WP2 - Semantic Parsing and Generation of Documents and Documents Components

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ITEA 3

WP2

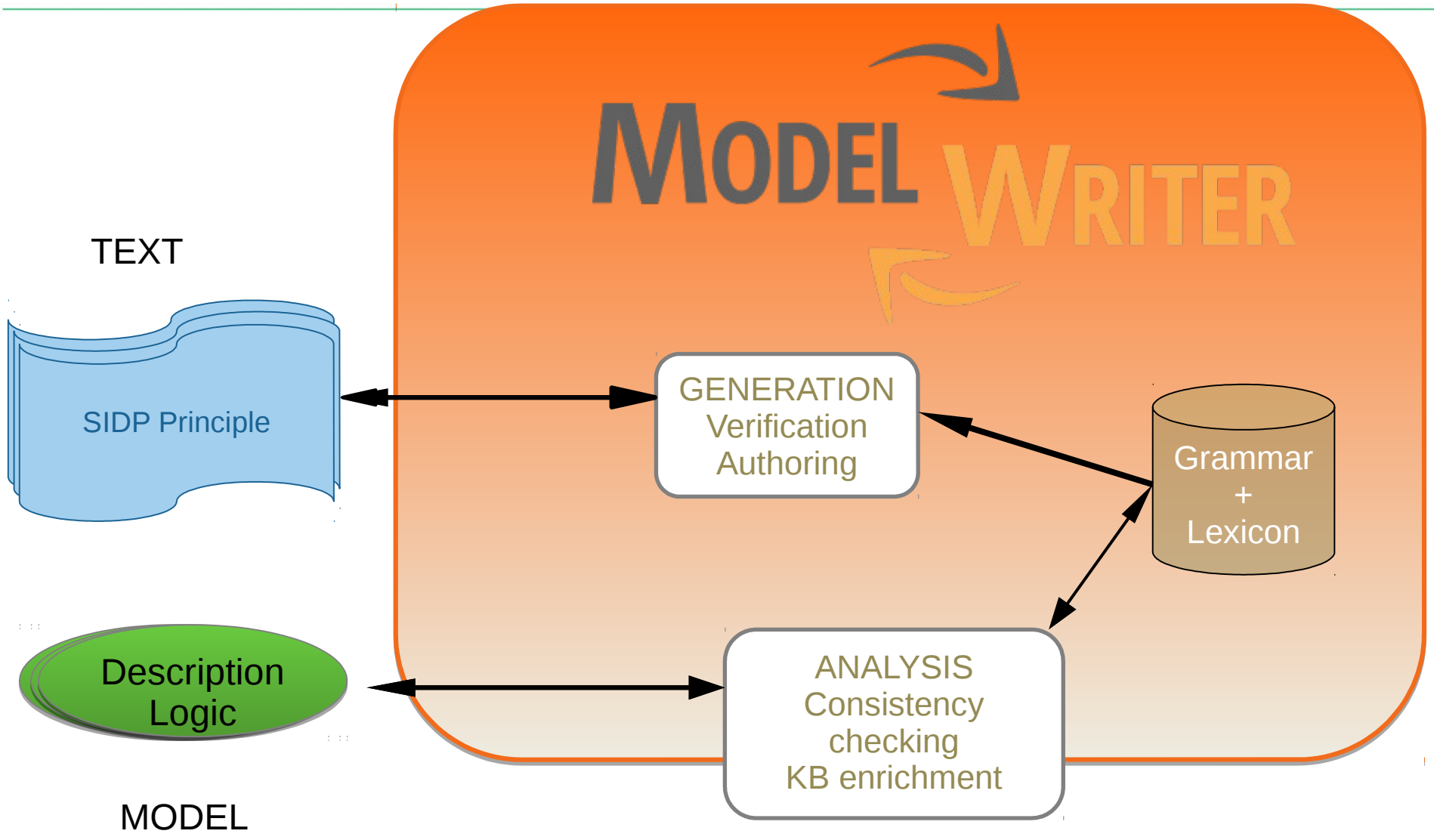
Goal: Provide tools and methods for:

- Converting texts to models and models to text
- Annotating text fragments with model elements

Tasks:

- T2.1 Data Collection
- T2.2 Semantic Parsing
- T2.3 Natural Language Generation
- T2.4 Definition of a common target semantic language
- T2.5 Development of a Semantic Parser and of a Natural Language Generator

Synchronising Text and Model



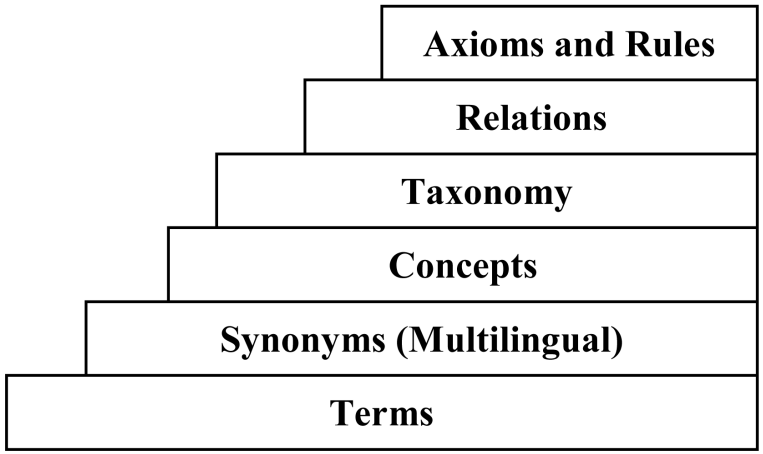
Related Work on Ontology Learning

Ontology Learning from Text

[Mädche and Staab 2000, Volker et al. 2007, Tablan et al. 2006, Zouaq and Nkambou 2008]

Restricted expressivity. Not applied to sentences (complex axioms).

Limited to : definition of new classes, creation of hierarchies between classes, definition of object and data-type properties, creation of instances, and setting of property values for instances



Related Work on Semantic Parsing

Deep parsing

[Currant et al. 2007, McCartney and Manning 2007]

First Order Logic Representations close to initial text. Trained on newspaper text (Penn Tree Bank).

==> *Not easily adaptable to Description Logic and SIDP text.*

Domain Specific Semantic Parsing

[Ge and Mooney 2009,Wong and Mooney 2007]

==> *Require parallel text-data training corpus.*

Open Domain Semantic parsing

[Kwiatkowski et al 2010, Bordes et al. 2012, Kwiatkowski et al 2013, Berant et al., 2013, Bordes et al. 2014, Wang et al. 2015]

==> *Restricted to questions. Require parallel question-answer training corpus.*

Related Work on Text Generation

Symbolic Approaches

[Dimitrios et al. 2007, Androtsopoulos et al. 2013, Power et al. 2010, Bontcheva et al. 2004]

Heavily dependent on hand-written modules.

Machine Learning Approaches

[Wong et al. 2007, Belz 2008, Angeli et al. 2010, Chen et al. 2008, Konstas and Lapata 2012a and 2012b]

Require parallel data-text training corpus.

Pattern-Based

[Duma et al. 2010, Blake et al. 2013, Schilder et al. 2013]

Require large quantity of parallel or comparable text-data training corpus. Limited Semantic Variability (set of RDF triples).

Contributions

Reversible Processing: Text <--> Model

Analysis: SIDP Rule → Description Logic
Generation: Description Logic → SIDP Rule

Verification by generation

Semantic Parsing of Complex Axioms

Pipe shall be identified by labels

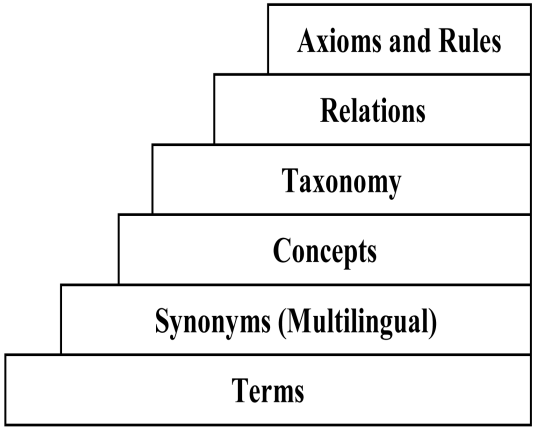
$$Pipe \sqsubseteq \exists identificationArg2^{-}.(Identification \sqcap \exists identificationArg3.Label)$$

Executable Semantic Parsing on DL KBs

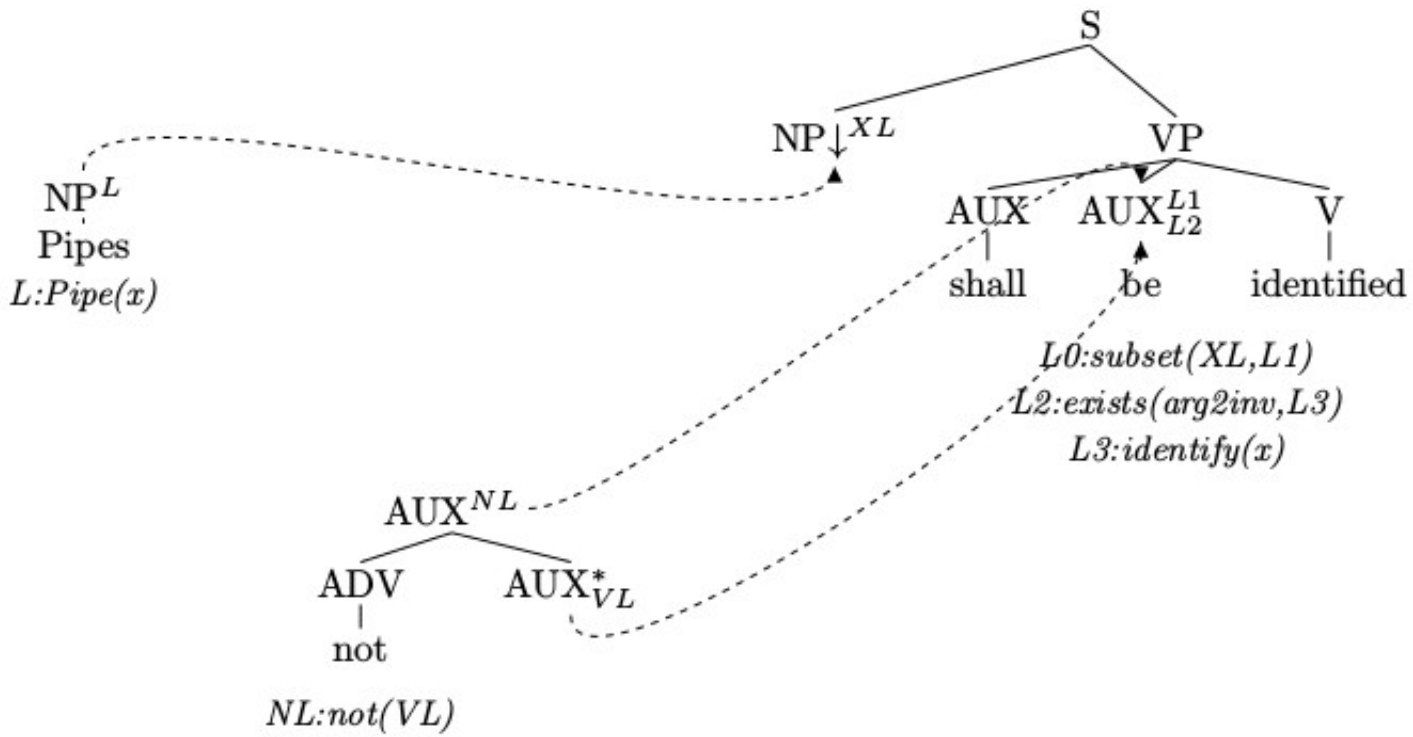
The output of semantic parsing is used to update a Description logic Knowledge Base and check the consistency of SIDPs (system installation design principle)

Genericity

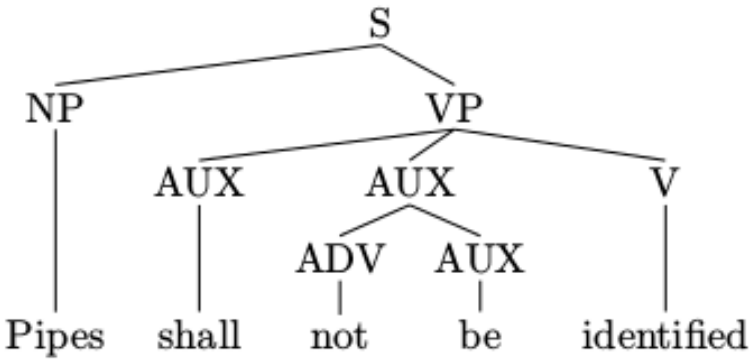
No training corpus required.
Adaptation to a new domain through grammar adaptation, extension or induction



Grammar-Based Parsing and Generation



Grammar-Based Parsing and Generation



PL:Pipe(x) L0:subset(PL,NL) NL:not(VPL)
VPL:exists(identifyA2inv,VL) VL:Identify(x)

$$Pipe \sqsubseteq \exists \neg identifyA2^{-}.(Identify)$$

Semantic Variations

Logical Operators	
Only S shall be used by O	$\neg S \sqsubseteq \neg \exists useA2^{-}.(use \sqcap \exists by.O)$
S should be used by all O	$O \sqsubseteq \exists by^{-}.(Use \sqcap \exists useA2.S)$
S shall not be used by O	$S \sqsubseteq \neg \exists useA2^{-}.(Use \sqcap \exists by.O)$
Word Order	
S shall be used by O only	$S \sqsubseteq \neg \exists useA2^{-}.(Use \sqcap \exists by.\neg O)$
All S shall be used by O	$S \sqsubseteq \exists useA2^{-}.(Use \sqcap \exists by.O)$
Arity	
S shall be used	$S \sqsubseteq \exists useA2^{-}.(use)$
S shall be used by O	$S \sqsubseteq \exists useA2^{-}.(use \sqcap \exists by.O)$
S shall be used by O on PO	$S \sqsubseteq \exists useA2^{-}.(use \sqcap \exists by.O \sqcap \exists on.PO)$
Sentence Structure	
S shall be used by O before entering connections	$(Use \sqcap \exists useA2.S \sqcap \exists by.O) \sqsubseteq \exists before.(Enter \sqcap \exists enterA2.Connections)$
Modifiers	
S shall be used directly by O	$S \sqsubseteq \exists useA2^{-}.(Use \sqcap \exists directly.(\exists by.O))$
S shall be used by O between C and D	$S \sqsubseteq \exists useA2^{-}.(Use \sqcap \exists useA3.(O \sqcap \exists betweenA1^{-}.(Between \sqcap \exists betweenA2.C \sqcap \exists betweenA3.D)))$

Updating the Model and Checking Consistency

The Semantic Representations output by the parser are converted to Description Logic

$l_0 : A(x)$ ⇒ :A

$l_0 : exists(R, l_1)\ \ l_1 : C$ ⇒ ObjectSomeValuesFrom(:R τ(C))

$l_0 : subset(l_1, l_2)\ \ l_1 : C_1\ \ l_2 : C_2$ ⇒ SubClassOf(τ(C_1) τ(C_2))

$l_0 : and(l_1, l_2)\ \ l_1 : C_1\ \ l_2 : C_2$ ⇒ ObjectIntersectionOf(τ(C_1) τ(C_2))

$l_0 : not(l_1)\ \ l_1 : C$ ⇒ not(τ(C))

E.g.,

Pipes should be identified by labels

$l_1 : Pipe(x) l_0 : subset(l_1, l_2)\ l_2 : exists(identifyA2inv, l_3)\ \ l_3 : and(l_4, l_5)$
$l_4 : Identify(z)\ \ l_5 : exists(by, l_6) l_6 : Label(y)$

```
SubClassOf(Pipe ObjectSomeValuesFrom(identifyA2inv
ObjectIntersectionOf(Identify ObjectSomeValuesFrom(by Label))))
```

The formula is added to the AIRBUS KB and Hermit is used to check for consistency

Experimental Setup and Results for Parsing

Grammar: 52 trees

Lexicon: 10781 lexical entries

Parsing algorithm: CKY + Robustness mechanism to skip unknown words

Input: 991 System Installation Design Principles

	Complete Parse	Partial Parse	Failure
Simple SIDP	132	329	24
Complex SIDP	0	496	10
All SIDP	132 (13%)	825 (83%)	34 (3%)

Updating the Model using Parsing Results (Complete Parses)

CONCEPTS	Nb. of new Concepts	184
	Nb. of Existing Concepts	30
PROPERTIES	Nb. of New Properties	62
SIDP AXIOMS	Nb. of SIDP Axioms (from Parsing)	132
	Nb of Invalid Axioms	0
	Nb. of Redundant Axioms	2
ALL	Total Nb. Of Added Elements	376
	Nb. of Axioms in Initial KB	12469
	Nb. of Axioms in Enriched KB	13029

Updating the Model using Parsing Results (All Parses)

CONCEPTS	Nb. of new Concepts	667
	Nb. of Existing Concepts	79
PROPERTIES	Nb. of New Properties	98
SIDP AXIOMS	Nb. of SIDP Axioms (from Parsing)	957
	Nb of Invalid Axioms	61
	Nb. of Redundant Axioms	125
ALL	Nb. of Inconsistent Axioms	20
	Nb. of added SIDP Axioms	749
	Total Nb. Of Added Elements	1514
	Nb. of Axioms in Initial KB	12469
	Nb. of Axioms in Enriched KB	14650

Generation Results

Grammar: 52 trees

Lexicon: 10781 lexical entries

Generation algorithm: Tabular + Polarity Filtering

Input: 957 Description Logic Axioms derived from the AIRBUS System Installation Design Principles

	Success	Failure
Simple SIDP	448	13
Complex SIDP	470	26
All SIDP	918 (96%)	39 (4%)

Verifying Parsing Results Using Generation

BLEU	< 0.33	> 0.32 and < 0.67	> 0.66
Complete Parses (S)	1	0	131 (14%)
Complete Parses (C)			
Partial (Simple)	143	117	69
Partial (Complex)	396	91	9
All Parses	540 (56%)	208 (22%)	209 (22%)

Regenerating from the DL formula derived through parsing from an SIDP:

- Produces a sentence identical to the input SIDP for complete parses
- Produces a sentence highly similar to the input SIDP in 44% of of the cases for partial parses

Perspectives and Future Work

- Improve lexicon construction using chunking
- Improve coverage on complex sentences including conditions
- Querying the KB (support for AIRBUS engineers)
- Improve robustness and genericity (experiment with deep learning approaches using data expansion techniques and sequence to sequence models)