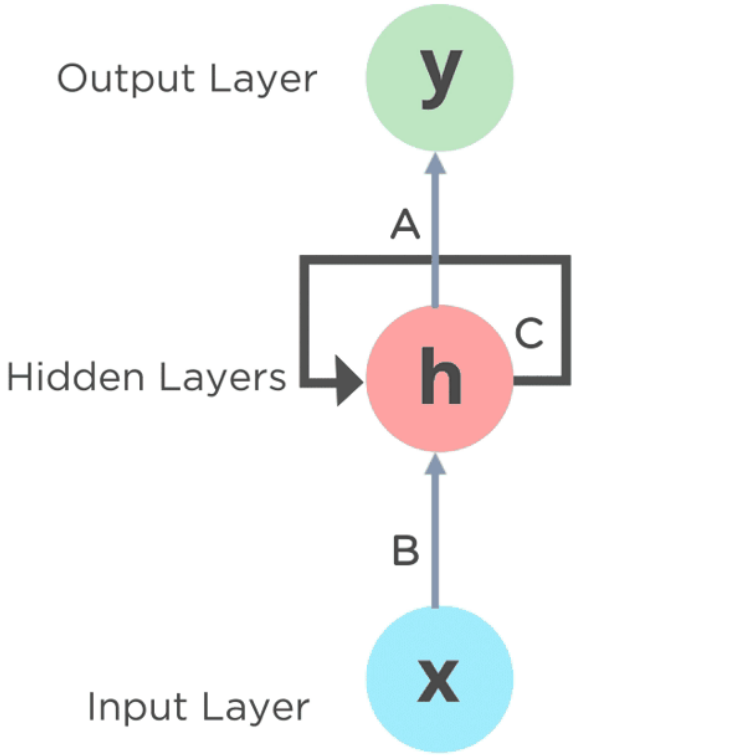
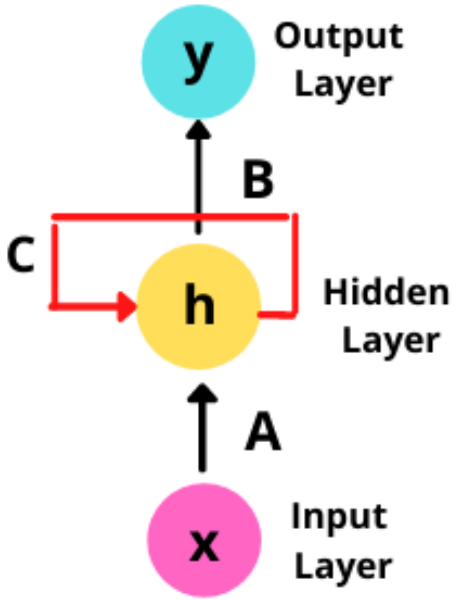
RNN

RECURRENT NEURAL NETWORK



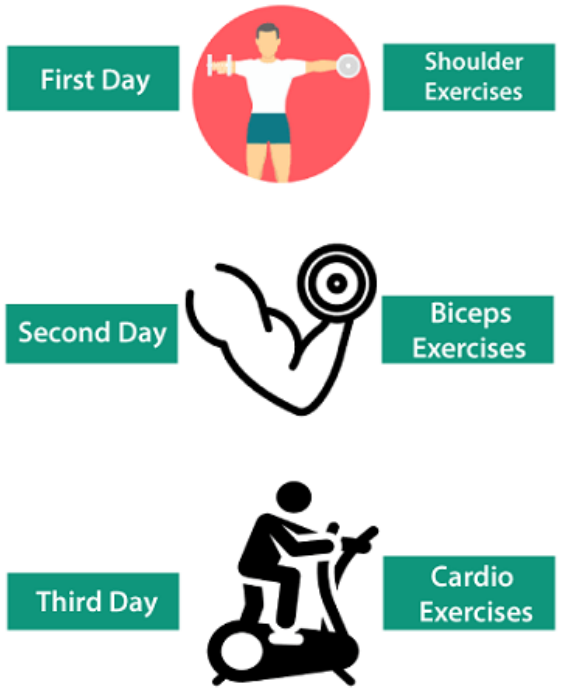
A, B and C are the parameters

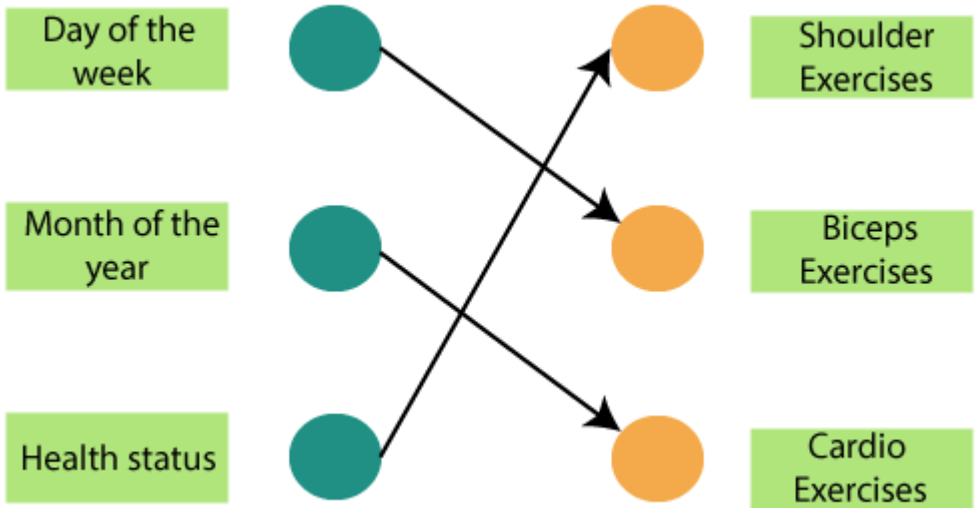


x: Input
y: Output
h: State of the hidden unit
A, B, C: Weights to be learned
A: Weights used for hidden state computation (from input)
B: Weights used for output computation
C: Weights used for hidden state computation (from the previous hidden state)

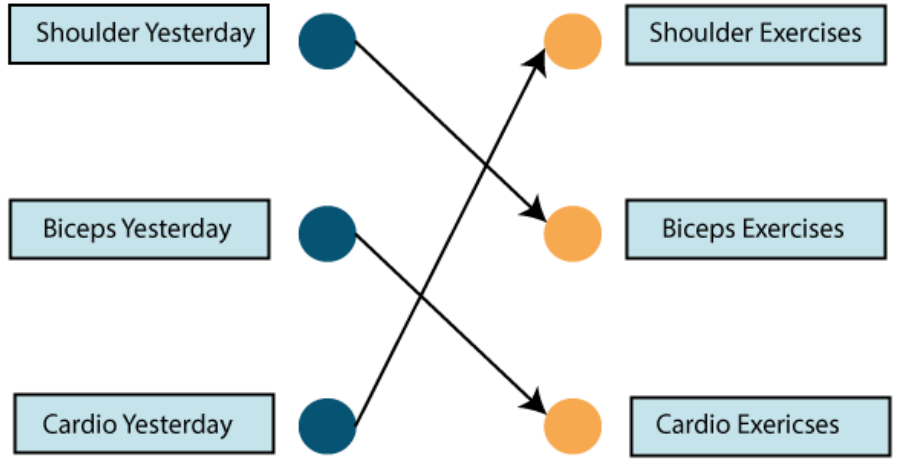
Reccurrent Neural Network

Scenario

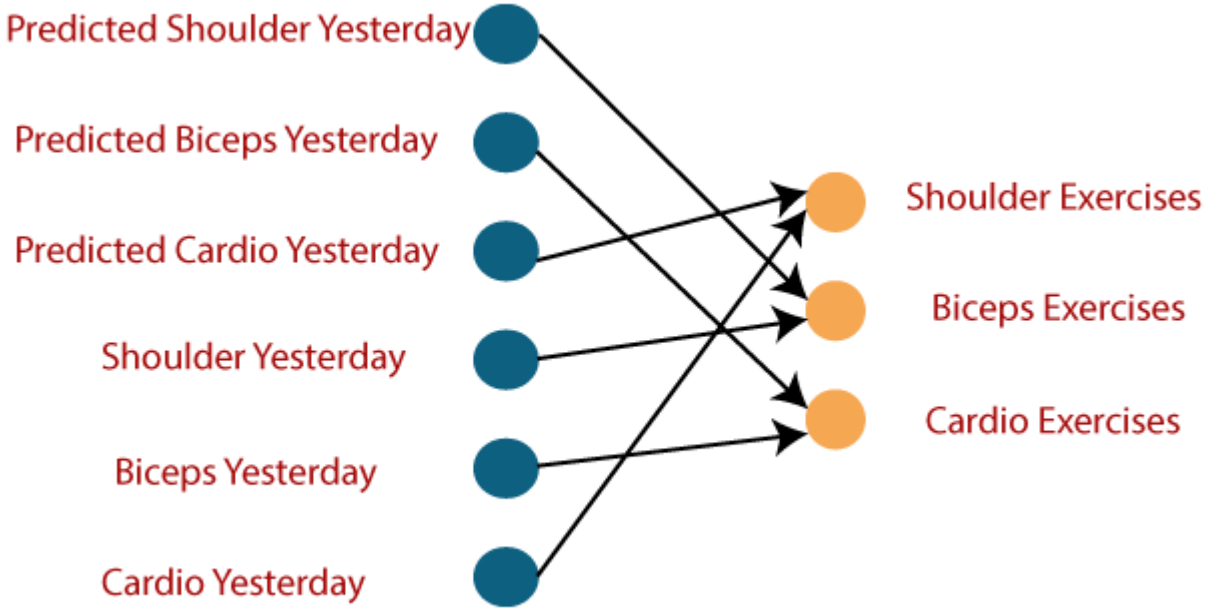




Feed-forward Neural network



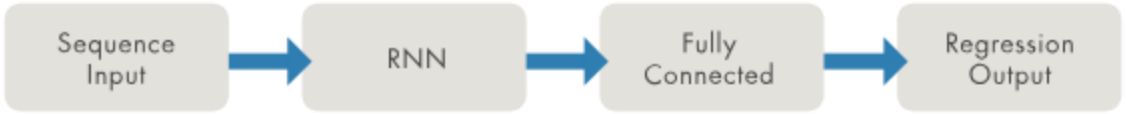
RNN



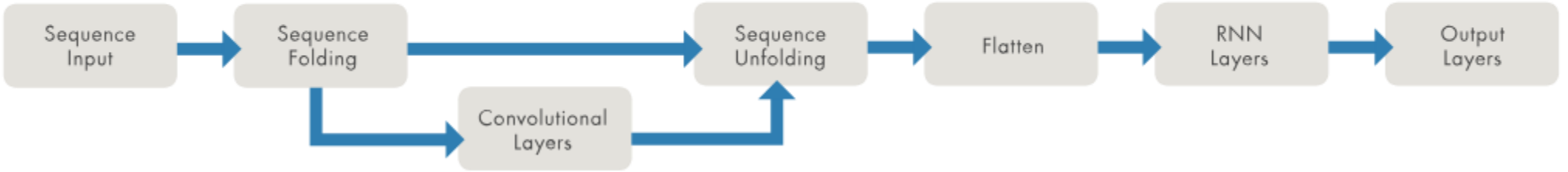
RNN NETWORK ARCHITECTURE

CLASSIFICATION

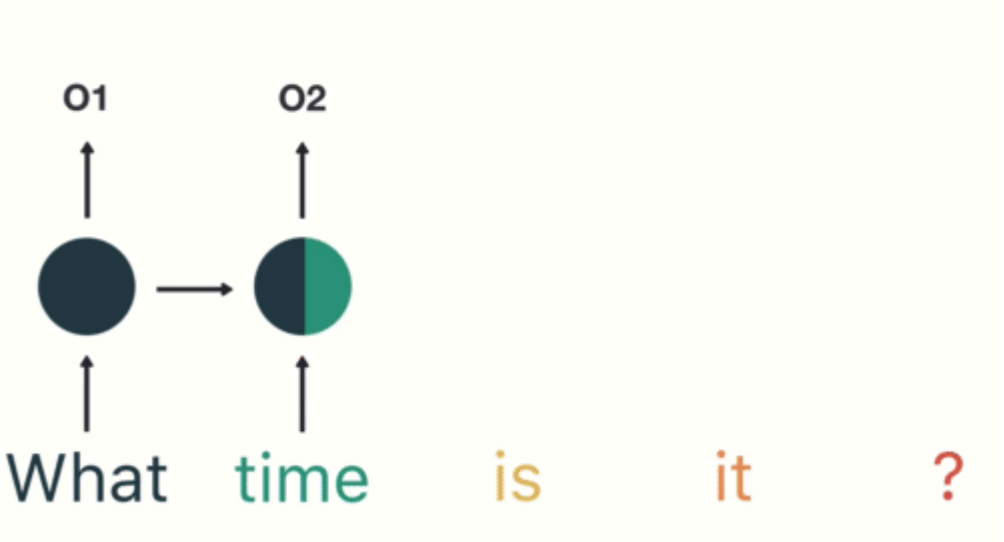
REGRESSION



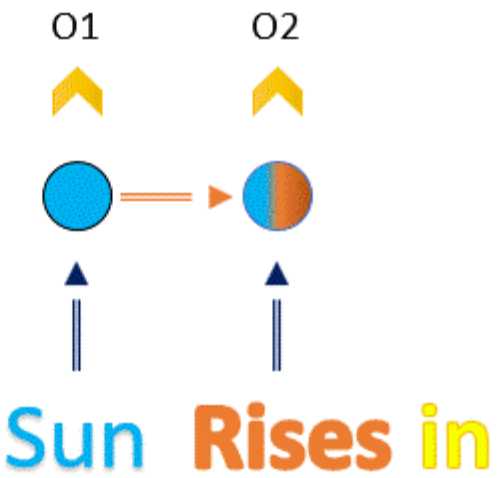
VIDEO CLASSIFICATION

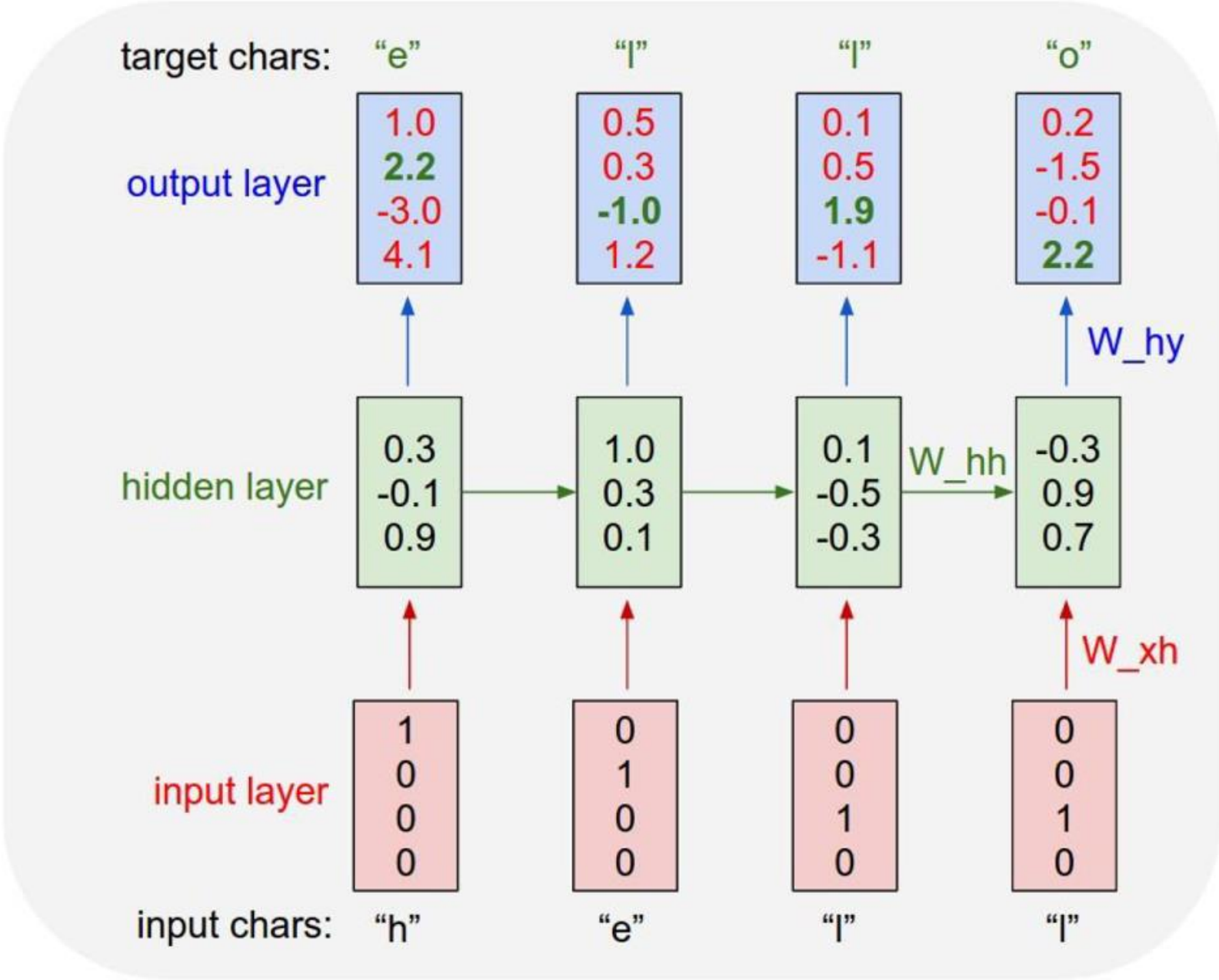


Example 1



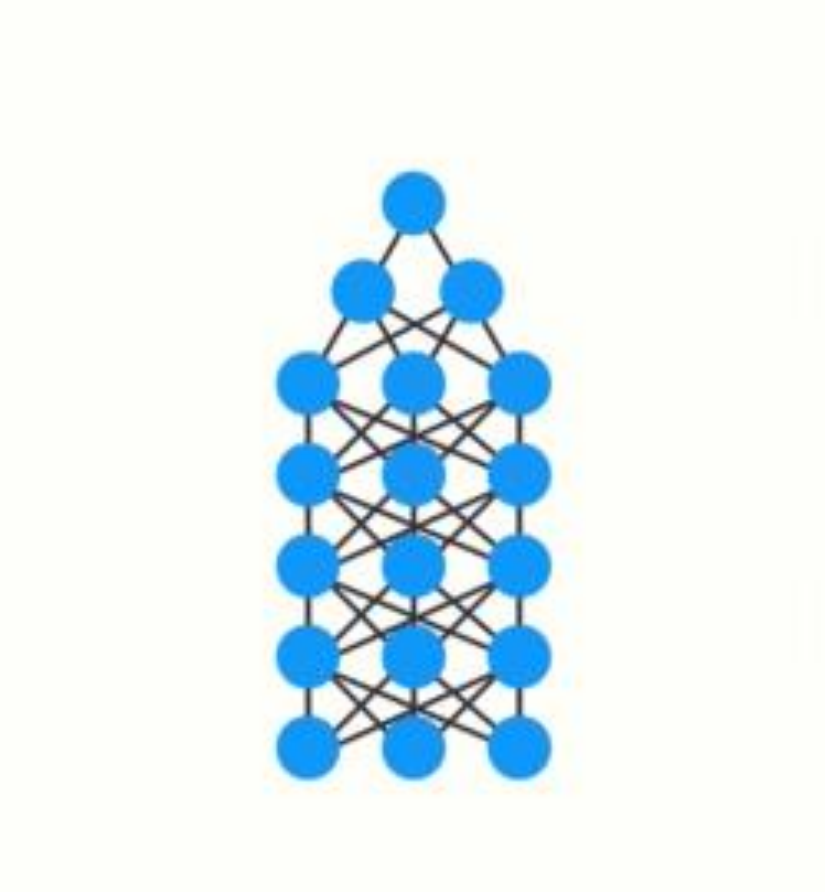
Example 2



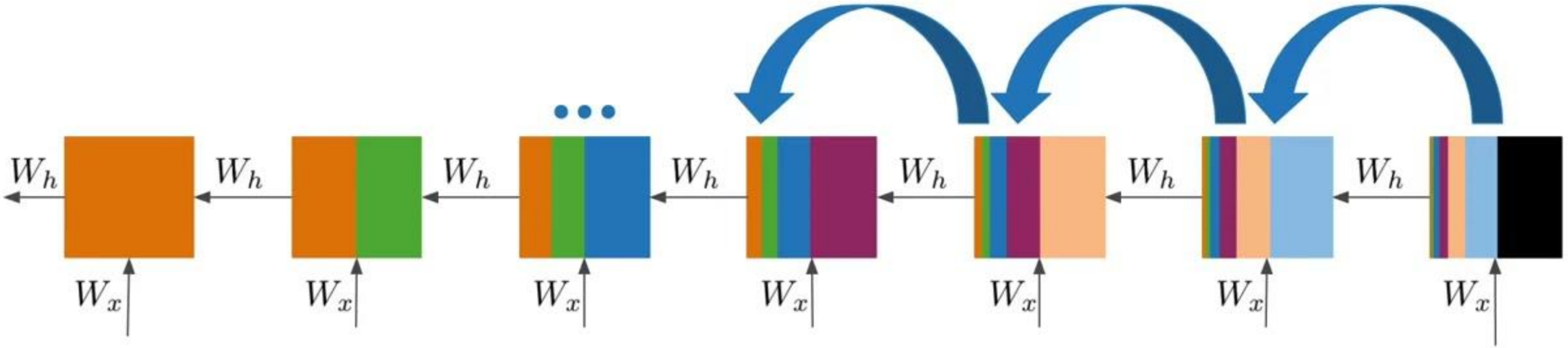


RNN Real Time Example

Back Propagation

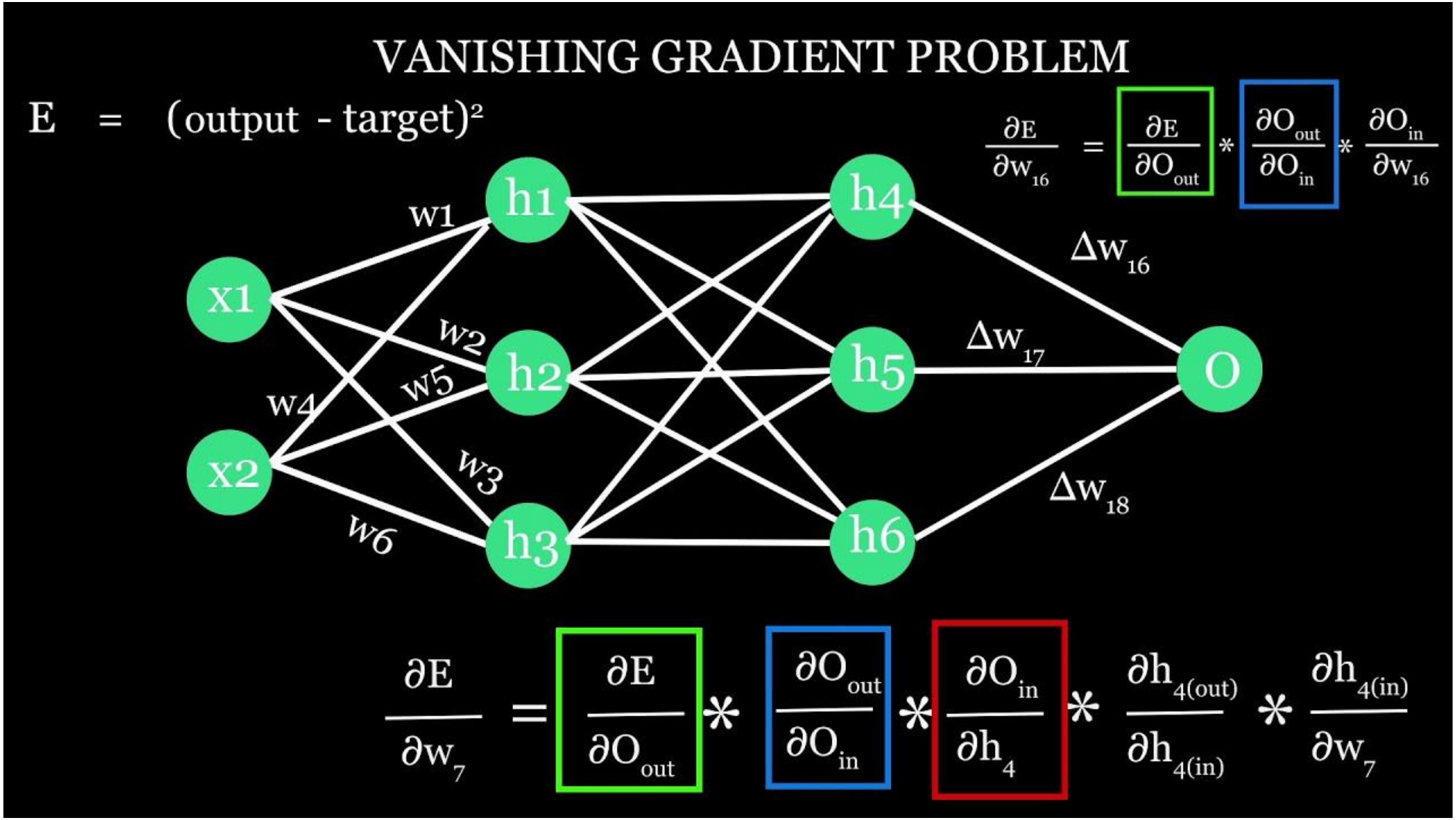


Backpropagation through time

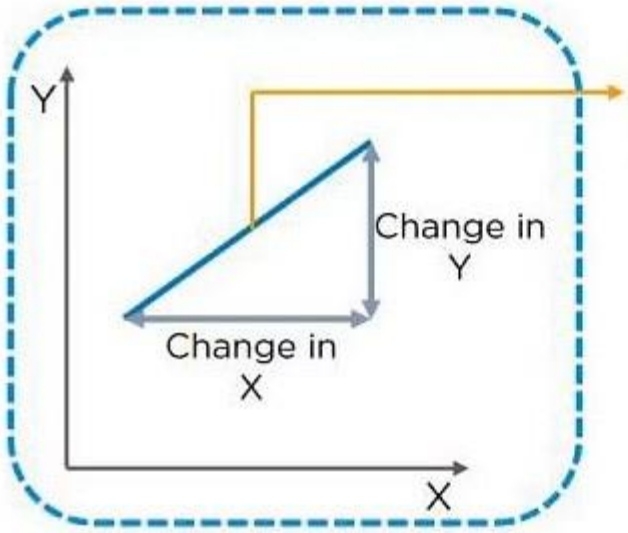


between 0 and 1

between -1 and 1

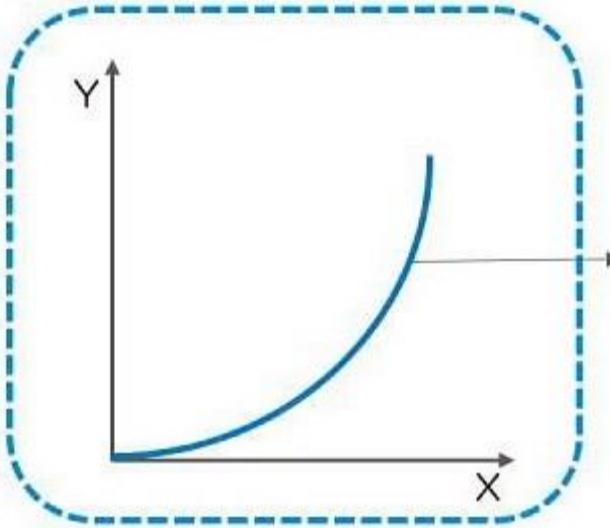

VANISHING GRADIENT PROBLEM
E = (output - target)²
$\frac{\partial E}{\partial w_{16}} = \frac{\partial E}{\partial O_{out}} * \frac{\partial O_{out}}{\partial O_{in}} * \frac{\partial O_{in}}{\partial w_{16}}$
x1
x2
h1
h2
h3
h4
h5
h6
O
w1
w2
w3
w4
w5
w6
Δw_{16}
Δw_{17}
Δw_{18}
$\frac{\partial E}{\partial w_7} = \frac{\partial E}{\partial O_{out}} * \frac{\partial O_{out}}{\partial O_{in}} * \frac{\partial O_{in}}{\partial h_4} * \frac{\partial h_{4(out)}}{\partial h_{4(in)}} * \frac{\partial h_{4(in)}}{\partial w_7}$

Vanishing gradients

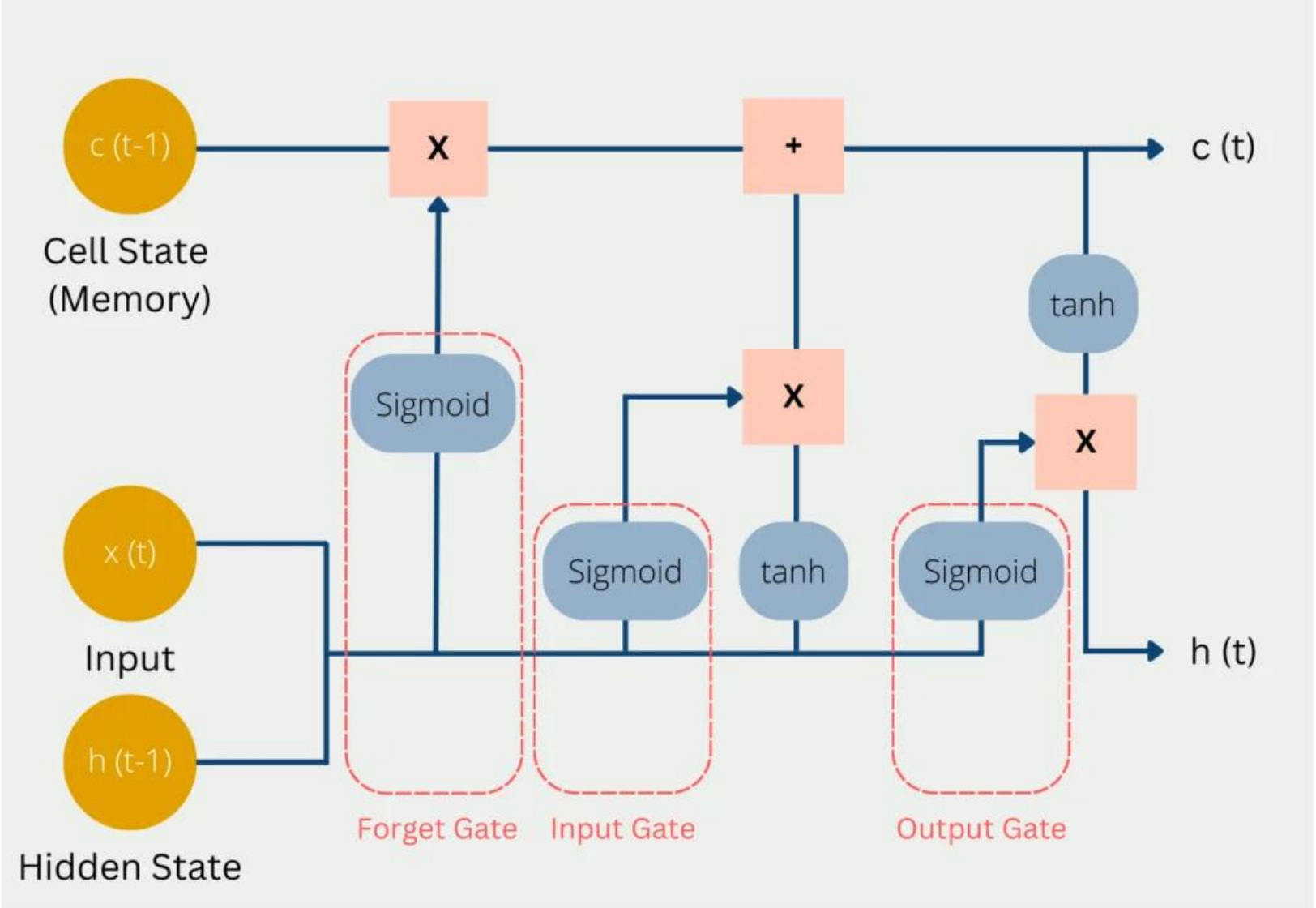


Slope decreases gradually to a very small value (sometimes negative) and makes training difficult

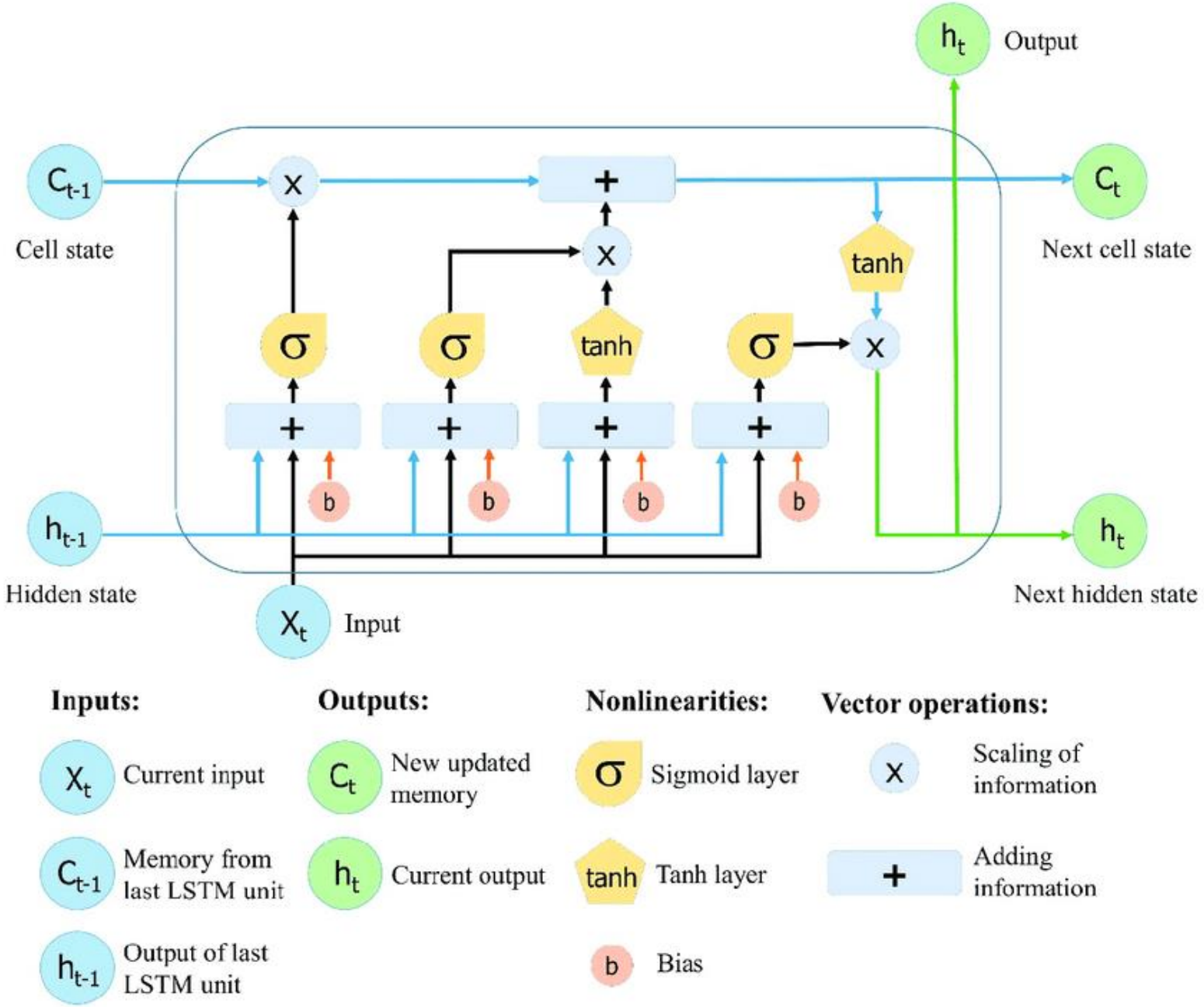
Explaoding gradients



Slope grows exponentially


c (t-1)
Cell State
(Memory)
x
+
c (t)
tanh
Sigmoid
x
x
x (t)
Input
Sigmoid
tanh
Sigmoid
h (t)
h (t-1)
Hidden State
Forget Gate
Input Gate
Output Gate

LSTM



Inputs:

X_t Current input

C_{t-1} Memory from last LSTM unit

h_{t-1} Output of last LSTM unit

Outputs:

C_t New updated memory

h_t Current output

Nonlinearities:

σ Sigmoid layer

tanh Tanh layer

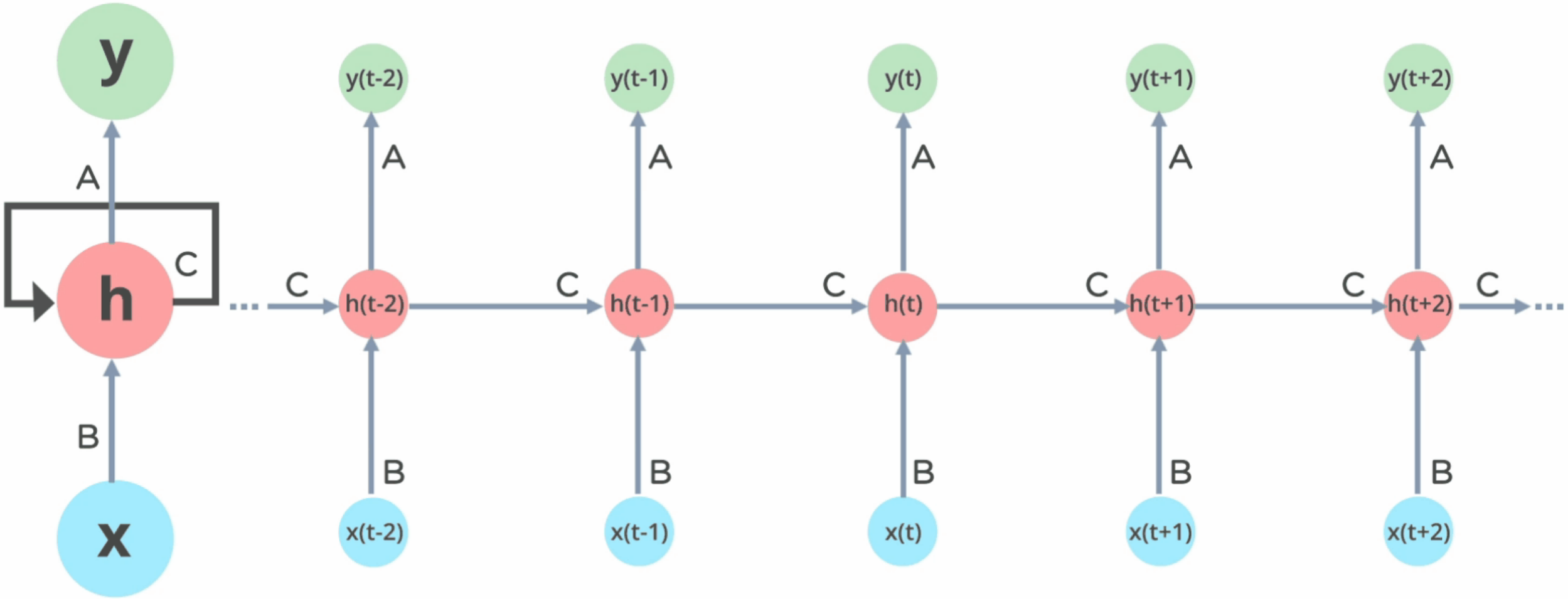
b Bias

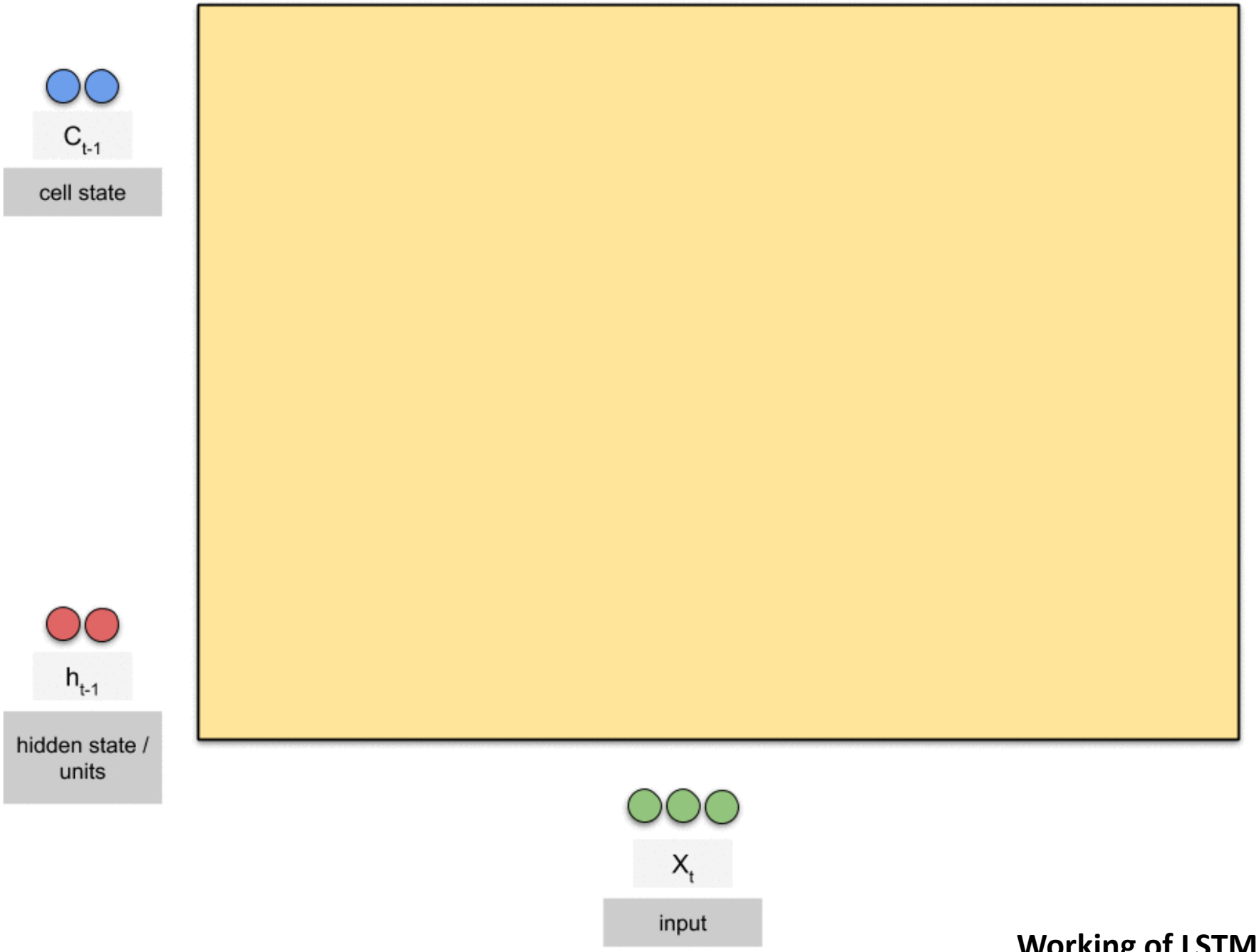
Vector operations:

x Scaling of information

\+ Adding information

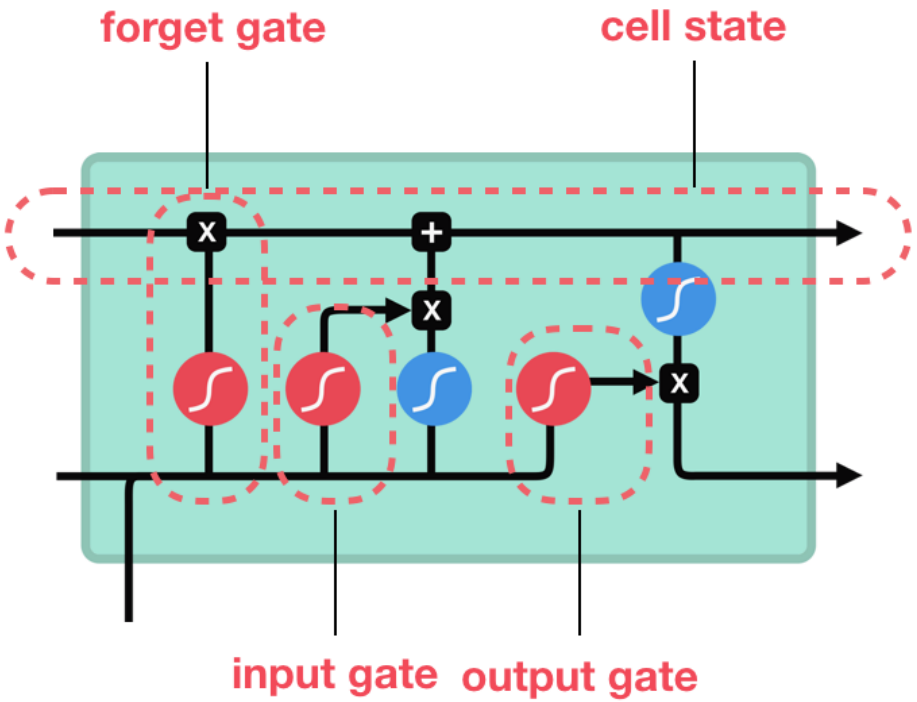
LSTM – Long Short Term Memory



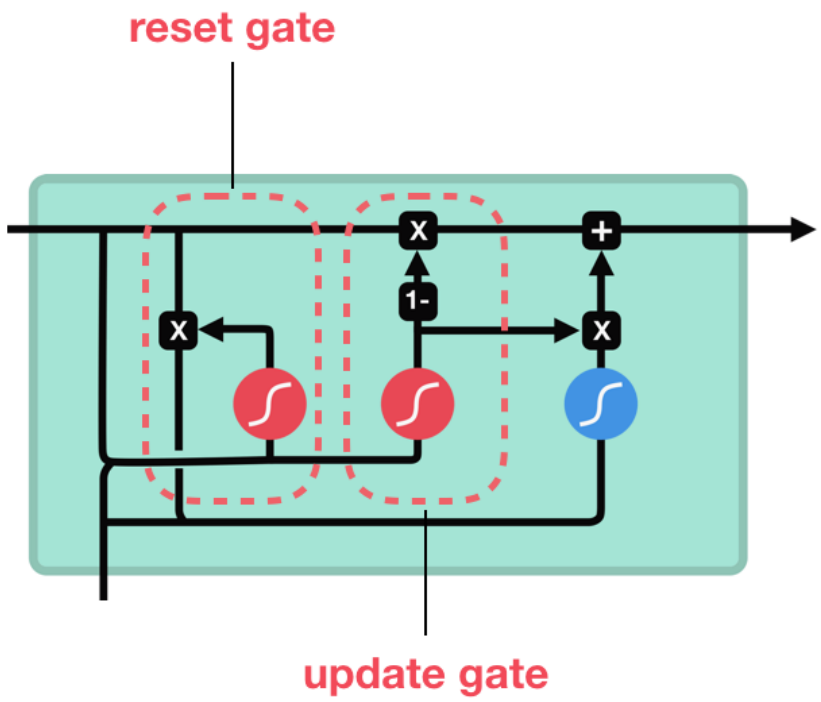


Working of LSTM

LSTM



GRU

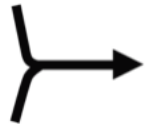


sigmoid

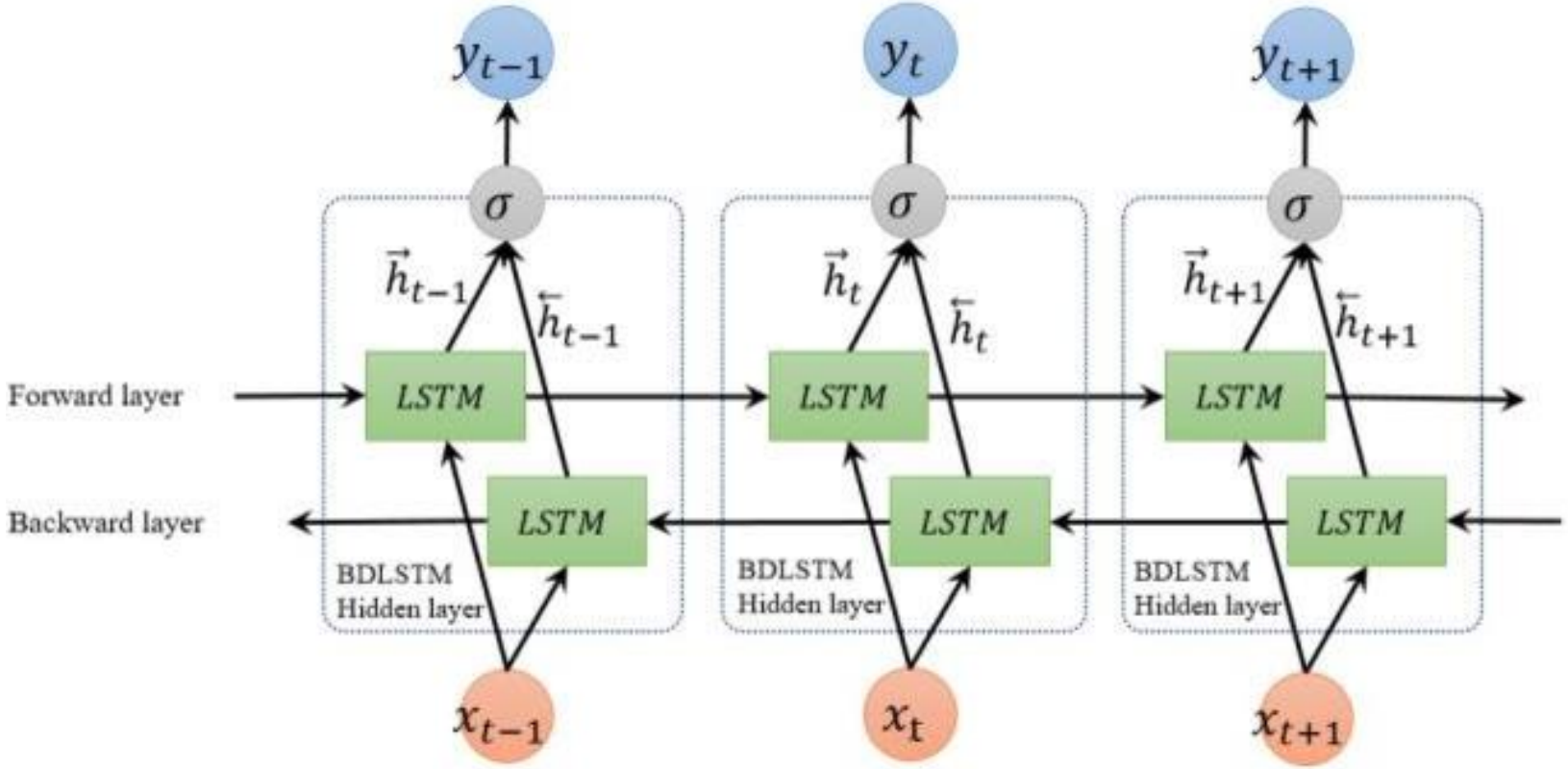
tanh

pointwise multiplication

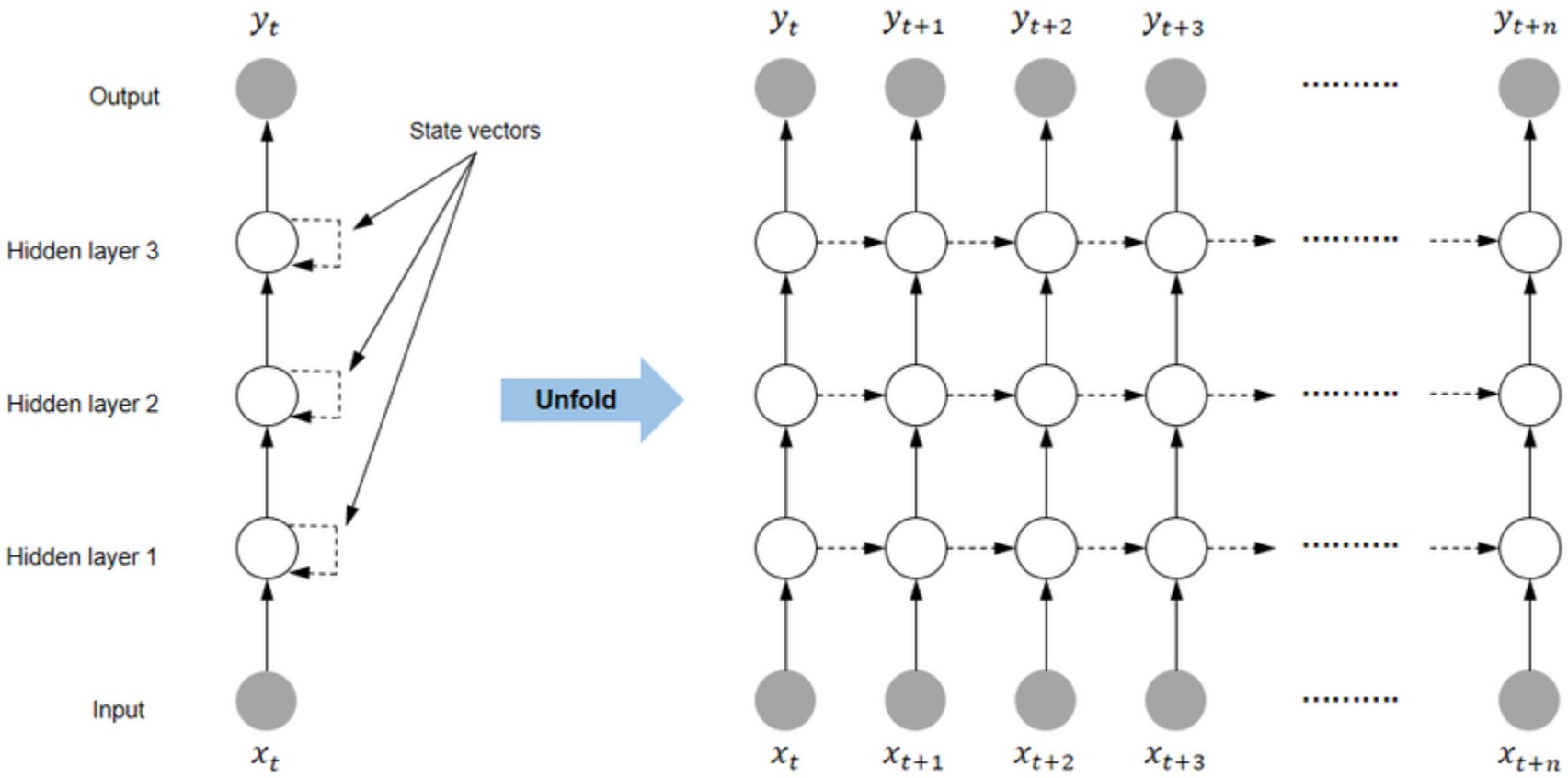
pointwise addition



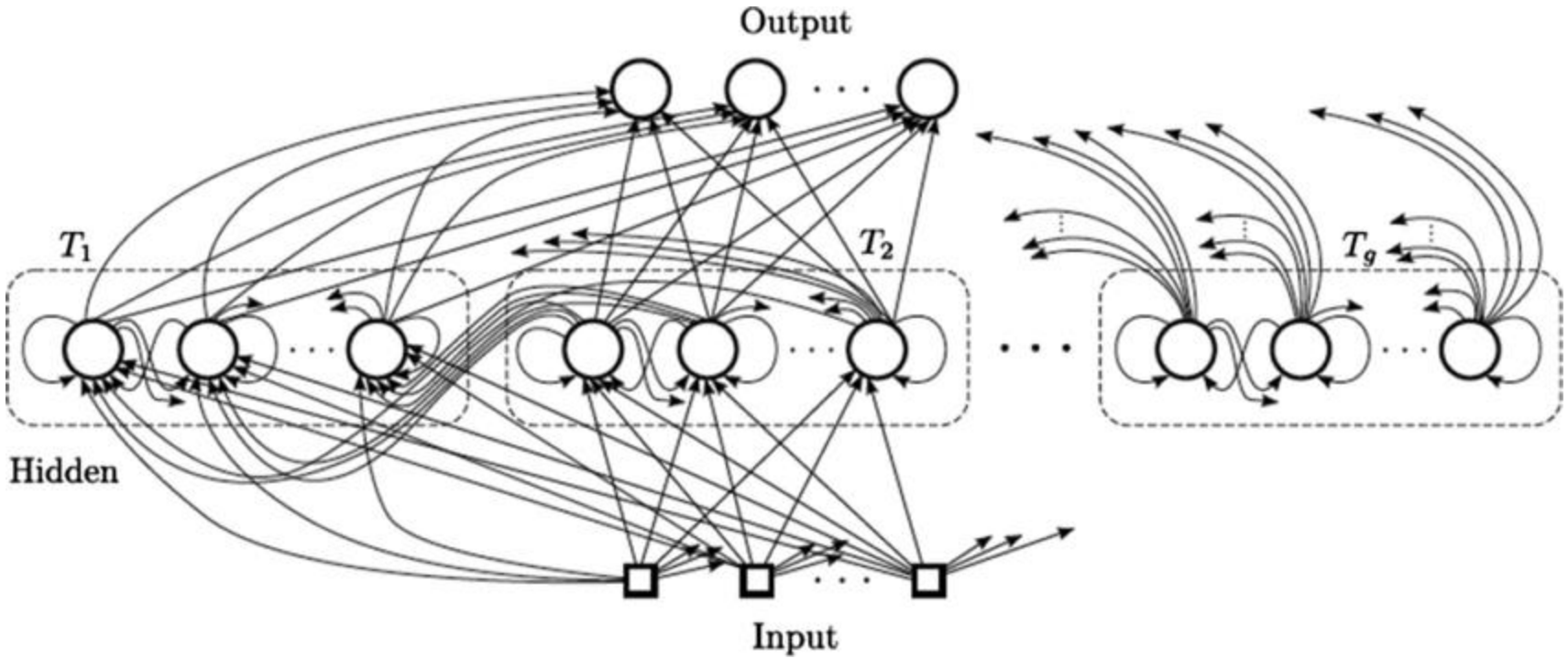
vector concatenation



Bidirectional RNNs

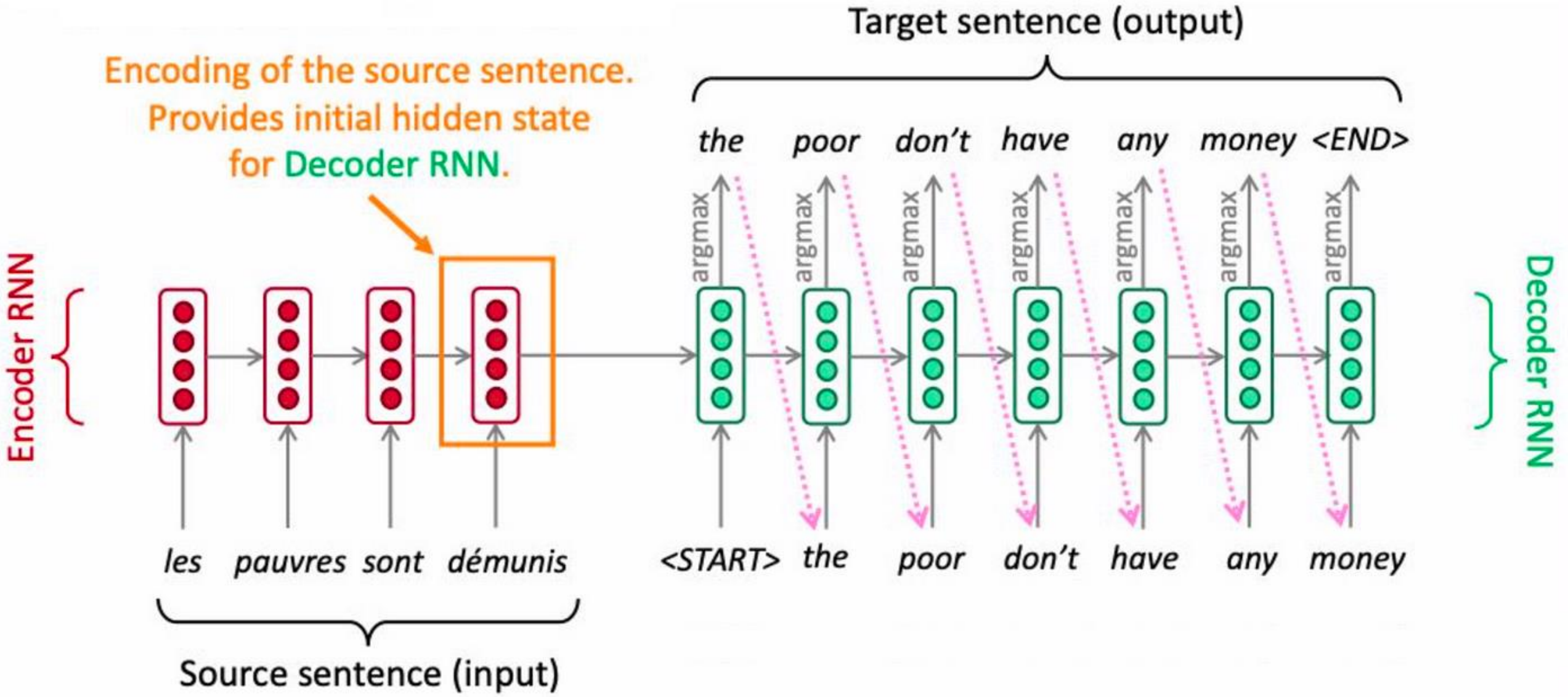

y_t
Output
State vectors
Hidden layer 3
Hidden layer 2
Hidden layer 1
Input
x_t
Unfold
y_t
y_{t+1}
y_{t+2}
y_{t+3}
y_{t+n}
x_t
x_{t+1}
x_{t+2}
x_{t+3}
x_{t+n}

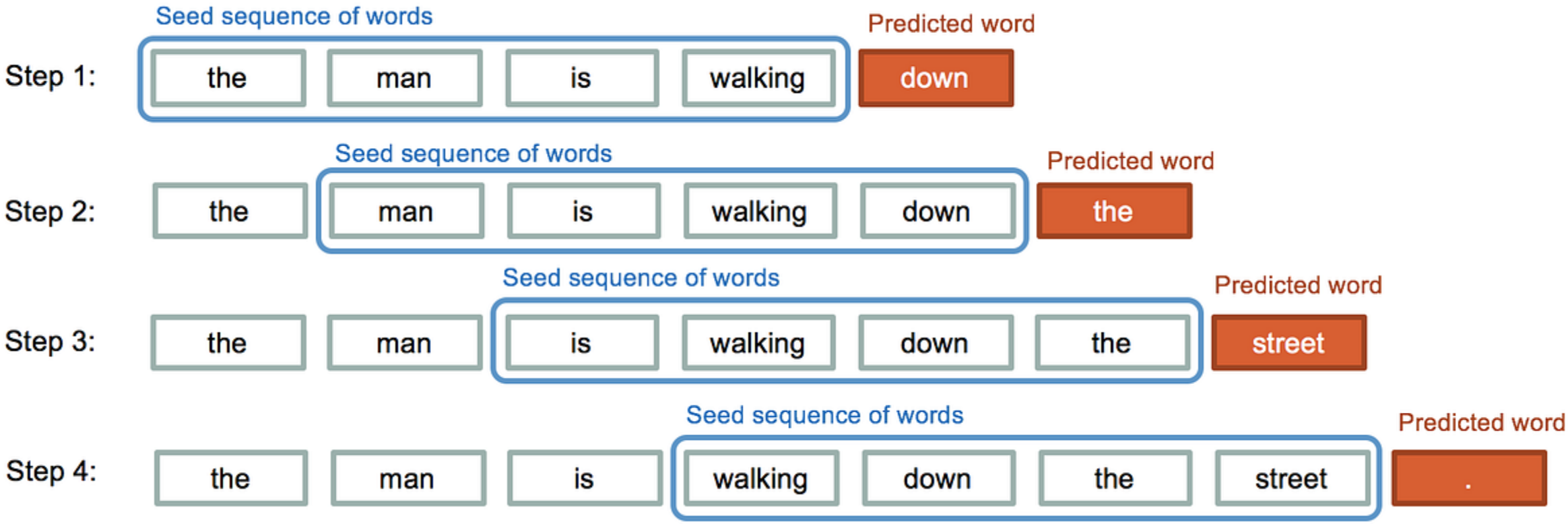
Deep RNN



Clockwork RNN

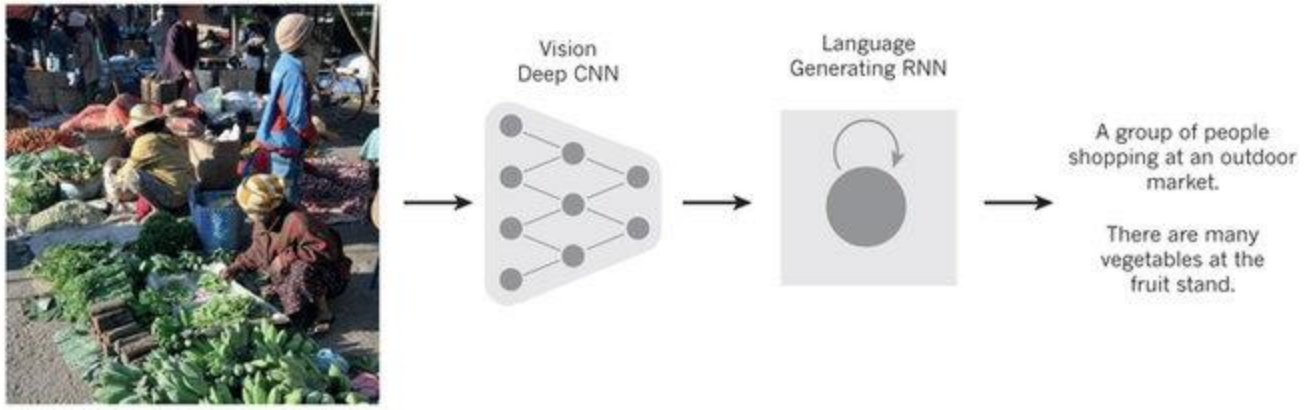
Language Translator





Word/Text prediction

Image Captioning




A woman is throwing a **frisbee** in a park.


A **dog** is standing on a hardwood floor.

A **stop** sign is on a road with a mountain in the background


A little **girl** sitting on a bed with a teddy bear.


A group of **people** sitting on a boat in the water.


A giraffe standing in a forest with **trees** in the background.