National University of Science and Technology POLITEHNICA Bucharest

Multimedia Technologies in Biometrics and Information Security Applications (BIOSINF)

Artificial Intelligence II: Deep learning methods

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Project Requirements

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Overview

In this project, students will explore the application of neural network-based systems to solve specific tasks. This document presents the general requirements for implementing the project for this course, along with project-specific criteria. Students can work individually or in teams of two. Each team must select a different project from the list provided below in Table 1. The project involves implementing and comparing various neural network architectures and techniques to accomplish the chosen task.

We are also open to new project proposals, if they fit our requirements, so do not hesitate to contact us.

1 General Requirements

1. Project report will be written in LaTeX, two-column format, with the following structure:

   i Abstract (brief description of your project and your results): 150-250 words

   ii State-Of-the-Art (SOA): 1-2 pages

   iii Method(s) and Dataset(s) Description (your approach, data pre-processing, post-processing, evaluation metrics, etc.): 2-3 pages

   iv Experiments and Results: 4-5 pages

   v Conclusions: 0.5 pages

   vi References: at least 10 references for the SOA and at least 5 throughout the rest of the report

   We encourage you to write it using the LaTeX template provided as reference here. Create an Overleaf account and start editing it.

2. *Do not include any source code in the written report.*

3. The code should be either handed in as one or more *Jupyter* notebooks, or as separate python files. You can also include all the source code on your own GitHub repo.

4. You can use any already implemented functionalities, just reference them accordingly in the source code (add URL)

5. You can use any `Python` packages you want.

6. The experimental section should include at least 3 ablation studies **of your choice**, **relevant** to the task.

7. A brief final presentation is to be prepared, which should contain media and info **only** from your report.

2 Projects

The complete list of projects is detailed below. Please note that each team should have a different project.

Nr.	Title	Specific Requirements	#students
1	Semantic Segmentation of Urban Street Scenes	2.1.1	2
2	License plate detection (bounding box detection & character recognition)	2.1.1	2
3	EEG Motor Movement Classification	2.1.2	1
4	EEG Seizure Detection/Classification	2.1.2	1
5	MRI Denoise & Deblur	2.1.3	2
6	Natural Image Denoise & Deblur	2.1.3	2
7	Audio Denoise & Deverb	2.1.3	2
8	Weather forecasting from Time Series	2.1.2	1
9	Stock / Currency / Price forecasting from Time Series	2.1.2	1
10	Binary sentiment classification from Text	2.1.2	1
11	Emotion Classification from Images	2.1.2	1
12	Explainable AI Methods applied to Image Classifiers	2.1.4	1
13	Explainable AI Methods applied to Speech Classifiers	2.1.4	1
14	Explainable AI Methods applied to Text Classifiers	2.1.4	1
15	Anomaly Detection for Industrial Visual Inspection	2.1.2	1
16	Hate Speech Detection	2.1.2	1
17	Neural Style Transfer for Images	2.1.2	1
18	Speaker Identification	2.1.1	2
19	Image inpainting	2.1.2	1
20	Voice Conversion	2.1.5	2

Table 1: List of proposed projects

2.1 Project-specific Requirements

2.1.1

- Experiment on at least 2 datasets.
- Compare at least 6 methods (≥ 3 train yourself, either from scratch or through transfer learning). It is not permitted to directly take results reported in papers.
- Use at least 3 distinct loss functions.
- Study the effect of transfer learning from one dataset to another.

2.1.2

- Experiment on at least 1 dataset.
- Compare at least 3 methods (≥ 2 train yourself, either from scratch or through transfer learning). It is not permitted to directly take results reported in papers.
- For Projects #3 and #4: Verify the inter-subject and intra-subject performance
- For Projects #8 and #9: Analyze the seasonality/cyclic patterns/trends in data and how it may influence performance
- For Projects #10 and #11: Analyze the bias (if there is any) of the emotion recognition system(s)
- For Project #15: Verify the performance when noise is added to data
- For Project #16: Experiment with training on multiple languages
- For Project #17: Analyze the influence of each loss component. Test your model using the style of a Romanian painter.

2.1.3

- Create your own dataset by using at least 2 of the blur kernels provided on the Course Github page. Experiment with different distributions of AWGN by changing the standard deviation. Other noise distributions may be considered as well, specific to each task.
- Compare at least 4 methods (≥ 2 train yourself, either from scratch or through transfer learning). It is not permitted to directly take results reported in papers.
- Implement at least one classic method using iterative algorithms for solving inverse problems.

2.1.4

- Experiment on at least 2 dataset
- Compare at least 3 classifiers (≥ 1 train yourself, either from scratch or through transfer learning). It is not permitted to directly take results reported in papers.
- Use at least 3 explainable methods to analyze the behaviour of your classifier(s), and interpret the results. Compare explanations obtained from different explainable methods.

2.1.5

- Experiment on at least 2 datasets.
- Compare at least 3 Vocoders for TTS and 2 Speech recognition systems. You could also consider training an end-to-end system.
- Study how the length of the input speech affects the quality of the output.

3 Recommended/Not recommended timeline

Weeks	Activity
3-5	SOA research. Problem Framing
5-6	Defining Methods. Choosing Datasets. Preparing Data.
6-8	First experiments. Debugging. Reiterate choices.
8-10	Main Experimentation Stage.
10-12	Final experiments. Project report.
13-14	*Project Submission. Presentation*

(a) ✓

Weeks	Activity
3-5	
5-6	
6-8	
8-11	
12	10 RedBull/night
13-14	*Project Submission. Presentation*

(b) ✖

As you embark on journey to tackle the challenges of Artificial Intelligence, we encourage you to embrace a mindset of gradual progress and continuous refinement in your project endeavors. Remember, Rome wasn't built in a day, and neither working neural network-based systems. By working steadily and consistently, you'll not only enhance your understanding of the concepts but also refine your skills in implementing and comparing various neural network architectures.

We encourage you to divide your project into manageable tasks and set realistic milestones to accomplish along the way. Start by thoroughly understanding the problem statement and exploring existing solutions and methodologies. Then, gradually build upon your knowledge by experimenting with different neural network models, optimizing their architectures, fine-tuning hyperparameters, and exploring novel techniques.

By working gradually, you'll give yourself the opportunity to thoroughly explore and understand each aspect of your project, allowing for more insightful analysis and meaningful comparisons. Additionally, tackling your project incrementally will help alleviate the stress and pressure that often accompanies last-minute rushes, enabling you to produce higher quality work and achieve better results, and of course a better grade.

Lastly, do not hesitate to contact us or your colleagues if you are stuck or out of ideas. We are here to help and we encourage regular discussions, insight sharing and constructive feedback.

Best of luck on your project journey,

Ana and Vlad.