Lecture 12
RNN

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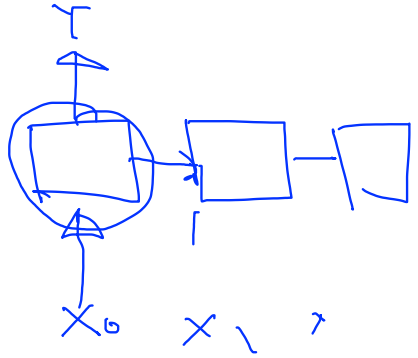
http://hunkim.github.io/ml/

Sequence data

- We don’t understand one word only
- We understand based on the previous words + this word. (time series)
- NN/CNN cannot do this



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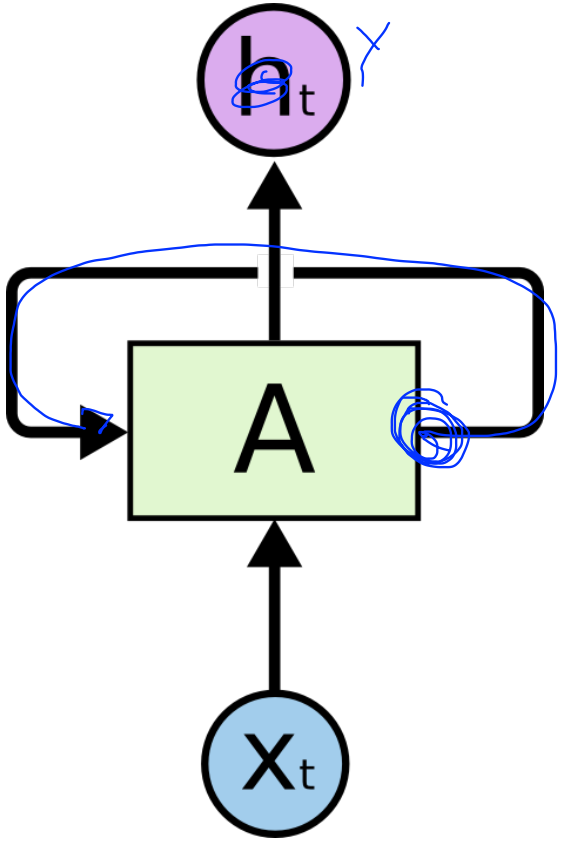
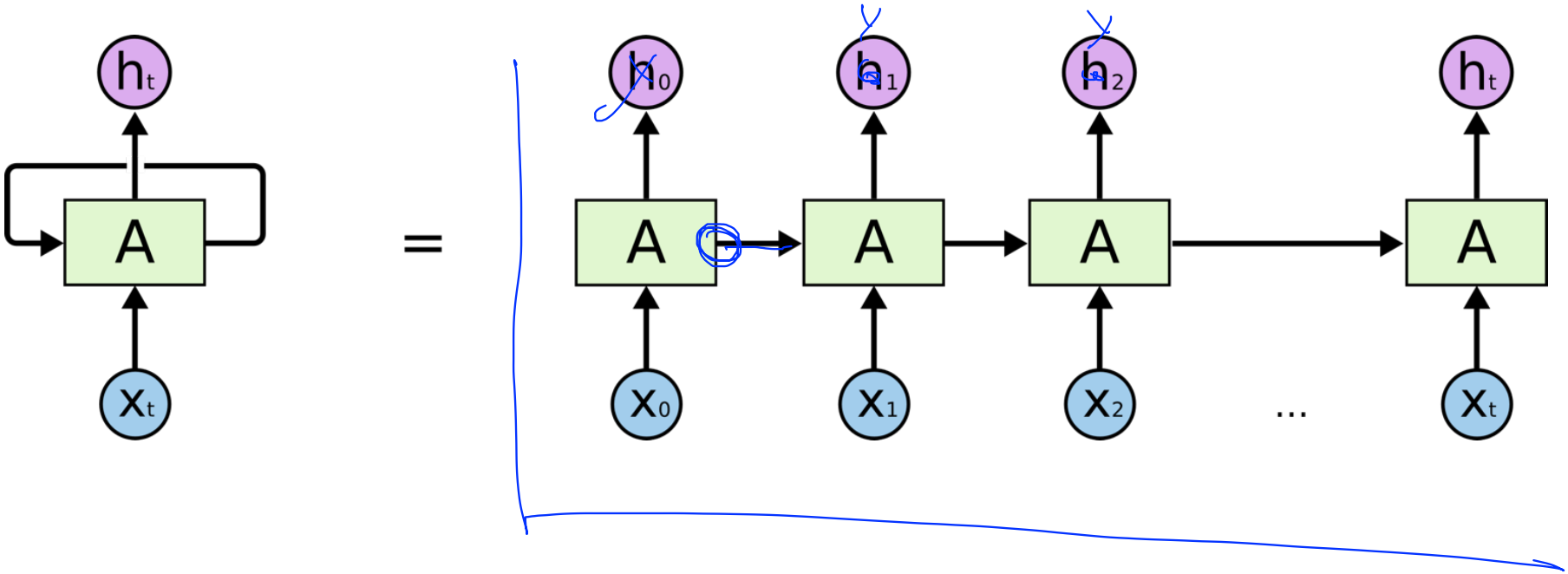


http://colah.github.io/posts/2015-08-Understanding-LSTMs/



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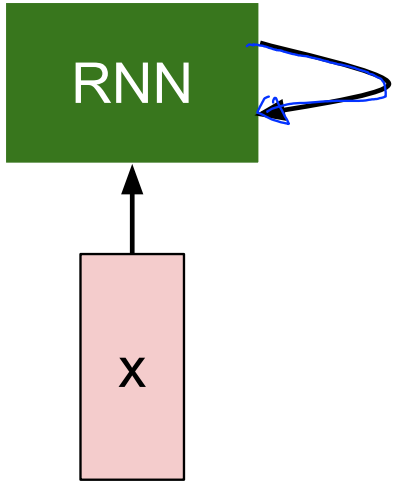
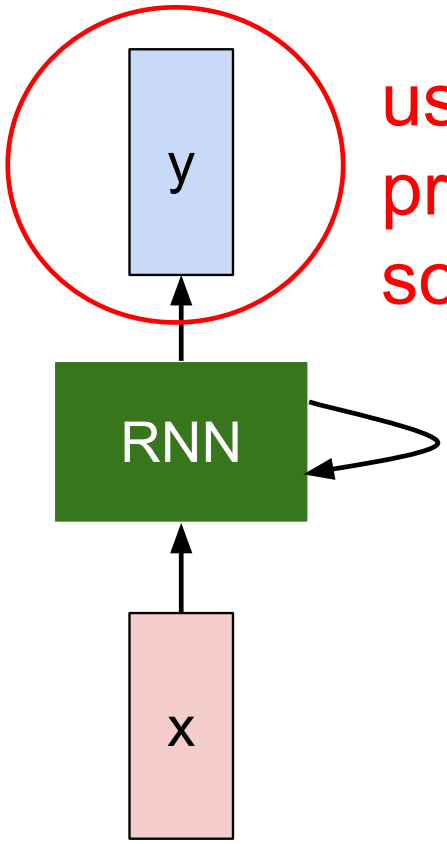
Recurrent Neural Network



Recurrent Neural Network



usually want to predict a vector at some time steps

Recurrent Neural Network

We can process a sequence of vectors **x** by applying a recurrence formula at every time step:

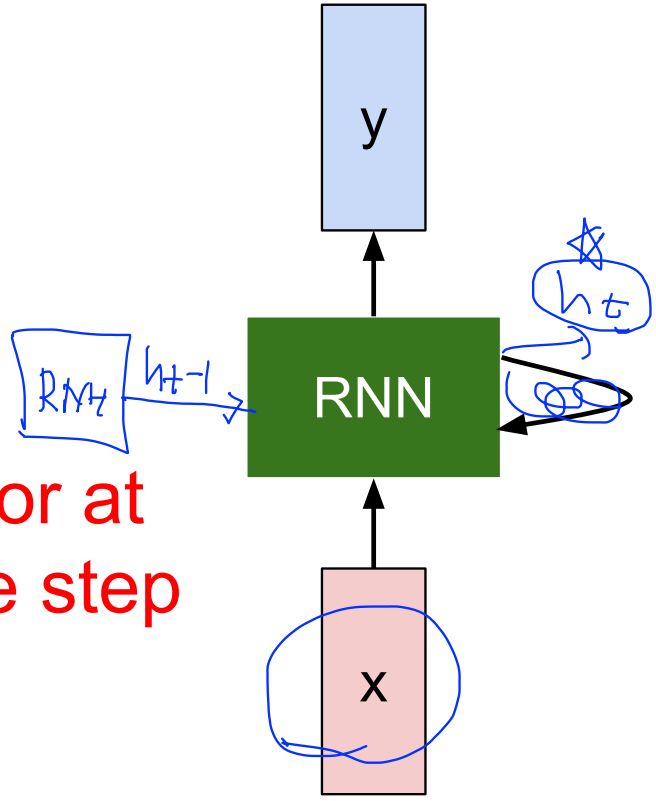
$$h_t = f_W(h_{t-1}, x_t)$$

new state

some function with parameters W

old state

input vector at some time step



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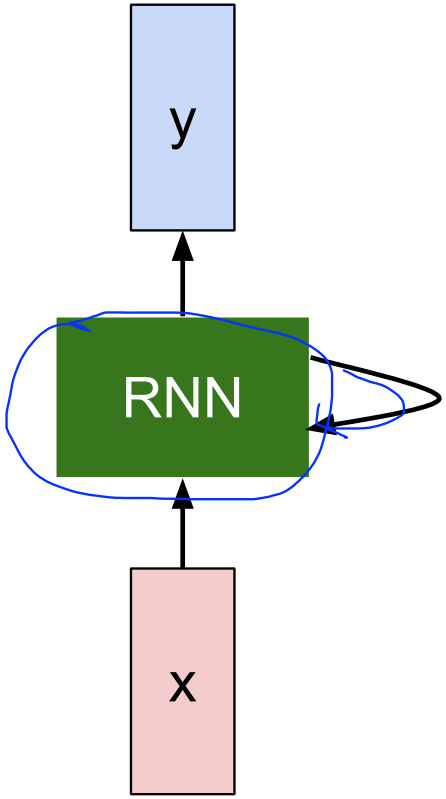
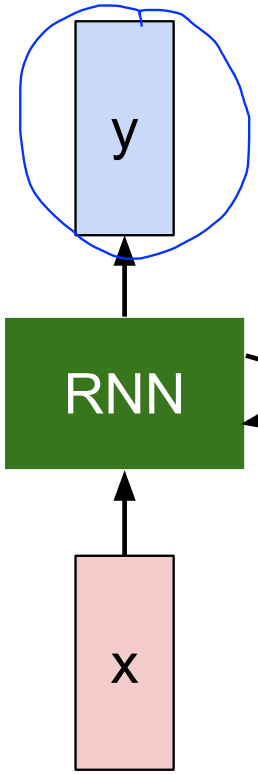


Notice: the same function and the same set of parameters are used at every time step.

(Vanilla) Recurrent Neural Network

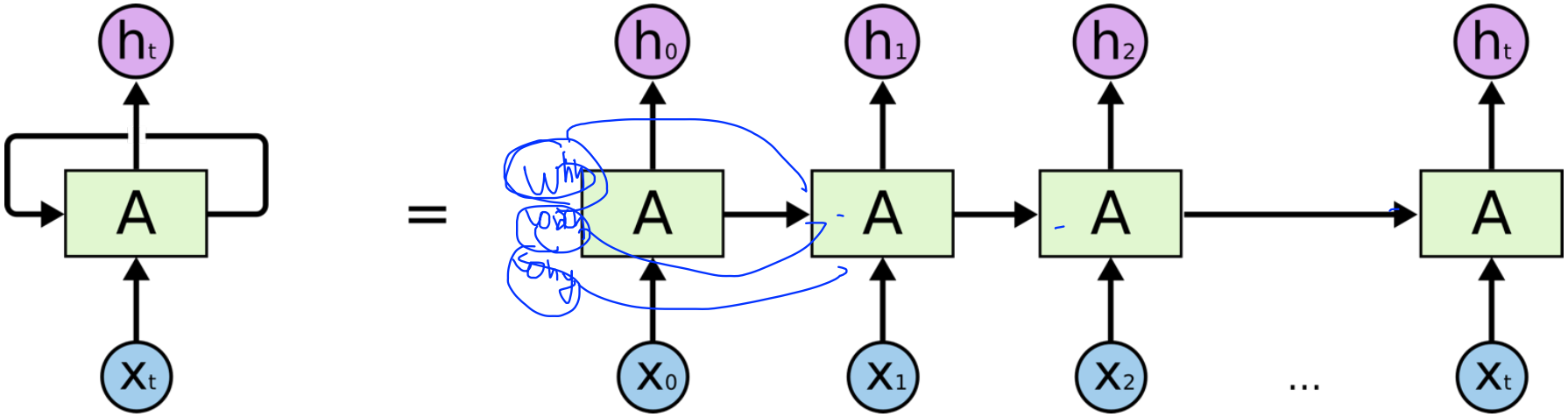
The state consists of a single *"hidden"* vector **h**:



$$h_t = f_W(h_{t-1}, x_t)$$

$$h_t = \tanh(W_{hh} h_{t-1} + W_{xh} x_t)$$

$$y_t = W_{hy} h_t$$



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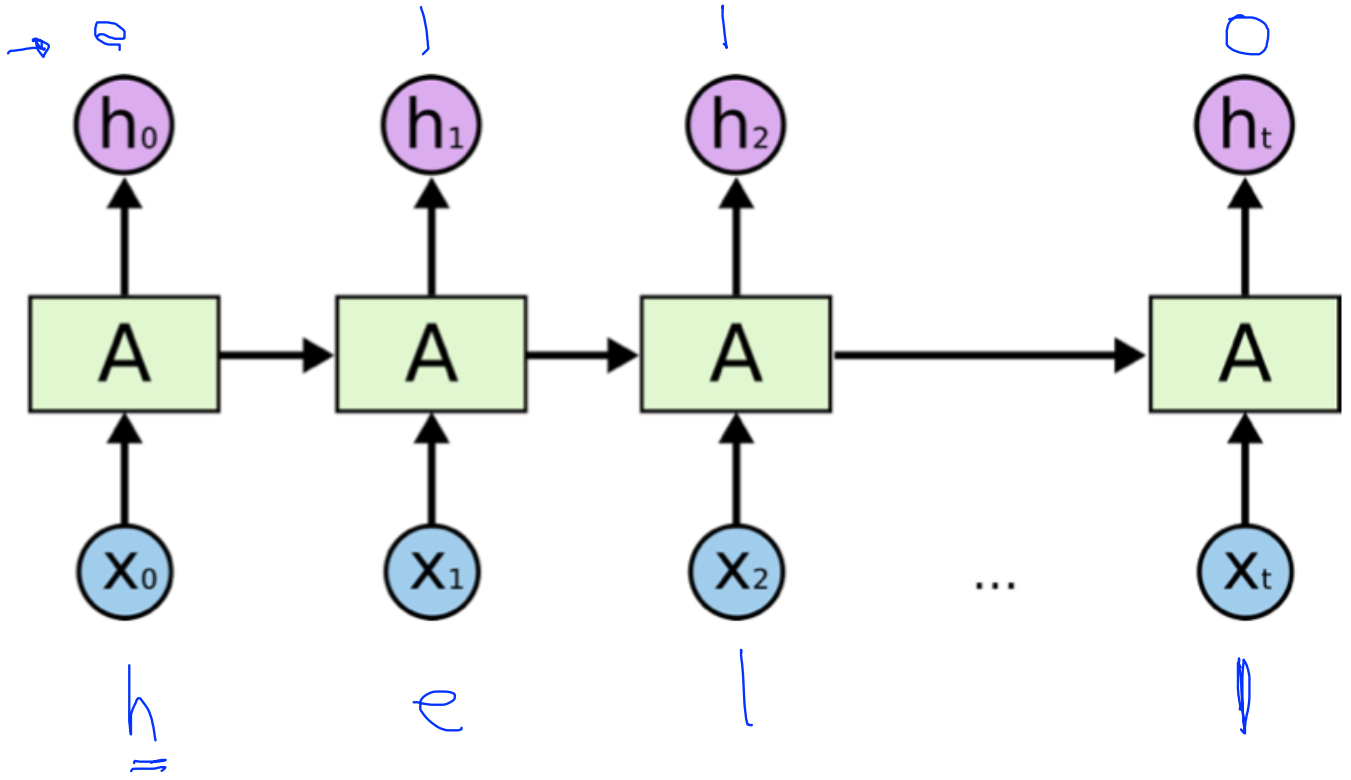
Character-level language model example

Vocabulary:
[h,e,l,o]

Example training sequence:
“hello”



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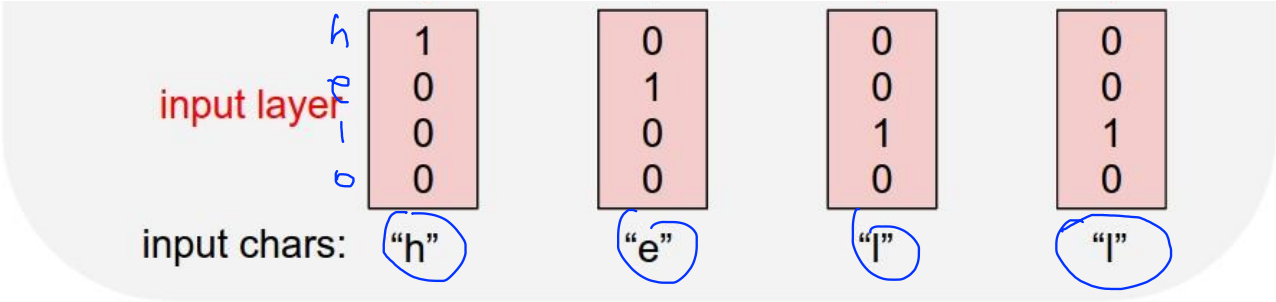

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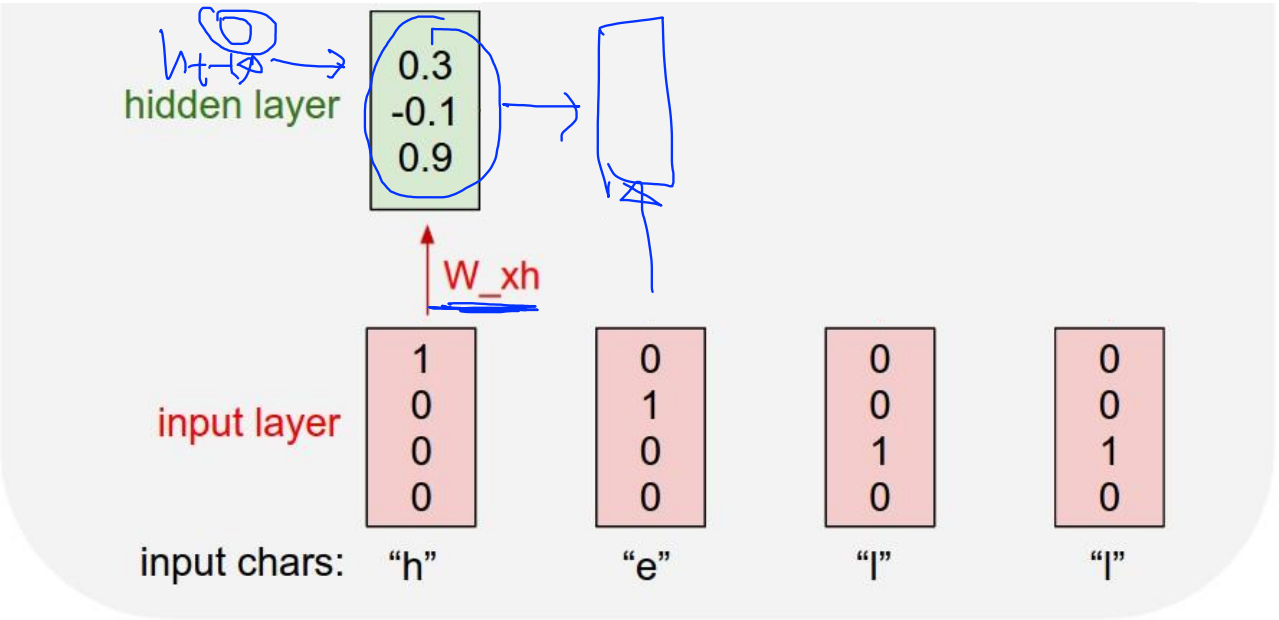

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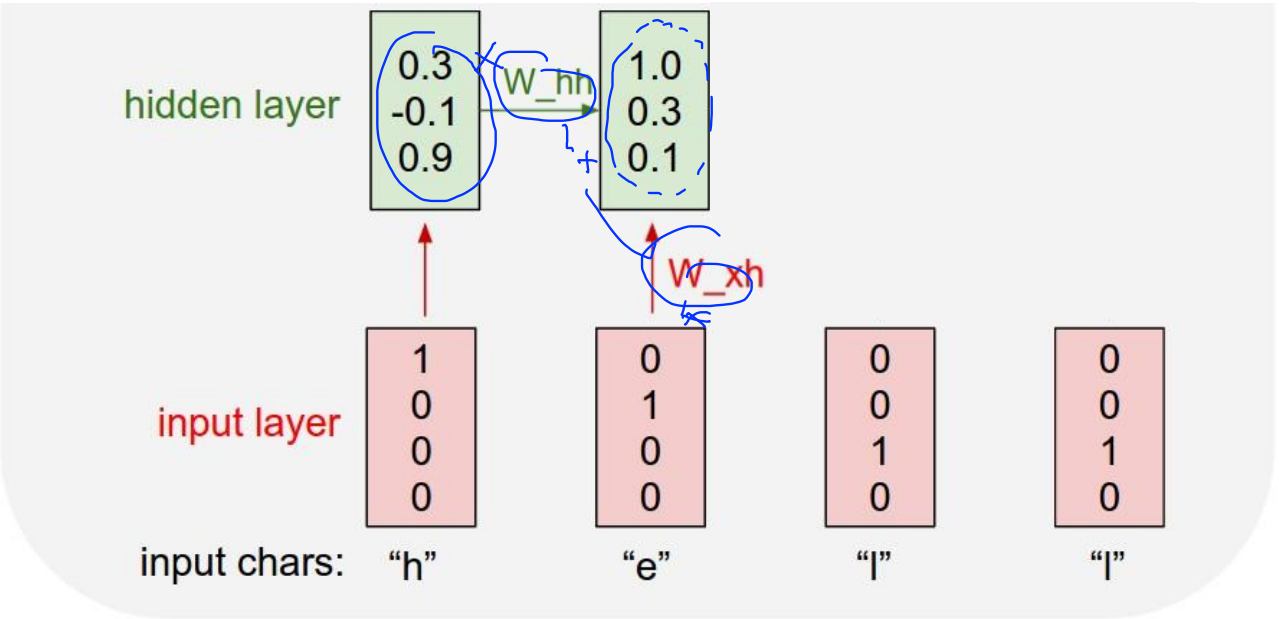

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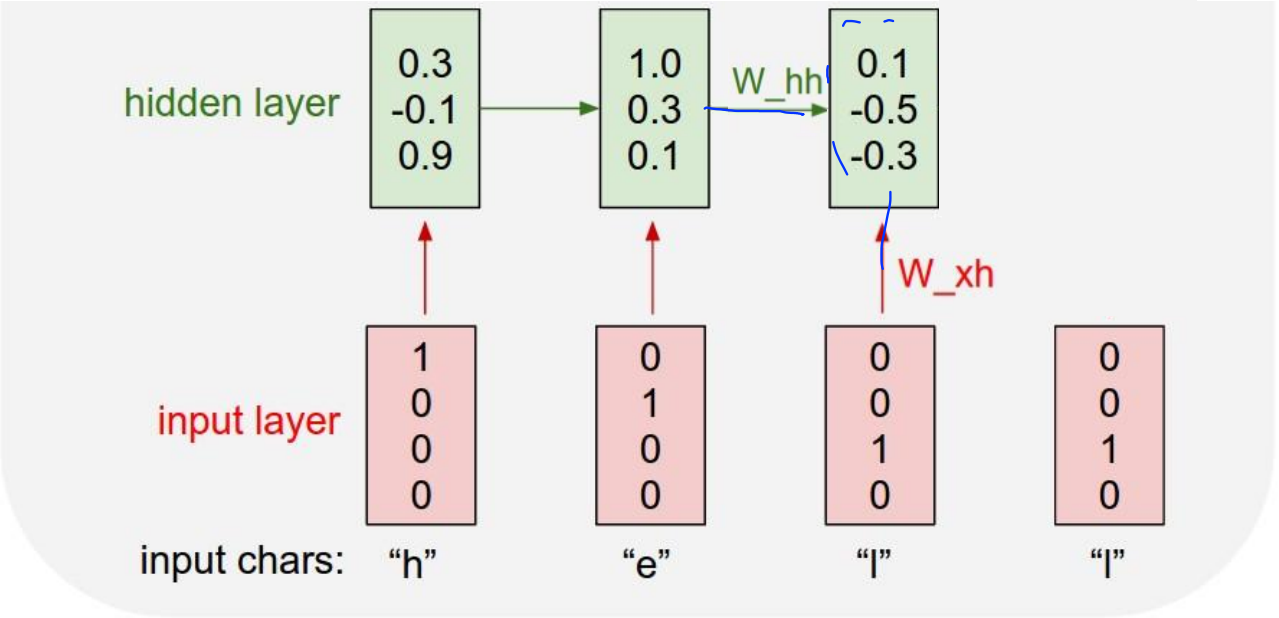

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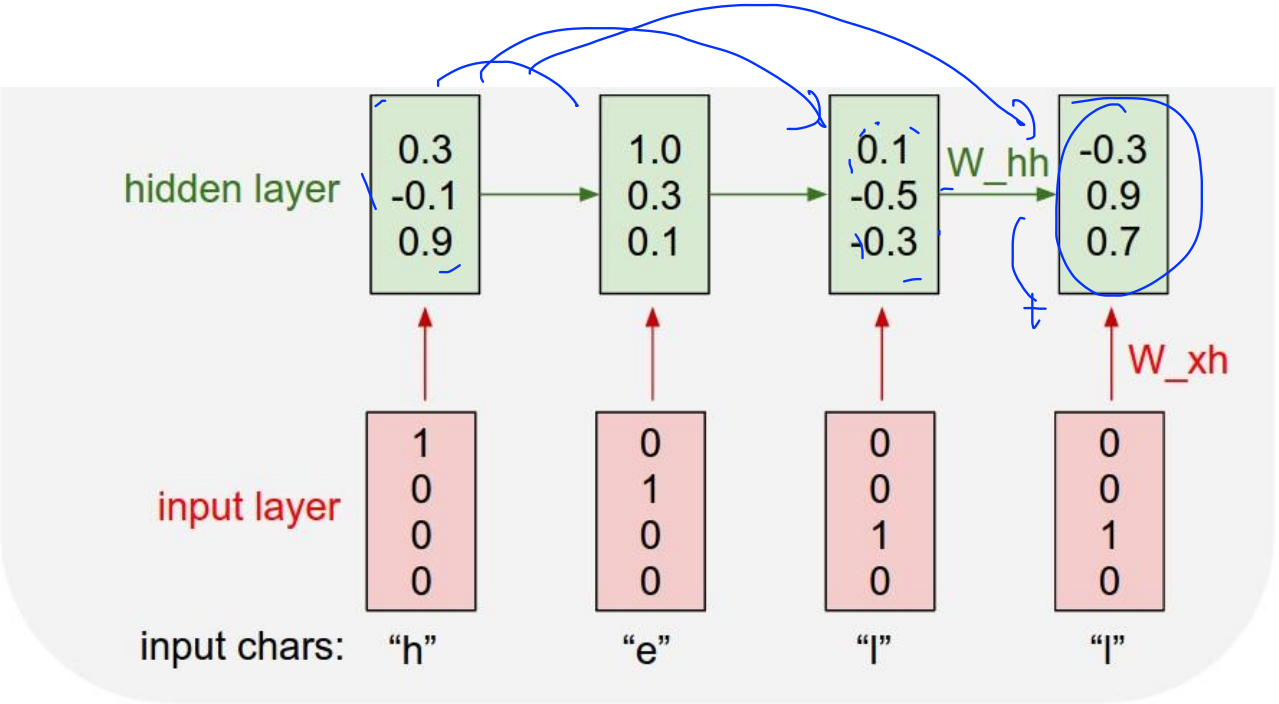

Character-level language model example

$$y_t = W_{hy} h_t$$

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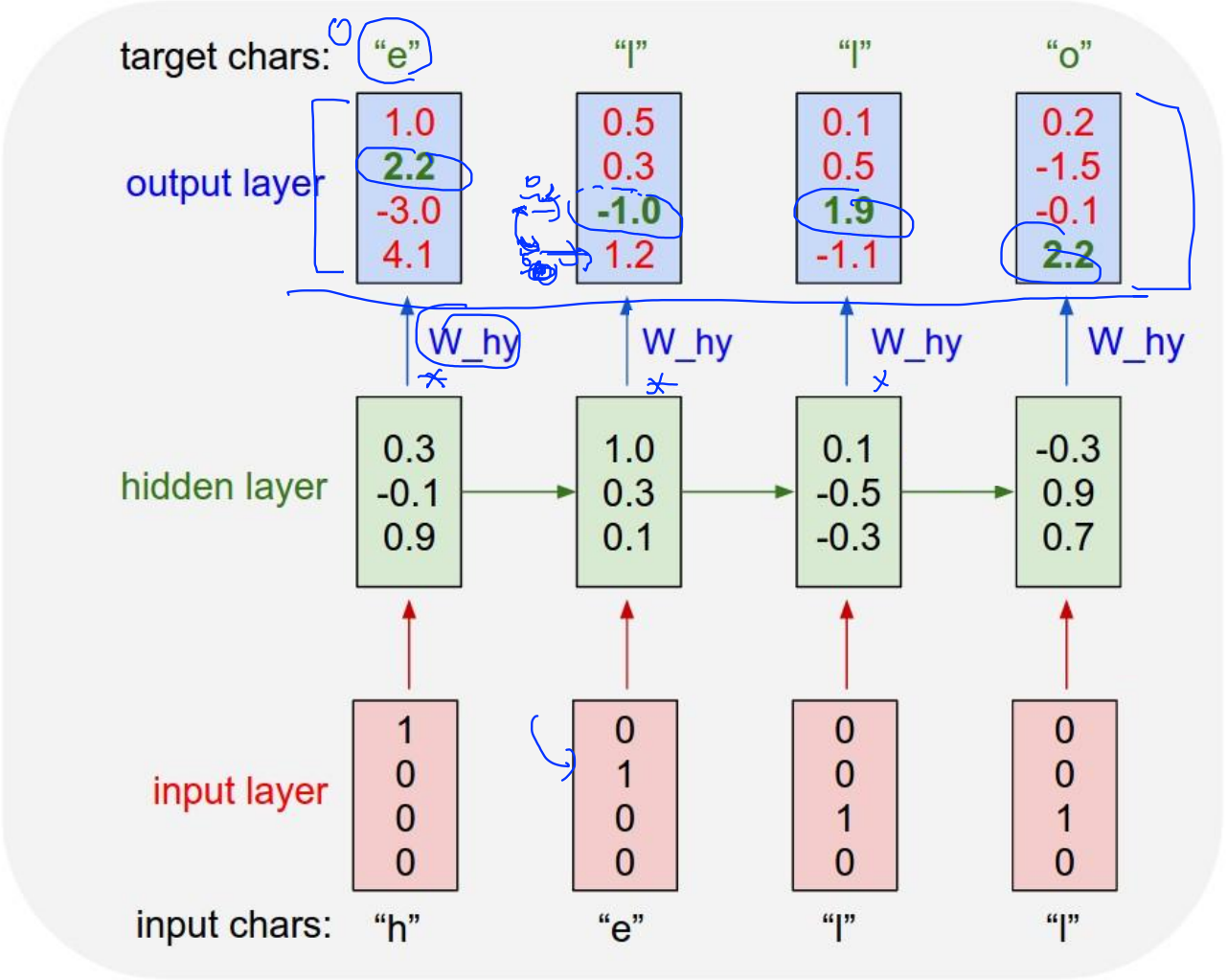

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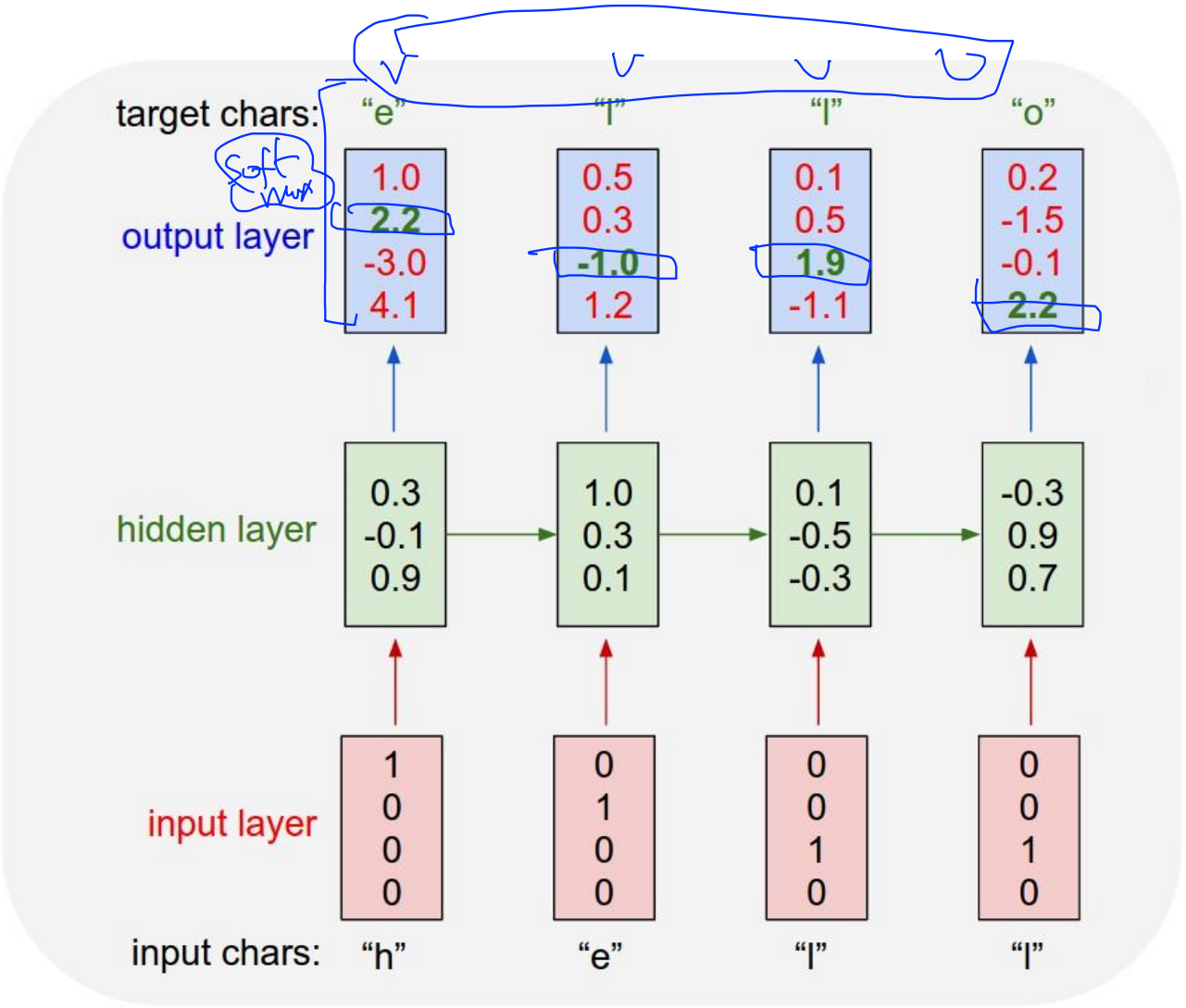


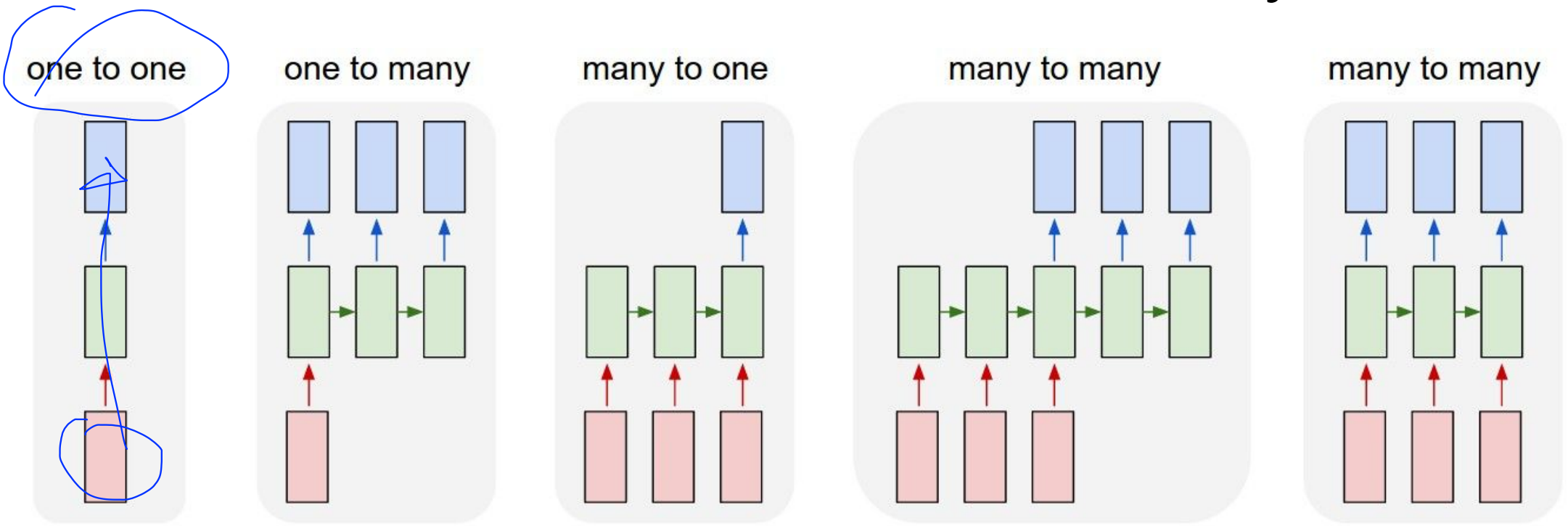
RNN applications

https://github.com/TensorFlowKR/awesome_tensorflow_implementations

- Language Modeling
- Speech Recognition
- Machine Translation
- Conversation Modeling/Question Answering
- Image/Video Captioning
- Image/Music/Dance Generation

http://jiwonkim.org/awesome-rnn/

Recurrent Networks offer a lot of flexibility:



Vanilla Neural Networks

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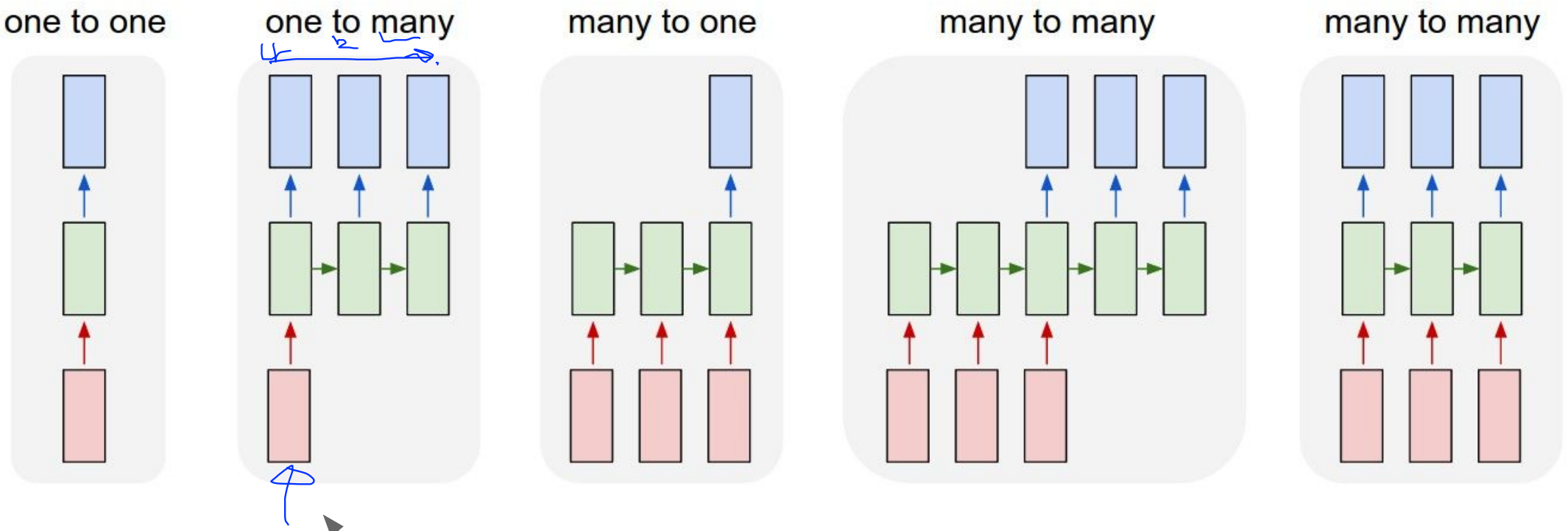

e.g. **Image Captioning**
image -> sequence of words

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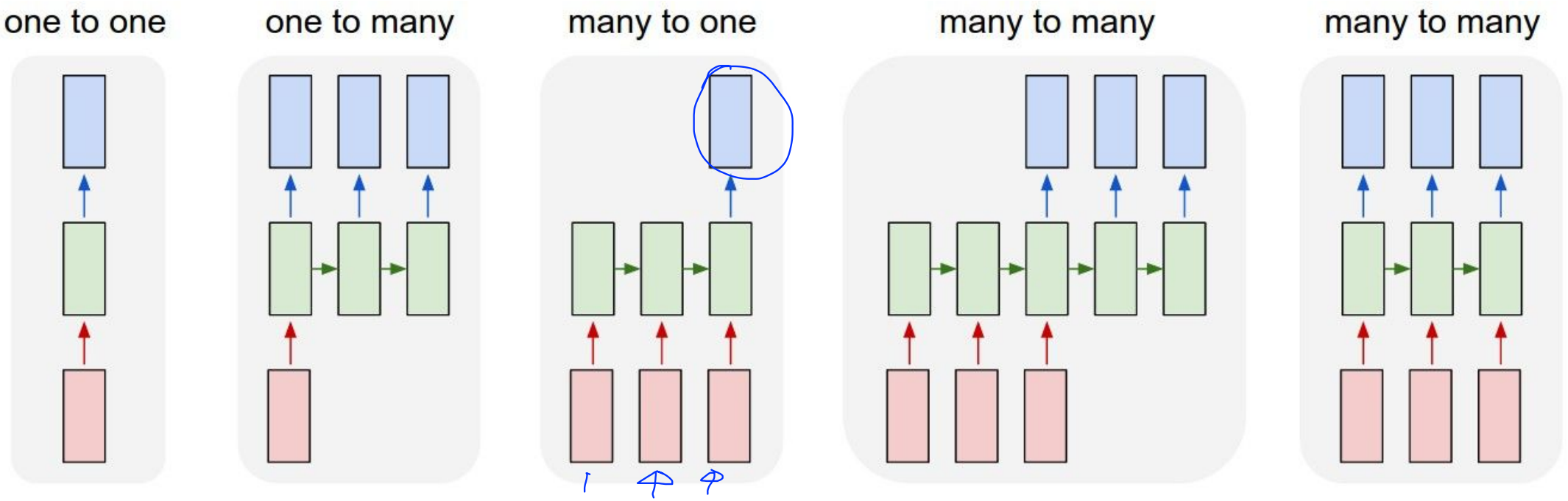

e.g. **Sentiment Classification**
sequence of words -> sentiment

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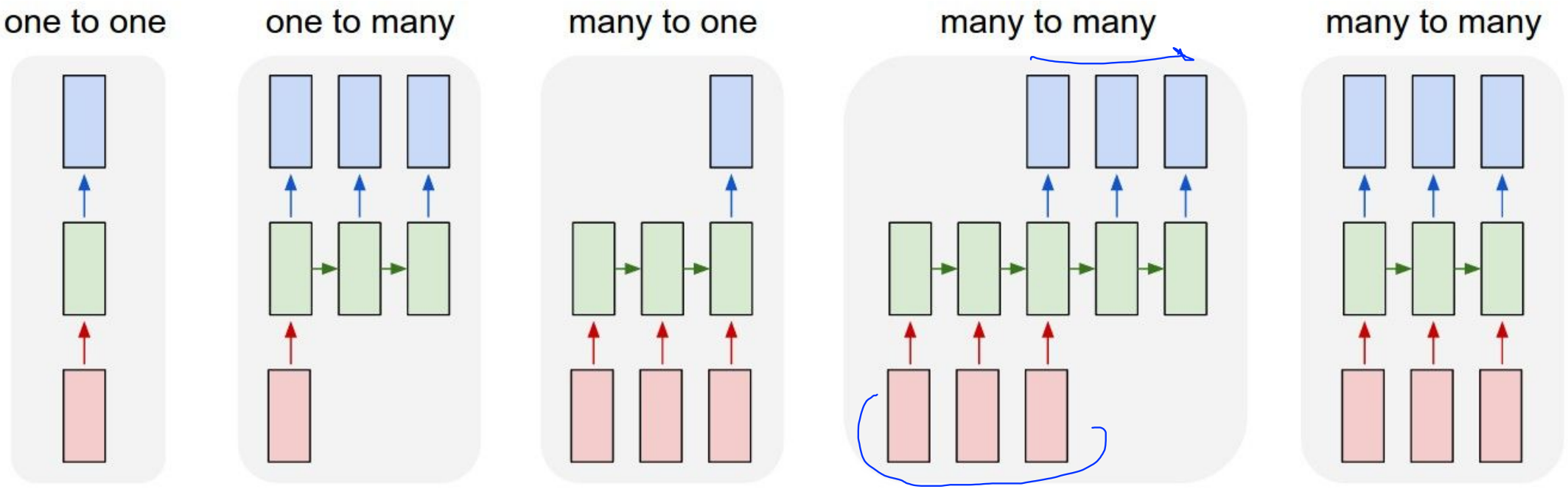

e.g. **Machine Translation**
seq of words -> seq of words

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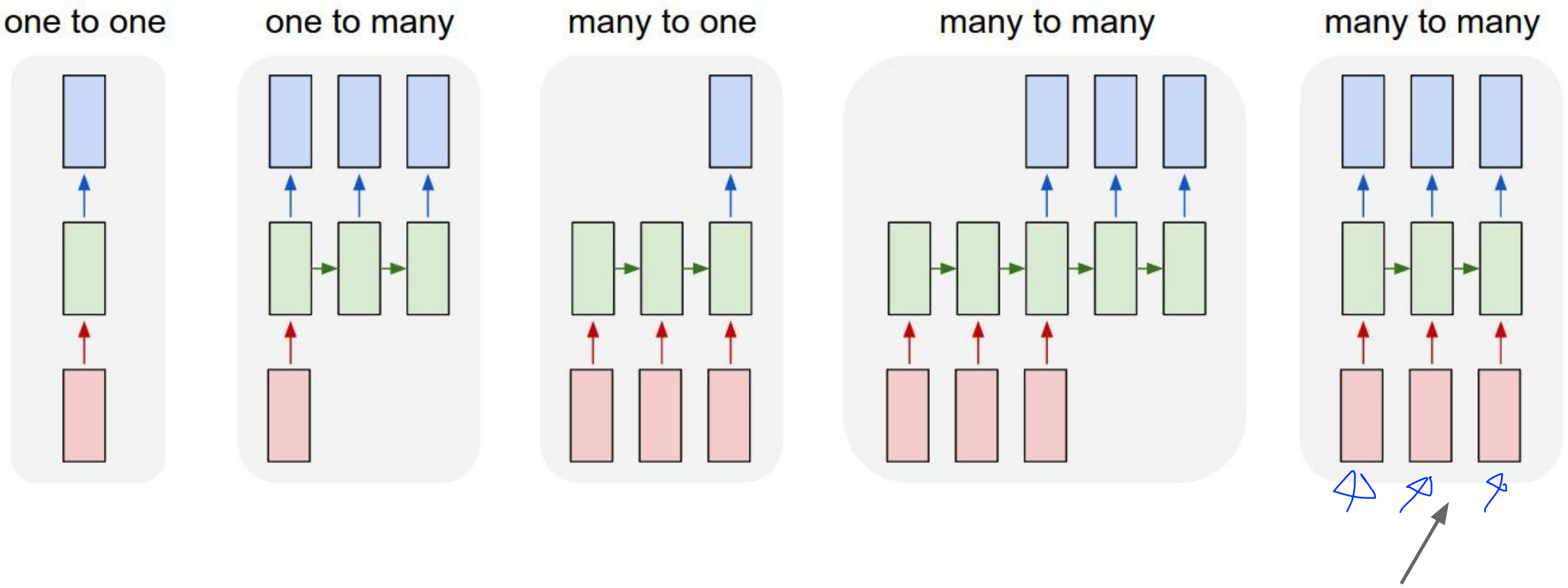
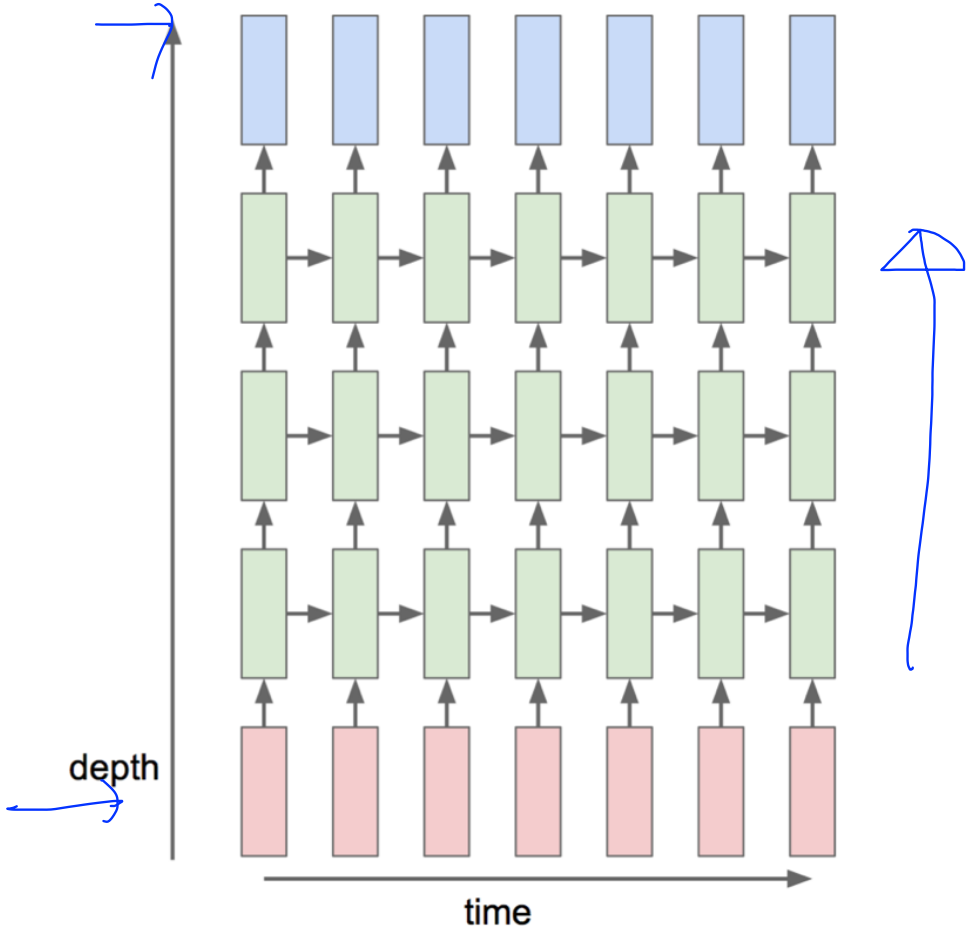


e.g. **Video classification on frame level**

Multi-Layer RNN



Training RNNs is challenging

- Several advanced models
  - Long Short Term Memory (LSTM)
  - GRU by Cho et al. 2014

Next

RNN in TensorFlow