The Cycic Friends Network

Getting Cyc Agents to Reason Together

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The Cycic Friends Network Personnel

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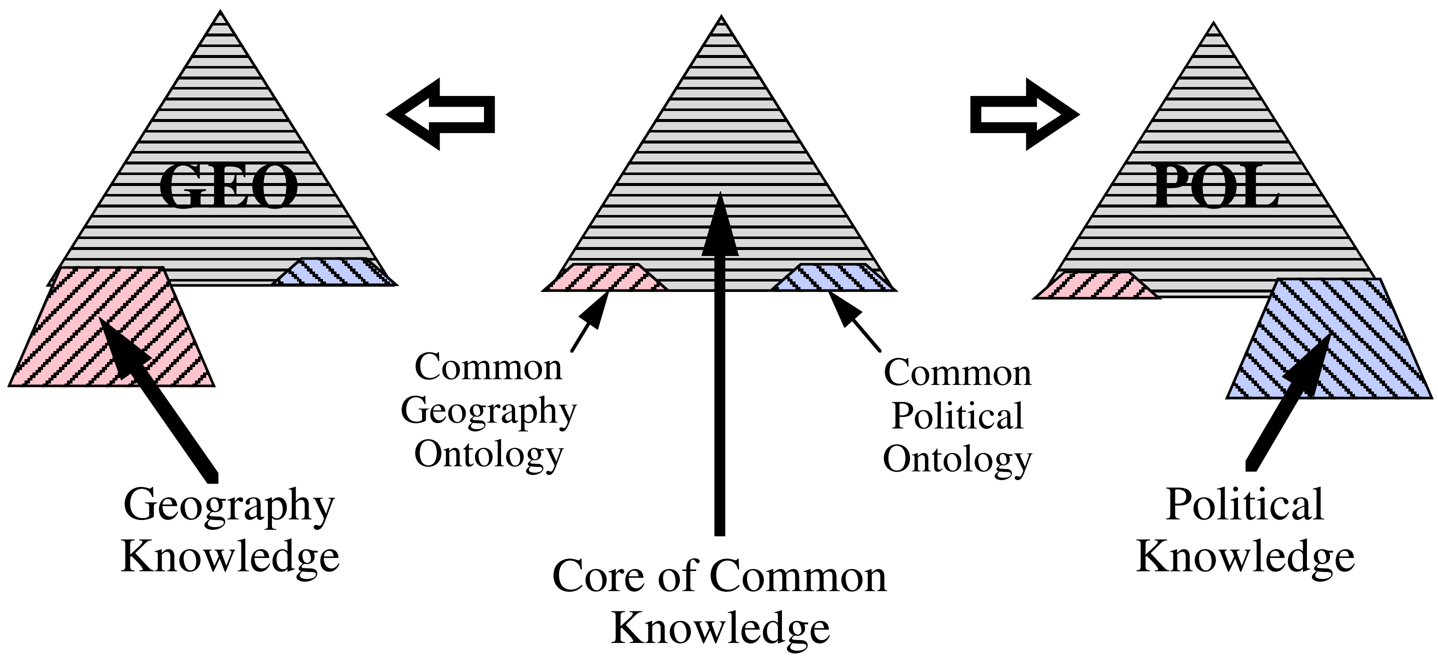
CYCORP

Cycic Friends Network Motivation

- **Problem**
  - Access to expertise
- **Purpose:**
  - Distributed commonsense inference among independent cooperative agents*
- **Approach:**
  - Use Cyc to perform commonsense reasoning.
  - Export nodes of Cyc's proof tree to other agents that might be able to expand them.
  - Use the infrastructure developed for the Knowledge Sharing Effort to coordinate the agents.

* `for (i = 0; i < 7; i++) print_random_buzzword();`

Agents share a core of common knowledge



Example Query

Who are some elected heads of state of countries north of the equator?

GEO knows

Great Britain is in the continent of Europe.

The continent of Europe is in the northern hemisphere.

India is in the northern hemisphere.

China is in the northern hemisphere.

The continent of South America is in the southern hemisphere.

Brazil is in the continent of South America.

South Africa is in the southern hemisphere.

The northern hemisphere is north of the equator.

If region A is north of region B, and region C is part of region A, then region C is north of region B.

POL knows

The head of state of Great Britain is John Major.

The head of state of India is Narasimha Rao.

The head of state of South Africa is Nelson Mandela.

The head of state of China is Deng Xiaopeng.

Great Britain has a democratic government.

India has a democratic government.

South Africa has a democratic government.

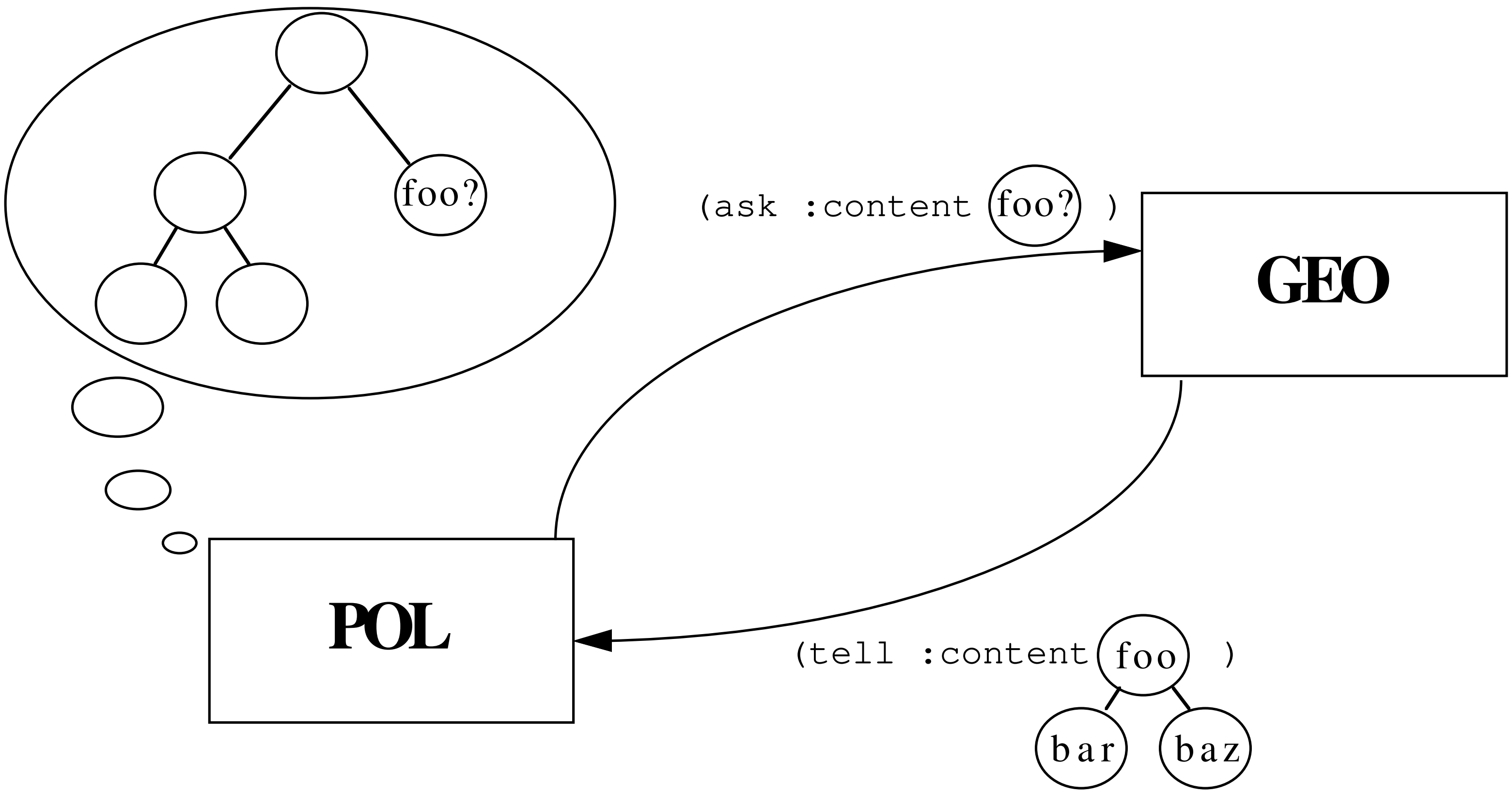
China has a communist government.

If a country has a democratic government, then the head of state of that country is an elected leader.

Cycic Friends Network Components

- The Cyc knowledge base
- The KQML agent communication language
- Agents
  - Name server agent
  - Broker agent
  - Cyc agents

Distributed Inference in CFN



Cyc

- **A ten-year project to build a large knowledge base for commonsense inference:**
  - **Contains facts, rules of thumb, heuristics.**
  - **Divided into about 100 *microtheories*, each of which is a bundle of assertions focused on a particular domain of knowledge.**
  - **Holds about 50,000 terms and about 500,000 assertions.**
  - **Most of what you have read about the workings of Cyc is no longer accurate.**

Cyc Components

- **The CycL language:**
  - **A flexible knowledge representation language.**
  - **Augments FOPC to handle equality, default reasoning, skolemization, and some second-order features**
- **The Cyc inference engine:**
  - **The Cyc inference engine performs general logical deduction, including *modus ponens*, *modus tolens*, and universal and existential quantification**
  - **Performs best-first search using proprietary heuristics to decide which nodes of the proof tree to expand.**

Knowledge Query and Manipulation Language (KQML)

- A high-level communication language and protocol for information exchange independent of content syntax and ontology.
- A language in which to wrap information, offering a uniform view of an information agent as a knowledge base.
- An extensible set of performatives expressing a belief or an attitude toward some information.

A KQML Message

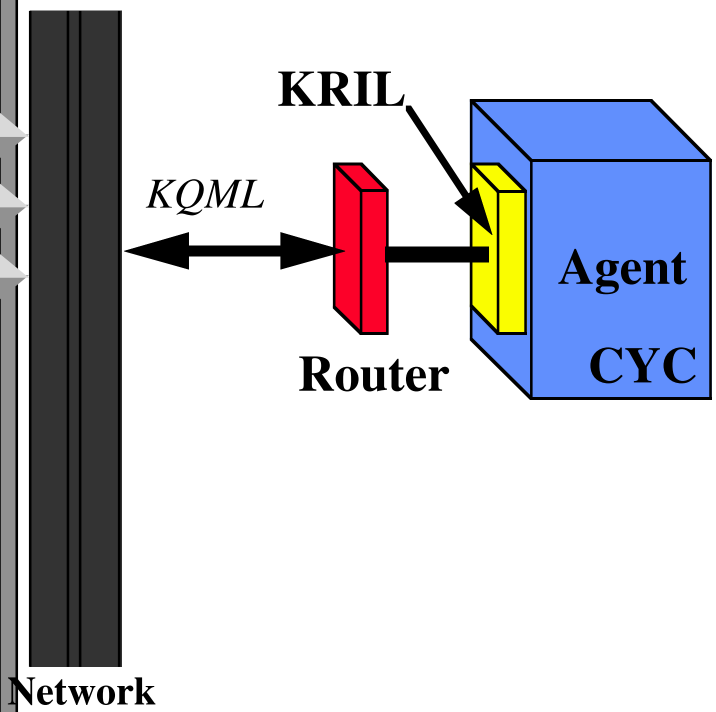
```
(tell   :sender        Gen-1
        :receiver      Gen-db
        :in-reply-to   id1
        :ontology      Genealogy
        :language      Prolog
        :content       "father(john, eve)")
```

performative

parameter

value

Loral/UMBC KQML Software Architecture



❥Routers

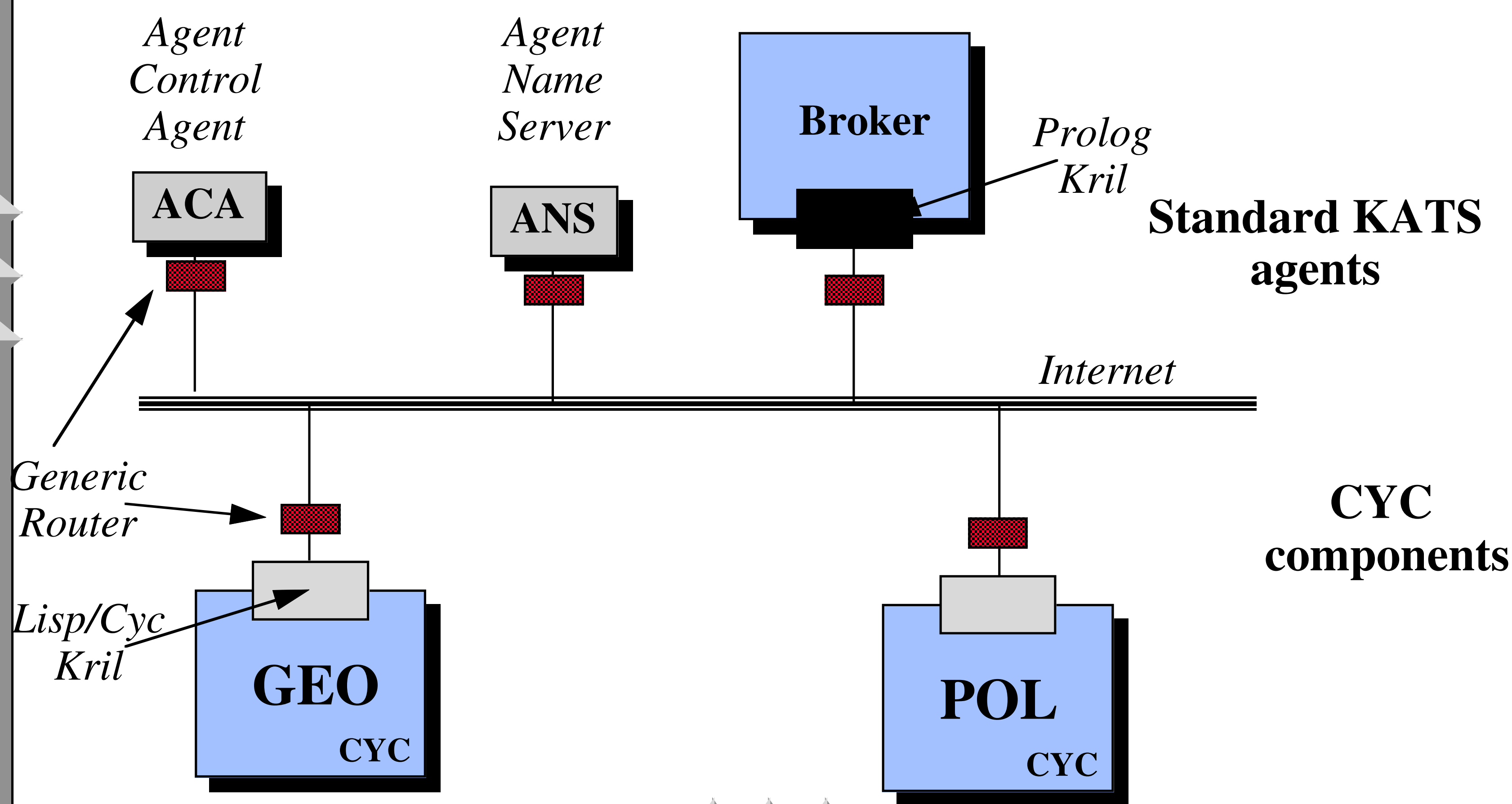
- Content-independent message router.
- One per agent--handles sending and asynchronous receiving of messages.

❥Facilitator Agents

- At least one per site, providing local DB of symbolically named services.
- Can provide mediation and translation services.
- Common types include *Agent Name Server*, *Control Agent,* and *Broker*.

❥ More info: Don McKay (mckay@vfl.paramax.com)

CFN Architecture



Cooperative Ad-hoc Inference (CAI)

- Inference distributed across the Internet
- No real control over other agents
  - don't know where they are
  - don't know what they know
  - don't know whether they're willing to help
  - don't know what they'll charge
  - don't know whether they're reliable

Issues for Cooperation in a CAI Environment

- How do you know you should ask for help?
- Who should you ask?
  - How do you find other agents?
  - How do you know what they know?
- How should the dialogue proceed?
  - Should you ask more than just a question?
  - Should a response be more than just an answer?
  - How should inconsistencies and contradictions be handled?

Conclusions

- The Cycic Friends Network successfully distributes commonsense inference across multiple agents.
- KQML makes it extremely easy to connect small numbers of agents together (but will it scale?)
- Cooperative Ad-hoc Inference raises challenges that have not been faced by DAI.