March 15th Exam

- You have 100 minutes to do the exam.

  To pass the exam you must get at least 28 out of 88 possible points.

  All non-electronic (and non-alive) support materials can be used.

Exercise 1Quiz

Positive Logic Program (8p)

Determine the **models** of the following logic program P and decide which models are **stable** :

$$P = \begin{cases} a \leftarrow \\ a \leftarrow e \\ c \leftarrow a \\ d \leftarrow a, c \\ e \leftarrow e \\ f \leftarrow e \\ f \leftarrow d, g \\ g \leftarrow a, e, f \\ g \leftarrow a, f \end{cases}$$

Exercise 2Quiz

Normal Logic Program (8p)

Determine the **stables models** of the following logic program P :

$$P = \begin{cases} colored \leftarrow \sim white \\ white \leftarrow \sim colored \\ green \leftarrow colored, \sim red, \sim blue \\ red \leftarrow colored, \sim blue, \sim green \\ blue \leftarrow colored, \sim red, \sim green \end{cases}$$

Exercise 3Quiz

Cardinality constraints (3+4+3 = 10p)

Consider the following logic program P:

$$P = \begin{cases} \{a, b, c\}2 \leftarrow \\ d \leftarrow 2\{a, b, c\} \\ \leftarrow \sim d \end{cases}$$

1) Compile the cardinality constraint of the first line of P into cardinality rules of the following form, along with normal and choice rules as well as integrity constraints. *(3p)*

$a_0 \leftarrow l\{a_1, \ldots, \sim a_n\}.$

2) Consider the logic program P' resulting from taking P and replacing the first rule by the previous subtask. Compile P' into a program P_2 with normal and choice rules as well as integrity constraints only, using the $x(i, j)$ construction from the lecture slides. *(4p)*

3) Determine the stable models of P and the corresponding stable models of P_2 *(3p)*

- Exercise 4Quiz

Logic Program with Variables (8p)

Determine the **stables models** of the following logic program P:

$$P = \begin{cases} a(0, 2) \leftarrow \\ a(1, 1) \leftarrow \\ a(1, 3) \leftarrow \\ a(2, 4) \leftarrow \\ b(X) \leftarrow a(X, Y) \\ c(X, Y) \leftarrow a(X, Y), \sim d(X, Y) \\ d(X, Y) \leftarrow a(X, Y), \sim c(X, Y), \sim b(Y) \end{cases}$$

- Exercise 5Quiz

Modeling (6+6 = 12p)

In an undirected graph, a **Clique** is a set of vertices such as *every vertex of the set is adjacent to every other vertex of the set*.

For example, the graph $(\{1; 2; 3; 4\}, \{(1,2), (2,3), (3,1), (1,4)\})$ has one clique of size 3 ($\{1,2,3\}$) on top of other smaller cliques.

We represent this graph as follow :

$vertex(1).\, vertex(2).\, vertex(3).\, vertex(4).$

$edge(1,2).\, edge(2,3).\, edge(3,1).\, edge(1,4).$

Specify a uniform problem encoding such that atoms over the predicate $select/1$ within stable models correspond to a clique for arbitrary instances. You should have one stable model per clique.

For example here you should have at least the stable model with $select(1), select(2), select(3)$.

(You can considere the empty set as a clique if you want.)

- Exercise 6Quiz

Simple solving (8p)

Determine the stable models of the following normal logic programs 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.

$$P = \begin{cases} a \leftarrow b, c \\ b \leftarrow a, \sim c \\ c \leftarrow \sim b \\ d \leftarrow f, \sim a \\ d \leftarrow e, \sim f \\ e \leftarrow c, \sim d \\ f \leftarrow \sim e \end{cases}$$

Exercise 7Quiz

Supported Models and Loop Formulas (5+3+2 = 10p)

Consider the following logic program P:

$$P = \begin{cases} a \leftarrow f \\ b \leftarrow a, \sim e \\ b \leftarrow f, \sim e \\ c \leftarrow a, d \\ c \leftarrow d, \sim e \\ d \leftarrow e, \sim b \\ e \leftarrow \sim b \\ f \leftarrow \sim d \\ f \leftarrow c, \sim b \end{cases}$$

1) Determine the **supported models** of P. *(5p)*

2) Write the **loop formulas** in $LF(P)$. *(3p)*

3) Determine the **stable models** of P. *(2p)*

Exercise 8Quiz

Unfounded set (3+3 = 6p).

Given the following logic program P:

$$P = \begin{cases} a \leftarrow b, c \\ b \leftarrow a, c \\ c \leftarrow a, b \\ d \leftarrow \sim e \\ e \leftarrow \sim b \end{cases}$$

1) Determine the unfounded sets w.r.t. the interpretation $< \emptyset, \emptyset >$. *(3p)*

2) Determine the unfounded sets w.r.t. the interpretation $< \{a\}, \{b\} >$. *(3p)*

Exercise 9Quiz

Fitting's and Well Founded Operators (4+4 = 8p)

Given the following logic program P:

$$P = \begin{cases} a \leftarrow \\ c \leftarrow b \\ c \leftarrow a \\ d \leftarrow \sim a \\ e \leftarrow a, \sim d \\ f \leftarrow g, \sim e \\ g \leftarrow f, \sim e \end{cases}$$

1) Determine the least fixpoint of Fitting's operator. *(4p)*

2) Determine the least fixpoint of the Well-founded operator. *(4p)*

Exercise 10Quiz

Nogood Propagation (6+4 = 10p)

Given the following logic program P:

$$P = \begin{cases} a \leftarrow e, \sim b \\ a \leftarrow \sim c \\ b \leftarrow \sim c, \sim d \\ c \leftarrow d, e \\ c \leftarrow \sim b, \sim d \\ d \leftarrow \\ e \leftarrow d, \sim b \\ e \leftarrow f \\ f \leftarrow \sim c, \sim d \end{cases}$$

1) Apply **nogood propagation** on $\Delta P \cup \Lambda P$ to the assignment given below until some nogood becomes violated. *(6p)*

dl	σ_d	$\overline{\sigma}$ δ
1	**T**a	
2	**F**{d,e}	
3	**F**b ...	...

2) Resolve the conflict using the **First-UIP scheme** and determine the **decision level** at which an **assertion** is obtained after backjumping. *(4p)*

dl | σd σ | δ

1 | Ta |

2 | F{d,e} |

3 | Fb |