

# Software Lab:

## LLM-based Automated Compliance Checking

### Description

Compliance checking of building designs against all relevant codes and standards has been an active research area for the past 50 years but remains unresolved. The difficulty stems from the complexity of the task and its various components. According to Eastman et al. [1], the first step is to interpret the building regulations and convert them into a machine-readable format, a challenge due to the intricacy of legal texts, domain knowledge, and subjective requirements. Next, building design information must be extracted and enriched with the data needed for compliance checks. The reasoning process then involves aligning regulatory terminology with the design data and performing checks—ranging from basic existential or quantitative tests to more complex calculations, simulations, or qualitative evaluations. Finally, the results must be documented alongside all relevant building elements and their properties.

Recently, Large Language Models (LLMs) have attracted considerable attention for their ability to tackle complex reasoning tasks, offering new potential for compliance checking. Ying and Sacks [2] demonstrated that LLMs can conduct simple compliance checks by ingesting building regulations in natural language; the LLM then calls a set of predefined functions to retrieve the necessary design information and execute the checks. Although effective, this approach was limited by the scope of those functions and was tested on relatively simple regulations. Meanwhile, Du et al. [3] introduced a more advanced multi-agent framework—with specialized agents for different tasks—capable of generating sophisticated building designs. By combining these approaches with other state-of-the-art methods, this project aims to handle more complex regulations that require inferred properties and topological relationships among building elements, moving compliance checking closer to a robust, fully automated solution.

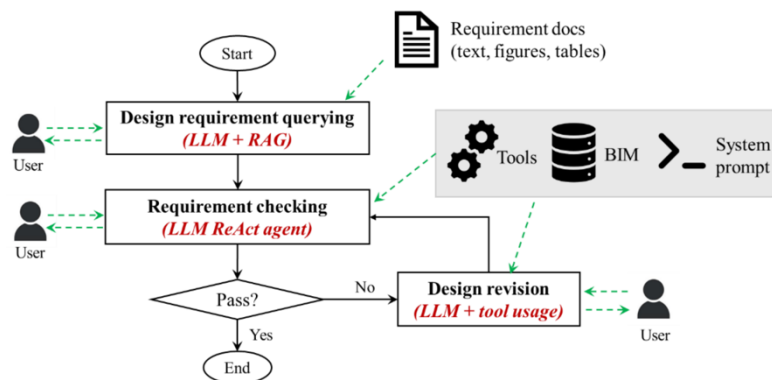


Figure 1. Agent-based ACC system by Ying and Sacks [2]

### Task

Implement an (agent-based) LLM system capable of performing Automated Compliance Checking:

- Perform a literature review to identify state-of-the-art LLM-based methods that address a similar research challenge.
- Create a dataset of IFC models with building elements that are compliant and not compliant with a range of regulatory requirements of different complexity
- Implement an (agent-based) LLM system (see DSPy) capable of parsing the regulatory requirements, extracting

the relevant information from the IFC model (using IfcOpenShell), and reasoning about the compliance of the building design with the regulatory requirements.

- Evaluate the system's ability to construct complex compliance-checking functions by combining or nesting simpler, atomic functions.

## Supervisor

Stefan Fuchs and Jiabin Wu, Chair of Computational Modeling and Simulation, stefan.m.fuchs@tum.de, j.wu@tum.de

## References

- [1] Eastman, C., Lee, J. min, Jeong, Y. suk, & Lee, J. kook. (2009). Automatic rule-based checking of building designs. *Automation in Construction*, 18(8), 1011–1033. <https://doi.org/10.1016/j.autcon.2009.07.002>
- [2] Du, Changyu, Sebastian Esser, Stavros Nousias, and André Borrmann. 2024. "Text2BIM: Generating Building Models Using a Large Language Model-Based Multi-Agent Framework." *ArXiv [Cs.AI]*. arXiv. <http://arxiv.org/abs/2408.08054>.
- [3] Ying, Huaquan, and Rafael Sacks. 2024. "From Automatic to Autonomous: A Large Language Model-Driven Approach for Generic Building Compliance Checking." In *Proceedings of the 41st International Conference of CIB W78, Marrakech, Morocco, 2-3 October, ISSN: 2706-6568*. <http://itc.scix.net/paper/w78-2024-59>.
- [4] Yang, F., & Zhang, J. (2024). Prompt-based automation of building code information transformation for compliance checking. *Automation in Construction*, 168(PA), 105817. <https://doi.org/10.1016/j.autcon.2024.105817>