




MATH 1106

Wk 1 Discussion 1/26/2024


Benjamin Thompson (he/they)

Cornell University

Slides Location

- 
- These slides can be found at bgthompson.com:
 - → Teaching [bar]
 - → Modeling with Calculus for the Life Sciences (MATH 1106) Spring 2024 [link]
 - → Wk1 Slides (F)

Discussion Outline

- 
- What is the format of the discussion sections? Why come to them?
 - What is it that mathematicians do?
 - Admin
 - Mathematics mythbusting
 - Math support groups
 - Plagiarism & Cheating
 - D&I Bias reporting
 - Worksheet

What is the format of these discussions?




- Worksheets, done collaboratively
- Quizzes

Today's a bit different though, the latter half will be course admin. (yay!)

Why bother coming to discussion sections?



Why bother coming to discussion sections?

- 
- Collaborative — It's significantly easier to collaboratively learn in person than online.
 - Easier to learn math from people who are also learning it
 - Diversity of perspectives — everyone has different understandings of mathematics / ways of thinking
 - Easy to ask questions / easy to get answers [sometimes :)]
 - A consistent time / space to learn math
 - Social!
 - Many others...

Question



- What is it that mathematicians do?

Question



- What is it that mathematicians do?
- Very difficult to come up with a precise answer...

Question



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- Very difficult to come up with a precise answer...

What is it that mathematicians do?



What is it that mathematicians do?

APPEARED IN BULLETIN OF THE
AMERICAN MATHEMATICAL SOCIETY
Volume 30, Number 2, April 1994, Pages 161-177

ON PROOF AND PROGRESS IN MATHEMATICS

WILLIAM P. THURSTON

This essay on the nature of proof and progress in mathematics was stimulated by the article of Jaffe and Quinn, “Theoretical Mathematics: Toward a cultural synthesis of mathematics and theoretical physics”. Their article raises interesting issues that mathematicians should pay more attention to, but it also perpetuates some widely held beliefs and attitudes that need to be questioned and examined.

The article had one paragraph portraying some of my work in a way that diverges from my experience, and it also diverges from the observations of people in the field whom I’ve discussed it with as a reality check.

What is it that mathematicians do?

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An incredibly influential Cornell math professor

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Could the difficulty in giving a good direct definition of mathematics be an essential one, indicating that mathematics has an essential recursive quality? Along these lines we might say that mathematics is the smallest subject satisfying the following:

- Mathematics includes the natural numbers and plane and solid geometry.
- Mathematics is that which mathematicians study.
- **Mathematicians are those humans who advance human understanding of mathematics.**

In other words, as mathematics advances, we incorporate it into our thinking. As our thinking becomes more sophisticated, we generate new mathematical concepts and new mathematical structures: the subject matter of mathematics changes to reflect how we think.

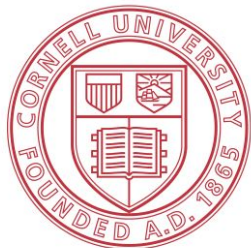
Calculation does not mean advancing human understanding



addition to knowledge that the theorem is true.

On a more everyday level, it is common for people first starting to grapple with computers to make large-scale computations of things they might have done on a smaller scale by hand. They might print out a table of the first 10,000 primes, only to find that their printout isn't something they really wanted after all. They discover by this kind of experience that what they really want is usually not some collection of “answers”—what they want is *understanding*.

We want you to practice advancing human understanding!



Math 1106

Name: _____

Homework 2


NetID: _____

Due 02/7

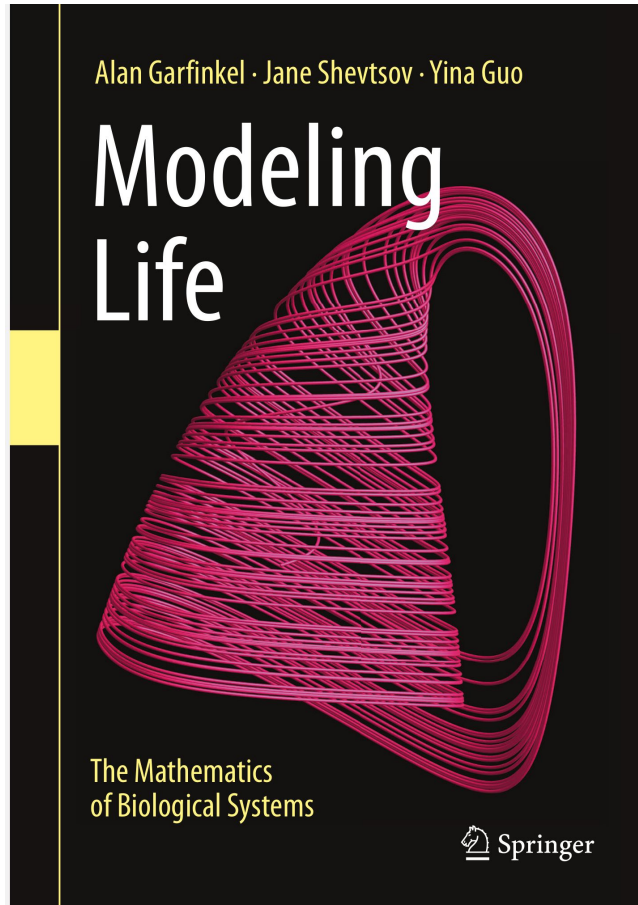
Worked with: _____

*Please complete these exercises, you may print this handout, annotate the PDF or write your answer on paper. When submitting your homework assign problems to your pages, see http://gradescope-static-assets.s3-us-west-2.amazonaws.com/help/submitting_hw_guide.pdf. It is important to be able to explain your reasoning to someone else in writing. **Please include full explanations and write your answers using complete sentences (not just a bunch of mathematical symbols!).** Points are specifically attributed to the clarity and accuracy of your explanations. Please upload all the pages of your homework to Gradescope.com by 11:00pm on the due date. Make your grader's life easier by writing neatly and legibly!!*

Assessment in the Course

- 
- 2 Prelims (30%) on at: 7:30pm on: 03/05, and 04/11 [calendar]
 - Final exam (25%) on at: TBD
 - Written homework and Online Homework (25%)
 - Quizzes (15%)
 - Participation (5%)

What is the course textbook?



A .pdf can be downloaded
from Cornell Library's
webpage

What is the course textbook?

Modeling Life

The Mathematics of Biological Systems

"by Alan Garfinkel, Jane Shevtsov, Yina Guo"

Author, etc.: [Garfinkel, Alan, author](#) Author info »

Format:  Book

Language: English.

Edition: 1st ed. 2017.

Published: Cham : Springer International Publishing : Imprint: Springer, 2017.

Subject: [Biomathematics.](#)
[Mathematical models.](#)
[Differential equations.](#)
[Mathematical and Computational Biology.](#)
[Mathematical Modeling and Industrial Mathematics.](#)
[Differential Equations.](#)

Summary: From predator-prey populations in an ecosystem, to hormone regulation within the body, the natural world abounds in dynamical systems that affect us profoundly. This book develops the mathematical tools essential for students in the life sciences to describe these interacting systems and to

Availability

✓ Online

[Access this title through Springer eBooks \(Mathematics and Statistics\).](#)

[Terms of use](#)

[Access this title through Springer Nature eBooks & Books Series \(LALC\).](#)

[Terms of use](#)

Restrictions

"License restrictions may limit access."

Homework deadlines

Spring 2024

View All Pages

Published Edit

Homework

Homework Schedule

HW	Due
1	Jan31
2	Feb7
3	Feb14
4	Feb21
5	Feb28
6	Mar13
7	Mar20
8	Mar27
9	Apr17
10	Apr24
11	May1
12	May7 (Shorter HW)

Part of your homework will be completed on WeBWork where you will get automatic feedback. You may login to WeBWork using this [link](#) and your NetID. If you cannot login to WeBWork, try again in 24hours, if that does not work, contact math1106-staff@cornell.edu.

Homework 1

Here is a [PDF](#) of homework, solutions will be posted to this page after the due date.

◀ Previous

Next ▶

Homework deadlines

Homework:

- There will be 12 homework sets posted on Canvas at least one week before their due date and are to be **completed on WeBWorK and turned in on Gradescope by 11:00pm on Wednesday.** The work you hand in should represent your own efforts and understanding. Don't risk an academic integrity violation by handing in copied solutions.
- Also note that any work you submit is a document that another person has to read, and the teaching team is not obliged to read unreasonably messy or disorganized submissions.
- **You are all permitted to miss two homework sets, to account for unexpected situation, do not email the instructor or TAs about missed/incomplete homework. Please plan carefully and save your "missed" for illness or emergencies.**
- In addition to missed homework, you will get to submit homework up to 48hrs late with **penalties.**

Mathematical Mythbusting



Everything published in mathematics is true. In particular, everything in mathematical textbooks is true.

Which one

True / False

?

Fermat's Last Theorem



Theorem:

$X^n + Y^n = Z^n$ has no non-zero integer solutions for $n \geq 3$.

- Unproven for 300+ years
- Proved by Andrew Wiles in the 90s.

Wiles first announced his proof on 23 June 1993 at a lecture in [Cambridge](#) entitled "Modular Forms, Elliptic Curves and Galois Representations".^[2] However, in September 1993 the proof was found to contain an error. One year later on 19 September 1994, in what he would call "the most important moment of [his] working life", Wiles stumbled upon a revelation that allowed him to correct the proof to the satisfaction of the mathematical community. The corrected proof was published in 1995.^[3]

From Wikipedia, "Wiles' Proof of Fermat's Last Theorem"


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The corrected proof was published in 1995.^[3]

From Wikipedia, "Wiles' Proof of Fermat's Last Theorem"

Typos / Errors in Textbooks




NOT in the course, you don't need to know this (obviously). But note there's an error every couple of pages.

- Page 144: In the third paragraph of the proof of the rising sun lemma (Lemma 1.6.17), b should be b_n in the definition of A and in the next two occurrences (i.e. “ t but not b ” should be “ t but not b_n ”, and “ $t_* \in [t, b]$ ” should be “ $t_* \in [t, b_n]$ ”).
- Page 145, bottom: “ $f'(x)$ exists” should be “ $F'(x)$ exists”. After Exercise 1.6.52, “ensure the almost everywhere existence” should be “ensure the absolute integrability of the derivative”.
- Pages 149-152: In Section 1.7.1, “Caratheodory extension theorem” should be “Caratheodory lemma” throughout.
- Page 150, Exercise 1.7.2: “Lebesgue outer measurable” should be “the Lebesgue outer measure”
- Page 151: In the last two displays, and in the first display on the next page, $E_{N+1} \setminus \bigcup_{n=1}^N E_n$ may be simplified to E_{N+1} . In the second paragraph, “a disjoint sequence of” should be “a sequence of disjoint”.
- Page 156: In Theorem 1.7.9, $-\infty < b < a < \infty$ should be $-\infty < a < b < \infty$. In the second paragraph of proof of this theorem, before “, adopting the obvious conventions”, add “to be the required value of $\mu_F(I)$ given by (1.33) (e.g., $|[a, b]|_F = F_+(b) - F_-(a)$)”.

From “An introduction to measure theory” by Terence Tao on Tao’s website.

Takeaways

- 
- Mathematicians aren't perfect (obviously), sometimes we make mistakes!
 - Never assume all mathematics is true! It is essential that *you* verify / check for *yourself* why something is true.
 - If something doesn't make sense in a textbook, it could be a typo. Sometimes even solutions have typos.

More Mythbusting



When mathematics is communicated, the only thing you need to worry about is whether or not it is correct.


In particular, correct numerical solutions in exams automatically get 100%

Which one

True / False

?

Question



Let $A \leq B \leq C$ be positive integers (i.e. 1,2,3,...)
which satisfy

$$A + B + C = ABC$$

What is the maximum possible value of ABC ?

Explain your reasoning.

(2 min)

Solution

We first show that if A, B, C satisfy the conditions of the question, then $AB \leq 3$.

Since

$$A \leq C,$$

$$B \leq C,$$

$$C \leq C,$$

$$ABC = A + B + C \leq C + C + C = 3C.$$

Since C is positive, we divide both sides by C and get $AB \leq 3$.

NOTE: There is no expectation in this course that you can figure out a solution like this in a few minutes. It takes years of practice.


Solution (continued)

Now that we know $AB \leq 3$, try and solve the problem:


What's the maximum possible value of ABC if $ABC = A + B + C$ and $A \leq B \leq C$ are positive integers?

(2 min)

Expectations around solutions

- 
- Solutions should primarily convince the reader why something is true.
 - Most questions will be graded as such.
 - In most 1000 / 2000 level math courses at Cornell, solutions are graded based on:
 - Completeness
 - Correctness

Expectations around solutions

- 
- Completeness:
 - Did the student have a good go at solving the problem?
 - Correctness:
 - How convincing is the solution?

Let's grade some example solutions to the previous problem with these criteria.

Example Solution 1



We first show $AB \leq 3$.

Since $ABC = A + B + C \leq 3C$ and $C \geq 0$, $AB \leq 3$.

Hence $(A,B) = (1,1), (1,2), (1,3)$.

Substituting these into $ABC = A + B + C$, the only possible value of C is 3. Hence the max is $1 \cdot 2 \cdot 3 = 6$.

Completeness: / 3

(Good go?)

Correctness / 3

(How convincing?)

Example Solution 2

It's possible to show that $ABC = A + B + C$ implies $AB \leq 3$.

So $AB = 1, 2, 3$.

So $(A, B) = (1, 1), (1, 2), (1, 3)$.

If $(A, B) = (1, 1)$, $C = C + 2$

→ no solution.

Completeness: / 3

(Good go?)

If $(A, B) = (1, 2)$, $2C = C + 3$

So $C = 3$, so $ABC = 6$.

If $(A, B) = (1, 3)$, $3C = C + 4$

So $C = 2$. But then $B > C$, which

Is not allowed.

→ Only solution is $(1, 2, 3)$

→ Maximum is 6.

Correctness / 3

(How convincing?)

Example Solution 3



6


Completeness: / 3

(Good go?)

Correctness / 3

(How convincing?)

Takeaways

- 
- Solutions in mathematics without an explanation *are usually difficult to understand*.
 - If asked to explain your reasoning, be sure to do so!
 - It's okay to write down partial ideas (e.g. "I tried to come up with a bound for a or b") if you're unable to come up with a solution.

Final Myth



Mathematics is done by geniuses, usually alone. In particular, mathematicians know how to solve most problems quickly.

Which one

True / False

?

Check out arXiv!

- Cutting-edge mathematics research is free: pretty much all mathematical papers are posted to arxiv.org

The screenshot shows the arXiv.org website. At the top left is the Cornell University logo and name. At the top right, a message reads: "We gratefully acknowledge support from the Simons Foundation and member institutions." Below this is the arXiv.org logo. To the right of the logo is a search bar with a "Search..." input field, a dropdown menu set to "All fields", and a "Search" button. Below the search bar are links for "Help" and "Advanced Search". A "Login" link is also present in the top right corner. On the left side, there is a section titled "Subject search and browse:" with a dropdown menu set to "Physics" and buttons for "Search", "Form Interface", and "Catchup". On the right side, there is a "COVID-19 Quick Links" section with a red header. It contains the text "See COVID-19 SARS-CoV-2 preprints from" followed by a bulleted list: "• arXiv" and "• medRxiv and bioRxiv". Below this list is an "Important:" notice: "e-prints posted on arXiv are not peer-reviewed by arXiv; they should not be relied upon without context to guide clinical practice or health-related behavior and should not be reported in news media as established".

- It's actually hosted by Cornell!

Loads of authors...

From arXiv



- When searching mathematics papers on the arXiv, the majority of papers have several authors
 - I.e. most mathematicians work on solving problems together.
- It's best to start early!
 - Find a classmate(s) to work with on problems (e.g. via Ed Discussion)

Circuit algebras are wheeled props

Authors: Zsuzsanna Dancso, Iva Halacheva, Marcy Robertson

Abstract: Circuit algebras, introduced by Bar-Natan and the first author, are a generalization of Jones's planar algebras, in which one drops the planarity condition on "connectors". They provide a useful language for the study of virtual and welded tangles in low-dimer complexity. In this note, we present the circuit algebra analogue of the well-known classification of planar algebras as pivot... [▼ More](#)

Submitted 21 September, 2020; **originally announced** September 2020.

Comments: 29 pages, many figures

MSC Class: 57M25; 18D50

2. [arXiv:2007.09828](#) [[pdf](#), [other](#)] [math.GT](#)

Over then Under Tangles

Authors: Dror Bar-Natan, Zsuzsanna Dancso, Roland van der Veen

Abstract: Over-then-Under (OU) tangles are oriented tangles whose strands travel over crossings before any under crossings. In this paper we discuss the idea of gluing which any tangle diagram could be brought to OU form. Unfortunately, the algorithm does not always succeed. However, by analyzing cases in which it does succeed we obtain a braid classification of OU tangles... [▼ More](#)

Submitted 4 February, 2021; **v1 submitted** 19 July, 2020; **originally announced** July 2020.

Comments: 35 pages, lots of figures


MSC Class: 57M25

3. [arXiv:1910.00979](#) [[pdf](#), [ps](#), [other](#)] [math.AG](#) [math.CO](#)


Deletion-contraction triangles for Hausel-Proudfoot varieties

Authors: Zsuzsanna Dancso, Michael McBreen, Vivek Shende


Abstract: To a graph, Hausel and Proudfoot associate two complex manifolds, B and C . The Hausel-Proudfoot conjecture states that B and C are birational. In this paper, we prove the conjecture for graphs with at most two vertices of degree greater than 2.

- 
- Almost all of mathematics research is about solving problems no one has been able to solve yet.
 - The idea that mathematicians know how to solve most problems is false, simply because there are always more unsolved problems!


Math is a language

- 
- Just as no one is born being able to speak a given language, no one is born being able to do math.
 - Reading a dictionary of another language will not make you fluent in that language... you need to practice!

Math is a language (continued)

- 
- If you encounter words / symbols you don't know the mean of in this course, ultimately it's your responsibility to look them up.

Warning

- 
- For native speaker of English, translating another language into English is usually a lot easier than translating in the opposite direction.
 - Don't fall into the same trap with math:
 - Understanding a solution is easier than coming up with it yourself. *You will be expected to come up with solutions.*
 - This only comes about with practice.

Math is hard




Math is hard; anyone who says math is easy is a liar.

What are some places you can get help with math?

Getting support
with math is not as
hard as getting in
here...




Math Support (not exhaustive)

- 
- Other students
 - Ed Discussion
 - Office hours
 - Math support center
 - Online Q&A boards (e.g. math exchange)
 - Student support groups
 - Tutorials / examples on Youtube / other platforms

Some student STEM support groups

- [Association for Women in Mathematics Cornell \(AWM\)](#)
- [Society for Women Engineers at Cornell \(SWE\)](#)
- [Women in Computing at Cornell \(WICC\)](#)
- [Underrepresented Minorities in Computing Cornell \(URMC\)](#)
- [ColorStack](#)
- [National Society of Black Engineers Cornell \(NSBE\)](#)
- [Society of Hispanic Professional Engineers Cornell \(SHPE\)](#)
- [American Indian Science & Engineering Society \(AISES\)](#)
- [First Generation Students Union Cornell](#)
- [Haven // qStem \(LGBTQI+ in STEM\)](#)
- [LGBT Resource Center](#)

Plagiarism

- 
- The consequences of plagiarism can be severe:
 - Failing a course
 - A permanent record of cheating on your transcript
 - *In the case of an exam, using non-approved internet resources is strictly prohibited.*

Takeaways

- If you're stuck on an assignment problem, seek help!
There are LOADS of ways to get help in the course.
- Highly, highly recommended way: the support course!

Extra Resources

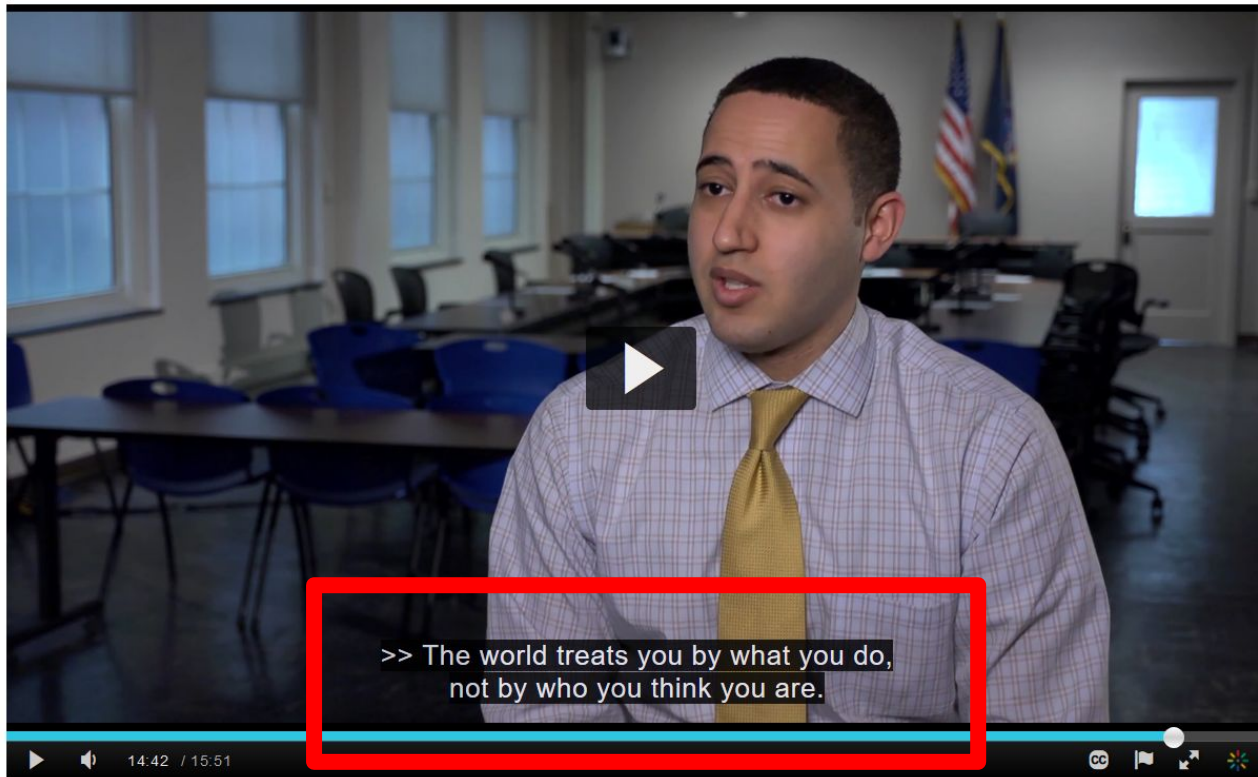
Support Course by LSC

Everyone is welcome to come to the support course for MATH1106, run by Dr. Fraser. The support course meets once a week (either M 1:25-2:40 MLT253 or W 2:55-4:10 MLT251), and is a time to review what you have done in class that

week, answer any questions you may have, and do extra practice problems. You do not need to be enrolled in the course to attend - just drop by whenever you'd like some extra help! You are also welcome to access extra problems and solution sets on the support course Canvas page, which you can find [here](#).

Math Support Center

<http://uann.pair.com/ref/msc/when/> 



From the
Cornell
“cheating”
video

- Former Mayor Myrick’s thoughts on cheating.

Not all faculty think a lot about D&I...

Diversity and Inclusion



[Our Story](#)

[Belonging at Cornell](#)

[Our Community](#)

[Our Commitments](#)

Our Commitments

Diversity Leadership
at Cornell

DIWD

Inclusive Excellence
Network

[Home](#) / [Our Commitments](#) / Bias Reporting at Cornell

Bias Reporting at Cornell

[Report A Bias Incident](#)

Since 2000, Cornell University has had a program to track bias that is occurring on all campuses in an effort to be proactive in creating an inclusive climate for all. The [Department of Inclusion and Workforce](#)

Anyone can use
this about anyone



It's not just bias


- It doesn't necessarily need to be intentional.
- E.g. a professor saying "him or her" instead of the more inclusive "they".



A screenshot of a dropdown menu with a blue header bar. The menu is open, showing a list of categories. The categories are: Bias, Criminal Activity, Discrimination, Harassment, Domestic and Dating Violence, Gender Based or Sexual Harassment, Hazing, Retaliation, Sexual Assault or Misconduct, Sexual Exploitation, Stalking, Violation of Interim Measure under Policy 6.4, Workplace Climate Concerns, and Other/Not Sure Which Category to Select. The menu is partially obscured by other elements on the page, including a grey bar on the left and a grey bar on the right.

- Bias
- Criminal Activity
- Discrimination
- Harassment
- Domestic and Dating Violence
- Gender Based or Sexual Harassment
- Hazing
- Retaliation
- Sexual Assault or Misconduct
- Sexual Exploitation
- Stalking
- Violation of Interim Measure under Policy 6.4
- Workplace Climate Concerns
- Other/Not Sure Which Category to Select


Anonymity Options



Please remember that the timing and manner in which the University addresses this report will vary depending on the information provided and whether involved parties are available for further discussion.

- You may contact me
- To the extent possible, I would like to remain anonymous to involved individuals, but you may contact me
- Please do not contact me

Summary

- 
- What is the format of the discussion sections? Why come to them?
 - What is linear algebra?
 - Admin
 - Mathematics mythbusting
 - Math support groups
 - Plagiarism & Cheating
 - D&I Bias reporting