Harnessing the Power of Computational Mathematics in Engineering- An introduction

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Outline

1. Session Outcomes
2. Agenda
3. Neumann's Quote on Mathematics
4. Role of intuition in long term learning
5. Testing Newmann's Claim
6. Mathematical Formalism
7. Backbone of Modern AI Generative Models
8. Where to Start?

Session Outcomes

Upon successful completion of the session, the participants will be able to :

- develop a basic understanding on the importance of Computational Mathematics in Engineering

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- develop a basic understanding on the importance of Computational Mathematics in Engineering
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- understand the key steps in Problem Solving

Agenda

- Demystifying the foundations of Computational Mathematics

My First Quote

"In mathematics, you don't understand things; you just get used to them"

John von Neumann

Testing Newmann's Claim...

Determinant of a matrix

Determinant of a square matrix, $\mathbf{A} = \begin{bmatrix} a & b \\ c & d \end{bmatrix}$ is defined as:

$$|A| = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

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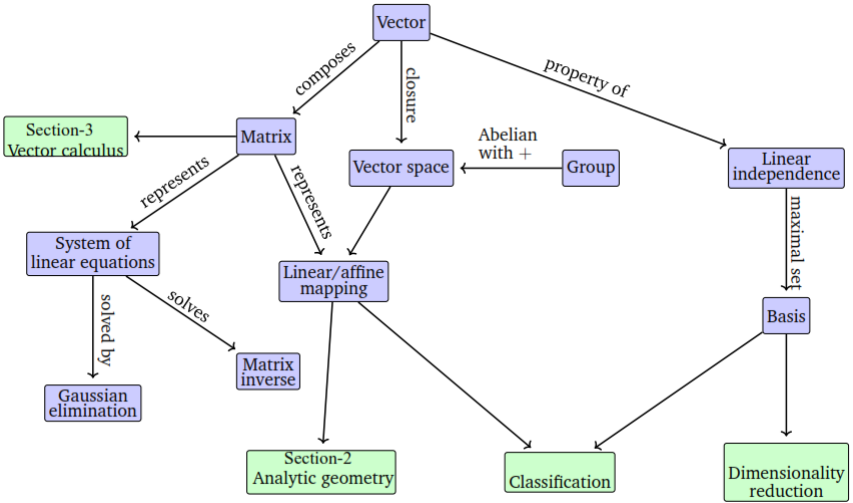
Why this name? What it really means?

Just look into a simple intuition!

`https://www.desmos.com/calculator/waxeevafki`

Linear Algebra & Matrix Operations



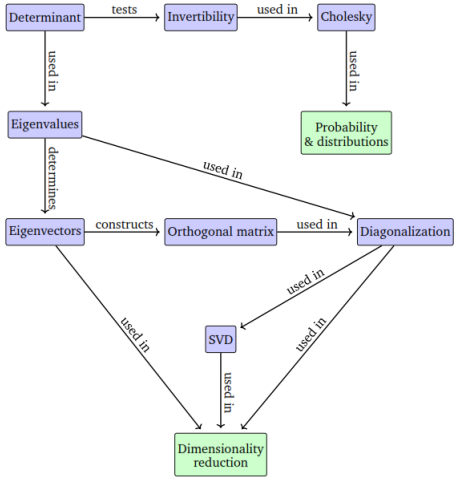
Algebra is extension of operations in number system

- vector is generalized form of numbers
- multiple vectors can be expressed in form of matrix
- matrices are used to represent related data in computers
- data manipulation can be achieved by matrix operations
- vector space is the extension of number system to set of vectors
- vector space is a container with self generating mechanism

Linear Transformations & Matrix implementation

- a linear transformation is a structure preserving mapping on vector spaces
- linear Transformations can be represented as Matrices
- properties of a LT can be characterized by its eigen values and eigen vectors
- span of eigen vectors defines a new transformed space
- we use this concepts in AI to make computations efficient

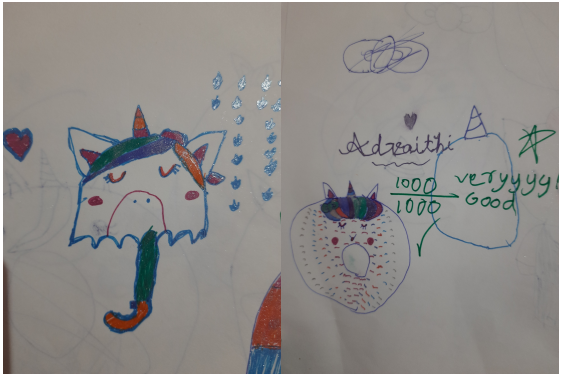
Matrix decomposition for AI



Relevance of Neumann's quote in a child's art...

Children's drawing

Changes in drawing- more informative & realistic



Problem- imperfections in the art!

Not feel good...

A fast ingenious (but smart) solution...

New generation & innovations

Attitude

Get faster result with minimal work. So go for smart solutions with AI tools.

Example

https://youtube.com/clip/UgkxvW3_lPW_k4NW7lio0Y1Tlaw-55TqaLIr?si=jUzVknzIyfeW1WQg

Backbone of Generative Models

The building blocks of all Generative Models are computational version of:

- Linear Algebra
- Multi-Variable Calculus
- Probability & Statistics
- Optimization

Where to start?...

Best option is change our approach to Mathematics as:

$$\text{Applied} \Longrightarrow \text{Computational}$$

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New approach in problem solving

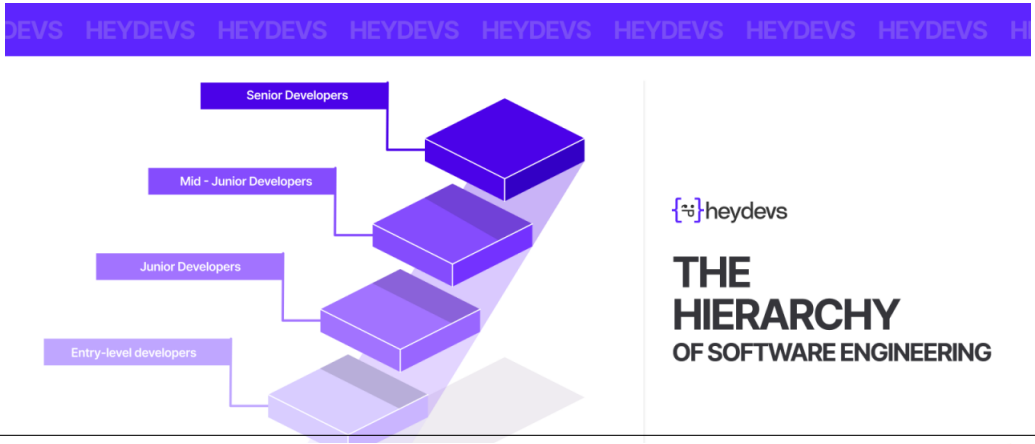
- Domain study
- Create a mind-map
- Select appropriate mathematical model
- Implement the model computationally
- Debug the model
- Finalize the solution

Popular Tools to Start Computational Mathematics

Some good playgrounds for Computational Math:

Why CME ?

AI will nullify 30% of current job positions and create more than 40% new jobs!



Experiencing Computational Linear Algebra with Python

Link to colab file:
https://colab.research.google.com/drive/17PJdnY0UE6XL4sLUf1DiqknsTZwSPk7L?authuser=1#scrollTo=UyeHYfkdvo12

How can I transform my learning?

Simple but practical option:

Practice Kaizen- change for the better or continuous improvement.

My Final Quote

"(Computational) Mathematics gives you wings"

Margot Gerritsen, Stanford

https://www.youtube.com/watch?v=LSxqpaCCPvY&t=2s

Thank You