

Neural Networks for Optimal Control Conclusions

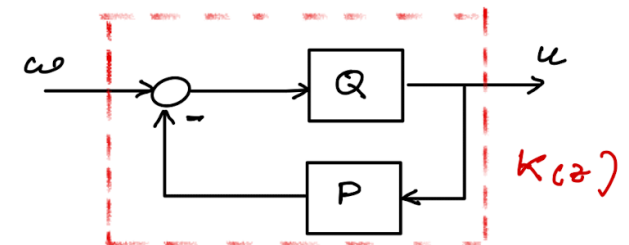
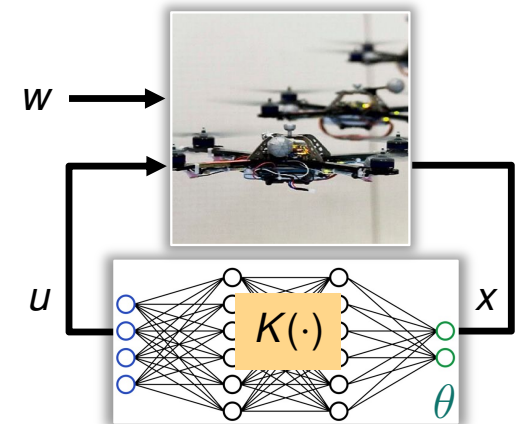
EPFL- EECI PhD School 2025

Please evaluate the course here

<http://www.eeci-igsc.eu/assessment2025/>

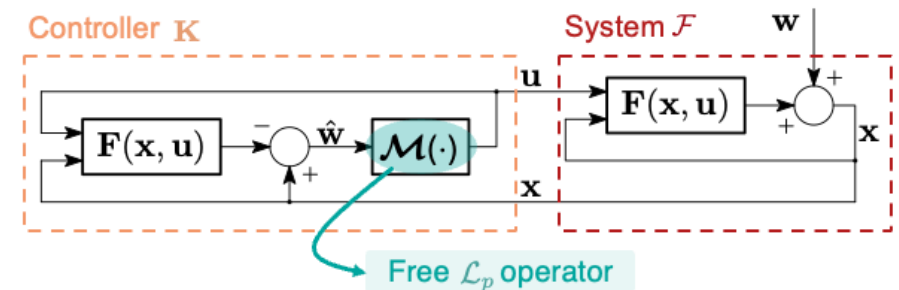
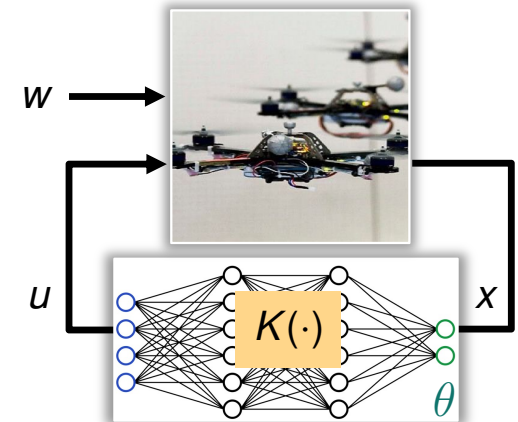
Part 1: Parametrization of all linear stabilizing controllers for LTI systems

- Internal stability of feedback systems
- Youla parametrization of all and only stabilizing controllers
 - Even for unstable but stabilizable systems by leveraging observers and eigenvalue assignment



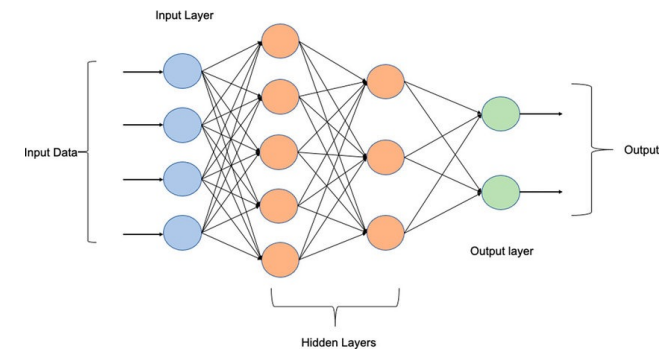
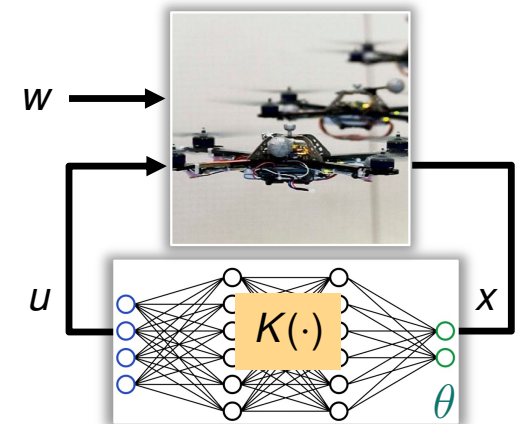
Part 2: Parametrization of all nonlinear stabilizing controllers

- For L_p -stable nonlinear systems
- IMC is enough!
 - Robustness for uncertain models
- How to solve optimal control using NN for modeling L_p operators
- Examples of performance boosting



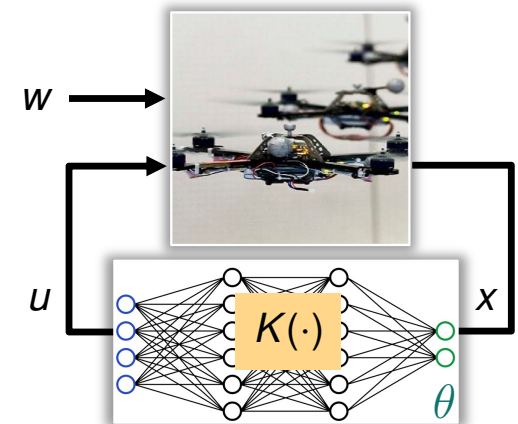
Part 3: Freely parametrized NNs for representing L_p operators

- Recurrent Equilibrium Networks (RENs)
- Lipschitz-bounded MLP networks
- State-space models (SSMs)
- Invertible layers (aka normalizing flows)



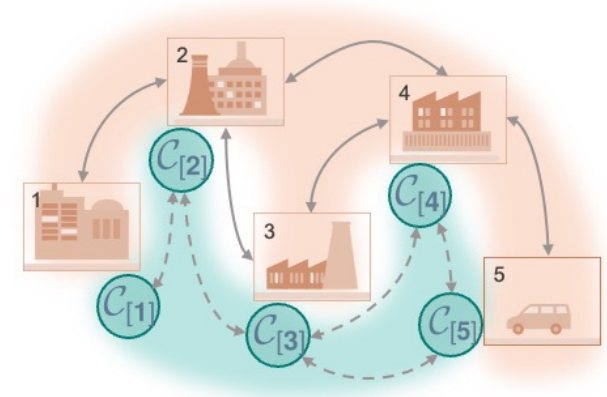
Part 4: Distributed NN control

- Distributed free parametrizations of L_p operators
 - Distributed performance boosting



Python exercise sessions

- Design of performance-boosting controllers with different kinds of NNs
- Identification of nonlinear stable systems



- Based on a project to be handed in before **Friday, May 16th**. The project can be done **individually or in groups of up to 4 people**.
- If you need only a certificate of attendance, no need to take the exam

Project contents

Goal: apply a NN control technique seen in the course to a system of your choice

Steps:

1. Choose any system you like, e.g. from [COMPLib](#)
2. Write a short report (max 10 pages) describing the system and control design procedure you have followed and providing simulations showing the usefulness of the NN controller
3. Send the report by email to giancarlo.ferraritrecate@epfl.ch

- Updated slides on Moodle
- Further developments and projects on Performance Boosting
 - <https://www.epfl.ch/labs/decode/>
 - <https://github.com/DecodEPFL>

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**SPOTTED A MISTAKE?
GOT A GENIUS IDEA
TO IMPROVE THE COURSE?
DROP US
AN EMAIL!**

**REMEMBER,
THIS COURSE
WILL BE
INFLECTED ON
FUTURE
STUDENTS TOO—
HELP US
SPARE THEM
THE SAME
SUFFERING.**



EPFL

G. Ferrari Trecate

THANK YOU!



Giancarlo Ferrari Trecate



Leonardo Massai



Danilo Saccani