EE7207 Lecture 8

Modern Recurrent Neural Networks

About me

Just call me Nick!

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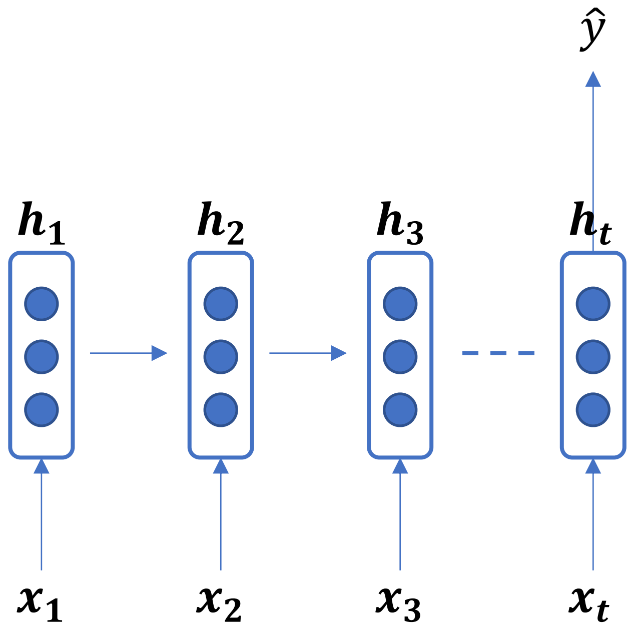
Examples of sequence data in applications

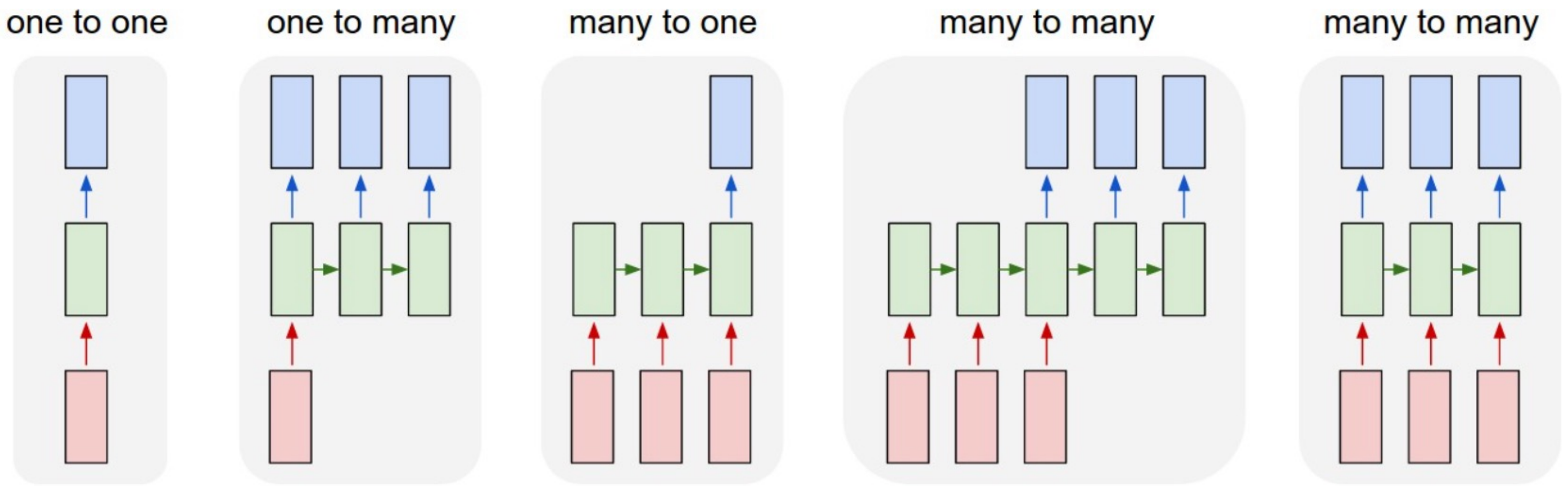
Language Model	Speech Recognition	Machine Translation	Stock Prediction
Sequence to one	Sequence to sequence	Sequence to sequence	Sequence to one
X: text sequence Y: next word	X: wave sequence Y: text sequence	X: text sequence (in one language) Y: text sequence (in another language)	X: sequence of market data Y: next day/year price/direction

- Most machine learning models can only handle structured data in a tabular form
- It’s difficult to deal with unstructured sequence data
- Earlier attempt of converting unstructured sequence data into structured form:
  - Bag-of-words: the text sequence is represented as the bag of its words, discarding the word order

Recurrent Neural Network

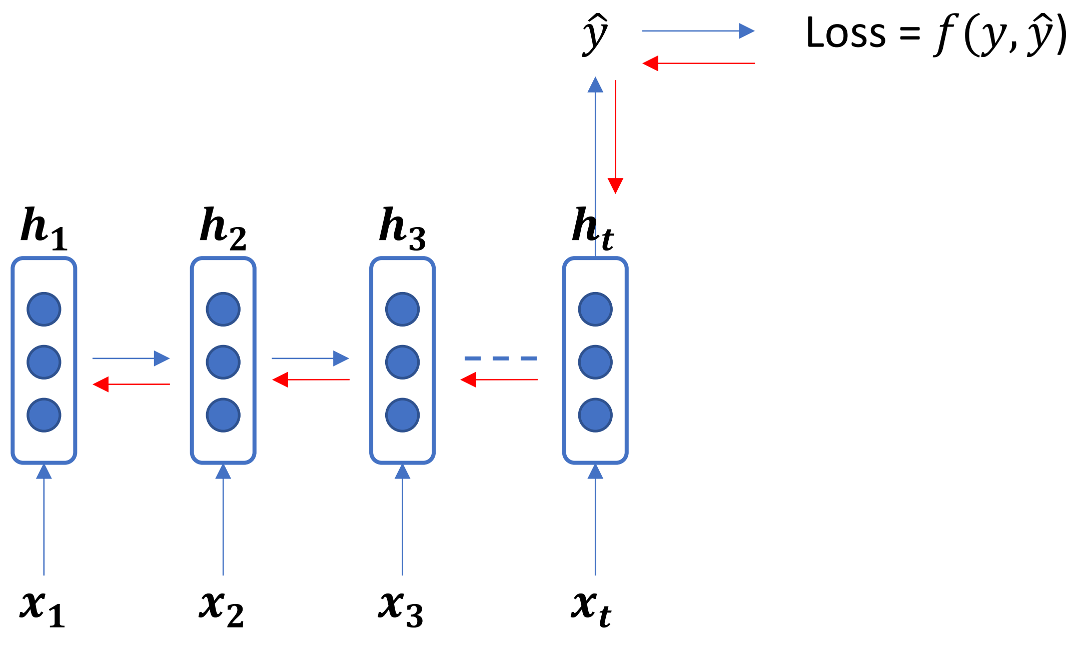


many to one example



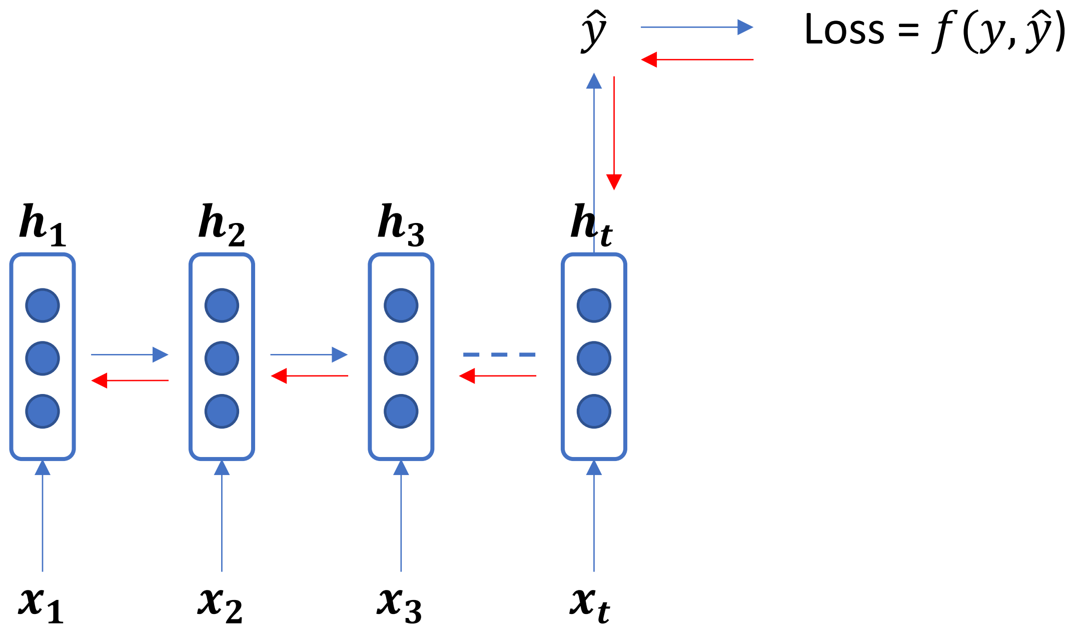
https://karpathy.github.io/2015/05/21/rnn-effectiveness/

Backpropagation through time



Vanishing gradients and exploding gradient problem

The chain rule: $\sigma'(\boldsymbol{h_t}) \times \sigma'(\boldsymbol{h_{t-1}}) \times \cdots \times \sigma'(\boldsymbol{h_1})$



The value becomes very large if each of them is greater than 1: exploding gradients problem

- Gradient clipping: cap the gradient at a predefined value

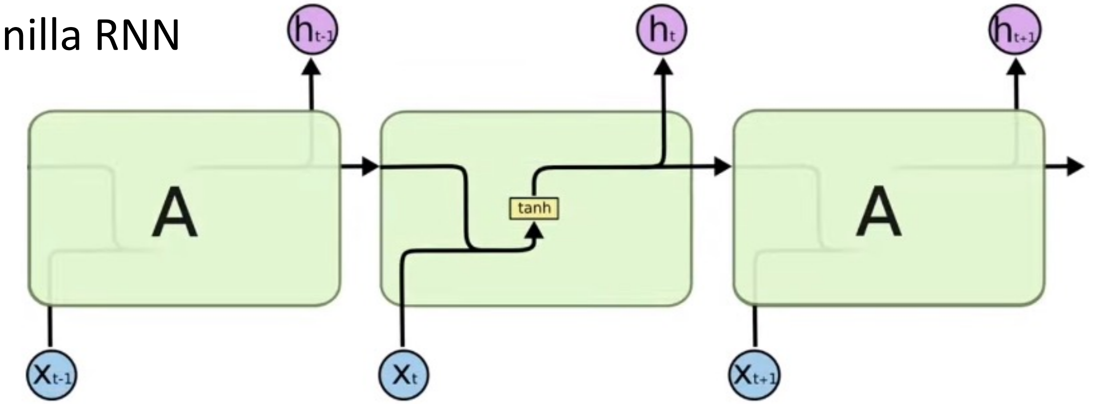
The value becomes 0 fast if each of them is less than 1: vanishing gradients problem

- No easy way to handle this for vanilla RNN, we'll be introducing LSTM and GRU that can (partially) address this issue

Vanilla RNN is not good at capturing long-term dependencies.

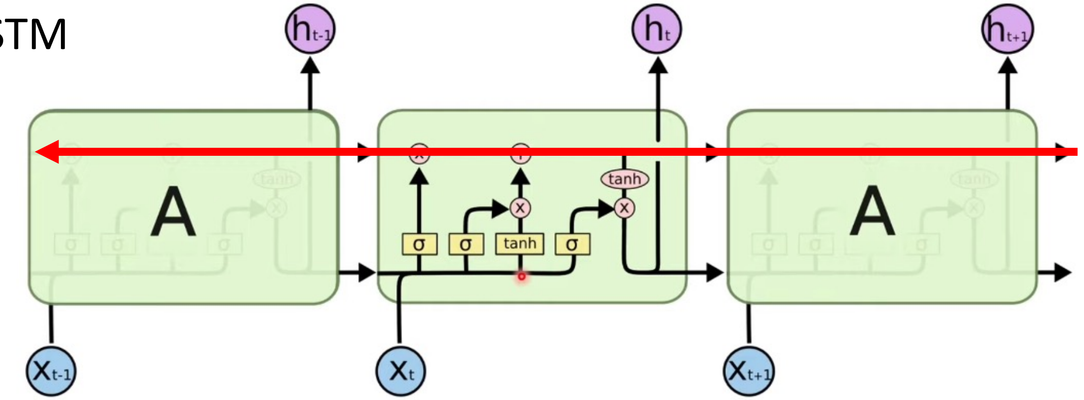
Long Short-Term Memory (LSTM) Networks

Vanilla RNN



- LSTM has gates to optionally let information through
- LSTM can decide how much old information to forget and how much new information to remember

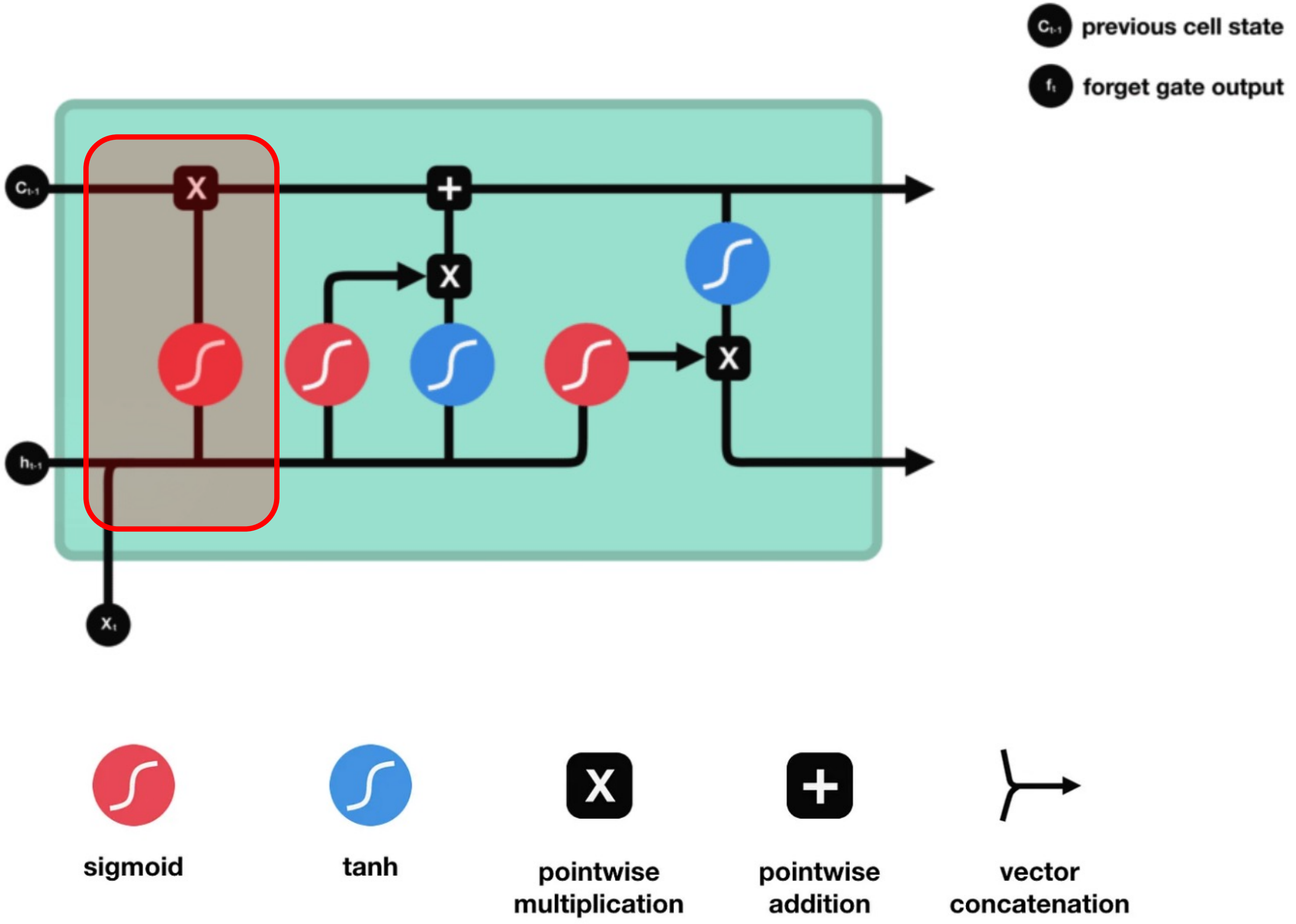
LSTM



- A highway for gradients to pass through
- Similar to ResNet for computer vision

LSTM Networks – Forget Gate

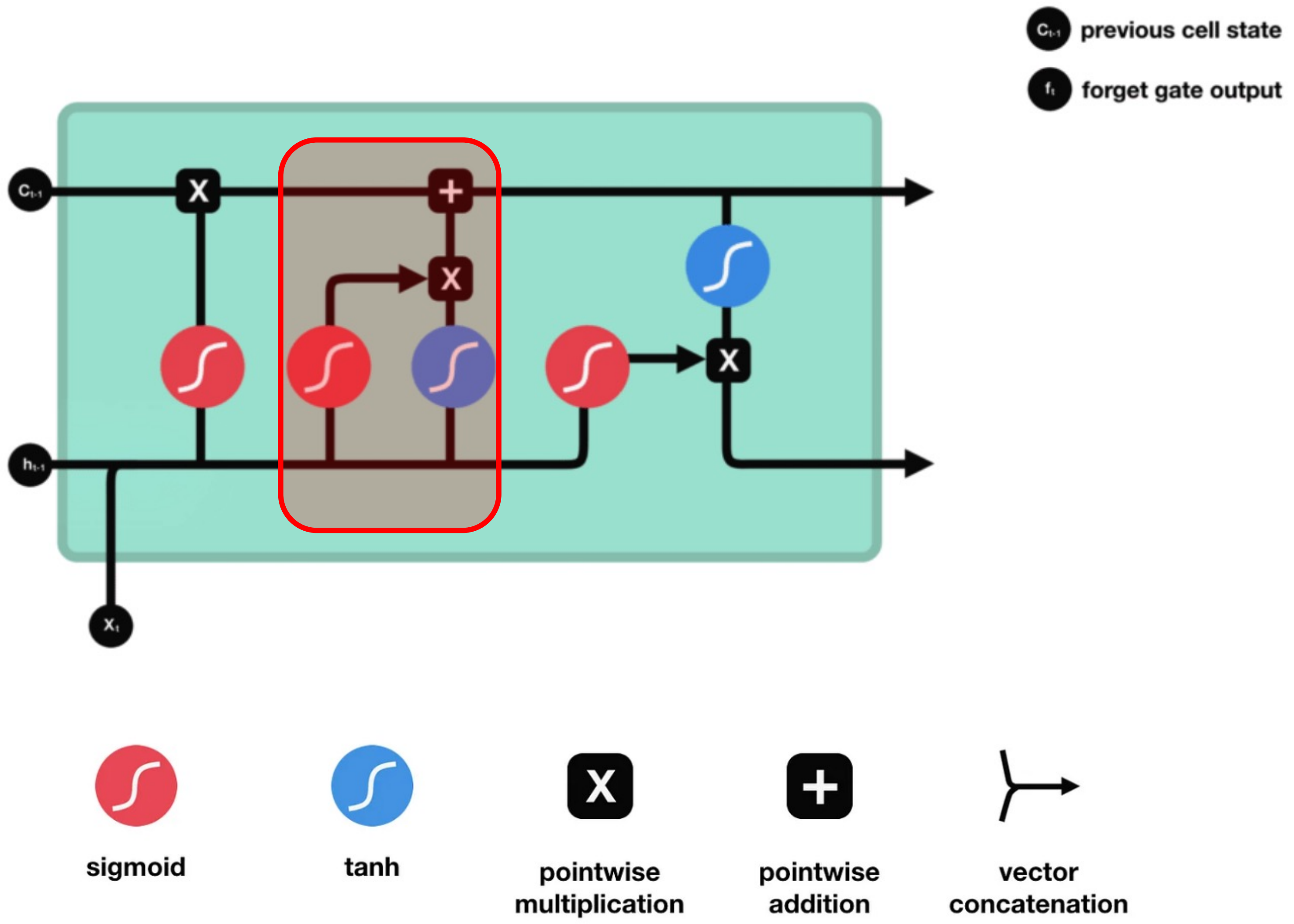
- Forget gate: how much information in previous cell state shall be kept or forgotten
- Input of sigmoid: previous hidden states and current input
- Output of sigmoid: value between 0 and 1
  - 0: forget all previous cell info
  - 1: keep all previous cell info



https://towardsdatascience.com/illustrated-guide-to-lstms-and-gru-s-a-step-by-step-explanation-44e9eb85bf21

LSTM Networks – Input Gate

- Input gate: how much new information to be added to the cell state
- Input of sigmoid: previous hidden states and current input
- Output of sigmoid: value between 0 and 1 to decide which values are important
- Output of tanh: regulate the value to be between -1 and 1
- Multiply tanh output with sigmoid output: discount non-important information from the tanh output



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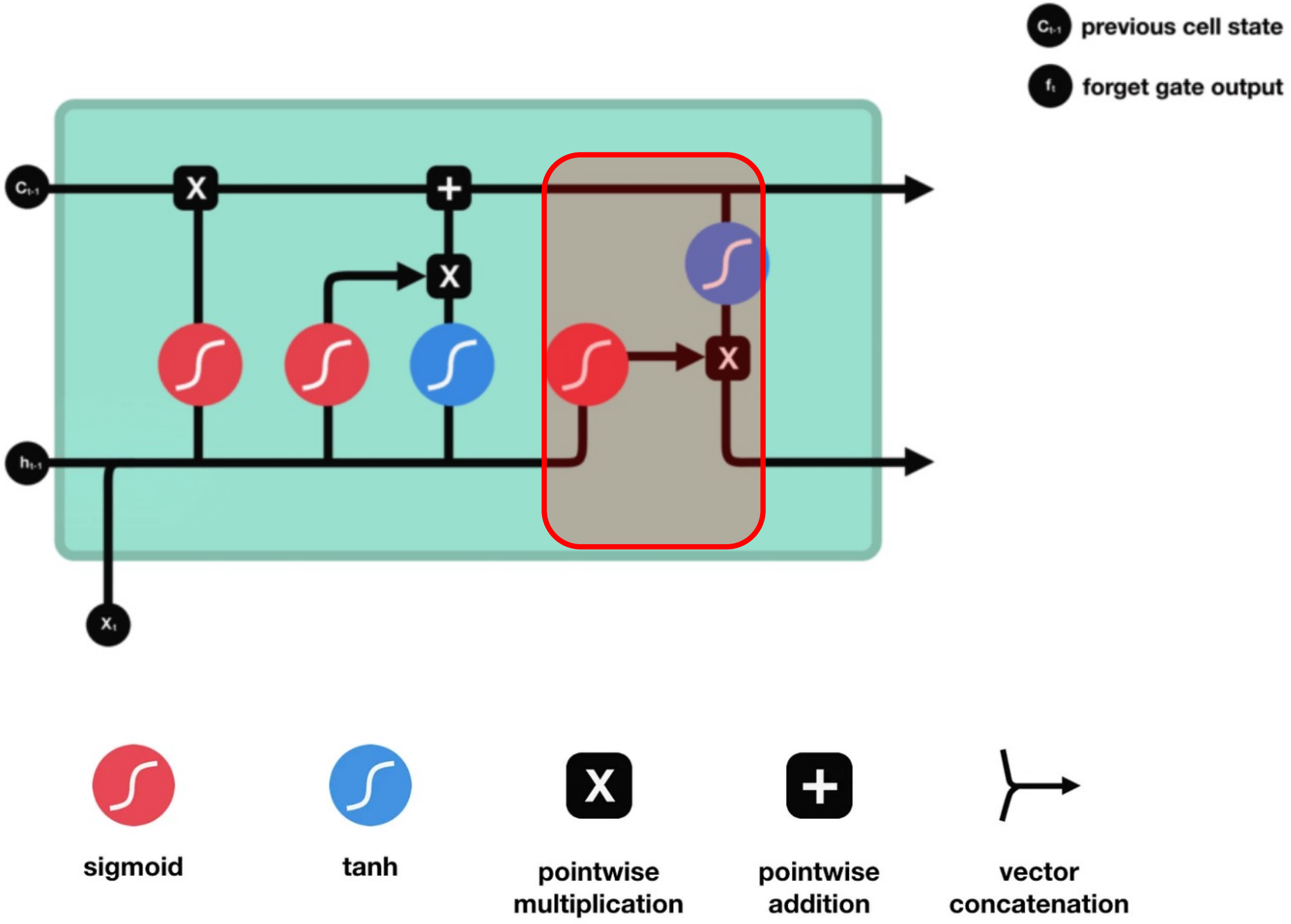
LSTM Networks – Output Gate

- Output gate: what shall be the next hidden state
- Input of sigmoid: previous hidden states and current input
- Output of sigmoid: value between 0 and 1 to decide which information hidden state shall carry forward
- Pass the newly updated cell state through a tanh function, then multiply with sigmoid output
- Result will be the updated hidden state



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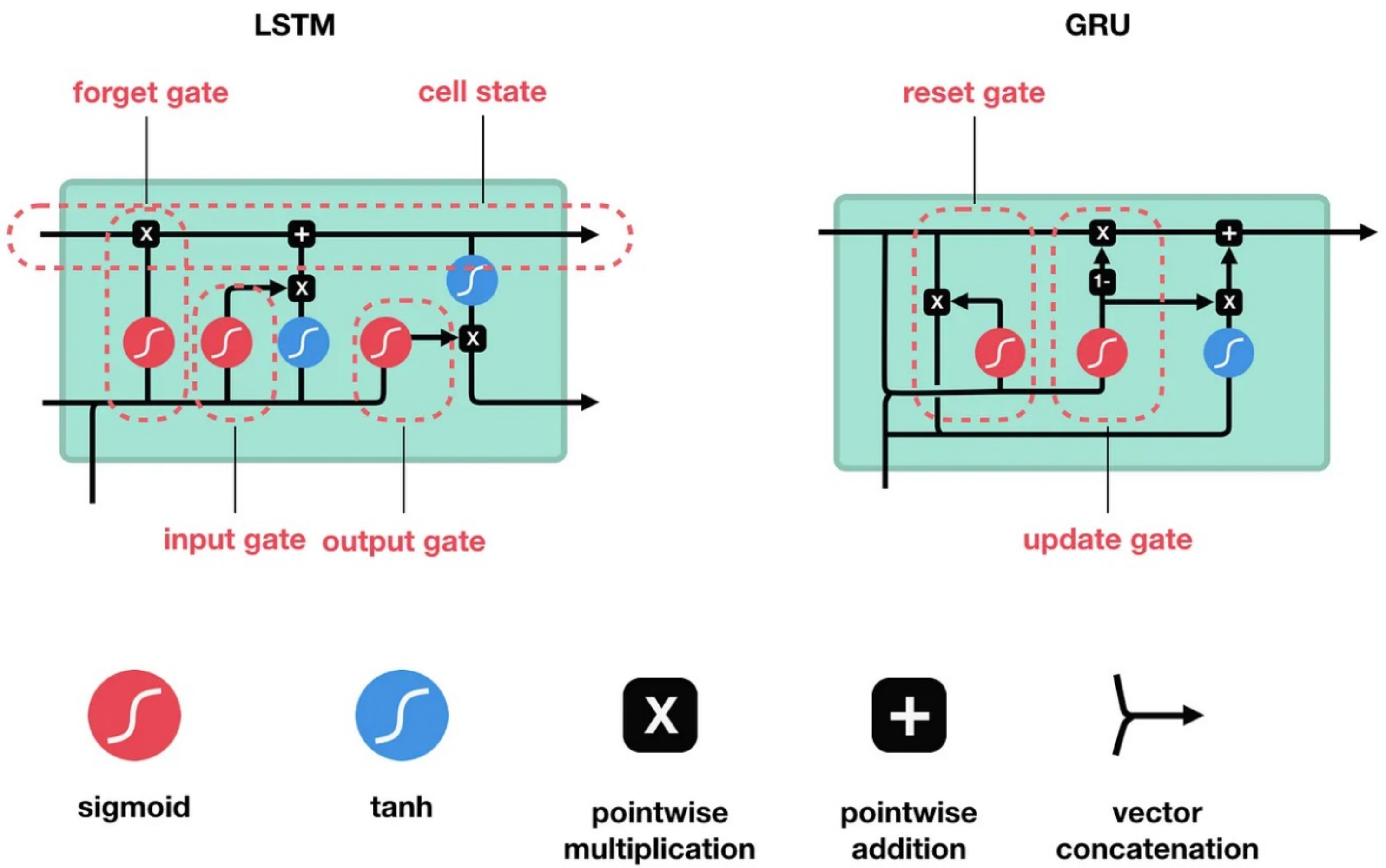
Gated Recurrent Units (GRUs)

- GRU is simpler than LSTM, and can be used to build much bigger networks
- LSTM is more general and powerful
- Both LSTM and GRU employs **Gating Mechanism** to address the issue of long term dependencies



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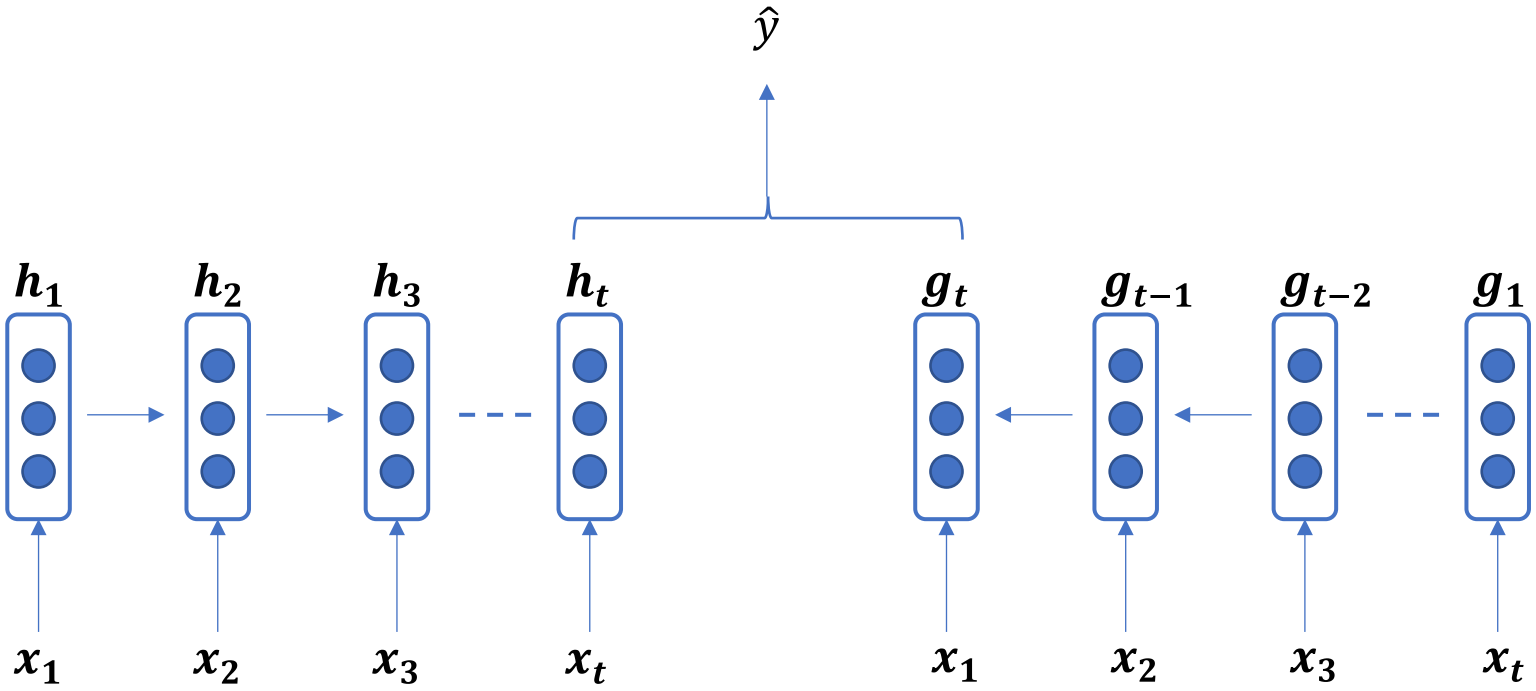
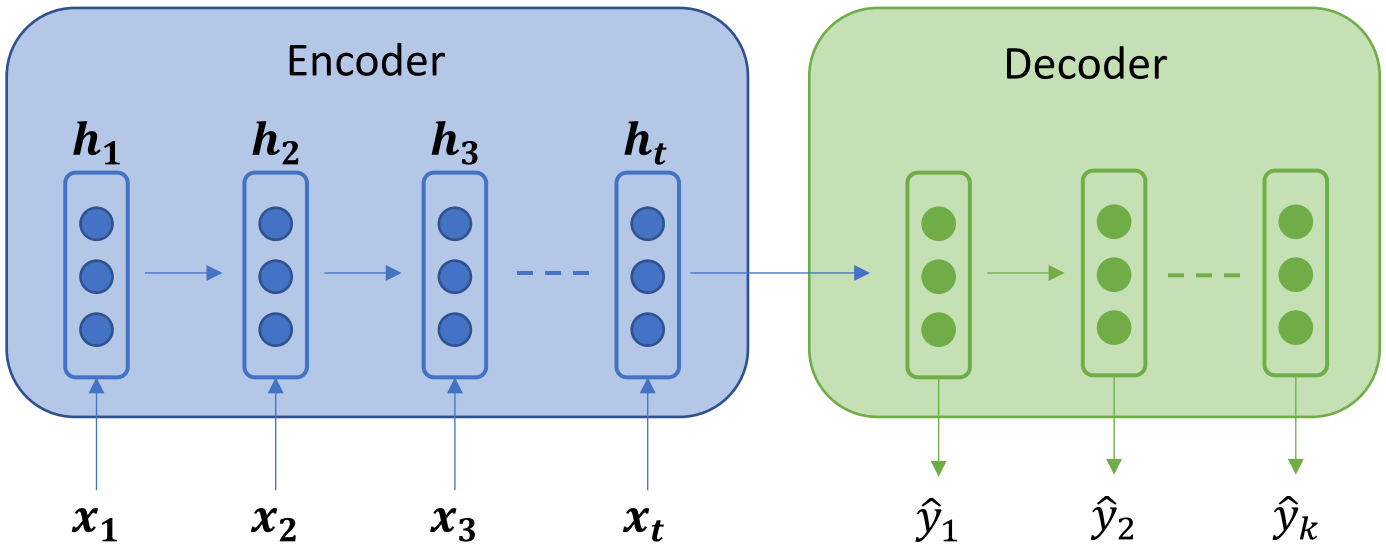
Bidirectional Recurrent Neural Networks (Bi-RNNs)



Encoder-Decoder Architecture



Real-world case study: sentiment classification on external news

Adopting AI in credit risk monitoring

20 November 2019 | By Nick Luo

5 mins read

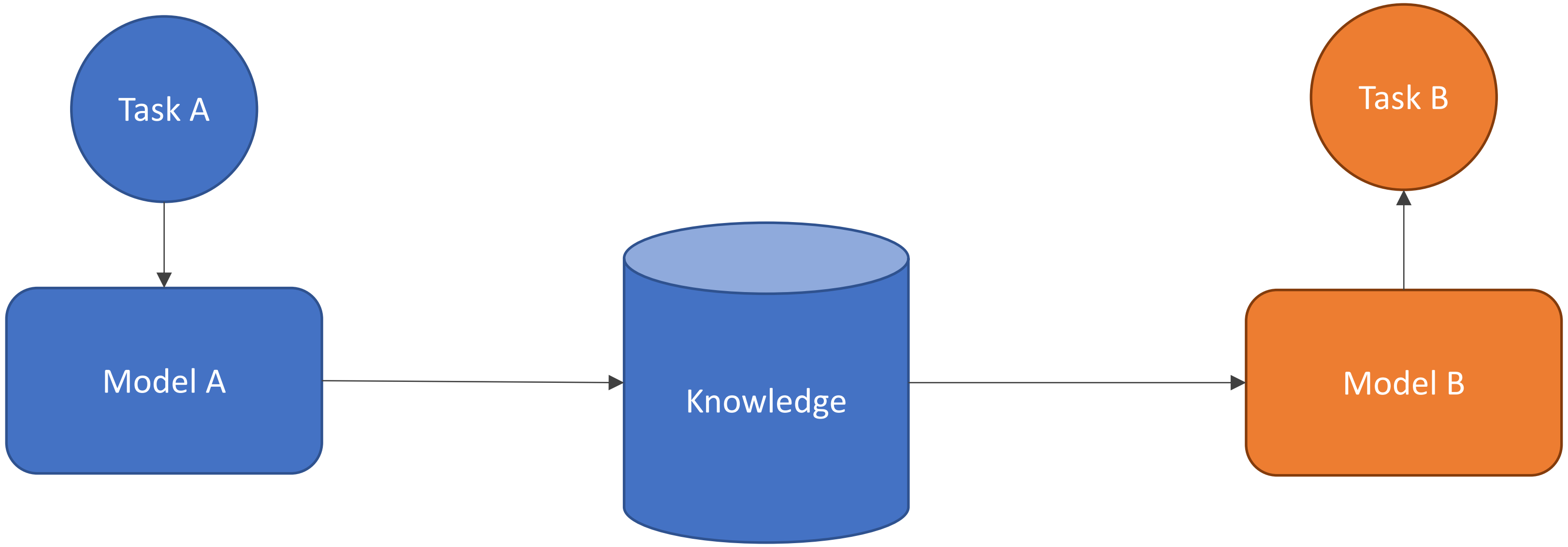
Adopting AI in credit risk monitoring

Nick Luo (pictured standing, second from left) is a Data Scientist with the OCBC AI Lab under Group Customer Analytics & Decisioning, and the key person behind the Bank's auto news-scanning AI model developed for the Wealth Management team. Hear what Nick has to say about the project and how it has improved efficiency.

https://www.ocbc.com/group/careers/blog/adopting-ai-in-credit-risk-monitoring.page

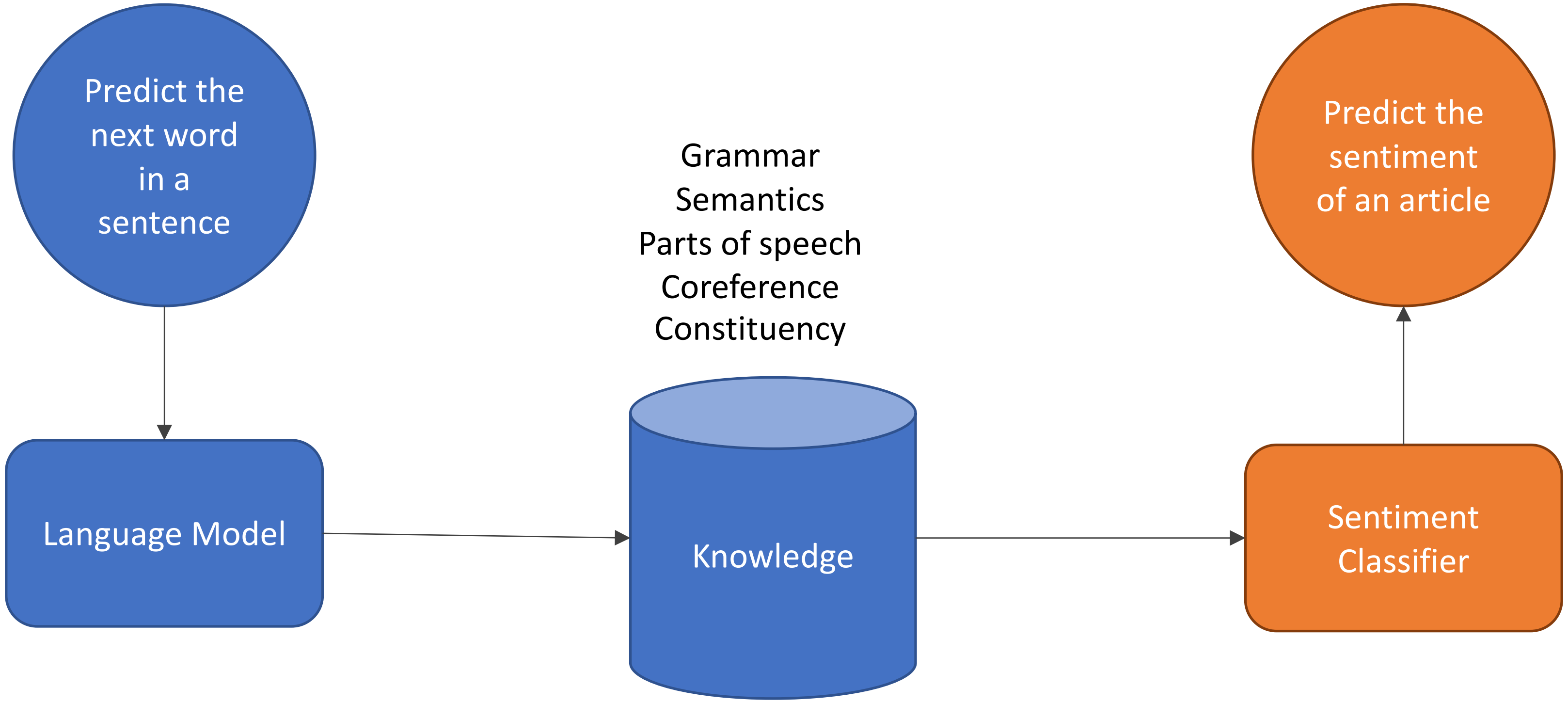
Finetune Language Models for Sentiment Analysis

- Huge amount of **labelled data** is needed to train a big neural network from scratch
- **Transfer learning** can significantly reduce the amount of labelled data
- Transfer learning refers to the use of a model that has been trained to solve one problem as the starting point to solve another related problem



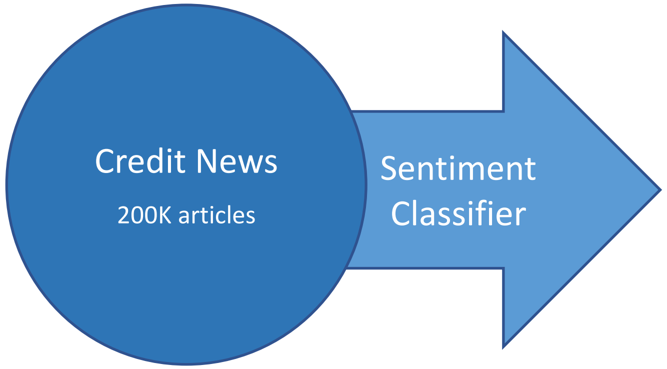
Finetune Language Models for Sentiment Analysis

- Use a trained language model as the starting point to build a sentiment classifier



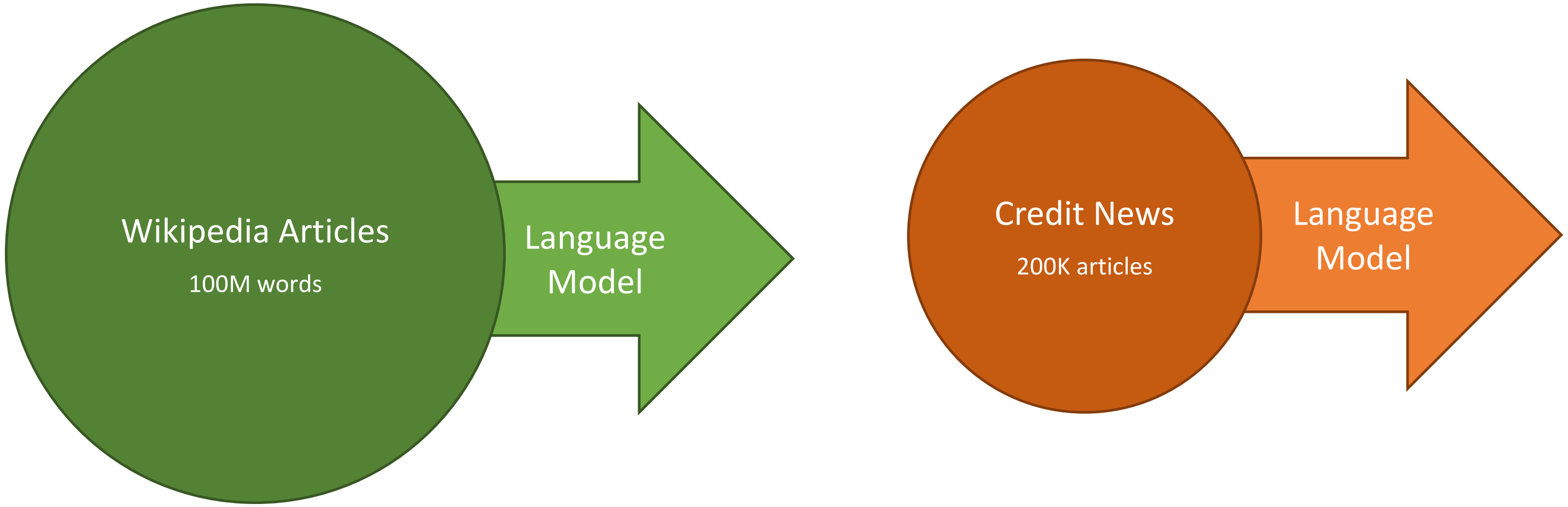
Transfer learning helps reduce the amount of labelled data needed

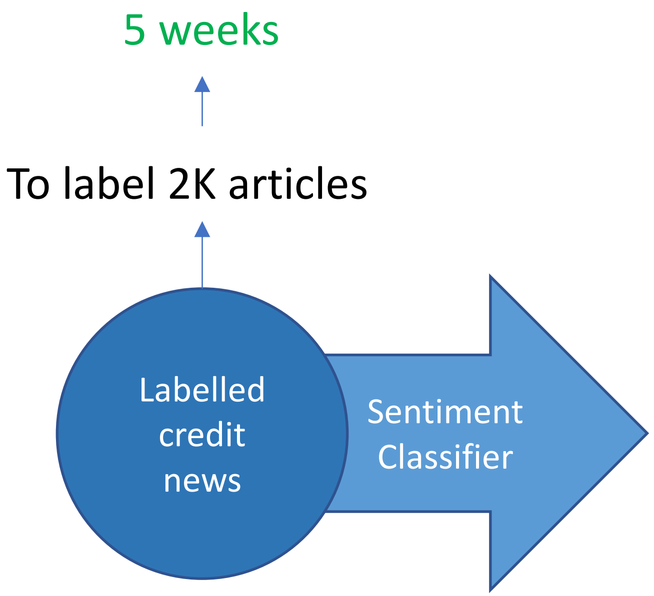
- Without transfer learning



- Need to label 200K articles
- 400 articles per week
- 500 weeks ≈ 10 years!

- With transfer learning





Assignment: Sentiment Classification Model for Movie Reviews