LLMs for Requirements and Software Design

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Requirements Engineering

- Requirement Engineering is the process of defining, documenting, and maintaining the requirements.

- Classification
  - *Functional Requirements*: what the system should do?
  - *Non-Functional Requirements*: how the system should behave?

Software Design

- Software design is the process of modeling how a software system will work

- It has two main phases
  - *Software Architecture*: defines the high-level system structure (e.g., components)
  - *Detailed Design*: defines the low-level details, such as classes and data structures

SLR on LLMs for SE

Large Language Models for Software Engineering: A Systematic Literature Review

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Large Language Models (LLMs) have significantly impacted numerous domains, including Software Engineering (SE). Many recent publications have explored LLMs applied to various SE tasks. Nevertheless, a comprehensive understanding of the application, effects, and possible limitations of LLMs on SE is still in its early stages. To bridge this gap, we conducted a Systematic Literature Review (SLR) on LLM4SE, with a particular focus on understanding how LLMs can be exploited to optimize processes and outcomes. We selected and analyzed 395 research articles from January 2017 to January 2024 to answer four key Research Questions (RQs). In RQ1, we categorize different LLMs that have been employed in SE tasks, characterizing their distinctive features and uses. In RQ2, we analyze the methods used in data collection, pre-processing,

LLMs for Software Engineering

- Number of studies for each SE activity
  - Software development (247)
  - Software maintenance (99)
  - Software quality assurance (66)
  - **Requirements engineering (17)**
  - **Software design (4)**
  - Software management (3)

X. Hou *et al*. "**Large Language Models for Software Engineering: A Systematic Literature Review**". TOSEM, 2024.

Requirements and Design Taks

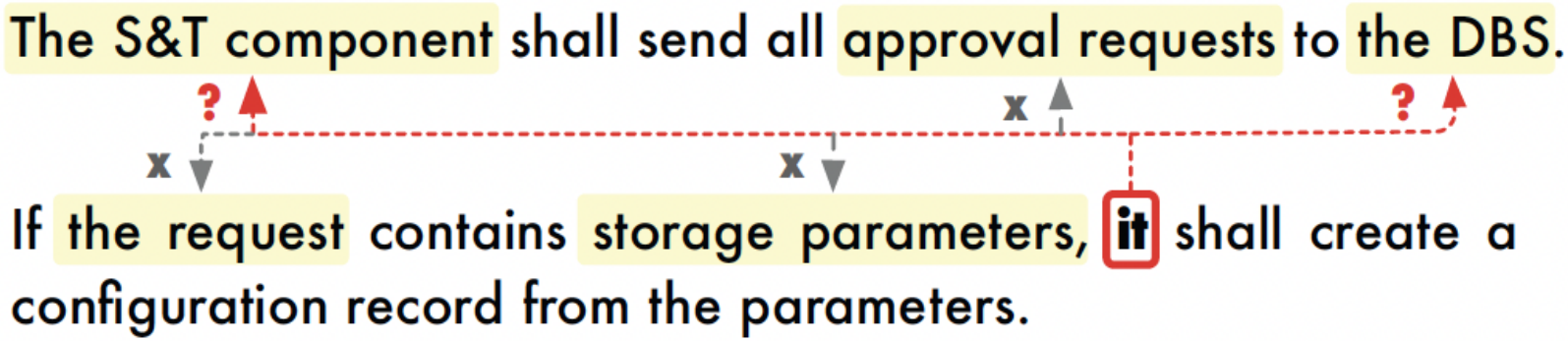
SE activity	SE task		Total
Requirements engineering	Anaphoric ambiguity treatment (4) Requirements analysis and evaluation (2) Coreference detection (1) Specification formalization (1) Use cases generation (1)	Requirements classification (4) Specification generation (2) Requirements elicitation (1) Traceability automation (1)	17
Software design	GUI retrieval (1) Software specification synthesis (1)	Rapid prototyping (1) System design (1)	4

- We lack studies about
  - User stories generation
  - Software architecture evaluation
  - etc.

X. Hou *et al*. "**Large Language Models for Software Engineering: A Systematic Literature Review**". TOSEM, 2024.

Ambiguity Example

- Ambiguity means different readers have varying understandings of the requirement
  - In the example below, the pronoun “it” can refer to two different entities



“S&T” and “DBS” stand for “Surveillance and Tracking” and “Database Server”, respectively.

Anaphoric Ambiguity Treatment

- Ambiguity is a common challenge in software requirements
- Ezzini *et al*. analyzed about 1,350 software requirements
  - **Results**: LLMs achieved an average precision of about 60% and a recall of 100%

S. Ezzini et al. "**Automated Handling of Anaphoric Ambiguity in Requirements: a Multi-Solution Study**". ICSE, 2022.

Requirements Classification

- LLMs have been used to classify Functional and Non-Functional requirements

- Luo *et al*. proposed a prompting approach for requirement classification
  - **Results**: the approach achieved F1-score of 53.27% and 72.96% in two datasets

X. Luo et al. "**Prcbert: Prompt Learning for Requirement Classification using BERT-based Pretrained Language Models**". ASE, 2022.

Specification Generation

- Program specifications are crucial for requirement analysis and testing
- Ma *et al*. proposes the use of LLMs for program specification generation
  - **Results**: SpecGen generated verifiable specifications for 279 out of 385 programs

L. Ma et al. "**SpecGen: Automated Generation of Formal Program Specifications via Large Language Models**". ICSE, 2025.

GUI Retrieval

- Rapid GUI prototyping is an early-stage software design activity
  - Creating GUI prototypes is expensive, time-consuming and requires experience
- Kolthoff *et al.* proposes a BERT-based approach to create GUI for mobile apps

K. Kolthoff et al. "**Data-driven Prototyping via Natural-Language-based GUI Retrieval**". ASE Journal, 2023.

Bibliography

- X. Hou *et al*. **Large Language Models for Software Engineering: A Systematic Literature Review**. TOSEM, 2024.
  - Section 6.2: How Are LLMs Used in RE?
  - Section 6.3: How Are LLMs Used in Software Design?