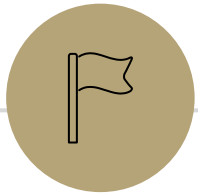


Logistics and Propositional Logic

CSE 311: Foundations of
Computing I
Lecture 1



Course Logistics

Course Staff



Anjali Agarwal (she / her)
Instructor

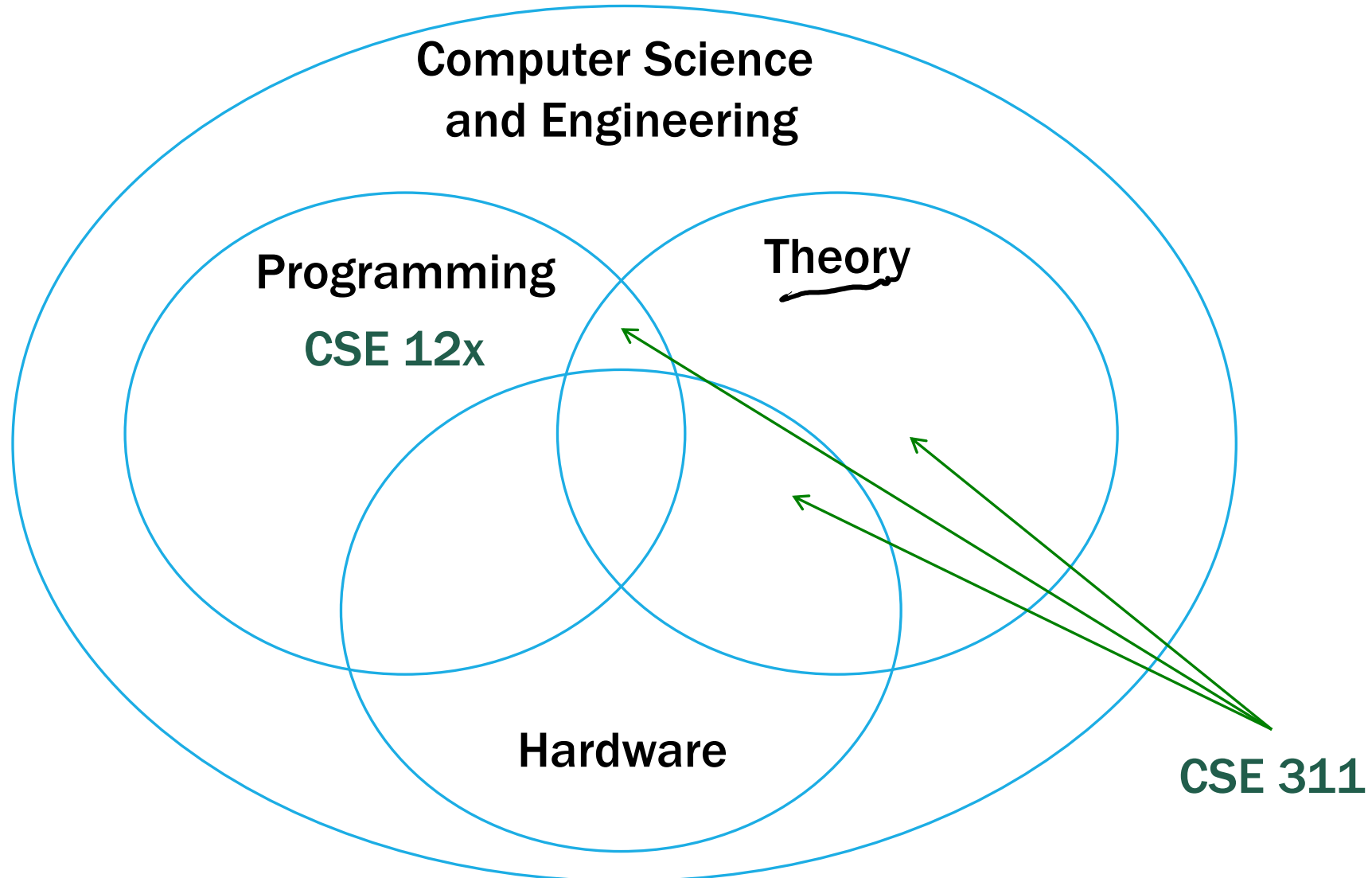


Cade Dillon (he / him)
TA



Robert Stevens (he / him)
TA

Perspective



Course Goals

1. Learn to make & clearly communicate rigorous formal arguments
 - Mathematical Proofs
2. Understand mathematical objects that are widely used in CS
 - Number Theory, Set Theory, Recursively-Defined Functions
3. Explore and analyze models of computation
 - Regular Expressions, Context-Free Grammars
4. Develop a toolkit for approaching computational problems
 - Programmer → Computer Scientist

Lectures & Sections

Lectures

- Monday, Wednesday, Friday. Recorded.

Sections

- TA-led sections meet on Thursdays
- Opportunity to practice and ask questions
- Materials are posted, but sections aren't recorded
- Participation is part of the course grade
- Can make-up absence from a couple of sections

Homework

- 7 written assignments (no programming)
- Posted Wednesday evenings, due the follow Wednesday at 11:59 pm
 - HW 1 released tonight, shorter
- Start early & consider typesetting

LaTeX

Exams

- In-class midterm on July 28th
- In-class final on August 17th and 18th

Getting Help

Office Hours

- Schedule posted on course website
- Begin this Monday

Ed Discussion

- Post any content or logistical questions

Study Groups

- 311 is *different* than programming

Textbook

- **Optional:** Discrete Mathematics and its Applications
Kenneth Rosen, 6th or 7th edition
- Helpful practice problems

Course Grades

55% Homework

15% Midterm Exam

25% Final Exam

5% Section Participation

Late Policy

- You have 4 late days for the quarter
- You can use a late day to turn in an assignment up to 24 hours late with no penalty
- You can use at most 2 late days per assignment
- In the case of extenuating circumstances, please reach out

Collaboration Policy

- Collaboration with others is **encouraged**
 - Do help other students learn
 - Do not help other students *avoid* learning
- Policy:
 - List all names of those you worked with
 - Don't take away pictures or notes from discussions
 - Write up the final solutions on your own

Course Tools



Course Website
(assignments, calendar)



Gradescope
(submissions, feedback)



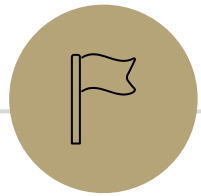
Ed Discussion
(discussion board)



Canvas
(lecture recordings)



Poll Everywhere
(lecture polling)



Propositional Logic

What is logic?

Logic is a language, like English or Java, with its own:

- Syntax: words, and rules for combining words.
- Semantics: ways to assign meaning to syntax.

$$\left[\begin{array}{l} \text{if } (\underline{\langle \text{cond} \rangle}) \ \varepsilon \\ \quad \underline{\langle \text{code} \rangle} \\ 3 \end{array} \right.$$

Why not use English?

English can be ambiguous or imprecise.

- Turn right here.

Does “right” mean the direction, or “right now”?

- We saw her duck.

Does “duck” mean the animal, or duck down?

- Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo.

This means “Bison from Buffalo, that bison from Buffalo bully, themselves bully bison from Buffalo”

Benefits of formal logic

- We can state sentences precisely
- We can state sentences concisely
- The meaning of our sentences is unambiguous

Propositions: building blocks of logic

Definition:

A **proposition** is a well-formed statement that is either true or false.

Examples:

All cats are mammals Prop ✓ True ✓

All mammals are cats Prop ✓ False ✓

Analogy

Boolean (true / false)
variables in Java

Are these Propositions?

$2 + 2 = 5$

yes - false

* x + 2 = 5

No - truth value depends on x

Akjsdf!

No - nonsense

Who are you?

No - question

There is life on Mars.

yes - prop can be unknown

There is an infinite number of primes.

yes - true

Proposition Notation

- We'll use variables to talk about arbitrary propositions
- Propositional variables: $p, q, r, s \dots$
- Truth Values:

T for true
 F for false

Atomic and Compound Propositions

Definitions:

An **atomic proposition** is a prop. that can't be broken
down further.

A **compound proposition** is a prop. that can be broken
down into simpler prop.

A **logical connective** combines atomic prop. into compound
prop.

Compound Proposition Example

It is raining in Seattle **and** it's June.

Atomic Propositions:

p : It is raining in Seattle

q : It is June

Logical Connectives:

and (\wedge)

Translation into Logic:

$p \wedge q$

Analogy

Boolean variables p, q

Java and connective **&&**

All Logical Connectives

Name

X

Logical Symbol

Java Symbol

Not

$\neg p$

!p

And

$p \wedge q$

p && q

Or

$p \vee q$

p || q

XOR

$p \oplus q$

p ^ q

Implication

$p \rightarrow q$

—

Biconditional

$p \leftrightarrow q$

p == q

Not (\neg)

$\neg p$ is true when p is false, and is false otherwise

A **truth table** is a table of all truth values of an expression

"input" "output"

p	$\neg p$
T	F
F	T

And (\wedge)

$p \wedge q$ is true when p, q are both true, and is false otherwise

inputs

output

p	q	$p \wedge q$
T	T	T
T	F	F
F	T	F
F	F	F

←

←

Or (\vee)

$p \vee q$ is true when **at least one** of p, q are true, and is false otherwise

p	q	$p \vee q$
T	T	T
T	F	T
F	T	T
F	F	F

Exclusive Or / XOR (\oplus)

$p \oplus q$ is true when **exactly one** of p, q are true, and is false otherwise

	p	q	$p \oplus q$
	T	T	F
↖	T	F	T
↖	F	T	T
	F	F	F

You may pick
blue or red.

Or vs. XOR

Identify the atomic propositions & translate the following English sentences into logic:

You may either redeem the \$10 off coupon or the 20% off coupon.

p : You may redeem the \$10 off coupon

q : You may redeem the 20% off coupon

$$p \oplus q$$

A degree in Computer Science or Data Science is required.

r : A degree in CS is required

s : A degree in DS is required.

$$r \vee s$$

Implication (\rightarrow)

$p \rightarrow q$ means "if p , then q "

premise conclusion
E.g. "If it's Wednesday, we wear pink."

p : It is Wednesday

q : We wear pink

$p \rightarrow q$

Why is this a proposition? True or False

Implication (\rightarrow)

promise

$p \rightarrow q$ means "if p , then q "

E.g. "If it's Wednesday, we wear pink."

inputs		output
p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

It's Wednesday and we are wearing pink \rightarrow

It's Wednesday and we are not wearing pink \rightarrow

It's not Wednesday and we are wearing pink \rightarrow

It's not Wednesday and we are not wearing pink \rightarrow

Implication (\rightarrow)

$p \rightarrow q$ means "if p , then q "

E.g. "If the Earth is flat, then all numbers are odd."

F



True

F

Vacuous Truth

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T



$$p \Rightarrow q \text{ vs. } q \Rightarrow p$$

These are different implications.

p : It is raining
 q : I have my umbrella

$$p \rightarrow q$$

If it is raining, I have my umbrella.

	It's raining	It's not raining
I have my umbrella	T	T
I do not have my umbrella	F	T

$$q \rightarrow p$$

If I have my umbrella, it is raining.

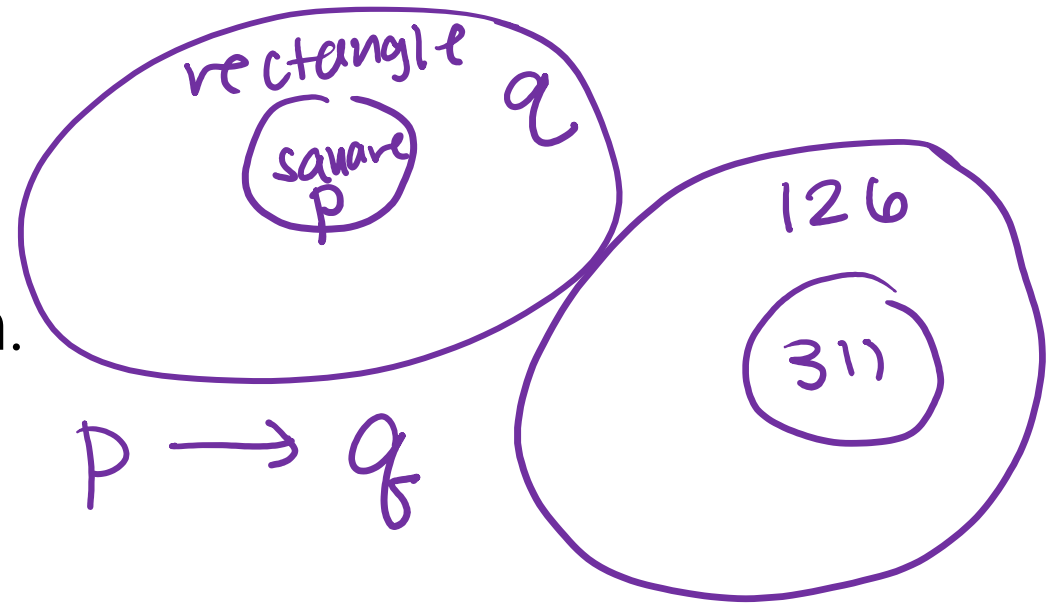
	It's raining	It's not raining
I have my umbrella	T	F
I do not have my umbrella	T	T

Translating Implications

Whenever I am hungry, I eat a sandwich.

p : I am hungry

q : I eat a sandwich



It is necessary to have internet connection to be able to use Zoom.

$\rightarrow r$: You have internet connection

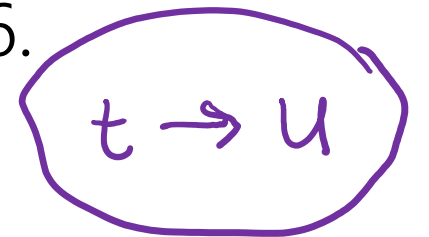
$\rightarrow s$: You can use Zoom



You may register for CSE 311 only if you have taken Math 126.

t : You may register for CSE 311

u : You have taken Math 126



Translating Implications

Implication:

$$p \rightarrow q$$

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

q is necessary for p

p	q	$p \rightarrow q$
T	T	T
T	F	F
F	T	T
F	F	T

Section Tomorrow

Practice with translating and writing truth tables!

If it is raining or snowing, Red Square is slippery.

p : It is raining

q : It is snowing

r : Red Square is slippery

$$\underline{(p \vee q)} \rightarrow \underline{r}$$