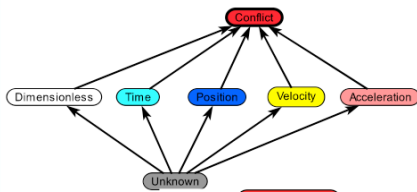


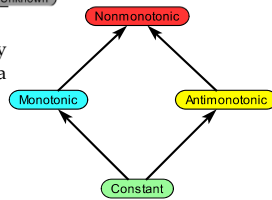
## Background

Using ontologies allows us to statically analyze Ptolemy models in a principled way. The first step to doing so is to represent the domain of interest as a lattice-based ontology.

Example Ontologies.



By formally expressing a body of knowledge as a lattice-based ontology, we can encode domain knowledge to inform analysis.



## Infinite Ontologies

While many types of knowledge can be encoded in finite ontologies, infinite ontologies can express a larger class of properties. We have found two patterns of infinite ontologies to be broadly useful:

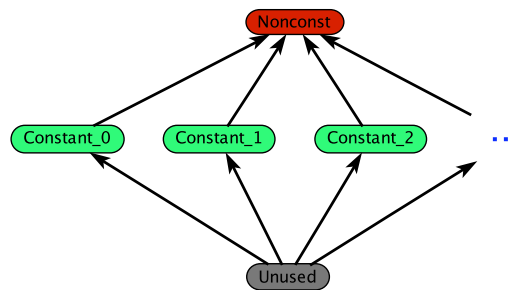
- **Infinite Flat Lattices:** Useful for including value information into the ontologies.
- **Recursive Lattices:** Useful for including structured information corresponding to structured data types.

## Acknowledgements

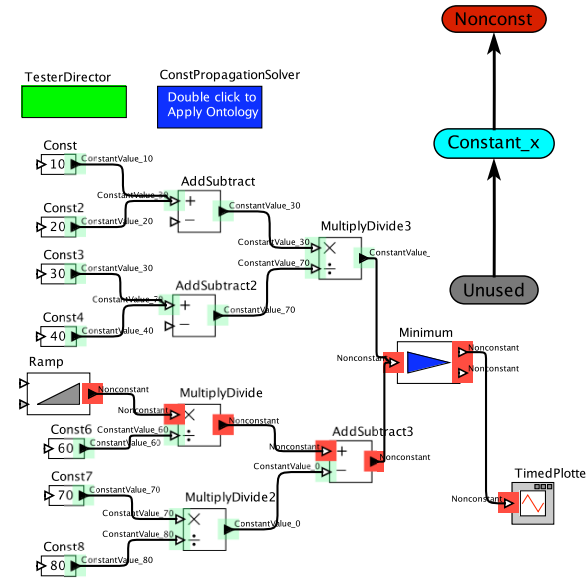
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## Infinite Flat Lattice Pattern

In the infinite flat lattice pattern, we allow lattices that are infinite in one dimension at specific points in the lattice. This is most often useful as a way of parameterizing a concept by a value in order to make something resembling a dependent type system in which values are incorporated into types.



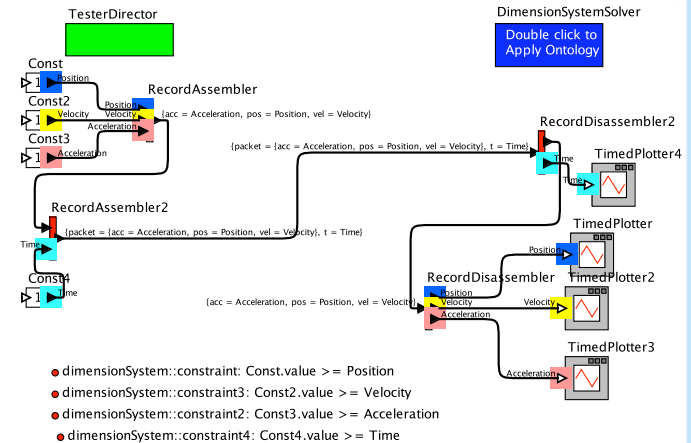
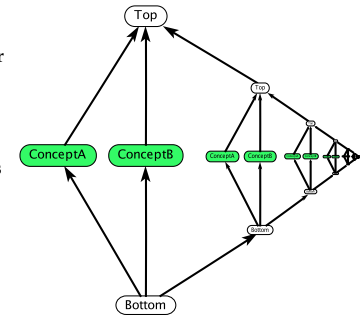
## Example: Constant Propagation



## Infinite Recursive Lattice

Recursive lattices may be contained within a concept in the lattice. In the lattice to the right, for example, the rightmost concept is isomorphic to the entire lattice.

A classic example of a recursive lattice is a type lattice that contains array or record types. Since arrays (or records) may recursively contain arrays or records within them, this creates an infinite lattice of potential types.



## Example: Monotonicity Analysis

In addition to dataflow-based graphs, Ptolemy expressions can also be analyzed with our solver. This example shows an analysis that determines whether expressions are monotonic, antimonotonic, constant, or not.

- Monotonic:  $x \leq y \Rightarrow f(x) \leq f(y)$
- Antimonotonic:  $x \leq y \Rightarrow f(x) \geq f(y)$
- Constant:  $f(x) = f(y)$

