DEPARTMENT OF INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Master's Thesis in Informatics

Thesis Proposal

Trung Nguyen

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I confirm that this master's thesis in informatics is my own work and I have documented all sources and material used.

Munich, September 8, 2025 Trung Nguyen

1 Introduction

Contract Lifecycle Management (CLM) is critical in enterprise environments, serving as operational and financial anchors for complex projects involving multiple stakeholders and regulatory requirements. Current CLM tools rely on rule-based automation or single-agent LLMs, presenting limitations in scalability, explainability, and domain-specific optimization.

Multi-agent systems (MAS) offer promising potential for addressing these limitations through specialized task decomposition, inter-agent collaboration, and enhanced explainability mechanisms. This research addresses the gap in multi-agent system applications for enterprise contract management workflows, particularly regarding compliance-aware orchestration and explainability requirements.

The thesis focuses on designing and evaluating multi-agentic AI systems for CLM tasks, encompassing system architecture design, orchestration strategies, comparative evaluation against single-agent baselines, and user trust assessment.

2 Problem Statement

Current CLM systems face critical challenges: scalability limitations in complex workflows, insufficient explainability leading to low enterprise trust, and inadequate handling of compliance and regulatory constraints across industries and jurisdictions.

Research gaps include: no established frameworks for multi-agent orchestration in enterprise CLM workflows, limited empirical evaluation comparing single-agent versus multi-agent approaches, insufficient attention to compliance-aware AI system design, and lack of standardized evaluation methodologies for trust and explainability assessment.

Core Research Problem: How can multi-agent systems be designed and evaluated to improve efficiency, accuracy, and trust in contract lifecycle processes?

This encompasses three key dimensions: (1) Design Challenge - developing appropriate MAS architectures for CLM workflows, (2) Coordination Challenge - establishing effective orchestration and collaboration strategies, and (3) Evaluation Challenge - creating comprehensive assessment frameworks for performance, compliance, and user trust.

3 Research Questions

Primary Research Question: How can multi-agent systems be designed and evaluated to improve efficiency, accuracy, and trust in contract lifecycle management processes?

Secondary Research Questions:

RQ1: System Design - How can multi-agent systems be architected for CLM tasks such as clause extraction, drafting assistance, and compliance monitoring? This explores agent specialization strategies, communication protocols, system scalability, and enterprise integration.

RQ2: Coordination and Orchestration - What orchestration and collaboration strategies enable efficiency and explainability in multi-agent CLM systems? This addresses task decomposition, conflict resolution, explainability frameworks, and performance optimization.

RQ3: Comparative Evaluation - How does a multi-agent approach compare to a single-agent baseline on performance, compliance adherence, and user trust? This establishes empirical evidence through systematic comparison across accuracy, compliance rates, user trust, and system reliability.

Research Hypotheses:

- H1: Multi-agent systems will demonstrate superior task specialization and modularity compared to single-agent approaches
- H2: MAS-based CLM systems will provide enhanced explainability through distributed reasoning
- H3: Multi-agent approaches will achieve higher compliance adherence rates
- H4: Users will demonstrate higher trust in MAS-based CLM systems

4 Methodology

Literature Review: Comprehensive review covering multi-agent orchestration frameworks, AI applications in legal technology and contract management, and compliance-aware explainable AI frameworks.

Prototype Development: Functional MAS-based CLM prototype implementing specialized agents for different CLM tasks (drafting, analysis, compliance), centralized orchestration mechanisms, communication protocols, and enterprise integration interfaces. Core functionality includes drafting assistance, clause classification, compliance checks, and explainability features.

Evaluation Framework: Multi-dimensional assessment including quantitative metrics (task completion time, accuracy metrics, compliance adherence, system performance) and qualitative metrics (explainability evaluation, usability studies, trust assessment, acceptance measurement).

Comparative Analysis: Systematic comparison between single-agent and multi-agent approaches using traditional rule-based CLM systems, single-agent LLM approaches, and hybrid systems across standard contract types, varying complexity levels, and different user expertise patterns.

User Study Validation: Industry professional study with contract managers, legal professionals, and IT professionals using task-based evaluation scenarios, think-aloud protocols, post-task questionnaires, and comparative preference studies.

Data Collection and Analysis: Collection from system performance logs, user interactions, expert interviews, and benchmark datasets. Analysis using statistical methods for quantitative metrics, qualitative content analysis for user feedback, and comparative statistical tests.

5 Starting Literature

Multi-Agent Systems in Enterprise Applications: Wooldridge (2009) provides MAS design principles, Jennings et al. (2014) explore coordination mechanisms, and Stone and Veloso (2000) offer insights on task decomposition and agent specialization for enterprise workflows.

AI in Legal Technology and Contract Management: Katz et al. (2017) present NLP for legal document analysis, Chalkidis et al. (2019) demonstrate ML approaches to contract classification, and Hendrycks et al. (2021) explore AI safety and reliability challenges in legal contexts.

Compliance-Aware AI Systems: Arrieta et al. (2020) provide comprehensive explainable AI surveys, Barocas et al. (2019) examine fairness and accountability in automated decision-making, and Raji et al. (2020) offer algorithmic auditing frameworks for regulated environments.

Trust and Explainability in Enterprise AI: Bussone et al. (2015) investigate trust factors in automated systems, Miller (2019) provides explainable AI theoretical foundations, and Liao et al. (2020) examine user acceptance in enterprise contexts.

Research Gaps: Limited research exists on multi-agent orchestration for enterprise contract management workflows, comparative evaluation of single-agent versus multi-agent approaches in legal technology, compliance-aware design patterns for MAS in regulated environments, and user trust assessment methodologies for multi-agent AI systems.

6 Schedule

Phase 1: Literature Review and Problem Framing (October - November 2024) Comprehensive literature review on multi-agent systems in enterprise contexts, analysis of existing CLM systems, review of compliance-aware AI frameworks, refinement of research questions, and initial system architecture design.

Phase 2: Methodology Development and System Design (December 2024 - January 2025) Detailed MAS architecture design for CLM workflows, specification of agent roles and communication protocols, development of evaluation framework, design of user study protocols, and technology stack selection.

Phase 3: Implementation and Data Collection (February - March 2025) Prototype development and implementation, baseline system implementation, experimental data collection, user study execution with industry professionals, and initial data analysis.

Phase 4: Analysis and Evaluation (April - May 2025) Comprehensive data analysis and statistical evaluation, comparative analysis between MAS and baseline approaches, user trust and acceptance assessment, compliance adherence evaluation, and results interpretation.

Phase 5: Writing and Finalization (June - July 2025) Thesis writing and documentation, results presentation and discussion, contribution analysis, thesis review and finalization, and preparation for thesis defense.

Key Milestones:

- October 31, 2024: Literature review completion
- December 15, 2024: System architecture specification
- February 28, 2025: Prototype implementation
- April 30, 2025: Data collection completion
- June 30, 2025: Final thesis submission

7 Expected Contributions

Scientific Contributions:

- Framework for MAS design in regulated enterprise workflows with agent specialization strategies, orchestration patterns, integration methodologies, and compliance design principles
- Comparative empirical results providing performance benchmarks, statistical analysis, scenario identification, and evidence-based guidelines for system architecture decisions
- Novel evaluation methodology for compliance-aware AI systems including regulatory compliance metrics, explainability frameworks, user trust measurement techniques, and validation protocols

Practical Contributions:

- Architecture guidance for CLM platform development with proven coordination strategies, tested explainability mechanisms, scalability patterns, and integration best practices
- Prototype foundation for MVP development offering validated architecture patterns, tested user interfaces, proven performance characteristics, and demonstrated compliance capabilities
- Industry best practices for implementing MAS in enterprise environments, balancing complexity with user trust, designing compliance-aware systems, and evaluating enterprise AI effectiveness

Research Impact: Academic contributions to multi-agent systems, enterprise AI, human-computer interaction, and legal technology domains. Industry impact on CLM software vendors, enterprise organizations, regulatory bodies, and AI system developers through architecture guidance, improved capabilities, compliance frameworks, and implementation best practices.

8 Proposed Titles

Primary Title: Design and Evaluation of Multi-Agentic AI Systems for Contract Lifecycle Management in B2B SaaS Platforms

Alternative Titles:

- Multi-Agent Orchestration for Enterprise Contract Management: Design Patterns and Performance Evaluation
- Compliance-Aware Multi-Agent Systems for Contract Lifecycle Management: Architecture and Trust Evaluation
- Multi-Agent versus Single-Agent Approaches in Contract Management: A Comparative Study of Performance and User Trust
- Explainable Multi-Agent Systems for Contract Lifecycle Management: Design, Implementation, and User Acceptance

Title Selection Criteria: The primary title was selected for comprehensiveness (covers design, evaluation, multi-agent systems, contract management, B2B SaaS), clarity in communicating research focus, academic appropriateness following standard conventions, industry relevance using familiar terminology, and uniqueness distinguishing this work from existing research.

German Translation: Design und Evaluierung von Multi-Agenten KI-Systemen für Contract Lifecycle Management in B2B SaaS Plattformen