Some important info

https://web.cs.kent.edu/~hmichaud/discrete

- Withdrawing

  - January 31 last day to withdraw

  - April 3 last day to withdraw without a "W"

- Homeworks

  - Label your homework (Example: "Homework #1")

  - Include your name - easy to forget in an email

  - If submitting via email, ONLY PDF

"I'm done with homework, I did it on my computer"

- Email
  - Attach a **PDF**. Anything that's NOT a PDF will not be accepted.
  - Include your full name
  - Include the Homework #
  - Send to hmichaud@kent.edu and c.c. grader (TBD)
- Print it out, turn it in during class
  - Next slide

"I'm done with homework, I did it on paper"

- Put the Homework # on it

- Put your name on it

- Keep it legible

- Turn it in Wednesday 1/27 in class

  - Forgot? Bring it to my mailbox before the end of the day. It's in the Computer Science department (MSB 2nd floor) before the main office.

Tutoring

- Gilson Dos Santos

- CS I, CS II, Discrete Structures

- 5:30 - 8:30PM Monday & Wednesday @ MSB 243

1.1 Recap

- Proposition
- Compound proposition
  - Negation: ¬p
  - Conjunction (AND): p ∧ q
  - Disjunction (inclusive OR): p ∨ q
  - Exclusive Or (XOR): p ⊕ q
  - Implication: p → q
    - converse q→p
    - inverse ¬ p → ¬ q
    - contrapositive ¬q → ¬ p
  - Biconditional: p ↔ q
- Equivalence
- Truth tables

1.2

Homework 1

p: You get a good grade
q: You do the homework

- It is necessary to do the homework to get a good grade.

  - Explanation: You have to do the homework if you want a good grade.

  - If you get a good grade, then you have done the homework.

- Other ways to write this..

  - A necessary condition for getting a good grade is doing the homework.

  - Getting a good grade implies that you did the homework.

  - Doing the homework is necessary for you to get a good grade.

  - You do the homework whenever you get a good grade.

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

2 propositions (p, q) -> 2^2 rows = 4 rows

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q

Constructing a truth table

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

p	q
F	
F	
T	
T	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q
F	F
F	T
T	F
T	T

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p
F	F	
F	T	
T	F	
T	T	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p
F	F	
F	T	
T	F	
T	T	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p
F	F	T
F	T	T
T	F	F
T	T	F

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p
F	F	T
F	T	T
T	F	F
T	T	F

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q → ¬p
F	F	T	
F	T	T	
T	F	F	
T	T	F	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p
F	F	T	T
F	T	T	T
T	F	F	T
T	T	F	F

Constructing a truth table

$$(q \to \neg p) \lor (\neg p \to \neg q)$$

p	q	¬p	q→¬p
F	F	T	T
F	T	T	T
T	F	F	T
T	T	F	F

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q
F	F	T	T	
F	T	T	T	
T	F	F	T	
T	T	F	F	

Constructing a truth table

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

p	q	¬p	q → ¬p	¬q
F	F	T	T	T
F	T	T	T	F
T	F	F	T	T
T	T	F	F	F

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q
F	F	T	T	T
F	T	T	T	F
T	F	F	T	T
T	T	F	F	F

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q	¬p→¬q
F	F	T	T	T	
F	T	T	T	F	
T	F	F	T	T	
T	T	F	F	F	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q	¬p→¬q
F	F	T	T	T	T
F	T	T	T	F	F
T	F	F	T	T	T
T	T	F	F	F	T

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q	¬p→¬q
F	F	T	T	T	T
F	T	T	T	F	F
T	F	F	T	T	T
T	T	F	F	F	T

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q	¬p→¬q	(q→¬p) ∨ (¬p→¬q)
F	F	T	T	T	T	
F	T	T	T	F	F	
T	F	F	T	T	T	
T	T	F	F	F	T	

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p	q	¬p	q→¬p	¬q	¬p→¬q	(q→¬p) ∨ (¬p→¬q)
F	F	T	T	T	T	
F	T	T	T	F	F	
T	F	F	T	T	T	
T	T	F	F	F	T	

Constructing a truth table

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

p	q	¬p	q→¬p	¬q	¬p→¬q	(q→¬p) ∨ (¬p→¬q)
F	F	T	T	T	T	T
F	T	T	T	F	F	T
T	F	F	T	T	T	T
T	T	F	F	F	T	T

Constructing a truth table

(q→¬p) ∨ (¬p→¬q)

p	q	(q→¬p) ∨ (¬p→¬q)
F	F	T
F	T	T
T	F	T
T	T	T

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

p: I have a million dollars
q: Moon tickets are inexpensive

If moon tickets are inexpensive, then I don't have a million dollars, or if I don't have a million dollars then moon tickets are not inexpensive.

Constructing a truth table

(q⭢¬p) ∨ (¬p⭢¬q)

p: It's hot outside
q: I wear a hat

If I wear a hat, then it isn't hot outside, or if it isn't hot outside then I don't wear a hat.

Constructing a truth table

$$(q \rightarrow \neg p) \lor (\neg p \rightarrow \neg q)$$

A compound proposition that is always true, no matter what the truth values of the propositional variables that occur in it, is called a **tautology**.

Constructing a truth table

$$(\neg\, p \rightarrow q) \vee r$$

Constructing a truth table

$$(\neg\, p \rightarrow q) \vee r$$

3 propositions (p, q, r) -> 2^3 rows = 8 rows

Constructing a truth table

$$(\neg\ p \rightarrow q) \lor r$$

p	q	r

Constructing a truth table

$$(\neg p \to q) \lor r$$

p	q	r
0		
0		
0		
0		
1		
1		
1		
1		

Constructing a truth table

$$(\neg\, p \rightarrow q) \vee r$$

p	q	r
0	0	
0	0	
0	1	
0	1	
1	0	
1	0	
1	1	
1	1	

Constructing a truth table

$$(\neg\, p \rightarrow q) \lor r$$

p	q	r
0	0	0
0	0	1
0	1	0
0	1	1
1	0	0
1	0	1
1	1	0
1	1	1

Constructing a truth table

$$(\neg\, p \rightarrow q) \lor r$$

p	q	r	¬ p
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Constructing a truth table

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

p	q	r	¬ p
0	0	0	
0	0	1	
0	1	0	
0	1	1	
1	0	0	
1	0	1	
1	1	0	
1	1	1	

Constructing a truth table

$$(\neg p \rightarrow q) \lor r$$

p	q	r	¬ p
0	0	0	1
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	0
1	0	1	0
1	1	0	0
1	1	1	0

Constructing a truth table

(¬ p → q) ∨ r

p	q	r	¬ p	¬ p → q
0	0	0	1	
0	0	1	1	
0	1	0	1	
0	1	1	1	
1	0	0	0	
1	0	1	0	
1	1	0	0	
1	1	1	0	

Constructing a truth table

$$(\neg p \rightarrow q) \lor r$$

p	q	r	¬ p	¬ p → q
0	0	0	1	
0	0	1	1	
0	1	0	1	
0	1	1	1	
1	0	0	0	
1	0	1	0	
1	1	0	0	
1	1	1	0	

Constructing a truth table

$$(\neg p \rightarrow q) \lor r$$

p	q	r	¬ p	¬ p → q
0	0	0	1	0
0	0	1	1	0
0	1	0	1	1
0	1	1	1	1
1	0	0	0	1
1	0	1	0	1
1	1	0	0	1
1	1	1	0	1

Constructing a truth table

$(\neg p \rightarrow q) \lor r$

p	q	r	¬ p	¬ p → q	(¬ p → q) ∨ r
0	0	0	1	0	
0	0	1	1	0	
0	1	0	1	1	
0	1	1	1	1	
1	0	0	0	1	
1	0	1	0	1	
1	1	0	0	1	
1	1	1	0	1	

Constructing a truth table

$$(\neg\, p \rightarrow q) \vee r$$

p	q	r	¬ p	¬ p → q	(¬ p → q) ∨ r
0	0	0	1	0	
0	0	1	1	0	
0	1	0	1	1	
0	1	1	1	1	
1	0	0	0	1	
1	0	1	0	1	
1	1	0	0	1	
1	1	1	0	1	

Constructing a truth table

$$(\neg p \rightarrow q) \lor r$$

p	q	r	¬ p	¬ p → q	(¬ p → q) ∨ r
0	0	0	1	0	0
0	0	1	1	0	1
0	1	0	1	1	1
0	1	1	1	1	1
1	0	0	0	1	1
1	0	1	0	1	1
1	1	0	0	1	1
1	1	1	0	1	1

Match up the truth tables with their logical connectives

1

p	?p
0	1
1	0

2

p	q	p?q
0	0	1
0	1	1
1	0	0
1	1	1

3

p	q	p?q
0	0	0
0	1	1
1	0	1
1	1	0

4

p	q	p?q
0	0	0
0	1	1
1	0	1
1	1	1

5

p	q	p?q
0	0	1
0	1	0
1	0	0
1	1	1

6

p	q	p?q
0	0	0
0	1	0
1	0	0
1	1	1

a. ¬   Negation
b. p∧q   Conjunction
c. p∨q   Disjunction
d. p⊕q   Exclusive Or (XOR)
e. p→q   Implication
f. p↔q   Biconditional

Match up the truth tables with their logical connectives

1 - a

p	¬p
0	1
1	0

2 - e

p	q	p→q
0	0	1
0	1	1
1	0	0
1	1	1

3 - d

p	q	p⊕q
0	0	0
0	1	1
1	0	1
1	1	0

4 - c

p	q	p∨q
0	0	0
0	1	1
1	0	1
1	1	1

5 - f

p	q	p↔q
0	0	1
0	1	0
1	0	0
1	1	1

6 - b

p	q	p∧q
0	0	0
0	1	0
1	0	0
1	1	1

a. ¬   Negation
b. p∧q   Conjunction
c. p∨q   Disjunction
d. p⊕q   Exclusive Or (XOR)
e. p→q   Implication
f. p↔q   Biconditional

Are these system specifications consistent?

- "Whenever the system software is being upgraded, users cannot access the file system."

- "If users can access the file system, then they can save new files."

- "If users cannot save new files, then the system software is not being upgraded."

Are these system specifications consistent?

- "Whenever the system software is being upgraded, users cannot access the file system." $p \rightarrow \neg q$

- "If users can access the file system, then they can save new files." $q \rightarrow r$

- "If users cannot save new files, then the system software is not being upgraded." $\neg r \rightarrow \neg p$

p: The software system is being upgraded.

q: Users can access the file system.

r: Users can save new files.

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r
F	F	F
F	F	T
F	T	F
F	T	T
T	F	F
T	F	T
T	T	F
T	T	T

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q
F	F	F	T
F	F	T	T
F	T	F	F
F	T	T	F
T	F	F	T
T	F	T	T
T	T	F	F
T	T	T	F

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q
F	F	F	T	T
F	F	T	T	T
F	T	F	F	T
F	T	T	F	T
T	F	F	T	T
T	F	T	T	T
T	T	F	F	F
T	T	T	F	F

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q	q→r
F	F	F	T	T	T
F	F	T	T	T	T
F	T	F	F	T	F
F	T	T	F	T	T
T	F	F	T	T	T
T	F	T	T	T	T
T	T	F	F	F	F
T	T	T	F	F	T

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q	q→r	¬r
F	F	F	T	T	T	T
F	F	T	T	T	T	F
F	T	F	F	T	F	T
F	T	T	F	T	T	F
T	F	F	T	T	T	T
T	F	T	T	T	T	F
T	T	F	F	F	F	T
T	T	T	F	F	T	F

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q	q→r	¬r	¬p
F	F	F	T	T	T	T	T
F	F	T	T	T	T	F	T
F	T	F	F	T	F	T	T
F	T	T	F	T	T	F	T
T	F	F	T	T	T	T	F
T	F	T	T	T	T	F	F
T	T	F	F	F	F	T	F
T	T	T	F	F	T	F	F

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q	q→r	¬r	¬p	¬r→¬p
F	F	F	T	T	T	T	T	T
F	F	T	T	T	T	F	T	T
F	T	F	F	T	F	T	T	T
F	T	T	F	T	T	F	T	T
T	F	F	T	T	T	T	F	F
T	F	T	T	T	T	F	F	T
T	T	F	F	F	F	T	F	F
T	T	T	F	F	T	F	F	T

Are these system specifications consistent?

p→¬q, q→r, ¬r→¬p

p	q	r	¬q	p→¬q	q→r	¬r	¬p	¬r→¬p
F	F	F	T	T	T	T	T	T
F	F	T	T	T	T	F	T	T
F	T	F	F	T	F	T	T	T
F	T	T	F	T	T	F	T	T
T	F	F	T	T	T	T	F	F
T	F	T	T	T	T	F	F	T
T	T	F	F	F	F	T	F	F
T	T	T	F	F	T	F	F	T

Are these system specifications consistent?

p → ¬q, q → r, ¬r → ¬p

p	q	r	¬q	p→¬q	q→r	¬r	¬p	¬r→¬p
F	F	F	T	T	T	T	T	T
F	F	T	T	T	T	F	T	T
F	T	F	F	T	F	T	T	T
F	T	T	F	T	T	F	T	T
T	F	F	T	T	T	T	F	F
T	F	T	T	T	T	F	F	T
T	T	F	F	F	F	T	F	F
T	T	T	F	F	T	F	F	T