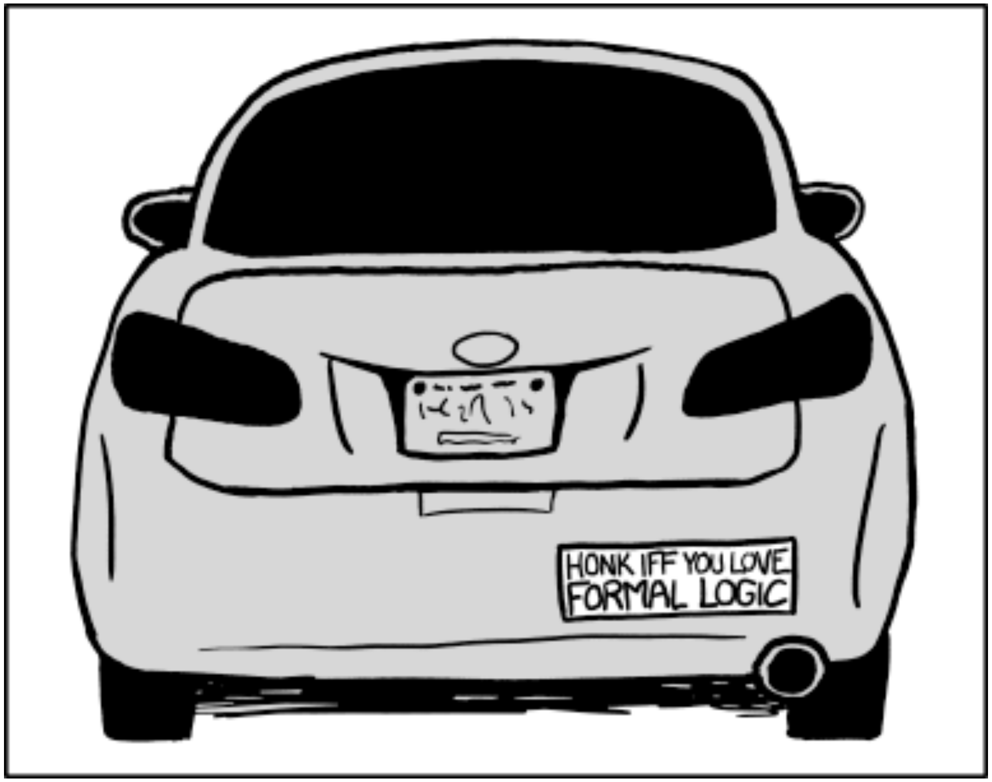
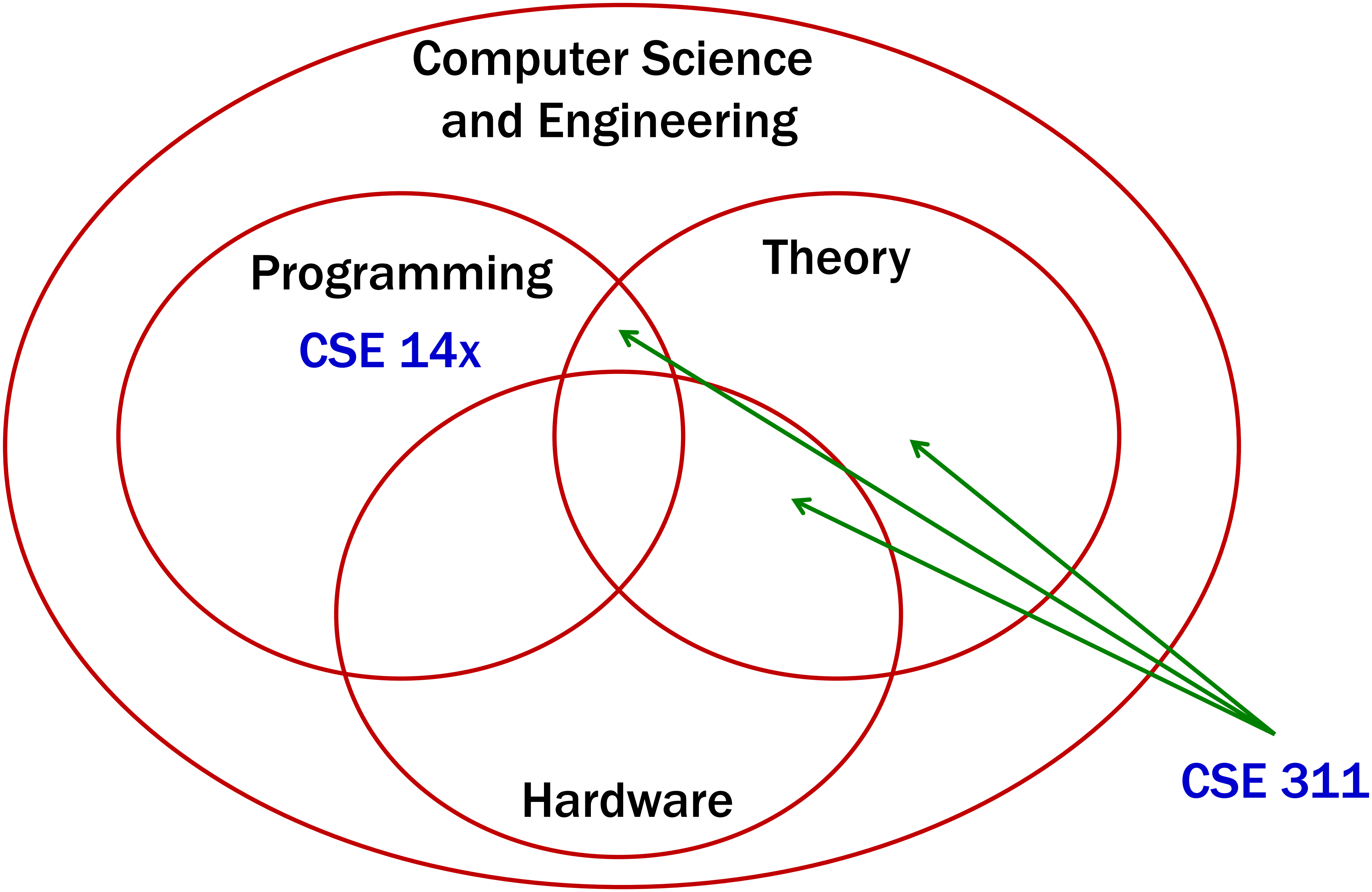
CSE 311: Foundations of Computing I

Lecture 1: Propositional Logic



About CSE 311

Some Perspective



About the Course

We will study the *theory* needed for CSE:

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?*

Relations/Relational Algebra:

How do we store information?

Finite State Machines:

How do we design hardware and software?

Turing 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

Course Logistics

Instructors

Thomas Rothvoss

Section B
MWF 9:30-10:20 in CSE2 G01

Office Hours:
M 10:30-11:30 both in CSE 342
W 11:30-12:30

Kevin Zatloukal

Section A
MWF 1:30-2:20 in JHN 102

Office Hours:
W 2:30-1:20 both in CSE 436
F 12:30-1:20

Office hours are for students in both sections

Section A lectures will be **recorded**

TAs

Teaching Assistants:

Yuqing Ai
Austin Chan
Philip Garrison
Kush Gupta
Siddharth Vaidynathan
Sean Jaffe
Belinda Li
Zhu Li
Oscar Sprumont
Jason Waataja

Section:

Thursdays

– starting this week

Office Hours: TBD

Administrivia

(Optional) Book:
Rosen: Readings for 6^{th} (used) or
7^{th} (cut down) editions.
Good for practice with solved problems

Administrivia

Homework:
- Due WED at 11:00 pm online
- Write up individually
- Extra Credit

Exams:
- Midterm in class
- Final exam, Monday, June 10
- Section A at 2:30-4:20
- Section B at 4:30-6:20
- both in JHN 102

Grading (roughly):
- 50% Homework
- 15-20% Midterm
- 30-35% Final Exam

Contact Us

Piazza message board
- use for most questions
- (opt out of “careers”)

Staff mailing list
- private matters only
- cse311-staff at cs

All Course Information @ cs.uw.edu/311

Course Web Site

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

Home
Syllabus
Grading
Exams
Canvas

CSE 331: Foundations of Computing I

Instructors: Thomas Rothvoss (rothvoss at uw) and 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 grading or other private matters, send email to cse311-staff at cs, which will reach both the instructors and TAs.

Lectures: Mondays, Wednesdays, and Fridays

	Time	Location	Instructor
B	9:30–10:20	CSE2 G01	Thomas Rothvoss
A	1:30–2:20	JHN 102	Kevin Zatloukal

Sections: Thursdays

	Time	Location	Instructor
AA	12:30–1:20	ECE 031	TBD
AB	1:30–2:20	ECE 045	TBD
AC	2:30–3:20	ECE 042	TBD
AD	11:30–12:20	MGH 271	TBD
AE	9:30–10:20	ART 317	TBD
AF	8:30–9:20	MGH 238	TBD
BA	8:30–9:20	MGH 238	TBD
BB	9:30–10:20	FTR 106	TBD
BC	10:30–11:20	MGH 251	TBD
BD	11:30–12:20	MGH 251	TBD
BE	12:30–1:20	MGH 271	TBD

About grades…

- Grades were very important up until now…

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  - good recommendations involve knowledge beyond the classes

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  - good recommendations involve knowledge beyond the classes
- Please <u>relax</u> and focus on learning

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)

Grading Policies

- 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

Collaboration Policy

- Collaboration with others is encouraged
- BUT you must:
  - list anyone you work with
  - turn in only your own work
- Recommended approach for group work
  - do not leave with any solution written down or photographed
  - wait 30 minutes before writing up your solution
- See Allen School Academic Misconduct policy also

Late Work

- To be accepted, late submission must be arranged at least 48 hours before the deadline

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…

– Buffalo buffalo Buffalo buffalo buffalo buffalo Buffalo buffalo

– We saw her duck

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  Does “right” mean the direction or now?

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  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?

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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;
}
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  }
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}
```

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

Propositions: building blocks of logic

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

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

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

- is either true or false
- is “well-formed”

All cats are mammals

true

All mammals are cats

false

Are These Propositions?

$2 + 2 = 5$

$x + 2 = 5$

Akjsdf!

Who are you?

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

Are These Propositions?

2 + 2 = 5

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

x + 2 = 5

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

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.

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

p "Garfield has black stripes"

q "Garfield is an orange cat"

r "Garfield likes lasagna"

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

Logical Connectives

Negation (not)	$\neg p$
Conjunction (and)	$p \land q$
Disjunction (or)	$p \lor q$
Exclusive Or	$p \oplus q$
Implication	$p \longrightarrow q$
Biconditional	$p \leftrightarrow q$

Logical Connectives

Negation (not)	$\neg p$
Conjunction (and)	$p \wedge q$
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↓

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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
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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	$p \to q$
T	T	T
T	F	F
F	T	T
F	F	T

Are these true?

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

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

Implication

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

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

$p \rightarrow q$

(1) "I have collected all 151 Pokémon if I am a Pokémon master"

(2) "I have collected all 151 Pokémon only if I am a Pokémon master"

These sentences are implications in opposite directions:

$p \rightarrow q$

---

(1) "I have collected all 151 Pokémon if I am a Pokémon master"

(2) "I have collected all 151 Pokémon only if I am a Pokémon master"

These sentences are implications in opposite directions:

(1) "Pokémon masters have all 151 Pokémon"

(2) "People who have 151 Pokémon are Pokémon masters"

So, the implications are:

(1) If I am a Pokémon master, *then* I have collected all 151 Pokémon.

(2) If I have collected all 151 Pokémon, *then* I am a Pokémon master.

$p \rightarrow q$

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*
- *q is necessary for p*

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