of a car when the car in front appears to be slowing down. Make assumptions about numbers of percepts and actions in such scenarios, derive the computational complexity of the mapping, and explain the computational power of classification.

New Core AI#2:

In “Intelligence without Representation” in Mind Design 2, Brooks argues for behavior-based systems and a decomposition based on activity instead of function. Using the creation of “Creatures” as a goal, he describes Allen and Herbert (mobile robots) as examples of his direction of AI research and suggests the ideas of situatedness and embodiment as key ideas to AI.

An ambitious graduate student at the time (who shall remain nameless) suggested that a wearable computer, acting as an intelligent assistant to its user, is an alternative instantiation of Brooks's approach to AI where situatedness and embodiment are still preserved but researchers do not need to
focus so much on creating physical mobile robots.

A) Argue this case. Specifically, what advantages does a wearable computing approach to Brooks's philosophy have over a mobile robotics approach? What disadvantages does it have?

B) Give explicit examples of the types of behaviors researchers should pursue for an intelligent wearable assistant to exhibit to be in line with Brooks's philosophy.

C) What sort of architecture would be appropriate to create for these intelligent agents, given Brooks's approach?

D) Finally, describe how the pursuit of wearable intelligent assistants might illuminate issues in human intelligence and cognitive science.

New Core AI #3

In First Order Logic, describe backward chaining, forward chaining, and resolution. What advantages and disadvantages does each have? Describe an example in computer gaming where one might want to use forward chaining.

If one of your two areas is Knowledge Representation and Reasoning, answer 2 of the 3 questions below:

KRR #1

Analysis of human behavior suggests that people often use stories to make sense of the large amount of data presented by the world. For example, in the early nineties Pennington & Hastie proposed their Story Model to explain how jurors make decisions in a criminal trial. The prosecuting attorney may present not only data about the crime but also a story that explains the evidence, causally connects various actions, and ascribes intentions to various actors. The defense attorney may challenge some of the evidence for the prosecutor’s story, or provide evidence against it, or provide an alternative story that explains the evidence. The juror may believe the prosecuting or the defense attorney’s story based on her interpretation of the evidence, or construct her own story based on her prior knowledge and experiences. (You don’t need to know more about Pennington & Hastie’s Story Model than this to answer this question. So you don’t want to spend your time chasing after their papers.)

Yet, AI attempts to use stories for sense making have been less than successful. Why? Take the specific scenario of the jury decision making described above. Sketch the design of an AI system that may act as an automated juror based on the Story Model. Illustrate the basic knowledge representations and inference methods. Now explain why in practice building such AI systems has turned out to be hard. What might we do about the problems you identify?

KRR #2

The planning problem is to find a sound sequence of actions that transforms the world from an initial state into one in which a goal situation holds. There are many AI problem-solving techniques that apply
pre-existing knowledge to novel problems. One way is transformative multi-reuse case-base planning, which attempts to solve a problem by iteratively selecting existing plans to familiar problems and composing them into a larger plan that solves the unfamiliar problem. Another way is hierarchical task network planning, which attempts to solve a problem by applying recipes (or task networks or decomposition rules) to abstract goals, progressively decomposing the problem into less abstract goals until primitive actions are selected.

Argue for why case-based planning and hierarchical task network planning are the same thing.

Argue for why case-based planning and hierarchical task network planning are NOT the same thing.

Which do you believe and why?

KRR #3

The WebCBR workshop at the International Conference on Case-Based Reasoning (ICCBR) is based on the following premise:

Advances in web technology have led to vast amounts of user-generated web content in the form of blogs, emails, reviews and opinions. Increasingly people search and browse other people's experiences on travel, medicine, retail, etc. These logs form a rich source of untapped experience data. In fact, the web can serve as a giant experience repository or "case base", containing not just data but actual experiences reported by people in real-world situations, that can be used for Case-Based Reasoning (CBR) to solve new problems in similar real-world situations.

Choose one of these domains (travel, medicine, retail) and design a CBR system that can serve as an intelligent assistant in that domain (e.g., a travel assistant, a medical diagnosis agent, a shopping assistant, respectively). The system should be able to solve problems autonomously or interactively with the user. The system should NOT merely be a recommender system or search engine, which simply retrieves information and lets the user figure out what to do with it; instead, the system should reason with experiences (cases) and develop solutions to the user's problem. Draw the cognitive architecture of your system, explain what each component does, and propose methods or algorithms by which each component can accomplish its designated subtask.

If one of your two areas is Cognitive Science, answer 2 of the 3 questions below:

CogSci #1

Many cognitive scientists claim that analogy is the core of cognition (e.g., Hofstadter in his famous book Godel, Esher & Bach). Not surprisingly, then, cognitive science has developed many theories of analogy (and more are still being developed). One method for addressing analogies uses only visual knowledge represented propositionally. Another method uses only affine transformations without any propositional representations. A major reason the affine method works for geometric analogies of the kind that appears on many intelligence tests is that the problems are “closed:” the test taker is given a small set of choices that contains the correct answer to the problem.
Now consider an “open” analogy problem such as the analogy from the model of the solar system to the model of an atom. In such open analogy problems, the correct answer is not known a priori. Would the visual method work for this problem? What about the affine method? First, make whatever assumptions you need about the representations of the source and the target problems in this scenario to make the visual (or affine) method work. Then, show how the visual (or affine) method may address this analogy. Next, critique the assumptions you made in the first part and the method you developed in the second. Finally, briefly describe an experiment that might be able to test the cognitive plausibility of the assumptions you made in the first part.

CogSci #2

In his argument for distributed cognition, Hutchins maintains that the traditional view of cognition has encouraged us to “mistake the properties of complex sociocultural systems for the properties of individual minds” (Cognition in the Wild, p.355).

1) Explain what is the “traditional view” he is arguing against and describe his alternative

2) From the perspective of a designer of technology, what, if any, difference would it make if one adopted the traditional view or the distributed cognition view. Take an example of a technology and compare and contrast the considerations that would figure in its conception and development from each.

CogSci #3: Allen Newell's "Unified Theories of Cognition" described the different "bands" of human cognition and proposed the Soar architecture as a means of modeling the band that represents symbolic reasoning and individual decision making. The purpose of this work was to force cognitive scientists to consider the multitude of different mechanisms involved in human cognition as working together in a single architecture rather than as disparate and unrelated entities. In other words, he proposed that research on cognitive architecture enabled researchers to think about human cognition as a whole.

John Anderson's work on ACT theory has followed similar path, enabling cognitive scientists to model very fine-grained aspects of human cognition such as attention, semantic memory, decision making, and learning.

The trajectories for these two architectures (and others) have taken very different paths in the cognitive science community. The Soar architecture has been embraced by AI researchers while ACT-R is much more widely used by cognitive psychologists. What aspects of a cognitive architecture, such as these, make them more appropriate for AI vs. cognitive psychology research? Be clear to use specific examples from these or other cognitive architectures.