Defining Activity Specifications in OWL

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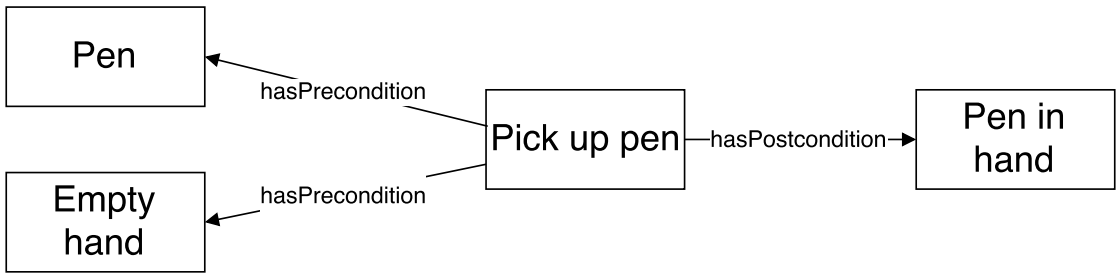
Motivating Scenario

Consider a simple activity: *pick up a pen*



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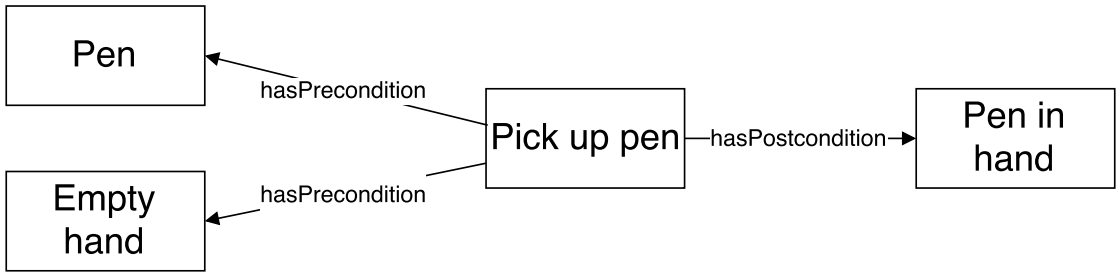


- What does "empty hand" mean?
- Can we recognize when this is true?
- How do we interpret more than one precondition?

OWL Activity and Event ontologies don't provide guidance for how to deal with this.

A Solution

A Content Design Pattern for Defining Activity Specifications in OWL – specifically the preconditions and postconditions of activities.

- Beyond simply identifying the precondition and postcondition properties,
- Define the semantics of the preconditions and postconditions themselves (i.e., the states).

The approach

This requires:

- A representation of activities, combined with
- A representation of fluents to capture causality

Activities

Start with a simple theory of activities:

$$\text{Activity} \sqsubseteq \exists \text{occursAt}.\text{Interval} \tag{1}$$

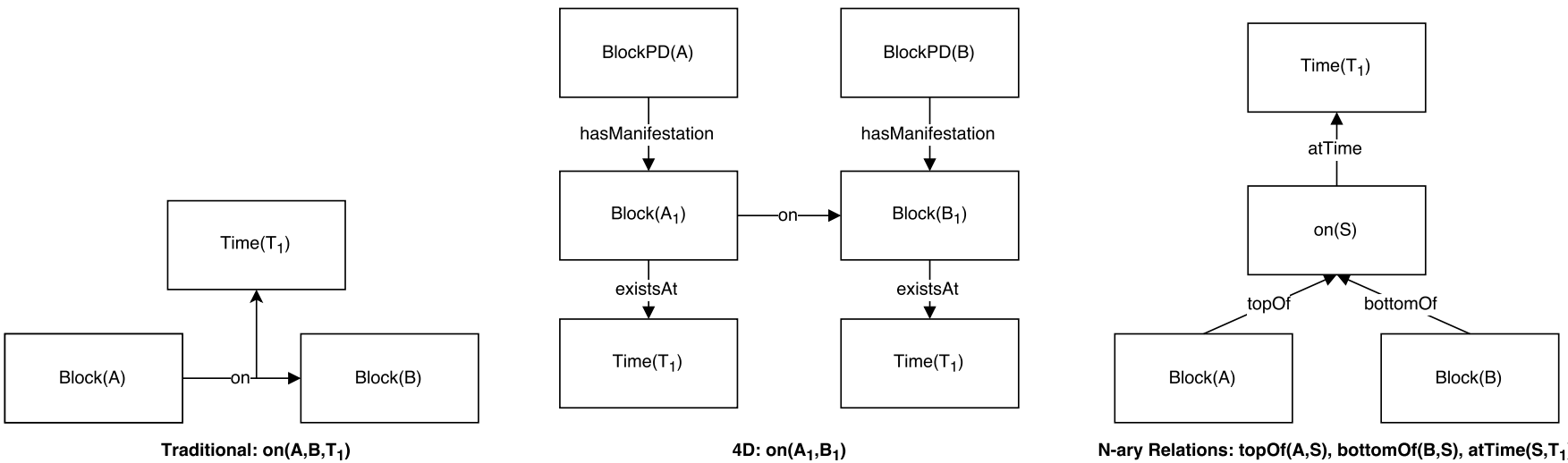
$$\text{occursAt} \circ \text{hasBeginning} \rightarrow \text{beginOf} \tag{2}$$

$$\text{occursAt} \circ \text{hasEnd} \rightarrow \text{endOf} \tag{3}$$

The idea: the bare minimum for the pattern to work! The resulting pattern may easily be extended as required.

Fluents: A Reinterpreted 4D Approach

One way to represent fluents in OWL is with the 4D approach. We prefer the reinterpretation presented by[1].



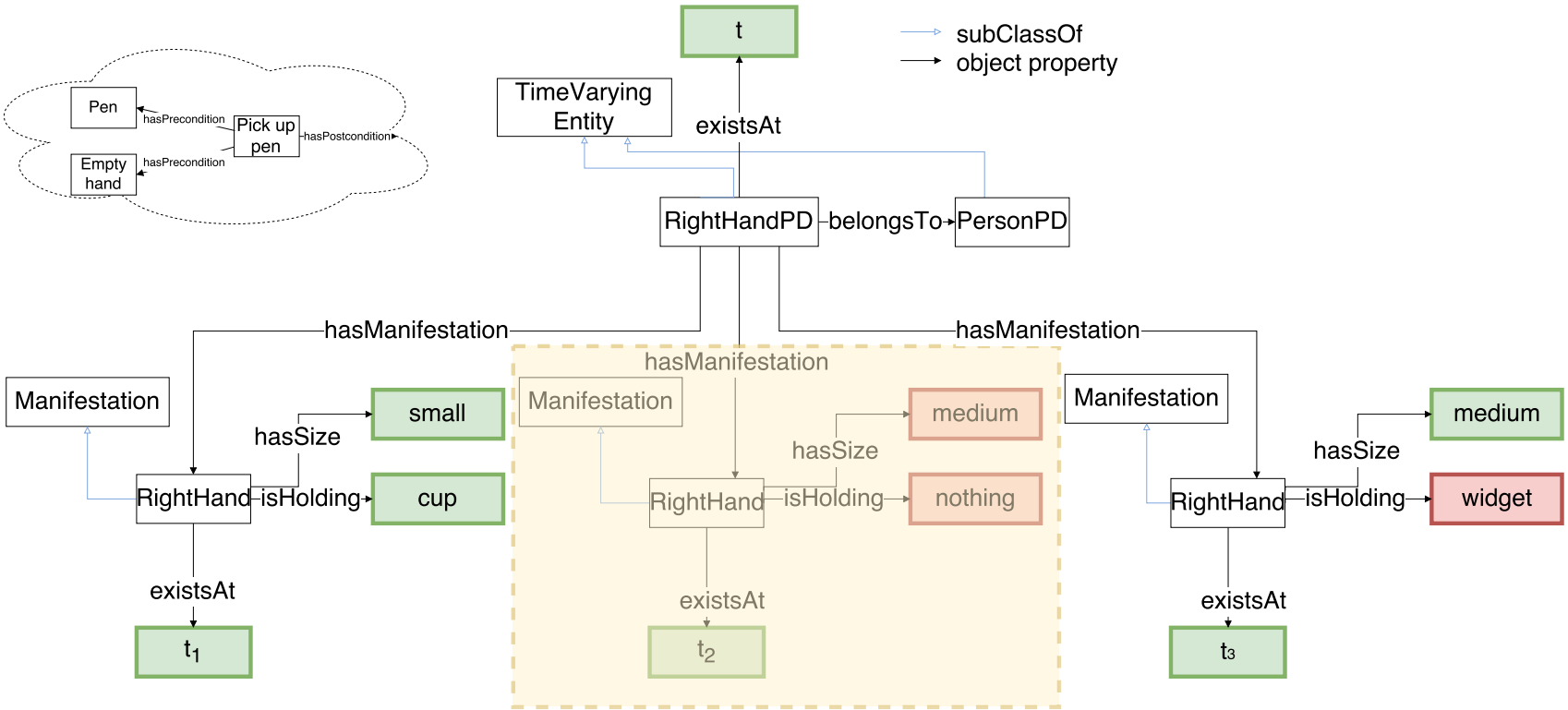
We can leverage a logical design pattern to implement this approach (also in this workshop!)

[1] Hans-Ulrich Krieger. "Where temporal description logics fail: Representing temporally-changing relationships". In: *Annual Conference on Artificial Intelligence*. Springer. 2008, pp. 249–257.

Manifestations as States

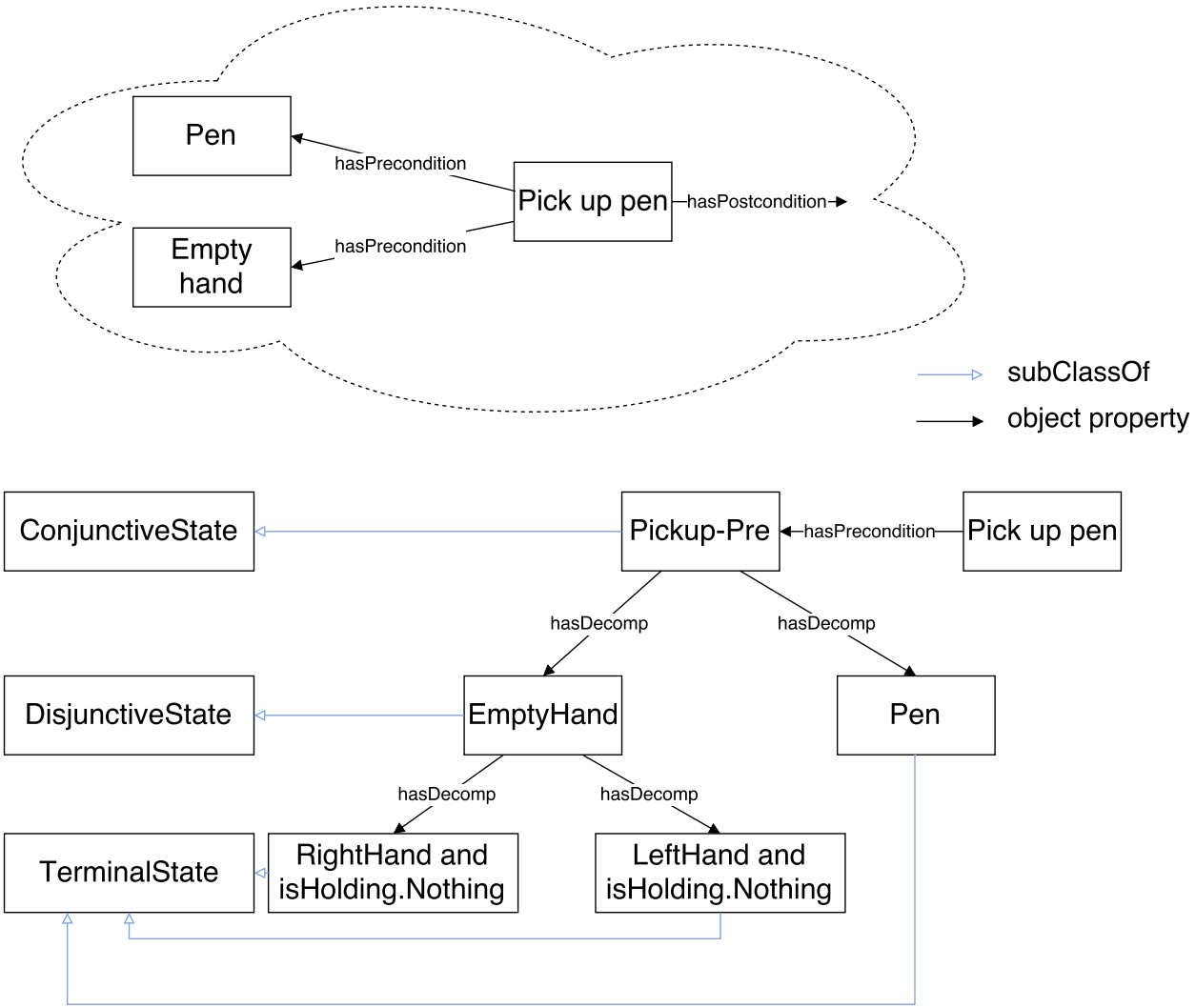
- Manifestations describe (part of) the state of the world.
- Similar intuition to the Event Calculus approach; describe causality by relating activities to their effect (and precondition) states (Manifestations).
- This provides a foundation from which we can:
  - Capture the temporal relationship between an activity occurring and its preconditions and effects being achieved.
  - Represent complex states (conjunctions and disjunctions of states).

Capturing Temporal States



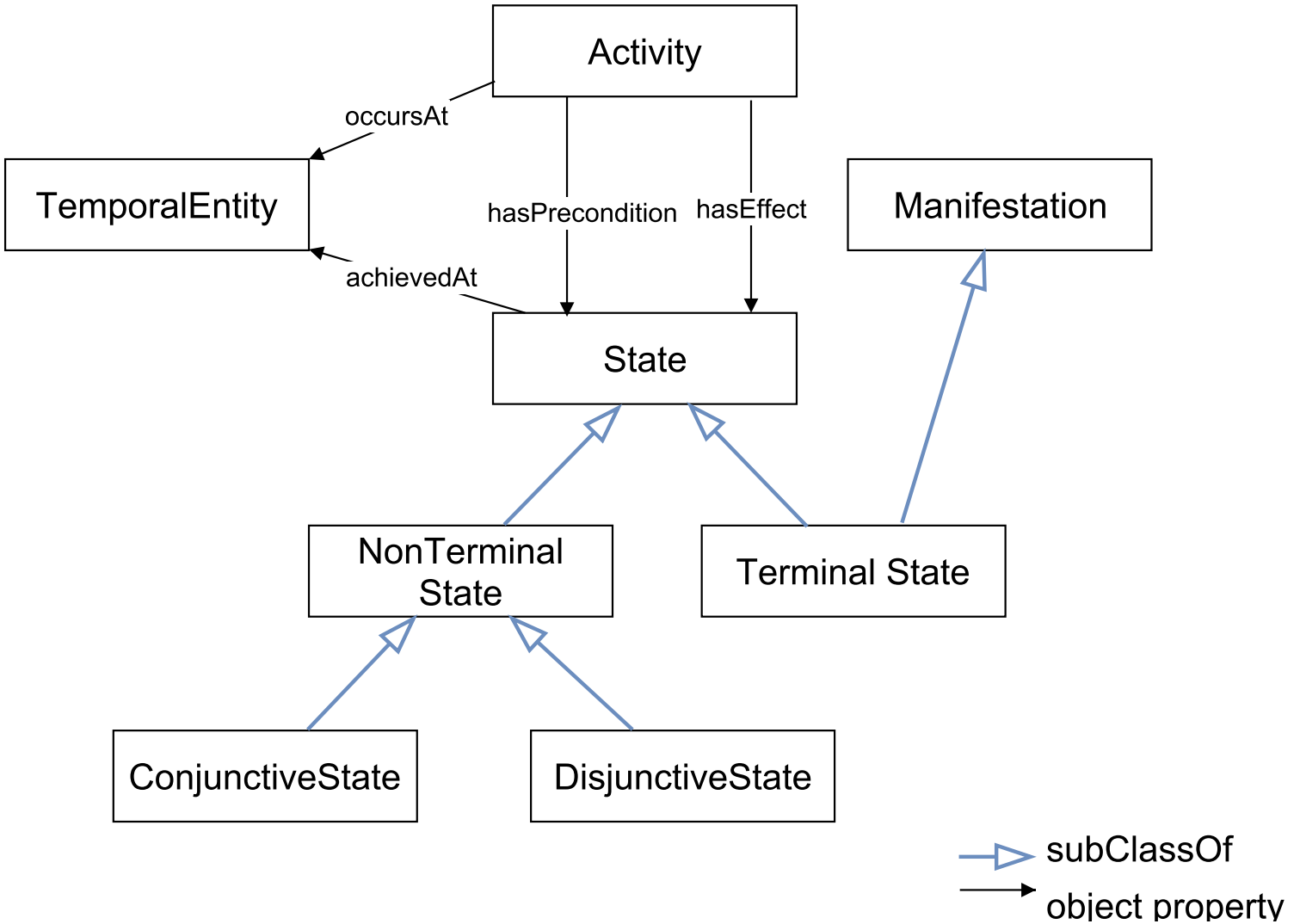
- Identify when a particular object satisfies a condition
- Describe classes of manifestations that satisfy a condition

Capturing Complex States



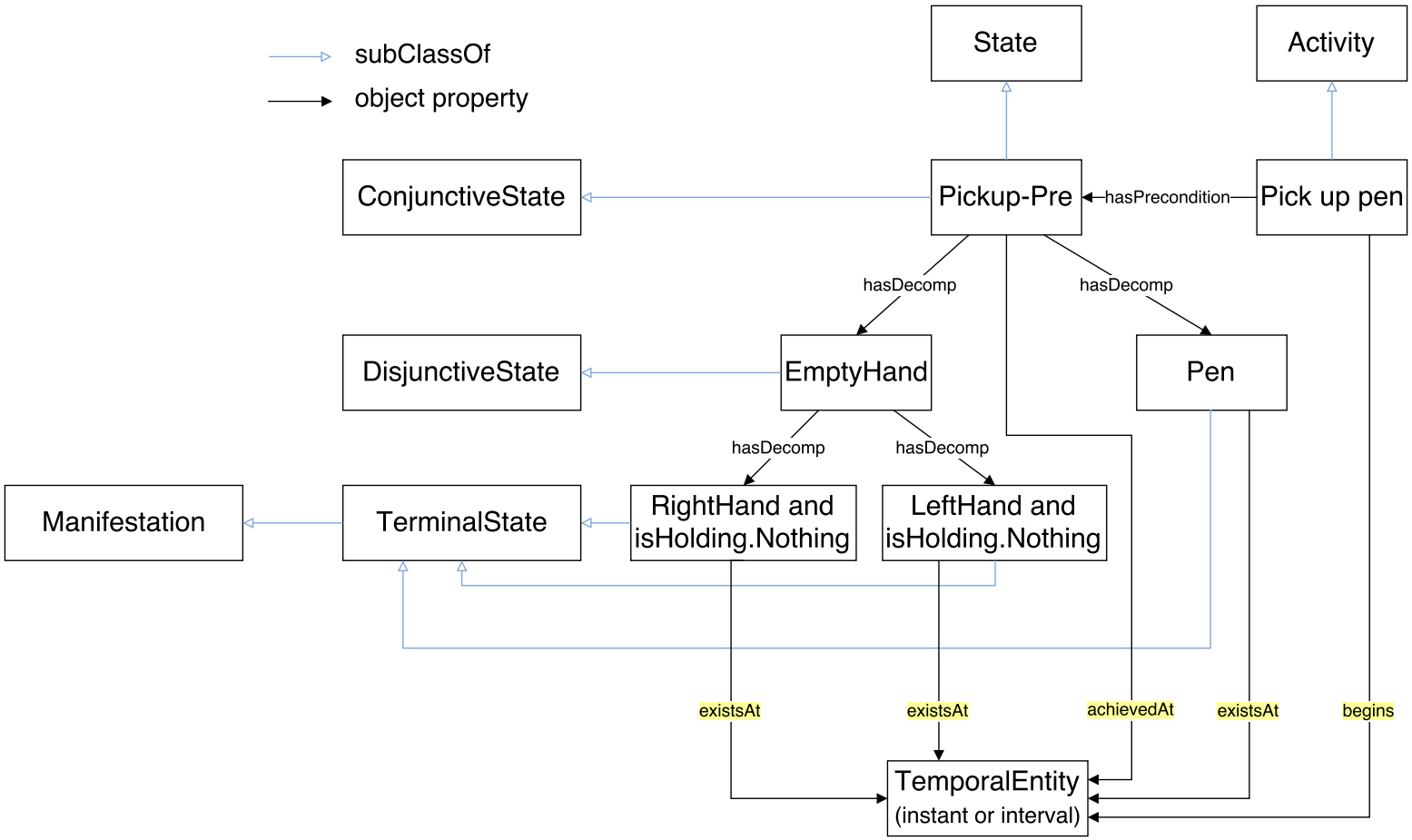
The design pattern

Combining a reinterpreted 4D view with a simple activity ontology:



Example revisited

Extending the design pattern to represent an activity specification



Summary

An effective approach to defining the semantics of preconditions and effects for activities in OWL

- Captures temporal constraints
- Supports complex states
- Minimal reliance on the underlying activity ontology
- Informed by earlier approaches to representing causality

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