



# Introduction to MATLAB

EL1150, Lecture 1, HT 2013



# What is Matlab?

- A software environment for interactive numerical computations
  - Examples:
    - Matrix computations and linear algebra
    - Solving nonlinear equations
    - Numerical solution of differential equations
    - Mathematical optimization
    - Statistics and data analysis
    - Signal processing
    - Modelling of dynamical systems
    - Solving partial differential equations
    - Simulation of engineering systems
-



# What will you learn in EL1150?

- Effective Matlab usage
    - Possibilities and limitations
    - Syntax and interactive computations
    - Matlab programming (using functions and script files)
    - Visualization
    - Optimization of code for efficient computations
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# How will you learn in EL1150?

- By solving problems by your own
- Practice, practice, practice
- Teaching assistant available for questions

# Why should you attend EL1150?

- Matlab used (on a daily basis) in many engineering companies





# Why should you attend EL1150?

- Matlab used in many courses at KTH

Numerical analysis

Signal and Systems I

Signals and Systems II

Modeling of Dynamical Systems

Automatic Control, Basic Course

Automatic Control, Advanced Course

Nonlinear Control

Hybrid and Embedded Control Systems

Chemical Process Control

Control Project Course

Signal Theory

Digital Signal Processing

Adaptive Signal Processing

Signal Processing Project

Communication Theory

Advanced Communication Theory

and many, many more...

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# Today's Lecture

- Course information
    - Course contents and literature
    - Course web
  - The Matlab Programming Environment
    - Background to Matlab
    - Interactive calculations
    - Vectors and matrices
    - Graphical illustrations
    - Matlab programming
    - Tutorials and help
  - The exam
    - Bilda
-



# EL1150 – Introduction to Matlab

- Student Handbook:
    - 1.5 credit self study course.
  - Objectives:
    - Gain basic knowledge of Matlab programming
    - To prepare for other courses where Matlab is used
    - To give insight into a state-of-the-art tool for technical computation and visualization
-





# Course Literature

- N. Bergman and F. Gustafsson, *"Matlab for Engineers Explained"*, Springer, 2003
    - Available via student book store ("kårbokhandeln")
    - Adlibris (1-2 days delivery)
    - Teaches practical Matlab usage (not a full manual)
    - Basic description of theoretical concepts
    - Based on examples with guided tours of the system
    - Exercises with solutions
    - Applications from engineering courses
  - Course covers first 60 pages
  - Suggested exercises:  
1-5, 8-17, 21, 23-32, 34, 37, 40-41, 44, 47-48
-



# Additional course material

- Exercise compendium on course webpage (free)
  - Matlab help and documentation
    - >> doc
    - >> help
    - >> demo
  - Tutorials on the web
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# Course webpage

<https://www.kth.se/social/course/EL1150/>



# Studies

- Self studies, guided tours
- Supervised computer sessions
- Questions via e-mail <[zhenhua.zou@ee.kth.se](mailto:zhenhua.zou@ee.kth.se)>
- Examination in Bilda ([bilda.kth.se](http://bilda.kth.se))
  - More info later



# Part II – Matlab Basics



# Matlab Background

- **Matlab** = **Matrix Laboratory**
- Originally a user interface for numerical linear algebra routines (Lapak/Linpak)
- Commercialized 1984 by The Mathworks
- Since then heavily extended (defacto-standard)

## Alternatives

Matrix-X

Octave

Lyme

(free; GNU)

(free; Palm)

## Complements

Maple

Mathematica

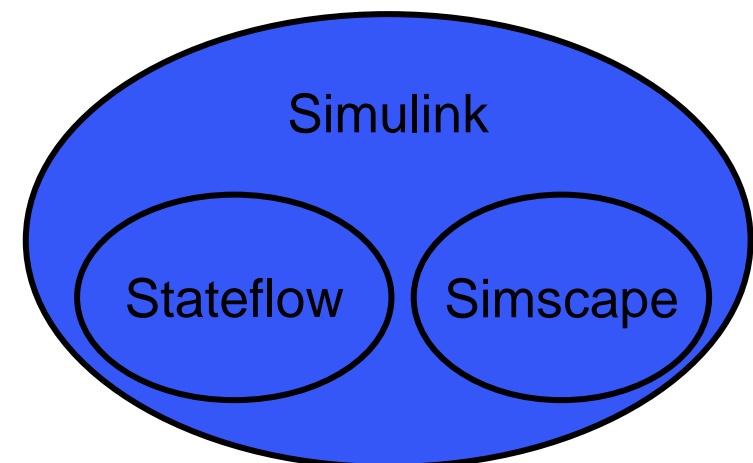
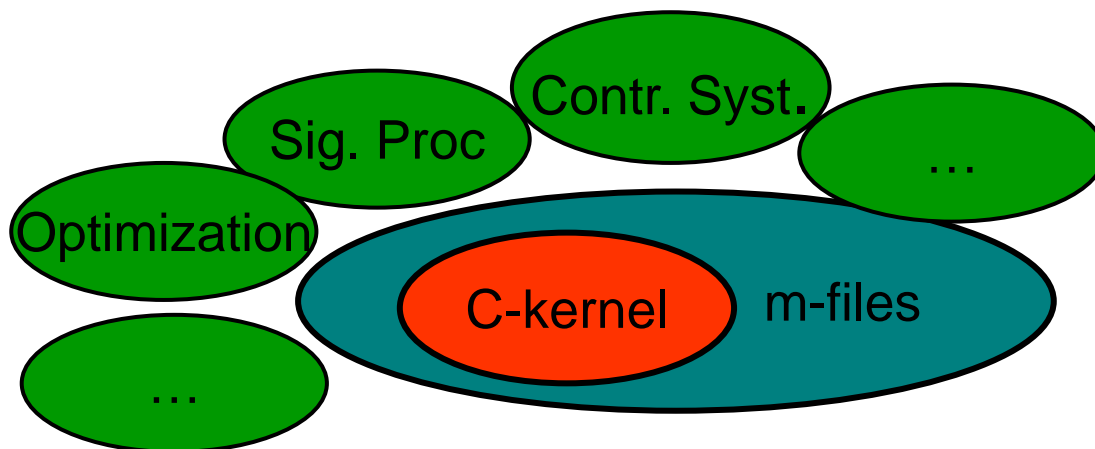
(symbolic)

(symbolic)

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# Construction

- Core functionality: compiled C-routines
- Most functionality is given as m-files, grouped into toolboxes
  - m-files contain source code, can be copied and altered
  - m-files are platform independent (PC, Unix/Linux, MAC)
- Simulation of dynamical systems is performed in Simulink





# Matlab session

- Interactive calculations
  - Variable and memory management
  - Vectors and matrices
  - Matrix operators
  - Matrix functions
  - Indexing matrices
  - Linear algebra
  - Graphics
  - Scripts and functions
  - **The help/demo system**
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# Mathworks Academia

- <http://www.mathworks.se/academia/>
  - Create a Mathworks account
  - Tutorials
  - MATLAB Examples
  - Cody
  - Explore...
-

# Memory pre-allocation

- Programming style has huge influence on program speed!  
Memory allocation takes a lot of time: Pre-allocate memory!

```
clear all
x=-1e4:1e4;
for ii=1:length(x)
    if x(ii)>=0,
        s(ii)=sqrt(x(ii));
    else
        s(ii)=0;
    end;
end;
```

slow.m

```
clear all
x=-1e4:1e4;
s=sqrt(x);
s(x<0)=0;
```

fast.m

- Use **profile** to find code bottlenecks!



# The exam

- The exam file is downloaded from Bilda
  - The exam is done on your own computer during 72 hours (24 Sep - 24 Oct)
  - The exam is corrected on your computer
  - A code is generated that you upload in Bilda
  - You get your result direct
- 
- Four problems drawn from different categories



# Example of exam problem

-----  
Sort numbers in descending order!

-----  
Write a function that creates a column vector  $s$ , that contains the elements of a vector  $x$  sorted in descending order (from largest to smallest).

Syntax:  $s = \text{dsort}(x)$

-----  
where  $s$  is the output vector and  $x$  is the input vector.

Basic functionality:

```
>> x = [1 5 2 3 9 4]
```

```
x =  
    1    5    2    3    9    4
```

```
>> s=dsort(x)
```

```
s =  
    9  
    5  
    4  
    3  
    2  
    1
```