

中国科学院大学
2026

数值代数 Numerical Algebra

课程介绍

About this course

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Mathematical Sciences



The Mathematical Sciences in 2025

DOI: 10.17226/15269
(Published in 2013)

Committee on the Mathematical Sciences in 2025

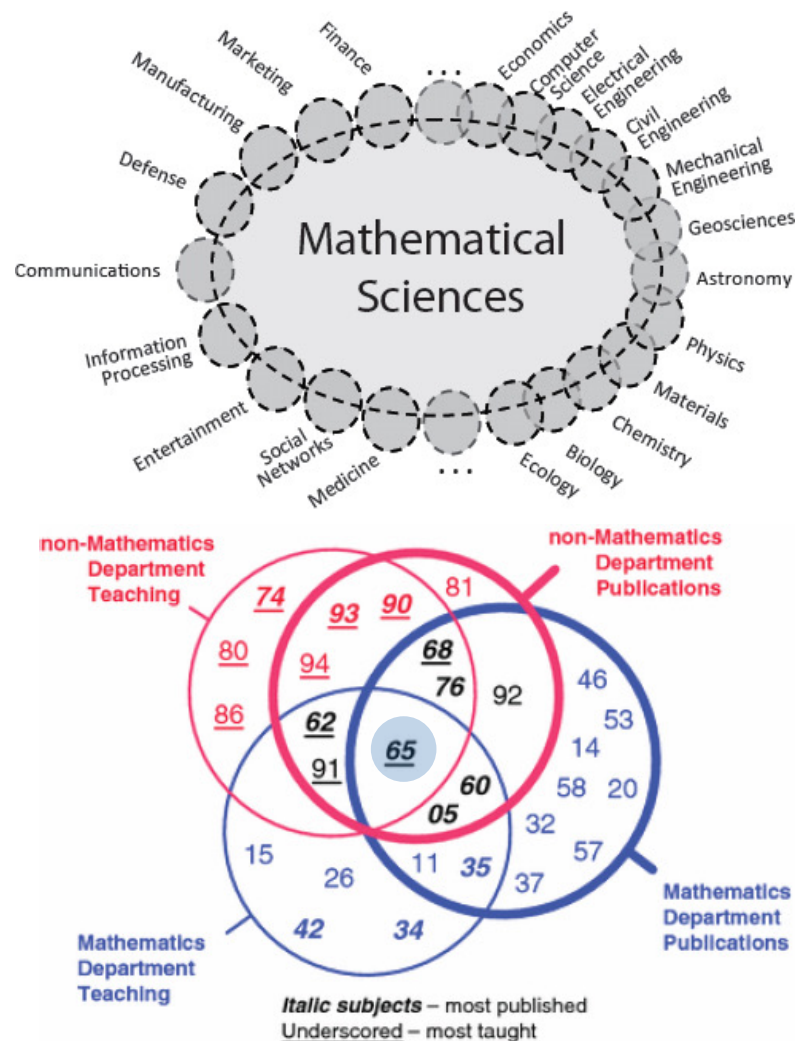
Board on Mathematical Sciences and Their Applications

Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

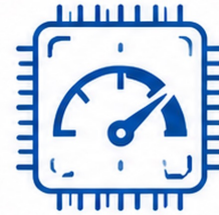
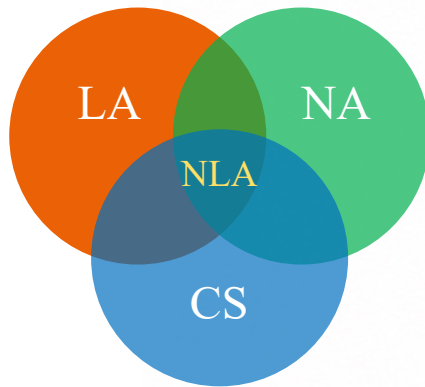
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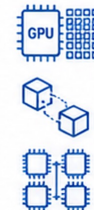
- 05 Combinatorics
- 11 Number theory
- 14 Algebraic geometry
- 15 Linear, multilinear algebra
- 20 Group theory
- 26 Real functions
- 32 Several complex variables
- 34 Ordinary differential equations
- 35 Partial differential equations
- 37 Dynamical systems
- 42 Fourier analysis
- 46 Functional analysis
- 53 Differential geometry
- 57 Manifolds, cell complexes
- 58 Global analysis
- 60 Probability theory
- 62 Statistics
- 65 **Numerical analysis**
- 68 Computer science
- 74 Mechanics of deformable solids
- 76 Fluid mechanics
- 80 Classical thermodynamics
- 81 Quantum theory
- 86 Geophysics
- 90 Operations research
- 91 Game theory, economics
- 92 Biology
- 93 Systems theory, control
- 94 Information and communications

The Art of NLA

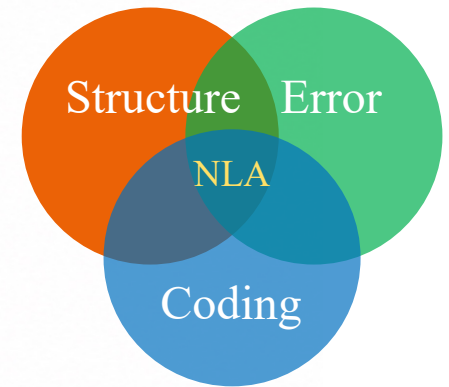


EFFICIENCY

- Sparse Structure
- Data Movement
- Mixed Precision



- GPU & Tensor Cores
- Communication Avoiding
- Parallel Scalability



ACCURACY

- Conditioning
- Roundoff Error
- Backward Error
- Error Propagation
- Iterative Refinement

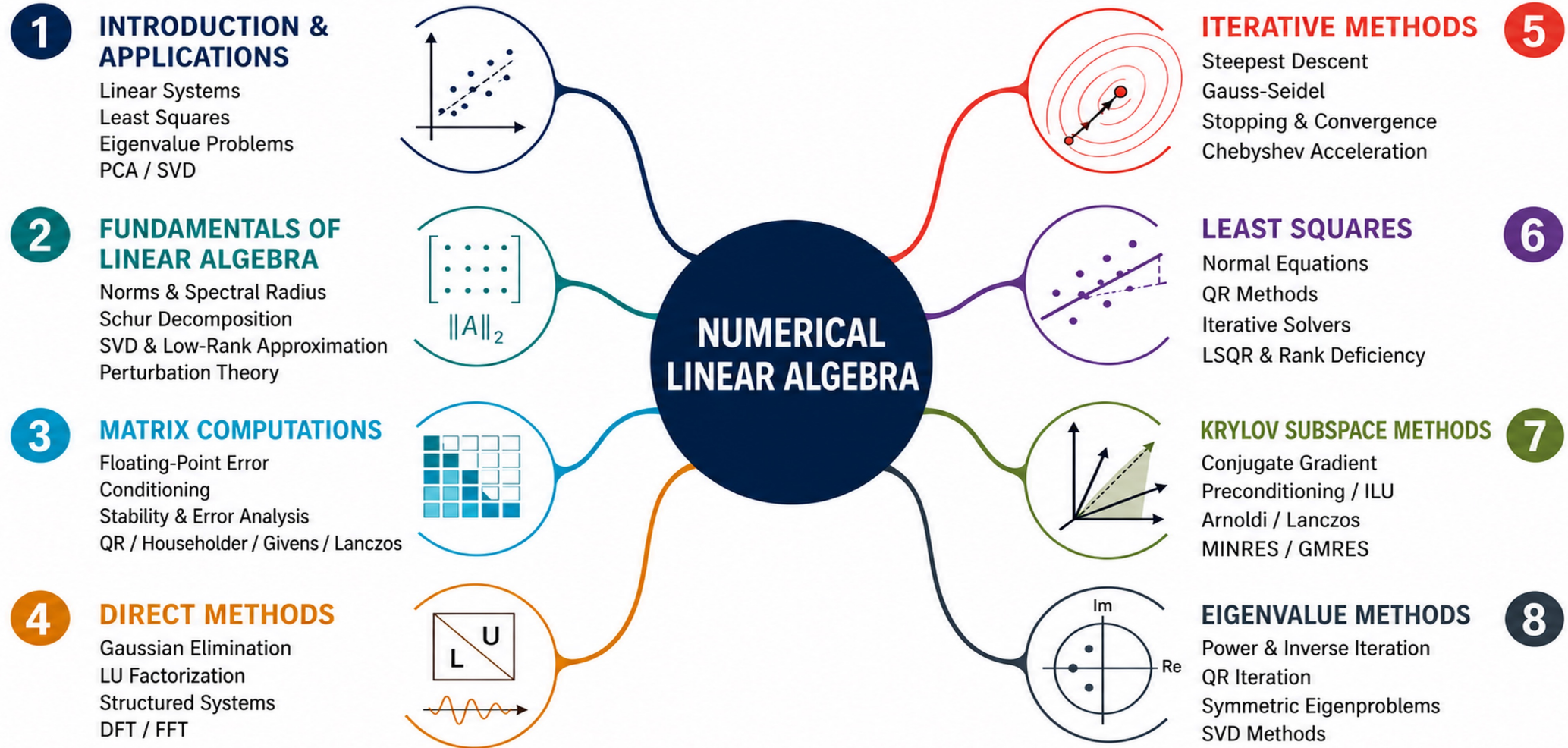


STABILITY

- Perturbation Bounds
- Stable Factorizations
- Robust Convergence
- Residual Monitoring
- Reliable Stopping



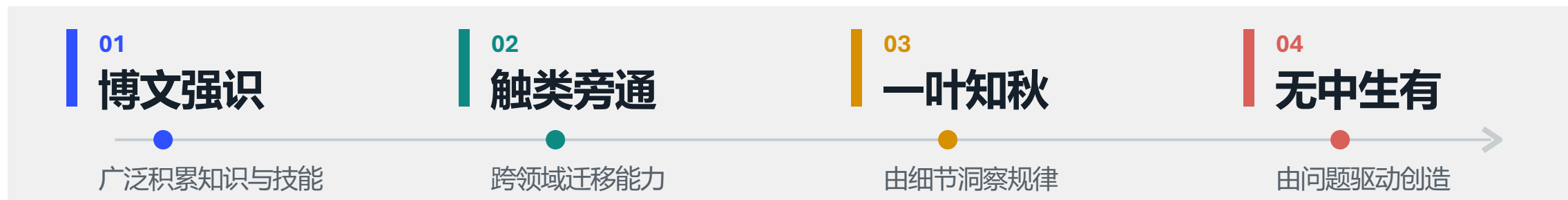
Mind Map for NLA





能力教育的四个境界

港科大（广州）熊辉校长 | 《AI时代的职业图谱》演讲



AI时代的能力闭环



把能力变成动作



好的提问，打开输出；好的鉴赏，决定答案能否成为行动

AI is Powerful, Yet “I” Decide



思辨 (Critical Thinking)

涵盖判断能力与怀疑精神，保持独立思考、质疑和判断的能力



创新 (Innovation)

即创新精神，是从0到1的原创能力和跨领域整合的能力



品味 (Taste)

代表审美、价值判断和情感共鸣的能力，是人类独特的财富



协作 (Collaboration)

指人机合作能力，明确人类与AI的分工，让AI成为能力的放大器

重新定义“教学”：内容与方法



重构课程体系

- 强化人类独有能力（思辨、创新、品味）
- 普及AI通识教育，理解技术边界，提升人机协作能力



AI赋能实战

- 利用AI实现个性化学习路径规划
- 推行项目式学习，在实战中掌握人机协作

田刚 “三个能力”（大湾区大学2026开学典礼）：提出问题的能力、独立思考的能力、终身学习的能力

Human Comprehension as a Gatekeeper



Stephen Wolfram (2024)

Creator of Mathematica and Wolfram Alpha

"Without such interpretive landmarks, we merely have a black-box computation, not assimilable human knowledge."

Source: "Can AI Solve Science?"



Terence Tao (2026)

Fields Medal Winner

"... a verified proof of a major result that no human understands well enough to explain... The bottleneck shifts from generating proofs to human understanding."

Source: arXiv:2608.08562



Springer–Nature AI Publishing Policy (2025)

Human accountability is non-transferable... Authors must be able to understand, verify and take responsibility for all content.

The Future of Coding

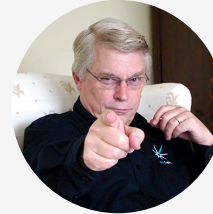


Linus Torvalds (2026)

Father of Linux and Git

"It is not acceptable to merge code that passes tests but cannot be understood ... by human maintainers."

Source: Open Source Summit NA 2026



Uncle Bob Martin (2026)

Originator of Clean Code principles

"We do not need to read every line of implementation code generated by AI agents ... Humans own specifications, architecture, test definitions."

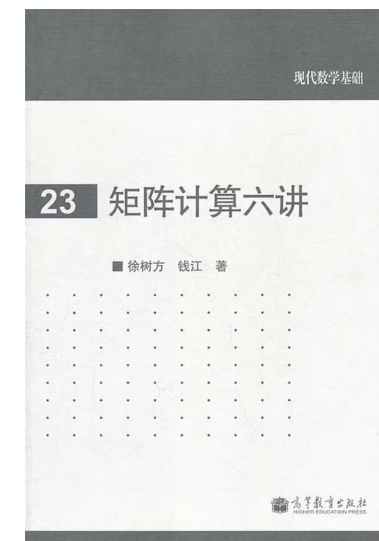
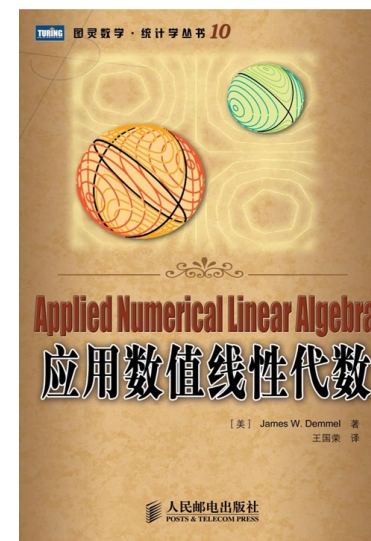
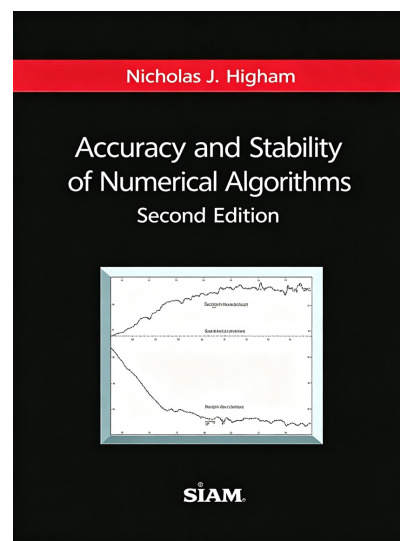
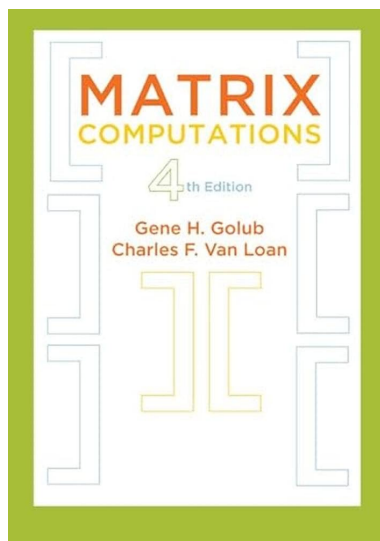
Source: Swarm-Forge Workflow

Takeaway Message: These perspectives are not mutually exclusive. The key takeaway is that human oversight remains paramount—whether at the level of deep understanding of complex proofs or defining robust tests that guide AI systems.

References



- Golub G H, Van Loan C F. **Matrix Computations**, 4th Edition. JHU Press, 2013
- 徐树方, **矩阵计算的理论与方法**, 北京大学出版社, 1995
- Demmel J W. **Applied Numerical Linear Algebra**. SIAM, 1997
- Higham N J. **Accuracy and Stability of Numerical Algorithms**, 2nd Edition. SIAM, 2002
- 徐树方、钱江, **矩阵计算六讲**, 高等教育出版社, 2011





Exercises

算法、理论、推导

20%



Homework

实践、编程、应用

30%



Final

计算、证明

50%

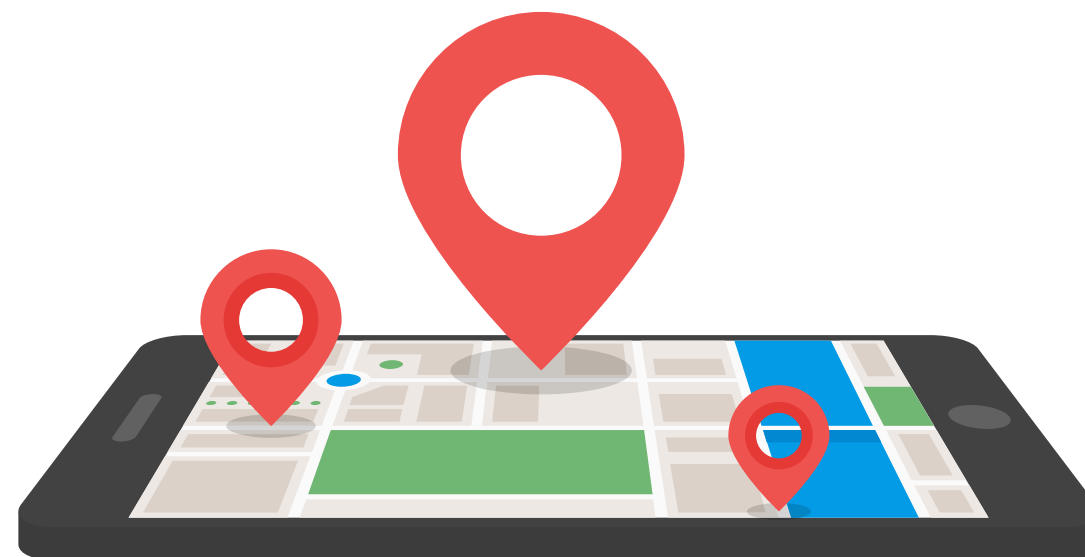
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THANKS

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