

Self-Attention


- Self-Attention [2]: attention [1] beyond Seq2Seq models.
- The original self-attention paper uses **LSTM**.
- To make teaching easy, I replace **LSTM** by **SimpleRNN**.

Original paper:

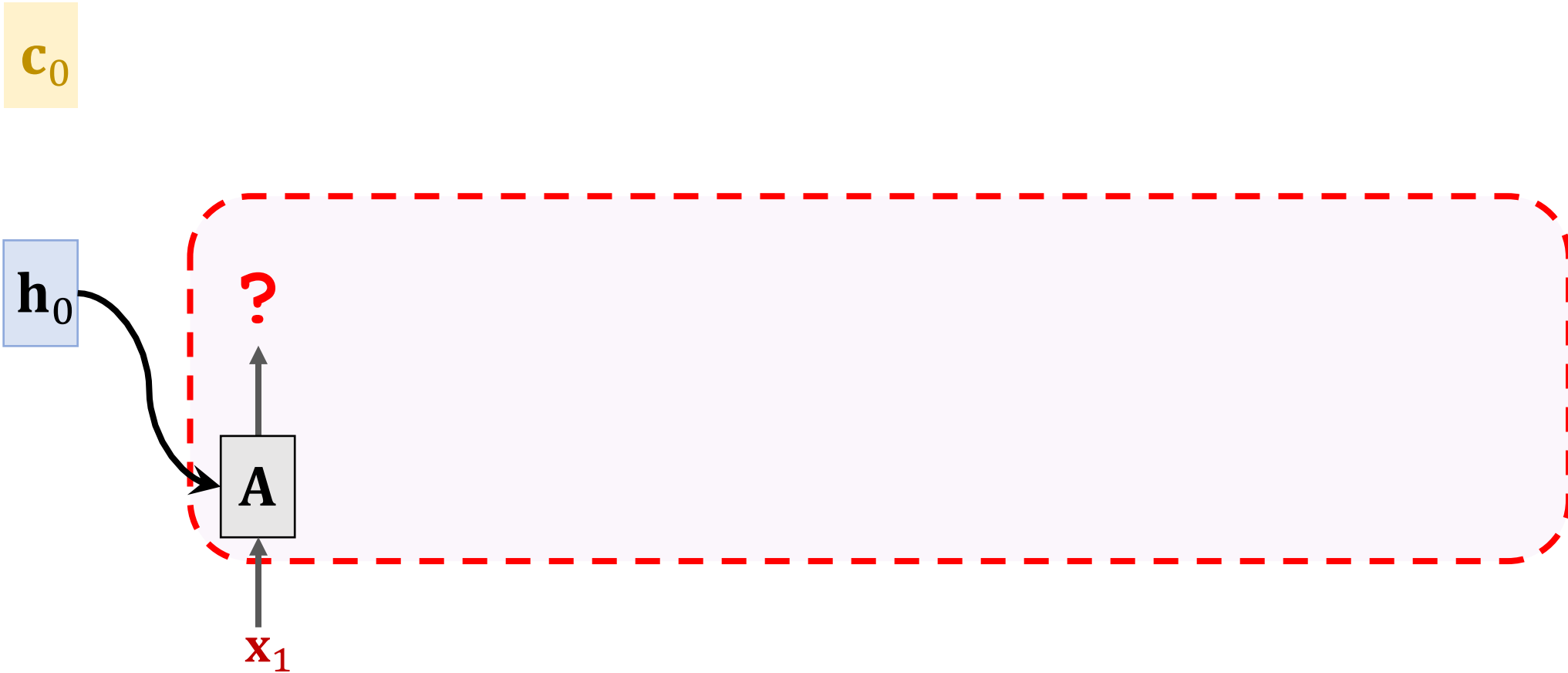
1. Bahdanau, Cho, & Bengio. [Neural machine translation by jointly learning to align and translate](#). In *ICLR*, 2015.
2. Cheng, Dong, & Lapata. [Long Short-Term Memory-Networks for Machine Reading](#). In *EMNLP*, 2016.

SimpleRNN + Self-Attention

$$\mathbf{c}_0 = \mathbf{0}$$

$$\mathbf{h}_0 = \mathbf{0}$$


SimpleRNN + Self-Attention



SimpleRNN + Self-Attention

SimpleRNN:

$$\mathbf{h}_1 = \tanh \left(\mathbf{A} \cdot \begin{bmatrix} \mathbf{x}_1 \\ \mathbf{h}_0 \end{bmatrix} + \mathbf{b} \right)$$

\mathbf{c}_0



SimpleRNN + Self-Attention

SimpleRNN:

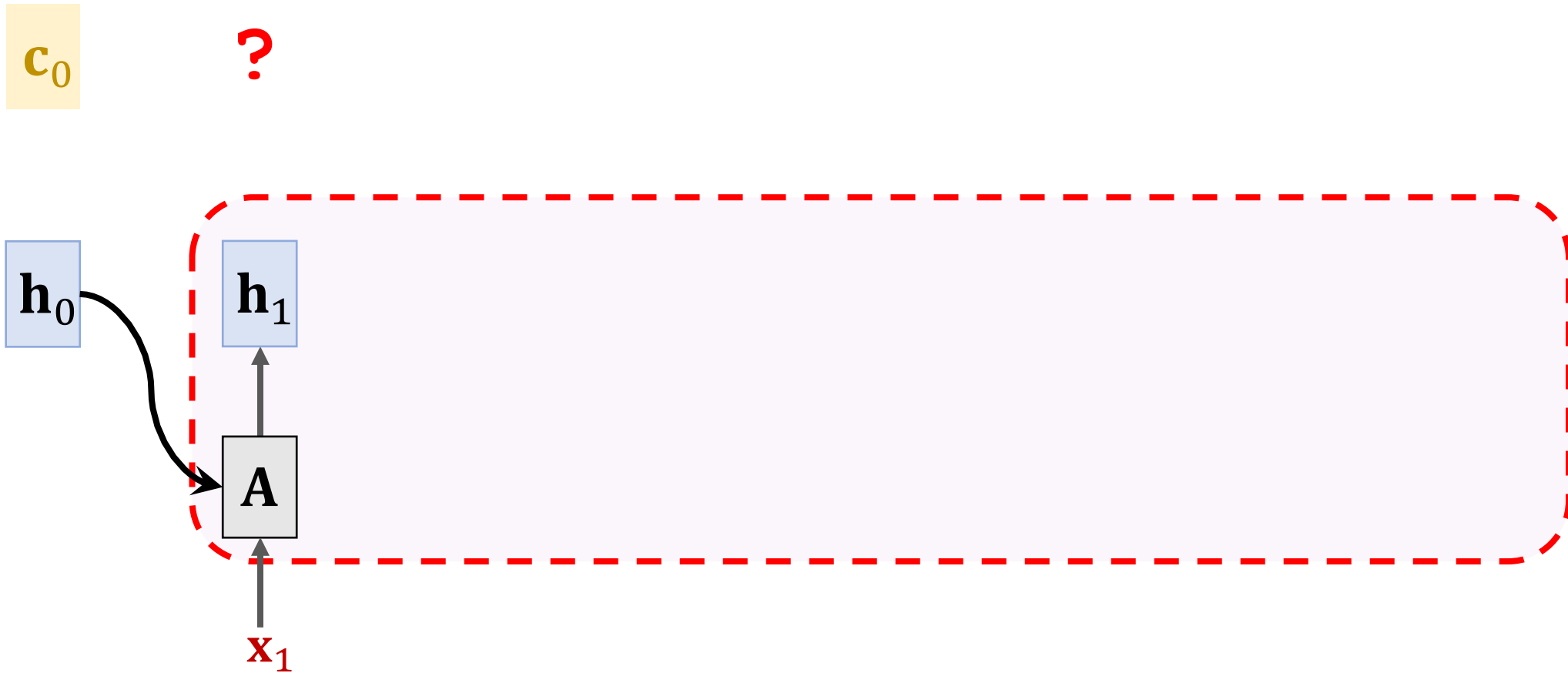
$$\mathbf{h}_1 = \tanh \left(\mathbf{A} \cdot \begin{bmatrix} \mathbf{x}_1 \\ \mathbf{h}_0 \end{bmatrix} + \mathbf{b} \right)$$

SimpleRNN + Self-Attention:

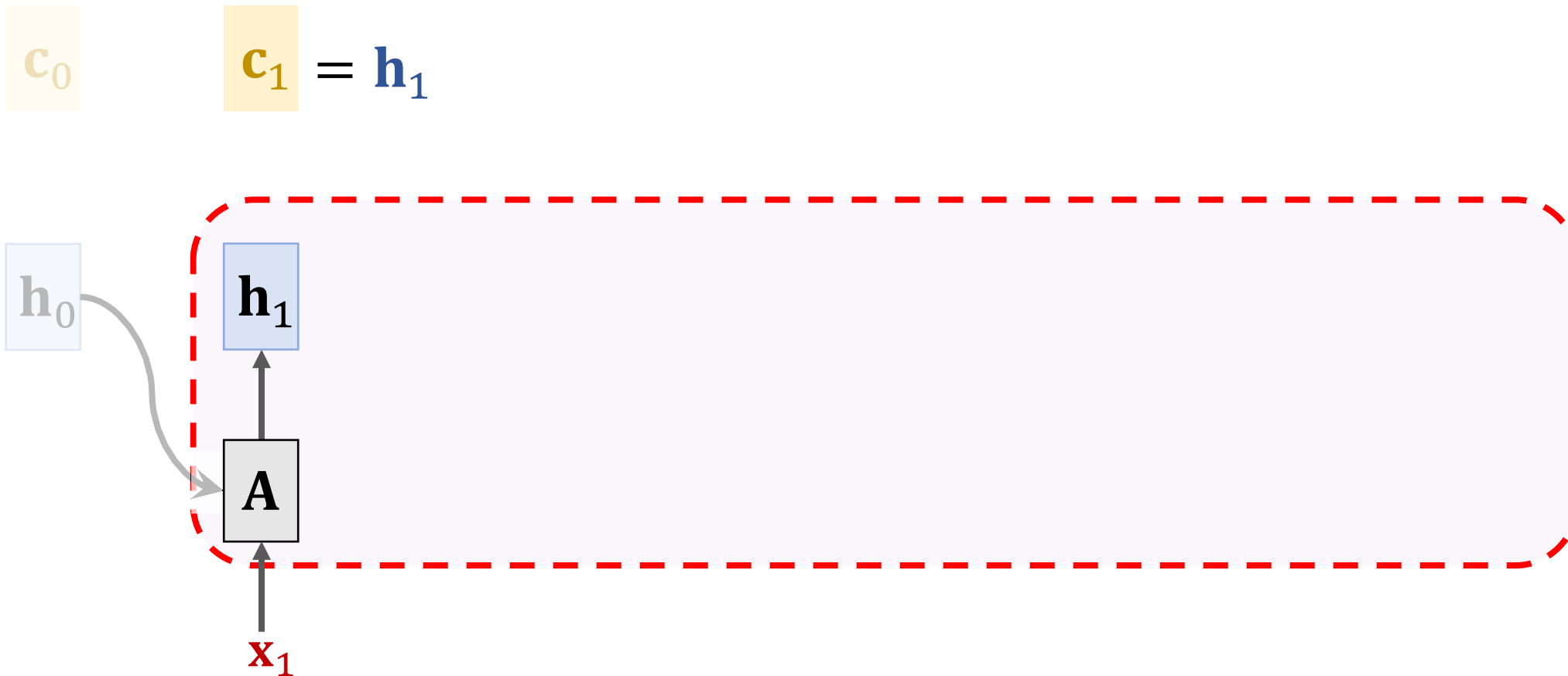
$$\mathbf{h}_1 = \tanh \left(\mathbf{A} \cdot \begin{bmatrix} \mathbf{x}_1 \\ \mathbf{c}_0 \end{bmatrix} + \mathbf{b} \right)$$



SimpleRNN + Self-Attention



SimpleRNN + Self-Attention

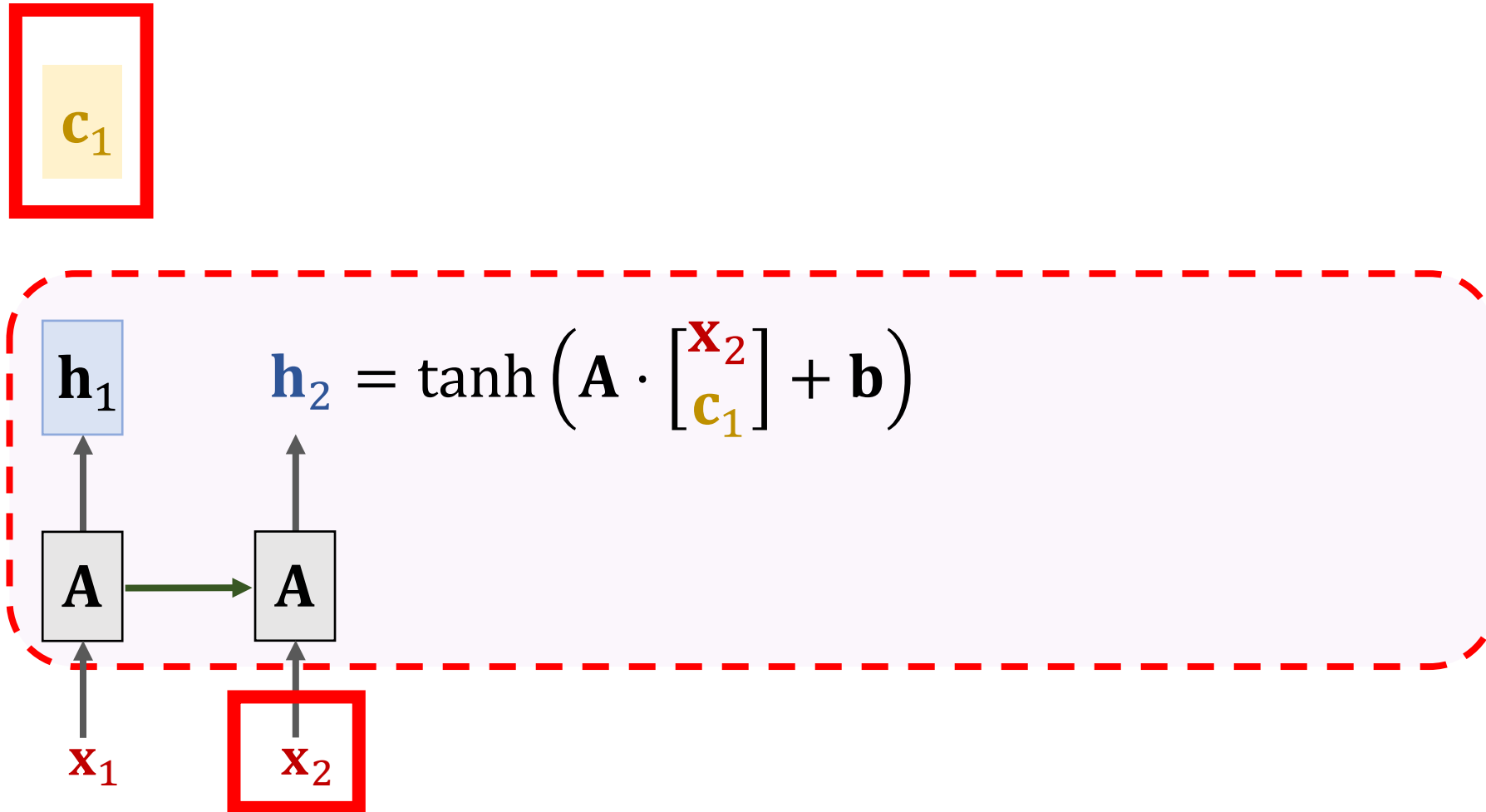


SimpleRNN + Self-Attention

c_1



SimpleRNN + Self-Attention



SimpleRNN + Self-Attention

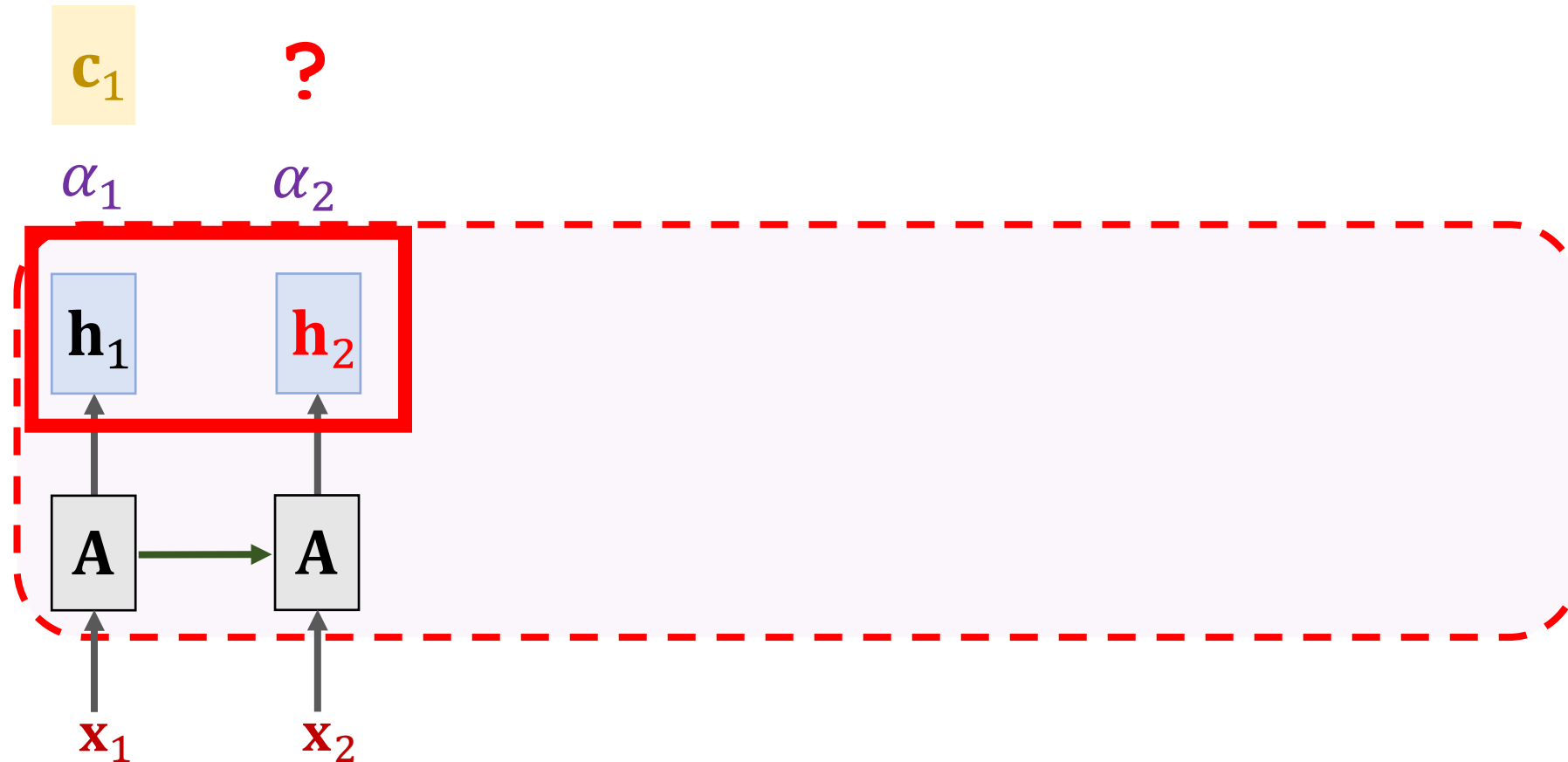
c_1

?

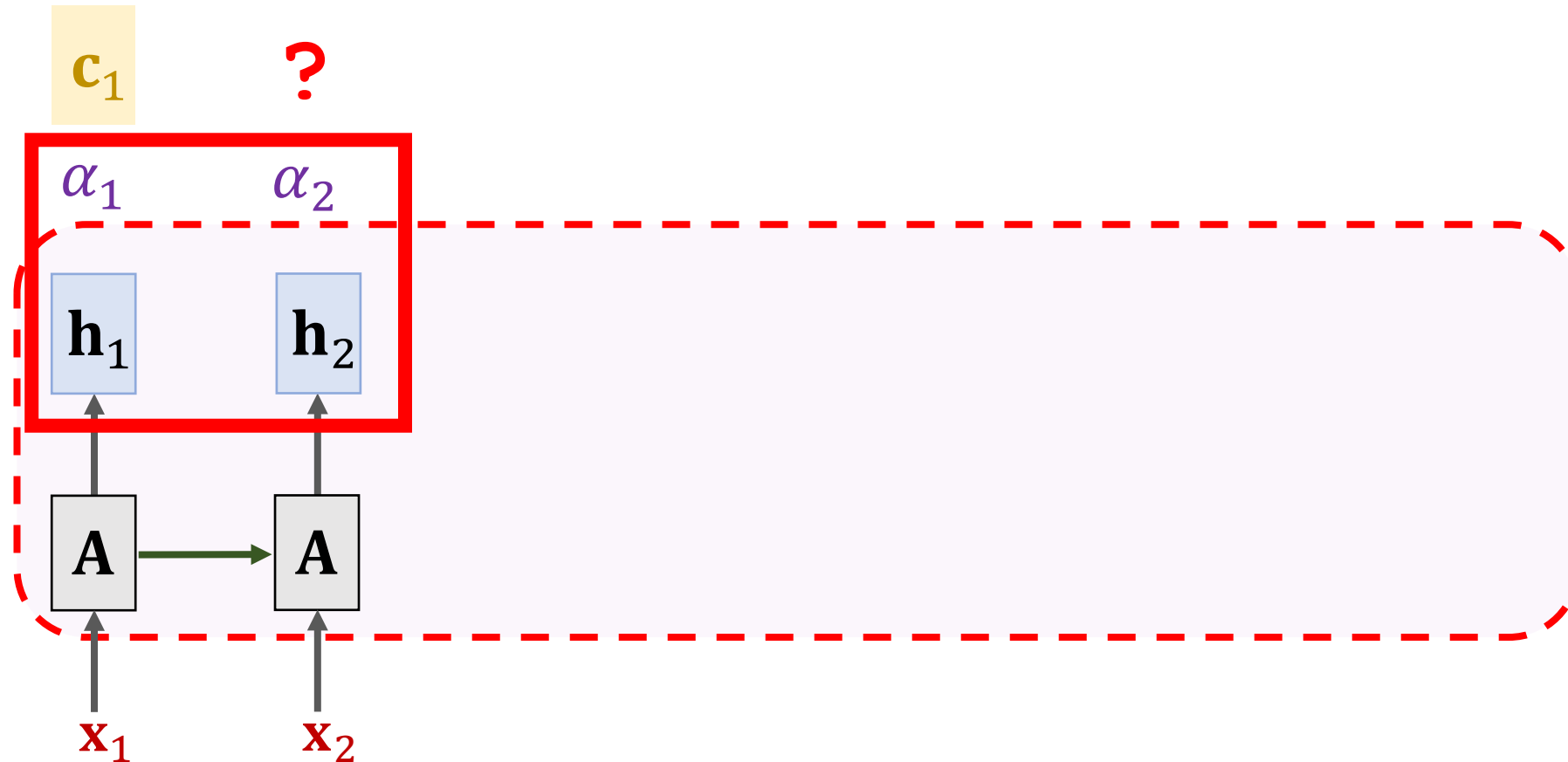


SimpleRNN + Self-Attention

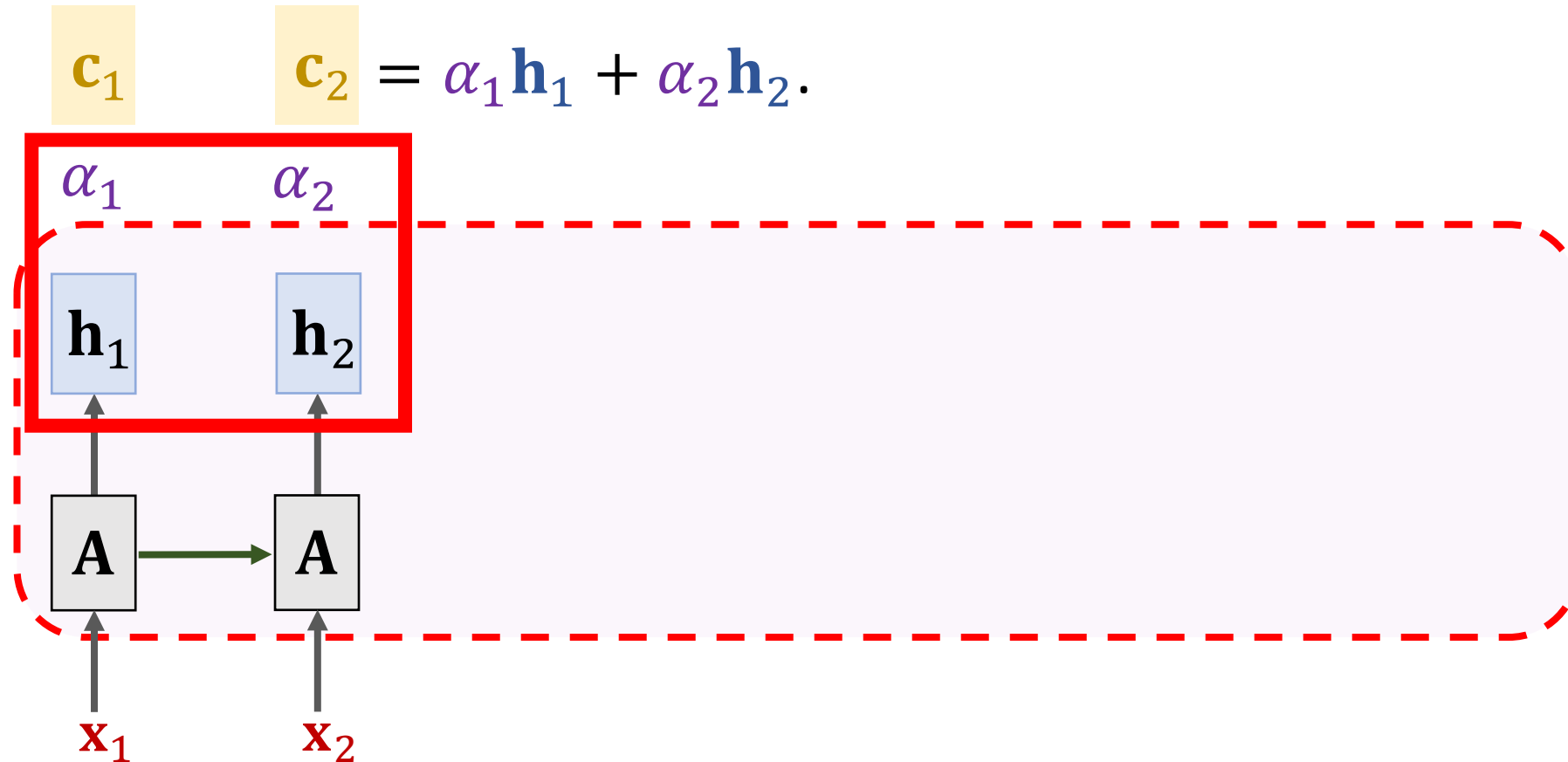
Weights: $\alpha_i = \text{align}(\mathbf{h}_i, \mathbf{h}_2)$.



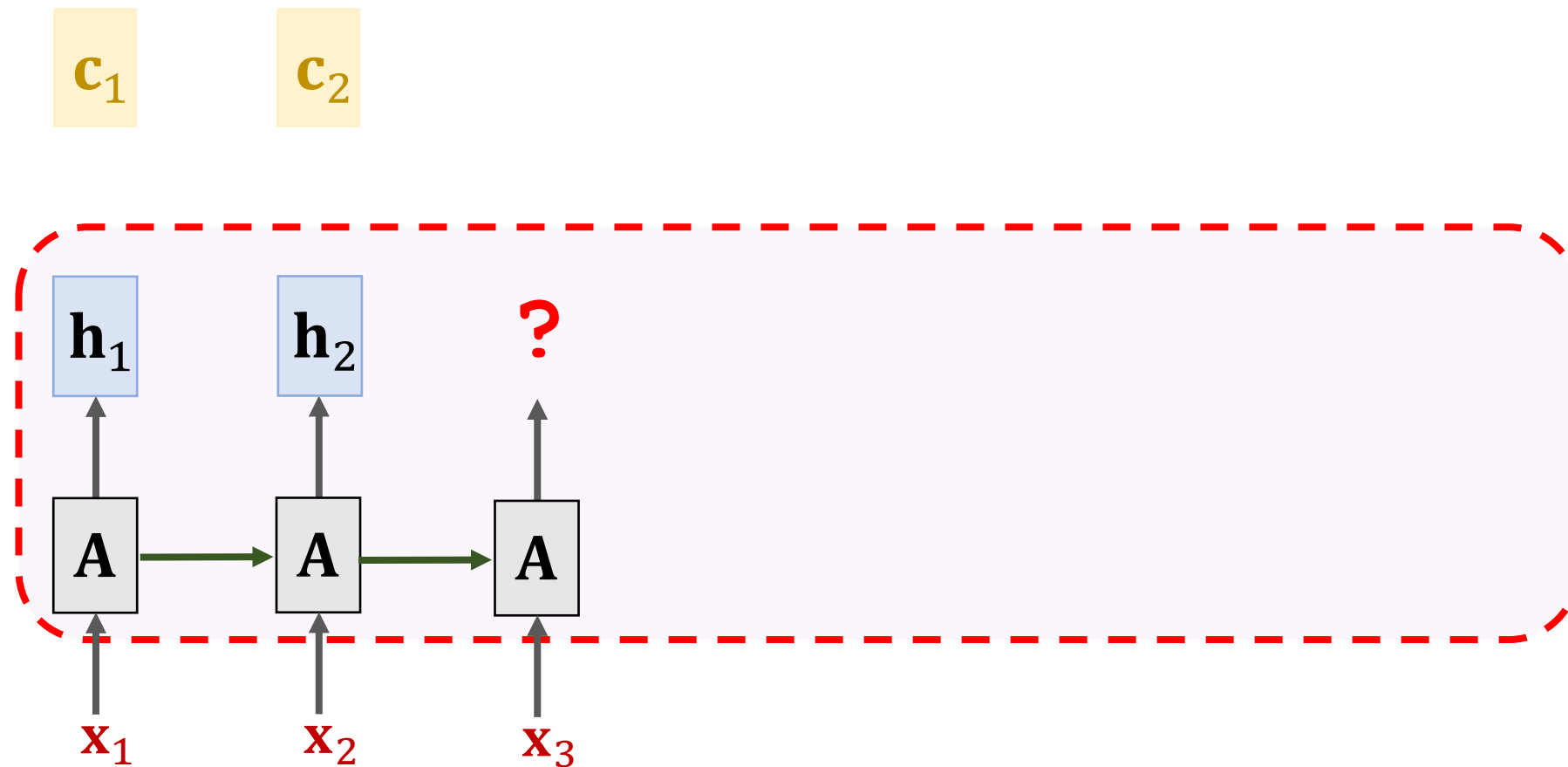
SimpleRNN + Self-Attention



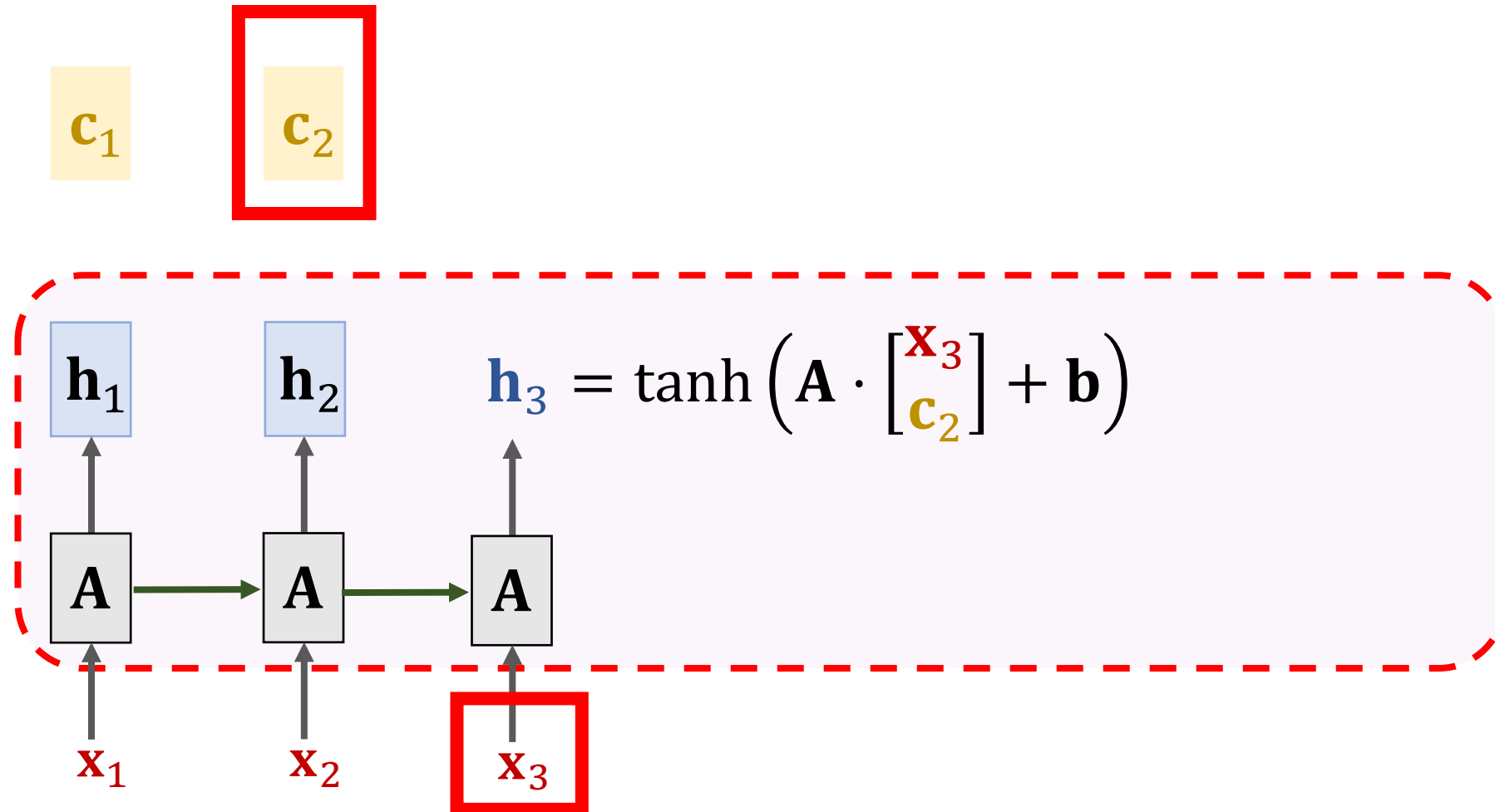
SimpleRNN + Self-Attention



SimpleRNN + Self-Attention



SimpleRNN + Self-Attention

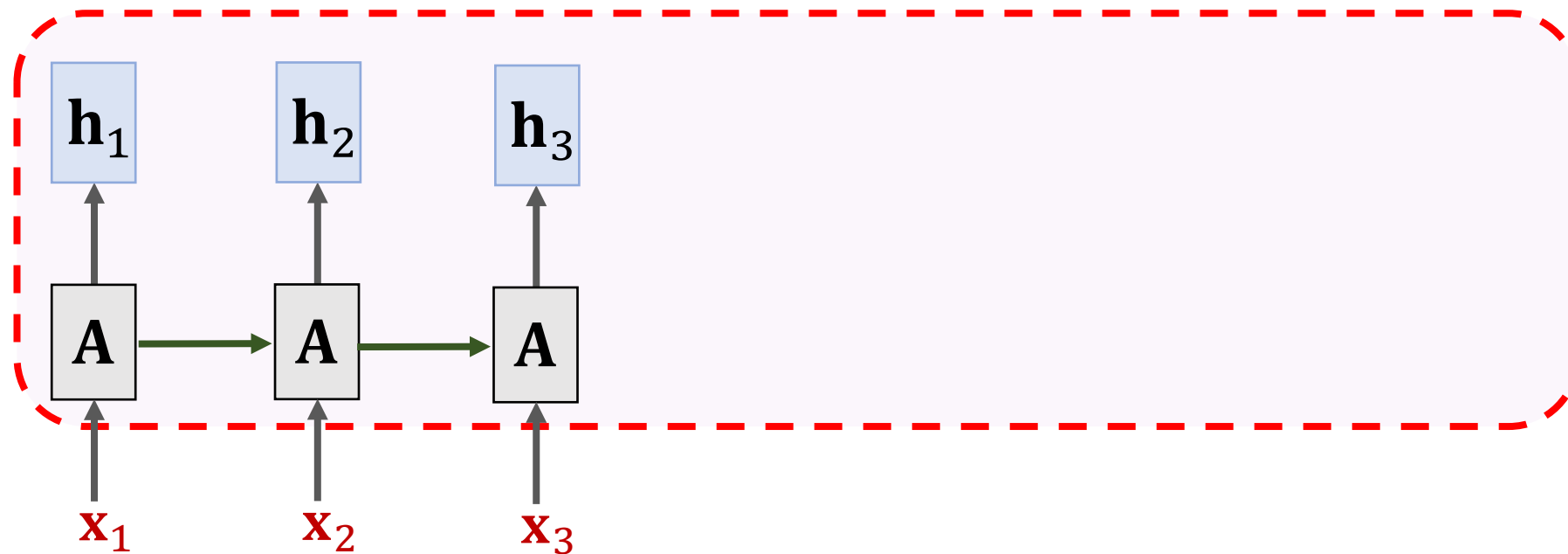


SimpleRNN + Self-Attention

c_1

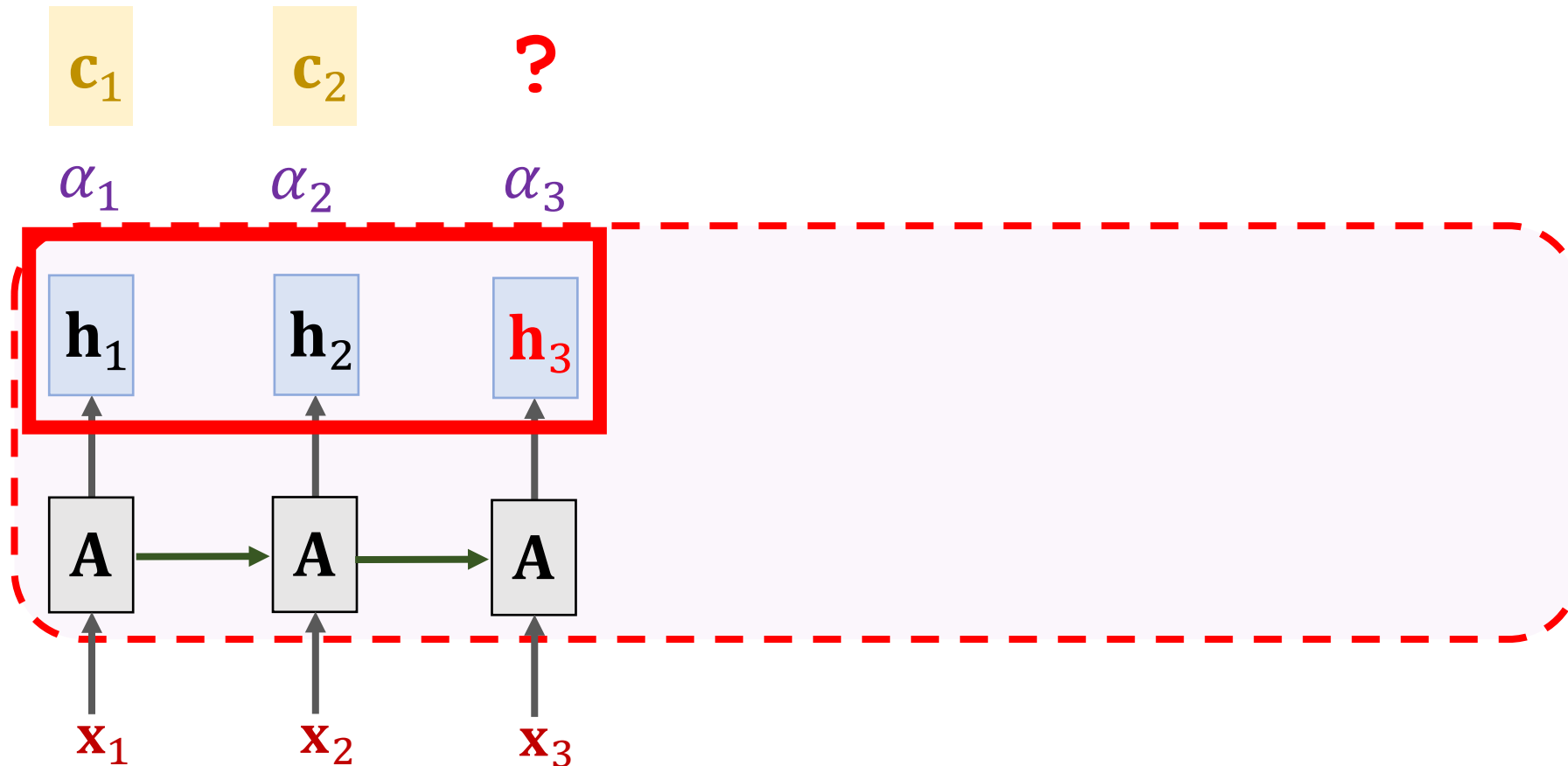
c_2

?

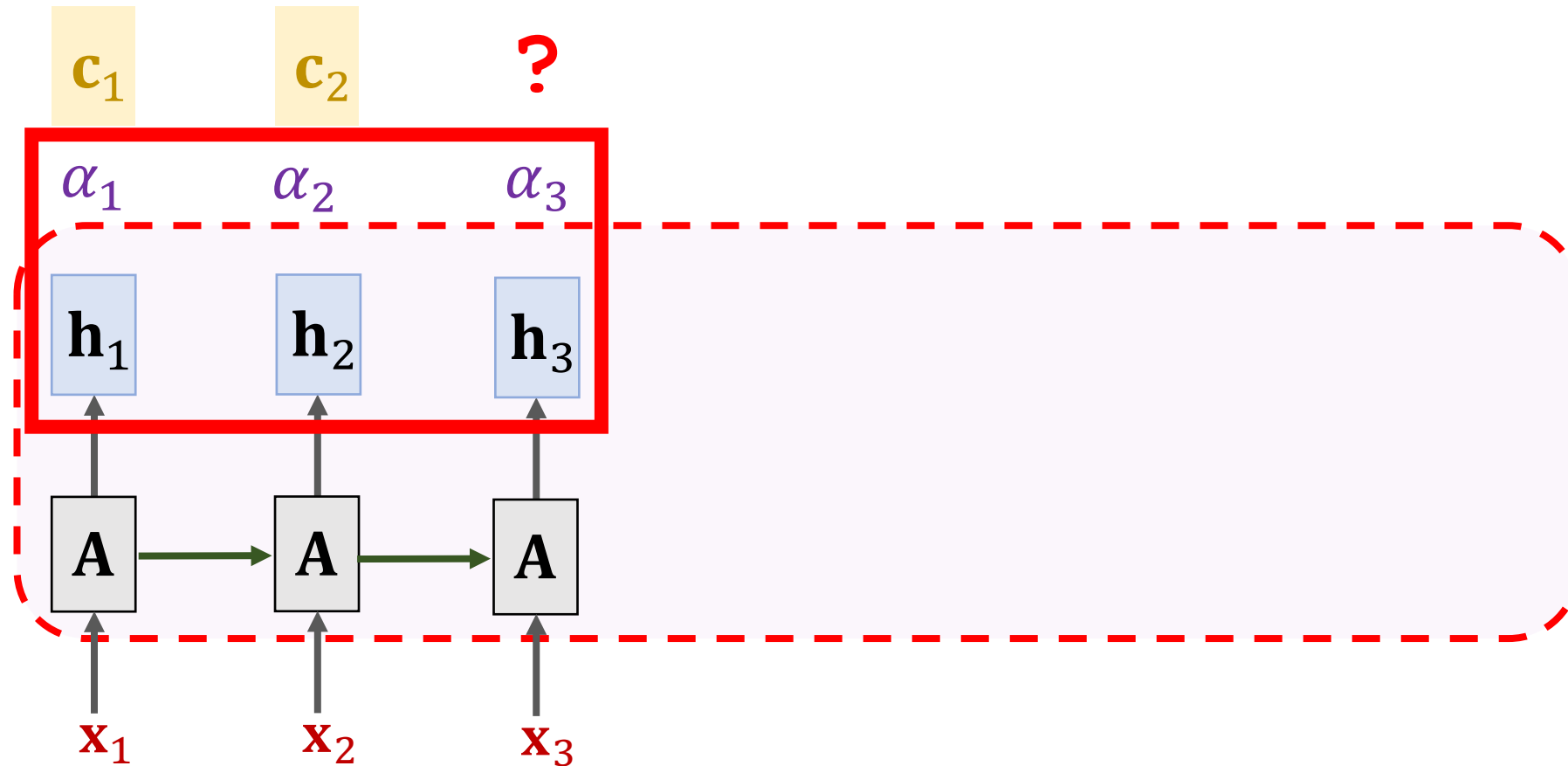


SimpleRNN + Self-Attention

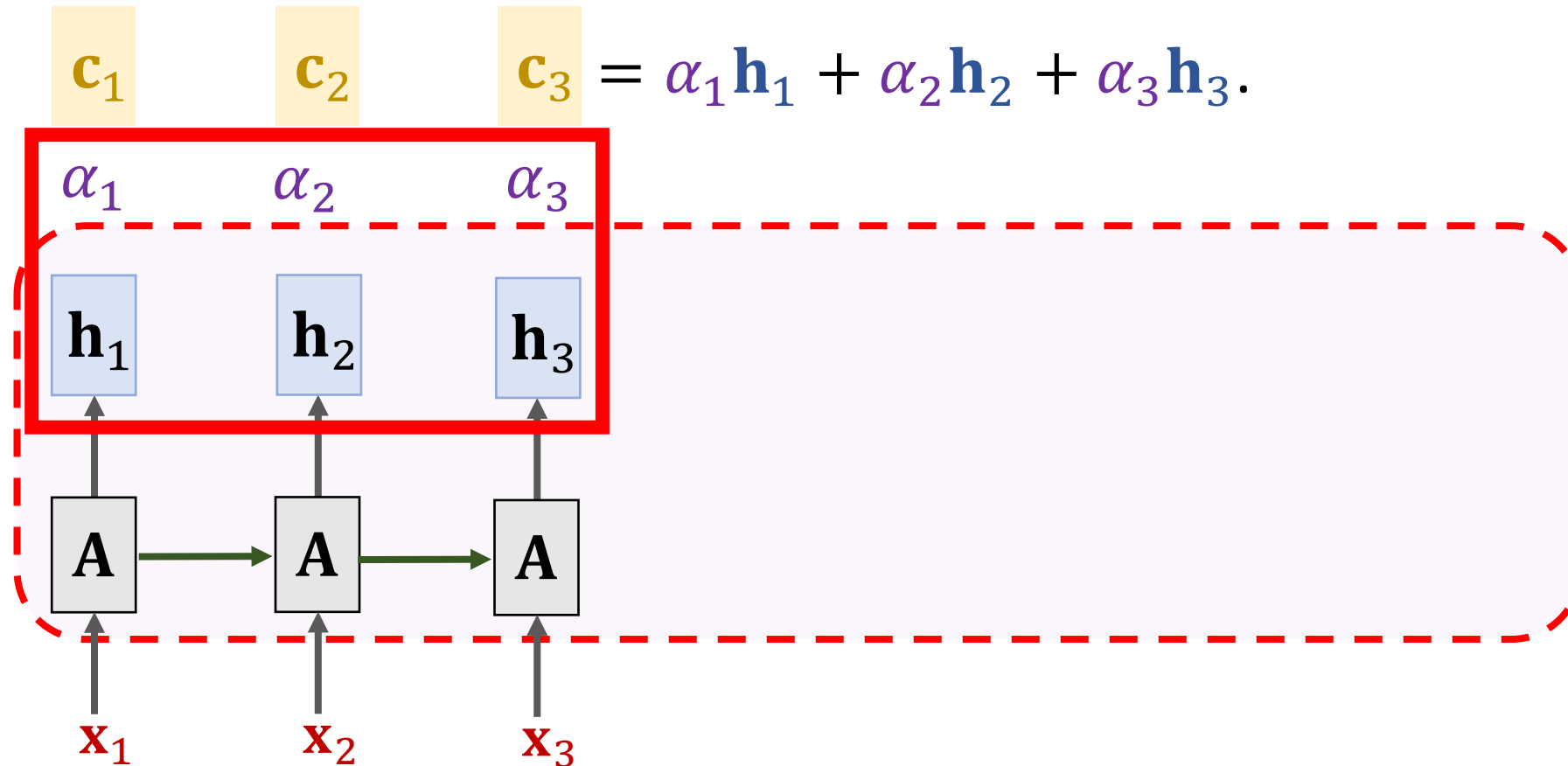
Weights: $\alpha_i = \text{align}(\mathbf{h}_i, \mathbf{h}_3)$.



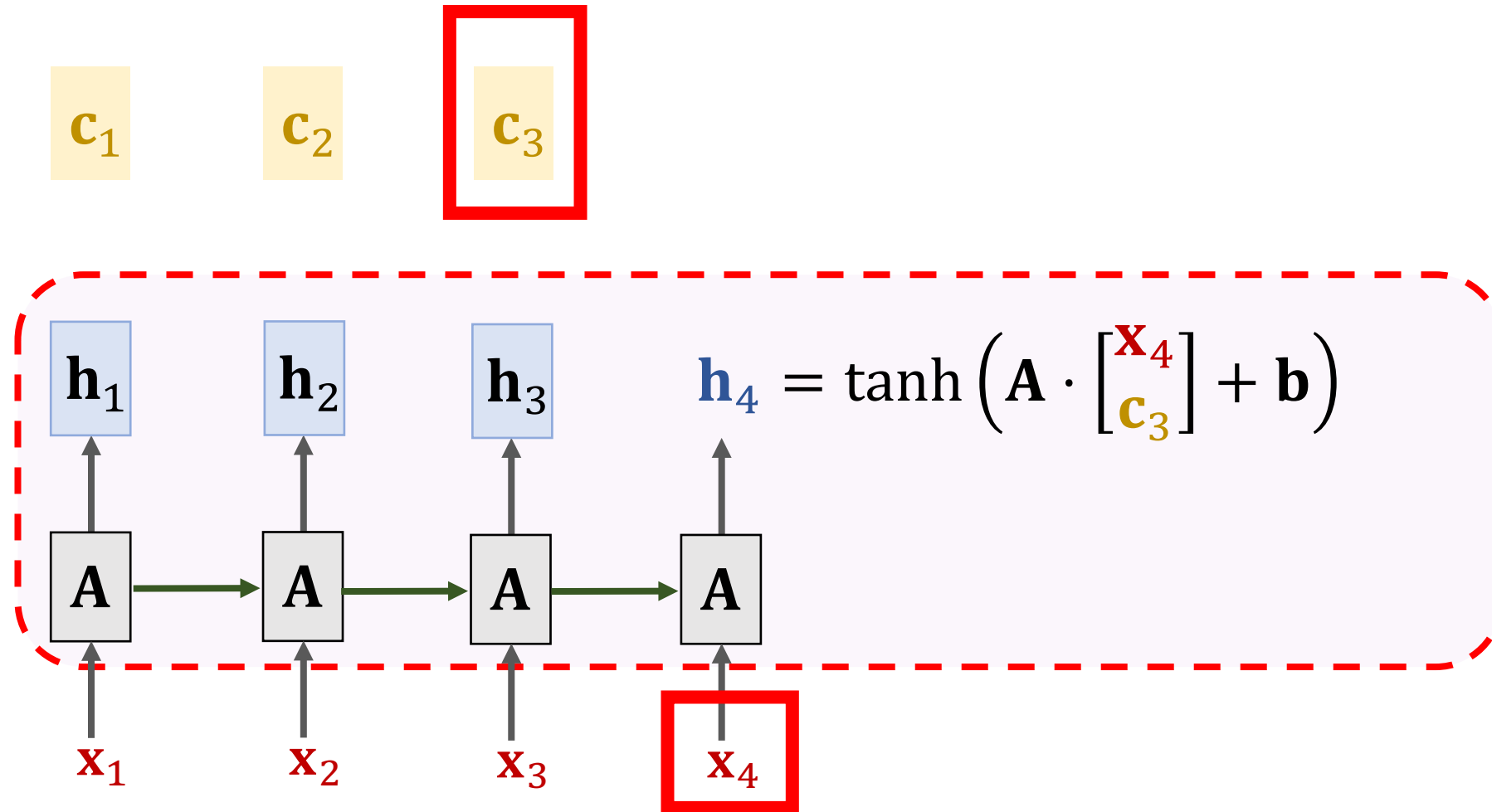
SimpleRNN + Self-Attention



SimpleRNN + Self-Attention



SimpleRNN + Self-Attention



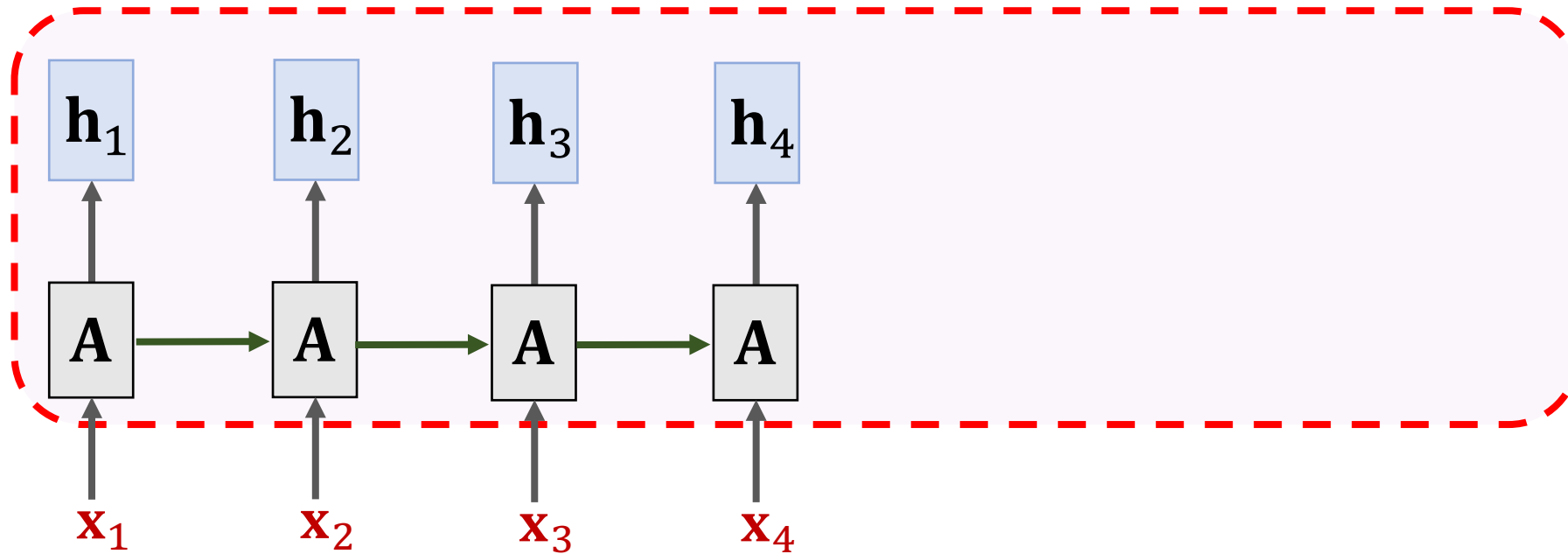
SimpleRNN + Self-Attention

c_1

c_2

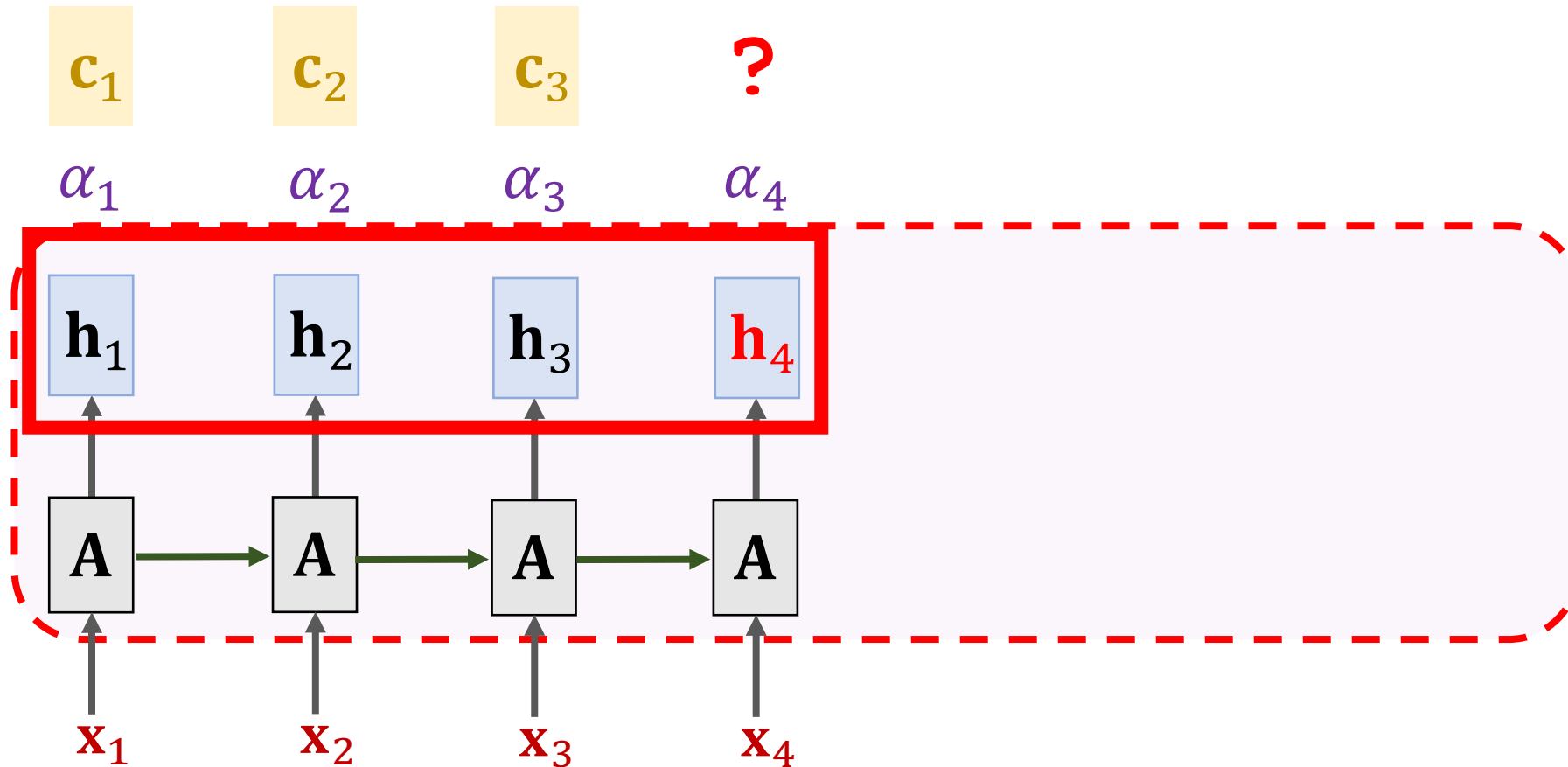
c_3

?

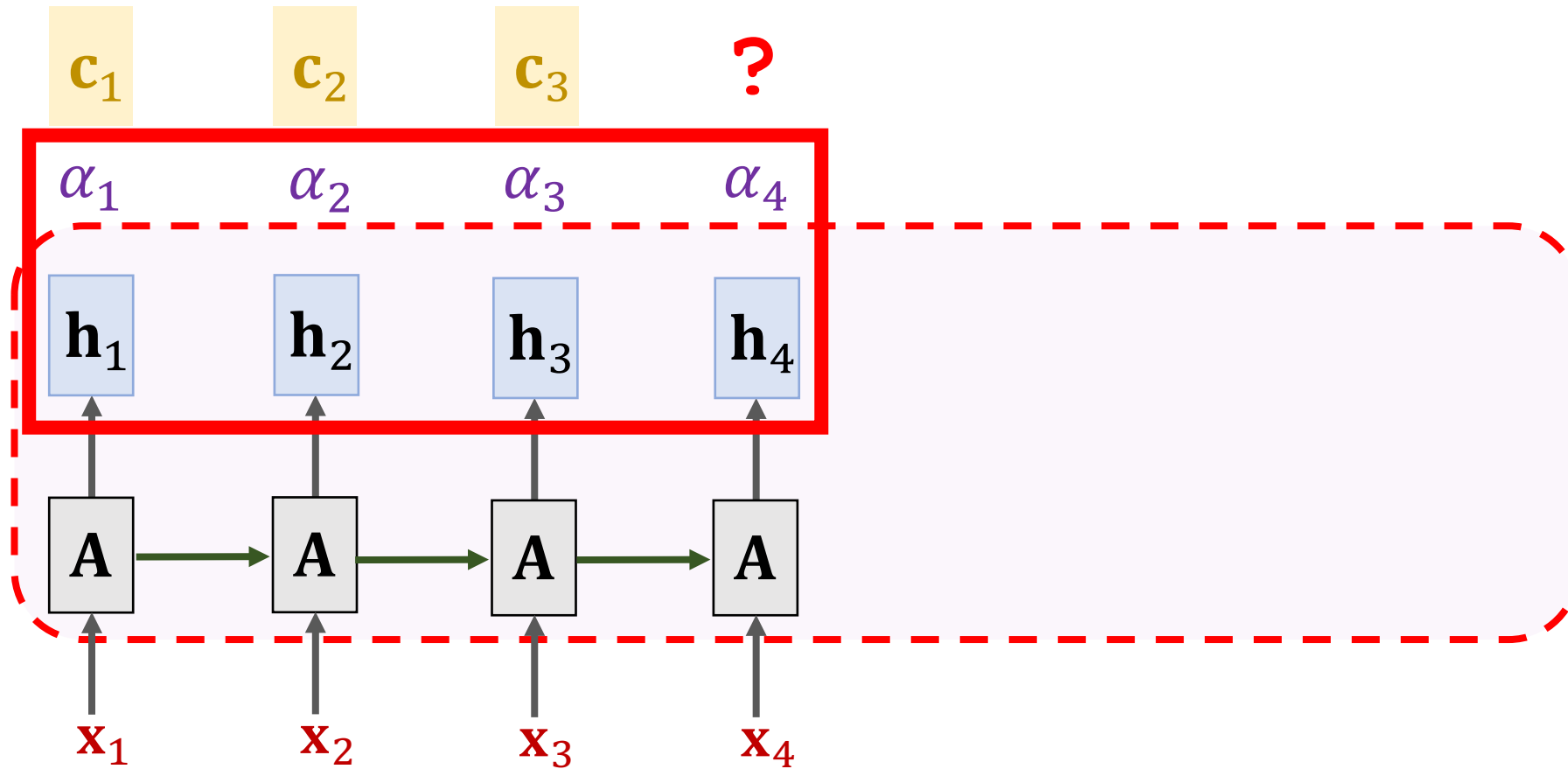


SimpleRNN + Self-Attention

Weights: $\alpha_i = \text{align}(\mathbf{h}_i, \mathbf{h}_4)$.

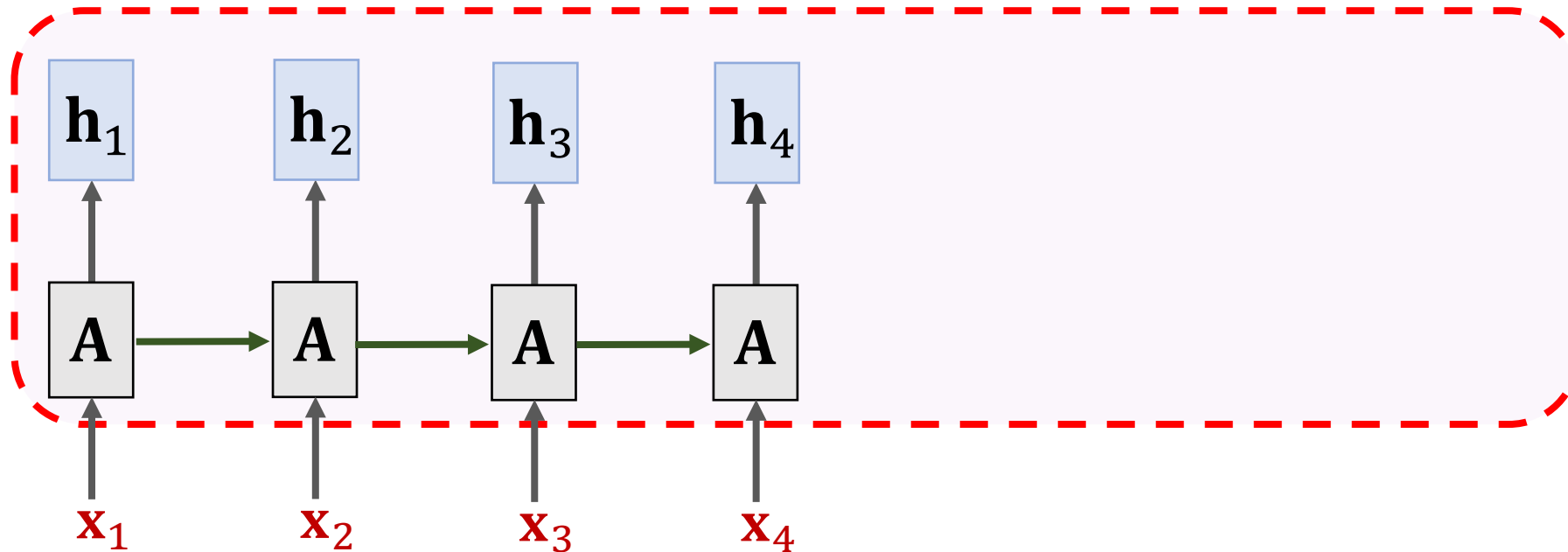


SimpleRNN + Self-Attention

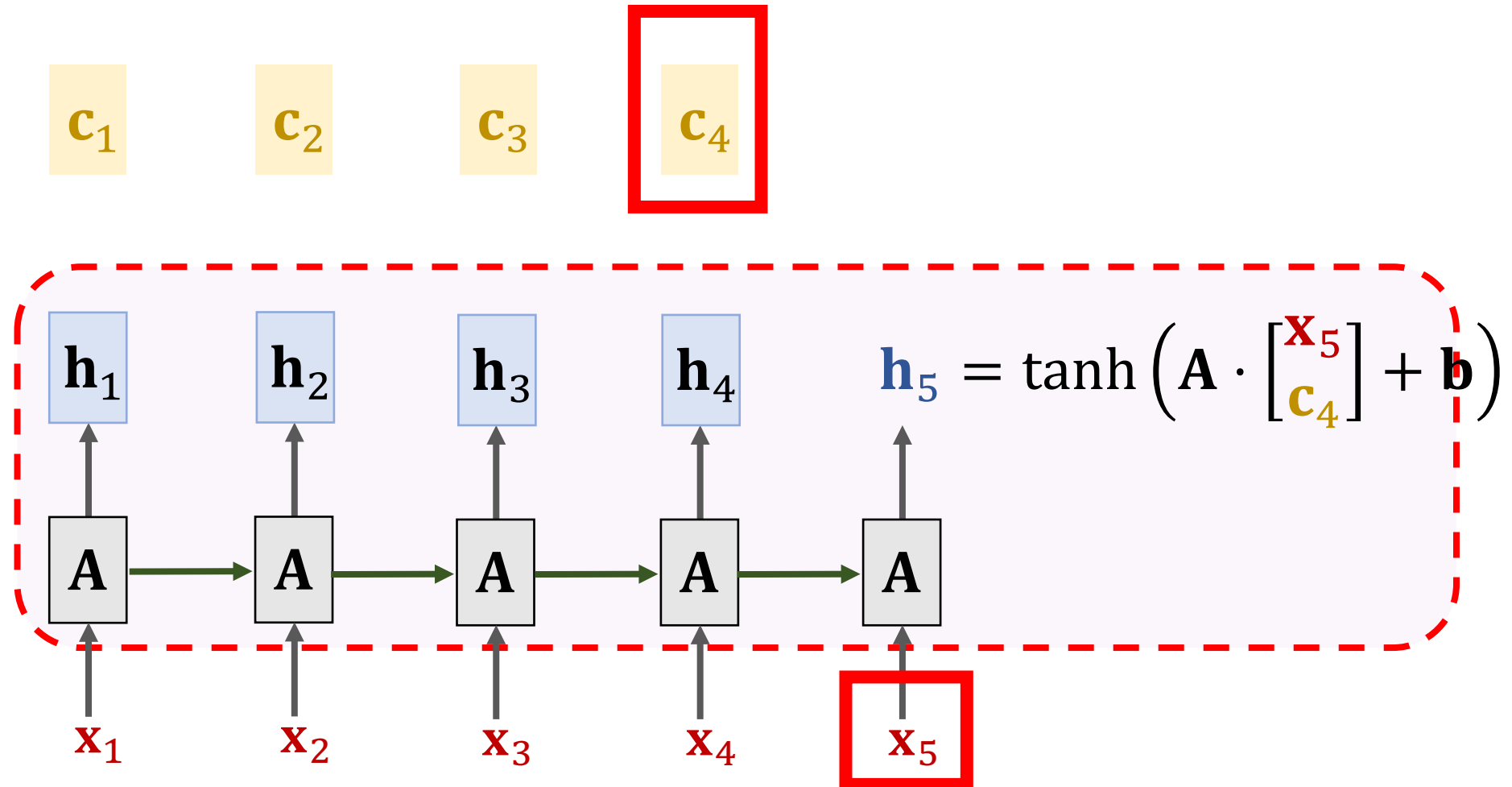


SimpleRNN + Self-Attention

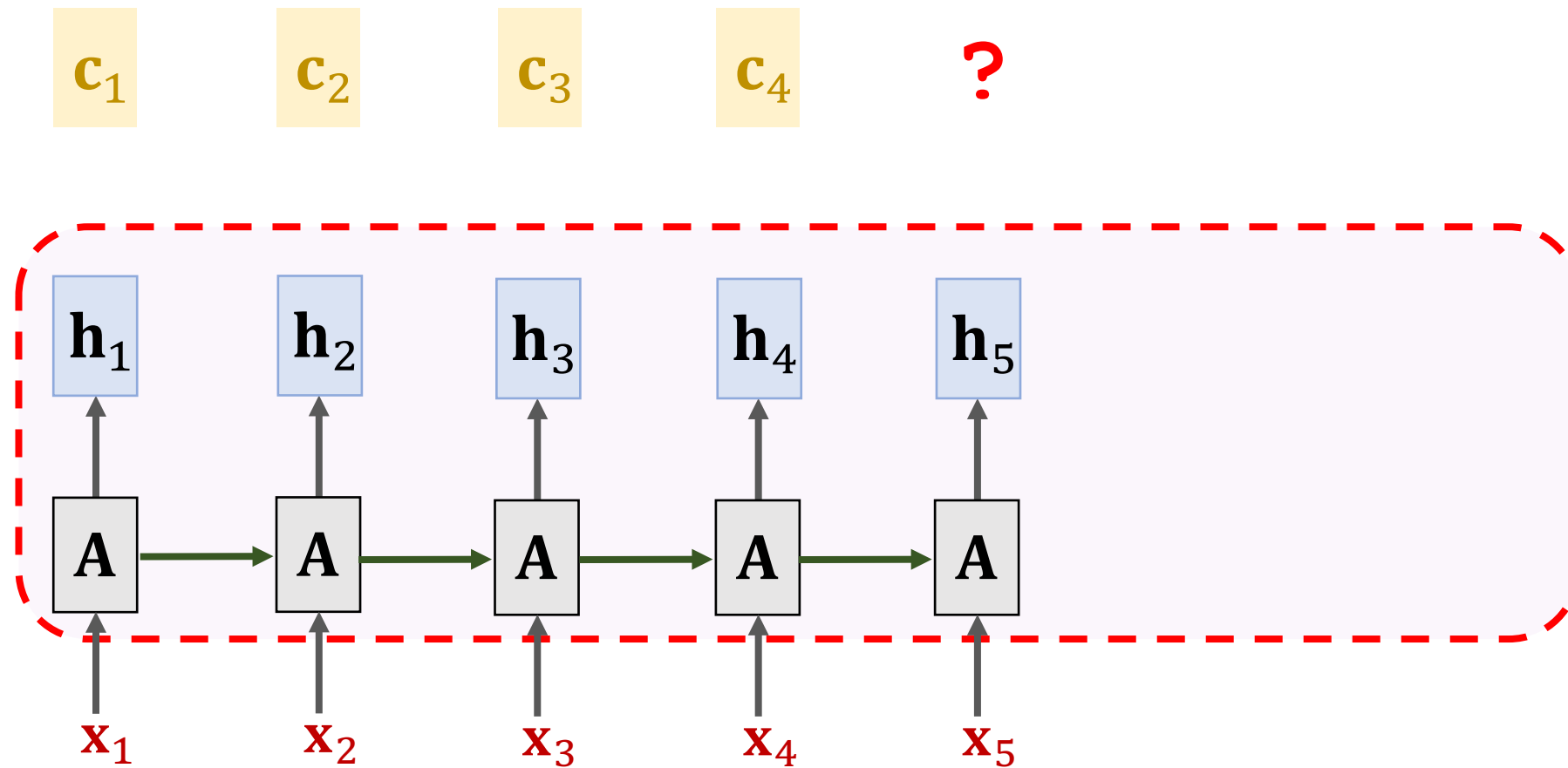
\mathbf{c}_1 \mathbf{c}_2 \mathbf{c}_3 $\mathbf{c}_4 = \alpha_1 \mathbf{h}_1 + \alpha_2 \mathbf{h}_2 + \alpha_3 \mathbf{h}_3 + \alpha_4 \mathbf{h}_4.$



SimpleRNN + Self-Attention

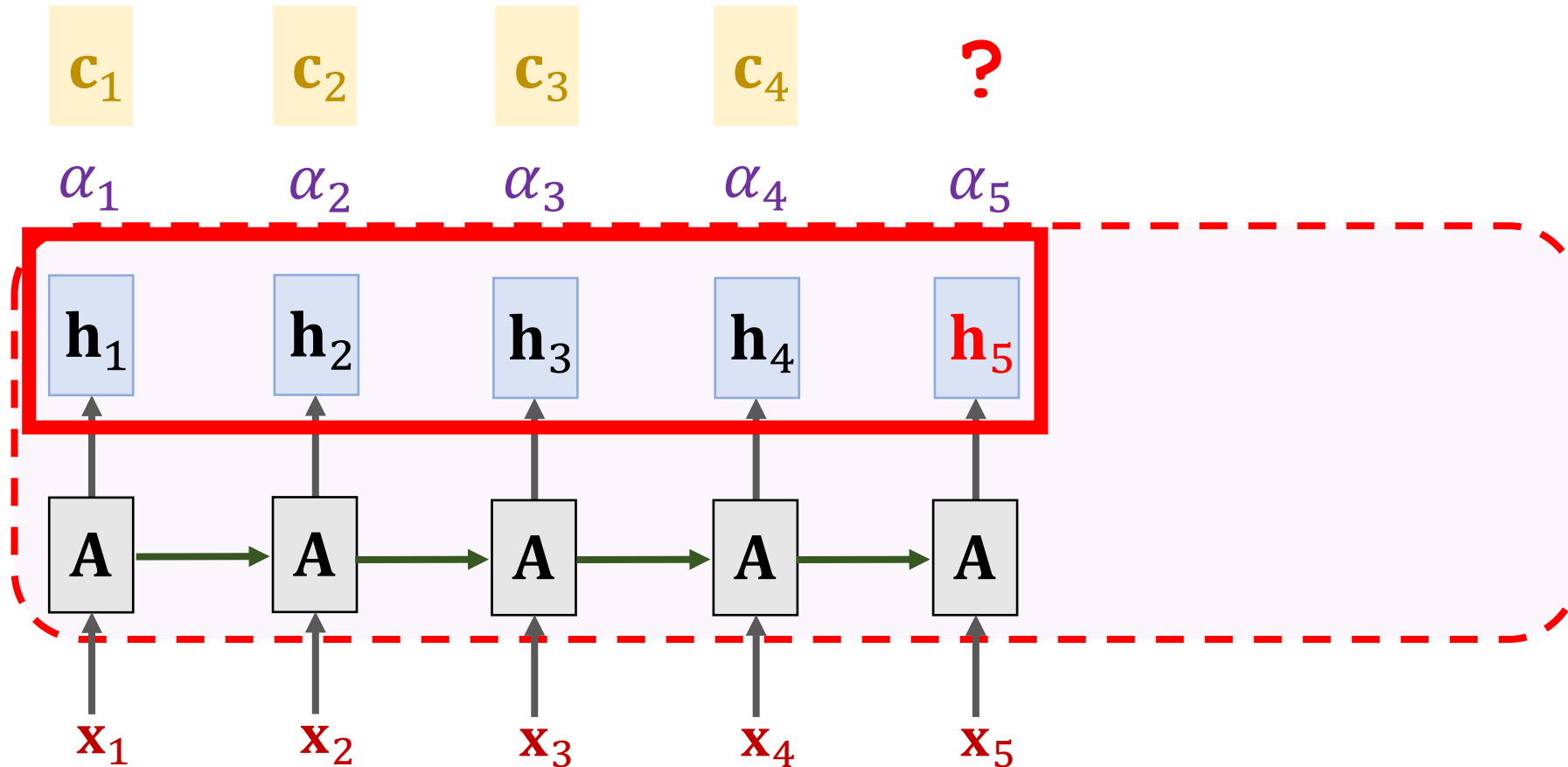


SimpleRNN + Self-Attention

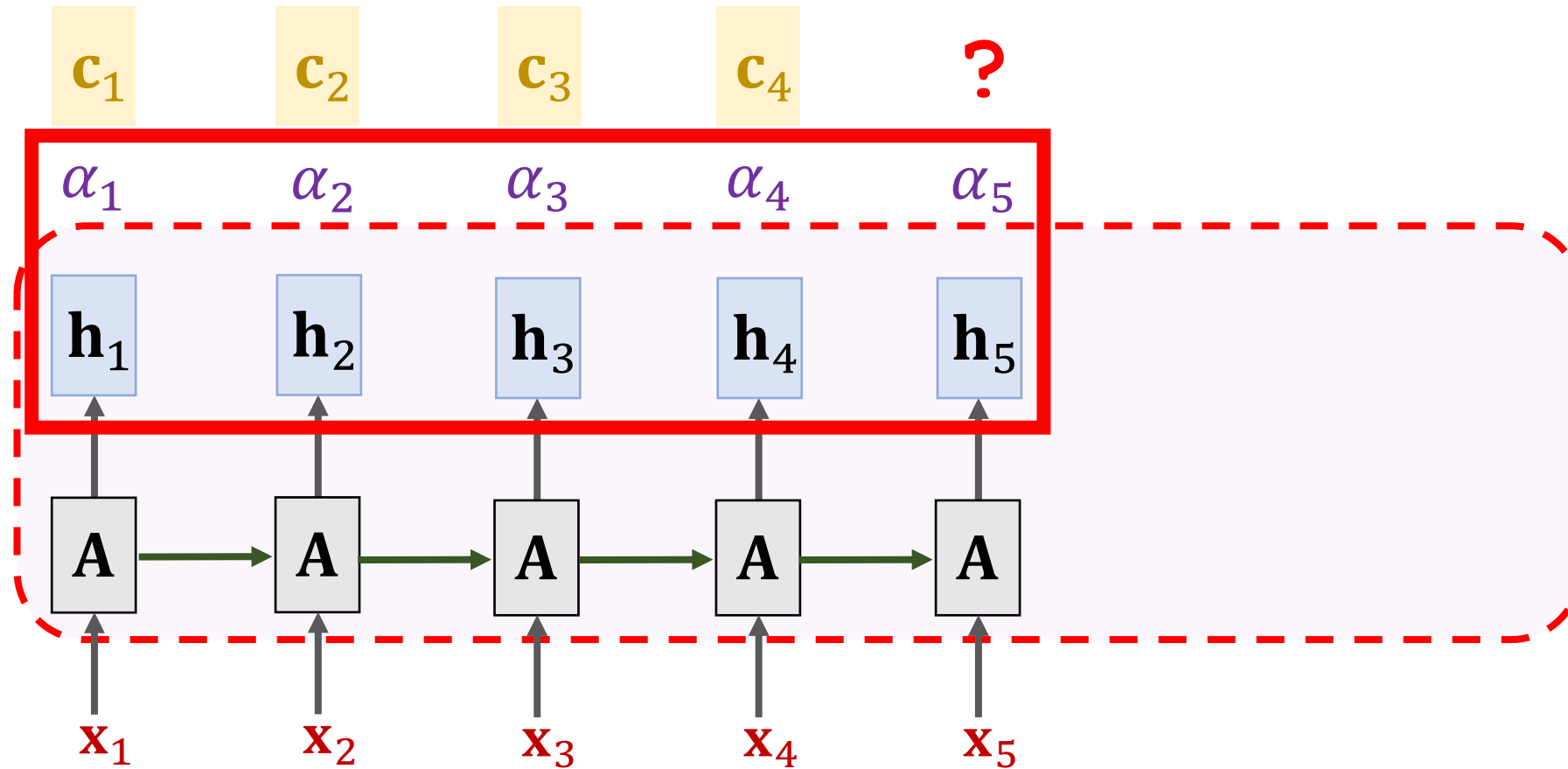


SimpleRNN + Self-Attention

Weights: $\alpha_i = \text{align}(\mathbf{h}_i, \mathbf{h}_5)$.

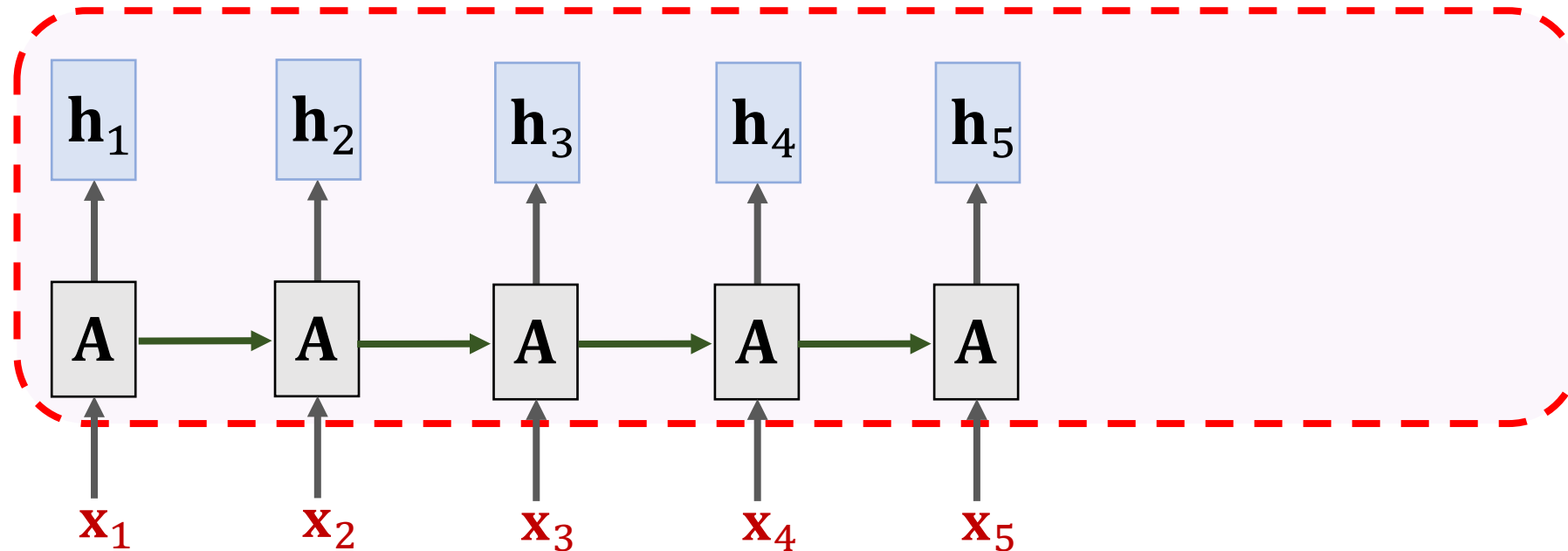


SimpleRNN + Self-Attention

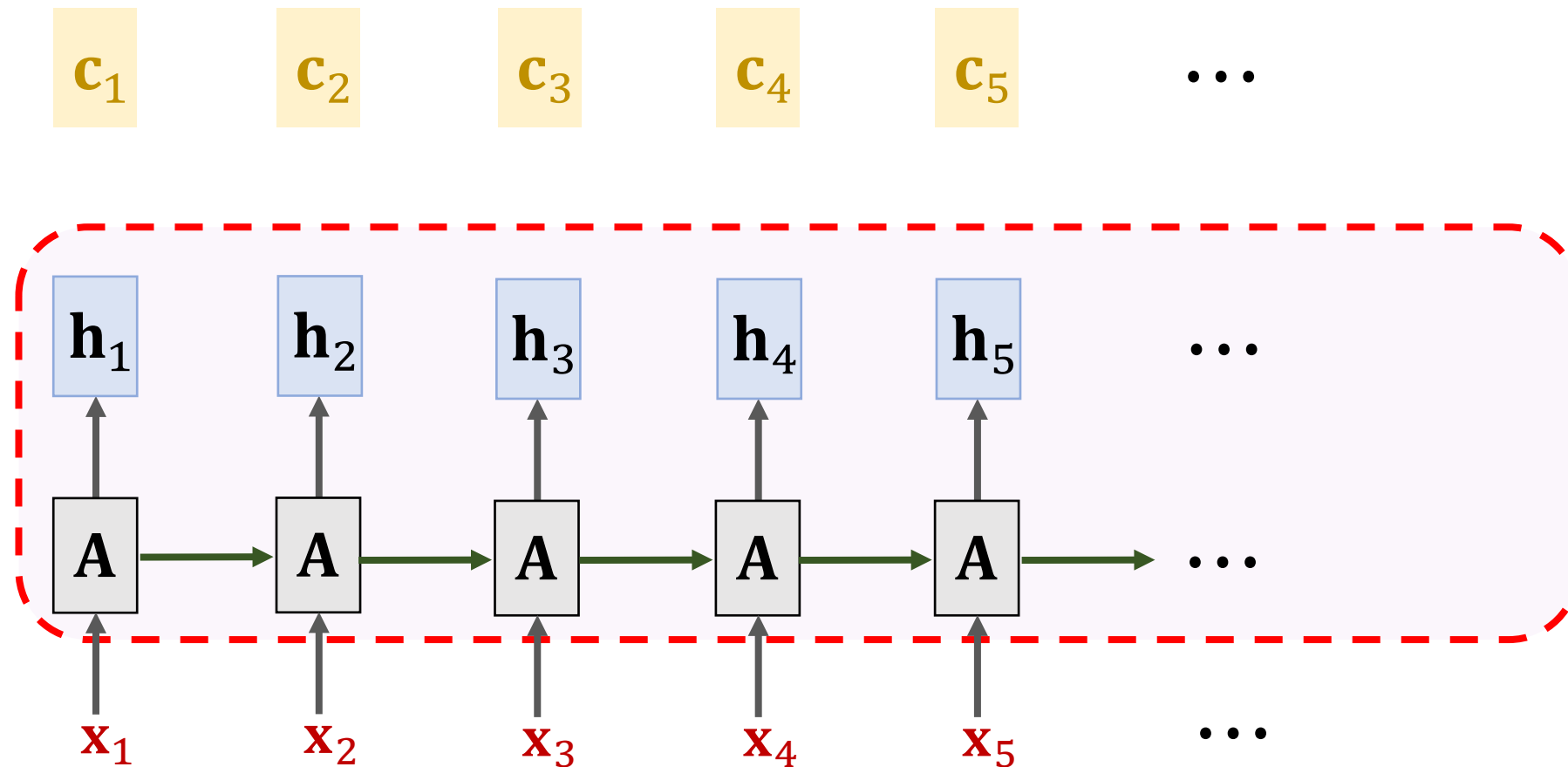


SimpleRNN + Self-Attention

\mathbf{c}_1 \mathbf{c}_2 \mathbf{c}_3 \mathbf{c}_4 $\mathbf{c}_5 = \alpha_1 \mathbf{h}_1 + \alpha_2 \mathbf{h}_2 + \cdots + \alpha_5 \mathbf{h}_5.$



SimpleRNN + Self-Attention



Summary

- With self-attention, RNN is less likely to forget.

Summary

- With self-attention, RNN is less likely to forget.
- Pay attention to the context relevant to the new input.

The
The FBI
The FBI is
The FBI is chasing
The FBI is chasing a
The FBI is chasing a criminal
The FBI is chasing a criminal on
The FBI is chasing a criminal on the
The FBI is chasing a criminal on the run
The FBI is chasing a criminal on the run .

Figure is from the paper “ Long Short-Term Memory-Networks for Machine Reading.”

Thank you!