

Recurrent Neural Networks

Introduction and overview of the latest advances and trends in the field

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Outline

- Learning Goals
- Motivation
- Recurrent Neural Networks (RNNs)
 - Basic architecture
 - Long short-term memory (LSTM)
 - Gated Recurrent Unit
- Summary

Learning Goals

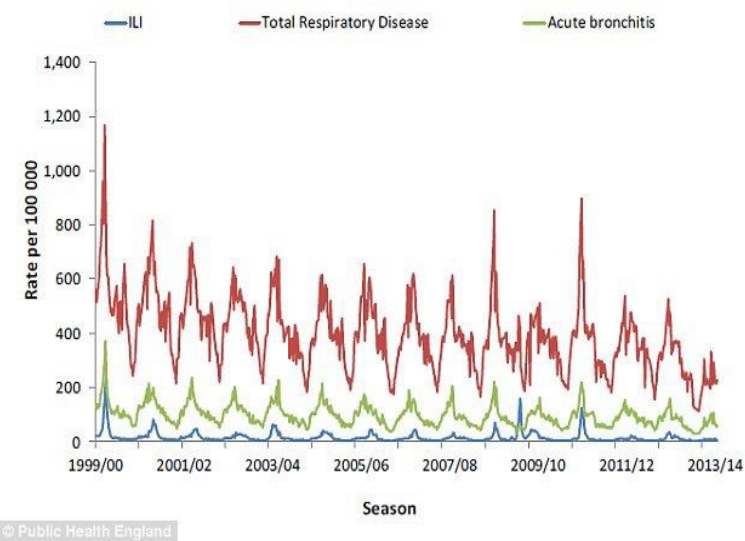
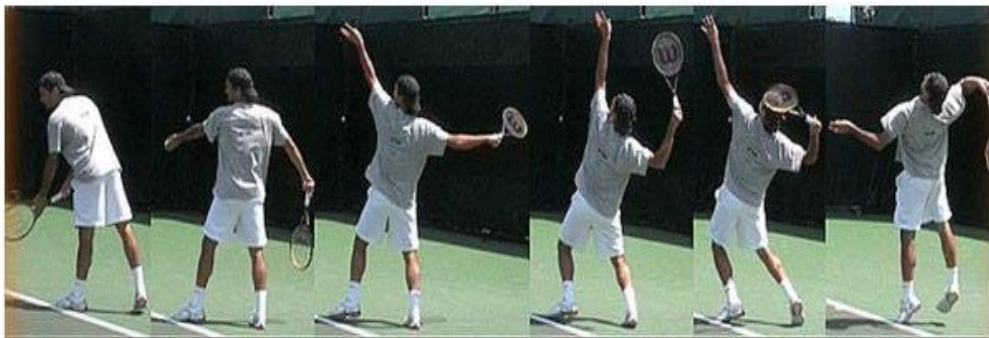
- Learn the intuition behind RNNs
- Get familiar with the most common types of RNNs (LSTM, GRU)

Motivation - Data is often sequential in nature

Steph Curry releases the ball and as it moves you know it is going to be 3 points to Golden State...



Motivation - Data is often sequential in nature



STOCK	BID	OFFER	LAST	VOL	STOCK	BID	OFFER
ASX					FARM PRIDE	0.100	0.140
EUR GROUP	0.060	0.070	0.000	0	FE LIMITED	0.026	0.030
EUROGOLD	0.098	0.140	0.000	0	FEOAX	0.120	0.130
EUROFAS	0.325	0.335	0.335	77T	FERRWEST	0.024	0.033
EUROZ	1.000	1.020	1.000	4T	FERRUM	0.052	0.057
EVOLUTION	1.935	1.940	1.935	2M	FIDUCIAN	0.800	0.810
EVZ LTD	0.041	0.050	0.050	5T	FIEAX	0.110	0.125
EXALT RES	0.000	0.000	0.000	0	FINBAR	1.075	1.080
EXCAX	0.040	0.049	0.040	50T	FINDERS	0.200	0.220
EXCALBUR	0.001	0.002	0.000	0	FIRSTONE	0.008	0.009
EXCELA	0.010	0.090	0.000	0	FIRSTFOLIO	0.014	0.015
EXCELSIOR	0.190	0.195	0.190	30T	FISSION EN	0.020	0.035
EXCO RES	0.260	0.265	0.260	5HT	FITZROYRES		
EXOMA ENER	0.072	0.075	0.072	35T			
EZAAX	0.430	0.490	0.000				
ERHOLD							

Introduction

- Building models of sequential data is important: automatic speech recognition, machine translation, natural language, ...
- Recurrent nets (RNN) are a simple and general framework for this type of tasks

Introduction

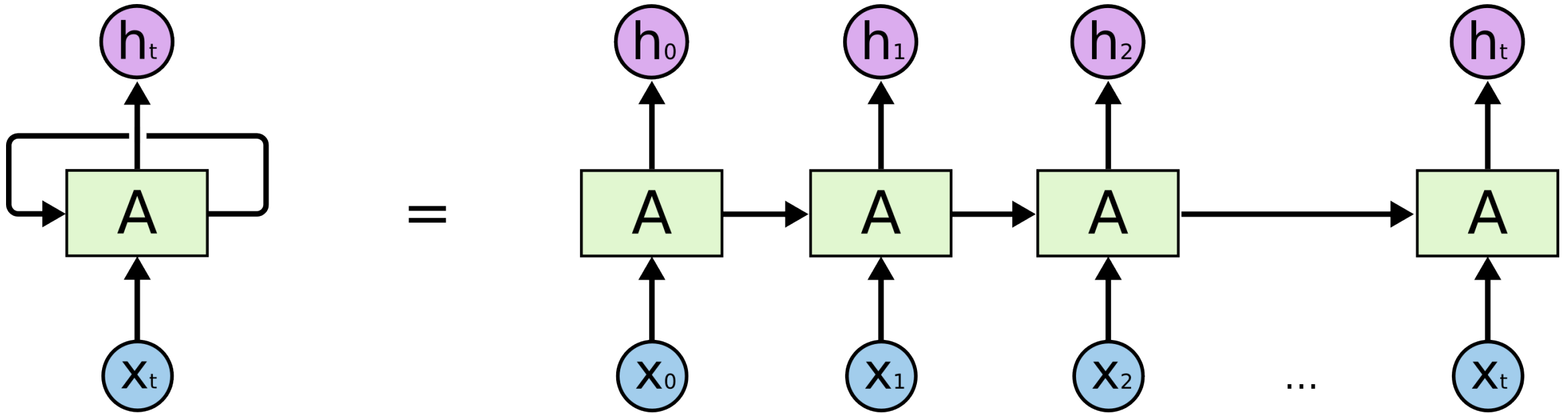
A B C A B C A B _

- What symbol comes next?
- What is its probability?

Yesterday it was Sunday, so today it must be _

- How to predict the next word?
- What is this good for?

Simple RNN



Major shortcomings

- Handling of complex non-linear interactions
- Difficulties using BPTT to capture long-term dependencies exploding gradients
- Vanishing gradients

Training: Backpropagation through time (BPTT)

- How to train the recurrent nets?
- The output value does depend on the state of the hidden layer, which depends on all previous states of the hidden layer (and thus, all previous inputs)
- Recurrent net can be seen as a (very deep) feedforward net with shared weights

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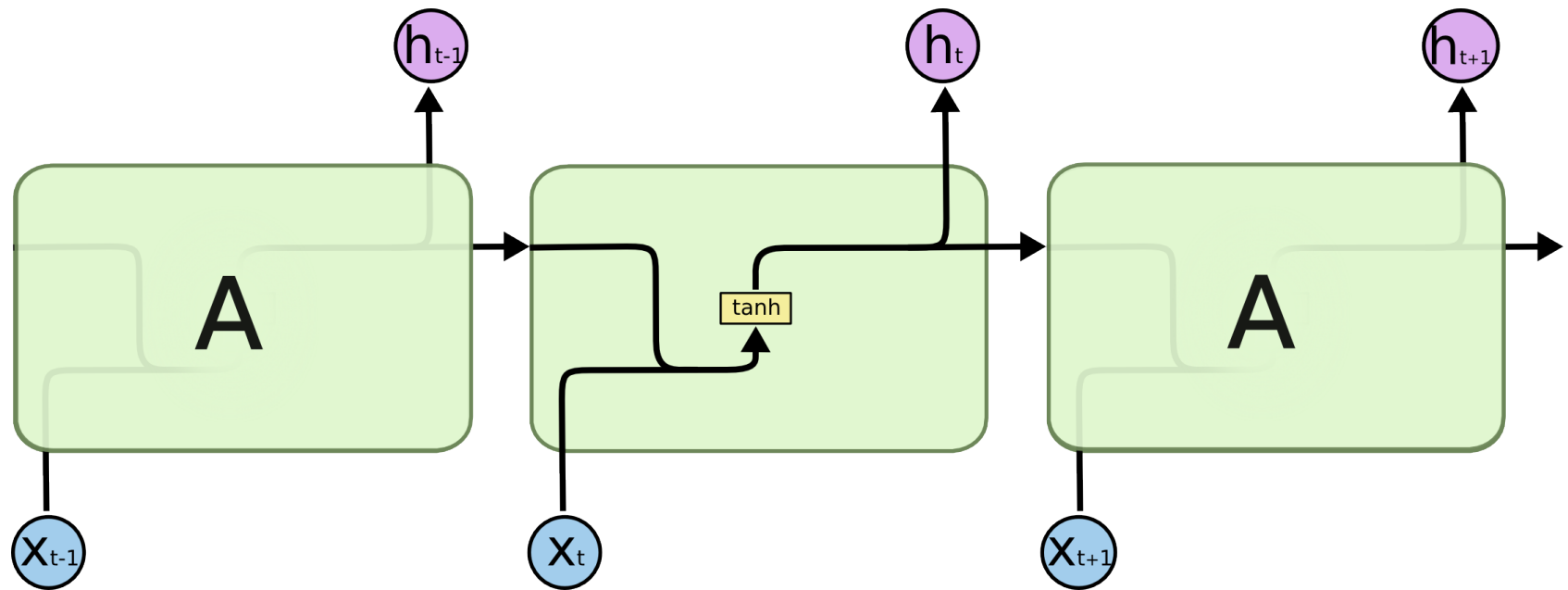
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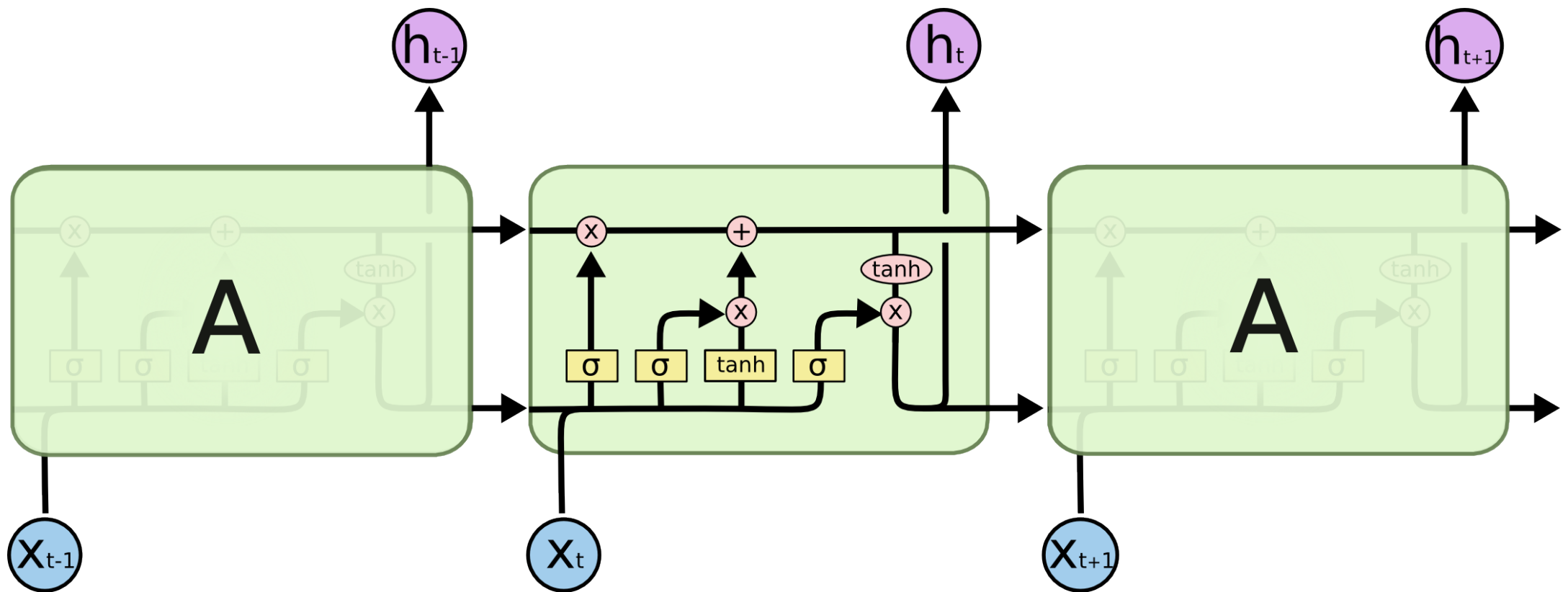
Vanishing gradients

- As we propagate the gradients back in time, usually their magnitude quickly decreases: this is called “vanishing gradient problem”
- In practice this means that learning long term dependencies in data is difficult for simple RNN architecture
- Special RNN architectures address this problem:
 - *Exponential trace memory* (Jordan 1987, Mozer 1989)
 - *Long Short-term Memory* (Hochreiter & Schmidhuber, 1997))
 - will be described in the second part of this lecture

Exploding gradients

- Sometimes, the gradients start to increase exponentially during backpropagation through the recurrent weights
- Happens rarely, but the effect can be catastrophic: huge gradients will lead to big change of weights, and thus destroy what has been learned so far
- One of the main reasons why RNNs were supposed to be unstable
- Simple solution (first published in RNNLM toolkit in 2010): clip or normalize values of the gradients to avoid huge changes of weights





Summary

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Neural Network
Layer



Pointwise
Operation



Vector
Transfer



Concatenate



Copy

Thank you!
