CSc 144–002 — Discrete Mathematics for Computer Science I — Fall 2023 (McCann)
https://cs.arizona.edu/classes/cs144/fall23-002/

Homework #4

(50 points)

Due Date: October 13th, 2023, at the beginning of class

Directions

1. **This is an INDIVIDUAL assignment; do your own work! Submitting answers created by computers or by other people is NOT doing your own work.**
2. Start early! Getting help is much easier n days before the due date/time than it will be n hours before. Help is available from the class staff via piazza.com and our office hours.
3. Write complete answers to each of the following questions, in accordance with the given directions. Create your solutions as a PDF document such that each answer is clearly separated from neighboring answers, to help the TAs easily read them. Show your work, when appropriate, for possible partial credit.
4. When your PDF is ready to be turned in, do so on gradescope.com. Be sure to assign pages to problems after you upload your PDF. Need help? See "Submitting an Assignment" on https://help.gradescope.com/.
5. **Solutions submitted more than five minutes late will cost you a late day. Submissions more than 24 hours late are worth no points.**

Topic: Arguments

1. (8 points) Each of the following short arguments is a fallacy. For each, give two "real world" examples: With the first example, show that it is possible that the conclusion is true when the hypotheses are true, With your second example, show that it is possible that the conclusion is false even though the hypotheses are true. Be aware that these fallacies may or may not be fallacy types presented in class.
   (a) Hypotheses: a, and $b \rightarrow a$. Conclusion: $\therefore b$.
   (b) Hypotheses: $\forall x\,(A(x) \rightarrow B(x))$, and $\neg\exists x\,(C(x) \wedge A(x))$. Conclusion: $\therefore \neg\exists\,(C(x) \wedge B(x))$.

Topic: Direct Proofs

2. (6 points) Prove, using a direct proof, that the sum of a multiple of eight and a multiple of twelve is a multiple of four. (*Hint:* The even numbers are multiples of two; you know how to represent those in a proof.)
3. (6 points) Prove, using a direct proof, that negating an odd integer produces an odd integer. (*Hint:* Think of a math operation, other than writing a hyphen in front, that turns a positive integer negative.)
4. (6 points) Prove, using a direct proof, that the difference of two rational numbers is also a rational number.
5. (6 points) Prove, using a direct proof, that $2fg \leq f^2 + g^2,\ f, g \in \mathbb{R}$. (*Hint:* What is the square of $(a - b)$?)

Topic: Additional Set Concepts

6. (2 points) What is the result of $\mathcal{P}(\{w, x, y, z\})$?
7. (2 points) The Bell numbers tell us the number of partitions that can be formed from a set, assuming that the set itself is one of the partitions. For a set of three values, there are 5 possible partitions. What are the five partitions of $\{g, h, i\}$?

(Continued on the back . . .)

Topic: Prolog

Background: On D2L is a video (in the Content – Assignments – Homework #4 area) that explains how to access our main instructional machine (`lectura.cs.arizona.edu`), and demonstrates how to run and use a version of Prolog (`gprolog`), including how to access lectura, create a text file containing a Prolog database, load a Prolog database into `gprolog`, and ask queries. We've also distributed a five–page tutorial document titled "Quick–'n'–Dirty Prolog Tutorial" that you should read.

The first thing you need to do is find the email you received when you started taking CS classes. It was sent from `it-admin@cs.arizona.edu` with the subject line of "Welcome of the Department of Computer Science." It contains information about your CS account. If you can't find that email, or changed your CS password at that time and forgot it, you can reset it by visiting `https://helpdesk.cs.arizona.edu` and clicking on the red link that reads "Click here to self manage your CS account/password." When you have your account ready to go, have read the tutorial, and have watched that video, you should be ready for the following questions. Start early so that you can get help if you need it!

8. (8 points) Authors write textbooks, either solo or with co–authors. Those textbooks are published by companies that sell them. Each textbook has a copyright date (the year the textbook was published). For this question, we have this limited set of facts: Dr. Seuss ("drseuss" in our database) wrote both "thelorax" (copyright 1971) and "hoponpop" (1963), both of which were published by "randomhouse". Random House also published "ulysses" by "jamesjoyce" in 1934, but Joyce's "dubliners" was published by "grantrichards" in 1914. If a company publishes a title and an author wrote that title, then that company pays that author. And, if an author wrote a title and that title has a copyright year, then we say that when the author wrote the title was that year.

   Create a Prolog database that contains three collections of facts and two rules, all based on the above description. The first set of facts has facts of the form $\boxed{\text{wrote(author,title).}}$, the second set has facts of the form $\boxed{\text{publish(company,title).}}$, and the third set has facts of the form $\boxed{\text{copyright(title,year).}}$. You'll have four wrote facts, four publish facts, and four copyright facts. There are also two rules: $\boxed{\text{pays(company,author)}}$ and $\boxed{\text{whenwritten(author,year)}}$, both of which are to be constructed to follow the logic of the descriptions of those relationships as described above.

   When your database is created on lectura, load it into Prolog and use it to answer these three queries:

   (a) `wrote(drseuss,thelorax).` (In English: Did Dr. Seuss write "The Lorax?")

   (b) `publish(randomhouse,dubliners).` (In English: Does Random House publish "Dubliners?")

   (c) `pays(randomhouse,A).` (In English: Which authors does Random House pay?)

   (For this last query, remember to press the semicolon key ($\boxed{;}$) when you see an answer followed by a question mark, to allow Prolog to find and display all of the answers.)

   As your answer to this question in your PDF, include screenshot(s) that show: (a) The facts and rules in your database, and (b) the results gprolog produced when you ran the three queries.

9. (6 points) In class on September 27, I showed you the "Has Hugo had a programming class?" example. We completed the argument ourselves, but Prolog can do it for us. Your task: Make Prolog do it!

   You'll need one fact (named `takes144`, stating that Hugo is taking CSc 144), and one rule (explaining to Prolog that $\forall x(C(x) \rightarrow P(x))$ means "if anyone is taking CSc 144, then they've had a programming class"). When this very small database is ready, use it to answer the question we answered in class: Has Hugo had a programming class?

   As your answer to this question in your PDF, include screenshot(s) that show: (a) The fact and the rule in your database, and (b) the result gprolog produced when you ran the query to answer the question.