Aalto University, Department of Information and Computer Science

T-79.5105 Answer Set Programming

Examination, May 16, 2011

TJ

Assignment 1 (Max. 10p)

(a) Define/explain the following terms/mathematical concepts in detail (2p each):

a *minimal model*, an *antichain*, and a *full set*.

(b) Which of the following claim are true and which false? Justify your answers precisely! (2p each)

Claim 1: For any normal programs P and Q: if $P \equiv_s \emptyset$, then $P \cup Q \equiv Q$.
Claim 2: For any *positive* normal programs P and Q: if $\mathrm{CM}(P) = \mathrm{CM}(Q)$, then $P \equiv Q$.

Assignment 2 (Max. 10p) Consider a normal logic program P consisting of the following rules.

$$a \leftarrow a, b. \quad a \leftarrow {\sim}b. \quad b \leftarrow {\sim}c, d. \quad c \leftarrow {\sim}b, {\sim}e. \quad d \leftarrow {\sim}f. \quad e \leftarrow {\sim}d.$$

Determine the following (sets of) models for P:

(a) $\mathrm{WFM}(P)$, (3p)

(b) $\mathrm{SM}(P)$ using the branch&bound algorithm and approximations, and (4p)

(c) $\mathrm{SuppM}(P)$ using the completion $\mathrm{Comp}(P)$. (3p)

Assignment 3 (Max. 8p) Consider the following primitives for answer set programming:

(a) Make b true if and only if all atoms except one amongst $a_1, \ldots, a_n$ are true.

(b) Make an even number of atoms amongst $a_1, \ldots, a_n$ true.

How would you express these primitives using

- rule types available in the `smodels` system and
- basic/normal rules only?

Assignments 4–5 are given on the reverse side of this sheet!!!

The name of the course, the course code, the date, your name, your student number, and your signature must appear on every sheet of your answers.

Assignment 4 (Max. 12p) Consider the problem of deciding whether two graphs $G_1 = \langle V_1, E_1 \rangle$ and $G_2 = \langle V_2, E_2 \rangle$ given as input are *isomorphic*, i.e., there is a bijection $f : V_1 \to V_2$ such that for all nodes $u, v \in V_1$,

$$\langle u, v \rangle \in E_1 \iff \langle f(u), f(v) \rangle \in E_2.$$

Suppose that the respective sets of edges E_1 and E_2 are represented using relations $\mathrm{Edge}_1(\cdot,\cdot)$ and $\mathrm{Edge}_2(\cdot,\cdot)$.

Write a **normal** logic program $P(G_1, G_2)$ which uses variables and input predicates $\mathrm{Edge}_1(\cdot,\cdot)$ and $\mathrm{Edge}_2(\cdot,\cdot)$ representing the graphs G_1 and G_2 such that $\mathrm{SM}(P(G_1, G_2)) \neq \emptyset \iff G_1$ and G_2 are isomorphic.

Given this and the complexity results concerning normal logic programs, what can be stated about the computational time complexity of deciding graph isomorphism?

Assignment 5 (Max. 10p) Consider the following normal program P:

$$\begin{array}{llll} a \leftarrow d. & a \leftarrow \sim e. & b \leftarrow e, \sim a. & \\ c \leftarrow b. & d \leftarrow a. & e \leftarrow c, \sim a. & e \leftarrow \sim d. \end{array}$$

(a) Form the *positive* dependency graph $\mathrm{DG}^+(P)$ of P and determine strongly connected components. (2p)

(b) Split the program in two *non-trivial* modules $\mathbb{P}_1$ and $\mathbb{P}_2$ such that $\mathbb{P}_1 \sqcup \mathbb{P}_2$ is justifiably defined. Provide interface specifications for the modules $\mathbb{P}_1$ and $\mathbb{P}_2$, and calculate the composition $\mathbb{P}_1 \oplus \mathbb{P}_2$ (4p).

(c) Apply the *module theorem* in order to calculate $\mathrm{SM}(\mathbb{P}_1 \sqcup \mathbb{P}_2)$ using $\mathrm{SM}(\mathbb{P}_1)$ and $\mathrm{SM}(\mathbb{P}_2)$. (4p)
