GIVE BRAIN TO BUILDINGS' ENERGY SYSTEMS

From reactive to predictive control: Smart Building Platform for energy and comfort optimisation

TU Delft
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SPECTRAL

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About me

- MSc in Electrical Engineering & Energy Technology (MPEI & LUT)
- Background in Renewable Energy & Building Performance Simulation (ERI-RAS, RuGBC & ENGEX)
- PDEng in Smart Buildings & Cities (TU/e BPS, SEAC & BIPV Nederlands)
- Smart Buildings Engineer at Spectral

Dmitry V. Surugin

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Smart Building Platform

- Building performance monitoring & real-time data visualization
- Detecting inefficiencies & abnormalities
- Portfolio-wide benchmarking & financial analytics
- Environmental sensing & submetering
- Fully-automated building control towards energy efficiency & comfort

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AI implications for smart buildings
in monitoring, analytics & predictive control

- Fault detection & preventive maintenance: proactive alarms for timely interventions
- Improving thermal comfort: merging PMV & AMV - data from sensors and occupants' feedback
- Forecasting energy consumption using weather & occupancy estimates
- Building control - predictive energy optimisation

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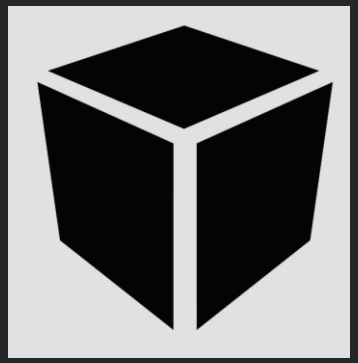
Thermal models for building control

physics-based & data driven



Black-box models

Physical processes in real buildings are too complex to be captured

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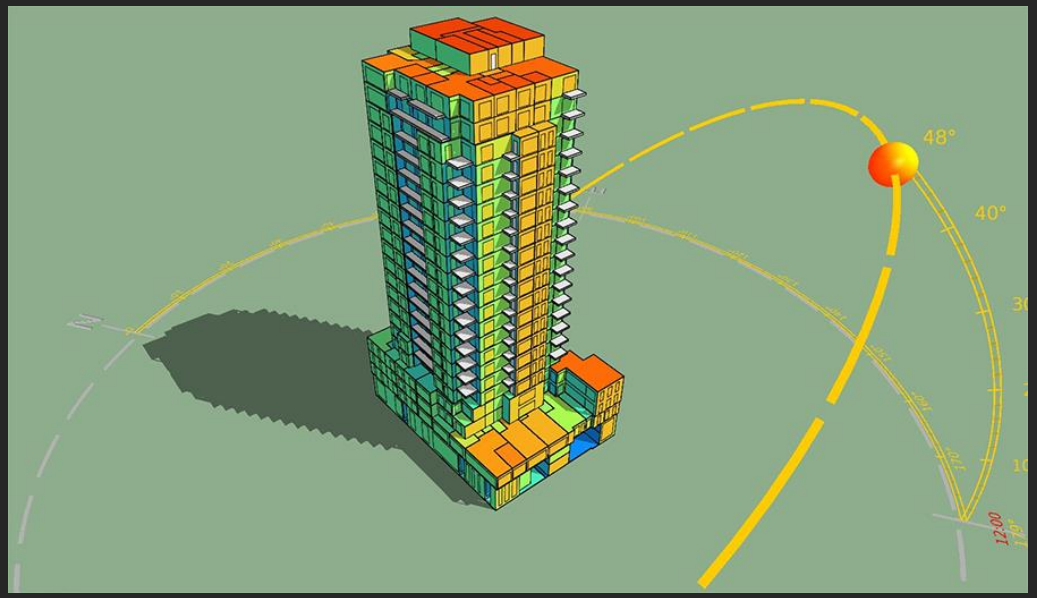
Building Energy Modelling & Performance Simulation

white-box approach



- 3D-building geometry
- Typical meteorological data
- Building constructions
- Plant/occupancy profiles
- Internal heat gains
- Ventilation rates
- HVAC systems

- Need for calibration simulations (e.g. data from energy meters, temperature sensors)
- Need for the runtime operation & optimisation (e.g. coupling E+ with BCVTB)

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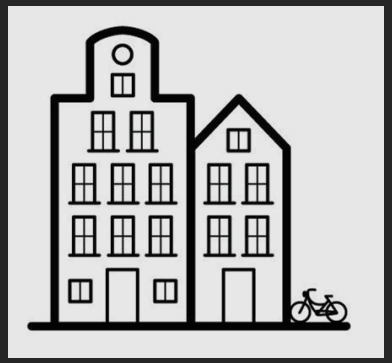
Thermal models for building control

physics-based & data driven



White-box models - building performance simulations

The prior knowledge of building is not comprehensive enough

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Thermal models for building control

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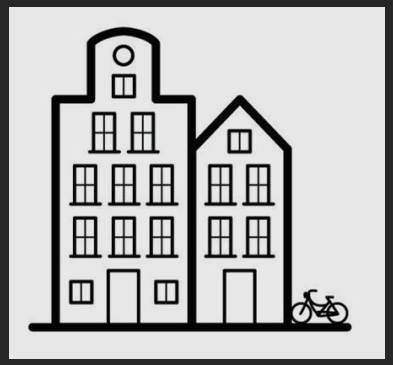

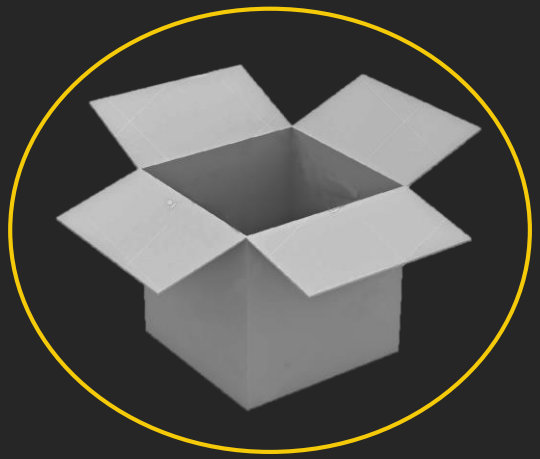

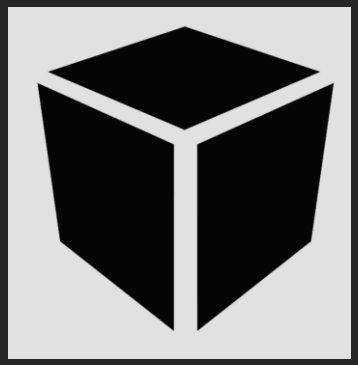

Grey-box

Effective to achieve a suitable characterisation of buildings' thermal response of buildings in a short time

ML to tackle the gap between predicted & actual performance

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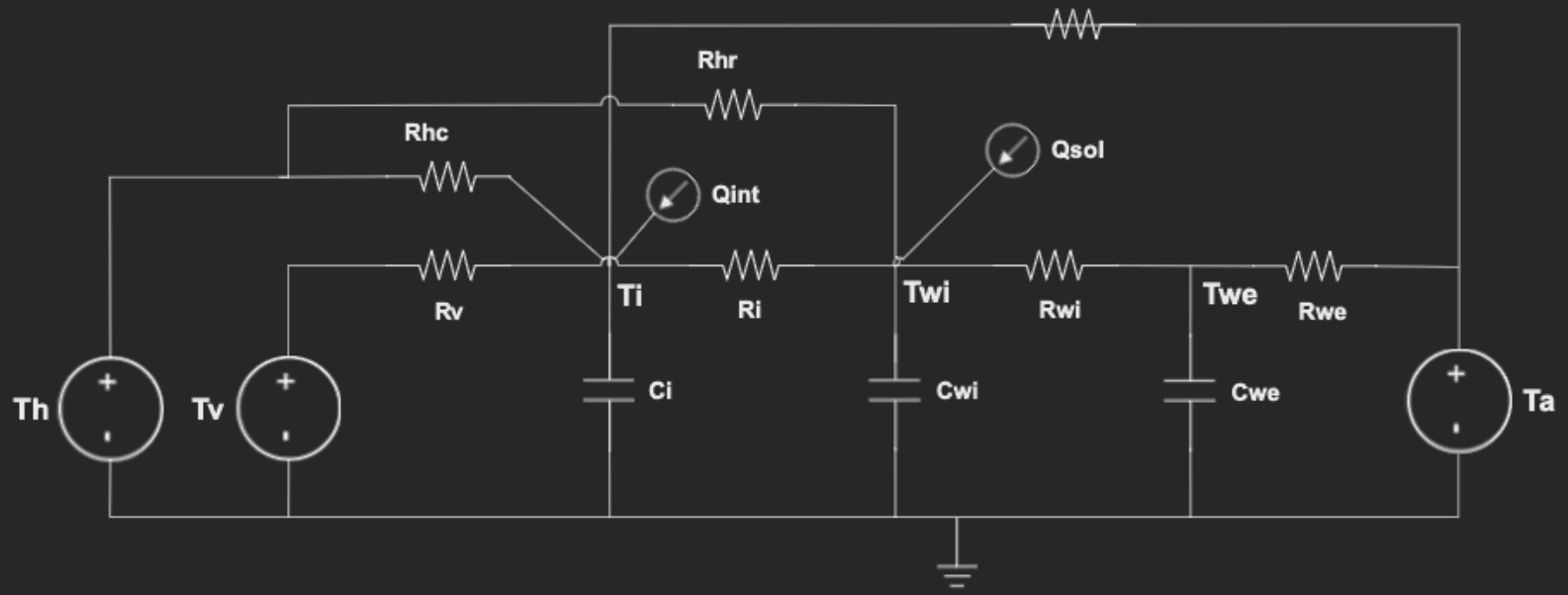
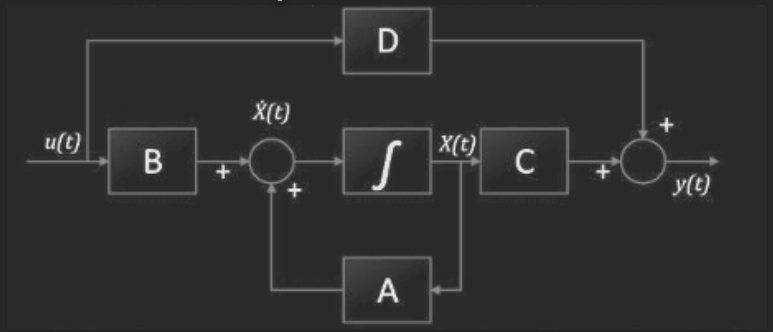
Grey-box building models for MPC

RC-circuits as a core



State-space formulation



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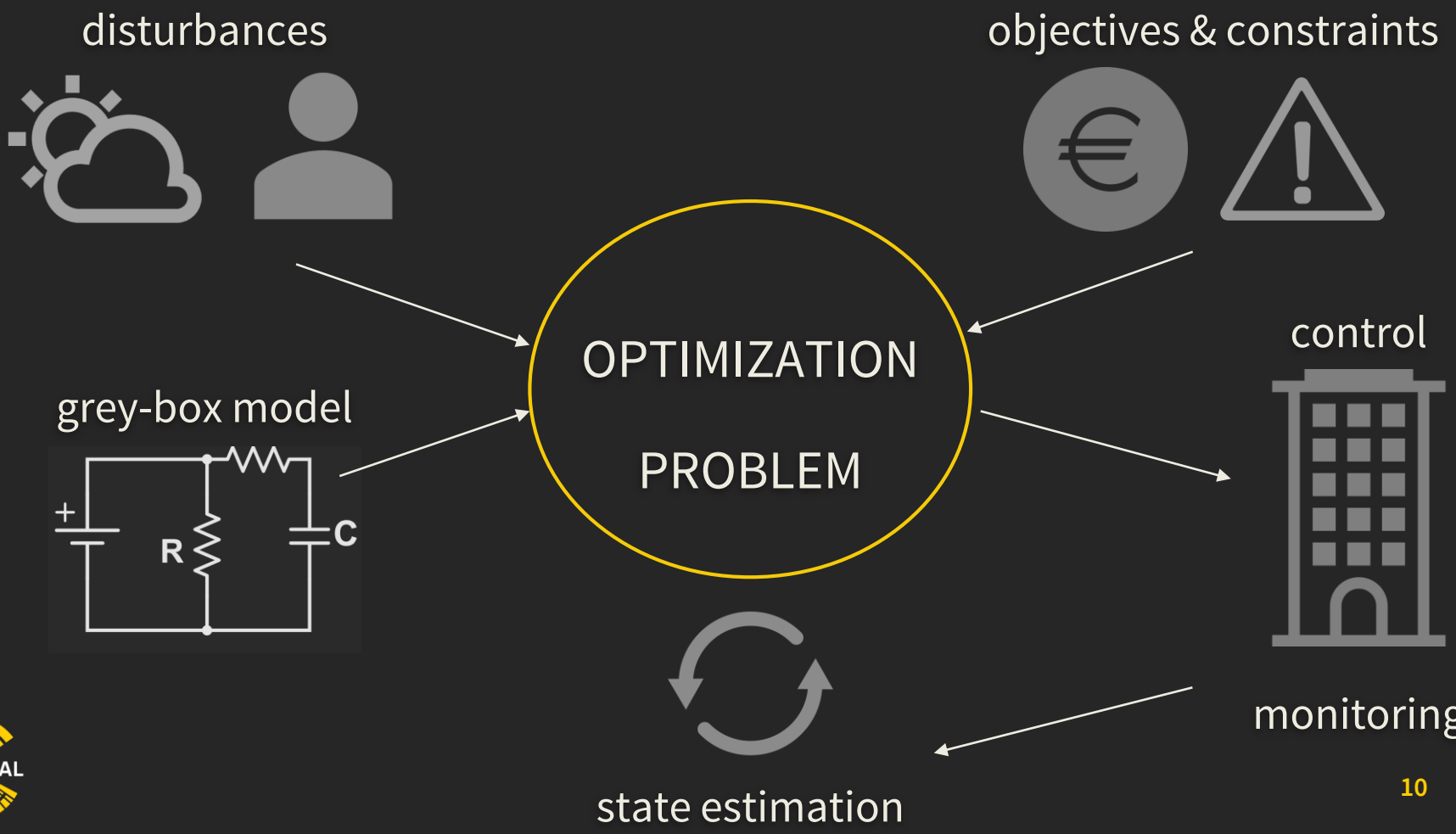
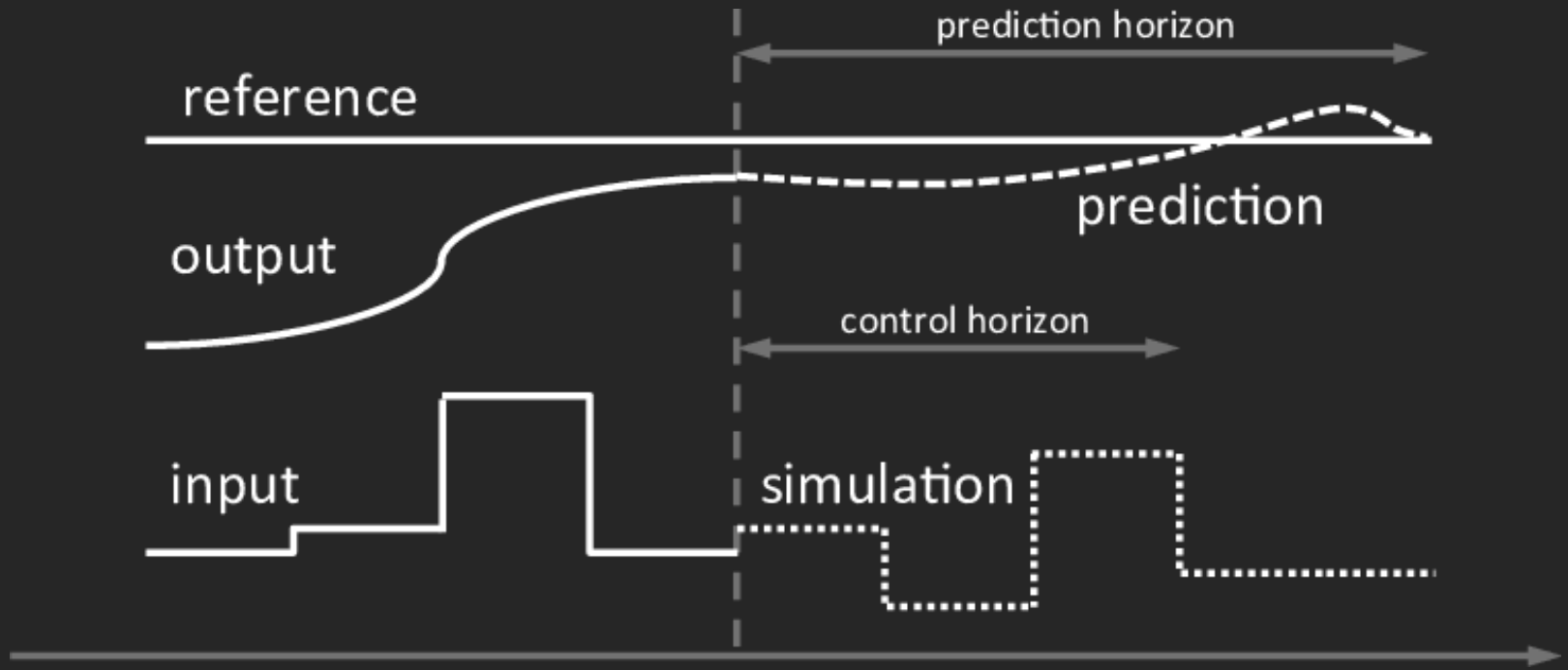
Grey-box building models for MPC

MPC framework



Grey-box building models for MPC

Moving horizon optimization



Using “digital twin” for MPC - implementing rolling horizon optimization on top of tuned RC-model with day-ahead forecasts, prices, comfort constraints

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Grey-box building models for MPC

Challenges we face

- Preparing reliable data for model training & parameter estimation
  - Missing building information & HVAC specifications
  - Unreliable & non-calibrated sensors
  - Wrongly mapped BMS registers
- Creating thermal model for predictive control
  - Finding optimal complexity - avoiding over-parameterization & non-representativeness
  - Comparing model prediction to measurements - avoiding over/under-fitting
  - Control granularity - limited availability of sensors & actuation points
  - Scalability and adaptability - creating replicable models to streamline the process
- Implementing MPC
  - Dealing with uncertainties - measurements, model, disturbances (occupants, weather)
  - Multiple conflicting optimization objectives

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Thank you!

Dank je wel!
Spasibo!
Kiitos paljon!

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