CSE 311 Foundations of Computing I

Spring 2013
Lecture 1
Propositional Logic

About the course

- From the CSE catalog:
  - **CSE 311 Foundations of Computing I (4)** Examines fundamentals of logic, set theory, induction, and algebraic structures with applications to computing; finite state machines; and limits of computability. Prerequisite: CSE 143; either MATH 126 or MATH 136.
- What I think the course is about:
  - Foundational structures for the practice of computer science and engineering

Why this material is important

- Language and formalism for expressing ideas in computing
- Fundamental tasks in computing
  - Translating imprecise specification into a working system
  - Getting the details right

Topic List

- Logic/boolean algebra: hardware design, testing, artificial intelligence, software engineering
- Mathematical reasoning/induction: algorithm design, programming languages
- Number theory: cryptography, security, algorithm design
- Relations/relational algebra: databases
- Finite state machines: Hardware and software design, automatic verification
- Turing machines: Halting problem

Administration

- Instructor
  - Paul Beame
- Teaching Assistants
  - Caitlin Bonnar,
  - Chelsea Dallas
  - Chantal Murthy
  - Noah Siegel
- Quiz sections
  - Thursdays
- Text: Rosen, Discrete Mathematics
  - 6^{th} Edition or 7^{th} Edition
- Homework
  - Due Wednesdays at start of class
  - Individual
- Exams
  - Midterm, Friday, May 10
  - Final Exam, Monday, June 10, 2:30-4:20 pm
  - All course information posted on the web: http://www.cs.washington.edu/311
- Grading Weight (Roughly)
  - 50% homework
  - 35% final exam
  - 15% midterm

Propositional Logic

Propositions

- A statement that has a truth value
- Which of the following are propositions?
  - The Washington State flag is red
  - It snowed in Whistler, BC on January 4, 2011.
  - There is an Argentinian Pope named Francis I
  - Space aliens landed in Roswell, New Mexico
  - Turn your homework in on Wednesday
  - Why are we taking this class?
  - If n is an integer greater than two, then the equation $a^n + b^n = c^n$ has no solutions in non-zero integers a, b, and c.
  - Every even integer greater than two can be written as the sum of two primes
  - This statement is false
- Propositional variables: *p, q, r, s, . . .*
- Truth values: **T** for true, **F** for false

Compound Propositions

- Negation (not) $\neg p$
- Conjunction (and) $p \wedge q$
- Disjunction (or) $p \vee q$
- Exclusive or $p \oplus q$
- Implication $p \rightarrow q$
- Biconditional $p \leftrightarrow q$

Truth Tables

p	$\neg p$

p	q	$p \wedge q$

or example: prerequisites for 311: either Math 126 or Math 136

p	q	$p \vee q$

p	q	$p \oplus q$

x-or example: "you may have soup or salad with your entree"

Understanding complex propositions

- Either Harry finds the locket and Ron breaks his wand or Fred will not open a joke shop

Atomic propositions
h: Harry finds the locket
r: Ron breaks his wand
f: Fred opens a joke shop

$(h \wedge r) \oplus \neg f$

Understanding complex propositions with a truth table

h	r	f	$h \wedge r$	$\neg f$	$(h \wedge r) \oplus \neg f$

Aside: Number of binary operators

- How many different binary operators are there on atomic propositions?

$p \to q$

p	q	$p \to q$

- Implication
  - p implies q
  - whenever p is true q must be true
  - if p then q
  - q if p
  - p is sufficient for q
  - p only if q

If pigs can whistle then horses can fly

Converse, Contrapositive, Inverse

- Implication: $p \to q$
- Converse: $q \to p$
- Contrapositive: $\neg q \to \neg p$
- Inverse: $\neg p \to \neg q$

- Are these the same?

Example
p: "x is divisible by 2"
q: "x is divisible by 4"

Biconditional $p \leftrightarrow q$

- p iff q
- p is equivalent to q
- p implies q and q implies p

p	q	$p \leftrightarrow q$

English and Logic

- You cannot ride the roller coaster if you are under 4 feet tall unless you are older than 16 years old
  - *q*: you can ride the roller coaster
  - *r*: you are under 4 feet tall
  - *s*: you are older than 16

$(r \wedge \neg s) \rightarrow \neg q$