Recurrent Neural Networks I

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Applications of Machine Learning (4AL3)

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McMaster University
ENGINEERING

Introduction

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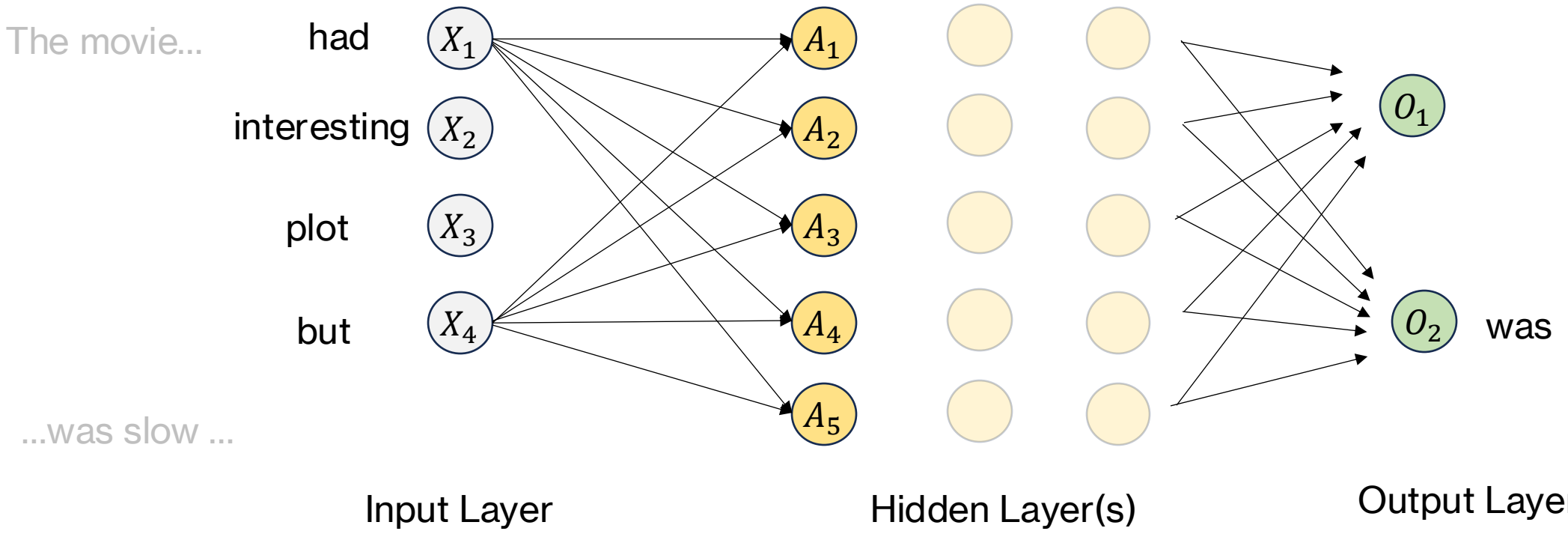
Is RNN supervised or semi supervised?

Feedforward Neural Networks

- Feedforward Neural networks employ fixed-size input vectors with associated weights to capture all relevant aspects of an example at once .



Recurrent Neural Networks

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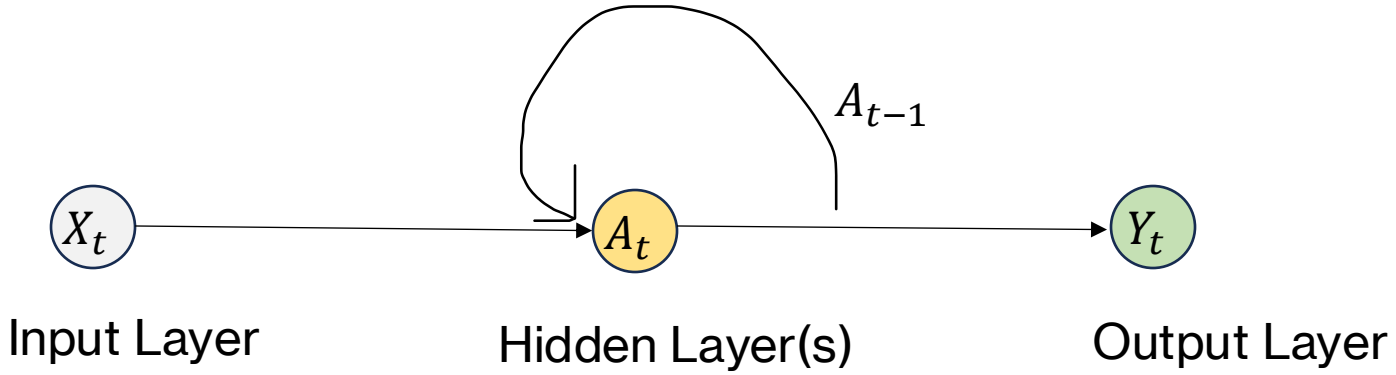

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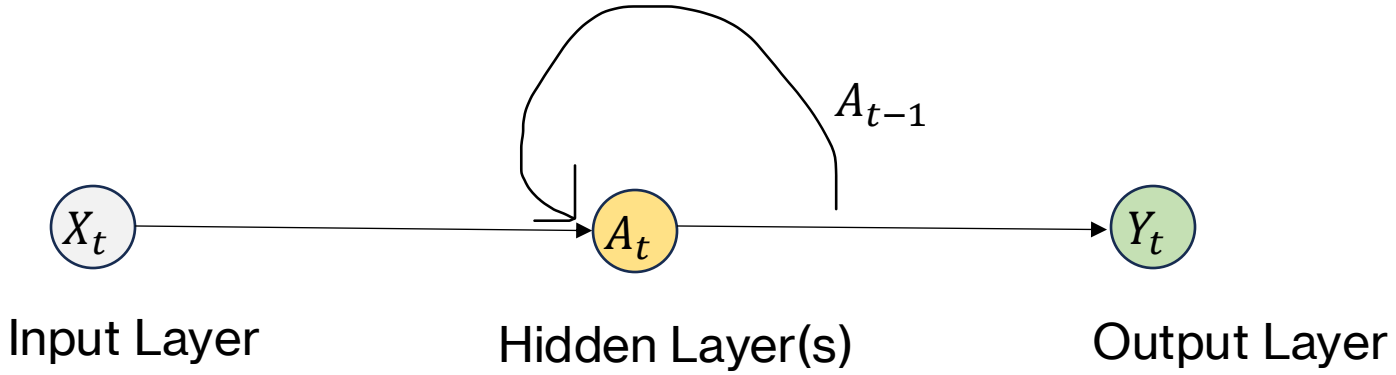

- The new set of weights determine how the network should make use of past context to calculate the output for the current input.

Recurrent Neural Networks: Inference

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$$h_t = g(Uh_{t-1} + Wx_t)$$

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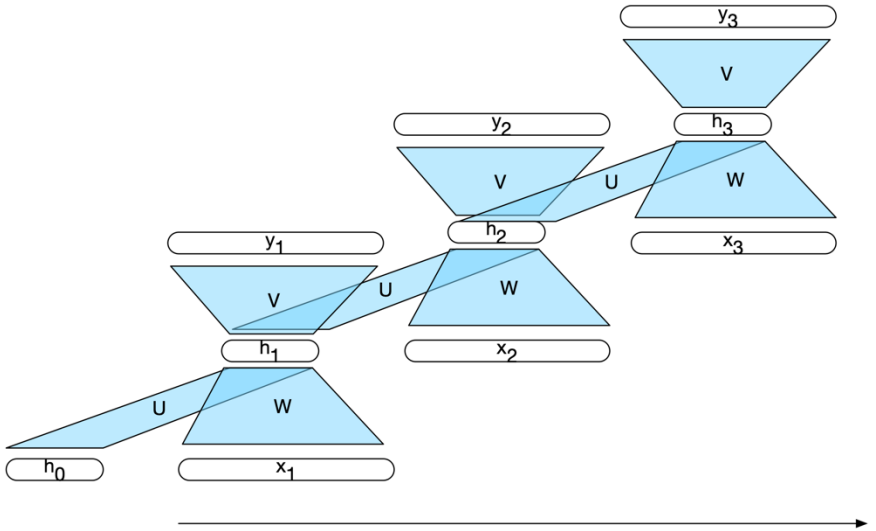

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Picture Credit: Speech and Language Processing - Jurafsky and Martin

Recurrent Neural Networks: Inference

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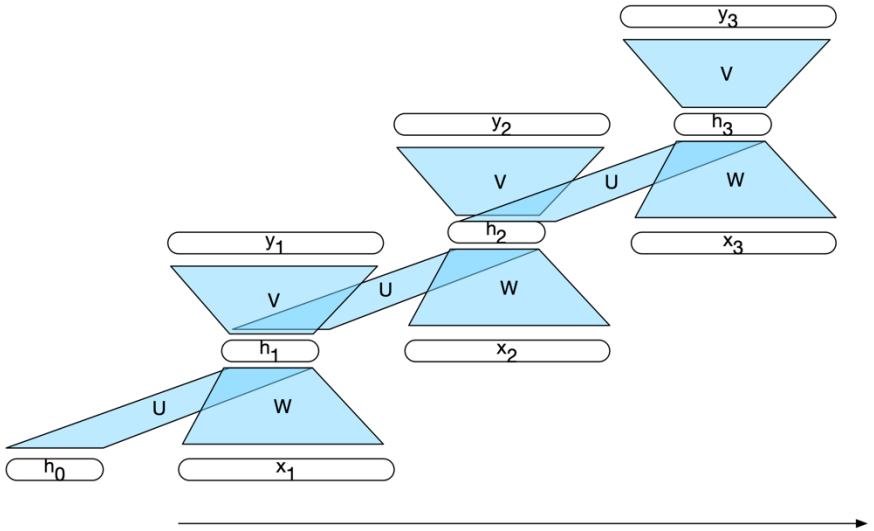
  - $h_0 \leftarrow 0$
    - for $i \leftarrow 1$ to length (x) do
      - $h_i \leftarrow g(Uh_{i-1} + Wx_i)$
      - $y_i \leftarrow f(Vh_i)$
    - return y



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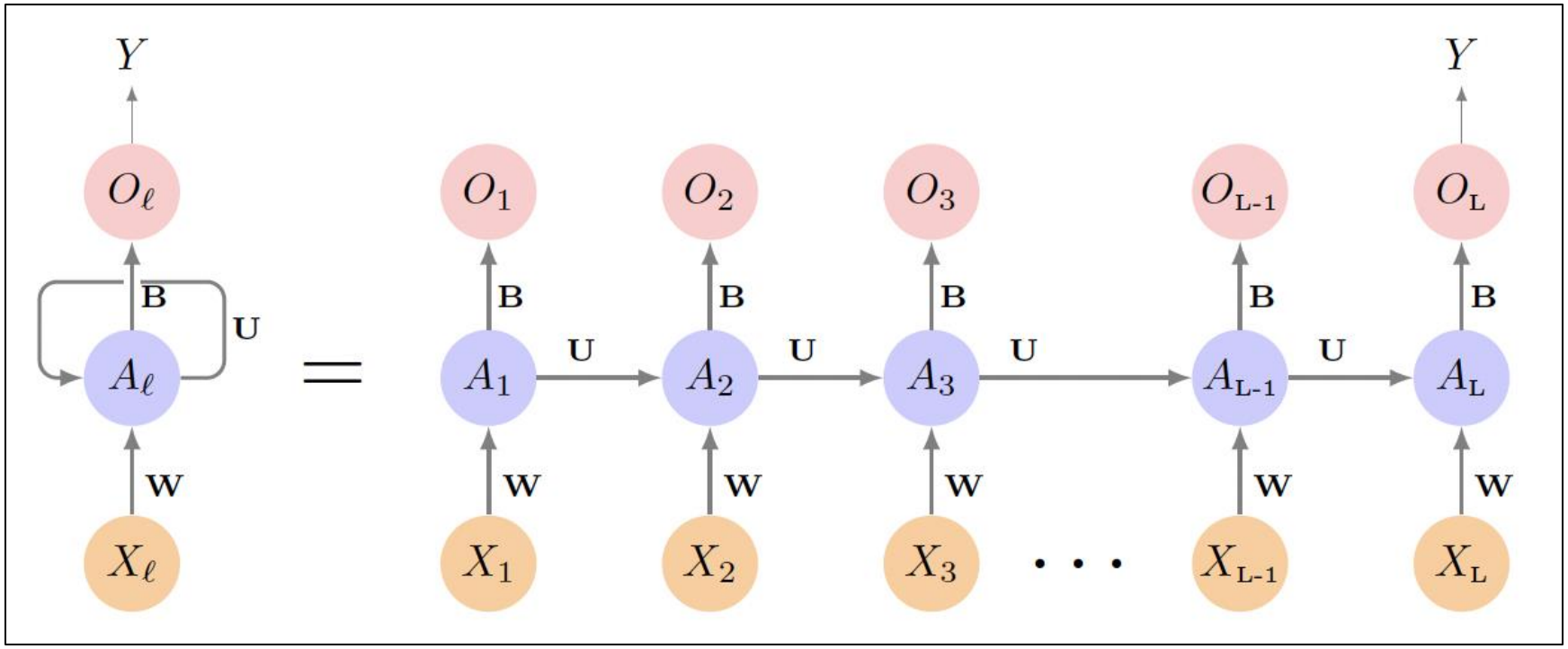


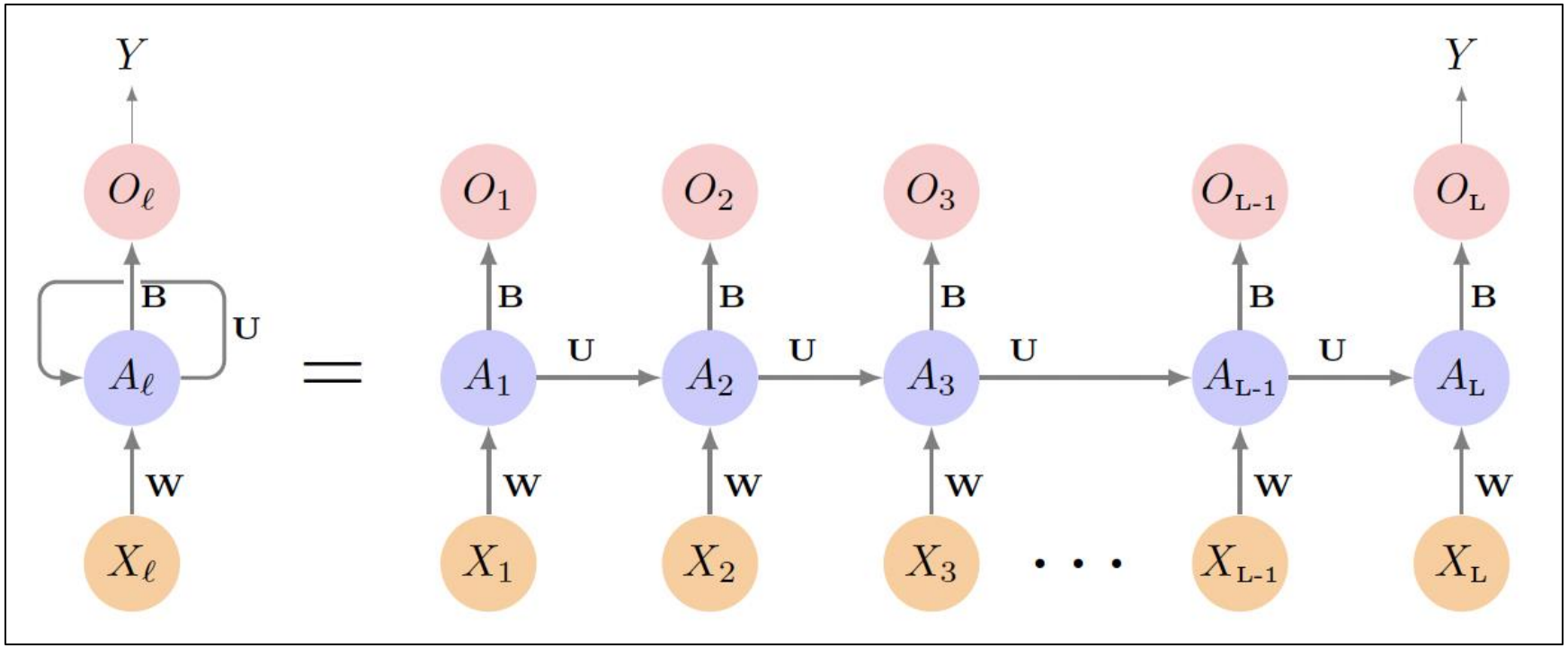
Picture Credit: ISLP

Recurrent Neural Networks: Inference

Output units

Hidden units

Input sequence



$$A_l^T = (A_{l1}, A_{l2}, \ldots, A_{lk}) \qquad A_{lk} = g\left(w_{k0} + \sum_{j=1}^{p} w_{kj} X_{lj} + \sum_{s=1}^{K} u_{ks} A_{l-1,s}\right) \qquad O_l = \beta_0 + \sum_{k=1}^{K} \beta_k A_{lk}$$

Picture Credit: ISLP

Recurrent Neural Networks: Inference

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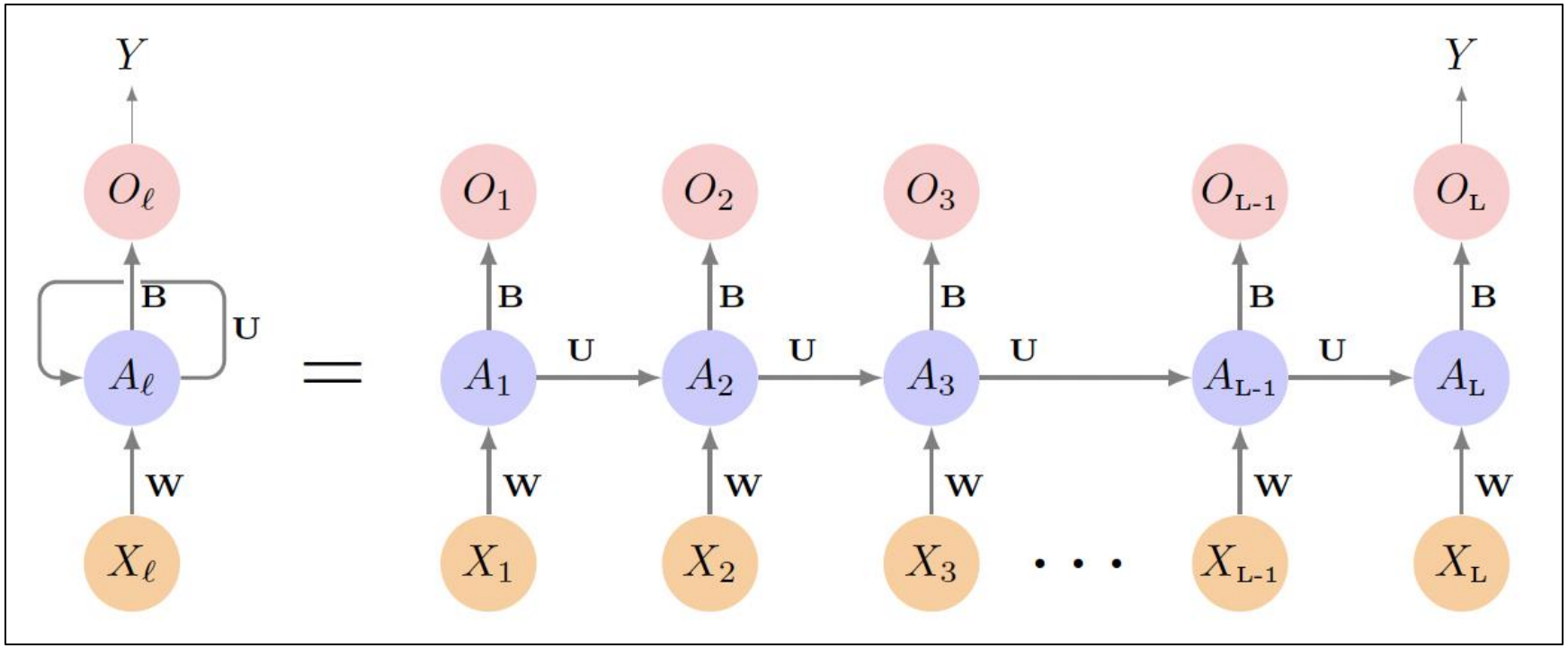
Hidden units

Input sequence

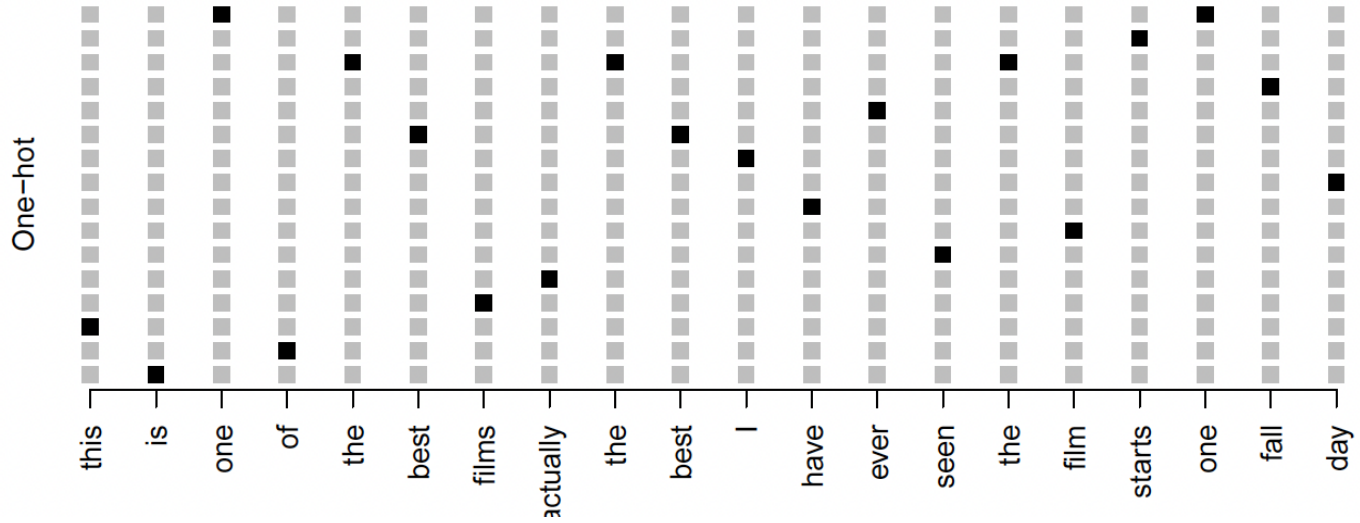


How do we evaluate if we are using RNN for regression task?

Picture Credit: ISLP

Recurrent Neural Network

- RNNs in text classification task.



Recurrent Neural Network

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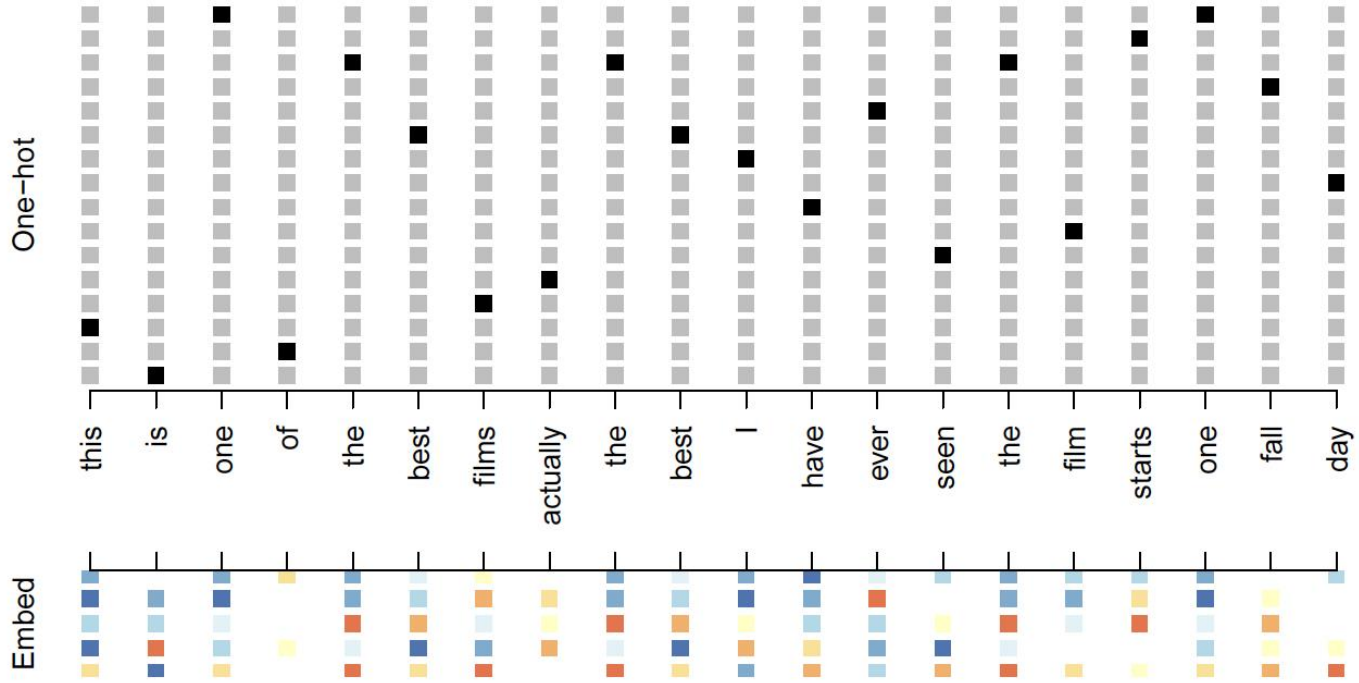

Using embedding spaces !

Recurrent Neural Network

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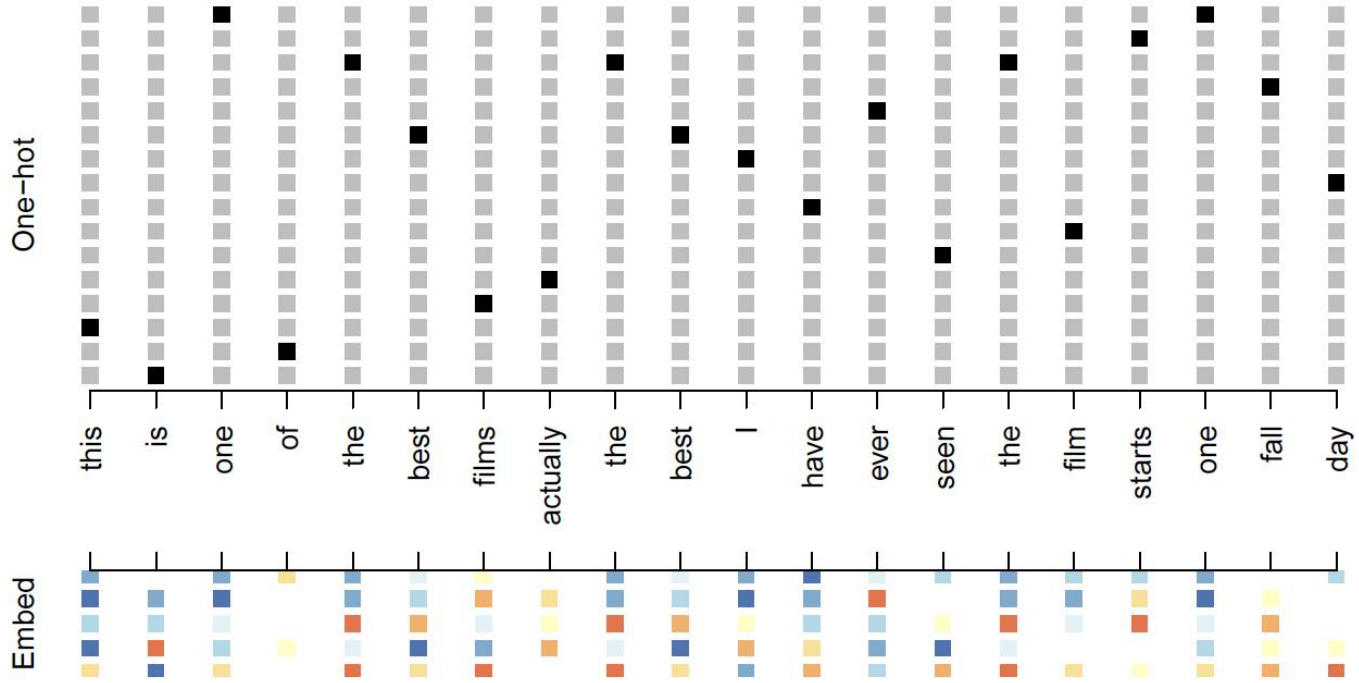

Embedding space can be learned or can weights can be frozen.

Popular frozen weights:

Word2Vec
Glove

Recurrent Neural Network

- RNNs in text classification task.

```
word_to_ix = {"how": 0, "are": 1, "you":2}
embeds = nn.Embedding(3, 5)  # 3 words in vocab, 5 dimensional embeddings
lookup_tensor = torch.tensor([word_to_ix["how"]], dtype=torch.long)
how_embed = embeds(lookup_tensor)
print(how_embed)
```

[2] ✓ 0.0s

```
tensor([[ 0.6614,  0.2669,  0.0617,  0.6213, -0.4519]],
       grad_fn=<EmbeddingBackward0>)
```

Using embedding spaces !

https://pytorch.org/tutorials/beginner/nlp/word_embeddings_tutorial.html

Recurrent Neural Network

- RNNs in text classification task.
- GloVe is an unsupervised learning algorithm for obtaining vector representations for words.
- Training is performed on aggregated global word-word co-occurrence statistics from a corpus, and the resulting representations showcase interesting linear substructures of the word vector space.

GloVe: Global Vectors for Word Representation

Jeffrey Pennington, Richard Socher, Christopher D. Manning

Introduction

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Getting started (Code download)

- Download the latest latest code (licensed under the Apache License, Version 2.0).
  Look for "Clone or download"
- Unpack the files: unzip master.zip
- Compile the source: cd GloVe-master && make
- Run the demo script: ./demo.sh
- Consult the included README for further usage details, or ask a question

Download pre-trained word vectors

- Pre-trained word vectors. This data is made available under the Public Domain Dedication and License v1.0 whose full text can be found at: http://www.opendatacommons.org/licenses/pddl/1.0/.
  - Wikipedia 2014 + Gigaword 5 (6B tokens, 400K vocab, uncased, 50d, 100d, 200d, & 300d vectors, 822 MB download): glove.6B.zip
  - Common Crawl (42B tokens, 1.9M vocab, uncased, 300d vectors, 1.75 GB download): glove.42B.300d.zip
  - Common Crawl (840B tokens, 2.2M vocab, cased, 300d vectors, 2.03 GB download): glove.840B.300d.zip
  - Twitter (2B tweets, 27B tokens, 1.2M vocab, uncased, 25d, 50d, 100d, & 200d vectors, 1.42 GB download): glove.twitter.27B.zip
- Ruby script for preprocessing Twitter data

Citing GloVe

Jeffrey Pennington, Richard Socher, and Christopher D. Manning. 2014. GloVe: Global Vectors for Word Representation. [pdf] [bib]

Highlights

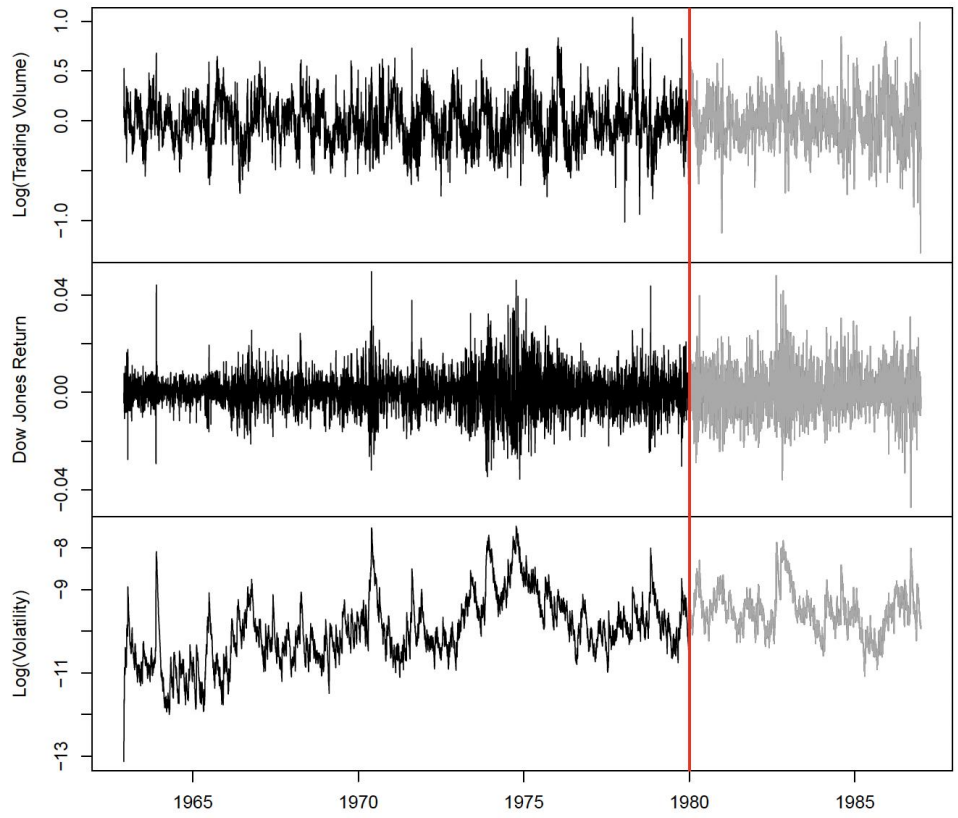
1. **Nearest neighbors**

The Euclidean distance (or cosine similarity) between two word vectors provides an effective method for measuring the linguistic or semantic similarity of the corresponding words. Sometimes, the nearest neighbors according to this metric reveal rare but relevant words that lie outside an average human's vocabulary. For example, here are the closest words to the target word *frog*:

0. *frog*
1. frogs
2. toad
3. litoria
4. leptodactylidae
5. rana
6. lizard
7. eleutherodactylus

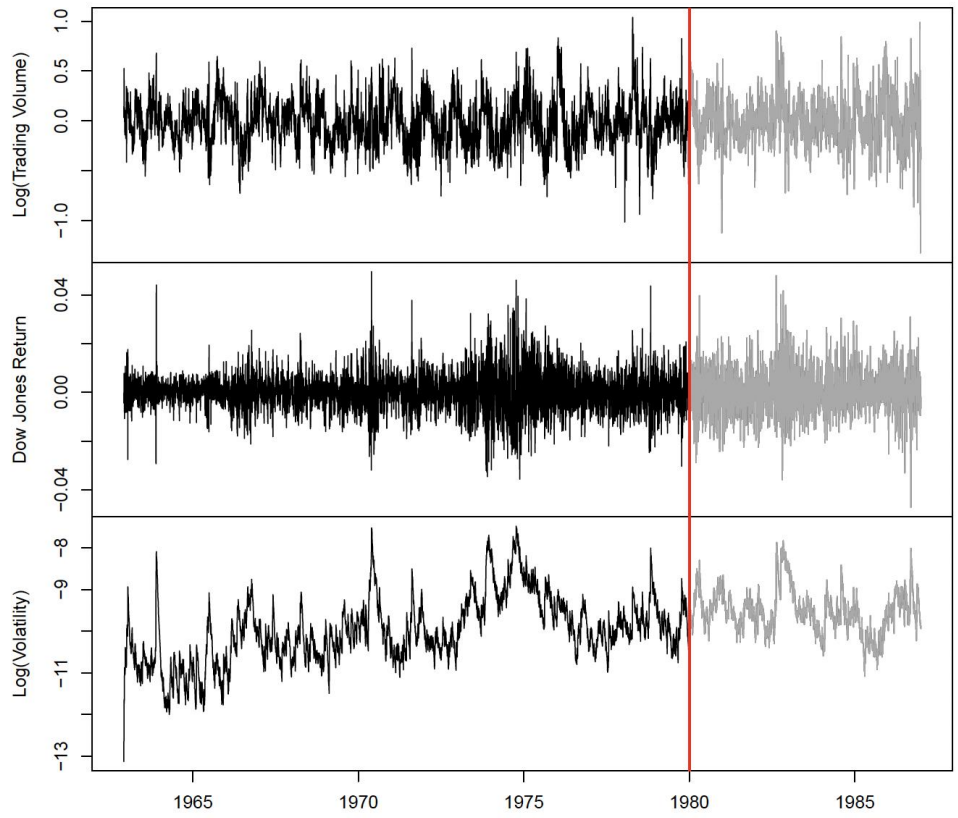
Recurrent Neural Network

- RNNs for time-series forecasting



Recurrent Neural Network

- RNNs for time-series forecasting
- Predicting trading trend (or stocks to buy and their prices) is extremely hard.
- Predicting trading volume is still something you can work with.



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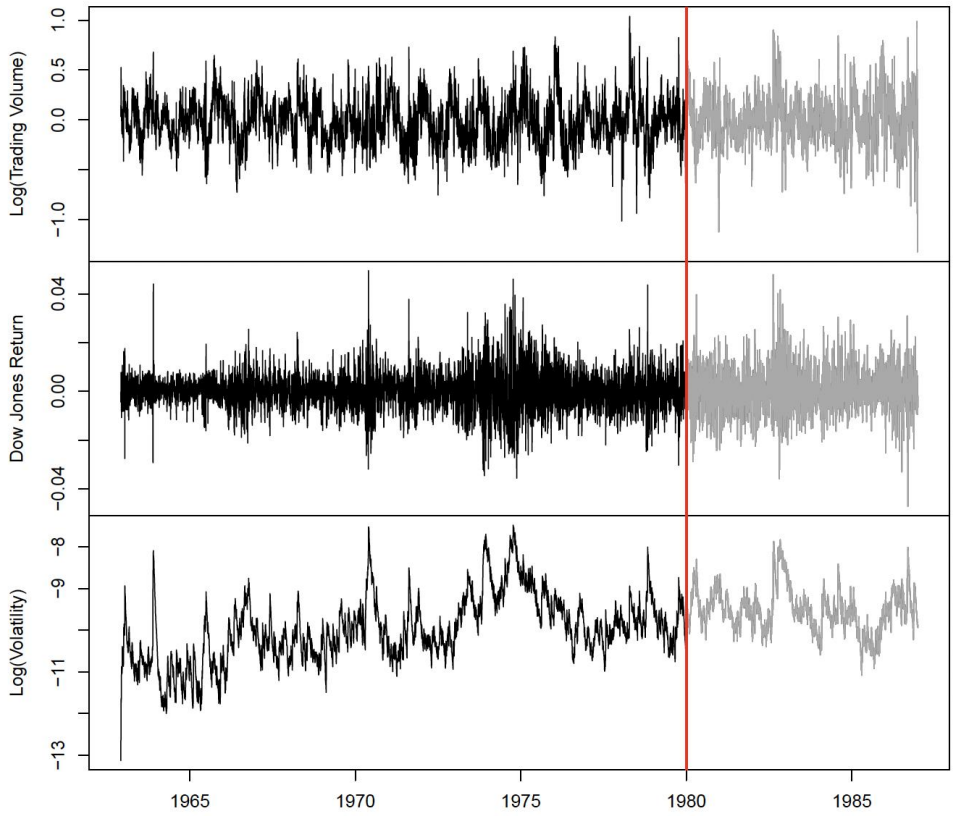
Input variables: (Volume, Return, Volatility)



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Readings

Supplemental Readings :

- ISLP: Chapter 10

Thank You

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