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

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Information Management

- Representation
- Analysis
- Decision
- 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

**Problems:**
- Proprietary systems
- Some Semantic ambiguity
- Excessive complexity
- Coherence between models
- Slant towards software development
# From UML to CT: Class diagrams

<table>
<thead>
<tr>
<th><strong>UML Entity</strong></th>
<th><strong>CT Entity</strong></th>
</tr>
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<tbody>
<tr>
<td>Class ( C ), Datatype ( D )</td>
<td>Objects ( C, D )</td>
</tr>
<tr>
<td>Attribute ( a : D )</td>
<td>Arrow ( a : C \rightarrow D )</td>
</tr>
<tr>
<td>Method ( m(x : X) : D )</td>
<td>Arrow ( m : C\text{–state} \times X \rightarrow C\text{–state} \times D )</td>
</tr>
<tr>
<td>Association ( B \longrightarrow C )</td>
<td>Span ( B \leftarrow R \rightarrow C )</td>
</tr>
<tr>
<td>Generalization ( B \rightarrow C )</td>
<td>Monic ( B \rightarrow C )</td>
</tr>
<tr>
<td>Agg/Comp, Nav, Dep</td>
<td>...</td>
</tr>
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</table>

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.


\[ N \times U \xrightarrow{\sim} Q \times U \]

\[ U \]

\[ \text{GuardState} \rightarrow \text{LogicState} \times \text{PhysState} \]

\[ \text{Transition} \rightarrow \text{LogicalState} \]

\[ \text{dynamics} \]

\[ \text{basepoint} \]

\[ \text{TangentVector} \]

\[ \text{dynamics} \]

\[ \text{basepoint} \]

\[ \text{Induces} \]

\[ \text{Initial} \]

\[ \text{Final} \]
A Conceptual Operating System
The Workshop

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
Goal 1: Collaboration & Community

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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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- Like other platforms, CT can benefit from network effects.

The negatives:
- The applied CT ecosystem faces a bootstrapping problem.

![Diagram]

Spencer Breiner
Category Theory at NIST
March 15, 2018 12 / 14
Some observations

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.