# Using Deep Learning and Evolutionary Algorithms for Time Series Forecasting (2018)

Last Time:

* Memcapacitor - <https://techxplore.com/news/2021-10-memcapacitor-devices-neuromorphic-applications.html>
  + Researchers at Max Planck Institute of Microstructure Physics and the startup SEMRON GmbH in Germany have recently designed new energy-efficient memcapacitive devices (i.e., capacitors with a memory) that could be used to implement machine-learning algorithms
  + 29,600 tera-operations per second per watt,
  + <https://www.nature.com/articles/s41928-021-00649-y>

## Notes:

* Week 11 – Chapters 1 – 4
* Week 12 – Chapters 5 - 8
* Reviewing related work:
  + Deep Learning and Evolutionary Algorithms applied to time series
    - Time-series approaches looked at
      * Lv et al., 2015 – traffic flow (traffic data) using stacked autoencoder (SAE) to learn temporal features
      * Kuremoto et al, 2014 – Deep Belief Networks – multiple layers of restricted Boltzmann machines (RBMs) to predict competition time series against MLP, Bayesian and Arima
      * Grover et all, 2015 – DBNs applied to weather
      * Thierou et al., 2007 – LSTM bi-directional model
    - Evolutionary approached looked at
      * Nalepa and Kawulok, 2014 – Evolutionary algorithms applied to hyperparameter optimization very effective
      * Gonzalez et al., 2015 – GA applied to both hyperparameters and feature selection – improved stability of Support vector machines and outperforming Tsai et al, 2006 previous work
      * Kennedy and Eberhart, 1995 - Particle Swarm Optimization applied to two hyperparameter optimization problems
        + Kuremoto et al., 2014 – applied to DBN

Number of neurons in hidden layer

Learning rates

Time lag (e.g. period)

* + - * + Lorenzo et al, 2017 – applied to solution space – looking at a minimum topology and optimize hyperparameters by PSO to achieve competitive image classification
      * Loshchilov et al., 2016 – Propose CMAES optimize parameters of a CNN
  + Author integrated techniques of time forecasting and applied evolutionary algorithms
* Thesis aims to assess performance of deep learning algorithms optimized by evolutionary algorithms
* Comparison of:
  + Feedforward multilayer perceptron (MLP) – Fully Connected (each nueron connected to next layer (three layer below)
    - Diagram, schematic

      Description automatically generated
  + Stacked Autoencoder (SAE) – multiple layer of Autoencoders
    - Popular as they provide feature extraction
    - Think feature 1, feature 2, followed by softmax classifier
    - Diagram

      Description automatically generated
  + Stack Denoising Autoencoder (SDAE) – Similar to SAE but input corruption only on initial training of each layer
    - Corruption techniques
      * Additive Gaussian Noise (add random value)
      * Masking Noise (to handle missing values)
  + Long Short-Term Memory Networks (LSTM)
* Hyperparameter optimization problem
* Evolutionary algorithm: CMAES (Covariance Matrix Adaptation Evolution Strategy)
* Datasets:
  + Random – Mackey-Glass and Lorenz System
  + Real data – Energy demand
* Additional observations:
  + LSTM, MLP work better on seasonal data
  + SAE and SDAE had difficulties learning time-structure

## Background

## Motivation and background

## Research objective/question(s)

## Prior relevant work/literature gap

## Theory, conceptual framing

## Methods

## Results

## Discussion

## Thoughts