

Introduction

Numerical computing means:

computing with numbers.

History:

- It is almost as old as civilization itself.
- **Modern numerical computing** began with **Isaac Newton** in the 17th century; his invention of calculus was driven by its use in solving **numerical** problems.
- Until the 20th century, calculation was primarily done with **pencil and paper** in the west and the **abacus** in the east.
- In the first half of the 20th century the **slide rule** made multiplication easy, but gave only **3 digits of accuracy**. **Mechanical calculators** were more costly and cumbersome, but accurate.

Computers

- **Computers** were first invented in the 1940's and 1950's for solving **hard scientific and engineering problems** which required a great deal of **numerical computing**.
- During the 1950's, the primary usage of computers was for **numerical computing in scientific applications**.
- In the 1960's, computers became widely used by large businesses, for **processing all kinds of information**.
- Computers became far more widespread, to medium-sized businesses in the 1970's, and to many millions of small businesses and individuals during the **PC revolution** of the 1980's and 1990's.

The main interest is **processing of information**, such as text, images, and sound.

Uses of Numerical Computing

In **most scientific disciplines**, computing with **numbers** remains by far the most important use of computers. e.g.

- **Physicists:** solve complicated equations, from modeling the expansion of the universe, to the microstructure of the atom, to test their theories against experimental data.

- **Chemists and biologists:** determine the molecular structure of proteins.
- **Medical researchers:** design new and better medical techniques, do statistical analysis of experimental and clinical observations.
- **Atmospheric scientists:** process huge quantities of data and solve appropriate equations to predict the weather.
- **Aeronautical engineers:** designing better airplanes: the Boeing 757, 767 & 737-800 were designed relying more heavily on **computer modeling** than on wind tunnel tests. Lower development costs allow smaller production runs.

Computer Science & Numerical Computing

CS for a time used less numerical computing. Compilers and operating systems manipulate symbol tables and character strings, not numbers. But NC is again important in computer science.

Fast reliable numerical algorithms are important for example in:

bioinformatics, computational geometry, data mining and information retrieval, animation, graphics, image processing, machine learning, modeling and simulation, pattern recognition, robotics and computer vision, etc.

Numerical computing is an important part of that technology which any computer scientist should understand at some level.

Software Bugs Relates to Numerical Computing

- Ariane 5 Explosion (1996)
- The Patriot Missile Failure (1991)
- Wrong Vancouver Stock Exchange Index (1983)

Programming Advice

- Be careful and be correct
- Use pseudocode
- Check and double check
- Use test case
- Modularize code
- Include warning messages

- Use meaningful variable names
- Include comments
- Use appropriate data structure
- Use built-in functions and program libraries
- Do not over-optimize