Table of Contents

[ Intro to Linear Algebra (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com) 2](#_Toc78367850)

[ https://learning.oreilly.com/attend/intro-to-linear-algebra-machine-learning-foundations/0636920057978/0636920057977/ 2](#_Toc78367851)

[ Linear Algebra II: Matrix Tensors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com) https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/ 2](#_Toc78367852)

[ Linear Algebra III: Eigenvectors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com) 2](#_Toc78367853)

[ https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/ July 28th 2021. 2](#_Toc78367854)

[**Intro to Linear Algebra (Machine Learning Foundations)** 2](#_Toc78367855)

[What you’ll learn and how you can apply it 3](#_Toc78367856)

[This live event is for you because… 3](#_Toc78367857)

[Prerequisites 3](#_Toc78367858)

[Schedule 4](#_Toc78367859)

[July 14, 2021 4](#_Toc78367860)

[**YOUR INSTRUCTOR** 4](#_Toc78367861)

[ Linear Algebra II: Matrix Tensors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com) https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/ 6](#_Toc78367862)

[Linear Algebra II: Matrix Tensors (Machine Learning Foundations) 6](#_Toc78367863)

[What you’ll learn and how you can apply it 7](#_Toc78367864)

[This live event is for you because… 7](#_Toc78367865)

[Prerequisites 7](#_Toc78367866)

[Schedule 7](#_Toc78367867)

[July 21, 2021 8](#_Toc78367868)

[YOUR INSTRUCTOR 8](#_Toc78367869)

[Week III - https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/ Linear Algebra III: Eigenvectors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com) 9](#_Toc78367870)

[Linear Algebra III: Eigenvectors (Machine Learning Foundations) 9](#_Toc78367871)

[What you’ll learn and how you can apply it 10](#_Toc78367872)

[This live event is for you because… 10](#_Toc78367873)

[Prerequisites 10](#_Toc78367874)

[Schedule 10](#_Toc78367875)

[July 28, 2021 11](#_Toc78367876)

# [Intro to Linear Algebra (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com)](https://learning.oreilly.com/attend/intro-to-linear-algebra-machine-learning-foundations/0636920057978/0636920057977/)

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# [Linear Algebra II: Matrix Tensors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com)](https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/) <https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/>

# [Linear Algebra III: Eigenvectors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com)](https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/)

# <https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/> July 28th 2021. @*21minutes 27 seconds start*

**Intro to Linear Algebra (Machine Learning Foundations)**

Manipulate Tensors in all the Major Libraries: TensorFlow, PyTorch, and NumPy

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The *Machine Learning Foundations series* of online trainings provides a comprehensive overview of all of the subjects — mathematics, statistics, and computer science — that underlie contemporary machine learning techniques, including deep learning and other artificial intelligence approaches. Extensive curriculum detail can be found at [the course’s GitHub repo](https://github.com/jonkrohn/ML-foundations).

All of the classes in the *ML Foundations* series bring theory to life through the combination of vivid full-color illustrations, straightforward Python examples within hands-on Jupyter notebook demos, and comprehension exercises with fully-worked solutions.

The focus is on providing you with a practical, functional understanding of the content covered. Context will be given for each topic, highlighting its relevance to machine learning. You will be better positioned to understand cutting-edge machine learning papers and you will be provided with resources for digging even deeper into topics that pique your curiosity.

There are 14 classes in the series, organized into four subject areas:

**Linear Algebra (three classes)**

* Intro to Linear Algebra
* Linear Algebra II: Matrix Tensors
* Linear Algebra III: Eigenvectors

**Calculus (four classes)**

**Probability and Statistics (four classes)**

**Computer Science (three classes)**

You’re welcome to pick and choose between any of the 14 individual classes based on your particular interests or your existing familiarity with the material. Note that each of the four subject areas are fairly independent, however theory within a given subject area generally builds over the 3-4 classes — topics in later classes of a given subject area often assume an understanding of topics from earlier classes. (Note that at any given time, only a subset of the *ML Foundations* classes will be scheduled and open for registration. To be pushed notifications of upcoming classes in the series, sign up for the instructor’s email newsletter at [jonkrohn.com](https://www.jonkrohn.com/).)

This class, *Intro to Linear Algebra*, is the first in the *Machine Learning Foundations* series. It is essential because linear algebra lies at the heart of all machine learning approaches. Through the measured exposition of theory paired with interactive examples, you’ll develop an understanding of what tensors — the fundamental building blocks of linear algebra — are, as well as how to manipulate them in TensorFlow, PyTorch, and NumPy. The content covered in this class is itself foundational for all the other classes in the *Machine Learning Foundations* series and it is especially relevant to *Linear Algebra II and III*.

What you’ll learn and how you can apply it

* Understand the fundamentals of linear algebra, a ubiquitous approach for solving for unknowns within high-dimensional spaces.
* Create and manipulate tensors — the fundamental building blocks of linear algebra — in all three of the major Python tensor libraries: TensorFlow, PyTorch, and NumPy.
* Develop a geometric intuition of what’s going on beneath the hood of machine learning algorithms, including those used for deep learning.
* Be able to more intimately grasp the details of machine learning papers and textbooks.

This live event is for you because…

* You use high-level software libraries (e.g., scikit-learn, Keras, TensorFlow) to train or deploy machine learning algorithms, and would now like to understand the fundamentals underlying the abstractions, enabling you to expand your capabilities
* You’re a software developer who would like to develop a firm foundation for the deployment of machine learning algorithms into production systems
* You’re a data scientist who would like to reinforce your understanding of the subjects at the core of your professional discipline
* You’re a data analyst or A.I. enthusiast who would like to become a data scientist or data/ML engineer, and so you’re keen to deeply understand the field you’re entering from the ground up (very wise of you!)

Prerequisites

* Programming: All code demos will be in Python so experience with it or another object-oriented programming language would be helpful for following along with the code examples.
* Mathematics: Familiarity with secondary school-level mathematics will make the class easier to follow along with. If you are comfortable dealing with quantitative information -- such as understanding charts and rearranging simple equations -- then you should be well-prepared to follow along with all of the mathematics.

**Materials, downloads, or Supplemental Content needed in advance**

* During class, we’ll work on Jupyter notebooks interactively in the cloud via Google Colab. This requires zero setup and instructions will be provided in class.

**Resources**

* If you’re feeling extremely ambitious, you can get a headstart on the content we’ll be covering in class by viewing Lessons 1-3 of Jon Krohn’s [Linear Algebra for ML LiveLessons](https://learning.oreilly.com/videos/linear-algebra-for/9780137398119/)

Schedule

The timeframes are only estimates and may vary according to how the class is progressing.

**Segment 1: Orientation to Linear Algebra (70 min)**

* What Linear Algebra Is
* A Brief History of Algebra
* Solving a System of Linear Equations
* Linear Algebra in Machine Learning
* Q&A and Break

**Segment 2: Data Structures for Algebra (70 min)**

* Tensors
* Scalars
* Vectors and Vector Transposition
* Norms and Unit Vectors
* Basis, Orthgonal, and Orthonormal Vectors
* Arrays in NumPy
* Matrices
* Tensors in TensorFlow and PyTorch
* Q&A and Break

**Segment 3: Common Tensor Operations (70 min)**

* Tensor Transposition
* Basic Tensor Arithmetic
* Reduction
* The Dot Product
* Final Exercises and Q&A

July 14, 2021

12:00 p.m. - 3:30 p.m. Eastern Daylight Time

**You're signed up!**

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**YOUR INSTRUCTOR**

* Jon Krohn

Jon Krohn is Chief Data Scientist at the machine learning company untapt. He authored the 2019 book [Deep Learning Illustrated](https://www.deeplearningillustrated.com/), an instant #1 bestseller that was translated into six languages. Jon’s also the presenter of dozens of hours of popular video tutorials such as [Deep Learning with TensorFlow, Keras, and PyTorch](https://learning.oreilly.com/videos/deep-learning-with/9780136617617). And he’s renowned for his compelling lectures, which he offers in-person at Columbia University, New York University, and the NYC Data Science Academy. Jon holds a PhD in neuroscience from Oxford and has been publishing on machine learning in leading academic journals since 2010.

Read more[linkedin](https://www.linkedin.com/in/jonkrohn/)[twitter](https://twitter.com/JonKrohnLearns)[link](https://www.jonkrohn.com/)

# [Linear Algebra II: Matrix Tensors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com)](https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/) <https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/>

# Linear Algebra II: Matrix Tensors (Machine Learning Foundations)

Use Tensors in Python to Solve Systems of Equations

[What you'll learn](https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/#whatYoullLearn)[Is this live event for you?](https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/#thisLiveEventIsForYouIf)[Schedule](https://learning.oreilly.com/attend/linear-algebra-ii-matrix-tensors-machine-learning-foundations/0636920057980/0636920057979/#liveEventSchedule)

The Machine Learning Foundations series of online trainings provides a comprehensive overview of all of the subjects — mathematics, statistics, and computer science — that underlie contemporary machine learning techniques, including deep learning and other artificial intelligence approaches. Extensive curriculum detail can be found at [the course’s GitHub repo](https://github.com/jonkrohn/ML-foundations).

All of the classes in the ML Foundations series bring theory to life through the combination of vivid full-color illustrations, straightforward Python examples within hands-on Jupyter notebook demos, and comprehension exercises with fully-worked solutions.

The focus is on providing you with a practical, functional understanding of the content covered. Context will be given for each topic, highlighting its relevance to machine learning. You will be better positioned to understand cutting-edge machine learning papers and you will be provided with resources for digging even deeper into topics that pique your curiosity.

There are 14 classes in the series, organized into four subject areas:

**Linear Algebra (three classes)**

* Intro to Linear Algebra
* Linear Algebra II: Matrix Tensors
* Linear Algebra III: Eigenvectors

**Calculus (four classes)**

**Probability and Statistics (four classes)**

**Computer Science (three classes)**

You’re welcome to pick and choose between any of the 14 individual classes based on your particular interests or your existing familiarity with the material. Note that each of the four subject areas are fairly independent, however theory within a given subject area generally builds over the 3-4 classes — topics in later classes of a given subject area often assume an understanding of topics from earlier classes.

(Note that at any given time, only a subset of the ML Foundations classes will be scheduled and open for registration. To be pushed notifications of upcoming classes in the series, sign up for the instructor’s email newsletter at [jonkrohn.com](https://www.jonkrohn.com/).)

This class, Linear Algebra II: Matrix Tensors, builds on the basics of linear algebra. It is essential because matrix properties are central to all machine learning approaches. Through the measured exposition of theory paired with interactive examples, you’ll develop an understanding of how linear algebra is used to solve for unknown values in high-dimensional spaces. The content covered in this class is itself foundational for several other classes in the Machine Learning Foundations series, especially Linear Algebra III.

## What you’ll learn and how you can apply it

* Solve systems of linear equations via the substitution and elimination approaches
* Understand all of the properties of matrices that are essential for ML, including the Frobenius norm, multiplication, and inversion
* Appreciate the importance of special matrix classes to ML, including symmetric, identity, diagonal, and orthogonal matrices
* Manipulate matrices meaningfully with affine transformations
* Develop a geometric intuition of what’s going on beneath the hood of machine learning algorithms, including those used for deep learning.
* Be able to more intimately grasp the details of machine learning papers and textbooks.

## This live event is for you because…

* You use high-level software libraries (e.g., scikit-learn, Keras, TensorFlow) to train or deploy machine learning algorithms, and would now like to understand the fundamentals underlying the abstractions, enabling you to expand your capabilities
* You’re a software developer who would like to develop a firm foundation for the deployment of machine learning algorithms into production systems
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### Prerequisites

* Programming: All code demos will be in Python so experience with it or another object-oriented programming language would be helpful for following along with the code examples.
* Mathematics: You should either have attended the Intro to Linear Algebra live training or be familiar with the content in Lessons 1-3 of Jon Krohn’s Linear Algebra for ML LiveLessons

**Materials, downloads, or Supplemental Content needed in advance**

* During class, we’ll work on Jupyter notebooks interactively in the cloud via Google Colab. This requires zero setup and instructions will be provided in class.

**Resources**

* If you’re feeling extremely ambitious, you can get a headstart on the content we’ll be covering in class by viewing Lessons 4-6 of Jon Krohn’s [Linear Algebra for ML LiveLessons](https://learning.oreilly.com/videos/linear-algebra-for/9780137398119/)

## Schedule

The timeframes are only estimates and may vary according to how the class is progressing.

**Segment 1: Solving Linear Systems (50 min)**

* The Substitution Strategy
* The Elimination Strategy
* Q&A and Break

**Segment 2: Matrix Multiplication (90 min)**

* Matrix-by-Vector Multiplication
* Matrix-by-Matrix Multiplication
* Symmetric and Identity Matrices
* Machine Learning and Deep Learning Applications
* Q&A and Break

**Segment 3: Special Matrices and Matrix Operations (70 min)**

* The Frobenius Norm
* Matrix Inversion
* Diagonal Matrices
* Orthogonal Matrices
* Applying Matrices
* Affine Transformations
* Final Exercises and Q&A

## July 21, 2021

12:00 p.m. - 3:30 p.m. Eastern Daylight Time

**You're signed up!**

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## YOUR INSTRUCTOR

#### Jon Krohn

Jon Krohn is Chief Data Scientist at the machine learning company Nebula. He authored the book Deep Learning Illustrated, an instant #1 bestseller that was translated into six languages. Jon is renowned for his compelling lectures, which he offers in-person at Columbia University, New York University, and leading industry conferences, as well as online via O'Reilly, his YouTube channel, and the SuperDataScience podcast. Jon holds a PhD from Oxford and has been publishing on machine learning in leading academic journals since 2010; his papers have been cited over a thousand times.

Read more[linkedin](https://www.linkedin.com/in/jonkrohn/)[twitter](https://twitter.com/JonKrohnLearns)[link](https://www.jonkrohn.com/)[search](https://learning.oreilly.com/search/?query=Jon%20Krohn)

# Week III - <https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/> [Linear Algebra III: Eigenvectors (Machine Learning Foundations) - O’Reilly Live Events (oreilly.com)](https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/)

Linear Algebra III: Eigenvectors (Machine Learning Foundations)

Decompose Matrices to Reduce Data Dimensionality and Identify Meaningful Patterns

[What you'll learn](https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/#whatYoullLearn)[Is this live event for you?](https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/#thisLiveEventIsForYouIf)[Schedule](https://learning.oreilly.com/attend/linear-algebra-iii-eigenvectors-machine-learning-foundations/0636920057982/0636920057981/#liveEventSchedule)

@21minutes

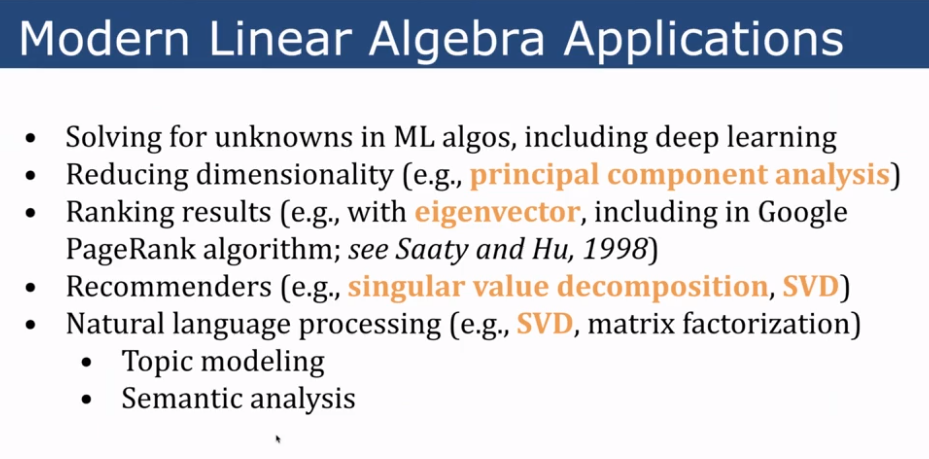


Figure @21 minutes

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This class, *Linear Algebra III: Eigenvectors*, builds on the tensors of Linear Algebra I and the matrix properties of Linear Algebra II to decompose matrices into their characteristic elements. These characteristic elements — called eigenvectors and eigenvalues — are used in a wide range of ML approaches. We’ll explore some of these approaches in theory and in practice during class, including singular value decomposition (SVD) for dimensionality reduction, the Moore-Penrose pseudoinverse for regression, and principal component analysis (PCA) for identifying meaningful patterns.

What you’ll learn and how you can apply it

* Decompose matrices into their characteristic eigenvectors and eigenvalues
* Appreciate the intimate relationship between eigenvalues and matrix determinants
* Reduce the dimensionality of data sets using singular value decomposition (SVD)
* Fit a regression line to data points with the Moore-Penrose pseudoinverse
* Identify meaningful patterns in unlabelled data with principal component analysis (PCA)

This live event is for you because…

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Prerequisites

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* Mathematics: You should either have attended the Linear Algebra II: Matrix Tensors live training or be familiar with the content in Lessons 1-6 of Jon Krohn’s [Linear Algebra for ML LiveLessons](https://learning.oreilly.com/videos/linear-algebra-for/9780137398119/)

**Materials, downloads, or Supplemental Content needed in advance**

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**Resources**

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Schedule

The timeframes are only estimates and may vary according to how the class is progressing.

**Segment 1: Eigenvectors and Eigenvalues (60 min)**

* The Eigenconcept
* Eigenvectors
* Eigenvalues
* High-Dimensional Eigenvectors
* Q&A and Break

**Segment 2: Matrix Determinants and Decomposition (60 min)**

* Matrix Determinants
* Matrix Decomposition
* Applications of Eigendecomposition
* Q&A and Break

**Segment 3: Matrix Operations for Machine Learning (90 min)**

* Singular Value Decomposition (SVD)
* The Moore-Penrose Pseudoinverse
* The Trace Operator
* Principal Component Analysis (PCA): A Simple Machine Learning Algorithm
* Resources for Further Study of Linear Algebra
* Final Exercises and Q&A

July 28, 2021

12:00 p.m. - 3:30 p.m. Eastern Daylight Time

**You're signed up!**

[Join now!](https://learning.oreilly.com/api/v1/live-event-user-registration/sessions/urn:orm:live-event-series:0636920057982:live-event:0636920057981:session:0636920058643/presentation/)Cancel registration