

Exam Projects for Neural Networks

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Intelligent Signal Processing
And MultiMedia lab



SAPIENZA
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NEURAL NETWORKS

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Table of Contents

1 GENERAL INFORMATION

- Exam for the course of Neural Networks

2 PROJECT TOPICS

- Design of the neural networks
- Optimization and regularization
- Beyond vector-valued data
- Privacy, security, and interpretability
- Audio classification
- Deep neural networks for 3D audio
- Other topics



GENERAL INFORMATION

- Exam for the course of Neural Networks

Information about the exam project

You can choose one **project** among those available.

A project requires *re-implementing* some parts of a scientific paper using tools *of your choice*.

At the end, you need to provide the **full code** of your simulations and a **technical project report** for a preliminary evaluation.

Upon validation, you will be assigned a time-slot and asked to give a brief **presentation** of the work (15 minutes).

During the presentation, you will be asked some questions on the theoretical part (i.e., on the whole course program).

Possibility to work in groups

The project can be carried out by **one student** or a **group** of students.

The choice is **up to you**. It could be a good chance for any of you to work in a group, but, if you prefer you can work alone.

The **difficulty** of the project will be proportionate with the number of students of a group.

During the exams, **all the members** of a group must present a part of your work.

Theoretical questions will be asked separately to each member of a group.

Project duration

You can start working on your project **when you prefer** from now to mid-September 2020.

On average, every project is carried out in **6 weeks**.

Working in group does not implies **working in less time**.

It is mandatory to deliver your project not beyond 3 months from your assignment.

So, please, ask for your project **only when you are ready** to start working!

Project as a part of the thesis

For those interested, there is the opportunity to continue your project, or part of it, with a **thesis**.

We have usually several **thesis proposals** on same topics of the projects.

If you **may be interested** in a thesis, you can also let us know this when you ask for your project.

If we know your interest in advance, we can propose you a project on a thesis topic, so you can decide to continue **if you want**.

If during your project you change idea and don't want to continue, there is no problem.

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New layers

Designing advanced layers for the neural networks, beyond what you saw in the course:

- advanced activation functions;
- convolutional blocks;
- recurrent blocks (e.g., new gating functions);
- attention-based layers;
- normalization strategies;
- ...

Optimization techniques

Advanced optimization algorithms and regularization terms for training neural networks:

- Novel first- and second-order optimization algorithms;
- Hyper-parameter optimization techniques;
- Pre-training and unsupervised training strategies;
- Sparse regularization terms;
- Compression in neural networks;
- ...

Beyond vector-valued data

Building neural networks for more structured types of data:

- Hyper-complex neural networks: networks working on quaternion/octonion data.
- Graph Networks: extending neural networks to graph-based inputs.
- Neural networks for relational data and knowledge bases.
- Word and sentence embeddings for text.

Privacy, security, and interpretability

Solving several challenging problems in neural networks.

- Applying networks to encrypted data;
- Securing neural networks against adversarial attacks;
- Explaining the prediction of a trained neural network;
- Fairness, bias, and discrimination.

Neural networks for audio classification

Applying neural networks to audio and speech problems.

- Classification/recognition of audio signals recorded in construction sites (2-3 *students*).
- Automatic monitoring of working activities in construction sites (2-3 *students*).
- Anomaly detection in virtualized Fog architectures (1-2 *students*).

The tutor for this group of projects is Prof. Michele Scarpiniti (michele.scarpiniti@uniroma1.it).

Deep neural networks for 3D audio

3D audio is gaining significant interest due to emerging applications like *virtual reality, gaming, robot assistance, speech recognition, surveillance, home automation*, etc.

- Deep neural networks for 3D sound event detection.
- Deep neural networks for 3D sound localization.
- Recurrent neural networks for multichannel speech separation: applied to high-order ambisonics recordings.
- Spatial audio feature discovery: for personalization of binaural hearing.

Other topics I

General topics related to the application of neural networks.

- Generative models;
- Continuous and lifelong learning in neural networks;
- Bayesian approaches to training neural networks;
- Neural networks for biomedical applications;
- Working on datasets from challenges.

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