MASTER THESIS PROPOSAL

Unsupervised/semi-Supervised video classification

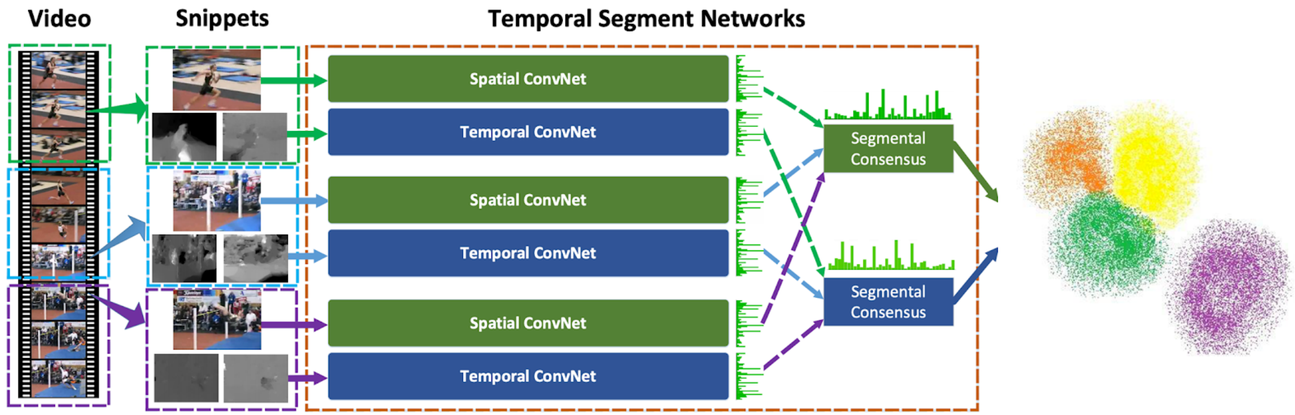
IBM Business Partner

NVIDIA DEEP LEARNING INSTITUTE

NVIDIA INCEPTION PROGRAM

add-for.com

When there are hundreds or thousands of cameras producing video streams all day long it is very useful to have an algorithm that analyzes such streams instead of a human. Today such technology exists and is called convolutional neural networks for video classification [1]. The downside of such neural networks is that we have a fixed number of cases on which the net is trained which is ok for benchmarking our algorithm on a specific dataset but not for real life applications such as security cameras where we don't know specifically for which scene the algorithm should give an alert signal. So we need to produce an abstract representation of the video scene (embedding)[2] and to classify it in an unsupervised way [3].



Who we're looking for

Students that are about to get their master degree in: Mathematics, Physics of Complex Systems.
Skills: Python, advanced math, abstraction skills, exp. w. at least one among TensorFlow / PyTorch.

Duration of this Projects: 5-6 months

Planned Activities

The first part of this thesis will be research state of the art algorithms for video classification and clustering.
The second part of the project will be devoted to the implementation of such algorithms and testing on real datasets.
Addfor will provide data sets of real-time image sequences obtained in different weather conditions and in non-optimal conditions (flickering and jittering) that represent the common difficulties found on real computer vision tasks.
The final purpose of the thesis will be to define an algorithm which starting from a video sequence will classify similar sequences as belonging to the same cluster in order to give an alert signal when there is an anomalous [4] sequence belonging to an unknown cluster.

Check these Links before moving on

[1] https://arxiv.org/pdf/1705.07750.pdf
[2] https://arxiv.org/pdf/1810.06951.pdf
[3] https://arxiv.org/pdf/1810.06951.pdf
[4] http://charuaggarwal.net/ICDE16_research_420.pdf

How to contact us

Directly by email to: sonia.cannavo@add-for.com

By LinkedIn: **linkedin.com/in/cannavò-sonia-66a95467**

MASTER THESIS PROPOSAL

Use of h264/h265 motion vectors as object motion estimation

IBM Business Partner

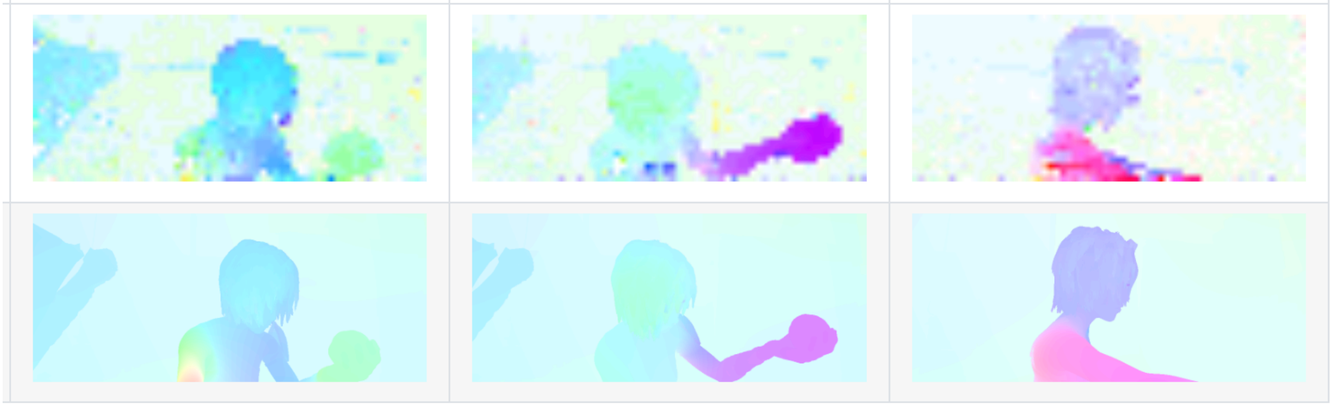
NVIDIA DEEP LEARNING INSTITUTE

NVIDIA INCEPTION PROGRAM

add-for.com

AVC and HEVC two of the most used codecs in video industry internally uses intra and extra frame motion vectors in order to achieve a better compression.

A very recurring task in computer vision is motion detection and a lot of solutions are already been given. Most of these solutions are very heavy on the underling hardware. Hence it will be very intresting to undestand if (and how) we can exploit these information that are already in the video stream to achieve similar results.



Planned Activities

1) Research of literature about state of the art motion estimation algorithm in video analysis;
2) Comparison between the algorithms found in phase 1) and mpeg motion vectors;
3) Identification of an algorithm for motion estimation starting from mpeg motion vectors.

Duration of this Project: 5-6 months.

Who we're looking for

Students that are about to get their master degree in: mathematics, physics, computer science, mathematical engineering, computer engineering, physics of complex systems.

Check these Links before moving on

https://pdfs.semanticscholar.org/98ca/f8325abb40aa6bbddd0e7f5d3a6c366d03e6.pdf

https://pdfs.semanticscholar.org/06ac/28ba7c9d5813564f1421c4600503aa82795d.pdf

http://image.ntua.gr/iva/files/papers/Robust%20optical%20flow%20estimation%20in%20MPEG%20sequences%20-%20K.%20Rapantzikos.%20M.%20Zervakis2005.pdf

https://www.semanticscholar.org/paper/Approximating-optical-flow-within-the-MPEG-2-domain-Coimbra-Davies/902d13657cf56287624ddf1cd8c1bb18b0f07ddd

How to contact us

Directly by email to: sonia.cannavo@add-for.com

By LinkedIn: linkedin.com/in/cannavò-sonia-66a95467

MASTER THESIS PROPOSAL

Model Based Reinforcement Learning

Reinforcement Learning (RL) [1] is a class of machine learning algorithms in which an agent interacts by trial-and-error in an environment.
RL together with Deep Learning has obtained excellent results in a great number of simulated environments, like video-games [2] or board-games [3]. This algorithms are very promising for industrial applications which involve optimal control.
The most Deep Reinforcement Learning (DRL) algorithms developed so far are model-free that is, they do not use a model of the environment during the training phase. Starting from the Dyna-Q tabular algorithm [1], the research community has tried to speed up RL training introducing a model of the environment. The model allows to reuse multiple times the experience acquired during the agent-environment interaction and it improves the agent's actions with respect to the control objective. Recently proposed solutions merge the ideas of DRL with model-based RL [4, 5].
The objective of the thesis is to study the possibility to develop existing model-free DRL algorithms by incorporating a model into the training phase.
The model introduce a computational overhead that has to be quantified with respect to the training speed-up. Therefore, an extended comparison between model-based and model-free has to inquire the cost-benefit impact of the model itself.

Who we're looking for

Students that are about to get their Master Degree in: computer science, computer engineering, mechatronic engineering, electronic engineering, aerospace engineering, mathematical engineering, mathematics, physics, physics of complex systems.

Required Skills:

- Proficiency in at least one programming language (Python, Lua, Matlab, C++, Java);
- Basic knowledge of machine learning, in particular supervised learning;
- Good knowledge of linear algebra.
- Basic knowledge of dynamical system modelling

Check these Links before moving on

[1] Reinforcement Learning: An Introduction
http://incompleteideas.net/book/the-book.html

[2] Deep-Q-Network
https://www.nature.com/articles/nature14236

[3] AlphaGo
https://deepmind.com/research/alphago/

[4] Imagination-Augmented Agents for Deep Reinforcement Learning
https://deepmind.com/research/publications/imagination-augmented-agents-deep-reinforcement-learning/

[5] Simulated Policy Learning in Video Models
https://ai.googleblog.com/2019/03/simulated-policy-learning-in-video.html?m=1

Planned Activities

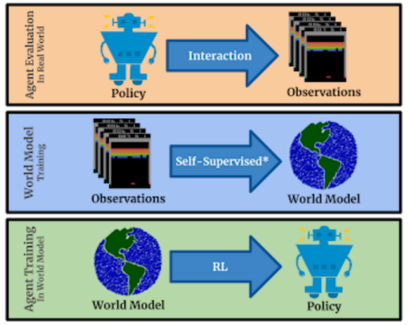
1. Acquire strong theoretical basis on Deep Reinforcement Learning;
2. Investigate the different possibilities to integrate a model into an existing model-free DRL algorithm;
3. Compare different pairs model-free and model-based algorithms finding the break-even value from the points of view of computational overhead and training speed-up.

Competencies to be acquired

The candidate will acquire:

- Expertise on recent Deep Reinforcement Learning algorithms;
- Experience in algorithm design, analysis and comparison with respect to a real application;
- Experience of data-driven modelling in the field of physical systems.

Duration of this Project: 5-6 months.



How to contact us

Directly by email to: sonia.cannavo@add-for.com

By LinkedIn: linkedin.com/in/cannavò-sonia-66a95467

MASTER THESIS PROPOSAL

IBM Business Partner

NVIDIA DEEP LEARNING INSTITUTE

NVIDIA INCEPTION PROGRAM

add-for.com

Explanation of Deep Neural Networks Predictions

Artificial Neural Networks are biologically-inspired programming paradigm which enables a computer to learn from observational data [1].
In the form of Deep Neural Networks (DNNs), they have achieved outstanding performance in a great number of different areas, from computer vision [2] to videogames [3].
The main drawback when applying DNNs in the real world is their lack of explainability. In other words, the DNN acts as a black box and it does not provide detailed information about why it reaches a certain classification/regression decision.
Recently there have been many efforts to design explanation algorithms, both for generic machine learning algorithms [4, 5, 6] or specific for DNNs [7].
The purpose of this thesis is to analyze and compare the recent explanation algorithms for DNNs. The student will conduct extended experiments on DNNs used for industrial applications.

Who we're looking for

.

Students that are about to get their Master Degree in mathematical engineering or computer science or computer engineering or electronic engineering or mathematics or physics or physics of complex systems.

Required Skills:

- Proficiency in at least one programming language (Python, Lua, Matlab, C++, Java);
- Basic knowledge of machine learning, in particular, supervised learning;
- Good knowledge of linear algebra.

(a) Original Image (b) Explaining *Electric guitar* (c) Explaining *Acoustic guitar* (d) Explaining *Labrador*

Figure 4: Explaining an image classification prediction made by Google's Inception neural network. The top 3 classes predicted are "Electric Guitar" ($p = 0.32$), "Acoustic guitar" ($p = 0.24$) and "Labrador" ($p = 0.21$)

Planned Activities

1. Acquire strong knowledge about the most recent DNN architectures and training procedures;
2. Investigate, analyze and compare the recently proposed explanation algorithms;
3. Conduct extended experiments to explain the predictions of DNNs used in industrial projects.

Duration of this Project: 5-6 months.

Competencies to be acquired

The candidate will acquire:

- Expertise on Deep Learning;
- Critical thinking about the interpretation of black-box machine learning algorithms

Check these Links before moving on

[1] Deep Learning
http://neuralnetworksanddeeplearning.com/
[2] Deep Residual Learning for Image Recognition (ResNet)
https://arxiv.org/abs/1512.03385
[3] Deep-Q-Network
https://www.nature.com/articles/nature14236
[4] LIME - "Why Should I Trust You?": Explaining the Predictions of Any Classifier
https://www.youtube.com/watch?v=hUnRCxnydCc
[5] LRP - On Pixel-Wise Explanations for Non-Linear Classifier Decisions by Layer-Wise Relevance Propagation
https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0130140
[6] SHAP - A Unified Approach to Interpreting Model Predictions
https://papers.nips.cc/paper/7062-a-unified-approach-to-interpreting-model-predictions
[7] DeepLIFT - Learning Important Features Through Propagating Activation Differences https://arxiv.org/abs/1704.02685

How to contact us

Directly by email to: sonia.cannavo@add-for.com

By LinkedIn: linkedin.com/in/cannavò-sonia-66a95467

MASTER THESIS PROPOSAL

Generative Adversarial Networks for Domain Adaptation between synthetic and real images

IBM Business Partner

NVIDIA DEEP LEARNING INSTITUTE

NVIDIA INCEPTION PROGRAM

add-for.com

Learning from as little human supervision as possible is a major challenge in Machine Learning. In the context of computer vision, Deep Learning is a class of supervised learning algorithms that require a great amount of human-labeled images in order to be trained [1]. An opportunity to reduce the needed amount of human labeling is offered by synthetic dataset, where the labeling procedure comes at almost no cost. The problem with the introduction of synthetic datasets is the domain gap with real images ones. Generative Adversarial Networks (GANs) [2, 3] are a class of deep neural networks able to generate synthetic data with the same distribution of a target dataset. They have been applied to very different areas with excellent results, from the generation of realistic face images to 3d points cloud [4].
The aim of this thesis is to study the possibility of using GAN to cover the domain gap between real and synthetic images [5]. The objective is to develop an algorithm that minimizes the amount of labeled real data needed to train a target deep neural network while obtaining the best classification accuracy.

(a) Source images

(b) SPIGAN-no-PI

(c) SPIGAN

Check these Links before moving on

[1] Deep Learning
http://neuralnetworksanddeeplearning.com/
[2] Generative Adversarial Networks
https://arxiv.org/abs/1406.2661
[3] Wasserstein GAN
https://arxiv.org/pdf/1701.07875.pdf
[4] The GAN Zoo
https://github.com/hindupuravinash/the-gan-zoo
[5] SPIGAN: Privileged Adversarial Learning from Simulation
https://openreview.net/pdf?id=rkxoNnC5FQ

Planned Activities

1. Acquire strong knowledge about the most recent DNN architectures and training procedures;
2. Acquire strong knowledge about the GAN models and their application to transform synthetic images to real ones
3. Conduct extended experiments on real-synthetic dataset pairs and analyzing the improvements and drawbacks of the domain adaptation approach based on GANs

Duration of this Project: 5-6 months.

The candidate will acquire:

- Expertise on Deep Learning;
- Expertise on Computer Vision;
- Experience about the training of most recent GAN models and architectures.

Who we're looking for

Students that are about to get their Master Degree in mathematical engineering or computer science or computer engineering or electronic engineering or mathematics or physics or physics of complex systems.

Required Skills:

- Proficiency in at least one programming language (Python, Lua, Matlab, C++, Java);
- Basic knowledge of machine learning, in particular, supervised learning;
- Good knowledge of linear algebra.

How to contact us

Directly by email to: sonia.cannavo@add-for.com

By LinkedIn: linkedin.com/in/cannavò-sonia-66a95467