Mathematics for Machine Learning
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About me

Im the founder of Roundtable
If you looking to get a tailored learning experience to pursue your goals and be matched with the best fellows to pursue them together - this is the place for you

FYI - you can pursue this experience with others as well
You can sign up here

Book:

PDF: MATHEMATICS FOR MACHINE LEARNING

Website: Website with Additional Resources

(from MML table of contents)
Mathematical Foundations

Chapter 1

Week 0: Introduction and First Subtopics in Linear Algebra

Just read it briefly =)

Chapter 2

Week 1: Introduction and First Subtopics in Linear Algebra

Overview

The first week aims to provide you with a solid introduction to Linear Algebra and its relevance to machine learning. We will focus on the foundational subtopics, specifically Systems of Linear Equations and Matrices. This week serves as the first stepping stone into the complex, yet fascinating, world of Linear Algebra.

Presenter: *to be filled by you guys*

Chapters for This Week

- **2.1 Systems of Linear Equations**: Understand what systems of linear equations are and how to solve them.
- **2.2 Matrices**: Introduction to matrices and their basic operations.

Learning Objectives

1. Gain a clear understanding of what linear equations are.
2. Learn how to solve systems of linear equations using different methods.
3. Understand the structure and utility of matrices.
4. Be able to perform basic matrix operations.

Supplementary Material

Short Videos

- "Introduction to Systems of Linear Equations" from Khan Academy
- Introduction to matrices

Blog Posts

- "An Intuitive Guide to Linear Algebra" from BetterExplained
- "Solving Systems of Linear Equations with Python" from Real Python

Specific Lectures from Top Universities

- "MIT 18.06 Linear Algebra, Lec 1: The Geometry of Linear Equations" from MIT OpenCourseWare
- "Stanford University: Linear Algebra Review and Reference" from Stanford's Machine Learning Course

Interactive Tools

- Matrix Multiplication Calculator
- Wolfram Alpha for solving systems of equations

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

Week 2: Intermediate Subtopics in Linear Algebra

Overview

Week 2 extends the journey into Linear Algebra by focusing on the abstract but critical concepts of Vector Spaces and Linear Independence. Understanding these two subtopics will offer a broader and deeper view of Linear Algebra, setting the stage for further advanced topics in subsequent weeks.

Presenter: *to be filled by you guys*

Chapters for This Week

- **2.4 Vector Spaces**: Understand the properties and structure of vector spaces.
- **2.5 Linear Independence**: Learn what it means for vectors to be linearly independent and how to test for it.

Learning Objectives

1. A Understand what a vector space is and be familiar with its properties.
2. Grasp the concept of linear independence and its importance.
3. Be able to determine if a set of vectors is linearly independent.

Supplementary Material

Short Videos

- Abstract vector spaces | Chapter 16, Essence of linear algebra
- Linear Independence and Linear Dependence, Ex 1
- Understanding Vector Spaces

Paper

- What is a Vector Space?
- How To Understand Linear Independence (Linear Algebra)

Specific Lectures from Top Universities

- 6. Column Space and Nullspace

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

Week 3: Advanced Concepts in Linear Algebra

Overview

The third week focuses on understanding the more advanced and abstract elements of Linear Algebra—Basis and Rank, as well as Linear Mappings. These topics are not just theoretical constructs; they have practical applications in a variety of fields including machine learning.

Presenter: *to be filled by you guys*

Chapters for This Week

- **2.6 Basis and Rank**: Grasp the concept of basis and rank, and understand their importance in linear algebra.
- **2.7 Linear Mappings**: Learn about linear transformations and mappings between vector spaces.

Learning Objectives

1. Understand what basis and rank are in the context of vector spaces.
2. Learn to identify and work with different types of linear mappings.
3. Understand the importance of these concepts in applications like dimensionality reduction and linear regression.

Supplementary Material

Short Videos

- Introduction to orthonormal bases | Linear Algebra | Khan Academy
- Linear transformations and matrices | Chapter 3, Essence of linear algebra
- Linear Maps | Linear Algebra

Blog Posts

- "Understanding Basis and Dimension"
- A beginner's guide to dimensionality reduction in Machine Learning | by Judy T Raj | Towards Data Science

Specific Lectures from Top Universities

- Independence, Basis, and Dimension

Interactive Tools

- Linear Transformation Visualizer

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

Week 4: Final Concepts and Wrap-Up

Overview

In the concluding week of your study of Linear Algebra, the focus is on Affine Spaces and consolidation of the topics covered in Weeks 1-3. You will apply these learnings by creating a deliverable like a blog post, a video, or a project that demonstrates your grasp of the subject.

Chapters for This Week

- **2.8 Affine Spaces**: Understand what affine spaces are and how they differ from vector spaces.

Learning Objectives

1. Learn about Affine Spaces and how they are used in computer graphics, robotics, and machine learning.
2. Consolidate all the concepts learned from Weeks 1-3.
3. Complete a project or write-up summarizing your learnings and applications of the covered material.

Supplementary Material

Short Videos

- What is...an affine space?

Blog Posts

- Affine space

Specific Lectures from Top Universities

- MA9711: 026 - Affine Spaces

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

Chapter 3

Week 5: Introduction to Analytic Geometry

Overview

The first week in the Analytic Geometry chapter introduces you to the core concepts of norms and inner products. These concepts provide you with the tools to understand distances and angles between vectors in multi-dimensional spaces, setting the foundation for more advanced topics in machine learning.

Presenter: *to be filled by you guys*

Chapters for This Week

- **3.1 Norms**: Understand what norms are and why they're important for measuring "size" in multiple dimensions.
- **3.2 Inner Products**: Dive into inner products to understand angles and orthogonality between vectors.

Learning Objectives

1. Learn what norms and inner products are, and how to compute them.
2. Understand the significance of these concepts in measuring distances and angles between vectors.
3. Start thinking about how these mathematical tools are applied in machine learning algorithms.

Supplementary Material

Short Videos

- How to Normalize a Vector
- Dot Product Intuition | BetterExplained
- Inner & outer products | Lecture 5 | Matrix Algebra for Engineers
- Linear Algebra: Inner Product Spaces (Sec. 5.2 Part 1)

Blog Posts

- Gentle Introduction to Vector Norms in Machine Learning - MachineLearningMastery.com
- Inner product

Interactive Tools

- Norm and Inner Product Explorer

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

  If the exercise requires knowledge that will be covered in the future - skip it and get back to it later on 🥲

Week 6: Lengths, Distances, and Angles

Overview

Week 2 dives deeper into the properties and applications of norms and inner products by introducing you to the ideas of lengths, distances, and angles between vectors. You'll build on last week's work to add another layer of depth to your understanding of analytic geometry.

Presenter: *to be filled by you guys*

Chapters for This Week

- **3.3 Lengths and Distances**: Master how to calculate lengths and distances between vectors.
- **3.4 Angles and Orthogonality**: Learn about angles between vectors and what it means for vectors to be orthogonal.

Learning Objectives

1. Understand how to compute lengths and distances in multiple dimensions.
2. Learn the concept of orthogonality and how to find angles between vectors.
3. Apply these concepts to real-world machine learning problems.

Supplementary Material

Short Videos

- Cross products | Chapter 10, Essence of linear algebra
- Least squares examples | Alternate coordinate systems (bases) | Linear Algebr…

Blog Posts

- "Vector Lengths and Distances in Machine Learning"
- 16. Orthogonal Projections and Their Applications

Specific Lectures from Top Universities

- Orthogonal Vectors and Subspaces

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

  If the exercise requires knowledge that will be covered in the future - skip it and get back to it later on 🙂

Week 7: Specialized Concepts in Analytic Geometry

Overview

Week 3 takes you further into the field of analytic geometry by introducing specialized topics like orthonormal basis and orthogonal complement. These notions have direct applications in machine learning algorithms where you often have to transform data into a more convenient coordinate system or project it onto subspaces.

Presenter: *to be filled by you guys*

Chapters for This Week

- **3.5 Orthonormal Basis**: Understand the concept of an orthonormal basis and how it simplifies calculations.
- **3.6 Orthogonal Complement**: Learn how to find the orthogonal complement of a subspace.
- **3.7 Inner Product of Functions**: A brief introduction to applying inner products to function spaces.

Learning Objectives

1. Understand what an orthonormal basis is and why it's useful.
2. Learn to compute the orthogonal complement of a subspace.
3. Get introduced to the inner product in function spaces and its implications.

Supplementary Material

Short Videos

- The Gram-Schmidt process | Alternate coordinate systems (bases) | Linear Alg…
- The Gram-Schmidt Process
- Gram-Schmidt process | Lecture 19 | Matrix Algebra for Engineers

Blog Posts

- Orthonormality and Gram-Schmidt Process

Specific Lectures from Top Universities

- 17. Orthogonal Matrices and Gram-Schmidt

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

  If the exercise requires knowledge that will be covered in the future - skip it and get back to it later on 🙂

Week 8: Consolidation and Content Creation

Overview

Week 8 serves as a culminating experience that synthesizes your understanding of analytic geometry. Through the creation of educational content, whether that's a blog post, video, presentation, or even interactive applications, you're not just demonstrating your mastery, but also contributing to the larger learning community.

Presenter: *to be filled by you guys*

Chapters for This Week

- 3.8 Orthogonal Projections: Dive deeper into the world of orthogonal projections and explore its applications.
- 3.9 Rotations: Understand the mathematics behind rotations and their significance in various fields.
- 3.10 Further Reading: Engage with more advanced materials and let them guide and inspire your content creation.

Learning Objectives

1. Reinforce and internalize the concepts and techniques from the Analytic Geometry chapters.
2. Enhance communication skills by translating complex mathematical concepts into engaging and understandable content.
3. Build a foundation for creating and sharing educational resources in the field.

Supplementary Material

Short Videos

- Linear Algebra 6.2.2 Orthogonal Projections
- Calculus 3 - Vector Projections & Orthogonal Components

- Linear transformation examples: Rotations in R2 | Linear Algebra | Khan Acade…
- The geometric view on orthogonal projections

Specific Lectures from Top Universities

- Projection into Subspaces
- 15. Projections onto Subspaces

To-dos:

- Complete exercises from the book that correspond to this week's subtopics.

  If the exercise requires knowledge that will be covered in the future - skip it and get back to it later on 🙂