CSE 311 Section 1

Propositional Logic

Administrivia & Introductions

Homework

- Submissions
  - LaTeX (highly encouraged)
    - overleaf.com
    - template and LaTeX guide posted on course website!
  - Word Editor that supports mathematical equations
  - Handwritten neatly and scanned
- All homeworks will be turned in via Gradescope
- Homeworks typically due on Wednesdays at 10pm
- You have 6 late days **total** to use throughout the quarter
  - Anything beyond that will result in a deduction on further late assignments
- Only 3 late days max can be used per assignment

Announcements & Reminders

- Sections are Graded
  - You will be graded on section participation, so please try to come ☺
- Section Materials
  - Handouts will be provided in at each section
  - Worksheets and sample solutions will be available on the course calendar later this evening
- HW1
  - Due Wednesday 1/11 @ 10pm

Your TAs

- TA 1
  - content
- TA 2
  - content

Icebreaker

- Small groups of 4-6ish
- Please share with your group
  - Your name
  - Number of years in department/ at UW
  - What was something fun you did over Winter break?
  - What are you concerned about for 311 / what are you excited about?
- Then, share how you like to eat your potatoes (baked, fried, chips, etc)
- We'll go around and see what style of potato is most popular!

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	$\neg p$
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

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

Problem 1 – 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) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Problem 1a – 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.

Problem 1a – 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

Problem 1a – 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

Problem 1a – 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
$p \rightarrow q$

Problem 1b

Problem 1b – Warm Up

Steps:

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

b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

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

Problem 1b – Warm Up

Steps:

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

b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Problem 1b – Warm Up

Steps:

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

b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Step 1

p: I am cold
q: I am going to bed
r: I am two-years old
s: I carry a blanket

NOTE: you need a subject for each proposition. “Going to bed” is not a proper proposition, you need to add the “I am” to make it a valid sentence, and thus a valid proposition!!!

Problem 1b – Warm Up

Steps:

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

b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Step 1

p: I am cold
q: I am going to bed
r: I am two-years old
s: I carry a blanket

Step 2

If p and q or r, then s

Problem 1b – Warm Up

Steps:

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

b) If I am cold and going to bed or I am two-years old, then I carry a blanket.

Step 1
p: I am cold
q: I am going to bed
r: I am two-years old
s: I carry a blanket

Step 2
If p and q or r, then s

Step 3
$[(p \wedge q) \vee r] \rightarrow s$

Problem 2

Problem 2 – If I can translate, then…

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

a) Whenever I walk my dog, I make new friends.

b) I will drink coffee, if Starbucks is open or my coffeemaker works.

c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.

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

e) Having an internet connection is necessary to log onto zoom.

f) I am a student because I attend university.

Work on parts (a), (c), and (f) with the people around you, and then we'll go over it together!

Problem 2 – If I can translate, then…

a) Whenever I walk my dog, I make new friends.

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

Problem 2 – If I can translate, then…

a) Whenever I walk my dog, I make new friends.

Step 1

p: I walk my dog

q: I make new friends

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

Problem 2 – If I can translate, then…

a) Whenever I walk my dog, I make new friends.

Step 1
p: I walk my dog
q: I make new friends

Step 2
Whenever p, q
If p then q

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

Problem 2 – If I can translate, then…

a) Whenever I walk my dog, I make new friends.

Step 1
p: I walk my dog
q: I make new friends

Step 2
Whenever p, q
If p then q

Step 3
$p \rightarrow q$

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

Problem 2 – If I can translate, then…

c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.

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

Problem 2 – If I can translate, then…

c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.

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

Step 1

p: One is a U.S. Citizen

q: One is over 18

r: One is eligible to vote

Problem 2 – If I can translate, then…

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

c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.

Step 1

p: One is a U.S. Citizen
q: One is over 18
r: One is eligible to vote

Step 2

Being p and q is sufficient for r
If p and q then r

Problem 2 – If I can translate, then…

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

c) Being a U.S. citizen and over 18 is sufficient to be eligible to vote.

Step 1

p: One is a U.S. Citizen
q: One is over 18
r: One is eligible to vote

Step 2

Being p and q is sufficient for r
If p and q then r

Step 3

$(p \wedge q) \rightarrow r$

Problem 2 – If I can translate, then…

f) I am a student because I attend university.

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

Problem 2 – If I can translate, then…

f) I am a student because I attend university.

Step 1

p: I am a student

q: I attend university

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

Problem 2 – If I can translate, then…

f) I am a student because I attend university.

Step 1
p: I am a student
q: I attend university

Step 2
p because q
If q then p

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

Problem 2 – If I can translate, then…

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

f) I am a student because I attend university.

Step 1
p: I am a student
q: I attend university

Step 2
p because q
If q then p

Step 3
$q \rightarrow p$

Problem 5

Problem 5 – Tea Time

Consider the following sentence:

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.
b) Fill out a truth table for your expression.

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

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

p: I am drinking tea
q: I am eating a cookie

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

a) Define propositional variables and translate the sentence into an expression in logical notation.

p: I am drinking tea
q: I am eating a cookie

$(p \rightarrow q) \vee (q \rightarrow p)$

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T			
T	F			
F	T			
F	F			

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T		
T	F			
F	T			
F	F			

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T		
T	F	F		
F	T			
F	F			

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T		
T	F	F		
F	T	T		
F	F	T		

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T	T	
T	F	F	T	
F	T	T	F	
F	F	T	T	

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T	T	T
T	F	F	T	
F	T	T	F	
F	F	T	T	

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T	T	T
T	F	F	T	T
F	T	T	F	
F	F	T	T	

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T	T	T
T	F	F	T	T
F	T	T	F	T
F	F	T	T	

Problem 5 – Tea Time

If I am drinking tea then I am eating a cookie, or, if I am eating a cookie then I am drinking tea.

b) Fill out a truth table for your expression. $(p \rightarrow q) \vee (q \rightarrow p)$

p	q	$p \rightarrow q$	$q \rightarrow p$	$(p \rightarrow q) \vee (q \rightarrow p)$
T	T	T	T	T
T	F	F	T	T
F	T	T	F	T
F	F	T	T	T

That's All, Folks!

Thanks for coming to section this week!
Any questions?