Attributed Description Logics: Reasoning on Knowledge Graphs

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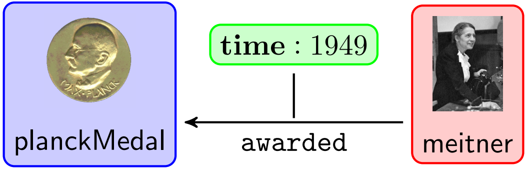
Full paper: `https://iccl.inf.tu-dresden.de/web/Inproceedings3045/en`

Knowledge Graphs

Wikidata: the free and open Knowledge Graph of the Wikimedia Foundation



time : 1949

planckMedal

awarded

meitner

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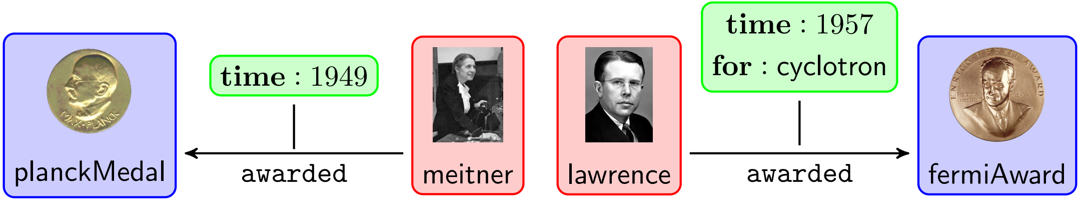

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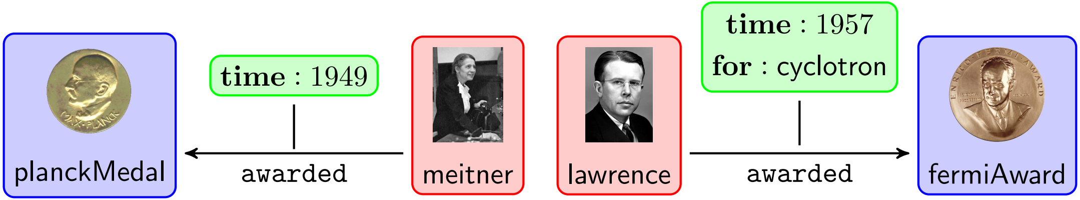

$$\mathtt{awarded}(\mathsf{meitner}, \mathsf{planckMedal})@[\mathbf{time} : 1949]$$

$$\mathtt{awarded}(\mathsf{lawrence}, \mathsf{fermiAward})@[\mathbf{time} : 1957, \mathbf{for} : \mathsf{cyclotron}]$$

Description Logics

Description Logics:

- decidable fragments of First-Order Logic
- variable-free syntax
- theoretical foundation of the Web Ontology Language (OWL)

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But what about the annotations?

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Reasoning:

- Ground all axioms
- Treat all annotated concepts and annotated roles as new names
- Add auxiliary axioms that handle inclusions of annotations

Complexities

Theorem

Combined complexity of satisfiability for attributed Knowledge Bases

non-attributed		*attributed*		
	DL	*ground*	*restricted*	*unrestricted*
P-*complete*	$\mathcal{ELH}_@$	P-*complete*	P-*complete*[1]	Exp-*complete*
Exp-*complete*	$\mathcal{ALCH}_@$	Exp-*complete*	Exp-*complete*	2Exp-*complete*
N2Exp-*complete*	$\mathcal{SROIQ}_@$	N2Exp-*complete*	N2Exp-*complete*	N2Exp-*complete*

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- Grounding is exponential in the size of the Knowledge Base
- Three syntactic restrictions ensure polynomial groundings
- [1]: Except when violating one (specific) condition, where we show PSpace-hardness

Conclusion & Outlook

Conclusion:

- First-class support for annotations in Knowledge Bases
- Reasoning via translation into standard DLs
- $\leadsto$ Existing tools can be used for attributed reasoning

Outlook:

- Further Extensions push DLs even closer to rule languages
- $\leadsto$ Focus on adapting rules for Knowledge Graphs?
- MARPL [Krötzsch, M., Thost IJCAI'17] is "Attributed Datalog"
- $\leadsto$ "Attributed Existential Rules"?