

# Math 254: Introduction to Linear Algebra

Notes #1.2 — Matrices, Vectors, ...

Peter Blomgren  
(blomgren@sdsu.edu)

Department of Mathematics and Statistics  
Dynamical Systems Group  
Computational Sciences Research Center  
San Diego State University  
San Diego, CA 92182-7720

<http://terminus.sdsu.edu/>

Spring 2022  
(Revised: January 18, 2022)



After this lecture you should:

- Know basic language and concepts:
  - Matrices, vectors, and their components
  - Matrix types: square, diagonal, triangular, zero, identity
  - The collection of all  $n$ -vectors, denoted  $\mathbb{R}^n$  is a vector space
- Vector addition
- Know the difference between the Coefficient matrix, and the Augmented matrix; their uses in the solution of linear systems
- Know how to use elimination to identify leading and non-leading (a.k.a. *free variables*), and when necessary introduce parameters to express *all* solutions of linear systems.
- Know what **Reduced-Row-Echelon-Form** (RREF) of a Matrix is, and how to achieve it using elementary row operations.



## Outline

- 1 Student Learning Objectives
  - SLOs: Matrices, Vectors, ...
- 2 Matrices, Vectors; Gauss-Jordan Elimination
  - Matrix – Vector Notation
  - Back to Solving Linear Systems
  - Summarizing
- 3 Suggested Problems
  - Suggested Problems
  - Lecture–Book Roadmap
- 4 Supplemental Material
  - Metacognitive Reflection
  - Problem Statements 1.2



## Equation Manipulation to Isolate Variables

Our current “business” is manipulating linear systems, of the form

$$\begin{cases} 3x + 21y - 3z = 0 \\ -6x - 2y - z = 62 \\ 2x - 3y + 8z = 32 \end{cases}$$

into a form which reveals the values of  $x$ ,  $y$ , and  $z$ :

$$\begin{cases} x & & = -3574/281 \\ & y & = 844/281 \\ & & z = 2334/281 \end{cases}.$$

We achieve this by cleverly adding/subtracting rows (equations) from each other.



## Matrix Notation — “Encoding” the Information

We realize that all the important information is in the coefficients (numbers), and that the variables ( $x, y, z$ ) just get carried around. We can “encode” all the information about the linear system

$$\left| \begin{array}{ccc|c} 3x + 21y - 3z & = & 0 \\ -6x - 2y - z & = & 62 \\ 2x - 3y + 8z & = & 32 \end{array} \right|$$

in a **matrix**

$$\underbrace{\begin{bmatrix} 3 & 21 & -3 & 0 \\ -6 & -2 & -1 & 62 \\ 2 & -3 & 8 & 32 \end{bmatrix}}_{\text{Augmented Matrix}}, \text{ or, sometimes: } \underbrace{\begin{bmatrix} 3 & 21 & -3 & | & 0 \\ -6 & -2 & -1 & | & 62 \\ 2 & -3 & 8 & | & 32 \end{bmatrix}}_{\text{Augmented Matrix with Coefficient Matrix and right-hand-side "separated."}}$$



## [Focus :: CS] What is a Matrix?

From a computer science point-of-view a matrix can be viewed as *data structure*, and depending on your mood (and/or preference of programming paradigm) you can think of it as e.g. a

- C—C++ style *2-dimensional array*,
  - ∴ `double A[3][3]; /* A is a 3-by-3 matrix */`
  - ∴ `A[0][0] = 1; /* Assigning 1 to a11 */`
  - ∴ `A[2][2] = 14; /* Assigning 14 to a33 */`
  - ∴ Yes, some languages count from 0 to (n-1); others from 1 to n.
- or an abstract *container class*.
- Python
  - ∴ uses (...) for immutable “tuples” and [...] for “lists”...
  - ∴ a matrix is a lists-of-lists: [[...], ..., [...]]



## Row – Column Indexing

Ponder the matrix “A” with 3 rows, and 4 columns:

$$A = \begin{bmatrix} 3 & 21 & -3 & 0 \\ -6 & -2 & -1 & 62 \\ 2 & -3 & 8 & 32 \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \end{bmatrix}$$

that is, usually we refer to the entries of a matrix  $A$  (upper-case), using double subscripts  $a_{ij}$  (lower-case); the subscripts  $i$ , and  $j$  are “standard” but  $r$  (row) and  $c$  (column) would be more intuitive.

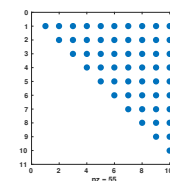
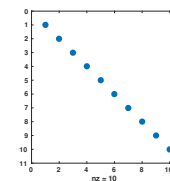
Sometimes you see the notation  $A \in \mathbb{R}^{3 \times 4}$  to denote a 3-by-4 (always [ROWS-by-COLUMNS]) matrix where the entries are real ( $\mathbb{R}$ ) numbers.

**Note:** The entries can be other mathematical objects, e.g. complex numbers,  $\mathbb{C}$ , polynomials, etc... but we will work with  $\mathbb{R}$  for quite while.



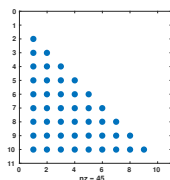
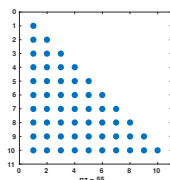
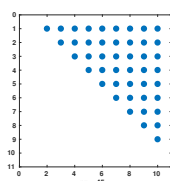
## Types of Matrices

- When  $A \in \mathbb{R}^{n \times n}$ , i.e. the matrix has the same number of rows and columns, it is a **square matrix**
- A matrix is **diagonal** if all entries  $a_{ij} = 0$  for all  $i \neq j$ . (Only entries of the type  $a_{ii}$  are non-zero.
- A square matrix is **upper triangular** if all entries  $a_{ij} = 0$  for all  $i > j$ .



## Types of Matrices

- A square matrix is **strictly upper triangular** if all entries  $a_{ij} = 0$  for all  $i \geq j$ .
- A square matrix is **lower triangular** if all entries  $a_{ij} = 0$  for all  $i < j$ .
- A square matrix is **strictly lower triangular** if all entries  $a_{ij} = 0$  for all  $i \leq j$ .



## Matrices of size $n \times 1$ and $1 \times n \Rightarrow$ “Vectors”

- A “matrix” with only one column is called a **column vector**:

$$\vec{v} = \begin{bmatrix} v_1 \\ v_2 \\ \vdots \\ v_n \end{bmatrix}$$

- A “matrix” with only one row is called a **row vector**:

$$\vec{w}^T = [ w_1 \quad w_2 \quad \cdots \quad w_n ]$$

By mathematical convention a **vector** is a **column vector**; so  $\vec{v}$  and  $\vec{w}$  are (column) vectors. The notation  $\vec{w}^T$  is the *transpose* of the vector  $\vec{w}$ , which is a *row vector*.



## Types of Matrices

- A matrix where all entries are zero is (surprisingly?) called a **zero matrix**.
- A square matrix where all diagonal entries are *ones*, and the off-diagonal entries are *zeros*

$$I_n = \begin{bmatrix} 1 & 0 & \cdots & 0 & 0 \\ 0 & 1 & \cdots & 0 & 0 \\ \vdots & \vdots & \ddots & \vdots & \vdots \\ 0 & 0 & \cdots & 1 & 0 \\ 0 & 0 & \cdots & 0 & 1 \end{bmatrix}$$

is called an **identity matrix**. “ $\cdots$ ” and “ $\vdots$ ” denote padding with 0-entries, and “ $\ddots$ ” diagonal 1-entries; filling the matrix out to its full size (whatever that may be).

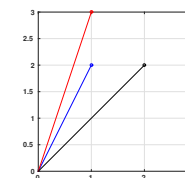


## Vector “Language”

- The entries of a vector are called its **components**;  $v_k$  is the  $k^{\text{th}}$  component of the vector  $\vec{v}$ .
- The set (collection) of *all* (column) vectors with  $n$  components is denoted by  $\mathbb{R}^n$ ; we refer to  $\mathbb{R}^n$  as a **vector space**.

It is easy to visualize vectors in  $\mathbb{R}^2$ ; we can think of the vector  $\vec{v}$  as an arrow from the origin  $(0,0)$  to the point  $(x,y) = (v_1, v_2)$ :

In the figure we have



$$\vec{u} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad \vec{v} = \begin{bmatrix} 1 \\ 3 \end{bmatrix}, \quad \vec{w} = \begin{bmatrix} 2 \\ 2 \end{bmatrix},$$

Without confusion, we can just let the terminal points  $(x,y) = (v_1, v_2)$  represent the vectors.

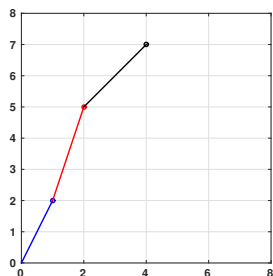


## Adding Vectors

With:

$$\vec{u} = \begin{bmatrix} 1 \\ 2 \end{bmatrix}, \quad \vec{v} = \begin{bmatrix} 1 \\ 3 \end{bmatrix}, \quad \vec{w} = \begin{bmatrix} 2 \\ 2 \end{bmatrix},$$

We can graphically show how to add vectors:



That is

$$\vec{u} + \vec{v} = \begin{bmatrix} 2 \\ 5 \end{bmatrix}, \quad \vec{u} + \vec{v} + \vec{w} = \begin{bmatrix} 4 \\ 7 \end{bmatrix}.$$



## The Augmented Matrix

Often, we separate the coefficients from the right-hand-side information in the Augmented Matrix:

$$\begin{bmatrix} 2 & 8 & 4 & 2 \\ 2 & 5 & 1 & 5 \\ 4 & 10 & -1 & 1 \end{bmatrix} \rightsquigarrow \begin{bmatrix} 2 & 8 & 4 & | & 2 \\ 2 & 5 & 1 & | & 5 \\ 4 & 10 & -1 & | & 1 \end{bmatrix}$$



## Making Use of our Matrix – Vector Notation

Now, given a linear system:

$$\begin{cases} 2x + 8y + 4z = 2 \\ 2x + 5y + z = 5 \\ 4x + 10y - z = 1 \end{cases}$$

We can extract the **Coefficient Matrix** (containing the coefficients of the unknown variables in the system)

$$\begin{bmatrix} 2 & 8 & 4 \\ 2 & 5 & 1 \\ 4 & 10 & -1 \end{bmatrix},$$

or the **augmented matrix**

$$\begin{bmatrix} 2 & 8 & 4 & 2 \\ 2 & 5 & 1 & 5 \\ 4 & 10 & -1 & 1 \end{bmatrix},$$

which captures all the information in the linear system.



## Solving Linear Systems Using the Augmented Matrix

We can solve the linear system by manipulating the Augmented Matrix:

$$\begin{aligned} & \begin{bmatrix} 2 & 8 & 4 & | & 2 \\ 2 & 5 & 1 & | & 5 \\ 4 & 10 & -1 & | & 1 \end{bmatrix} / 2 \\ & \begin{bmatrix} 1 & 4 & 2 & | & 1 \\ 2 & 5 & 1 & | & 5 \\ 4 & 10 & -1 & | & 1 \end{bmatrix} \begin{array}{l} -2r_1 \\ -4r_1 \end{array} \\ & \begin{bmatrix} 1 & 4 & 2 & | & 1 \\ 0 & -3 & -3 & | & 3 \\ 0 & -6 & -9 & | & -3 \end{bmatrix} \begin{array}{l} /(-3) \\ /(-3) \end{array} \end{aligned}$$



## Solving Linear Systems Using the Augmented Matrix

$$\begin{array}{l}
 \left[ \begin{array}{ccc|c} 1 & 4 & 2 & 1 \\ 0 & 1 & 1 & -1 \\ 0 & 2 & 3 & 1 \end{array} \right] \begin{array}{l} \\ -2r_2 \\ \end{array} \\
 \left[ \begin{array}{ccc|c} 1 & 4 & 2 & 1 \\ 0 & 1 & 1 & -1 \\ 0 & 0 & 1 & 3 \end{array} \right] \begin{array}{l} -2r_3 \\ -r_3 \\ \end{array} \\
 \left[ \begin{array}{ccc|c} 1 & 4 & 0 & -5 \\ 0 & 1 & 0 & -4 \\ 0 & 0 & 1 & 3 \end{array} \right] -4r_2 \\
 \left[ \begin{array}{ccc|c} 1 & 0 & 0 & 11 \\ 0 & 1 & 0 & -4 \\ 0 & 0 & 1 & 3 \end{array} \right], \quad \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 11 \\ -4 \\ 3 \end{bmatrix}
 \end{array}$$



## Infinitely Many Solutions

If we parameterize (the non-leading, or “free” variables):  $x_2 = s$ ,  $x_5 = t$ , and  $x_7 = u$ , we can write the infinitely many solutions:

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \\ x_6 \\ x_7 \end{bmatrix} = \begin{bmatrix} 1 & + & s & - & 4t & - & 7777u \\ & & s & & & & \\ 2 & & & - & 2t & + & 777u \\ 3 & & & & & - & 77u \\ 0 & & & & t & & \\ 4 & & & + & & & 7u \\ & & & & & & u \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \\ 2 \\ 3 \\ 0 \\ 4 \\ 0 \end{bmatrix} + s \begin{bmatrix} 1 \\ 1 \\ 0 \\ 0 \\ 0 \\ 0 \\ 0 \end{bmatrix} + t \begin{bmatrix} -4 \\ 0 \\ -2 \\ 0 \\ 1 \\ 0 \\ 0 \end{bmatrix} + u \begin{bmatrix} -7777 \\ 0 \\ 777 \\ -77 \\ 0 \\ 7 \\ 1 \end{bmatrix}$$

If we plug that into the original system of linear equations we see that it indeed is the (collection of) solution(s)!

Note that  $s$ ,  $t$ , and  $u$  are allowed to take any values in  $\mathbb{R}$  (independent of each other)...



## The (Math) World is not limited to 2, or 3 Variables (Dimensions)

We can (easily?) imagine a system of 4 linear equations with 7 unknowns:

$$\left| \begin{array}{ccccccc} x_1 & - & x_2 & & & & \\ & & & x_3 & & & \\ & & & & x_4 & & \\ & & & & & x_6 & - \\ & & & & & & x_7 \end{array} \begin{array}{l} + 4x_5 \\ + 2x_5 \\ \\ - 7777x_7 \\ - 777x_7 \\ 77x_7 \\ - 7x_7 \end{array} = \begin{array}{l} 1 \\ 2 \\ 3 \\ 4 \end{array} \right|,$$

so that solving for the leading variables\* gives:

$$\left| \begin{array}{l} x_1 = 1 + x_2 - 4x_5 - 7777x_7 \\ x_3 = 2 - 2x_5 + 777x_7 \\ x_4 = 3 - 77x_7 \\ x_6 = 4 + 7x_7 \end{array} \right|$$

\* **Leading variables** are the first ones to appear in each equation (after elimination); here  $x_1$ ,  $x_3$ ,  $x_4$ , and  $x_6$ .



## What Makes a System “Easy” to Solve?

Three properties make a system “easy” to solve:

- P1 The leading coefficient in each equation is 1.
- P2 The leading variable in each equation does not appear in any other equation.
- P3 The leading variables appear in “natural order,” with increasing indices as we go down the system:  $x_1$ ,  $x_3$ ,  $x_4$ , and  $x_6$  as opposed to any other ordering.

If/when the system does not satisfy these properties, we use elimination to get there...



## Another Example...

Keeping P1, P2, P3 in mind...

We go straight to the Augmented Matrix:

$$\left[ \begin{array}{ccccc|c} 2 & 4 & -2 & 2 & 4 & 2 \\ 1 & 2 & -1 & 2 & 0 & 4 \\ 3 & 6 & -2 & 1 & 9 & 1 \\ 5 & 10 & -4 & 5 & 9 & 9 \end{array} \right] \quad (/2)$$

$$\left[ \begin{array}{ccccc|c} 1 & 2 & -1 & 1 & 2 & 1 \\ 1 & 2 & -1 & 2 & 0 & 4 \\ 3 & 6 & -2 & 1 & 9 & 1 \\ 5 & 10 & -4 & 5 & 9 & 9 \end{array} \right] \quad \begin{array}{l} -r_1 \\ -3r_1 \\ -5r_1 \end{array}$$

$$\left[ \begin{array}{ccccc|c} 1 & 2 & -1 & 1 & 2 & 1 \\ 0 & 0 & 0 & 1 & -2 & 3 \\ 0 & 0 & 1 & -2 & 3 & -2 \\ 0 & 0 & 1 & 0 & -1 & 4 \end{array} \right] \quad \begin{array}{l} -r_2 \\ +2r_2 \end{array}$$



## ... Identifying the Solutions

$$\left[ \begin{array}{ccccc|c} x_1 & x_2 & x_3 & x_4 & x_5 & \text{value} \\ \textcircled{1} & 2 & & & 3 & 2 \\ & & \textcircled{1} & & -1 & 4 \\ & & & \textcircled{1} & -2 & 3 \end{array} \right]$$

So that:

$$\begin{cases} x_1 = 2 - 2x_2 - 3x_5 \\ x_3 = 4 + x_5 \\ x_4 = 3 + 2x_5 \end{cases}, \text{ or}$$

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \\ x_5 \end{bmatrix} = \begin{bmatrix} 2 - 2s - 3t \\ s \\ 4 + t \\ 3 + 2t \\ t \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \\ 4 \\ 3 \\ 0 \end{bmatrix} + s \begin{bmatrix} -2 \\ 1 \\ 0 \\ 0 \\ 0 \end{bmatrix} + t \begin{bmatrix} -3 \\ 0 \\ 1 \\ 2 \\ 1 \end{bmatrix}.$$

Parameters:  $x_2 = s$ ,  $x_5 = t$



## Another Example...

Keeping P1, P2, P3 in mind...

$$\left[ \begin{array}{ccccc|c} 1 & 2 & -1 & 0 & 4 & -2 \\ 0 & 0 & 0 & 1 & -2 & 3 \\ 0 & 0 & 1 & 0 & -1 & 4 \\ 0 & 0 & 1 & 0 & -1 & 4 \end{array} \right] \quad \begin{array}{l} +r_3 \\ -r_3 \end{array}$$

$$\left[ \begin{array}{ccccc|c} 1 & 2 & 0 & 0 & 3 & 2 \\ 0 & 0 & 0 & 1 & -2 & 3 \\ 0 & 0 & 1 & 0 & -1 & 4 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{array} \right] \quad \begin{array}{l} \rightsquigarrow r_3 \\ \rightsquigarrow r_2 \end{array}$$

$$\left[ \begin{array}{ccccc|c} \textcircled{1} & 2 & 0 & 0 & 3 & 2 \\ & \textcircled{1} & 0 & -1 & 4 & \\ & & \textcircled{1} & -2 & 3 & \end{array} \right] \quad \begin{array}{l} \text{leading zeros} \\ \text{suppressed} \\ \text{for clarity} \end{array}$$



## Solving a System of Linear Equations

### “Elimination Strategy”

We go equation-by-equation from top to bottom ( $i$  runs from 1 to  $n$ ):

- For the  $i^{\text{th}}$  equation: if the leading variable is  $x_j$  with non-zero coefficient  $c$ ; divide the equation by  $c$  to make the leading coefficient 1.
- Eliminate  $x_j$  from all other equations.
- Go to the next equation.

### “Exit Strategy”

- If we get  $zero = nonzero$  at any point; then there are no solutions. [STOP]
- If we complete without inconsistencies:
  - **rearrange** the equations so that the leading variables are in “natural order”
  - Solve each equation for the leading variable
  - Choose parameters for the **non-leading variables** [if there are any] (appropriate “alphabet soup”)
  - Express leading variables using parameters.



## Reduced Row Echelon Form

After elimination according to this strategy, the matrix is in:

### Reduced Row Echelon Form

A Matrix is said to be in *Reduced Row Echelon Form* if it satisfies the following conditions:

- 1 If a row has non-zero entries, then the first non-zero entry is a 1, called *the leading 1* (or *pivot*) of this row.
- 2 If a column contains a leading 1, then all other entries in that column are 0. [ELIMINATION IS COMPLETE]
- 3 If a row contains a leading 1, then each row above it contains a leading 1 further to the left. [SORTING OF ROWS]

The last condition implies that rows of 0's, if any, must appear at the bottom of the matrix.



## Suggested Problems 1.2

Available on “Learning Glass” videos:

- (1.2.1) Find all solutions to a 2-by-3 linear system using elimination.
- (1.2.3) Find all solutions to a 1-by-3 linear system using elimination.
- (1.2.9) Find all solutions to a 3-by-6 linear system using elimination.
- (1.2.11) Find all solutions to a 4-by-4 linear system using elimination.
- (1.2.18) Determine which matrices are in RREF.
- (1.2.21) Find values of matrix entries so that the resulting matrix is in RREF.



## Getting to Reduced Row Echelon Form

We get to *Reduced Row Echelon Form* by performing

### Elementary Row Operations

- Divide a row by a non-zero scalar
- Subtract a multiple of a row from another row
- Swap two rows

This strategy of solving linear systems by reduction to Reduced Row Echelon Form is referred to as **Gaussian Elimination**, or **Gauss-Jordan Elimination**.

Gauss (1777–1855), Jordan (1842–1899); but the Chinese used it loooooong before that.

“Gauss-Jordan Elimination”  $\rightsquigarrow$  RREF

“Gaussian Elimination”  $\rightsquigarrow$  REF (leading variables NOT 1's; *LU*-factorization)



## Lecture – Book Roadmap

Lecture	Book, [GS5-]
1.1	§2.2
1.2	§1.1, §1.3, §2.1, §2.3



## Metacognitive Exercise — Thinking About Thinking &amp; Learning

I know / learned

Almost there

Huh?!?

Right After Lecture

After Thinking / Office Hours / SI-session

After Reviewing for Quiz/Midterm/Final



## (1.2.1), (1.2.3)

(1.2.1) Find all solutions to the linear system using elimination:

$$\begin{cases} x + y - 2z = 5 \\ 2x + 3y + 4z = 2 \end{cases}$$

(1.2.3) Find all solutions to the linear system using elimination:

$$| x + 2y + 3z = 4 |$$



## (1.2.9), (1.2.11)

(1.2.9) Find all solutions to the linear system using elimination:

$$\begin{cases} x_4 + 2x_5 - x_6 = 2 \\ x_1 + 2x_2 + x_5 - x_6 = 0 \\ x_1 + 2x_2 + 2x_3 - x_5 + x_6 = 2 \end{cases}$$

(1.2.11) Find all solutions to the linear system using elimination:

$$\begin{cases} x_1 + 2x_3 + 4x_4 = -8 \\ x_2 - 3x_3 - x_4 = 6 \\ 3x_1 + 4x_2 - 6x_3 + 8x_4 = 0 \\ -x_2 + 3x_3 + 4x_4 = -12 \end{cases}$$



## (1.2.18)

(1.2.18) Determine which of the matrices are in Reduced Row Echelon Form:

$$\text{a. } \begin{bmatrix} 1 & 2 & 0 & 2 & 0 \\ 0 & 0 & 1 & 3 & 0 \\ 0 & 0 & 1 & 4 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

$$\text{b. } \begin{bmatrix} 0 & 1 & 2 & 0 & 3 \\ 0 & 0 & 0 & 1 & 4 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

$$\text{c. } \begin{bmatrix} 1 & 2 & 0 & 3 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 2 \end{bmatrix}$$

$$\text{d. } [ 0 \ 1 \ 2 \ 3 \ 4 ]$$





(1.2.21)

(1.2.21) For which values of  $a$ ,  $b$ ,  $c$ ,  $d$ , and  $e$  is the following matrix in reduced-row-echelon-form?

$$\begin{bmatrix} 1 & a & b & 3 & 0 & -2 \\ 0 & 0 & c & 1 & d & 3 \\ 0 & e & 0 & 0 & 1 & 1 \end{bmatrix}$$



Piazza Setup and Use, 1 of 3

Does not apply Fall 2021

[TECH::SETUP]

## Two Separate Websites

plazza

<https://piazza.com/>

### • Piazza Account

- Mini-Quizzes
- Access using app, or web interface



SAN DIEGO STATE  
UNIVERSITY

Blackboard at San Diego State University

<https://Canvas.SDSU.edu/>

### • GRADEBOOK



Piazza Setup and Use, 2 of 3

Does not apply Fall 2021

[TECH::SETUP]

## Goal: Your Points in the GRADEBOOK!

### How do we get there?

#### 1 Set up a **Piazza Account**

- You should have gotten an invitation sent to your [...]@sdsu.edu email address; or go to
- <https://piazza.com/sdsu/fall2021/math254blomgren>
- It is FREE
- Download the app from the iOS App Store, or Google Play

#### 2 **If you want credit:** You can register multiple email addresses to a piazza account — one of them must match your email address in Canvas.

- In Piazza go to Account/Email Settings



Piazza Setup and Use, 3 of 3

Does not apply Fall 2021

[TECH::SETUP]

## Goal: Your Points in the GRADEBOOK!

### How do we get there?

- 3 Scores will be transferred after EACH LECTURE
  - The transfer is manual, so there may be a bit of a delay.
- 4 *If something is not right, please let me know!* — Email me!

If you cannot participate in the use of Piazza (due to lack of a suitable device) — let me know, and we'll figure something out.

