

Survey of Knowledge Base Content

- *Introduction*
- Fundamental Expression Types
- Top Level Collections
- Time and Dates
- Spatial Properties and Relations
- Event Types
- Information
- More Content Areas

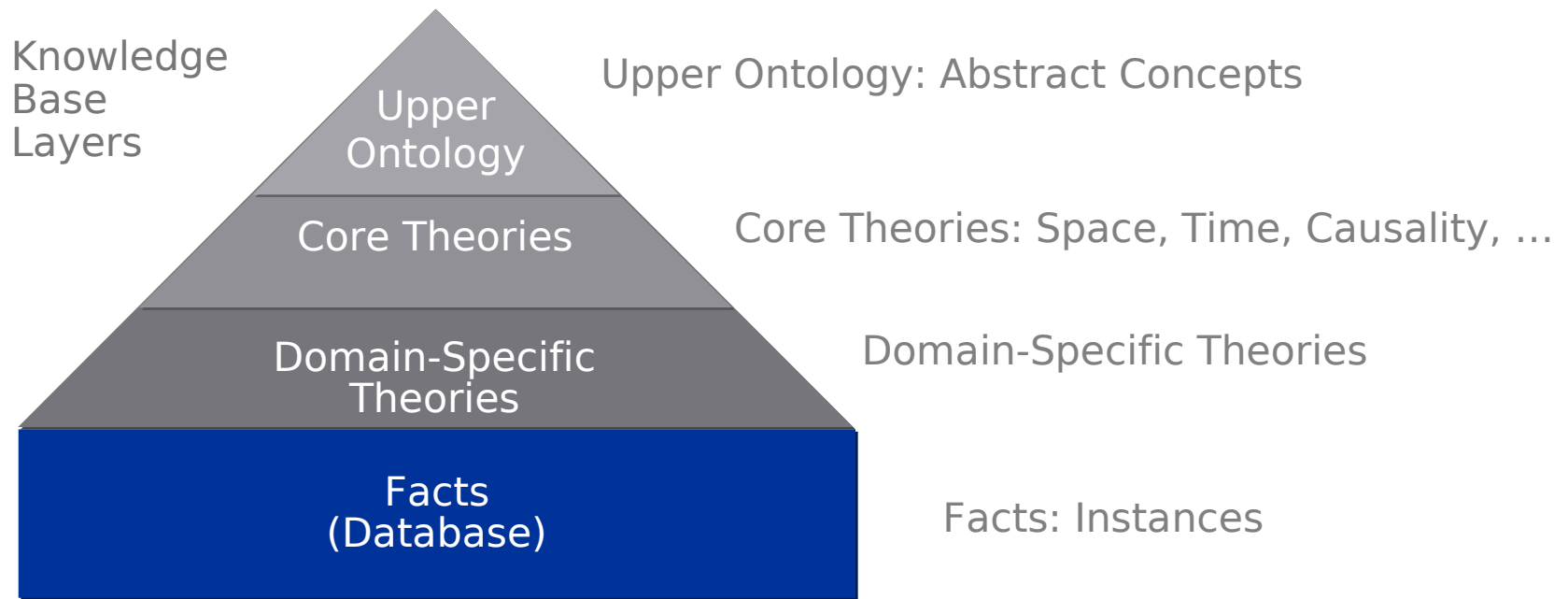


The Form and Content Of The Knowledge Base

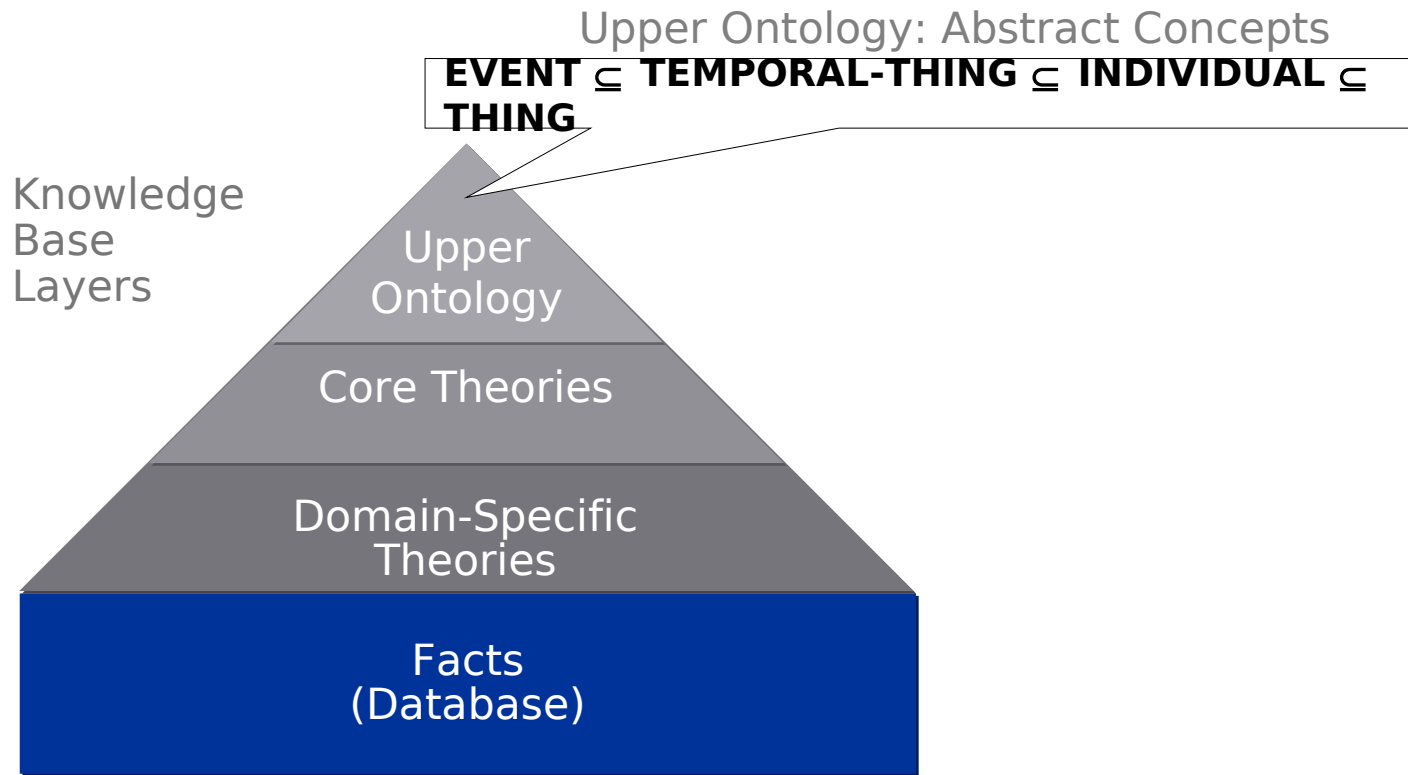
- The main advantage of Cyc over other systems for representing knowledge is its use of a formal language in which inferential connections between concepts and statements are encoded in a machine accessible way.
- The content of the Knowledge Base comprises:
 - A vast taxonomy of concepts and relations
 - A rich formal representation of their interconnections



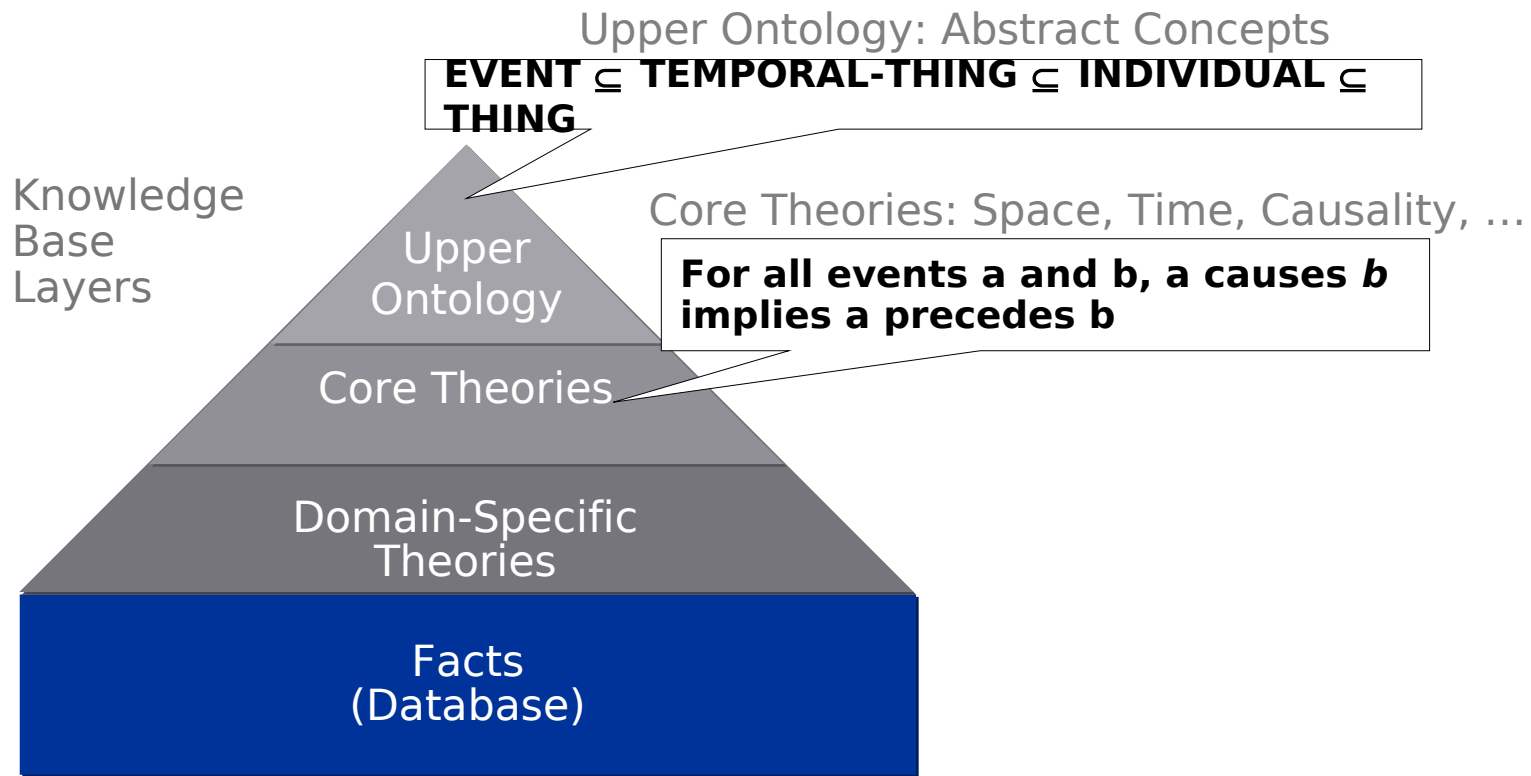
Arrangement, by Generality



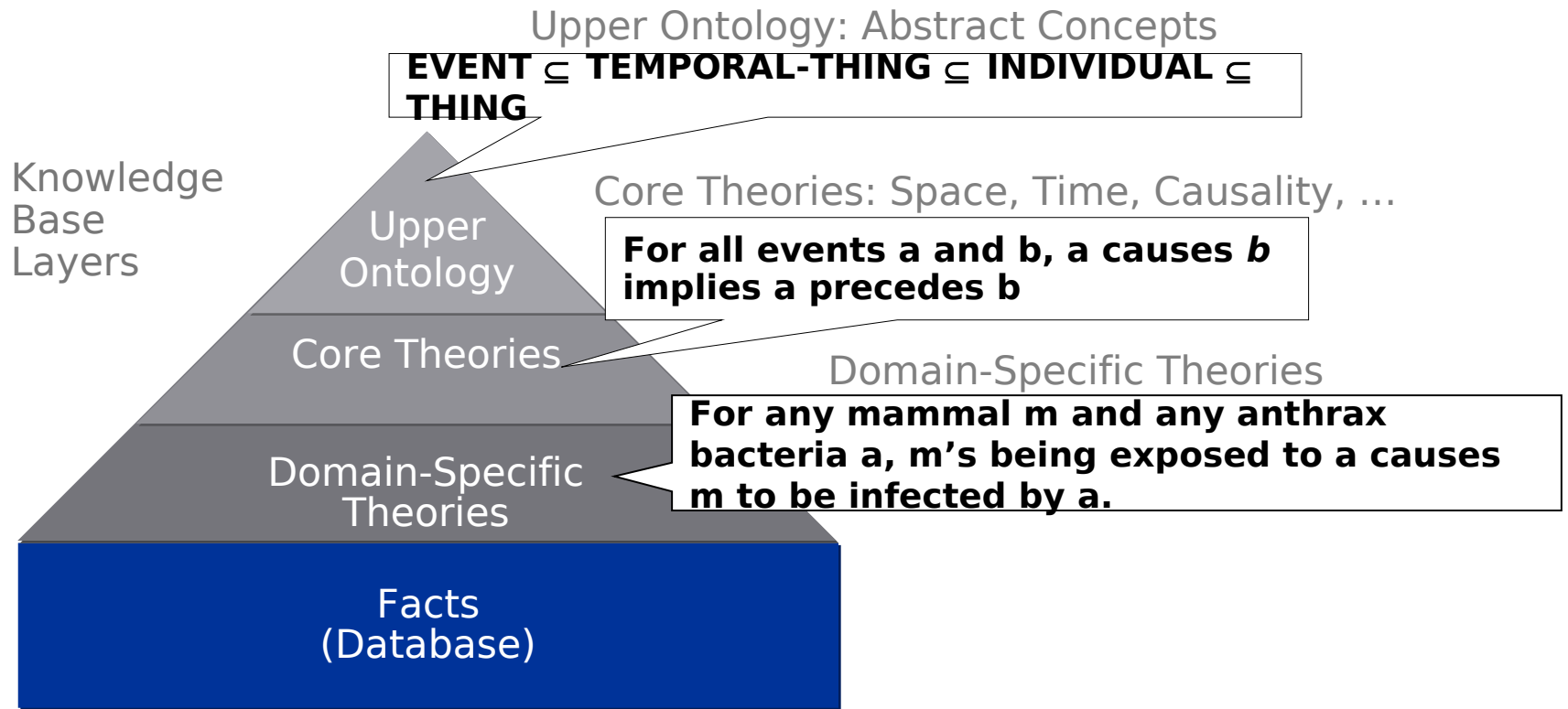
Arrangement, by Generality



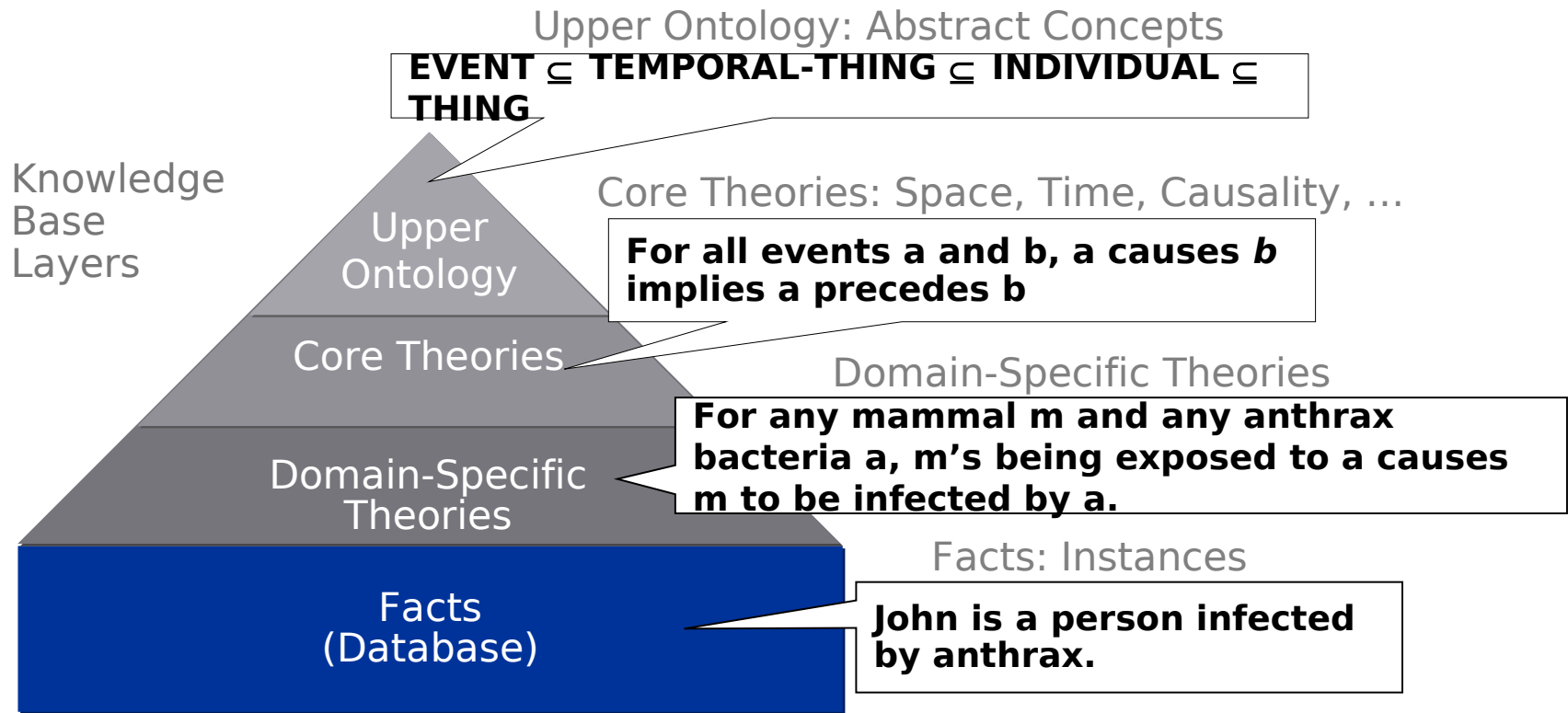
Arrangement, by Generality



Arrangement, by Generality



Arrangement, by Generality



Summary

- The KB is a vast taxonomy of concepts and relations
- CycL is a rich formal representation of their interconnections
- The KB can be thought of as made up of layers ordered by degree of generality



CYCORG

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Constants

Constants denoting individuals, collections, and collections of collections:

- #GeorgeWBush, #Sudan, #0-TheDigit
- #WorldLeader, #Country
- #AutomobileTypeByBrand, #WineTypeByColor



Functions

Functions and Functional Expressions:

- #\$\$PresidentFn

(#\$\$PresidentFn #\$\$Mexico)

- #\$\$MotherFn

(#\$\$MotherFn (#\$\$PresidentFn #\$\$UnitedStates))

- #\$\$GroupFn

(#\$\$GroupFn #\$\$Person)



Terms Used to Relate: #Sisa and #genls

Fundamental terms relating individuals to collections, and interrelating collections:

- #Sisa

 - (#Sisa #GeorgeWBush #WorldLeader)

 - (#Sisa #Cat #OrganismClassificationType)

- #genls

 - (#genls #Cat #Carnivore)



Terms Used to Relate: #\$typeGenls

Fundamental terms relating individuals to collections, and interrelating collections:

- #\$typeGenls

 - (#\$typeGenls #\$OrganismClassificationType #\$BiologicalLivingObject)

- (#\$genls #\$Cat #\$Carnivore)

- (#\$isa #\$Cat #\$OrganismClassificationType)



Terms Used to Relate: #\$disjointWith

Fundamental terms relating individuals to collections, and interrelating collections:

- #\$disjointWith
(#\$disjointWith #\$Fish #\$Mammal)



Other Terms Used to Relate

Other Relational Terms:

- #biologicalRelatives

(#biologicalRelatives #JerryLeeLewis #JimmySwaggart)

- #geographicalSubregions

(#geographicalSubregions #UnitedStates #Utah-State)

- #greaterThan

(#greaterThan 25 3)

- #orbits

(#orbits #MoonOfEarth #PlanetEarth)

- #authorOfLiteraryWork-CW

(#authorOfLiteraryWork-CW #HermanMelville #MobyDickNovel)



Connecting Relational Terms: #\$genIPreds and #\$genInverse

Terms Connecting Relational Terms:

- #\$genIPreds

 - (#\$genIPreds #\$geographicalSubregions #\$physicalParts)

 - (#\$genIPreds #\$physicalParts #\$temporallyIntersects)

 - (#\$genIPreds #\$father #\$biologicalRelatives)

- #\$genInverse

 - (#\$genInverse #\$causes-EventEvent #\$startsAfterStartingOf)

 - (#\$genInverse #\$father #\$biologicalRelatives)



Predicates for Well-formedness: #\$arity and #\$argxIsa

Predicates For Describing Syntactic and Semantic
Conditions for Well-Formedness:

- #\$arity
(#\$arity #\$biologicalMother 2)
- #\$arg1Isa, #\$arg2Isa, etc.
(#\$arg1Isa #\$biologicalMother #\$Animal)
(#\$arg2Isa #\$biologicalMother #\$FemaleAnimal)



Logical Connectives: #Or

#Or

(#Or

(#Iisa #ChrisX #CollegeGraduate)

(#Iisa #ChrisX #ComputerProgrammer)

(#Iisa #ChrisX #Genius))



Logical Connectives: #Sand and #Snot

#Sand, #Snot

(#Snot

(#Sand

(#Sisa #ChrisX #MalePerson)

(#Sisa #ChrisX #FemalePerson)))



Logical Connectives: #Implies

#Implies

(#Implies

(#isa #ChrisX #MalePerson)

(#not (#isa #ChrisX #FemalePerson)))



Quantifiers: #forall

#forall

(#forall ?COUNTRY

(#forall ?PERSON

(#implies

(#and

(#isa ?COUNTRY #Superpower)

(#headsGovernment ?COUNTRY ?PERSON))

(#hasStatus ?PERSON #WorldLeader))))



Quantifiers: #thereExists

#thereExists

(#forAll ?ANIMAL

(#implies

(#isa ?ANIMAL #Vertebrate)

(#thereExists ?PART

(#and

(#isa ?PART #Tongue)

(#anatomicalParts ?ANIMAL ?PART))))))



Summary

- Constants denote individuals, collections, and collections of collections
- Functions and Functional Expressions denote terms
- Terms used to relate: #isa, #genls, #typeGenls, #disjointWith
- Connecting Relational Terms: #genlPreds and #genlInverse
- Predicates For Describing Well-Formedness: #arity and #argxIsa
- Logical Connectives and Quantifiers



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Some Top Level Collections



#\$Dog (the collection of all dogs)

#\$isa: **#\$OrganismClassificationType**

#\$BiologicalTaxon

#\$BiologicalSpecies

#\$DomesticatedAnimalType

#\$genls: **#\$CanineAnimal**

But these are only the immediate categories



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45 Collections of which #"\$Dog" is a Specialization

Agent Agent-Generic AirBreathingVertebrate Animal AnimalBLO
BilateralObject BiologicalLivingObject CanineAnimal Carnivore
CarnivoreOrder ChordataPhylum Coelomates Container-
Underspecified Dog EukaryoticOrganism Eutheria
FrontAndBackSidedObject Heterotroph HexalateralObject
Homeotherm HumanScaleObject Individual IndividualAgent
LeftAndRightSidedObject Location-Underspecified Mammal
NaturalTangibleStuff NonPersonAnimal OrganicStuff Organism-
Whole PartiallyTangible PerceptualAgent Region-Underspecified
SentientAnimal SolidTangibleThing SomethingExisting
SpatialThing SpatialThing-Localized System-Generic
TemporalThing TerrestrialOrganism Thing
TopAndBottomSidedObject Trajector-Underspecified Vertebrate



11 Collections of which #\$Dog is an Instance

#\$OrganismClassificationType

#\$ConventionalClassificationType_

#\$ExistingObjectType

#\$TemporalStuffType

#\$ObjectType

#\$Collection

#\$SetOrCollection

#\$MathematicalThing

#\$MathematicalOrComputationalThing

#\$Intangible

#\$PartiallyIntangible

#\$Thing



Summary

- The collections hierarchy
- Specialization (#\$genls)
- Instance (#\$isa)



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Functions Which Return Time Intervals

#\$YearFn, #\$DayFn, #\$MinuteFn, #\$SecondFn

Example:

(#\$YearFn 2000)



Functions Which Return Time Intervals: Composite Expressions

#\$YearFn, #\$DayFn, #\$MinuteFn, #\$SecondFn

Example:

```
(#$SecondFn 59  
  ($$HourFn 23  
    ($$DayFn 31  
      ($$MonthFn $$December  
        ($$YearFn 2000))))))
```



Time As A Quantity

Some Functions Denoting Quantities of Time:

#\$YearsDuration, #\$HoursDuration, #\$SecondsDuration

Example:

(#\$duration (\$YearFn 2000) (\$YearsDuration 1))



Relations Between Temporal Things

- #TemporalBoundsIntersect
- #TemporallyIntersects
- #StartsAfterStartingOf
- #EndsAfterStartingOf
- #EndsAfterEndingOf
- #StartingDate
- #TemporallyContains
- #TemporallyCooriginating
- #TemporalBoundsContain
- #TemporalBoundsIdentical
- #StartsDuring
- #OverlapsStart
- #StartingPoint
- #SimultaneousWith
- #After



Relations of Types of Intervals

- #TemporalStuffType
- #TemporalObjectType
- #TemporallyDisjointIntervalType
- #CyclicalIntervalGroupType



Relations of Types of Intervals

- #includedInIntervalType
- #subsumesIntervalType
- #intersectsIntervalType
- #subsumedByIntervalType
- #followingIntervalType



Summary

- Functions which return time intervals
- Time as a quantity
- Relations between temporal things
- Relations of time intervals



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- ***Spatial Properties and Relations***
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Spatial Properties and Relations

- Surfaces, Portals and Cavities
- Shape Attributes (63)
- Types of Spatial Symmetry
- Direction and Orientation Vocabulary
- Relative Positions of Objects
- Nearness and Location
- Being Between
- 'In-' Predicates (~ 60)
- Connections Predicates (~ 65)
- Mereological Relations



Senses of 'In'

- Can the inner object leave by passing between members of the outer group?
 - Yes -- Try #Sin-Among

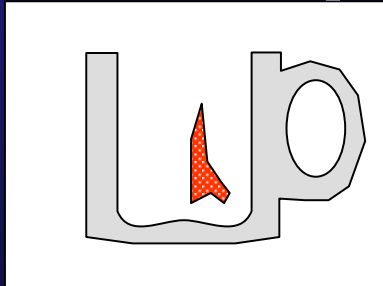


Senses of 'In'

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

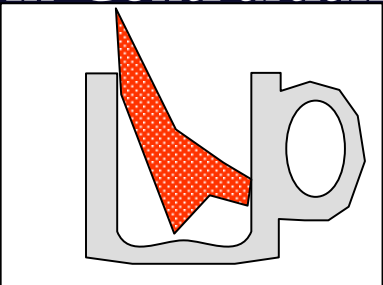
– None of it. -- Try

#\$in-ContCompletely



– Yes -- Try

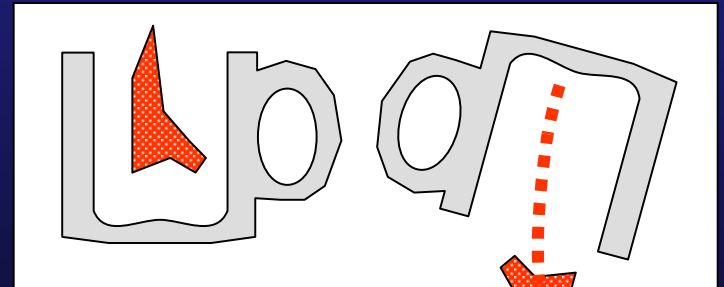
#\$in-ContPartially



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

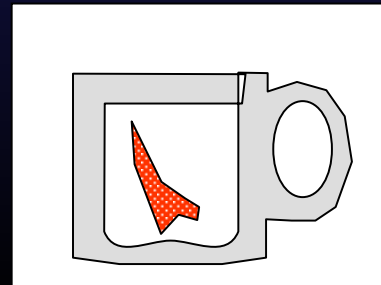
– Yes -- Try

#\$in-ContOpen



– No -- Try

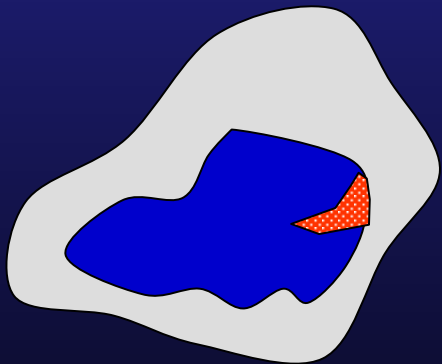
#\$in-ContClosed



Senses of 'In'

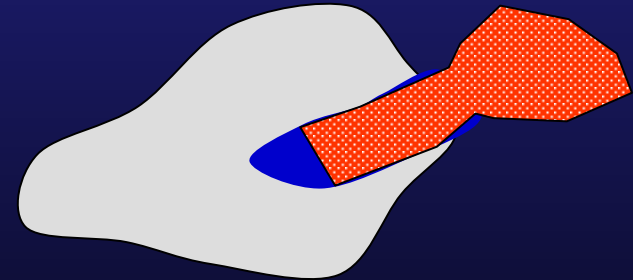
Is it attached to the inside of the outer object?

- Yes -- Try #connectedToInside



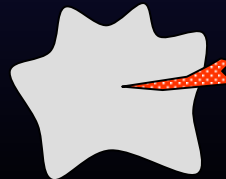
Can it be removed, if enough force is used, without damaging either object?

- Yes -- Try #in-Snugly or #screwedIn



Does the inner object stick into the outer object?

- Yes -- Try #sticksInto



Senses of 'Part'

- #parts
- #intangibleParts
- #subInformation
- #subEvents
- #physicalDecompositions
- #physicalPortions
- #physicalParts
- #externalParts
- #internalParts
- #anatomicalParts
- #constituents
- #ingredients



Organizations

- #governingBody
- #WholeOrganizationFn
- #parentCompany
- #subOrgs-Command
- #subOrgs-Permanent
- #subOrgs-Temporary
- #subOrgs-OnlyDuringOperation
- #physicalQuarters
- #hasHeadquartersInCountry
- #officeInCountry
- #memberTypes
- #organizationHead
- #PolicyFn



Summary

- Senses of 'In'
 - #Sin-Among
 - #Sin-ContCompletely, #Sin-ContPartially, #Sin-ContClosed, #Sin-ContOpen
 - #SconnectedToInside, #Sin-Snugly, #SscrewedIn, #SsticksInto
- Senses of 'Part'
- Organizations



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Some Events Types

- #PhysicalStateChangeEvent
- #TemperatureChangingProcess
- #BiologicalDevelopmentEvent
- #ChangingDeviceState
- #CuttingNails
- #Cracking
- #Carving
- #ShapeChangeEvent
- #MovementEvent
- #GivingSomething
- #DiscoveryEvent
- #Buying
- #Thinking
- #Baking
- #Singing
- #PumpingFluid



Roles and ActorSlots (the world's largest collection)

- Agency or initiating an event
- Objects acted on or changed
- Objects created or destroyed
- Facilitating objects or stuff in an event
- Slots of motion and location
- Instruments
- Beneficiary/maleficiary
- Specialized actor roles, like #\$\$plaintiffs



Roles and ActorSlots

“Moe clobbered Curly with the British scepter.”



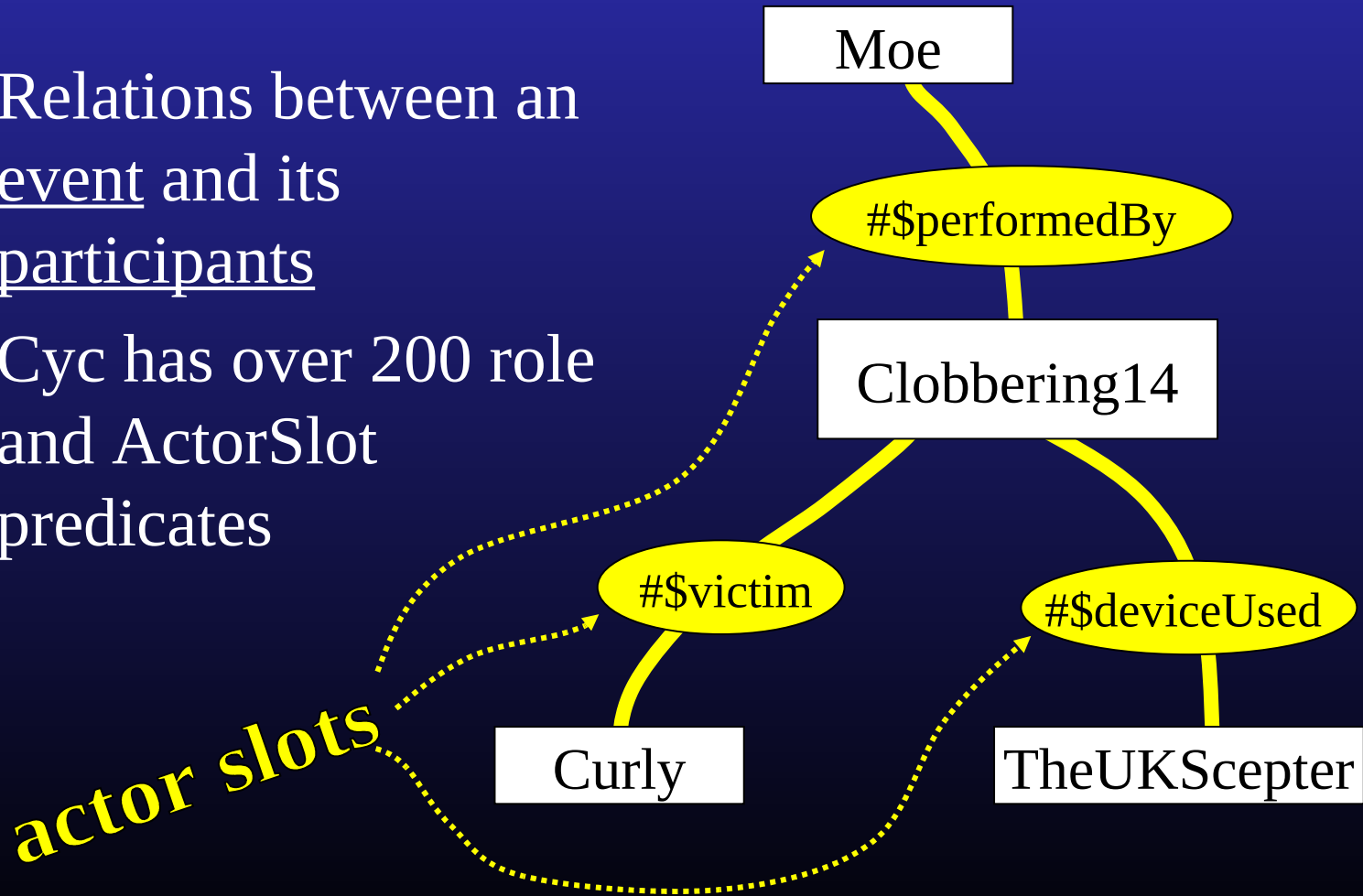
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Roles and ActorSlots

“Moe clobbered Curly with the British scepter.”

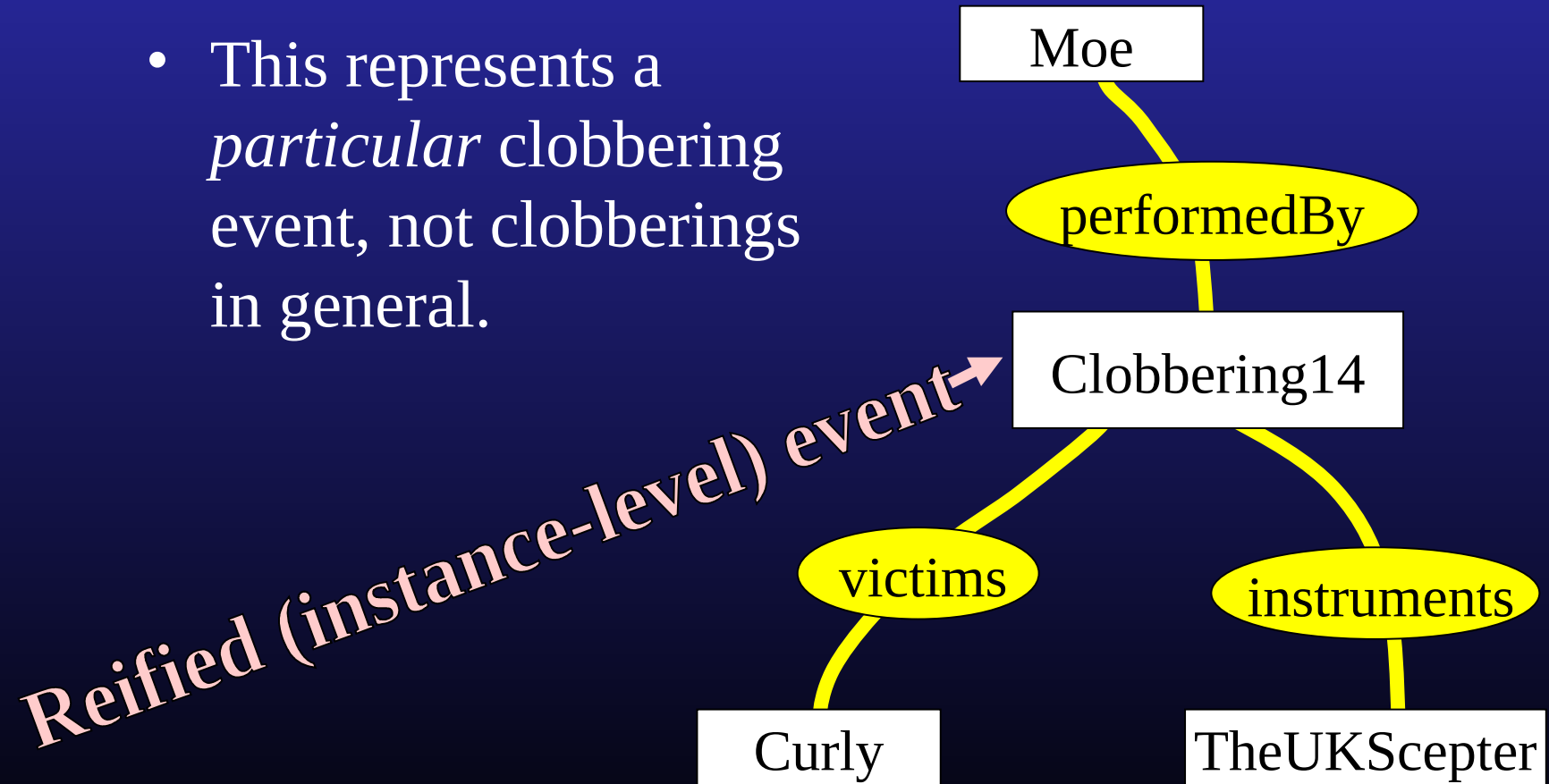
- Relations between an event and its participants
- Cyc has over 200 role and ActorSlot predicates



Roles and ActorSlots

“Moe clobbered Curly with the British scepter.”

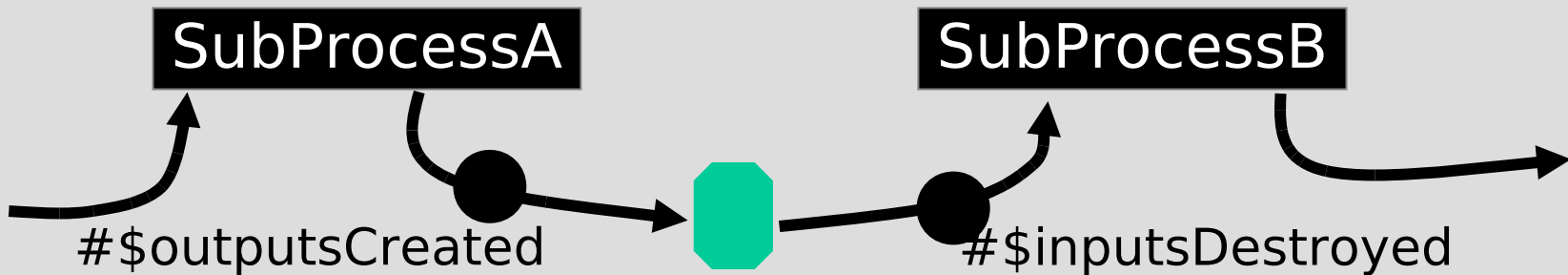
- This represents a *particular* clobbering event, not clobberings in general.



Roles in events and subevents

- A product of one subevent of the Krebs Process is the input to another.
- Hence, different ActorSlot predicates.

Krebs Process



Summary

- Cyc has a large variety of predicates for representing roles performed in events and the actors who perform them.
- Events are represented by relating actors to the event.
- The product of one sub-event in the input to another.



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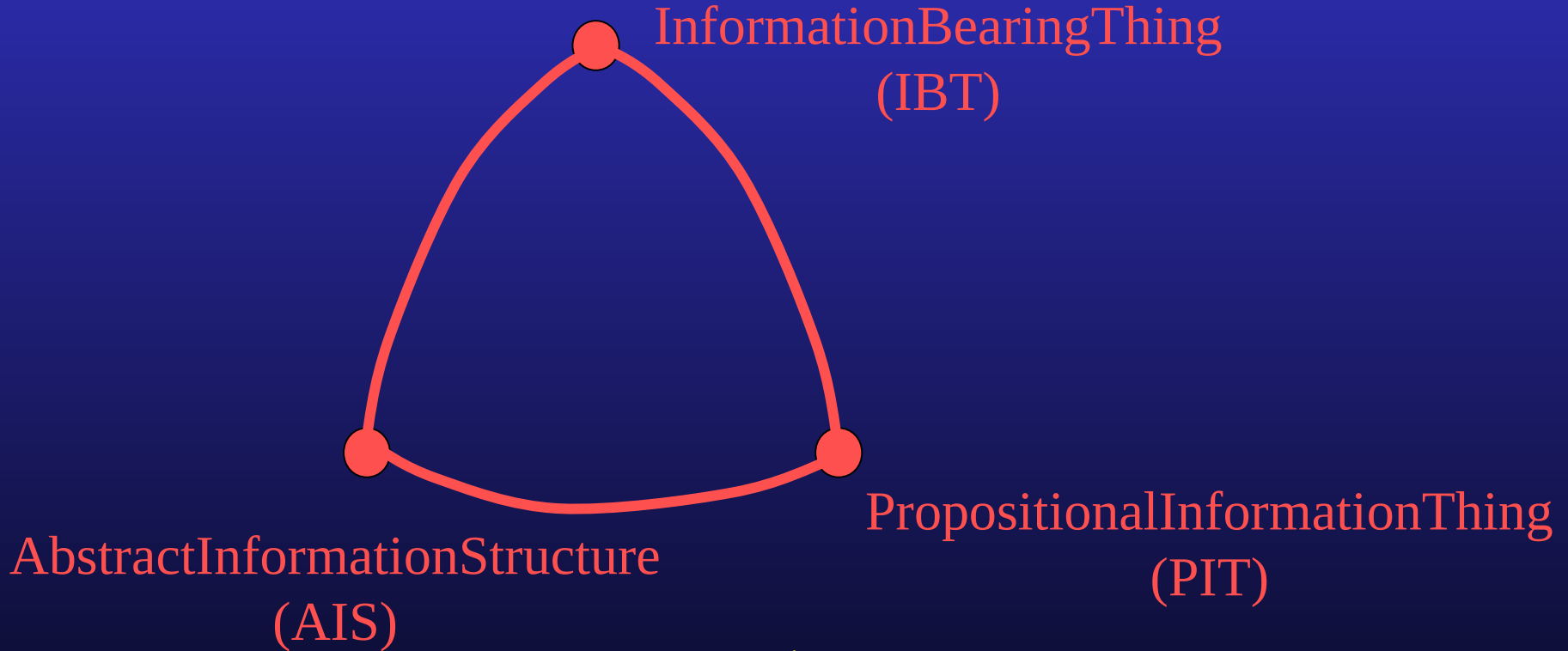
Information

- Information-Bearing Things
 - Books, web-page copies, radio broadcasts, utterances
- Abstract strings, characters
- Propositional Content
- Conceptual Works



What is “Moby Dick” ?





“ T i s M o b y
D i c k ! ”

```
(#$thereExists ?SEE  
  ($sand  
    ($$isa ?SEE Seeing)  
    ($$objectPerceived ?SEE #MobyDick)  
    ($$perceiver ?SEE #CaptainAhab)))
```





InformationBearingThing
(IBT)

Problem: These
are not what people
usually ask about.

(and

(isa ?SEE Seeing)

(objectPercieved ?SEE MobyDick)

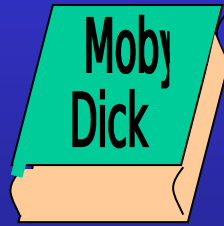
(perceiver ?SEE CaptainAhab))

“ ‘ T i s M o b y
D i c k ! ”

AbstractInformationStructure
(AIS)

PropositionalInformationThing
(PIT)





#\$InformationBearingThing
(IBT)

#\$ConceptualWork
(CW)



#\$MobyDickTheBook-CW

(and
(isa ?SEE Seeing)
(objectPercieved ?SEE MobyDick)
(perceiver ?SEE CaptainAhab))

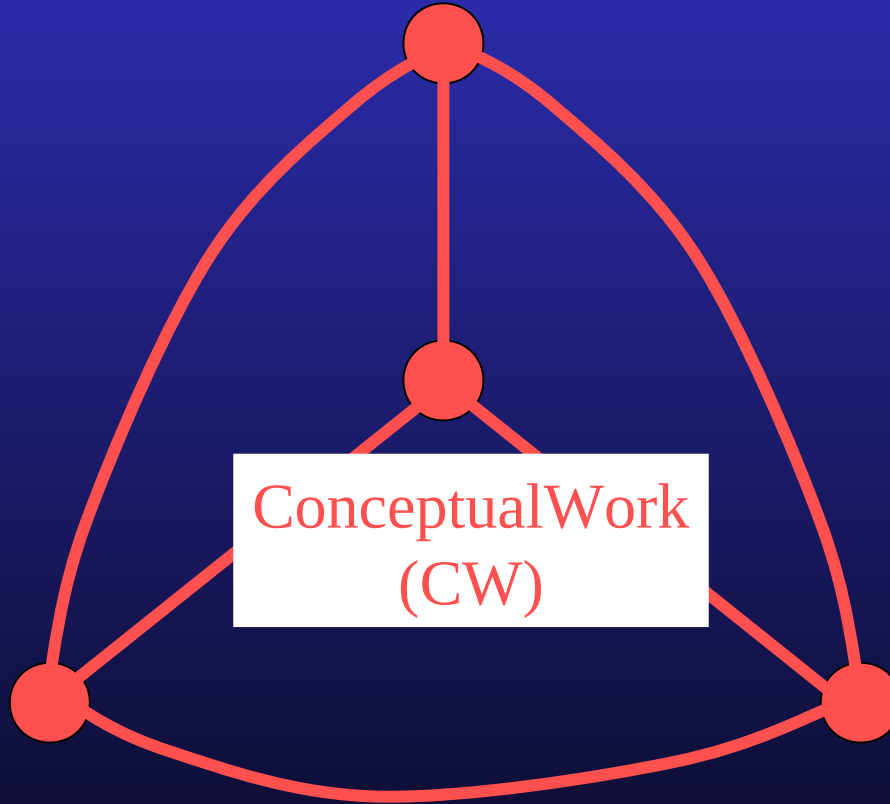
“ ' T i s M o b y
D i c k ! ”

#\$AbstractInformationStructure
(AIS)

#\$Proposition and
#\$PropositionalInformationThing
(PIT)



InformationBearingThing
(IBT)

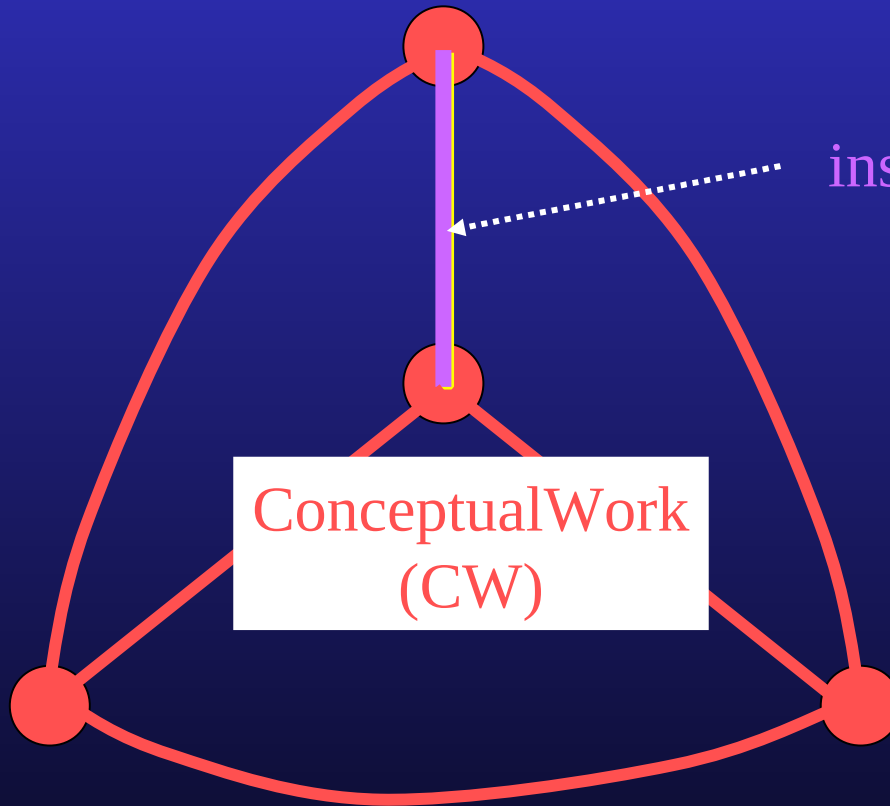


AbstractInformationStructure
(AIS)

PropositionalInformationThing
(PIT)



InformationBearingThing
(IBT)



instantiationOfCW

AbstractInformationStructure
(AIS)

PropositionalInformationThing
(PIT)



InformationBearingThing
(IBT)

textOfIBT

instantiationOfCW

InfoStructureOfCW

ContainsInfo-Propositional-CW

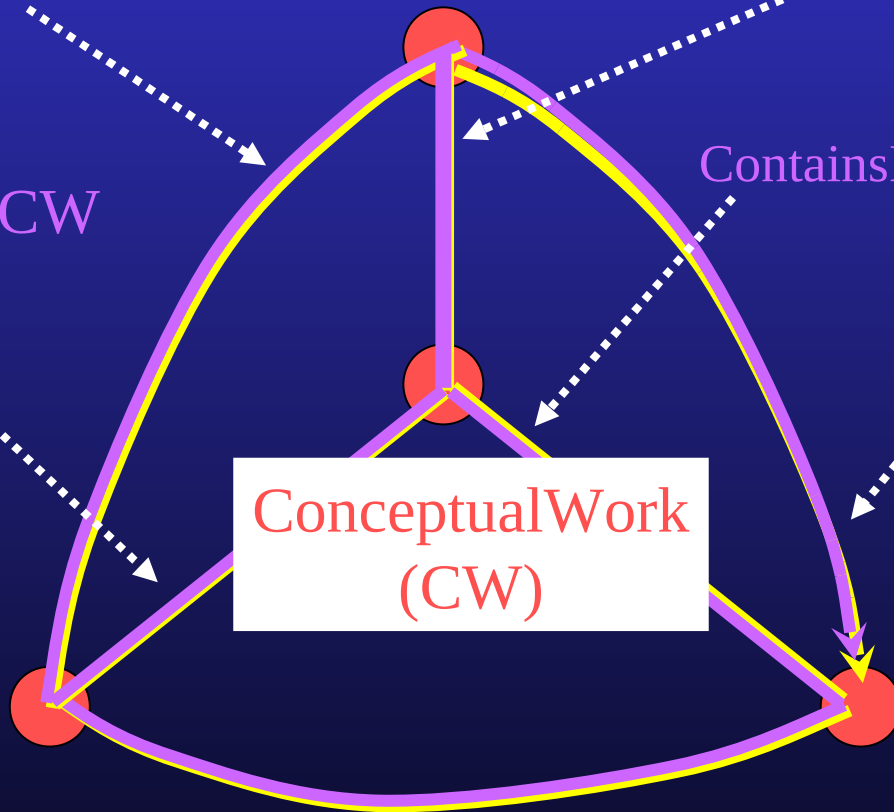
PITOfIBTEn

ConceptualWork
(CW)

AbstractInformationStructure
(AIS)

PropositionalInformationThing
(PIT)

#\$infoStructureRepresents



Summary

- InformationBearingThing
- AbstractInformationStructure
- PropositionalInformationThing
- ConceptualWork
- Relating these categories



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Emotion

- Feeling Attributes Types
 - #Abhorrence
 - #Adulation
 - #Relaxed-Feeling
 - #Gratitude
 - #Anticipation-Feeling
 - Over 120 of these
- Relations Pertaining to emotions
 - #contraryFeelings
 - #feelsTowardsObject
 - #appropriateEmotion
 - #feelsTowardsPersonType
 - #actionExpressesFeeling



Propositional Attitudes

Relations Between Agents and Propositions

- #goals
- #intends
- #desires
- #hopes
- #expects
- #beliefs
- #opinions
- #knows
- #rememberedProp
- #perceivesThat
- #seesThat
- #tastesThat



Biology

- Organisms classified by:
 - Taxon
 - Habitat
 - Source of Nutrients
- Organism Anatomy
 - Gross Anatomy
 - Cell biology
 - Physiological Processes
- Life stages
- Some scientific, #ChordataPhylum, some not, #Worm



Materials

- Common Substances
- Attributes of Materials
- States Of Matter
- Solutions
- Electrical Conductivity
- Thermal Conductivity
- Structural Attributes
- Tangible Attributes



CYCOPR

Devices

- Specializations Of #PhysicalDevice
- Device States
- Device Actions
- Device Predicates
- Device Purposes



Food

- Food Types
- Edibility
- Preparing food
- Consuming food
- Hunger



Weather

- Weather Attributes
 - #ClearWeather
 - (#LowAmountFn
#Raininess)
- Weather Events
 - #TornadoAsEvent
 - #SnowProcess
- Weather Objects
 - #CloudInSky
 - #TornadoAsObject



Geography

- Geopolitical Entities
- Addresses
- Specific Ethnic and Language information
- Borders
- Districts, States, etc.
- Seas, islands, straits, etc.



Summary

- Emotion
- Propositional Attitudes
- Biology
- Materials
- Devices
- Food
- Weather
- Geography

