On Commonsense Domains within the Winograd Schema Challenge

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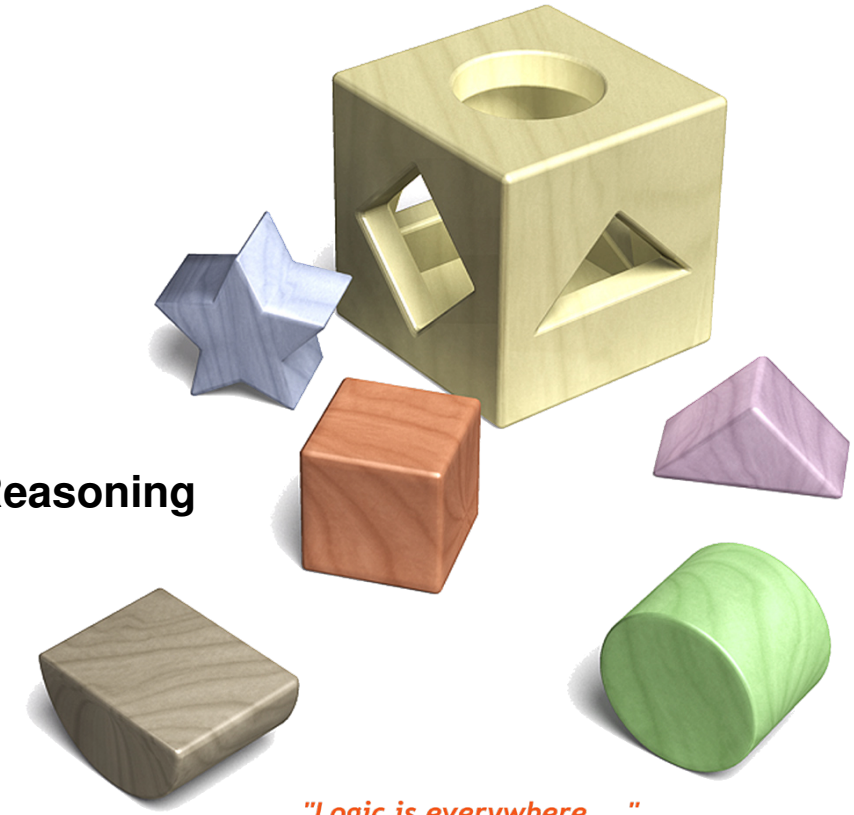
- Winograd Schema Challenge
- Previous Approaches
- Knowledge Types Identification and Reasoning
- Categorization of Winograd Schemas
- Conclusion



"Logic is everywhere ..."

Motivation

- **Winograd Schema Challenge (Levesque et al., 2012)**

  S: **The trophy does not fit into the brown suitcase because it is too [small/large].**

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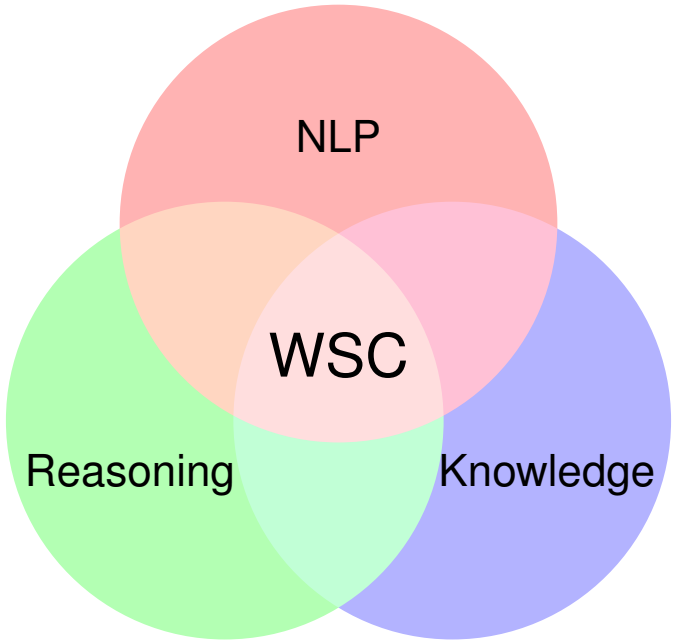

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Sentence containing two nouns	**trophy, suitcase**
One ambiguous pronoun	**it**
A special word	**small/ large**
Question about the referent of the pronoun	**What is too [small/large]**
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- **Characteristics:**
  - **Easy to answer for an adult English speaker**
  - **Always contains special word**
  - **Google proof**

Competition

- Competition in 2016 at IJCAI-16
  - Two time-constraint rounds - 210 min. each
    - Pronoun Disambiguation Problems (PDPs) - 60
    - Parts of Winograd Schemas - 150
  - Four competitors
  - Best result: 58% correctly resolved PDPs
  - There was no second round
- Current state-of-the-art (Radford et al., 2019) achieves 70.7% accuracy on the WSs dataset

Previous Approaches

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Technique	PDPs Size - Correct	WSC Size - Correct	WSC* Size - Correct	Remarks
Supervised ranking SVM model (2012)	-	-	282-30% - 205-73%	-provided additional dataset set -no evaluation on WSC dataset
Classification task with NN (2018)	-	282-100% - 157-56%	282-30% - 177-63%	-first to use substitution of the pronoun with the antecedents
Knowledge Embeddings (2016)	60-100% - 40-66.7%	-	-	-best results in the 2016 WSC competition
Google's language models (2018)	60-100% - 42-70%	273-100% - 173-63.7%	-	-no reasoning involved in the discovery of the correct answer -state-of-the-art for PDPs
OpenAI language models (2019)	-	273-100% - 193-70.70%	-	-current state-of-the-art for WSC -requires a lot of data for training -results are not reproducible
Graphs with Relevance theory (2014)	-	4-2.6% - 4-100%	-	-manual construction of graphs -first representation of WS as dependency graph
2 identified categories (2015)	-	71-25% - 49-69%	-	-first attempt of identifying commonsense knowledge types -developed the KParser
Semantic relations categories (2019)	-	100-34% - 100-100%	138-14% - 111-80%	-provided Reasoning Algorithm -identified 12 commonsense typ which capture the entire WSC
Knowledge hunting framework (2018)	-	273-100% - 119-43.5%	-	-refined query generation -developed an algorithm for scoring the retrieved sentences

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- **Evaluation and results**
  - **PDPs 70% accuracy**
  - **WSC 63.7% accuracy**

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- Identified 12 knowledge types which cover the entire WSC dataset
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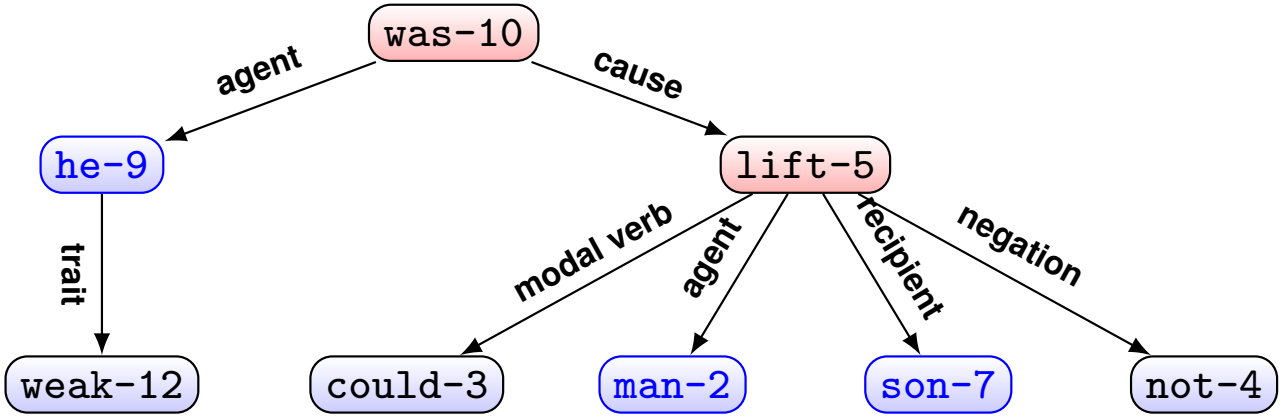
- Solver
  1. Semantic graph of the input sentence and question
  2. Semantic graph representation of background knowledge
  3. Graph merging
  4. Project question graph on the merged graph
  5. Answer - the node from the merged graph which is from the same domain as the unknown node from the question graph

Semantic graph representation[1]

- **"The man couldn't lift his son because he was so weak".**



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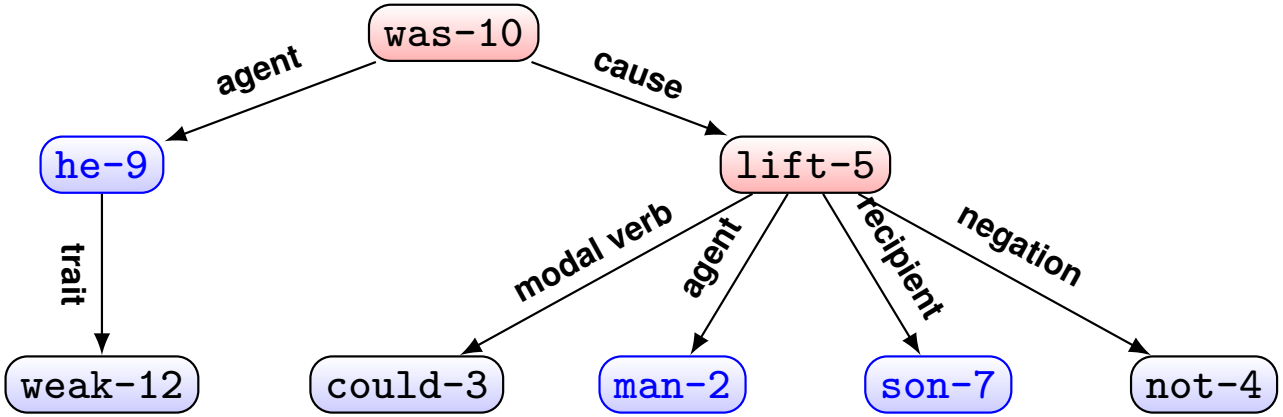

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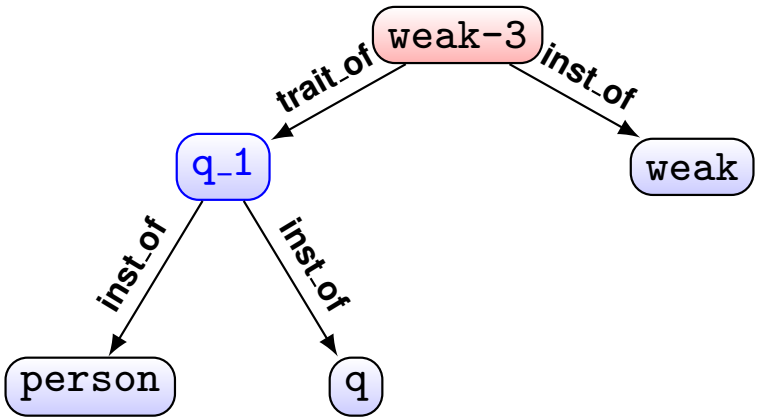

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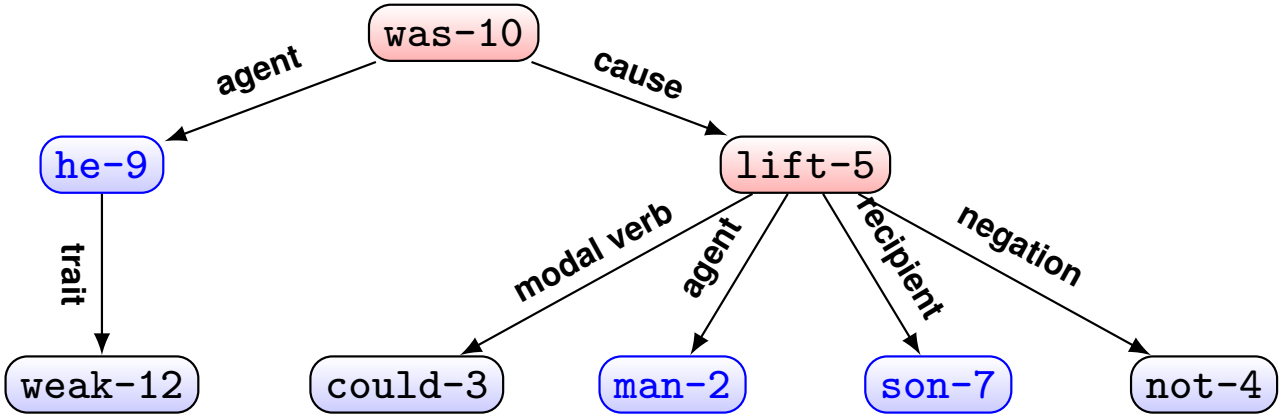

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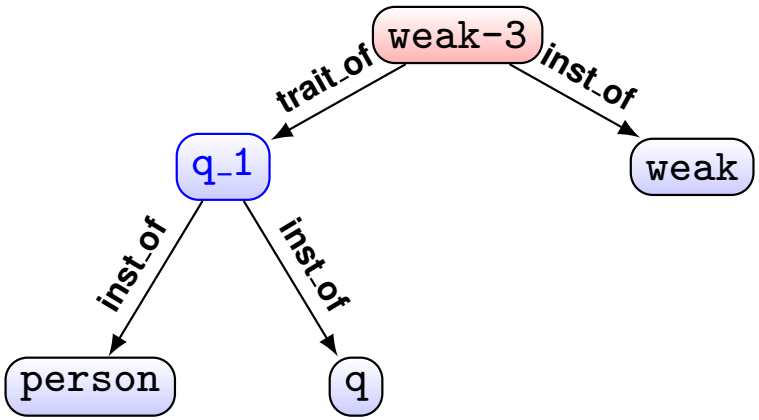
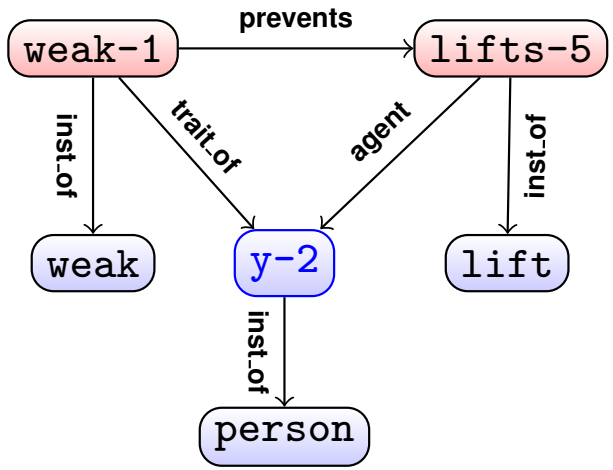


- "weak y prevents y lifts"



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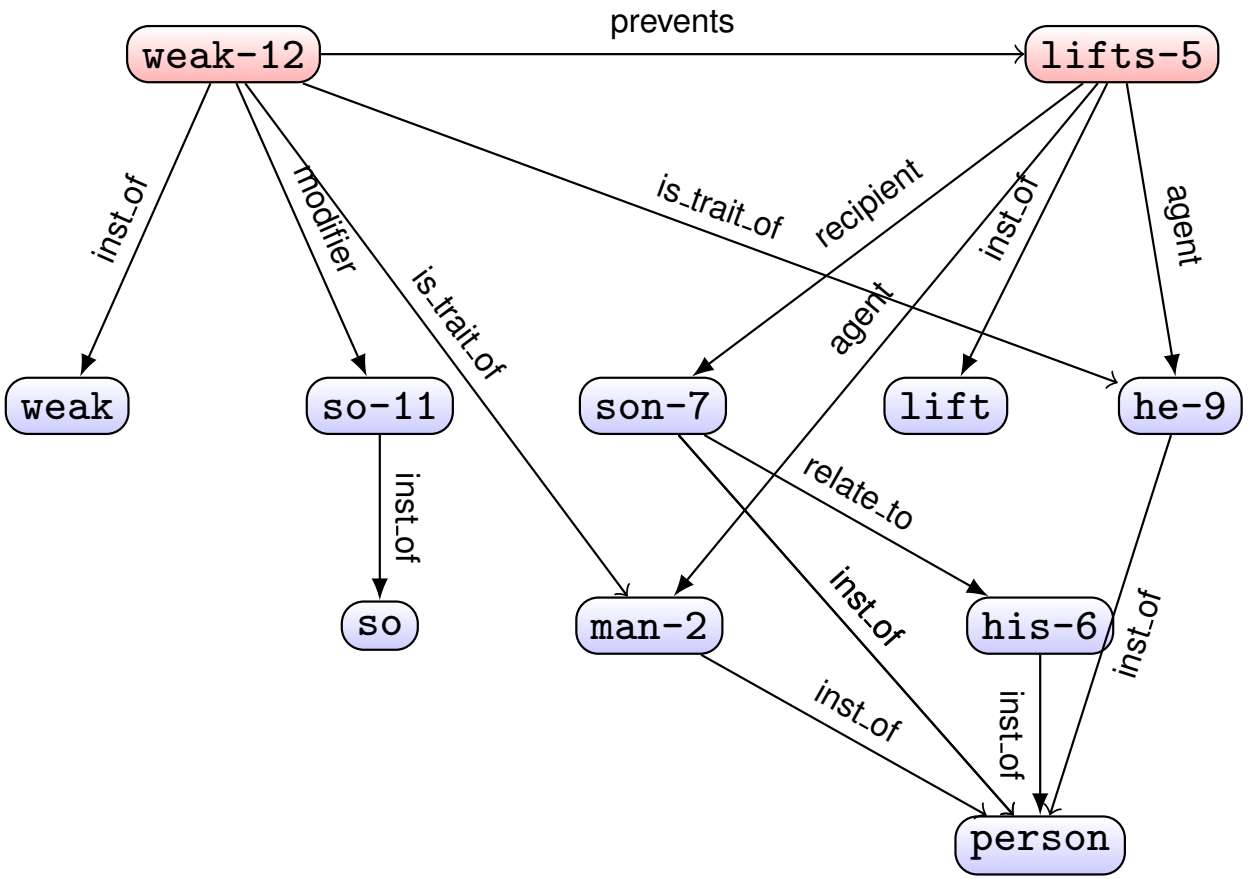
Reasoning procedure



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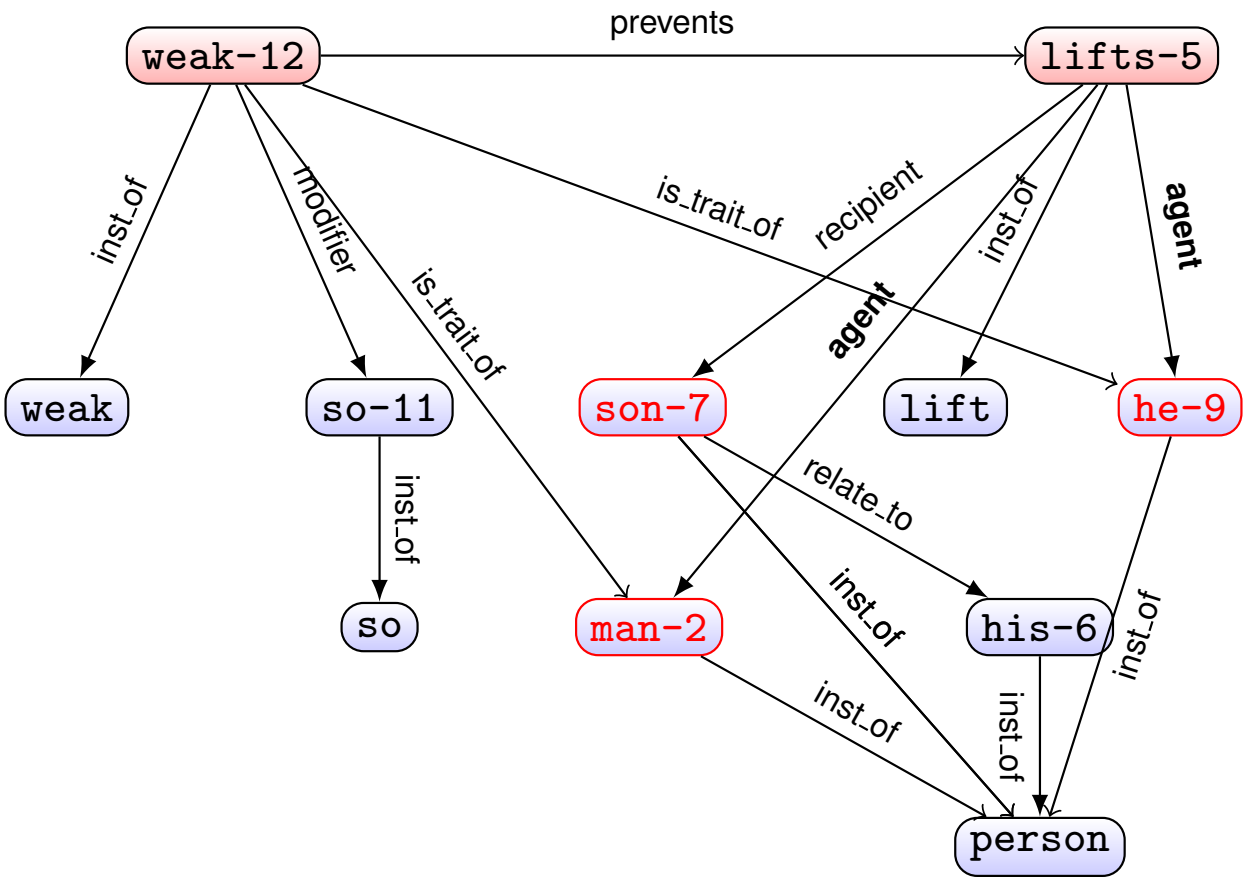


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has_k(weak,prevents,lifts).
has_k(lifts,agent,y).
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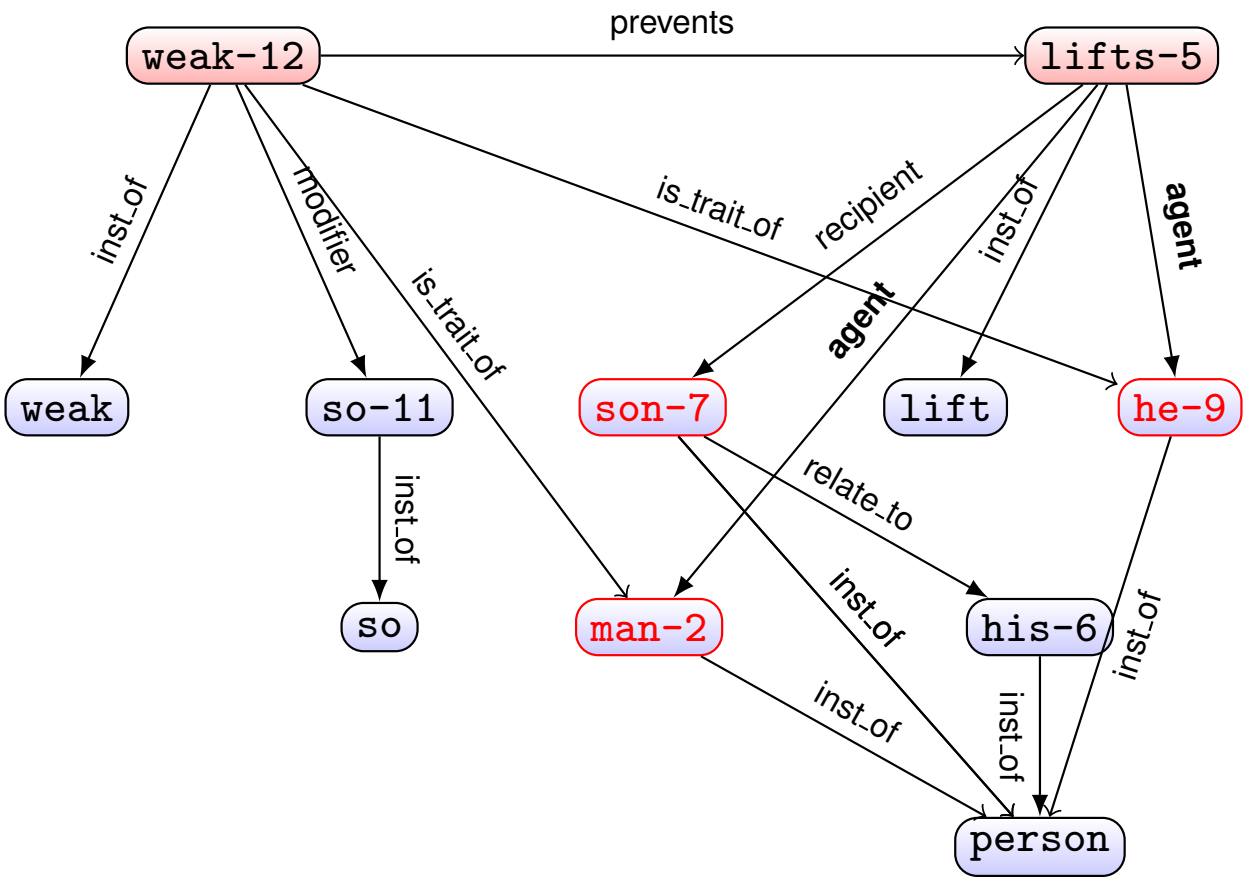


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  - **Current state-of-the-art has a poor performance**
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- **Motivation**
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  - **Idea**
    1. **Analyze the input Winograd Schema and identify the domain of the least necessary knowledge**
    2. **Search for knowledge specific to this domain**
    3. **Apply reasoning procedure**
- **Categorization based on the content of the Winograd sentence**

Identified Categories

Category	Example
1. Physical	**S:** John couldn't see the stage with Billy in front of him because he is so **[short/tall]**. **Q:** Who is so [short/tall]?
2. Emotional	**S:** Frank felt **[vindicated/crushed]** when his longtime rival Bill revealed that he was the winner of the competition. **Q:** Who was the winner of the competition?
3. Interactions	**S:** Joan made sure to thank Susan for all the help she had **[given/received]**. **Q:** Who had [given/received] help?
4. Comparison	**S:** Joe's uncle can still beat him at tennis, even though he is 30 years **[older/younger]**. **Q:** Who is [older/younger]?
5. Causal	**S:** Pete envies Martin **[because/although]** he is very successful. **Q:** Who is very successful?
6. Multiple knowledge	**S:** Sam and Amy are passionately in love, but Amy's parents are unhappy about it, because they are **[snobs/fifteen]**. **Q:** Who are [snobs/fifteen]?

Annotation of Winograd Schemas

- **Strong agreement between the annotators**
  Cohen's kappa score 0.66
- **Annotation Results**

Category	Annotator 1	Annotator 2
Physical	36– 24%	39– 26%
Emotional	7– 4.6%	9– 6%
Interactions	44–29.3%	24–16%
Comparison	19–12.6%	26–17.3%
Causal	16–10.6%	18–12%
Multiple knowledge	28–18.6%	34–22.6%

Graph Representation for Physical Category

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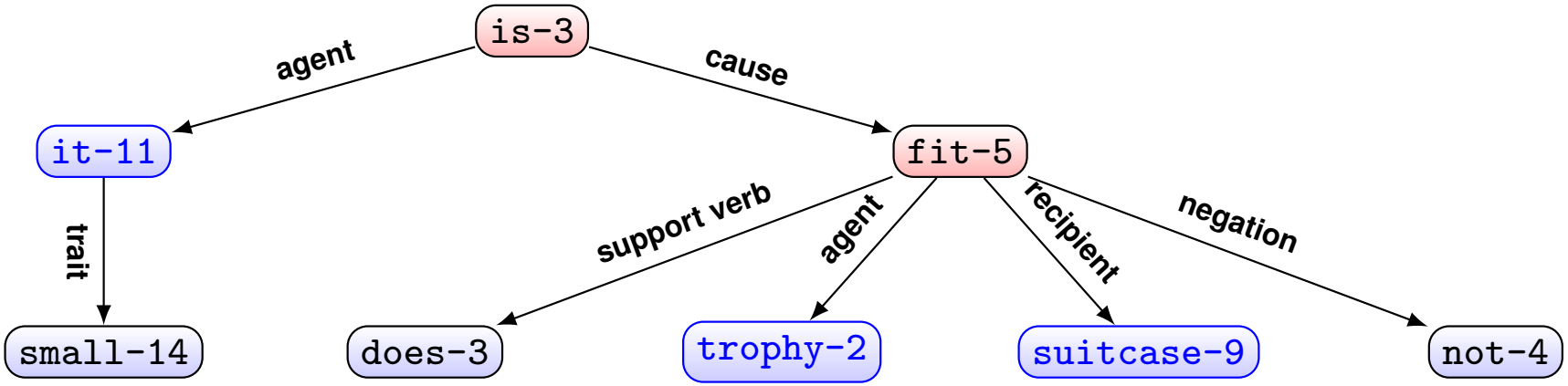

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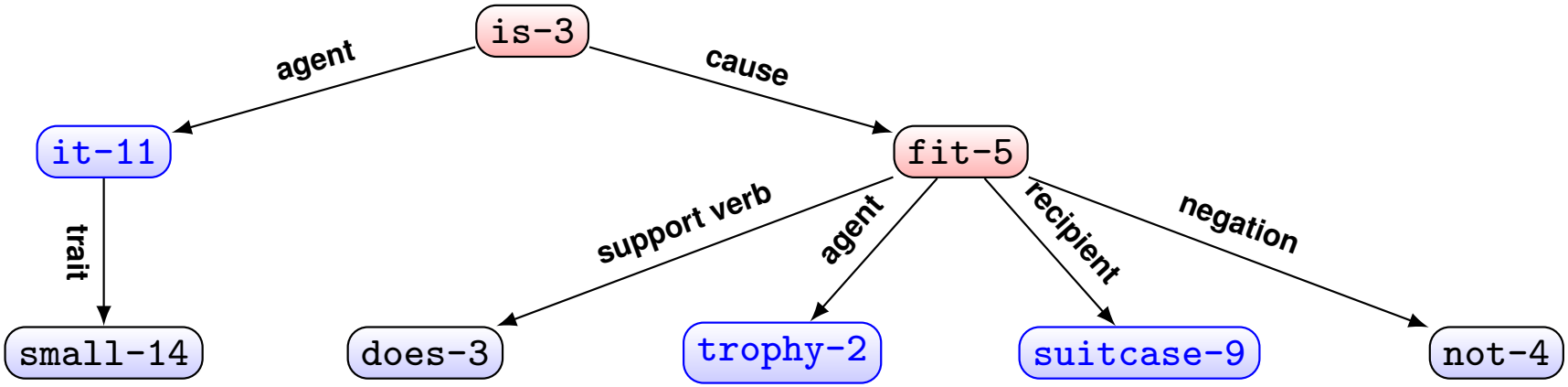

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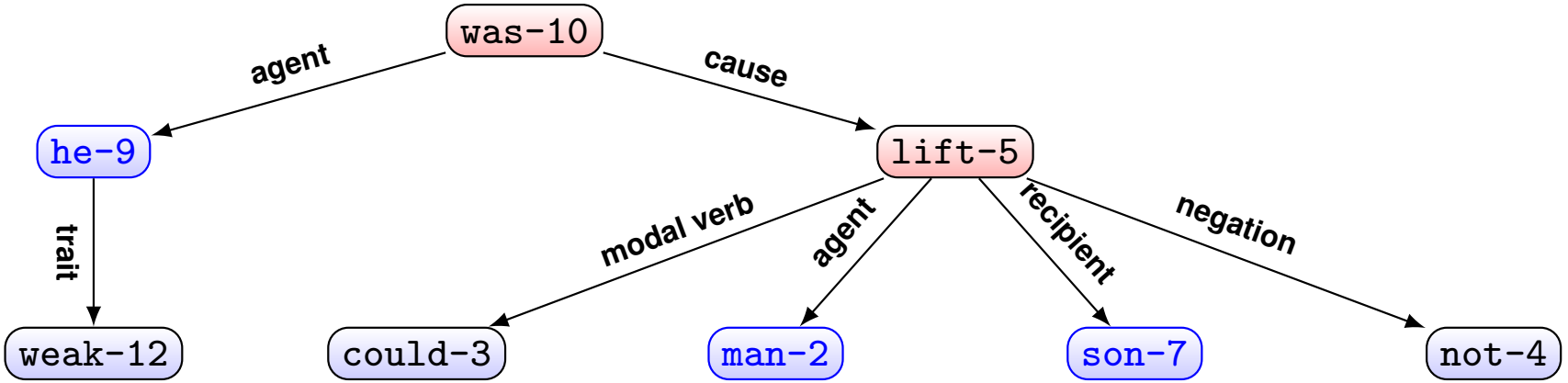

Reasoning

- **Knowledge required for both examples is about physical features**
- **Similar reasoning rules for categorizing the traits**

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- **Reasoning Algorithm**
- **Change of background knowledge**

- **Contributions**
  - Overview of different approaches towards WSC
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- **Thank you!**

References

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