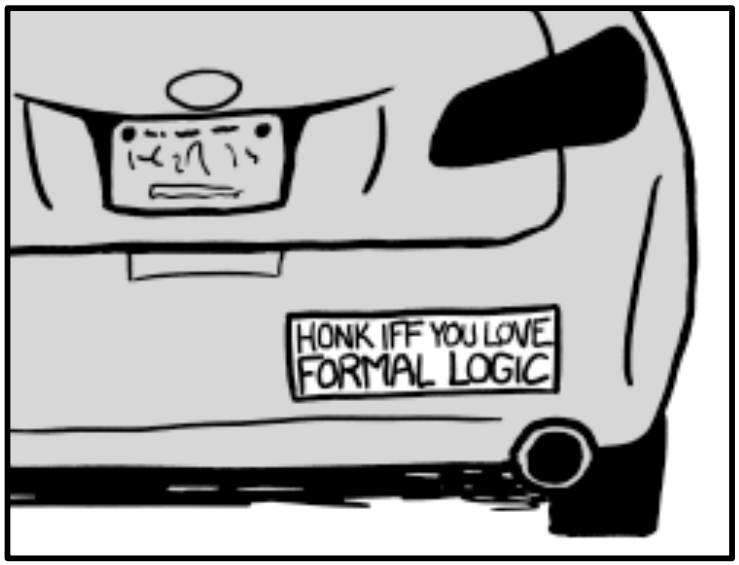
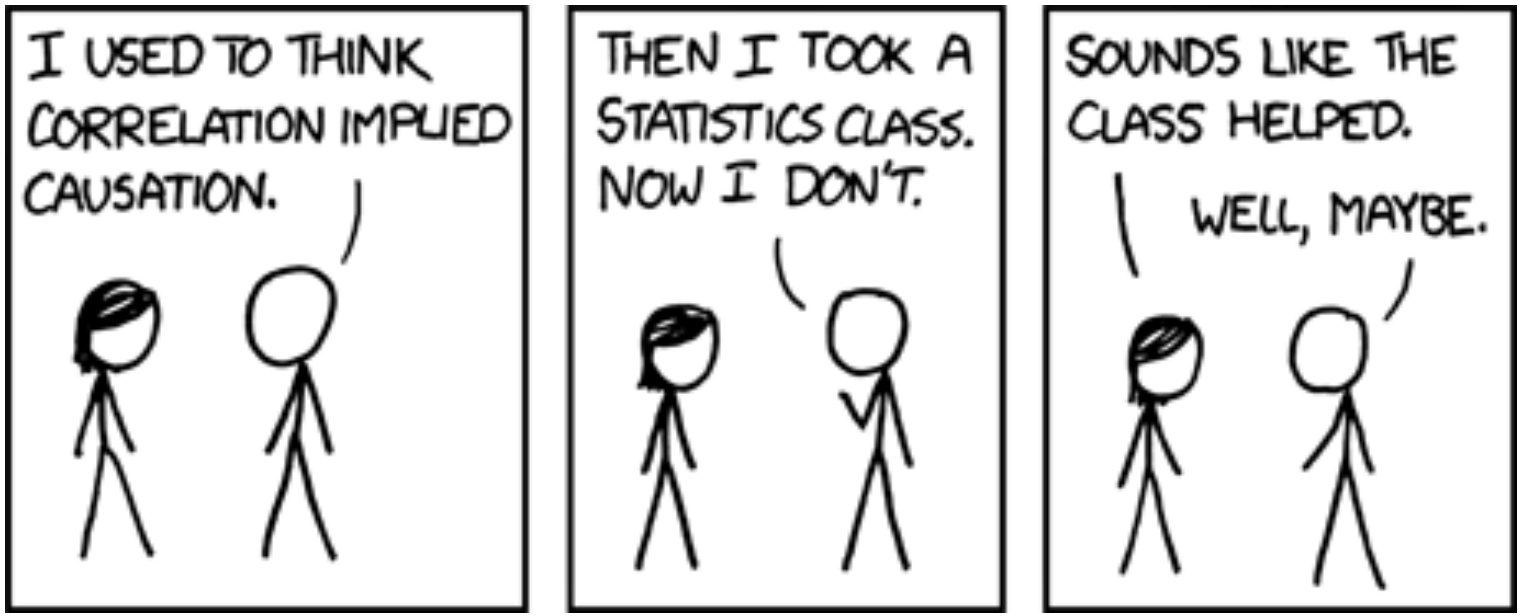
CSE 311: Foundations of Computing I

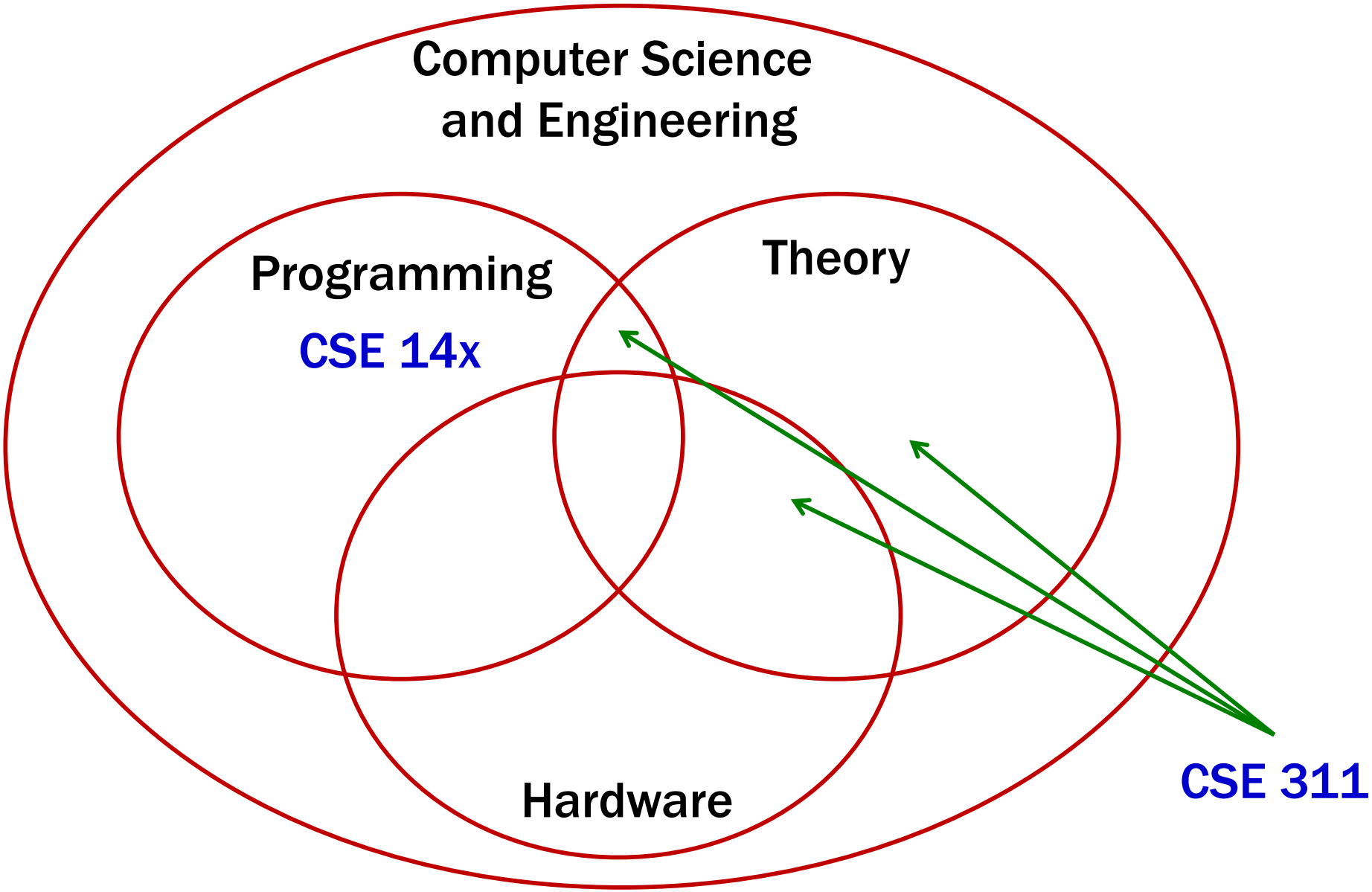
Lecture 1: Propositional Logic





About CSE 311

Some Perspective



About the Course

We will study the *theory* needed for CSE:

Formal Logic:

How can we describe ideas *precisely*?

Formal Proofs:

How can we be *positive* we're correct?

Number Theory:

How do we keep data *secure?*

Sets/Relations/Relational Algebra:

How do we store and describe information?

Finite State Machines:

How do we design hardware and software?

General Computing Machines:

Are there problems computers *can't* solve?

About the Course

And become a better programmer

By the end of the course, you will have the tools to...

- reasoning about difficult problems
- automating difficult problems
- communicating ideas, methods, objectives
- understand fundamental structures of CS

About the Course

And become more comfortable with formal methods

Difficult problems often require formalism ("math")

- don't confuse correlation with causation

Formalism is a tool we apply when problems get difficult

- helps us get through without making mistakes
- sometimes even gives "turn the crank" solutions

Course Logistics

Course Web Site

cs.uw.edu/311

CSE 311: Foundations of Computing I | Home | Calendar | Assignments | Lectures | Sections | Message Board

- Home
- Syllabus
- Grading
- Documents
- Exams
- Canvas

CSE 311: Foundations of Computing I

Instructors Kevin Zatloukal (kevinz at cs)

Message Board:
Please use the message board whenever possible. The answer to your question is likely to be helpful to others in the class, and, by using the message board, the answer be available to them as well. When you sign up, make sure to opt out of Piazza Careers to ensure data privacy.

Contact: For other private matters, send email to cse311-staff at cs, which will reach both the instructor and TAs.

Lectures: Mondays, Wednesdays, and Fridays

	Time	Location	Instructor
A	10:30–11:20	CSE2 G10	Kevin Zatloukal
B	1:30–2:20	CSE2 G20	Kevin Zatloukal

Sections: Thursdays

	Time	Location	Instructor
AA	9:30–10:20	MGH 251	Oscar Sprumont
AC	10:30–11:20	MGH 254	Joy Ji
AD	11:30–12:20	JHN 175	Daniel Fuchs
AE	12:30–1:20	SAV 156	Austin Chan
AG	1:30–2:20	LOW 205	Siddharth Bedekar
BA	12:30–1:20	THO 202	Zhu Li
BB	1:30–2:20	CDH 110B	Jason Waataja
BC	2:30–3:20	MGH 271	Frank Qin
BD	11:30–12:20	DEN 213	Karishma Mandyam
BE	12:30–1:20	SAV 156	Austin Chan
BG	1:30–2:20	LOW 205	Siddharth Bedekar

Instructors

Kevin Zatloukal

Section A
MWF 10:30-11:20 in CSE2 G10

Kevin Zatloukal

Section B
MWF 1:30-2:20 in CSE2 G20

Office Hours:
MF 12:00-1:00 in CSE 436
W 2:30-3:20 in CSE 436

Section B lectures will be recorded

TAs

Section	Time	Instructor
AA	9:30	Oscar Sprumont
AC	10:30	Joy Ji
AD	11:30	Daniel Fuchs
BD	11:30	Karishma Mandyam
AE/BE	12:30	Austin Chan
BA	12:30	Zhu Li
AG/BG	1:30	Siddharth Bedekar
BB	1:30	Jason Waataja
BC	2:30	Frank Qin
		Meha Agarwal

Office Hours

- **multiple hours very day of the week (starting on Friday)**
- **see web site for times and locations**

Optional Textbook

Discrete Mathematics and It's Applications
by Kenneth H. Rosen

Readings for 6^{th} (used) or 7^{th} (cut down) editions

Useful for

- alternative presentation of (most) material
- many solved problem examples

Administrivia

Homework

- generally due Wednesdays by 11pm
- submit PDFs in GradeScope (auto-signup later this week)
- extra credit problems for extra learning (little grade effect)

Exams

- midterm in class (see calendar)
- final exam Monday of finals week
  - section B at 2:30-4:20 in CSE2 G20
  - section A at 4:30-6:20 in CSE2 G20

Grading (roughly)

- 50% homework
- 15-20% midterm
- 30-35% final

Contact Us

Piazza message board (link on web site)

- best way to ask questions
- opt out of "careers"

Staff mailing list (cse311-staff at cs)

- for private matters
- goes to myself and the TAs

Course mailing list (auto-subscribed)

- for important course announcements
  - e.g, changes to homework problems or due dates
- used infrequently but do check your email

About grades…

- Grades were very important up until now
- Grades are **much less** important going forward
  - companies care much more about your interviews
  - grad schools care much more about recommendations
- Understanding the material is much more important
  - interviews test your knowledge from 300-level classes
  - good recommendations involve knowledge beyond the classes
- Please **relax** and focus on learning as much as possible
  - all of the 300-level material will be useful in your career

Please calm down about grades

- Most time spent on questions about grading issues is not worthwhile to either the student or teacher
- Try to avoid asking “will I lose points if…”
- If the thought of losing points worries you, show more work
  - no sense having a 30 minute discussion to save 10 minutes
- Try to avoid the phrase “not fair”
  - (this is probably not about the course material)

Collaboration Policy

- Collaboration with others is encouraged
  BUT you must:
  - **list** anyone you work with
  - **write up** all solutions on your own

- Important rules:
  - do not leave with any solution written down or photographed
  - wait 30 minutes before writing up your solution

- You cannot "collaborate" with Google, MathOverflow, etc.

- See Allen School Academic Misconduct policy

Grading Policies

- Solutions must be readable for us to grade them!
  - requires both legible handwriting and a good quality scan

    alternatively: you can type them
  - you will lose points if your solution is too hard to read

- One week to submit a regrade request (in GradeScope)
  - only if you believe a correct answer was marked incorrect

- We will not debate size of point deductions

- We will grade problems based on the problem *intent*
  - send your legalistic arguments to the law school

Late Work

- To be accepted, late submission must be arranged at least 48 hours before the deadline
  - or send a selfie with the emergency room doctor to cse311-staff

Propositional Logic

What is logic and why do we need it?

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

- words and rules for combining words into sentences (syntax)
- ways to assign meaning to words and sentences (semantics)

Why learn another language when we know English and Java already?

Why not use English?

- Turn right here…

  Does “right” mean the direction or now?

- Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo

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

- We saw her duck

  Does “duck” mean the animal or crouch down?

Natural languages can be imprecise

Why not use Java?

What does this code do:

```
public static boolean mystery(int x) {
  for (int r = 2; r < x; r++) {
    for (int q = 2; q < x; q++) {
      if (r*q == x)
        return false;
      }
    }
  }
  return x > 1;
}
```

Determines if x is a prime number

Programming languages can be verbose

Why learn a new language?

We need a language of reasoning to

- state sentences more precisely
- state sentences more concisely
- understand sentences more quickly

Formal logic has these properties

Propositions: building blocks of logic

A ***proposition*** is a statement that

- is either true or false
- is "well-formed"

Propositions: building blocks of logic

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All cats are mammals

true

All mammals are cats

false

Are These Propositions?

$2 + 2 = 5$

This is a proposition. It's okay for propositions to be false.

$x + 2 = 1236$, where x is your PIN number

This is a proposition. We don't need to know what x is.

You will get a 3.6 in this class

Not a proposition. Doesn't have a fixed truth value

Akjsdf!

Not a proposition because it's gibberish.

Who are you?

This is a question which means it doesn't have a truth value.

Every positive even integer can be written as the sum of two primes.

This is a proposition. We don't know if it's true or false, but we know it's one of them!

A first application of logic

"If I were to ask you out, would your answer to that question be the same as your answer to this one?"

Propositions

We need a way of talking about *arbitrary* ideas...

Propositional Variables: $p, q, r, s, \ldots$

Truth Values:

- T for true
- F for false

Logical Connectives

Negation (not)	$\neg p$
Conjunction (and)	$p \wedge q$
Disjunction (or)	$p \vee q$
Exclusive Or	$p \oplus q$
Implication	$p \longrightarrow q$
Biconditional	$p \longleftrightarrow q$

A Compound Proposition

"Garfield has black stripes if he is an orange cat and likes lasagna, and he is an orange cat or does not like lasagna"

We'd like to *understand* what this proposition means.

A Compound Proposition

"Garfield has black stripes if he is an orange cat and likes lasagna, and he is an orange cat or does not like lasagna"

We'd like to *understand* what this proposition means.

First find the simplest (**atomic) propositions**:

- p "Garfield has black stripes"
- q "Garfield is an orange cat"
- r "Garfield likes lasagna"

(p if (q and r)) and (q or (not r))

Logical Connectives

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(p if (q and r)) and (q or (not r))

(**p if** (q ∧ r)) ∧ (**q** ∨ ¬**r**)

Some Truth Tables

p	$\neg p$

p	q	$p \wedge q$

p	q	$p \vee q$

p	q	$p \oplus q$

Some Truth Tables

p	$\neg p$
T	F
F	T

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

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

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

Implication

"If it's raining, then I have my umbrella"

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

It's useful to think of implications as promises. That is "Did I lie?"

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

Implication

"If it's raining, then I have my umbrella"

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

It's useful to think of implications as promises. That is "Did I lie?"

	It's raining	It's not raining
I have my umbrella	No	No
I do not have my umbrella	**Yes**	No

The only lie is when:

(a) It's raining AND

(b) I don't have my umbrella

Implication

"If it's raining, then I have my umbrella"

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

Are these true?

$2 + 2 = 4 \rightarrow$ *earth is a planet*

The fact that these are unrelated doesn't make the statement false! "2 + 2 = 4" is true; "earth is a planet" is true. T→T is true. So, the statement is true.

$2 + 2 = 5 \rightarrow$ *26 is prime*

Again, these statements may or may not be related. "2 + 2 = 5" is false; so, the implication is true. (Whether 26 is prime or not is irrelevant).

Implication is not a causal relationship!