The Role of the WordNet Relations in the Knowledge-based Word Sense Disambiguation Task

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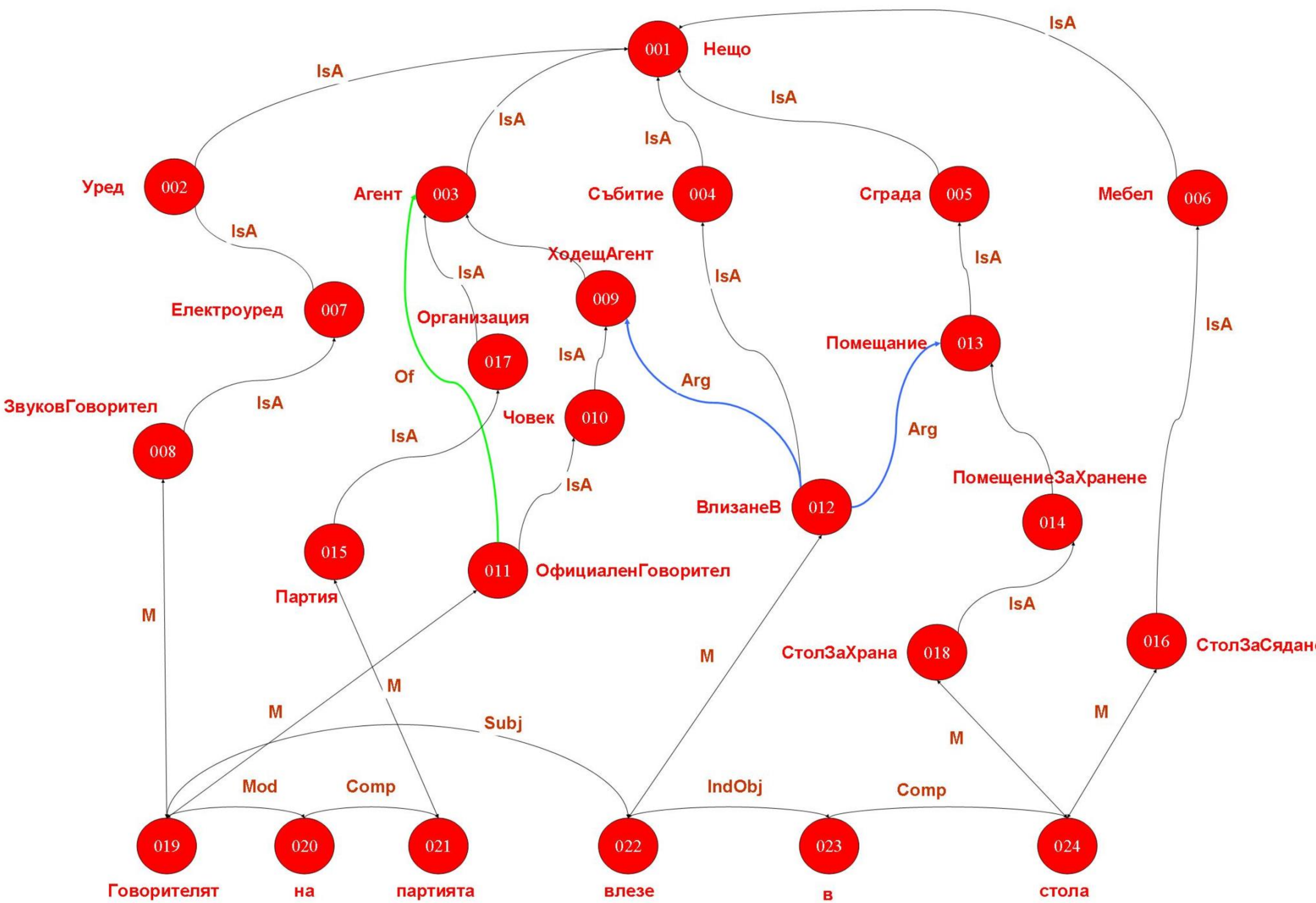
Plan of the Talk

- Brief introduction to Knowledge-based Word Sense Disambiguation (WSD)
- WSD initial experiments
- New Knowledge Graph extensions (over WordNet, Extended WordNet and SemCor)
- Contribution of the various semantic relations
- Conclusions

Knowledge-based WSD (1)

- Relies on lexical databases, such as WordNet, DBPedia, various ontologies, etc. represented as a graph (Knowledge Graph)
- Does not require large and expensive manually constructed corpora
- But: *often suffers from sparseness*
- Algorithms are variants of Random Walk on Graphs



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004 Събитие
005 Сграда
006 Мебел
007 Електроуред
008 ЗвуковГоворител
009 ХодещАгент
010 Човек
011 ОфициаленГоворител
012 ВлизанеВ
013 Помещание
014 ПомещениеЗаХранене
015 Партия
016 СтолЗаСядане
017 Организация
018 СтолЗаХрана
019 Говорителят
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UKB: Graph Based Word Sense Disambiguation and Similarity

- Knowledge-based approach to word sense classification; no supervision in the form of a manually annotated corpus needed
- Personalized PageRank algorithm
- http://ixa2.si.ehu.es/ukb

Initial Experiments on Bulgarian

- We use the knowledge graph developed by UKB team via mappings from Bulgarian WordNet to English WordNet

Graph	Accuracy
WN	51.72 %
WNG	53.82 %

- Not very optimistic
- A possible solution: *adding more knowledge to the graph*

Initial Knowledge Graph Enrichment

We performed several extensions of the Knowledge Graph with additional arcs

- Domain relations from WordNet
- Inferred hypernymy relations
- Syntactic relations from the gold corpus
- Extended syntactic relations

Syntactic Relations

- From *Universal Dependency Representation of BulTreeBank* dependency relations were extracted that denote **event-participant** semantic relations:

  SynSet1 – DepRel – SynSet2

- 15,675 triples
- 8,772 dependency relations: 1,844 *nsubj*, 3,875 *nmod*, 1,025 *amod*, 716 *iobj* and 1,312 *dobj*

Inferred Syntactic Relations

- If in the triple SynSet1 – DepRel – SynSet2, SynSet11 is hyponym of SynSet1 and SynSet1 is participant in the event then we add the triple SynSet11 – DepRel – SynSet2

A doctor kisses a girl. → *A surgeon kisses a girl.*

- Resulted semantic relations: 372,247 (*nsubj*), 1,125,823 (*nmod*), 377,577 (*amod*), 114,760 (*iobj*) and 292,202 (*dobj*)

More Syntactic Relations

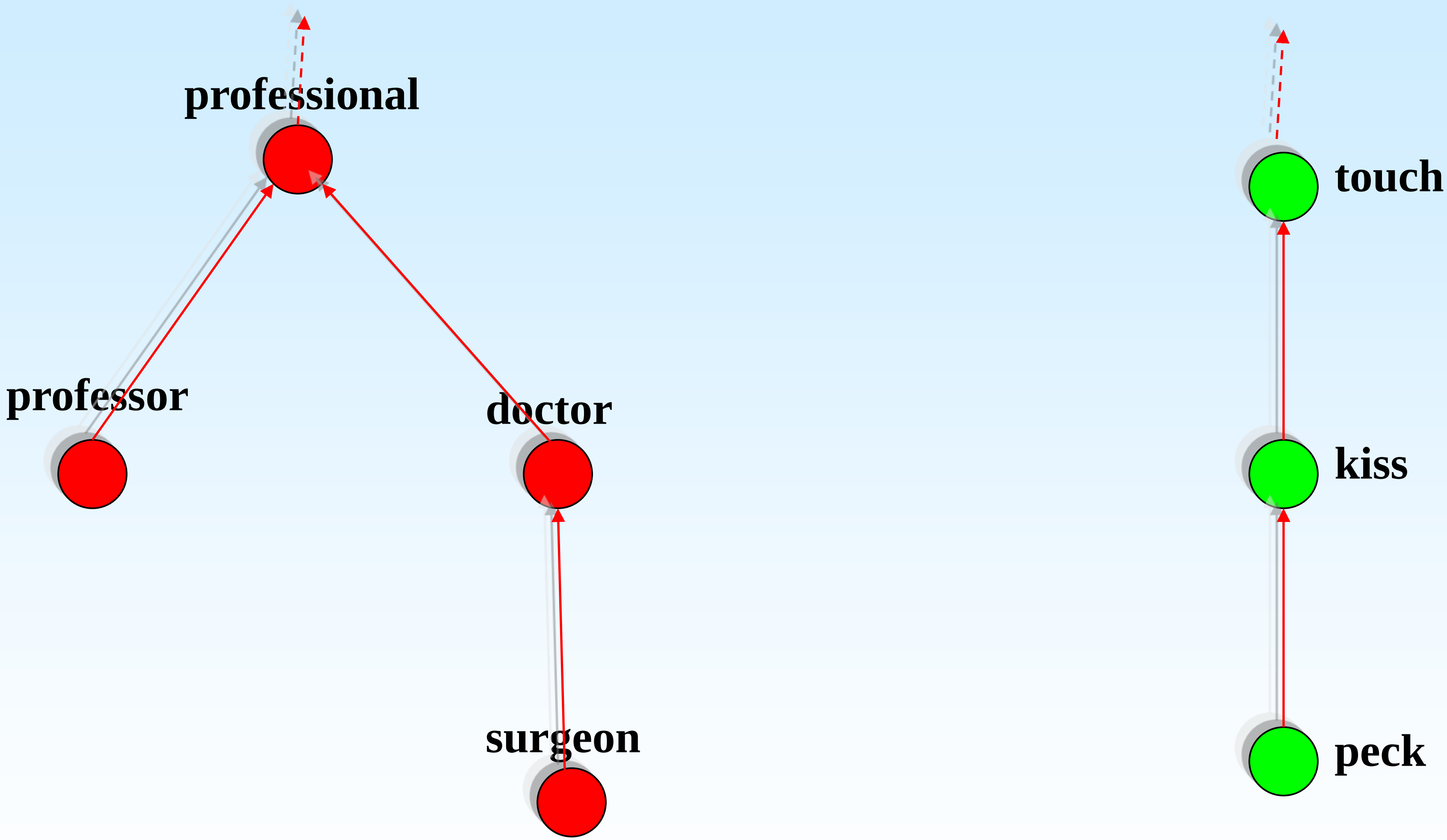
- The relations in the treebank are not the most general ones
- Our goal for each event to find the most general concept restricting each participant in the event. The same participants in more general event:

  A doctor kisses a girl. → A professional kisses a woman. → A professor kisses a bar girl.

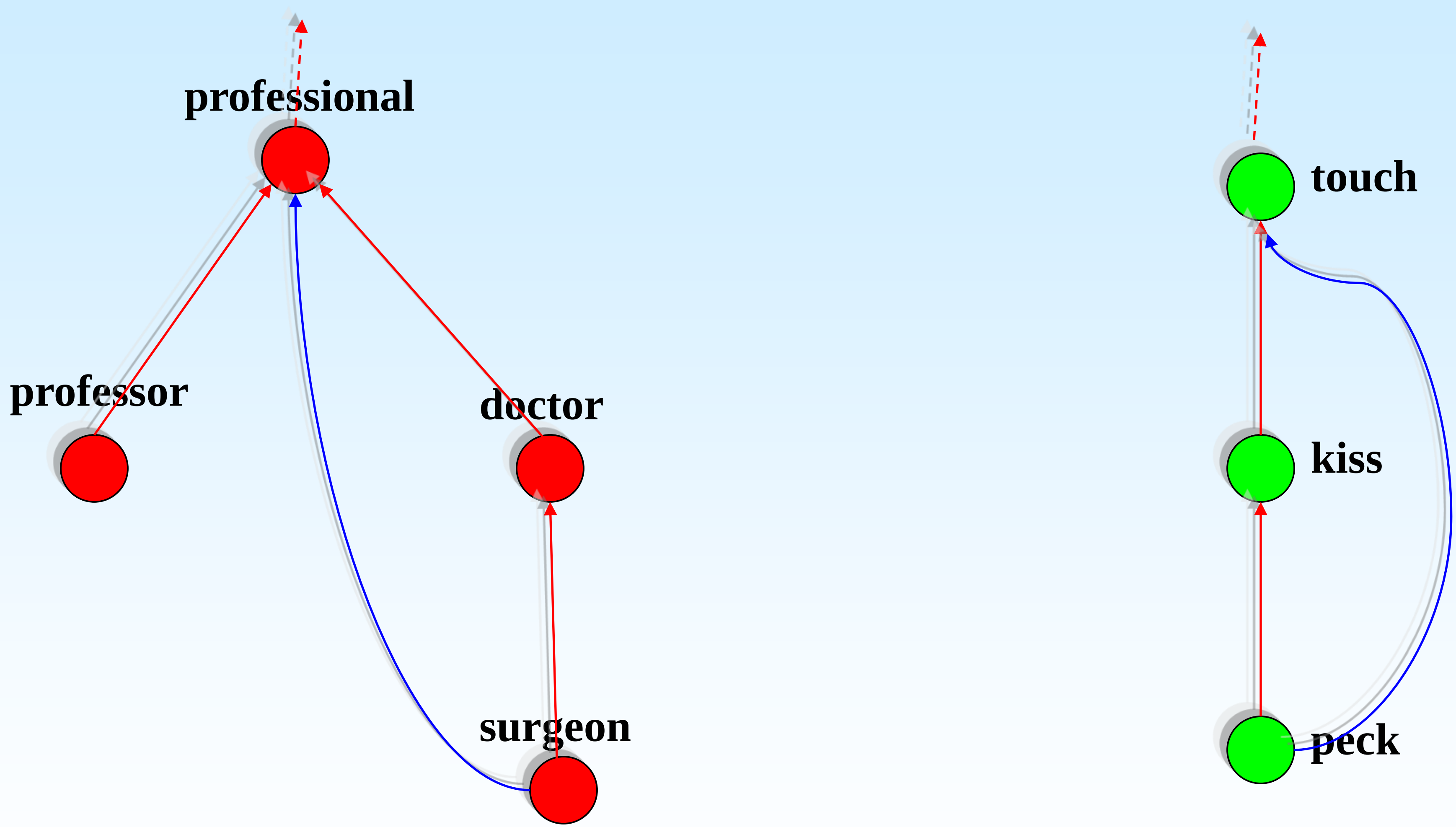
  A doctor kisses a girl. → A doctor touches a girl.

- Strategy in the experiments: *move to the direct hypernym and extend with all hyponyms*

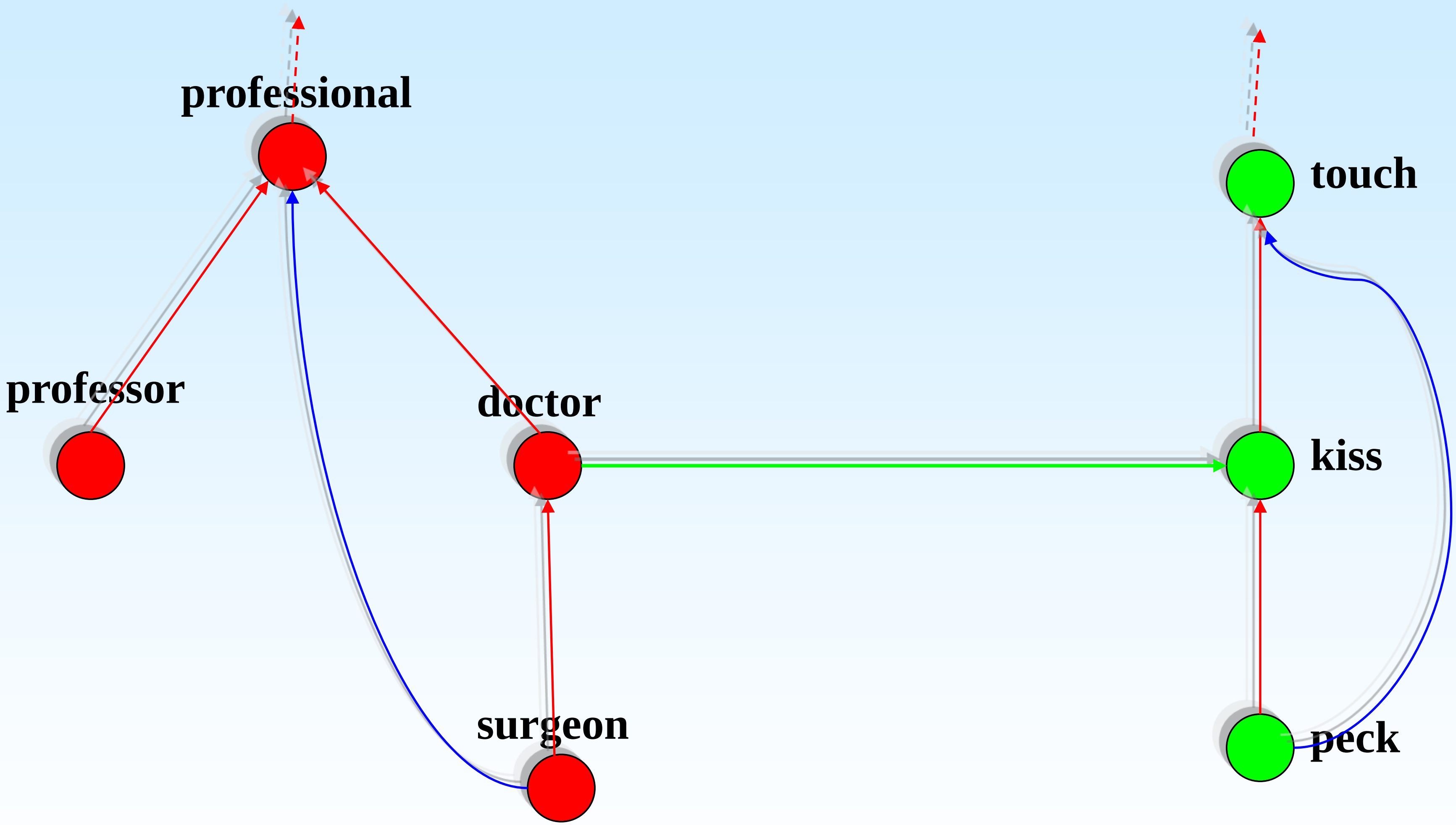
Knowledge Graph Extensions



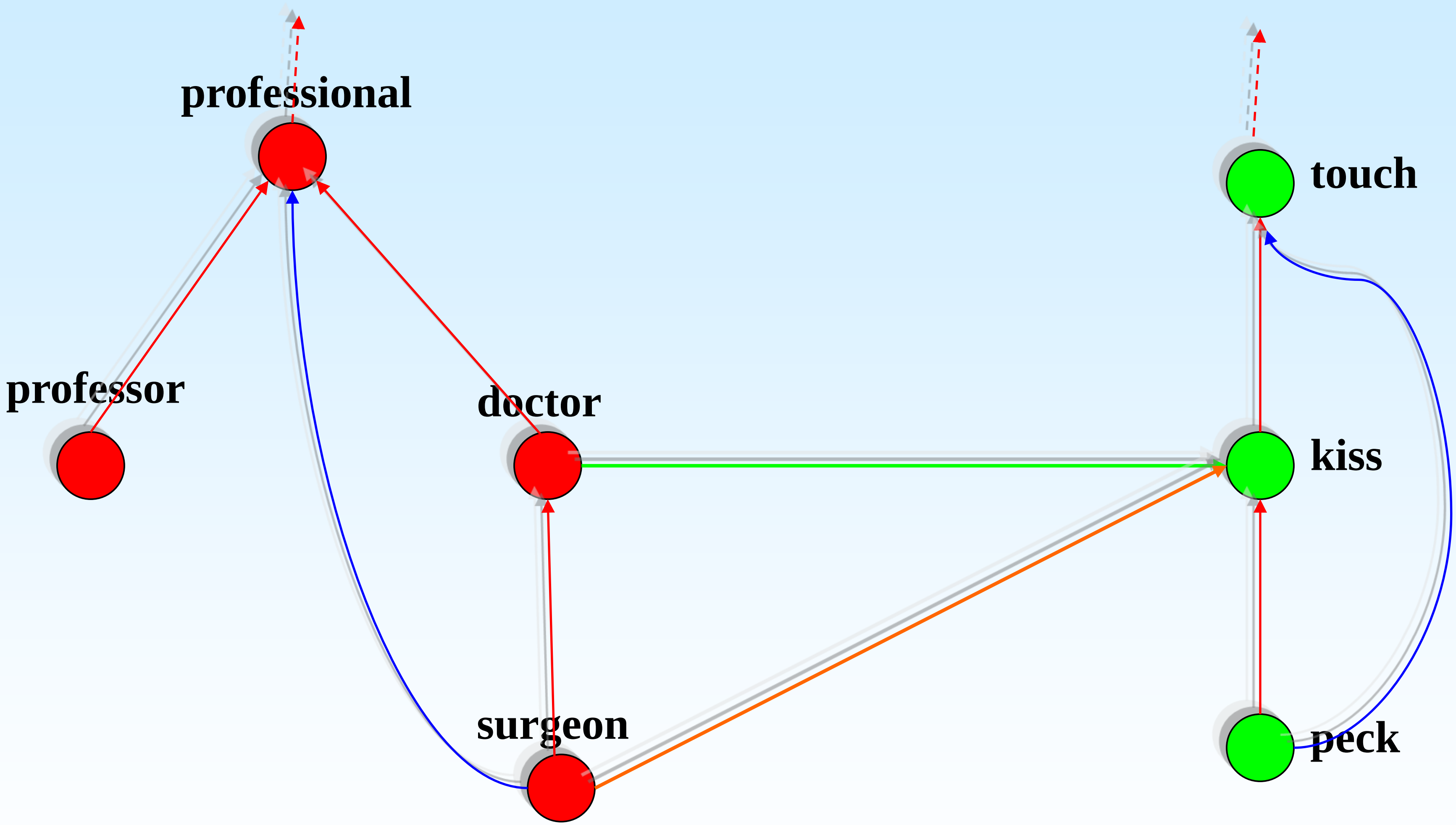
Knowledge Graph Extensions – Inheritance



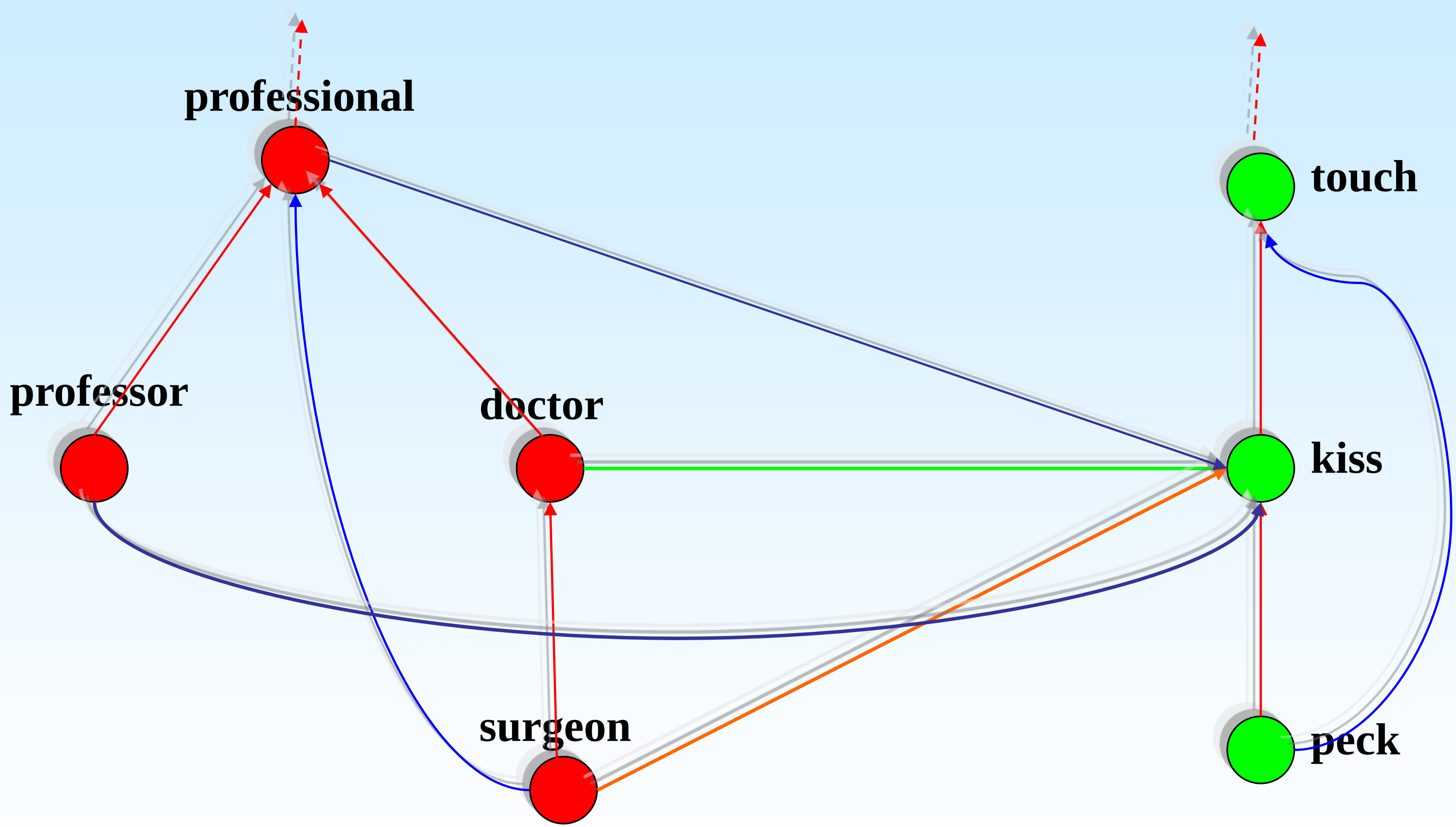
Knowledge Graph Extensions – Syntax



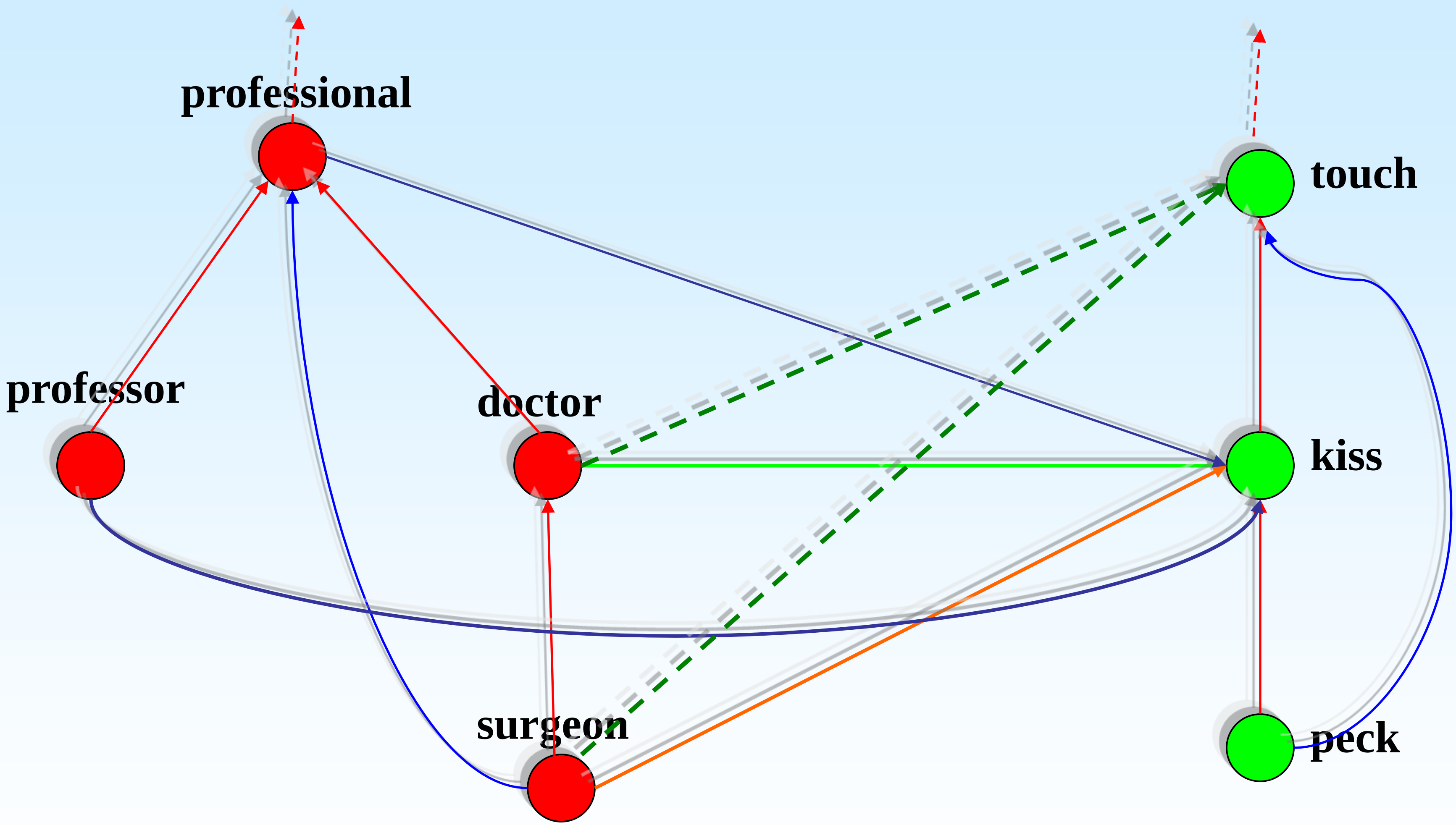
Knowledge Graph Extensions – Syntax ↓



Knowledge Graph Extensions – Syntax ↑↓



Knowledge Graph Extensions – Syntax V↑



Initial Knowledge Graphs

- **WN**: WN relations
- **WNG**: WN relations + relations from the glosses
- **WNI**: WN relations + inferred hypernymy relations
- **WNGI**: WN + glosses + hypernymy
- **WNGID1**: WN + glosses + hypernymy + synset-to-domain
- **WNGID2**: WN + glosses + hypernymy + domain synset-to-synset
- **WNGIS**: WN + glosses + hypernymy + dependency relations
- **WNGISE**: WN + glosses + hypernymy + extended dependency
- **WNGISED1**: WN + glosses + hypernymy + extended dependency + synset-to-domain
- **WNGISED2**: WN + glosses + hypernymy + extended dependency + domain synset-to-synset
- **WNGISEUD2**: WN + glosses + hypernymy + extended dependency one level up + domain synset-to-synset

Initial Results for Bulgarian

KGraph	Accuracy
WN	0.517
WNG	0.538
WNI	0.535
WNGI	0.537
WNGID1	0.538
WNGID2	**0.550**
WNGIS	0.565
WNGISE	0.616
WNGISED1	0.617
WNGISED2	0.624
WNGISEUD2	**0.656**

New Experiments

- To study the extension of knowledge graph evaluated on different language and corpus: SemCor corpus – divided in training and test part (3 : 1)
- 16 relations constituting WordNet knowledge graph
- Similarly for the relations within Extended WordNet
- Syntactic Relations

16 WordNet Relations

KGraph	SemCor	BTB
WN	**49.24**	**51.72**
GL	**51.48**	**47.02**
WNG	**58.83**	**53.82**
WN-Hyp	33.38	44.89
WN-Hyp + **WN-Ant**	**39.79**	**47.55**
WN-Hyp + **WN-At**	35.77	46.18
WN-Hyp + **WN-Cls**	34.12	46.11
WN-Hyp + **WN-Cs**	33.30	40.94
WN-Hyp + **WN-Der**	**38.93**	**49.26**
WN-Hyp + **WN-Ent**	33.09	44.29
WN-Hyp + **WN-Ins**	33.89	45.00
WN-Hyp + **WN-Mm**	33.42	44.61
WN-Hyp + **WN-Mp**	35.60	45.03
WN-Hyp + **WN-Ms**	33.32	45.00
WN-Hyp + **WN-Per**	**39.62**	**47.29**
WN-Hyp + **WN-Ppl**	33.29	40.57
WN-Hyp + **WN-Sa**	**38.07**	44.48
WN-Hyp + **WN-Sim**	**42.71**	44.49
WN-Hyp + **WN-Vgp**	33.96	41.11

16 WordNet Relations- Best Results

- Combination of relations with similar or better results from the whole graph – 49.24 %

WN-Hyp + **WN-Ant** + **WN-Der** + **WN-Per** + **WN-Sa** + **WN-Sim** + **WN-Mp** + **WN-Cls** : 49.10 %

WN-Hyp + **WN-Ant** + **WN-Der** + **WN-Per** + **WN-Sa** + **WN-Sim** + **WN-Mp** + **WN-Cls** **+** **WN-Vgp** : 49.50 %

Inference over WordNet Relations

WN-HypInfer – transitive closure

WN-AntInfer – disjoint relation for N-N and V-V: man-woman → bachalor-woman

WN-Cs1stVerbInfer – each hyponym of the first argument could be a cause for the synset of the second argument

WN-Cs2ndVerbInfer – the synset of the first argument could be a cause for each hypernym of the second argument

WN-DerVNInfer – noun derived from verb are participants: kiss → kisser

WN-InsInfer – an instance of a class → instance of super classes

Inference over WN Relations: Results

KGraph	Accuracy	KGraph	Accuracy
WN+WN-HypInfer	**54.15**	**WNG+WN-HypInfer**	**58.93**
WN+WN-AntInfer	48.49	**WNG+WN-AntInfer**	**59.08**
WN+WN-ClsInfer	48.48	**WNG+WN-ClsInfer**	57.66
WN+WN-Cs1stVerbInfer	**49.21**	**WNG+WN-Cs1stVerbInfer**	58.85
WN+WN-Cs2ndVerbInfer	49.25	**WNG+WN-Cs2ndVerbInfer**	58.80
WN+WN-DerNAInfer	48.49	**WNG+WN-DerNAInfer**	58.41
WN+WN-DerNNInfer	47.82	**WNG+WN-DerNNInfer**	58.62
WN+WN-DerNVInfer	47.79	**WNG+WN-DerNVInfer**	55.68
WN+WN-DerVNInfer	48.69	**WNG+WN-DerVNInfer**	58.89
WN+WN-Ent1stVerbInfer	49.21	**WNG+WN-Ent1stVerbInfer**	58.84
WN+WN-Ent2ndVerbInfer	49.21	**WNG+WN-Ent2ndVerbInfer**	58.79
WN+WN-InsInfer	48.89	**WNG+WN-InsInfer**	58.23

Extended WordNet Relations

KGraph	Accuracy
WN+WNG-A	52.80
WN+WNG-N	**56.85**
WN+WNG-R	51.56
WN+WNG-V	52.61

Syntactic Relations from SemCor

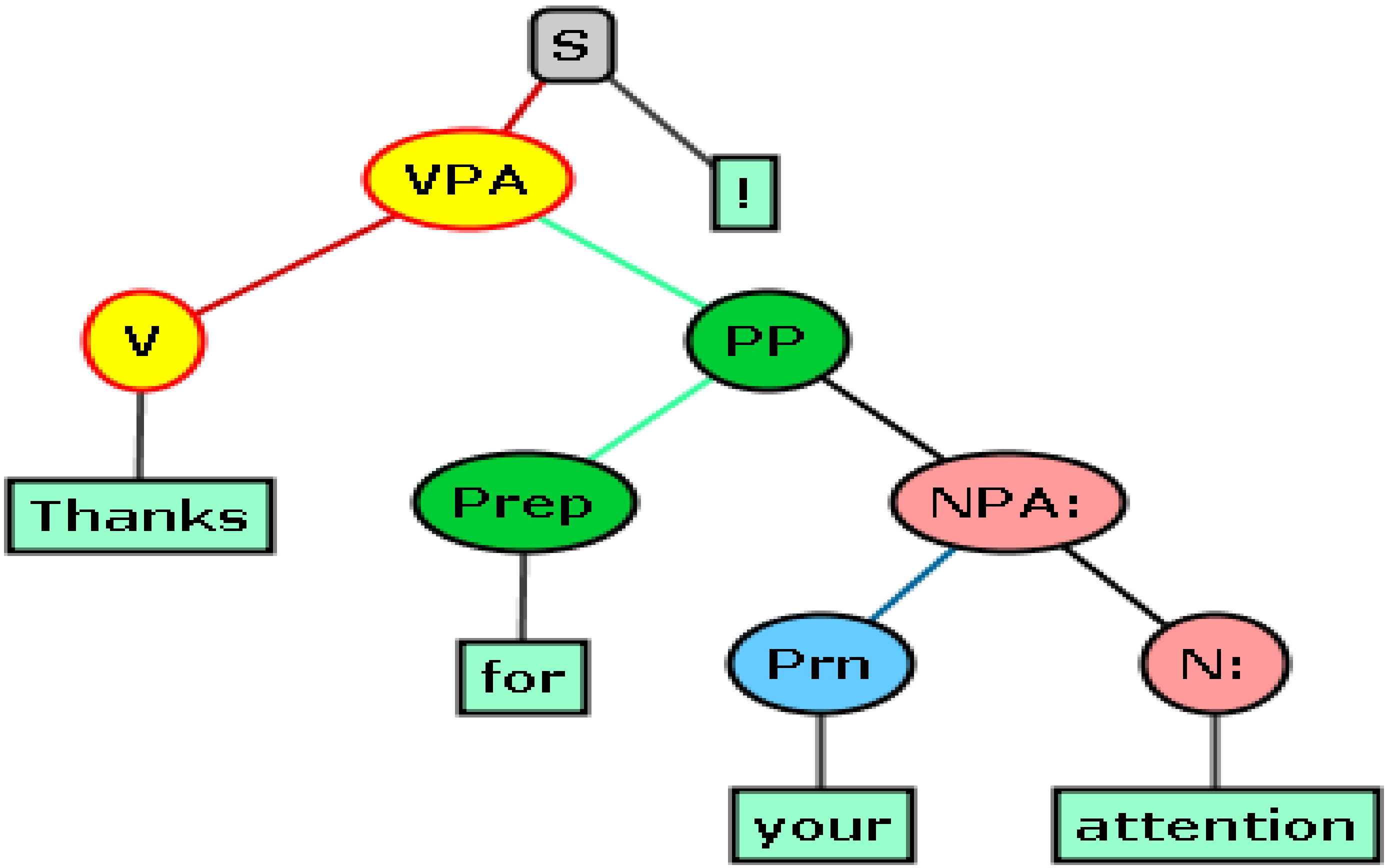
KGraph	Accuracy
WNG+SC-AA	**59.08**
WNG+SC-AN	**59.13**
WNG+SC-AV	**59.28**
WNG+SC-NN	**58.69**
WNG+SC-NV	59.20
WNG+SC-RA	**59.35**
WNG+SC-RN	**58.77**
WNG+SC-RR	58.92
WNG+SC-RV	59.24
WNG+SC-VN	58.92
WNG+SC-VV	59.09

Best Results

- **WNG + SC-AA + SC-AN + SC-AV + SC-NN + SC-NV + SC-RA + SC-RN + SC-RR + SC-RV + SC-VN + SC-VV : *60.13* %**
- **WNG + SC-AA + SC-AN + SC-AV + SC-NV + SC-RA + SC-RN + SC-RR + SC-RV + SC-VN + SC-VV : *60.14* %**
- **WNG + SC-AA + SC-AN + SC-AV + SC-NV + SC-RA + SC-RR + SC-RV + SC-VN + SC-VV + WN-HypInfer + WN-AntInfer : *60.42* %**

Conclusions

- Factors influence the results
  - The connectivity in the knowledge graph
  - The non-monotonicity of the presented knowledge
- Knowledge transfer between languages
- Future work
  - Application of more complex inference rules
  - Modification of relations per synset and context
  - Algorithm optimization to handle large knowledge graphs
  - Integration with other approaches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