

Specializing Large-Language Models for Collaboration in Software Engineering

Domain and scientific/technical context:

The reliable application of LLM-based agents to software engineering requires a tremendous increase in their accuracy and minimisation of their bias. While LLMs continue increasing in size and performance, it seems that phenomena like hallucinations of a single agent are substantially inevitable, since they are linked to the fundamental inference mechanism in generative models. On the other hand, evidence starts accumulating about the possibility of achieving the required performance by collaboration and debate among groups of agents.

As it happens among humans, quality of work increases with specialisation of workers on tasks, organised collaboration, and discussion among workers with different backgrounds. Differently from humans, the instantiation of multiple required AI agents, and the collaboration and discussion among them, are very fast and cheap, making this approach particularly convenient.

The MOSAICO EU project¹ proposes the theoretical and technical framework to implement this approach and to scale it to very large groups of collaborating agents, i.e. AI-agent communities. The project gathers world-leading experts on tool-assisted software engineering: European academic teams, well-known tool providers (Qodo, Eclipse), and industrial users (Collins Aerospace, Immersion, Unparallel, NBG).

Scientific/technical challenges:

In this context, the PhD student will define an LLM-based agent (**Collaboration Agent**) that deals with the decomposition of a software engineering task in subtasks, assignment of subtasks to other kinds of agents, and orchestration of their work. For instance, a collaboration agent will identify test-set minimization as a subtask of an automated testing task, assign it to an appropriate agent, and connect its input/outputs to other subtasks.

The Collaboration Agents will also monitor ongoing collaborations. They will be able to detect problems and inefficiencies in the collaboration patterns, such as long arguments among pairs of agents, or frequent iterations of the same communication. In such cases the orchestrator will propose updated or alternative patterns to the orchestration framework.

Considered methods and targeted results:

The PhD student will first propose a standardised language to express collaboration patterns for software engineering tasks. The language will be tailored from existing **modelling languages for processes** (e.g., BPMN), that are already known by existing LLMs. Such LLMs will be used to automatically **extract** a dataset of such collaboration patterns from standard operating procedures, technical documents and/or research papers on multi-agent collaboration and crowdsourcing. The dataset connects models describing the pattern to textual description of the task performed through the collaboration.

¹ <https://cordis.europa.eu/project/id/101189664>

Afterwards, the PhD student will research Collaboration Agents capable of proposing a suitable collaboration pattern (in the previous language) for a given SE task. They will define an API for the Collaboration Agent, by **prompt engineering** techniques (e.g. a prompt adapter). They will research **fine-tuning** of a specific LLM with the dataset of collaboration patterns, and use this LLM as back-end for a default Collaboration Agent. The Collaboration Agents will be made aware of a software-engineering task taxonomy, by **retrieval augmented generation** (RAG) techniques.

Advisors:

The candidate will work under the co-supervision of [Pr. Massimo Tisi](#) and Dr. Theo Le Calvar (NaoMod team, IMT Atlantique - Nantes Campus).

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Profile and Skills:

The candidate must hold a master's degree or equivalent in Computer Science, with a solid background in Software Engineering. Some prior knowledge or a particular interest for AI in general, and more specifically LLMs, is also recommended. In addition, strong programming skills are highly appreciated. She/he must also have solid oral and written communication skills in English, with the aim to publish and present the PhD research results in high-level international journals and conferences. The candidate is also expected to participate in the life of the MOSAICO European project where English is the used language. For instance, she/he will participate in project meetings as well as in the elaboration of project deliverables. As a consequence, autonomous, curious and strongly motivated candidates are expected.

Conditions:

The candidate will sign a 3-year doctoral contract at IMT Atlantique. The work will mostly take place at the Nantes campus of IMT Atlantique (west of France, only 2 hours from Paris by train), with participation in some MOSAICO events (e.g., meetings in Europe). She/he will have a yearly gross salary of 30.000€, including health insurance and other social benefits provided by IMT Atlantique and the French state (for public transportation, cultural activities, etc.). The candidate is expected to start as soon as possible, though a delay could be envisioned in case of a very solid and interesting application.

Application:

Applications are expected to be received before December 31st, 2024.

The interested candidates should send the following documents to the advisors:

- A detailed CV;
- Transcripts of the obtained grades, at least for the Master degree or equivalent;
- One or more letters of recommendation or reference contacts from past academic or industrial advisors;

- Links to open source code repositories or to relevant code contributions realized by the candidate;
- Generally, any other document or piece of information that can demonstrate the ability of the candidate to pursue a PhD work.