

Matrix Algebra

Matrix: A system of any mn numbers arranged in a rectangular array of m rows and n columns is called a matrix of order $m \times n$. A matrix is usually denoted by a single capital letter, namely A, B, C, \dots or by the symbols $[a_{ij}], (a_{ij}), ||a_{ij}||$.

The matrix of order $m \times n$ is written as:

$$\begin{bmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & a_{22} & \dots & a_{2n} \\ \dots & \dots & \dots & \dots \\ a_{m1} & a_{m2} & \dots & a_{mn} \end{bmatrix}_{m \times n}$$

Example: $A = \begin{bmatrix} 1 & -2 & 3 \\ 2 & 3 & -1 \\ -3 & 1 & 2 \end{bmatrix}_{3 \times 3}$; $B = \begin{bmatrix} 1 \\ 2 \\ 3 \end{bmatrix}_{3 \times 1}$; $C = [1 \ 2 \ 3]_{1 \times 3}$; $D = \begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}_{2 \times 3}$.

Difference between a matrix and a determinant:

The differences between a matrix and a determinant are as follows:

Matrix	Determinant
1. A matrix cannot be reduced to a single number.	1. A determinant can be reduced to a single number.
2. In a matrix, the number of rows may not be equal to the number of columns.	2. In a determinant, the number of rows must be equal to the number of columns.
3. An interchange of rows or columns gives a different matrix.	3. An interchange of rows or columns gives the same determinant with +ve or -ve sign.
4. Examples: $\begin{bmatrix} 1 & 2 \\ 3 & 4 \end{bmatrix}$; $\begin{bmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \end{bmatrix}$.	4. Examples: $\begin{vmatrix} 1 & 2 \\ 3 & 4 \end{vmatrix}$; $\begin{vmatrix} 1 & 2 & 3 \\ -2 & 1 & 0 \\ 2 & 3 & 4 \end{vmatrix}$.

Complex Matrix: Any matrix having complex elements is called a complex matrix.

Example: $A = \begin{bmatrix} 2+i & -2i & 3 \\ 2 & 3i & -1 \\ -3 & 1+2i & 2i \end{bmatrix}$.

Matrix Algebra

Katherine Harding



Matrix Algebra:

Advanced Linear and Matrix Algebra Nathaniel Johnston, 2021-05-19 This textbook emphasizes the interplay between algebra and geometry to motivate the study of advanced linear algebra techniques. Matrices and linear transformations are presented as two sides of the same coin with their connection motivating inquiry throughout the book. Building on a first course in linear algebra, this book offers readers a deeper understanding of abstract structures: matrix decompositions, multilinearity, and tensors. Concepts draw on concrete examples throughout, offering accessible pathways to advanced techniques. Beginning with a study of vector spaces that includes coordinates, isomorphisms, orthogonality, and projections, the book goes on to focus on matrix decompositions. Numerous decompositions are explored, including the Schur, spectral, singular value, and Jordan decompositions. In each case, the author ties the new technique back to familiar ones to create a coherent set of tools. Tensors and multilinearity complete the book with a study of the Kronecker product, multilinear transformations, and tensor products. Throughout, Extra Topic sections augment the core content with a wide range of ideas and applications, from the QR and Cholesky decompositions to matrix-valued linear maps and semidefinite programming. Exercises of all levels accompany each section. *Advanced Linear and Matrix Algebra* offers students of mathematics, data analysis, and beyond the essential tools and concepts needed for further study. The engaging color presentation and frequent marginal notes showcase the author's visual approach. A first course in proof-based linear algebra is assumed. An ideal preparation can be found in the author's companion volume, *Introduction to Linear and Matrix Algebra*.

Introduction to Linear and Matrix Algebra
Nathaniel Johnston, 2021-05-19 This textbook emphasizes the interplay between algebra and geometry to motivate the study of linear algebra. Matrices and linear transformations are presented as two sides of the same coin with their connection motivating inquiry throughout the book. By focusing on this interface, the author offers a conceptual appreciation of the mathematics that is at the heart of further theory and applications. Those continuing to a second course in linear algebra will appreciate the companion volume, *Advanced Linear and Matrix Algebra*. Starting with an introduction to vectors, matrices, and linear transformations, the book focuses on building a geometric intuition of what these tools represent. Linear systems offer a powerful application of the ideas seen so far and lead onto the introduction of subspaces, linear independence, bases, and rank. Investigation then focuses on the algebraic properties of matrices that illuminate the geometry of the linear transformations that they represent. Determinants, eigenvalues, and eigenvectors all benefit from this geometric viewpoint. Throughout, Extra Topic sections augment the core content with a wide range of ideas and applications, from linear programming to power iteration and linear recurrence relations. Exercises of all levels accompany each section, including many designed to be tackled using computer software. *Introduction to Linear and Matrix Algebra* is ideal for an introductory proof-based linear algebra course. The engaging color presentation and frequent marginal notes showcase the author's visual approach. Students are assumed to have completed one or two university-level mathematics courses, though calculus is not an explicit

requirement Instructors will appreciate the ample opportunities to choose topics that align with the needs of each classroom and the online homework sets that are available through WeBWorK

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bogged down in proofs or tedium The reader can check each matrix result with numerical examples of exactly what they mean and understand their implications The book does not shy away from advanced topics especially the ones with practical applications

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