

The **deadline** for this **home assignment**<sup>1</sup> is **December 5, 2013**.

Please upload your solution file(s) to our home assignments server at the following URL: <http://puzzle.ics.hut.fi/T-79.5105/>

A *pentomino* is a figure that is composed of five squares which are connected along their edges. In famous **pentomino puzzles** (cf. <http://en.wikipedia.org/wiki/Pentomino> for details), the idea is to *tile* a rectangular area of fixed size using the 12 different pentominoes that exist (up to excluding reflections and rotations). Since the area to be covered with pentominoes consists of  $12 \times 5 = 60$  squares, the puzzle has natural variants based on the possible dimensions of the rectangle:  $3 \times 20$ ,  $4 \times 15$ ,  $5 \times 12$ , and  $6 \times 10$ . Formalize the solutions of a parameterized ( $k = 3, 4, 5, 6$ ) pentomino puzzle by writing down a logic program  $P$  in the input language of **gringo**. Please **do not exclude symmetric solutions** in your formalization!

a) Your solution should meet the following criteria:

- An input predicate **occupy**( $p, o, x, y$ ) is used to describe which squares, relative to origin  $(0, 0)$ , are occupied by a pentomino  $p$  in its orientation  $o$ . Here  $x$  and  $y$  have ranges in the interval  $-3 \dots 3$  depending on  $p$ . Possible orientations are denoted by constants **o1**, ..., **o4**. Please see the assignment specific files for examples. Yet another input predicate **fix**( $p, o, x, y$ ) is used to fix the position of a pentomino  $p$  at coordinates  $(x, y)$  in its orientation  $o$ . The ranges of  $x$  and  $y$  are  $1 \dots k$  and  $1 \dots (60/k)$  and the possible orientations  $o$  of  $p$  depend on the pentomino  $p$ .
- Output predicates **xloc**( $p, x$ ), **yloc**( $p, y$ ), and **placed**( $p, o$ ) express that a pentomino  $p$  is placed at  $(x, y)$  in its orientation  $o$ .

In principle, your program should work for any parameter value  $k = 3, 4, 5, 6$  supplied to your program from command line. Return your **gringo**-encoding as your answer to this part.

- b) Count the number of solutions of the given  $3 \times 20$  puzzle instance where location of one pentomino has been fixed. Provide the number of solutions as your answer.
- c) Treat the given  $4 \times 15$  puzzle instance as in the previous item.
- d) Count the number of solutions of the given  $5 \times 12$  puzzle instance where the locations of two pentominoes have been fixed. Again, provide the number of solutions as your answer.

**NOTE:** This home assignment is **strictly personal** and you are supposed to work out your answers on your own.

<sup>1</sup><http://puzzle.ics.hut.fi/T-79.5105/students/336790/assignment3/a/assignment.pdf>