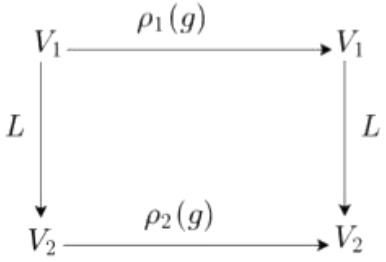
Advanced Linear Algebra for ML

Virtual Bootcamp for Mastering Linear Algebra rigorously in 12 weeks!

Live Lectures | Live Tutorial Sessions| Assignments feedback | Virtual office hours



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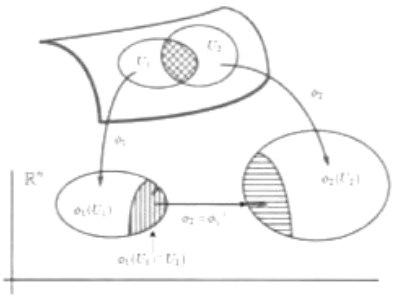

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Liverpool, UK

INTRODUCTION

It is well-known that many new ML engineers and data scientists often face a gap in mathematical skills. Even seasoned practitioners can sometimes feel limited by insufficient mathematical knowledge. While learning to implement an ML algorithm in Python through tutorials is valuable, truly understanding why and how the algorithm works requires a deeper grasp of the underlying mathematics. It is also a fact that ML professionals with strong mathematical skills tend to receive higher salaries and more competitive compensation packages compared to those with lesser mathematical expertise.

While online mathematical courses offered through platforms like Coursera have revolutionised access to education by making high-quality content available to a global audience, they often fall short in providing the interactive and engaging learning environment that live lectures offer. In these video-based courses, learners are left to passively consume information without the opportunity to ask questions in real-time or receive immediate clarification on complex topics. This lack of direct interaction can lead to misunderstandings and gaps in knowledge, particularly in subjects as intricate as advanced linear algebra.

Moreover, the absence of hands-on support and personalised feedback can hinder a student's ability to fully grasp and apply the material. Online video-driven courses often lack the collaborative elements that are crucial for deeper learning, such as group discussions, problem-solving sessions, and one-on-one mentoring. These components are essential for developing a robust understanding and for fostering a sense of community among learners. By contrast, live lectures provide a dynamic and responsive learning environment where students can engage directly with instructors and peers, facilitating a more comprehensive and supportive educational experience.

THE BENEFITS OF THIS COURSE

Unlike existing online mathematical courses for ML delivered via platforms like Coursera, this bootcamp offers unique features:

- **Live Lectures:** Attend live sessions with a PhD-level mathematician who rigorously taught Linear Algebra at Penn State, focusing on concepts relevant to ML. Topics include Vector Spaces and Subspaces, Linear Transformations, Matrices, Eigenvalues, Eigenvectors, and more.

- **Replays (exclusively available to participants):** If you miss a session, recordings will be available.
- **Live Tutorial Sessions:** Participate in live tutorials to learn theorem proofs and computations such as matrix multiplication. These sessions will not be recorded to encourage active participation and reduce the fear of making mistakes.
- **Feedback:** Receive feedback on assignments to help enhance your proof-writing and computational skills.
- **ML Applications:** Learn how to apply mathematical concepts to popular ML use cases, such as Principal Component Analysis (PCA), Latent Semantic Analysis (LSA) and more.
- **Community:** Join a network of ML professionals who value the role of mathematics in creating impactful solutions.
- **Career Fair (Optional):** Pitch yourself to select companies from ML to quantum computing looking for new talent.
- **Bonus Maths (Optional):** For the hardcore students, we will provide a complimentary review of differentiable manifolds to prepare for the subsequent specialisation in 'Lie Groups & Representations for Deep Learning.'

This specialisation leverages pedagogical techniques, honed over four years of offering free mathematical courses to the QF community. Our approach is designed to help you learn quickly and intuitively, while simultaneously developing your abstract mathematical skills, equipping you to develop ML algorithms with confidence.

COURSE STRUCTURE

A free, optional prerequisite course on 'Mathematical Proof Writing Techniques' will be available from September 17 to October 16. Following this, the Linear Algebra Bootcamp will run from October 23, 2024, to January 8, 2025, with a time commitment of just 6 hours per week (recommended) for participants:

- **1 hour of live lectures**
- **2 hours of live tutorials**
- **3 hours for homework assignments (estimate)**

We recognize that learners may have other commitments, such as work or studies. To accommodate this, we're open to shifting some or all of the live interactive sessions to the weekends, based on the preferences of the majority. Additionally, depending on group size, we can consider splitting the class into two groups: one for those who prefer weekday sessions and another for those who prefer weekends.

We will teach the subject from a mathematician's perspective, emphasising proofs and abstract constructions rather than the traditional approach used for engineering students, which centres on matrix calculations. We will use "Algebra, Topology, Differential Calculus, and Optimization Theory for Computer Science and Machine Learning" by Jean Gallier and Jocelyn Quaintance as our textbook, supplemented with additional mathematical abstraction. Our course is designed to provide a comprehensive understanding of linear algebra in a rigorous way. We aim to cover chapters 1-9 of the textbook, excluding chapter 5.

A more comprehensive syllabus will be created and shared with all course registrants after conducting a mathematical background survey with them. This survey will help us tailor our teaching strategy to provide the best possible learning experience, taking into account the varying mathematical backgrounds of the students.

MAIN REFERENCES

1. Gallier, J., & Quaintance, J. (2020). *Linear algebra and optimization with applications to machine learning*. World Scientific Publishing.
2. Bach, F. (2024). *Learning theory from first principles (eBook here).*