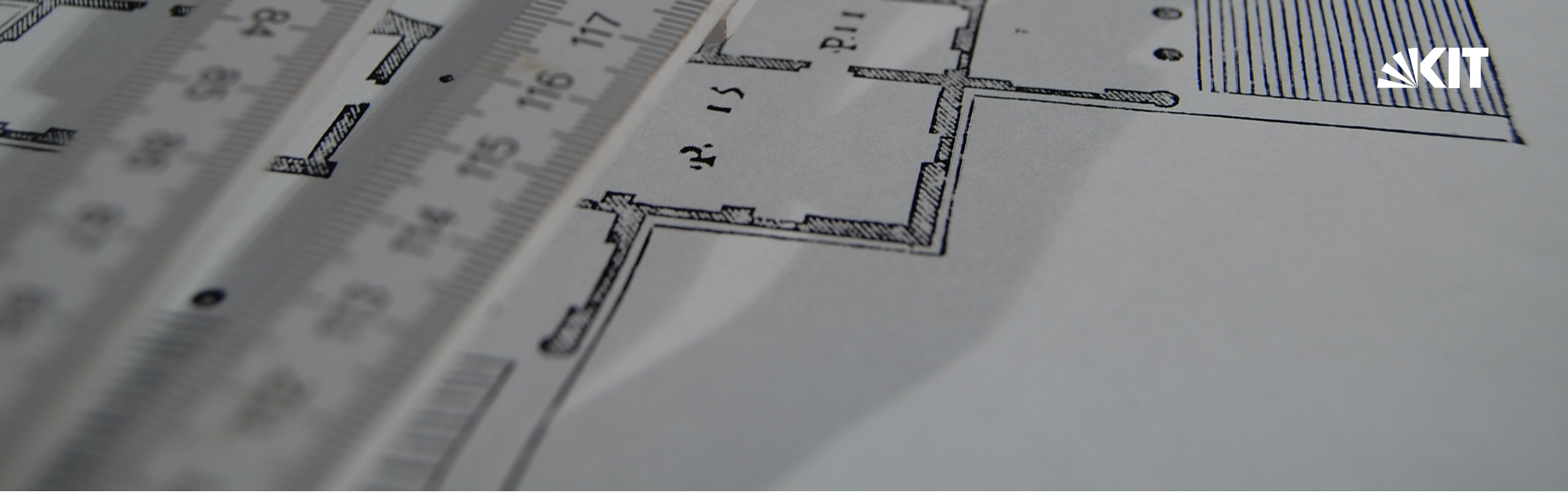


Automated Prompt Engineering for Traceability Link Recovery

Bachelor's Thesis Proposal Presentation

Institute of Information Security and Dependability (KASTEL), Prof. Anne Koziolek
Modelling for Continuous Software Engineering (MCSE), Supervisor: M.Sc. Dominik Fuchß

Daniel Schwab | 23. June 2025

PIBA

- **Problem**: Traceability Link Recovery with LiSSA does not perform well enough in larger RE2RE projects
- **Idea**: Improve recovery using automatically optimized prompts
- **Benefit**: Less manual labor required to find suitable prompts and increased recovery rates
- **Actions**: Implement automatic prompt engineering algorithm into the LiSSA framework and evaluate performance

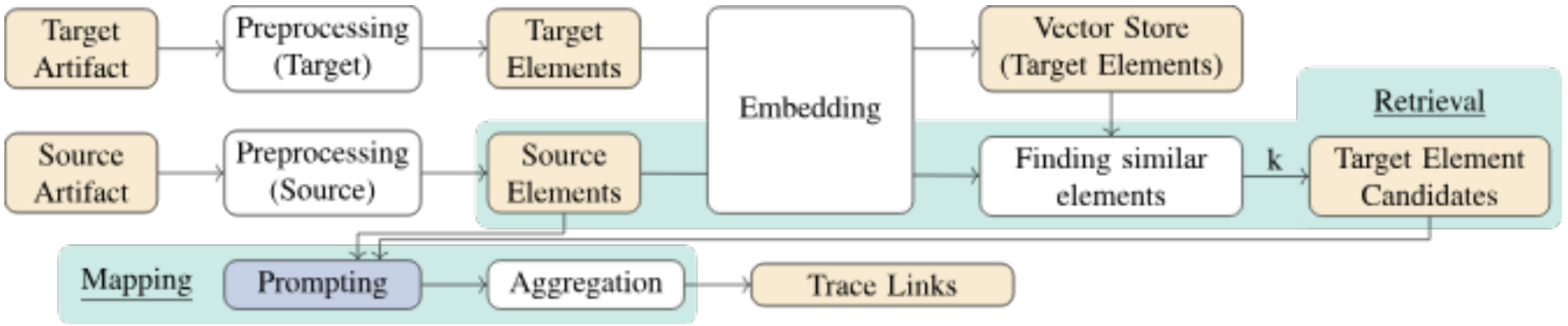
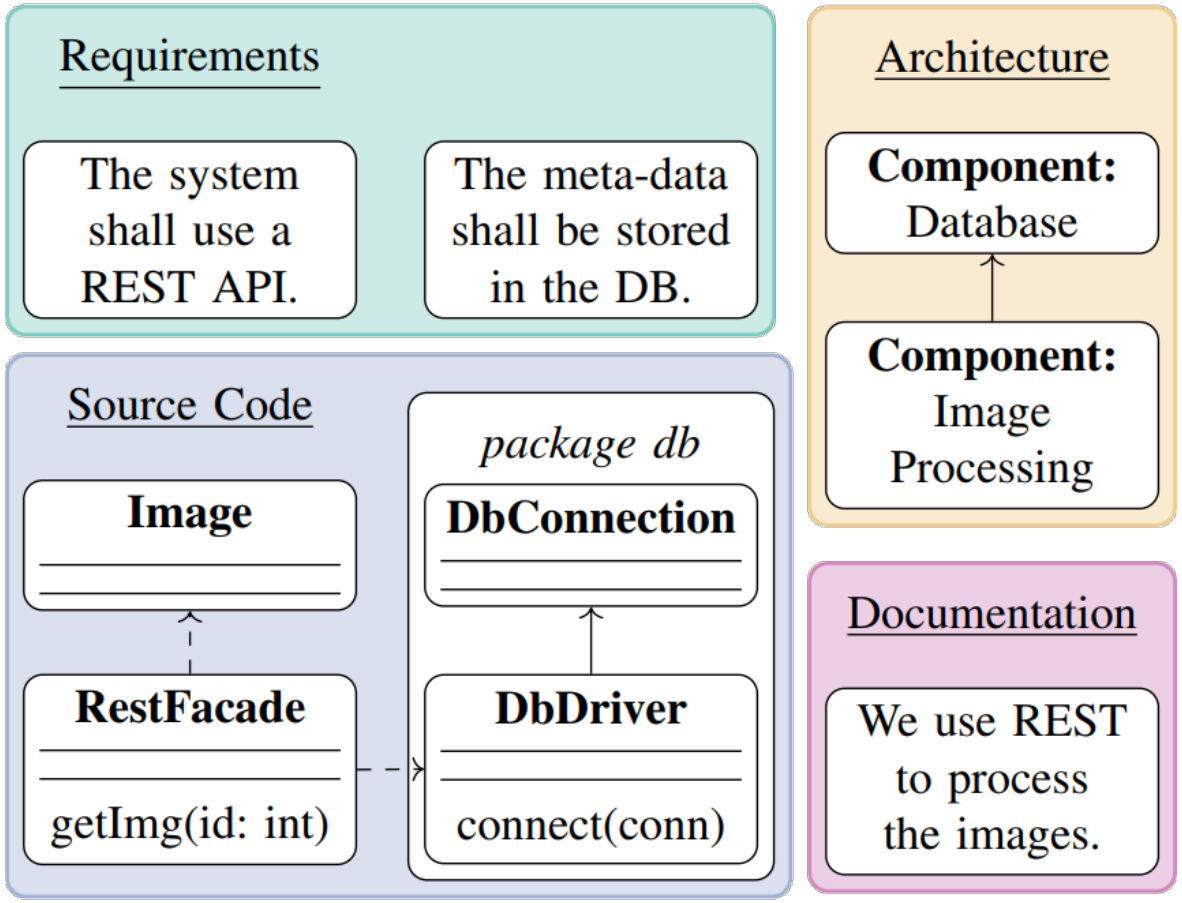


Figure: LiSSA pipeline by Fuchß et al. 2025

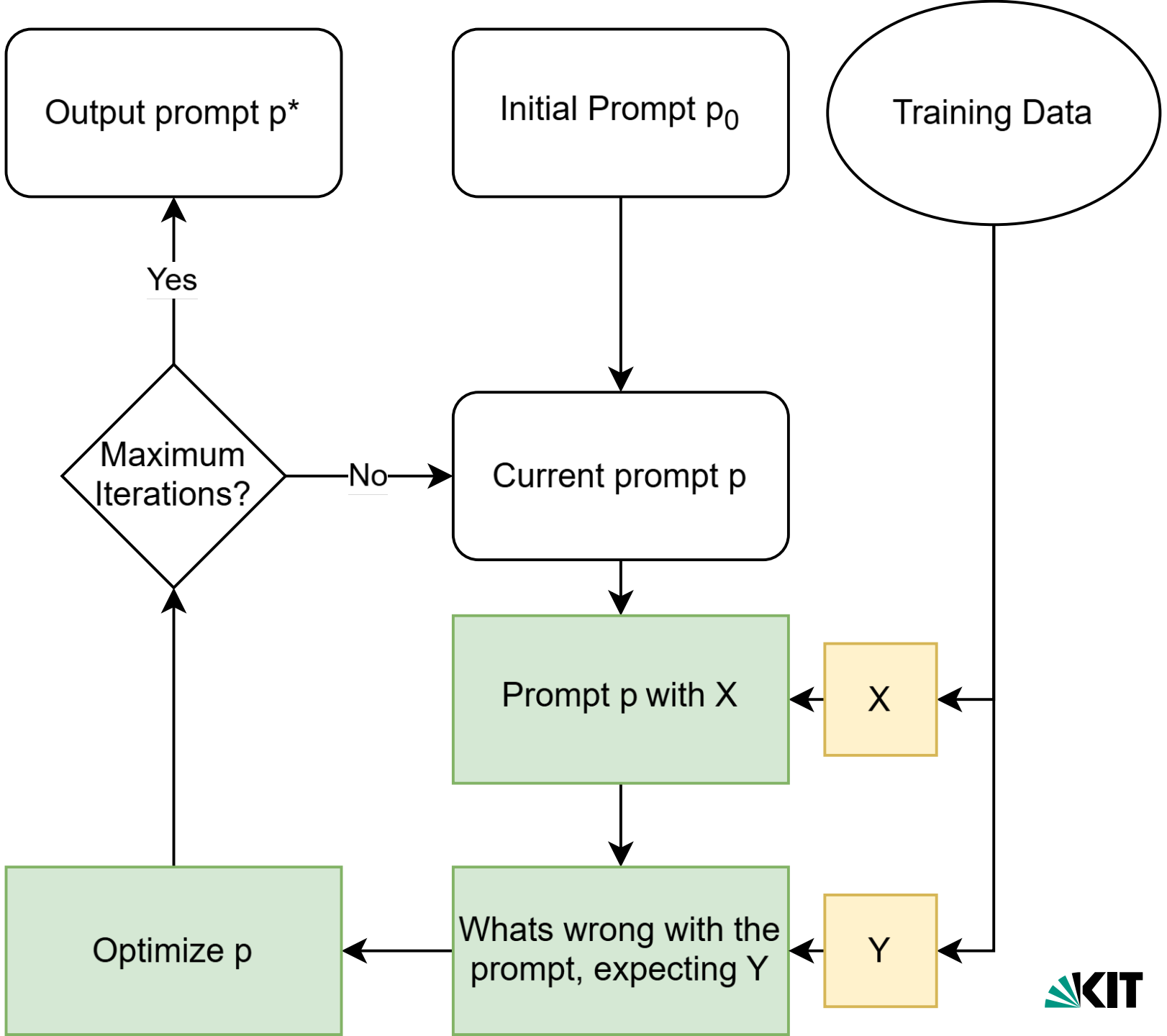
What is Traceability Link Recovery (TLR)

- Many artifacts are created during software development
- Often, inconsistencies will be present, such as naming
- Goal: Link elements across multiple domains or versions to ensure consistency and validation
- Image: Overview of possible artifacts for TLR by Fuchß et al. 2025

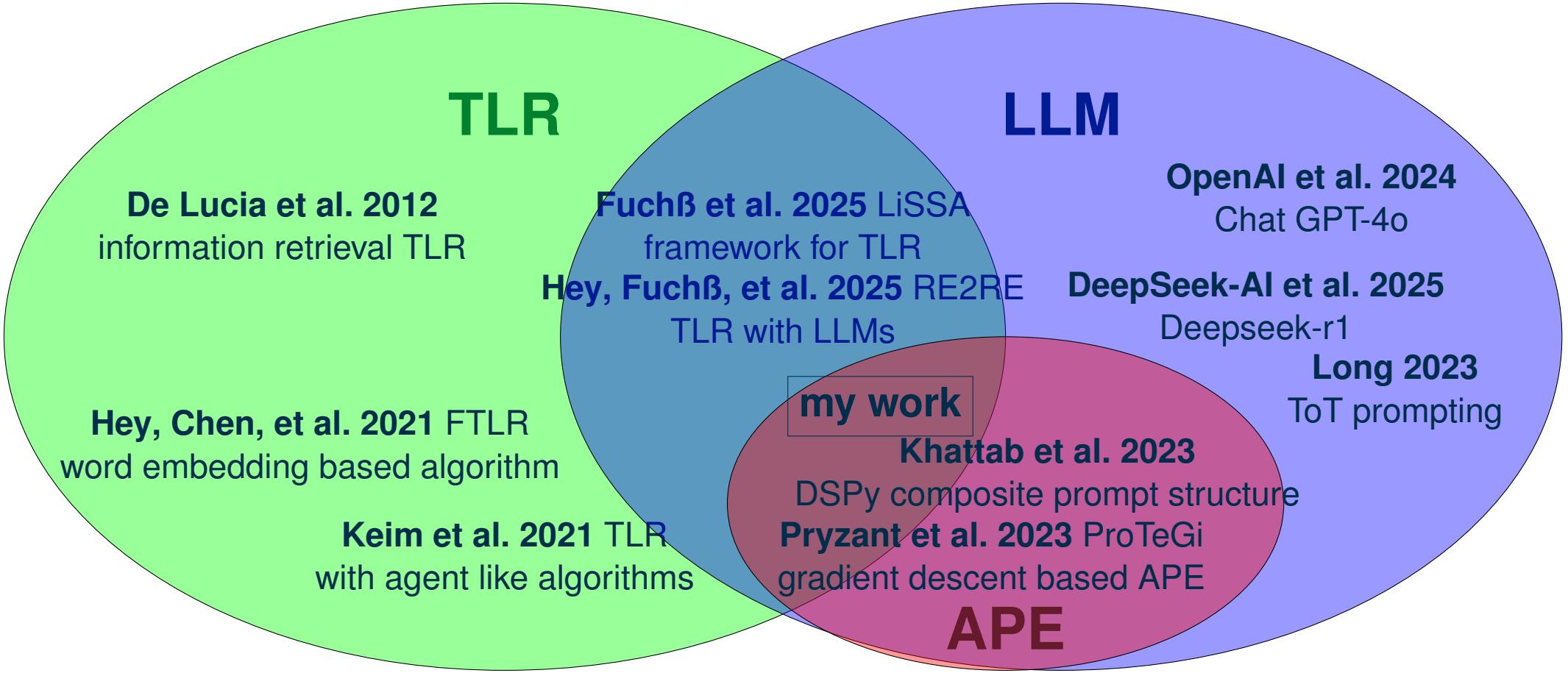


What is Automated Prompt Engineering

- Use the LLM to refine prompts instead of manually formulating them
- Improve initial prompt by training with a subset of the actual data
- Optimization prompt to fix previous shortcomings

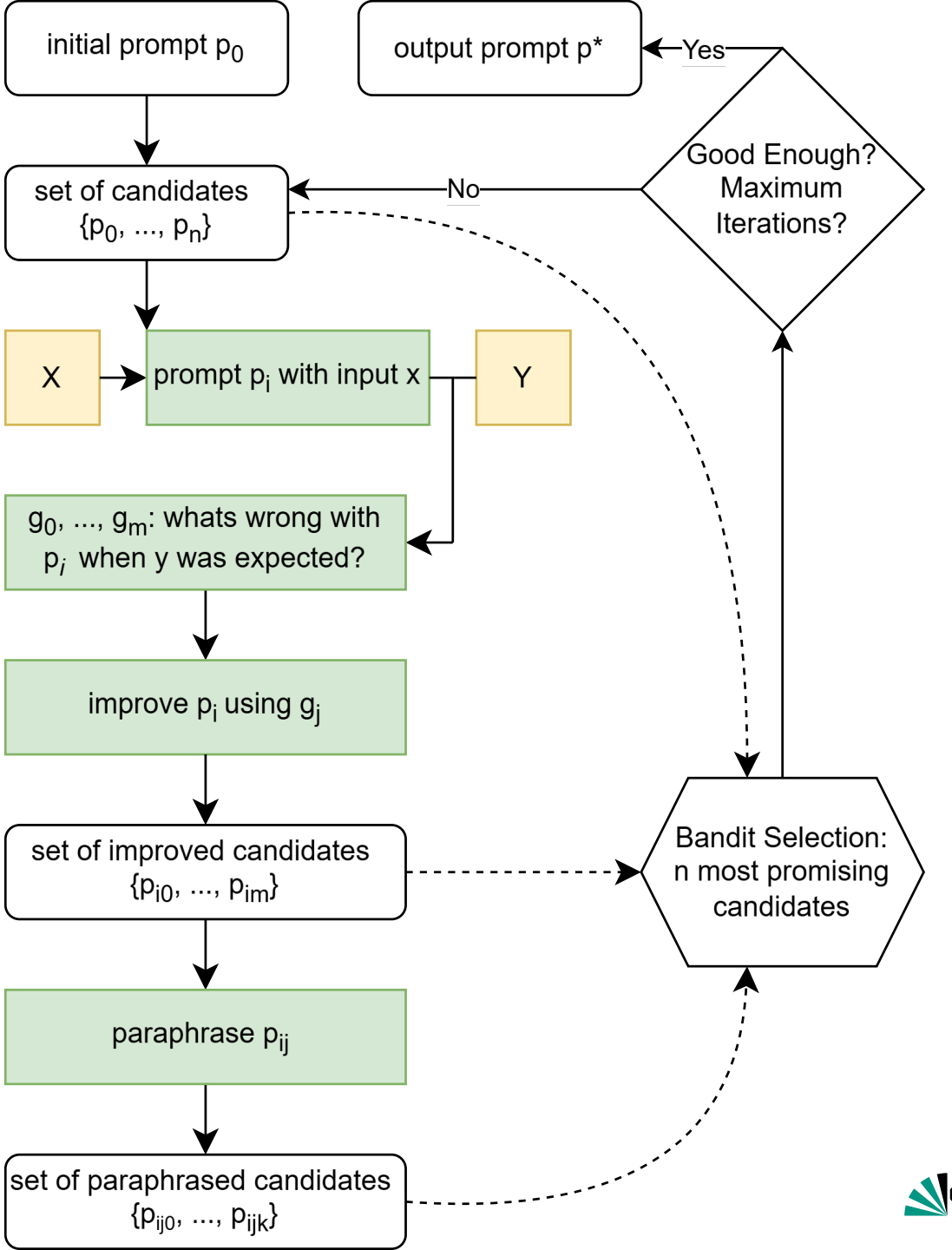


Related Work



Automated Prompt Engineering with Gradient Descent

- Improved APE algorithm by Pryzant et al. 2023
- Generate many new prompt candidates on each layer
- Steer them against the error direction using gradients
- Select the most promising candidates cheaply using a well-studied multiple-armed bandit algorithm



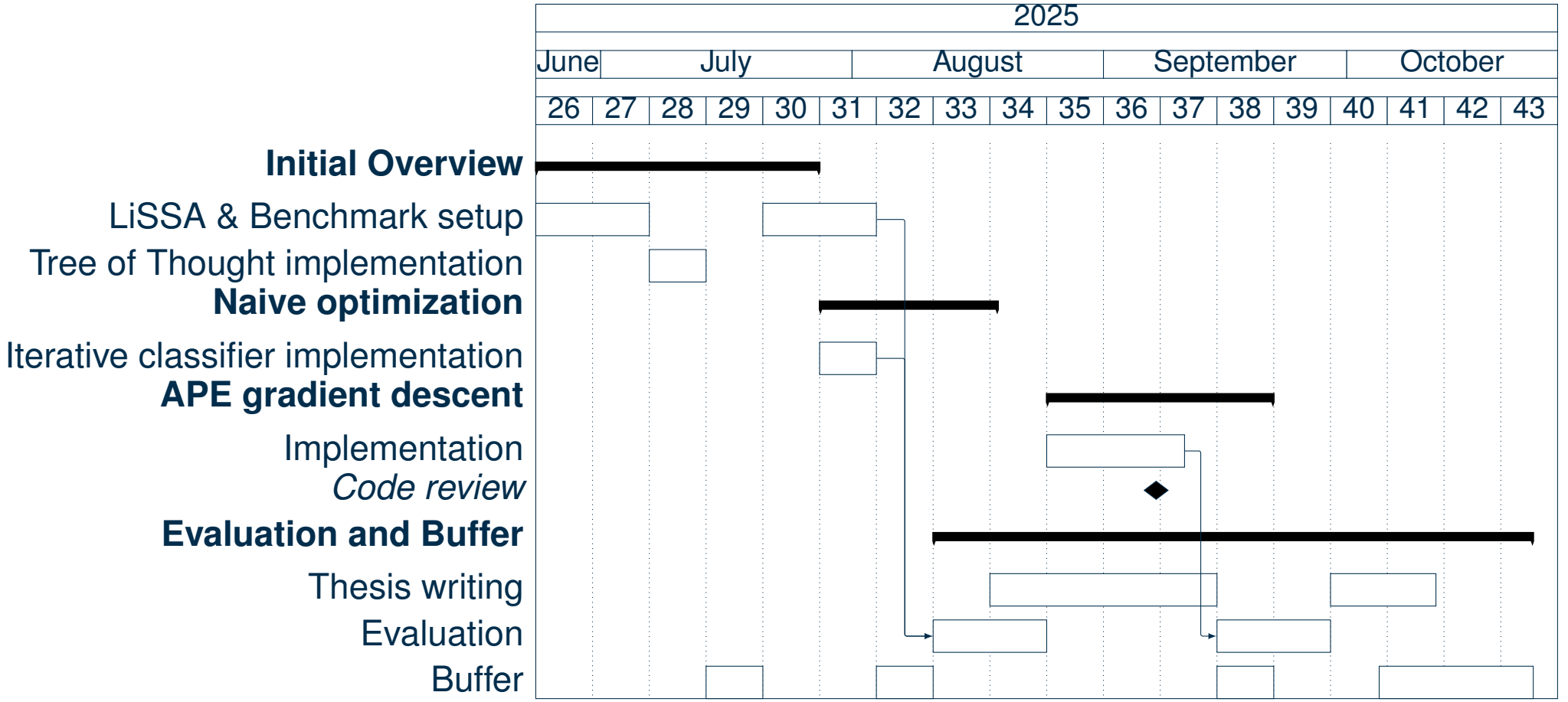
Evaluation

- Compare performance (precision, recall, F1-score, F2-score) against current manually designed zero-shot and chain-of-thought prompt
- Apply variations of different initial prompts and different LLMs to the optimization problem and compare outputs

Dataset	Metric	IR only	KISS GPT-4o	CoT GPT-4o
CCHIT	P.	.198	.234	.367
	R.	.157	.157	.138
	F1	.175	.188	.200
	F2	.164	.168	.158
Dronology	P.	.386	.394	.512
	R.	.695	.695	.655
	F1	.497	.503	.575
	F2	.600	.603	.620
Average including datasets that are omitted in this table	P.	.329	.340	.497
	R.	.500	.500	.458
	F1	.387	.401	.451
	F2	.445	.452	.452

Table: Reduced results by Hey, Fuchß, et al. 2025, Table 2

Thesis Schedule



Acronyms

- TLR: Traceability Link Recovery
- LLM: Large Language Model
- APE: Automatic Prompt Engineering
- RE2RE: Requirements-to-Requirements
- FTLR: Fine-grained Traceability Link Recovery
- LiSSA: Linking Software System Artifacts
- DSPy: Declarative Self-improving Python
- ProTeGi: Prompt Optimization with Textual Gradients
- ToT: Tree-of-Thought
- IR: information retrieval
- KISS: keep it short and simple
- CoT: Chain-of-Thought

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