A NOVEL LARGE LANGUAGE MODEL FOR VOXEL-BASED BRAIN FUNCTION MAPPING IN NEUROIMAGING: PROOF OF CONCEPT

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INTRODUCTION

- Functional brain imaging (fMRI) plays a crucial role in understanding the relationship between brain structure and function.
- We present a novel system that integrates a coordinate retrieval mechanism with a large language model (LLM) to automatically extract and summarize brain functions associated with specific voxel coordinates.

METHODS

- We utilized the *NeuroSynth* database, containing coordinate-based activation data from >9,700 studies.
- We utilized Retrieval Augmented Generation (RAG), employing Facebook AI Similarity Search FAISS index for efficient, voxel-based similarity searching within the *NeuroSynth* dataset.
- The retrieved data, including functions and relevant literature, is then fed into the *LLAMA 3.1* LLM (Meta AI).
- The LLM provided customizable output that includes the reported function of the coordinates, a concise explanation, and relevant references from the literature, presented in a natural language format.

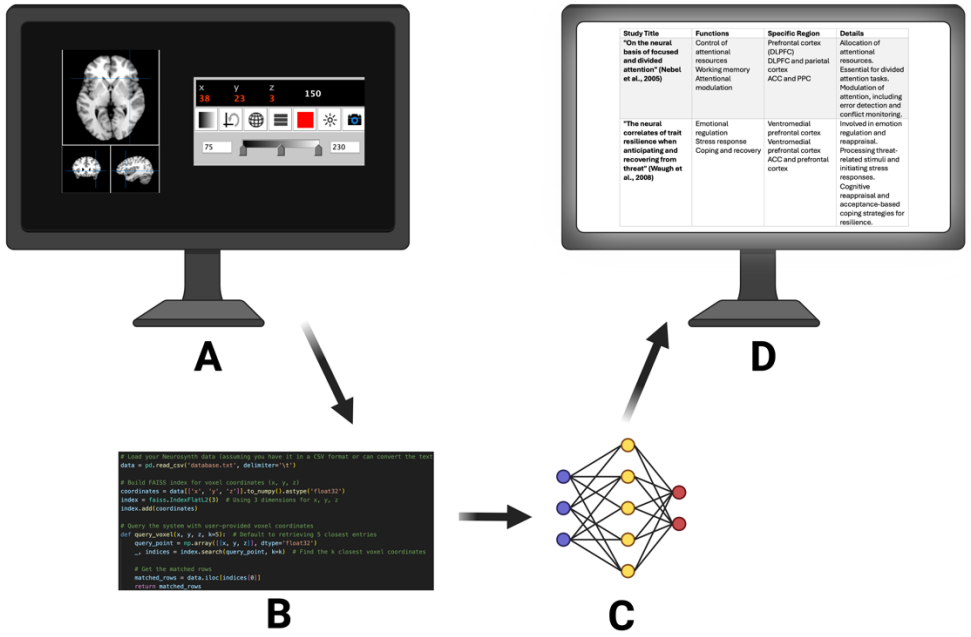


Figure 1: An example input/output to test the system

A: The user selected an area that corresponds to voxel coordinates of (38,23,3).
B: The RAG retrieved four relevant references in a query runtime of 0.0483 seconds.
C: These references were inputted to the LLM, which had a runtime of 36.7515 seconds to provide the functions and relevant references in natural language format as shown in **D**.

RESULTS

- The developed system allows radiologists to select specific brain regions via a GUI, either by inputting X,Y,Z coordinates or directly selecting the area on three-dimensional MRI brain images.
- The system was tested by selecting several ROIs and manually reviewing the articles provided by the LLM to ensure the correct coordinates were reported with their respective functions.

CONCLUSION

- Our RAG-enhancing LLM system offers a novel approach to understanding functional brain mapping in radiology.
- This tool holds great potential for improving the efficiency and accuracy of neuroimaging interpretation in various scenarios, including surgical planning, neuroscience research, and education.

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