DARPA ASKE TA1 ANSWER M7 Report: Lessons Learned; Updated Architectures, Algorithms, and Approaches[1]

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Introduction

In this report we endeavor to report succinctly what we have learned and how it has affected our approach as we begin Phase 2 of the ASKE TA1 ANSWER program.

For reference, our ANSWER Phase 2 task, objective, and milestones are as follows.

Task: Proof of Concept

Objective: Extend capabilities in extraction from code, extraction from text, knowledge representation and reasoning in K-CHAIN, and controlled-English representation for human readability

Approach: Based on what is learned in Phase 1, identify gaps, develop solutions, and identify strategies to boost capability and performance in all areas

Milestones:
M7: Report: lessons learned, updated architectures, algorithms, and approaches
M9: Report proposed evaluation metrics and initial results of applying metrics measurements to PoC implementation
M11: Scripted demonstration of PoC system; report of performance of system on NASA hypersonic aerodynamic models and documents
M12: Progress report
M13: Interim report quantifying PoC system performance
M15: live demonstration of system showing performance metrics for application to NASA hypersonic aerodynamic models and documents; progress report
M18: Final report on PoC system architecture, algorithms, and methodology along with performance (quantification of accuracy, robustness) and generalizability

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Lessons Learned and Implications for Modified Approach

1. It was harder than we anticipated to integrate our pieces of functionality to get an end-to-end demo. This will be alleviated by having a "demo" and a "development" ("dev") version of each service running and always available for others to use. The "demo" version will be stable and be a dependable version of the last snapshot functionality. The "dev" version will be the bleeding edge with latest functionality and hence less stable. We will also go to a more agile approach to breaking down, implementing, and delivering integrated functionality

2. Our use case (NASA Hypersonics Web pages) does not have good examples of everything we are trying to use as input, e.g., comments in code. We may need to create some test cases or identify another source to help develop, validate, and evaluate some functionality.

3. We were overly optimistic in what we identified as Phase 1 functionality. We did not complete implementation of the following:
   a. Model comparison
   b. Model composition or append functionality for a unified computational model of curated knowledge, where suitable subgraphs can be used during inference.
   c. Use of locality in curation
   d. Integration of extractions from code and text
   e. Capture of assumptions and constraints, i.e., augmented type information, for new models

4. The problem is too large for us to develop all the pieces we need with the resources available. Hence, we will be looking at what other ASKE participants have built that we might integrate into our framework to enhance functionality and provide a more capable tool.

5. The computational graph approach of GE TA1 and TA2 is confusing to those outside GE. We will work more closely with GE TA2 to integrate the computational frameworks.

Updated Architecture, Algorithms, and Approach

1. We will reevaluate our approach to mixed initiative by doing a more formal requirements analysis, resulting in either an improved version of our current architecture and approach or a modified architecture and approach.

2. We will explore other probabilistic programming frameworks that were favorably represented in the MWS 2019 conference and/or the PI meeting, e.g., Julia, Turing based on Julia, PyMC3 based on Python, etc.

3. As we integrate the computational approach of GE TA1 and GE TA2, we will rationalize differences to achieve greater commonality. For example, one outcome may be that DBN and K-CHAIN are identified to be two different frameworks at the computational graph layer and open to user choice. See #5 above.

4. We will devote effort at this beginning stage of Phase 2 to understand more fully the approach of and artifacts developed by other ASKE providers to determine if we can use what they have done in our own efforts. See #4 above.

5. The evolutionary nature of our approach, which uses information learned along with background knowledge to improve future extraction and curation, seems unique and we will focus effort on demonstrating its feasibility and value.
6. If resources permit, we will explore capturing user feedback to make the extraction from text models to learn in a continuous fashion. This might be in the existing Web interface or may be integrated into the Dialog interface.
7. Currently K-CHAIN supports Build and Evaluate functionality, we will focus on Append functionality to create complex computational models based on simpler computational models that have been created earlier. This will support evolution of the knowledge and computational model as more data becomes available.

Conclusion

We expect the lessons learned reported above and our modifications to improve our approach and capability. None of these is a major change to our architecture and fundamental approach, which seems to us to be sound.