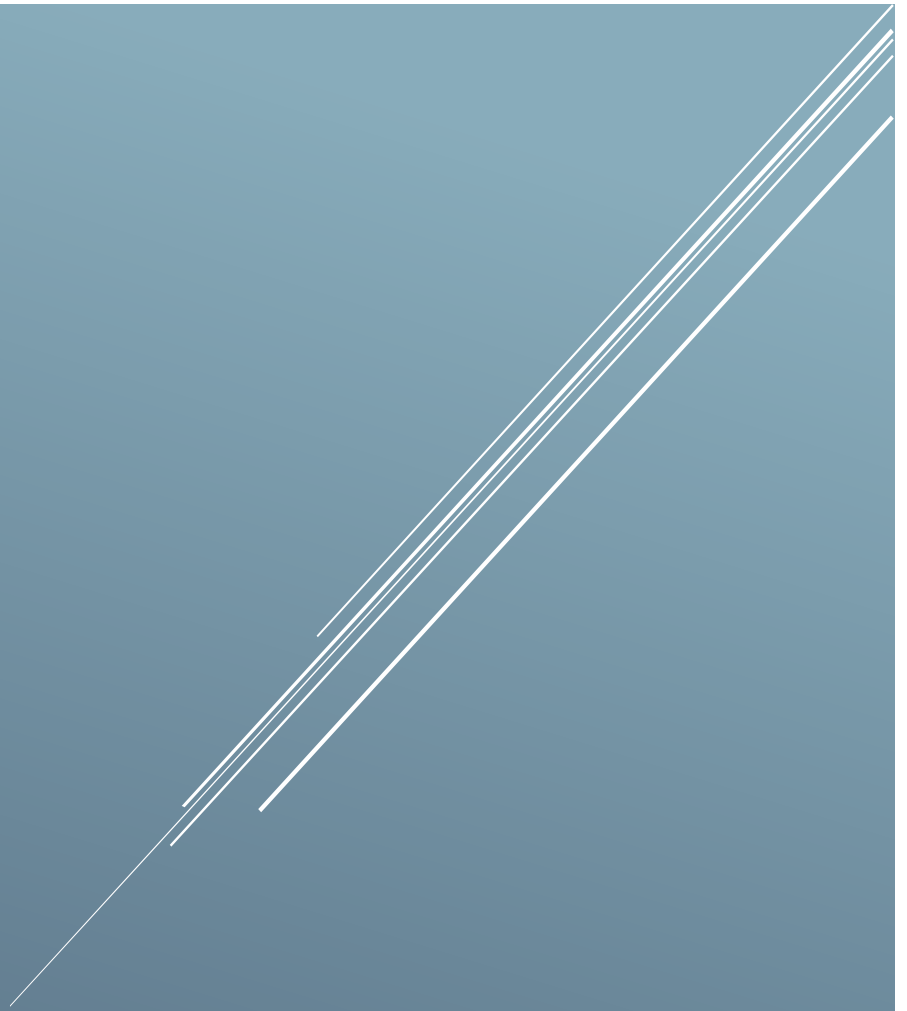




A.I. ENHANCED BUILDINGS, WAY TO SUSTAINABILITY?

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„Cities are more than the sum of their infrastructure. They transcend brick and mortar, concrete and steel. They're the vessels into which human knowledge is poured. “

- Rick Yancey, The Last Star

Mankind's passion for improvement and innovation satisfies a need of increasing efficiency, ease and comfort in our everyday life. We can see huge achievements and discoveries made faster than ever before just in two decades. Specially, information technologies are improving unbelievably quickly. Nowadays "smart technologies" are huge influencers in almost every aspect of our lives. Huge percentage of population is using smart phones and laptops on daily basis, which caused a shift in our expectations. To be able to connect to internet and browse web, check our e-mails, take photos or just listen to music is considered as basic features of our phones. Hand-in-hand with these features goes a need of higher performance, better capabilities and improvements in every way. Due to this special requirements people are trying come up with sophisticated solutions or at least processes how to achieve them. Such a way and solution at the same time can be artificial intelligence which significance is increasing.

We now live at the beginning of new era of "smart world". We are able to connect our devices together in a way, they extend functions of each other. Gathering information was never easier than it is now. Of course, such accessibility brings some problems. We have enormous amount of data, such amount we can easily loose track of and sometimes we struggle with proper interpretation of data. This is an issue which can be solved by using artificial intelligence, which would not only process already obtained data, but also focus on gathering new relevant data addressed to certain focus. Such an A.I. could be a handy addition to our buildings. To create a building satisfying our desired comfort levels and performance expectations in ever changing conditions is not an easy task. To achieve it, we use various types of sensors monitoring temperature, air quality, light levels and even more. Even though, these sensor systems do their work, there is always something what can be improved. Such an improvement can be holistic sophisticated systems monitoring and operating facility efficiently to given conditions and occupants desires and needs.

Speaking of construction nowadays means not only to come up with technically and aesthetically sufficient solution, but also to consider impacts of a building in a way of sustainability. The lower the impacts the better. One of huge issues of construction and building itself is its energy dependence. According World Green Building Council's statistics for year 2017 construction demands around 36% of total consumed energy worldwide. It is no surprise, that energy issue is one of the most discussed topic.

In my dissertation I would like to focus on using artificial intelligence (A.I.) in buildings in a way, it can be used as one of the answers and solutions to high energy consumption. With its ability to monitor and gather data through data mining, machine learning and deep learning processes, we will be able to have sufficient information to create energy models and simulations, which will be able to adapt quicker to achieve lower energy consumption.

So far, only few studies dealing with this topic exists. Key study for my research is *Data Mining and Machine Learning in Building Energy Analysis* by Frédéric Magoulès and Hai-Xiang Zhao. This study is

focused more on computer engineering approach, although my intention is to apply this approach to current construction industry demands and to reflect current construction trends. In other words, monitor and analyse building's energy performance of HVAC systems according to given conditions and usage.

Since this is still a wide topic, I would like to focus on heating systems due to its high energy consumption. According European Commission, households heating systems take 79% of total consumed energy and non-residential buildings consume 70,6%. Taken into consideration, that 36% of total energy consumed goes just for construction, we are dealing with enormous consumption rates just for heating purposes.

Goal of my research is to conclude if application of A.I. in buildings could be beneficial for energy savings. I will be trying to analyse current capabilities of A.I. and its application to nowadays sensors systems. One of the aspects I would also like to deal with is building operation according occupant's routines and habits, which can have significant impact on energy consumption caused by heating systems.

Topic of A.I. brings several problems we should take into consideration. First, it cannot be dealt just according only one scientific discipline. A.I. is a complex human creation, which has its origin and impacts in several disciplines, like IT one of the most significant ones, ethics, sociology. Focusing on my topic, also construction principles would be significant. Although by my opinion, this is not a huge problem, because it is good to see cooperation between disciplines, still it can make a result interpretation a bit difficult due to implementation of various points of view. Also, due to relatively short period of time A.I. is dealt with, to gather relevant and real data will be so far challenging process. Nevertheless, if I will be able to obtain real data, I will implement them into my work.

LITERATURE REVIEW

Books I will be using can be divided into two groups. First group is computer engineering focused, which I will be using as a base for my work to be able to create needed theoretical models, which I will be applying to the parameters and conditions obtained from second group, such as construction and energy analysing focused books.

As mentioned before, book used as a base for my research is *Data Mining and Machine Learning in Building Energy Analysis* by Frédéric Magoulès and Hai-Xiang Zhao. I will be using written principles to create applicable model. This model will be then modified by principles of machine learning mentioned in book *Machine Learning Algorithms* by Giuseppe Bonaccorso.

To create model's simulation environment, I will be combining theories from *Energy Manual: Sustainable Architecture* and *Building Energy Simulation: A Workbook Using DesignBuilder™*. Theories mentioned in *Adaptive Thermal Comfort: Foundation and Analysis* are influenced by sociological aspects of human usage of buildings, which will help me to create more realistic model.

With theoretical model and simulation environment I will need conditions, which will be applied to the model to obtain relevant outcome. Such condition I will be created by combination of set up parameters in books *Nízkoenergetický Ekologický Dům (Low-energy Ecological House)* and *Nízkoteplotní Vytápění a Obnovitelné Zdroje Energie (Low-temperature Heating Systems and Renewable Energy Sources)*. Both books are dealing with problematics of effective energy consumption from building holistic point of view and by focusing on low-temperature heating systems.

METHODS

I'll be applying theoretical models, acquired through study of A.I. based on computer engineering methods, to the conditions given by construction and sustainable standards and requirements. Important aspect of applied model will be prediction of human behaviour done by A.I.'s self-learning mechanisms, corresponding to sociological aspects of building's usage. After model optimisation to heating systems according construction and sustainable designs and minimising of possible threats, created theoretical models will be applied to simulate model situation with outlining of important parameters influencing energy consumption caused by heating systems. These parameters will be used to demonstrate possible advantages and disadvantages of A.I. enhanced systems and compared with human operated systems.

RESULTS

With combination of computing, sustainability demands, construction procedures and sociological elements I hope I will be able to outline possible application of A.I. into a building in a way to achieve wanted thermal comfort with lower energy consumption than just using sensors systems. I would also like to set possible boundaries when we can say using A.I. is reasonably sufficient and profitable or the exact opposite. Part of my results will be thinking over some problems which can occur and come up with possible solutions. Even though my results will be mainly theoretical, I would like to outline some starting ideas, which can be therefore used for practical purposes.

EVALUATION

People create two significant groups when they are speaking of artificial intelligence. One group is embracing the idea of A.I. and they are focusing their effort to come up with possible solutions, its implementation and thinking of its present and future in common. The other group is sceptical and to some extent afraid of it. To proper evolution of A.I. we need both groups. If we omit the ideas of artificial intelligence killing people or enslaving the mankind, sceptics come up with problems related to implementation of A.I. to our everyday lives, such as its control, privacy issues, safety. I doubt that beginnings of it will be smooth and perfect. There is still so much we need to learn and adapt, but sceptic's questions and thoughts help to focus on certain topics to lower negative impacts or even eliminate them before then occur. Sooner we start to deal with the problems the better.

Although my work will be about possible benefits of enhancing our buildings with artificial intelligence, I would be glad if other people use my dissertation as their starting point for their work or just a material to think about. For me, it will be a starting point for my future research, which I would like to be more practical.

As I mentioned before, artificial intelligence with its various origins, focuses, capabilities is one of the most complex creations ever done by human. Therefore, it is only natural to use A.I. to various tasks than just for energy savings. More likely this will be just one of the features offered in the pack. A.I. enhanced building could be one of the options for people with disabilities. In case of emergency such an upgraded building could detect the thread and call appropriate services.

There is wide range of A.I. applications in almost every aspect of our lives and even wide range in construction industry and I will be glad if my small piece will be able to contribute.

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