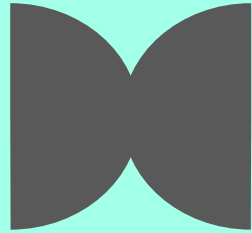


LaTeX Workshop



Melissa Beerbower
Professional
Development

Agenda



Create 4 documents in Overleaf file:

- Article Draft
- Research Log
- Bibliography
- Annotated Bibliography

Populate those files with material:

- Article Draft: nothing yet!
- Research Log: examples of common math content
- Bibliography: current reading materials
- Annotated Bibliography: nothing yet!

Make an Account on Overleaf



<https://www.overleaf.com/register>

Create your account

 Continue with Google

 Continue with ORCID

OR

Email

Password



Must be at least 8 characters. Avoid common passwords.

Create account

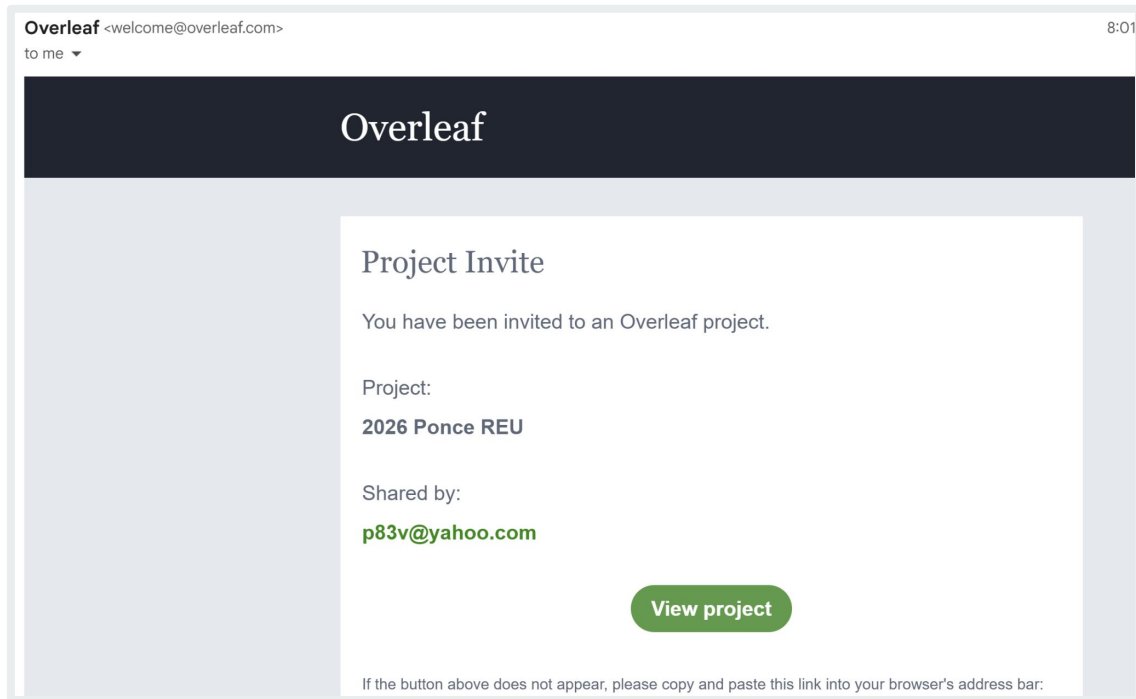
Accept Invite to Research Experience for Undergrads

The free version of Overleaf doesn't allow access to multiple editors. For undergraduate research, your graduate mentors and professors need access.

Send the email you used for your Overleaf accounts to the professor mentoring your undergraduate research, and they will send you an invite to join the REU Overleaf.

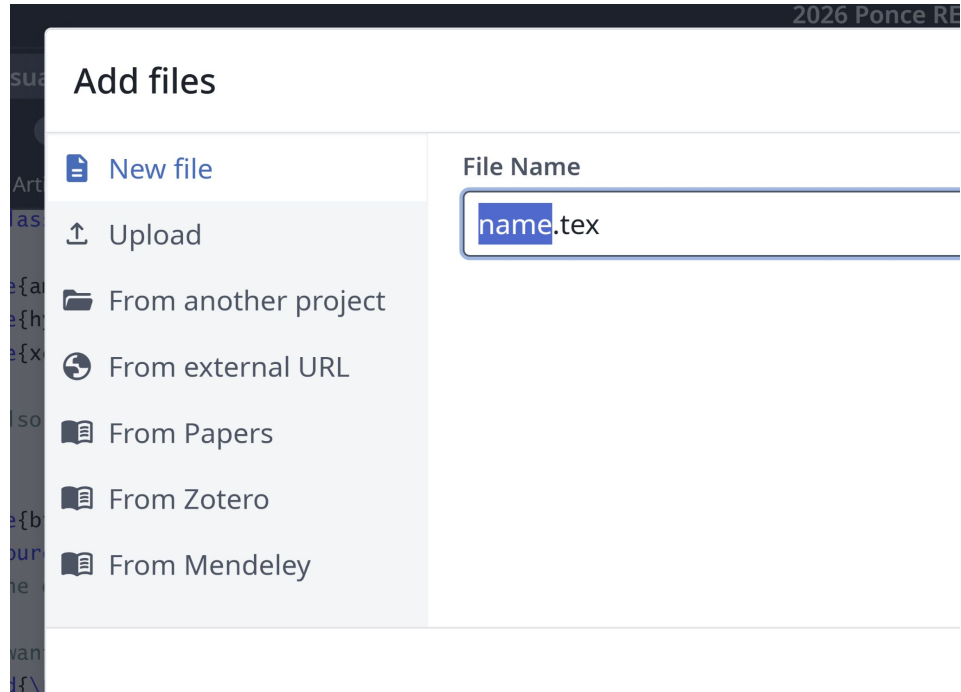
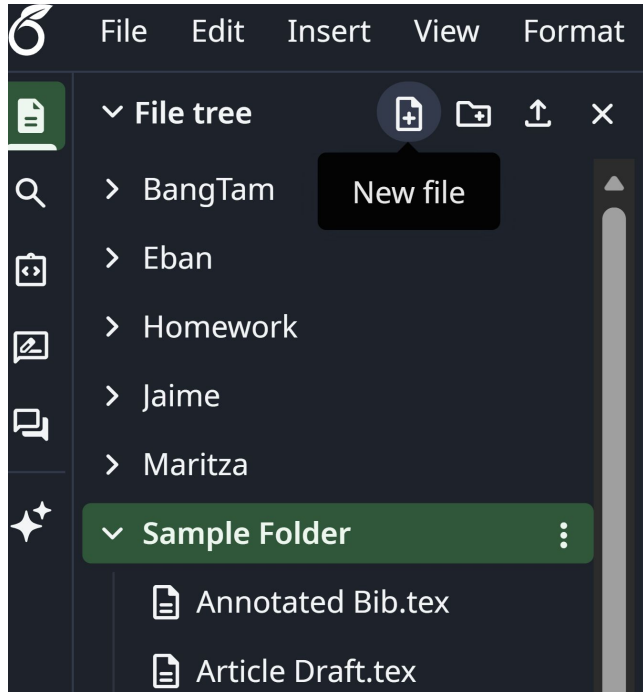
Check your emails and join the project!

If your mentors don't already have a Sample Folder in the REU file, you can find the Sample Folder on my website.



Create 'Article Draft' in Your Folder

- You may rename your folder with your preferred name.
- Create a new file in your folder. Name it 'Article Draft'.
- Copy code from document titled 'Article Draft' in the Sample Folder (see next slide).



6

File Edit Insert View Format Help

File tree

BangTam

Eban

Jaime

Maritza

Sample Folder

Annotated Bib.tex

Article Draft.tex

Bibliography.bib

Postertex

Research Log.tex

Slide Deck.tex

Tung

File outline

Introduction.

Main Results.

Future Work.

Code Editor Visual Editor

Normal text

B I

WRITEFULL

Sample Folder > Article Draft.tex

1 \documentclass{amsart}

2

3 \usepackage{amsmath}

4 \usepackage{hyperref} %You need this for the email format

5 \usepackage{xcolor} %You need this for colored text

6

7 %You can also include multiple packages in one line: \usepackage{amsmath,

hyperref}

8

9 \usepackage{biblatex} %Imports biblatex package

10 \addbibresource{Bibliography.bib} %Import the bibliography file

11 %This is one of several ways to make a bibliography in LaTeX.

12

13 %You will want to use commands to make typing easier

14 \newcommand{\PF}{\mathrm{PF}}

15

16 %The commands below allow your mentors to make comments within the body of your

work.

17 \newcommand{\pamela}[1]{\bf\color{purple}Pamela: #1}

18 \newcommand{\cyrus}[1]{\bf\color{blue}Cyrus: #1}

19 \newcommand{\jennifer}[1]{\bf\color{green}Jennifer: #1}

20 \newcommand{\melissa}[1]{\bf\color{cyan}Melissa: #1}

21

22 \title{Title}

23

24

25 \date{\today}

26

27

28 \author[You]{Your Name}

29 \address[Y.-Name]{Your University}

30 \email{\href{you@youruniversity.edu}{you@youruniversity.edu}}

31

32

33 \author{Beerbower}{Melissa Beerbower}

34

35

36 \author{Elder}{Jennifer Elder}

37 \address[J.-Elder]{Department of Computer Science, Mathematics and Physics,

2026 Ponce REU

Recompile

1 / 1

101%

TITLE

YOUR NAME, MELISSA BEERBOWER, JENNIFER ELDER, PAMELA E. HARRIS,
AND CYRUS YOUNG

ABSTRACT. We will write an abstract together.

1. INTRODUCTION.

We denote the set of parking functions of length n by PF_n . *Melissa: Good luck with LaTeX!*

There may or may not be a connection between parking functions and [1]. However, this style of bibliography prints only items from the bib file that we cite in the body of the article.

2. MAIN RESULTS.

3. FUTURE WORK.

REFERENCES

[1] Bruce E. Sagan and Foster Tom. "Chromatic symmetric functions and change of basis", *Int. Algebr. Comb.* 9.1 (2026), pp. 307-325. ISSN: 2589-5486. DOI: [10.5802/alco.468](https://doi.org/10.5802/alco.468). URL: <https://doi.org/10.5802/alco.468>.

(Y. Name) Your University
Email address: you@youruniversity.edu

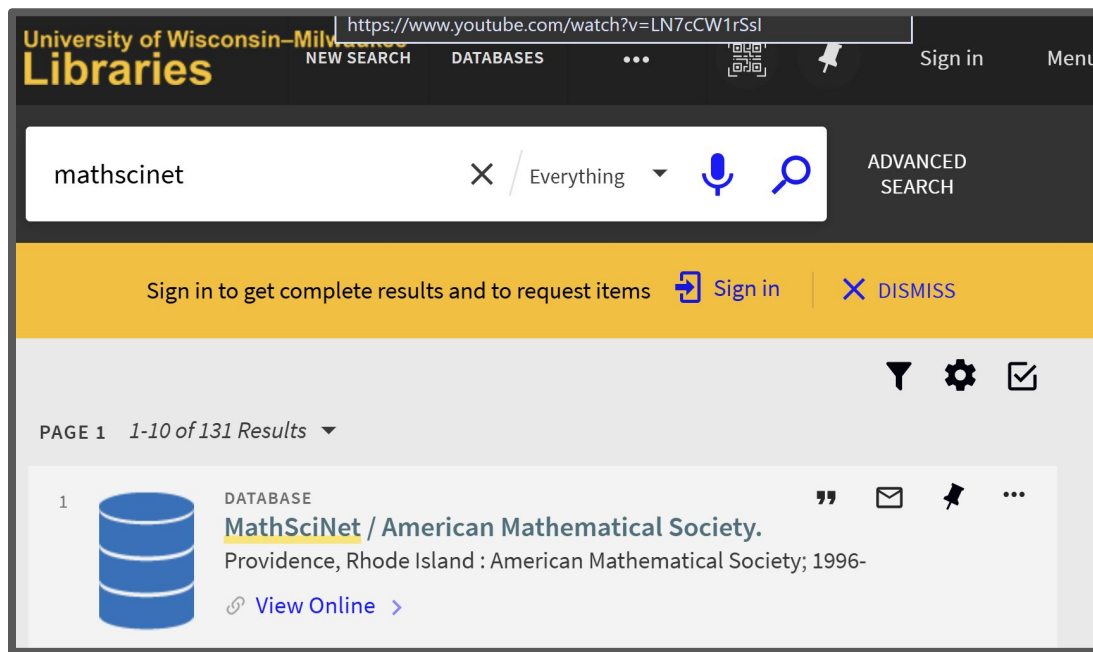
(J. Elder) DEPARTMENT OF COMPUTER SCIENCE, MATHEMATICS AND PHYSICS, MISSOURI WESTERN STATE UNIVERSITY, ST. JOSEPH, MO 64507
Email address: jelder@missourivestern.edu

(M. Beerbower, P. E. Harris) DEPARTMENT OF MATHEMATICAL SCIENCES, UNIVERSITY OF WISCONSIN-MILWAUKEE, MILWAUKEE, WI 53211 UNITED STATES
Email address: beerbow2@uwm.edu
Email address: peharris@uwm.edu

(C. Young) DEPARTMENT OF MATHEMATICAL SCIENCES, UNIVERSITY OF WISCONSIN-MILWAUKEE, MILWAUKEE, WI 53211 UNITED STATES
Email address: young424@uwm.edu

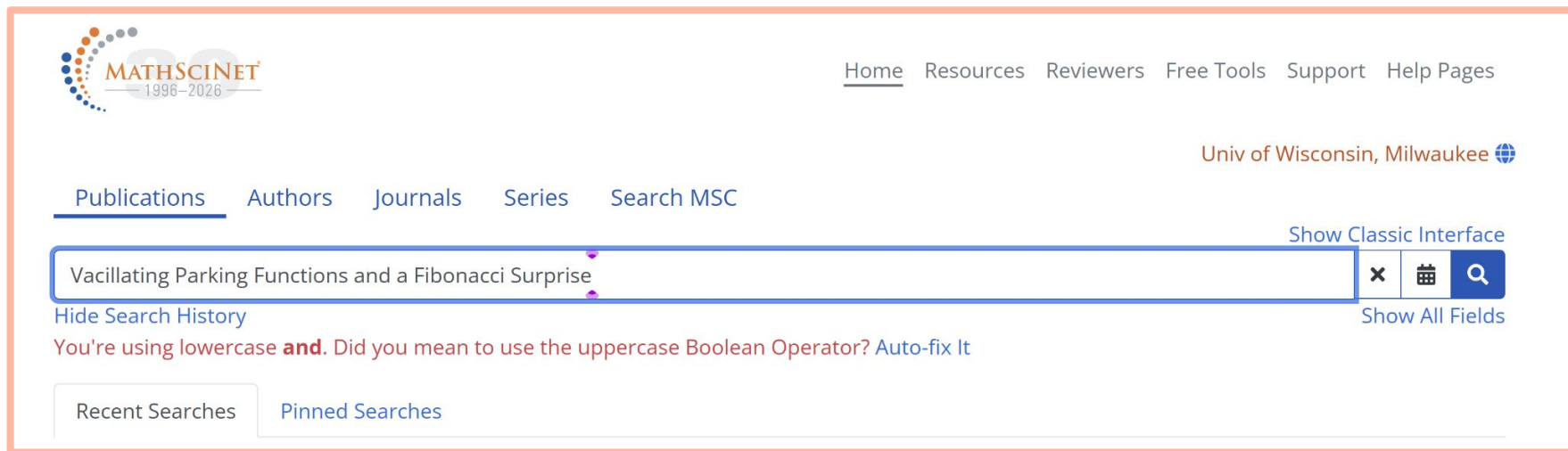
Create Bibliography

- Create new document in file. Name it xyz.bib.
- In another tab, go your university's library and search for MathSciNet. You will be prompted to log in with your university ID.



Create Bibliography

- Open the Homework folder. The articles you have been assigned should be here.
- In another tab, go to [Publications Search - MathSciNet](#). Search for the articles.



The screenshot shows the MathSciNet website interface. At the top left is the MathSciNet logo with the text "1996-2026". To the right is a navigation bar with links: Home, Resources, Reviewers, Free Tools, Support, and Help Pages. Below this is a secondary navigation bar with links: Publications (underlined), Authors, Journals, Series, and Search MSC. On the right side of this bar is the text "Univ of Wisconsin, Milwaukee" followed by a globe icon. Below the navigation bar is a search bar containing the text "Vacillating Parking Functions and a Fibonacci Surprise". To the right of the search bar are three icons: a close button (x), a calendar icon, and a search icon (magnifying glass). Below the search bar is a link "Hide Search History". To the right of the search bar is a link "Show Classic Interface". Below the search bar is a message: "You're using lowercase **and**. Did you mean to use the uppercase Boolean Operator? [Auto-fix It](#)". At the bottom left are two tabs: "Recent Searches" and "Pinned Searches".

MATHSCINET
1996-2026

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[Publications](#) [Authors](#) [Journals](#) [Series](#) [Search MSC](#)

Univ of Wisconsin, Milwaukee

[Show Classic Interface](#)

Vacillating Parking Functions and a Fibonacci Surprise

[Hide Search History](#)

You're using lowercase **and**. Did you mean to use the uppercase Boolean Operator? [Auto-fix It](#)

[Recent Searches](#) [Pinned Searches](#)

MathSciNet

Find citations for the articles in Homework folder from MathSciNet. (Note that you cannot do this for the papers by Kimberly Hadaway.)



Home Resources Reviewers Free Tools Support Help Pages

Univ of Wisconsin, Milwaukee 

MR4976968

Indexed

  Article  Cite  Review PDF 

Harris, Pamela E. (1-WIM-NDM)
Vacillating parking functions and a Fibonacci surprise.
Math Horiz. **33** (2025), no. 2, 12–15.

Classifications

- [05A15 - Exact enumeration problems, generating functions](#)
- [11B39 - Fibonacci and Lucas numbers and polynomials and generalizations](#)

Citations

From References: 0
From Reviews: 0

Copy Citations and Paste into Your Bibliography

The screenshot shows the MathSciNet interface for the citation MR4976968. The page includes the MathSciNet logo (1996-2026), navigation links (Home, Resources, Reviewers, Free Tools, Support, Help Pages), and the affiliation 'Univ of Wisconsin, Milwaukee'. The citation title is 'Vacillating parking functions and a Fibonacci surprise' by Harris, Pamela E., published in Math Horiz. 33 (2025). A modal window titled 'Citation Formatting' is open, allowing the user to select a format (BibTeX is selected) and copy the citation preview. The preview shows the citation in BibTeX format with fields for article, author, title, journal, fjournal, volume, year, number, pages, and ISSN. A 'Close' button is at the bottom right of the modal.

MATHSCINET
1996-2026

Home Resources Reviewers Free Tools Support Help Pages

Univ of Wisconsin, Milwaukee

MR4976968

Indexed

Harris, Pamela E.
Vacillating parking functions and a Fibonacci surprise
Math Horiz. 33 (2025)

Classifications
05A15 - Exact enumeration theory
11B39 - Fibonacci and Lucas numbers and polynomials and analogues

Citations
From References: 0
From Reviews: 0

Citation Formatting

Select a format to change the citation preview

BibTeX

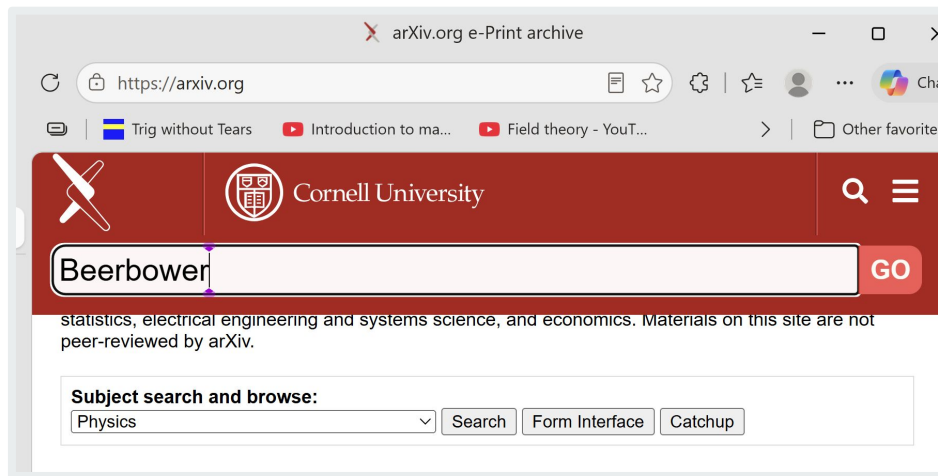
Copy

```
@article{MR4976968,  
  AUTHOR = {Harris, Pamela E.},  
  TITLE = {Vacillating parking functions and a Fibonacci surprise},  
  JOURNAL = {Math Horiz.},  
  FJOURNAL = {Math Horizons},  
  VOLUME = {33},  
  YEAR = {2025},  
  NUMBER = {2},  
  PAGES = {12--15},  
  ISSN = {1072-4117,1947-6213},
```

Close

ArXiv: Unpublished Articles

Math research is ongoing! Frequently, you need to cite articles that have not yet been officially published. Researchers often post their work on ArXiv when they submit it to a journal. Even after an article is accepted for publication, only the ArXiv version will be available until the print version is publishable, at which point then the article will be posted to MathSciNet.



50 results per page. Sort results by: Announcement date (newest first)

1. arXiv:2603.20535 [pdf, ps, other] [math.CO](#)
Lehmer Parking Functions and Their Outcomes
Authors: Melissa Beerbower, Jennifer Elder, Pamela E. Harris, Ilana Lavenex, Adam Martinson, Molly Oldham
Abstract: We introduce Lehmer parking functions and study their set of parking outcomes. Our main results establish that the number of outcomes of Lehmer parking functions of length n is given by a Bell number, which is exactly the number of set partitions of an n element set. We also show that the number of outcomes of weakly decreasing Lehmer parking functions is given by a Catalan number, which corre... [More](#)
Submitted: 20 March, 2026; **originally announced:** March 2026.
Comments: 14 pages, 10 figures
MSC Class: Primary 05A05; Secondary 05A10; 05A15; 05A18; 05A19

2. arXiv:2603.00693 [pdf, ps, other] [math.CO](#)
Counting ℓ -interval Fubini rankings through their parking outcome
Authors: Bjorn Andreas Ager-Hart, Melissa Beerbower, Pamela E. Harris, Adam Martinson, Molly Oldham
Abstract: Fubini rankings with n competitors are n -tuples with e $[n] = \{1, 2, 3, \dots, n\}$ that encode the conclusion of a race where the competitors are parking functions, we can study their parking outcome by encoding the final parking order of the cars using the Fubini ranking. We establish that the number of Fubini rankings with n competitors is given by a Bell number. [More](#)
Submitted: 28 February, 2026; **originally announced:** March 2026.

3. arXiv:2510.27574 [pdf, ps, other] [math.CO](#)
Lucky Cars in Fubini Rankings and Unit Fubini Rankings
Authors: Camilo Barreto, Melissa Beerbower, Jennifer Elder, Pamela E. Harris, Lucy Martinez, José L. Ramírez, Samuel Ramírez, Grant Shirley, Julio C. Vásquez
Abstract: We study lucky cars in subsets of parking functions, called Fubini rankings and unit Fubini rankings. A Fubini ranking is a sequence of nonnegative integers that encodes a valid

Not yet accepted for publication

Accepted for publication, not yet printed

ArXiv: Citations

Step 1: Click on arXiv:###.

Step 2: Scroll down to Export BibTeX Citation button.

Step 3: Copy and paste into your bibliography.

50 results per page. Sort results

1. [arXiv:2603.20535](#) [pdf, ps, other formats]

Lehmer Parking Function

Authors: [Melissa Beerbower](#), [Jennifer Elder](#), [Pamela E. Harris](#), [Ilana Lavene](#), [Lucy Martinez](#), [Adam Martinson](#), [Molly Oldham](#)

Abstract: We introduce Lehmer parking functions and study their set of parking outcomes. Our main results establish that the number of outcomes of Lehmer parking functions of length n is given by a Bell number, which is exactly the number of set partitions of an n element set. We also show that the number of outcomes of weakly decreasing Lehmer parking functions is given by a Catalan number, which corresponds to a subset of set partitions on a set with n elements referred to as non-intersecting set partitions.

We introduce Lehmer parking functions and study their set of parking outcomes. Our main results establish that the number of outcomes of Lehmer parking functions of length n is given by a Bell number, which is exactly the number of set partitions of an n element set. We also show that the number of outcomes of weakly decreasing Lehmer parking functions is given by a Catalan number, which corresponds to a subset of set partitions on a set with n elements referred to as non-intersecting set partitions.

Comments: 14 pages, 10 figures
Subjects: [Combinatorics \(math.CO\)](#)
MSC classes: Primary [05A05](#), Secondary [05A10](#), [05A15](#), [05A18](#), [05A19](#)
Cite as: [arXiv:2603.20535](#) [[math.CO](#)]
(or [arXiv:2603.20535v1](#) [[math.CO](#)] for this version)
<https://doi.org/10.48550/arXiv.2603.20535>

Submission history

From: [Jennifer Elder](#) [[view email](#)]
[v1] Fri, 20 Mar 2026 22:11:04 UTC (631 KB)

Access Paper:

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Change to browse by: [math](#)

References & Citations

[NASA ADS](#) [Google Scholar](#) [Semantic Scholar](#)

[Export BibTeX Citation](#)

BibTeX formatted citation

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@misc{beerbower2026lehmerparkingfunctionsoutcomes,
  title={Lehmer Parking Functions and Their Outcomes},
  author={Melissa Beerbower and Jennifer Elder and Pamela E. Harris and
  Ilana Lavene and Lucy Martinez and Adam Martinson and Molly Oldham},
  year={2026},
  eprint={2603.20535},
  archivePrefix={arXiv},
  primaryClass={math.CO},
  url={https://arxiv.org/abs/2603.20535},
}
```

Data provided by: [arXiv API](#)

[new](#) [recent](#) [2026-03](#)

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References & Citations

[NASA ADS](#) [Google Scholar](#) [Semantic Scholar](#)

[Export BibTeX Citation](#)

Citing Expository or Humanities Paper

In the Homework Folder, you will find one of Kimberly Hadaway's expository papers, co-authored with Dr. Pamela E. Harris. This paper is not on ArXiv or MathSciNet. The citation is on Dr. Harris's CV. Go to their professional website and search their CV.

In your bib, copy and paste a typical entry and fill in the info for the expository paper.

Expository Writing

10. *Placement of Satellites and Antennas: Keeping our Connection to the Cosmos Alive*
Lily Carillo, Jillian Cervantes, and Pamela E. Harris. To appear in *Girls' Angle Bulletin*.
9. *Vacillating Parking Functions and a Fibonacci Surprise*
Pamela E. Harris. *Math Horizons* Volume 33, 2025 - Issue 2, pages 12–15.
8. *Parking Towards $\sqrt{2}$, One Fraction at a Time*
Ari Cruz, Bruce Fang, Pamela E. Harris, J. Carlos Martinez Mori. *Math Horizons* Volume 33, 2025 - Issue 1, pages 5–9.
7. *Optimal Resource Placement: From Disneyland to Dominating Sets, Part 2*
Jillian Cervantes* and Pamela E. Harris. *Girls' Angle Bulletin*, April/May 2024, Volume 17, Number 4, p. 8–12.
6. *Optimal Resource Placement: From Disneyland to Dominating Sets, Part 1*
Jillian Cervantes* and Pamela E. Harris. *Girls' Angle Bulletin*, February/March 2024, Volume 17, Number 3, p. 14–17.
5. *Multiplex juggling and its connection to Kostant's partition function, Part 2*
Pamela E. Harris and Maria Rodriguez Hertz*. *Girls' Angle Bulletin*, June 2021/July 2021 Volume 14 Number 5, p. 12–15.
4. *Multiplex juggling and its connection to Kostant's partition function, Part 1*
Pamela E. Harris and Maria Rodriguez Hertz*. *Girls' Angle Bulletin*, April 2021/May 2021 Volume 14 Number 4, p. 9–14.

17

3. *Honk! Honk! (Introduction to Parking Functions), Part 2*
Kimberly Hadaway* and Pamela E. Harris. *Girls' Angle Bulletin*, February 2021/March 2021 Volume 14 Number 3, p. 14–20.
2. *Honk! Honk! (Introduction to Parking Functions), Part 1*
Kimberly Hadaway* and Pamela E. Harris. *Girls' Angle Bulletin*, December 2020/January 2021 Volume 14 Number 2, p. 15–20.

```
Code Editor Visual Editor
? Ask TeXGPT for help
Sample Folder > Bibliography.bib

1 @article {MR5039069,
2   AUTHOR = {Sagan, Bruce E. and Tom, Foster},
3   TITLE = {Chromatic symmetric functions and change of basis},
4   JOURNAL = {Algebr. Comb.},
5   FJOURNAL = {Algebraic Combinatorics},
6   VOLUME = {9},
7   YEAR = {2020},
8   NUMBER = {1},
9   PAGES = {307--325},
10  ISSN = {2589-5486},
11  MRCLASS = {05E05 (05C15)},
12  MRNUMBER = {5039069},
13  DOI = {10.5802/alco.468},
14  URL = {https://doi.org/10.5802/alco.468},
15 }
16
17 @article {HonkPart1,
18   AUTHOR = {Hadaway, Kimberly and Harris, Pamela E.},
19   TITLE = {Honk! Honk! (Introduction to Parking Functions), Part 1},
20   JOURNAL = {Girls' Angle Bulletin},
21   FJOURNAL = {Girls' Angle Bulletin},
22   VOLUME = {14},
23   YEAR = {2020},
24   NUMBER = {2},
25   PAGES = {15--20},
26   % ISSN = {2589-5486},
27   % MRCLASS = {05E05 (05C15)},
28   % MRNUMBER = {5039069},
29   % DOI = {10.5802/alco.468},
30   URL = {https://www.girlsangle.org/page/bulletin-archive/GABv14n02E.pdf#page=15},
31 }
32
33 @article {HonkPart2,
34   AUTHOR = {Hadaway, Kimberly and Harris, Pamela E.},
35   TITLE = {Honk! Honk! (Introduction to Parking Functions), Part 2},
36   JOURNAL = {Girls' Angle Bulletin},
37   FJOURNAL = {Girls' Angle Bulletin},
38   VOLUME = {14},
39   YEAR = {2021},
40   NUMBER = {3},
41   PAGES = {14--20},
42   % ISSN = {2589-5486},
43   % MRCLASS = {05E05 (05C15)},
44   % MRNUMBER = {5039069},
```

Create 'Research Log' & 'Annotated Bibliography'



- Create two more files, one named 'Research Log' and one named 'Annotated Bibliography'.
- Copy code from the files of the same name in the Sample Folder.
- These files are for your notes. You may format them any way you wish. The code is just to get you started.
- Starting today, you will write in your 'Research Log' everyday!
- In the Bibliography Workshop, we will discuss how to do a proper and thorough bibliography search. That's when you will start filling your Annotated Bibliography.

Adding Material to Your Files



Now you have four files in your folder:

- Article Draft
- Daily Log
- Bibliography
- Annotated Bibliography

Next, we are going to practice formatting typical content such as matrices, tables, images, lists, and equations in your Research Log file.

Note About Preambles & Packages



As you use in Overleaf, it is helpful to add only packages that you need to your file. Less clutter helps you to better observe cause and effect when you are experimenting with all the fun techniques you find online.

For the exercises in this workshop, assume that you do not need to add a package unless the exercise explicitly says to add a package. Note that you are starting with just one package, `amsmath`.

Always add packages before `\begin{document}`. Everything before `\begin{document}` is called the Preamble. Preambles are for packages, commands, formatting titles, and author information.

Equations \$101\$



Here are four ways to include an equation in LaTeX:

- Inline with `$$`,
- Within backslashes and brackets `\[ \]`,
- In an equation environment, and
- In an align environment.

Equations I

```
6
7 \begin{document}
8 \maketitle
9
10 You can write an equation or math symbol within the body of a paragraph by
    enclosing it in dollars signs:  $f(x)=x^2$ . Then you can continue writing.
11
12 You can write an equation within backslashes and brackets within a paragraph.
    This environment will break your paragraph and center your equation, like this.
    \[f(x)=x^2\] And then you can proceed with what you were writing. You can also
    use backslashes and brackets on their own outside a paragraph, like this:
13
14 \[f(x)=x^2\]
15
16 Or even like this:
17
18 \[
19 f(x) =
20 \begin{cases}
21 x^2, & \text{if } x \geq 0 \\
22 -x, & \text{if } x < 0
23 \end{cases}
24 \]
```

Code to the left; compiled to the right.

Notice that you don't need to add any packages to your file to implement these techniques.

Note that $\[\]$ automatically centers equations.

Note $\{cases\}$ environment. Fancy!

You can write an equation or math symbol within the body of a paragraph by enclosing it in dollars signs: $f(x) = x^2$. Then you can continue writing.

You can write an equation within backslashes and brackets within a paragraph. This environment will break your paragraph and center your equation, like this.

$$f(x) = x^2$$

And then you can proceed with what you were writing. You can also use backslashes and brackets on their own outside a paragraph, like this:

$$f(x) = x^2$$

Or even like this:

$$f(x) = \begin{cases} x^2, & \text{if } x \geq 0 \\ -x, & \text{if } x < 0 \end{cases}$$

Equations II

25 For particularly long or grand equations, you may want to use the equation
26 environment:

```
27  
28 \begin{equation*}  
29   f(x) = x^2.  
30 \end{equation*}
```

31
32 Notice the asterisk. If you remove the asterisk, LaTeX will number all the
equations in the equation environment in your paper.

```
33  
34 \begin{equation}  
35   f(x) = x^2.  
36 \end{equation}  
37  
38 \begin{equation}  
39   \binom{n}{m} = \frac{n!}{(n-m)!m!} .  
40 \end{equation}  
41  
42 \begin{equation}  
43   n! = n(n-1)(n-2) \cdots 2(1).  
44 \end{equation}
```

45
46

Code to the left; compiled to the
right.

Notice the **.

Notice use of \frac, \binom,
\cdots.

For particularly long or grand equations, you may want to use the equation
environment:

$$f(x) = x^2.$$

Notice the asterisk. If you remove the asterisk, LaTeX will number all the
equations in the equation environment in your paper.

(1)
$$f(x) = x^2.$$

(2)
$$\binom{n}{m} = \frac{n!}{(n-m)!m!}.$$

(3)
$$n! = n(n-1)(n-2) \cdots 2(1).$$

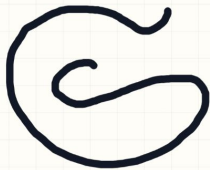
Detexify & Packages

DETEXIFY

Draw. Find. Copy.

Canvas
ready · 1123 symbols, 39494 samples

Clear



Find the LaTeX command for a symbol you can draw but not name.

DRAW SYMBOLS MAC

Results
Best matches first

	<code>\mathfrak{S}</code> math <code>\usepackage{amssymb}</code> <code>\usepackage[OT1]{fontenc}</code>	0.1656
	<code>\upsigma</code> math <code>\usepackage{upgreek}</code> <code>\usepackage[OT1]{fontenc}</code>	0.2098
	<code>\mathscr{O}</code> math <code>\usepackage{mathrsfs}</code> <code>\usepackage[OT1]{fontenc}</code>	0.2153
	<code>\Satz</code> text <code>\usepackage{marvosym}</code> <code>\usepackage[OT1]{fontenc}</code>	0.2358

Detexify LaTeX handwritten symbol recognition

When you don't know how to type a math symbol in LaTeX, go to Detexify and draw it. To the right, you will see the code that you need. When it says 'math mode' that means you must type it between `$$` or in an equation or align environment.

Equations Exercise

Assignment: Type these equations into your Research Log.

$$\mathbb{Z}_{2^3} \times \mathbb{Z}_{2^2} \times \mathbb{Z}_3 \times \mathbb{Z}_{3^4} \times \mathbb{Z}_5 \times \mathbb{Z}_5 \times \mathbb{Z}_{17} \times \mathbb{Z}_{17^8} \times \mathbb{Z}_{983}$$

```
15  
16  $\{a,b\}$   
17  
18 {a,b}  
19  
20  $x_a, x_{abc}$ 
```

$$G \cong F(\{a, b\}) / \ker \pi \longrightarrow H.$$

$$\int_a^b f'(t) dt = f(b) - f(a)$$

$\{a, b\}$
 a, b
 x_a, X_{abc}

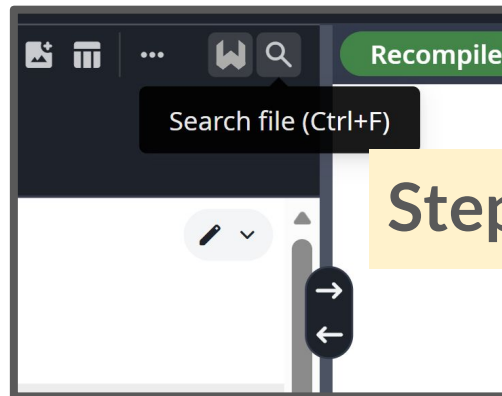
Commands, Find and Replace

Assignment: Create a command for the integer symbol. Implement the command and replace every $\mathbb{Z}$ from the last exercise with a $\mathbb{Z}$.

Step 1

```
8 \newcommand{\Z}{\mathbb{Z}}
9
10
11 \title{Your Research Log}
12
13 \begin{document}
14 \maketitle
15
16
17 $\mathbb{Z}_{2^3} \times \mathbb{Z}_{2^2} \times \mathbb{Z}_3 \times \mathbb{Z}_{3^4} \times \mathbb{Z}_5 \times \mathbb{Z}_5 \times \mathbb{Z}_{17} \times \mathbb{Z}_{17^8} \times \mathbb{Z}_{983}$
18
19
```

Step 2



$$\mathbb{Z}_{2^3} \times \mathbb{Z}_{2^2} \times \mathbb{Z}_3 \times \mathbb{Z}_{3^4} \times \mathbb{Z}_5 \times \mathbb{Z}_5 \times \mathbb{Z}_{17} \times \mathbb{Z}_{17^8} \times \mathbb{Z}_{983}$$

Step 3

Equations in Align Environment

In the align environment, everything is in math mode, so you have to type `\text{}` for words.

`&` indicates where you want your equations to line up. You can make multiple `&`'s per line, but you must use the same number on each line.

```
9
10 Cayley's Theorem states that every group is a subgroup of the symmetric group. Hence,
11
12 \begin{align*}
13 \mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2 &= G & \text{ is a group, } \\
14 \text{iff } \mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2 &\leq \mathfrak{S}_n & \text{ for some positive integer } n. \\
15 |\mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2| &= 8 & \text{ give us that, } \\
16 n \geq 4 & \text{ since, } \\
17 \mathfrak{S}_3 < 8 < \mathfrak{S}_4 & \text{ in fact, we claim that, } \\
18 G < \mathfrak{S}_6. & \\
19 \end{align*}
20
21
22 $G \cong \{(12), (34), (56), (12)(34), (12)(56), (34)(56), (12)(34)(56), e\}$.
```

Cayley's Theorem states that every group is a subgroup of the symmetric group. Hence,

$$\begin{aligned} \mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2 &= G && \text{is a group,} \\ \iff \mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2 &\leq \mathfrak{S}_n && \text{for some positive integer } n. \\ |\mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2| &= 8 && \text{give us that,} \\ n &\geq 4 && \text{since,} \\ \mathfrak{S}_3 < 8 < \mathfrak{S}_4 &&& \text{in fact, we claim that,} \\ G &< \mathfrak{S}_6. \end{aligned}$$

$$G \cong \{(12), (34), (56), (12)(34), (12)(56), (34)(56), (12)(34)(56), e\}.$$

Notice that `\\` indicates the end of a line but that you must not put `\\` on the last line.

Notice the asterisk `*`. Just like in the equation environment, the asterisk tells LaTeX to not number the lines.

However, the `*` in align environment numbers on the right of the page, rather than the left.

Equations in Align Assignment

Assignment: Type this equation sequence from *Linear Algebra Done Wrong* into your Research Log.

As an illustration, let us write down a formal proof of the first distributive law (axiom 7) of a vector space. We want to show that $\alpha(T_1 + T_2) = \alpha T_1 + \alpha T_2$. For any $\mathbf{v} \in V$

$$\begin{aligned}\alpha(T_1 + T_2)\mathbf{v} &= \alpha((T_1 + T_2)\mathbf{v}) && \text{by the definition of multiplication} \\ &= \alpha(T_1\mathbf{v} + T_2\mathbf{v}) && \text{by the definition of the sum} \\ &= \alpha T_1\mathbf{v} + \alpha T_2\mathbf{v} && \text{by Axiom 7 for } W \\ &= (\alpha T_1 + \alpha T_2)\mathbf{v} && \text{by the definition of the sum}\end{aligned}$$

So indeed $\alpha(T_1 + T_2) = \alpha T_1 + \alpha T_2$.

Matrices

Note that you don't need to add any packages to make matrices.

$$\begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix}, \begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}, \begin{pmatrix} 1 & 2 \\ 3 & 4 \end{pmatrix}, \left\{ \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right\}$$

$$\left| \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right|$$

$$\left\| \begin{matrix} 1 & 2 \\ 3 & 4 \end{matrix} \right\|$$

```
17
18 ▾ $\begin{matrix}
19     1 & 2\\
20     3 & 4
21 \end{matrix}$,
22 ▾ $\begin{bmatrix}
23     1 & 2\\
24     3 & 4
25 \end{bmatrix}$,
26 ▾ $\begin{pmatrix}
27     1 & 2\\
28     3 & 4
29 \end{pmatrix}$
30 ▾ , $\begin{Bmatrix}
31     1 & 2\\
32     3 & 4
33 \end{Bmatrix}$
34
35 ▾ $\begin{vmatrix}
36     1 & 2\\
37     3 & 4
38 \end{vmatrix}$
39
40 ▾ $\begin{vmatrix}
41     1 & 2\\
42     3 & 4
43 \end{vmatrix}$
44
```

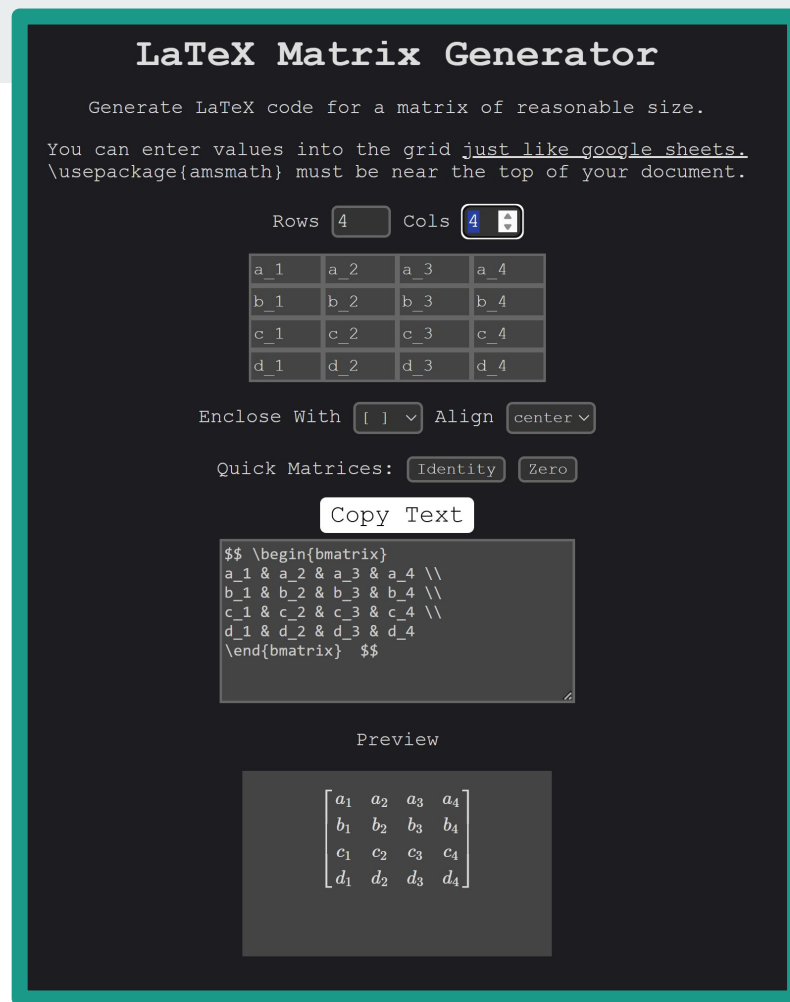
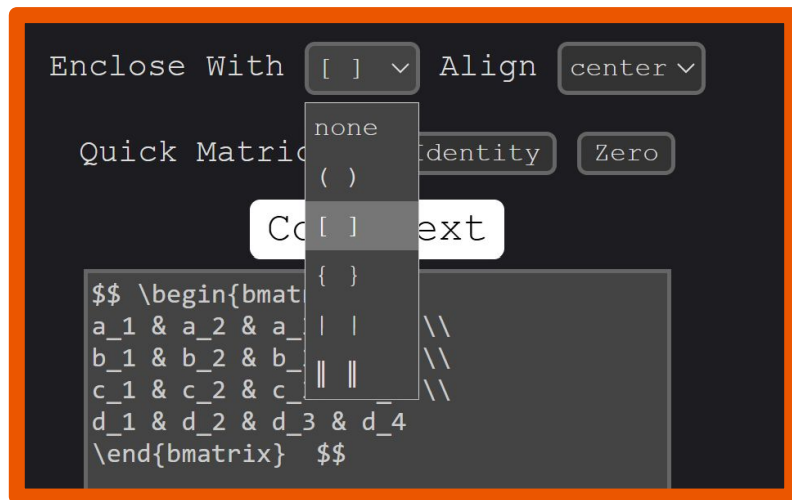
Put \$\$ around your matrix, not around every entry!

Commas, but no empty lines creates inline list.

Letters b, B, v, V, p, create different closures for matrices

Matrix Generator

Making matrices can be annoying. Here is a little short cut: [LaTeX Matrix Generator](#).



Matrices

Assignment: Create this matrix from *Linear Algebra Done Wrong*.

You will need to use the following code:

`\hdots` `\vdots`

`a_{m,n}` `a_n`

Curious? Try `\ddots`, `\ldots`,
`\cdots`, `\cdot`, `\therefore`,
`\because`

1. Different faces of linear systems.

There exist several points of view on what a system of linear equations, or in short a *linear system* is. The first, naïve one is, that it is simply a collection of m linear equations with n unknowns $x_1, x_2, \dots, x_n$,

$$\begin{cases} a_{1,1}x_1 + a_{1,2}x_2 + \dots + a_{1,n}x_n = b_1 \\ a_{2,1}x_1 + a_{2,2}x_2 + \dots + a_{2,n}x_n = b_2 \\ \dots \\ a_{m,1}x_1 + a_{m,2}x_2 + \dots + a_{m,n}x_n = b_m \end{cases}.$$

To solve the system is to find *all* n -tuples of numbers $x_1, x_2, \dots, x_n$ which satisfy all m equations simultaneously.

If we denote $\mathbf{x} := (x_1, x_2, \dots, x_n)^T \in \mathbb{F}^n$, $\mathbf{b} = (b_1, b_2, \dots, b_m)^T \in \mathbb{F}^m$, and

$$A = \begin{pmatrix} a_{1,1} & a_{1,2} & \dots & a_{1,n} \\ a_{2,1} & a_{2,2} & \dots & a_{2,n} \\ \vdots & \vdots & & \vdots \\ a_{m,1} & a_{m,2} & \dots & a_{m,n} \end{pmatrix},$$

then the above linear system can be written in the *matrix form* (as a *matrix-vector equation*)

$$A\mathbf{x} = \mathbf{b}.$$

To solve the above equation is to find all vectors $\mathbf{x} \in \mathbb{F}^n$ satisfying $A\mathbf{x} = \mathbf{b}$.

Tables

LaTeX has several options for tables ([Tables - Overleaf, Online LaTeX Editor](#)). Here is one way. Notice that [h!] keeps your table *approximately* where you typed it. Notice that \\ ends a line, but you don't use it on the last line of the table.

```
13
14
15
16
17 \begin{table}[h!]
18   \centering
19   \begin{tabular}{c c c}
20     $x_1$ & $y_1$ & $z_1$ \\
21     $x_2$ & $y_2$ & $z_2$
22   \end{tabular}
23 \end{table}
24
```

YOUR RESEARCH LOG

 x_1 y_1 z_1 x_2 y_2 z_2

Tables

Let's add some lines to make our table easier to read.

```
28
29 \begin{table}[h!]
30   \centering
31   \begin{tabular}{|c|c|c|}
32     \hline
33       $x_1$ & $y_1$ & $z_1$ \\
34     \hline
35     \hline
36       $x_2$ & $y_2$ & $z_2$ \\
37     \hline
38   \end{tabular}
39 \end{table}
40
```

x_1	y_1	z_1
x_2	y_2	z_2

Tables

Assignment: Here is a table from Dummit & Foote's 'Abstract Algebra,' p. 160. Add this table to your Research Log. You will need the following code: `\cdot`, `\times`, and `\textbf{bold text here}`.

Similarly, all permissible lists of invariant factors and the corresponding abelian groups of order 180 are easily seen to be the following:

Invariant Factors	Abelian Groups
$2^2 \cdot 3^2 \cdot 5$	Z_{180}
$2 \cdot 3^2 \cdot 5, 2$	$Z_{90} \times Z_2$
$2^2 \cdot 3 \cdot 5, 3$	$Z_{60} \times Z_3$
$2 \cdot 3 \cdot 5, 2 \cdot 3$	$Z_{30} \times Z_6$

Lists with Itemize

What if you want to make a bulleted list? Use itemize:

- Apple
- Frog
- Yo-yo
- Shoes

What if you are itemizing a list of equations? Use math mode:

- $x^2 + 2x + 7 = 0$
- $\frac{x^2-1}{x+1}$

What if you want an alphabetized list? Add letters like this:

- (a) $7 \times 6 = 42$
- (b) $42 \div 7 = 6$

```
11
12 ▾ \begin{itemize}
13     \item Apple
14     \item Frog
15     \item Yo-yo
16     \item Shoes
17 \end{itemize}
18
19
20 ▾ \begin{itemize}
21     \item  $x^2 + 2x + 7 = 0$ 
22     \item  $\frac{x^2-1}{x+1}$ 
23 \end{itemize}
24
25
26 ▾ \begin{itemize}
27     \item [(a)]  $7 \times 6 = 42$ 
28     \item [(b)]  $42 \div 7 = 6$ 
29 \end{itemize}
30
```

Lists with Enumerate

Notice that I did not need to add a package to the file to use enumerate or any of the symbols in these equations.

What if you want a numbered list? Use enumerate:

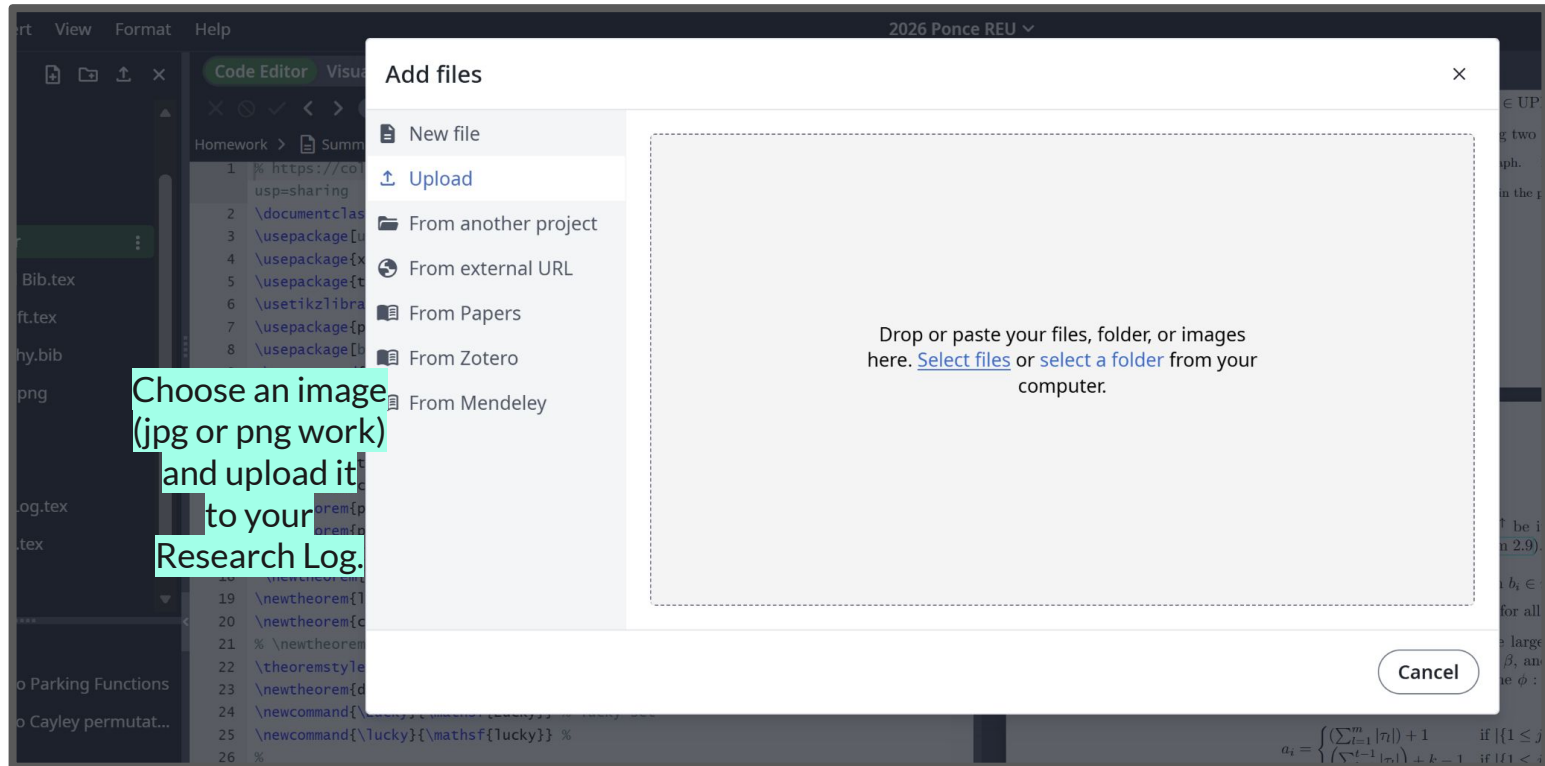
- (1) Mushroom
- (2) Kitten
- (3) Matcha
- (4) Robin

What if you want to enumerate a list of equations? Use math mode:

- (1) $T \oplus S \cong T \otimes S$
- (2) $f : T \longrightarrow S$
- (3) $t \mapsto f(t)$
- (4) $\Rightarrow f(t) \in S$

```
36
37 \begin{enumerate}
38   \item Mushroom
39   \item Kitten
40   \item Matcha
41   \item Robin
42 \end{enumerate}
43
44
45 \begin{enumerate}
46   \item  $T \oplus S \cong T \otimes S$ 
47   \item  $f: T \longrightarrow S$ 
48   \item  $t \mapsto f(t)$ 
49   \item  $\Rightarrow f(t) \in S$ 
50 \end{enumerate}
51
```

Images: Uploading

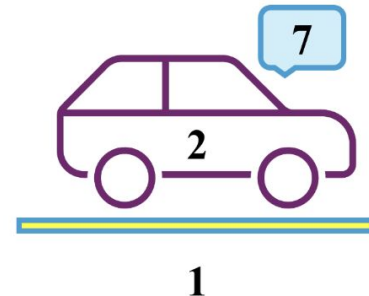


Images: Inserting, Centering, Fixing

In the file tree, my image is labeled “Car_1_2_7.png.” There are several ways to insert an image into your file, ([Inserting Images - Overleaf, Online LaTeX Editor](#)). Here is one way: First add `graphicx` package. Also, the `[h]` in line 11 tells LaTeX to keep the image *approximately* where the code is on the page.

```
1 \documentclass{amsart}
2 \usepackage{amsmath}
3 \usepackage{graphicx}
4
5 \title{Your Research Log}
6
7 \begin{document}
8 \maketitle
9
10
11 \begin{figure}[h]
12 \includegraphics[width=8cm]{Sample Folder/Car_1_2_7.png}
13 \centering
14 \end{figure}
15
16 Everyday you should type up what you have observed, ideas you have, sketch of a
17 proof of your conjectures, etc. An excellent entry is an example of the object
18 you are studying. Your future self thanks you!
19
20 What you should \textbf{not} do is spend endless hours designing beautiful
21 graphics, tables, or diagrams. If you cannot make your illustrations in a
22 reasonably short amount of time, upload an image of your drawing. In fact, it is
23 a good idea to start by upload images of your drawings and only delete them once
24 you have an alternative.
25
26 \end{document}
```

YOUR RESEARCH LOG



Images: Captioning and Resizing

Assignment: Resize your image and caption it.

```
6
7 \title{Your Research Log}
8
9 \begin{document}
10 \maketitle
11
12
13 \begin{figure}[h]
14 \includegraphics[width=3cm]{sample Folder/Car_1_2_7.png}
15 \centering
16 \caption{Renegade Car}
17 \end{figure}
18
19
```

YOUR RESEARCH LOG

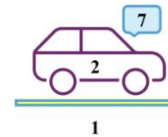


FIGURE 1. Renegade Car

Theorem, Definition, Example, Proof Environments

Assignment: create an example, theorem, lemma, proof, proposition, or definition.

```
1 \documentclass{amsart}
2 \usepackage{amsmath}
3 \usepackage{graphicx}
4
5 % Define the example environment
6 \theoremstyle{definition}
7 \newtheorem{example}{Example}
8 %\newtheorem{example}{Example}[section] will label the example 0.1
9 %\newtheorem{theorem}{Theorem} You can do this for theorems, lemmas,
10 %propositions, definitions, and conjectures as well.
11
12
13
14 \title{Your Research Log}
15
16 \begin{document}
17 \maketitle
18
19
20 \begin{figure}[h]
21 \includegraphics[width=3cm]{Sample Folder/Car_1_2_7.png}
22 \centering
23 \caption{Renegade Car}
24 \end{figure}
25
26 \begin{example}
27   If Car 2 wants spot 7 and ends up parking in spot 1, does Car 2 live in a
28   parking function?
29 \end{example}
```

YOUR RESEARCH LOG

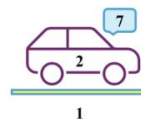


FIGURE 1. Renegade Car

Example 1. If Car 2 wants Spot 7 and ends up parking in Spot 1, does Car 2 live in a parking function?

Everyday you should type up what you have observed, ideas you have, sketch of a proof of your conjectures, etc. An excellent entry is an example of the object you are studying. Your future self thanks you!

What you should **not** do is spend endless hours designing beautiful graphics, tables, or diagrams. If you cannot make your illustrations in a reasonably short amount of time, upload an image of your drawing. In fact, it is a good idea to start by upload images of your drawings and only delete them once you have an alternative.

Referencing within a Paper

Assignment: Add `hyperref` package to your document. Label your example and add the reference to your image's caption.

```
Sample Folder > Research Log.tex
1 \documentclass{amsart}
2 \usepackage{amsmath}
3 \usepackage{graphicx}
4
5 % Define the example environment
6 \theoremstyle{definition}
7 \newtheorem{example}{Example}[section]
8
9 %Package for references
10 \usepackage{hyperref}
11
12
13 \title{Your Research Log}
14
15 \begin{document}
16 \maketitle
17
18
19 \begin{figure}[h]
20 \includegraphics[width=3cm]{Sample Folder/car_1_2_7.png}
21 \centering
22 \caption{Renegade Car, \ref{sample Example}}
23 \end{figure}
24
25 \begin{example}\label{sample Example}
26   If Car 2 wants Spot 7 and ends up parking in Spot 1, does car 2 live in a
   parking function?
27 \end{example}
28
29 Everyday you should type up what you have observed, ideas you have, sketch of a
proof of your conjectures, etc. An excellent entry is an example of the object
you are studying. Your future self thanks you!
```

YOUR RESEARCH LOG

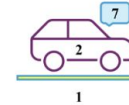


FIGURE 1. Renegade Car, [0.1](#)

Example 0.1. If Car 2 wants Spot 7 and ends up parking in Spot 1, does Car 2 live in a parking function?

Everyday you should type up what you have observed, ideas you have, sketch of a proof of your conjectures, etc. An excellent entry is an example of the object you are studying. Your future self thanks you!

What you should **not** do is spend endless hours designing beautiful graphics, tables, or diagrams. If you cannot make your illustrations in a reasonably short amount of time, upload an image of your drawing. In fact, it is a good idea to start by upload images of your drawings and only delete them once you have an alternative.

Referencing within a Paper

Notice that we can label and reference tables as well.

```
45
46 \vfill
47 \begin{table}[h!]
48   \centering
49   \begin{tabular}{|c|c|c|}
50     $x_1$ & $y_1$ & $z_1$ \\
51     \hline
52     $x_2$ & $y_2$ & $z_2$ \\
53   \end{tabular}
54   \caption{Nice Table}
55   \label{Nice Table}
56 \end{table}
57
58 Go look at my nice table \ref{Nice
59 Table}.
60
```

x_1	y_1	z_1
x_2	y_2	z_2

TABLE 1. Nice Table

Go look at my nice table 1.

Referencing Your Bibliography

To reference your bibliography, `\usepackage` and `\addbibresource` as shown to the right.

Notice that you use `\cite` for your bibliography, but you used `\label` and `\ref` for referencing your own work within your paper.

```
3
4 \usepackage{biblatex} %Imports biblatex package
5 \addbibresource{Bibliography.bib} %Import the bibliography file
6 %This is one of several ways to make a bibliography in LaTeX.
7
8 \title{Your Research Log}
9
10 \begin{document}
11 \maketitle
12
13
14 I want my readers to understand how relevant Bruce Sagan's work on
   chromatic symmetric functions to my current research \cite{MR5039069}.
   Now my readers can find out how to change the basis of a chromatic
   symmetric function for themselves.
15
16
17
```

I want my readers to understand how relevant Bruce Sagan's work on chromatic symmetric functions to my current research [1]. Now my readers can find out how to change the basis of a chromatic symmetric function for themselves.

Assignment



Use your LaTeX skills to write **every day** in your Research Log.

References, Acknowledgments



- *Linear Algebra Done Wrong*, by Sergei Treil, [LADW 2017-09-04.pdf](#)
- *Abstract Algebra*, by David Dummit and Richard Foote, 3rd edition
- Thanks to my mentors and colleagues whose work I used as examples: Dr. Pamela E. Harris, Dr. Jennifer Elder, and Kimberly Hadaway.
- Thanks to Jonathan Walker Moses for recommending the matrix generator!