Exam

Answer Set Solving in Practice

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University of Potsdam — Winter Semester 2021/2022

Date: 18.2.2022

You have 120 minutes to do the exam, plus 15 additional minutes to upload the generated PDF file in Moodle.
To pass the exam you must obtain at least $\boxed{31}$ out of 91 possible points.

All **non electronic** support material can be used.

Name: **Matriculation Number:**

Points:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	**Total:**

Exercise 1 (5 Points)

Find the stable models of the following logic program P:

$$P = \left\{ \begin{array}{l} a \leftarrow c, \neg b \\ b \leftarrow \neg a, \neg d \\ b \leftarrow \neg a, \neg c \\ b \leftarrow c, d \\ c \leftarrow \neg b \\ d \leftarrow b, \neg c \end{array} \right\}$$

Exercise 2 (5 Points)

Find the stable models of the following logic program with variables P:

$$P = \left\{ \begin{array}{r} p(a,b,c) \leftarrow \\ q(X) \leftarrow p(X,Y,Z), \neg q(Z) \\ q(Y) \leftarrow p(X,Y,Z), \neg q(X) \\ q(c) \leftarrow q(X), \neg q(a) \end{array} \right\}$$

Exercise 3 (8 Points)

Consider the following logic program P:

$$P = \left\{ \begin{array}{l} \{a\} \leftarrow \\ \quad b \leftarrow \neg a \\ \quad c \leftarrow 1\{a, b\}1 \\ \quad\quad \leftarrow \neg c \end{array} \right\}$$

3-a) Compile P into a normal logic program P' using the translations from the lecture slides. In particular, use the $x(i, j)$ construction to translate the cardinality rule of the program.

3-b) Determine the stable models of P and the corresponding stable models of P'.

Exercise 4 (5 + 10 = 15 Points)

For the following logic program P and set of facts I:

- Find the dependency graph G_P, the positive dependency graph G_P^+, and one topological order L_P. Moreover, given L_P, determine the set of atoms R_r for every rule $r \in P$.
- Find the ground instantiation of P and I. Start by initializing the sets of true atoms F and possible atoms D to I. Then, ground successively the components of L_P applying on-the-fly simplifications. For this, use the sets F, D and R_r, and update F and D after grounding each component.

$$P = \left\{ \begin{array}{rl} choose(C) & \leftarrow course(C), \neg nchoose(C) \\ nchoose(C) & \leftarrow course(C), \neg choose(C) \\ many(D) & \leftarrow choose(C1), day(C1, D), choose(C2), day(C2, D), C1 \neq C2 \\ & \leftarrow next(D1, D2), many(D1), many(D2) \end{array} \right\}$$

$$I = \left\{ \begin{array}{rlrl} course(1..3) & \leftarrow & & \\ day(1, mon) & \leftarrow & day(1, tue) & \leftarrow \\ day(2, tue) & \leftarrow & day(2, wed) & \leftarrow \\ day(3, wed) & \leftarrow & & \\ next(mon, tue) & \leftarrow & next(tue, wed) & \leftarrow \\ choose(1..2) & \leftarrow & & \end{array} \right\}$$

Exercise 5 (15 Points)

Determine the stable models of the following normal logic program P using the simplistic solving algorithm of the lecture, and specify the sets L and U that are generated at each iteration inside the $expand_P$ procedure.

$$P = \left\{ \begin{array}{l} a \leftarrow \neg f \\ b \leftarrow \neg g \\ c \leftarrow \neg b, \neg d \\ c \leftarrow \neg c, \neg e \\ d \leftarrow b, \neg e \\ e \leftarrow f \\ f \leftarrow e \\ g \leftarrow a, \neg b \end{array} \right\}$$

Exercise 6 (5 + 3 = 8 Points)

Let P be the following normal logic program:

$$P = \left\{ \begin{array}{lll} a \leftarrow g, \neg b & b \leftarrow a, d & b \leftarrow c, \neg e \\ c \leftarrow d, \neg g & e \leftarrow \neg a, \neg b & e \leftarrow \neg c \\ d \leftarrow \neg f & g \leftarrow e, \neg d & g \leftarrow a, \neg f \end{array} \right\}$$

6-a) Find the Fitting Semantics of P.

6-b) Find the well-founded Semantics of P.

Exercise 7 (5 Points)

Find all the unfounded sets of the following normal program P with respect to the partial interpretation $\langle\{c\}, \{d\}\rangle$.

$$P = \left\{ \begin{array}{l} a \leftarrow d \\ a \leftarrow \neg b, \neg c \\ b \leftarrow c, d \\ b \leftarrow \neg a \\ c \leftarrow b, \neg a \\ d \leftarrow a \end{array} \right\}$$

Exercise 8 (8 + 4 + 3 = 15 Points)

Let P be the following normal logic program:

$$P = \left\{ \begin{array}{lll} a \leftarrow \neg c & a \leftarrow d, \neg e & b \leftarrow a, \neg c \\ c \leftarrow f, \neg b & d \leftarrow a & d \leftarrow e, \neg f \\ e \leftarrow f, \neg c & f \leftarrow b, e & f \leftarrow \neg b \end{array} \right\}$$

8-a) Find all models of $CF(P)$.

8-b) Write the loop formulas in $LF(P)$.

8-c) Find all the stable models of P.

Exercise 9 (10 + 5 = 15 Points)

Let P be the following logic program:

$$P = \left\{ \begin{array}{lll} a \leftarrow c, \neg e & a \leftarrow \neg f, \neg b & b \leftarrow \neg a \\ b \leftarrow d, \neg e & c \leftarrow d, \neg f & c \leftarrow e, \neg b \\ d \leftarrow b, \neg f & e \leftarrow b, \neg d & f \leftarrow e, \neg d \end{array} \right\}$$

The following table represents an assignment A with the decision level dl of every literal. Decision literals are placed under σ_d, and literals under $\overline{\sigma}$ are implied by a nogood $\delta \in \Delta_P \cup \Lambda_P$:

dl	σ_d	$\overline{\sigma}$	δ
1	$\mathbf{T}c$		
2	$\mathbf{F}\{e, \neg d\}$		
		$\mathbf{F}f$	$\{\mathbf{T}f, \mathbf{F}\{e, \neg d\}\}$
3	$\mathbf{T}d$		

9-a) Find a conflict nogood ε with NogoodPropagation(P,$\emptyset$,A).

9-b) Derive a conflict nogood δ with the FirstUIP method starting from ε.