

The Cyc Platform

**A Representational Seed for a
National Knowledge Infrastructure**

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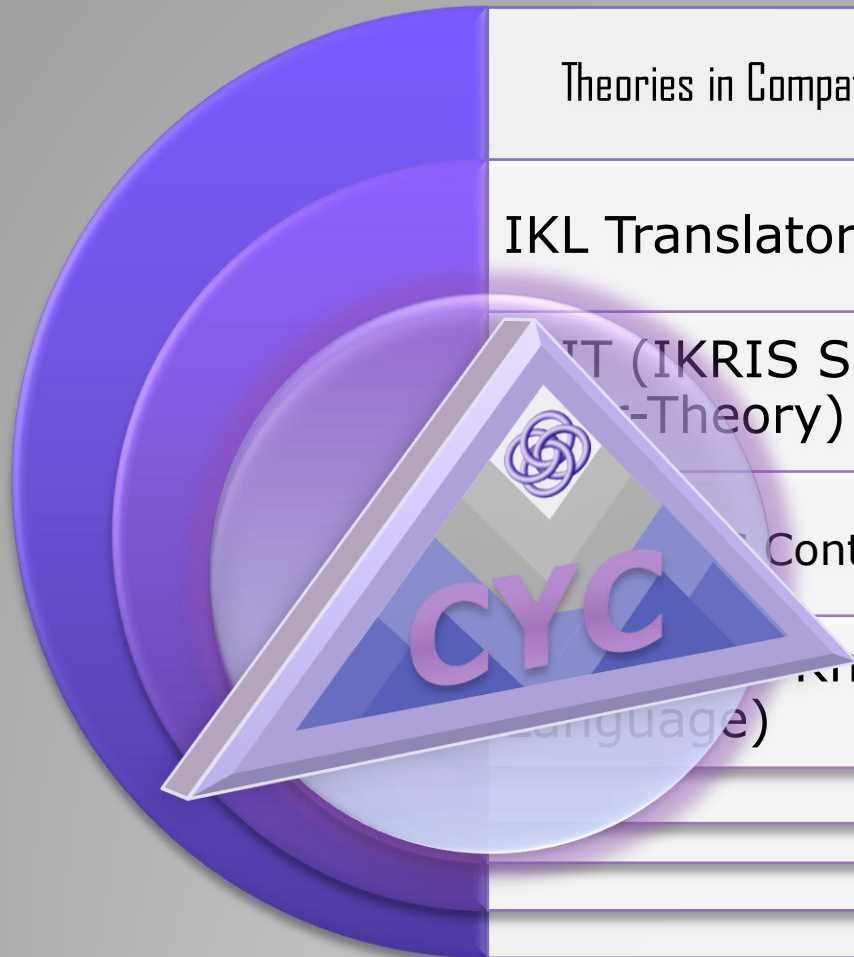
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Theories in Compatible Logics

- Terrorism, Medicine, Environment, Trade, Law and Regulation...

IKL Translators

- CycL, Kani, CL, Slate...

IKL Scenarios (IKRIS Scenarios
-Theory)

- Representing situations and scenarios

Context Logic)

- A context representation formalism

Knowledge

- A KR interlingua based on Common Logic

IKRIS Workshop Results

EVENT \supset TEMPORAL-THING \supset PARTIALLY-TANGIBLE-THING

Upper
Ontology

$(\forall a, b) a \in \text{EVENT} \wedge b \in \text{EVENT} \Rightarrow$
 $\text{causes}(a, b) \Rightarrow \text{precedes}(a, b)$

Core
Theories

$(\forall m, a) m \in \text{MAMMAL} \wedge a \in \text{ANTHRAX} \Rightarrow$
 $\text{causes}(\text{exposed-to}(m, a), \text{infected-by}(m, a))$ \square

Domain-Specific
Theories

Very specific information
(some indirect, via SKSI)

(ist FtLaudHolyCrossERCCase#403921
(caused CutaneousAnthrax
(SkinLesions Ahmed_al-Haznawit)))

First Order Predicate Calculus: unambiguous; enable mechanical reasoning

Every American has a president.
Every American has a mother.

Higher Order Logic: contexts,
predicates as variables,
nested modals, reflection,...

$\exists y. \forall x. \text{Amer}(x) \Rightarrow \text{president}(x, y)$
 $\forall x. \exists y. \text{Amer}(x) \Rightarrow \text{mother}(x, y)$

Cyc Reasons via Formal Logic



Thing

Intangible Thing Individual

General Knowledge about Terrorism:

Terrorist groups are capable of directing assassinations:

(implies

(isa ?GROUP TerroristGroup)

(behaviorCapable ?GROUP AssassinatingSomeone directingAgent))

...

If a terrorist group considers an agent an enemy, that agent is vulnerable to an attack by that group:

(implies

(and

(isa ?GROUP TerroristGroup)

(considersAsEnemy ?GROUP ?TARGET))

(vulnerableTo ?GROUP ?TARGET TerroristAttack))

Earth &
Solar System

Buildings
Weapons

& Electrical
Devices

Literature
Works of Art

Language
Relations,
Culture

Social
Activities

Transportation
& Logistics

Travel
Communication

Everyday
Living

Military
Organizations

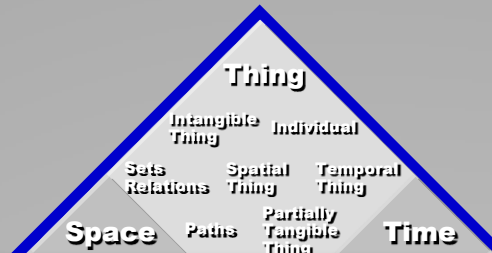


General Knowledge about Terrorism

Specific data, facts, and observations about terrorist groups and activities



Cyc-L Represents Domains



Specific Facts about Al Qaida:

(basedInRegion AlQaida Afghanistan) Al-Qaida is based in Afghanistan.

(hasBeliefSystems AlQaida IslamicFundamentalistBeliefs) Al-Qaida has Islamic fundamentalist beliefs.

(hasLeaders AlQaida OsamaBinLaden) Al-Qaida is led by Osama bin Laden.

...

(affiliatedWith AlQaida AlQudsMosqueOrganization) Al-Qaida is affiliated with the Al Quds Mosque.

(affiliatedWith AlQaida SudaneseIntelligenceService) Al-Qaida is affiliated with the Sudanese Intell Service

...

(sponsors AlQaida HarakatUIAnsar) Al-Qaida sponsors Harakat ul-Ansar.

(sponsors AlQaida LaskarJihad) Al-Qaida sponsors Laskar Jihad.

...

(performedBy EmbassyBombingInNairobi AlQaida) Al-Qaida bombed the Embassy in Nairobi.

(performedBy EmbassyBombingInTanzania AlQaida) Al-Qaida bombed the Embassy in Tanzania.

General Knowledge about Terrorism



Specific data, facts, and observations about terrorist groups and activities



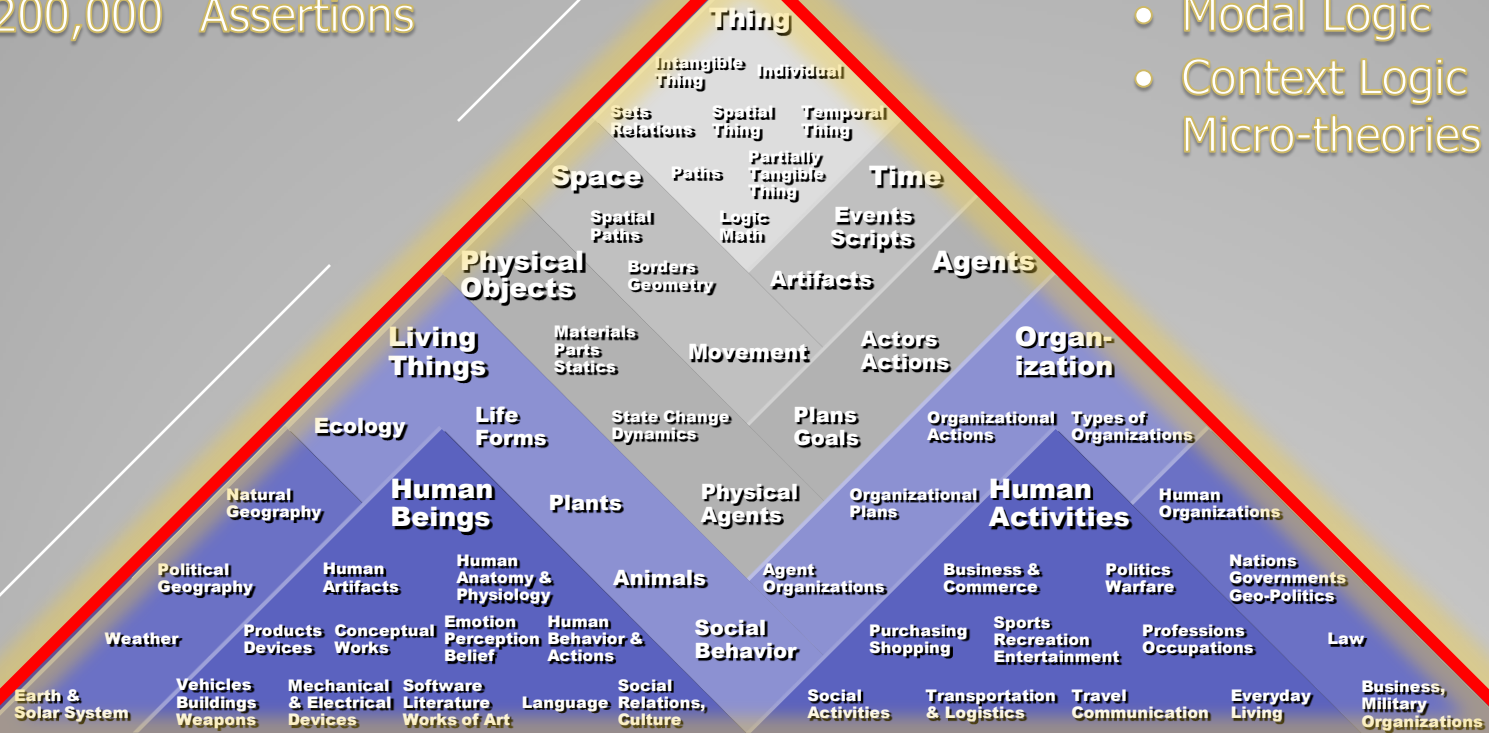
Cyc-L Represents Facts

Cyc contains:

15,000 Predicates
300,000 Concepts
3,200,000 Assertions

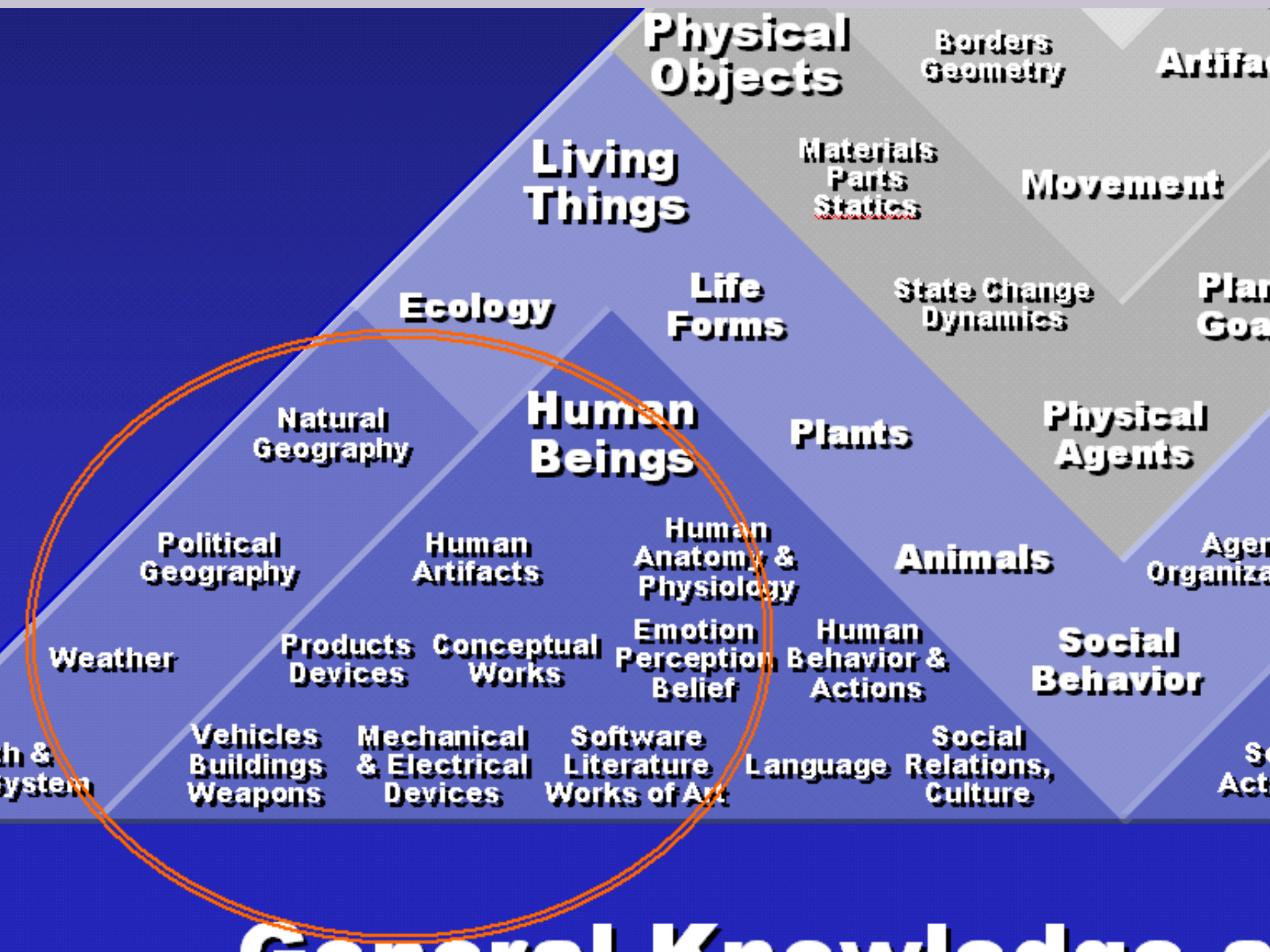
Represented in:

- First Order Logic
- Higher Order Logic
- Modal Logic
- Context Logic
- Micro-theories



General Knowledge about Various Domains

Specific data, facts, and observations



Contexts are vital

- Enable scalable, evolving Knowledge Bases

Shorter and simpler assertions

- "Nelson Mandela is president." vs. "Nelson Mandela is president throughout 1995 in South Africa."

Controlled consistency

- Local consistency supports inference.
- Global inconsistency allows efficient representation of different sources, data-models, points of view, disagreeing scientific theories, hypotheses, and changes over time and location

Depend on Reasoning

- Combining contexts and types of contexts requires "context space" reasoning

Cyc Microtheories are Contexts

(genIMt

(MtSpace

LebanonDataContext

(TimeIndex: June, 1985)

(TemporalGranularity: Month)

(SpatialGranularity: Governorate))

**THE CONTENT
OF THIS
CONTEXT**

(MtSpace

MiddleEastDataContext

(TimeIndex: 1985)

(TemporalGranularity: Day)

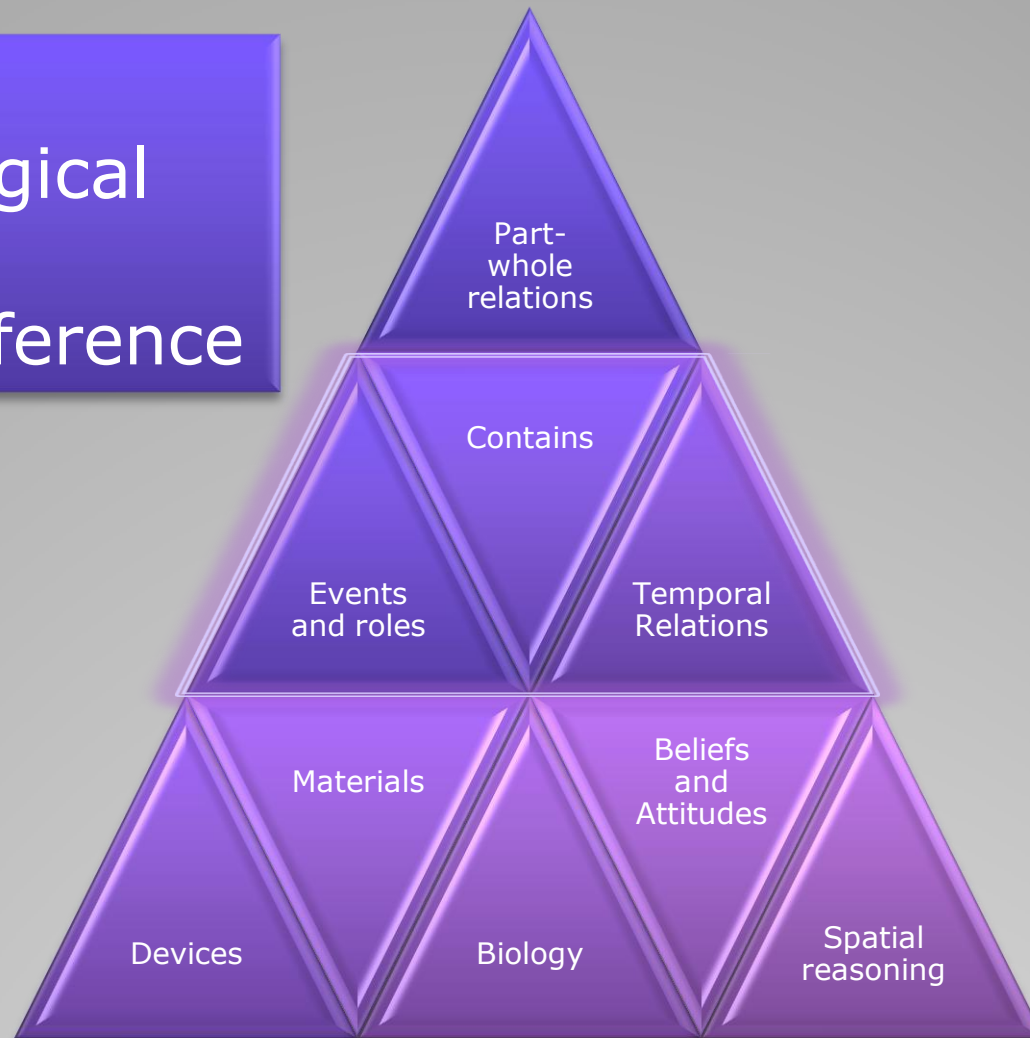
(SpatialGranularity: SquareMile))

**SUBSUMES THE
CONTENT OF
THIS CONTEXT**

Context Subsumption

Context Subsumption

Cyc-L non-linguistic logical vocabulary supports inference



The Power of Cyc Content



37 Relations Between Temporal Things

- **#\$temporalBoundsIntersect**
- **#\$temporallyIntersects**
- **#\$startsAfterStartingOf**
- **#\$endsAfterEndingOf**
- **#\$startingDate**
- **#\$temporallyContains**
- **#\$temporallyCooriginating**
- **#\$temporalBoundsContain**
- **#\$temporalBoundsIdentical**
- **#\$startsDuring**
- **#\$overlapsStart**
- **#\$startingPoint**
- **#\$simultaneousWith**
- **#\$after ...**

Temporal Relations



Some of these Relations are very General, such as:

#\$temporallyIntersects

Such relations are particularly useful when they are known not to hold between a pair of individuals:

(#\$not (\$temporallyIntersects ?X ?Y))

That implies all of these:

(#\$not (\$spouse PERSON-X PERSON-Y))

(#\$not (\$consultant AGENT-X AGENT-Y))

(#\$not (\$accountHolder ACCOUNT-X AGENT-Y))

(#\$not (\$residesInRegion AGENT-X REGION-Y))

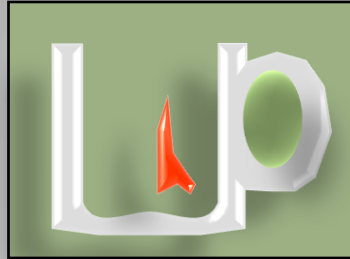
(#\$not (\$officiator EVENT-X PERSON-Y))

Temporal Relations



- Does part of the inner object stick out of the container?

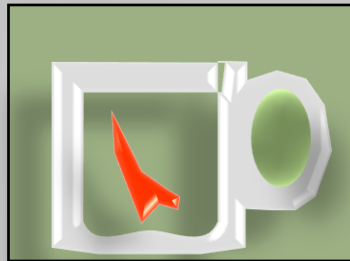
- None of it. -- Try
#\$in-ContCompletely



- Yes -- Try
#\$in-ContPartially



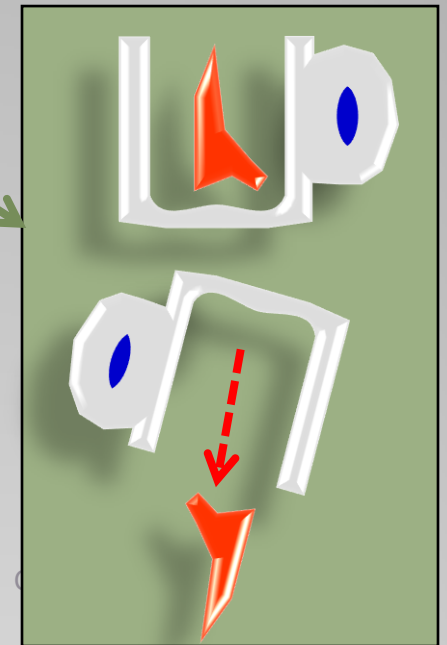
- No -- Try
#\$in-ContClosed



- If the container were turned around could the contained object fall out?

- Yes -- Try

#\$in-ContOpen



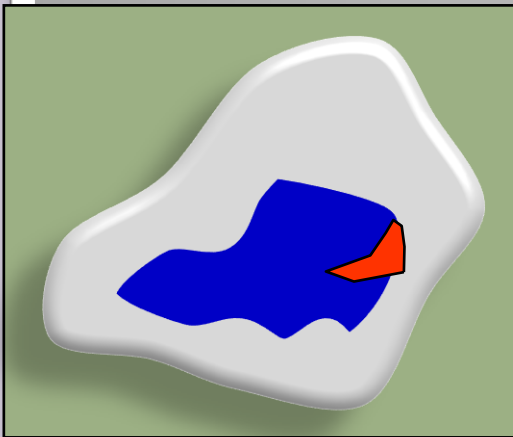
Senses of 'In'



Is it attached to the inside of the outer object?

– Yes -- Try

#\$connectedToInside



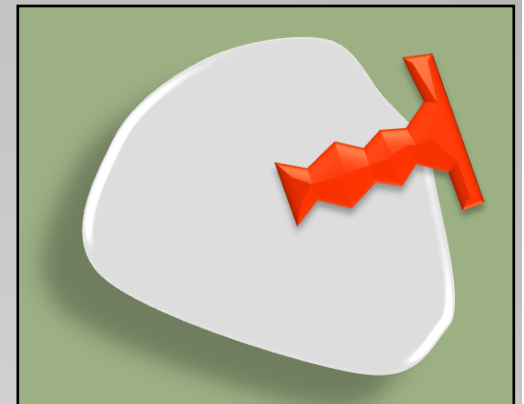
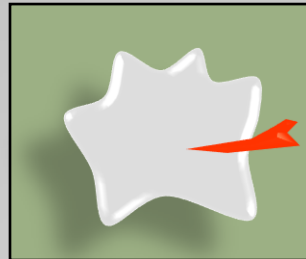
Can it be removed by pulling, if enough force is used, without damaging either object?

– No -- Try **#\$in-Snugly** or **#\$screwedIn**

Does the inner object stick into the outer object?

–Yes – Try

#\$sticksInto



Senses of 'In'

- **#\$PhysicalStateChangeEvent**
- **#\$TemperatureChangingProcess**
- **#\$BiologicalDevelopmentEvent**
- **#\$ShapeChangeEvent**
- **#\$MovementEvent**
- **#\$ChangingDeviceState**
- **#\$GivingSomething**
- **#\$DiscoveryEvent**
- **#\$Cracking**
- **#\$Carving**
- **#\$Buying**
- **#\$Thinking**
- **#\$Mixing**
- **#\$Singing**
- **#\$CuttingNails**
- **#\$PumpingFluid ...**

11,000 more

Event Types



- **#\$TransportationEvent**
- **#\$ControllingATransportationDevice**
- **#\$TransportWithMotorizedLandVehicle**
- **(#\$SteeringFn #\$RoadVehicle)**
- **#\$TransporterCrashEvent**
- **#\$VehicleAccident**
- **#\$CarAccident**
- **#\$Colliding**
- **#\$IncurringDamage**
- **#\$TippingOver**
- **#\$Navigating**
- **#\$EnteringAVehicle ...**

Some Transportation Event Types



- **#\$performedBy**
- **#\$causes-EventEvent**
- **#\$objectPlaced**
- **#\$objectOfStateChange**
- **#\$outputsCreated**
- **#\$inputsDestroyed**
- **#\$assistingAgent**
- **#\$beneficiary**
- **#\$fromLocation**
- **#\$toLocation**
- **#\$deviceUsed**
- **#\$driverActor**
- **#\$damages**
- **#\$vehicle**
- **#\$providerOfMotiveForce**
- **#\$transportees ...**

Over 400 more.

Relating Events and Participants



Attack874

isa: TerroristAttack.
performedBy: JihadGroup.
deviceUsed: Bomb8388.
eventOccursAt: CityOfLondonEngland.
victim: Person9399.
victim: Person52666.
assistingAgent: AlQaeda.
objectsDestroyed: Structure2990.
objectsDestroyed: Vehicle523452.

Representation of A Sample Event



Mohamed Atta



Biographical data:

Mohamed Atta is Egyptian. [New York City, NY](#) is where Mohamed Atta died.

- Mohamed Atta was born in 1968.
- Mohamed Atta was born on September 1, 1968.

- Mohamed Atta was born in [Egypt](#).
- Mohamed Atta was born in [Cairo, Egypt](#).

Documentation data:

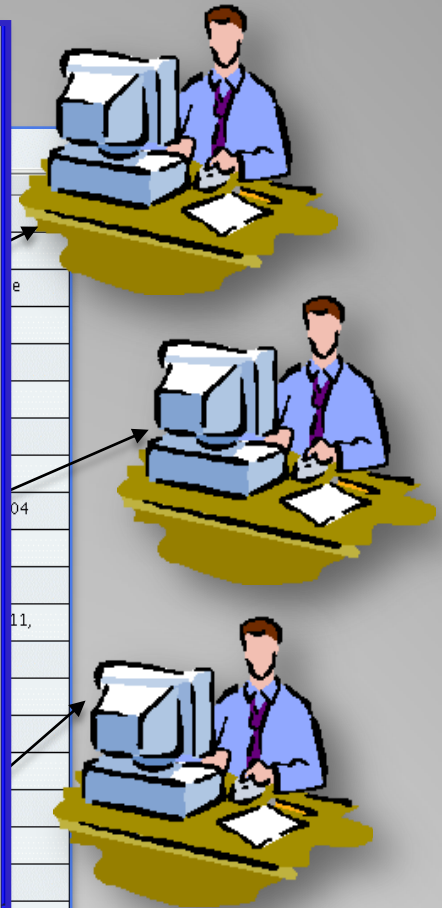
Note: Atta received his commercial pilot's license in December, 2000. Comment: Hijacker on [American Airlines Flight 11 September 11 2001](#).

Miscellaneous:

Mohamed Atta was a leader of [Hamburg al Qaida Cell](#) from sometime on [the late part of the 1990's](#) to sometime on September 11, 2001. In 1996, Mohamed Atta was the head of [Islamic Prayer and Discussion Group](#). #hasAuthorityOver holds of [Nawaf al-Hazmi](#) and Mohamed Atta from sometime in June, 2001 to sometime on September 11, 2001. Mohamed Atta deliberately took part in [American Airlines Flight 11](#).

When: the late part of the 1990's

Name Birth/Death Identification Physical Description Locations Expertise Occupation Associations Arrests Attacks

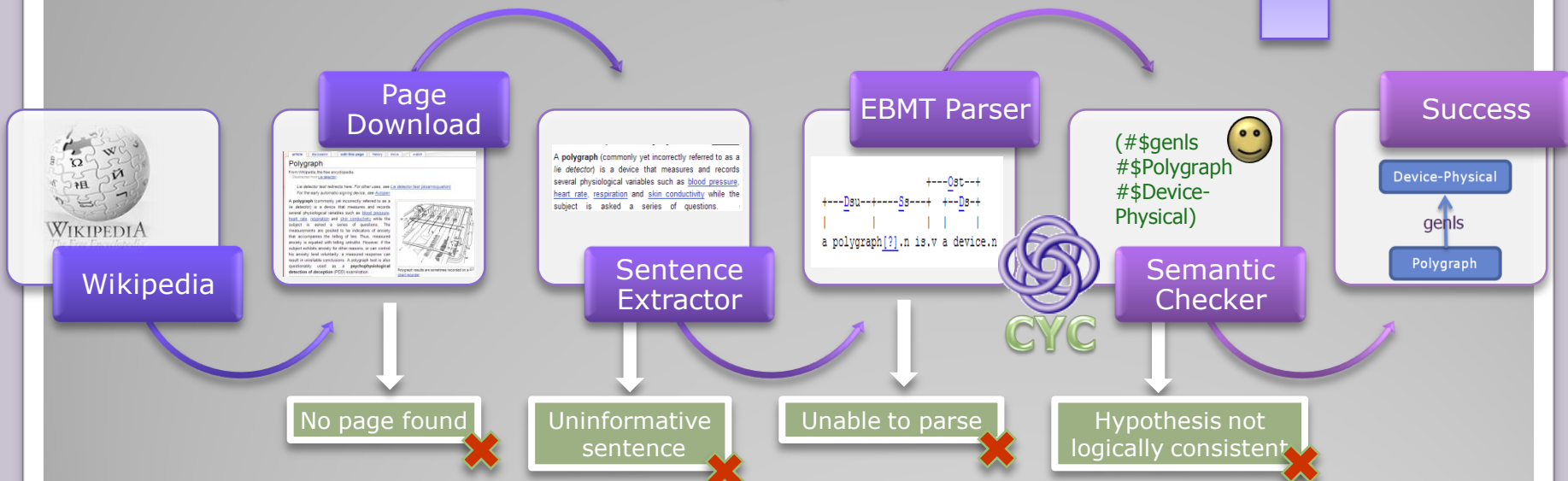
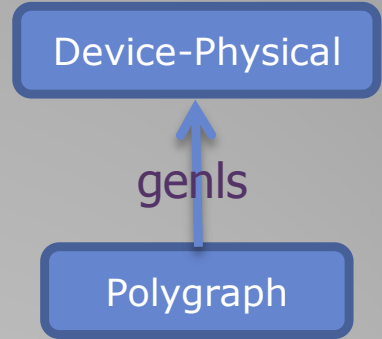


Acquiring Cyc Representations



... Klingberg contacted the USSR for the first time in 1957, and soon after that he started his espionage activity. Israel's foreign and domestic intelligence agencies, Mossad and Shin Bet, started suspecting Klingberg of espionage, but shadowing brought no results. At one point, the scientist also successfully passed the polygraph test...

Unknown word "polygraph"



Automatically Adding to the Model

Analogy

BrussellKidnapScript-JillCarroll-20060930M is similar to BrussellKidnapScript-JillCarroll-20060930M in these ways:

Base Entity	Target Entity	Score
2006	2004	1.0
JillCarroll	NicholasBerg	1.0
March	July	0.5900000
January	April	0.5480000
BrussellKidnapScript-JillCarroll-20060930	BrussellKidnapScript-NicholasBerg-20060930	0.1444999
7	10	0.068
Iraq	Iraq	0.0400000
UnitedStatesOfAmerica	UnitedStatesOfAmerica	0.0360000
30	4	0.0360000

Brussel/STT

Status: Analyzed 28 A

Situation Type: Kidnapping

Roles

- kidnap-victim
- kidnapper

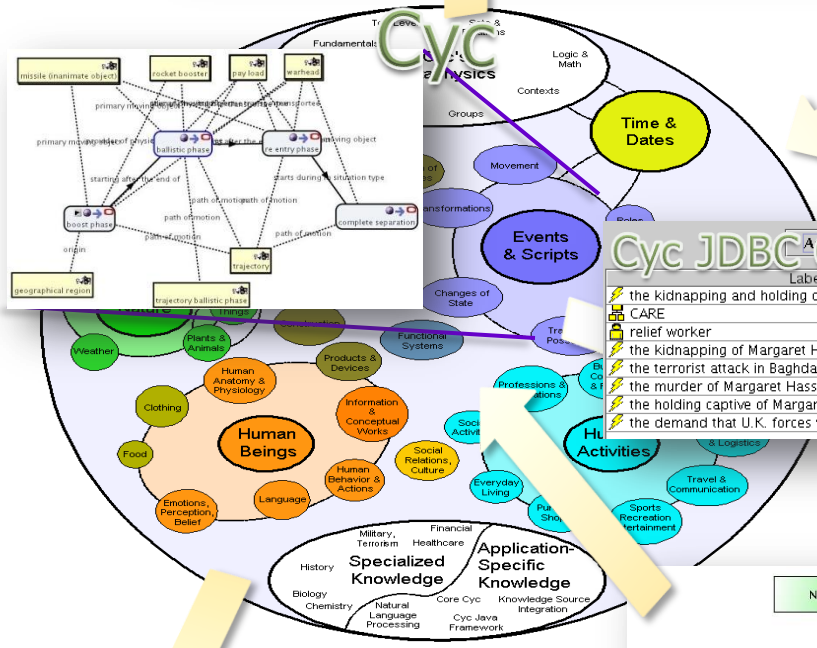
Scenes

- kidnapping-abduct
- kidnapping-appear
- kidnapping-threat
- kidnapping-escape

Role: kidnap-victim

- first-name:
 - Thomas x1
- last-name:
 - Hamill x1
- gender:
 - male x9
- age:
 - 43 x4
- occupation:
 - truck driver x4

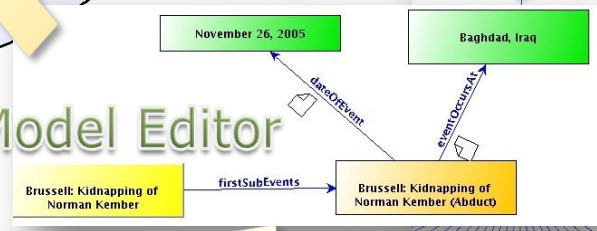
Cyc



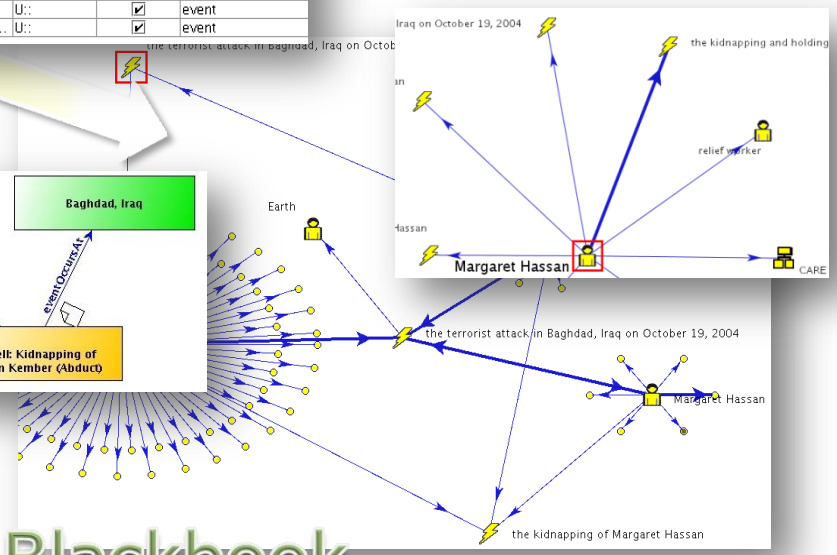
Cyc JDBC Connect

Label	security...	Accepted	sub-type
the kidnapping and holding of Margaret Hassan	U::	<input checked="" type="checkbox"/>	event
CARE	U::	<input checked="" type="checkbox"/>	organization
relief worker	U::	<input checked="" type="checkbox"/>	type of profession
the kidnapping of Margaret Hassan	U::	<input checked="" type="checkbox"/>	event
the terrorist attack in Baghdad, Iraq on October 19, 2004	U::	<input checked="" type="checkbox"/>	event
the murder of Margaret Hassan	U::	<input checked="" type="checkbox"/>	event
the holding captive of Margaret Hassan	U::	<input checked="" type="checkbox"/>	event
the demand that U.K. forces withdraw in exchange for the...	U::	<input checked="" type="checkbox"/>	event

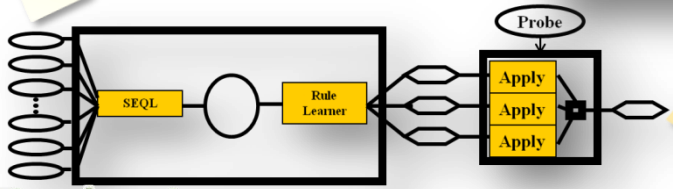
Model Editor

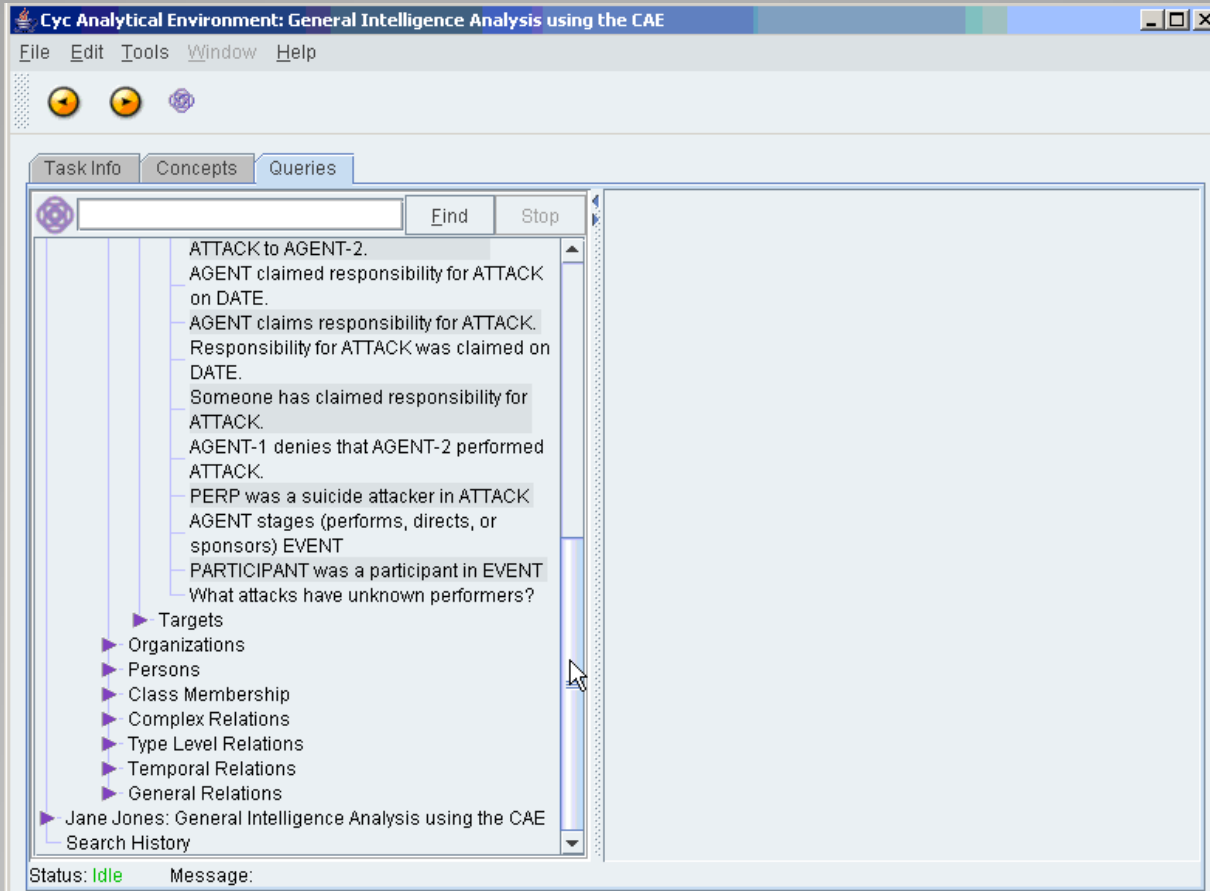


Blackbook



Rule Learner





Dragging snippets of English together constructs logical queries.

Using the Knowledge



- Time is ripe for national knowledge infrastructure
 - Based on formal logic with contexts
 - With existing inferentially powerful terminology
 - Using Cyc for compatibility with IKL *and* Semantic Web
- It's buildable, extensible, and usable
 - Assisted knowledge entry
 - Automated knowledge acquisition
 - Effective query interfaces
- Cyc is part of the bridge that gets us there



Wrap-up