Practical Reasoning with OWL and Rules

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Semantic Web Technology Showcase
ESTC 2007

Reasoning for the Semantic Web

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$\rightsquigarrow$ essential background technology for semantic knowledge representation

Main tasks for backends in semantic systems:

- ontology management
- inferencing
- query answering

The KAON2 Ontology Management Suite

KAON2: OWL reasoner and ontology management API

- Reasoner optimised for large ABoxes
- API for ontology manipulation and serialisation
- Database bindings
- DIG and SPARQL interfaces

Binaries available from `http://kaon2.semanticweb.org`

Reasoning Support in KAON2

- Supported language: OWL DL without *enumerated classes* (nominals) but with *qualified cardinality restrictions*.
- Algorithm not based on tableau method
- Using first-order resolution calculus

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KAON2 computes inferences in two processing steps:

OWL DL ABox

OWL DL TBox (w/o nominals)

OWL DL query

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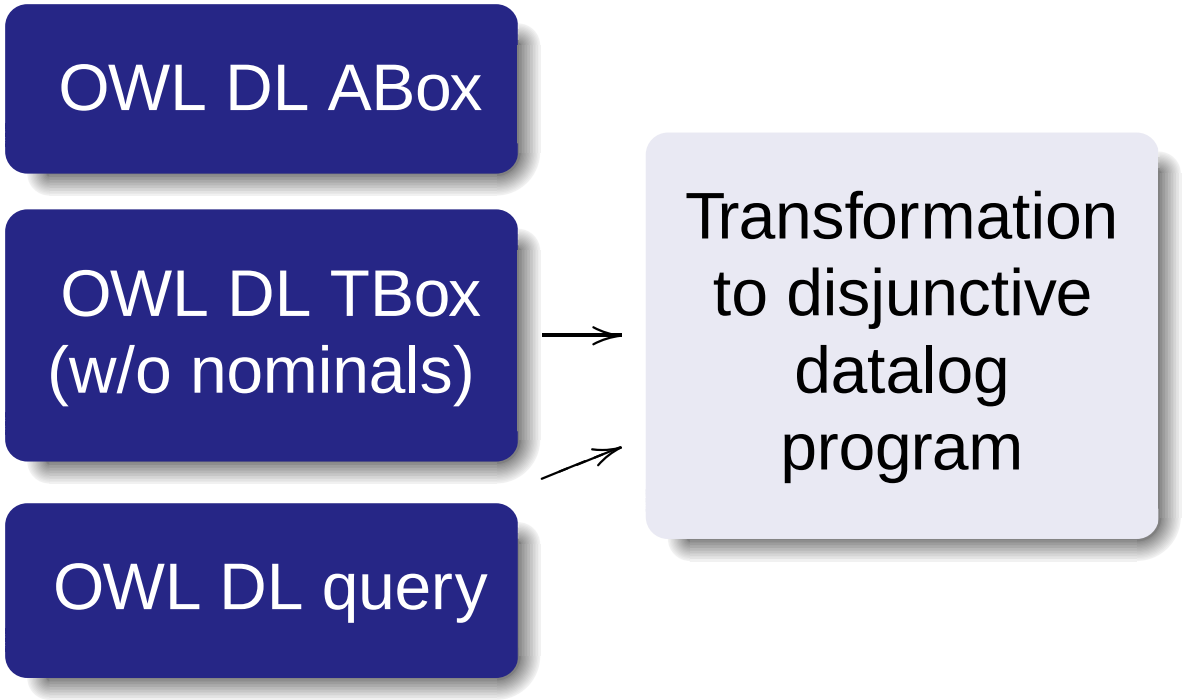

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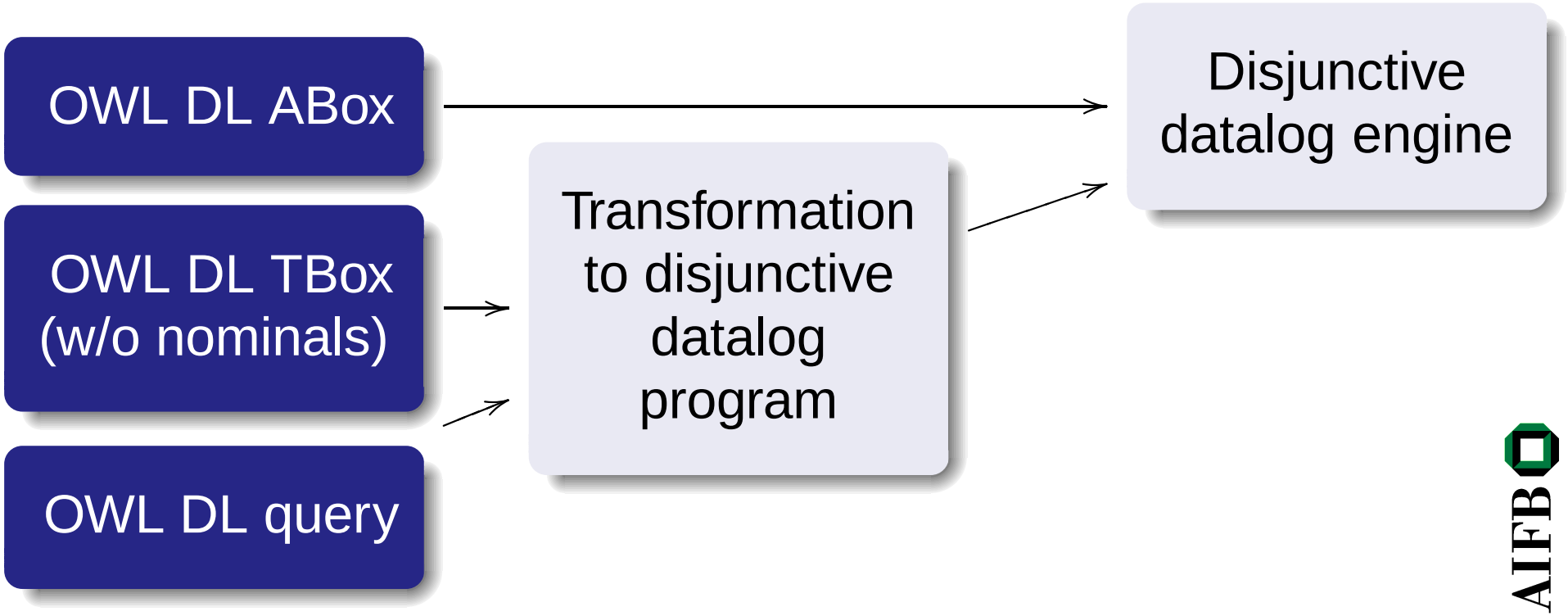

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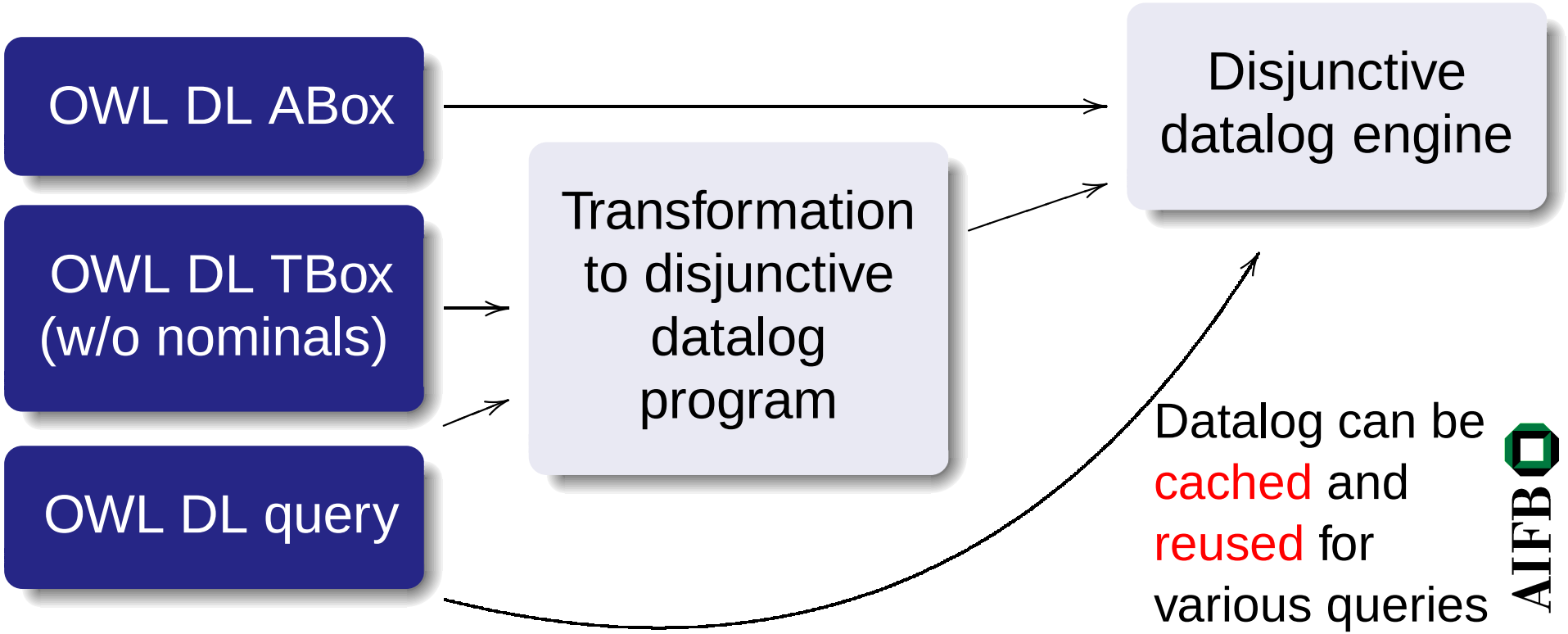

KAON2 Complexity and Performance

Recall: $P \subseteq NP$

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1. Process query and TBox to obtain disjunctive datalog $\rightsquigarrow$ ExpTime
2. Add ABox
3. Use Datalog reasoner for query answering $\rightsquigarrow$ NP (w.r.t. ABox)

Features

- TBox translation not necessary for every query
- Datalog-reasoning exploits well-known optimisation strategies (e.g. *magic sets*)
- Data complexity is NP
- Overall algorithm is worst-case optimal (ExpTime)

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$\rightsquigarrow$ Investigation of tractable fragments of OWL

- OWL Lite is not suitable (ExpTime)
- Proposed languages: DL Lite (LogSpace), $\mathcal{EL}^{++}$ (PTime), Horn-$\mathcal{SHIQ}$ (PTime for instance data)
- KAON2 supports Horn-$\mathcal{SHIQ}$: precompile ontology to Datalog program (no disjunctions)
  $\rightsquigarrow$ suitable for non-trivial ontologies with large ABoxes

Ontologies and Rules

Various proposals for Semantic Web rule lanuages:

- First-Order Logic: SWRL
- Logic Programming: F-Logic, Prolog, WRL, . . .

$\rightsquigarrow$ partially reconciled in various approaches
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Rules in KAON2

- support for decidable fragment of SWRL: DL-safe rules
- intuition: restrict SWRL rules to *known individuals*
- no increase of reasoning complexity

The NeOn Toolkit

Ontology engineering environment – `www.neon-toolkit.org`

- Supports the lifecycle of networked ontologies
  - Modeling
  - Collaboration
  - Integration/modularization of ontologies
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- Modular and extensible platform
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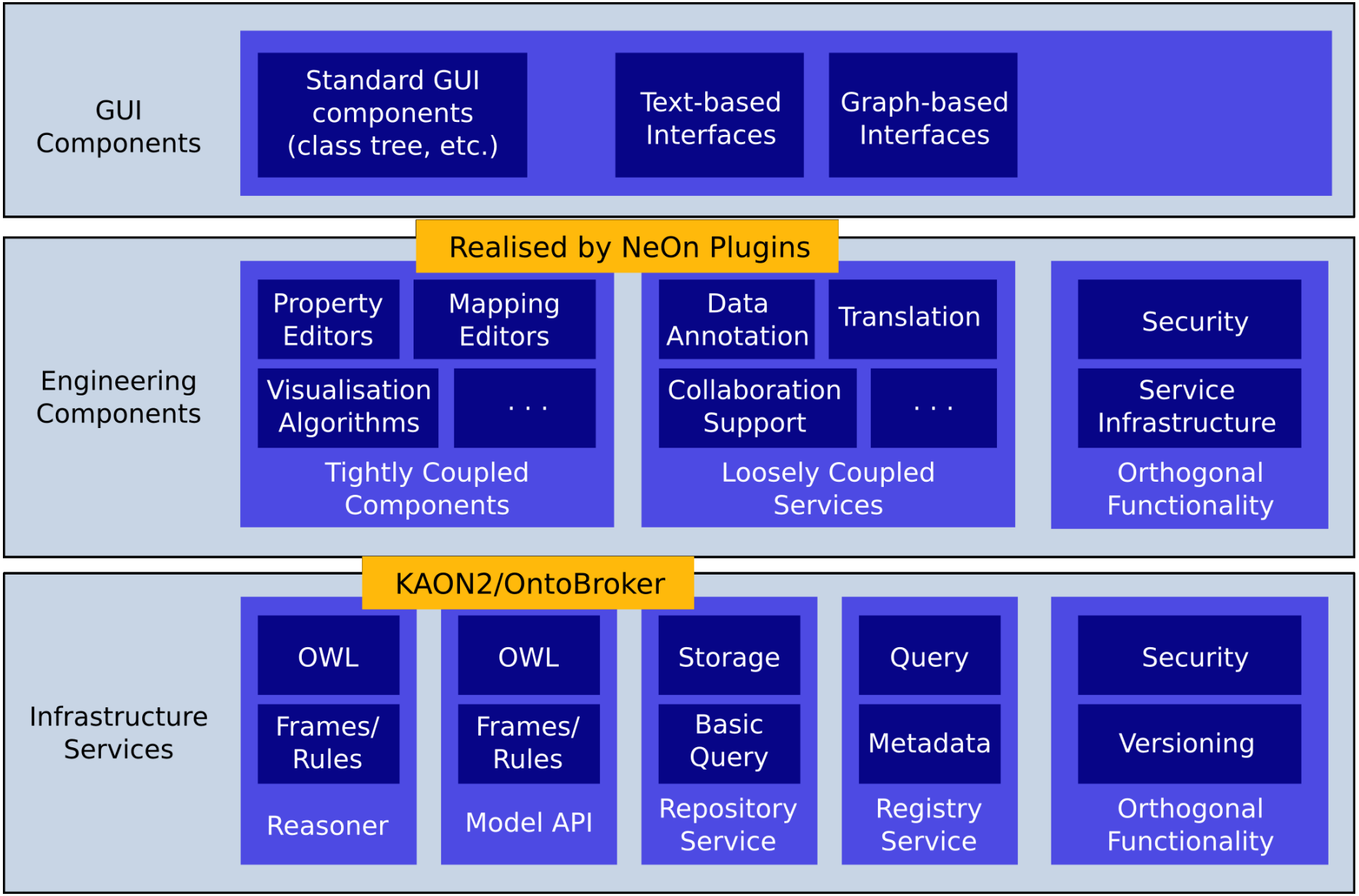
- Dual language approach
  - Frame-like modeling with FLogic rules
  - OWL DL modeling

NeOn Toolkit Architecture



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Conjunctive queries

The knowledge base can be queried for conjunctions of

- terms $A(x)$ and $\neg A(x)$ where A is a concept name, and
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KAON2 support: conjunctive queries for *known* individuals
$\rightsquigarrow$ similar to DL-safe rules

Conjunctive queries for OWL DL and OWL 1.1: current research

Outlook

KAON2

- Ontology management and reasoning for (part of) OWL
- Partial support for *SWRL rules* and *conjunctive queries*
- Free for non-commercial use – commercial support by *ontoprise*

  `http://kaon2.semanticweb.org`

NeOn Toolkit

- Novel ontology engineering environment
- Official lauch: next week at ESWC!

  4th June 2007, 18:20
  Congress Center Innsbruck, Freiburg Hall, 3rd floor
  `http://www.neon-toolkit.org`

Future work

- Tractable OWL variants
- Improved querying for OWL
- OWL 1.1