

Guided Tour of Machine Learning in Finance

Week 4: Reinforcement Learning

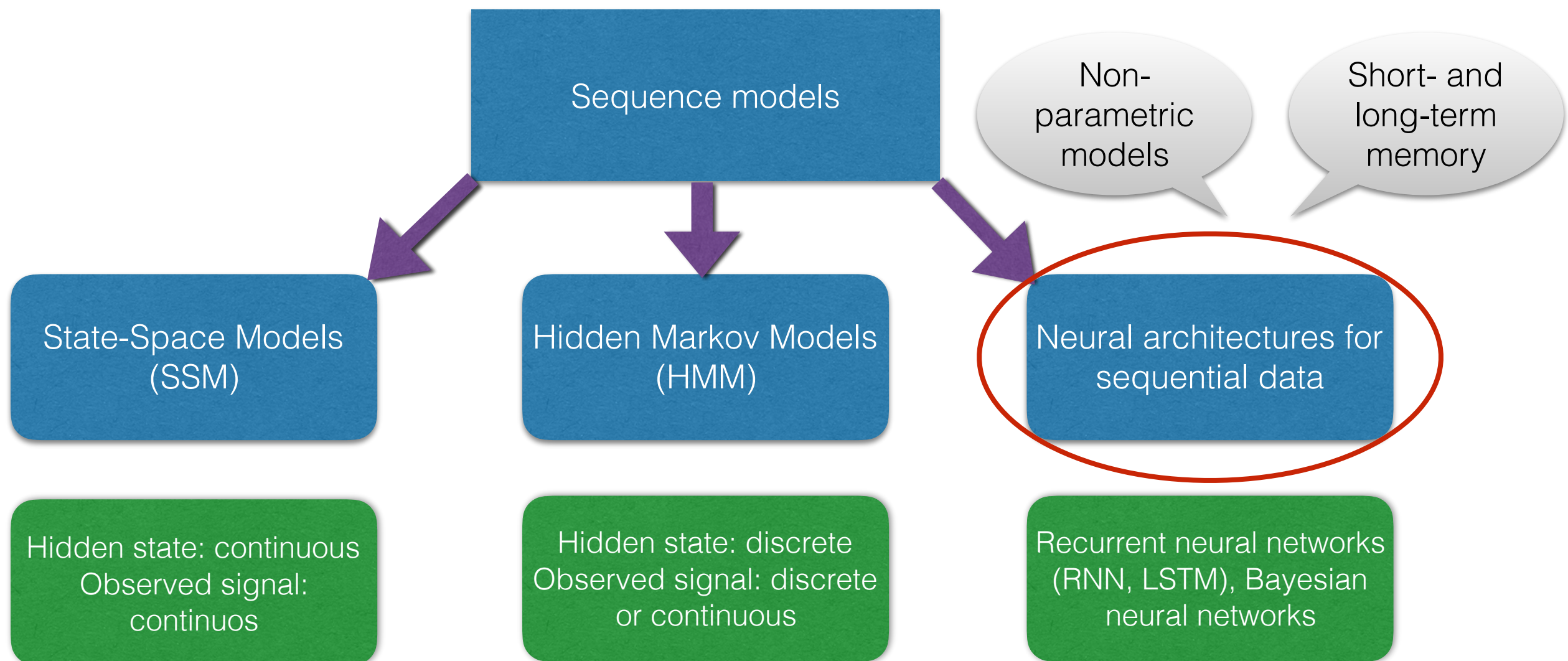
4-1-5-Neural-networks-for-sequential-data

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Sequence models

Parametric (SSM, HMM) vs non-parametric (neural) of sequence modeling with a hidden state $p(y|\mathbf{x})$

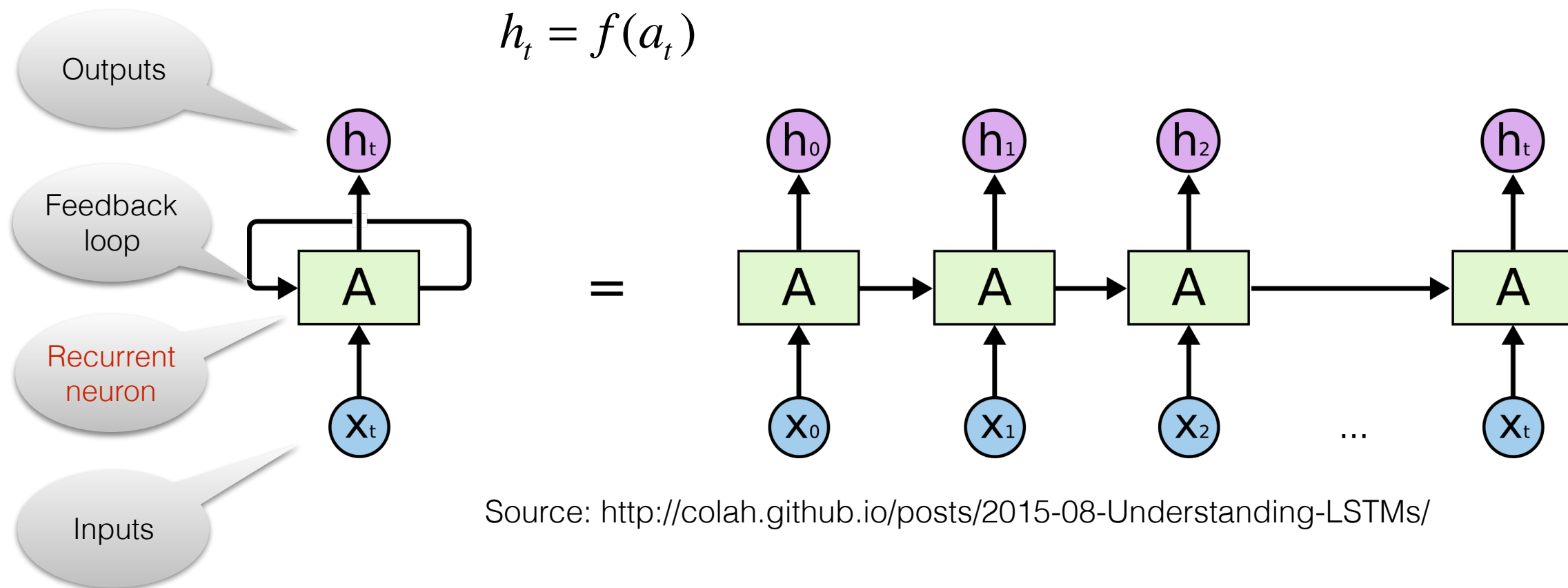


Recurrent neurons

Inputs for a recurrent neuron: the current input x and the previous neuron state

$$a_t = W_x x_t + W_a a_{t-1} + b + \varepsilon_t$$

$$h_t = f(a_t)$$



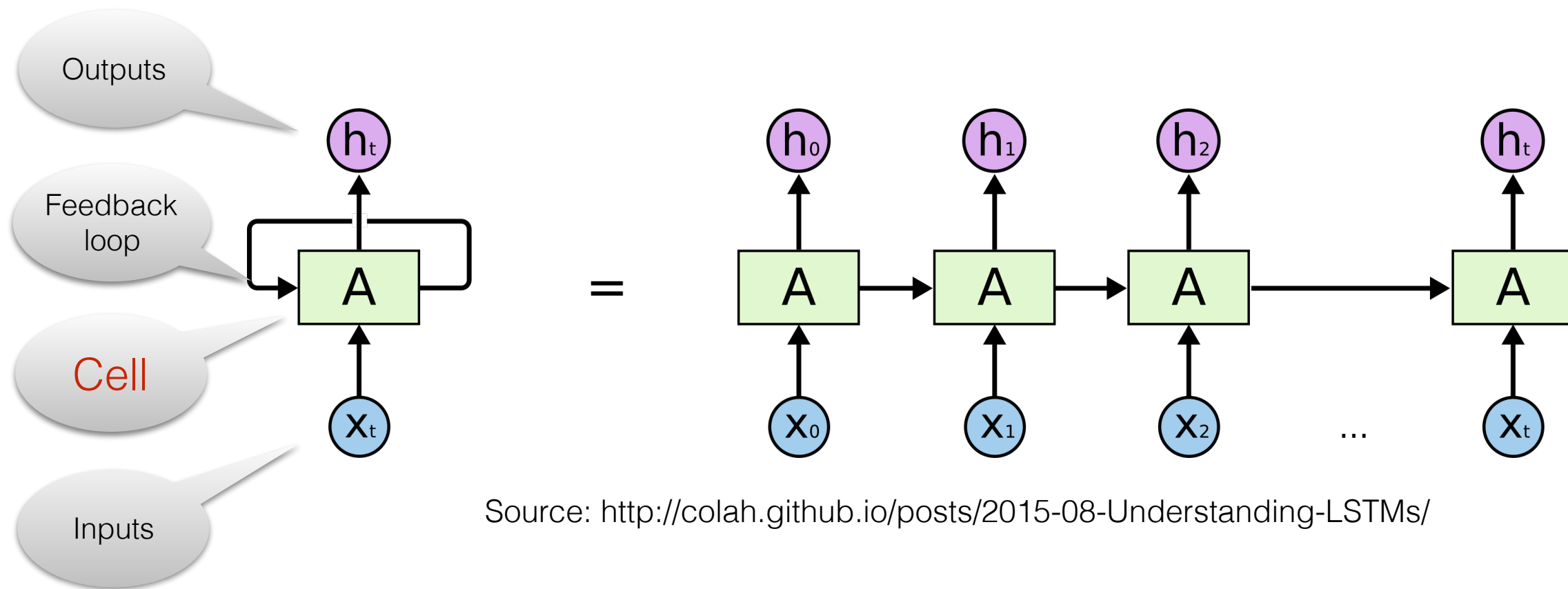
Source: <http://colah.github.io/posts/2015-08-Understanding-LSTMs/>

- Markov dynamics with in the hidden state a_t (jontly with a_t)
- The hidden state a_t accumulates the information about the past
- When looking only at observables h_t , the dynamics appear non-Markov, i.e.

$$p(h_t | h_{1:t-1}) \neq p(h_t | h_{t-1})$$

Recurrent neural networks (RNN)

Recurrent neural networks (**RNN**) are obtained by using **cells** composed of recurrent neurons.



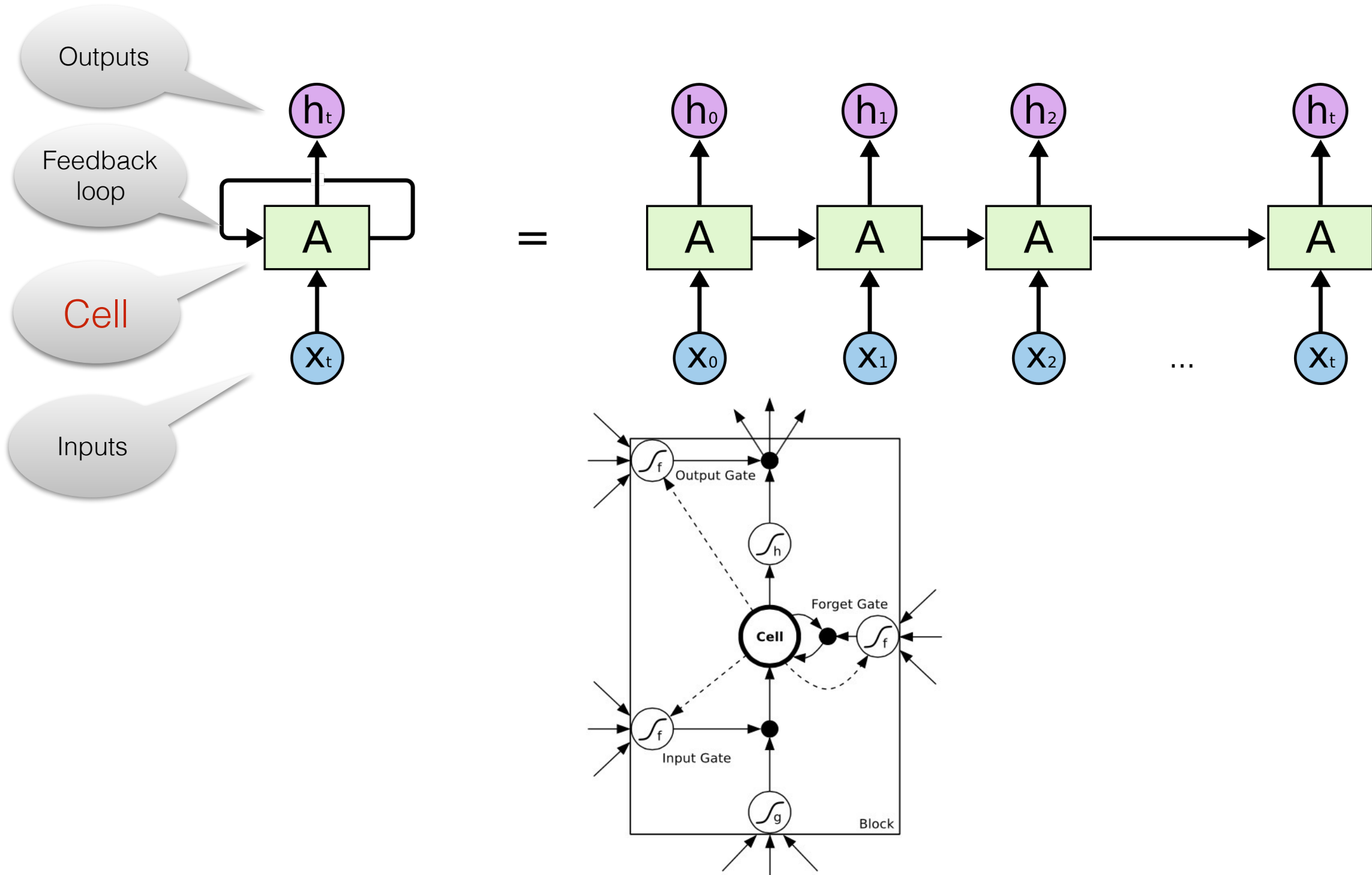
Source: <http://colah.github.io/posts/2015-08-Understanding-LSTMs/>

$$a_t^k = W_x^k x_t + W_a^k a_{t-1} + b_k + \varepsilon_t$$

$$h_t = f\left(\sum_k W_a^k a_t^k + b_h\right)$$

Long-Short Term Memory (LSTM) networks

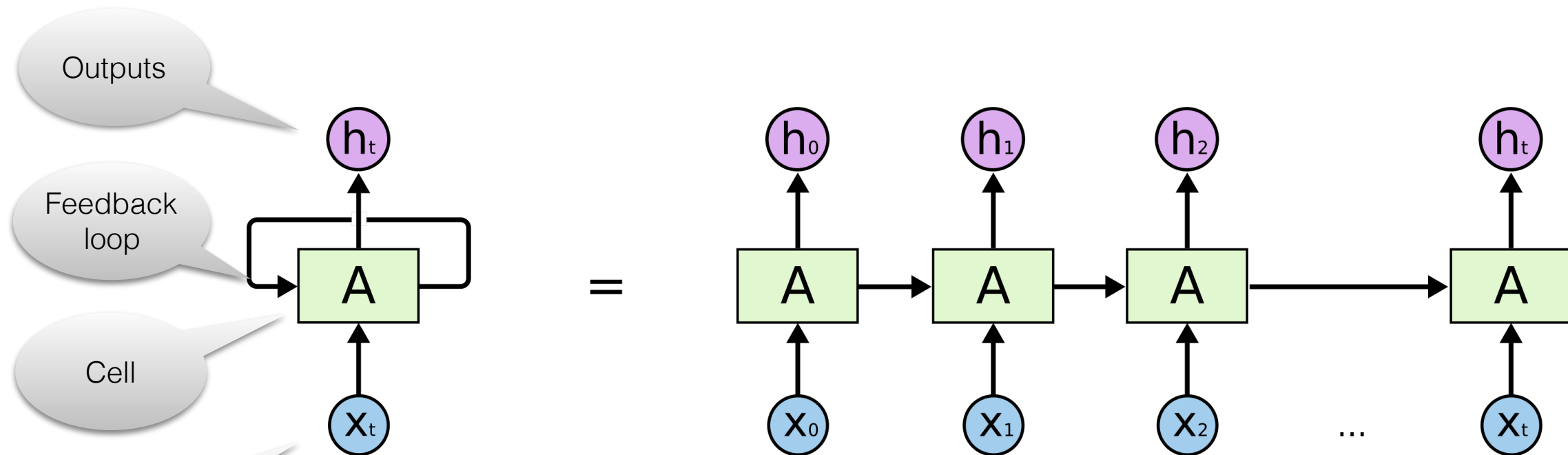
LSTM networks have a cell with a more complex structure.



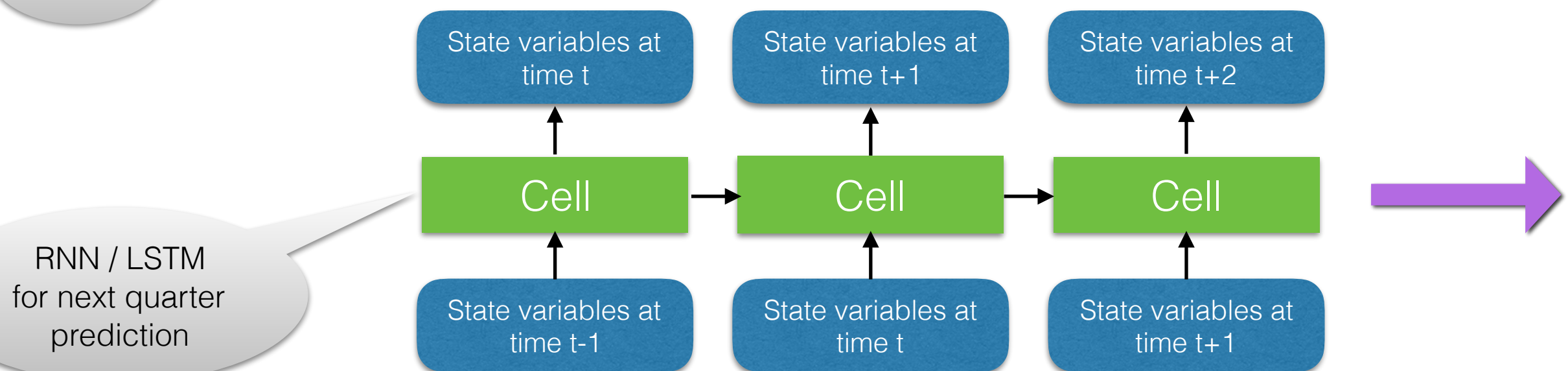
Source: <http://eric-yuan.me/wp-content/uploads/2015/06/2.jpg>

Recurrent neural networks: RNN and LSTM

Recurrent neural networks (**RNN**) or Long-Short Term Memory (**LSTM**) networks enable modeling bank failures as **predictions from sequences** of feature vectors, rather than from a single feature vector at time t .

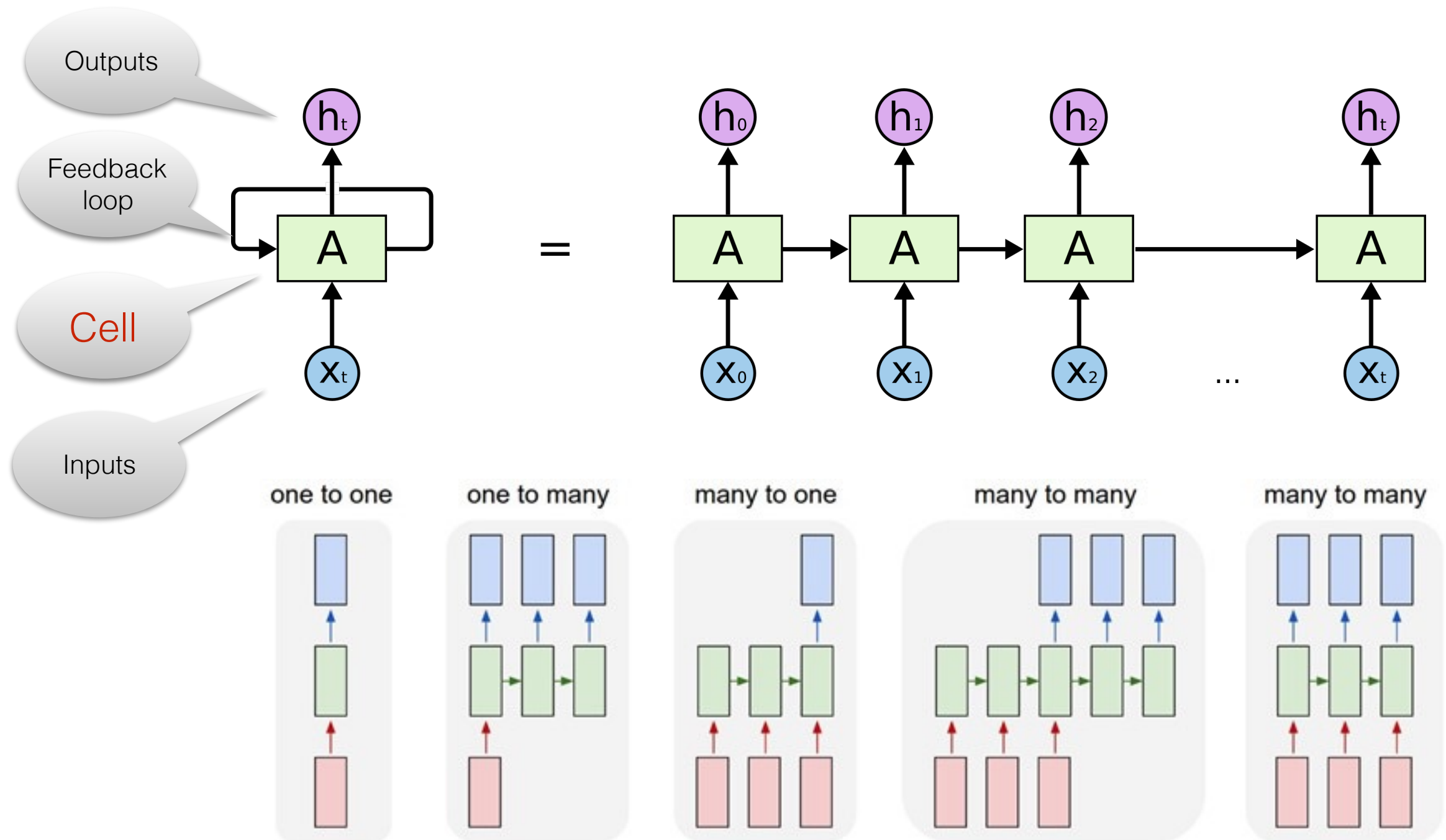


Source: <http://colah.github.io/posts/2015-08-Understanding-LSTMs/>



Sequence modeling with neural networks

LSTM networks have a cell with a more complex structure.



Source: <http://karpathy.github.io/2015/05/21/rnn-effectiveness/>

Control question

Select all correct answers

1. A recurrent neuron is a neuron that always returns to its initial state, no matter what data is passed as its inputs.
2. A recurrent neuron is a neuron that uses its previous internal state as one of the inputs at the current state.
3. Unlike a Recurrent Neural Networks (RNN), that only have a Recurrent memory, Long-Short Term Memory (LSTM) networks have both a Long- and Short-Term memory.
4. Unlike SSM and HMM models that have only a short-term memory, Neural models such as RNN and LSTM capture both short-term and long-term memory.

Correct answers: 2, 4