ICT Next Generation Architecture Desiderata

2/23/2009 (Version 5)

Top Level

1. Is the goal an architecture, a language/toolkit, or some combination?

2. Upon what system(s), if any, should it be built?
    a. Build on Soar8, Soar9, ACT-R, Alchemy, factor graphs, Whiteboards, etc.?

3. Look at more uniformly/flexibly providing virtual humans at different levels of sophistication/complexity/weight/generality to support wider range of existing and upcoming ICT projects
    a. Chatterbot (NPC editor?), simple goal-oriented agent, full VH, etc.

Virtual Human Architecture

1. Overall virtual human architecture may be in pretty good shape in terms of decent APIs, replaceable modules and extendibility
    a. May need better or more homogeneous message standards
    b. Was a call for better APIs between cognitive system and other aspects of virtual human, and between different aspects of cognitive system
        i. Soar8 and Soar9 apparently do support better APIs

2. More of body and better tie of mind to body and body to (real and virtual) world so can do perception, proprioception, motor behavior, and non-cognitive emotional aspects
    a. May need high-bandwidth interactions (such as streams) in virtual human (and cognitive?) architecture, for perception (vision and possibly speech) and motor control (SmartBody rendering, etc.)
        i. Something like Whiteboards as an approach?
    b. Perception for interacting in virtual world, interfacing with real world, emotion and social cognition
    c. Models of physiology and/or brain stem for emotion
    d. Better control over more aspects of body
    e. Need closer ties between recognition and understanding in speech?

Cognitive Architecture

1. A new overall vision for the cognitive architecture seems to be the biggest need
    a. Based on a uniform implementation level?
    b. Based on more standard representation and reasoning capabilities to help communicate with broader AI community?

2. Rethink relationship among dialogue, emotion and cognition(/plan execution)
    a. Extract and leverage commonality
    b. Understand/modularize how components depend on each other
        i. Sit down an figure out what each needs and provides
    c. Incorporate more emotion impact on architecture/behavior
        i. Requires more aspects of behavior to exist (beyond just verbal and nonverbal communication)
        ii. Requires better interfaces to existing behaviors (such as speech)
    d. Reduce disconnect between thought and language use

3. Represent and reason about beliefs, utilities, social attitudes, obligations, intentions, deals, etc.
    a. Allow nesting of beliefs, attitudes, etc. for theory of mind
    b. Allow uncertainty in representation

4. Support hypothetical(/temporal) reasoning and generative planning
    a. Represent situations for evaluation
    b. Search/simulate across states via something like beam search that maintains, and allows comparisons across multiple states at once
    c. Integrate with off-the-shelf planner or add generative planning in agent
        i. Planning problems are not large

5. Give agents a "life"
    a. Cumulative existence across sessions
        i. Develop relationships with people
            1. Relates to episodic learning and adaptive theory of mind
        ii. Long-term emotional moods, development of friendships, etc.
    b. Multiple possibly conflicting motivations/goals
        i. Participating in dialogues with humans is just one of these

6. Social cognition and theory of mind w/ utilities and beliefs (about others)
    a. Facilitate grounding (common meanings among agents)
    b. Reasoning about influence (what you say will alter beliefs of others)
    c. Recursive and adaptive

7. What about role of learning in the architecture (which is ignored at this point)?
    a. Episodic learning to help yield appropriate adaptive behavior over time
        i. Helps supports an extended "life"
    b. Skill acquisition to convert deep/slow knowledge into shallow/fast
        i. Deep knowledge is easier to acquire and adds robustness
        ii. Shallow knowledge facilitates real-time behavior
    c. Knowledge/concept acquisition to facilitate system construction
    d. Social learning to continually improve models of others
    e. Yielding secondary emotions via learning
    f. Learning from human demonstration/imitation/advice about what to do

8. Are there implications from neurobiology that should be incorporated into the architecture?

9. Support selectively spinning off individual capabilities, such as emotion and planning, to other ICT efforts and for contact with the broader research community
    a. Requires more modularization
    b. Implement independent of Soar?
        i. Via more standard representation and reasoning mechanisms?

Development

1. Ease specification and consistent use of high-level/abstract control structures, strategies, data structures and knowledge
    a. Provide wide range of such constructs, as in standard languages?
    b. Use consistently and automatically across system
        i. Write once, use many times (for knowledge at least)
        ii. Both use strategies and recognize them in others
        iii. Consider an external knowledge representation that is converted into multiple internal forms (and is usable in other systems)
    c. Avoid using "assembly language" – rules and wmes – when inappropriate
    d. Fill in details automatically when possible so that human need not
    e. Don't require details to be specified when really not needed (do without)
    f. Maintain aspects as unknown (variablized) during planning and reasoning (as in symbolic execution)
    g. Allow people to work at right level of detail for them

2. Better balance between incremental exploration and rapid prototyping versus structured development
    a. Discourage spaghetti code
        i. Use more standard representation and reasoning mechanisms to constrain how things are coded?
        ii. Institute code reviews?

3. Log, display, checkpoint, rollback & replay activity for debugging/analysis
    a. See what generated/deleted a wme that no longer exists
    b. View graph structures corresponding to preferences
    c. Log and view virtual human messages
    d. Replay behavior via logs

4. Enable regression testing with automatic validation of behavior at an abstract enough level that small random variations from what is specified are ignored as long as behavior is "functionally comparable"
    a. Specify behavioral equivalence sets
    b. Build a "regression agent" focused on evaluating behavioral equivalence

5. Utilize, and integrate in, existing generic ontologies and knowledge bases
    a. Offline to aid in system development
    b. Online to aid in generating responses for "out of paradigm" situations
    c. Use the Cyc, Omega5 or WordNet ontologies/KBs?
    d. Use extraction of information from web searches and/or Twitter queries?
    e. Enforce type hierarchies?

6. Role of learning and knowledge reuse in system development

7. Make it easier to create new characters
    a. Integrated authoring environment for task models and language
        i. Based on the Protégé ontology system and the Owl language?

8. Support exploration by students and others
    a. Code too difficult to understand and modify at present
    b. Route to integrating (rewritten?) contributions back into system

Procedural

1. Need a driver for integration that yields motivation and resources
    a. Is integration a chore or something rewarding to individual researchers and groups?
    b. How much of a central integration group should there be versus effort by "capability" individuals/groups

2. One route to get broad buy in is to find a next generation environment/game that will excite everyone and drive next-generation architecture research.
    a. This might be a social game involving both virtual and real human players that would push the inclusion of more realistic theory of mind, learning/adaptation of this theory, etc.
    b. The Clue-like game, Gunslinger and Virtual Patient have been suggested as possibilities
    c. A community HLAI testbed environment?

3. Need process for integrating new capabilities and enhancements, written by students and others, into overall system
    a. Need to be rewritten and integrated centrally or some other way?

4. Have a series of sessions on individual capabilities where determine what each capability needs and provides in service of better modularizations and APIs, or in finding commonality that can be leveraged