Commonsense Knowledge Bases

LCL reading group
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Commonsense: what

"The collection of facts and information that an ordinary person is expected to know"

Vague: ordinary? Expected?

Hard AI problem

Commonsense: why

Inference:
"The sun was coming down" → daytime

Perception:
cylinder on a plane → mug on a table

Robotics:
"Bring me some water" → kitchen, glass, tap

Commonsense: how

Entities vs. Concepts

Facts vs. Beliefs

background knowledge, default knowledge, ...

Wait, where is the NLP in there?

Knowledge is in the text on the Web

~50 billion Websites*

6.000 tweets/s.

40.000 google queries/s.

* from http://www.worldwidewebsize.com/

Outline

- General Knowledge Bases

- ConceptNet
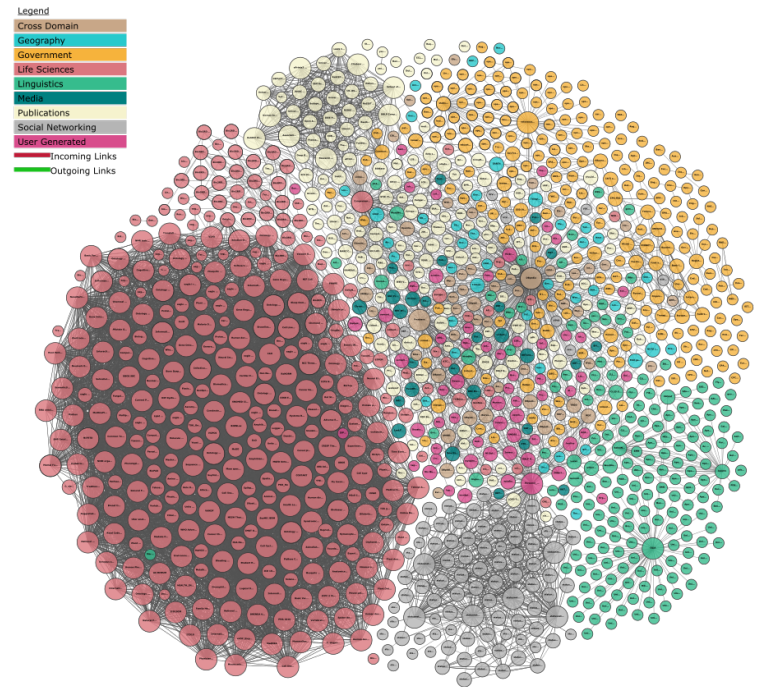
- NeLL

- DeKO

- Demos

General Knowledge Bases

DBpedia

- RDF triples extracted from Wikipedia infoboxes
- The central hub of Linked Data

```
select distinct ?location where {
  dbr:FCC dbo:location ?location
}

dbr:FCC dbo:location dbr:12th_Street
dbr:FCC dbo:location dbr:Washington,_D.C.
```
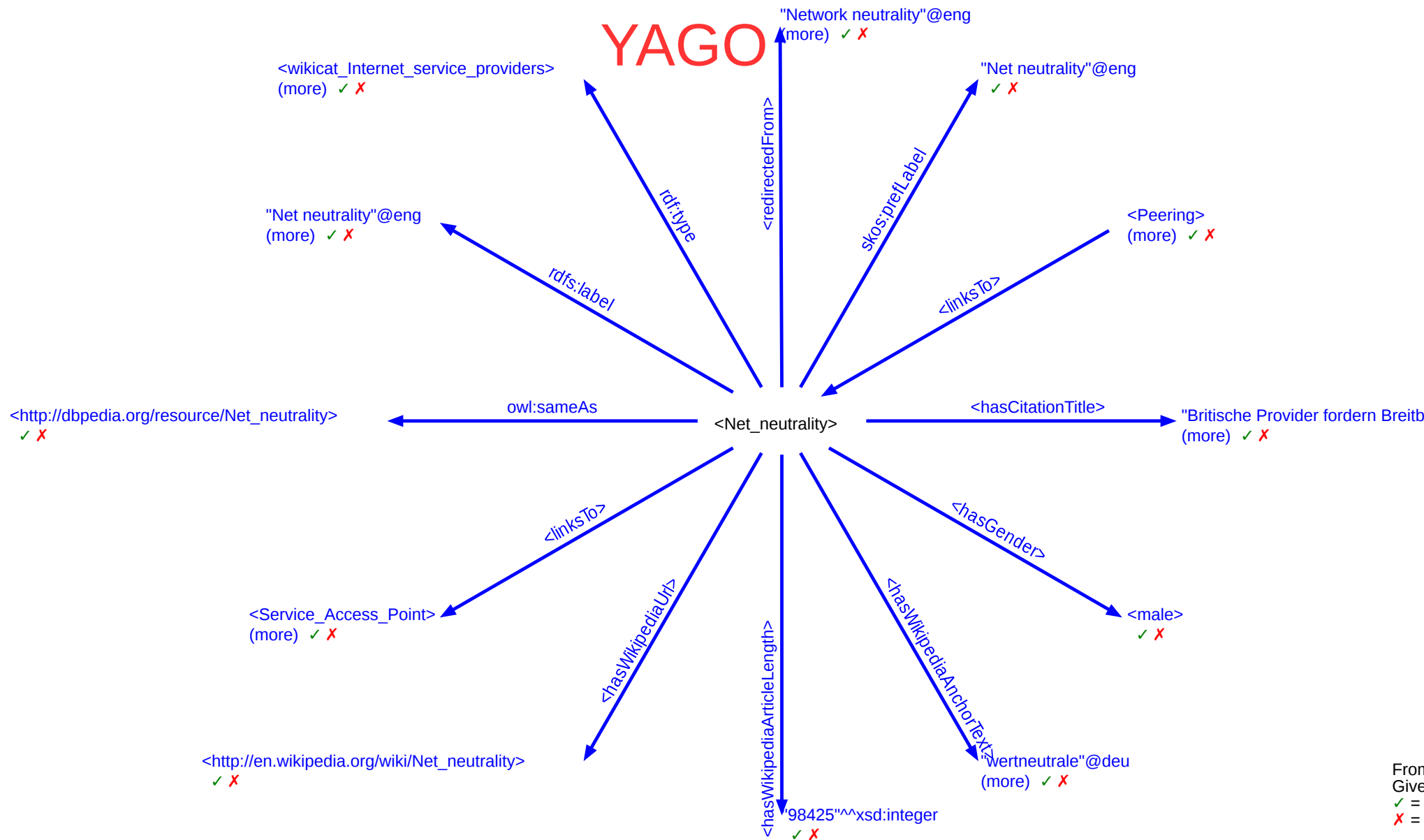
General Knowledge Bases

YAGO
(Yet Another Great Ontology)

Wikipedia+WordNet+GeoNames

General Knowledge Bases

YAGO

"Network neutrality"@eng (more) ✓ ✗

<wikicat_Internet_service_providers> (more) ✓ ✗

"Net neutrality"@eng ✓ ✗

"Net neutrality"@eng (more) ✓ ✗

<Peering> (more) ✓ ✗

<http://dbpedia.org/resource/Net_neutrality> ✓ ✗

<Net_neutrality>

"Britische Provider fordern Breitb (more) ✓ ✗

<Service_Access_Point> (more) ✓ ✗

<male> ✓ ✗

<http://en.wikipedia.org/wiki/Net_neutrality> ✓ ✗

"wertneutrale"@deu (more) ✓ ✗

"98425"^^xsd:integer ✓ ✗

<redirectedFrom>

rdf:type

skos:prefLabel

rdfs:label

<linksTo>

owl:sameAs

<hasCitationTitle>

<linksTo>

<hasGender>

<hasWikipediaUrl>

<hasWikipediaArticleLength>

<hasWikipediaAnchorText>

Fro
Give
✓ =
✗ =

General Knowledge Bases

CyC

WordNet

DOLCE

Suggested Upper Merged Ontology

...

ConceptNet

- Knowledge graph of *assertions* (edges) on *terms* (nodes)

- Originated from the Open Mind Common Sense project (M. Minsky et al.)

ConceptNet: sources

- Open Mind Common Sense (OMCS) and sister projects in other languages

- Parsing Wiktionary, in multiple languages, with a custom parser ("Wikiparsec")

- "Games With a Purpose

- Open Multilingual WordNet

- JMDict (Breen 2004), a Japanese-multilingual dictionary

- OpenCyc, a hierarchy of hypernyms provided by Cyc

- A subset of DBPedia

ConceptNet: terms

- Natural language expressions
  e.g. "/c/en/lead"

- Potentially disambiguated
  e.g. "/c/en/lead/n"
  (not really though)

ConceptNet: relations

36 heterogeneous core relations

Antonym, DistinctFrom, EtymologicallyRelatedTo, LocatedNear, RelatedTo, SimilarTo, Synonym AtLocation, CapableOf, Causes, CausesDesire, CreatedBy, DefinedAs, DerivedFrom, Desires, Entails, ExternalURL, FormOf, HasA, HasContext, HasFirstSubevent, HasLastSubevent, HasPrerequisite, HasProperty, InstanceOf, IsA, MadeOf, MannerOf, MotivatedByGoal, ObstructedBy, PartOf, ReceivesAction, SenseOf, SymbolOf, UsedFor

ConceptNet: embeddings

- "co-occurrence" matrix + PPMI + SVD

- Expanded retrofitting

- Merging GloVe and word2vec
  → ConceptNet Numberbatch

- Evaluation on word relatedness, SAT analogies and story endings

Never Ending Learning

Continuously running since 2010

Many classification problems

Humans in the loop

Never Ending Learning

The Never-ending learning paradigm

Computer programs that:
• learn many different types of knowledge or functions,
• from years of diverse, mostly self-supervised experience,
• in a staged curricular fashion, where previously learned knowledge enables learning further types of knowledge,
• where self-reflection and the ability to formulate new representations and new learning tasks enable the learner to avoid stagnation and performance plateaus.

Never Ending Learning: input

- an initial ontology defining categories
- approximately a dozen labeled training examples for each category and relation
- the Web
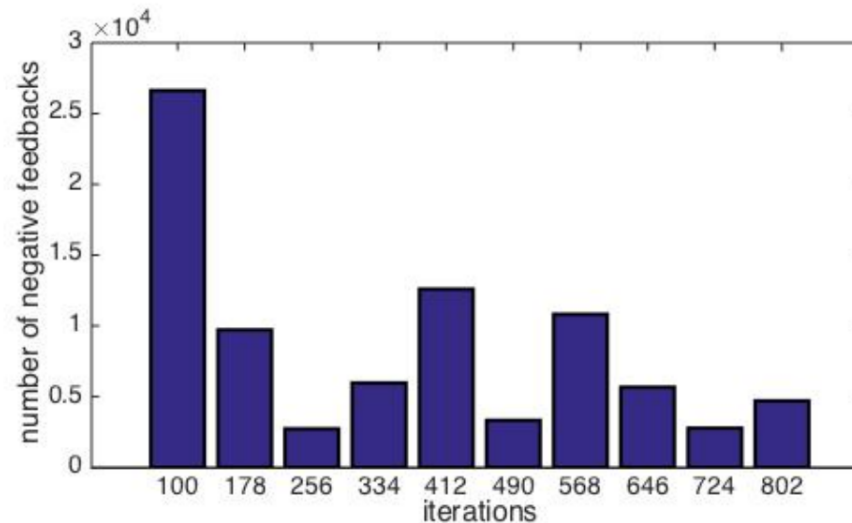- occasional interaction with humans

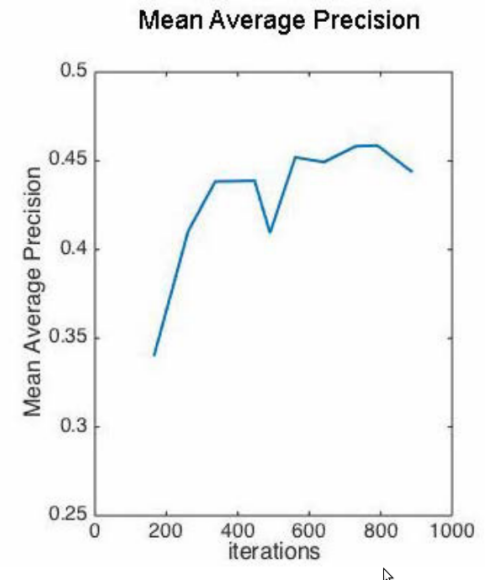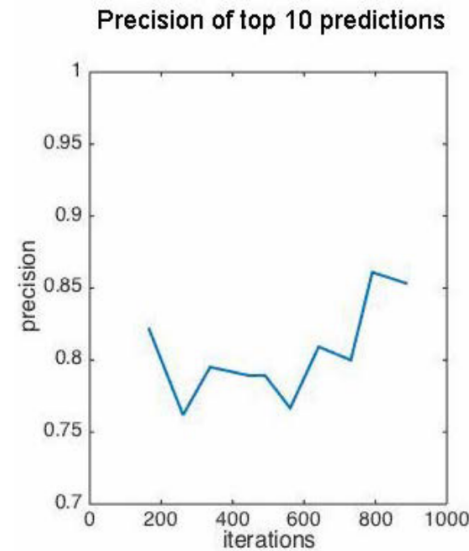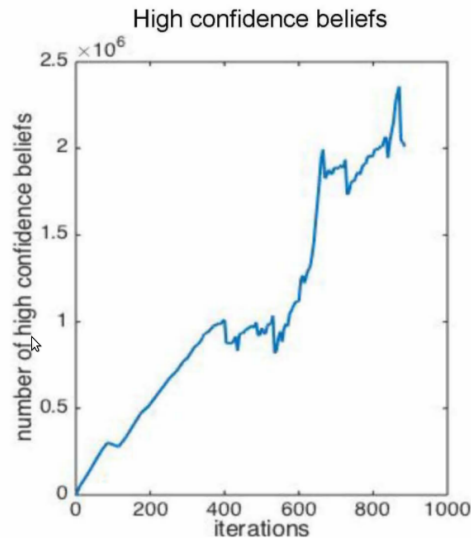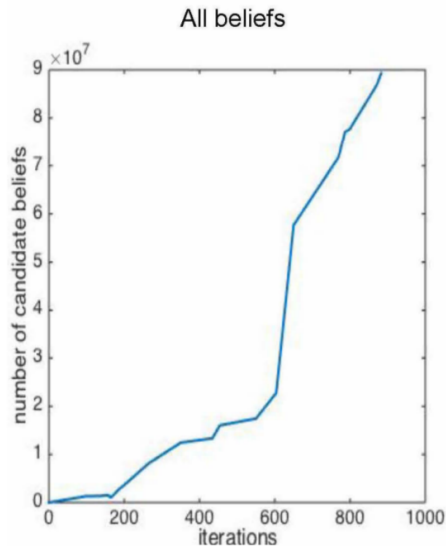# Never Ending Learning: tasks

- Category Classification
- Relation Classification
- Entity Resolution
- Inference Rules

The tasks are linked together by Coupling Constraints. Classifiers learn from each other's output.

Never Ending Learning: architecture
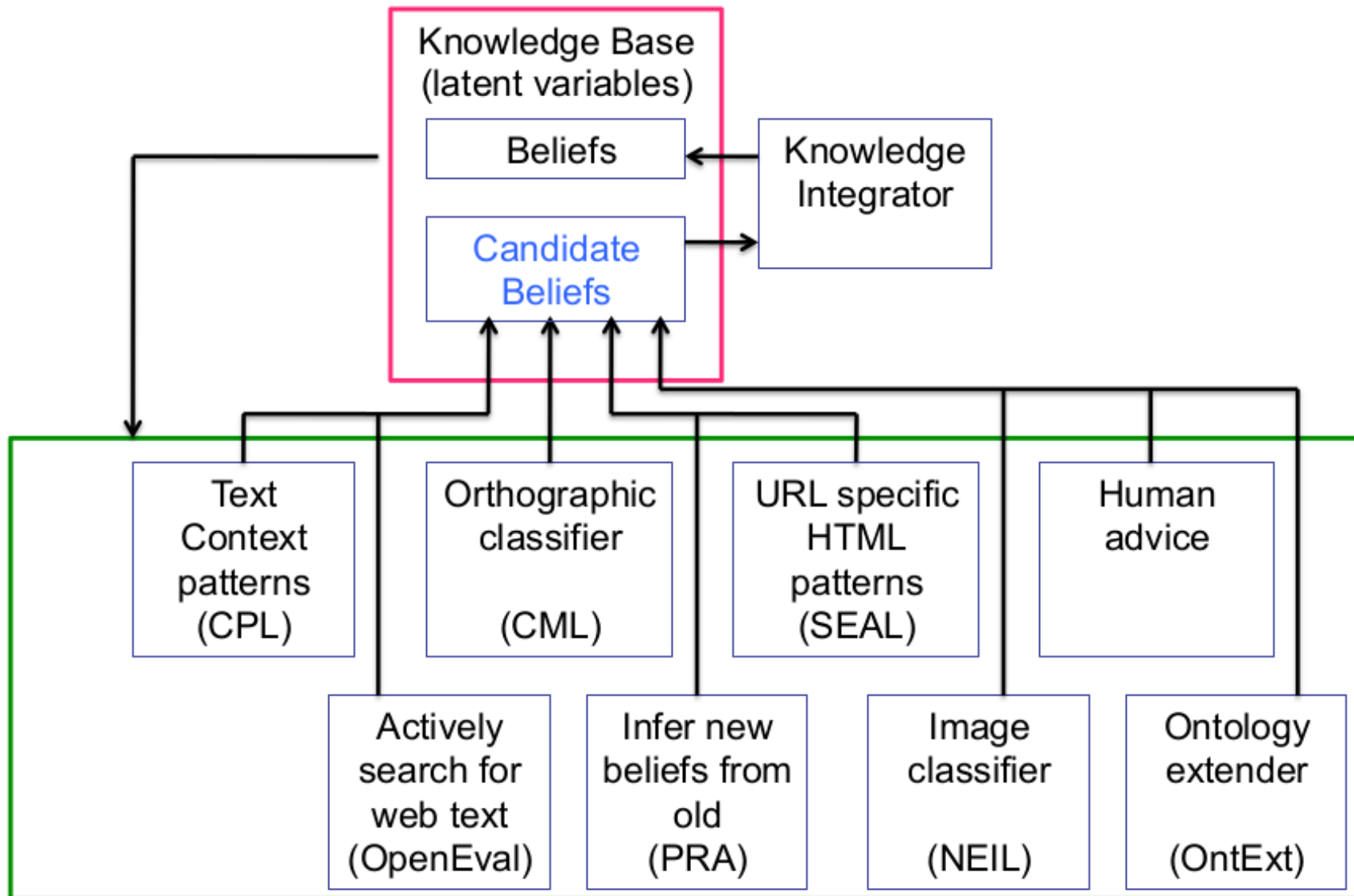
Never Ending Learning: evaluation

DeKO

Default Knowledge about Objects

Web Knowledge Base aimed at **robotics**

DeKO: features

Knife

http://dbpedia.org/resource/Knife

A **Knife** is:

locatedAt Kitchen
locatedAt Dining_room
locatedAt Dining_car
locatedAt Beer_hall
locatedAt Restaurant
locatedAt Galley
of type Object
usedFor Writing
usedFor Carving
usedFor Cooking
usedFor Eating
usedFor Counting
usedFor Shaving
usedFor Coring
usedFor Throwing
usedFor Scratching
usedFor Collecting
usedFor Pricking
usedFor Turning
usedFor Hunting
usedFor Gashing
usedFor Notching
usedFor Engraving
usedFor Mashing
usedFor Spearing

- RDF/LOD
- Named graphs on Dbpedia resources
- Default predicates reusing upper ontologies
- FrameNet frames

Knowledge:
- Categorization
- location
- Usage
- frame roles

DeKO: sources

- Crowdsourcing
- Distributional relational hypothesis
- Keyword linking
- Frame instance clustering

DeKO: frame instances

- Frame: Frame Type + Frame Elements
- Frames are the T-box, Frame instances are the A-box
- KNEWS extracts frame instances from natural language

```
<http://framebase.org/ns/fi-Operatevehicle031fa5ad>
  <http://www.w3.org/1999/02/22-rdf-syntax-ns#type>
  <http://framebase.org/ns/frame-Operatevehicle-drive.v> .

<http://framebase.org/ns/fi-Operate_vehicle031fa5ad>
  <http://framebase.org/ns/fe-Driver>
  <http://wordnet-rdf.princeton.edu/wn31/02764397-n> .

<http://framebase.org/ns/fi-Operate_vehicle031fa5ad>
  <http://framebase.org/ns/fe-Vehicle>
  <http://wordnet-rdf.princeton.edu/wn31/02961779-n> .
```

DeKO: frame instances

Measuring frame instance similarity

$$sim(fi_1, fi_2) = \alpha\, sim_{ft}(fi_1, fi_2) + (1 - \alpha) sim_{fe}(fi_1, fi_2)$$

$$sim_{ft}(fi_1, fi_2) = wup(ft_i, ft_j)$$

$$sim_{fe}(fi_1, fi_2) = \frac{1}{2}\Big(\frac{1}{|fi_1|} \sum_{fe_i \in fi_1} \max_{fe_j \in fi_2} wup(fe_i, fe_j) +$$

$$+ \frac{1}{|fi_2|} \sum_{fe_i \in fi_2} \max_{fe_j \in fi_1} wup(fe_i, fe_j) \Big)$$

DeKO: frame instances

Clustering frame instances

Similarity metric	Frame types	Frame elements
Based on frame types ($\alpha = 1$)	Commerce_buy (75)	*Goods* thing-n#8-n (11)
		Goods star+sign-n#1-n (4)
		Goods ticket-n#1-n (3)
		Goods book-n#1-n (2)
		Goods clothes-n#1-n (2)
		Goods placard-n#1-n (2)
		Goods cycle-n#6-n (2)
		Buyer thing-n#8-n (2)
		Goods machine-n#6-n (2)
		Goods shirt-n#1-n (2)
		Goods filter-n#2-n (2)
		Goods pellet-n#2-n (2)
		Buyer male-n#2-n (2)
Based on frame elements ($\alpha = 0$)	Stimulus_focus (8)	*vn-Theme* book-n#1-n (24)
	Categorization (4)	*Item* book-n#1-n (4)
	Hear (4)	*vn-Patient* book-n#1-n (2)
	Reading (4)	
	Reading_aloud (4)	

```
<http://framebase.org/ns/frame-Ride_vehicle>
<http://framebase.org/ns/fe-Vehicle>
<http://wordnet-rdf.princeton.edu/wn31/02837983-n>.
```