BILL, RECORD LECTURE!!!!

BILL RECORD LECTURE!!!

Welcome to CMSC 250: Discrete Structures

Today:
Admin,
Intro to Discrete
Structures

Admin

Necessary Administrative

Everything in these slides is also on the written syllabus on the course website.

Necessary Administrative

Everything in these slides is also on the written syllabus on the course website.

Course Webpage:

https://www.cs.umd.edu/users/gasarch/COURSES/250/S24/index.html

Necessary Administrative

Everything in these slides is also on the written syllabus on the course website.
Course Webpage:
https://www.cs.umd.edu/users/gasarch/COURSES/250/S24/index.html

1. Taught by William Gasarch. Tu-Th 12:30-1:45 in IRB 2107
2. TAed by Emily Kaplitz. M-W 10:00AM-10:50AM in IRB 2107

Necessary Administrative Stuff

- Course Website: We will post HW and Slides there.
- We will post recordings to Elms.
- Gradescope: You will **submit HW** there.
- Gradescope: We will **grade HW** there.
- Regrade Requests due within a week of the HW being graded.
- Grades on Gradescope.
- Piazza is great for asking questions.

IF you are auditing this class for whatever reason- perhaps you are having a hard time getting permission to take it, or perhaps you like the material but don't want to take it, let me know and I will put you on the class email list and invite you to join the Piazza.

How to Ask Questions

How to Ask Questions

- Ask questions in lecture

How to Ask Questions

- Ask questions in lecture
- Ask questions in recitation

How to Ask Questions

- Ask questions in lecture
- Ask questions in recitation
- Ask questions on piazza

How to Ask Questions

- Ask questions in lecture
- Ask questions in recitation
- Ask questions on piazza
- Office hours

How to Ask Questions

- Ask questions in lecture
- Ask questions in recitation
- Ask questions on piazza
- Office hours
  Bill-TuTh 11:00-12:15 2:00-3:15 in IRB 2242.
  Emily-M 11:00AM-12:00AM at open area IRB 1266 across from CS helpdesk.

How to Ask Questions

- ▶ Ask questions in lecture
- ▶ Ask questions in recitation
- ▶ Ask questions on piazza
- ▶ Office hours
  Bill-TuTh 11:00-12:15 2:00-3:15 in IRB 2242.
  Emily-M 11:00AM-12:00AM at open area IRB 1266 across
  from CS helpdesk.
- ▶ Email us- put 250 on the subject line.
  Bill: gasarch@umd.edu
  Emily: ekaplitz@umd.edu

How to Ask Questions

- ▶ Ask questions in lecture
- ▶ Ask questions in recitation
- ▶ Ask questions on piazza
- ▶ Office hours
  Bill-TuTh 11:00-12:15 2:00-3:15 in IRB 2242.
  Emily-M 11:00AM-12:00AM at open area IRB 1266 across from CS helpdesk.
- ▶ Email us- put 250 on the subject line.
  Bill: gasarch@umd.edu
  Emily: ekaplitz@umd.edu
- ▶ Appointments (possibly on zoom).

What You Need For This Class

What You Need For This Class

- CMSC 131 (First Prog Course),

What You Need For This Class

▶ CMSC 131 (First Prog Course),
  Good Numbering: 131 is for 1st Prog Course.

What You Need For This Class

- ► CMSC 131 (First Prog Course),
  Good Numbering: 131 is for 1st Prog Course.
- ► Math 141 (Second Calc Course).

What You Need For This Class

- ▶ CMSC 131 (First Prog Course),
  Good Numbering: 131 is for 1st Prog Course.
- ▶ Math 141 (Second Calc Course).
  Bad Numbering: 141 is for 2nd Calc Course.

What You Need For This Class

- ▶ CMSC 131 (First Prog Course),
  Good Numbering: 131 is for 1st Prog Course.
- ▶ Math 141 (Second Calc Course).
  Bad Numbering: 141 is for 2nd Calc Course.
- ▶ A love of mathematics. Or at least a like of mathematics.

What You Need For This Class

- ▶ CMSC 131 (First Prog Course),
  Good Numbering: 131 is for 1st Prog Course.
- ▶ Math 141 (Second Calc Course).
  Bad Numbering: 141 is for 2nd Calc Course.
- ▶ A love of mathematics. Or at least a like of mathematics.
- ▶ You are in some Honors Prog or have Permission from Dept.

How to Get the Most Out of This Class

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:

   3.1 You can ask questions.

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:
   3.1 You can ask questions.
   3.2 If you miss class and don't watch the video before the next class you could fall far behind.

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:
   3.1 You can ask questions.
   3.2 If you miss class and don't watch the video before the next class you could fall far behind.
   3.3 Reinforcement Learning.

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:
    3.1 You can ask questions.
    3.2 If you miss class and don't watch the video before the next class you could fall far behind.
    3.3 Reinforcement Learning.
    3.4 I sometimes use the whiteboard and that might not get onto the recording.

How to Get the Most Out of This Class

1. Read notes and slides before class. (**Caution** Some of the slides are in progress. They will be labeled as such. You should not read those, they may contain fake news.)

2. Ask questions on Piazza and/or bring questions to class.

3. This course will be taped so can catch up or review. However, coming to class has the following advantages:

   3.1 You can ask questions.
   3.2 If you miss class and don't watch the video before the next class you could fall far behind.
   3.3 Reinforcement Learning.
   3.4 I sometimes use the whiteboard and that might not get onto the recording.
   3.5 Recording might not work that day.

HWs and Exams

- ▶ HWs most weeks.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.
- ▶ **Dead Cat Policy:** Can submit HW Wed **before** recitation without penalty.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.
- ▶ **Dead Cat Policy:** Can submit HW Wed **before** recitation without penalty.
- ▶ **WARNING:** YOU have an extension. HW solutions are posted Wednesday. So NO extensions past that.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.
- ▶ **Dead Cat Policy:** Can submit HW Wed **before** recitation without penalty.
- ▶ **WARNING:** YOU have an extension. HW solutions are posted Wednesday. So NO extensions past that.
- ▶ We will keep track of your lateness NOT for grade, but for recommendation letters.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.
- ▶ **Dead Cat Policy:** Can submit HW Wed **before** recitation without penalty.
- ▶ **WARNING:** YOU have an extension. HW solutions are posted Wednesday. So NO extensions past that.
- ▶ We will keep track of your lateness NOT for grade, but for recommendation letters.
- ▶ We will use the term **Morally Due** for the Monday, but it is known that via dead cat you can hand it in Wednesday.

HWs and Exams

- ▶ HWs most weeks.
- ▶ Due Monday **before** recitation begins. But see next item.
- ▶ **Dead Cat Policy:** Can submit HW Wed **before** recitation without penalty.
- ▶ **WARNING:** YOU have an extension. HW solutions are posted Wednesday. So NO extensions past that.
- ▶ We will keep track of your lateness NOT for grade, but for recommendation letters.
- ▶ We will use the term **Morally Due** for the Monday, but it is known that via dead cat you can hand it in Wednesday.
- ▶ There will be two midterms and a final. See syllabus for details on that.

HW

What you say, what I hear:

HW

What you say, what I hear:

You Say I submitted it **Wednesday** at midnight thinking it was due then, and not 10:00AM. Can it still count?

HW

What you say, what I hear:

You Say I submitted it **Wednesday** at midnight thinking it was due then, and not 10:00AM. Can it still count?

I hear Oh, so you submitted it **Monday** at midnight, then realized that the Dead-Cat Policy saved you. You are telling me that you **appreciate** the Dead-Cat Policy!

HW

What you say, what I hear:

You Say I submitted it **Wednesday** at midnight thinking it was due then, and not 10:00AM. Can it still count?
I hear Oh, so you submitted it **Monday** at midnight, then realized that the Dead-Cat Policy saved you. You are telling me that you **appreciate** the Dead-Cat Policy!

You Say Oh, I forgot to hand it in on **Wed at 10:00** but I can prove I did it on time because my computer time stamps my work.

HW

What you say, what I hear:

You Say I submitted it **Wednesday** at midnight thinking it was due then, and not 10:00AM. Can it still count?
I hear Oh, so you submitted it **Monday** at midnight, then realized that the Dead-Cat Policy saved you. You are telling me that you **appreciate** the Dead-Cat Policy!

You Say Oh, I forgot to hand it in on **Wed at 10:00** but I can prove I did it on time because my computer time stamps my work.
I hear Oh, so you forgot to hand it in **Monday at 10:000**, then realized this, got it in on Wed at 10:00. You are telling me that you **appreciate** the Dead-Cat Policy!

HW

What you say, what I hear:

You Say I submitted it **Wednesday** at midnight thinking it was due then, and not 10:00AM. Can it still count?
I hear Oh, so you submitted it **Monday** at midnight, then realized that the Dead-Cat Policy saved you. You are telling me that you **appreciate** the Dead-Cat Policy!

You Say Oh, I forgot to hand it in on **Wed at 10:00** but I can prove I did it on time because my computer time stamps my work.
I hear Oh, so you forgot to hand it in **Monday at 10:000**, then realized this, got it in on Wed at 10:00. You are telling me that you **appreciate** the Dead-Cat Policy!
I am not sure why you are telling me about **time stamps**, but, as the kids say, whatever.

Textbook

Required Text None.

Recommended Text None.

If you really want a text then buy used (cheap) or borrow:

1. Essential Discrete Mathematics for Computer Science by Lewis and Zax. (Disclosure: Lewis was my PhD Advisor).

2. Discrete Mathematics: Introduction to Mathematical Reasoning by Epp.

3. Discrete Mathematics and its Application by Rosen.

Textbook

Required Text None.
Recommended Text None.
If you really want a text then buy used (cheap) or borrow:

1. Essential Discrete Mathematics for Computer Science by Lewis and Zax. (Disclosure: Lewis was my PhD Advisor).

2. Discrete Mathematics: Introduction to Mathematical Reasoning by Epp.

3. Discrete Mathematics and its Application by Rosen.

There will be slides, and recordings of lecture online.
Other Resources This is standard material which is all over the web, but:

1. A random web source may use a different notation than I do.

2. A random web source may cover different topics than I do.

3. A random web source may be **wrong**.

You are INVITED to talk to us

It has been said that some students do not seek help because they do not know they can.

You are INVITED to talk to us

It has been said that some students do not seek help because they do not know they can.

You Can!

You are INVITED to talk to us

It has been said that some students do not seek help because they do not know they can.

You Can!

If **for whatever reason** you are falling behind in the class, or are having trouble with the HW, see us in office hours or **you can make an appointment to see us!** Either in person or on zoom.

Discrete Structures

Our Key question

Given a statement that you think is true, how to you establish that it is true?

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use Facebook the worst you feel,

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use
   Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`
   They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use
Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`
They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social
   Science: the more you use
   Facebook the worst you feel, see `https://hbr.org/2017/04/`
   `a-new-more-rigorous-study-confirms-the-more-you-use-fa`
   They need to control for other variables. And needs to be
   unbiased. And hard to know what-causes-what. Later study
   may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use
   Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`
   They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments. Example Millikan's oil-drop experiment (1909) showed that charge was quantized. 'Began' quantum mechanics.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use
   Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`
   They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments. Example Millikan's oil-drop experiment (1909) showed that charge was quantized. 'Began' quantum mechanics. Later experiment may cause one to modify the conclusions.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use
   Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa`
   They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments. Example Millikan's oil-drop experiment (1909) showed that charge was quantized. 'Began' quantum mechanics. Later experiment may cause one to modify the conclusions.

3. In **Mathematics** we have proofs!

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa` They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments. Example Millikan's oil-drop experiment (1909) showed that charge was quantized. 'Began' quantum mechanics. Later experiment may cause one to modify the conclusions.

3. In **Mathematics** we have proofs! We can show truths in a way that Social Science or Physical Science can.

Our Key question

Given a statement that you think is true, how to you establish that it is true?

1. In the **Social Sciences** Statistics and Polls. **Example** Social Science: the more you use Facebook the worst you feel, see `https://hbr.org/2017/04/a-new-more-rigorous-study-confirms-the-more-you-use-fa` They need to control for other variables. And needs to be unbiased. And hard to know what-causes-what. Later study may cause one to modify the conclusions.

2. In the **Physical Sciences** you can do controlled experiments. Example Millikan's oil-drop experiment (1909) showed that charge was quantized. 'Began' quantum mechanics. Later experiment may cause one to modify the conclusions.

3. In **Mathematics** we have proofs! We can show truths in a way that Social Science or Physical Science can.

4. All fields are worth studying if done right and honestly.

Methods of Proof

Methods of Proof

1. **Direct Proof** Take premises and use reasoning to get conclusion.

Methods of Proof

1. **Direct Proof** Take premises and use reasoning to get conclusion.
2. **Indirect Proof or Contradiction** Assume OPPOSITE of what you want to do and get a contradiction.

Methods of Proof

1. **Direct Proof** Take premises and use reasoning to get conclusion.
2. **Indirect Proof or Contradiction** Assume OPPOSITE of what you want to do and get a contradiction.
3. **Induction** too much to talk about in this intro slide. It does allow us to prove **for all** statements.

Methods of Proof

1. **Direct Proof** Take premises and use reasoning to get conclusion.
2. **Indirect Proof or Contradiction** Assume OPPOSITE of what you want to do and get a contradiction.
3. **Induction** too much to talk about in this intro slide. It does allow us to prove **for all** statements.
4. There are other methods as well.

Why is this Course Relevant for Computer Science?

Why is this Course Relevant for Computer Science?

1. Some parts of this course are **directly relevant**: Circuits. Cryptography. Reasoning about conditional statements.

Why is this Course Relevant for Computer Science?

1. Some parts of this course are **directly relevant**: Circuits. Cryptography. Reasoning about conditional statements.

2. Some parts of this course are **indirectly relevant**: We teach you how to reason about numbers and sets. This will help you reason about algorithms and programs.

Why is this Course Relevant for Computer Science?

1. Some parts of this course are **directly relevant**: Circuits. Cryptography. Reasoning about conditional statements.

2. Some parts of this course are **indirectly relevant**: We teach you how to reason about numbers and sets. This will help you reason about algorithms and programs.

3. Some parts of this course are **needed for later courses**.
   351: Algorithms
   451: More Algorithms
   452: Theory of Computation
   456: Cryptography
   Any Grad Course in Theory

Why is this Course Relevant for Computer Science?

1. Some parts of this course are **directly relevant**: Circuits. Cryptography. Reasoning about conditional statements.

2. Some parts of this course are **indirectly relevant**: We teach you how to reason about numbers and sets. This will help you reason about algorithms and programs.

3. Some parts of this course are **needed for later courses**.
   351: Algorithms
   451: More Algorithms
   452: Theory of Computation
   456: Cryptography
   Any Grad Course in Theory

4. This entire course will give you **mathematical maturity** which will serve you well in computer science and in life.