

# Data Science for Building Energy Simulation

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Integrated Data, Energy Analysis + Simulation



<https://ideaslab.io>

## Postdoctoral Researchers



Hongyuan Jia

Postdoctoral Fellow



Wenxin Li

Postdoctoral Fellow

## PhD Students / Research Assistants



Shuxu Qin

Research Apprentice



Long Zheng

PhD Student



Sicheng Zhan

PhD Student



Siyu Cheng

PhD Student



Yaonan (Claire) Gu

PhD Student



Yue Lei

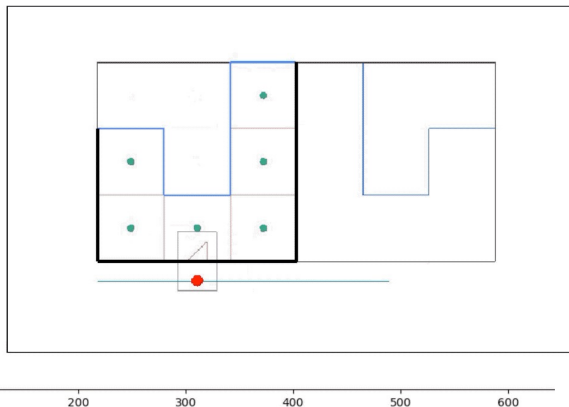
PhD Student

# Overview

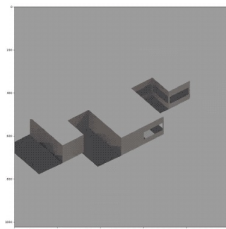
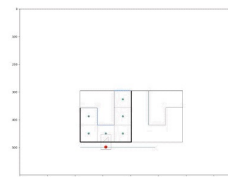
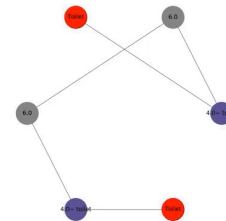
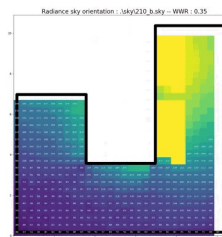
- Enabling Data Science
- Model calibration as an application
- Our free and open-source toolkits
- What's next

## Parameters:

1. unit shape
2. bathroom location
3. entry point
4. WWR, sill height, window height
5. Orientation [0, 30, 60, 90, 120, 150, 180, 210, 240, 270, 300, 330]
6. Month/day/hour
7. daylight illuminance grid size.



Orientation : 210<sup>o</sup> WWR : 0.35





BEST  
Directory

Home FAQ Softw

Building Energy Software Tools

Formerly hosted by US Dept. of Energy

Find Software

Search

Search Software And Training

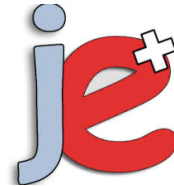
Total Results: 207



Excel

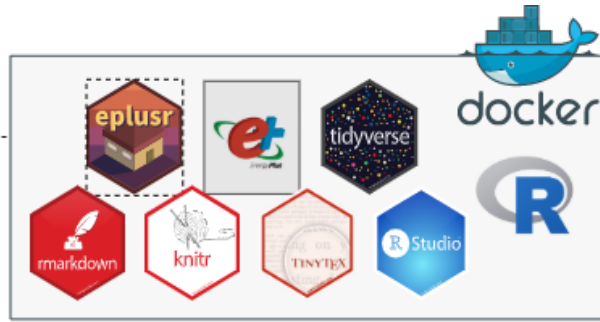
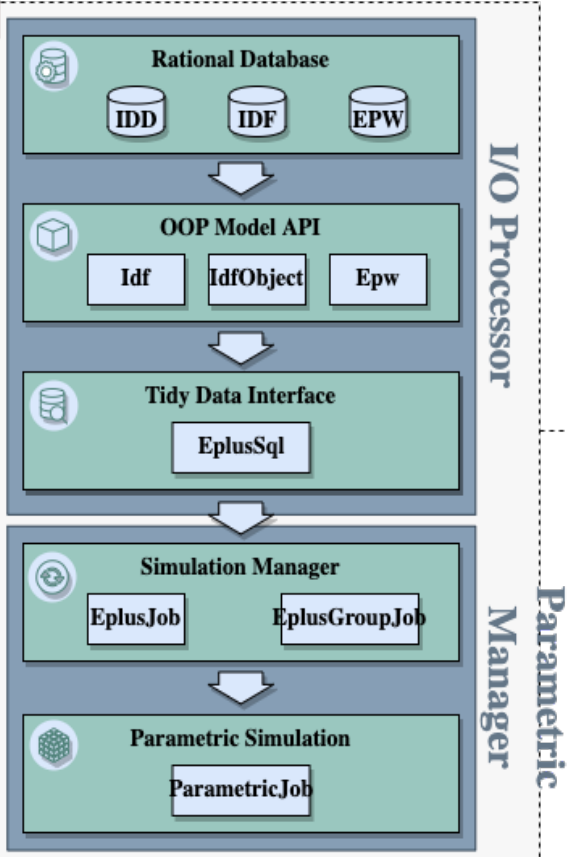


DesignBuilder



GenOpt  
Generic Optimization Program





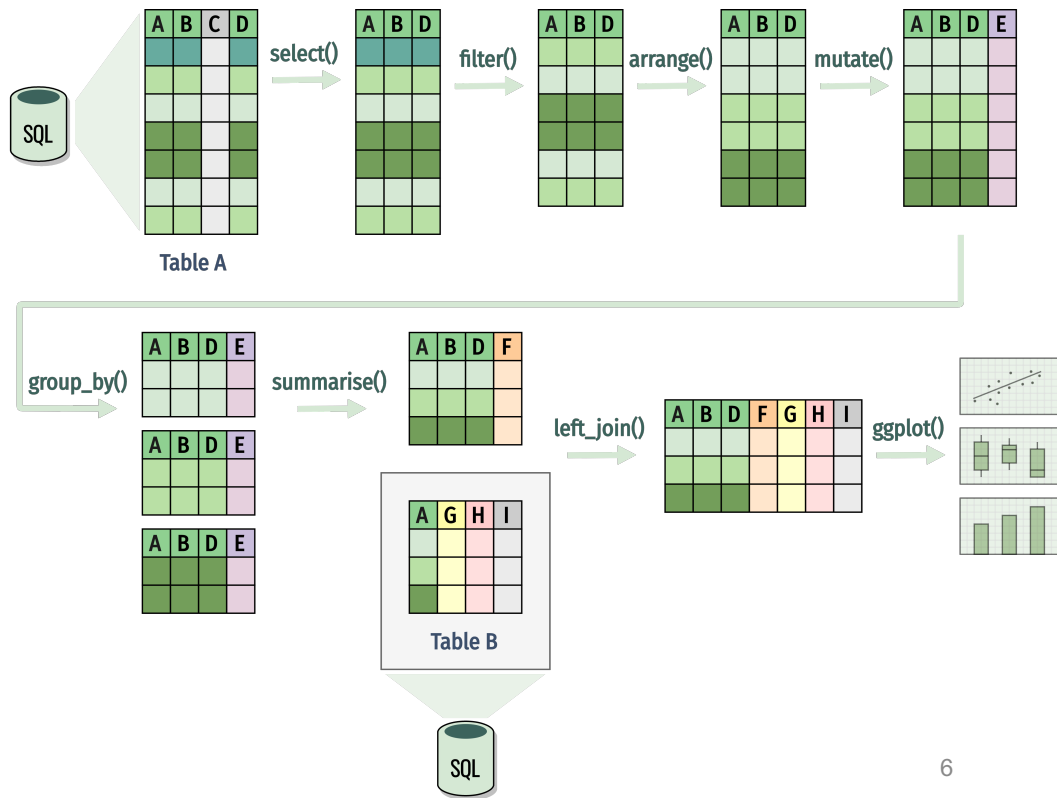
## Enabling Data Science via R

- I/O processor for structured I/O
- Parametric manager for flexible and extensible simulations

# Structured I/O

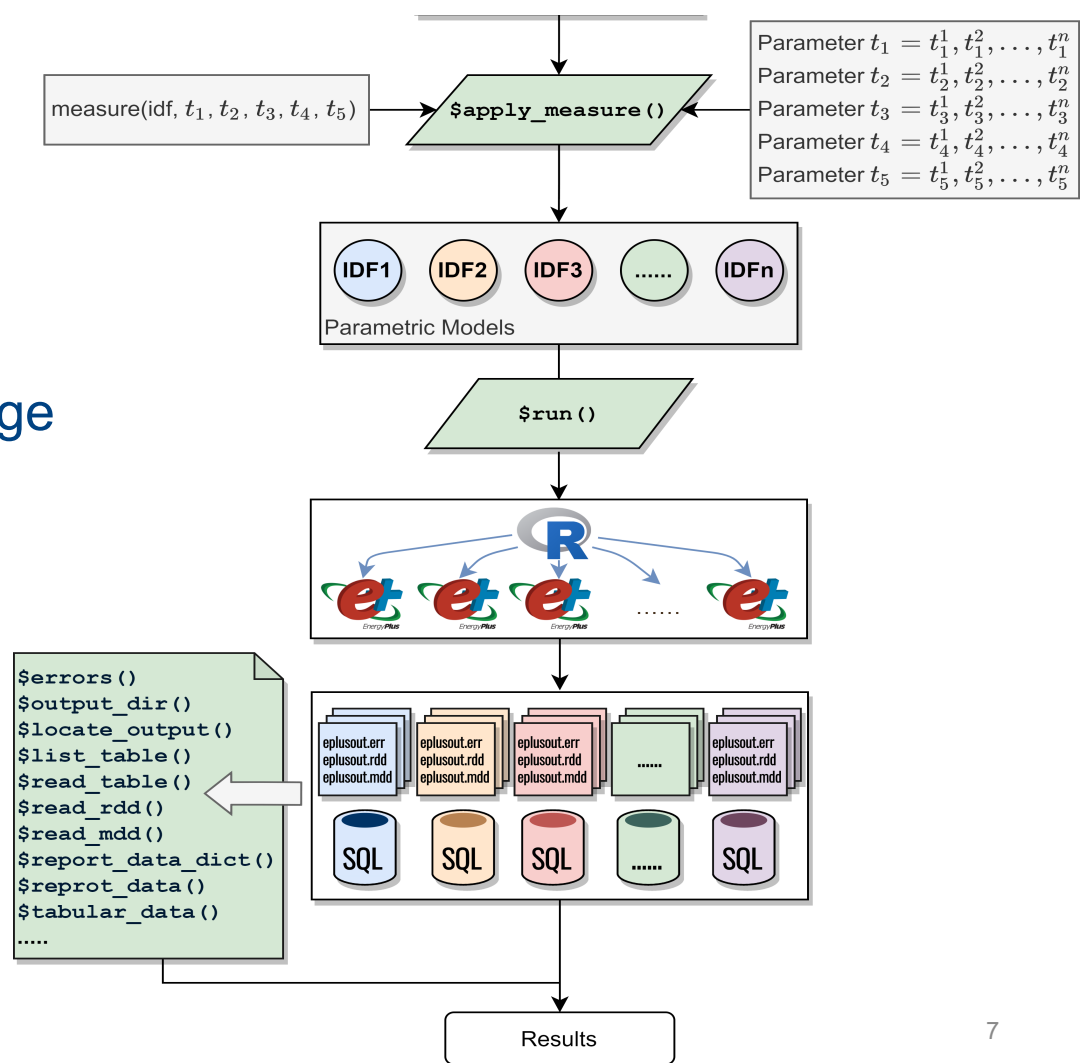
Relational Database | Object-oriented | Tidy data

- Large volumes of simulation data easily reduced to focus analysis on the most relevant data
- Take advantage of R data wrangling and visualization capabilities

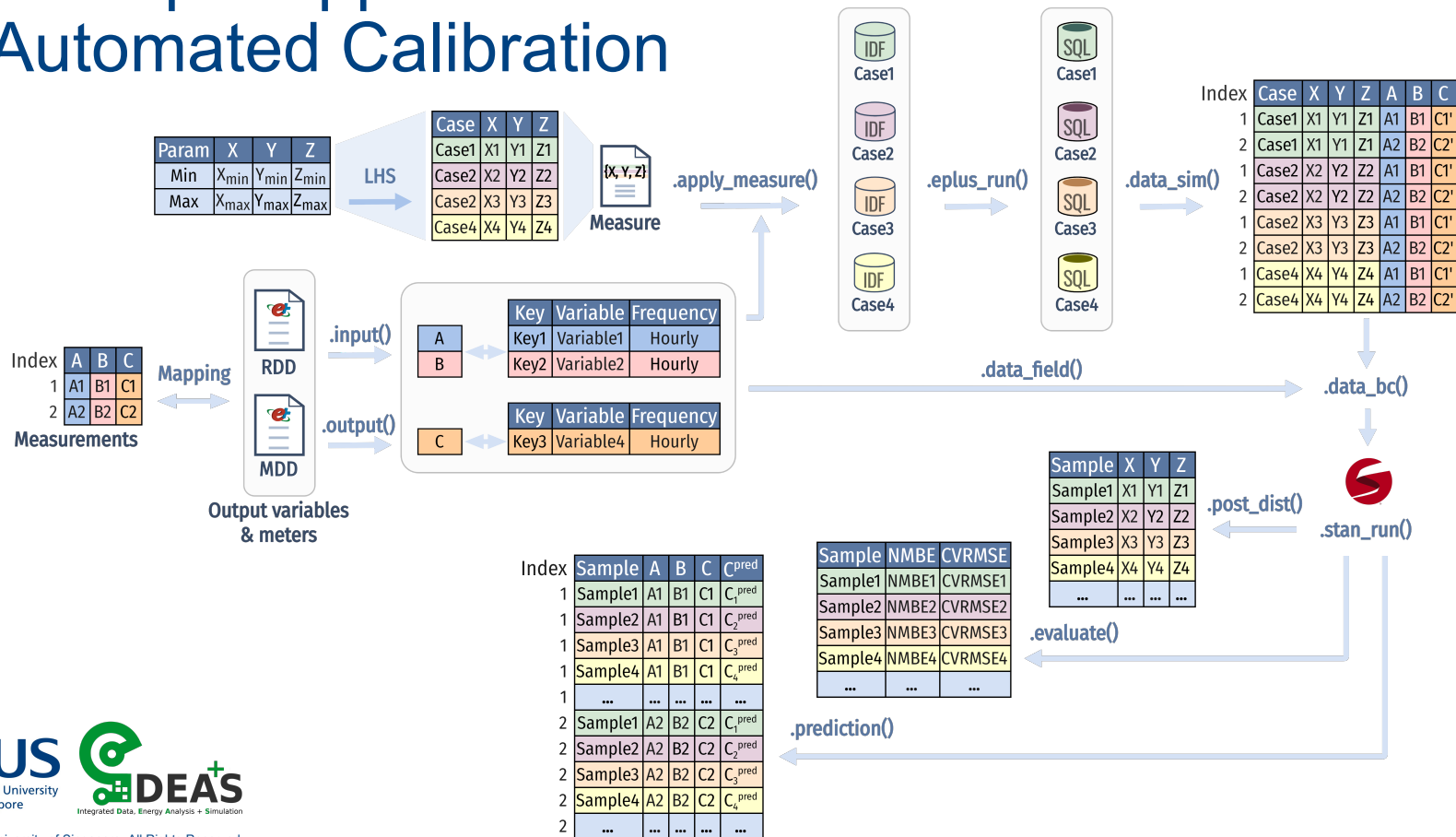


# Parametric Manager

- Easy management of large parametric simulations
- Runs all parametric simulations in parallel



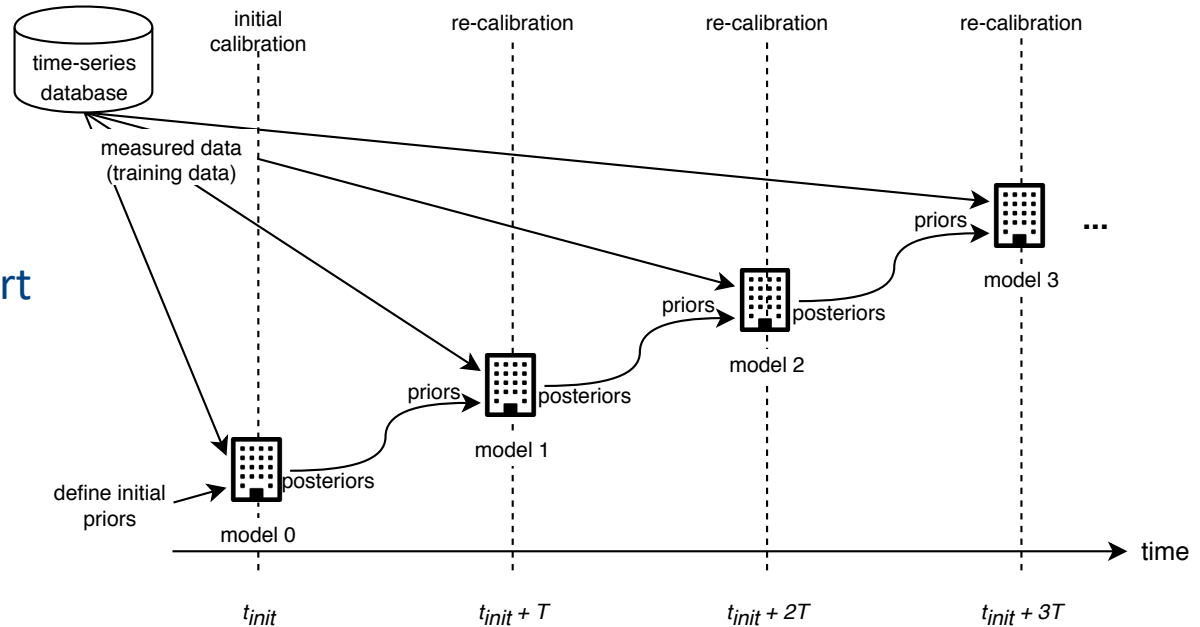
# Example Application: Automated Calibration





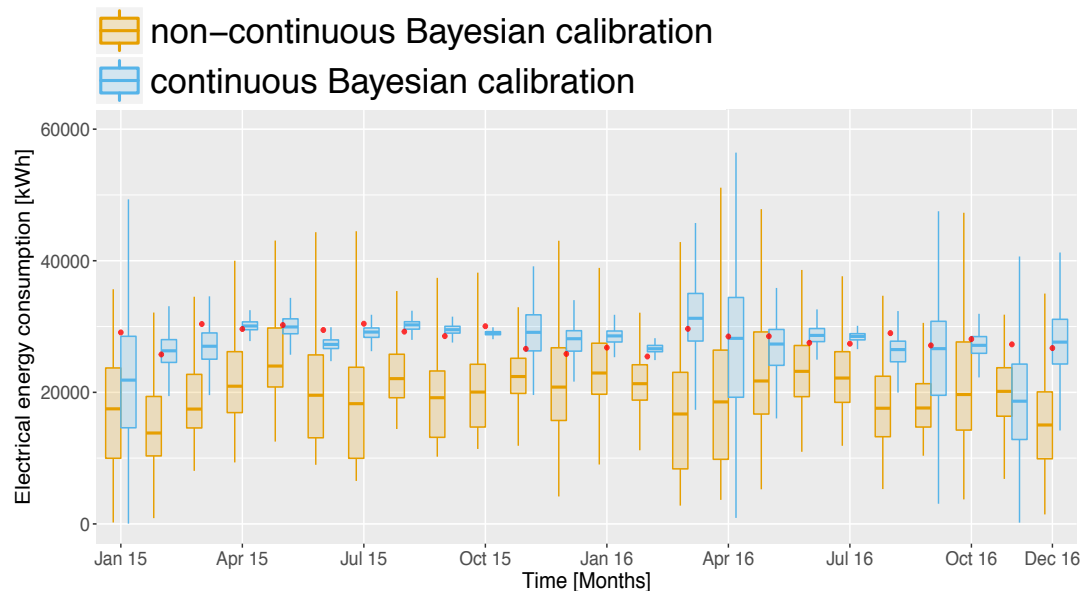
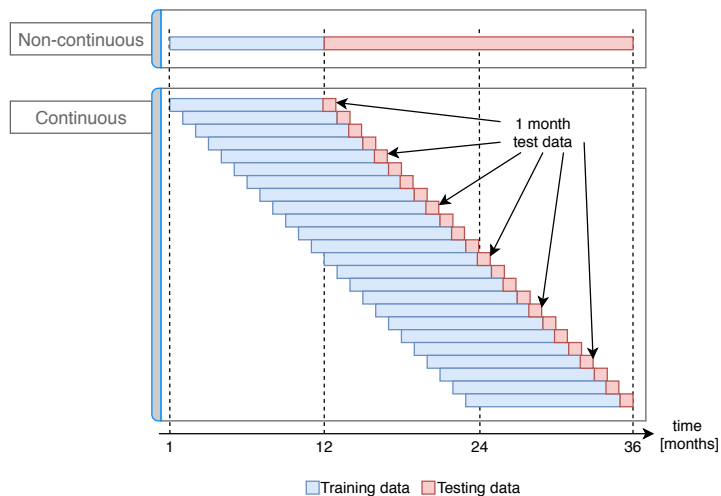
# Continuous Model Updating

Model continuously updated using real time data from smart meter if Web API available



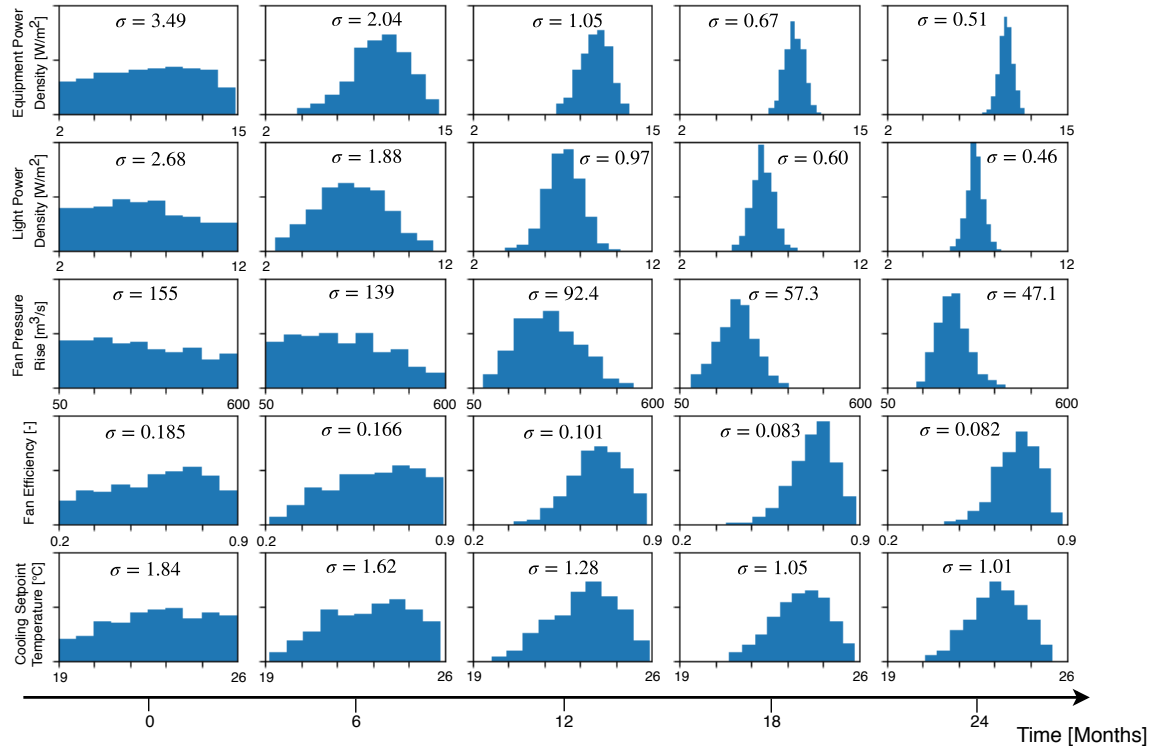
Chong, A., Xu, W., Chao, S., & Ngo, N. T. (2019). Continuous-time Bayesian calibration of energy models using BIM and energy data. *Energy and Buildings*, 194, 177-190.7.

# Continuous Model Updating



Metric	Predictions over	Predictions over testing data	
	Training data	Non-continuous (training = 12 months)	Continuous (training = 12 months)
CVMRSE [%]	1.04	29.78	10.12
NMBE [%]	-0.00	-28.41	-2.78

# Reductions in Posterior Uncertainties



# Our Free and Open-Source Developments

Released under the terms of MIT License



- Bayesian calibration using Stan



<https://github.com/adChong/bc-stan>



- eplusr – R package for integrating EnergyPlus with R

<https://github.com/hongyuanjia/eplusr> | <https://cran.r-project.org/web/packages/eplusr>



- epwshiftr – R package for creating climate change projection weather files for energy simulation

<https://github.com/ideas-lab-nus/epwshiftr> | <https://cran.r-project.org/web/packages/epwshiftr>

# R for Building Energy Simulation



<https://forms.office.com/r/Auv6wnH6Xj>

Free, Open-Access, Web-based Book

A screenshot of the book's website interface. On the left is a table of contents with sections like '1 R Basics', '2 Explore', '3 Modify', '4 Program', and '5 Calibrate'. The main content area on the right shows the book title 'R for Building Energy Simulation', the author 'Adrian Chong', the date '2021-06-16', and a 'Preface' section. The preface text describes the book's purpose and learning approach. Below the preface is a 'Structure of this book' section and a 'Prerequisites' section.

1 R Basics

- 1.1 Coding fundamentals in R
- 1.2 Importing data
- 1.3 Tidy data
- 1.4 Dates and times
- 1.5 Pipes
- 1.6 Regular expressions
- 1.7 Functions
- 1.8 Cheatsheets

2 Explore

- 2.1 Specify outputs
- 2.2 Visualizing data

3 Modify

- 3.1 Parse model
- 3.2 Model structure
- 3.3 Object interdependencies
- 3.4 Modify inputs

4 Program

- 4.1 Measures
- 4.2 Parametric simulation
- 4.3 Optimization

5 Calibrate

- 5.1 Sensitivity analysis
- 5.2 Optimization
- 5.3 Bayesian calibration

## R for Building Energy Simulation

*Adrian Chong*

2021-06-16

### Preface

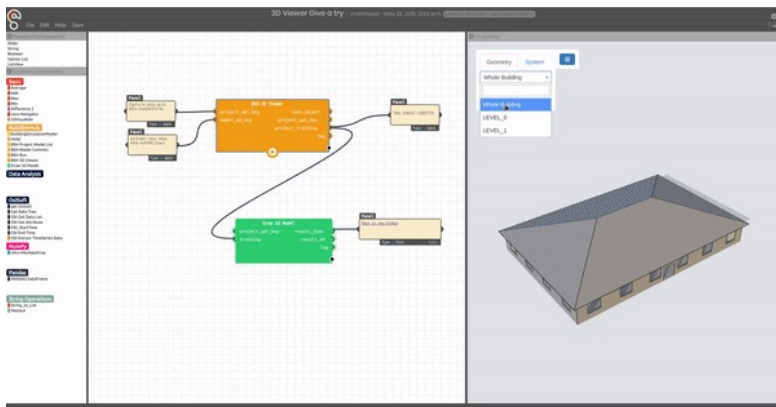
This is the website for the module **PF4213-Building Energy Analysis and Simulation** at the National University of Singapore. This book will introduce you to building energy simulation and how to perform data analytics with energy models using R. You will learn how to get your model into R, simulate it, transform the inputs and outputs, and visualize and explore them. This book is designed to be interactive and for you to **learn by doing**. It is highly recommended that you do not copy and paste all the code in this book but instead type them out. Copying and pasting snippets of code isn't the best way to learn because more often than not you are just reading the code at an abstract level without understanding what it does. In contrast, typing the code forces you to try to understand what the code is doing.

### Structure of this book

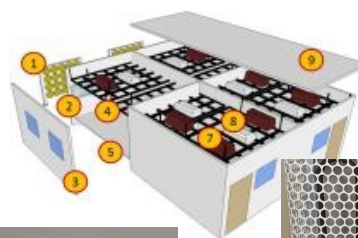
### Prerequisites

# What's Next

Open-source web-based  
visual programming interface



High quality open dataset +  
open model





# THANK YOU



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<https://ideaslab.io>