LANGUAGES FOR AI, MODULE 2
JULY 15, 2024

Time: 2 hours.

Please write the answers to exercises 1-2, 3-4 and 5-6 on three different sheets of paper.

1. (5 points) Consider the language of propositional logic. Use natural deduction to prove that the following holds, or find a counter-example to show that it does not hold (remember that $\neg F$ is only a shorthand for $F \to \bot$).
   - $(A \wedge B) \vdash (A \wedge B \wedge C) \to C$
   - $C \vdash (A \wedge B) \to (B \wedge C)$
2. (5 points) Transform the following propositional logic formula into an equivalent formula in Disjunctive Normal Form
   $$(A \to (B \to C)) \to (A \to (C \to B))$$
3. (5 points) Bianchi, Rossi, and Neri are suspected of a crime. They testify as follows:
   - Bianchi: "Rossi is Innocent and Neri is guilty".
   - Rossi: "Bianchi is innocent if and only if Neri is guilty".
   - Neri: "I'm guilty and both the others are innocent".

   Express the testimony of each suspect as a formula in propositional logic. Assuming that all testimonies are false, who is innocent and who is guilty?
4. (5 points) Formalise the following sentence into FOL:
   - There is a piano player who likes any piece of music, provided that is romantic and it is not for piano solo.
   - Some piece of music are boring, except from those written by Bach.
   - If everybody is playing someone is annoyed.
5. (6 points) 5 students are about to take an exam. The room that the professor managed to book is unfortunately quite small. It has 2 seats by the window, one right under the air conditioner, 1 in the back rows and 1 near the professor's desk.

   Andrew should not be near the window because he is always complaining about the sun, on the other hand, Bella cannot stand the air conditioning. Clara is always trying to cheat, so it would be advisable to keep a close eye on her. Dan is always distracted, so the window and the back seats should be avoided. Ethan is a new students, and the professor does not know whether he has any preferences.

   Model the problem using MiniZinc or CLP.

   Hint: you can use the seats as variables and the students as values.
6. (6 points) Define the Prolog predicate *exists(L)*, where L is a list on integer numbers, that is true if there is a number in the list that is the sum of the two numbers that precede it.

   For example:

   ?- exists([1,2,4,3,7]).

   True (Because the sum of 4 and 3 equals 7)

   ?- exists([1,2,4,3,6]).

   False.