EEE314
Automatic Control Systems

T.C. Trakya University
Faculty of Engineering
Department of Electrical and Electronics Engineering
Control Section

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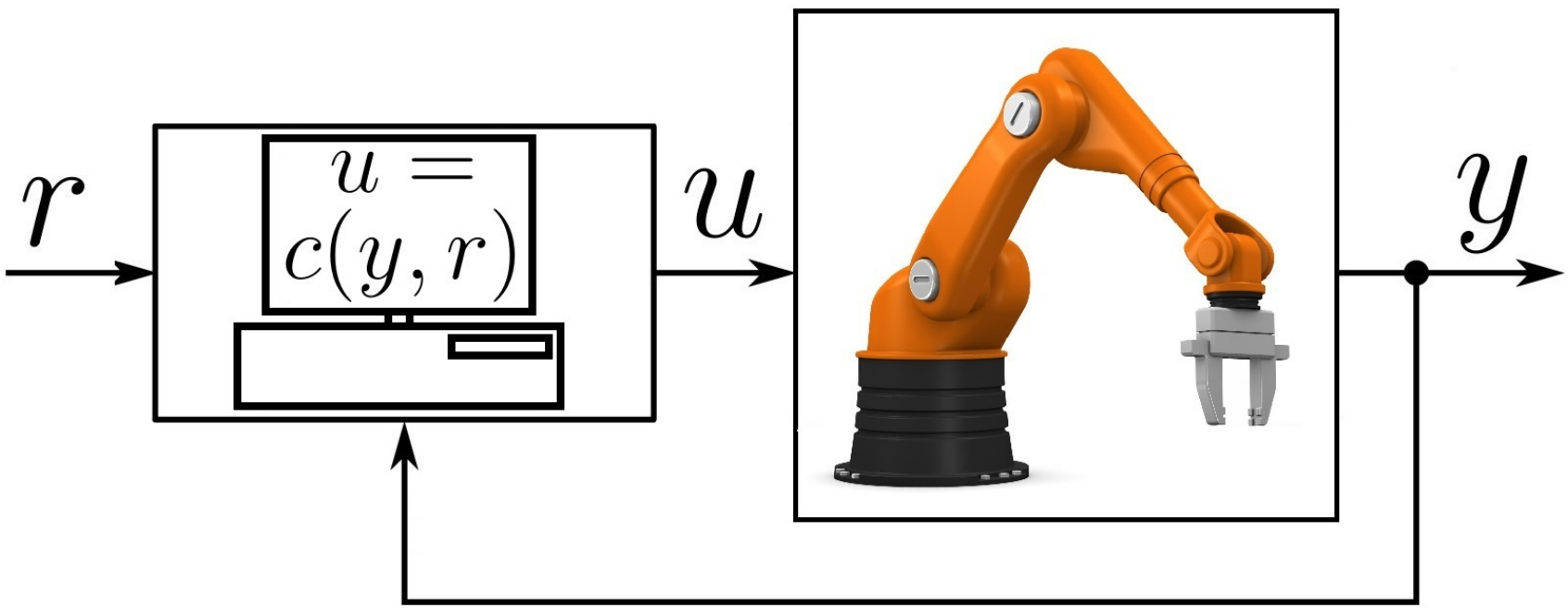
sirmatel.github.io

Course info - Intro

automatic control:

engineering of dynamical system operation under uncertainty via feedback



Course info - Course webpage

everything related to the course is here:

sirmatel.github.io/teaching/314

Dersin internet sayfası

ders ile ilgili her şey burada:

sirmatel.github.io/teaching/314

Course info - Syllabus

all course info is here:

syllabus

check weekly for announcements

Ders uygulama belgesi

bütün ders bilgileri burada:

ders uygulama belgesi

duyurular için her hafta bakın

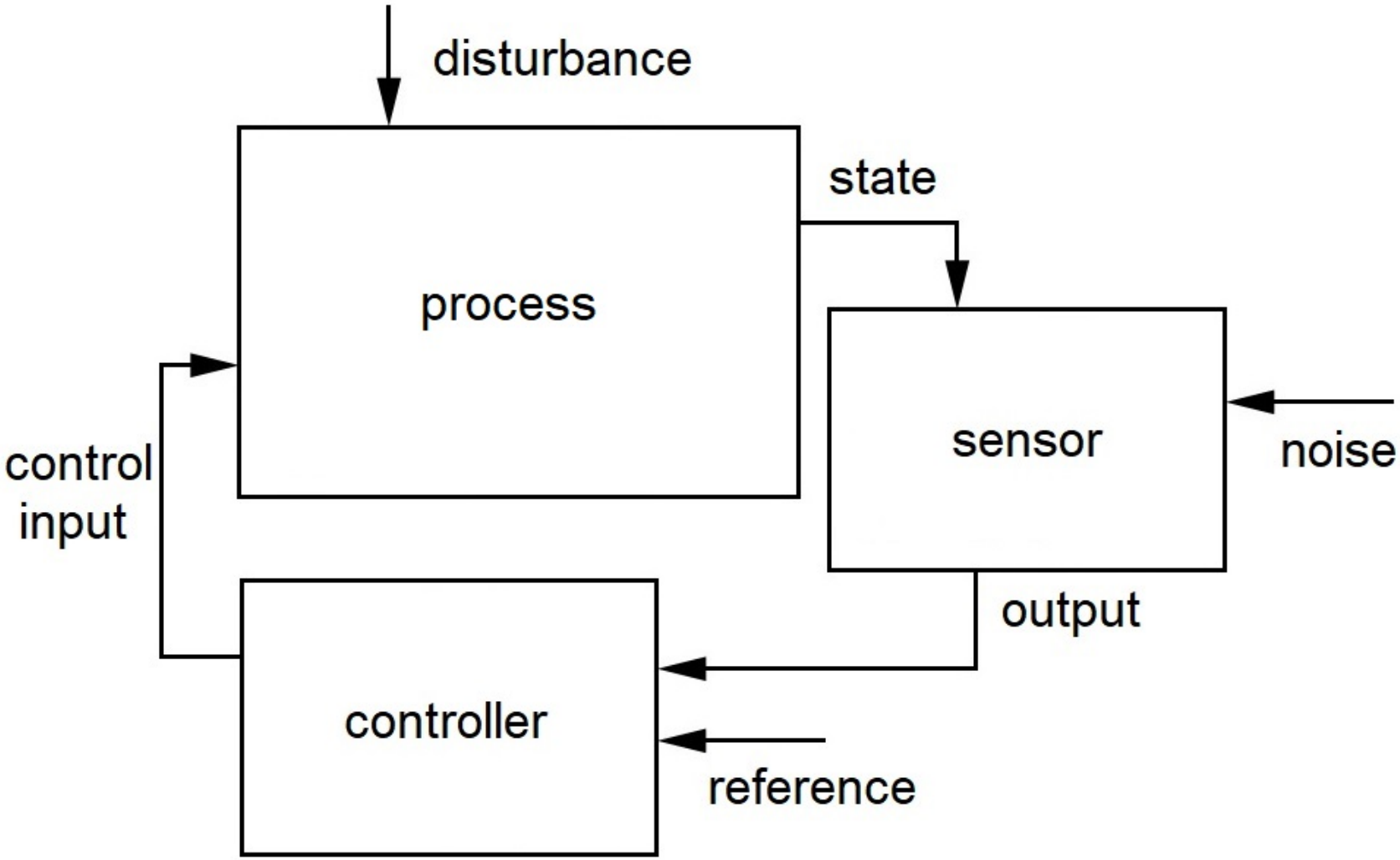
Automatic control - Definition

centrifugal governor (18. c.)

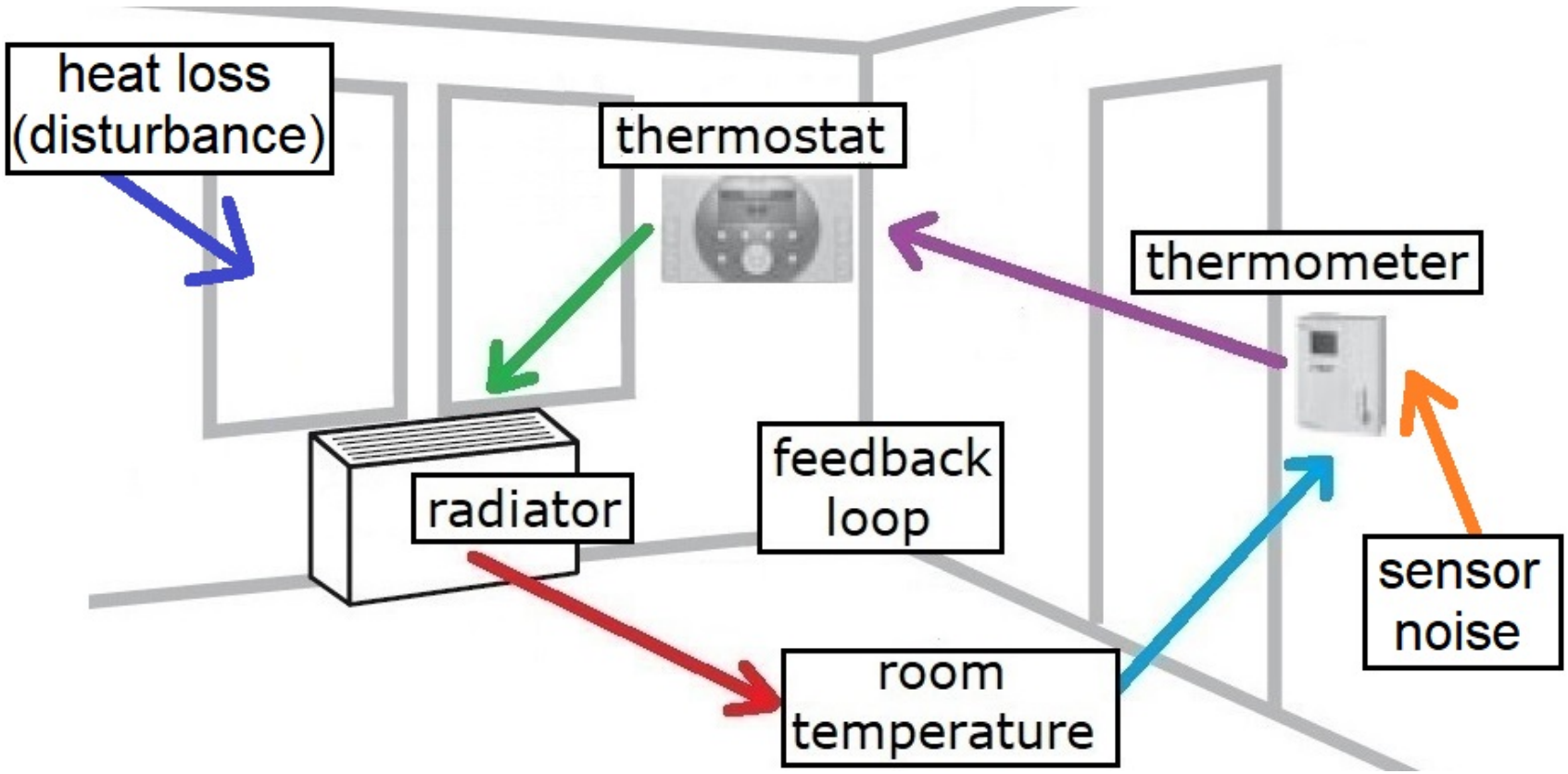
Source: Mirko Junge, CC BY 3.0

Automatic control is a field of engineering/applied mathematics, dealing with the analysis and design of **feedback** mechanisms which enable **dynamical systems** to **behave** approximately as desired without human intervention (and alleviate, to a certain extent, the effect of **uncertainties** that can disrupt this behaviour).

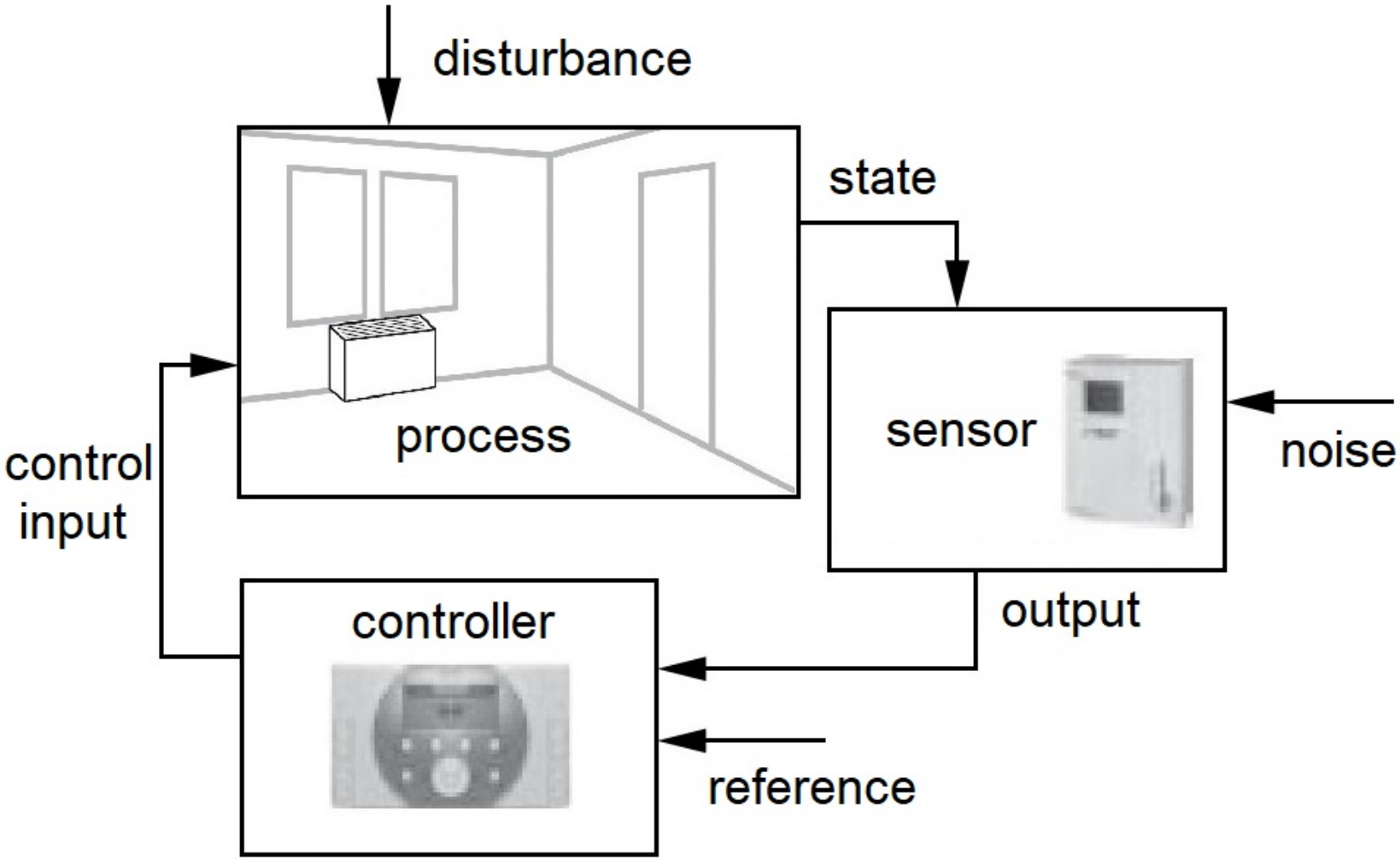
Structure of an automatic control system



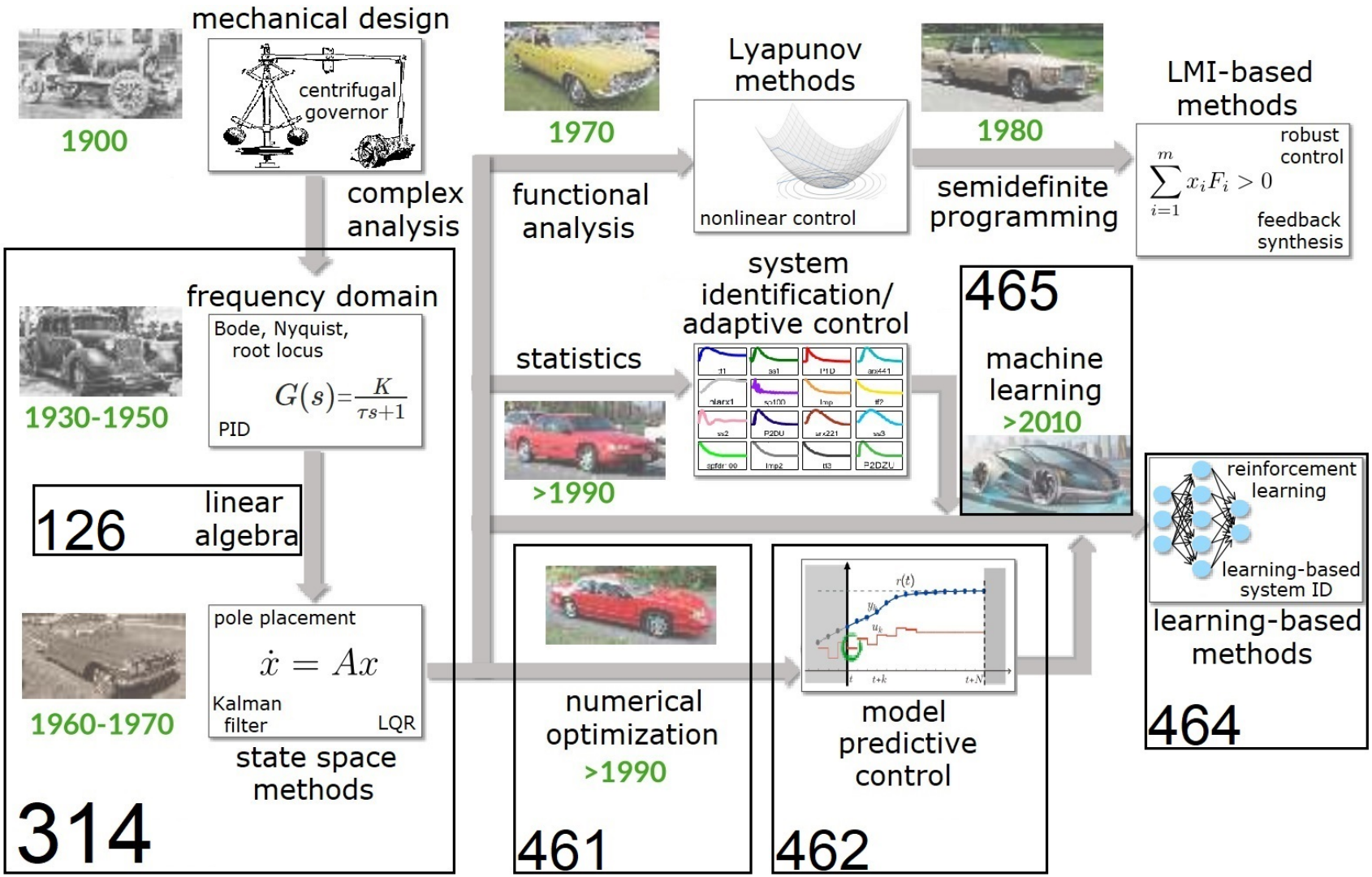
Example: Room temperature control



Example: Room temperature control

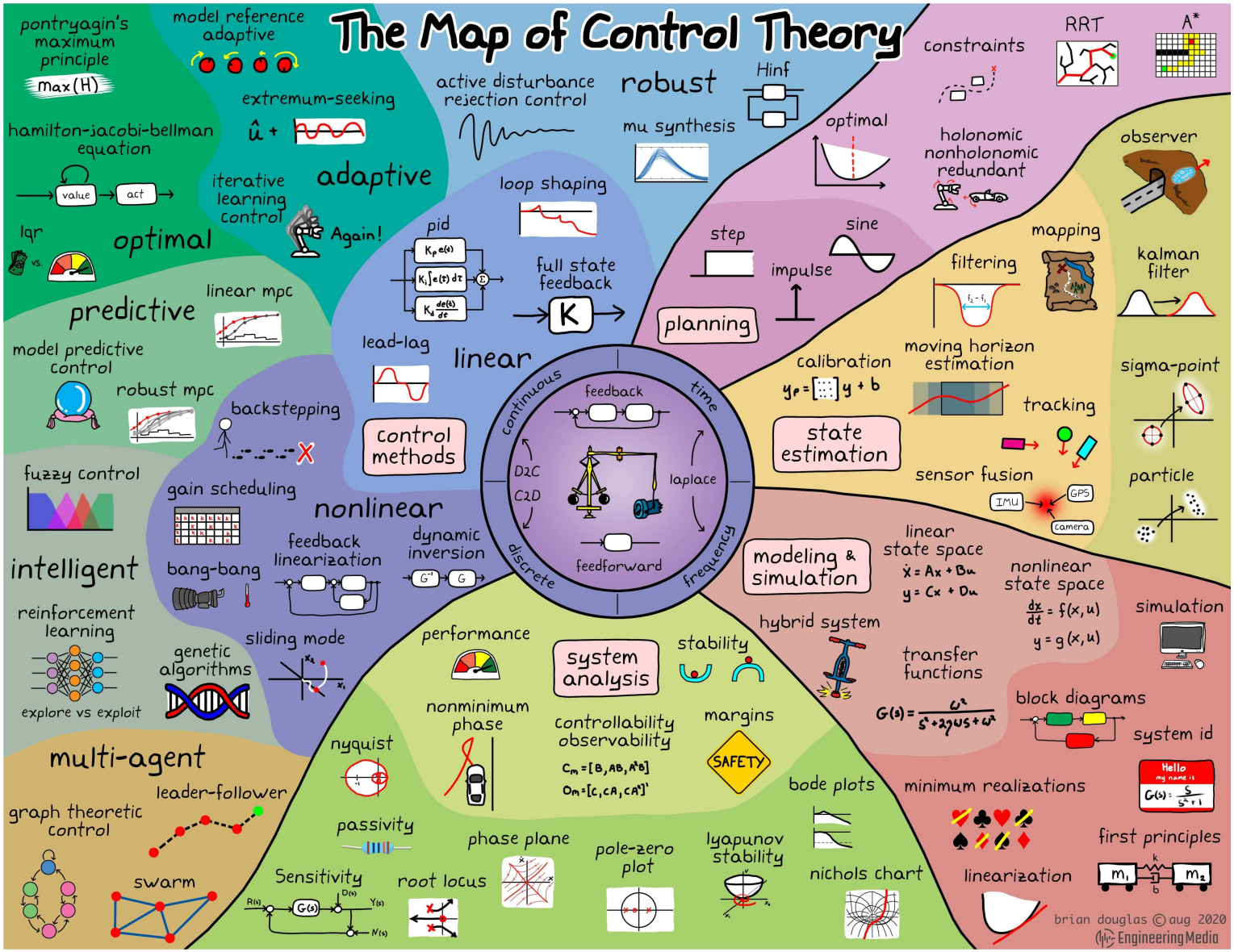


Short history of automatic control



Source: Alberto Bemporad, Machine Learning: A New ICE (Identification, Control, Estimation) Age? (adapted)

The Map of Control Theory

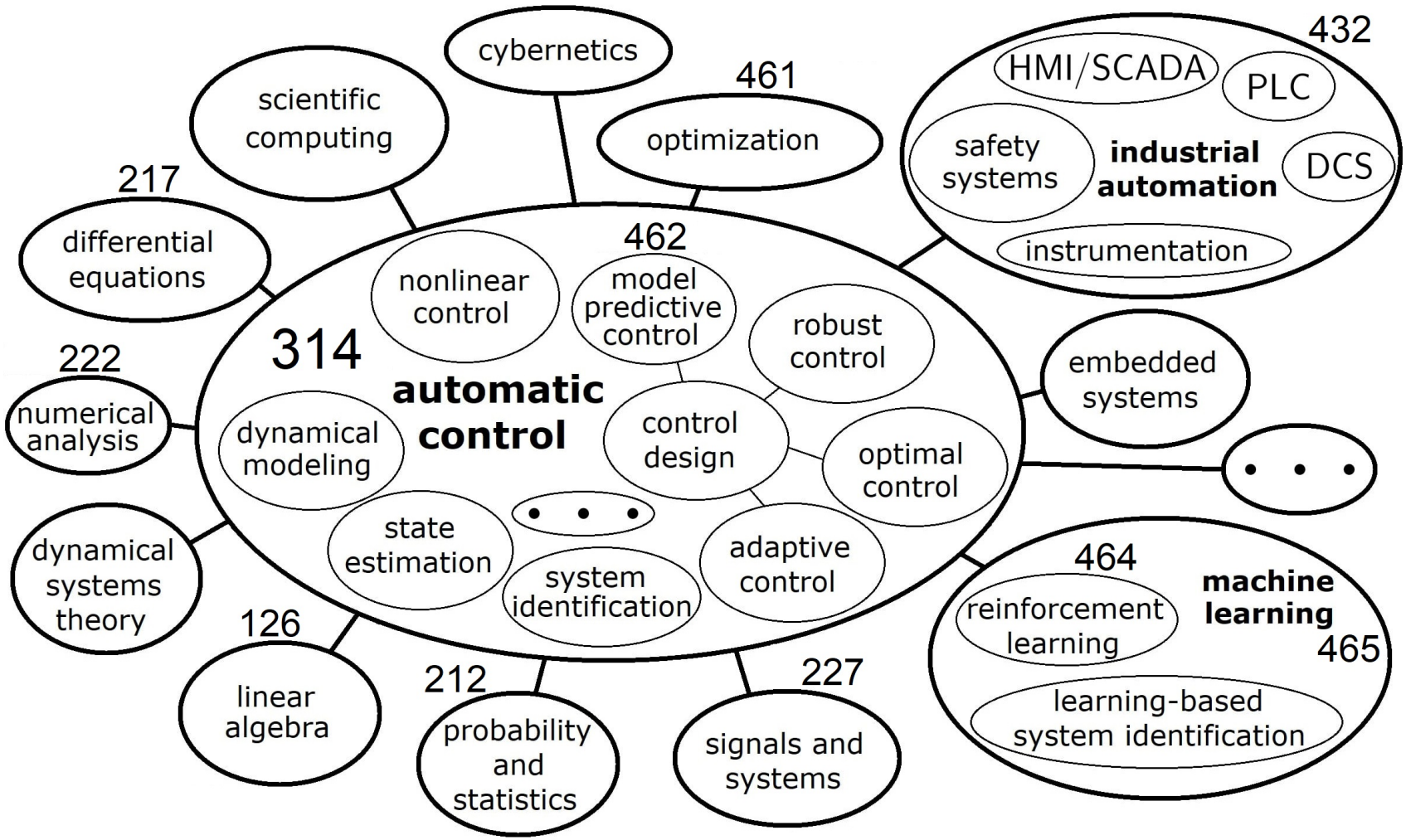


Source: Brian Douglas, The Map of Control Theory

Aspects of control systems projects

1) dynamical modeling: describing system behavior with a mathematical model (usually differential equations)
2) system analysis: examining theoretical features of the system (e.g., stability, controllability etc.) using the model
3) simulation: computing trajectories describing system behavior using the model
4) system identification: estimating the model or its parameters using system measurements
5) model validation: testing validity of the model and its parameters using system measurements
6) state estimation design: designing mechanisms that can estimate system states using the model and system measurements
7) control design: designing feedback mechanisms for shaping system operation under uncertainty using the model and system measurements

Automatic control and related fields



Examples of control applications

autonomous vehicles

active noise cancellation

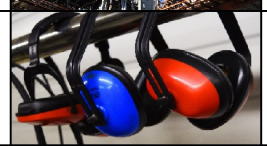
infrastructure networks

robots

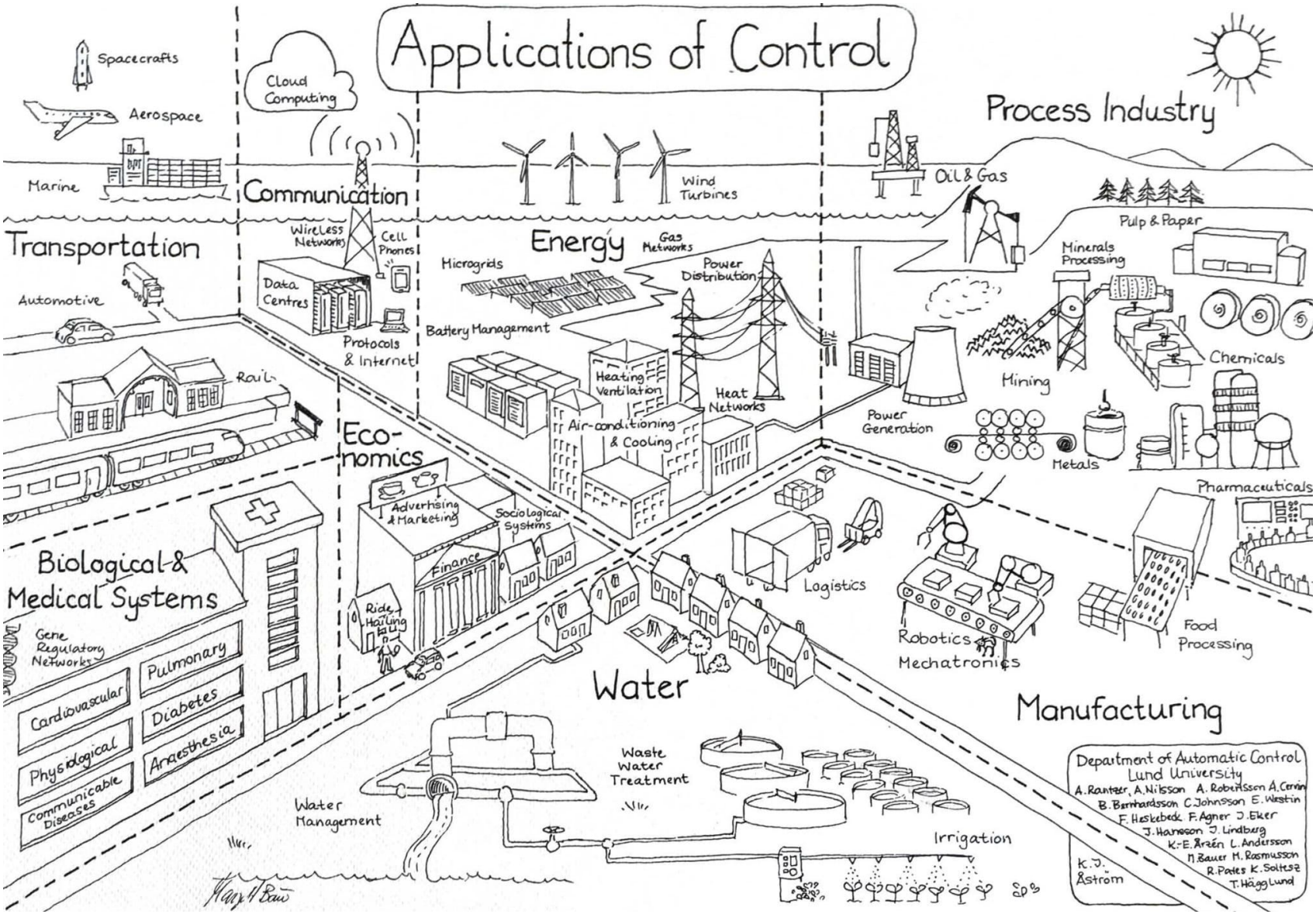
transportation systems

chemical plants

Engineering/mathematics matrix

		fields of applied mathematics					
		differential equations	probability and statistics	automatic control	optimization	machine learning	...
fields of engineering	civil						
	mechanical						
	electrical						
	chemical						
	electronics						
	mechatronics						
	⋮						

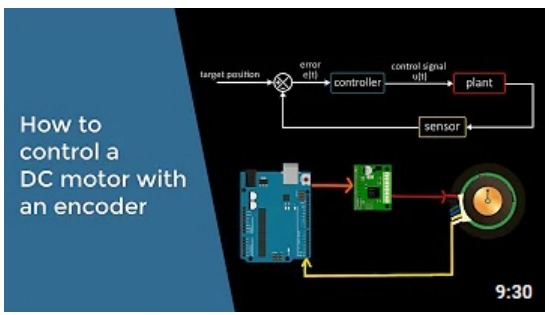
Map of control applications



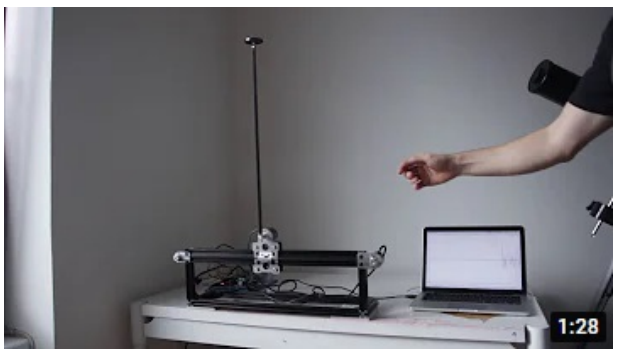
Source: Department of Automatic Control, Lund University, Sweden

Some standard control experiments

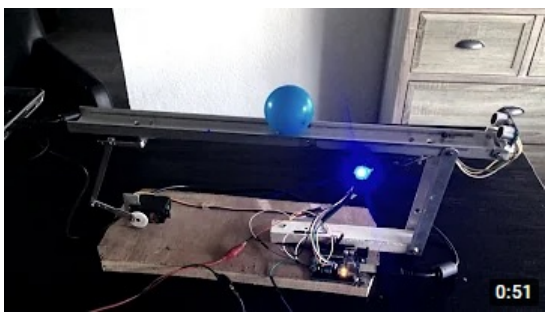
DC motor



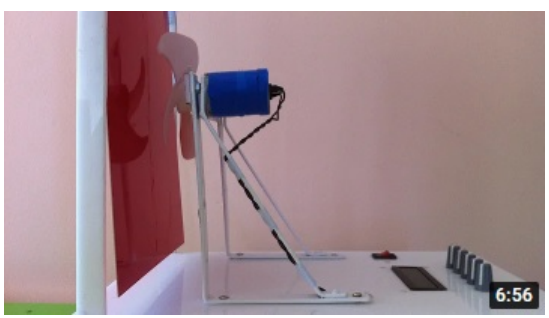
inverted pendulum



ball and beam



fan and plate

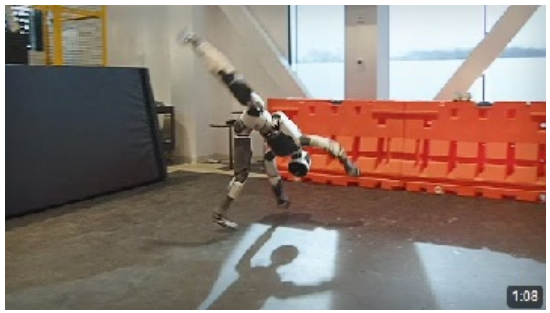


ball and plate

four tanks system

Some advanced control applications

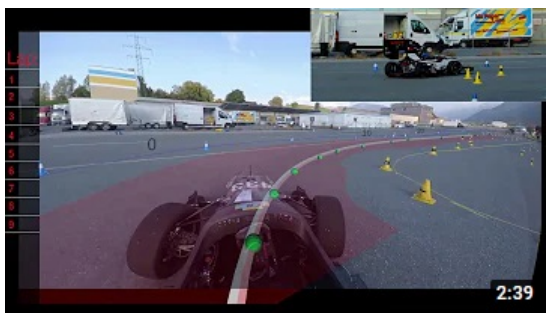
humanoid robot



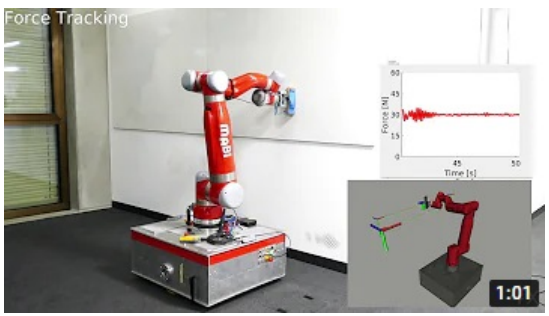
quadrotor

quadruped robot

autonomous race car



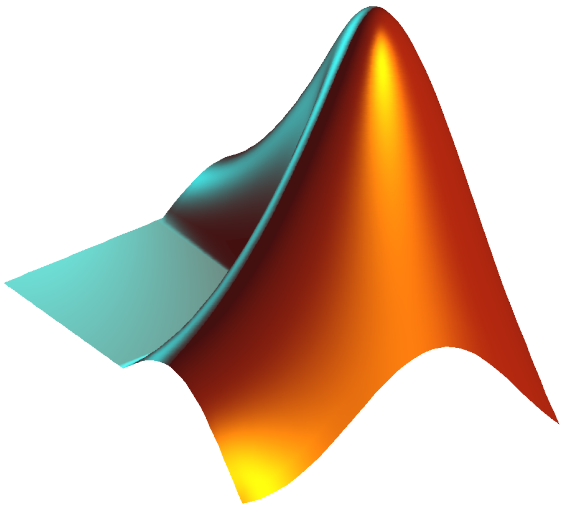
mobile industrial robot



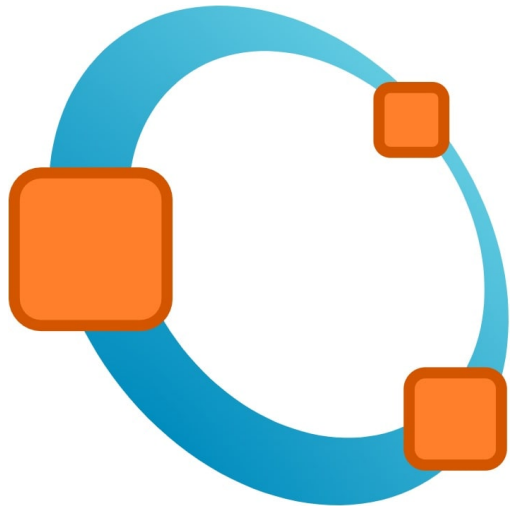
kite and generator

Programming (numerical computing)

MATLAB®



GNU Octave



Kaynak: John W. Eaton

Python

Scilab

Julia

SageMath

Kaynak: The Sage team

Resources

see under resources at:

sirmatel.github.io/teaching/314

for lecture slides, lecture videos, textbooks, exam questions with solutions etc.

Recommended resources on control

- **Textbook:** *Feedback Systems: An Introduction for Scientists and Engineers*. K. J. Åström and R. M. Murray
- **Exam questions with solutions:** Automatic Control 1&2 (exercise collection - past written examinations). Alberto Bemporad
- **Repository:** Resourcium (website with links to resources and structured content on control and automation)
- **Programming tutorials:** Control Tutorials for MATLAB® and Simulink® (website with tutorial examples on control systems with codes and explanations)
- **Short lectures:** Steve Brunton (channel with videos on control systems and related topics)
- **Virtual control laboratory:** Control Challenges (website with animated virtual control experiments/games)

General professional advice

those who know the following topics very well (and also have adequate expertise about the sector they are working in) can work successfully (now, and in the future) in any country and in any (especially STEM related) line of work:

- **English**
- **engineering math/applied math** (linear algebra, probability and statistics, multivariable calculus, numerical methods, optimization, . . .)
- **computer science**

Websites (general)

- learning English: Duolingo, Memrise, Busuu, ...
- open courses: MIT OpenCourseWare, Stanford Engineering Everywhere, MERLOT, ...
- open-access textbooks: LibreTexts Commons
- computer science: CS50 Introduction to Computer Science (Harvard)
- programming/numerical computing: Python/SciPy, GNU Octave, MATLAB, Scilab, Julia, SageMath, ...