Reflective Essay: Knowledge Representation and Reasoning Module

ePortfolio: https://gpessoaamorim.github.io/portfolio/#knowledge_representation_reasoning

1. Introduction

As a clinical data scientist, the Knowledge Representation and Reasoning (KRR) module offered a fascinating exploration into formal approaches to organizing and modelling complex knowledge domains. This reflective essay examines my learning journey, employing Rolfe et al.'s critical reflection framework (Rolfe, Freshwater and Jasper, 2001) to describe my experiences (WHAT), analyse their significance (SO WHAT), and consider future applications (NOW WHAT).

2. Activities Performed and Learning Outcomes ("WHAT")

The KRR module encompassed several key learning activities that progressively built my understanding of formal knowledge representation techniques. The theoretical foundation included an exploration of the historical evolution of knowledge representation, from ancient civilizations to modern computational approaches, establishing systematic knowledge organisation as a fundamental human endeavour (Collaborative Discussion 1).

The essay on the Intelligence Task Ontology (ITO) model (Blagec et al., 2022) provided an opportunity to critically analyse a sophisticated ontology-based system, examining both its strengths in organizing AI research and its limitations regarding maintenance, sustainability, and representation of uncertainty. This analysis reinforced the importance of understanding both the potential and constraints of ontological approaches.

Collaborative Discussion 2 proved invaluable for deepening theoretical understanding. Through peer interactions, I explored the standalone value of knowledge representation beyond reasoning applications, and engaged with diverse perspectives on ontology languages like OWL2 (including their different strengths and pitfalls). These discussions enhanced my appreciation for the complexity and nuance involved in formal knowledge representation approaches.

Central to the module was mastering ontological approaches through hands-on experience with Protégé, both during the many formative activities (results included in the ePortfolio) and the final assignment. The latter involved creating a job-matching ontology demonstrating semantic relationships between entities like job seekers, employers, skills, and qualifications. While I had limited previous exposure to Protégé for creating mutually exclusive categories in ICD-10 clinical ontologies, this module provided comprehensive training in developing complex ontological structures and automated reasoning approaches.

3. Personal Reflection on Learning Journey ("SO WHAT")

This module represented a significant paradigm shift in how I conceptualize knowledge organisation and representation. Coming from a background where data is typically structured in relational databases and tabular formats, the ontological approach initially seemed abstract, difficult to visualise, and unnecessarily complex. However, as the module progressed, I began to appreciate the limitations of traditional data structures for representing complex, interconnected knowledge domains.

These insights became especially vivid through development of the job-matching ontology, where I witnessed firsthand how semantic relationships could enable sophisticated reasoning beyond simple keyword matching. This experience was transformative because it demonstrated how ontologies could capture nuanced relationships that tabular databases simply cannot represent effectively. For instance, the ability to create new categories through logical statements and infer that a candidate with "Python programming" skills might be suitable for "data science" roles, even when not explicitly stated, showcased the power of semantic reasoning.

Working with the ITO case study further reinforced these insights. Analysing how the research team systematised AI research through ontological structures highlighted scalability and automation challenges, but also the immense potential for organising complex, rapidly evolving knowledge domains. This resonated strongly with my pharmaceutical industry experience, where knowledge about drug interactions, patient demographics, and treatment outcomes is often stored in fragmented, poorly connected systems.

The collaborative discussions were particularly enriching, exposing me to diverse perspectives from colleagues with varying technical backgrounds. These interactions challenged my assumptions and helped me develop more nuanced views on the trade-offs between different knowledge representation approaches. The emphasis on OWL2's expressiveness versus computational efficiency provided practical insights into real-world implementation considerations.

One unexpected aspect was developing an appreciation for the philosophical underpinnings of knowledge representation. Understanding that formal approaches to KRR address fundamental questions about how knowledge should be structured and reasoned with gave me deeper appreciation for the field's theoretical foundations while maintaining focus on practical applications. I particularly enjoyed learning about KRR model limitations, such as handling uncertainty or subjective definitions.

4. Learning and Changed Actions ("NOW WHAT")

The knowledge and skills acquired have fundamentally altered my approach to data organisation and knowledge management in my pharmaceutical industry role. I now recognise numerous opportunities to apply ontological principles to improve how we represent and utilize complex healthcare knowledge. For example, I frequently encounter challenges integrating disparate data sources about patient demographics, treatment protocols, and clinical outcomes. Traditional relational database approaches often fail to capture complex relationships between these elements effectively. The ontological modelling techniques learned offer a pathway to creating more sophisticated knowledge representations that could enable better clinical decision support, research insights, and business strategy.

I am particularly excited about applying these concepts to model existing knowledge on healthcare systems, where relationships between providers, treatments, patient populations, and outcomes are highly interconnected and context-dependent. The semantic reasoning capabilities demonstrated in the job-matching ontology could be adapted to identify customers with high potential for treatment or care pathway optimisation based on complex factor combinations, maximising return-on-investment from sales calls and quality improvement programs.

Moving forward, I plan to advocate for pilot projects within my organisation exploring ontology-based approaches to specific knowledge management challenges. I am also keen to explore the semantic reasoning capabilities of alternative clinical ontologies, such as SNOMED-CT. Importantly, this module has equipped me with both technical skills to develop prototype systems and theoretical understanding to articulate their value to stakeholders unfamiliar with formal KRR approaches.

Finally, the critical analysis skills developed through examining ITO have also enhanced my ability to evaluate knowledge management systems more rigorously. I now approach system design with greater awareness of sustainability challenges, the importance of community engagement in knowledge curation, and the need to balance expressiveness with practical implementation constraints.

5. Conclusion

The Knowledge Representation and Reasoning module has been a transformative educational experience that fundamentally changed how I approach knowledge organisation and management. Despite initial challenges in grasping abstract ontological concepts, I emerged with both practical skills in formal knowledge representation and a deep appreciation for the theoretical foundations underlying these approaches.

The module's combination of theoretical exploration, hands-on practical work, and collaborative discussions provided a comprehensive learning experience bridging academic concepts with real-world applications. The insights gained about ontological modelling, semantic reasoning, and traditional data structure limitations have immediate relevance to my pharmaceutical industry work, and broader healthcare knowledge management applications.

As I continue in my role as a data scientist, I am eager to explore how these formal KRR approaches can address longstanding challenges in healthcare data integration and clinical decision support. This learning journey has reinforced my commitment to pursuing innovative approaches to complex data challenges while maintaining awareness of practical implementation considerations and sustainability requirements.

References

Blagec, K. et al. (2022) 'A curated, ontology-based, large-scale knowledge graph of artificial intelligence tasks and benchmarks', Scientific Data, 9(1), p. 322. Available at: https://doi.org/10.1038/s41597-022-01435-x.

Rolfe, G., Freshwater, D. and Jasper, M. (2001) Critical Reflection for Nursing and the Helping Professions: A User's Guide. Palgrave MacMillan.