HEINZ-STILLGER-PREIS

TECHNISCHE UNIVERSITÄT DARMSTADT

DeepPattern

Introducing Convolutional Neural Networks for Architectural Pattern Recognition

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Fachgebiet DDU, SoSe 2020

Watch the video
https://youtu.be/b9f7d2NJ6pQ

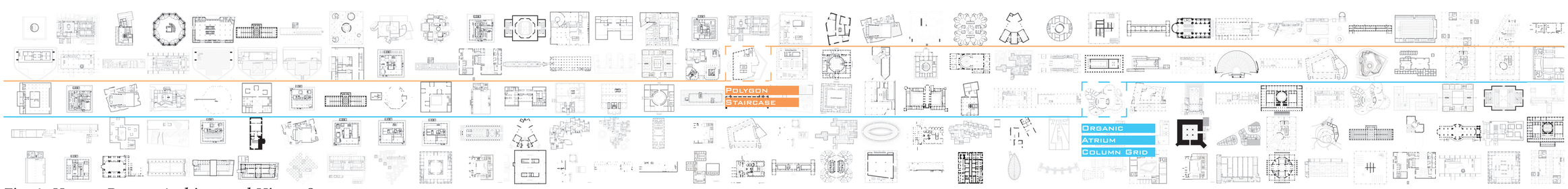

Fig. 1, How to Browse Architectural History?

Problem Statement

The promising concept from Christopher Alexander´s design-methodology of *Pattern Languages* needs to be approached on a more holistic level. This paper proposes to leverage the potential of Big Data and Machine Vision to analytically classify architectural patterns in floor plans. The Research uses Convolutional Neural Networks (abbr. CNN) to automatically find patterns across varying typologies, centuries and styles. The title *DeepPattern* implies the connection between the task of Pattern Recognition with Deep Learning and the theory of Pattern Languages. The method proposed by Alexander et al (1978) is applied to the task of extracting data in architecture with digital methods, for which I propose the term *Architectural Pattern Recognition.*

Research Objectives

It is thus relevant to know if Machine Vision techniques can understand the logic of architectural patterns. The Experiment carried out was built to answer the following question: Can an Image Classification AI correctly classify patterns in floor plans?

State of the Art

The breakthrough of CNN in 2014 has revolutionized Pattern Recognition in Machine Learning. Recent Developments in architectural research are also vast. One current method for floor plan analysis by Dodge et al (2017) uses semantic labeling of room types to extract spatial informations. Also, office Certain Measures (2018) classifies airport terminals from city maps according to their urban morphology. However, when looking on architectural design categories on a broader scale, the focus only on room layout or boundary morphologies is a too limited view, because it excludes other valuable informations, which are yet hard to detect. CNN have not at all been used for pattern recognition in floor plans.

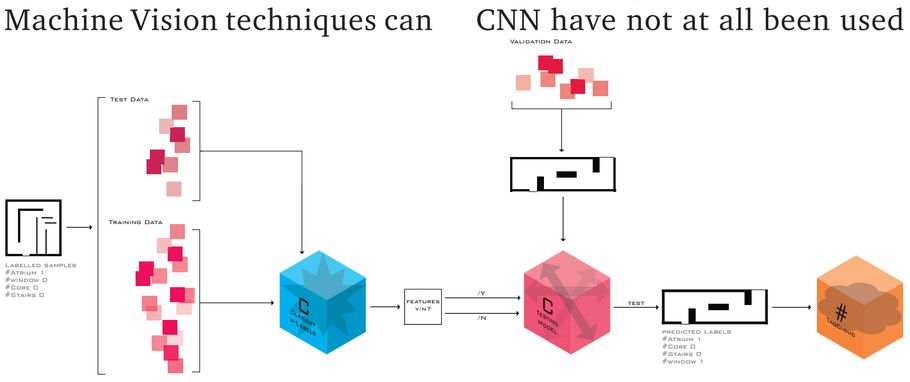

Fig. 2, Experiment Setup

Method and Results

A dataset of ca. 1000 floor plans, sourced from the Fachmodul D assignment during the WiSe 19/20 was used to train the Pattern Recognition bots (Fig.3). The setup of the experiment is shown in Fig. 2. Each bot was designed to learn only one pattern, resulting in nine Bots in total (Fig. 4). All achieved remarkable results in the training. After the training the bots were tested on 12 new floor plans of varying styles and different patterns, in order to test the precision. Two examples of this final test are displayed in Fig. 5. In average the test results are sufficient (Fig. 5). This can surely be improved with a larger dataset and more computing power.

Resume

CNN proved to be a valuable tool to perform Architectural Pattern Recognition in floor plans. The Bots understand the exterior patterns like organic or rectangle shape. They do not sufficiently understand interior patterns like Atrium or Column grid. It therefore becomes evident that they learned the basic concept of architectural patterns, but problems remain. The most important next step is to establish a visual design-tool for a *suggestive architectural search* (Fig. 1). This research shows the potential of Machine Learning as an analytical tool and outlines possible futures of Pattern Languages. The long-term goal is not to push Generative Design forward, but to invent more fruitful human-bot collaboration tools, which are useful for an architect´s design practice.

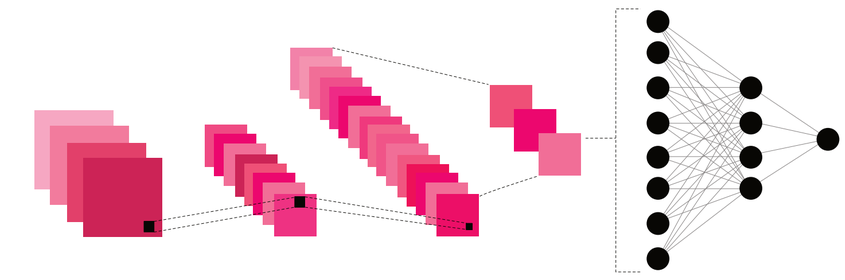

Fig. 3, Convolutional Neural Network structure

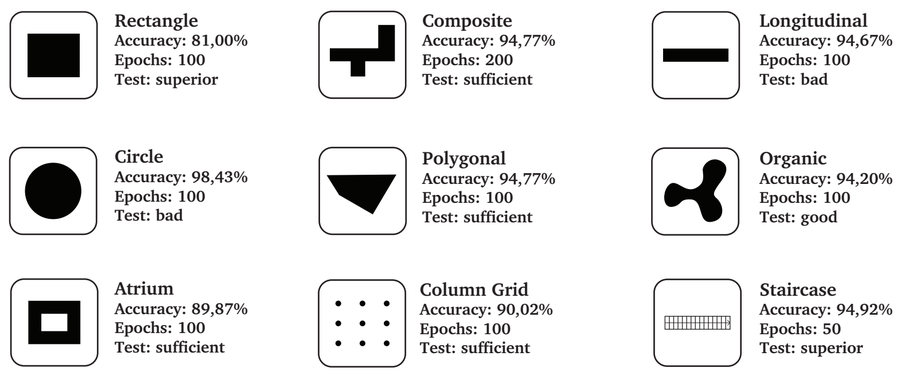

Fig. 4, The Pattern Recognition Bots

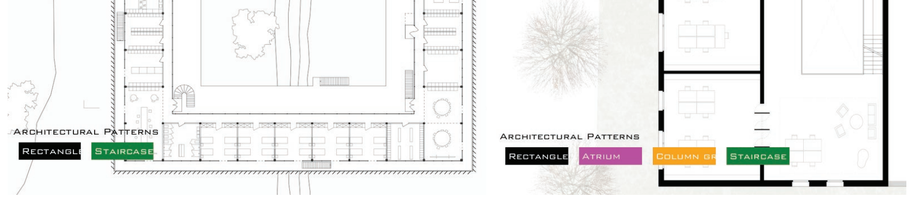

Fig. 5, Bot Estimated Architectural Patterns

References

Alexander, C et al (1977). A Pattern Language.

Dodge et al, (2017). Parsing Floor Plan Images.

Certain Measures, (2018). Aerial Futures.