Slide 1

Administrivia

- (Most lectures will start with some "administrivia".)
- One purpose of the syllabus is to spell out policies (more about that shortly).
- Most other information will be on the Web, either on my home page (here, office hours) or the course Web page (here).

  A request: If you spot something wrong with course material on the Web, please let me know!

Slide 2

"Why Do I Have To Take This Course?"

- It's "math for CS majors": We want to teach you basic concepts in addition to technical skills. For this you need some math background — or at least a bit of "mathematical maturity".
- Odds are good you *will* need material from this course in other required courses.
- "Because we said so."
- It might be fun.

Slide 3

Course Topics

- Formal logic — as an example of a "formal system", to help with boolean algebra.
- Proof techniques — induction in particular is useful in CS, and we'll talk a little about proofs of program correctness.
- Recursion.
- Sets, counting, and probability.
- Relations, functions, and order of magnitude of functions ("big-O notation").
- Graphs and trees.

Slide 4

Course FAQ

- "What will my grade be based on?" (See syllabus.)
- "When are the exams?" (See syllabus.)
- "What happens if I can't turn in work on time, or I miss a class?" (See syllabus.)
- "What's your policy on collaboration?" (See syllabus.)

Slide 5

Course FAQ, Continued

- "When is the next homework due?" (See "Lecture topics and assignments" page.)
- "When are your office hours?" (See my home page.)

  Note that part of my job is to answer your questions outside class, so if you need help, please ask! in person or by e-mail or phone.

Slide 6

Why Study Propositional Logic?

- Because it's conceptually related to Boolean algebra (used in programming, circuit design, etc.).
- Because it's related to proofs, which you should know a bit about.
- As an example of a "formal system" — represent something symbolically, define and apply rules for manipulating symbols, etc. Other examples in automata theory, theory of databases, etc.
- Because when you ask Dr. Theory (Myers) what you should learn in this course, he says "logic, logic, logic, logic!"
- Because after logic, the rest of the course will (probably) seem easy!

Slide 7

Propositional Logic — The Big Picture

- Underlying many fields is a notion of “valid argument”, one thing “following logically” from another — math, science, law, etc. (Consider example at the start of chapter 1.)
- Can define precisely what this means using natural language, but it’s difficult and clumsy.
- If we use mathematical notation instead, it’s easier to produce/follow chains of reasoning.

  (Analogous to “word problems” in algebra — the idea is to turn something that’s clumsy to work with into mathematical symbols, operate on the symbols with well-defined math, and translate the result back into words.)
- Emphasis in this course is on the logic/math part rather than on translating real-world English into symbols.

Slide 8

Statements / Propositions

- Definition — something (in natural language, a sentence) that is either true or false. (We might not know which.)
- Which of these are statements?
  - Water is wet.
  - Water is not wet.
  - Is the sky blue on Venus?
  - There is life on Mars.
- Notational convention — A, B, C, etc., are statements.

Slide 9

Connectives

- Can build up more complicated statements by combining simpler ones, using "connectives" — each has intuitive meaning, formal definition.
- "and" connective pretty clear — $A \wedge B$ defined by truth table
- "or" connective also pretty clear — $A \vee B$ defined by truth table

  Notice that this is "inclusive or" — not always the same as what we mean by "or" in natural language.
- "not" connective also pretty clear — A' defined by truth table
- "implies" connective is trickier — $A \rightarrow B$ defined by truth table

  Why define it that way? Stay tuned . . .
- "is equivalent to" connective also pretty clear — $A \leftrightarrow B$ defined by truth table

Slide 10

Why Did We Define Implication That Way?

- Definition of $A \rightarrow B$ when A is true seems reasonable, right?
- When A is false, though — why say $A \rightarrow B$ is true?
  - "Benefit of the doubt" argument: We have to call it either true or false, and it's not obviously false.
  - "It's math" argument: Maybe this definition *doesn't* express some fundamental truth. But in some sense math is its own universe, and we can define things any way we want (though we hope the definitions fit together in a nice way and maybe have applications).

    (In fact, some treatments of propositional logic just define implication formally, in terms of other connectives, and don't try to justify it.)

Slide 11

Compound Statements / Well-Formed Formulas

- Natural-language equivalents of statements joined by connectives:
  - Water is wet and grass is green.
  - If Jo(e) is a CS major, Jo(e) must take this course.
- We can "nest" connectives, e.g., $(A \wedge B)'$.
- We can define a notion of "well-formed formula" (wff) based on this (formal definition should be recursive, and we'll do that later) — basically, a "sensible" combination of statement letters, connectives, and parentheses.
- Notational convention — P, Q, ... for wffs.
- We can use truth tables to figure out truth values for wffs. (How many rows do we need?) Let's do an example ...

Slide 12

More Definitions

- Some wffs are always true — "tautologies". Examples?
- Some wffs are always false — "contradictions". Examples?
- We can talk about two wffs P and Q being "equivalent" — $P \leftrightarrow Q$ is a tautology.

  Write $P \Leftrightarrow Q$.

  Table of common equivalences on p. 8.

  Additional widely-used equivalences — "De Morgan's Laws" (p. 9).

Propositional Formulas in Other Contexts

- Notice similarities between the connectives here and
  - Boolean expressions in programming languages.
  - Expressions for "advanced search" in some search engines, database queries, etc.
- Can use rules we have so far to simplify such expressions (e.g., De Morgan's Laws can be useful in simplifying boolean expressions in programs).

Slide 13

Minute Essay

- (Most lectures will end with a "minute essay" — as a quick check on your understanding, a way for me to get some information, etc., and also to track attendance.)
- Tell me about why you are taking this course — as a prospective CS major or minor? for some other reason? what is your major?
- Tell me how you are meeting the prerequisite for this course — CSCI 1311 or CSCI 1320 and instructor's name (and when you took the course, if you remember).
- What are your goals for this course?
- Thinking about all the math courses you've ever taken:
  - What topic(s) did you particularly like or find useful?
  - What topic(s) did you particularly dislike or find confusing or not useful?

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