LSTM

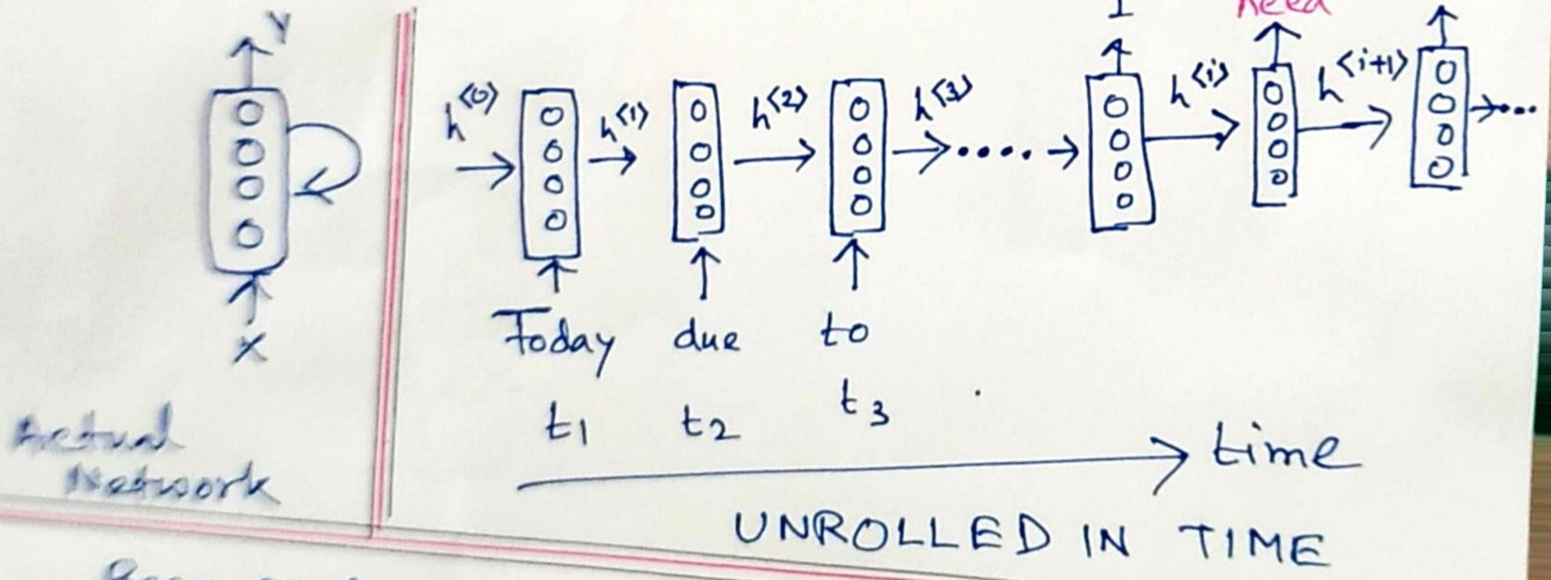
A form of RNN that addresses short term memory problem : Introduced by Hochreiter & Schmidhuber (1997)

> Today, due to current COVID-19 situation, I ......
>
> Last year, due to current COVID-19 situation, I .....

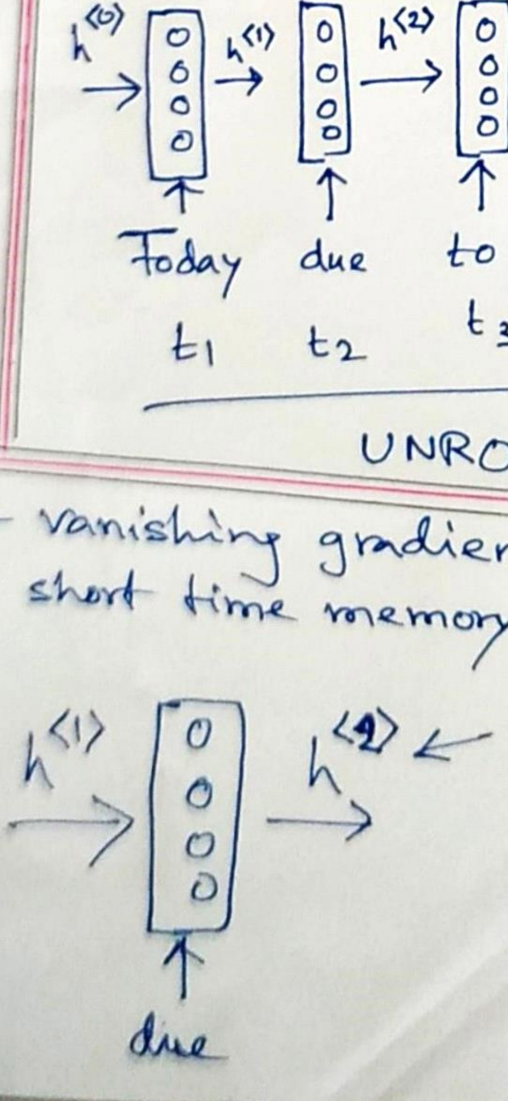
Autocompletion will be significantly influenced by the begining of the sentence.

> Today, due to current COVID-19 situation, I need to take a loan
>
> Last year, due to current COVID-19 situation, I had to take a loan

Generic representation of RNN

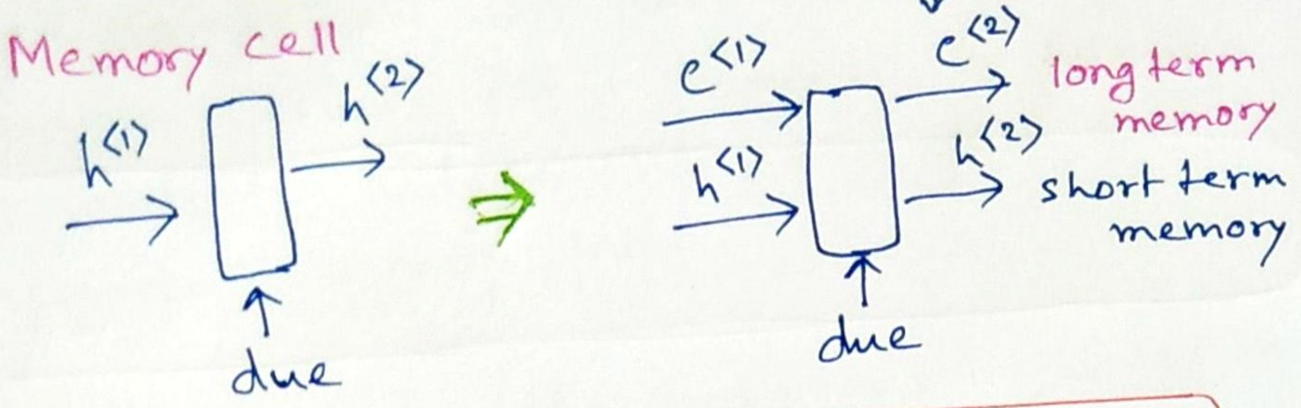


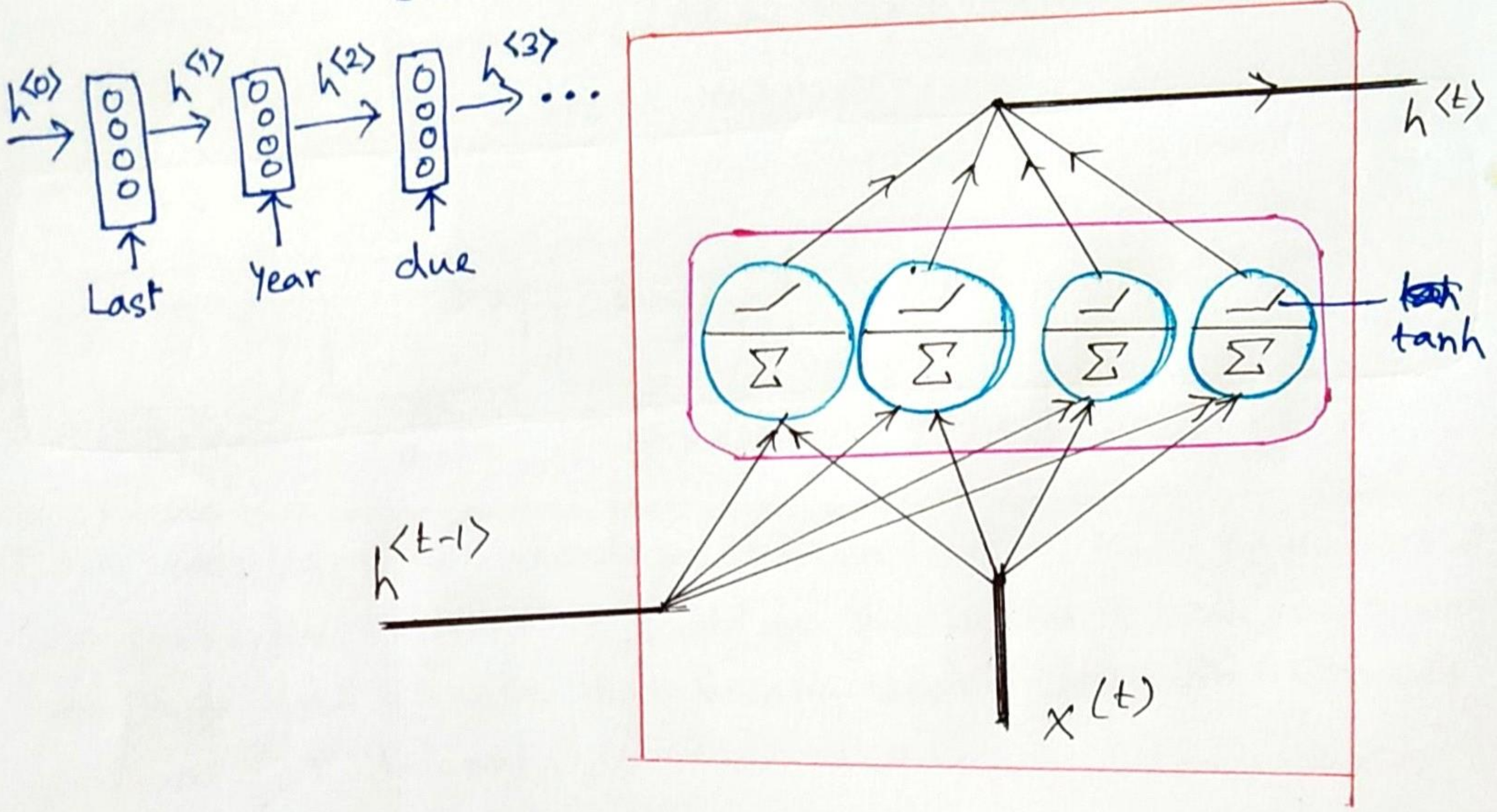
Because of vanishing gradients, traditional RNN have very short time memory.

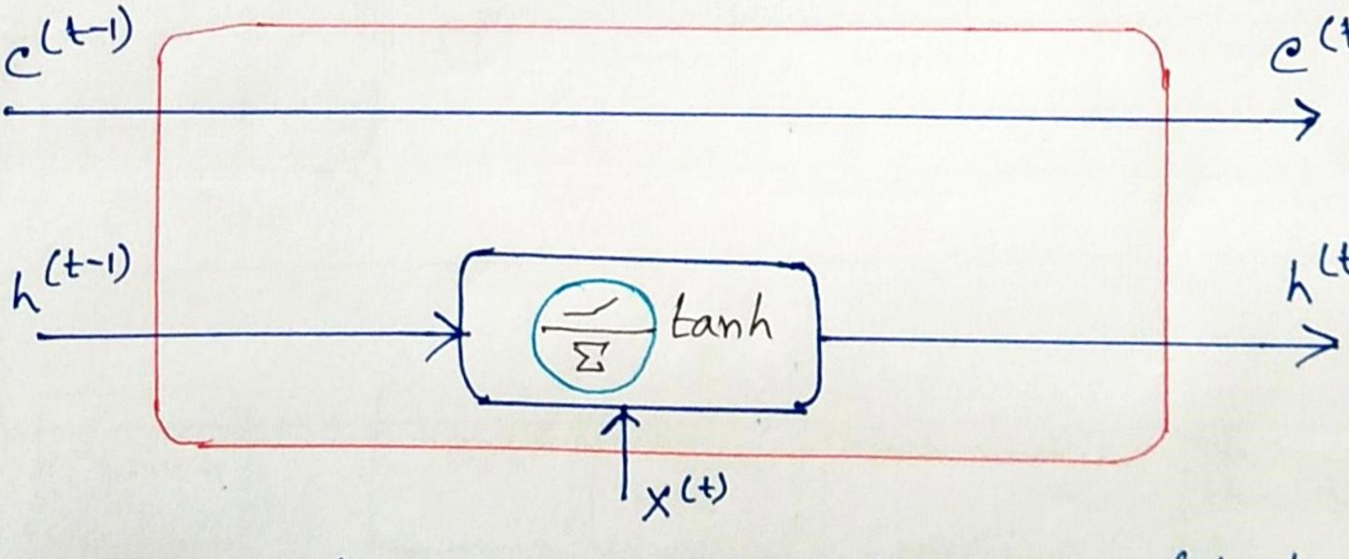


these hidden states are nothing but short term memory.

LSTM







Lara eats samosa everyday, it shoud not be hard to guess that ~~her~~ favourite cuisine is.....

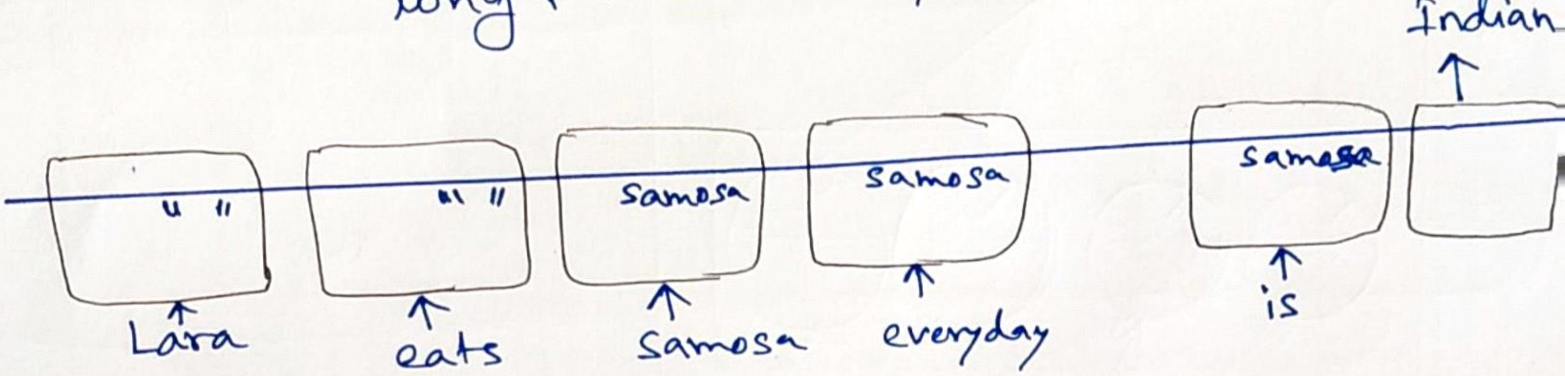
Indian

LSTM

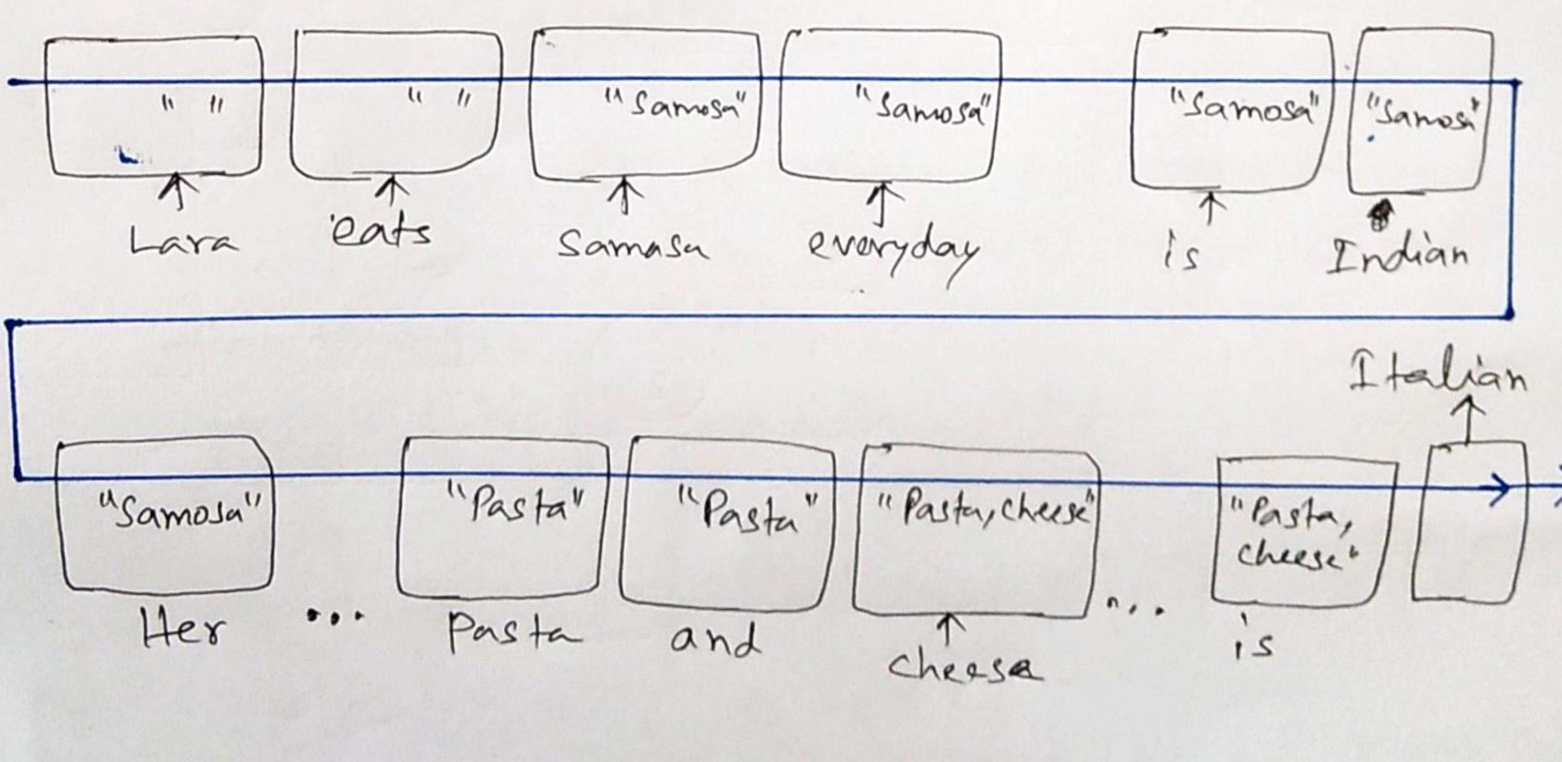
Traditional RNN will have problem here because of short term memory: by the time it comes to autocomplete, the effect of "samosa" is very fade.

Way-out

Preserve the important keywords in long term memory.



Lara eats samosa everyday, it should not be hard to guess that her favourite cuisine is Indian. Her brother Bhavin is a lover of Pasta and cheese that means Bhabin's favourite cuisine is ..... (Italian).



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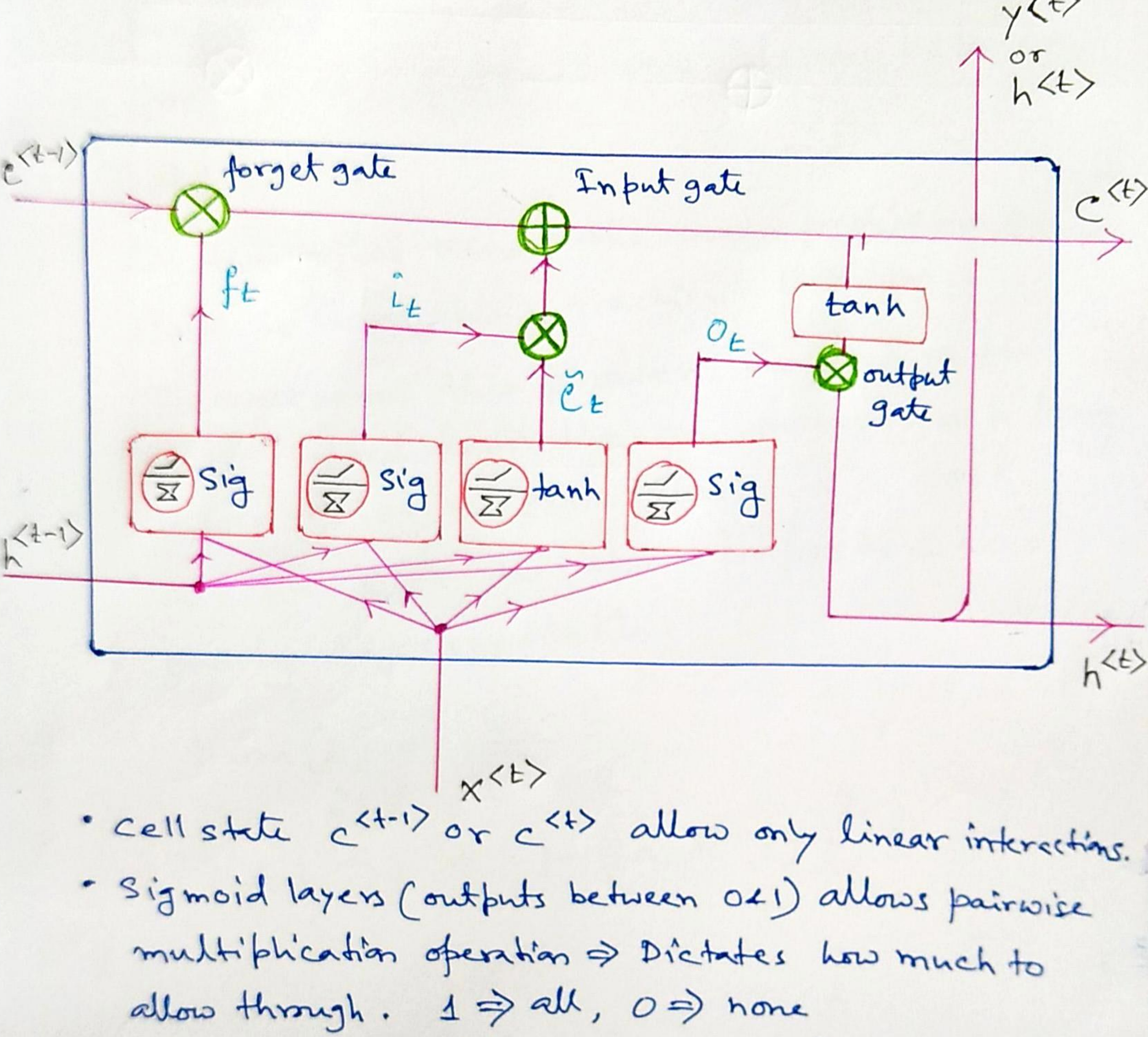

- cell state $c^{<t-1>}$ or $c^{<t>}$ allow only linear interactions.
- Sigmoid layers (outputs between 0&1) allows pairwise multiplication operation ⇒ Dictates how much to allow through. 1 ⇒ all, 0 ⇒ none

$$f_t = \sigma(W_f \cdot [h_{t-1}, x_t] + b_f)$$

$$i_t = \sigma(W_i \cdot [h_{t-1}, x_t] + b_i)$$

$$\tilde{C}_t = \tanh(W_c \cdot [h_{t-1}, xt] + b_c)$$

$$C_t = f_t * C_{t-1} + i_t * \tilde{C}_t$$

$$O_t = \sigma(W_o [h_{t-1}, x_t] + b_o \; \| \; h_t = O_t * \tanh(C_t)$$

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Insight for sig & tanh activation fns.

For Input & output gates sigmoid is preferred because of its normalization properties. outputs are always between 0 & 1.

On the other hand, the main problems of RNN is vanishing gradient problem.

To overcome this problem we need a fn. whose second derivative can sustain for a long before going to zero. Tanh is a good function with the above property & also easily differentiable.

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

$$\tanh'(z) = 1 - (\tanh(z))^{2}$$