Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

Graduation Plan: All tracks

Submit your Graduation Plan to the Board of Examiners (Examencommissie-BK@tudelft.nl), Mentors and Delegate of the Board of Examiners one week before P2 at the latest.

The graduation plan consists of at least the following data/segments:

Personal information	
Name	Maryam Sadat Abouei Mehrizi
Student number	5342309

Studio		
Name / Theme	Building Technology Graduation Studio / Computational Design	
Main mentor	Michela Turrin	Design informatics
Second mentor	Charalampos Andriotis	AI labs
Argumentation of choice of the studio	Multidisciplinary optimization has demonstrated their use in assisting with design decision-making. In the design informatics discipline within the studio, it is possible to explore AI for soft criteria in multi-objective and multidisciplinary architectural design optimization.	

Graduation project	
Title of the graduation project	Machine learning-based assessment tool for predicting daylight and visual comfort
Goal	
Location:	-
The posed problem,	There is a rising interest in computational daylight simulations as the most accessible technique to gather accurate and exhaustive data on the lighting conditions of buildings. The primary reason for using daylight simulation technologies is to accelerate and test the design process early on. The design of the external shadings has a significant influence on indoor daylight distribution. Designers need to conduct considerable simulation work to calculate the daylight metrics and explore better alternative designs. However, implementing daylighting and visual comfort simulation in the early design process, where many vital decisions are made, is difficult, as many

	designers usually ignore it due to the lack of time and the complex process of simulations. In addition to speeding up daylight computations, computational tools are the only reliable simulation approach. The recognition and application of simulation-based daylighting techniques might be a powerful component of a comprehensive building plan. The procedure is complicated and time-consuming, which is one of the most significant disadvantages of using this approach. Using machine learning algorithms to predict daylight availability and glare to reduce the time and costs of daylight computation in the early design stages is not a new topic in the field. However, there is a gap in using AI methods to predict visual comfort in the decision-making stage for solar shading design
Research questions and	- Main question: - How can machine learning algorithms be used as an assessment tool in visual comfort and prediction in early design stages based on different solar shading designs? - - Sub questions: - How can a facade system be assessed in terms of visual comfort? - What are the requirements and parameters that characterize the Shading design in terms of visual comfort? - What design approach could be best to avoid glare while simultaneously optimizing the amount of daylight in the building? - Which machine learning algorithm is most suitable for capturing relations and similarities of different shading design? - Which machine learning algorithm will result in higher accuracy in the prediction of visual comfort?

	- What are the differences in processing time and results from values acquired by simulations and machine learning algorithms?
Design assignment in which this result.	We can improve space characterization by gathering and analysing data from occupants. The purpose of this research is to determine the consequences of the findings for the development and use of spatial data and the more effective use of subjective input from human occupants in the post-occupancy evaluation and building controls. ~~For~~ example, suppose the user's data (to be still specified which data is needed and viable in the thesis scale) are known. In that case, this model can predict the occupant's visual preference in the layout. The assignment concerns the visual prediction of occupants in an office in delft(the location still needs to be finalized). This method can be informative to the designers and facility managers to allocate furniture and employees based on their visual preferences. It is possible to have different zonings in different scales for spaces, floors, and whole buildings based on their similarity in terms of visual comfort. This technique may be instructive in terms of benchmarking the energy efficiency of buildings.
Process	
Method description	
The result of the project is a machine learning model to predict the visual comfort of occupants; this can be achieved using a research methodology that consists of five different phases: Research framework phase, literature review phase, data gathering phase, data processing phase, training the machine learning model phase and result phase. All the stages play a role in achieving the result. A background study is the first step in the research framework. The problem statement identifies the main issue that needs to be addressed, followed by the research objective to help solve the problem. A research question is formulated with various sub-questions based on this framework to define the research in steps. Literature Review provides all necessary information about the topic required to	

proceed further in the research. The categories into which these topics were divided are the state of the art of machine learning models for personal comfort, understanding the fundamentals of light and visual comfort, and understanding the principles of data gathering for visual preference and IEQ.

The data gathering requirements will be determined using the reviewed literature. There might be a possible collaboration with Mipmap company to provide sensors that need further discussion. Gathering Occupants' feedback about their visual/privacy comfort (through questionnaires) corresponding to their location and other individuals is also another step. Building spatial and layout data should also be extracted.

The data obtained from sensors and questionnaires should be pre-proceed, and the machine learning algorithm based on the literature reviews should be chosen for features from sub-questions.

The machine learning model should be trained with data to predict the visual preference of occupants.

In the end, the model's accuracy can be tested to predict the visual preference of a group of occupants in the selected location.

Literature and general practical preference

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Reflection

1. What is the relation between your graduation (project) topic, the studio topic (if applicable), your master track (A, U,BT,LA,MBE), and your master program (MSc AUBS)?

With the outcome of this research, an assessment tool can be used for visual comfort and daylight prediction. The tool can provide the designer with constrains and opportunity in terms of the shading design. The tool can provide increased convenience for designers in the early-stage design. In the long term, this can be time and cost consuming for companies to have an assessment tool for predicting different daylight metrics and visual comfort. This will result in an efficient shading design and daylight simulations to improve visual comfort for the occupant.

2. What is the relevance of your graduation work in the larger social, professional, and scientific framework?

Scientific relevance:

Daylighting is a major theoretical inquiry since Le Corbusier emphasized the topic's relevance as one of three critical requirements throughout the design of projects. The most sophisticated study on thermal comfort and microclimate demonstrates its effect on occupants' comfort conditions following sustainable architectural design principles. The most recent results in the physiology study a favorable long-term influence of daylight on individual well-being as
it regulates the circadian rhythm. The significance of implementing optimal daylighting practices in buildings has increased interest in computational daylight simulations, which have become the most accessible method for evaluating interior lighting conditions. However, during the master's thesis, I discovered that this procedure is time-consuming and costly. The study's primary objective is to investigate AI potentials to lower the time required for computational calculations and 3D model preparation. This thesis addresses the possibility of substituting a simulation engine with an algorithm for machine learning. As the literature review is built upon studies from other disciplines, such as computer science, its interpretation through Building Technology relates to contemporary discussions of AI and architecture. This means the project uses knowledge formulated from external disciplines to an alternative design strategy. Therefore the project is relevant in academic and general discussions.

Social relevance:

Achieving visual comfort in office or academic spaces will significantly impact the user's functional efficiency, productivity, overall health, and satisfaction. The visual preference prediction would result in placing occupants with the same visual

preferences in the same zoning, which can significantly reduce the building's overall energy consumption level.

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PROJECT TIMELINE