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

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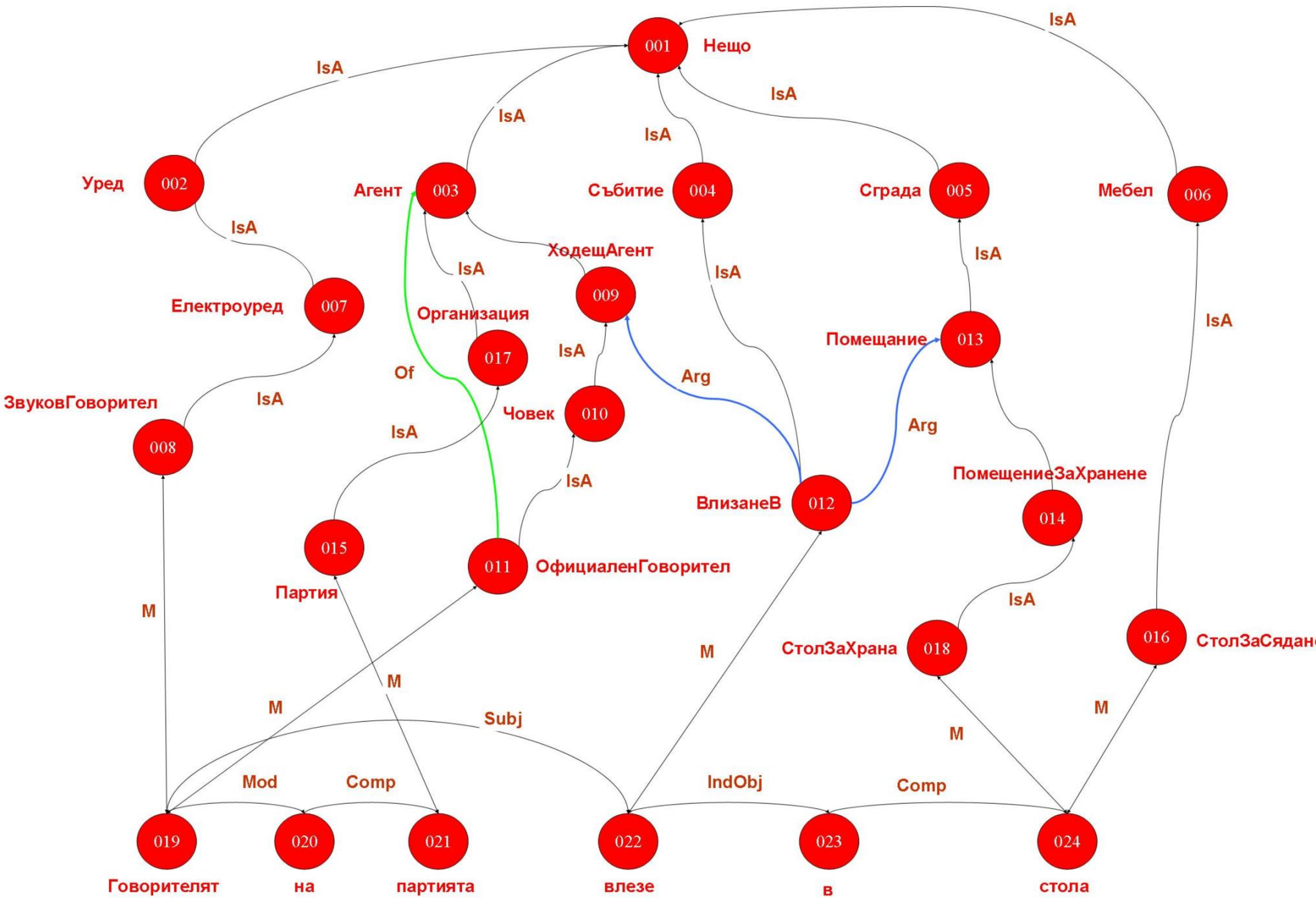
Plan of the Talk

- 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


001 Нещо
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010 Човек
011 ОфициаленГоворител
012 ВлизанеВ
013 Помещание
014 ПомещениеЗаХранене
015 Партия
016 СтолЗаСядане
017 Организация
018 СтолЗаХрана
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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 <u>doctor</u> kisses a girl. → A <u>surgeon</u> kisses a girl.

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

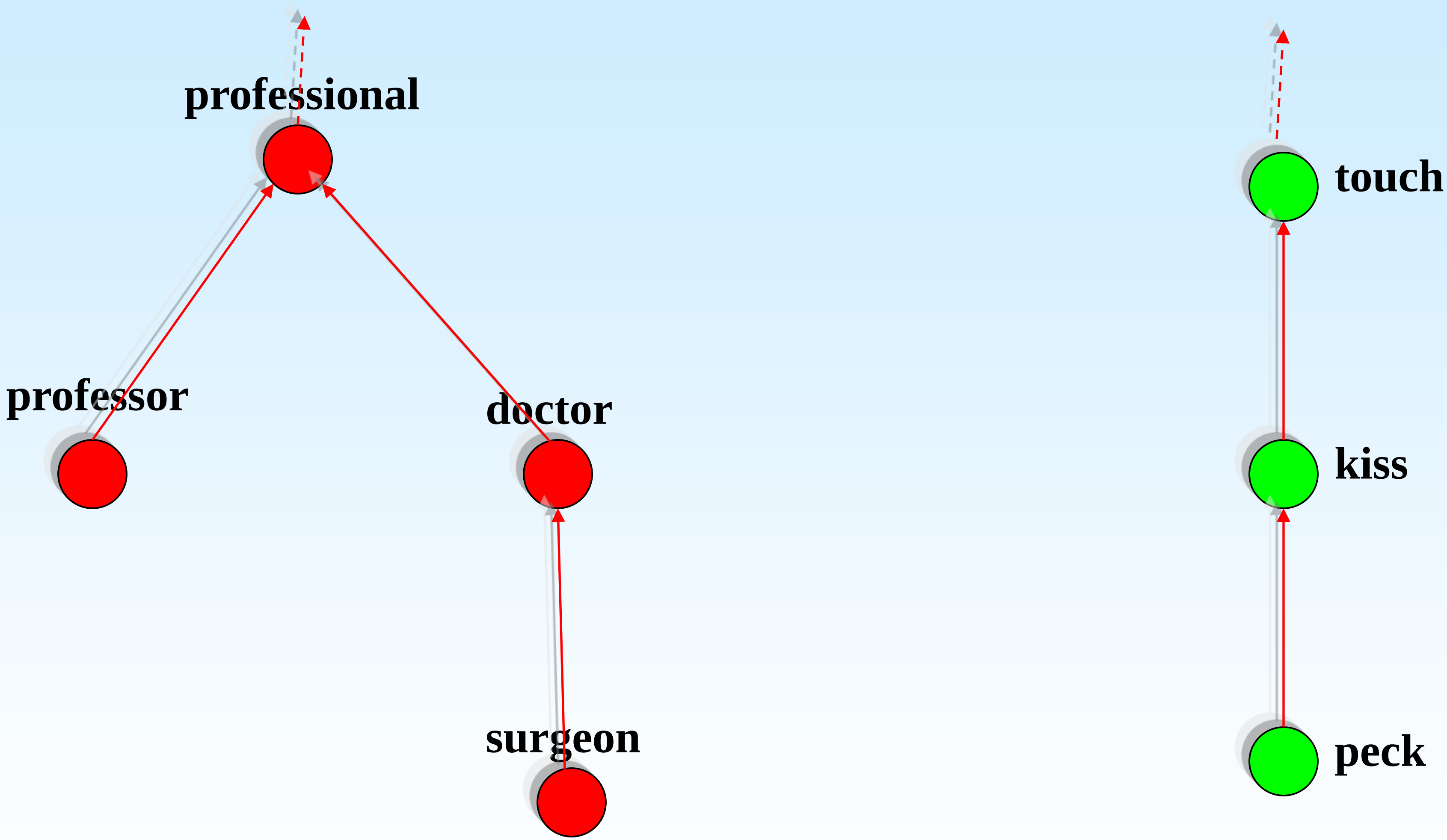
More Syntactic Relations

- 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:

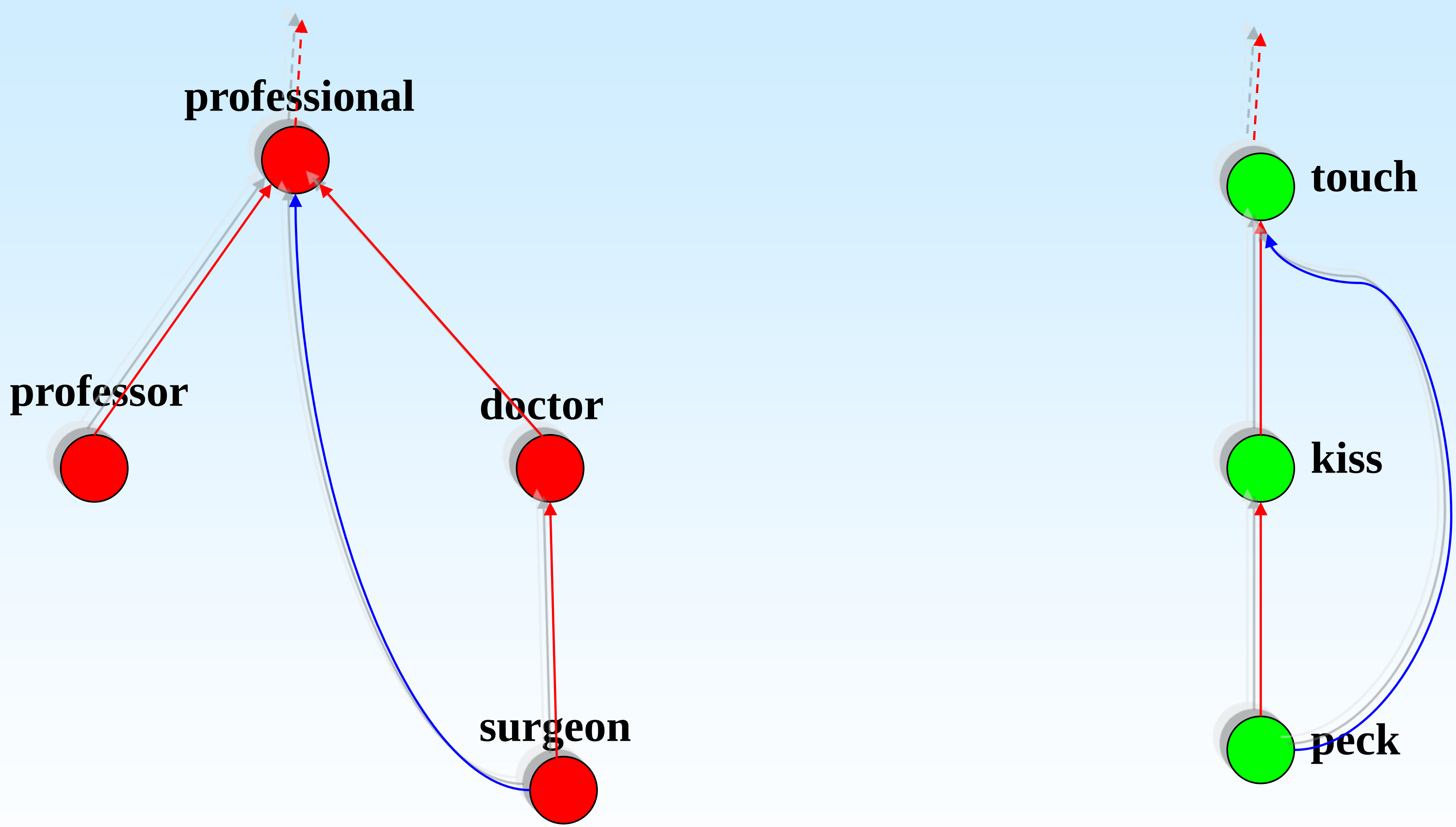
  A doctor kisses a girl. → *A professional kisses a woman.* → *A professor kisses a bar girl.*

  A doctor kisses a girl. → *A doctor touches a girl.*
- Strategy in the experiments: *move to the direct hypernym and extend with all hyponyms*

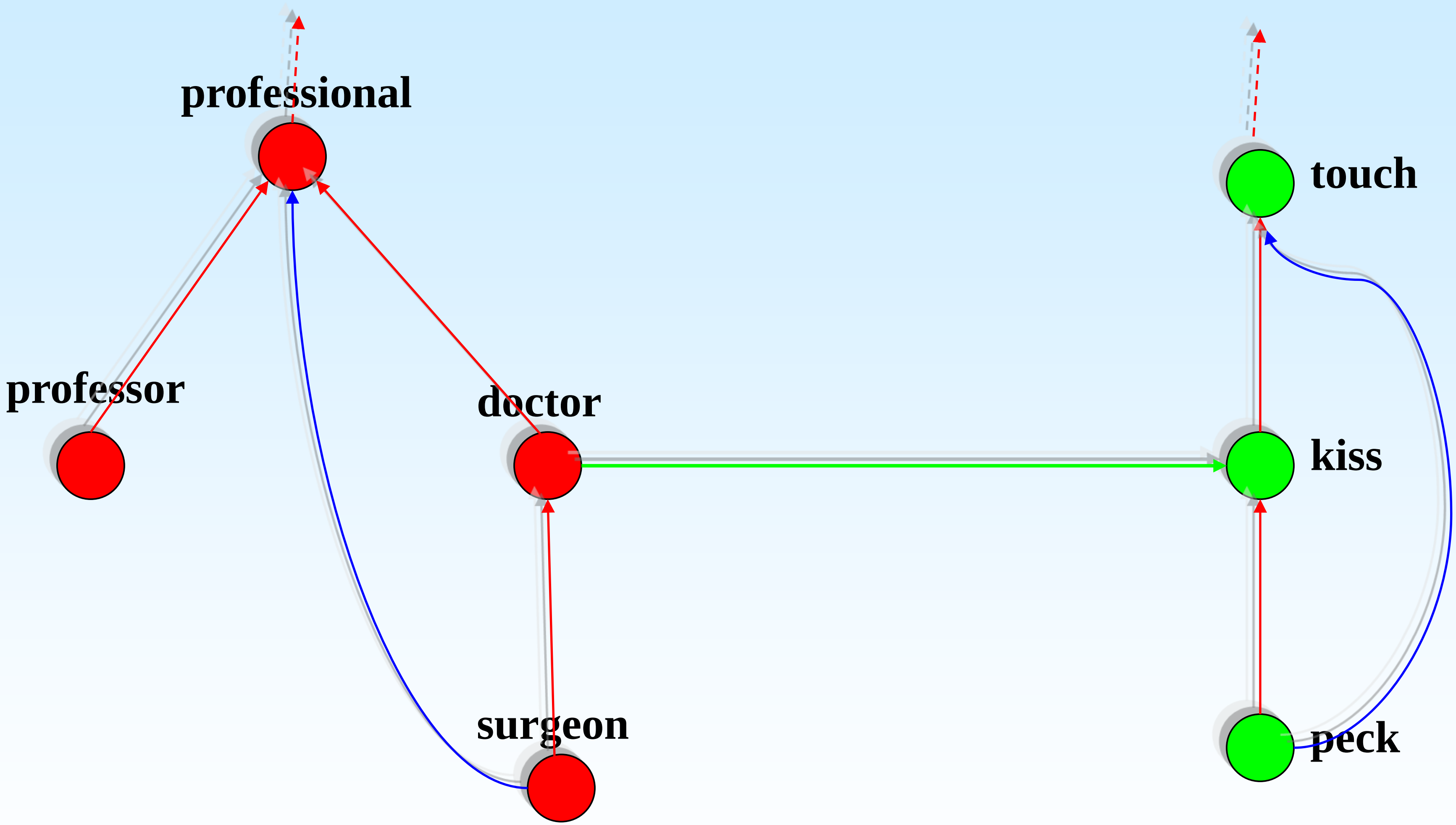
Knowledge Graph Extensions



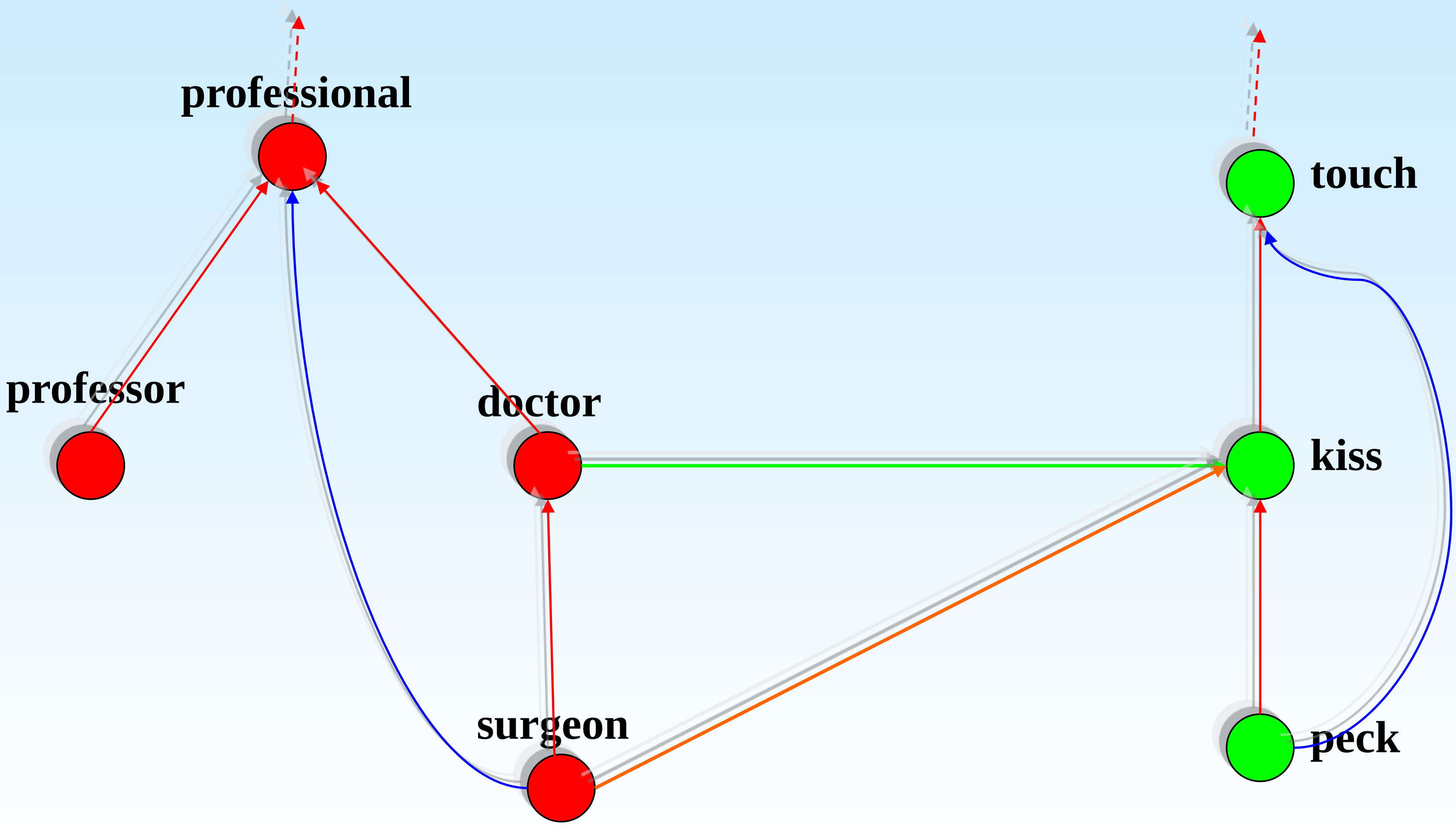
Knowledge Graph Extensions – Inheritance



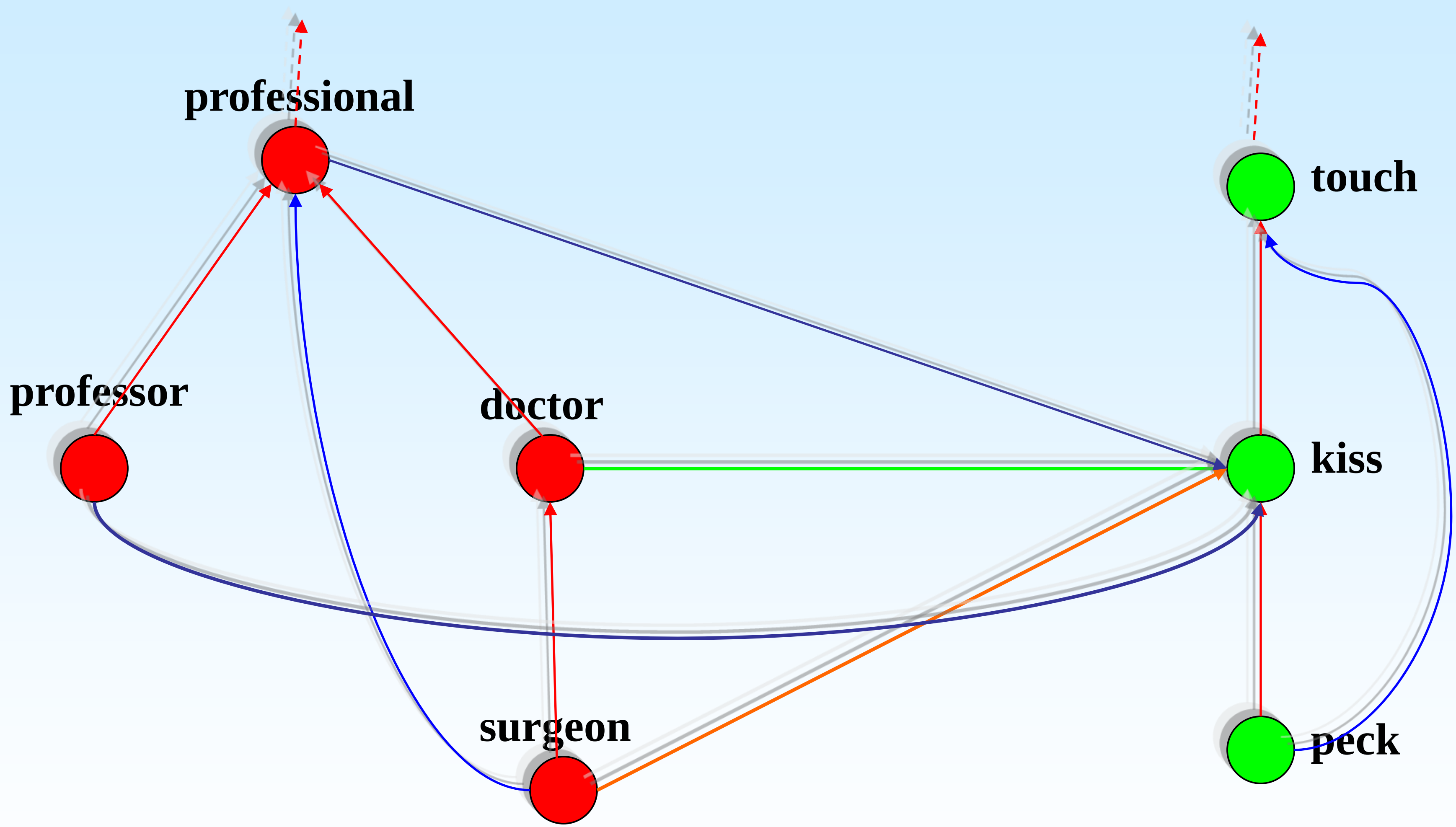
Knowledge Graph Extensions – Syntax



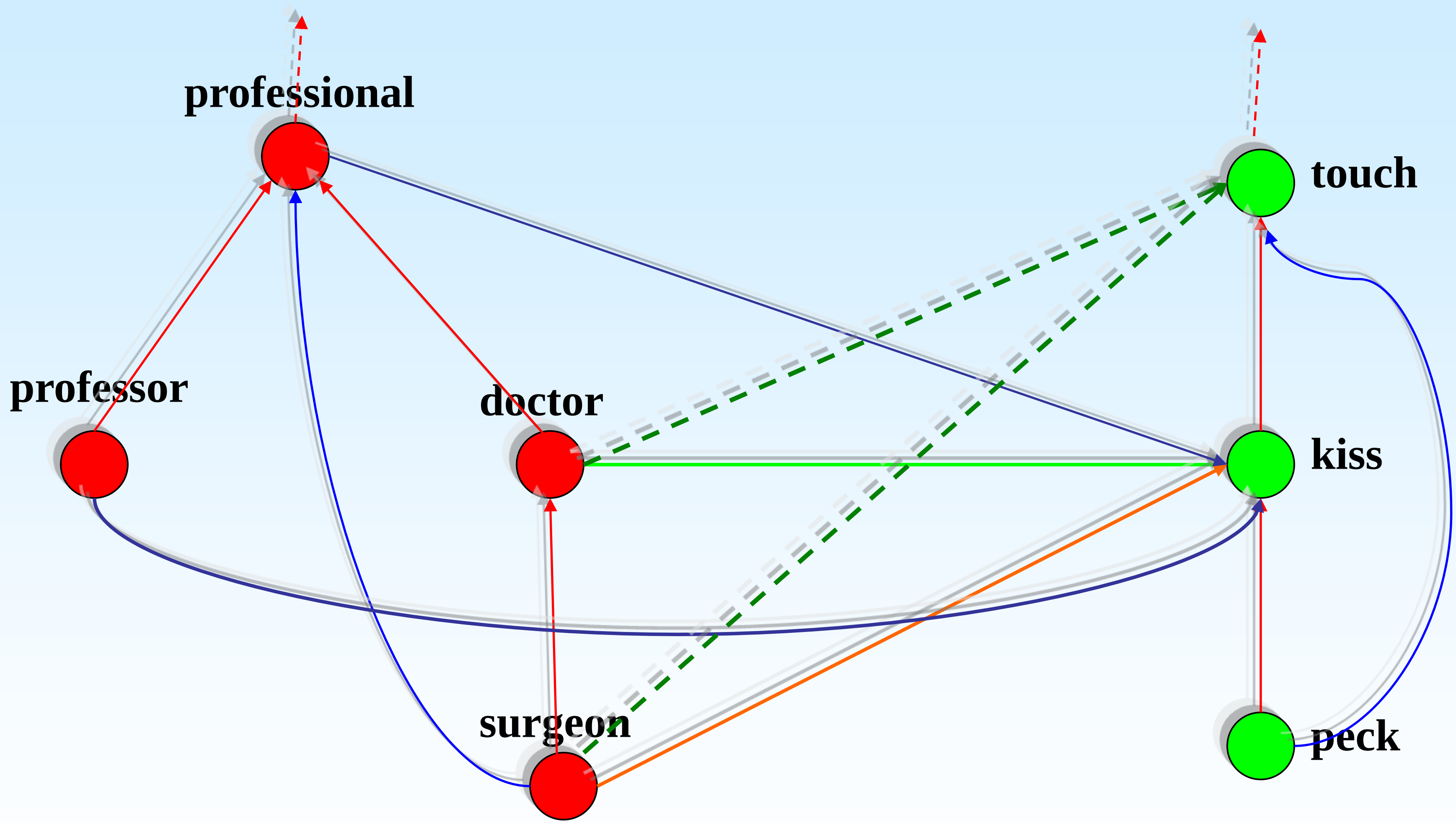
Knowledge Graph Extensions – Syntax ↓



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

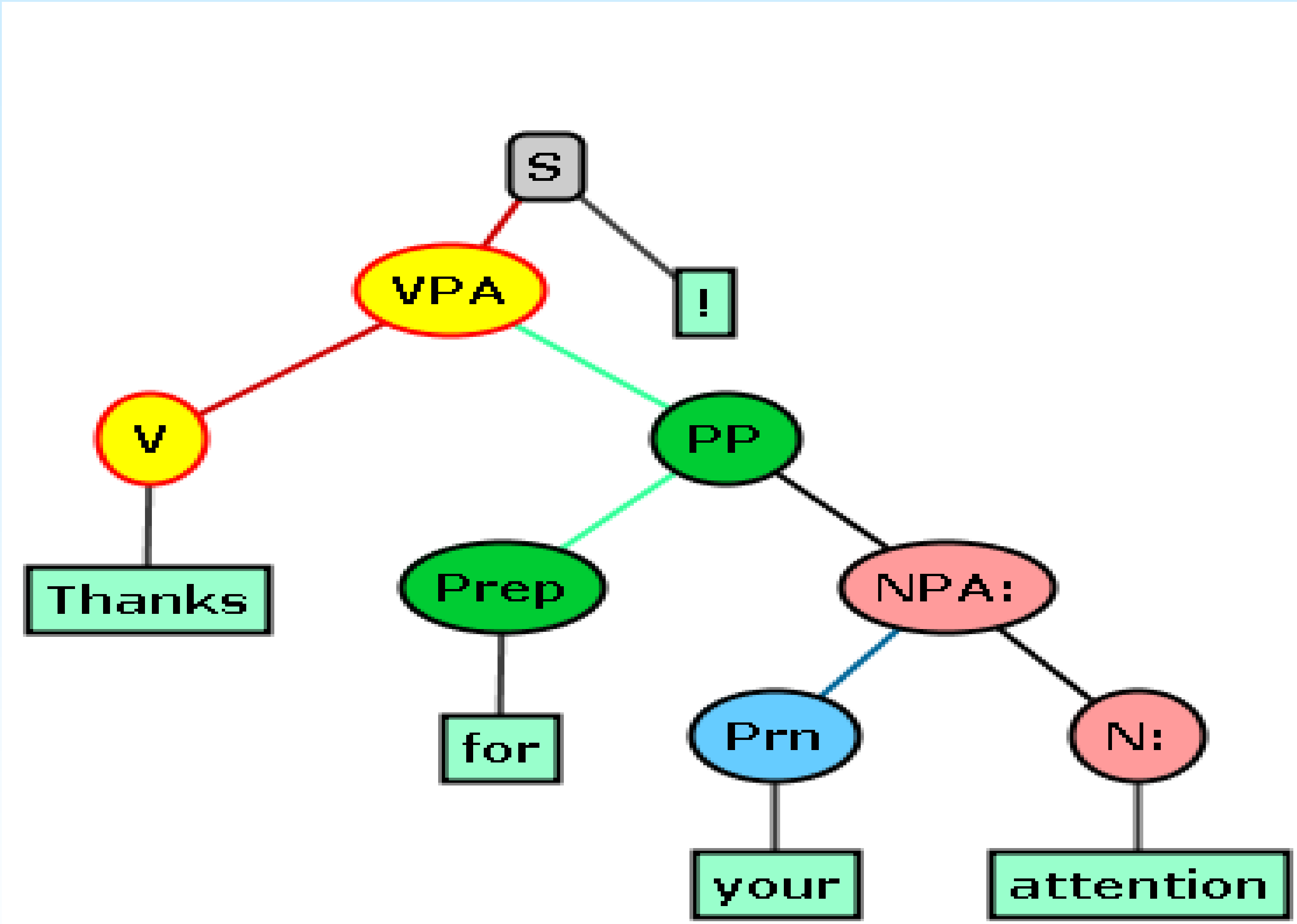
WNG + SC-AA + SC-AN + SC-AV + SC-NN + SC-NV + SC-RA + SC-RN + SC-RR + SC-RV + SC-VN + SC-VV : ***60.13*** **%**

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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VPA
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Thanks
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attention