Course of "Automatic Control Systems"
2023/24

Introduction – part 1

Prof. Francesco Montefusco

Department of Economics, Law, Cybersecurity, and Sports Sciences

Università degli studi di Napoli Parthenope

francesco.montefusco@uniparthenope.it

Team code: **mfs9zfr**

Course Administration

- **E-mail: francesco.montefusco@uniparthenope.it**
- **Books**
  - Introduction to Dynamic Systems: Theory, Models, and Applications, D. G. Luenberger. John Wiley & Sons
  - Fondamenti di Controlli Automatici, 4° Ed , P. Bolzern, R. Scattolini, N. Schiavoni. McGraw-Hill (Italian)
  - Modern Control Engineering, 3rd Edition, K. Ogata, Prentice Hall, (2004)
- **Slides of the lectures**
- **Prerequisites**
  - Basic classes in mathematical analysis, physics, algebra and geometry
- **Exam**
  - Written exam
  - Oral exam including discussion of a project report about analysis of the dynamics of a linear system, and the device of a closed-loop control system with required characteristics by using Matlab/Simulink

Contents of the course

- This course is an introductory course on control systems providing the students with the basic engineering knowledge of dynamic systems and feedback.

- The course is conceptually divided in three parts:
  - Analysis of linear dynamic system in the time and frequency domains
  - Key concepts in control
  - Design method of feedback control systems for linear dynamic system

- After the course the student should be able
  - to describe and explain how feedback mechanisms affect system properties such as stability, speed of response, precision, sensitivity and robustness.
  - to design feedback systems guaranteeing a set of these properties

Introduction to automatic control

- Automation or automatic control is a discipline whose aim is the study of the methodologies able to reduce or completely eliminate the human intervention in applications of interest.

- Benefits:
  - Quality
  - Accuracy
  - Reliability
  - Repeatability
  - Cost reduction
  - Security
  - …

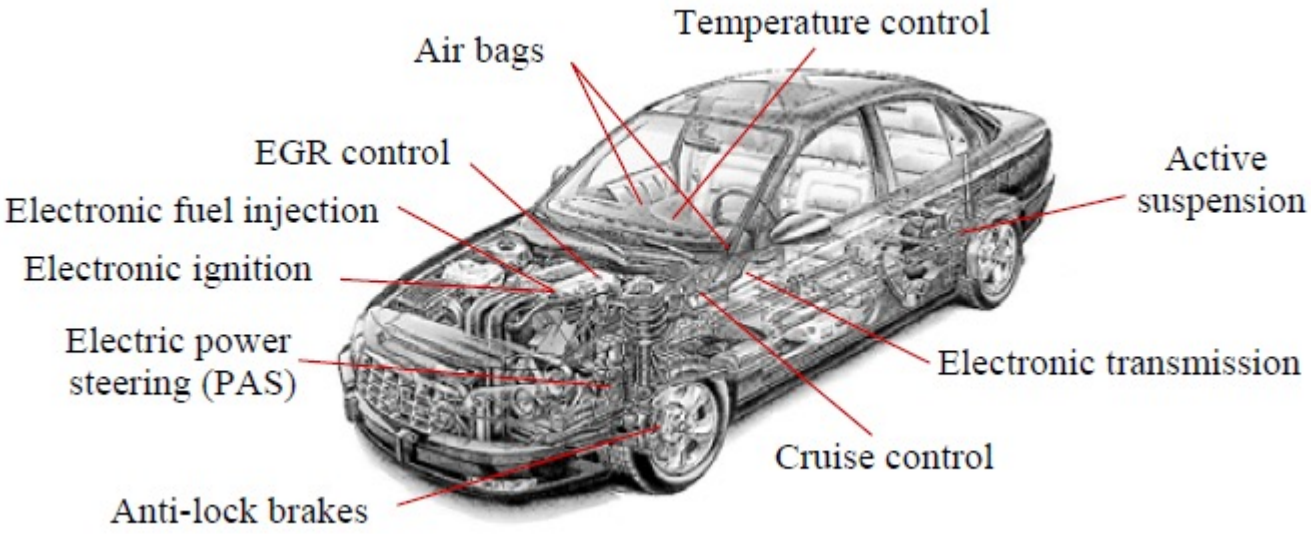
Applications

- Applications in most engineering domains:
  - Aerospace
  - Cars and Vehicles
  - Process industry
  - Energy storage and distribution
  - Home automation
  - Logistic
  - Biology
  - Autonomous systems and robots
  - …

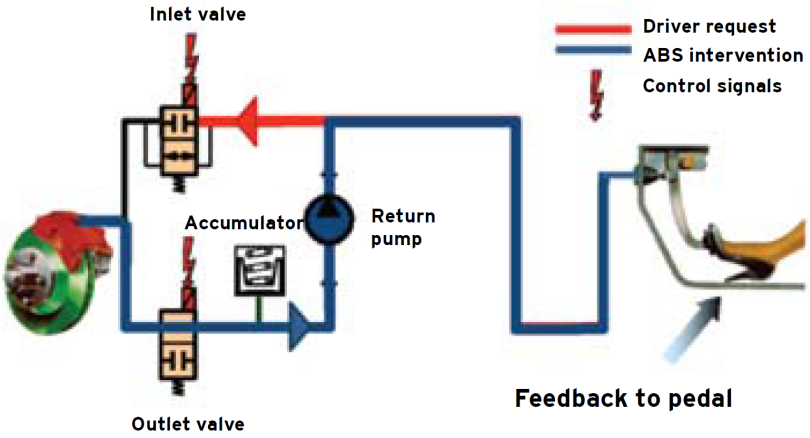
Aerospace

Vehicle control

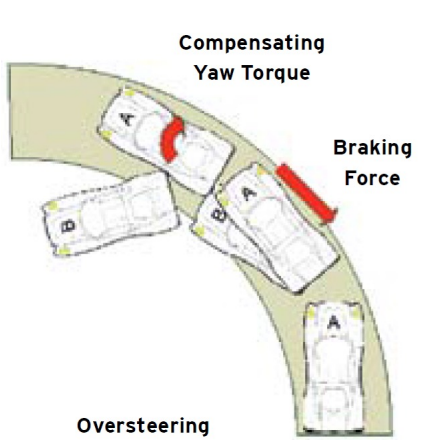
Automobile control

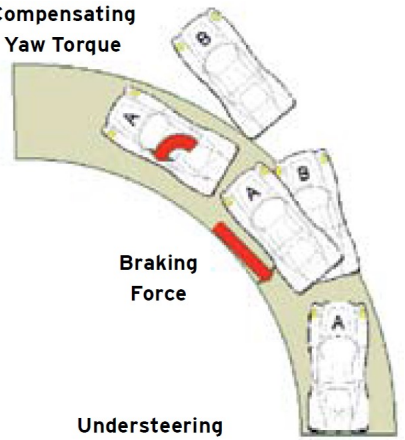


ABS: Antilock braking system (Bosch, 1978)

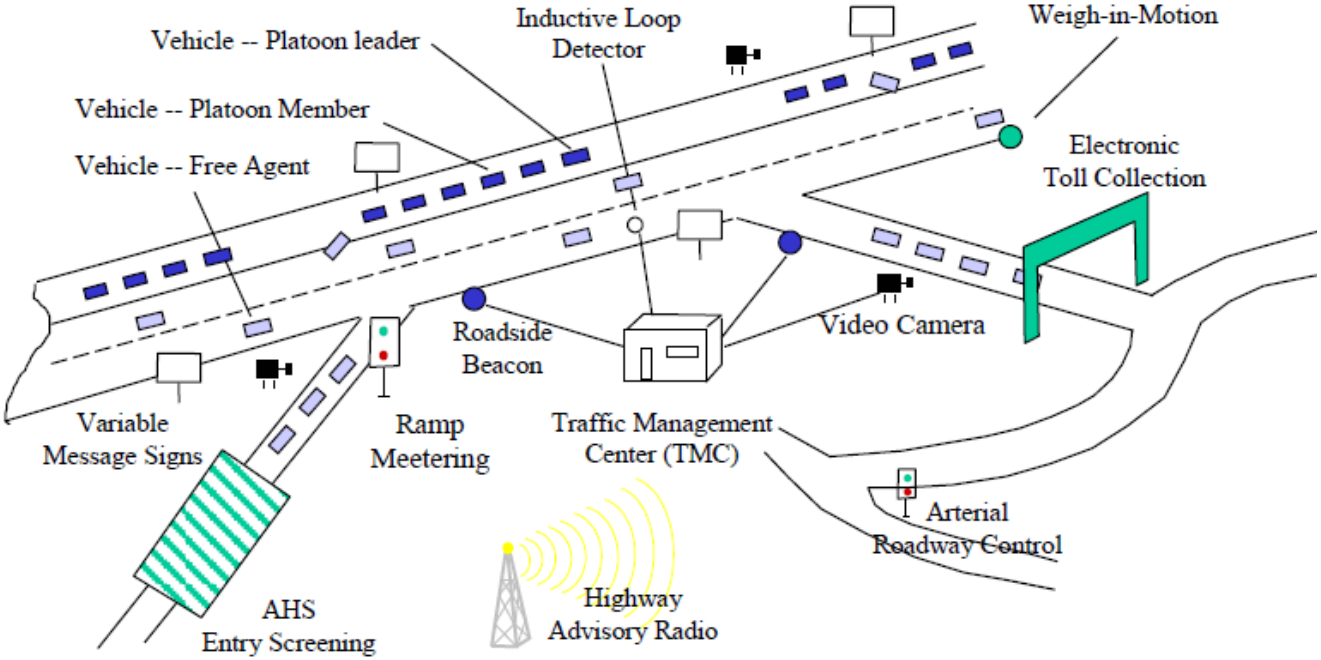


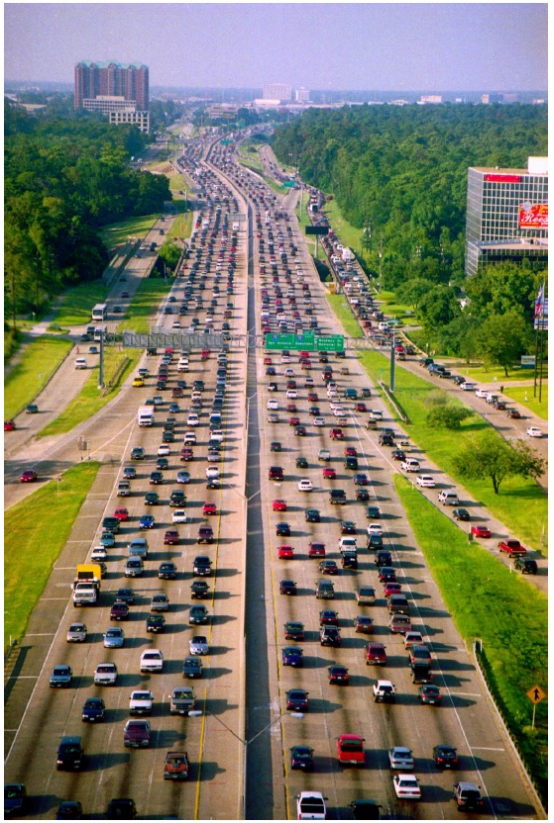
ESC: Electronic Stability Control (Mercedes-Benz, 1992)





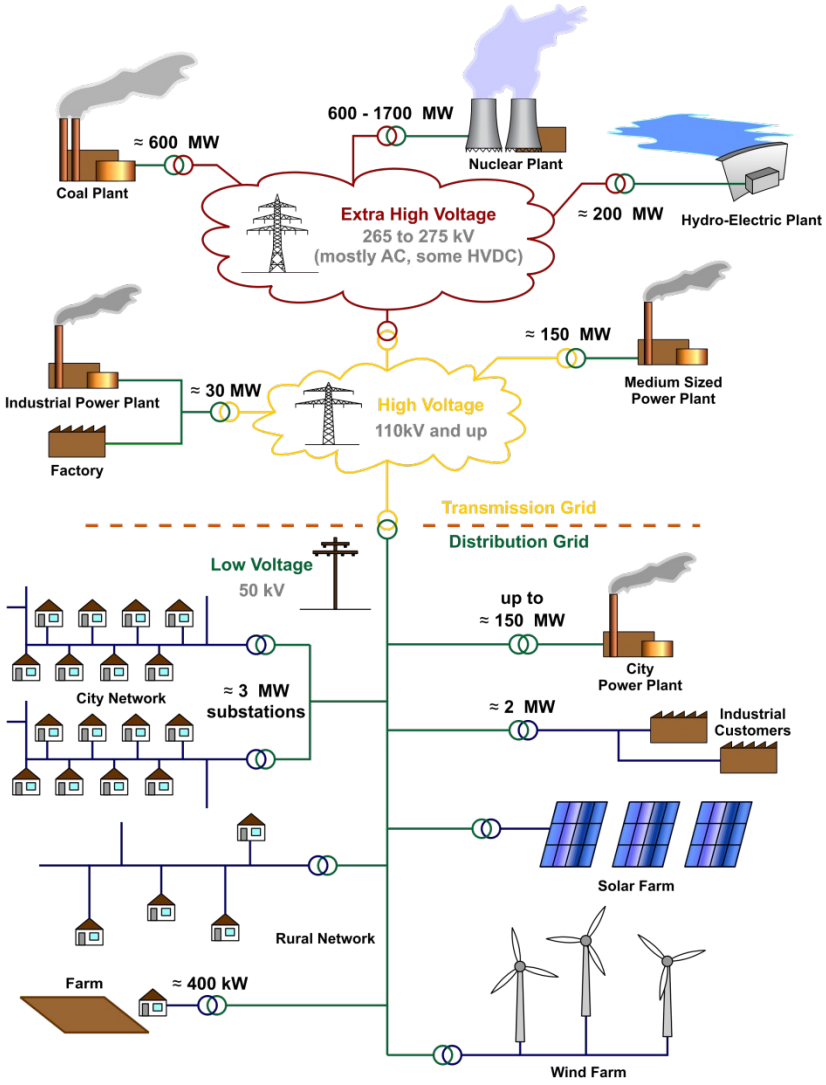
Intelligent vehicle highway systems





Process Industry

Energy control (power grids)

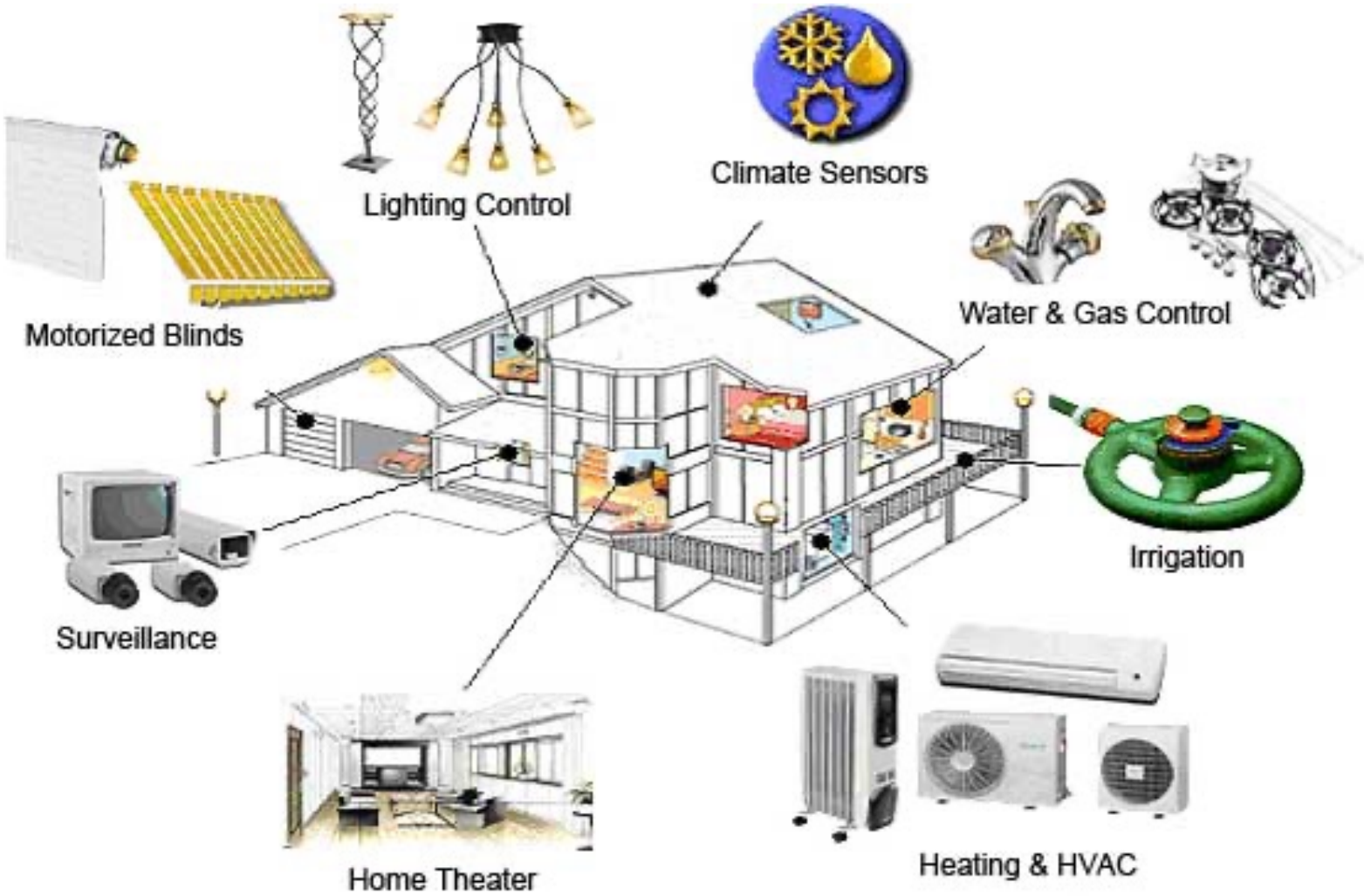


Automation in logistic

Automated storage and retrieval system

automated guided vehicle (bot)

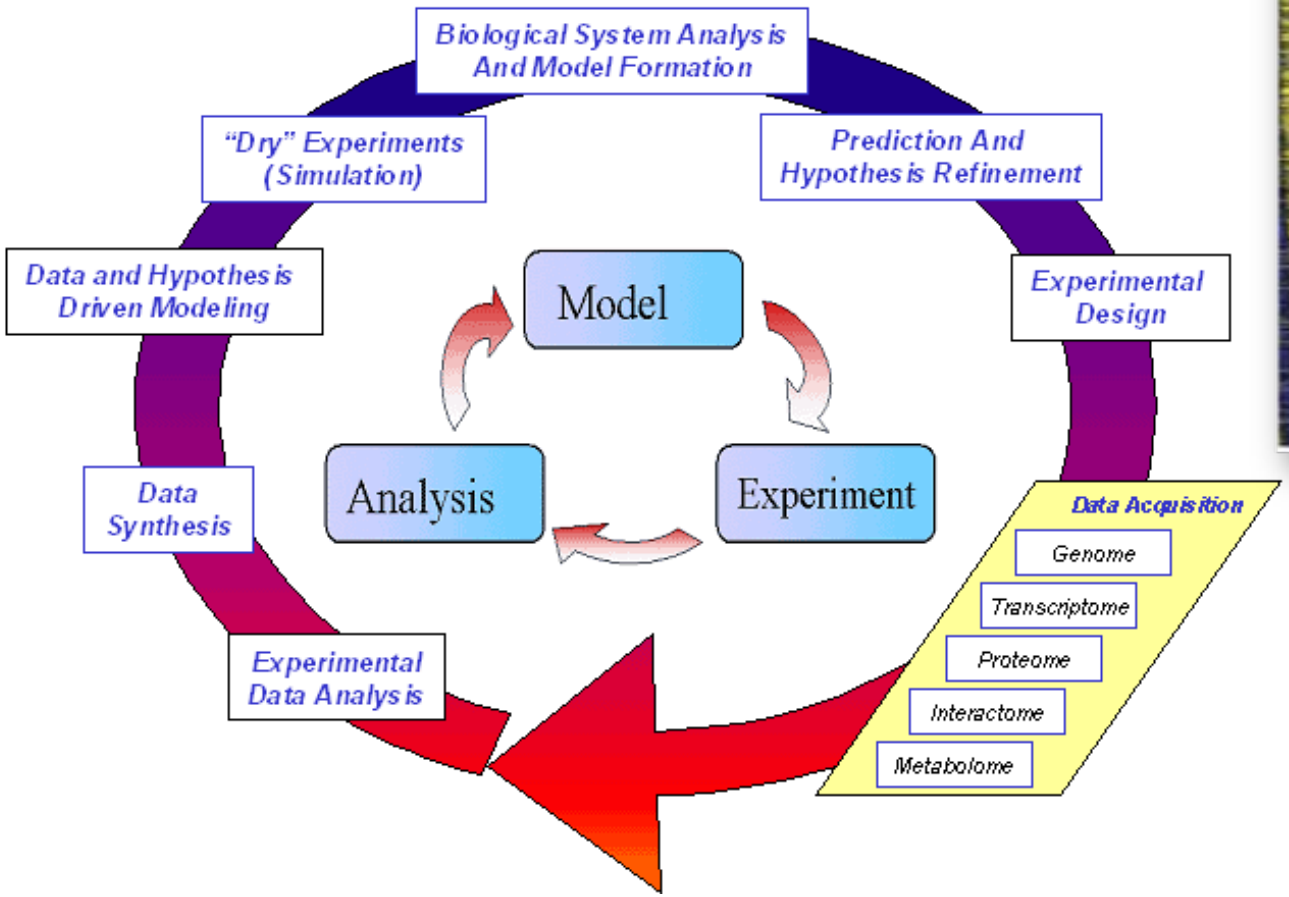
Home automation

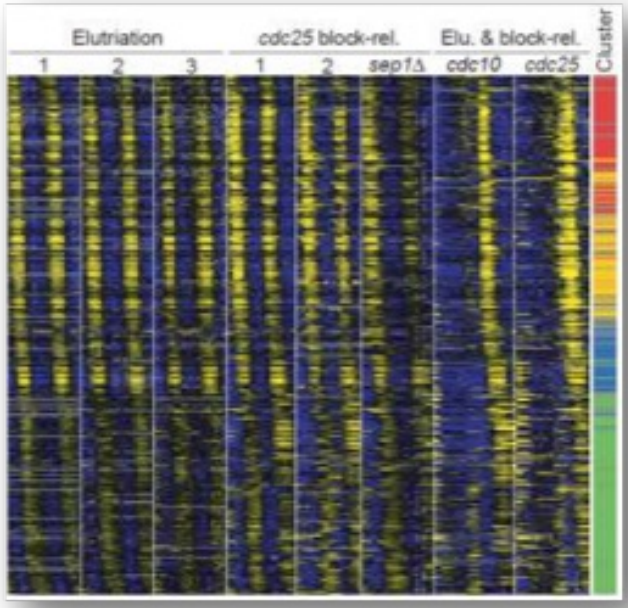


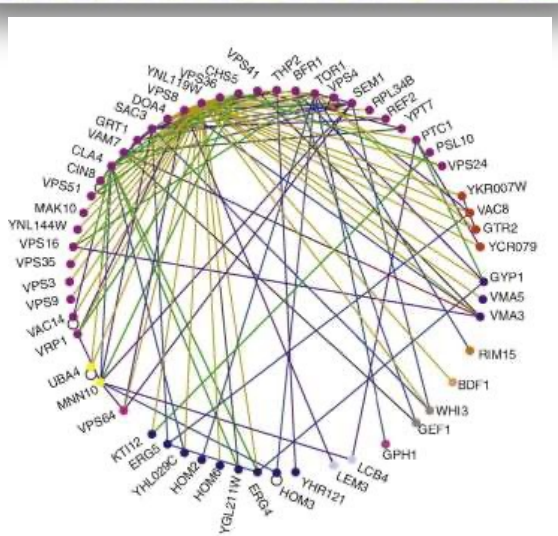
Automation in the Life Sciences

Computer-controlled system

Systems Biology







Detailed program of the course 1/2

- Introduction
- Analysis of linear dynamic system
  - Definition and classification of dynamical systems
  - Free and forced evolution of linear system in the time domain
  - Stability analysis
  - Definition and properties of Laplace transform
  - Transfer function
  - Analysis of linear systems in the frequency domain
  - Bode diagrams

Detailed program of the course 2/2

- Understanding of key concepts in control
  - Feedback and feedforward controls
  - Block diagrams
  - Steady-state and transient requirements

- Design method of feedback control systems
  - Nyquist plots and Nyquist criteria
  - Nichols plots and Nichols charts
  - Frequency shaping technique for closed loop control design
  - PID
  - Example