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PictoAI: Increasing the Meaningfulness of Cartographic Pictograms Using Artificial Intelligence?

Jule Drews [a,*], Dennis Edler [a], Julian Keil [a], Frank Dickmann [a]

[a] *Ruhr University Bochum, Geography Department, Cartography, Bochum, Germany, Jule Drews – jule.drews@ruhr-uni-bochum.de, Dennis Edler – dennis.edler@ruhr-uni-bochum.de, Julian Keil – Julian.Keil@ruhr-uni-bochum.de, Frank Dickmann – frank.dickmann@ruhr-uni-bochum.de*

* Corresponding author

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Abstract:

The rapid advancements in artificial intelligence (AI) have significantly influenced various scientific domains, offering innovative solutions to longstanding challenges. Thematic cartography, which includes pictograms used to convey spatial data intuitively, can gain significant benefits from these technological advancements. Although graphic AI's integration into cartography is still in its early stages, as demonstrated by this study, the potential it holds is immense and transformative. This study introduces PictoAI, a new AI tool specially developed for this research to improve pictogram design in thematic cartography. Developed in two iterations (an API-based and a Custom-GPT version), PictoAI automates the creation of cartographically optimized pictograms, potentially enhancing the meaningfulness of pictograms and, accordingly, map readability.

Pictograms play a crucial role in thematic cartography, enabling the visual representation of diverse thematic data in maps. Traditionally, their design, which is fundamental for effective communication, usually depends on the expertise of graphic designers. The advent of AI in pictogram design, as exemplified by the development of PictoAI, may introduce a shift in this domain. PictoAI harnesses state-of-the-art graphic AI technologies, employing the capabilities of the DALL·E 3 model, an advanced image generation model. This tool enhances the automation of pictogram creation by interpreting textual prompts to generate visually consistent and thematically appropriate pictograms that are specifically tailored for cartographic use. An integral aspect of PictoAI's effectiveness is its prompting system, which simplifies the design process for users. By requiring only a single keyword input, PictoAI utilizes pre-set prompts that are fine-tuned to adhere to cartographic standards. These rules try to ensure high iconicity and generalization, among other critical factors, facilitating the creation of customized pictograms that maintain visual clarity and thematic relevance. This approach not only democratizes the design process but also ensures that users without deep graphic design skills can generate functional and accurate pictograms for thematic maps.

The methodology of this study focuses on comparing PictoAI-generated pictograms with established designs from OpenStreetMap (OSM), assessing enhancements in meaningfulness and thematic relevance. A comparative analysis was conducted on selected OSM pictograms, and their counterparts generated by PictoAI (figure 1). To make a suitable selection, OSM pictograms were categorized into three levels of meaningfulness, following a study conducted by Keil et al. (2018). This allowed the analysis and evaluation of complexities of pictogram interpretation.

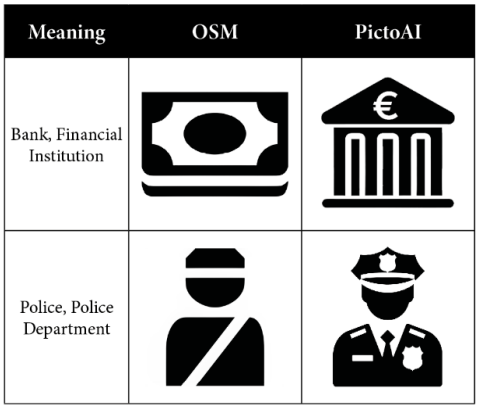

Figure 1. Examples of selected OSM-pictograms and their PictoAI counterparts.

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To test the effectiveness of the pictograms empirically, a study was conducted with 70 participants divided into two groups. One group was viewing 24 OSM pictograms, and the other group was viewing the 24 counterpart PictoAI-generated pictograms. Each participant was shown the pictograms and asked to describe what they thought the pictogram represented on a map. Their responses were then categorized as either correctly or incorrectly interpreted based on predefined criteria.

First results from this comparative analysis suggest that PictoAI-generated pictograms exhibit an improvement in interpretability over their OSM counterparts. These findings, supported by a high level of statistical significance as determined by the Pearson Chi-Square test ($p < .001$), underscore the potential of AI to elevate the design and function of pictograms in thematic cartography. This statistical validation confirms that PictoAI-generated pictograms more accurately represent their intended themes compared to traditional OSM designs.

This advancement not only has the potential to contribute to a reflection of standard practices in pictogram design but may also enhance the accessibility and utility of thematic maps. Although this research is ongoing and currently represents a work in progress, these initial results are quite promising and indicate the potential for a continued exploration of AI applications in cartography. PictoAI has already been made accessible in the GPT Store, inviting researchers and practitioners to explore this innovative tool and contribute to its ongoing development (https://chat.openai.com/g/g-1465GB5y0-pictoai).

References

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