2nd Synthesis Framing the Relations- AI, Machine Learning, Reasoning, and Ontologies
Ontology Summit 2017 Track A on Knowledge Extraction

Graph Identification++

Turning Data into Knowledge using Statistics and Semantics
Prof. Lise Getoor

Opportunity!

Gary Berg-Cross, Cognitive Psychologist,
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April, 20 2617
Outline

Recap

Session 2 Speakers & Their Topics

Broader views framing – Understanding, General AI, Unsupervised Learning, Cognitive Scaffolds
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Ontology Learning – Some Advances  
Insight Centre for Data Analytics, National University of Ireland, Galway

∀x ( country(x) → ∃y capital_of(y,x) ∧ ∀z (capital_of(z,x) → y=z) )

disjoint( river, mountain )

capital_of ≤_R located_in  
Associate terms, construct hierarchies & label relations

flow_through( domain:river, range:geopolitical_entity )

capital ≤_c city, city ≤_c geopolitical_entity  
Concept Hierarchy

c := country := < i(c), ||c||, Ref_c(c) >

{country, nation}

river, country, nation, city, capital ...

Terms

Synonyms

Concepts

Relation Hierarchy

Axiom Schemata

General Axioms

Bottom up parts of speech & phrasing, learn concepts & relations from text etc.
Recap from Session 1 & Synthesis

We have alternate approaches (NLP & ML) but possible hybrid

Slowly realizing some reality to the perception of advances in areas (NLP, ML, data mining, & knowledge representation) but perhaps entering a more systematic fusion/hybrid stage

Big data & IoT opportunities (NELL etc.) but also a Social Machines idea

NLP & Ontology Learning have become more cognitive and contextual and leverage Web resources so methods & tools evolving (I.e. FRED)

Remaining major challenges of heterogeneity, formalization & integration

Need to add a more cognitive stance (discourse understanding, leveraging old knowledge to make learning cumulative)
Our Three Session 2 Speakers & Their Talks

Track A Session 2 (April)

1. Michael Yu (UCSD) - "Inferring the hierarchical structure and function of a cell from millions of biological measurements".
2. Francesco Corcoglioniti (Post-doc at Fondazione Bruno Kessler, Italy) "Frame-based Ontology Population from text with PIKES"
3. Evangelos Pafilis (Hellenic Center Marine Research [HCMR]) - “EXTRACT 2.0: interactive extraction of environmental and biomedical contextual information."
Summary

1. The structure of hierarchical systems like the cell can be accurately inferred from data
   1. Enabled by a deluge of experimental measurements
   2. Complements manually curated knowledge (e.g. GO)
2. This structure can be “functionalized” to make biological predictions
   1. Accurate translation of genotype to phenotype
   2. Machine learning guided by ontologies
Conclusion: PIKES Is a Knowledge Extraction Suite

PIKES is
- a tool for Frame-based Ontology Population from English text
- extracting events and complex relations (semantic frames)
- representing all contents in RDF + named graph
- featuring 2-phases: linguistic feature extraction + knowledge distillation

Benefits
- competitive with state of the art in terms of quality / throughput
- 2-phase decoupling allows tuning the two phases independently

Related/ongoing work
- PreMOOn - lemon extension for predicate models
- KE4IR - knowledge extraction for IR
- KnowledgeStore - store for PIKES data
- KEM - RDF/OWL model for knowledge extraction (ongoing work)

Background knowledge pmo:nb10_support.01
a ks:ArgumentNominalization

INSERT { ?m ks:denotes ?i; ks:implies ?if; ks:expresses ?g.
GRAPH ?g { ?i a ks:Instance. ?if a ks:Frame }
?s a ks:ArgumentNominalization.
BIND (ks:mint(?m) AS ?g) BIND (ks:mint(?a, ?m) AS ?i)
BIND (ks:mint(concat(?a, "_pred"), ?m) AS ?if)
EXTRACT: designed to assist metagenomic record environment annotation, not text corpora

http://extract.hcmr.gr

EXTRACT 2.0
Interactive Extraction of Metadata

Encyclopedia of Life http://www.eol.org

• 1-stop-shop 4 biodiversity knowledge

Evangelos

EXTRACT identifies genes/proteins, chemical compounds, organisms, environments, tissues, diseases, phenotypes and Gene Ontology terms mentioned in a given piece of text and maps them to their corresponding ontology/taxonomy entries.

Bookmarklet: To install please Drag and Drop the following link in your Bookmark Bar: EXTRACT

Usage: a. select a piece of text of interest in a web page and then b. click on the bookmarklet. c. A pop-up such as the following will appear (supported browsers: Chrome, Firefox, Safari, Opera, Internet Explorer). By hovering the mouse cursor over the text tags or the table rows you can visually inspect which words have been identified as which entities.
There is considerable overlap between the 3 tracks. We can leveraged insight from work in KR, AI, ML and Ontology as well as all our speakers and the community discussion of approaches, issues and problems.

Our View is organized into several topics:
- Some AI perspectives & definitions
- Some identification of issues and paths forward as input for Communique
Some Definition Discussion

Like Ontology, Artificial Intelligence (AI) can be hard to define or scope but we know there are several strands and components.

There are Computational Intelligence like Synthetic Intelligence of early (good old fashioned) Symbolic AI or GOFAI (John Haugeland), but also fuzzy systems, & neural networks.

There are now variants within these such as:
• Artificial Narrow Intelligence (ANI): Machine intelligence that equals or exceeds human intelligence or efficiency at a specific (domain) task.

• Artificial General Intelligence (AGI): A machine with the ability to apply intelligence to any problem, rather than just one specific problem (human-level intelligence).
Cognitive Scaffolding

Among the issues, is how the different approaches fit together & whether starting narrowly you can get to AGI or do you need some cognitive scaffolding.

Starter ontologies such as used by NELL would be part of a scaffolding. A more dynamic approach is constructionist.
One (social cognition?) View on AI vs. HI

- “Machines have calculations; humans have understanding.
- Machines have instructions; we have purpose (intentions)
- Machines have objectivity; we have passion.”
KR in the age of Deep Learning, Watson, and the Semantic Web

Jim Hendler
Tetherless World Professor of Computer, Web and Cognitive Sciences
Director, Institute for Data Exploration and Applications
Rensselaer Polytechnic Institute
http://www.cs.rpi.edu/~hendler
@jahendler (twitter)
Major talks at: http://www.slideshare.net/jahendler
Semantic Deep Learning is new and its darkness may give us some deep trouble.

Can we understand how the algorithms generate results?

“It’d be like explaining Shakespeare to a dog”
One view of the integration challenge

The challenge

Tetherless World Constellation, RPI

- If we want to implement KR systems on top of neural and associative learners we have an issue
  - The numbers coming out of Deep Learning and Associative graphs are not probabilities
  - They don’t necessarily ground in human-meaningful symbols
    - “sub-symbolic” learning ...
    - Association by clustering ...
    - Errorful extraction ...
Explicit, understandable knowledge

- Can we avoid throwing out the reasoning baby with the grounding bathwater?
  - We still need planning systems
  - We still want to be able to define the rules that a system should follow
  - We want to be able to interact with and understand these systems
    - Even if computers don’t need to be symbolic communicators, WE DO!!!
• Context is key
  – AI systems still perform best in well-defined contexts (or trained situations, or where their document set is complete, etc.)
  – Humans are good at recognizing context and deciding when extraneous factors don’t make sense
• Extreme example: Stanislav Yevgrafovich Petrov (the man who saved the world)
• Modern AI is making some huge strides
  – Eg. DL, Associative Learning, Knowledge Graphs, ...

• But the need for KR has not gone away
  – Eg. Surrogacy, Recommended Inference, Human communication

• The integration challenge will require goring some sacred cows
  – Grounding, explanation, context ....

• But we need to do it.
Hybrid Connectionist Models in 90s--- Prof. Ron Sun
IJCAI Workshop on Connectionist-Symbolic Integration: From Unified to Hybrid Approaches, 1995

Now CLARION system that extract rules from NN

General Intelligence & Unsupervised Learning

If you provide a deep learning system tons of information, it begins to acquire useful knowledge.

- DL seems good at image recognition, speech recognition and NLP

- Many think it the Best Solution for Big Data but probably a hybrid is needed.
  
  Big hype is to think that it could give us Super Intelligent Devices

Geoffrey Hinton points out that modern networks can just work with top down (supervised learning) IF the network is small enough relative to the amount of the training data.

But the real goal of AI is broad-based understanding, and (agreeing with John Sowa) there will likely never be enough labeled training data for general intelligence. So how do we get there? Unsupervised Learning..
Grounding, Experience and Unsupervised Learning

Need to learn via experience to have a grounded understanding of its environment, an agent must be able to acquire representations through experience [Pierce et al., 1997; Mugan et al., 2012, https://scholar.google.com/citations?user=afS-7AAAAAJ&hl=en&oi=sra]

Without a grounded understanding, the agent is limited to what was programmed in.

It seems that unsupervised learning could be used to learn the meanings of words, grounded in the experience of reading.

Current approach is to use deep Boltzmann machines, to try and learn to see the world through experience. Developmental robotics is another approach.
General Intelligence and Cognitive Scaffolding

In the context of AGI some (e.g. Peter Voss) thinks we need a core set of cognitive abilities to provide affordance for development of general knowledge and skill.

These are essential to develop knowledge and skill needed to interact with incomplete, potentially contradictory and noisy environments using finite computing and time resources.
Image Schema as Common Experience Scaffolding

**Cognitive Linguistics Hypothesis**  G. Lakoff & M. Johnson (The Body in the Mind )

Possible, common human experiences with the world are simple & limited, and a core part of meaning is grounded in perception and action. This core meaning is represented in ‘image schemata’ which act as metaphorical frames & cognitive building blocks.

Image Schema

Object

Motion

Full-Empty

Container

Blockage

Process/\emerge\

Surface

Part-Whole

Path, Link

Collection

Merging

Scale

Social Evolution & Conceptual Blending

http://www.idiagram.com/ideas/illustration.html

Gilles Fauconnier & Mark Turner
Part of an AI Scaffold List (Peter Voss)

- Recognize existing patterns/entities, even with partial and/or noisy input. What is this?

- Determining what existing categories a pattern belongs to (and how well it fits). What kind of thing is this?

- Predict the remainder and/or continuations of a given partial pattern (predict). What is next?

- Be able to learn new patterns/entities, and to be able to categorize them.

- Focus/selection/importance: Selecting pertinent information at the input level as well as during learning and cognition.

- Be able to learn new skills both mental and physical

- To be able to learn via a wide range of modes, including: unsupervised, supervised, exploration, instruction, etc.

- Support integrated long-term memory i.e. its knowledge base must be immediately available to all other abilities.....