Notice of the Final Oral Examination
for the Degree of Master of Applied Science

of

GABY BAASCH

BSc (University of British Columbia, 2015)

“Identification of thermal building properties using gray box and deep learning methods”

Department of Civil Engineering

Friday, December 18, 2020
10:00 A.M.
Remote Defence

Supervisory Committee:
Dr. Ralph Evins, Department of Civil Engineering, University of Victoria (Supervisor)
Dr. Tom Gleeson, Department of Civil Engineering, UVic (Member)

External Examiner:
Dr. Margaret Storey, Department of Computer Science, UVic

Chair of Oral Examination:
Dr. Yin Man Lam, Department of Anthropology, UVic

Dr. Stephen Evans, Acting Dean, Faculty of Graduate Studies
Abstract

Enterprising technologies and policies that focus on energy reduction in buildings are paramount to achieving global carbon emissions targets. Energy retrofits, building stock modelling, heating, ventilation, and air conditioning (HVAC) upgrades and demand side management all present high leverage opportunities in this regard. Advances in computing, data science and machine learning can be leveraged to enhance these methods and thus to expedite energy reduction in buildings but challenges such as lack of data, limited model generalizability and reliability and un-reproducible studies have resulted in restricted industry adoption [46]. In this thesis, rigorous and reproducible studies are designed to evaluate the benefits and limitations of state-of-the-art machine learning and statistical techniques for high-impact applications, with an emphasis on addressing the challenges listed above.

The scope of this work includes calibration of physics-based building models and supervised deep learning, both of which are used to estimate building properties from real and synthetic data.

• Original grey-box methods are developed to characterize physical thermal properties (RC and RK) from real-world measurement data.

• The novel application of supervised deep learning for thermal property estimation and HVAC systems identification is shown to achieve state-of-the-art performance (root mean squared error of 0.089 and 87% validation accuracy, respectively).

• A rigorous empirical review is conducted to assess which types of gray and black box models are most suitable for practical application. The scope of the review is wider than previous studies, and the conclusions suggest a re-framing of research priorities for future work.

• Modern interpretability techniques are used to provide unique insight into the learning behaviour of the black box methods.

Overall, this body of work provides a critical appraisal of new and existing data-driven approaches for thermal property estimation in buildings. It provides valuable and novel insight into barriers to widespread adoption of these techniques and suggests pathways forward. Performance benchmarks, open-source model code and a parametrically generated, synthetic data set are provided to support further research and to encourage industry adoption of the approaches. This lays the necessary groundwork for the accelerated adoption of data-driven models for thermal property identification in buildings.