Semantic Construction Grammar
- a meaning-centric approach to NL Understanding

Michael Witbrock,
Dave Schneider
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a sad realisation and an opportunity

- logical representations good for inference are sometimes very far from natural language
- … in unpredictable ways
- … and they need to be right in ways NL does not
- So, syntactic mapping is (pretty much) hopeless
- BUT, storage is pretty much free,
- … and inference is getting there
- … and ILP works at least some of the time

\[
(EBLT \cap \text{FrameNet} \cap \text{Cyc}) \Rightarrow \text{EBMTL} \Rightarrow \text{SCG}
\]
Semantic Construction Grammar

representational context: Cyc vocabulary and syntax
Cyc contains:

- O(10k) Predicates
- O(100k) Concepts
- O(10M) 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
Very specific information (some indirect, via SKSI)

First Order Predicate Calculus: unambiguous; enable mechanical reasoning

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

\[ \exists y. \forall x. \text{Amer}(x) \Rightarrow \text{president}(x,y) \]

\[ \forall x. \exists y. \text{Amer}(x) \Rightarrow \text{mother}(x,y) \]

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

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

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

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

**Formal Representation for Reasoning**
- TransportationEvent
- ControllingATransportationDevice
- TransportWithMotorizedLandVehicle
  - (SteeringFn RoadVehicle)
- TransporterCrashEvent
- VehicleAccident
- CarAccident
- Colliding
- IncurringDamage
- TippingOver
- Navigating
- EnteringAVehicle
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’
Does part of the inner object stick out of the container?

- None of it.
  - $\text{in-ContCompletely}$
- Yes
  - $\text{in-ContPartially}$
- No
  - $\text{in-ContClosed}$

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

- Yes
  - $\text{in-ContOpen}$
First Order

• (isa ASBFinancialCorp PubliclyHeldCorporation)
• (corporateOfficers ASBFinancialCorp GeraldRJenkins)

With Context

• In Mt: FinancialTransactionMt
  (relationAllExists performedBy RepurchaseProgram PubliclyHeldCorporation)

Rule

• In Mt: FinancialTransactionMt
  (forAll ?X (implies
    (isa ?X RepurchaseProgram)
    (thereExists ?Y (and (isa ?Y PublicallyHeldCorporation) (performedBy ?X ?Y))))))

Second Order

• (implies
  (equals ?SET (TheSet ?THING)))

Modal

• (beliefs Israel (relationInstanceExists possesses Syria ClusterBomb))

Meta

• (opaqueArgument beliefs 2)
OpenCyc (Current): [http://sw.openyc.org/concept/Mx4r8qkJXAW-QdmV1JNLSFyIA]
OpenCyc (Versioned): [http://sw.openyc.org/2008/06/10/concept/Mx4r8qkJXAW-QdmV1JNLSFyIA]

**shipping**

*shering [HiringForWorkOnAShip]*
A collection of events; a subcollection of EmployeeHiring. In each HiringForWorkOnAShip, someone hires someone else for work on a ship.
http://sw.openyc.org/concept/Mx4rOlVkermEdmAAAACs6hRjg

**shipping**

Shipping of objects from one physical location to another. Shipping from the perspective of being done as a dedicated service, such as what UPS, the US Postal Service, or Dominoes Pizza Delivery might do.
http://sw.openyc.org/concept/Mx4rVj6n5wpEbGdrcN5Y29ycA

**shipping address [ShippingAddress]**
A specialization of MailingAddress. Each instance of ShippingAddress is a mailing address which does not include a P.O. Box number. Typically then, a shipping addresses includes a street name and number and often an apartment or suite number. For example: '3721 Executive Center Drive, Suite 100, Austin, TX 78731', the shipping address of Cycorp.
http://sw.openyc.org/concept/Mx4rVj6n5wpEbGdrcN5Y29ycA

**shipping-receiving clerk [shipping and receiving clerk]**
The collection of all shipping-receiving clerks. A type of DeskWorker. Shipping_ReceivingClerk is a PersonTypeByOccupation.
http://sw.openyc.org/concept/Mx4rVj6n5wpEbGdrcN5Y29ycA

**shipping and receiving department [ShippingAndReceivingDepartment]**
A specialization of Department. Each instance of this collection is an organization's centralized office for dispatching (material) items to the outside world, and also accepting them as they come in.
http://sw.openyc.org/concept/Mx4rVikLoZwcEbGdrcN5Y29ycA
OpenCyc Collection: loading a vehicle

Unique ID: [ Mx4rSbwolPpYEdqAAAACs71DGQ]
English ID: [LoadingAVehicle]
English Aliases: ["had loaded a vehicle", "has loaded a vehicle", "have loaded a vehicle", "load a vehicle", "loaded a vehicle", "loads a vehicle", "will have loaded a vehicle", "will load a vehicle"]

The collection of instances of Loading in which the toLocation is a vehicle.

A Type of: loading, putting something into something else
Instance of: type of temporally stuff-like thing
Subtypes:
Instances:
Same as:
Main courses
(with choice)

Dish of the day

or Tartar steak, frites

or Stewed beef with gueuze sauce and frites

or Grilled salmon béarnaise

or Mussels in casserole, frites (in season, 600g)
Bruxelles Centre Ville properly geographically subsumes La Grande Place.

Brussels, Belgium properly geographically subsumes Bruxelles Centre Ville.

Someone should visit the cafe when visiting Bruxelles Centre Ville.

Which of the following describe ‘Aux Armes de Bruxelles’?
- restaurant space

Create | Cancel
Aux Armes de Bruxelles has type of dish on the menu.

Aux Armes de Bruxelles serves cuisine.

chef is the chef at Aux Armes de Bruxelles.
sous-chef is sous-chef at Aux Armes de Bruxelles.
waitperson is waitperson at Aux Armes de Bruxelles.

Each shift at Aux Armes de Bruxelles have non-negative integer people working.

Work happens during calendar day from time of day type to time of day type in Aux Armes de Bruxelles.

localized event happens on Choose a value from time of day type to time of day type at Aux Armes de Bruxelles.

The last part of the wikipedia URL for Aux Armes de Bruxelles is

Aux Armes de Bruxelles is located in spatial thing non situational.
Aux Armes de Bruxelles has type of dish on the menu.

Aux Armes de Bruxelles serves Belgian cuisine.

chef is the chef at Aux Armes de Bruxelles.
sous-chef is sous-chef at Aux Armes de Bruxelles.
waitperson is waitperson at Aux Armes de Bruxelles.

Each shift at Aux Armes de Bruxelles have non-negative integer people working.

Work happens during calendar day from
time of day type to time of day type in Aux Armes de Bruxelles.

localized event happens on choose a value from
time of day type to time of day type at Aux Armes de Bruxelles.

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Aux Armes de Bruxelles is located in spatial thing non situational.
Semantic Construction Grammar

putting semantics first
Renaissance Artists → (SubcollectionOfWithRelationToFn Artist activeDuringPeriod TheRenaissance)

Bronze Age Farmers → (SubcollectionOfWithRelationToFn Farmer activeDuringPeriod TheBronzeAge)

Kind of TimeInterval
Noun Form: not plural

Kind of Agent-Generic
Noun form
Attributive Adjective & Noun

Yellow Submarine
(SubcollectionWithRelationToFn Submarine mainColorOfObject Yellow)

Sick Child
(SubcollectionWithRelationToFn HumanChild stateOfHealth Sick)

Supporting Lexical Assertions:
(adjSemTrans Yellow-TheWord 0 RegularAdjFrame
(mainColorOfObject :NOUN YellowColor))

(adjSemTrans Sick-TheWord 0 RegularAdjFrame
(stateOfHealth :NOUN Sick))
S: a man feeds a dog pepperoni and mushroom pizza

Parsed: a man feeds a dog pepperoni and mushroom pizza

Partial Parse:

E: feeding in the set of EVENT such that
  - some pizza with pepperoni and mushrooms was completely consumed in EVENT,
  - EVENT was a service provided to some dog,
  - and some man provided EVENT as a service

AC: (equalSymbols ?EVT
  (CollectionSubsetFn FeedingEvent
   (TheSetOf ?EVENT
    (thereExists ?FEEDER
     (thereExists ?FED
      (thereExists ?FOOD
       (and
        (isa ?FOOD
         (PizzaFn
          (TheSet Pepperoni EdibleMushroom)))
        (consumedObject ?EVENT ?FOOD)
        (isa ?FED Dog)
        (recipientOfService ?EVENT ?FED)
        (isa ?FEEDER AdultMaleHuman)
        (providerOfService ?EVENT ?FEEDER)))))))
A man feeds a dog pepperoni and mushroom pizza.

- AdultHumanMale
- Man-TheProgram
- FeedingEvent
- Feeding-PromotingSomething
- Dog
- HotDog
- Pepperoni
- (StuffFn Mushroom-Broadly)
- Mushroom-Broadly
- EdibleMushroom
- Pizza
50 Generalisations:
Agent-Underspecified BiologicalLivingObject Boundary-Underspecified EnduringThing-Localized
EukaryoticOrganism FiniteSpatialThing
FixedFunctionalSystem FunctionalSystem Fungus FungusBLO Heterotroph Individual Landmark-Underspecified Location-Underspecified Mushroom-Broadly NaturalTangibleStuff Opaque OrganicMaterial Organism-Whole PartiallyTangible PolyDimensionalThing PositiveDimensionalThing Region-Underspecified SomethingExisting SpatialThing SpatialThing-Localized SpatialThing-NonSituational SpatiallyBoundedThing TemporallyContinuousThing SurfaceRegion-Underspecified System TemporallyExistingThing TemporallyContinuousThing TemporallyExistingThing Thing ThreeDimensionalThing Trajector-Underspecified TrueFungus (CollectionDifferenceFn SpatialThing Situation) (CollectionUnionFn (TheSet BiologicalLivingObject FictionalCharacter)) (CollectionUnionFn (TheSet BiologicalLivingObject (GroupFn BiologicalLivingObject))) (CollectionUnionFn (TheSet Fungus Bacterium)) (CollectionUnionFn (TheSet Organism-Whole Cell)) (CollectionUnionFn (TheSet SpatialThing VectorInterval)) (CollectionUnionFn (TheSet TemporalThing Collection)) (MeaningInSystemFn SENSUS-Information1997 "DECOMPOSABLE-OBJECT")

75 Generalisations:
Agent-Underspecified Artifact-Generic BiologicalLivingObject Boundary-Underspecified BusinessRelatedThing Container-Underspecified ContainerIndependentShapedThing CulturalThing EdibleMushroom
EdibleStuff EnduringThing-Localized EukaryoticOrganism FiniteSpatialThing FixedFunctionalSystem Food FoodOrDrink FoodOrDrinkOrIngredient FunctionalSystem Fungus FungusBLO GroceryMarketCategory Heterotroph HumanScaleObject Individual Landmark-Underspecified Location-Underspecified Mushroom-Broadly NaturalTangibleStuff NonFluidlikeTangibleThing Opaque OrganicMaterial Organism-Whole PartiallyTangible PartiallyTangibleProduct PolyDimensionalThing PositiveDimensionalThing Product Region-Underspecified SolidFood SolidTangibleThing SomethingExisting SpatialThing SpatialThing-Localized SpatialThing-NonSituational SpatiallyBoundedThing SpatiallyContinuousThing SurfaceRegion-Underspecified System TemporallyExistingThing TemporallyContinuousThing TemporallyExistingThing Thing ThreeDimensionalThing Trajector-Underspecified TrueFungus (CollectionDifferenceFn SomethingExisting Organization) (CollectionDifferenceFn SpatialThing Situation) (CollectionUnionFn (TheSet Action Artifact-Generic PropositionalConceptualWork)) (CollectionUnionFn (TheSet BiologicalLivingObject FictionalCharacter)) (CollectionUnionFn (TheSet BiologicalLivingObject (GroupFn BiologicalLivingObject))) (CollectionUnionFn (TheSet DurableGood ServiceEvent Product)) (CollectionUnionFn (TheSet FirstOrderCollection Artifact-Generic)) (CollectionUnionFn (TheSet Fungus Bacterium)) (CollectionUnionFn (TheSet Organism-Whole Cell)) (CollectionUnionFn (TheSet SolidTangibleThing LiquidTangibleThing)) (CollectionUnionFn (TheSet SpatialThing VectorInterval)) (CollectionUnionFn (TheSet TemporalThing Collection)) (EdibleByFn HomoSapiens) (MeaningInSystemFn SENSUS-Information1997 "DECOMPOSABLE-OBJECT") (MeaningInSystemFn SENSUS-Information1997 "NONDECOMPOSABLE-OBJECT") (MeaningInSystemFn SENSUS-Information1997 "SEPARABLE-ENTITY") …
### 110 Generalisations, including:

- AboveGround
- AerobicBLO
- AerobicOrganism
- Agent-Generic
- Agent-NonArtifactual
- Agent-NonGeographical
- Agent-PartiallyTangible
- Agent-Underspecified
- AirBreathingVertebrate

**Animal**
- AnimalBLO
- AxisymmetricObject
- BilateralObject
- BilaterallySymmetricObject
- BiologicalLivingObject
- Boundary-Underspecified
- CanineAnimal
- CanisGenus
- Carnivore
- CarnivoreOrder
- CellularTangibleThing
- ChordataPhylum
- Coelomate
- CompositeTangibleAndIntangibleObject
- Container-Underspecified
- ContainerIndependentShapedThing
- DiplodOrganism
- Diplod Dog
- DomesticatedAnimal
- EmbodiedAgent
- EnduringThing-Localized
- EukaryoticOrganism
- Eutheria
- FiniteSpatialThing
- FixedFunctionalSystem
- FrontAndBackSidedObject
- FunctionalSystem
- HexalateralObject
- Homeotherm
- HumanScaleObject
- Individual
- IndividualAgent
- Landmark-Underspecified
- Location-Underspecified
- Mammal
- MulticellularOrganism
- NaturalTangibleStuff
- NonFluidlikeTangibleThing
- NonHumanAnimal
- NonPersonAnimal
- Opaque
- OrganicMaterial
- Organism-Whole
- PartiallyIntangible
- PartiallyIntangibleIndividual
- PartiallyTangible
- PerceptualAgent
- PerceptualAgent-Embodied
- PolyDimensionalThing
- PositiveDimensionalThing
- Quadruped
- Region-Underspecified
- Sentient
- SentientAnimal
- SolidTangibleThing
- SomethingExisting
- SpatialThing
- SpatialThing-Localized
- SpatialThing-NonSituational
- SpatiallyBoundedThing
- SpatiallyContinuousThing
- SurfaceRegion-Underspecified
- System
- TameAnimal
- TemporalThing
- TemporallyContinuousThing
- TemporallyExistingThing
- TerrestrialFunctioningObject
- TerrestrialOrganism
- Thing
- TopAndBottomSidedObject
- Trajector-Underspecified
- Vertebrate
- ViviparousAnimal

### 68 Generalisations, including:

- Agent-Underspecified
- Artifact-Underspecified
- Artifact-Generic
- Artifact-NonAgentive
- Boundary-Underspecified
- BusinessRelatedThing-Underspecified
- Container-Underspecified
- ContainerIndependentShapedThing
- CulturalThing
- EdibleStuff
- EdibleStuffComposite
- EnduringThing-Localized
- FiniteSpatialThing
- Food
- FoodComposite
- FoodOrDrink
- FoodOrDrinkOrIngredient
- GroceryMarketCategory
- HotDog
- HumanScaleObject
- InanimateObject
- InanimateObject-NonNatural
- Individual
- InertArtifact
- Landmark-Underspecified
- Location-Underspecified
- NonFluidlikeTangibleThing
- NonNaturalThing
- Opaque
- OrganicMaterial
- PartiallyTangible
- PartiallyTangibleProduct
- PolyDimensionalThing
- PositiveDimensionalThing
- PreparedFood
- Product
- Region-Underspecified
- Sausage
- SolidFood
- SolidFoodArtifact
- SolidTangibleArtifact
- SolidTangibleThing
- SomethingExisting
- SpatialThing
- SpatialThing-Localized
- SpatialThing-NonSituational
- SurfaceRegion-Underspecified
- TemporalThing
- TemporallyExistingThing
- Thing
- ThreeDimensionalThing
- Trajector-Underspecified
- (CollectionDifferenceFn)
- (SomethingExistingOrganization)
- (SpatialThingSituation)
- (TemporalThingBiologicalLivingObject)
- (TheSet)
- (TheSetArtifact-Generic)
- (PropositionalConceptualWork)
- (ServiceEventProduct)
- (TheSetEventArtifact)
$\text{EdibleStuff}\#0$ and $\text{EdibleStuff}\#1$ pizza

**Logic:**

\[
(\#\text{equalSymbols}\ ?\text{PIZZA} \\
(\#\text{PizzaFn}\ (\#\text{TheSet} \text{EdibleStuff}\#1 \text{EdibleStuff}\#0)))
\]

**Var:** ?PIZZA  **Type:** #$\text{Pizza}$

**E:** pizza with mushrooms and pepperoni

**AC:**

\[
(\text{equalSymbols}\ ?\text{PIZZA} \\
(\text{PizzaFn} \\
(\text{TheSet EdibleMushroom Pepperoni})))
\]
a $IntelligentAgent#0 feeds a $Animal#1 $EdibleStuff#2


E: feeding in the set of EVENT such that
- some pizza with mushrooms and pepperoni was completely consumed in EVENT,
- EVENT was a service provided to some dog,
- and some man provided EVENT as a service

<template>
  <nlPattern class="123000">
    $Business#0
    [is|is to|to|will|is going to|{}]
    [acquire|buy|buys|acquiring|gain]
    $Business#1
  </nlPattern>
  <cyclPattern>
    ($and
     ($isa ?X #$OrganizationMerger-CreationEvent)
     ($mergedFromOrg ?X $Business#1)
     ($mergedToOrg ?X $Business#0))
  </cyclPattern>
  <type>$CyclLSentence-Assertible</type>
  <microTheory>$CurrentWorldDataCollectorMt-NonHomocentric</microTheory>
</template>
An Afghan inquiry has said an attack in the heart of Kabul on January 18, that left five dead and 38 others wounded, was ordered by an Afghan commander in Pakistan who was part of the Haqqani network - a group allied to the Taliban and al-Qaeda.

Their evidence comes from a man arrested 24-hours after the assault, who admitted he sheltered the suicide bombers and took them to some of their targets in Kabul.

The Afghan intelligence agency also showed confessions from men responsible for previous suicide bombings who admitted they had received their training in Pakistan.

Al Jazeera's David Chater reports from Kabul. 26 Jan 2010
An Afghan inquiry has said an attack in the heart of Kabul on January 18, that left five dead and 38 others wounded, was ordered by an Afghan commander in Pakistan who was part of the Haqqani network - a group allied to the Taliban and al-Qaeda. [Again]
An Afghan inquiry has said an attack in the heart of Kabul on January 18, that left five dead and 38 others wounded, was ordered by an Afghan commander in Pakistan who was part of the Haqqani network - a group allied to the Taliban and al-Qaeda.
SCG – a lot left to do

anaphora, syntax, inference driven integration, other lexica, adaptation and template induction, knowledge acquisition, metaphor
坐姿

BirthdayParty

生日聚会
Syntactic Features
Anaphora via semantics

Barack Obama sat in the Oval Office. Mrs. Obama watched him.

Anaphora via semantics
Taking Advantage of Paraphrases

an attack in the heart of Kabul on January 18, that left five dead and 38 others wounded,

\textit{AttackOnObject}, that left five dead and 38 others wounded,

c.f. \textit{AttackOnObject} has killed five people and injured 38

Existing: 

\begin{verbatim}
Existing: <template>
<nlPattern class="140060">$AttackOnObject#0 has killed $NonNegativeInteger#2 people and injured $NonNegativeInteger#3</nlPattern>
<cyclPattern>(#$thereExists ?ATTACK
 (#$and
  (#$isa ?ATTACK $AttackOnObject#0)
  (#$relationInstanceExistsCount #$animalWoundedIn ?ATTACK #$Person $NonNegativeInteger#3)
  (#$relationInstanceExistsCount #$organismKilled ?ATTACK #$Person $NonNegativeInteger#2) ) )
</cyclPattern>
</template>
\end{verbatim}

Desired: 

\begin{verbatim}
Desired: <template>
<nlPattern class="140060">$AttackOnObject#0, that left $NonNegativeInteger#2 dead and $NonNegativeInteger#3 others wounded</nlPattern>
< cyclPattern>(#$thereExists ?ATTACK
 (#$and
  (#$isa ?ATTACK $AttackOnObject#0)
  (#$relationInstanceExistsCount #$animalWoundedIn ?ATTACK #$Person $NonNegativeInteger#3)
  (#$relationInstanceExistsCount #$organismKilled ?ATTACK #$Person $NonNegativeInteger#2) ) )
</ cyclPattern>
</template>
\end{verbatim}
Taking Advantage of Paraphrases

an attack in the heart of Kabul on January 18, that left five dead and 38 others wounded,

*AttackOnObject*, that left five dead and 38 others wounded,

c.f. *AttackOnObject* has killed five people and injured 38

**Existing:**

```xml
<template>
  <$nlPattern class="140060">$AttackOnObject#0 has killed $NonNegativeInteger#2 people and injured $NonNegativeInteger#3</nlPattern>
  <$cyclPattern>(#$thereExists ?ATTACK
    (#$isa ?ATTACK $AttackOnObject#0)
    (#$relationInstanceExistsCount #$animalInjuredIn ?ATTACK #$Person $NonNegativeInteger#3)
    (#$relationInstanceExistsCount #$organismKilled ?ATTACK #$Person $NonNegativeInteger#2)   )    )
  </cyclPattern>
</template>
```

**Desired:**

```xml
<template>
  <$nlPattern class="140060">$AttackOnObject#0, that left $NonNegativeInteger#2 dead and $NonNegativeInteger#3 others wounded</nlPattern>
</template>
```

**Parsed:**

An Afghan inquiry has said an attack in the heart of Kabul, that left five dead and 38 others wounded, was ordered by an Afghan commander in Pakistan who was part of the Haqqani network - a group allied to the Taliban and al-Qaeda. [Again]
Metaphors break the rules

Ricoeur (1975): metaphors use “impertinent predication”

- *Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood.* (Yu, 1995),
  - a physical process, *lifting an object*, applied to an intangible mental substance, mood

- *Túlcsordult a szíve a boldogságtól / His heart overflowed with joy.* (Kövecses 2005)
  - a physical process, overflowing, again, mood

http://cyc.com/cyc/technology/whitepapers
Metaphors break the rules

- Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood. (Yu, 1995),

http://cyc.com/cyc/technology/whitepapers

Mt : InferencePSC
(implies (and (isa ?X FeelingAttribute) (isa ?Y LiftingAnObject))
  (not (objectActedOn ?Y ?X)))
Query was proven True
Metaphors break the rules

- Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood. (Yu, 1995),

  - physical process, lifting an object, applied to an intangible mental substance, mood

    (denotation Lift-TheWord Verb 0 LiftingAnObject)
    (verbSemTrans Lift-TheWord 0 TransitiveNPFrame
      (and
        (isa :ACTION LiftingAnObject)
        (objectActedOn :ACTION :OBJECT)
        (doneBy :ACTION :SUBJECT)))
    (denotation Mood-TheWord MassNoun 0 FeelingAttribute),
Restoring order: Metaphorical transformations

- Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood. (Yu, 1995),

Pattern: LiftingAnObject objectActedOn FeelingAttribute

Metaphorical transformations

- Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood. (Yu, 1995),

Pattern: LiftingAnObject objectActedOn FeelingAttribute

(altitudeAboveSeaLevel ?OBJ ?END-ALT))

Distance

ScalarQuantity

ScalarQuantity

(greaterThan ScalarInterval ScalarInterval)
Metaphorical transformations

- *Zhe-xia tiqi le wo-de xingzhi / This time it lifted my mood.* (Yu, 1995),

**Metaphor: higher is better**

(altitudeAboveSeaLevel ?OBJ ?END-ALT))

AscendingEvent:
"Islamic Jihad claimed responsibility for a February 25 suicide bombing in Tel Aviv that killed five Israelis."

Complex nominals

\[ \forall x \text{isa}(x, \text{Clnd} \rightarrow \text{21822}) \Rightarrow (\text{hasCitizenship}(x, \text{Israel}) \land \text{personKilled} (\text{Clnd} \rightarrow \text{21811}, x)) \]

Active Integration

Needs-based Ontology Extension

<table>
<thead>
<tr>
<th>Role</th>
<th>Types</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>personKilled</td>
<td>People</td>
<td>vacationer, newlywed, bus rider, mouseketeer</td>
</tr>
<tr>
<td>eventOccursAt</td>
<td>Places</td>
<td>Police station, army recruiting center, souk, marquee</td>
</tr>
<tr>
<td>deviceUsed</td>
<td>Weapons</td>
<td>Suicide vest, boomerang, crossbow, bus bomb, shaped charge</td>
</tr>
<tr>
<td>killers</td>
<td>Agent</td>
<td>Somali youth, pirates, military doctor, rebel recruit</td>
</tr>
</tbody>
</table>
Their evidence comes from a man arrested 24-hours after the assault, who admitted he sheltered the suicide bombers and took them to some of their targets in Kabul.

To prove: the transport in the bombing happened before the attack.
Training in Pakistan

Previous suicide bombings

Sheltering bombers

Transport

Suicide Bomb Attack

Arrest

24 hours

Rules

- **Transport** of something to a place happens before the end of the thing transported (so, not after the attack).

- If there is one transport, of some X, as a sub-situation, and that X plays a required role in some other sub-situation, and the destination of the transport is near the location of the other sub-situation, then the transport happens before (in this case, the other sub-situation is the attack)

**to prove**: the transport in the bombing happened before the attack

"Their evidence comes from a man arrested 24-hours after the assault, who admitted he sheltered the suicide bombers and took them to some of their targets in Kabul"
"Islamic Jihad claimed responsibility for a February 25 suicide bombing in Tel Aviv that killed five Israelis."

Causal Constraints:

- \(\text{startsAfterEndOfInSituationType, TerroristSuicideBom}\
  \text{bニング, ClaimingResponsibility, Detonation}\)
- \(\text{requiresForRole, Bombing, Bomb, deviceUsed}\)
- \(\text{requiresForRole, Detonation, Bomb, inputsDestroyed}\)
- \(\text{requiresForRole, TerroristSuicideBom}\
  \text{bニング, Person, bodilyDoer}\)

We need these constraints, can they be read or learned?
Techniques:

- **Acquire candidates:**
  - Automatically acquire from dbPedia, or
  - Read from Wikipedia, or
  - Import from macro-readers, or
  - Fillers of templates, where there is evidence for effectiveness for type inference

**Confirmation** by human beings, or
- by generate and test
• Primacy of Semantics
• Importance of mapping not to “logical form”, but to logic
• Importance of doing inference during understanding
• Not opposed to syntax
• Working on anaphora
• Partially inspired by metaphor