Math for AI

NSF LEVEL UP AI Workshop Recommendations

Computing Research Association

July 2026

As part of the NSF LEVEL UP AI project, the Computing Research Association (CRA) and New Mexico State University convened educators, researchers, and professionals across the computing community to build consensus on strategies to increase capacity for undergraduate Artificial Intelligence (AI) education. The LEVEL UP AI Atlanta (December 2025) and Phoenix (January 2026) design workshops addressed key bottlenecks in AI education infrastructure, which had been identified in Spring 2025 roundtable discussions (Cowit et al., 2025). The *Designing "Math for AI"* in-person design workshops in Atlanta and Phoenix were attended by 22 participants from 21 institutions (Link to Contributors). Utilizing a backwards design methodology (Wiggins & McTighe, 2005), the workshops facilitated the creation of this recommendations document.

Many current AI programs derived their structure from traditional computer science programs where students typically take four or five dedicated math course prerequisites, and often these need to be completed before entering core AI courses. Such a large number of math prerequisites could serve as a deterrent for many promising students. This document outlines how the workshop participants propose math can be restructured, reducing the length of the mathematics pre-requisite chain, while making "Math for AI" courses more relevant to computing students. The intent of these recommendations is not to diminish the importance of mathematical sophistication in AI, but to propose a pathway where the relevant mathematical content can be acquired without creating bottlenecks to AI courses or increasing the curricular complexity of an AI degree program.

The "Math for AI" structure recommended in this document is designed to be flexible and adaptable for different schools and contexts, offering slimmed down "modules" of key mathematics courses (e.g., Discrete Math) that only include the mathematical content deemed necessary for AI. These modules can either be taught in stand-alone "Math for AI" courses or integrated into computing/AI courses. For instance, specific statistics content can be incorporated into a required "Introduction to Data Science" course. Whether institutions choose to implement modules as two dedicated "Math for AI" courses or incorporate some modules in AI/computing courses, institutions with an AI pathway should include all the mathematics learning areas recommended in this document. The mathematics areas outlined should often be reinforced with applied real-world AI examples, to teach implementation and encourage students to view this knowledge as important to their learning and career goals.

Necessary Learning Outcomes:

The relative importance of "Math for AI" topics was a major discussion area of the two LEVEL UP AI workshops. Any institution implementing "Math for AI" will need to discuss topic importance and introduction timing, and if some topics should be covered more than once. As different AI Pathways may have different goals, we **do not** label the importance of the "Math for AI" topics in this recommendations report. However, it will be important for programs to determine for themselves which topics are foundational for learning AI and should be covered multiple times in an AI Pathway, critical knowledge areas for an AI Pathway which should be covered in depth at some point, and areas in which only some familiarity is important which require only late program introduction.

Module	Key Topic
Prerequisite Topics	Algebra, Precalculus/Trigonometry
Discrete Math	First-order/predicate/boolean logic & combinatorics
	Sets, relations, functions, graphs
	Algorithms & complexity analysis (often covered sufficiently in first year programming courses)
	Proof techniques
Calculus	Limits, derivatives, integrals
	Partial derivatives, gradients
	Calculus of matrices & vectors
Probability & Statistics (Data Analysis)	Types/levels of data (i.e., categorical (nominal/ordinal), interval, ratio) & operations they support
	Data types - binary, categorical, numeric, string, working with blended types
	Combined data types - data frames, matrices, lists, etc.
	Data visualization
	Summary statistics & confidence

CRA Computing Research Association

Module	Key Topic
	Variances
	Distributions (with real-world examples)
	Covariances, ANOVA
Probability & Statistics (Modeling)	Probability theory & expectation
	Model evaluation (with linear regression example)
	Bayes theorem & applications
	Optimization
Linear Algebra (Vector Foundations)	Similarity/Dissimilarity Measures: (e.g., Euclidean distance, cosine similarity, Jaccard's coefficient, Pearson correlation, *p*-norms, etc.)
Linear Algebra (Matrix/Tensor Foundations)	Basis; matrix algebra, matrix decomposition (connect to dimension reduction)
	Linear transformations
	Vector spaces
Linear Algebra (Data Analysis)	Rationale for data reduction (sampling, PCA, LDA, etc.)
	Eigenvalues & eigenvectors (geometric intuition)
Linear Algebra (Motivating Examples)	Data visualization (e.g., t-SNE, anisotropy)
Desirable Electives *(Some of these can be*	State machines
	Calculus-based prob & stats & beyond
	Calculus: single-variable & partial derivatives
	Linear algebra (all other topics)
	Non-linear functions
	Verifiability / Provability (programmatically demonstrable

Module	Key Topic
found in non-core AI math courses)	logic)
	Maximum Likelihood
	Optimization (first order/second order optimality conditions, gradient descent, stochastic gradient descent, minimax theorem, optimization, lagrange multipliers)

Problem-Solving Dispositions

Abstract problem-solving dispositions should be in mind as a general goal when teaching mathematics for AI.

- Pattern matching & expansion for problem solving. How to go from a simple concept to a more complex example (using appropriate resources)
- Problem → Mathematical Tools → Coding/Solutions → Analysis & Assessment→ Refine & Reiterate ↩

Institutional Considerations

Computing programs pursuing the creation of “Math for AI” courses should communicate with their own universities’ mathematics departments to foster cross-departmental collaboration networks, building off complimentary expertise and taking into account institutional redundancy. One possibility of collaboration is through co-taught “Math for AI” courses, i.e., co-taught with both computing and mathematics faculty.

Authors

Michael Peterson, University of Hawaii at Hilo

Issac Shaffer, Northern Arizona University

Enrico Pontelli, New Mexico State University

Noah Q. Cowit, Computing Research Association

Suggested Citation

Peterson, M., Shaffer, I., Pontelli, E., & Cowit, N. Q., (2026). *"Math for AI": NSF LEVEL UP AI Workshop Recommendations.* Washington, D.C.: Computing Research Association (CRA). https://cra.org/wp-content/uploads/2026/07/Math-for-AI-NSF-LEVEL-UP-AI-Workshop-Recommendations.pdf

Acknowledgement

We greatly appreciate the efforts of the NSF LEVEL UP AI Advisory Board and Leaders of Partnering Organizations, who are foundational to the success of this project.

Citations:

Cowit, N. Q., Tadimalla, S. Y., Jones, S. T., Maher, M. L., Camp, T., & Pontelli, E. (2025). *Developing Strategies to Increase Capacity in AI Education* (arXiv:2509.21713). Computing Research Association (CRA). https://doi.org/10.48550/arXiv.2509.21713

Wiggins, G. P., & McTighe, J. (2005). *Understanding by Design*. Association for Supervision and Curriculum Development.

This material is based upon work supported by the U.S. National Science Foundation (NSF) under Award No. CNS-2434416.

Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.