Brain activity: classification and regression problems

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Overview

Source

- Electroencephalograph
- Magnetic resonance imaging

Data

- Images of brain activity
- Sensory-motor cortex activation dynamics

Models

- Convolutional Neural Network
- LSTM Neural Network

neurofeedback

Introduction

- Preventive medicine
- Biological feedback

neurofeedback

Introduction

- Magnetic resonance imaging (MRI) scanner
- Sensory-motor cortex activation dynamics

neurofeedback

Introduction

- Heart rate monitor
- Beats per minute

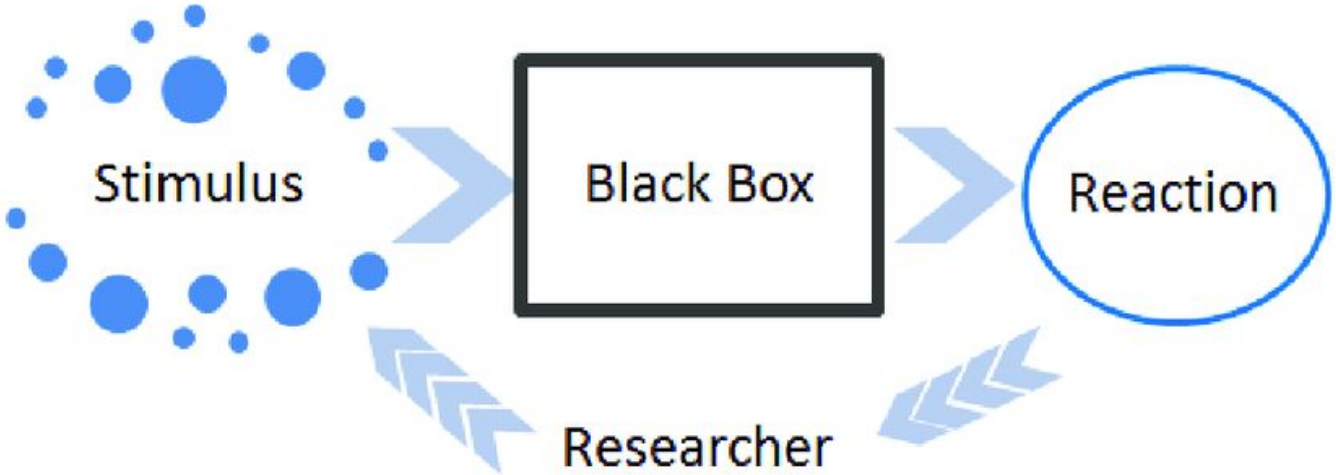
Introduction

- Electroencephalograph (EEG)
- Neurofeedback

neurofeedback

Introduction

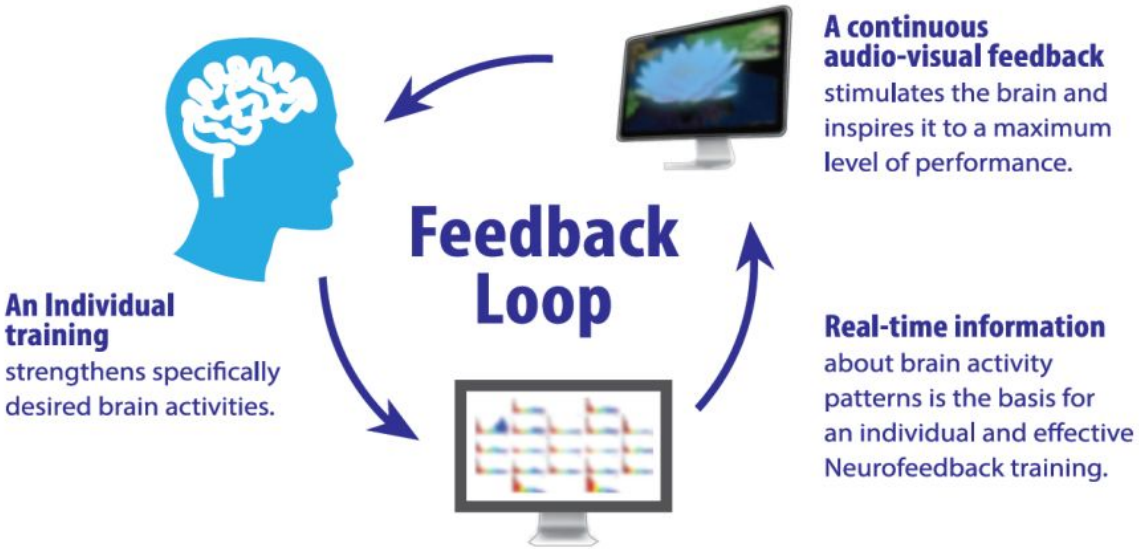
- Body as a black box

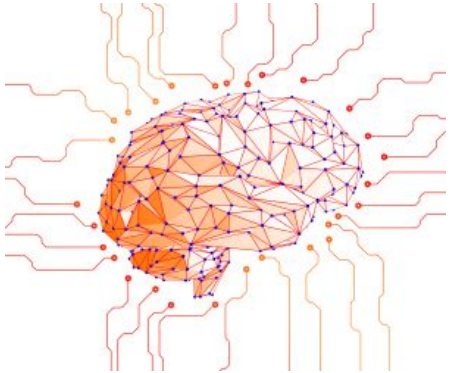


neurofeedback

Introduction

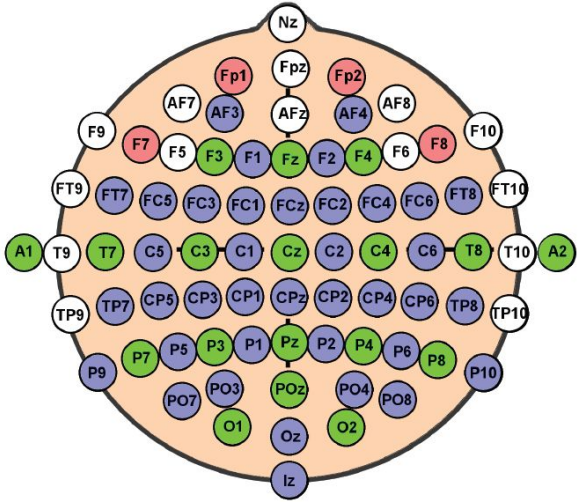
- Feedback loop: input signal, effort of will, output signal

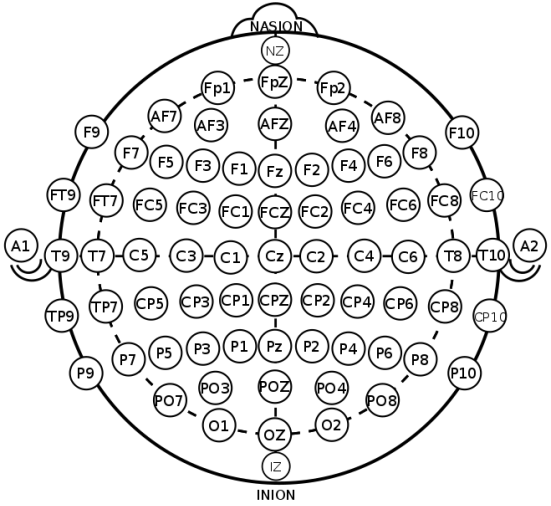


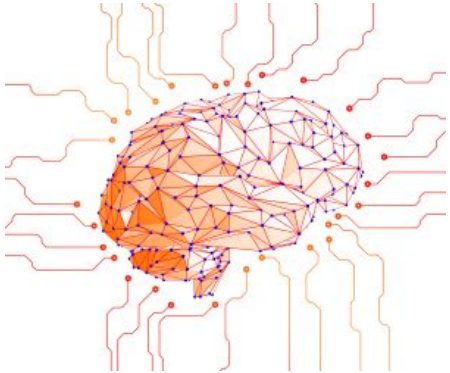


EEG signals classification

- Electrophysiological monitoring method to record electrical activity of brain
- N electrodes (sensors) placed on the scalp

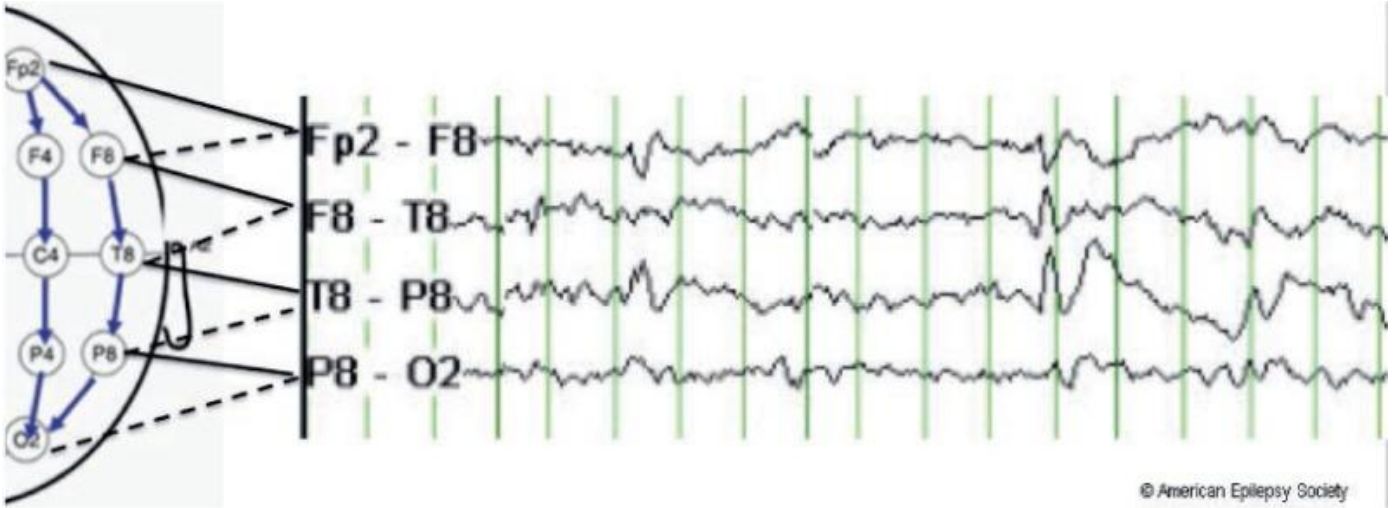


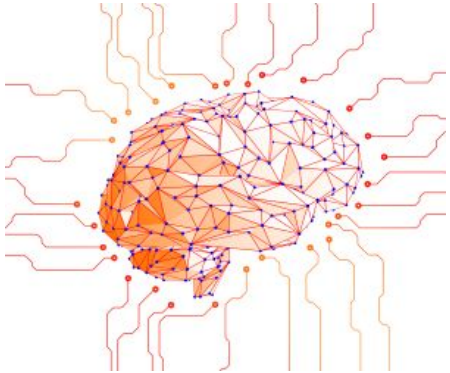




EEG signals classification

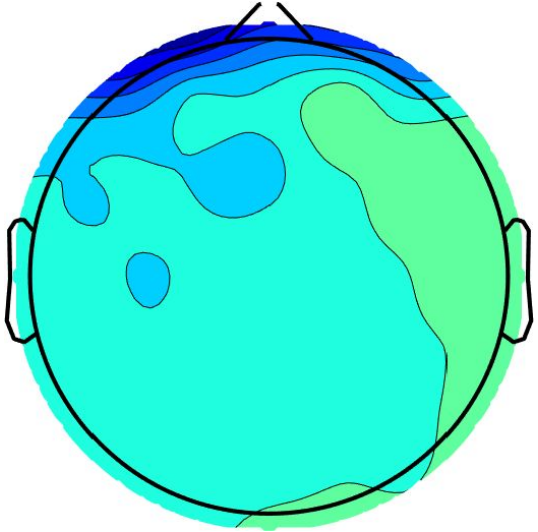
- Raw EEG is N time series, where N is a number of electrodes
- Time series consist of target signal as well as noise signals

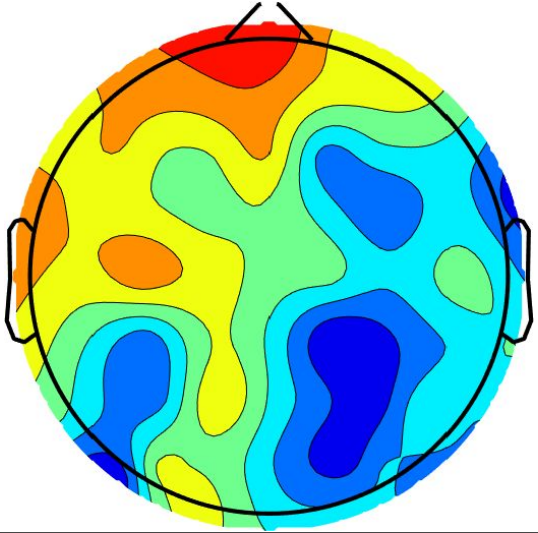


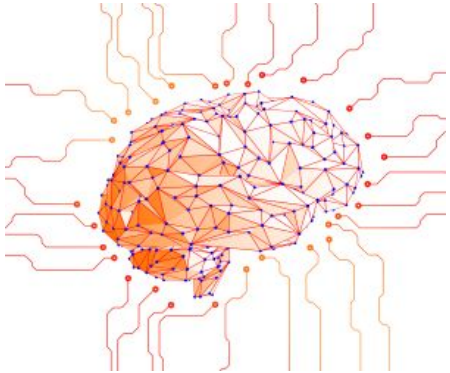


EEG signals classification

- Several methods of graphic representation
- One of them - spectral power

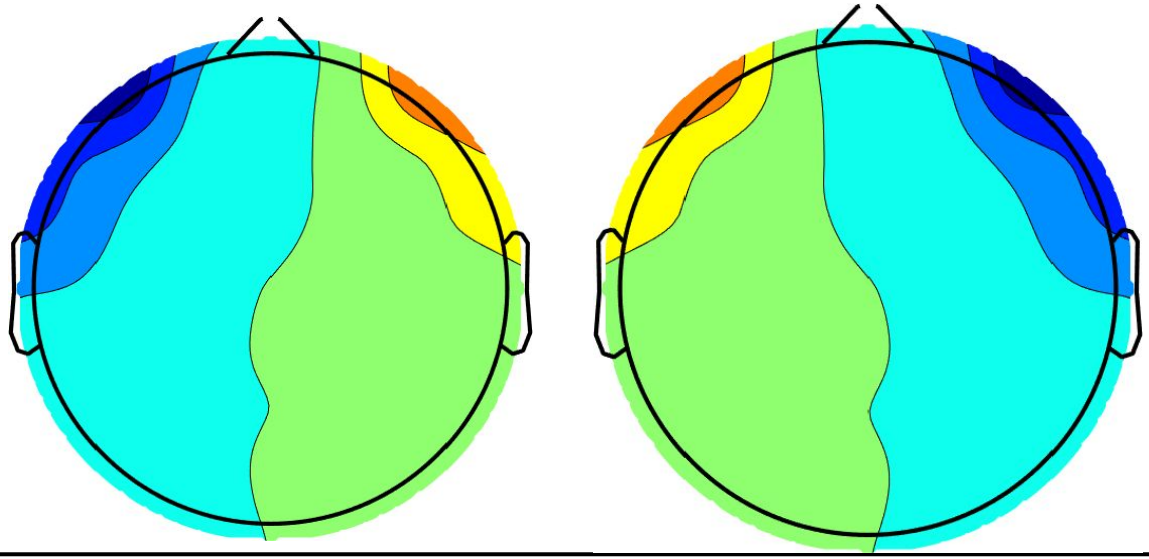


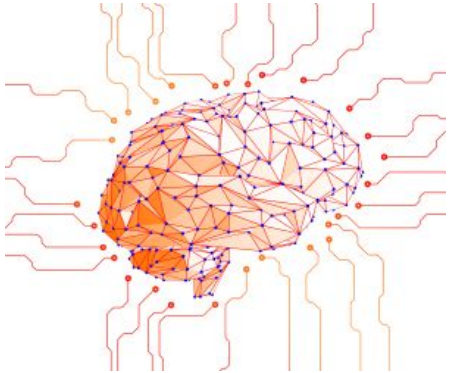




EEG signals classification

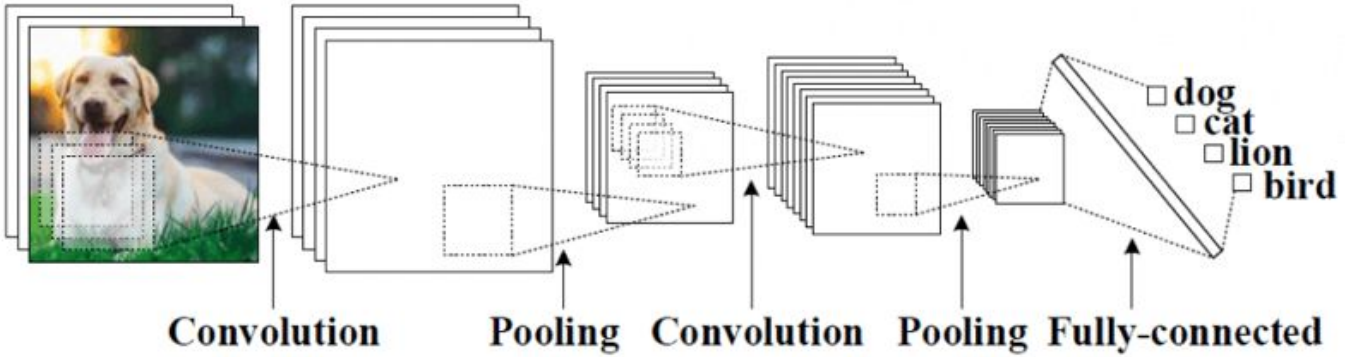
- 7,241 images at the enter
- 22,164 images after flipping horizontally and bootstrapping

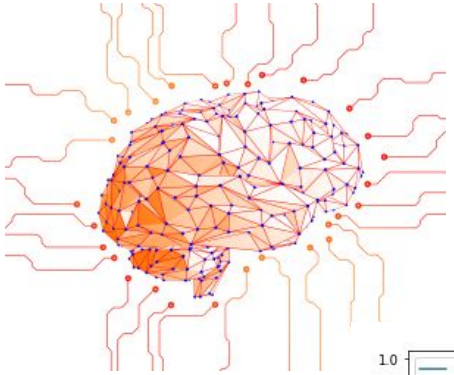




EEG signals classification

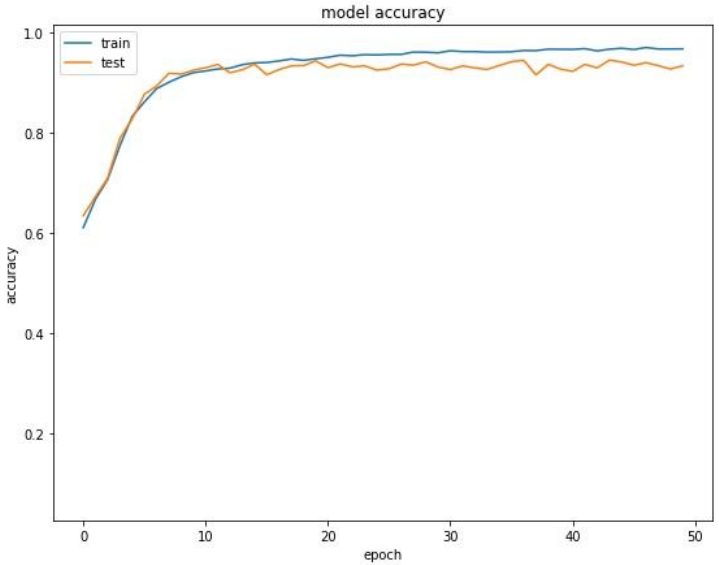
- Convolutional neural network
- 4 convolutional and 4 max pooling layers
- 2 fully connected layers

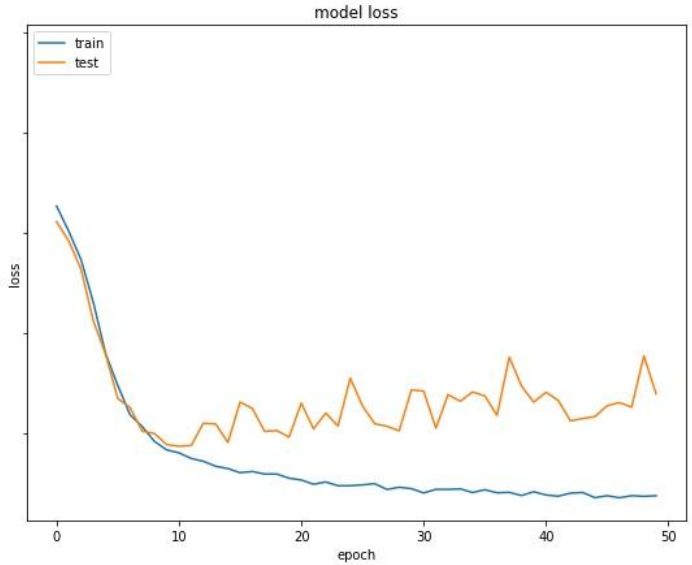




EEG signals classification

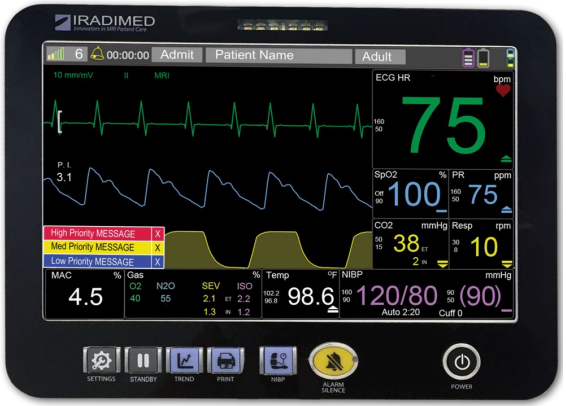
- Existing model has accuracy 86%
- New model has accuracy 93% on test dataset





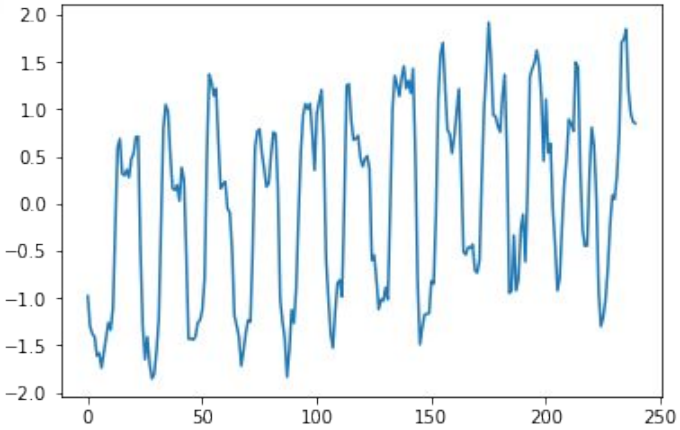
MRI time series regression

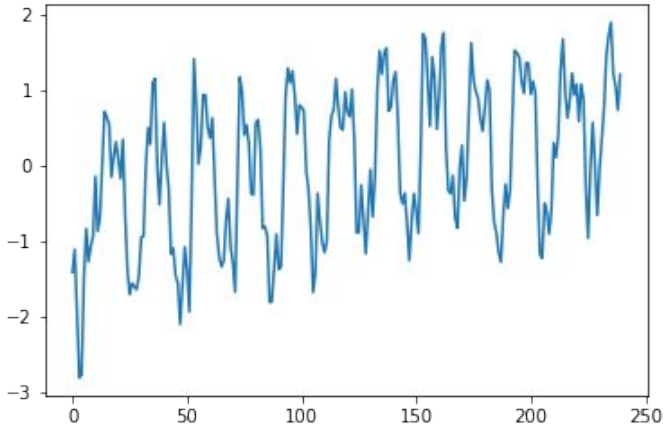
- Neurofeedback based on sensory-motor cortex activation
- Person lies into the MRI scanner and see his or her indicators on the MRI monitor



MRI time series regression

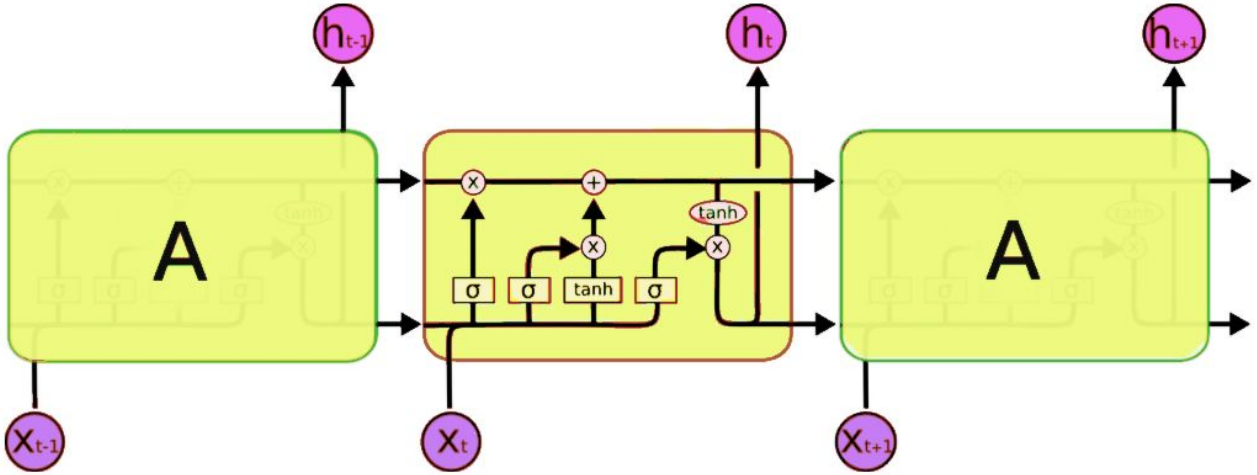
- At the enter we have five time-series
- Creating new time-series based on existing





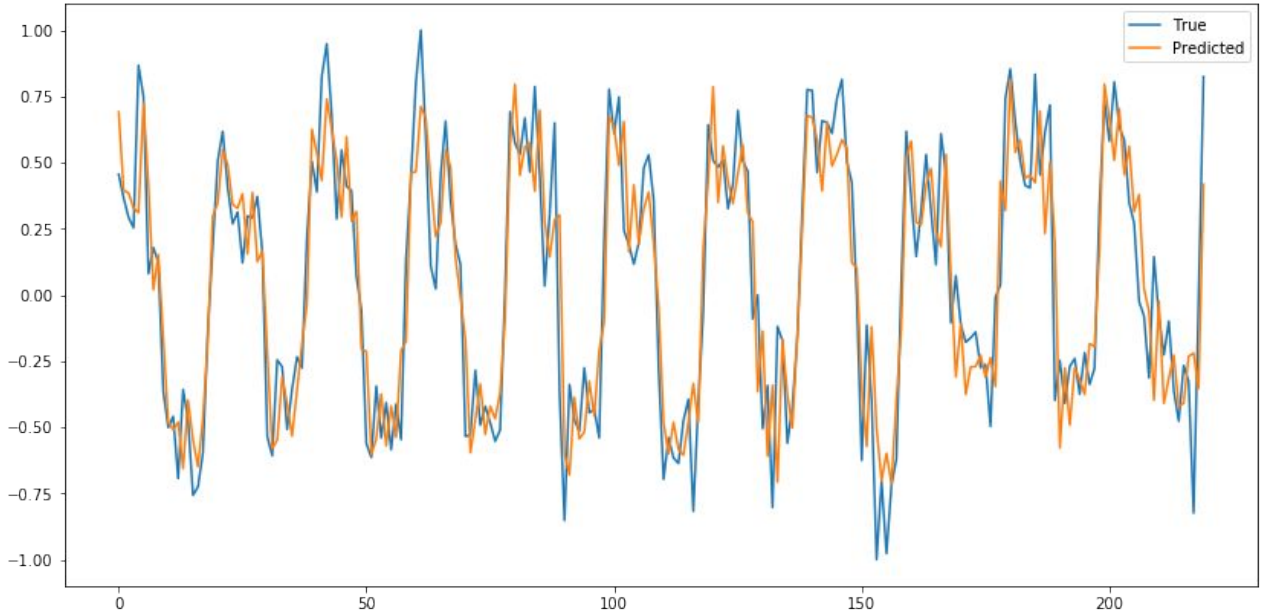
MRI time series regression

- Long short-term memory neural networks
- Neural network with one LSTM layer



MRI time series regression

- Result of time-series prediction



Future work

- The result of the work is not only two working models
- Every part of the project will be included in a publication

Special thanks for Pavel Rudych!

Thank you!

Any questions?