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# Adaptive learning-based time series prediction framework for building energy management

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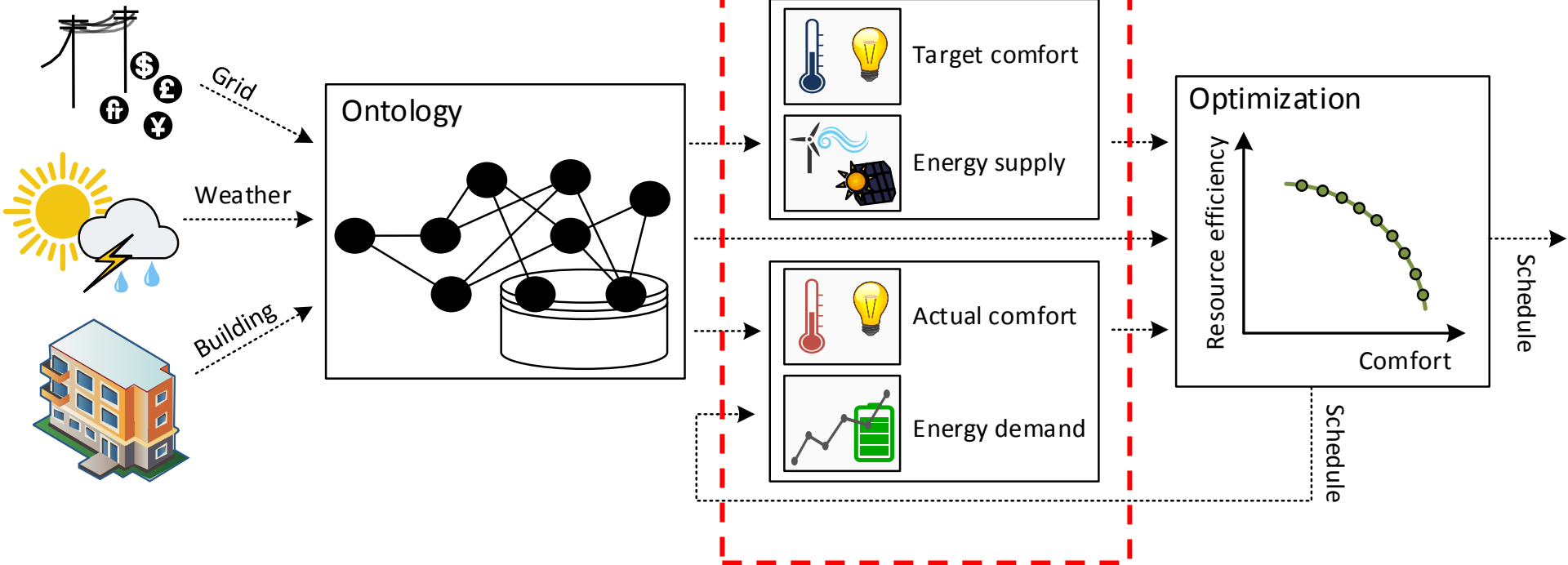
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# Motivation



- Importance of building energy management
  - Knowledge about (building) process behavior
    - Precondition for optimization
    - Expensive engineering approach
    - Inherent in monitoring data
- **Ontology-based prediction framework**

# Framework design



# Model identification



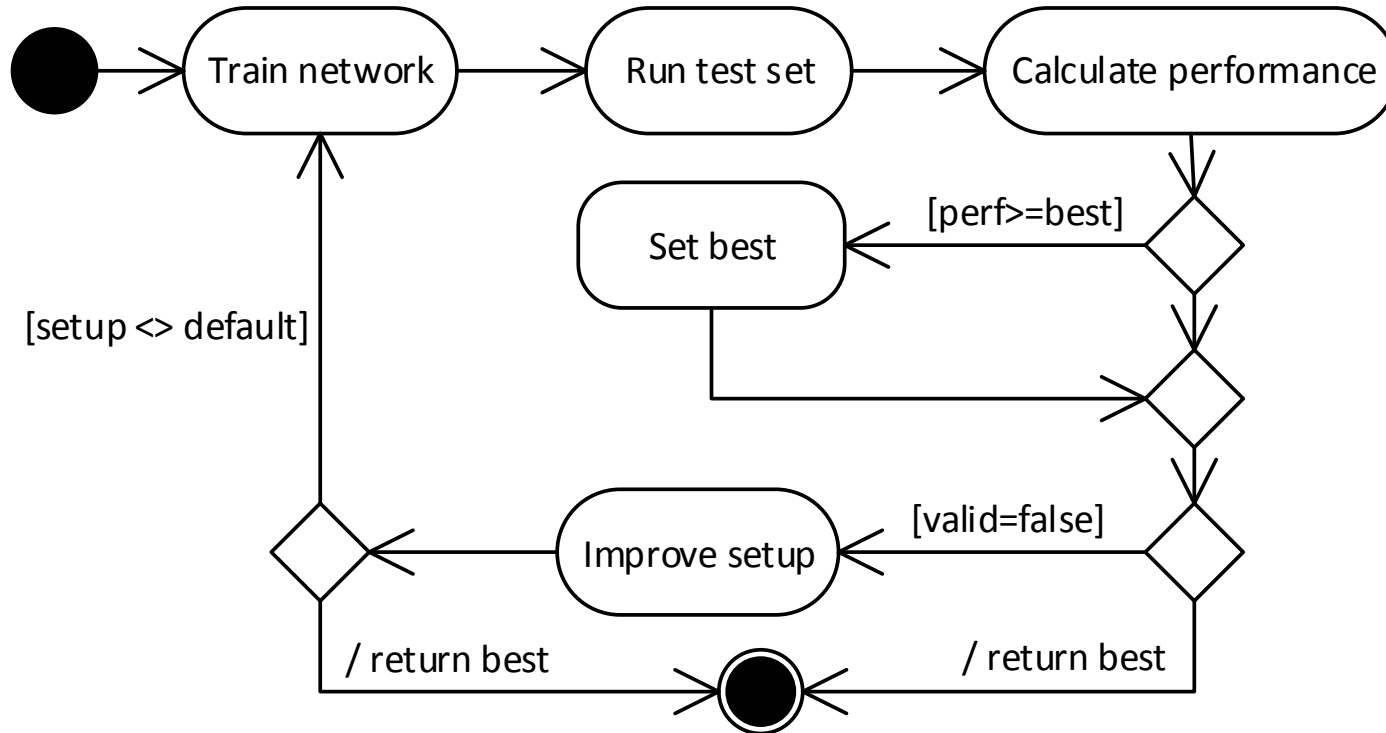
- Ontology as basis
- Interpret context information
- Find services for
  - Energy production
  - Comfort targets
  - Energy consumption
  - Comfort influences

# Model identification

```
SELECT DISTINCT ?data ?zone ?type ?parent
WHERE
{
  ?data rdf:type sc:DataService.
  ?data s
  ?data s
  ?contro
  ?data s
  ?contro
  ?paramD
  ?paramC
  ?type r
}
```

Data	Zone	Type	Parent
indoor_temp	office_3	TemperatureParameter	outdoor_temperature
			outdoor_radiation
indoor_hum	office_2	HumidityParameter	outdoor_temperature
			indoor_temperature
...	...	...	...

# Network design scheme



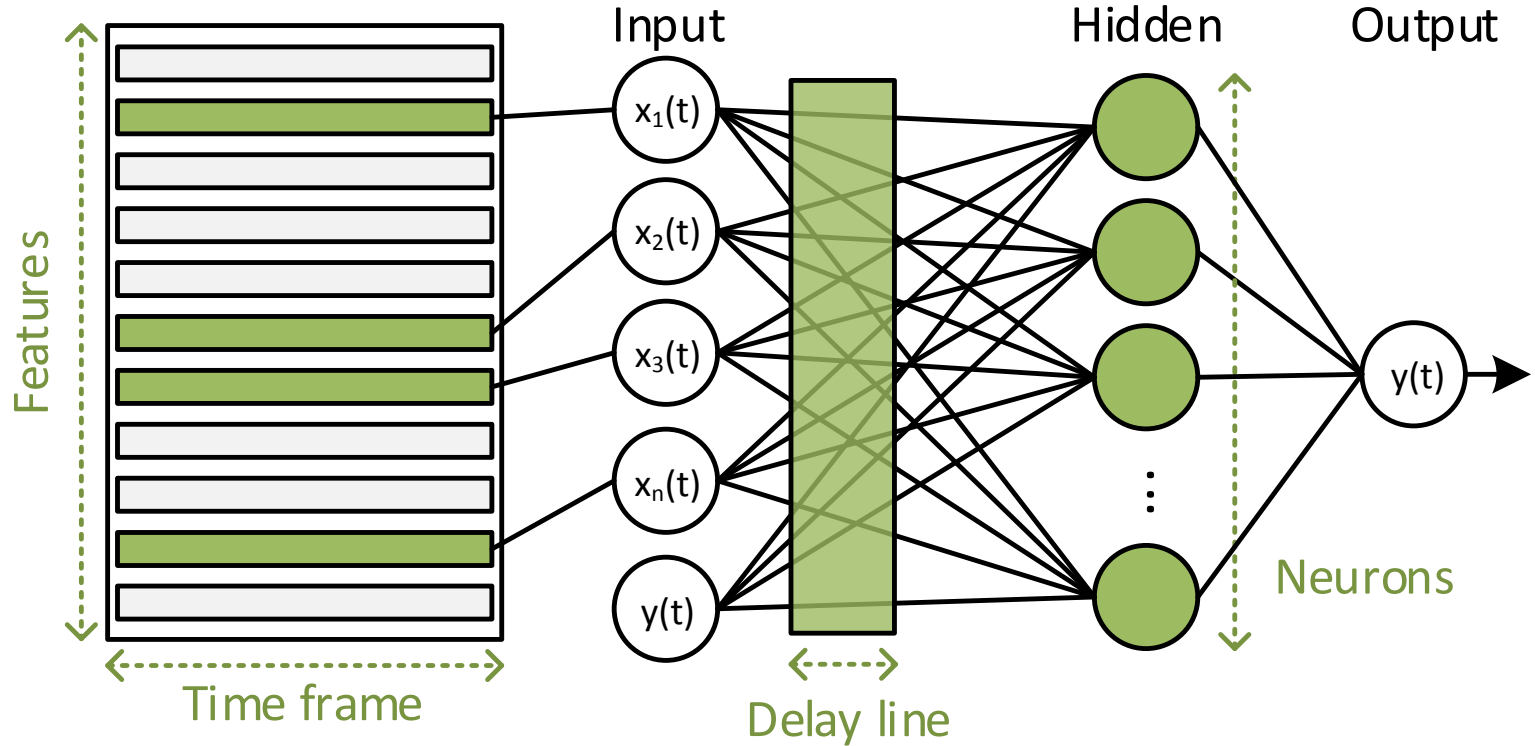
# Performance calculation



- Comparison to thresholds
- Indication of retraining or modification
- Utilization of monitoring data
- Measures based on forecast error
- Calculation of weighted, relative deviation from threshold
- Ranking of forecast models



# Improvement heuristic



# Improvement heuristic



- Ordering of variables
  1. Feature set
  2. Length of time frame
  3. Hidden neurons
  4. Delay line
- Not all permutations tested
- Termination after  $n$  unsuccessful steps

# Online assessment



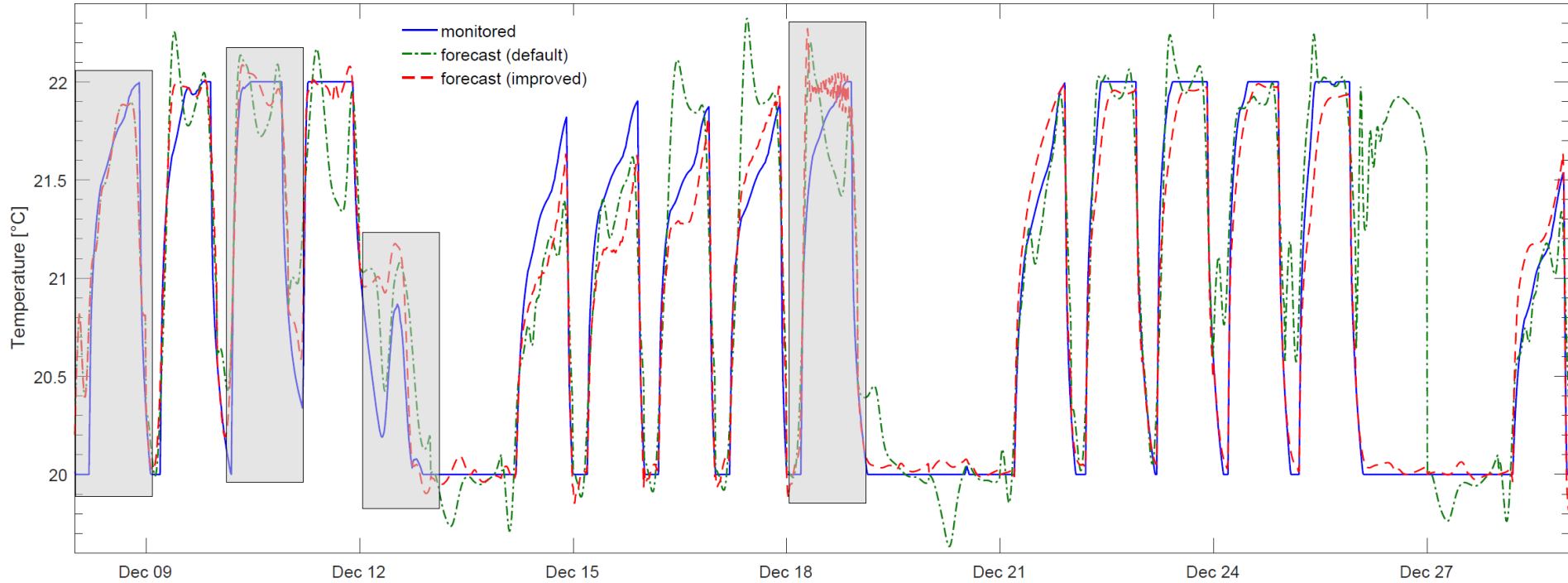
- Integration into optimization workflow
- Triggered by monitoring data
- Continuous evaluation
- Optional reconfiguration
- Mobile training principle

# Evaluation



- Simulation framework: EnergyPlus
- Building: office building
- Size: 3 floor with 5 zones
- Location: Vienna, Austria
- Systems:
  - PV production
  - Controllable HVAC system

# Evaluation



# Evaluation



- Importance of training set
- Careful selection of thresholds and weights
- Gradual adjustment of thresholds
- Performance trends instead of ex post assessment
- Filters for smoothing
- Suitable alternative to expert modeling
- Transparent and automatic integration

# Conclusion



- **Data-driven modeling of building processes**
  - Comfort and energy-related time series
  - Automation model creation
  - Continuous evaluation and improvement
- **Future work**
  - Trend approximation
  - Heuristic for default configuration
  - Automatic threshold determination

**Thank you!**



**FFG**



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STIPENDIEN

