Using Generative AI for Digital Planning
OpenCityAI: Generative AI for Smart Cities

Junfeng Jiao[1], Sean Hardesty Lewis[2], Connor Phillips[1],

[1]Department of Architecture, [2]Department of Mathematics

GOOD SYSTEMS
Ethical AI at UT Austin

The University of Texas at Austin
Research Development
Vice President for Research, Scholarship and Creative Endeavors

URBAN INFO LAB
The University of Texas at Austin

TEXAS Architecture

The University of Texas at Austin
Department of Mathematics
College of Natural Sciences

Introduction

Digital planning for cities often employs traditional approaches that fall short in adapting to urban changes. The integration of new technologies could enhance the precision and speed of planning efforts, aligning urban development more closely with communities' needs.

We propose a new domain-specific AI chatbot named "OpenCityAI", which has been comprehensively trained on urban data. OpenCityAI utilizes live-updated city data from city portals to accurately converse with cited answers for urban questions. The model supports multilingual input and responses with over thirty different languages[1], and an additional tool for visualizing cited dataset sources in real-time when an answer is given. OpenCityAI has the potential to democratize access to complex urban data by making it accessible and conversational to users, as well as assisting city planners and decision-makers in finding and analyzing relevant datasets. The primary function of this model will be a conversational user interface that allows querying and discourse, providing citizens with cited urban information.

[1] English, Arabic, Azerbaijani, Catalan, Chinese, Czech, Danish, Dutch, Esperanto, Finnish, French, German, Greek, Hebrew, Hindi, Hungarian, Indonesian, Irish, Italian, Japanese, Korean, Persian, Polish, Portuguese, Russian, Slovak, Spanish, Swedish, Turkish, Ukrainian

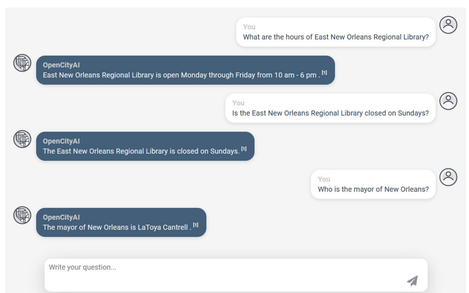

Figure 1: A sample conversation with OpenCityAI, showcasing accurate, cited replies to a few urban questions.

Research Goal

The aim of our research is to showcase training and deploying a deterministic generative AI model on city data, which we then validate and optimize for a specific use case of digital planning[1]. By utilizing live data, our generative model will be capable of automatically updating itself, making accurate predictions, and responding to questions with cited information. This will enable us to develop a robust tool for accessing and interpreting urban data in real-time, thus enhancing decision-making processes for users.

Methods

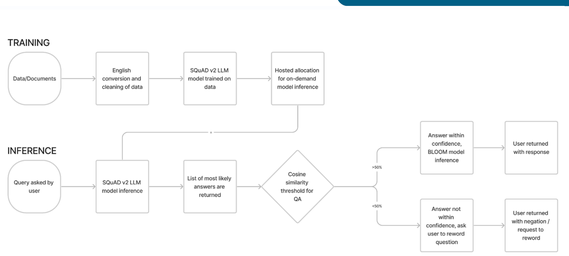

Figure 2: A diagram of the chatbot iterative training and inference workflow.

Scan to visit our website!
https://opencityai.com

Figures

To generate accurate answers, we develop a multi-layer AI model using two fine-tuned models: a BERT retrieval model trained using SQuAD2.0 and a generative BLOOM model[2][3]. The retrieval model finds the most likely answer with an accuracy based on cosine similarity in the trained datasets, which then utilizes the generative model to answer the question with the cited answer[4]. The OpenCityAI model was validated as being significantly more effective than existing AI solutions in supplying accurate, city-related data.

Figure 3: A sample conversation with OpenCityAI in Arabic, showcasing multilingual ability.

To validate the model, a sample of 1500 randomly selected urban data questions were used. These questions came from publicly available urban datasets. The authors would like to note that non-response answers indicating the model was not allowed to answer or did not have access to the data were treated as incorrect due to the public nature of the urban datasets which the questions came from.

Model	OpenCityAI	LLAMA	Gemini	GPT-4
Overall Accuracy (%)	**93%**	5%	11%	23%

Figure 4: Validation table showcasing accuracy on urban data questions between Urban Information Lab's OpenCityAI, Facebook's LLAMA, Google's Gemini, and OpenAI's GPT-4.

Results

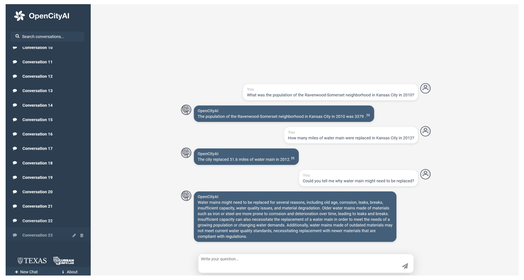

Figure 5: OpenCityAI demonstration conversation in-browser.

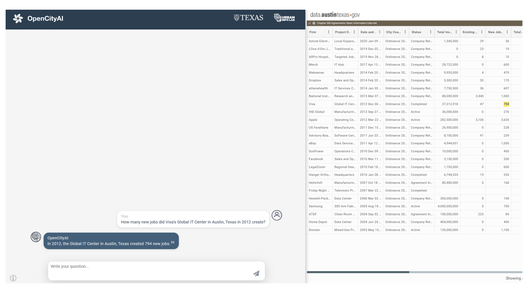

Figure 6: OpenCityAI's data visualization system in-browser.

Our study demonstrated the potential use of OpenCityAI to the digital planning process, showcasing the model's ability to serve as a reliable source of urban information. We developed a multi-layer AI model trained extensively on city portals and validated it to be significantly more effective at answering urban informatic questions than current AI solutions. We expanded the capabilities of the model, implementing daily iterative training on the latest city data, multilingual support for more than thirty languages, and a real-time visualization system for seeing datasets that are being used for the response. We reviewed the risks associated with the model such as sidelining human expertise, misinterpreting data, and potential bias in AI training due to training datasets.

Conclusion

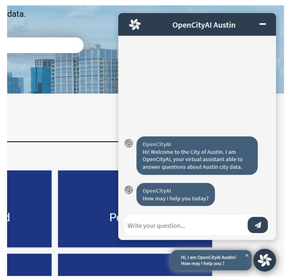

Figure 7: An example minimal chat application in-browser, showing a potential on-screen OpenCityAI assistant.

Our model represents a significant advancement in accurate, citation-based question answering for generative AI models. With OpenCityAI, it is possible to accurately obtain cited, live-updated urban information with visualization and multilingual support for city data questions. As a domain-specific conversational user interface available to the public at no cost, our model has the potential to inform individuals about current urban information and converse about various city topics. We believe that our model will prove to be an invaluable tool for digital planning, providing city planners and decision-makers with crucial and necessary information to make informed decisions.

Acknowledgments

The authors would like to express their sincere gratitude to Dr. Yanliu Lin, Dr. Stan Geertman, Dr. Patrick Witte (Human Geography and Spatial Planning, Utrecht University), and Dr. Nuno Pinto (Urban Planning and Urban Design, University of Manchester) for their support in our project. Additionally, the authors would like to acknowledge the Computers, Environments, and Urban Systems (CEUS) journal for their publication support.

References

[1] Silver, David, et al. "Deterministic Policy Gradient Algorithms." In Proceedings of the 31st International Conference on Machine Learning (ICML-14). 2014. https://proceedings.mlr.press/v32/silver14.html
[2] Rajpurkar, Pranav, Robin Jia, and Percy Liang. 2018. "Know What You Don't Know: Unanswerable Questions for SQuAD." Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics (Volume 2: Short Papers), 784–789. https://doi.org/10.18653/v1/P18-2124
[3] Goodfellow, Ian J., Jean Pouget-Abadie, Mehdi Mirza, Bing Xu, David Warde-Farley, Sherjil Ozair, Aaron Courville, and Yoshua Bengio. 2014. "Generative Adversarial Nets." In Advances in Neural Information Processing Systems 27 (NIPS 2014). https://arxiv.org/abs/1406.2661
[4] Lewis, Mike, Yinhan Liu, Naman Goyal, Marjan Ghazvininejad, Abdelrahman Mohamed, Omer Levy, Ves Stoyanov, and Luke Zettlemoyer. 2020. "BART: Denoising Sequence-to-Sequence Pre-training for Natural Language Generation, Translation, and Comprehension." arXiv preprint arXiv:1910.13461. https://arxiv.org/abs/1910.13461