

# Laurea Magistrale in INFORMATICA

## Principi di Linguaggi di Programmazione

### Paradigmi

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(Timing: 2 hours – Grading: (pts n-m) is the score range to be obtained in each exercise)

**Exercise 1.** (pts 5 - 9) Let  $H$  be the set of strings on the alphabet  $\{a,b,c,d\}$ . Use Prolog to define:

- (a) (pts 1) A concrete representation for the values of  $H$
- (b) (pts 4) A predicate  $inc/2(u,v)$  which holds whenever  $u$  and  $v$  are strings of  $H$  and  $u$  includes  $v$ .
- (c) (pts 4) A predicate  $split/4(u,ub,v,ue)$  which holds whenever  $u$ ,  $ub$ ,  $v$ , and  $ue$  are strings of  $H$  and  $u=ub.v.ue$ , i.e.  $u$  is the concatenation of  $ub$ ,  $v$ ,  $ue$ .

**Exercise 2.** (pts. 5 - 10) Let  $IRel$  be an Abstract Data Type for immutable binary, non-empty, relations on two generic types. These relations have the following public operations:

- $newIRel(u,v)$ : returns a new  $IRel$  that contains the only pair  $(u,v)$ ;
- $add(u,v,r)$ : returns a new  $IRel$   $r'$  that may differ from  $r$  for the pair  $(u,v)$ , provided that  $u$  and  $v$  have the right types for  $r$ ;
- $get2(u,r)$ : returns the list that contains all and only the  $v$  such that  $(u,v)$  is a pair of  $r$ .

Use Caml to define:

- (a) (pts 2) An API for  $IRel$
- (b) (pts 8) An ADT for  $IRel$  such that:
  - 1. values are represented by a list of distinct pairs;
  - 2. it includes a private operation  $contain(u,v,r)$  that:
    - i. returns true iff the relation  $r$  contains the pair  $(u,v)$ ;
    - ii. it is defined by using the iterative programming methodology

**Exercise 3.** (punti 6 - 11) Let  $MRel$  be a Java Class for an ADT of non-empty relations, like in exercise 2, but now, mutable.

- (a) (pts 4) Define a Java class  $MRelS$  that extends  $MRel$  by adding the new public operation  $size()$  that returns the number of distinct pairs of the relation.
- (b) (pts 7) Define a class  $MRelR$  that extends  $MRelS$  by adding a new public operation  $remove(u,v)$  that modifies the relation by removing the pair  $(u,v)$ , if any.