Msc Project Proposals: 2023 - 2024

PID	Supervisor	Description

1803385   **Angeli,D.**

A toolbox for economic infinite horizon dynamic programming

Offered to: Control

From: CAP

Dynamic programming is a recursive technique for the solution of optimal control problems. While, such problems can be formulated both for finite or infinite control horizons, normally very strong assumptions are needed on the cost functional to make sense of such problems in an infinite horizon set-up.

Recently, new results have hinted at the possibility of considerably relaxing such assumptions, paving the way to the definition of optimal control problems on an infinite horizon for much more general systems and cost functions. The aim of this project is to develop a toolbox to allow for the solution of such infinite horizon problems and to test it in scenarios of growing complexity to highlight its potential and limitations.

1803384   **Angeli,D.**

Neural Lyapunov Control of Nonlinear Systems

Offered to: Control

From: CAP

Designing feedback stabilizers for nonlinear systems has always posed challenges, due to the difficulties in finding so called Lyapunov functions, which allow to validate the design and prove stability of the closed-loop system.

A novel approach to parameterize Lyapunov functions, by using Deep Neural Networks has recently emerged [1] and has shown some promise on its ability to automatically search for such Lyapunov functions.

Goal of the project is to understand the potentiality of this approach on a case study and propose improvements or guidelines for its implementation in practical scenarios.

[1] Chang, Rui, Gao, Neural Lyapunov Control

1803388   **Gunduz,D.**

Large Language Models for Data Compression

Offered to: AML

From: ISN

Large language models (LLMs) have achieved remarkable success, rivalling or often surpassing the performance of human experts in text-related tasks. t. These models, such as GPT-4, are trained on vast amounts of data, enabling them to grasp the subtleties of language and context. In essence, LLMs excel at predicting the next word (token) in a sentence based on the past words (tokens). On the other hand, there is a strong connection between prediction and compression. These connections were already studied by Shannon in 1951 in order to estimate the entropy of the English language [1]. Since LLMs exhibit impressive predictive capabilities, they are well-positioned to be strong compressors. Recently, researchers at Deepmind extended the compression capabilities of LLMs to other modalities, achieving impressive results [2]. In this project, we will aim at applying these novel technique to other modalities, as well as further improving their performance using ideas from information and coding theory.

[1] Claude E Shannon, "Prediction and entropy of printed english," Bell system technical journal, vol. 30, no. 1, pp. 50–64, 1951.

[2] Delétang et al., "Language Modeling Is Compression," arXiv preprint, Sep. 2023.

PID	Supervisor	Description

1803389 **Junyent-Ferre,A.**

Design of a low-power intelligent lift state estimation system

Sensors and monitoring systems that can be deployed with minimal disruption are very key for certification, quality assurance and general supervisory tasks. This project will focus on the development of a system that can be deployed in a lift to collect information about the lift position, direction of travel and occupancy in real time. Ideally, the system would be self-contained and battery-powered with enough autonomy to operate continuously for multiple days. Consequently, it should use low-power sensors such as microphones and light sensors rather than cameras or more complex sensors. The goal of the project is to develop a working proof of concept prototype and demonstrate its operation in a real lift. This is a good project for those interested in embedded systems, signal processing and machine-learning.

Offered to: AML CSP

From: CAP

1803390 **Junyent-Ferre,A.**

Design of an automatic dynamic performance characterisation system for power electronic converter controls

Future electrical power systems will be entirely powered by generators and energy storage devices with power electronic converters. Multiple control structures and controller tuning methods for these converters exist today and it is becoming more and more important for grid operators and certification companies to be able to test and characterise the dynamic behaviour of these devices without having access to the details of their controllers (ie with little Intellectual Property disclosure). The idea of this project is to develop a software interface to perform a series of tests on a dynamic model of an inverter to extract information about its behaviour. The tests will involve testing for a range of steady-state operating conditions, a frequency sweep and a series of transient tests of interest (eg voltage dips, frequency excursions, etc). The project will be developed in Matlab Simulink. The project is interesting for those students who want to learn more about power system dynamics and inverter control.

Offered to: FPN

From: CAP

1803392 **Manikas,A.**

A Systematic Design of Active Filters Using Lookup Tables and Simulation

Active filters are vital in modern electronics with applications to communication, instrumentation, audio, biomedical and power systems.
This project will be supervised by prof Rallis Papademtriou

The aim of the project is to demonstrate, by building an appropriate lab suite, a systematic design of active filters enabling close agreement between rapid, practical hand analysis (using lookup tables) and simulation (with the e-learning tools Filter Pro or Filter Lab). The former generates insight but lacks accuracy, while the latter provides the required accuracy but doesn't generate as much insight. The result is that a considerable amount of intuition can be built up.
The educational product will cover Sallen-Key, Infinite-Gain Multiple Feedback (IGMF), Biquad, State-variable and other topologies. It will also cover the cascading of multiple sections for high-order filters, as well as band-pass, low-pass and high-pass responses.
Note: Video lectures with slides (by RCP) on the topic will be made available for filling any gaps in background.

Offered to: ADIC

From: CSP

PID	Supervisor	Description

1803387   **Mikolajczyk,K.M.**

Computer vision projects 2023-2024

     Offered to: AML

     From: **ISN**

Please have a look at the topics below with related papers, email me if you find an area you are interested in (K.Mikolajczyk@imperial.ac.uk, Subject: MSc project 2023, include your CV if you are committed to do one of my projects.
See the recording from the session on Monday 20 Nov, in AML lab.

I will hold a Q&A session on Teams to discuss the topics in more detail on Friday 24 Nov, 9:30am.
https://teams.microsoft.com/dl/launcher/launcher.html?url=%2F_%23%2Fl%2Fmeetup-join%2F19%3A6cdb950db3fc4842a6c9fc96b92d08c3%40thread.tacv2%2F1700517627595%3Fcontext%3D%257b%2522Tid%2522%253a%25222b897507-ee8c-4575-830b-4f8267c3d307%2522%252c%2522Oid%2522%253a%2522d761ecaa-d2b5-41e2-919a-2def2d971c53%2522%257d%26anon%3Dtrue&type=meetup-join&deeplinkId=99530d41-27a2-43b5-80a0-69bd0723bae4&directDl=true&msLaunch=true&enableMobilePage=true&suppressPrompt=true

All projects require expertise in Deep Learning.

Possible project topics include:

Robot control using LLM
https://michaal94.github.io/CLIER/

Rendering realistic images from sparse depth
Using diffusion models to reconstruct images of objects and scenes

Point tracking in RGB-D video
https://paperswithcode.com/paper/3d-point-cloud-registration-with-multi-scale
https://deepmind-tapir.github.io/

Depth estimation for transparent objects
https://arxiv.org/abs/2307.15052

Stereo matching
https://paperswithcode.com/paper/stereo-matching-in-time-100-fps-video-stereo
https://arxiv.org/abs/2211.10408
Video generation using diffusion models
https://paperswithcode.com/paper/diffusion-models-for-video-prediction-and
https://paperswithcode.com/paper/adding-conditional-control-to-text-to-image

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1803381   **Toumazou,C.**

Smart Payment for healthy food products and integration of the microbiome

     Offered to: Control ADIC
                  FPN CSP

     From: **CAS**

NantBeam can provide the personalized shopping experience based on your dna results, however the system is not integrated with the supermarket checkout system. This project will focus on designing an integrated checkout system on the wearable to enable personalised shopping through a payment cloud based on your own genetic traits. The project will be mainly a digital MCU interface to the wearable and and a local Machine learning algorithm. The project will also consider the the intrinsic correlation between breath analysis of the microbiome and DNA through a wearable technology and breath sensors.