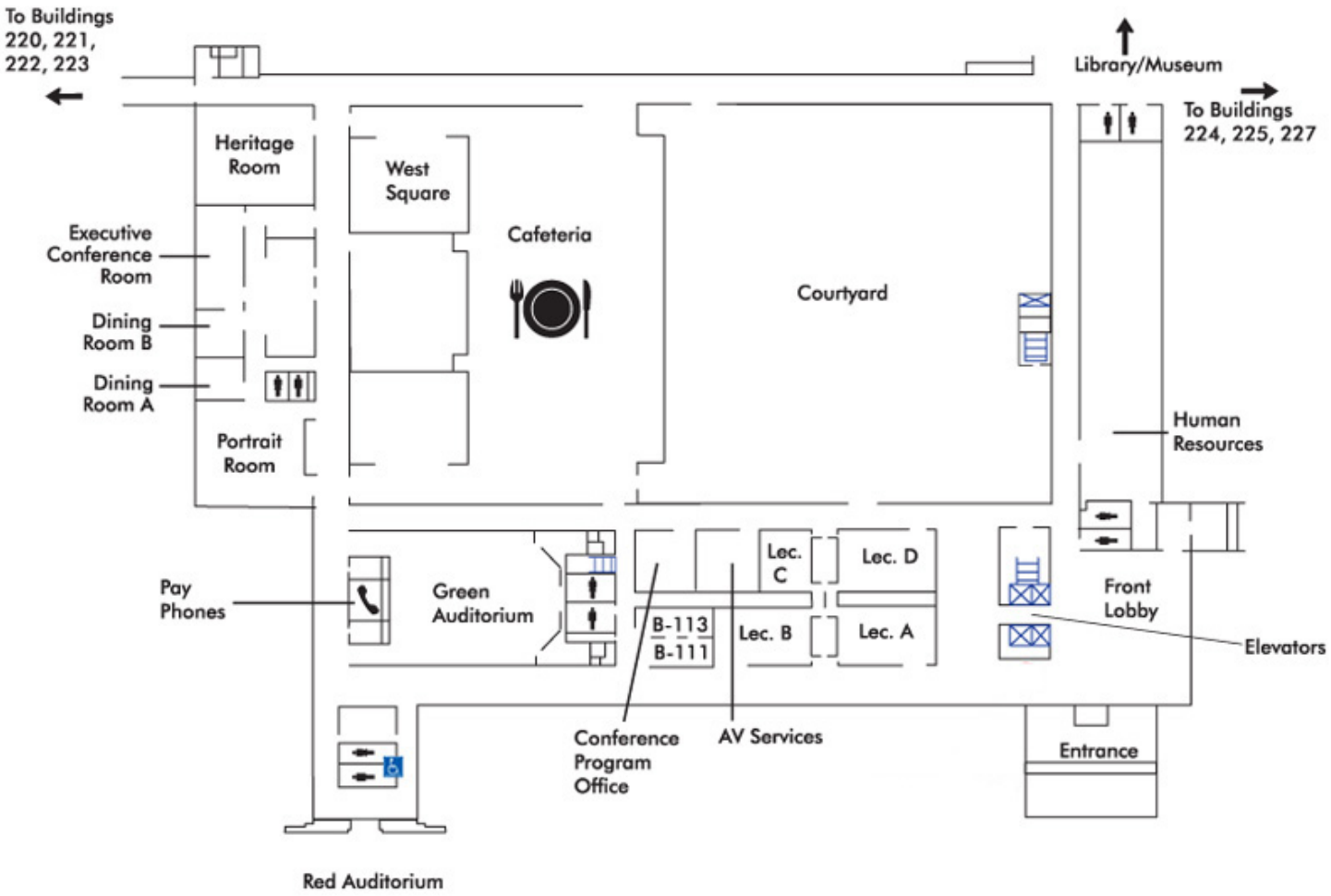
# Welcome to NIST!

Orientation:



# Why NIST?

**Mission**: To promote U.S. innovation and industrial competitiveness...

NIST is a branch of the US Department of **Commerce**.

NIST acts as an interface for academia & industry.

**Some Interests around NIST**:

- Internet of Things
- Cyberphysical Systems
- Systems of Systems
- Global Supply Chain Integration
- Software Security and Specification
- Data Integration
- New Material Design
- Scientific Reproducibility

# Some common themes

| | |
|---|---|
| **Heterogeneity** | In components, interfaces, protocols, etc. |
| **Composition(ality)** | How do the pieces fit together, and what happens when they do? |
| **Joint Cognition** | What tasks should be delegated to humans vs. machines, and what should be provided to support those tasks? |
| **Multiplicity of perspectives** | Large teams, many scales, many sciences, many economic roles. |

# Some common themes

| | | | |
|---|---|---|---|
| **Heterogeneity** | In components, interfaces, protocols, etc. | Information Management | Representation |
| **Composition(ality)** | How do the pieces fit together, and what happens when they do? | | Analysis |
| **Joint Cognition** | What tasks should be delegated to humans vs. machines, and what should be provided to support those tasks? | | Decision |
| **Multiplicity of perspectives** | Large teams, many scales, many sciences, many economic roles. | | Transformation |

# Model-Based/-Driven Engineering & Design

**Goal:** To model software & systems in sufficient fidelity to blueprint/specify analyses, simulation, testing, implementation, etc.

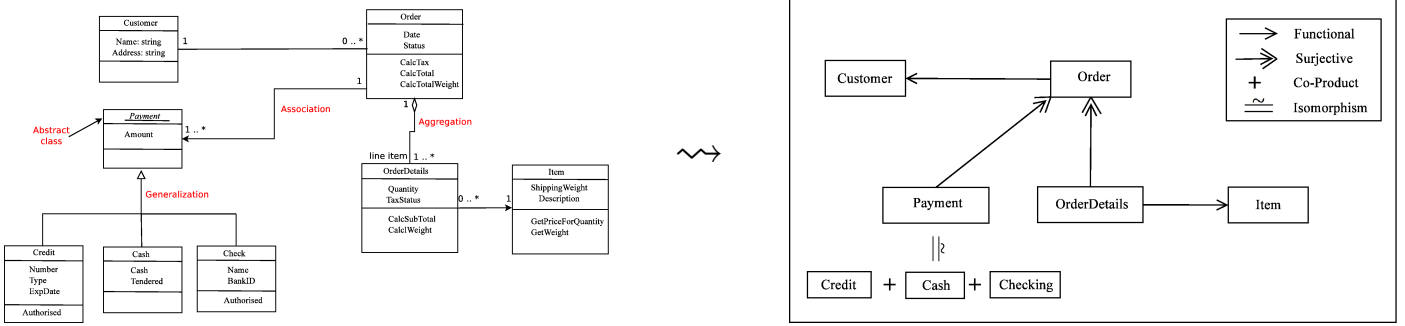
**Benefits:**
- Traceability from requirements to validation.
- Unified representation across all parties.
- Automated generation of tests, simulations, etc.
- Code generation

**Current Methods:** UML/SysML
Proprietary systems

**Some Problems:** Semantic ambiguity
Excessive complexity
Coherence between models
Slant towards software development

# From UML to CT: Class diagrams

| **UML Entity** | **CT Entity** |
|---|---|
| Class $C$, Datatype $D$ | Objects $C$, $D$ |
| Attribute $a : D$ | Arrow $a : C \to D$ |
| Method $m(x : X) : D$ | Arrow $m : C\text{−state} \times \mathrm{X} \to \mathrm{C}\text{−state} \times \mathrm{D}$ |
| Association B — C | Span $B \leftarrow R \to C$ |
| Generalization B ⊳— C | Monic $B \rightarrowtail C$ |
| Agg/Comp, Nav, Dep | ... |

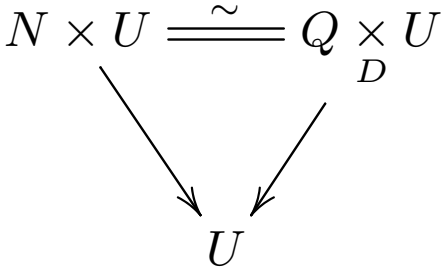


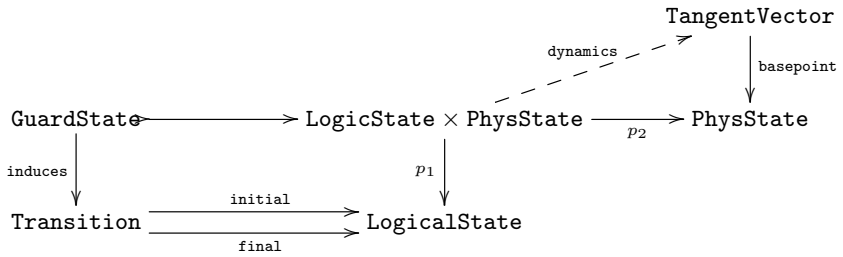

Joint with S. Padi & E. Subrahmanian

# Modeling with categories

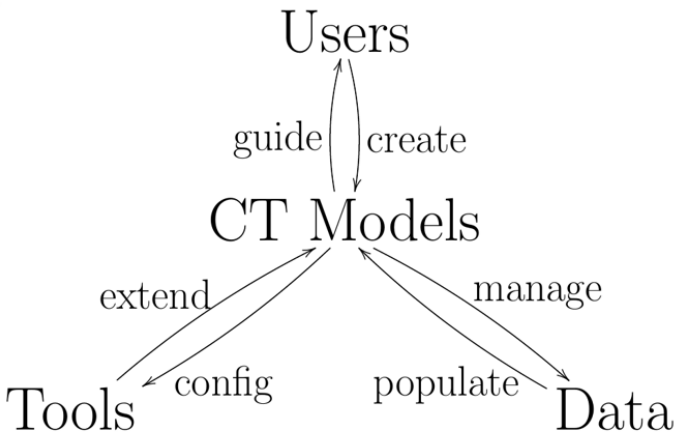
Main tools: Ontology logs represent static entities and relationships.
String diagrams represent processes and interactions.
Functors define relationships between models.

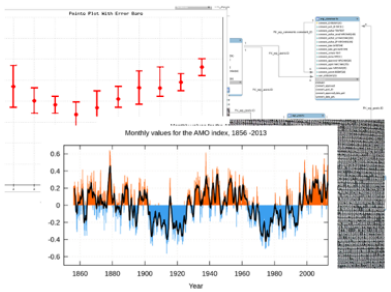
Big benefits Mathematical models with unambiguous semantics.
Deep connections with modern math, physics & CS.
Generic methods, encouraging modularity.
Common framework for object- and meta-level concerns.



# A Conceptual Operating System

## Two main goals:

1) Foster collaboration and community.
2) Develop a landscape and roadmap for practical applications of CT.

# Goal 1: Collaboration & Community

Who's here:

- 16-18 academics: $\sim \frac{1}{2}$ CT oriented, $\sim \frac{1}{2}$ domain oriented
- 13-15 industry representatives: small businesses to multinationals, a few CT tools
- 10-12 government representatives: military, national labs, NSF

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Who's here (ideologically):

- $\sim$ 40% True Believers
- $\sim$ 20% Optimistic
- $\sim$ 30% Intrigued
- $\sim$ 10% Skeptical

# Goal 1: Collaboration & Community

Some potential outcomes:

| | |
|---|---|
| P2P | Papers/Projects, Internships, Grants, ... |
| Group | Special Issues/Edited Volumes, SIGs (Tools & Exposition), Local Workshops/Seminars, ... |
| Community | Portal, Platform, ... |

# Goal 2: Landscape & Roadmap

**What are the field's resources today?** People (who? where? what interests?), ideas (methods? use cases?), tool support (scope? capabilities?)

**What do we want for/from the field?** Applications (system modeling/design? formal verification? informatics?), tools (capabilities? UI/UX?), exposition (use cases? CT for X?)

**How do we get from here to there?** Focus & strategy, milestones, funding strategies, obstacles & risks, marketing & outreach

**Outcome:** NIST information report outlining current/future applied CT landscape and roadmap synthesized from (i) small group reports, (ii) individual comments and (iii) general discussion.

# Some observations

The positives:

- CT is more like a platform than an application.
- Like other platforms, CT can benefit from network effects.

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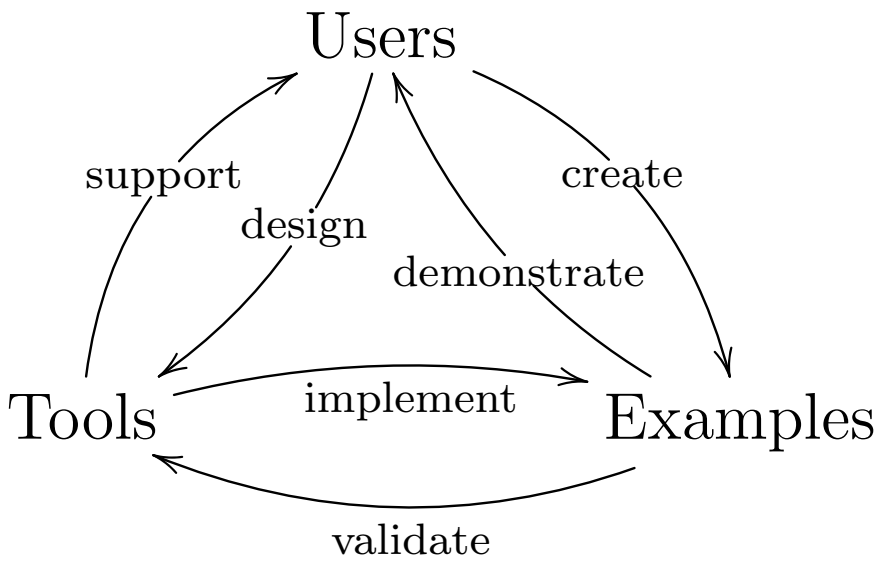
The negatives:

- The applied CT ecosystem faces a bootstrapping problem.



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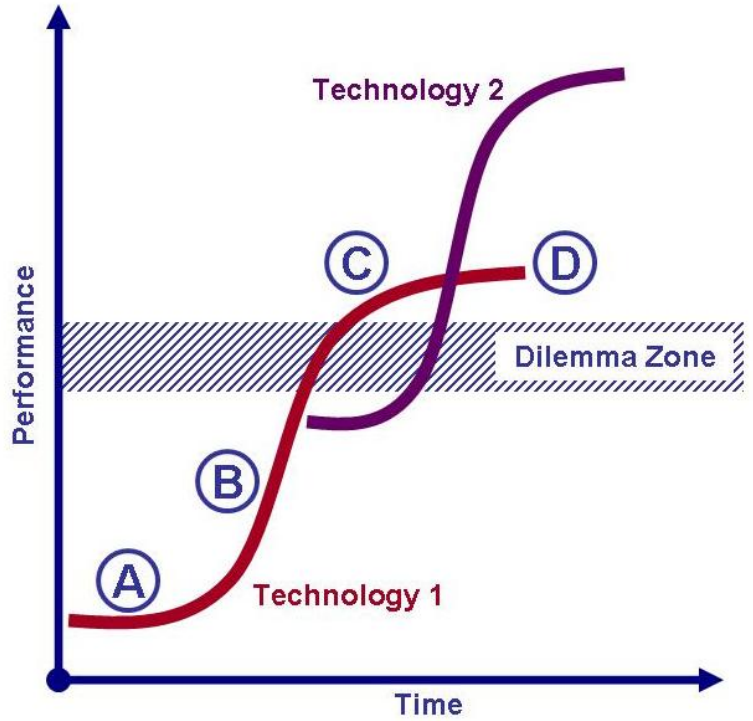
The positives:

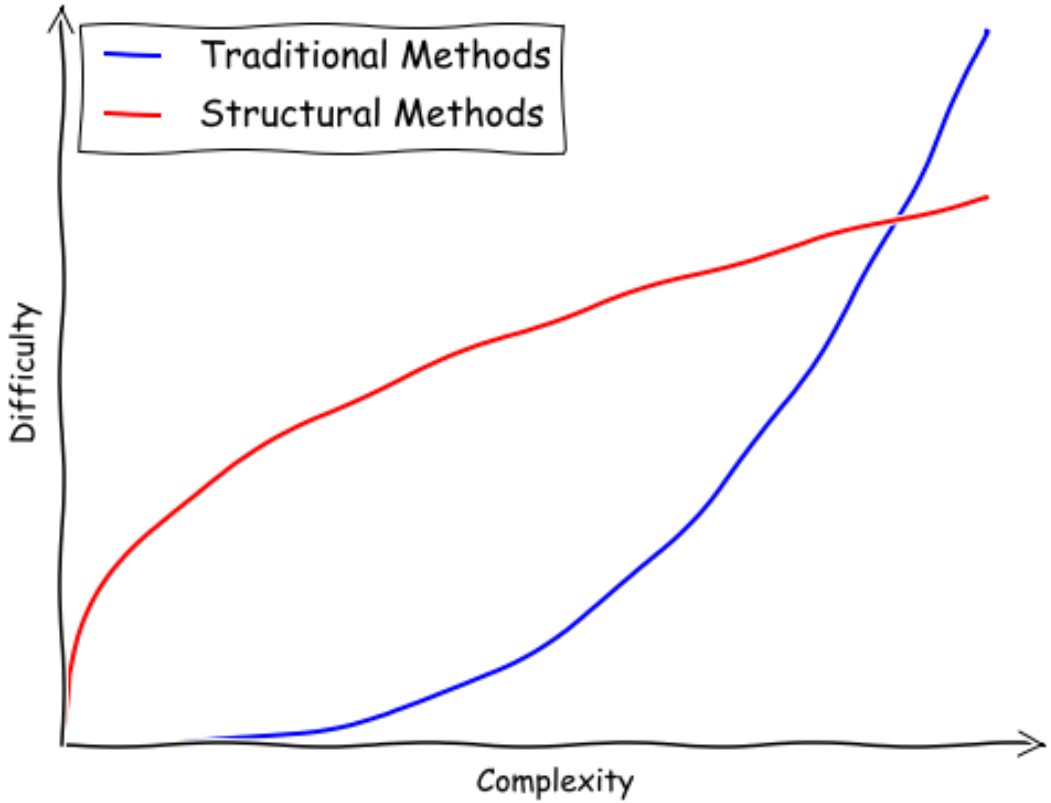
- CT is more like a platform than an application.
- Like other platforms, CT can benefit from network effects.

The negatives:

- The applied CT ecosystem faces a bootstrapping problem.
- Applied CT faces an innovator's dilemma.



# Bending the curve



# Schedule

Thursday, 3/15:

- 3 30-minute talks (Coecke, Pavlovic, Baez & Foley)
- 11 10-minute talks
- 1 hour+ breakout session (Landscape)

Friday, 3/16:

- 1 30 minute talk (Spivak)
- Breakout report
- Funding discussion
- 1-hour breakout (Roadmap)
- Breakout report & general discussion

Thanks for coming

Let's have a fun and productive meeting.