Advanced Time Series

Lecture 4: **Classification**

Gleb Ivashkevich

HW 2/3 review

A Multi-Horizon Quantile Recurrent Forecaster

https://arxiv.org/abs/1711.11053

Implementation:

- deadline is Mar 1 24:00
- see instructions in full-mode Google Classroom
- compare with DeepAR (today)

Today

Time series forecasting ⟶ classification:

- **DeepAR** implementation
- **other architectures** for t.s. forecasting
- **time series classification** problem: setup
- **fully convolutional network** for t. s. classification
- **InceptionTime** for t. s. classification

DeepAR implementation

DeepAR

Differences/simplifications:

- only target + calendar features
- global averaging
- household-split, instead of time-split
- no household encoding
- stock LSTM

LSTNet & others: all the blocks

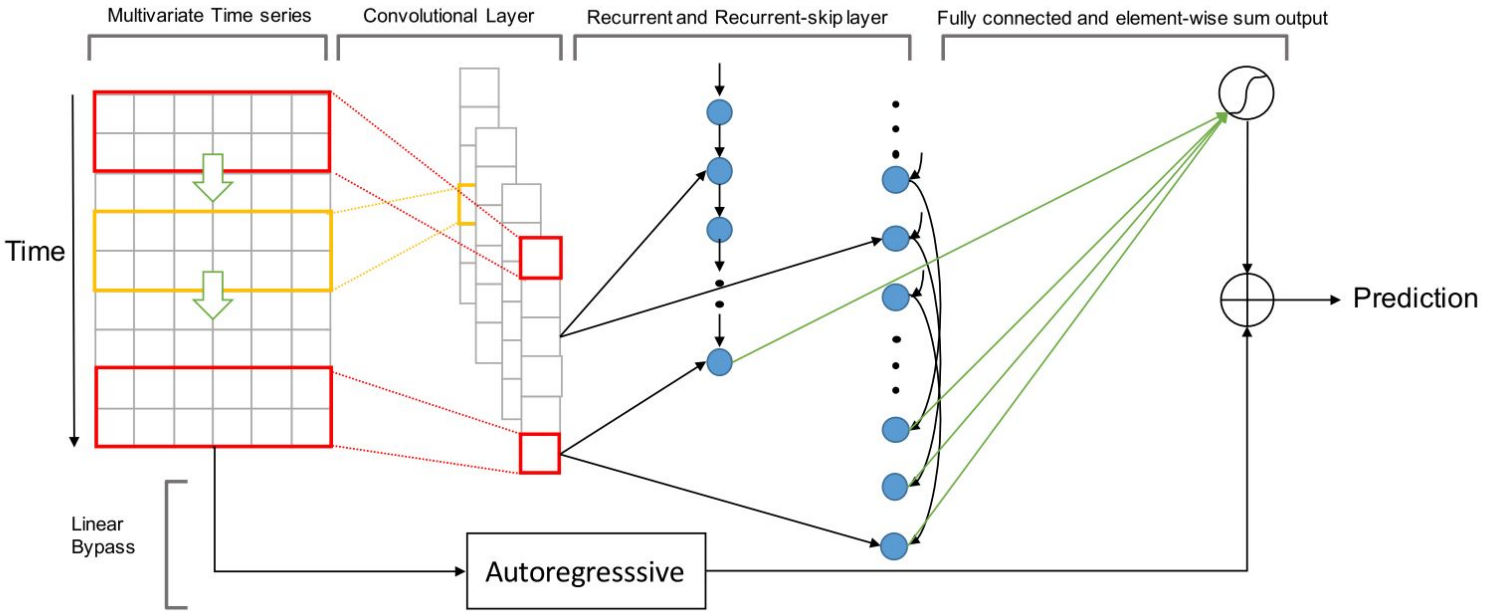
LSTNet

Setup:

- multivariate time series
- global + local patterns
- Conv + Recurrent + skip connections + AR loop

Modeling Long- and Short-Term Temporal Patterns with Deep Neural Networks

LSTNet

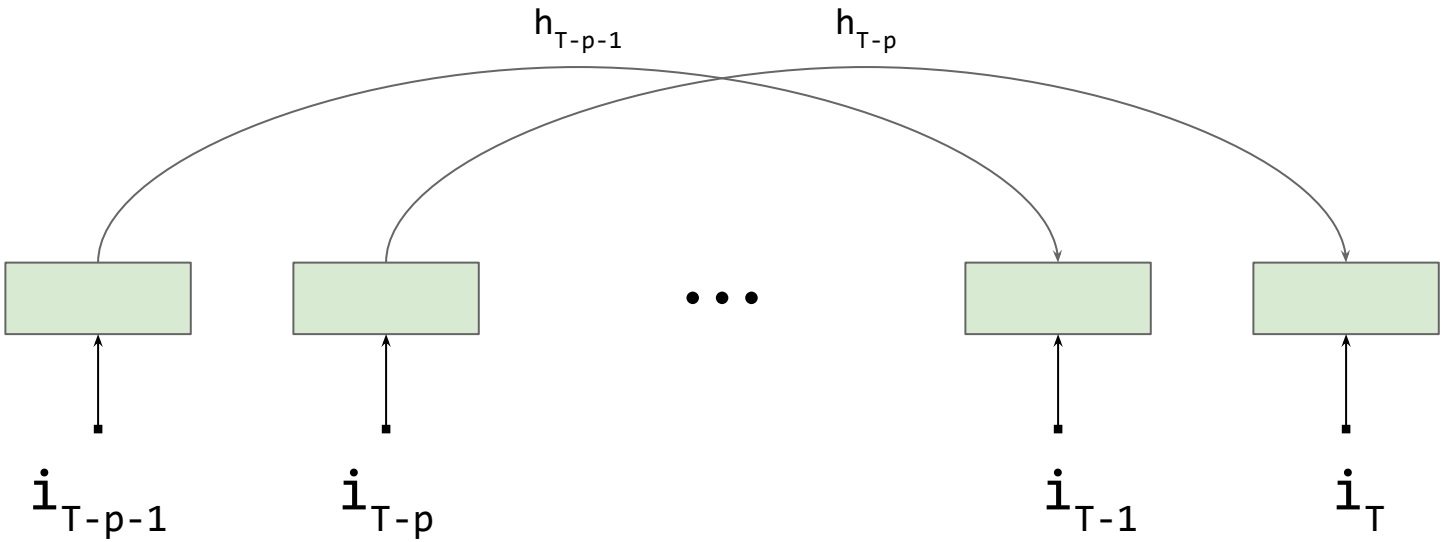

Multivariate Time series
Convolutional Layer
Recurrent and Recurrent-skip layer
Fully connected and element-wise sum output
Time
Prediction
Linear
Bypass
Autoregresssive

LSTNet

Features:

- **convolutions** look natural for multivariate t.s.: capture short range dependencies between variables
- **recurrent layer** (GRU) captures long range dependencies
- recurrent **skip-connections:** capture seasonality (longer range)

LSTNet: recurrent-skip

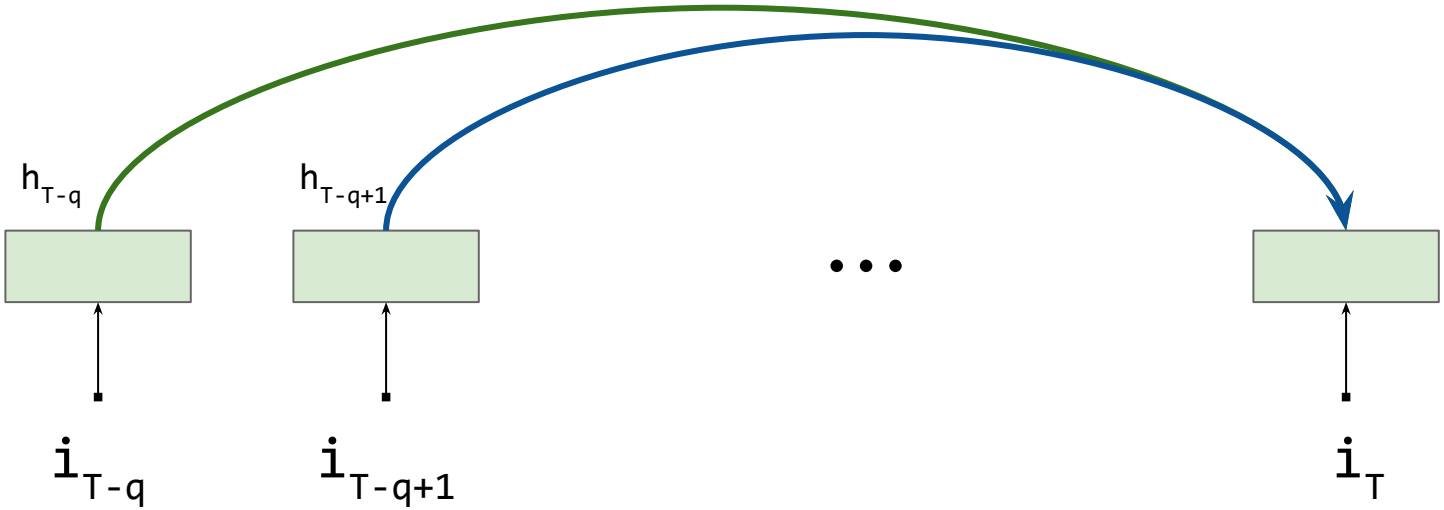


LSTNet

Features:

- **temporal attention**(instead of rec. skip)**:** no need to specify lag time
- **AR bypass:** discussed earlier
- available in GluonTS

LSTNet: temporal attention



LSTM-MSNet

Setup:

- input data: similar to DeepAR
- explicit handling of seasonality
- slicing: similar to W2 encoder-decoder

[LSTM-MSNet: Leveraging Forecasts on Sets of Related Time Series with Multiple Seasonal Patterns]

DeepGLO

Setup:

- **high-dimensional t. s.**
- **no normalization**: handled by initialization
- **temporal CNN**

[Think Globally, Act Locally: A Deep Neural Network Approach to High-Dimensional Time Series Forecasting]

Other

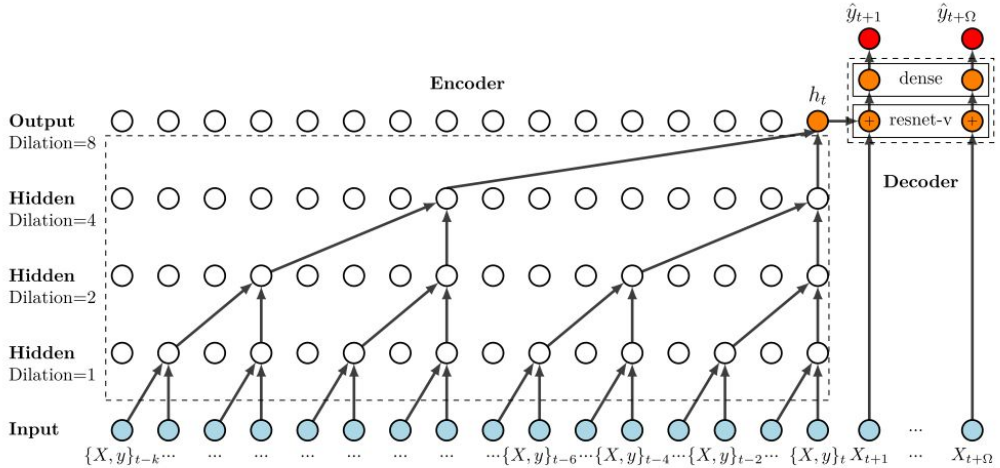
N-BEATS: Neural basis expansion analysis for interpretable time series forecasting

Shape and Time Distortion Loss for Training Deep Time Series Forecasting Models

Probabilistic Forecasting with Temporal Convolutional Neural Network

Other

[Probabilistic Forecasting with Temporal Convolutional Neural Network]



Time series classification

Classification

Setup:

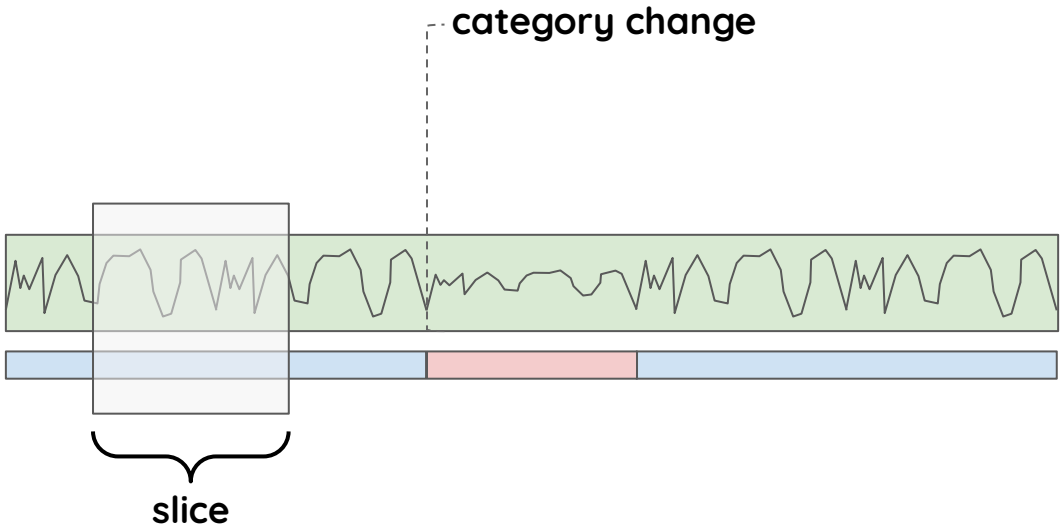
- given a **slice** of (usually multivariate) time series, get it's **category**
- **wide variety** of slice duration and typical time scales
- **patterns**, not long-term dependencies
- hence, convolutions
- generally, **conceptually simpler** compared to forecasting

Patterns

Setup:

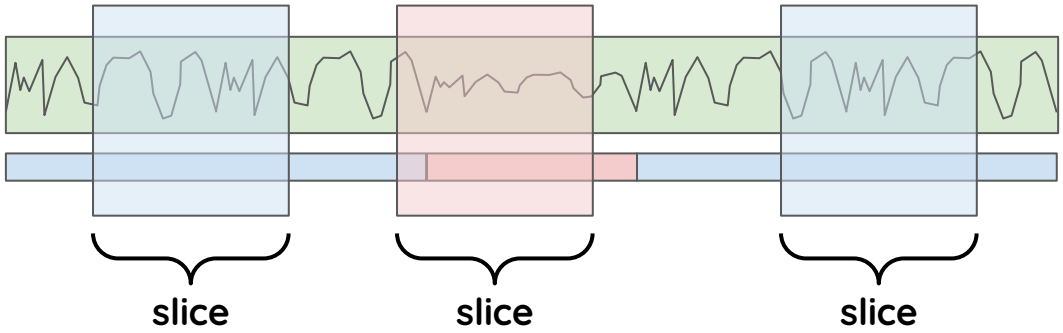
- given a **slice** of (usually multivariate) time series, get it's **category**
- **wide variety** of slice duration and typical time scales
- **patterns**, not long-term dependencies
- hence, convolutions

Patterns

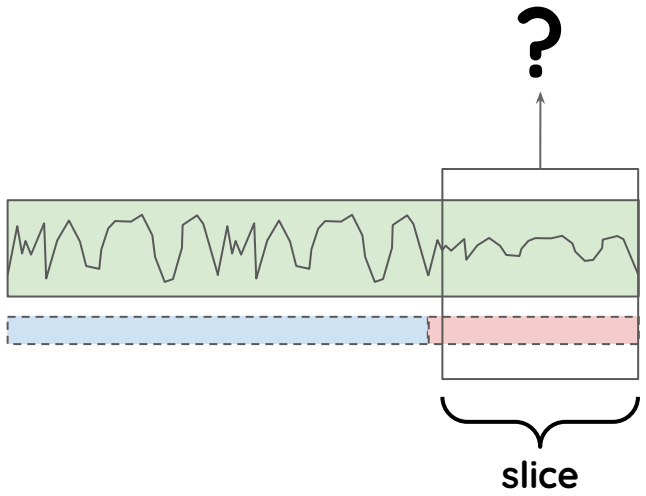


There are **no categories** if changes are **too gradual** and can be modeled with recurrent networks

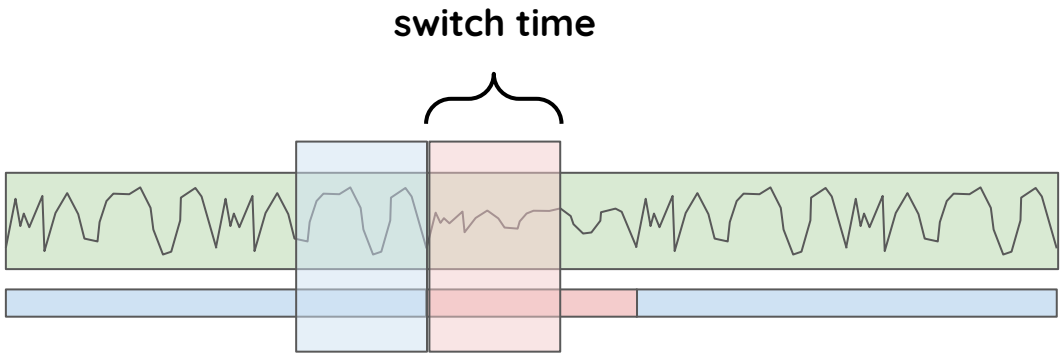
Training setup



Inference setup



Switch time



Switch time is about the size of the **classification window**. Must be **aligned** carefully to category duration time.

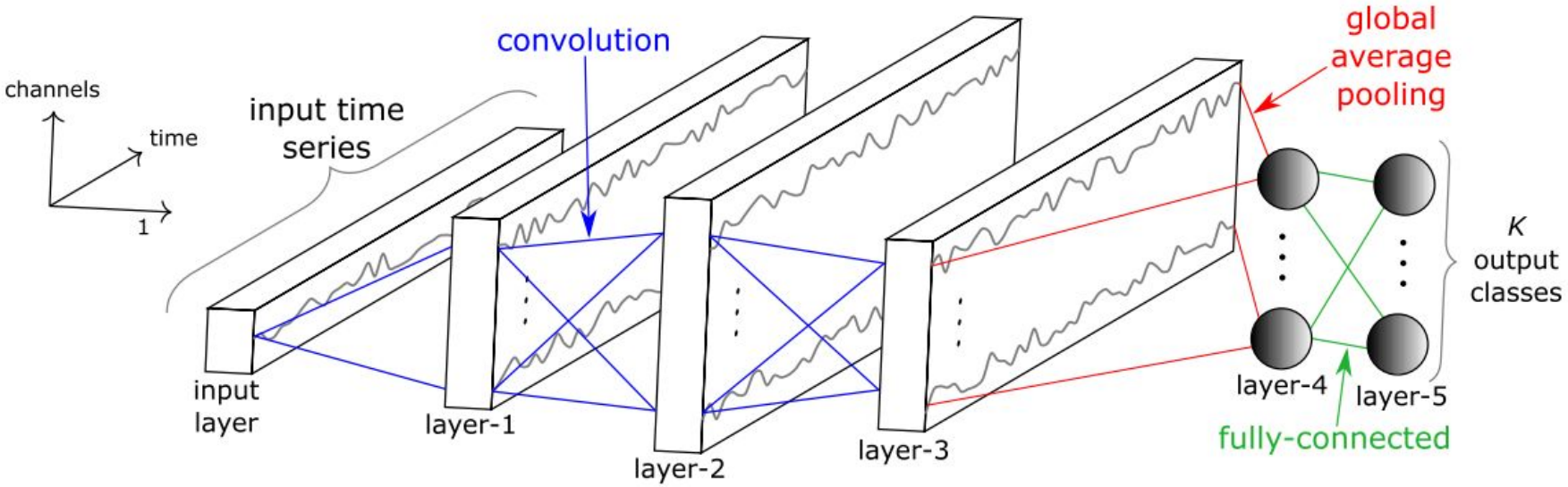
Classical

A lot of approaches:

- manually created windowed features + classical models
- **DTW** (dynamic time warping) as a distance measure
- etc.

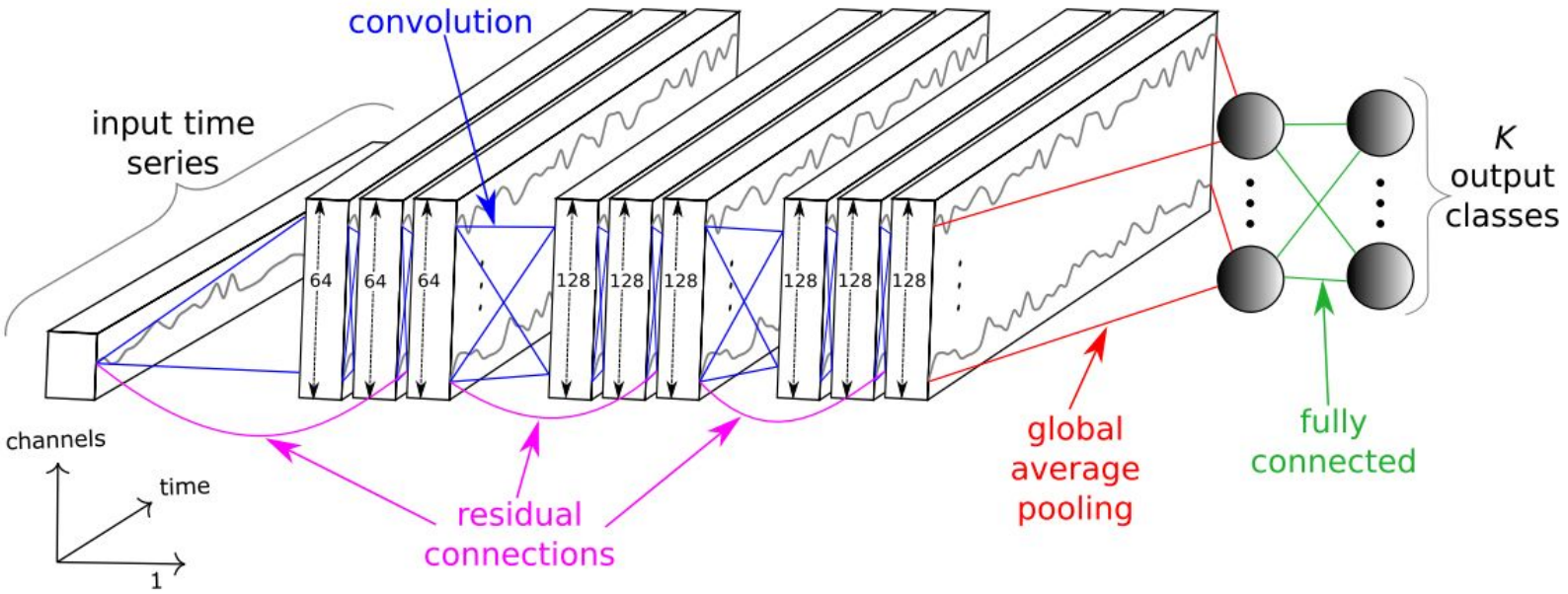
Classification architectures

Fully convolutional



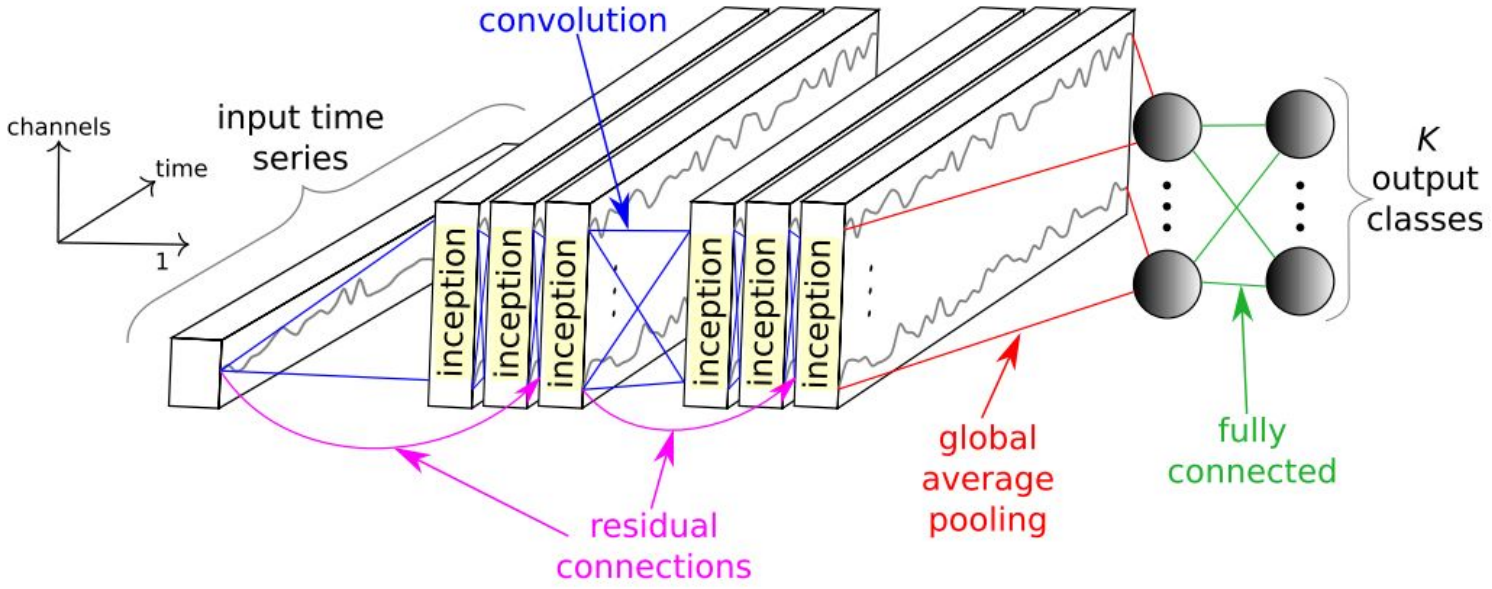
- Pictures: [Deep learning for time series classification: a review]

Residual



- Pictures: [Deep learning for time series classification: a review]

InceptionTime



- Picture: [InceptionTime: Finding AlexNet for Time Series Classification]

Next time

- dilated convolutions: more details
- InceptionTime implementation
- classification for t. s. segmentation and anomaly detection

questions?