Commonsense Reasoning

Lara J. Martin (she/they)

https://laramartin.net/interactive-fiction-class

Modified from slides by Chris Callison-Burch

Learning Objectives

- Find out about existing popular commonsense knowledge bases
- Connect knowledge graphs to planning

Review: Definition of Common Sense

The basic level of **practical knowledge** and **reasoning**

concerning **everyday situations and events**

that are **commonly shared** among most people.

It's OK to keep the closet door open

It's not OK to keep the refrigerator door open because the food might go bad

Essential for humans to live and interact with each other in a reasonable and safe way

Essential for AI to understand human needs and actions better

Review:
Ways of categorizing existing knowledge bases

Represented in **symbolic logic**
(e.g., LISP-style logic)

Represented in **natural language**
(how humans *talk* and *think*)

NELL
(Mitchell et al., 2015)

OpenCyc 4.0
(Lenat, 2012)

ConceptNet 5.5
(Speer et al., 2017)

Knowledge of "***what***"
(taxonomic: `A isA B`)

Knowledge of "***why***" and "***how***"
(inferential: *causes* and *effects*)

ATOMIC
(Sap et al., 2019)

Review:
Some commonsense cannot be extracted

Text is subject to **reporting bias**
(Gordon & Van Durme, 2013)

Noteworthy events

- Murdering 4x more common than exhaling

Commonsense is not often written

- Grice's maxim of quantity

found when extracting commonsense knowledge on four large corpora using Knext (Gordon & Van Durme, 2013)

When communicating, people try to be as informative as they possibly can, and give as much information as is needed, and no more.

Eliciting commonsense from humans

EXPERTS CREATE KNOWLEDGE BASE

Advantages:

- Quality guaranteed
- Can use complex representations (e.g., CycL, LISP)

Drawbacks:

- Time cost
- Training users

OpenCyc 4.0 (Lenat, 2012)

WordNet (Miller et al., 1990)

NON-EXPERTS WRITE KNOWLEDGE IN NATURAL LANGUAGE PHRASES

Natural language

- Accessible to non-experts
- Different phrasings allow for more nuanced knowledge

Fast and scalable collection

- Crowdsourcing
- Games with a purpose

ATOMIC (Sap et al., 2019)

ConceptNet 5.5 (Speer et al., 2017)

Knowledge bases and mitigating biases

PersonX clutches a gun → because X wanted to

- to be safe
- to protect himself
- to protect themselves
- to defend themselves
- to defend himself

ATOMIC (Sap et al., 2019)

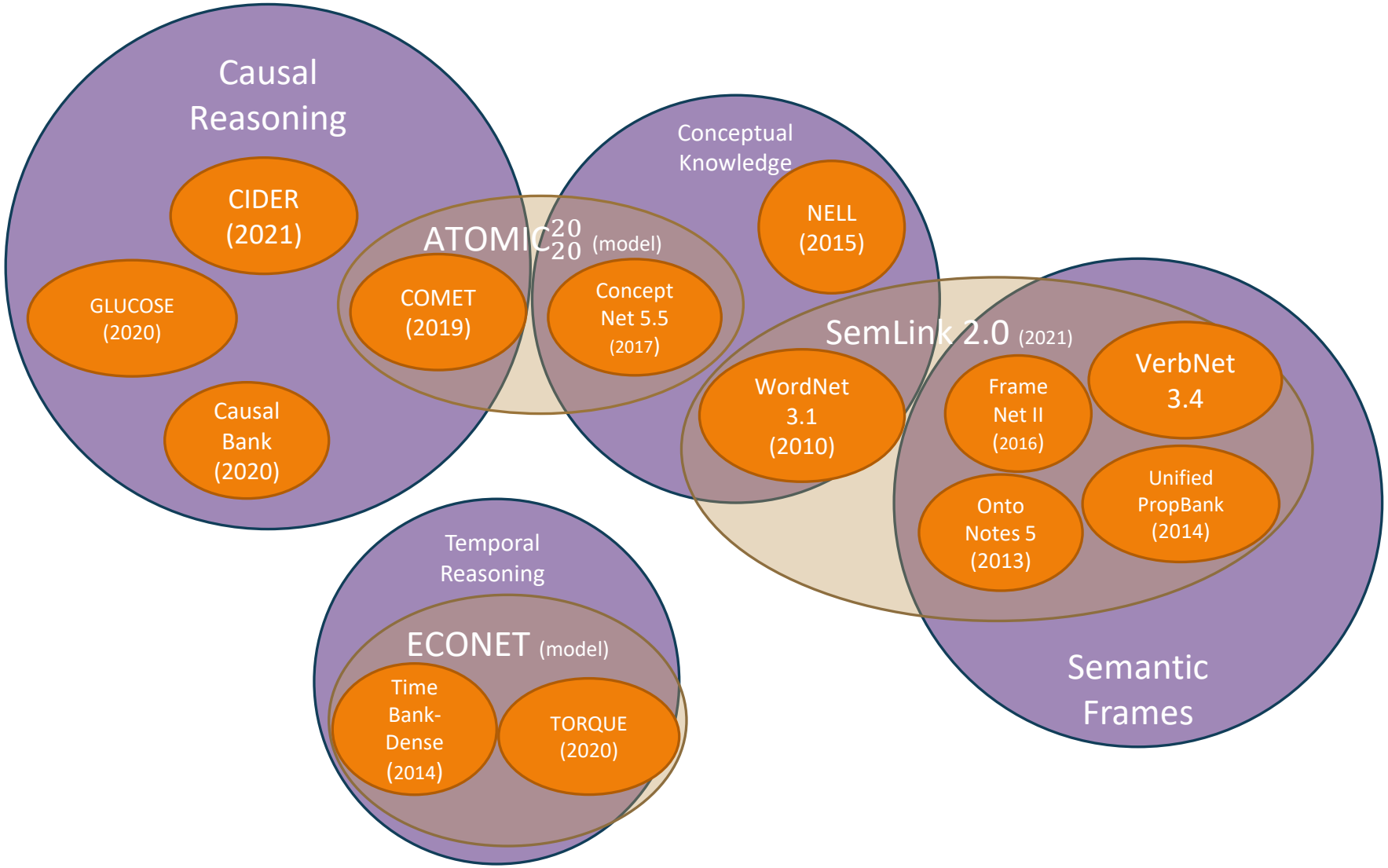
Jaquain clutches a gun → because X wanted to

- to kill someone
- none
- to protect himself
- to be safe
- to protect themselves

Karen clutches a gun → because X wanted to

- to be safe
- to protect himself
- to shoot
- to get the gun
- none

COMET (Bosselut et al., 2019): ATOMIC + OpenAI GPT

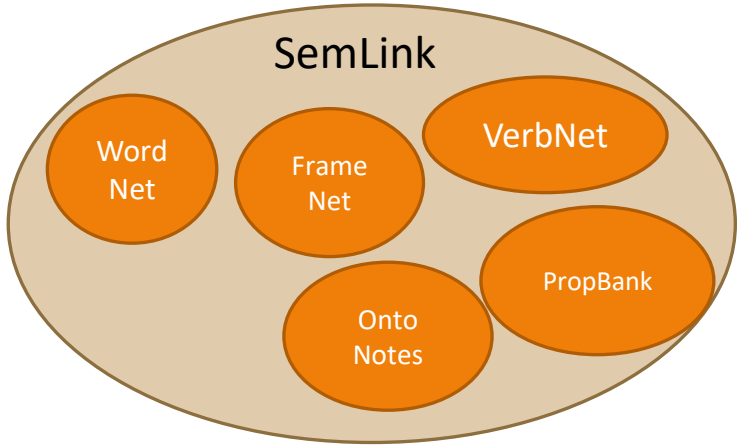

Causal Reasoning
CIDER (2021)
GLUCOSE (2020)
Causal Bank (2020)
ATOMIC2020 (model)
COMET (2019)
Conceptual Knowledge
Concept Net 5.5 (2017)
NELL (2015)
SemLink 2.0 (2021)
WordNet 3.1 (2010)
Frame Net II (2016)
VerbNet 3.4
Onto Notes 5 (2013)
Unified PropBank (2014)
Semantic Frames
Temporal Reasoning
ECONET (model)
Time Bank-Dense (2014)
TORQUE (2020)

SemLink/Unified Verb Index 2.0

https://github.com/cu-clear/semlink

Combines 5 systems:

VerbNet, PropBank, FrameNet, WordNet and OntoNotes

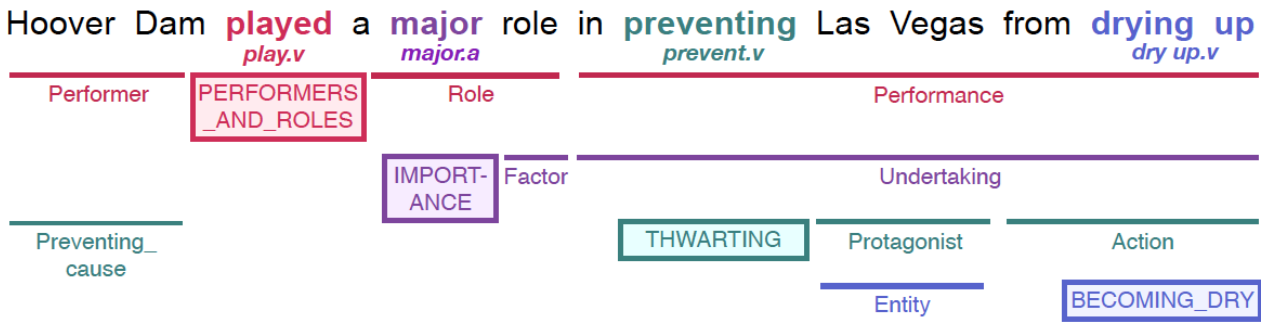


Use: above link

Kevin Stowe, Jenette Preciado, Kathryn Conger, Susan Windisch Brown, Ghazaleh Kazeminejad, James Gung, and Martha Palmer. 2021. SemLink 2.0: Chasing Lexical Resources. In *Proceedings of the 14th International Conference on Computational Semantics (IWCS)*, pages 222–227, Groningen, The Netherlands (online). Association for Computational Linguistics.

FrameNet II

https://framenet.icsi.berkeley.edu/



Data Source: British National Corpus, US newswire, American National Corpus; annotated

Languages: English, global initiative: https://www.globalframenet.org/

Use: Open-SESAME; Raw data needs to be requested

Josef Ruppenhofer, Michael Ellsworth, Miriam R. L Petruck, Christopher R. Johnson, Collin F. Baker, & Jan Scheffczyk. *FrameNet II: Extended Theory and Practice* (Revised November 1, 2016.)

Picture from Open-SESAME (Swabha Swayamdipta, Sam Thomson, Chris Dyer, & Noah A. Smith. "Frame-Semantic Parsing with Softmax-Margin Segmental RNNs and a Syntactic Scaffold" on arXiv.

VerbNet v3.4

https://verbs.colorado.edu/verbnet/

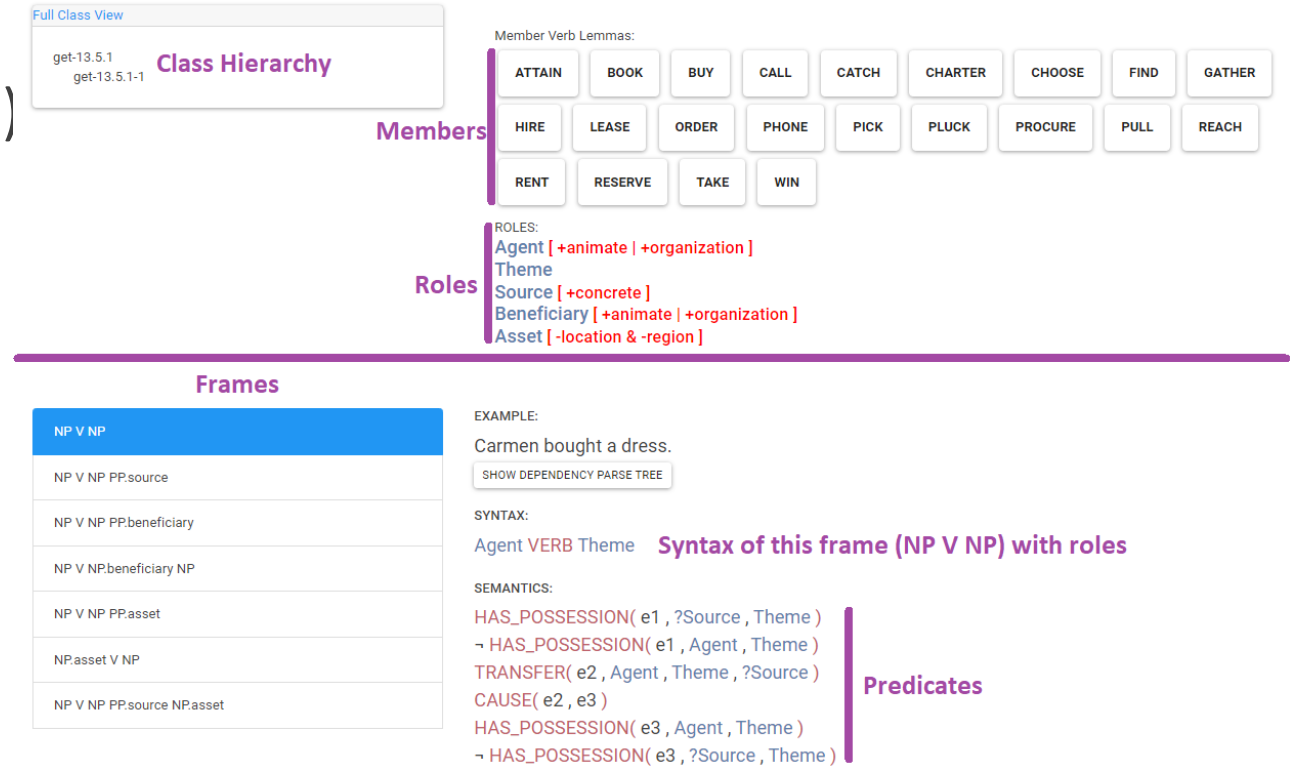
Verb classes based on Beth Levin (1993)

Data Source: hand-crafted

Languages: English

Use: raw data

Demo: https://uvi.colorado.edu/uvi_search



K. Kipper Schuler, "VerbNet: A Broad-Coverage, Comprehensive Verb Lexicon," University of Pennsylvania, 2005.

Levin, B. (1993) "English Verb Classes and Alternations: A Preliminary Investigation", University of Chicago Press, Chicago, IL.

Unified* PropBank

http://propbank.github.io/

Proposition→ true/false statement

Data Source: hand-crafted; added to PennTreebank

Languages: English, Hindi, Chinese, Arabic, Finnish, Portugue
(Plus a way to map English to different languages)

Use: raw data

*semantic propositions regardless of part of speech (e.g. cre

Event relation: Offer

25. **Predicate**: *offer*-verb
Roleset id: offer.01 transaction
Roles: Arg0: entity offering
Arg1: commodity
Arg2: price
Arg3: benefactive or entity offered to
Example: *He offered to buy the house.*

26. **Predicate**: *offer*-noun
Roleset id: offer.01 transaction
Roles: Arg0: entity offering
Arg1: commodity
Arg2: price
Arg3: benefactive or entity offered to
Example: *His offer to buy the house...*
He made an offer to buy the house.

27. **UNIFIED ROLESET**
Predicate aliases: *offer*-verb, *offer*-noun
Roleset id: offer.01 transaction
Roles: Arg0: entity offering
Arg1: commodity
Arg2: price
Arg3: benefactive or entity offered to
Example: *He offered to buy the house.*
His offer to buy the house..
He made an offer to buy the house.

```
(o / offer-01
  :ARG0 (h2 / he)
  :ARG1 (b2 / buy-01
          :ARG0 h2
          :ARG1 (h3 / house)))
```

Martha Palmer, Dan Gildea, Paul Kingsbury, The Proposition Bank: A Corpus Annotated with Semantic Roles *Computational Linguistics Journal*, *31:1*, 2005.

Claire Bonial, Julia Bonn, Kathryn Conger, Jena Hwang and Martha Palmer (2014) PropBank: Semantics of New Predicate Types. *The 9th edition of the Language Resources and Evaluation Conference*. Reykjavik, Iceland.

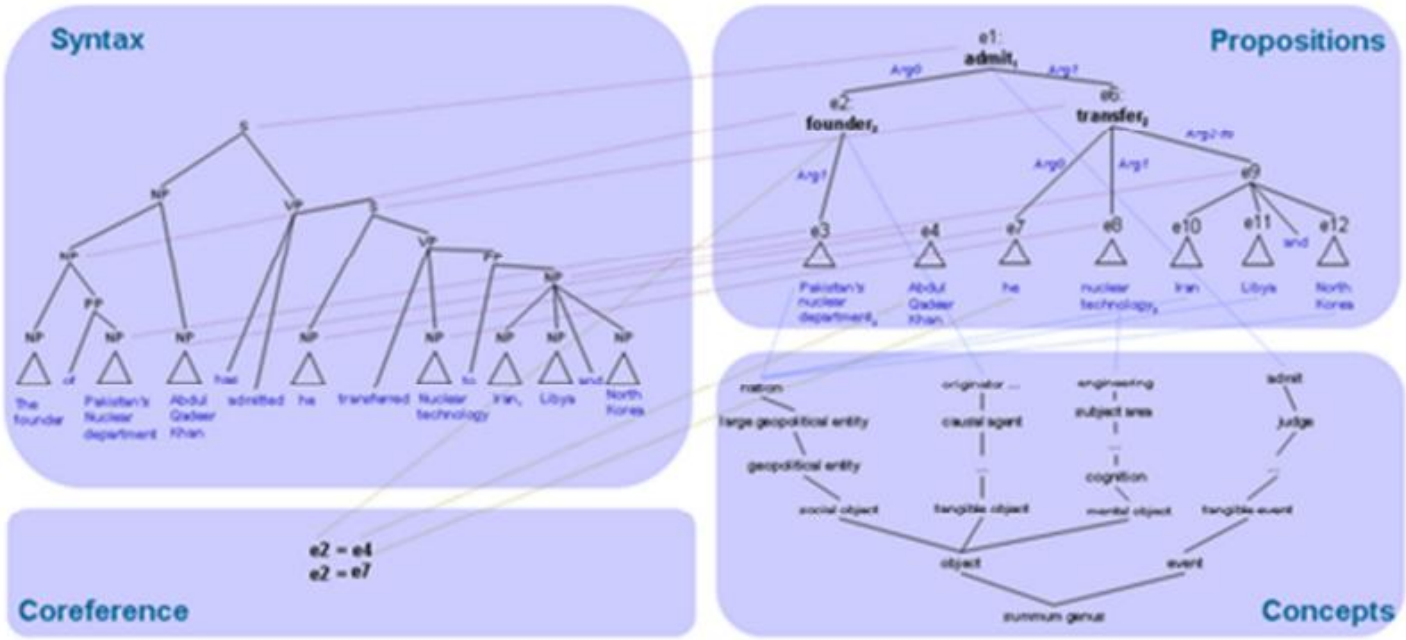
OntoNotes 5.0

https://catalog.ldc.upenn.edu/LDC2013T19

Data Source: news, telephone conversations, blogs, talk shows, etc.

Languages: English, Chinese, Arabic

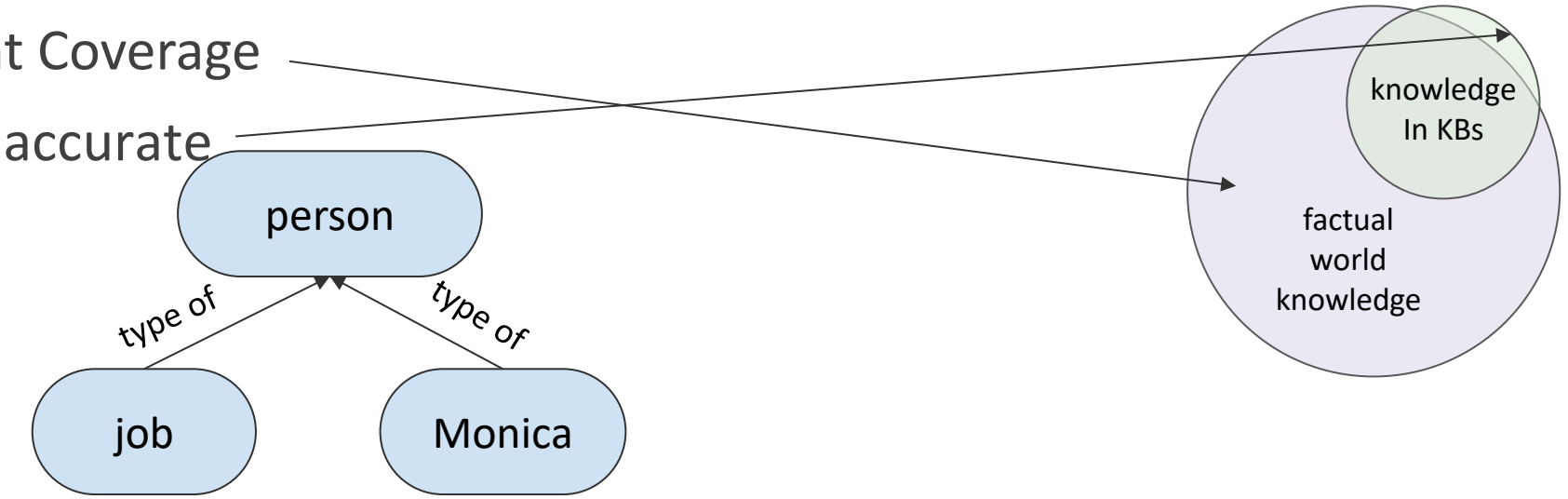
Use: raw data (same link)



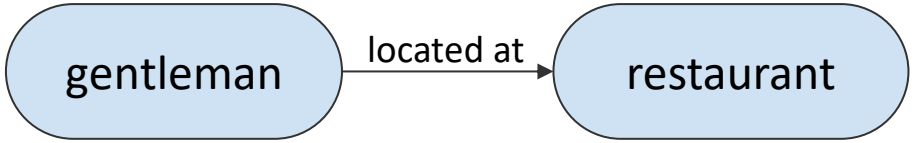
S. S. Pradhan, E. Hovy, M. Marcus, M. Palmer, L. Ramshaw and R. Weischedel, "OntoNotes: A Unified Relational Semantic Representation," International Conference on Semantic Computing (ICSC 2007), 2007, pp. 517-526, doi: 10.1109/ICSC.2007.83.

Limitations

- Insufficient Coverage
- Not 100% accurate



- Easy to incorporate simple resources with stationary facts (ConceptNet) but they are limited in expressiveness:



Think-Pair-Share

How might you use a knowledge base in a planning-based system?