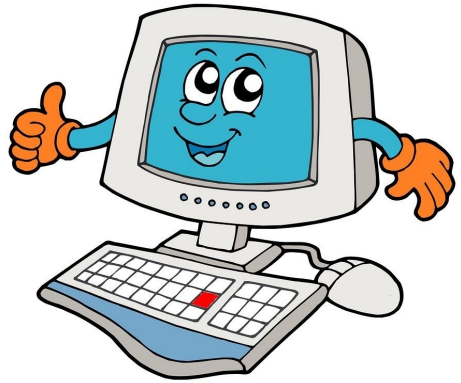
Recurrent Neural Network

: Processing Sequence Data

Reminder

저는 너구리일까요? 라쿤일까요?

cat or dog
classifier



당신은 고양이 입니다.

내?

Reminder

(910,512,3,1)

저는 고정된 시간 안에서 존재합니다.

여러분(혹은 컴퓨터)은 저를 움직이지 않는 사진으로만 인식할 수 있죠.

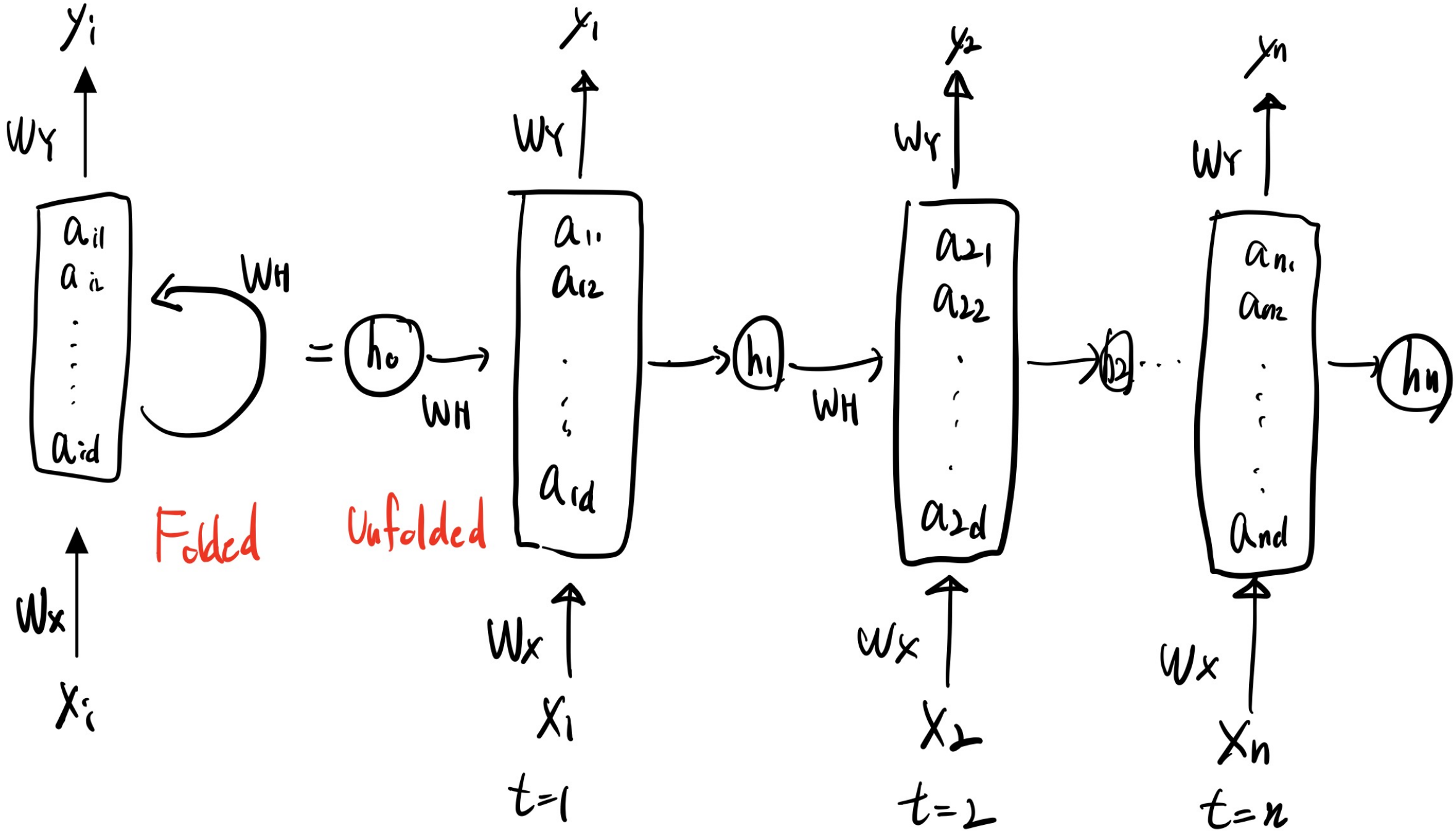
- 우리는 지금까지 하나의 time-step을 가지고 있는 input과 output을 가지고 이야기를 했습니다.
- 때로는 시퀀스나 맥락이 필요한 데이터가 있습니다.

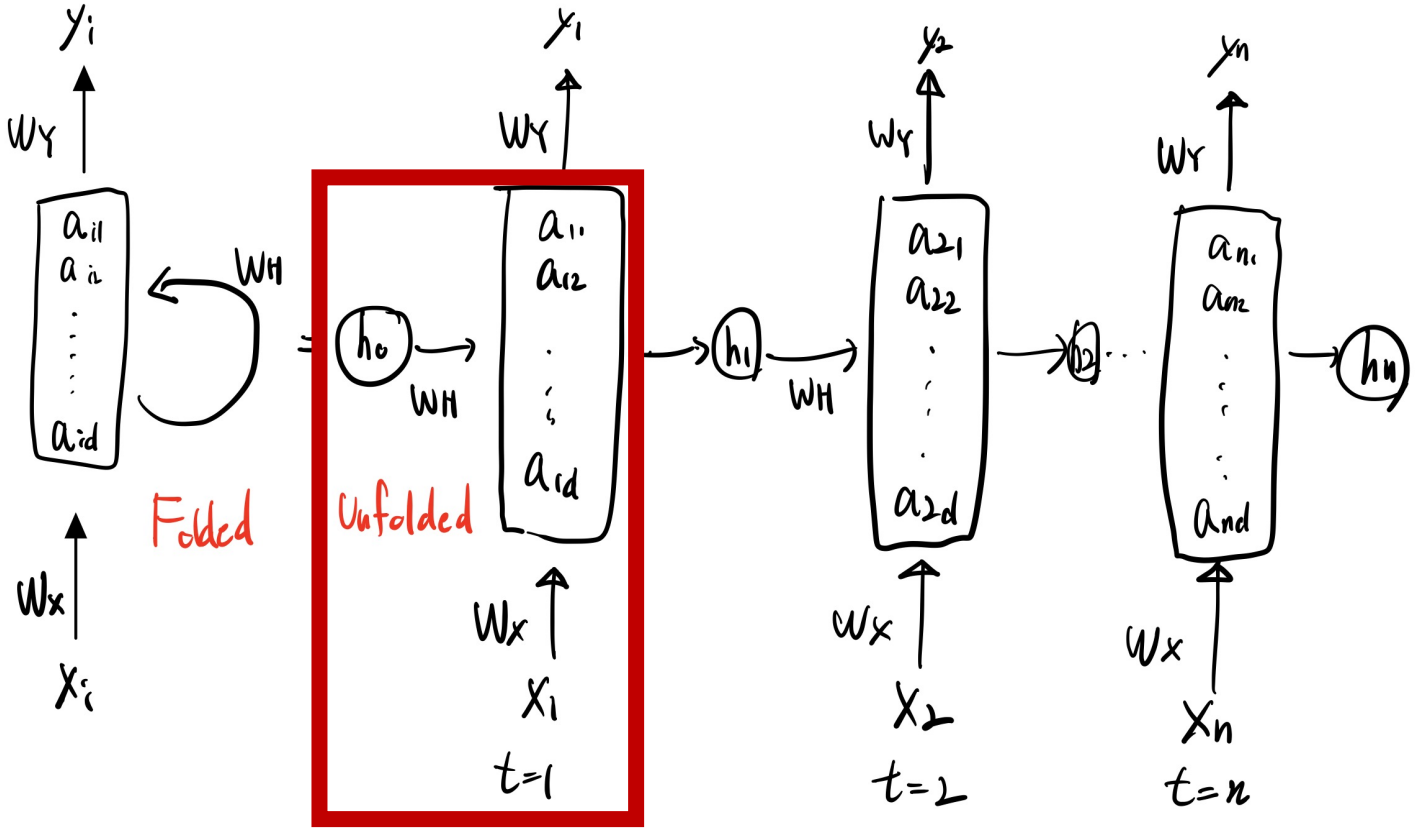
입라는쿤저다니

저는 라쿤 입니다

- weather forecast
- time series
- speech recognition
- audio or video processing

Simple RNN


y_i
W_Y
a_{i1}
a_{i2}
a_{id}
W_H
W_x
x_i
Folded
=
h_0
W_H
Unfolded
y_1
W_Y
a_{11}
a_{12}
a_{1d}
W_x
x_1
$t=1$
h_1
W_H
y_2
W_Y
a_{21}
a_{22}
a_{2d}
W_x
x_2
$t=2$
h_2
y_n
W_Y
a_{n1}
a_{n2}
a_{nd}
W_x
x_n
$t=n$
h_n



$$a_t = W_H h_{t-1} + W_X X_t + b_h$$

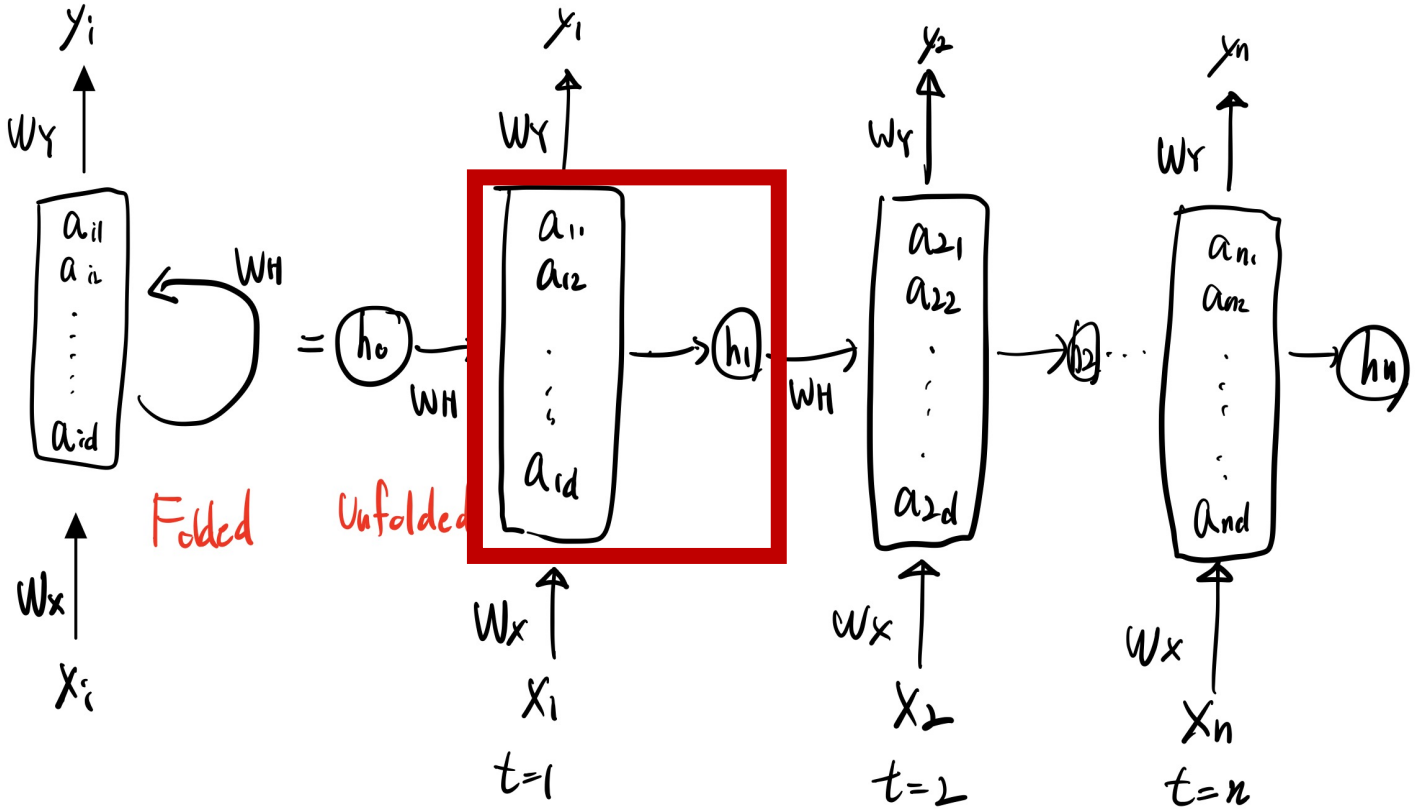
t : current time step

X_t : input at time step t
h_{t-1} : hidden state step t-1

W_X : input weight matrix
W_H : hidden state weight matrix

b_h : bias vector

a_t : hidden nodes step t

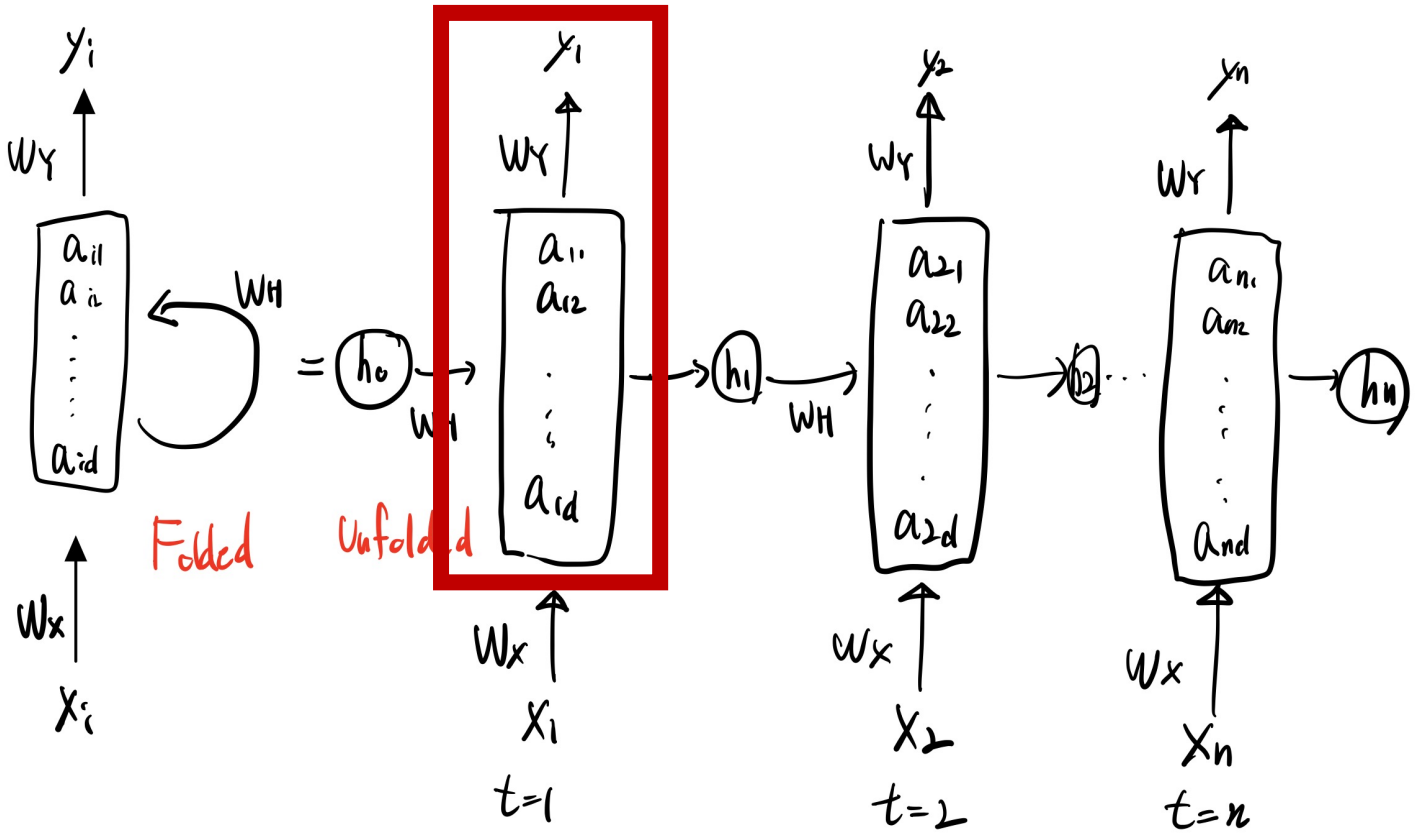


$$h_t = tanh(a_t)$$

t : current time step,
a_t : hidden nodes step t

h_t : hidden state step t

$$tanh(a_t) = \frac{e^{a_t} - e^{-a_t}}{e^{a_t} + e^{-a_t}}$$

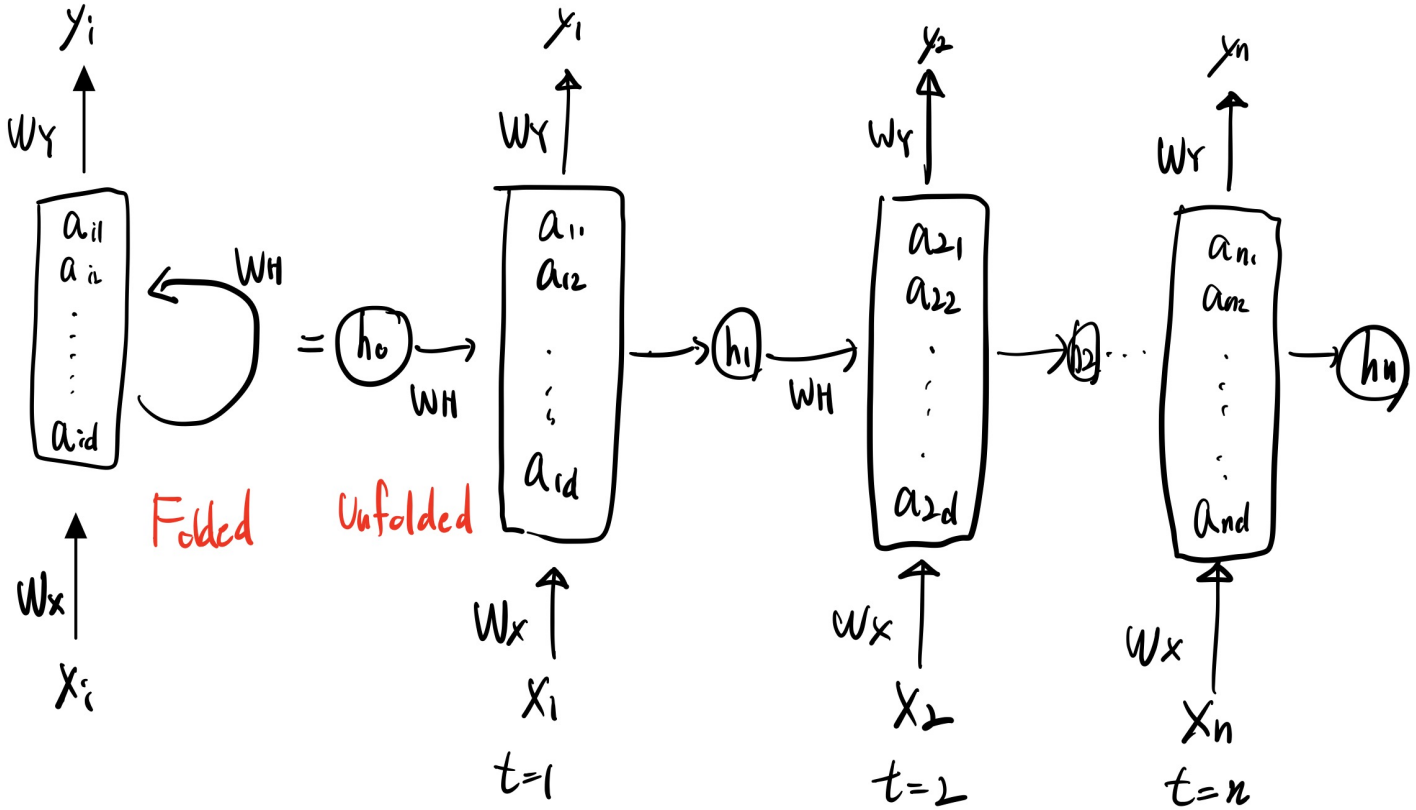


$$y_t = softmax(W_Y h_t + b_y)$$

t : current time step
h_t : hidden state step t
W_Y : output weight matrix
b_y : bias vector

y_t : output at time step t

$$softmax(W_Y h_t + b_y) = \frac{e^{W_Y h_t + b_y}}{\sum e^{W_Y h_t + b_y}}$$

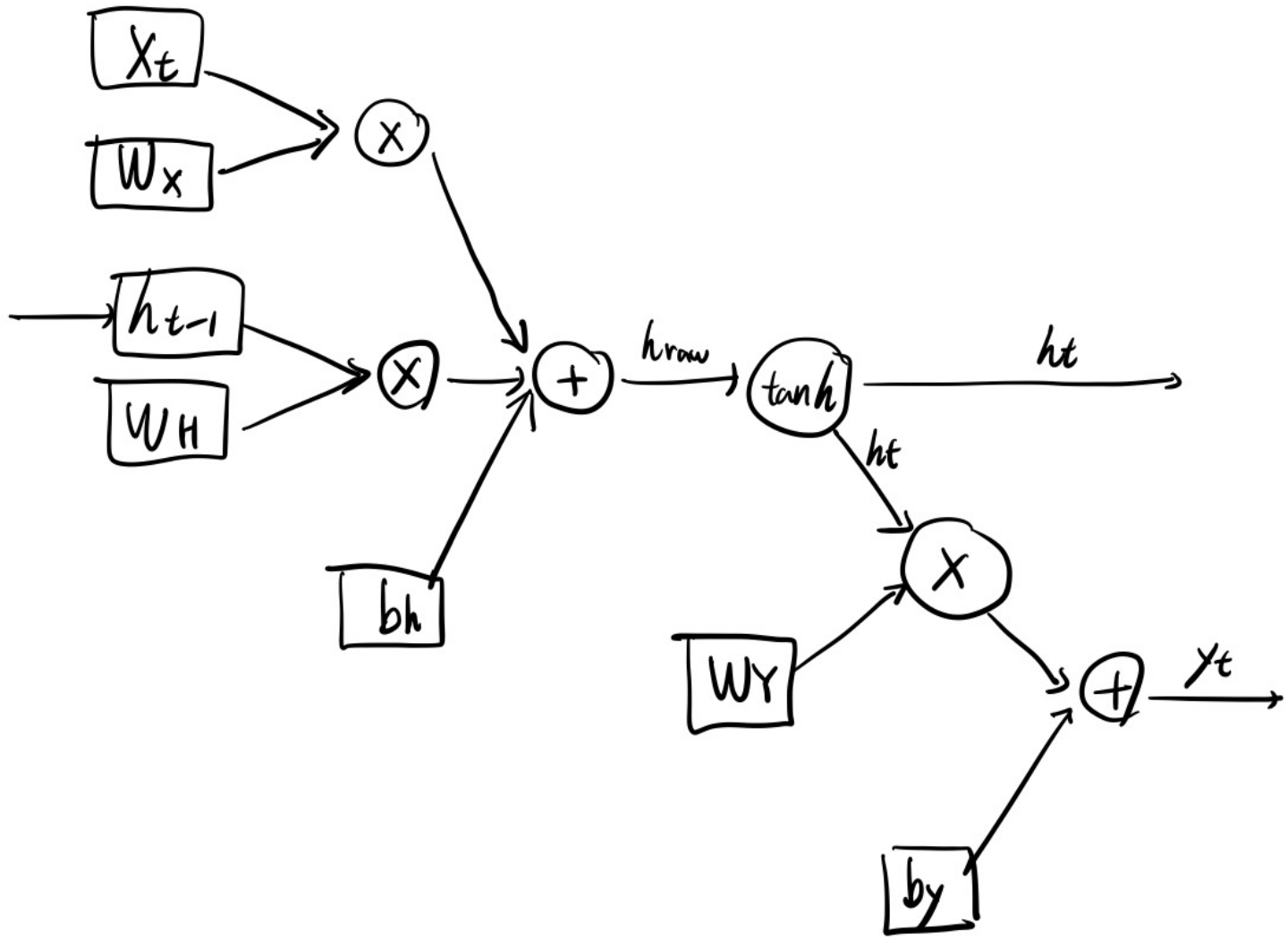


Dimensions

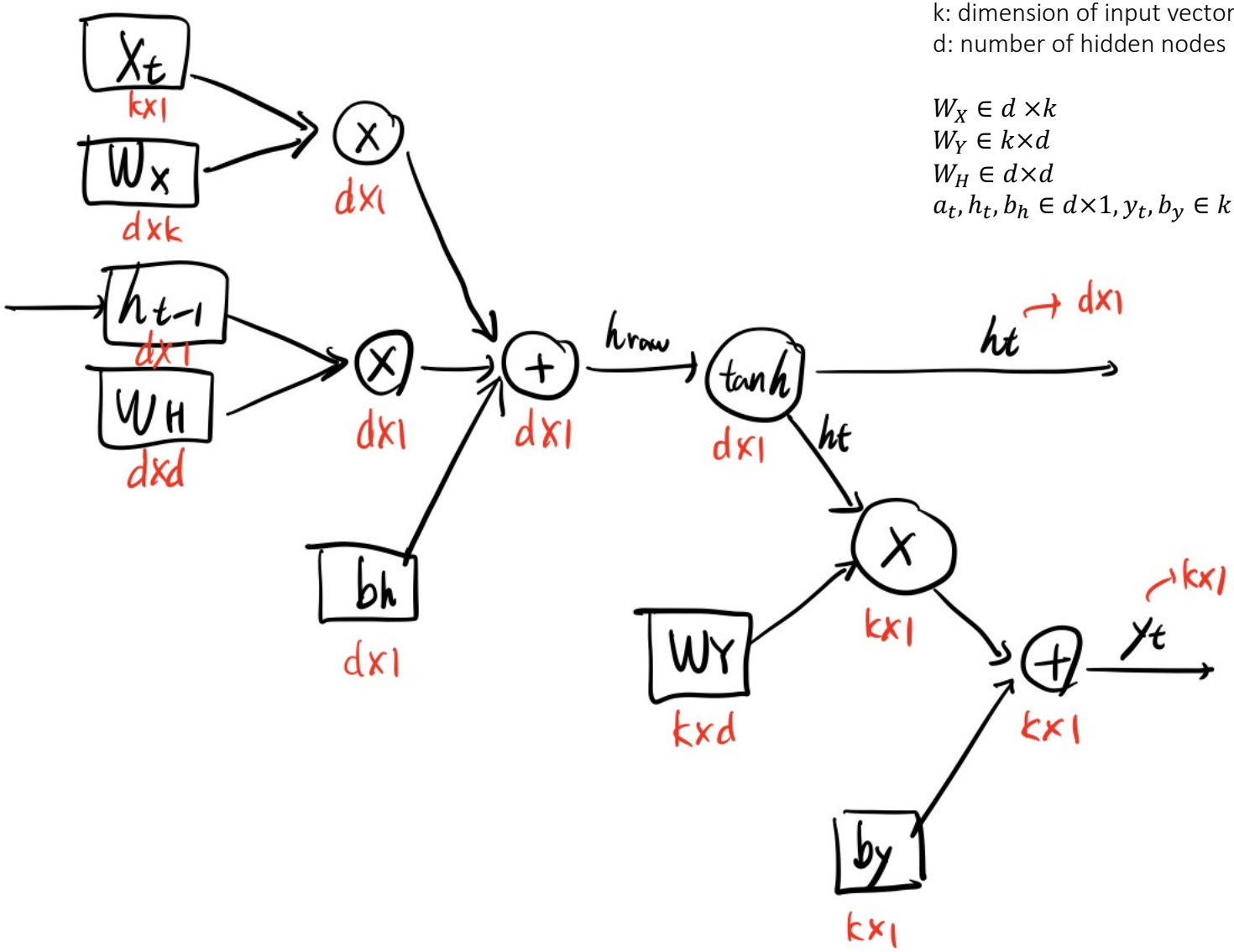
k: dimension of input vector x
d: number of hidden nodes

$W_X \in d \times k$
$W_Y \in k \times d$
$W_H \in d \times d$
$a_t, h_t, b_h \in d \times 1, y_t, b_y \in k \times 1$

Forward Propagation Pipeline



Forward Propagation Pipeline

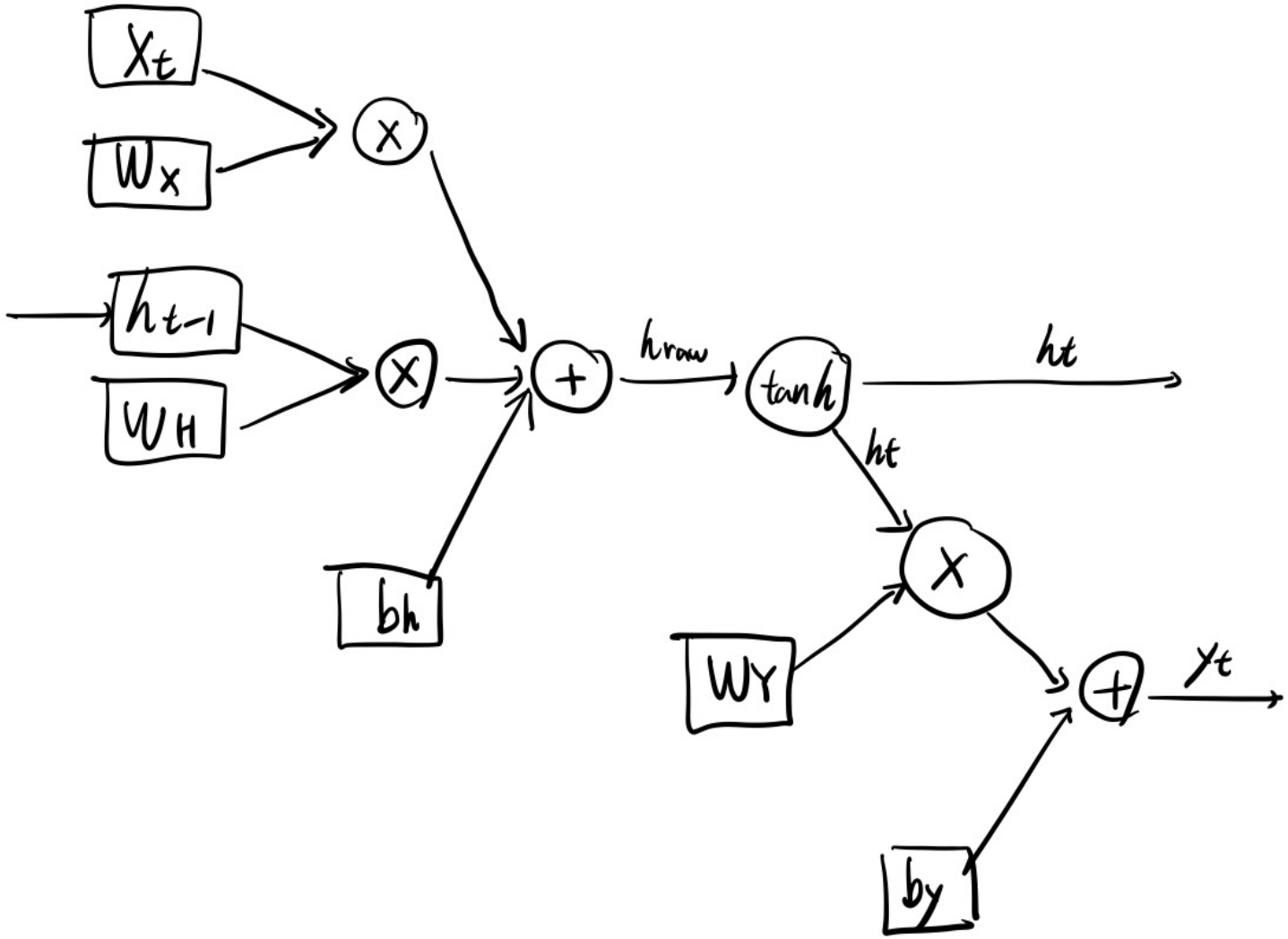


Dimensions

k: dimension of input vector x
d: number of hidden nodes

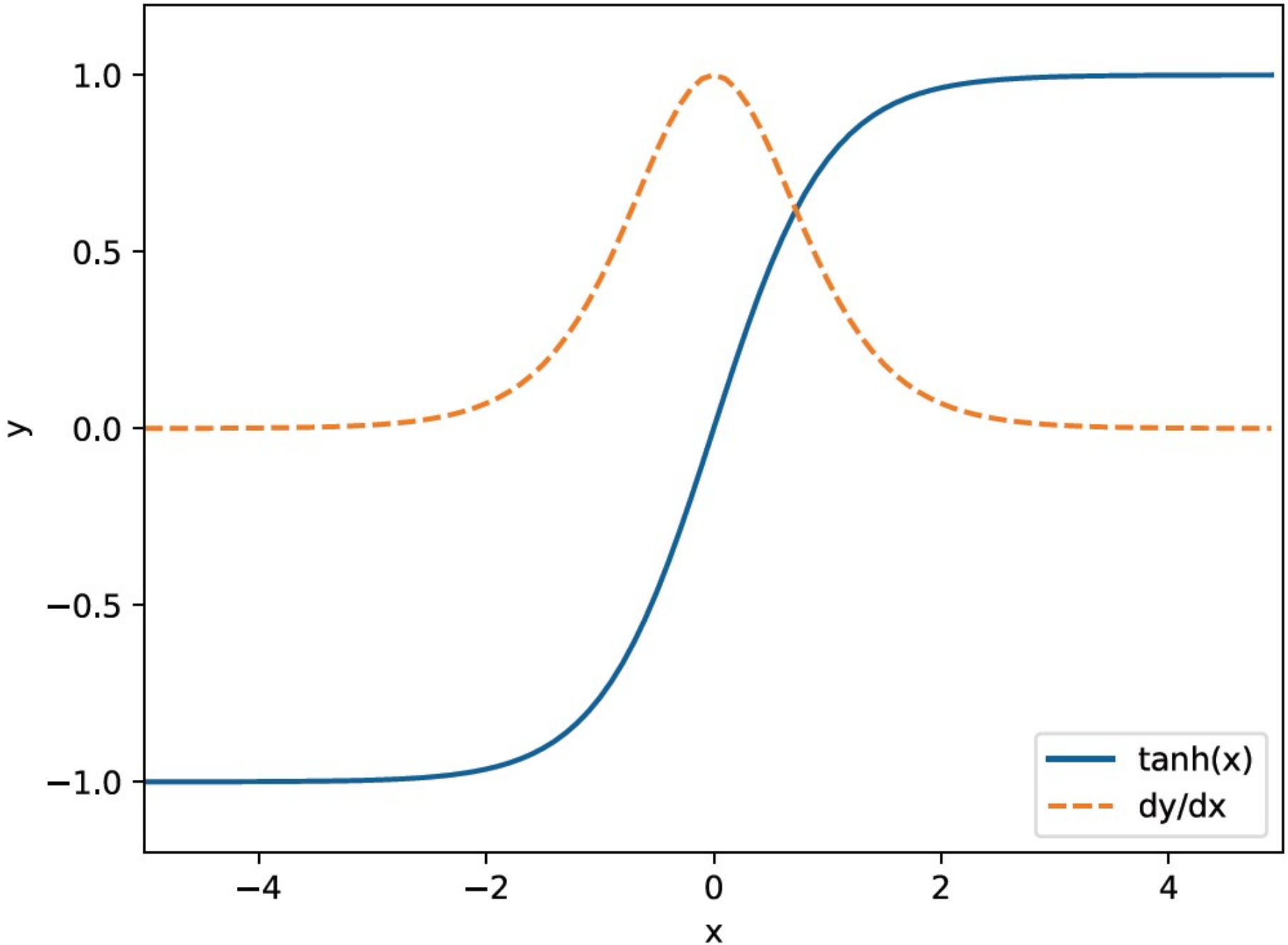
$W_X \in d \times k$
$W_Y \in k \times d$
$W_H \in d \times d$
$a_t, h_t, b_h \in d \times 1, y_t, b_y \in k \times 1$

역전파
필기

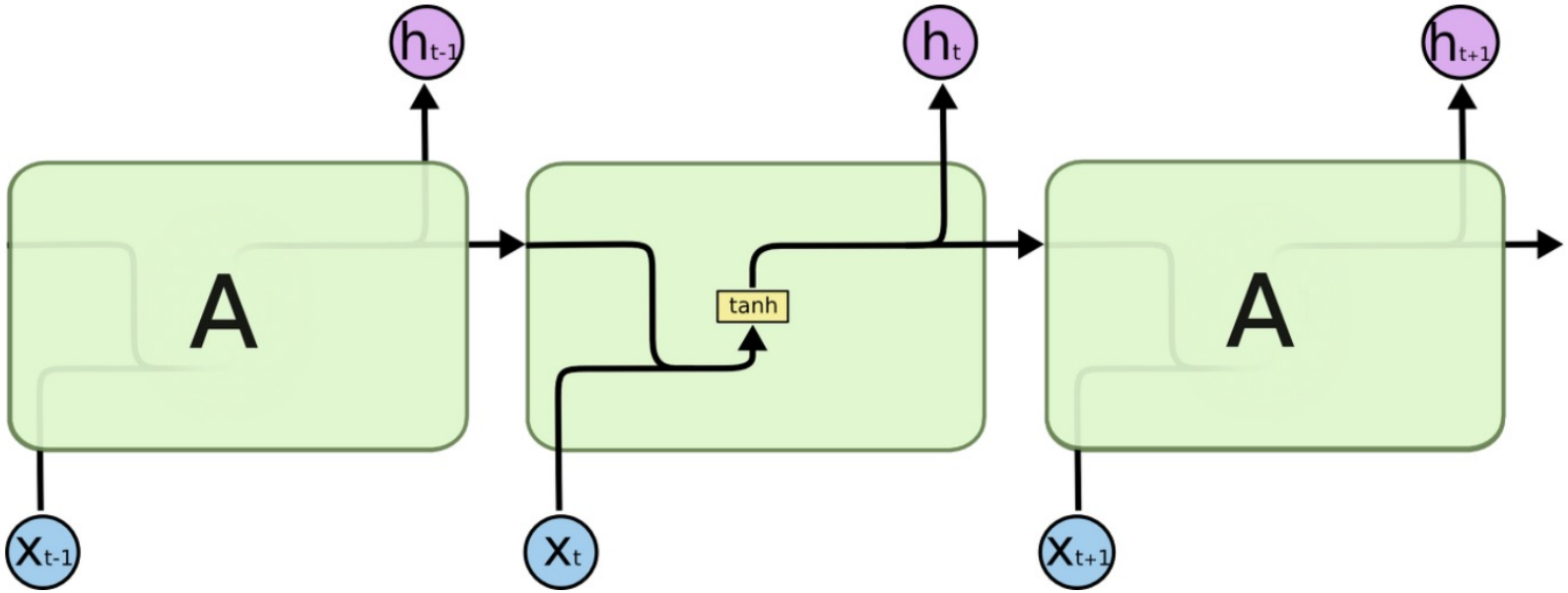


필기용

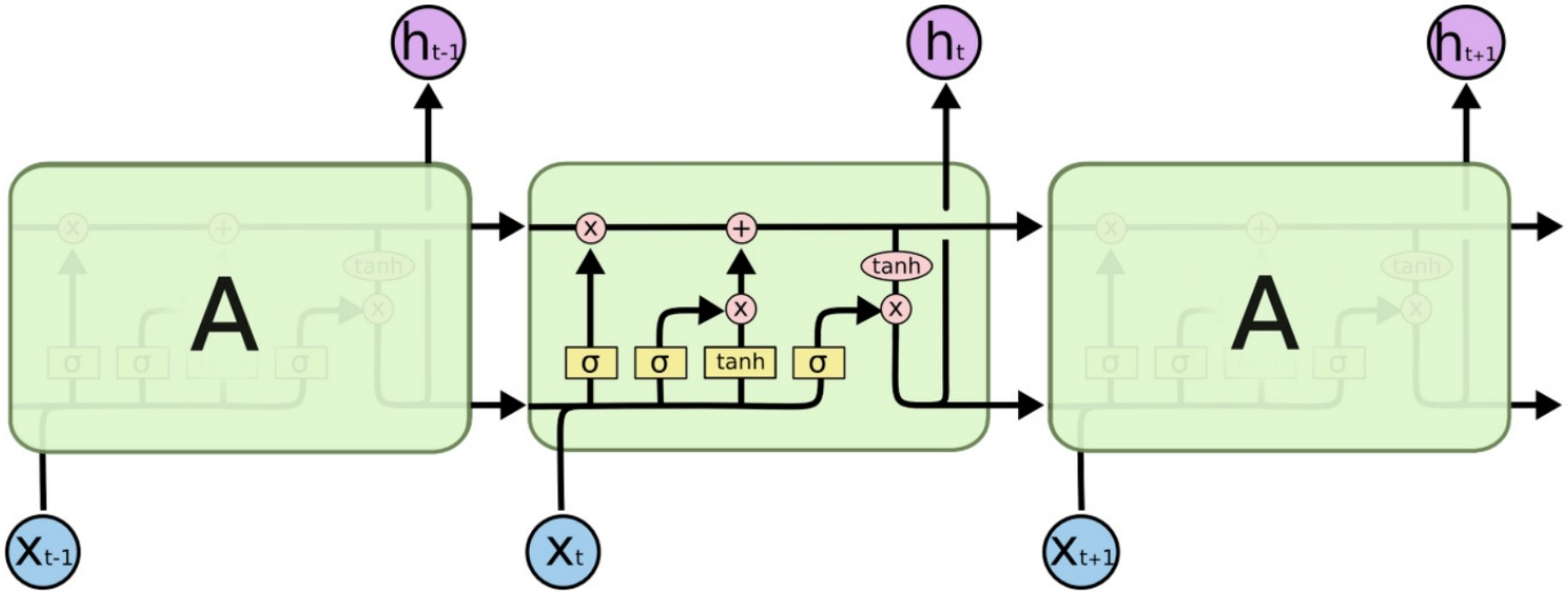
그림 6-6 $y = \tanh(x)$의 그래프(점선은 미분)



LSTM

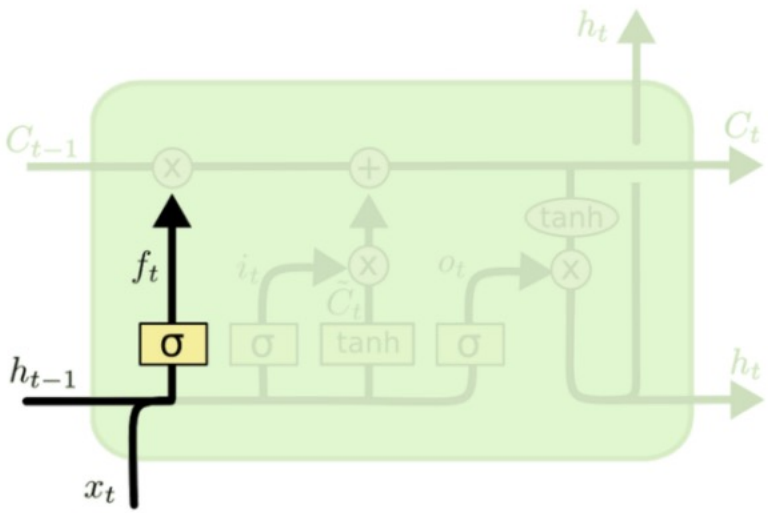

h_{t-1}
h_t
h_{t+1}
A
tanh
A
x_{t-1}
x_t
x_{t+1}

RNN

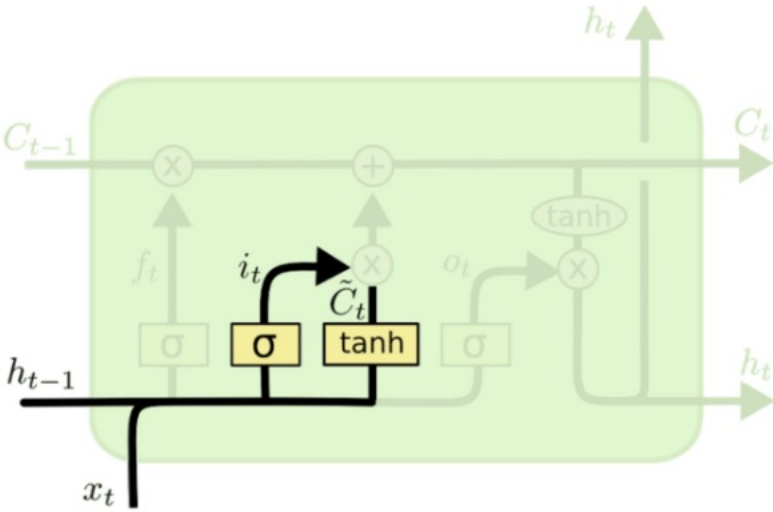

h_{t-1}
h_t
h_{t+1}
A
tanh
σ
σ
tanh
σ
A
x_{t-1}
x_t
x_{t+1}

LSTM

$$
\begin{aligned}
f_t &= \sigma(W_{xh\_f} x_t + W_{hh\_f} h_{t-1} + b_{h\_f}) \\
i_t &= \sigma(W_{xh\_i} x_t + W_{hh\_i} h_{t-1} + b_{h\_i}) \\
o_t &= \sigma(W_{xh\_o} x_t + W_{hh\_o} h_{t-1} + b_{h\_o}) \\
g_t &= \tanh(W_{xh\_g} x_t + W_{hh\_g} h_{t-1} + b_{h\_g}) \\
c_t &= f_t \odot c_{t-1} + i_t \odot g_t \\
h_t &= o_t \odot \tanh(c_t)
\end{aligned}
$$

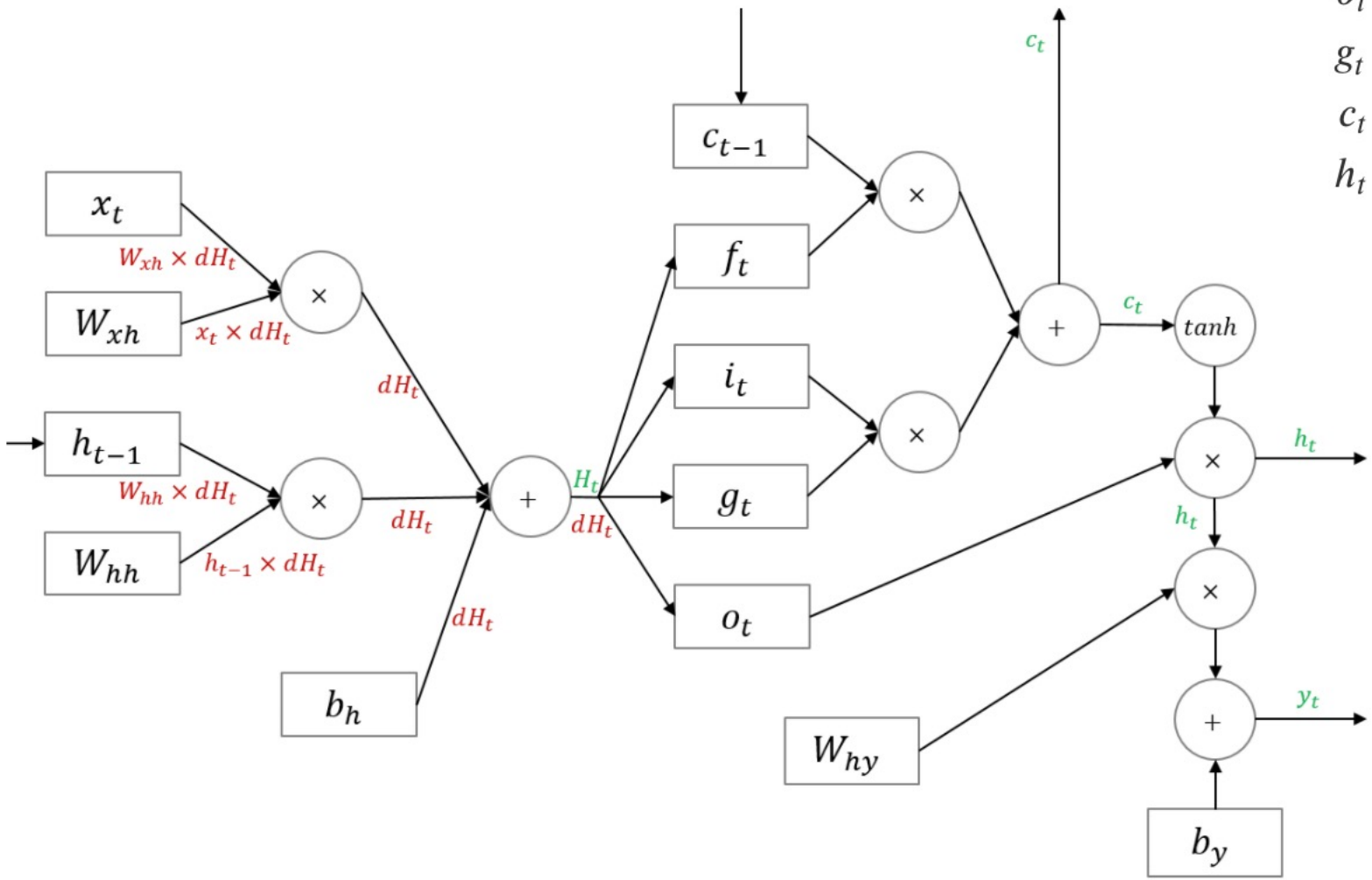


<forget gate>



<input gate>

$$
\begin{aligned}
f_t &= \sigma(W_{xh\_f} x_t + W_{hh\_f} h_{t-1} + b_{h\_f}) \\
i_t &= \sigma(W_{xh\_i} x_t + W_{hh\_i} h_{t-1} + b_{h\_i}) \\
o_t &= \sigma(W_{xh\_o} x_t + W_{hh\_o} h_{t-1} + b_{h\_o}) \\
g_t &= \tanh(W_{xh\_g} x_t + W_{hh\_g} h_{t-1} + b_{h\_g}) \\
c_t &= f_t \odot c_{t-1} + i_t \odot g_t \\
h_t &= o_t \odot \tanh(c_t)
\end{aligned}
$$



Why?

과제:

(numpy만 사용해서) simple rnn 순전파, 역전파 구현

input vector = [1,0,0,0],[0,1,0,0],[0,0,1,0]
y_true = [0,1,0,0],[0,0,1,0],[0,0,0,1]
k = 4
d = 3
t = 3
활성화함수: tanh