CS1800 Discrete Structures

Recitations 2

Strange & Varma *Date: September 24 & 25, 2026*

- This recitation handout contains practice problems. You do *not* need to submit anything.
- We do recommend handwritting your solutions to completion. Do ensure that you are aware of how and why each step in the solution exists.
- For best effects, read through the questions before your recitation section and if possible attempt them on your own. This way you can compare your perspective to the TAs during the recitation.
- If you get stuck on a problem, use your recitation section to get help. Of course, you can also use office hours or post on Campuswire!
- The solutions to this recitation will be posted after Friday. Use those to verify your own attempts and for any clarification.

Problem 1 (English to/from Logical expression)

For the first part of the question, let s = "stocks are increasing" and i = "interest rates are steady" and b = "it is a bullish market". Rewrite the English statements using $\wedge, \vee, \neg$ and the boolean variables s and i and translate the boolean formulae into English statements.

i. Stocks are increasing but interest rates are steady.

ii. Neither are stocks increasing nor are interest rates steady.

iii. If the interest rate is not steady then the stock will not increase.
Simplify the statement by first finding the contrapositive of the implication logic expression and then rewriting that boolean formula back into an English sentence.

iv. Translate to English: $b \implies (s \vee \neg i)$

v. Translate to English: $\neg(i \wedge \neg s) \implies b$.
How is this implication statement related to the previous implication statement (choose from contrapositive, inverse, converse)?

Problem 2 (Quantifying the shapes)

Refer to Figure 1 to answer the following questions for each of the statements provided.

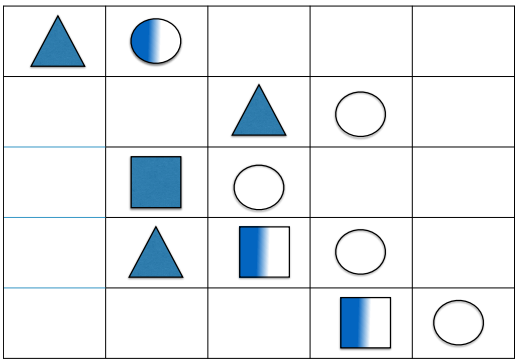


Figure 1: Figure for problem 4. A Tarski World, a tool for understanding logical statements invented by Jon Barwise and John Etchemendy, named after Alfred Tarski

- Express it using logical symbols $(\forall, \exists, \rightarrow, \wedge, \vee, \neg)$ as well as the predicates: Circle, Square, Triangle, Fully Shaded, Half Shaded, Clear.
  You can use notation $Row(shape), Column(shape)$ to denote the row number and column number of shape. Use these when rewriting the statements as logical expression. A statement of the form x is above y refers to the fact that the shape x is on a row above shape y irrespective of column; that is, $Row(x) > Row(y)$. Similarly for left/right/below and so on.
- Tell if it is true or false
- If a statement is universally quantified (with a $\forall$ symbol) and false, then provide a counter-example
- If a statement is existentially quantified (with a $\exists$ symbol) and true, then provide an example

Note, you may only use the negation symbol $\neg$ in front of a predicate.

1. For every triangle x, there is a square y, where x is above y.

2. There is a circle x, such that for all squares y, x is above y.
3. There is a triangle x and a circle y such that x and y have the same shading.
4. For all circles x, there exist a square y, such that y is to the right of x.
5. For all triangles x, and for all squares y, if x is above y, then x is to the right of y.
6. **(****)** It is not true that: For all triangles x, and for all squares y, if x is above y, then x is to the right of y.

Problem 3 (Logical expression simplification)

Write beside each step the rule being used in the following proof of equivalence or fill in the missing step given the rule.

$$(\neg c \vee (c \vee a)) \wedge \neg(\neg b \wedge \neg b)$$

$\equiv ((\neg c \vee c) \vee a) \wedge \neg(\neg b \wedge \neg b)$ _____ law

$\equiv$ De Morgan's law

$\equiv$ Double Negation law x2

$\equiv ((\neg c \vee c) \vee a) \wedge b$ _____ law

$\equiv$ Complement law

$\equiv$ _____ law

$\equiv b$ _____ law

Problem 4 (Convert to decimal)

NOTE: If you haven't done this in class yet, skip for now and attempt after the lecture.

Convert the following non-decimal numbers into decimal. Recall that the subscript tells you the base used:

(a) 1323_4

(b) 162_8

(c) 10101000011_2

(d) $AB3_{16}$ (A and B are the next "digits" after 8, 9 equaling values of 10 and 11 respectively.)

Problem 5 (Convert from decimal)

NOTE: If you haven't done this in class yet, skip for now and attempt after the lecture.

Convert these decimal numbers to the specified base:

(a) 133 to base 2

(b) 162 to base 9

(c) 121 to base 4

(d) 729 to base 2