Class starts after this song

Elton John – Bennie and the Jets (1973)
requested by Jerone Samari (TA-of-CM3)

I am a senior studying physics (objectively cooler).
In my free time I like to bike and swim!

Duke

Logistic Bulletin Board

- CM4-7 readings/prepare quizzes all released
  - This should keep you from being bored in this class

Exam 1: 2/14(W) in-class

- Scope: CM1-3 (logic, proof, math tools)
- Closed-book but with an official reference sheet
  - Official sheet will be on Canvas next week
  - You may replace the official sheet with your own (one single-sided 8.5″x11″, can be typed/hand-written/hybrid)
  - If you use your own reference sheet, you have to *submit the sheet along with the exam*

Exam 1: 2/14(W) in-class

- Practice exam 1 (mirrors the actual exam 1 in length, scope, difficulty) will be released by 2/7 for you to take a stab

- Recitation on 2/12(M) will be a *practice exam review session*
  - No work/attendance required
  - TAs go through practice exam sols/approaches together with you
  - Sample grading results released after all recitations

Manually-graded assignment policies

- Gradescope assignments must be *typed*
  - In other words: handwritten and photocopied work is not accepted
  - Exception is when you *augment* your work with figures/diagrams
- You may do the assignments *solo* or *in pairs*
  - You must stick with the same pair throughout the feedback process for the same assignment (i.e., if round 1 is solo, can't pair for round 2)
  - Can't collaborate with the same partner in consecutive CMs
    - So your partner for CM2 assignment cannot be the same one in CM1
    - No such rule for EMs (EMs are not ordered at all)

CM1 | Assign Questions and Pages

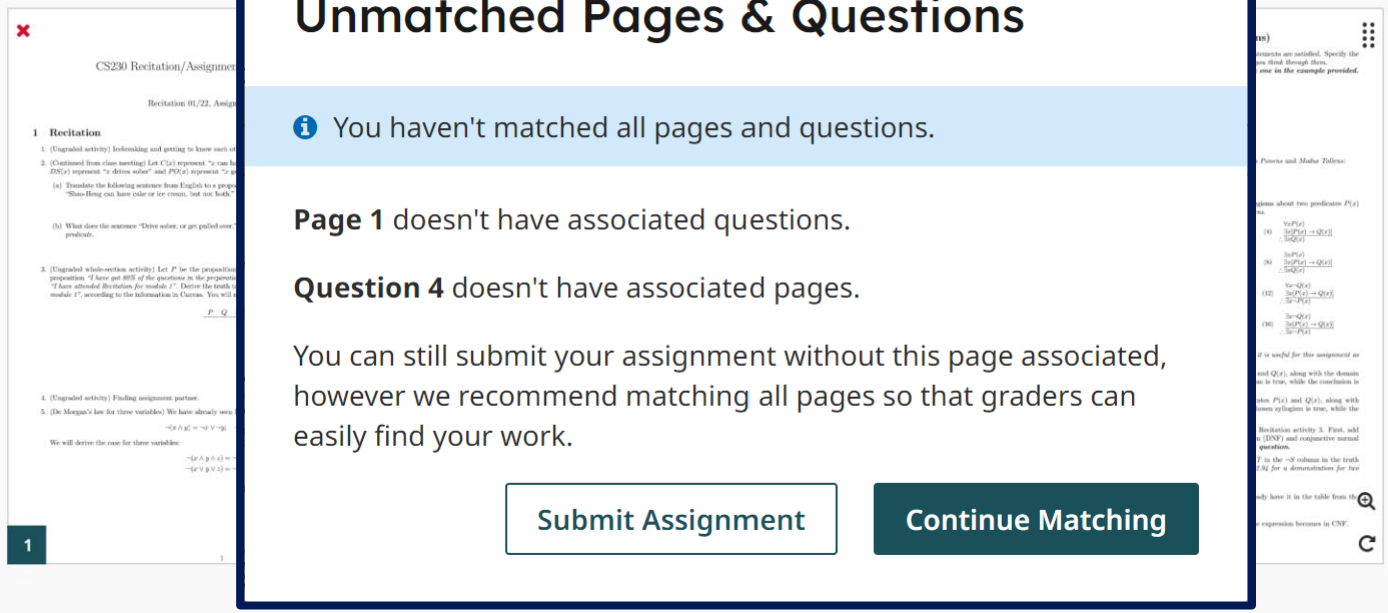
Submitted at: January 23, 1:08 PM

Select questions and pages to indicate where your responses are located. Use esc to deselect al… use the arrow keys on the keyboard.

Question Outline

Select a question or a page.

Title	Points
1 1	0.0 pts
1.1 a	0.0 pts
1.2 b	0.0 pts
1.3 c	0.0 pts
2 2	0.0 pts
2.1 a	0.0 pts
2.2 b	0.0 pts
2.3 c	0.0 pts
3 3	0.0 pts
3.1 a	0.0 pts
3.2 b	0.0 pts
4 Recitation part (skip if attended recitation)	0.0 pts



- Double check you label the correct pages to each question
- If you don't submit recitation work, Gradescope will warn you that you haven't labeled pages for it (which is normal)

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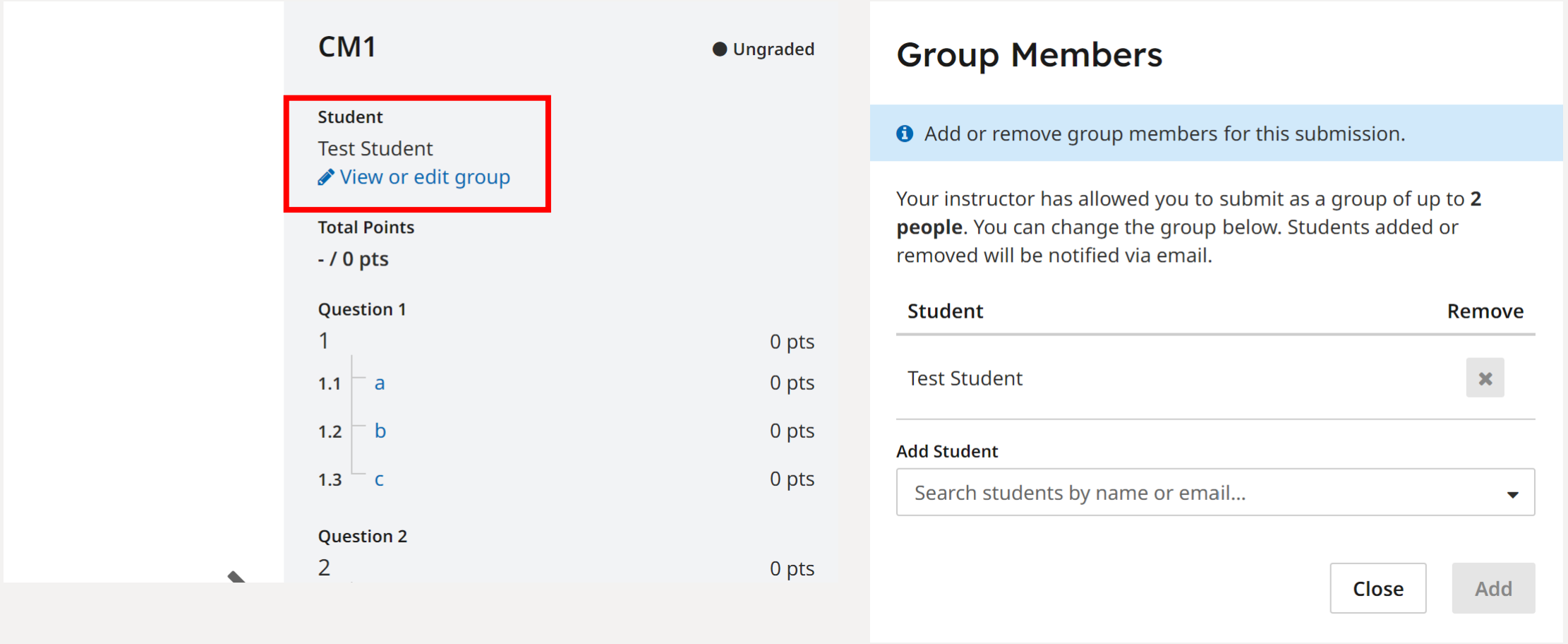

- Then add your teammate here; DO NOT SUBMIT SEPARATELY

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Communication policies

- Check *course website* before asking a logistical question anywhere
- For technical help (i.e., on course content), use consulting hours and/or Ed discussions (see *Help Resources* on course website)
  - Don't ask for technical help via email
- For personal questions about the course (grades, accommodations, etc.) use our course inbox: *compsci-230@duke.edu* (reaches head staff)
  - Send your STINFs/NoVAPs/etc. here as well!

CS230 Spring 2024
Module 03: Math Tools

Duke

Why math tools?

- Mod and congruence: basics of number theory
  - foundation of (classical) cryptography (EM)
- Sequences and recurrence relations:
  - for quantifying complicated (recursive) constructs
  - heavily used in algorithm analysis
    - some in CS201, more in CS330
- Asymptotic notations:
  - for characterizing algorithms… and more (probability, etc.)

Terminology Musing

	Approach 1	Approach 2
$a_n \leq a_{n+1}\ \forall n \in \mathbb{N}$	increasing	non-decreasing
$a_n < a_{n+1}\ \forall n \in \mathbb{N}$	strictly increasing	increasing
$a_n \geq a_{n+1}\ \forall n \in \mathbb{N}$	decreasing	non-increasing
$a_n > a_{n+1}\ \forall n \in \mathbb{N}$	strictly decreasing	decreasing

Terminology Musing

	Approach 1	Approach 2
$a_n \leq a_{n+1}\ \forall n \in \mathbb{N}$	~~increasing~~	non-decreasing
$a_n < a_{n+1}\ \forall n \in \mathbb{N}$	strictly increasing	~~increasing~~
$a_n \geq a_{n+1}\ \forall n \in \mathbb{N}$	~~decreasing~~	non-increasing
$a_n > a_{n+1}\ \forall n \in \mathbb{N}$	strictly decreasing	~~decreasing~~

More terminology musing

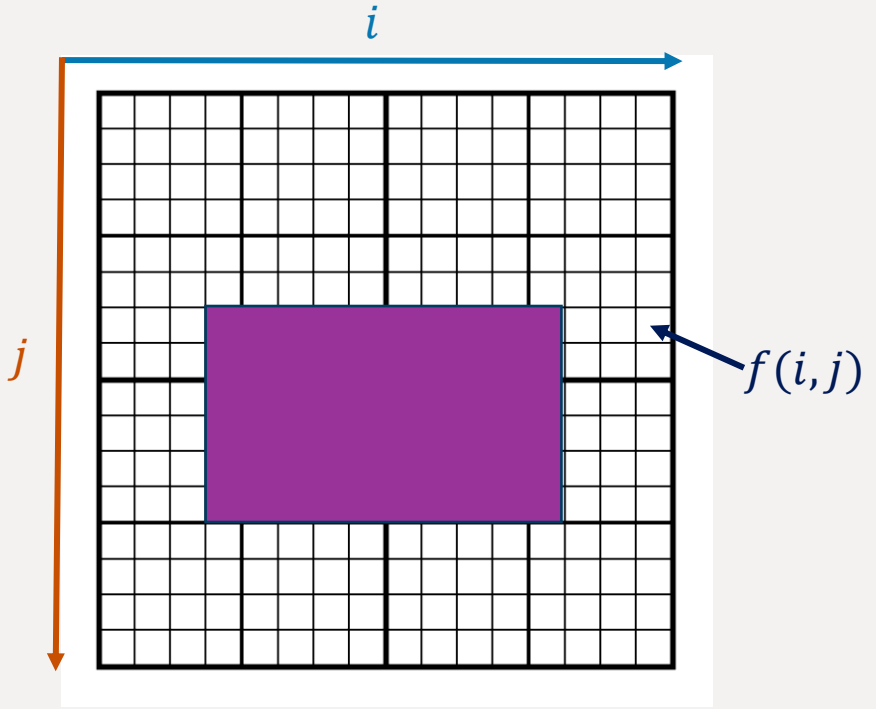
- We here use $\{a_n\}_{n=0}^{\infty}$ to represent the sequence $a_0, a_1, a_2, \ldots$
- Later, we will also use curly brackets to represent sets
- Sets ignore the *order* of elements and *repeated* elements
  - Think about Python `Set` or Java `Hashset`
- Therefore, do NOT write a sequence as $\{a_0, a_1, a_2, \ldots\}$

PI: Monotonicity

- A monotone sequence is either nondecreasing or nonincreasing (can be both, can be stronger)
- If $\{a_i\}$ and $\{b_i\}$ are "same direction": $\{a_i + b_i\}$ is also in that direction
- Otherwise, $\{a_i\}$ and $\{-b_i\}$ are "same direction", and $\{a_i - b_i\}$ is also in that direction
- Finally notice that if $\{a_i + b_i\}$ is monotone then $\{-a_i - b_i\}$ is also monotone; same with the other options

Summation tricks/manipulations

- $\sum_{n=a}^{b} f(n) = \sum_{n=0}^{b} f(n) - \sum_{n=0}^{a-1} f(n)$
- $\sum_{n=a}^{b} f(n) = \sum_{n=0}^{b-a} f(n+a)$
- $\sum_{i=a}^{b} \sum_{j=c}^{d} f(i,j) = \sum_{j=c}^{d} \sum_{i=a}^{b} f(i,j)$



Summation vs. Product tricks

- $\sum_{n=s}^{t} \log_b f(n) = \log_b \prod_{n=s}^{t} f(n)$

- $\prod_{n=s}^{t} C^{f(n)} = C^{\left(\sum_{n=s}^{t} f(n)\right)}$

To the asymptotic notations!

Class starts after songs

I am a math and computer science major. I enjoy traveling, reading, and knitting.

Marie-Hélène Tomé (TA-of-CM3)

Polyphia – G.O.A.T. (2018),
SOLOMON – Listen up (2023)
requested by Anoushka Sinha (TA-of-CM3)

I'm a junior majoring in Math and Computer Science. Outside of academics I like to sing, dance, and rock climb!

Duke

Logistic Bulletin Board

- CM1 Gradescope assignment grading results: published **later today in-class**
  - Common misunderstandings of problems
  - How to read feedback/decide whether to resubmit
  - Difference of **resubmissions** vs. **regrade requests**
  - Both due **2/7 (Wed) 11:59pm**

PI: Congruence Meets Arithmetics

- ☐ $(a \bmod n) + (b \bmod n) = ((a + b) \bmod n)$ $a = 1, b = 1, n = 2$
- ☐ $(a \bmod n) - (b \bmod n) = ((a - b) \bmod n)$ $a = 1, b = 2, n = 2$
- ☐ $(a \bmod n) \times (b \bmod n) = ((a \times b) \bmod n)$ $a = 2, b = 2, n = 3$
- ☐ $((a \bmod n) \bmod (b \bmod n)) = ((a \bmod b) \bmod n)$ $a = 1, b = 1, n = 1$