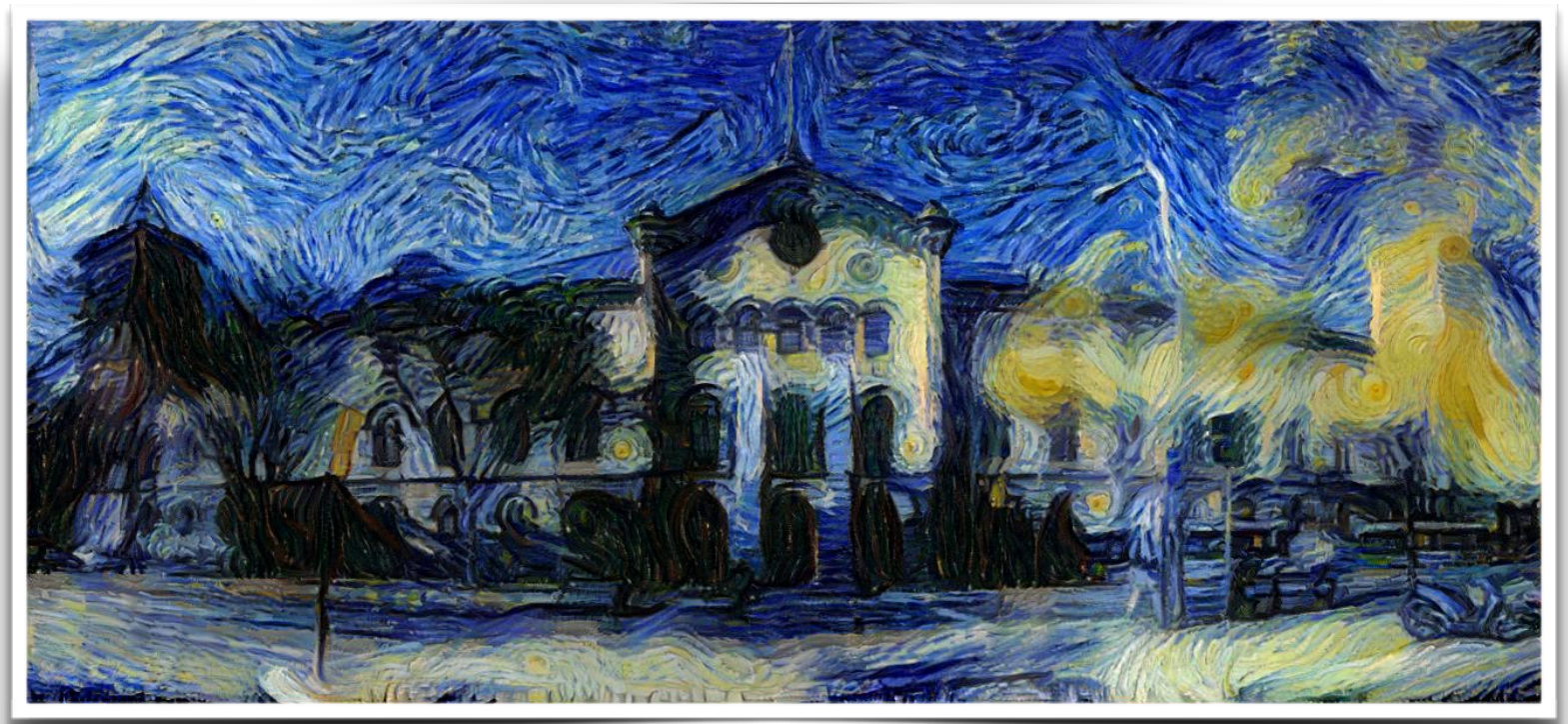

Deep Learning From Scratch

Time Series Analysis

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Time series is a collection of data points collected at **constant time intervals**.

Usually, they are analyzed to determine the long term trend so as to **forecast** the future or perform some other form of analysis.

This kind of data has two specific characteristics:

- **It is time dependent**. So the basic assumption of a linear regression model that the observations are independent doesn't hold in this case.
- Along with an increasing or decreasing trend, most time series have some form of **seasonality trends**.

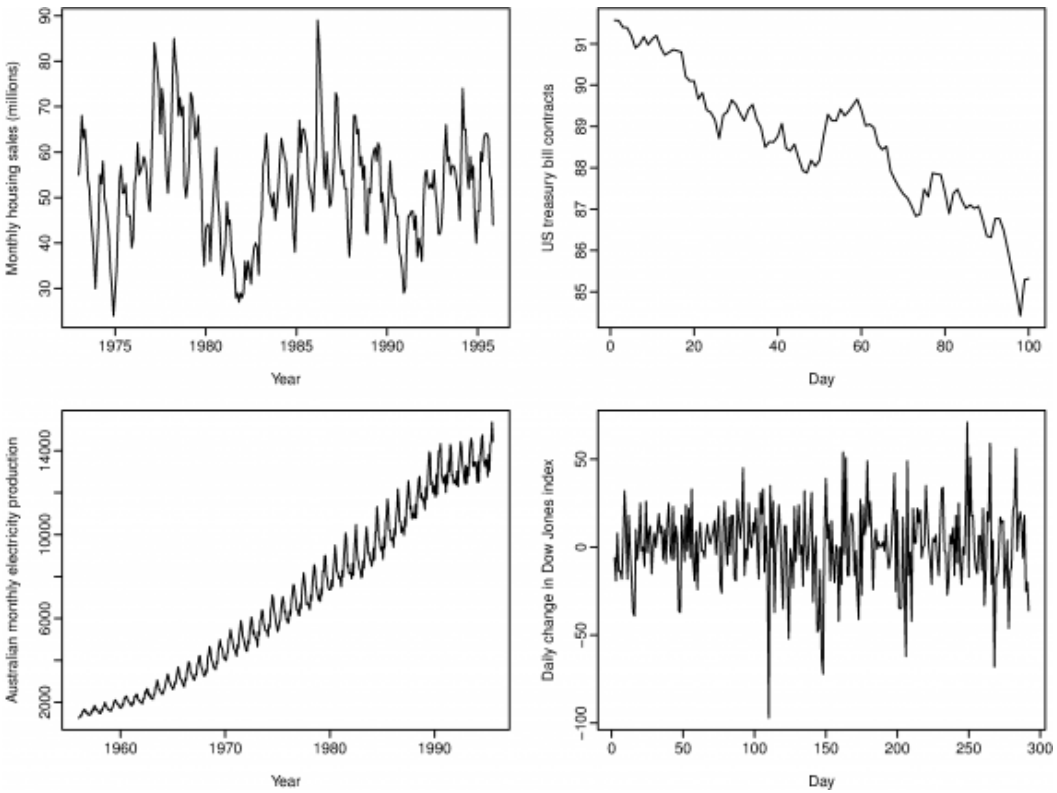
There are three types of time series patterns:

Trend: A trend exists when there is a long-term increase or decrease in the data. It does not have to be linear. Sometimes we will refer to a trend "changing direction" when it might go from an increasing trend to a decreasing trend.

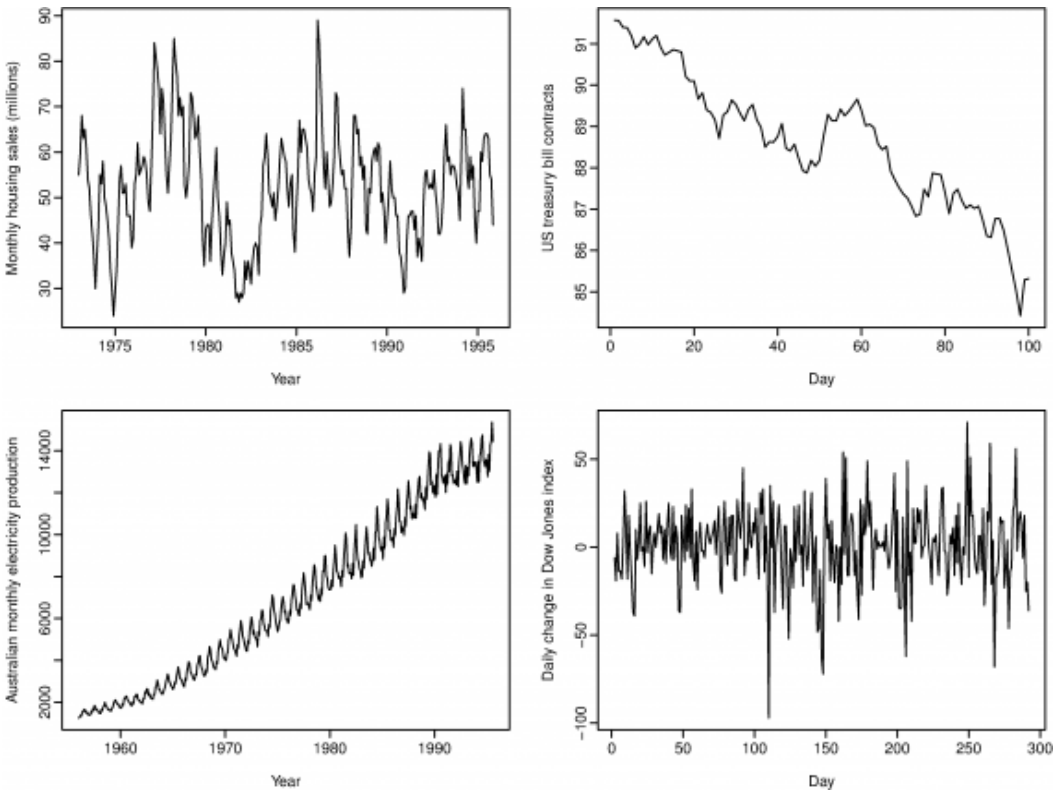
Seasonal: A seasonal pattern exists when a series is influenced by seasonal factors (e.g., the quarter of the year, the month, or day of the week). Seasonality is always of a fixed and known period.

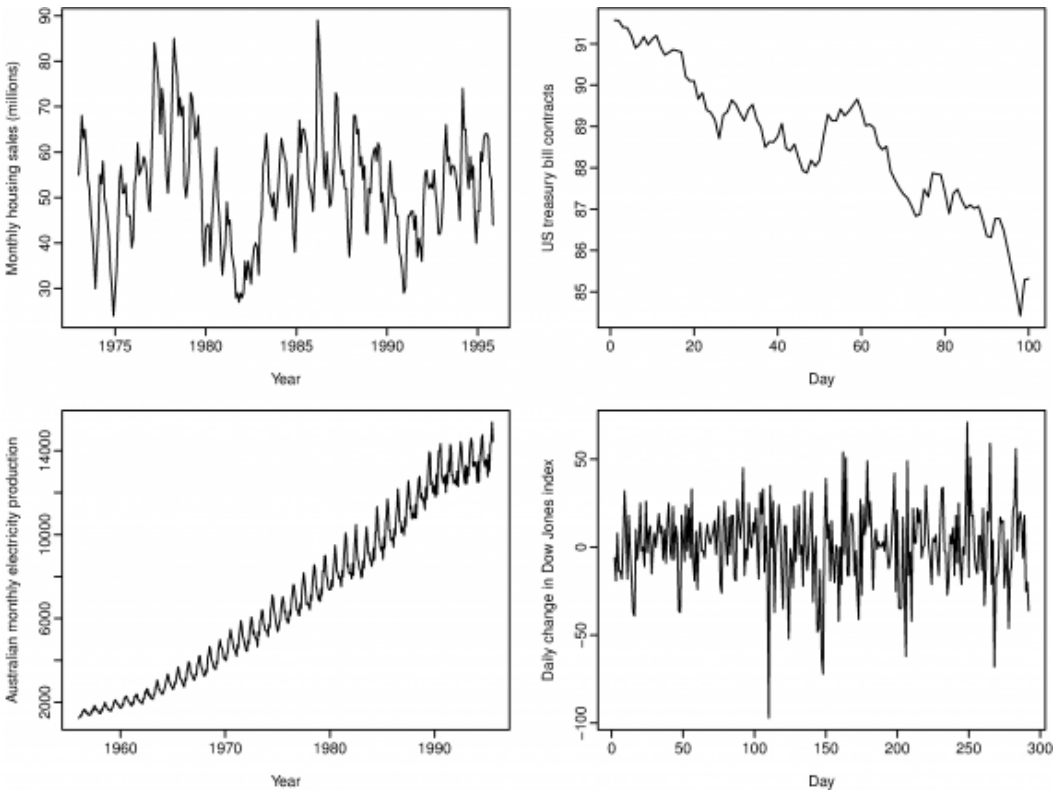
Cyclic: A cyclic pattern exists when data exhibit rises and falls that are not of fixed period. The duration of these fluctuations is usually of at least 2 years.

The **monthly housing sales** show strong seasonality within each year, as well as some strong cyclic behaviour with period about 6–10 years. There is no apparent trend in the data over this period.

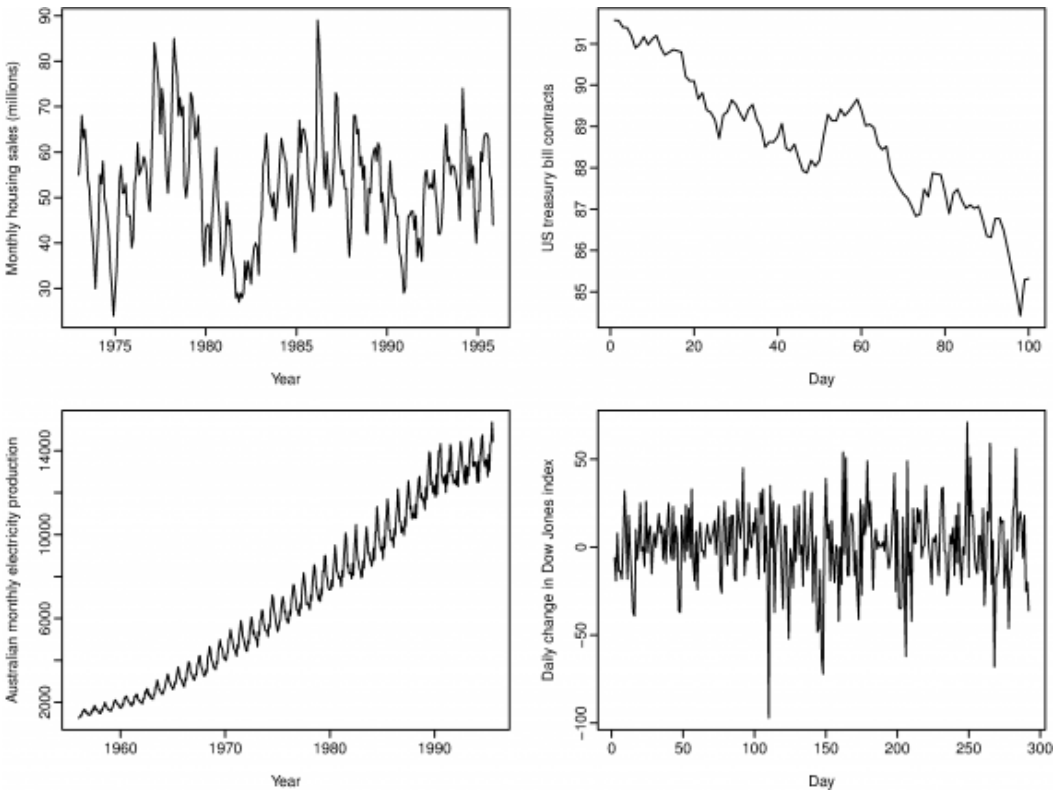


The **US treasury bill contracts** show results from the Chicago market for 100 consecutive trading days in 1981. Here there is no seasonality, but an obvious downward trend.

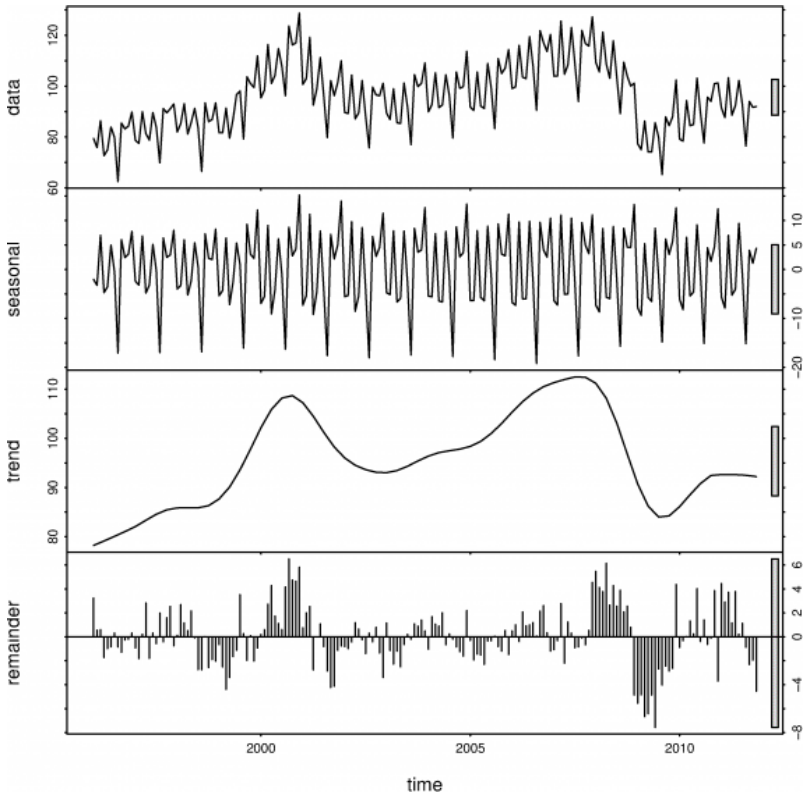




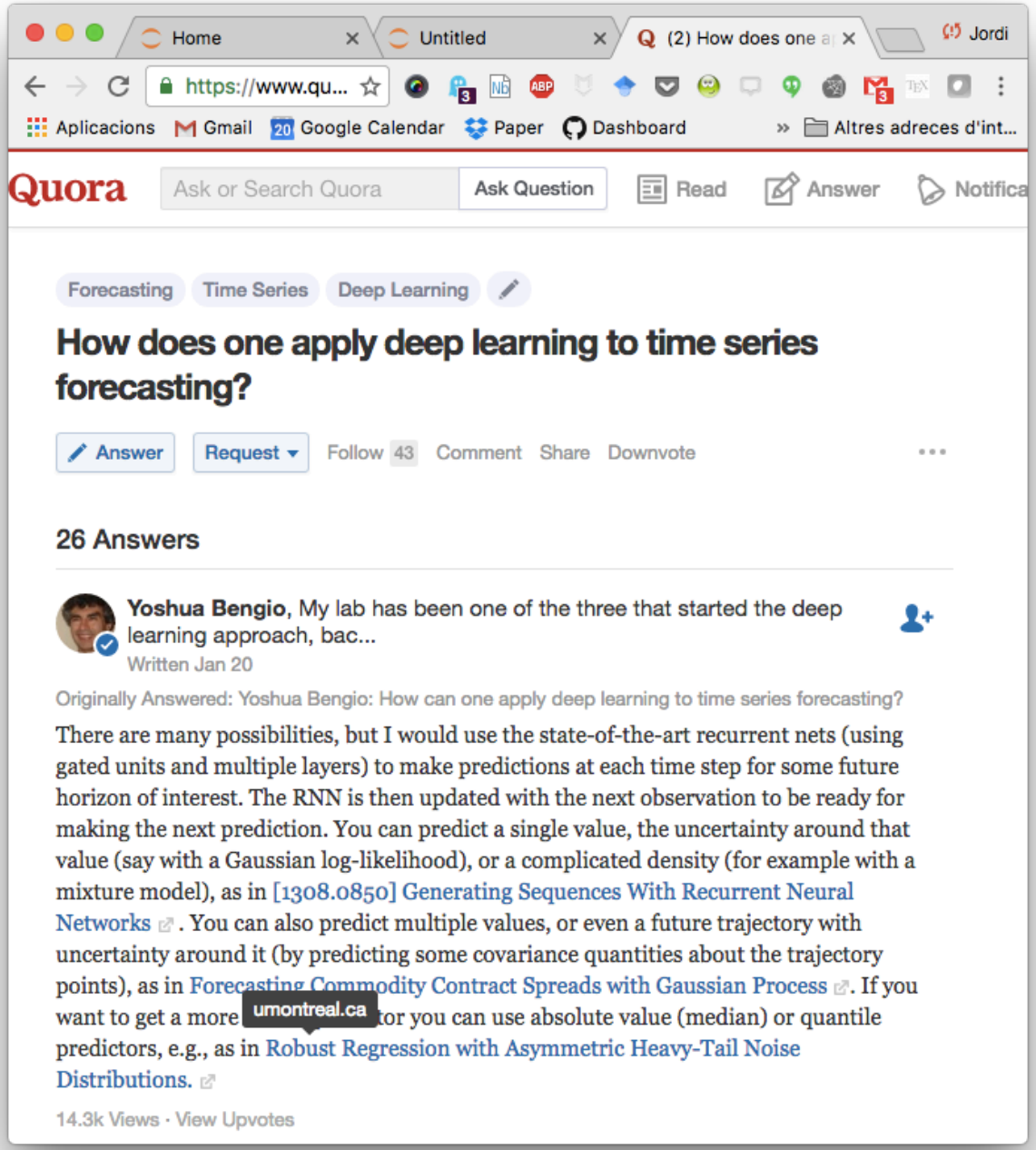
The **Australian monthly electricity production** shows a strong increasing trend, with strong seasonality. There is no evidence of any cyclic behaviour here.



The daily change in the **Dow Jones index** has no trend, seasonality or cyclic behaviour. There are random fluctuations which do not appear to be very predictable.



The classical method of **time series decomposition** originated in the 1920s and was widely used until the 1950s. It still forms the basis of later time series methods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Time Series
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26 Answers
Yoshua Bengio, My lab has been one of the three that started the deep learning approach, bac...
Written Jan 20
Originally Answered: Yoshua Bengio: How can one apply deep learning to time series forecasting?
There are many possibilities, but I would use the state-of-the-art recurrent nets (using gated units and multiple layers) to make predictions at each time step for some future horizon of interest. The RNN is then updated with the next observation to be ready for making the next prediction. You can predict a single value, the uncertainty around that value (say with a Gaussian log-likelihood), or a complicated density (for example with a mixture model), as in [1308.0850] Generating Sequences With Recurrent Neural Networks . You can also predict multiple values, or even a future trajectory with uncertainty around it (by predicting some covariance quantities about the trajectory points), as in Forecasting Commodity Contract Spreads with Gaussian Process . If you want to get a more
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tor you can use absolute value (median) or quantile predictors, e.g., as in Robust Regression with Asymmetric Heavy-Tail Noise Distributions.
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