



**Proposal Defense**  
***Doctor of Philosophy in Intelligent Systems***

**“THETICAL: The Hybrid Engine for The Inference and Generation of Case-based Argumentation in Law” by Morgan A. Gray**

**Date:** August 5, 2025

**Time:** 10:00 a.m. – 12:00 p.m.

**Place:** 5317 Sennott Square, 3810 Forbes Ave, Pittsburgh, PA 15213

**Committee:**

- Kevin Ashley, Professor of Law, School of Law, University of Pittsburgh
- Milos Hauskrecht, Professor, School of Computing and Information, Department of Computer Science, University of Pittsburgh
- Lorraine (Xiang) Li, Assistant Professor, School of Computing and Information, Department of Computer Science, University of Pittsburgh
- Katie Atkinson, Professor of Computer Science, School of Electrical Engineering, Electronics and Computer Science, Faculty of Science and Engineering, University of Liverpool

**Abstract:**

Computational models of legal reasoning have long been able to make legal arguments in domains where factors are used to determine a legal conclusion. However, these systems rely on significant manual efforts to construct a knowledge base and formal domain of reasoning able to produce legal argument. In law, pre-trained LLMs, alone, have shown to be insufficient for use as a knowledge base. Systems relying on Retrieval Augmented Generation (RAG) show improvement, however, the generally unstructured knowledge bases used for RAG fall short of providing the kind of detailed information needed to construct detailed legal arguments. Even with interventions such as RAG, LLMs continue to hallucinate in the legal domain. This dissertation presents a system that automatically compiles a structured knowledge base that can be used to make predictions with machine learning models that can subsequently be validated and explained with post-hoc arguments generated from LLM based agents. The system leverages both data-based methods of analysis and local systems of argumentation to reason about an input scenario, that is, facts to be analyzed with respect to a conclusion. The first contribution is the generation of legal arguments using adversarial agents according to legal argument schemes. The second is prediction of outcomes, accounting for factor magnitude, with supervised and reinforcement learning. Third is the post-hoc explainability by validating such predictions with natural language arguments that analyze the efficacy of the prediction in context of case law.