

Assignment 1 (Max. 10p)

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

the *least model*, a *planning problem*, and *brave reasoning*.

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

Claim 1: For any normal programs P , Q , and R : if $P \equiv_s Q$, then $P \cup R \equiv_s Q \cup R$.

Claim 2: For any normal programs P and Q : if $P \equiv Q$, then $\text{SuppM}(P) = \text{SuppM}(Q)$.

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

$a \leftarrow \sim d, \sim c.$ $b \leftarrow \sim c.$ $c \leftarrow \sim b.$ $d \leftarrow a, c.$ $d \leftarrow b, \sim e.$ $e \leftarrow \sim a.$ $e \leftarrow d, \sim b.$

Determine the following (sets of) models for P :

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

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

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

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

(a) Make b true if and only if exactly two atoms among a_1, \dots, a_n are true.

(b) Make an even number of atoms amongst a_1, \dots, 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.

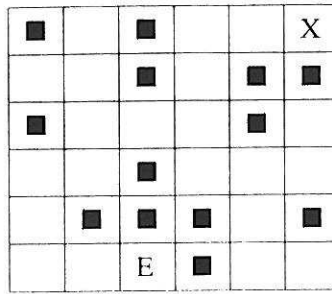


Figure 1: An Example of a valid maze of size 6

Assignment 4 (Max. 12p) Consider the problem of designing an $n \times n$ maze based on an $n \times n$ grid such as the one illustrated in Figure 1 when $n = 6$. In general, the requirements for a *valid* maze are:

1. Each cell in the grid can be either empty or contain a wall, denoted by "■" in the figure.
2. There are two special *empty* cells which are the entrance and the exit of the maze, respectively denoted by "E" and "X" in the figure.
3. The entrance and the exit of the maze must be along the *borders* of the grid, i.e., they are not supposed to be inner cells in the grid.
4. Each empty cell C must be *reachable* from the entrance E via empty cells, i.e., there is a sequence of empty cells C_1, \dots, C_n where $C_1 = E, C_n = C$, and C_i is adjacent to C_{i-1} for every $1 < i \leq n$.
5. The exit must be similarly reachable from every empty cell via empty cells.
6. There should be at least k cells containing a wall.

Formalize the requirements for a valid maze by writing a logic program in the syntax of `lparse`. The parameters n and k should be constants in your program—to be specified when the grounder is called. Moreover, use output predicates `Wall(·, ·)`, `Enter(·, ·)`, and `Exit(·, ·)` to represent valid solutions.

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 $DG^+(P)$ 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 $SM(\mathbb{P}_1 \sqcup \mathbb{P}_2)$ using $SM(\mathbb{P}_1)$ and $SM(\mathbb{P}_2)$. (4p)

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