

# ARVis: Visualizing Relations between Answer Sets

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## Motivation and Related Work

Improve answer set programming versatility:

- Tools for user support needed
- In particular tools with GUI

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Several existing tools that support visualization in context of ASP:

- ASPViz [Cliffe et al., 2008]
- IDPDraw [Wittocx, 2009]
- Kara (part of SeaLion) [Kloimüllner et al., 2011]
- ASPIDE [Febbraro et al., 2011]
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However, no system for visualization of *relations* between answer sets

# Motivation and Related Work

Visualization of relations can be used for

- Expressing preference criterion
- Representation of results that build upon graph structure<sup>1</sup>
- Debugging

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We propose tool ARVis - “Answer Set Relationship Visualizer”



Key features:

- Problem and relations each expressed in an ASP encoding
- Results visualized as an interactive graph

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## Case Study - Abduction

Goal: Find explanations for observed manifestations

### Abduction

Problem (propositional case) consisting of

- background theory  $T$  of formulae over variables  $V$ ,
- manifestations  $M$ ,
- a set of hypotheses  $H \subseteq V$ .

Explanations  $E$  satisfying  $E \subseteq H$  where

- $T \cup E$  is consistent
- and  $T \cup E \models M$  holds.

## Case Study - Abduction

Goals to be achieved with ARVis:

- 1 Provide possible explanations  $E$  for observed behavior
- 2 Relate all explanations  $E'$ ,  $E''$  wrt. to their “quality”

“Quality” can be expressed w.r.t. some criteria [Eiter and Gottlob, 1995]

- Subsets, i.e.  $E' \subset E''$
- Cardinality, i.e.  $|E'| < |E''|$
- Weights of hypotheses
- Priorities of individual hypotheses



## Case Study - Abduction

### Example

We see that the kids are playing outside ( $M$ ):

$$M = \{\text{play outside}\}$$

$$T = \{\text{homework finished} \rightarrow \text{want to relax,} \\ \text{got new toy} \rightarrow \text{want to play,} \\ \text{not raining} \wedge \text{want to play} \rightarrow \text{play outside,} \\ \text{sunny} \wedge \text{want to relax} \rightarrow \text{play outside}\}$$

$$H = \{\text{sunny, got new toy, not raining, homework finished}\}$$

$$V = \{\text{sunny, homework finished, got new toy,} \\ \text{want to play, not raining,} \\ \text{want to relax, play outside}\}$$

## Case Study - Abduction

- 1 ASP Program 1 derives all possible explanations  $E$ .
- 2 ASP Program 2 relates the explanations w.r.t. different preferences.

### Example

Explanations provided by Program 1:

$$E_1 : \quad \{\text{not raining, got new toy, sunny}\}$$

$$E_2 : \quad \{\text{not raining, got new toy}\}$$

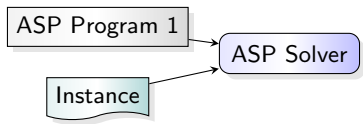
$$\vdots$$

$$E_7 : \quad \{\text{sunny, homework finished}\}$$

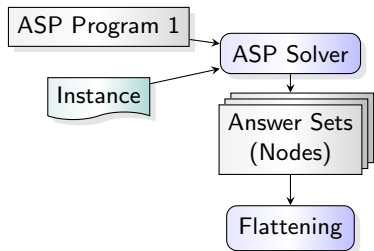
Relations provided by Program 2:

Subset:  $\{E_2 \subset E_1, E_7 \not\subset E_1, \dots\}$   
 Cardinality:  $\{|E_2| < |E_1|, |E_7| < |E_1|, \dots\}$

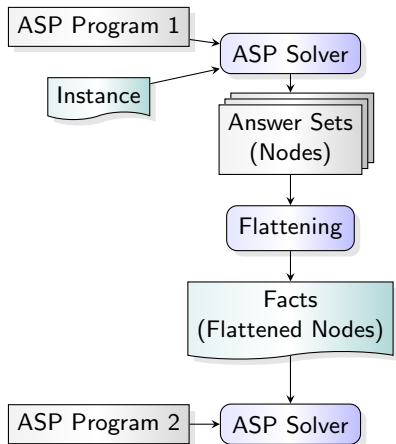
## ARVis - Conceptual Design



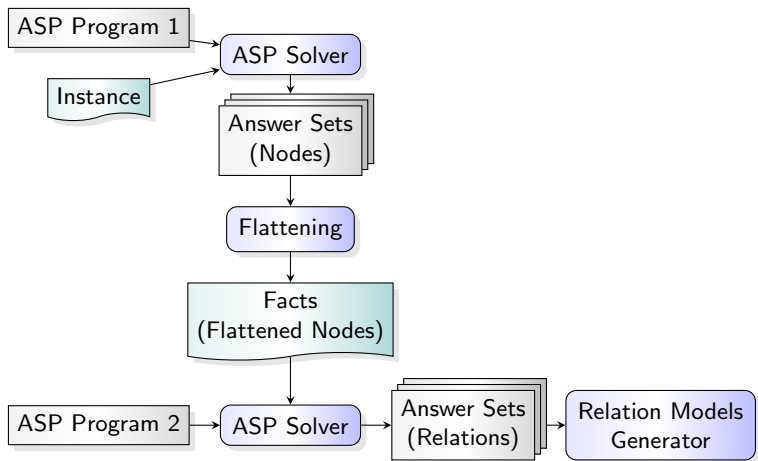
# ARVis - Conceptual Design



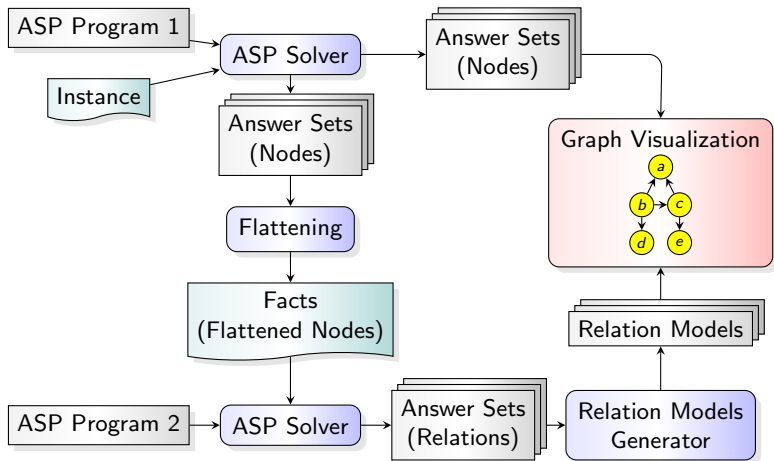
# ARVis - Conceptual Design



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# ARVis - Conceptual Design



ARVis Answer Set Relationship Visualizer

ARVis ASP Program 1 (Nodes) Flattening ASP Program 2 (Relations) Edge Selection **Visualization**

Graph model:

- Model 1
- Model 2
- Model 3
- Model 4
- Model 5
- Model 6
- Model 7
- Model 8**
- Model 9
- Model 10

Graph Visualization:

```

graph TD
    2((2)) --> 1((1))
    2((2)) --> 4((4))
    1((1)) --> 3((3))
    4((4)) --> 3((3))
    5((5)) --> 3((3))
    6((6)) --> 3((3))
    5((5)) --> 6((6))
    7((7)) --> 5((5))
  
```

Layout graph by:

Filter predicates:

- hypothesis
- manifestation
- solution**
- variable

Answer sets (for selected nodes):

Answer: 1  
 solution("it's not raining"). solution("kids got a new toy"). solution("sunny day").

Answer: 2  
 solution("it's not raining"). solution("kids got a new toy").

Answer: 7  
 solution("kids finished their homework"). solution("sunny day").



## ARVis – System Facts and Conclusion

### System facts:

- Platform-independent – Implemented in Java, using Jung library
- Broad solver support – Support for Potassco family and DLV
- Domain-independent – Problems solely specified in ASP
- Performant – Handles 100s of nodes with 1000s of relations




### Application areas:

- Any problem where preferences between solutions are relevant
- Problem domains with an underlying graph structure







<http://www.dbai.tuwien.ac.at/proj/arvis/>

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