

# Model-Based Systems Engineering → Semantics

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# Overview

1 Systems Engineering Drivers

2 Model-based Systems Engineering

3 Ontologies and Ontology-Enabled Computing

4 Ontology-Enabled Computing at JPL (2000-2006)

5 The Data-Ontology-Rule Footing

**Part 3**

6 Case Study: Detection and Diagnostic Analysis of Faults in Buildings





## The Data-Ontology-Rule Footing

Building Block for Semantic Modeling and  
Event-driven Execution of Multi-Domain Systems

MSSE/Ph.D. (Civil Systems) Students

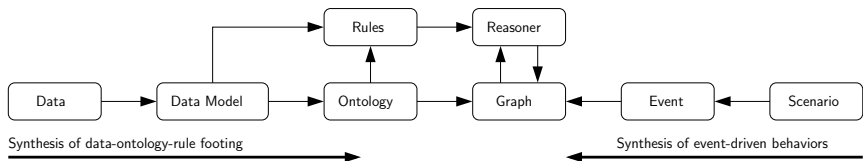
- ① Parastoo Delgoshaei (2013-2017);
- ② Maria Coelho (2015-present).

# Data-Driven Approach

## Guiding Principles:

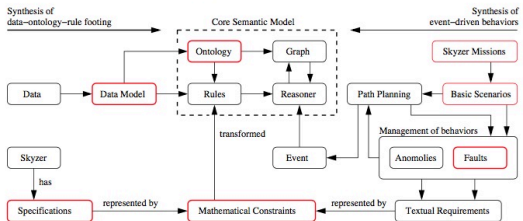
- 1 One footing for ontologies, rules and data ...
- 2 Use (but do not extend) foundational level ontologies ...
- 3 Ontologies visit data models to get individuals ...
- 4 Semantic graph dynamically responds to incoming events ...
- 5 Enhance power of rules with backend functions ...

## Preliminary Schematic:

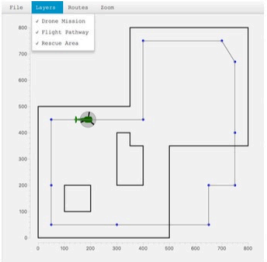


# Data-Driven Approach (Synthesis of UAV Operations)

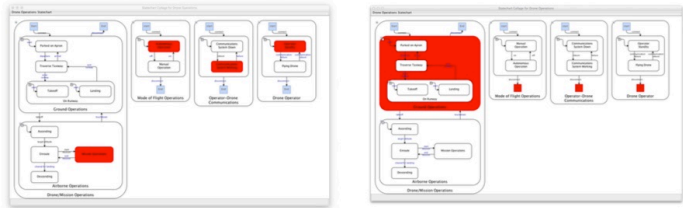
## Synthesis of data-ontology-rule footing + event-driven behaviors.



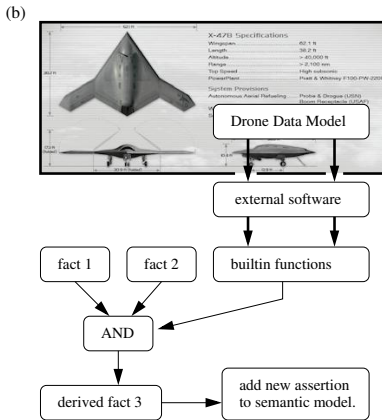
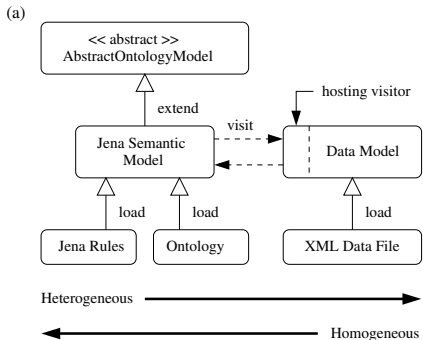
## Simulation in Whistle ...



## Visualization of subsystem behaviors ...



# Data-Driven Approach (Populating Models with Data)







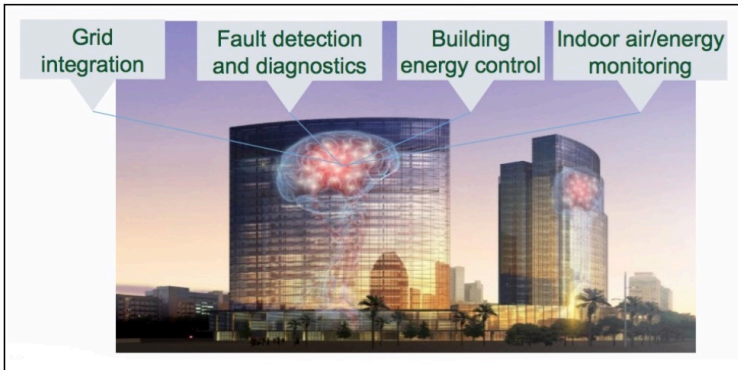
# Case Study

## Detection and Diagnostic Analysis of Faults in HVAC Equipment

Source: Delgoshaei and Austin, 2017.

# Fault Detection in Buildings

## Example 1: Buildings that Think! (Work at NIST / UMD, 2017)



**Research Question:** How to use **AI / Semantics** to bring **data**, **context** and **algorithms** together for **decision making**?

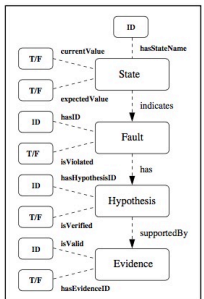
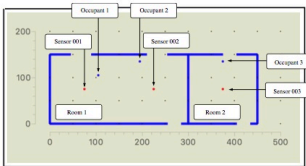
Legend: data = building geometry; context = occupant behavior; algorithms = reasoning.



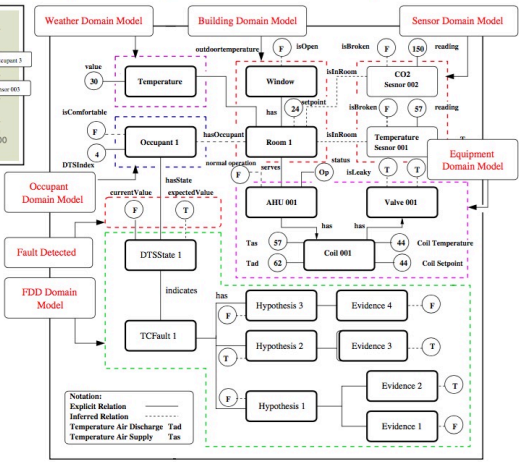


# Multi-Domain Rule-based Reasoning

## Case Study Problem

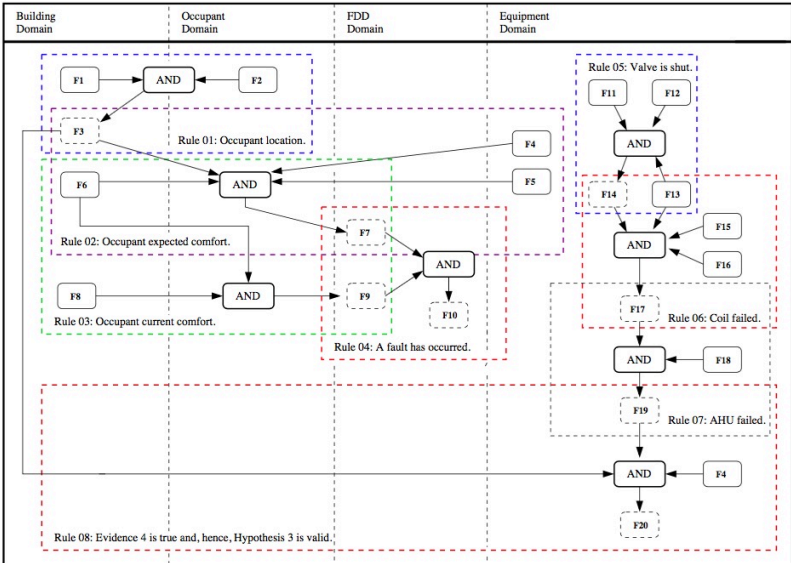


## Snapshot of Fully Assembled Semantic Graph



# Multi-Domain Rule-based Reasoning

## Snapshot of Multi-Domain Evaluation and Forward Chaining of Rules



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