

CSC 421 Artificial Intelligence – Assignment 3

Q1. (8 points) Using propositional resolution, show the following propositional sentence is unsatisfiable.

$$(p \mid q \mid \neg r) \ \& \ ((\neg r \mid q \mid p) \rightarrow ((r \mid q) \ \& \ \neg q \ \& \ \neg p))$$

To do this, convert this sentence to **clausal form** and derive the empty clause using **resolution**. Show the details of each step in your conversion to clausal form as well as your resolution steps. For the resolution steps you don't need to use TFM.

You can use <https://logictools.org/prop.html> to verify your clausal form. Conjunctive Normal Form (CNF) is the same as clausal form, just the clauses are expressed as OR of literals, and a set of clauses is AND-ed together). Logictools uses this format to display clausal form.

Q2. (9 points) Express the following problems in FOL, then, using Prover9, attempt to prove the conclusions. You can submit only the Prover 9 format.

a.

Every horse can outrun every dog.

Some greyhounds can outrun every rabbit.

Show that every horse can outrun every rabbit.

b.

All hummingbirds are richly colored.

No large birds live on honey.

Birds that do not live on honey are dull in color.

Conclusion: All hummingbirds are small.

Hint. Add a background knowledge premise not explicitly mentioned in the problem:

all x (hummingbird(x) \rightarrow bird(x)).

c.

My gardener is well worth listening to on military subjects;

No one can remember the battle of Waterloo, unless he is very old;

Nobody is really worth listening to on military subjects, unless he can remember the battle of Waterloo.

Conclusion: My gardener is very old.

Q3. (8 pts) Redo the probability calculation for pits in [1,3], [2,2] assuming that each square contains a pit with probability 0.01, independent of the other squares.

Q4. (9 pts) [Adapted from a CMU machine learning assignment]

As part of a comprehensive study of the role of CMU 10-601 (Machine Learning) on people's happiness, CMU has been collecting data from graduating students. In an optional survey, the following questions were asked:

- Do you party frequently [Party: Yes/No]?
- Are you wicked smart [Smart: Yes/No]?
- Are you very creative [Creative: Yes/No]? (Please only answer Yes or No)
- Did you do well on all your homework assignments? [HW: Yes/No]
- Do you use a Mac? [Mac: Yes/No]
- Did your course project succeed? [Project: Yes/No]
- Did you succeed in your most important class (which is 10-601)? [Success: Yes/No]
- Are you currently Happy? [Happy: Yes/No]

You can obtain the comma-separated survey results from the accompanying file.

Each row in *students.csv* corresponds to the responses of a separate student.

The columns in *students.csv* correspond to each question (random variable) in the order Party, Smart, Creative, HW, Mac, Project, Success, and Happy.

The entries are either zero, corresponding to a No response, or one, corresponding to a Yes response.

After consulting a behavioral psychologist they obtained the following complete set of conditional relationships:

- HW depends only on Party and Smart
- Mac depends only on Smart and Creative
- Project depends only on Smart and Creative
- Success depends only on HW and Project
- Happy depends only on Party, Mac, and Success

1. (1 pt) Draw the Bayesian network.

2. (2 pt) Estimate the probabilities of the conditional probability tables using the data provided

3. (2 pts) What is the probability of being happy given that you party often, are wicked smart, but not very creative? Show details of computation.

4. (2 pts) What is the probability of being happy given that you are wicked smart and very creative? No details required. Use the AIspace tool.

5. (0.5 pts) What is the probability of being happy given you do not party, and do well on all your homework and class project? No details required. Use the AIspace tool.

6. (0.5 pts) What is the probability of being happy given you own a mac?
No details required. Use the AIspace tool.

7. (0.5 pts) What is the probability that you party often given you are wicked smart?
No details required. Use the AIspace tool.

8. (0.5 pts) What is the probability that you party often given you are wicked smart and happy?
No details required. Use the AIspace tool.