BIM + Graph: Distill Complexity for Relationship Analysis and Semantic Enrichment

White paper Draft

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Students: James McBennett & Ren Rainville

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RESEARCH FRAMEWORK:

The research framework underpinning this thesis is predicated on the integration of architectural project work and the Building Information Modeling (BIM) process. The complexity arises from the fact that each architectural project demands distinct wall specifications between varying types of spaces and necessitates specific area plans within Autodesk Revit. The positioning of area boundary lines in Revit embodies a sophisticated matrix of spatial adjacency and relationships.

Subsequent to exporting the BIM to a graphical interface, these adjacency and relationships can be abstracted and amalgamated into a data-rich yet geometrically sparse environment. This streamlined environment facilitates the issuing of instructions to the design software to specify wall types and predict the location of area boundaries within the walls.

The long-term objective is to train a system to emulate this process and make it accessible via a web-based application. This platform would enable users to draw lines, insert text, respond to queries, and thereby provide visual output within the interface. Moreover, the resulting output file, in JSON format, would be compatible with Revit or other BIM software, with plans for plug-in integration in the future. This interface will aim to bridge the gap between user-friendly design inputs and the technical outputs required for effective building information modeling.

QUESTION / HYPOTHESIS:

This thesis examines the prevalent reliance on Building Information Modeling (BIM), with its intrinsic complexity, as the exclusive method for managing data pertaining to intricate building structures. The primary hypothesis is that the integration of Graph Theory and Machine Learning may engender enhanced workflows. Such improvement could potentially streamline the education process for those in the early stages of their architectural careers, consequently permitting a greater allocation of time to the creative aspect of design rather than the often time-consuming documentation.

Moreover, GraphML presents as a promising tool for integrating into BIM workflows, particularly with respect to Autodesk Revit. Revit is fundamentally an expansive database that incidentally produces 2D Construction Documents (which serve as instructions for building construction).

The proposed web application aims to amalgamate this graph representation visually, facilitating the user's interaction and enabling the creation of floor plans through line drawings. The research posits that this innovative approach could revolutionize the way architectural design and building data is handled, providing a more intuitive and efficient methodology.

RESEARCH METHODOLOGY / APPROACH:

Research will be conducted with practicing architects and less experienced staff to determine needs. Graph machine learning will be used to train a model that predicts room adjacencies, egress locations and wall types for a multi-family residential building Revit model.

Research Design: The research will follow an exploratory and experimental design to investigate the efficiency of initiating Revit models for multi-family residential buildings. It will involve developing a predictive tool that generates interior layouts with Revit properties and parameters based on limited user inputs. The study will include both qualitative and quantitative analysis to evaluate the tool's effectiveness and appeal to architects of varying experience levels.

Data Collection:

User Input Data: Collect data from architects regarding their current practices, challenges faced, and preferences when starting a new Revit model for multi-family residential buildings. This data will provide insights into the inputs required by the tool and customization options needed by users.

Revit Models: Gather a collection of existing Revit models for multi-family residential buildings as a reference dataset. These models will be used for training and validation of the predictive tool.

Tool Development: Develop a predictive tool using graph machine learning techniques. The tool will be trained using the collected dataset of Revit models and associated user inputs. It will be designed to generate efficient starting points for new Revit files based on limited inputs, such as site boundary, project density and an initial polyline curve. The tool should be customizable to cater to the preferences and creative practices of architects.

Tool Evaluation:

User Surveys and Interviews: Conduct surveys and interviews with architects to gather feedback on the generated Revit models using the developed tool. Evaluate the tool's appeal, ease of use, customization options, and effectiveness in generating efficient starting points.

Performance Metrics: Measure the efficiency and accuracy of the tool by comparing the generated Revit models with manually created models by experienced architects. Use metrics such as time required for model setup, adherence to Revit properties and parameters, standards, and overall user satisfaction.

Data Analysis: Analyze the collected data, both qualitative and quantitative, to assess the tool's performance, user feedback, and the alignment of generated models with the objectives. Identify patterns, trends, and areas of improvement based on the analysis.

Iterative Refinement: Incorporate user feedback and analysis results to refine the predictive tool iteratively. Address any limitations, enhance the customization options, and improve the efficiency and accuracy of the generated Revit models.

Conclusion and Recommendations:

Summarize the findings of the research, including the efficiency of the developed tool in initiating Revit models for multi-family residential buildings. Provide recommendations for further enhancements and potential applications in the field of architecture. Discuss the impact of the tool on both inexperienced and experienced architects and the potential for advancements in architectural practices.

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