

Campus Est, Via La Santa 1,  
CH-6962 Lugano-Viganello  
T +41 (0)58 666 66 66, F +41 (0)58 666 66 61  
info@idsia.ch, www.idsia.ch  
N. IVA: CHE-108.955.570 IVA

# Deep Learning for Nonlinear System Identification

**Date:** April 22-23, 2024

**Location:** Polo Universitario Lugano, Campus Est, Via la Santa 1, CH 6962 Lugano-Viganello, Switzerland

**Organizer:** SUPSI – Scuola Universitaria Professionale della Svizzera Italiana

**Lecturers:** Dario Piga, e-mail: [dario.piga@supsi.ch](mailto:dario.piga@supsi.ch) Marco Forgione, e-mail: [marco.forgione@supsi.ch](mailto:marco.forgione@supsi.ch); Gabriele Maroni, e-mail: [gabriele.maroni@supsi.ch](mailto:gabriele.maroni@supsi.ch);

**Rooms:** Sala Polivalente, Sector A, Ground floor.

## Summary of the Course

This two-day course intends introduce students to new tools for nonlinear system identification.

After an introduction to nonlinear system identification and deep learning, two main topics will be covered:

- dynoNet: a novel neural network architecture with dynamic neurons described by transfer functions
- Learning of neural networks models in a state-space form

In the exercise sessions, students will apply the methodologies presented in the preceding lesson. These sessions will be conducted in Python, using the PyTorch package. A quick introduction to PyTorch will be provided. Since the course precedes the Workshop on Nonlinear System Identification Benchmarks, most of the exercises will involve data coming from the benchmarks. However, students are also encouraged to work with their own datasets, if they have them available.

## Prerequisites

Basic knowledge of dynamical systems

Basic knowledge of Python is required. We encourage conducting exercise sessions in groups (max. 3 persons), with at least one member of the group having basic knowledge of PyTorch.

## Workload and ECTS

Total number of hours in class: 16 academic hours, considering 1 academic hour = 45 minutes.

**Final exam** is possible to receive ECTS. Total workload expected from the student to pass the exam: 30 hours (including hours in the class), corresponding to 1 ECTS.

***Tentative Schedule******Day 1: April 22<sup>nd</sup>, 2024***

<b>Time</b>	<b>Title/Topic</b>	<b>Lecturer</b>
<b>08:45-09:00</b>	<b>Welcome</b>	
<b>09:00-10:30</b>	<b>Introduction to Nonlinear System Identification</b>	Dario Piga
<b>10:30-11:00</b>	<b>Break</b>	
<b>11:00-12:30</b>	<b>Introduction to Deep Learning</b>	Dario Piga
<b>12:30-14:00</b>	<b>Lunch break</b>	
<b>14:00-15:30</b>	<b>Introduction to PyTorch</b>	Gabriele Maroni
<b>15:30-16:00</b>	<b>Break</b>	
<b>16:00-17:30</b>	<b>Exercise session</b>	Piga, Forgione, Maroni

*Day 2: April 23<sup>rd</sup>, 2024*

<b>Time</b>	<b>Title/Topic</b>	<b>Lecturer</b>
<b>09:00-10:30</b>	<b>DynoNet- Transfer functions in deep learning (theory)</b>	Dario Piga
<b>10:30-11:00</b>	<b>Break</b>	
<b>11:00-12:30</b>	<b>DynoNet- Transfer functions in deep learning (exercise)</b>	Marco Forgione
<b>12:30-14:00</b>	<b>Lunch break</b>	
<b>14:00-15:30</b>	<b>Deep learning for state-space identification (theory)</b>	Marco Forgione
<b>15:30-16:00</b>	<b>Break</b>	
<b>16:00-17:30</b>	<b>Deep learning for state-space identification (exercise)</b>	Piga, Forgione, Maroni