



Onto2Soar

An Ontology to Soar Knowledge Interface

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The problem: Knowledge Representation

- How to represent knowledge about the world in Soar?
- How to share knowledge between Soar agents, or between an agent and a non-Soar actor?
- How to allow non-programmers to add or modify knowledge in an agent system?

Traditional Solution: Productions

- Create productions that elaborate declarative structures in Soar
 - Doesn't allow explicit processing of knowledge
 - No introspection, limited inferencing
 - Needs a new production for every information piece
 - Expensive to code and error-prone
 - SMEs will not and should not write Soar

Script Generated Productions

- Maybe automate productions via scripting?
- Need a new script for every data type - no standard representation of types
 - Difficult to tie different categories of data together (F/A-18 carries GBU-12)
 - No explicit relationships between data types (F/A-18 is a Plane, is a Vehicle)
 - Still looks like/is code – not user-friendly
 - Must have script interpreter
 - Adding new types is difficult
 - New procedure needed for each
 - No inheritance (reuse)

What could be used to represent knowledge?

on·tol·o·gy

“The branch of metaphysics that deals with the nature of being.”

1. <philosophy> A systematic account of Existence.
2. <artificial intelligence> (from philosophy) An explicit formal specification of how to represent the objects, concepts and other entities that are assumed to exist in some area of interest and the relationships that hold among them.
3. <semantic web> A specification of a conceptualization.

The Opportunity

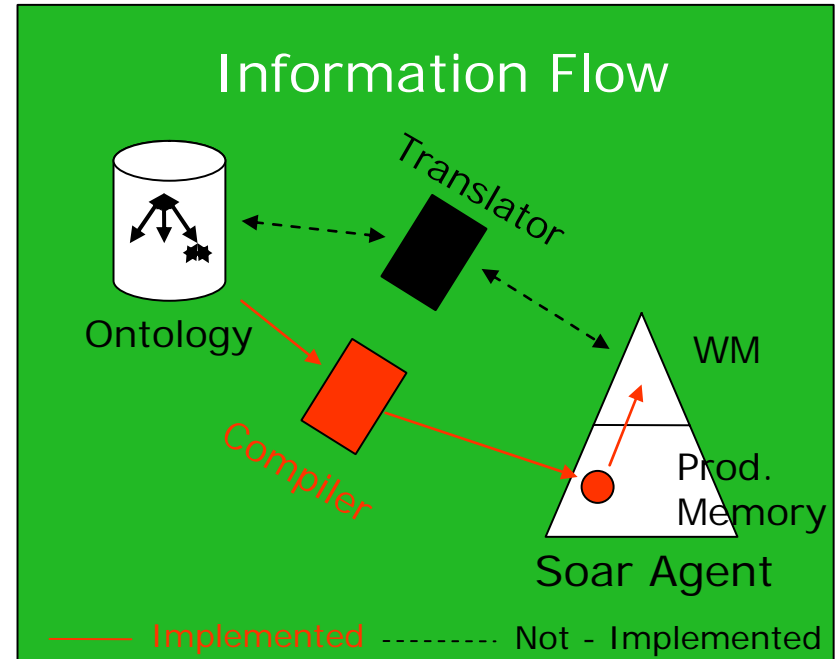
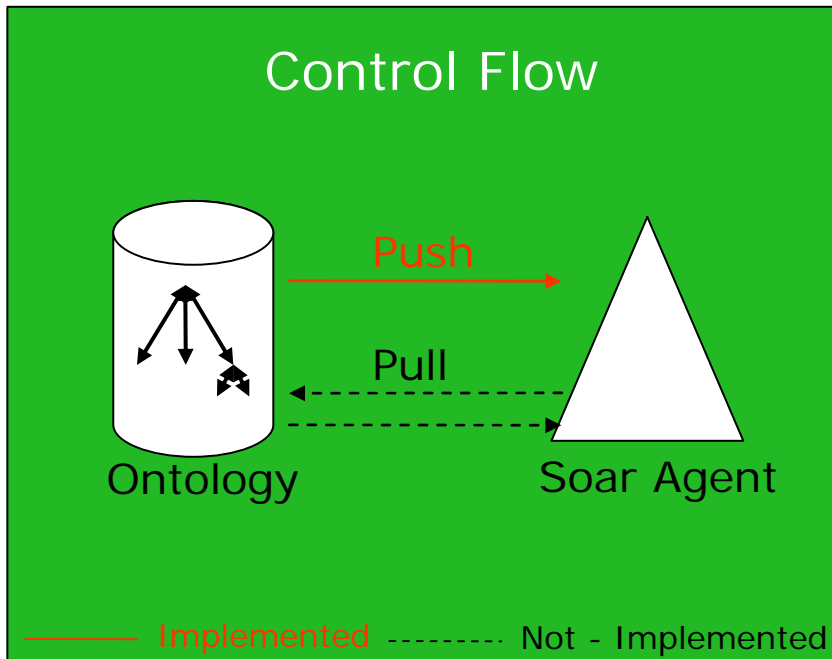
- There is an active research community in the area of ontologies, especially the semantic web community (stanford, DARPA, etc)
- Many pre-existing ontologies
 - For instance: <http://www.daml.org/ontologies>
- Ontology editor applications available commercially and through public domain

Accepted Ontology Formats

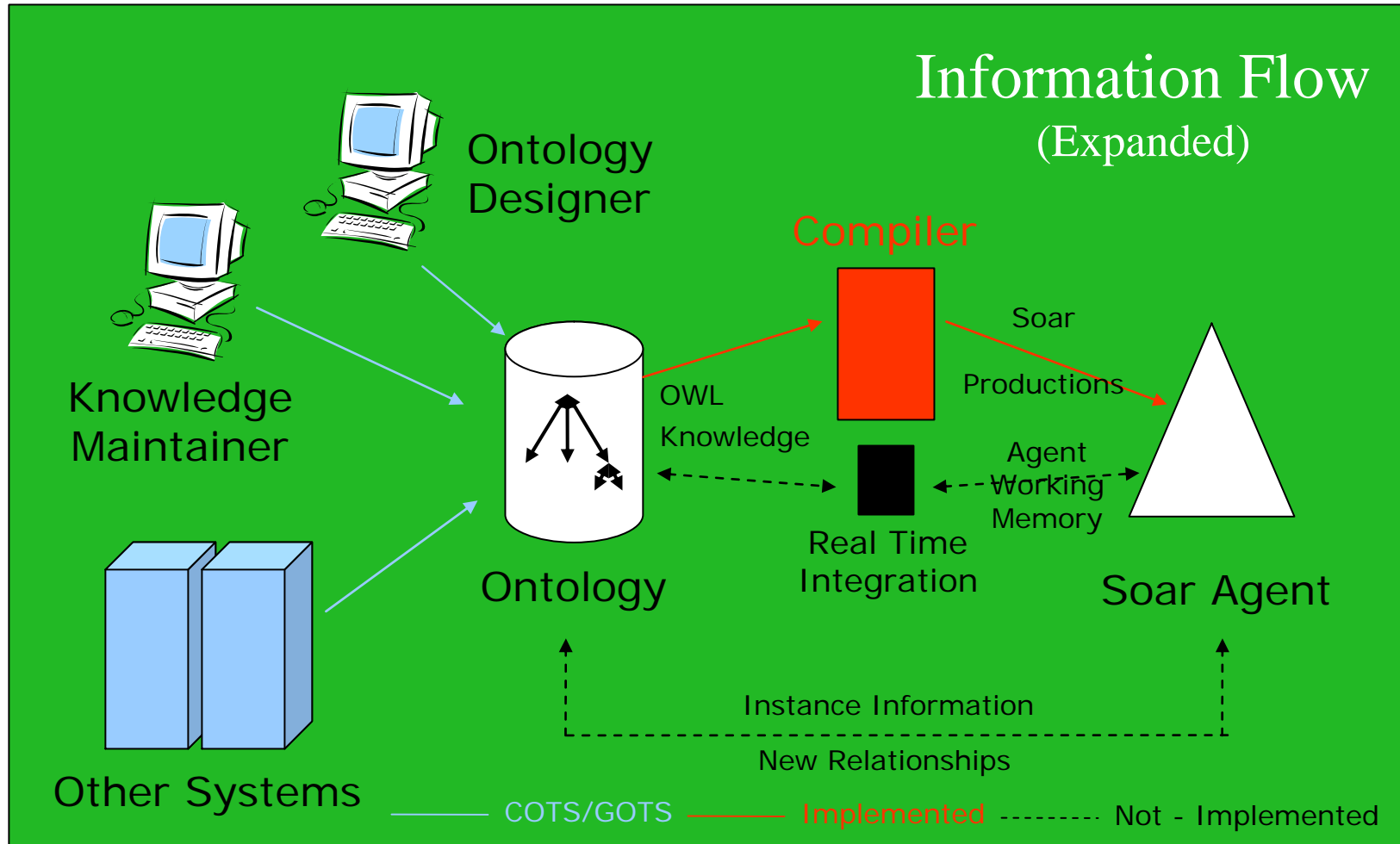
- OWL or DAML+OIL
 - DAML+OIL: Darpa Agent Modeling Language + Ontology Inference Layer
 - OWL: Web Ontology Language
 - Both have formalisms for
 - Classes + Class Hierarchies
 - Properties + Property Restrictions
 - Instances
 - Namespaces
 - And more...

Current translation mechanism

- One-way, Compile-Time



Onto2Soar v 0.7



Onto2Soar v 0.7

- Now supports DAML+OIL, OWL and N3 formats
- Within these, support for:
 - Classes
 - Properties
 - Superclasses
 - Namespaces
 - Soar Queries

Example – WME Ontology Representation

```
sp {daml2soar*class*Physical_Object
(state <ts> ^world-knowledge <world-knowledge>)
(<world-knowledge> ^ontology <ontology>)
(<ontology> ^name DAML2Soar_Default)
-->
(<ontology> ^class <class0>)
(<class0> ^name Physical_Object)
(<class0> ^namespace
|file:/home/lisse/downloads/eclipse/workspace/DAML2Soar/src/co
m/soartech/daml2soar/test/test_classes.daml_|)
(<class0> ^type <type1>)
(<class0> ^superclass <type2>)
<type1> ^name class)
<type1> ^namespace |http://www.soartech.com/DAML2Soar_|)
<type2> ^name Thing)
<type2> ^namespace |http://www.daml.org/2001/03/daml+oil_|)}
```

Example – Standard Ontology Relation Query

Is a “Vehicle” a “Thing”?

```
sp {test*daml2soar*superclass-query*yes
```

```
(state <s> ^world-knowledge <wk>)
```

```
-->
```

```
(<wk> ^query <Q>)
```

```
(<Q> ^name superclass-query*1
```

```
  ^interrogative superclass-of
```

```
  ^subject <subj>
```

```
  ^object <obj>)
```

```
(<subj> ^name Thing
```

```
  ^namespace ...)
```

```
(<obj> ^name Vehicle
```

```
  ^namespace ...)}  
}
```

Current Progress

- It works (still)!
- New, optimized code base.
- 530 Soar Productions created in 4 minutes from the SUMO ontology, downloaded from the web
- Layered interface approach facilitated transition from DAML+OIL parsing to DAML+OIL and OWL parsing

And... now announcing

- Licensing schemes
 - Free academic use license!
 - Beta testing license and commercial license available through special arrangement
 - Interested? Contact lisse@soartech.com

Onto2Soar :

Next steps

- Interpret more features of OWL through Onto2Soar (enumerations, etc)
- Instances
- Build user community

Possible Future Directions

- Allow dynamic interaction between ontology and agent
- Explore interactions of ontologies and Soar/RBS programming methodologies
- Ontology transmission/sharing between agents
- Procedural knowledge representation formalisms
- Integration with other tools (Visual Soar/Protégé?)
- Suggestions?

The Onto2Soar team

- Sean Lisse – Lead developer
- Bob Wray – Lead scientist
- Laura Hamel
- Jack Zaiantz
- Jon Beard