

## Definition and Orchestration of LLM-Based Agents for Software Engineering and Modeling

### 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 project<sup>1</sup> 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:

The PhD student will formalize and implement a well-founded, LLM-specific and composable notion of AI agent for software engineering, and use it as a basis for an intelligent dynamic and scalable orchestration framework.

Major companies in generative AI are announcing their proposals for LLM-based agents, generally as APIs for defining autonomous assistants in specific chat-based tasks. The PhD student will research a notion of AI agents that is well-founded in order to connect with consensus theory, LLM-specific in order to be compatible with AI backends, and highly composable in order to scale to AI communities and crowds.

### Considered methods and targeted results:

The PhD student will produce a **runtime infrastructure** to provision (when needed) and instantiate the appropriate AI agents, and enact their collaboration efficiently.

To design MOSAICO agents, the PhD student will look at literature on well-founded frameworks for multi-agent systems. We will adapt one of the flavours of the **Belief-Desire-Intention (BDI) paradigm** to LLM-based agents, so as to represent mental states of AI agents translated into a set of variables enabling AI agent decisions in a collaborative way. This adaptation will require developing new techniques in **Prompt Engineering (PE)**. Agents in the MOSAICO repository will be associated with prompts and PE will be used to automatically rewrite such prompts into

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

conversation patterns that can reliably drive AI agents towards the desired behaviour in the specific case.

### **Advisors:**

The candidate will work under the co-supervision of [Pr. Massimo Tisi](#) and [Dr. Hugo Bruneliere](#) (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. They 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). They will have a yearly gross salary of 30.000€ (augmenting each year), 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 share the following documents with 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 and/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.