HOCHSCHULE LANDSHUT

Artificial Intelligence I

Lab 5 - Winter Semester 2023 / 2024
https://moodle.haw-landshut.de/course/view.php?id=10282

1. In each of the following we give an English sentence and a number of candidate logical expressions. For each of the logical expressions, state whether it (1) correctly expresses the English sentence; (2) is syntactically invalid and therefore meaningless; or (3) is syntactically valid but does not express the meaning of the English sentence.

(a) Paris and Marseilles are both in France.

(i) $\text{In}(\text{Paris} \wedge \text{Marseilles}, \text{France})$

(ii) $\text{In}(\text{Paris}, \text{France}) \wedge \text{In}(\text{Marseilles}, \text{France})$

(iii) $\text{In}(\text{Paris}, \text{France}) \vee \text{In}(\text{Marseilles}, \text{France})$

(b) Every cat loves its mother or father.

(i) $\forall x\ \text{Cat}(x) \Rightarrow \text{Loves}(x, \text{Mother}(x) \vee \text{Father}(x))$.

(ii) $\forall x\ \neg\text{Cat}(x) \vee \text{Loves}(x, \text{Mother}(x)) \vee \text{Loves}(x, \text{Father}(x))$.

(iii) $\forall x\ \text{Cat}(x) \wedge (\text{Loves}(x, \text{Mother}(x)) \vee \text{Loves}(x, \text{Father}(x)))$.

2. Represent the following sentences in first-order logic, using the vocabulary (add constants and / or predicates if you think that something is missing in the vocabulary):

- $\text{Takes}(x, c, s)$: student x takes course x in semester s;
- $\text{Passes}(x, c, s)$: student x passes course x in semester s;
- $\text{Score}(x, c, s)$: the score obtained by student x in course c in semester s;
- $x > y$: x is greater than y;
- F and G: specific French and Greek courses;
- $\text{Buys}(x, y, z)$: x buys y from z;
- $\text{Sells}(x, y, z)$: x sells y to z;
- $\text{Fools}(x, y, t)$: person x fools person y at time t;
- $\text{Student}(x), \text{Person}(x), \text{Agent}(x), \text{Insured}(x), \text{Smart}(x), \text{Politician}(x)$: predicates satisfied by members of the corresponding categories.

(a) Some students took French in spring 2009.

(b) Every student who takes French passes it.

(c) Only one student took Greek in spring 2009.

(d) The best score in Greek is always higher than the best score in French.

(e) Every person who buys a policy is smart.

(f) There is an agent who sells policies only to people who are not insured.

(g) Politicians can fool some of the people all of the time, and they can fool all of the people some of the time, but they can't fool all of the people all of the time.

3. Consider a situation where one is trying to create an expert system in order to make patient diagnoses. The patient *John* presents the following facts about their situation

- *John* is running a temperature
- *John* is coughing
- *John* has colored phlegm

Our KB consists of the following rules:

(A) $\forall x$ Cough$(x) \wedge$ Temp$(x) \Rightarrow F(x)$

(B) $\forall x$ Phlegm$(x) \wedge F(x) \Rightarrow$ Bact(x)

(C) $\forall x$ Bact$(x) \Rightarrow$ Antibiotic(x)

described by the predicates Cough(x) [person x coughing], Temp(x) [person x running temperature], F(x) [person x having an infection], Phlegm(x) [person x having a colored phlegm], Bact(x) [person x having a bacterial infection] and Antibiotic(x) [administering an antibiotic to x].

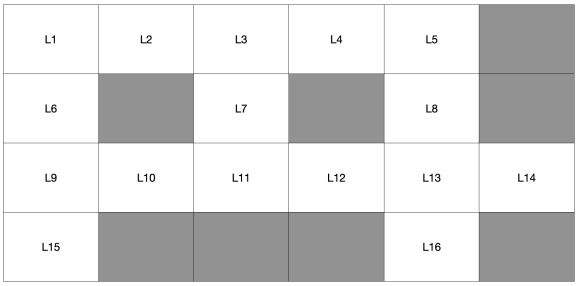
Describe *Johns* conditions using the predicates above. Does our medical expert system recommend the administration of an antibiotic to *John*? Derive your conclusion formally and state the specific rules (from the lecture) you used in every step.

4. Convert the following set of sentences into symbolic form and construct a proof for the final sentence based on the first two sentences:

Wherever there are deer, there are also lions. There is at least one deer in Serengeti. Therefore, there must also be at least one lion in Serengeti.

Use $D(x)$ and $L(x)$ respectively for x being a deer or lion, and $P(x, y)$ for x living in place y. Use the constant S for the place Serengeti.

5. Solving crossword puzzles with Prolog. Below you see a small crossword puzzle. The cells in the puzzle are to be filled with letters. The cells are labelled $L1, L2, \ldots, L16$. These labels will be the names of the variables whose values will be found by the program you need to write.



The possible values of these variables are the letters from the given vocabulary. The vocabulary is given by the predicates `word` with 3 to 6 arguments. These are the words that may be used in the solution:

```
word(d,o,g).      word(r,u,n).      word(t,o,p).      word(f,i,v,e).
word(f,o,u,r).    word(l,o,s,t).    word(m,e,s,s).    word(u,n,i,t).
word(b,a,k,e,r).  word(f,o,r,u,m).  word(g,r,e,e,n).  word(s,u,p,e,r).
word(p,r,o,l,o,g). word(v,a,n,i,s,h). word(w,o,n,d,e,r). word(y,e,l,l,o,w).
```

Construct a predicate `solution`, whose arguments are all the 16 letters in the puzzle, that states the constraints that have to be satisfied by these letters. If you are successful, to solve the puzzle, Prolog needs to be asked:

```
?- solution(L1,L2,L3,L4,L5,L6,L7,L8,L9,L10,L11,L12,L13,L14,L15,L16)
```