Deep Learning for Time Series

Becoming gurus of time series together

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Agenda

1. Time
2. Time series
3. Time series analysis
4. Limitation of traditional time series methods
5. Deep learning for time series

1.

Why is “time” important?

Let’s start with reaching a consensus of time

Albert Einstein's considered "Time" is the fourth dimension in the universe in Special Relativity.

Time “Series”

A time series is a sequence taken at successive equally spaced data points in time.

Three main types of data science

Regression

Classification

Time series

Time Series Analysis

Methods for analyzing time series data in order to extract meaningful statistics and other characteristics of the data.

2.

Concept Recap

Let’s start with the time series analysis sharing two weeks ago

Basic components of time series

Trend

Long term movement of data

Cycle

Long term (1 year+) wavelike variations

Seasonality

Short term, regular variation

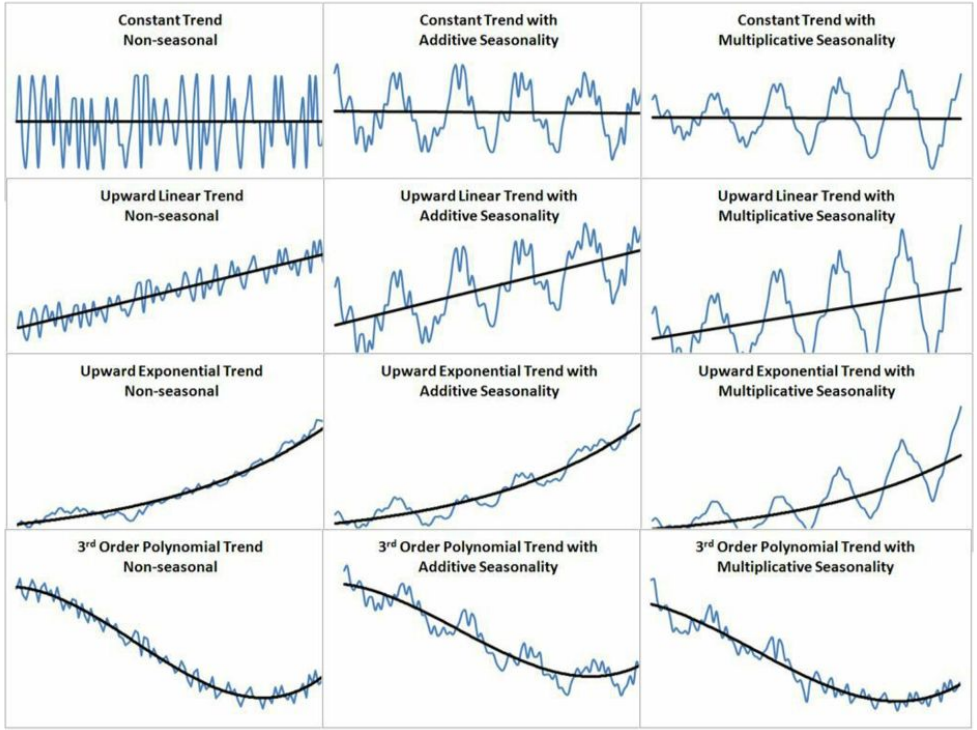
Random Variations

Residual variations after all other elements

Irregular Variations

Unusual circumstance and did not reflect typical behavior

Common trend and seasonality patterns



How to forecast?

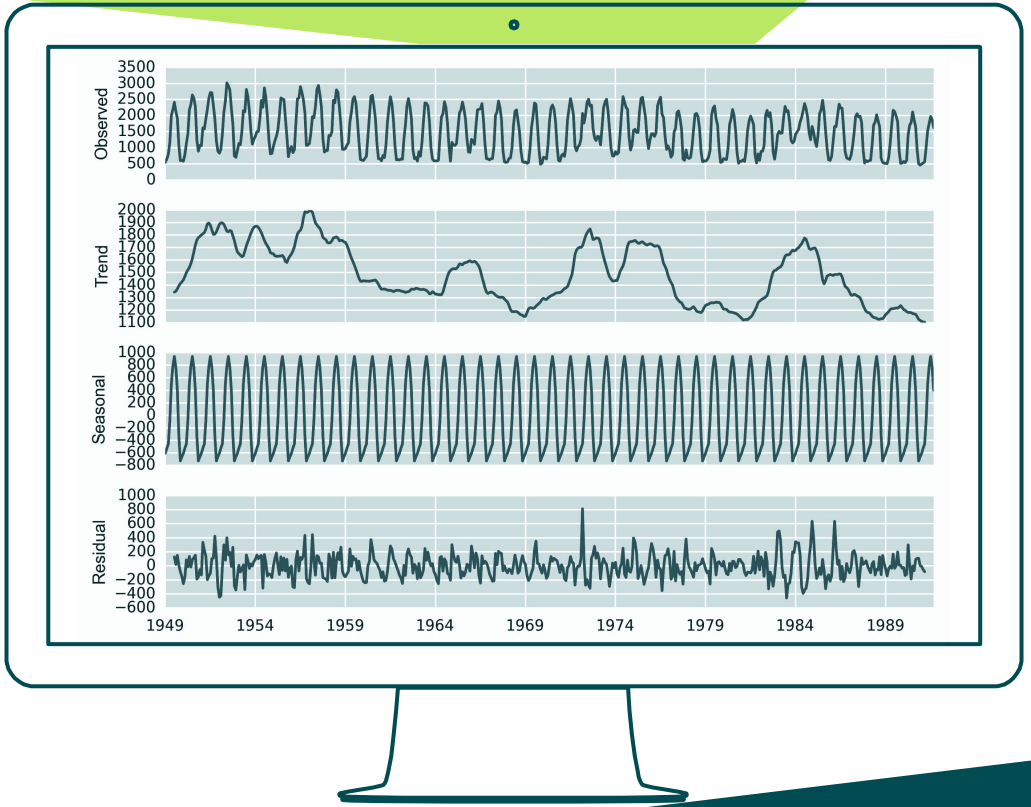
Basically, classic time series forecasting models are trying to decompose and learn the series from the five elements.

E.g.

$$F = T+S+C+I$$

$$F = T*S*C*I$$

Decomposition of time series

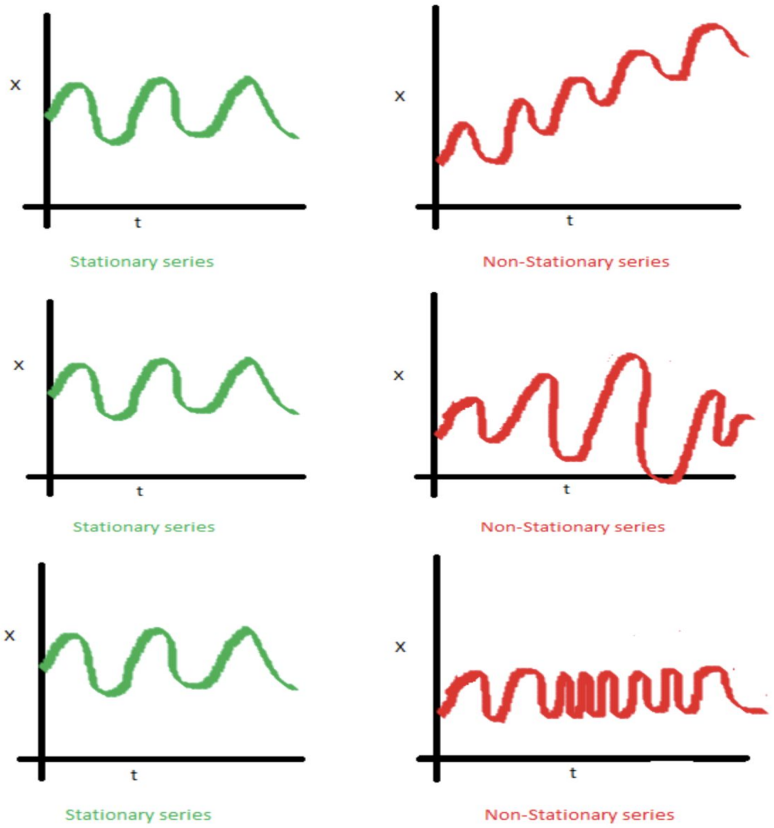


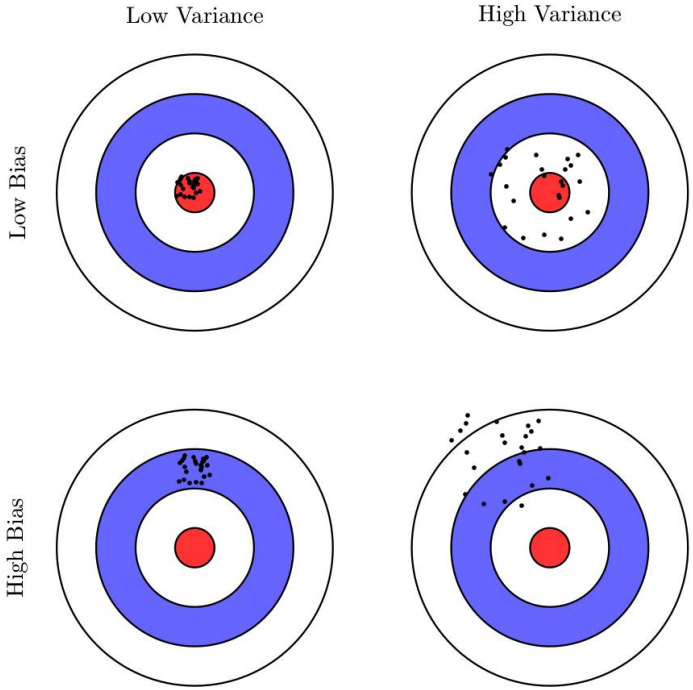
But

Nonstationary and time-varying volatility make time series be hard to analyze.

We need to make series stationary to forecast easier.

What is nonstationary?





How

N-order differences or linear combination make series tend to be a constant or a linear function.

-Sir William Granger

N-order diff. = $Y_t - Y_{t-n}$

Linear com. = $Y_t - \alpha X_t$

Traditional time series methods

ARIMA family

AR, MA, ARMA, ARIMA, SARIMA, vecARIMA...

Exponential smoothing family

Single exp smoothing, double exp smoothing, Holt exp smoothing...

ARCH family

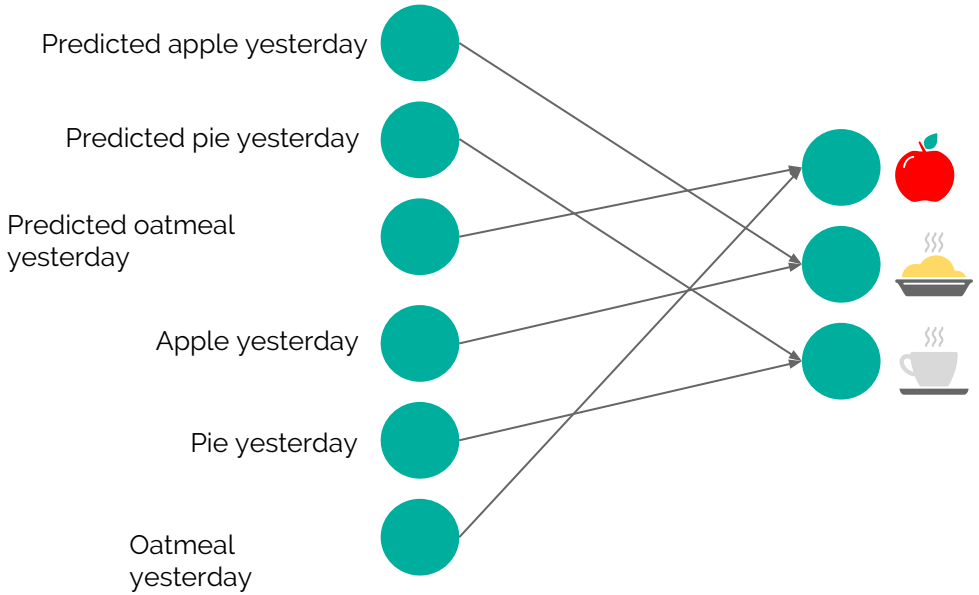
ARCH, GARCH, EGARCH...

Limitation of traditional forecast models

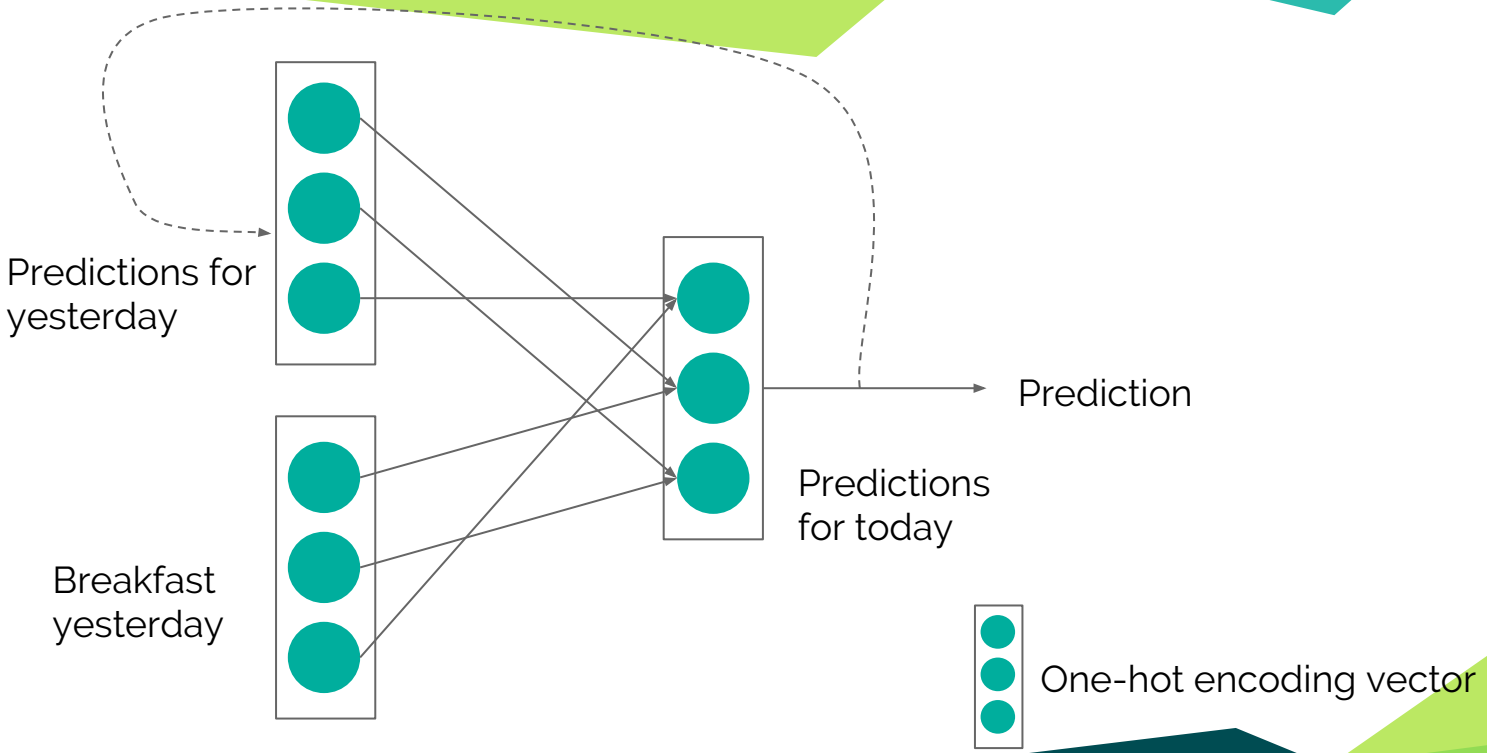
- Focus on complete data
- Focus on linear relationships
- Focus on fixed temporal dependence
- Focus on univariate data
- Focus on one-step forecasts

Deep Learning for Time Series

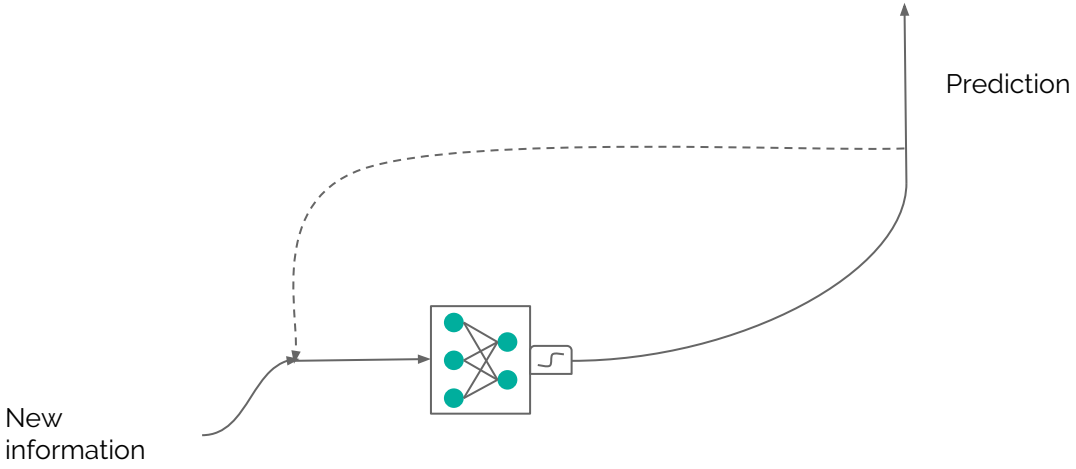
Start from what's for breakfast tomorrow?



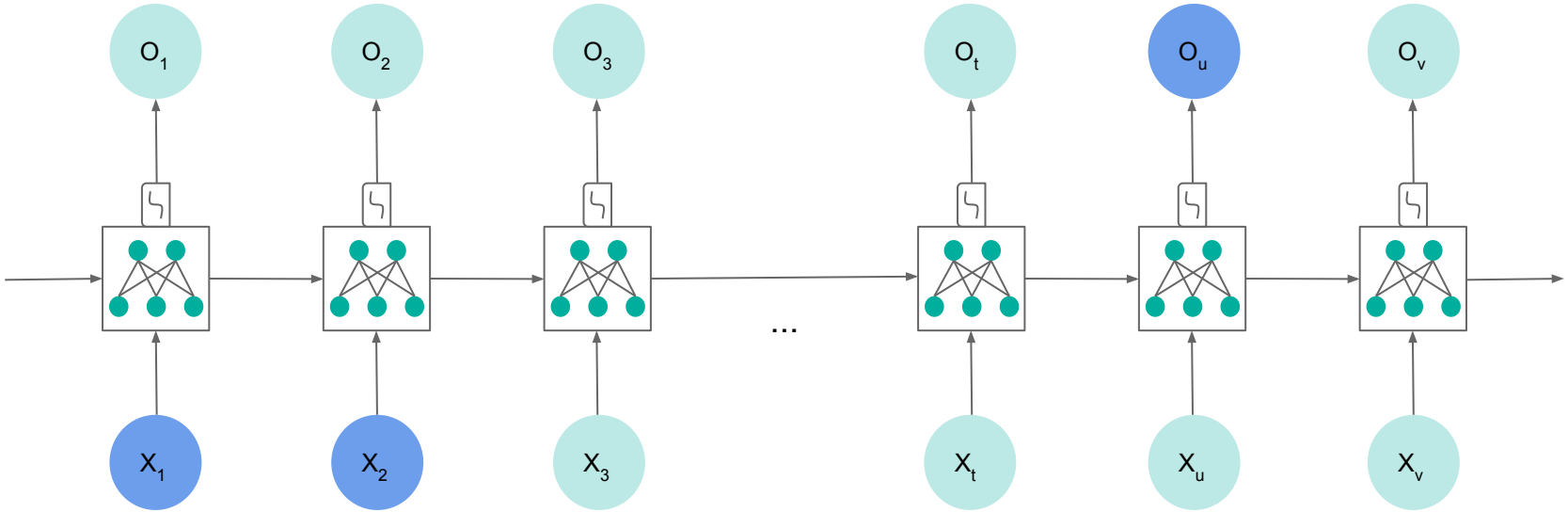
RNN


Predictions for yesterday
Breakfast yesterday
Predictions for today
Prediction
One-hot encoding vector

Simplified RNN



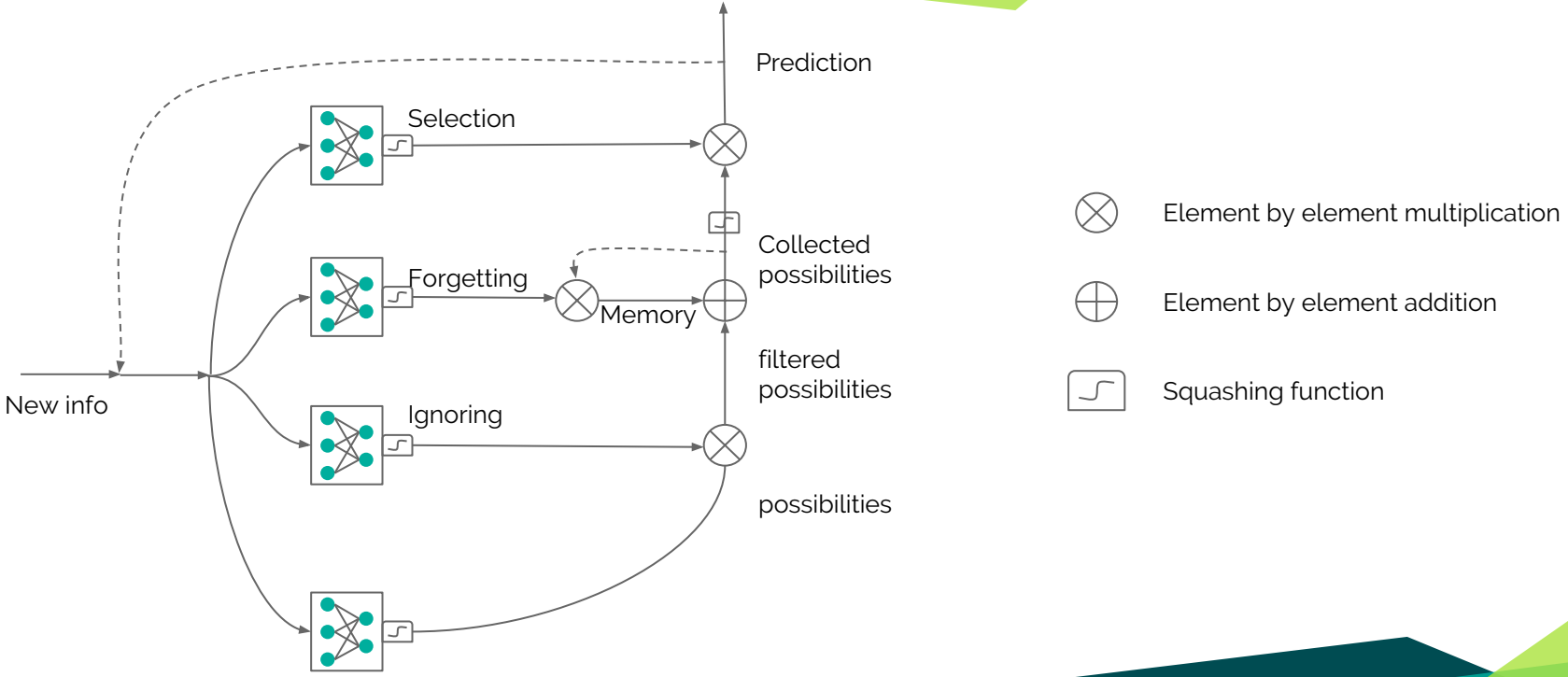
Expend RNN



Limitation of RNN

- Short term memory
- Vanishing/ Exploding gradients

LTSM


Prediction
Selection
Forgetting
Memory
Collected possibilities
filtered possibilities
Ignoring
possibilities
New info
Element by element multiplication
Element by element addition
Squashing function

References

1. A beginner’s guide to RNN and LSTM
2. 遞歸神經網路(RNN)和長短期記憶模型(LSTM)的運作原理
3. Deep learning for time series analysis
4. Time Series Prediction with LSTM Recurrent Neural Networks in Python with Keras

Hands on