CS1800
9/19 - Tues.

Admin

- HW1 due Fri 11:59
- OH online/in person
- notes on website
- live Q+A on piazza

Agenda

1. Logic statements + operators
2. Truth table
3. Implications (aka "conditionals")

1. Logic Statements

decimal ⟷ binary

sentences (NLP) ⟷ logic statements

sentences	logic statements
squishy, ambiguous	direct, unambiguous, one meaning

pure reason

code

- computers have 0/1
  - ↳ False / true

- logic statement
  - declarative
  - has a truth value (T/F)
  - usually labelled P, Q, R, ...

ex

	decl?	truth val?
There is life on mars	✓	✓
4 + 2 = 6	✓	✓
x + 2 = 6	✓	:((x?)

- Bostonians love Dunkin ✓ !! :) (which Bostonians?)
- when is HW due? !! :(

↳ simple statements
  - one thing
  - one truth value

compound statement – more common
- combine one or more simple statements
- use logical operators
  ↳ **not, and, or** — all that's needed!

ex's with operators

$P = -2 \leq -2$ (T) ⟶ logic statement

negation/not $\neg$

$\neg P$ is the negation of P

↳ P and $\neg P$ have complementary truth values

$\neg P = -2 > -2$ (F)

And (∧)

P = Lancy is an Aries

Q = Lancy is a Horse

$P \wedge Q$

- P has a truth value
- Q has a truth value
- $P \wedge Q$ has a truth value
  - ↳ False when P, Q, or both are False
  - otherwise True

Or (∨)

P = Kayla ♡ cooper

Q = Kayla ♡ sarge

$P \vee Q$

- P has a truth value
- Q has a truth value
- $P \vee Q$ has a truth value
  - ↳ True when P, Q, or both are True

    False otherwise

2. Truth tables

- specify value of a compound statement, when it depends on values of simple statements
- also: mini proof to show 2 compound statements are equivalent
- one column = one step
- start with inputs of simple statements

negation

P	¬P
T	F
F	T

input

and

P	Q	$P \wedge Q$
T	T	T
T	F	F
F	T	F
F	F	F

inputs

or

P	Q	$P \vee Q$
T	T	T
T	F	T
F	T	T
F	F	F

inputs

10:48

P	Q	$\neg(P \wedge Q)$	$\neg P \vee \neg Q$
T	T		
T	F		
F	T		
F	F		

P	Q	$P \wedge Q$	$\neg(P \wedge Q)$	$\neg P$	$\neg Q$	$\neg P \vee \neg Q$
T	T	T	F	F	F	F
T	F	F	T	F	T	T
F	T	F	T	T	F	T
F	F	F	T	T	T	T

- Compound statements have same truth values for all inputs

$$\neg(P \land Q) \equiv \neg P \lor \neg Q$$

DeMorgan's law

3. Implications (conditionals)

- and / or / not are the <u>only</u> logical operators we need
- other operators exist for convenience!

$$P \Rightarrow Q$$

P implies Q

If P, then Q

-  to 
  - ↳ respect the original statement

English statement:

> If Aces win championship, Larry gets \$

P = Aces win champs

Q = Larry gets \$

$$P \Rightarrow Q$$

P	Q	$P \Rightarrow Q$
T	T	T
T	F	F
F	T	T
F	F	T

English Statement:

We get cake if it's my birthday

P = we get cake

Q = It's my birthday

P	Q	$Q \Rightarrow P$
T	T	T
T	F	T
F	T	F
F	F	T

$P \Leftarrow Q$?

Fill in truth values
(Don't worry about implication)

P = we get cake
Q = it's my birthday

P	Q	We get cake only if it's my birthday	We get cake if and only if it's my birthday
T	T		
T	F		
F	T		
F	F		

cake today $P \Rightarrow Q$

P	Q	only if	if and only if
T	T	T	T
T	F	F	F
F	T	T	F
F	F	T	T

$(P \Rightarrow Q) \wedge (Q \Rightarrow P)$

$P \Longleftrightarrow Q$

Biconditionnal