AI for Custom Floor Plan Generation

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Abstract. The most important areas in architectural planning and design include floor plan optimization and prediction. The following research focuses on using machine learning for predicting and providing suggestions on multiple floor plans according to defined user parameters, which can include plot dimensions, number of floors, and number of bedrooms. We take a dataset containing the dimensions of 2D floor plans and extract meaningful features like plot area and room sizes using feature engineering and data pre-processing techniques. The proposed model makes use of Linear Regression to establish relationships between plot area, structural parameters, and room dimensions.

In furtherance of usability, an interactive system is developed to generate specific floor plans. The system offers predictions on room sizes from user inputs and applies variation techniques to achieve multiple realistic options for a floor plan. It also projects its results in a standardized format with room dimensions for easy applicability. Evaluating MSE for the model, it is exhibited that it can predict accurate room size.

The framework allows architects and planners to design preliminary floor plans on a scalable, data-driven level. It cuts down the time and effort in doing manual planning but still provides room for flexibility in customization. Future work would involve integrating more complex models and expanding datasets to further enhance prediction accuracy and accommodate a variety of architectural styles.

Keywords: Architectural Planning, Floor Plan Generation, 2D Floor Plans, Building Design Automation, Architectural Data Analysis, Floor Plan Suggestions.

1 Introduction

Fig1 represents various fields of use AI in our day to day lives which also includes the areas of architecture. This research represents a data driven approach to 2D floor plan designing using the predictive modeling structure [1]. This will also involve the marking of room and other features dimensions based on user required plot details entered.

This research will also support in classification of floor plan images as these images are used at various real-estate websites for attracting customers [2]. This also involves making a model that takes user input for making the output more customized as per the user need instead of self-generation of images without any constraints or specifications [3].

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This research focuses on proving a solution for designing 2D floor plans by suggesting the dimensions for various areas of the house hence significantly reducing the time and effort required to complete the initial steps of architectural planning.

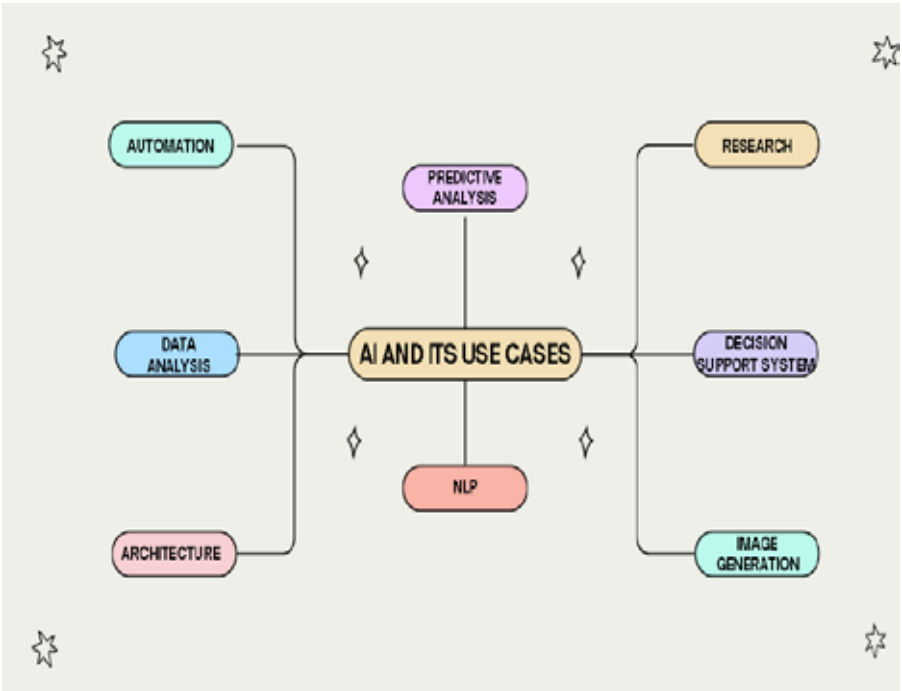

Fig. 1. Various use cases of AI in day to day lives

2 Related works

Research paper [4] focuses on a similar problem but majorly solves a problem of marking various regions on a floor plan from a CAD drawing. This has helped to get a direction for starting our research by going step by step in a hierarchical manner.

Research paper [5] focuses on extracting textual data from floor plan image this model can help in analyzing the floor plan and making the designing task easy and hence understanding the 2D model.

Research paper [6] focuses on generating a 3D model for a plan which involves uploading a 2D blueprint and then converting it to a 3D model which can help in validating the output of generated floor plans.

Research paper [7] Uses virtual and augmented reality systems for converting 2D floor plan blueprints to 3D rendered models which uses the printed images marked with different colored dots representing different sections.

Research paper [10] uses blockchain approach to land data acquisition which can help in increasing the dataset with more realistic values for model training

Research paper [11] uses latest techniques and AI models for selecting effective test cases for a program which can be used to make the algorithm handle more variety of data and testing the program for better performance.

3 Methodology

3.1 Background

Architectural designing and planning remain the base of the construction industry, with ongoing functionality and aesthetics. Thus, the method of generating floor plan is an important part of building design because it affects the usability and efficiency to build environments. Traditionally, it takes a lot of personnel attention because architects could manually design based on their experience and user needs. Many iterations are required to meet customer expectations.

The emergence of huge statistics and traits in machine learning have opened the chances to the automation and optimization of skills across exclusive domain names, consisting of architecture. Predictive modeling and feature engineering techniques can be applied to architectural planning to cope with the inefficiencies inherent in traditional design workflows. Analyzing historic records and figuring out styles the use of system mastering models can assist in generating feasible floor plans that adhere to user choices and constraints and decrease the dependence on manual iterations reducing the time spent in drawing blue prints.

Major research in this area was done using computational techniques within design automation, but the integration of machine learning for predictive modeling in floor plan generation is relatively underexplored. Recent works have showed the applicability of machine learning into urban planning, structural analysis, and interior design, among others. There is a necessity for systematic approaches that develop these advances to automate early stages of architectural design, particularly with regard to floor plans.

This paper extends on these developments by proposing a data-driven framework to predict and propose floor plans based on machine learning techniques. The framework uses historical data on the dimensions of 2D floor plans and structural attributes to create predictive models that can estimate room sizes based on plot dimensions, the number of floors, and the number of bedrooms. By closing the gap between data-driven methodologies and architectural design practices, this study is an attempt to prove how machine learning can streamline the initial stages of floor plan creation, thus making it more efficient and accessible.

3.2 Research Problem

This paper is developed primarily around a machine learning-based system to produce floor plans. Traditionally, designing 2D floor plans is manual and iterative and dependent on the architect and planner. Though this does provide the designer with the option to create freely and with full personalization, it is a very time-consuming and resource-heavy process, particularly at the design inception.

It proposes to utilize massive datasets along with machine learning approaches to generate an automated process of floor planning. The data-driven framework aims at predicting the dimension of rooms according to input variables like plot size, number of floors, and the number of bedrooms. This approach is considered to function like a suggestion system, thus giving multiple feasible layouts of the floor plan to fulfill specific requirements for users.

The main problems this study intends to address include:

• The requirement of a uniform approach to process and analyze various floor plan data.

• Development of predictive model that precisely estimates room size and layout configuration.

•The integration of user preferences into the suggestion system to generate personalized and practical design solutions.

The proposed system automates the early stages of floor plan design by incorporating feature engineering, data pre-processing, and a Linear Regression model. This reduces time and effort associated with manual iterations. It helps in reducing the gap between traditional floor planning practices and modern data-driven approaches helping both professional and nonprofessional users to generate floor plans or getting a guideline to build one.

This research introduces an application of predictive modeling along with feature engineering in architecture that contributes to the broader objective of enhancing efficiency and adaptability in architectural planning and designing the blueprints.

3.3 Significance of the research

The old way of drafting floor plans is very labor intensive and time-consuming, and these factors significantly contribute to project schedules and resources. Generally, architects require 15-30 hours in the preparation of a detailed 2D floor plan for a medium-sized plot. It involves several iterations where designs are modified to achieve the functional and aesthetic requirements. Moreover, 12% [8] of manually made plans need considerable revision because they contain mistakes and inconsistencies or because of user objections and structural constraints. Mistakes during the design process may result in delays and higher project costs. Furthermore, larger and more complex projects are likely to experience these inefficiencies.

It is an inherently human-process reliant on architects and planners for expertise, resource-intensive, and subject to human judgment. Given the size of the global architectural services market at about USD 355 billion in 2023 [9] with an annual growth rate of 4.5%, there is an increased demand for more efficient ways of floor plan design, less burdensome for professionals yet with a comparable quality of design.

This research will overcome the challenges by utilizing machine learning to automate and optimize the floor plan generation process. The proposed system predicts room

sizes and suggests multiple viable floor plan layouts, thereby saving considerable time. The model is estimated to reduce design iteration time by up to 50%, saving an average of 10-15 hours per project, thereby streamlining the early stages of floor plan development.

This study has importance because it has the potential to transform the process of architectural planning. Through the introduction of machine learning in floor plan generation, this study brings forth a data-driven and predictive approach with less time being spent on mundane tasks and also reduced human error. It is able to provide architects and planners with quicker, more accurate suggestions for faster design cycles and the efficient use of resources.

In addition, the proposed suggestion system will make floor plan design more accessible, so that professionals and non-experts alike can explore design possibilities easily. This research lays the foundation for more adaptive, data-centric methodologies in architectural planning, with broad implications for the industry at large, by bridging the gap between traditional architectural design and modern computational methods.

3.4 Proposed Model

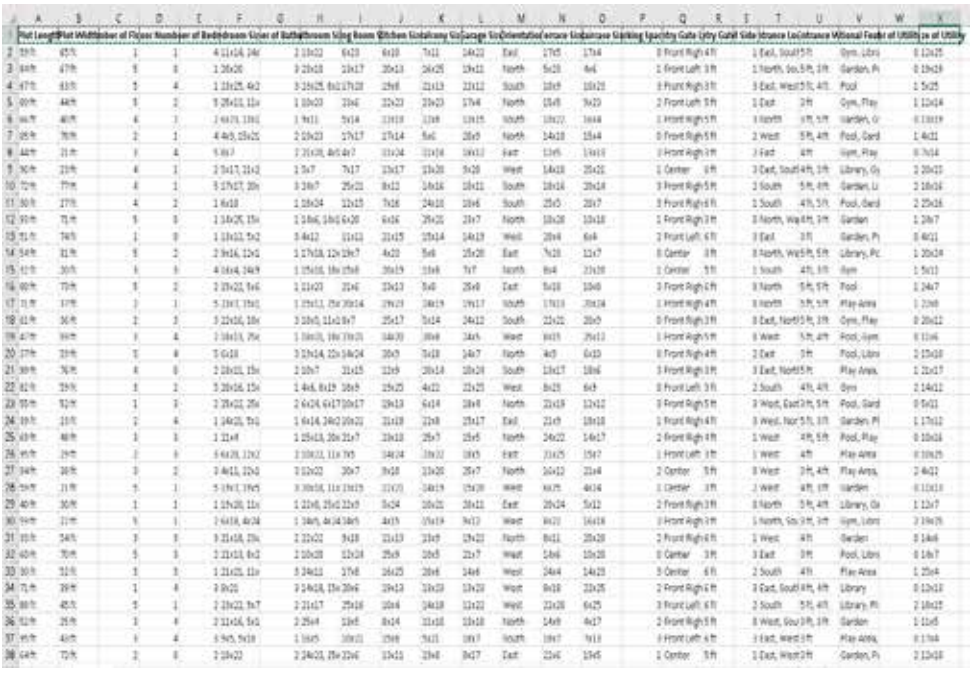

Fig. 2. Image Shows the Sample Dataset That Is Being Used for The Model Training.

The proposed model Fig 2 utilizes machine learning techniques to generate 2D floor plans on an automatic basis using the plot dimensions, number of floors, and number of rooms a user requires. Utilizing the existing floor plan dataset, we can train our machine learning models to predict sizes for key areas like bedrooms, bathrooms, kitchen, and garage based on given input features. The following is the structure and methodology of the model:

The dataset consists of the columns plot length and width, number of floors, floor number, number of bedrooms, bedroom sizes, number of bathrooms, bathroom size, living room size, kitchen size, balcony size, garage size, orientation, terrace size, stair case size, parking space, main entry gate location, main entry gate width, number of side entrance, side entrance location, side entrance width, additional features, number of utility areas, size of utility. Plot length and width are used to find the total area available for construction.

3.4.1 Data Pre-processing

- The dataset is pre-processed by parsing the sizes of bedrooms, bathrooms, kitchens, and other components from raw string formats into numerical values, representing the area in square feet.
- Missing values are handled by discarding rows with critical missing data such as bedroom sizes, number of floors, garage size, and kitchen size.
- Feature engineering is performed to compute the total plot area based on plot length and width, which becomes a crucial input feature for generating floor plan suggestions.

3.4.2 Feature Engineering and Transformation

- Length and width plot dimensions are applied to calculate the total plot area, which is a feature to determine how much space is available for the rooms and other components.
- Parses each room type's dimensions- a corresponding bedroom, bathroom, kitchen and so on-as numerical features which represent the area.
- Individual bedroom and bathroom sizes are expanded into separate columns based on the number of rooms in each type. This enables the model to suggest room sizes for varying numbers of bedrooms or bathrooms.

3.4.3 Model Training and Evaluation

- We use Linear Regression models to predict room sizes based on the given input features, such as plot area, number of floors, garage size, kitchen size, and entry gate width. This model is trained on a portion of the data (80%) and evaluated on a holdout testing set (20%).
- A Linear Regression model for each room type, such as bedrooms, bathrooms, and kitchen sizes, is built to predict size from the input features.
- Model performance is estimated by Mean Squared Error (MSE), the average squared difference between predicted room sizes and actual room sizes in the dataset. The lower the MSE values, the better the predictive performance.

3.4.4 Floor Plan Suggestion System

- After training, the model can give suggestions for a floor plan according to user inputs like plot dimensions, number of floors, and number of rooms.
- The suggestion system predicts the optimal sizes for bedrooms, bathrooms, kitchen, and garage based on the given constraints. It outputs room sizes in a width x length format, assuming square rooms for simplicity.
- The system also offers some default values regarding garage size and entry gate width, according to general construction standards.

3.4.5 User Input for Customization

- The model engages the user by allowing them to input some of the key parameters such as plot length, plot width, number of floors, and the number of bedrooms and bathrooms they would like.
- Given the input, the system computes the best fit sizes for the rooms and outputs a suggested floor plan with measurements. The model displays the suggestions in a friendly manner.

4 Results and Evaluation

The machine learning model for generating 2D floor plans was trained on a dataset of existing floor plans. After pre-processing the data and engineering relevant features such as plot area, number of floors, room sizes, and other building components, three separate Linear Regression models were trained to predict the sizes of bedrooms, bathrooms, and kitchens based on user input features. The mean squared error was the primary metric of performance used to evaluate models, and results are reported below.

4.1 Model Evaluation

- Bedroom size prediction. On bedroom sizes, mean squared error stood at 17898.86115901169; this meant it was very accurately predicting the given bedroom size inputs based on information such as area of plots of land, floors a house was reported to have in it, a garage's and entry gate of a home are, the space in a given kitchen.
- Bathroom Size Prediction: The model trained to predict bathroom sizes achieved a Mean Squared Error (MSE) of 19687.28173232393. Results indicate that the model does well in estimating bathroom sizes, though still room for improvement, especially with unusual layouts or configurations.
- Kitchen Size Forecast: The MSE from the Linear Regression model of predicting kitchen size came up to 2.254390286633779e-26. The fit and performance for this model was rather good with almost negligible error against the true value with a maximum tolerance in accordance to the changes due to difference in design and overall layout in most kitchens.

4.2 Model Performance

The overall performance of the model is evaluated by considering the MSE scores for each component, namely bedrooms, bathrooms, and kitchen. These results provide a quantitative measure of how accurately the model predicts the sizes of rooms in a floor plan:

- Bedroom Mean Squared Error: 17898.86115901169
- Bathroom Mean Squared Error: 19687.28173232393
- Kitchen Mean Squared Error: 2.254390286633779e-26

This will likely be satisfactory with relatively low MSE values in all components for general inputs in floor plans that yield room size predictions. Nonetheless, some of the edge cases-for example, uniquely shaped plots or user-defined configurations-may call for further adjustments and tuning to these models.

4.3 Floor Plan Suggestions

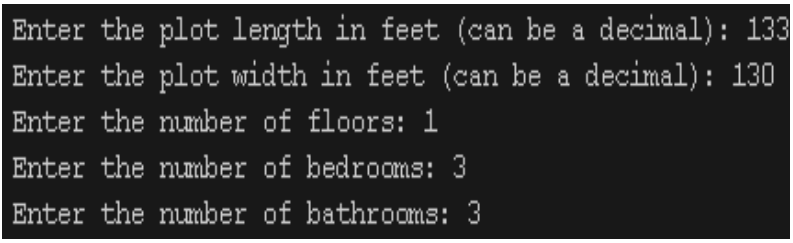

Fig. 3. Shows the input parameters that a user needs to add (User is prompted to provides these inputs)

Once trained, the model was applied to generate floor plan suggestions based on user inputs, including plot dimensions, number of floors, and desired number of rooms. The floor plan suggestion system successfully predicted the optimal sizes for bedrooms, bathrooms, kitchens, and garage space based on the given constraints. The generated floor plans, based on predicted room sizes, were shown to align well with typical design standards in real estate construction. Fig. 3. Shows the input parameters that a user needs to add (User is prompted to provides these inputs).

While the model performed well in providing recommendations for standard layouts, further refinements can be made to the system for more complex building designs. For example, the inclusion of more advanced machine learning algorithms or reinforcement learning techniques could help the model to adapt to custom requests more effectively, particularly for irregular-shaped rooms or multi-functional spaces. Fig. 4. Shows the Suggested Bedroom Sizes and Other Parameters Form the AI Model.

Fig. 4. Shows the Suggested Bedroom Sizes and Other Parameters Form the AI Model

5 Discussion

This research is for integration software into the architectural industry which can also be of a grate use in India as it is a developing country. This research also finds the amount of time being spent at the initial stages of construction. The results of this research are the AI model being developed gives suggestions of the dimensions of various areas of a house based on the plot dimensions being passed to it.

The output this AI model can help in creating a guided model based on user preferences that develops a 2D floor plan and will also make it easy to analyze the design prepared. Earlier models do not use a guided model for floor plan generation and instead uses a reinforced technique to generate a floor plan.

This research and model can help reducing time and effort at the base stage of construction industry which involves designing various iterations of floor plan for a particular area which can take much longer than expected in some cases.

6 Conclusion

This study uses a data driven approach with an author generated dataset for developing an AI model which can take user input for the plot dimensions and suggest the dements of various part sof the house based on the numbers specified by the user which involves the number of bedrooms, bathrooms, kitchen etc and can generate multiple suggestions. This model and research will help in modernizing the designing phase of the architecture industry hence speeding up the process and reducing human effort.

Disclosure of interest. The authors have no competing interests to declare that are relevant to the content of this article.

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