Introduction to applied scientific computing using MATLAB

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Course Goals

- Introduction to the use of MATLAB as an aid to scientific research
  - Have an understanding for basic concepts in programming
  - Be able to read, process and display data in MATLAB
  - Be able to read and understand existing code
  - Solve problems and implement algorithms in MATLAB

- Develop your "computational senses," senses that you need in computer problem-solving
  - Know how to use MATLAB in other courses

Course Goals

- Understanding the importance of writing readable code
- Know which tools to use to solve various scientific problems
- Analysis of your Solutions using Scientific Computing Pipeline
- Presenting Research Results
  - Scientific report

Agenda

- MMSP Group
- Introduction to scientific computing
- Why using MATLAB?
- LaTeX
  - overleaf
- Course Materials
- Hands-on Exercises
- Who to install MATLAB

About Us

- Where and who are we and what do we do?
  - Multimedia signal Processing Group (MMSP)
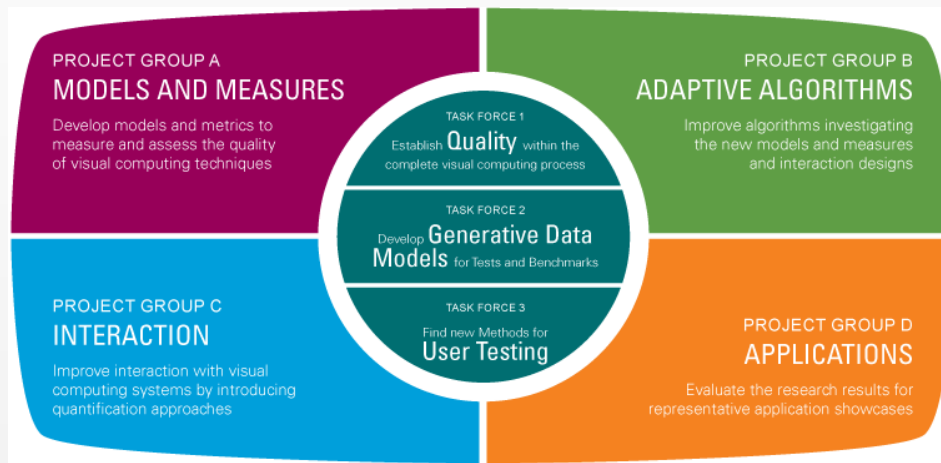   - Prof. Dr. Dietmar Saupe

    https://www.mmsp.uni-konstanz.de/
  - Quantitative Methods for Visual Computing Project (SFB-TRR161)
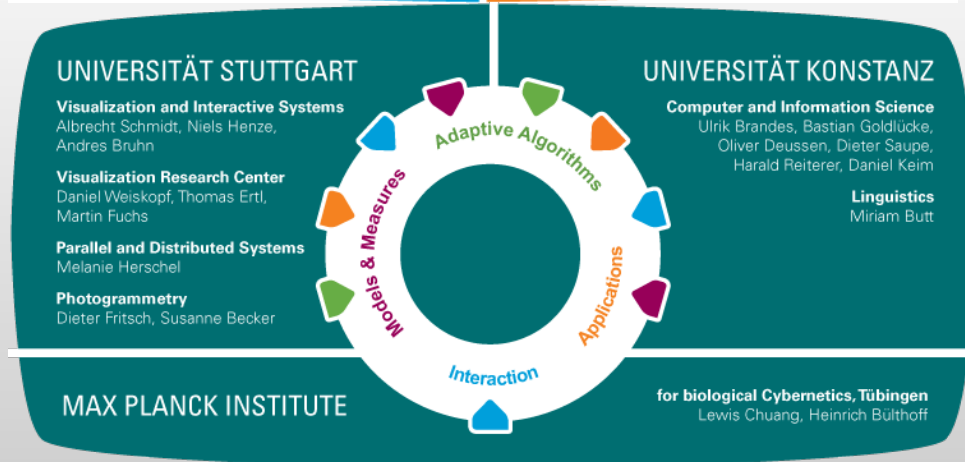
    http://www.sfbtrr161.de/

    - Project: A05

      Image/Video Quality Assessment

Quantitative Methods for Visual Computing Project

Structure of the Program

Institutions and People

What is Scientific Computing?

- from *Wikipedia.com*
  - Scientific computing (or computational science) is the field of study concerned with constructing mathematical models and numerical solution techniques and using computers to analyze and solve scientific and engineering problems.

  - In practical use, it is typically the application of computer simulation and other forms of computation to problems in various scientific disciplines.

Motivation for the Course

- Scientific Computing is A course to bridge the gap between theory and applications
  - With emphases on
    - Problem solving
    - Hands-on coding
    - Data & approach visualization
    - Real-world applications
- Programming is a key competence for todays researcher
- Some courses depend on you being able to program
  - Programming will be a tool not subject of study.

Scientific Computing Pipeline
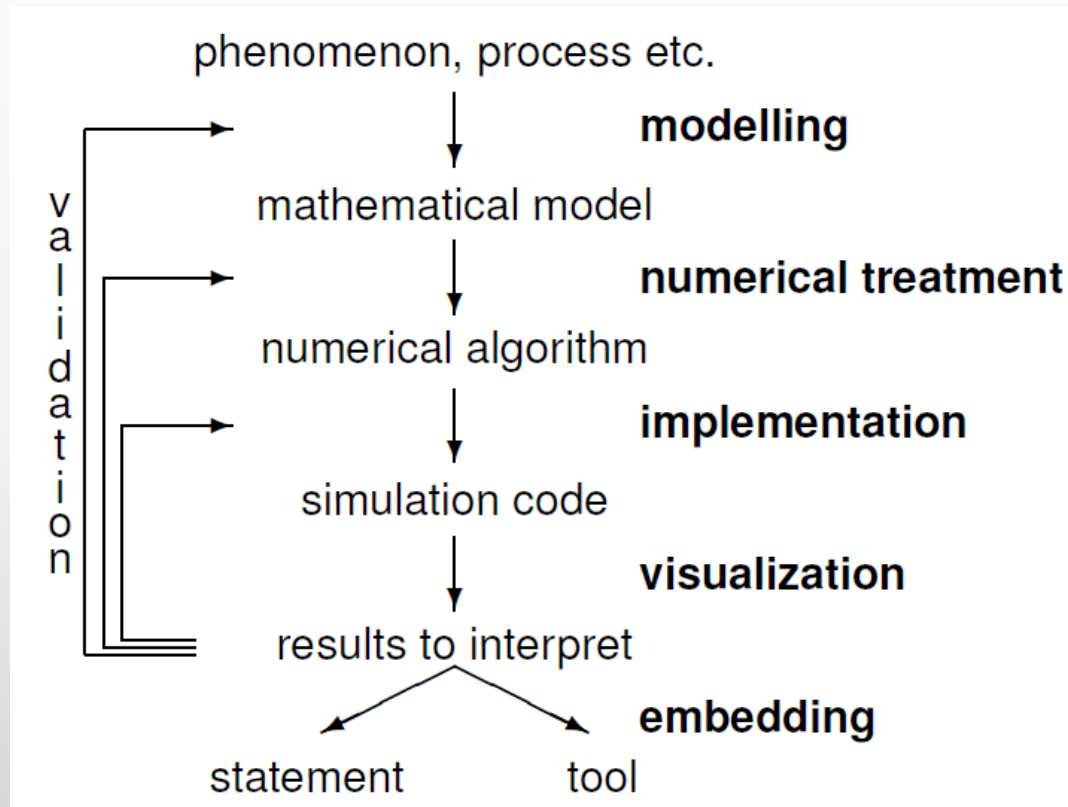
What is MATLAB?

- MATLAB is a tool for interactive numerical computations
- Focus on rapid prototyping with complex computations
- Extensive code-base in a wide range of fields such as:
  - control
  - financial data analysis
  - optimization
  - image processing
- Tools to visualize and analyze data
- Used in many engineering companies, research project, etc

Why MATLAB?
Comparison with Other Languages

- MATLAB is an engineering prototyping language meant for ease of use with its vast mathematical resources

- C is a low-level language meant for production-level performance

- Other languages (e.g. Python) bridge the gap but do not have nearly the built-in mathematical capability

Why MATLAB?
Comparison with C

- Suppose we want to multiply two matrices A and B

- AB is a new matrix where

$$(AB)_{ij} = \sum_{k=1}^{n} A_{ik} B_{kj}$$

Why MATLAB?
Comparison with C

o C code for matrix multiplication

```
1   // Initialize matrix C to accumulate
2   // sum in each C[i][k]
3   for(i=0; i<I; i++)
4     for(k=0; k<K; k++)
5       C[i][k] = 0;
6
7   // matrix multiplication, C = AB
8   for(i=0; i<I; i++)
9     for(j=0; j<J; j++)
10      for(k=0; k<K; k++)
11        C[i][j] += A[i][k] * B[k][j];
```

Why MATLAB?
Comparison with C

○ MATLAB code for matrix multiplication

```
1   C = A*B;
```

○ We want to learn the syntax of MATLAB but we really want to understand how to exploit MATLAB's abilities

○ Our goal: learn the "MATLAB Way" for accomplishing tasks

Why MATLAB?
Comparison with C

- MATLAB
  - Interpreted (executed by interpreter program)
  - \+ Fast developing time
  - \- Slow run-time
  - \+ Portable Better for scientific code
- C:
  - Compiled (and executed directly by CPU)
  - \- Slower developing time
  - \+ Possible to write fast programs
  - = Standard libraries are portable
  - Better for system programming
  - Used for system programming: OS, embedded systems
    - Examples: Linux Kernel, MATLAB

Course

- lecture
  - syntax
  - theory
  - methods
  - simple examples

- Lab
  - more examples
  - make your own experiences

- A laptop with MATLAB is recommended at each session.

Materials

- slides

- exercise

- We need to collect corpus for assignments
  - Face recognition ➜ Face photos
  - Financial data ➜ Information gathering to market orders, Stock Prediction
  - Image quality➜ natural photos
- There is no textbook. Supplementary reading materials will be handed out in class.
- All materials will be available from the course web site:
  - https://www.mmsp.uni-konstanz.de/teaching/winter-20172018/

Latex

- Introduction to Latex
- https://www.overleaf.com
- Writing reports/papers using Latex

Who to Install MATLAB

- University of Konstanz is a member of the state-wide MATLAB agreement.

- University staff as well as students may use the software including all tools for non-commercial, academic research and education.

- The software may be used on university workstations as well as on private computers

- To use the latest MATLAB version, login with your email in the Mathworks website: https://www.mathworks.com/downloads/web_downloads/get_release?release=R2017b

Contact

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Thank you for your attention