CSE 311 Section 0

Introduction

Announcements & Reminders

- Sections are Graded
  - You will be graded on section participation, so please try to come ☺
  - If you are unable to attend, please submit the completed handout to Gradescope by 6pm the day after section.
  - This quarter there are both quizzes and sections. Remember to come to your registered section on quiz days.

- Section Materials
  - Handouts will be provided in at each section
  - Worksheets and sample solutions will be available on the course calendar later this evening

Your TAs

- Your name
  - email
  - favorite class:
  - something about you
  - Office Hours: !!

Tips for 311!

- Tackling challenging homework problems may feel intimidating at first but **don't go at it alone**! Find study groups, join us in office hours, and ask questions on Ed.

- Section will often be challenging and fast but valuable for your learning. **This is your time to ask lots of questions and clarify your learning**!
- Sometimes homework problems will mirror section problems, use that to your advantage!

- This class is the best time to learn how to Latex, please consider learning now as it will save you time for future courses! Feel free to come to office hours to get help with Latex!

- We have created an example latex template that you can find here: https://www.overleaf.com/read/rnxmrjvgbtrx#e59d4e

Icebreaker

- Get into groups of 3-5
- Please share with your group
  - Name
  - Number of years at UW
  - What was something you did over winter break?
- Then try to find 5 things you all have in common
- We'll go around then and introduce each other and share these.

Icebreaker Bingo

Has a birthday this month	Has traveled outside the country	Can play an instrument	Taking CSE 351	Has attended a sports game
Is a double major/has a minor	Likes pineapple on pizza	Has a Wordle streak	Has lived in more than one state/country	Has watched Zootopia 2
Likes matcha	Has a cat	Free space	Taking more than 15 credits	Is the oldest sibling
Likes sushi	Is left-handed	Lives on or near campus	Can solve a Rubik's cube	Has done a Hackathon
Has pulled an all nighter	Taking CSE 331	Uses VS Code	Likes iced coffee year-round	Has met Dubs

Propositions & Implications

Quick Concept Review

- **Propositions** are statements with a boolean truth value!
  - "**The AQI of Seattle is 50**" is a proposition. We know it's either true or false.
  - "**The AQI of Seattle?**" is not. Suddenly it could be hundreds of values.
  - In formal logic, we like to assign a proposition into a variable for later use.
- **Logical connectives** connect propositions to form new propositions!

$$\neg p$$

$$p \wedge q$$

$$p \vee q$$

$$p \rightarrow q$$

$$p \leftrightarrow q$$

Truth Tables

Gives us a simple way to describe how logical connectives operate

p	¬p
T	F
F	T

p	q	p∧q
T	T	T
T	F	F
F	T	F
F	F	F

p	q	p∨q
T	T	T
T	F	T
F	T	T
F	F	F

Implications

Some common formulations:

- 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 → q
T	T	T
T	F	F
F	T	T
F	F	T

Vacuous truths: a false hypothesis, but true truth value

“Only if”

I attended my 8:30am class only if I woke up early

Which is equivalent?

If I woke up early then I attended my 8:30 am class

or

If I attended my 8:30 am class then I woke up early

“Only if”

I attended my 8:30am class only if I woke up early

If I woke up early then I attended my 8:30 am class

NOT Equivalent: The original statement **does not specify** what happens **when you wake up early**, you can wake up early to go play tennis in the morning!

If I attended my 8:30 am class then I woke up early

Equivalent: The original statement only **specifies exactly** what happened **when you went to your 8:30 class**, you **must** have woken up early. Nothing else could have happened for you to be attending the 8:30 class.

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

(a) If I am lifting weights this afternoon, then I do a warm-up exercise.

(b) I can go home only if I have finished my homework.

Work on this problem with the people around you,
and then we'll go over it together!

Warm Up

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a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1

p: I am lifting weights this afternoon

q: I do a warm-up exercise

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1

p: I am lifting weights this afternoon

q: I do a warm-up exercise

Step 2

If p **then** q

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

a) If I am lifting weights this afternoon, then I do a warm-up exercise.

Step 1
p: I am lifting weights this afternoon
q: I do a warm-up exercise

Step 2
If p **then** q

Step 3
$p \rightarrow q$

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

b) I can go home only if I have finished my homework.

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

b) I can go home only if I have finished my homework.

Step 1:
p: I can go home
q: I have finished my homework

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

b) I can go home only if I have finished my homework.

Step 1:
p: I can go home
q: I have finished my homework

Step 2:
p only if q

Warm Up

Steps:

1. Create propositional variables
2. Replace all propositions with created variables
3. Replace the operators

b) I can go home only if I have finished my homework.

Step 1:
p: I can go home
q: I have finished my homework

Step 2:
p only if q

Step 3
$p \rightarrow q$

Normal Forms

(Canonical) Normal Forms

- Standard ways of translating a truth table into a proposition.
- We already did these in lecture when we translated implications into an expression only using ands, ors, and nots!
- Once you translate into one of these forms, **don't simplify your expression any further!** It often looks like you can factor variables out to make it prettier, but the whole point is to write the expression into this standardized way, so just leave it as-is ☺

DNF (OR of ANDs)

- Disjunctive Normal Form
  - OR of ANDs
  - Method:
    1. Read the TRUE rows of the truth table
    2. AND together all the variable settings in a given (true) row
    3. OR together the true rows

DNF (OR of ANDs)

1. Read the TRUE rows of the truth table
2. AND together all the variable settings in a given (true) row
3. OR together the true rows

p	*q*	*G(p,q)*
T	T	T
T	F	F
F	T	T
F	F	F

$p \wedge q$

$\neg p \wedge q$

$$G(p,q) \equiv (p \wedge q) \vee (\neg p \wedge q)$$

CNF (AND of ORs)

- Conjunctive Normal Form
  - AND of ORs
  - Method:
    1. Read the FALSE rows of the truth table
    2. OR together the negations of all the variable settings in the false row
    3. AND together the false rows

CNF (AND of ORs)

1. Read the FALSE rows of the truth table
2. OR together the negations of all the variable settings in the false row
3. AND together the false rows

p	*q*	*G(p,q)*
T	T	T
T	F	F
F	T	T
F	F	F

$\neg p \vee q$

$p \vee q$

$$G(p,q) \equiv (\neg p \vee q) \wedge (p \vee q)$$

Canonical Forms

Consider the functions $F(A, B, C)$ and $G(A, B, C)$ specified by the following truth table:

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

a) Write the DNF and CNF expressions for $F(A, B, C)$.

We will do the DNF together and then you will work on the CNF with the people around you

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

DNF: (OR of ANDs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

DNF: (OR of ANDs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

DNF: (OR of ANDs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

	A	B	C	F(A,B,C)	G(A,B,C)
$A \wedge B \wedge C$	T	T	T	T	F
$A \wedge B \wedge \neg C$	T	T	F	T	T
	T	F	T	F	F
	T	F	F	F	F
$\neg A \wedge B \wedge C$	F	T	T	T	T
$\neg A \wedge B \wedge \neg C$	F	T	F	T	F
	F	F	T	F	T
$\neg A \wedge \neg B \wedge \neg C$	F	F	F	T	F

Canonical Forms

a) Write the DNF and CNF expressions for $F(A, B, C)$.

DNF: (OR of ANDs)

	A	B	C	F(A,B,C)	G(A,B,C)
$A \wedge B \wedge C$	T	T	T	T	F
$A \wedge B \wedge \neg C$	T	T	F	T	T
	T	F	T	F	F
	T	F	F	F	F
$\neg A \wedge B \wedge C$	F	T	T	T	T
$\neg A \wedge B \wedge \neg C$	F	T	F	T	F
	F	F	T	F	T
$\neg A \wedge \neg B \wedge \neg C$	F	F	F	T	F

$$(\boldsymbol{A} \wedge \boldsymbol{B} \wedge \boldsymbol{C}) \vee (\boldsymbol{A} \wedge \boldsymbol{B} \wedge \neg \boldsymbol{C}) \vee (\neg \boldsymbol{A} \wedge \boldsymbol{B} \wedge \boldsymbol{C}) \vee (\neg \boldsymbol{A} \wedge \boldsymbol{B} \wedge \neg \boldsymbol{C}) \vee (\neg \boldsymbol{A} \wedge \neg \boldsymbol{B} \wedge \neg \boldsymbol{C})$$

Canonical Forms

CNF: (AND of ORs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

CNF: (AND of ORs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

A	*B*	*C*	*F(A,B,C)*	*G(A,B,C)*
T	T	T	T	F
T	T	F	T	T
T	F	T	F	F
T	F	F	F	F
F	T	T	T	T
F	T	F	T	F
F	F	T	F	T
F	F	F	T	F

Canonical Forms

CNF: (AND of ORs)

a) Write the DNF and CNF expressions for $F(A, B, C)$.

	A	B	C	F(A,B,C)	G(A,B,C)
	T	T	T	T	F
	T	T	F	T	T
$\neg A \vee B \vee \neg C$	T	F	T	F	F
$\neg A \vee B \vee C$	T	F	F	F	F
	F	T	T	T	T
	F	T	F	T	F
$A \vee B \vee \neg C$	F	F	T	F	T
	F	F	F	T	F

Canonical Forms

a) Write the DNF and CNF expressions for $F(A, B, C)$.

CNF: (AND of ORs)

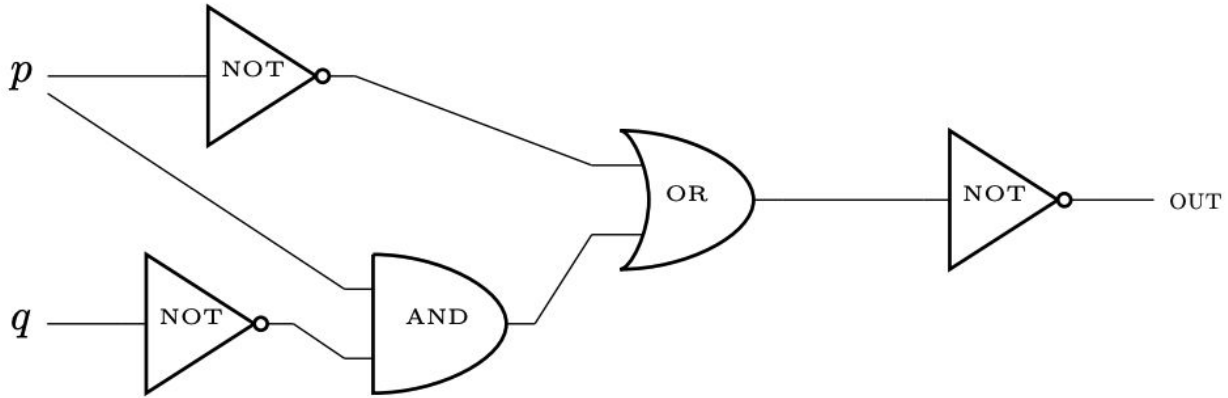
	A	B	C	F(A,B,C)	G(A,B,C)
	T	T	T	T	F
	T	T	F	T	T
$\neg A \vee B \vee \neg C$	T	F	T	F	F
$\neg A \vee B \vee C$	T	F	F	F	F
	F	T	T	T	T
	F	T	F	T	F
$A \vee B \vee \neg C$	F	F	T	F	T
	F	F	F	T	F

$$(\neg A \vee B \vee \neg C) \wedge (\neg A \vee B \vee C) \wedge (A \vee B \vee \neg C)$$

Circuits

Circuits

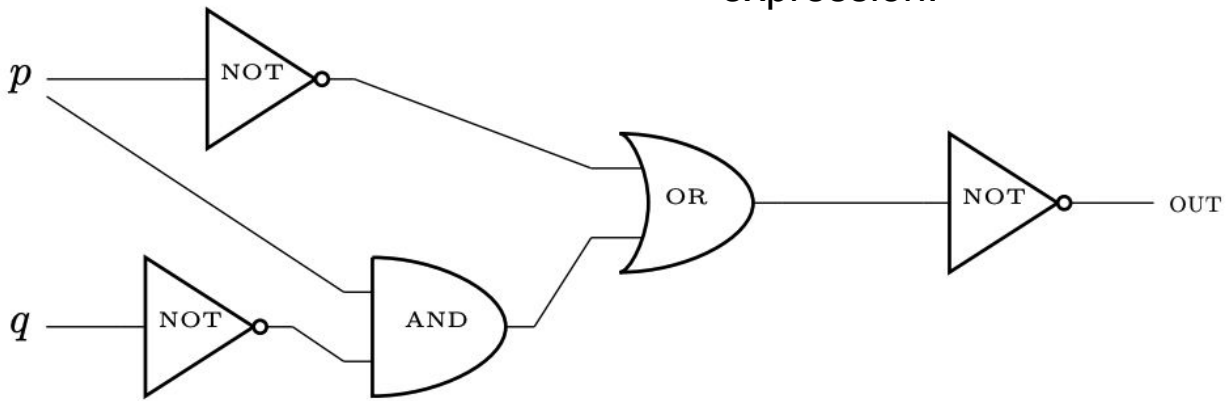
Translate the following circuit into a logical expression.



Work on this problem with the people around you, and then we'll go over it together!

Circuits

Translate the following circuit into a logical expression.



$\neg(\neg p \vee (p \wedge \neg q))$

Usefulness of Gates

Some sets of logical gates can implement all boolean functions! Examples:

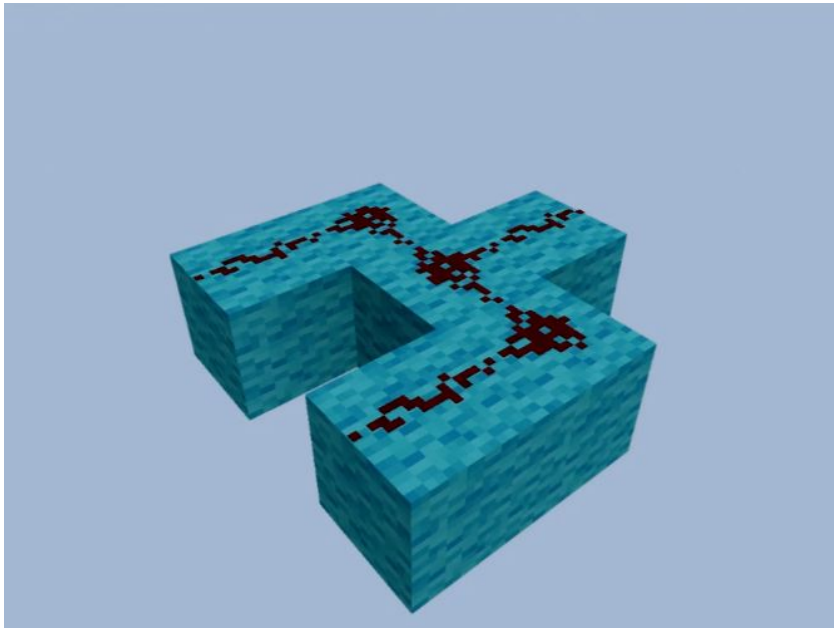
- {AND, OR, NOT}
  - {AND, NOT}
  - {OR, NOT}
- {NAND}
- {NOR}

A Theoretical Example...

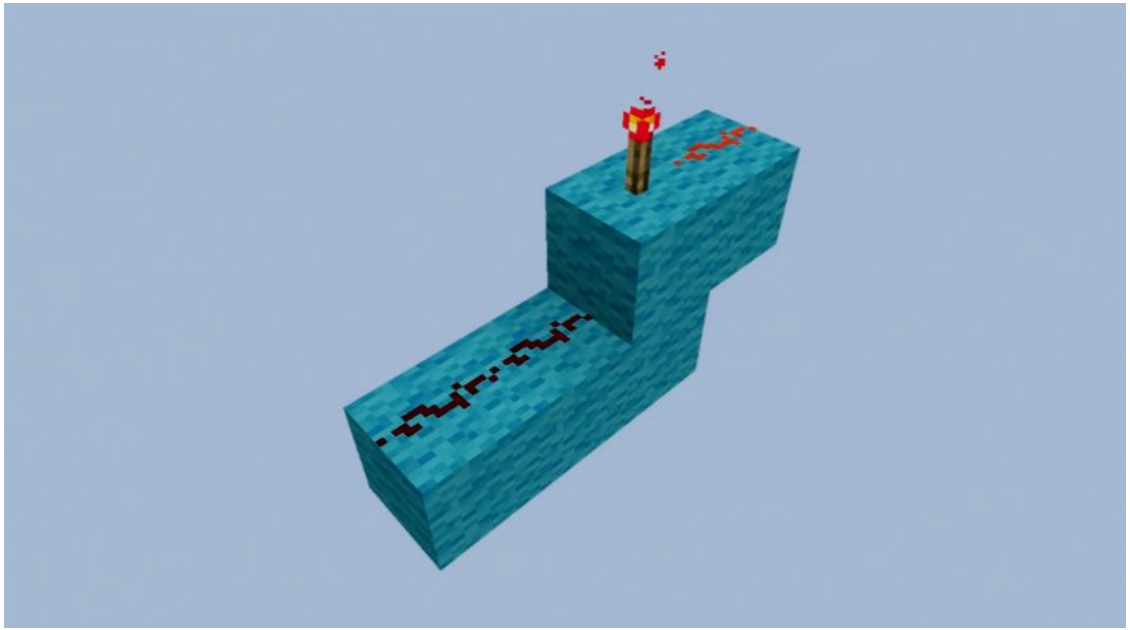
“In physics, if you’re working in condensed matter, you’re coming up with new **theoretical** materials. … What would they be good for? … Could I actually compute with this if we could build this thing? … Could I build enough gates that we could do general purpose computing? If so, it might be worth trying to figure out if we can actually build that state of matter.”

- Kevin Zatloukal, PhD in quantum algorithms

Redstone OR Gate



Redstone NOT Gate



That's All, Folks!

Thanks for coming to section this week!
Any questions?