Deep Learning course

Session 11 – Recurrent Neural Networks (RNN)

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Outline

Sequential data

- Time series (finance).
- Sound (speech recognition).
- Video (activity classification).
- Text (translation, sentiment analysis).
- DNA (sequence analysis).

Sequential data

In general, data that is indexed over time:

e.g., univariate series,

$$y_t = f(y_{t-1}, \ldots, y_1; \mathbf{w}),$$

or multivariate series,

$$\mathbf{y}_t = f(\mathbf{y}_{t-1}, \ldots, \mathbf{y}_1; \mathbf{w}),$$

or even,

$$\mathbf{y}_t = f(\mathbf{x_t}, \mathbf{y}_{t-1}, \ldots, \mathbf{y}_1; \mathbf{w}).$$

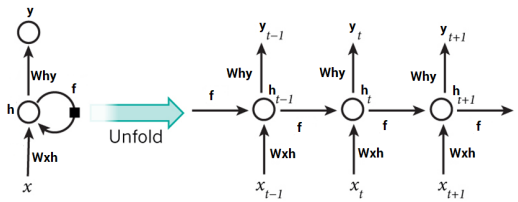
Outline

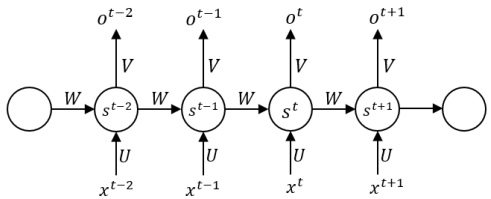
Recurrent Neural Networks (RNN)

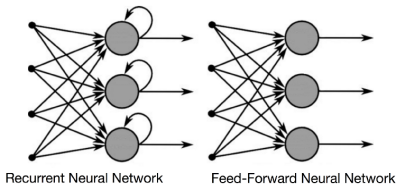
Recurrent Neural Networks (RNN) are the state-of-the-art methods when dealing with sequential data.

Predict by taking into consideration the current input, plus what it has learned from previously seen inputs.

- MLP with internal memory (over time).







Recurrent Neural Networks (RNN)

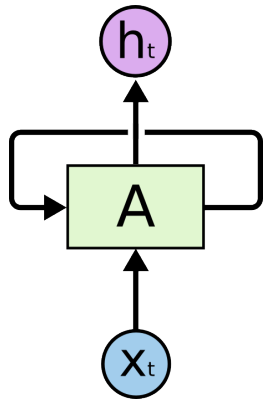
Mathematically,

$$\mathbf{a}_t = f(\mathbf{w}^{(aa)}\mathbf{a}_{t-1} + \mathbf{w}^{(ax)}\mathbf{x}_t + \mathbf{b}^{(a)}),$$

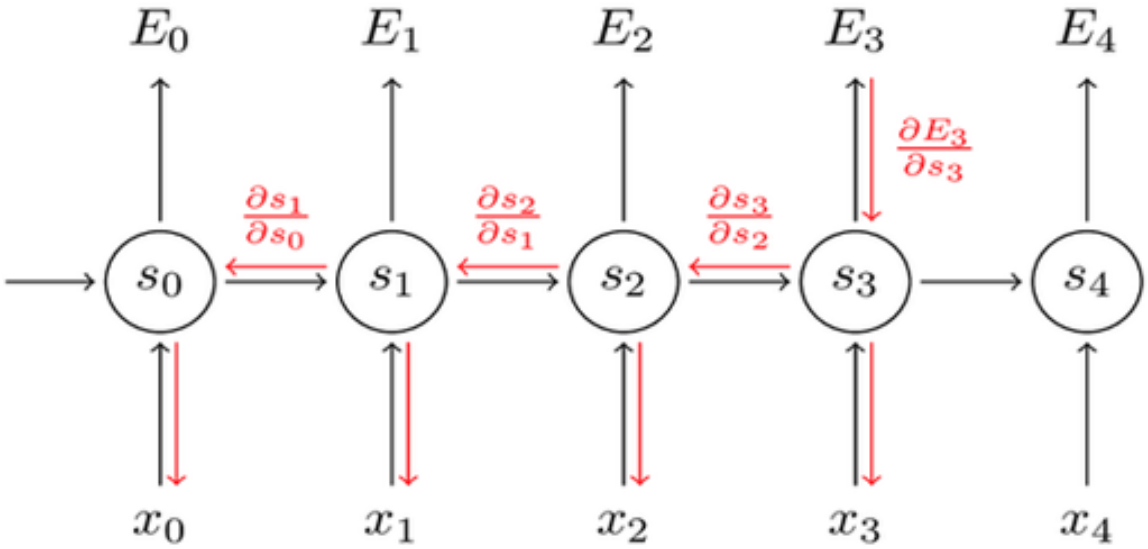
where $f(\cdot)$ is often a tanh or ReLU activation function.

$$\mathbf{y}_t = g(\mathbf{w}^{(ya)}\mathbf{a}_t + \mathbf{b}^{y}),$$

where $g(\cdot)$ is often a sigmoid function. And $\mathbf{a}_0 = 0$.



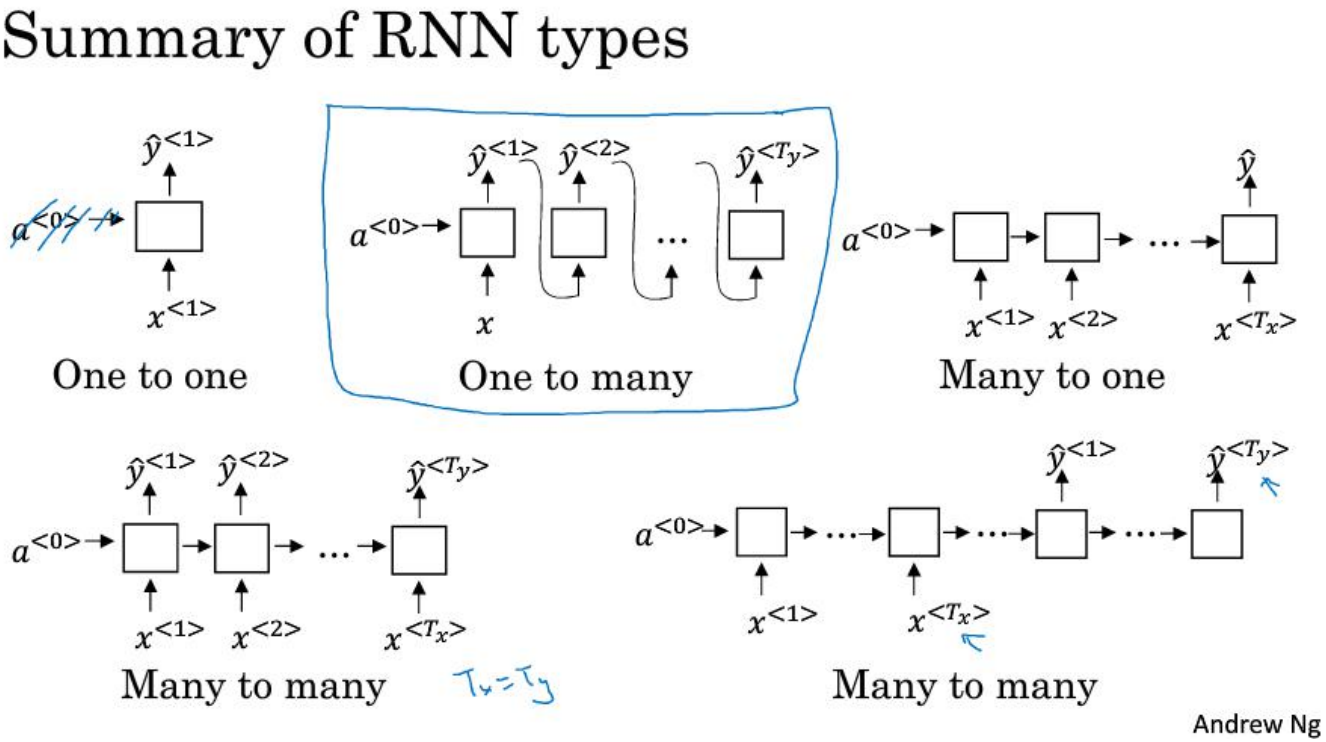
Issues



Backpropagation Through Time

- Vanishing/Exploiting gradient.

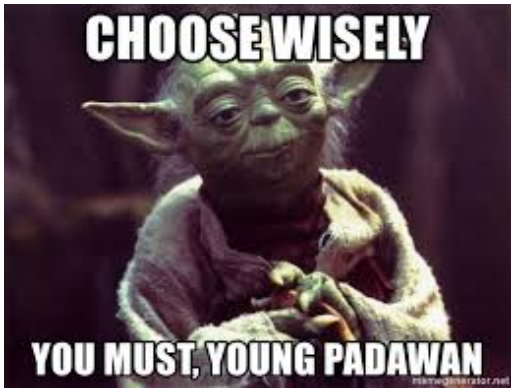
Types of RNNs



Chose depending on your application.

Types of RNNs, examples

- One-to-one: univariate time series regression.
- One-to-many: assign a sequence of labels to an image.
- Many-to-one: sentiment analysis.
- Many-to-many: label each frame of a video.
- AE-many-to-many: text translation.



To know more

- Goodfellow, DL Book. Chapter 10.
- https://www.youtube.com/watch?v=5VI-bK7tfD8&list=PLBAGcD3siRDittPwQDGIIAWkjz-RucAc7
- https://towardsdatascience.com/recurrent-neural-networks-and-lstm-4b601dd822a5
- http://colah.github.io/posts/2015-08-Understanding-LSTMs/

Thank you.

Q&A