Leveraging Large Language Model Agents to Mimic Human Multi-Step Decision-Making in Environmental Reviews

Introduction

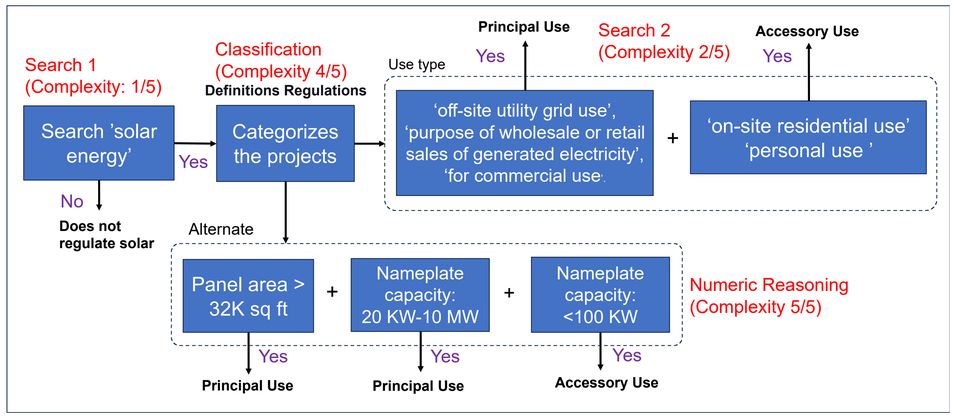
- Extract and classify complex and context specific information from zoning and ordinance documents to enhance data transparency
- Identify if a jurisdiction regulates solar energy projects for Principal and Accessory Use
- **Principal Use (PU):** Activities relevant to the dominant/primary intent of use for that parcel. e.g., a solar farm that is used to supply electricity to the grid
- **Accessory Use (AU):** Secondary and incidental. e.g., a solar panel on a rooftop to provide electricity for onsite consumption

Dataset[1]

- Zoning Database for six Great Lakes states (MI, OH, IN, IL, WI, & MN)
- Total 1856 ordinance documents from 83 counties
- 1251 with Ground Truth of which 920 within GPT-4o's context limit

Human Workflow

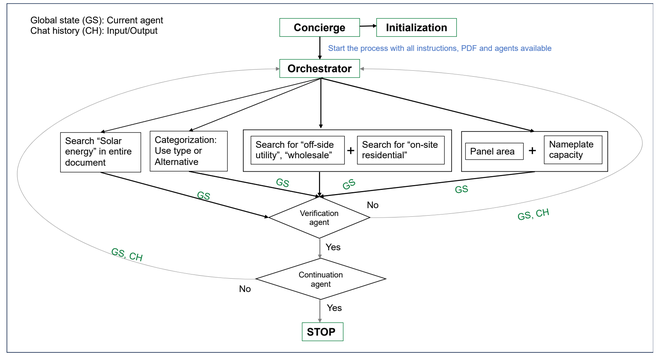
- Multi-step sequential process by human annotators to identify the regulation type



Each block denotes a decision process based on the document content and pre-defined criterions

Agentic Approach

- Emulate the human annotation process using individual LLM (GPT-4o) agents at each decision point



Multiple agents (GPT-4o) are implemented and coordinated via Llamaindex Multiagent concierge framework

Findings

Reasoning path exit	# docs	F1 (macro)		F1 (micro)	
		PU	AU	PU	AU
Search 1	627	0.49	0.49	0.99	0.97
Use type definition	196	0.74	0.69	0.92	0.85
Alternate criterion	29	0.39	0.71	0.52	0.82
Overall	852*	0.93	0.89	0.96	0.93

*68 of 920 documents processed ran out of time threshold/other errors where agents failed

Conclusion

- Demonstrated the viability of using LLM based agentic workflows for ordinance reviews with structured criteria but with flexible language interpretation
- Future work to implement hybrid expert-in-loop system with human feedback for high complexity decision points for increased performance
- Explore the performance on use cases with less class imbalance

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1: https://energyzoning.org/

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