Video Project # 2 Topics

The following are the topics for Video Project # 2. The number you received in the PDF posted for your Discussion section corresponds to the Project you were randomly selected to do.

In addition to the topic itself, we list a few ideas for getting started. Each of these topics relates quite closely to concepts from the course lectures and in most cases your textbook and supplemental videos. You are encouraged to review all course material related to these topics.

Of course, each of these topics are important beyond our specific course! Indeed, most of these topics have excellent Wikipedia articles. You are heavily encouraged to search for additional resources on-line.

Remember, there are no "right answers" we have in mind for your video projects. We encourage you to be creative and have fun!

You can consult with the course Instructors/TAs and your classmates on this video topic. However, each student is responsible for submitting their own video project.

Topic #	Topic Name	Ideas for Getting Started
1	Orthogonal bases	What are they? Why are they useful? Give an example. See Section 3.4 in the textbook
2	Gram-Schmidt Process	What is it? Why is it used? Give an example.
3	Determinants	What is it? How do you compute determinants for a 2×2 or 3×3 matrices? What does nonzero or zero determinant mean? Give an example.
4	Eigenvalues & eigenvectors	What are they? How do we find them? Give an example.
5	Diagonalization of a matrix	What does it mean? How does it relate to matrix factorization. Give an example.
6	QR decomposition	What is it? How do we find the matrices Q and R. Give an example.
7	Difference equations	What are they? How do we solve them? Give an example.
8	Similarity matrices	What are they? What are the eigenvalues of two similar matrices? Give an example. See Week13_R lecture notes and Section 5.6 in the textbook.
9	Complex Eigenvalues for Real and Complex Matrices	When a real matrix has a complex eigenvalue you always get them in pairs: $a \pm ib$ but the same is not true for complex matrices. Give an example and explain why. See Section 5.5 in the textbook.
10	Positive definite matrices	What are they? What can we say about their eigenvalues? Are positive definite matrices invertible? See Section 6.2 in the textbook.
11	Singular value decomposition	What is it? How are the singular values related to eigenvalues? Give an example. See this video.
12	Matrix norm & condition number	What are they? How are they useful in solving a system of equations?
13	Computing eigenvalues and iterative methods	What are some iterative methods for computing eigenvalues? Give an example. See this video.
14	Solving differential equations using linear algebra	How can we use linear algebra to solve differential equations? Give an example. See Section 5.4 in the textbook or Week11_R_MarkedUp lecture notes.

Topic #	Topic Name	Ideas for Getting Started
15	Least squares projection	What is it? How does it relate to solving a system of equations? Give an example. See Section 3.3 in the textbook.
16	Matrix diagonalization and compute A^k	How do we diagonalize a matrix? How does matrix diagaonlization help us compute A^k. Give an example.
17	How does determinant tell us about solving $Ax = b$?	If the determinant is nonzero, does $Ax = b$ have a solution, no solution, or infinitely many solutions? Give an example.
18	Diagonalizability of a matrix	When is a matrix diagonalizable? How does it relate to eigenvectors? Does it relate to invertibility of the matrix? Give an example.
19	Symmetric matrices vs Hermitian matrices	What are they? What are the differences between the two? Give an example.
20	Orthogonal matrices vs unitary matrices	What are they? What are the differences between the two? Give an example.
21	Invertibility of a matrix and eigenvalues	When is a matrix invertible? How are eigenvalues related to a matrix being invertible? Give an example of something that is and is NOT invertible based on eigenvalues.
22	Relationships between trace, determinant, and eigenvalues	How are these relationships helpful? How can we use trace and determinant to find eigenvalues? Give an example.
23	Markov matrix	What is it? How does the dominant eigenvalue and eigenvector inform the long-term behavior of a Markov system? Give an example. See Section 5.3 in the textbook and see this video.
24	Orthogonal projection	What is it and how does it relate to least squares projection? Give an example. See Section 3.4 in the textbook and this video.
25	Schur Lemma	What does this mean? How does it come up? Why is this useful? Give an example. See Section 5.6 in the textbook.
26	Eigenvalues of Symmetric and Hermitian Matrices	What is special about them and why? Give an example. See Section 5.5 in the textbook.
27	Eigenvectors of Symmetric and Hermitian Matrices	What is special about them and why? See Section 5.5 in the textbook and this video.
28	Normal Matrix	What does this mean? Give us some interesting properties. Give us an example. See this reference and this video.
29	Idempotent Matrix	What does this mean? Give us a couple cool properties. Give an example. See this video.
30	Nilpotent Matrix	What does this mean? Give us a couple cool properties. Give an example. See this video.