CS311H
Discrete Math for CS: Honors

Prof: Peter Stone
TA: Matthew Hausknecht
Proctor: Sudheesh Katkam

Department of Computer Science
The University of Texas at Austin
Good Morning, Colleagues
Good Morning, Colleagues

Are there any questions?
Logistics

- Questions about the syllabus?
Logistics

• Questions about the syllabus?
  – Office hours up
Logistics

• Questions about the syllabus?
  – Office hours up
  – Assignments for next week up
Logistics

- Questions about the syllabus?
  - Office hours up
  - Assignments for next week up
  - Trying to keep a high pace, but push back if you’re lost
Logistics

- Questions about the syllabus?
  - Office hours up
  - Assignments for next week up
  - Trying to keep a high pace, but push back if you’re lost

- Email class-related questions to me, TA, and proctor (or better yet, use piazza)
Logistics

• Questions about the syllabus?
  – Office hours up
  – Assignments for next week up
  – Trying to keep a high pace, but push back if you’re lost

• Email class-related questions to me, TA, and proctor (or better yet, use piazza)

• Modules star: Prof. Adam Klivans
Logistics

• Questions about the syllabus?
  – Office hours up
  – Assignments for next week up
  – Trying to keep a high pace, but push back if you’re lost

• Email class-related questions to me, TA, and proctor (or better yet, use piazza)

• Modules star: Prof. Adam Klivans
  – Make sure the laws make sense while watching modules
Logistics

- Questions about the syllabus?
  - Office hours up
  - Assignments for next week up
  - Trying to keep a high pace, but push back if you’re lost

- Email class-related questions to me, TA, and proctor (or better yet, use piazza)

- Modules star: Prof. Adam Klivans
  - Make sure the laws make sense while watching modules

- Module questions: last is free form
Logistics

- Questions about the syllabus?
  - Office hours up
  - Assignments for next week up
  - Trying to keep a high pace, but push back if you’re lost
- Email class-related questions to me, TA, and proctor (or better yet, use piazza)
- Modules star: Prof. Adam Klivans
  - Make sure the laws make sense while watching modules
- Module questions: last is free form
  - Post it also on piazza!
Logistics

• Questions about the syllabus?
  – Office hours up
  – Assignments for next week up
  – Trying to keep a high pace, but push back if you’re lost

• Email class-related questions to me, TA, and proctor (or better yet, use piazza)

• Modules star: Prof. Adam Klivans
  – Make sure the laws make sense while watching modules

• Module questions: last is free form
  – Post it also on piazza!
  – And ask in class!
Logistics (cont.)

• How to treat the book
Logistics (cont.)

• How to treat the book
  – Work problems
Logistics (cont.)

• How to treat the book
  – Work problems
  – Student’s Solutions Guide
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
  - Never be idle
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
  - Never be idle
  - Can’t have the right pace for everyone
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
  - Never be idle
  - Can’t have the right pace for everyone
  - Point out my mistakes
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
  - Never be idle
  - Can’t have the right pace for everyone
  - Point out my mistakes

- Go to discussion section
Logistics (cont.)

- How to treat the book
  - Work problems
  - Student’s Solutions Guide

- Class sessions: for working problems
  - If you don’t get it, seek help
  - If you do get it, be engaged as a teacher
  - Never be idle
  - Can’t have the right pace for everyone
  - Point out my mistakes

- Go to discussion section

- Quizzes may happen in class or discussion section
Some important concepts

- Notation: ¬
Some important concepts

- Notation: ¬ ∨
Some important concepts

- Notation: \( \neg \lor \land \)
Some important concepts

- Notation: \( \neg \lor \land \Rightarrow \)
Some important concepts

• Notation: \( \neg \lor \land \Rightarrow \)

• Proposition vs. predicate vs. function
Some important concepts

- Notation: ¬ ∨ ∧ ⇒
- Proposition vs. predicate vs. function
- Truth table
Some important concepts

- Notation: $\neg \lor \land \Rightarrow$
- Proposition vs. predicate vs. function
- Truth table
  - Especially for $P \Rightarrow Q$
Some important concepts

- Notation: \( \neg \lor \land \Rightarrow \)

- Proposition vs. predicate vs. function

- Truth table
  - Especially for \( P \Rightarrow Q \)
  - (Correlation vs. causation)
Some important concepts

- Notation: $\neg \lor \land \Rightarrow$

- Proposition vs. predicate vs. function

- Truth table
  - Especially for $P \Rightarrow Q$
  - (Correlation vs. causation)

- DeMorgan’s laws (including for more than 2 elements)
Some important concepts

- Notation: \( \neg \lor \land \Rightarrow \)
- Proposition vs. predicate vs. function
- Truth table
  - Especially for \( P \Rightarrow Q \)
  - (Correlation vs. causation)
- DeMorgan’s laws (including for more than 2 elements)
- CNF and DNF (single term “and” or “or”)
Some important concepts

• Notation: \( \neg \lor \land \Rightarrow \)

• Proposition vs. predicate vs. function

• Truth table
  – Especially for \( P \Rightarrow Q \)
  – (Correlation vs. causation)

• DeMorgan’s laws (including for more than 2 elements)

• CNF and DNF (single term “and” or “or”)
  – Why do we care in practice?
Some important concepts

• Notation: $\neg \lor \land \Rightarrow$

• Proposition vs. predicate vs. function

• Truth table
  - Especially for $P \Rightarrow Q$
  - (Correlation vs. causation)

• DeMorgan’s laws (including for more than 2 elements)

• CNF and DNF (single term “and” or “or”)
  - Why do we care in practice?

• Distributing negation over quantifiers
Simplify

\[ (\neg T \lor F) \land (\neg F \lor T) \land \neg (F \lor F) \]
Simplify

- \((\neg T \lor F) \land (\neg F \lor T) \land \neg (F \lor F)\)

- \(\neg (F \lor \neg (T \land \neg (\neg T \lor \neg (F \land T))))\)
Simplify

\[ \neg T \lor F \land (\neg F \lor T) \land \neg (F \lor F) \]

\[ \neg (F \lor \neg (T \land \neg (\neg T \lor \neg (F \land T)))) \]

\[ \equiv \neg (F \lor \neg (T \land \neg (\neg T \lor \neg F))) \]
\[ \equiv \neg (F \lor \neg (T \land \neg (F \lor T))) \]
\[ \equiv \neg (F \lor \neg (T \land \neg T)) \]
\[ \equiv \neg (F \lor \neg (T \land F)) \]
\[ \equiv \neg (F \lor \neg F) \]
\[ \equiv \neg (F \lor T) \]
\[ \equiv \neg T \]
\[ \equiv F \]
Satisfiable?

\[ (P \lor Q) \land (P \lor \neg Q) \land (\neg P \lor Q) \land (\neg P \lor \neg Q) \]
Satisfiable?

- \((P \lor Q) \land (P \lor \neg Q) \land (\neg P \lor Q) \land (\neg P \lor \neg Q)\)
- \(\neg (A \lor C \lor \neg (B \land \neg A \land \neg (\neg B \lor A \lor C)))\)
CNF, DNF, or neither? (and convert)

- \((A \land \neg B) \lor (B \land \neg C)\)
CNF, DNF, or neither? (and convert)

• \((A \land \neg B) \lor (B \land \neg C)\)

• \((A \land B) \lor (\neg B \land C) \lor \neg(A \land C)\)
Prove equivalence

\[ A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C)) \equiv A \]
Prove equivalence

- \( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \)

Proof

\( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \) (original)
Prove equivalence

- \( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \)

Proof

\[
\begin{align*}
A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) & \equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C))) \quad (\land \text{ commut.})
\end{align*}
\]
Prove equivalence

\[ A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \]

Proof

\[ A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \text{ (original)} \]
\[ \equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C))) \text{ (\land commut.)} \]
\[ \equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor (C \land \neg C)))) \text{ (dist.)} \]
Prove equivalence

- \( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \)

Proof

\[
A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \text{ (original)} \\
\equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C))) \text{ (\& commut.)} \\
\equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor (C \land \neg C)))) \text{ (dist.)} \\
\equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor F))) \text{ (negation)}
\]
Prove equivalence

- \( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \)

Proof

\[
A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \quad (\text{original})
\]
\[
\equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C))) \quad (\land \text{ commut.})
\]
\[
\equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor (C \land \neg C)))) \quad (\text{dist.})
\]
\[
\equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor F))) \quad (\neg \text{ negation})
\]
\[
\equiv A \land (B \lor \neg(\neg B \land C \land \neg A)) \quad (\lor \text{ ident.})
\]
Prove equivalence

\[ A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \equiv A \]

Proof

\[ A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C))) \] (original)

\[ \equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C))) \] (\land \text{ commut.})

\[ \equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor (C \land \neg C')))) \] (dist.)

\[ \equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor F))) \] (negation)

\[ \equiv A \land (B \lor \neg(\neg B \land (C \land \neg A)) \] (\lor \text{ ident.})

\[ \equiv A \land (B \lor B \lor \neg C \lor A) \] (De Morgan, double neg)

Prove equivalence

• \( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C')))) \equiv A \)

Proof

\( A \land (B \lor \neg(C \land \neg B \land (\neg A \lor \neg C'))) \) (original)
\( \equiv A \land (B \lor \neg(\neg B \land C \land (\neg A \lor \neg C'))) \) (\( \land \) commut.)
\( \equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor (C \land \neg C')))) \) (dist.)
\( \equiv A \land (B \lor \neg(\neg B \land ((C \land \neg A) \lor F'))) \) (negation)
\( \equiv A \land (B \lor \neg(\neg B \land C \land \neg A)) \) (\( \lor \) ident.)
\( \equiv A \land (B \lor B \lor \neg C \lor A) \) (De Morgan, double neg)
\( \equiv A \) (absorbtion)
Assignments for Thursday

- Module 3 with associated readings
Assignments for Thursday

• Module 3 with associated readings

• Start on first HW assignment (requires module 3 to complete)