
Advanced course

Scientific computing

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When we study a partial differential equation, in most cases, we do not have access to an exact solution and it is then necessary to compute a numerical approximation. Either by using the finite differences method or the finite elements method, we obtain a linear system that can be solved by several approaches. In this course, we will discuss different direct and iterative methods, and the issues that can arise by manipulating numbers in finite precision.

1. Storing and manipulating numbers

- Represent a real number in finite precision
- Rounding error in basic arithmetic operations
- Storage of sparse matrices

2. Direct methods

- Ascending and descending algorithms
- Gauss method
- LU decomposition

3. Iterative methods

- Jacobi, Gauss-Seidel methods
- Gradient methods
- Krylov methods

References

- [1] Nicholas J. HIGHAM. *Accuracy and Stability of Numerical Algorithms*. SIAM, 2022.