

### Exercise 1 (8 points)

AI experts are well payed unless they are unemployed.  
 Every AI expert in the company AIco gets an AI bonus.  
 Everyone getting an AI bonus is employed.  
 Gino gets an AI bonus.

- (a) Represent the above sentences in first order logic.
- (b) Transform them in CNF and tell whether there are any non-Horn clauses.
- (c) Prove that Gino is well payed by resolution, adding knowledge if necessary.
- (d) Prove by resolution that every AI expert in AIco is well payed.

### Exercise 2 (4 points)

Illustrate the procedure for generating a clausal (conjunctive) normal form of a generic formula in first order logic.

- (a) provide the CNF of the formula  $A \wedge B \iff C \vee D$
- (b) provide the CNF of the formula  $\forall x \exists y f(x) \wedge g(x, y) \Rightarrow \exists z h(x, z)$

### Exercise 3 (4 points)

- (a) Write a PROLOG program `allE(X)` that, given a list, returns `true` if all of its elements are the same atom. With the empty list the program must return `false`.
- (b) Write a PROLOG program `allButOne(X)` that, given a list, returns `true` if all of its elements but one are the same atom. Example input: `L=[a,b,a,a,a]` returns `true`, while `L=[a,b,a,c]` returns `false`.
- (c) **Optional: to be done after everything else is completed.** Write a PROLOG program `allButOne(X,Y,Z)` that, given a list, returns `true` if all of its elements but one are the same atom, and returns the two atoms in the list. Example input: `L=[a,b,a,a,a]` returns `Y=a,Z=b`.

**Notation for text format: no pictures!!!**

symbol	textual	C-like
$\forall$	ALL	
$\exists$	EXI	
$\iff$	IFF	<code>&lt;== &gt;</code>
$\Rightarrow$	IMP	<code>== &gt;</code>
$\vee$	OR	<code>  </code>
$\wedge$	AND	<code>&amp;&amp;</code>
$\neg$	NOT	<code>!</code>

Since we adopt capital letters for the logical connectives it may be more readable to use for predicates, functions and variables with a lower case initial.

In case of doubt about precedence rules use parentheses.