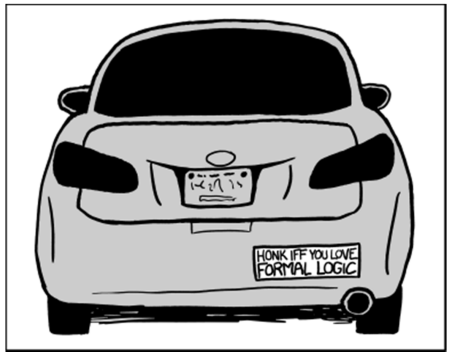
CSE 311: Foundations of Computing

Fall 2013

Lecture 1: Propositional logic



about the course

We will study…

- Logic
- Formal proofs
- Set theory and functions
- Basic number theory
- Induction
- CS structures: regular expressions, grammars, graphs, finite state machines
- A little computability theory

To form a solid foundation for further study of CSE

about the course

Why?

- Basis for thinking correctly and abstractly
- Communicating precisely (formal specifications)
- Correctness of programs
- Representing knowledge
- Algorithm design
- Reasoning about huge inputs / big data
- Understanding what problems are hard to solve

administration

Instructors: Paul Beame and James Lee

Teaching assistants:

Emily Behrendt
Armando Diaz Tolentino
Hanchuan Li
Vincent Liew
Jianghong Shi
King Xia

Quiz sections: Thursdays
Not tomorrow

Book: Rosen
Discrete Mathematics
6th or 7th edition

Homework:
Due WED at start of class
Write up individually

Exams:
Midterm: November 4th
Final: December 9th
2:30-4:20 or 4:30-6:20
Non-standard time

Grading:
50% homework
35% final exam
15% midterm

All course information at http://www.cs.washington.edu/311

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.
  - The home page renders correctly in Internet Explorer.
  - Space aliens landed in Roswell, New Mexico.
  - Turn your homework in on Wednesday.
  - Who let the dogs out?
  - 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 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 $p \leftrightarrow q$

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p = It is raining.
q = I feel sad.

truth tables

p	$\neg p$

p	q	$p \wedge q$

p	q	$p \vee q$

p	q	$p \oplus q$

understanding complex propositions

Either Henry gets on base and Reggie hits a home run, or Fernando wins the game.

Atomic propositions
h: Henry gets on base
r: Reggie hits a home run
f: Fernando wins the game

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

complex propositions with a truth table

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

aside: how many...?

How many different binary operators are there on atomic propositions?

p	q	$p \,?\, q$

$p \rightarrow q$

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**

p	q	$p \rightarrow q$

***If pigs could whistle then horses could fly.**

converse, contrapositive, inverse

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

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

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