Formally Verified Numerical Methods

Challenge:



Solution:

- End-to-end proofs in Coq
- Layered & modular
- New libraries, new tools, analysis algorithms

CCF-2219757 Princeton University, Andrew Appel CCF-2219758 Cornell University, David Bindel mathematical problem spec. domain-specific mathematics

 \mathbb{R} functional model

library tool

F functional model

Sparse

matrix

Verified Software Toolchain

C program



Scientific Impact:

- Connect the mathematical theory of numerical analysis to machine-checked formal methods.
- Demonstrate layered modular approach to formal-methods community
- Validate results and methods in computational science

Broader Impact and Broader Participation:

- Primary impact: scientific/engineering computation
- Transition to practice: verified libraries
- Outreach: invited talk at 2025 International Workshop on Verification of Scientific Software



The NSF Formal Methods in the Field PI Meeting (2024 FMitF PI Meeting) November 12-13, 2024 | The University of Iowa | Iowa City, Iowa