

Data Mining Approach for Estimating Residential Attic Thermal Resistance from Aerial Thermal Imagery, Utility Data, and Housing Data

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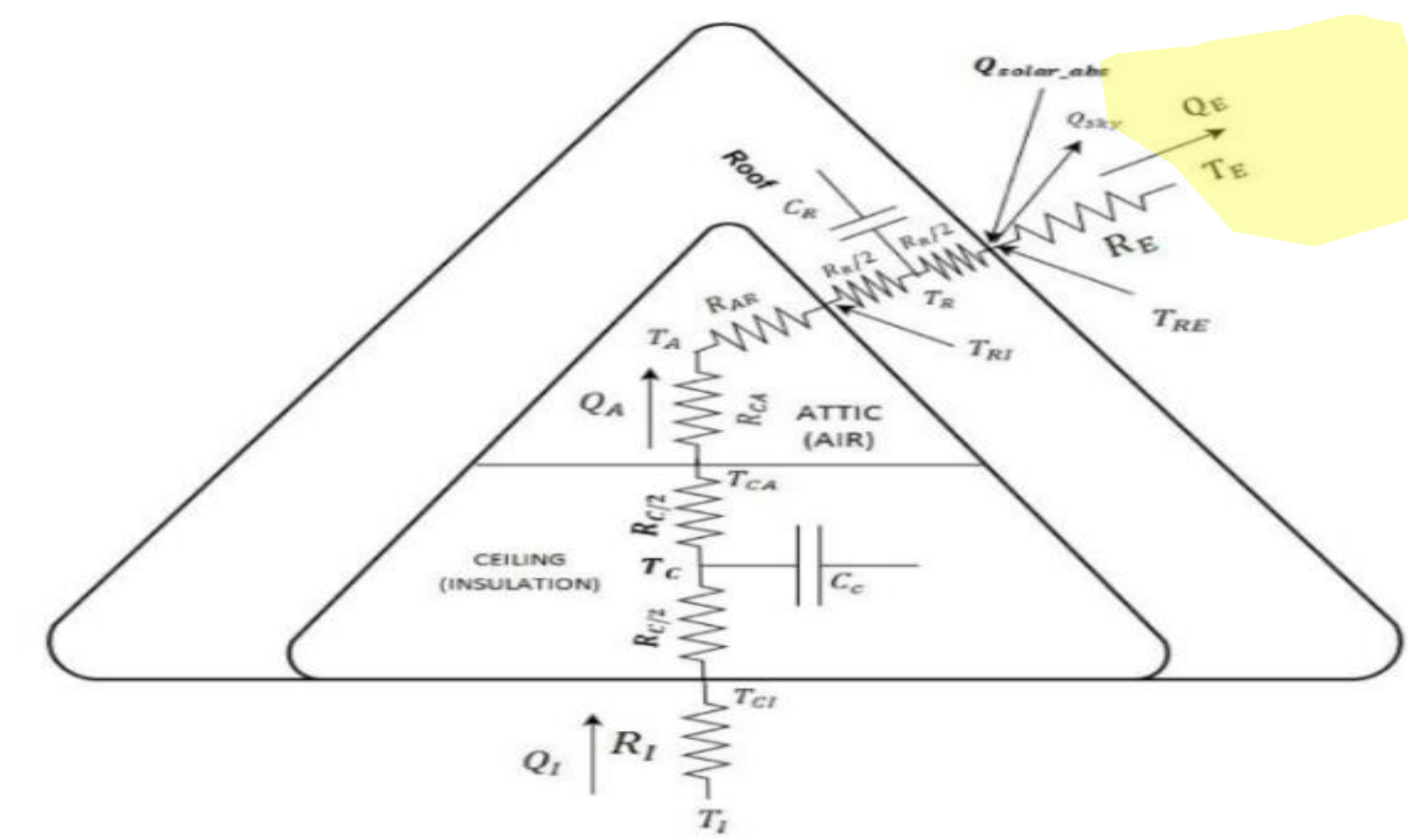
Advisor: Kevin Hallinan

Research Objective: Develop an At-Scale Approach for Estimating U-values for Roofs from Aerial Thermal Images

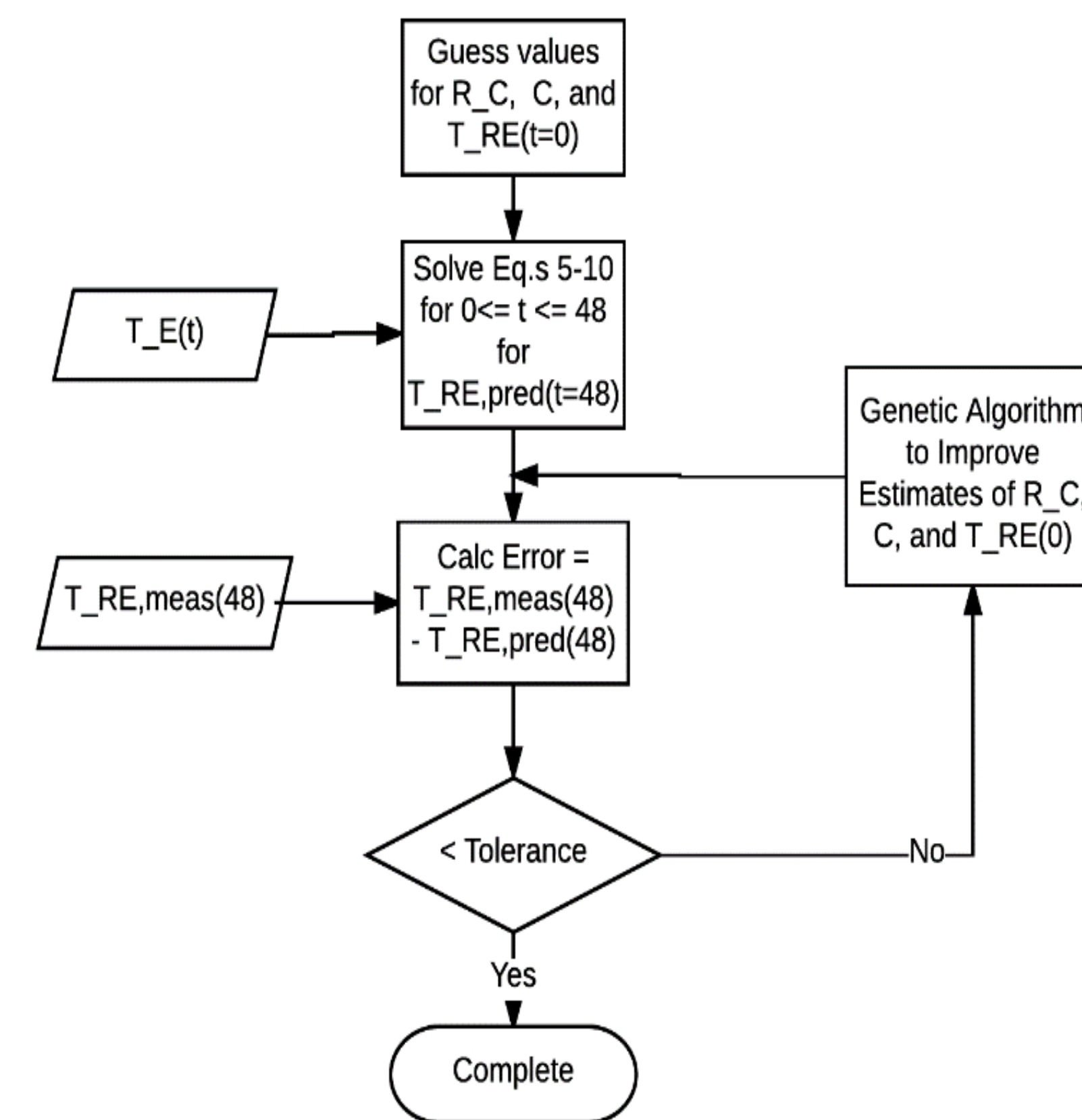
Introduction/Motivation

Traditional building energy audits are:

- Expensive.(US\$0.50/sf)
- There are not enough energy auditors for US buildings (~100M)
- Qualitative, as single point in time images are strongly effected by prior weather conditions and emissivity.



Physics –Based Model Detailing Solution (Flow Chart)

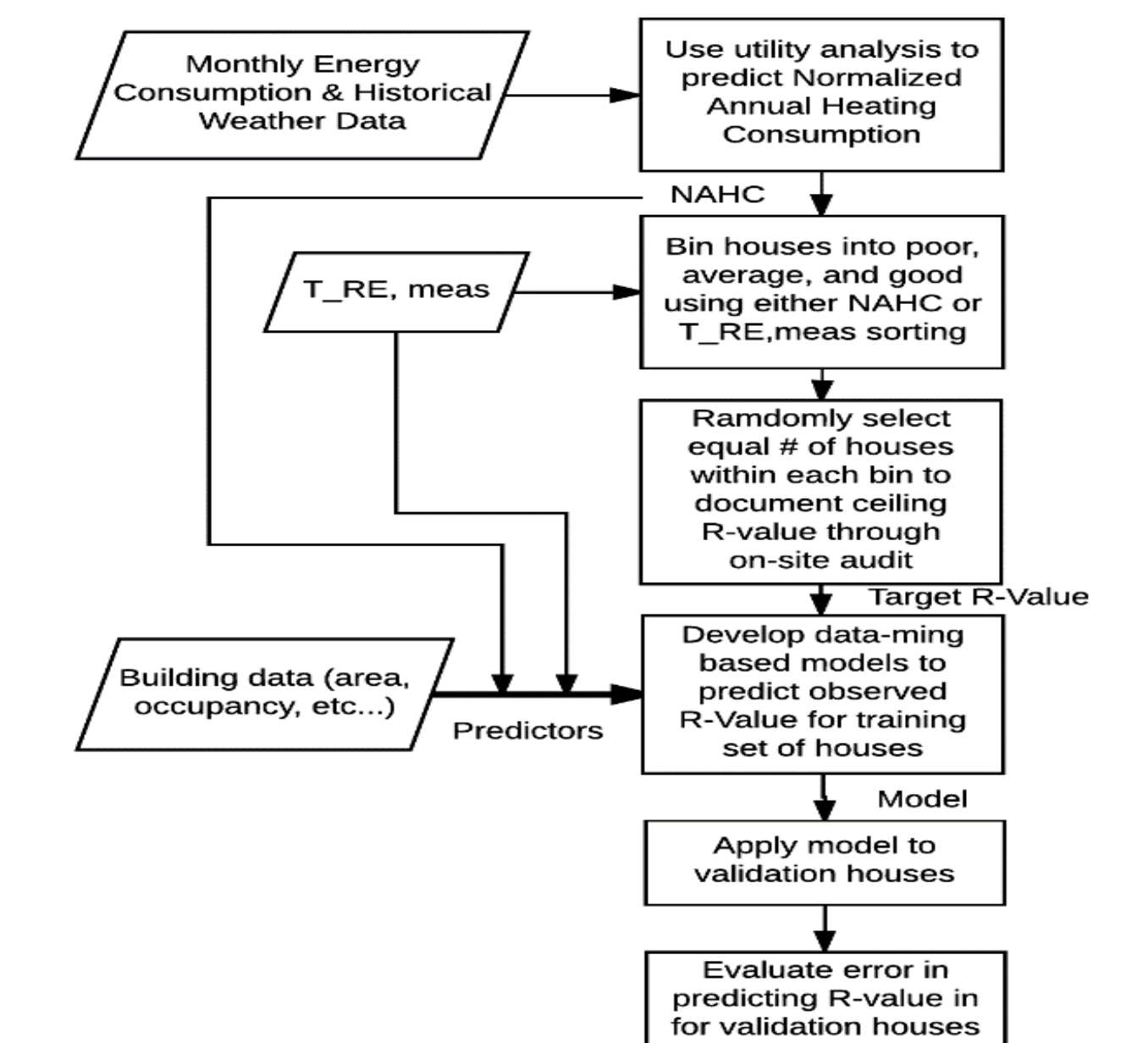


Physics Based Model Results

Predicted vs actual wall U-value for UD residences

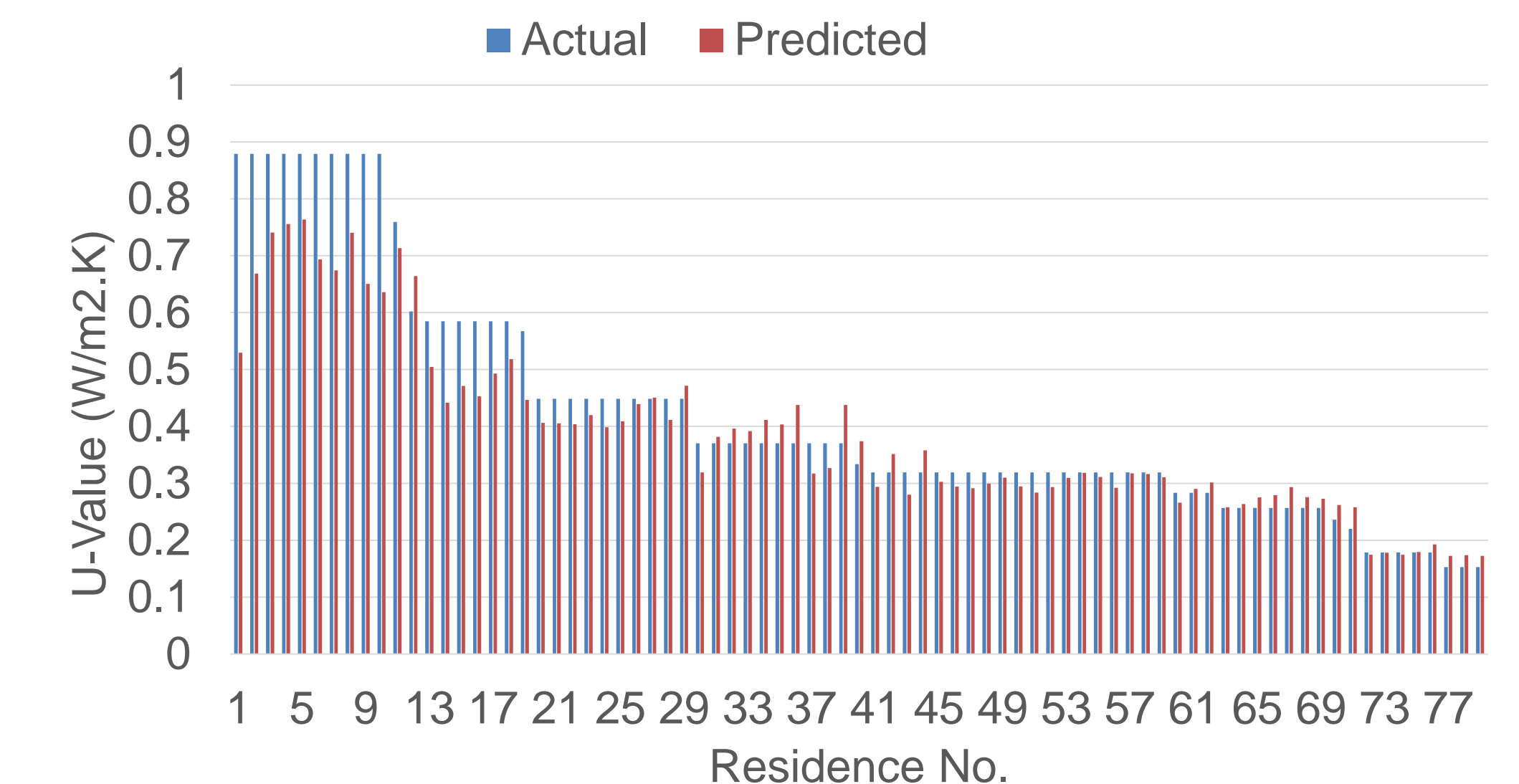
| | | | | | | | | | | | | |
|---------------------|------|------|------|------|------|------|------|------|------|------|------|------|
| U-Value (Actual) | 0.15 | 0.15 | 0.15 | 0.88 | 0.88 | 0.58 | 0.76 | 0.33 | 0.32 | 0.32 | 0.60 | 0.22 |
| U-Value (Predicted) | 1.00 | 0.80 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 0.89 | 1.00 | 1.00 | 1.00 | 0.74 |

Data Mining Model Detailing Solution (Flow Chart)



R-squared value in predicting R-value = 0.98!

Data Mining Model Results (Ceiling)



R-squared value in predicting R-value = 0.98

Conclusions

- Demonstrated potential of approach to fairly accurately estimate a Ceiling U-value when the roof emissivity is known or when there is a calibrated temperature measurement made on a surface
- The results indicate that accurate U-value prediction can be obtained for a relatively small set of training houses
- This approach offers clear opportunity for conducting low cost energy audits at scale.

Methodology

Fly over image – University of Dayton – Dec. 27, 2014
(Acknowledgement: Woolpert LLC)



I. Physics based estimation of U-values

Utilize an inverse model to predict thermal resistance and capacitance

Prediction of R- and C- Values:
Dynamic Genetic Algorithm
Inverse Model

