Graduation Plan

Master of Science Architecture, Urbanism & Building Sciences

A Computational Method to Generate One-story Floor Plans for Nursing Homes Based on Daylight Hour Potential and Shortest Path of Circulations

Lincheng Jiang

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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	Lincheng Jiang
Student number	4801334
Telephone number	
Private e-mail address	

Studio		
Name / Theme	Computational Layout Optimization	
Main mentor	Pirouz Nourian	Design Informatics
Second mentor	Regina Bokel	Building Physics and Services
Argumentation of choice of the studio	China is stepping into an aging society, needs for elderly care related infrastructures and facilities are rising. Nursing homes as important components of elderly welfare require complex decision making during the design process. With the interest into the topic of utilizing algorithms to promote design capability of architects over such complex design issues, I choose studio Computational Layout Optimization for my graduation thesis.	

Graduation project	
Title of the graduation project	A Computational Method to Generate One-story Floor Plans for Nursing Homes Based on Daylight Hour Potential and Shortest Path of Circulations
Goal	
Location:	None
The posed problem,	Nursing homes have been facilities where requirements for efficiency and residents' needs for quality of life collide, involving even more complex design and decision-making process when the call for sustainability is brought up. Industries of architecture have developed experiences over such issues and depend on them over the design of such types of buildings during past years. Those experiences effectively helped architects to ensure the minimal requirements of both aspects being met, but also set up constrains on the design process.

	With the help and developments from computer science, it's very possible to provide architects with more simple and powerful tools to better achieve their design vision over these complex design issues.
research questions and	The main research topic can be break into several sub-questions: - How should the program of requirements be modelled into spatial relations? - How can spatial relations be projected into an actual space? - How should the relations among evaluating circulations, walking distance and daylight hour be? In another word, what is the hierarchy? - How should the designer interact with the computational process? What is his/her role?
design assignment in which these result.	The objective of this thesis is to develop a computational method that generates one-story-heigh floor plan, that meets both circulation and daylight hour requirements of the building, which can be integrated into the architectural design process. It is about integrating daylight potential analysis and pathfinding to improve both liveability and efficiency of the building. This thesis consists of the research on methodology and design cases to which the method is implemented. Methodology wise, this work is in the area of the "Science of the Artificial" (Nourian, 2019). While the thesis involves optimization theory, graph theory, force-directed methods, computational geometry and daylight hour analysis in some way, the detailed discussion of each subject falls out of the scope of the project.

[This should be formulated in such a way that the graduation project can answer these questions.
The definition of the problem has to be significant to a clearly defined area of research and design.]

Process

Method description

A. Literature and background knowledge study
First, a broad study of literature within the scope of interests is conducted. While narrowing down the scope of research, background knowledge about set theory and graph theory, topology and geometry, and algorithms are being learned through online open courses. At this stage, the basic knowledge that is required to complete the thesis is obtained. Also, the status quo of studies and practices of computational layout generation is being reviewed. To ensure the validity of the research, literature studies will be continually carried on through the research process.

B. Problem formulation and concept development
This step is about breaking down the topic into subproblems, formatting specific problems that need to be solved. Developing feasible concept solutions for each subproblem including concept workflows, mathematical modelling concept and algorithm concept.

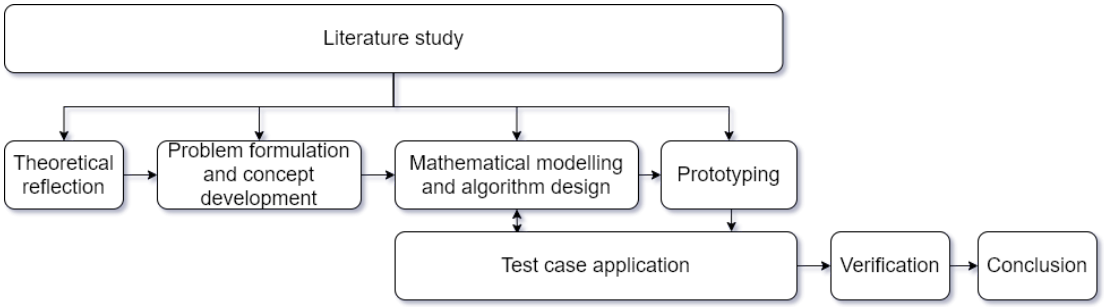
C. Mathematical modelling and algorithm design
At this stage, the feasible concept solutions are developed into mathematical models and algorithms. Algorithms are broken into several parts, each part deals with specific subproblem.

D. Prototyping
At this stage, algorithms are implemented with Python, and trials and errors and done through a series of toy problems. Toy problems are specific problems needs to be solved or realised towards the final goal.

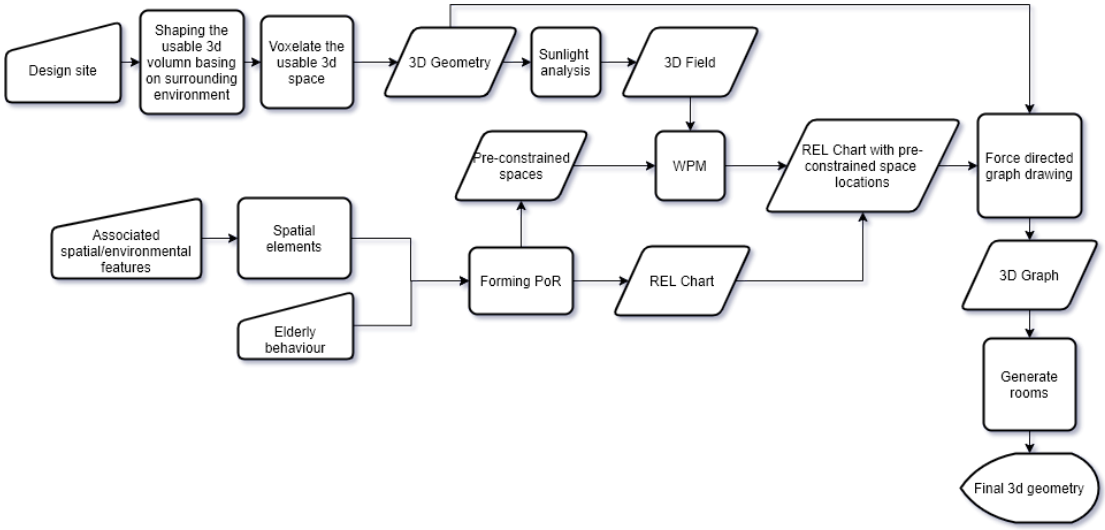
E. Test case application
The prototype algorithm is implemented to generate a one-story-heigh nursing home plan.

F. Verification
Using existing analysis theories and software to analyse the outcome of the test case. Compare it with a manually designed floor plan. Evaluate the effectiveness of the general methodology.

G. Conclusion and summary
Conclude and summery the result of the design and the developed methodology.
Research flow chart:



Test case application workflow chart:



Literature and general practical preference

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Roudsari, M. S., & Pak, M. (2013). Ladybug: A parametric environmental plugin for grasshopper to help designers create an environmentally-conscious design. Proceedings of the 13th International IBPSA Conference Held in Lyon, France Aug 25–30th, 3128-3135.

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World Health Organization. (1995). WHOQOL-100. Geneva, Switzerland: World Health Organization.

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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 programme (MSc AUBS)?

   This topic is within the scope of the studio topic Computational Layout Optimization. Within the track of Building Technology. It is part of the research framework of Chair Design Informatics. This graduation project seeks using computational method to bridge between architecture design and computer science. It provides designers a tool to generate practical floor plans regarding circulations and daylight hour potentials of the floor plan through their workflow of design.

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

   Chinese society is aging fast. Needs for elderly welfare infrastructures and facilities are rising. Nursing homes as important components of elderly welfare require complex decision making during the design process. It serves as a humanity infrastructure which requires for liveability, in this thesis, daylight hour is discussed, yet also provides serves that ask for circulation efficiency.

   This graduation work would help architects better optimize spatial plans of buildings under these two requirements, which potentially improves the future built environment for elderlies. It can also work as a framework for other design cases that requires the satisfaction of multiple criteria.