



deeplearning.ai

# Sequence to sequence models

---

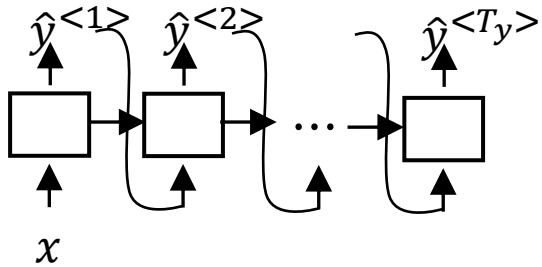
# Transformers Intuition

# Transformers Motivation

Increased complexity,  
sequential

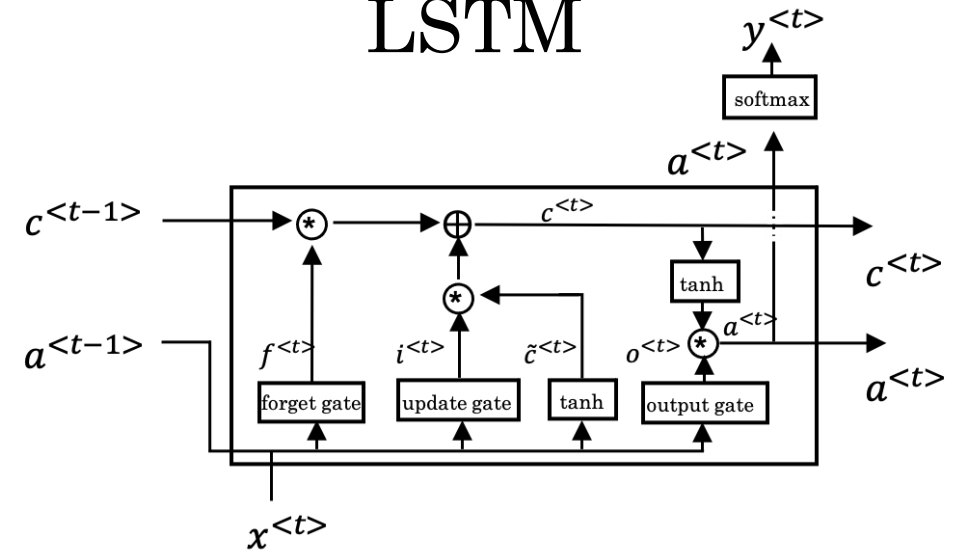


RNN



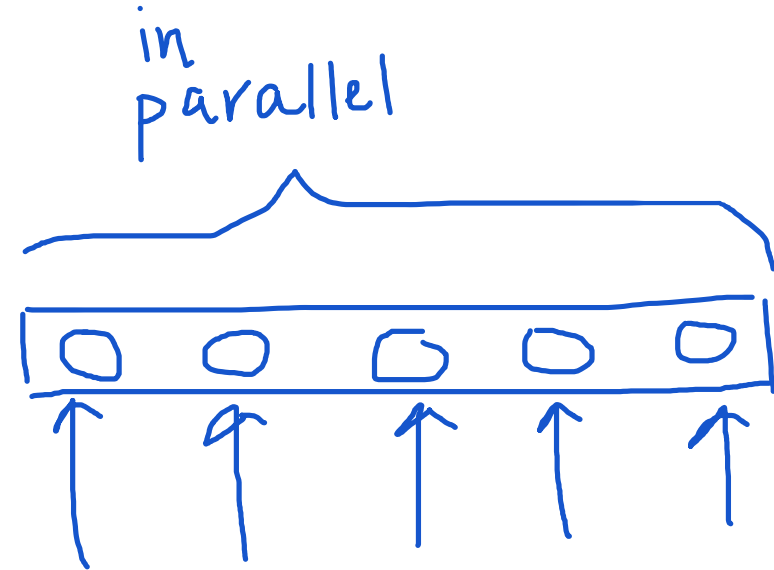
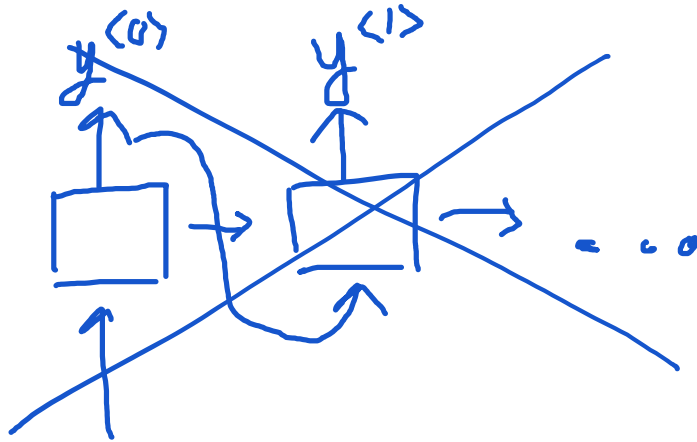
GRU

LSTM



# Transformers Intuition

- Attention + CNN
  - Self-Attention
  - Multi-Head Attention





deeplearning.ai

# Sequence to sequence models

---

## Self-Attention

# Self-Attention Intuition

$A(q, K, V)$  = attention-based vector representation of a word

↪ calculate for each word

## RNN Attention

$$\alpha^{<\cancel{t}, t'>} = \frac{\exp(e^{<t, t'>})}{\sum_{t'=1}^{T^x} \exp(e^{<t, t'>})}$$

$x^{<1>}$   
Jane

$x^{<2>}$   
visite

$x^{<3>}$   
l'Afrique

$x^{<4>}$   
en

$x^{<5>}$   
septembre

## Transformers Attention

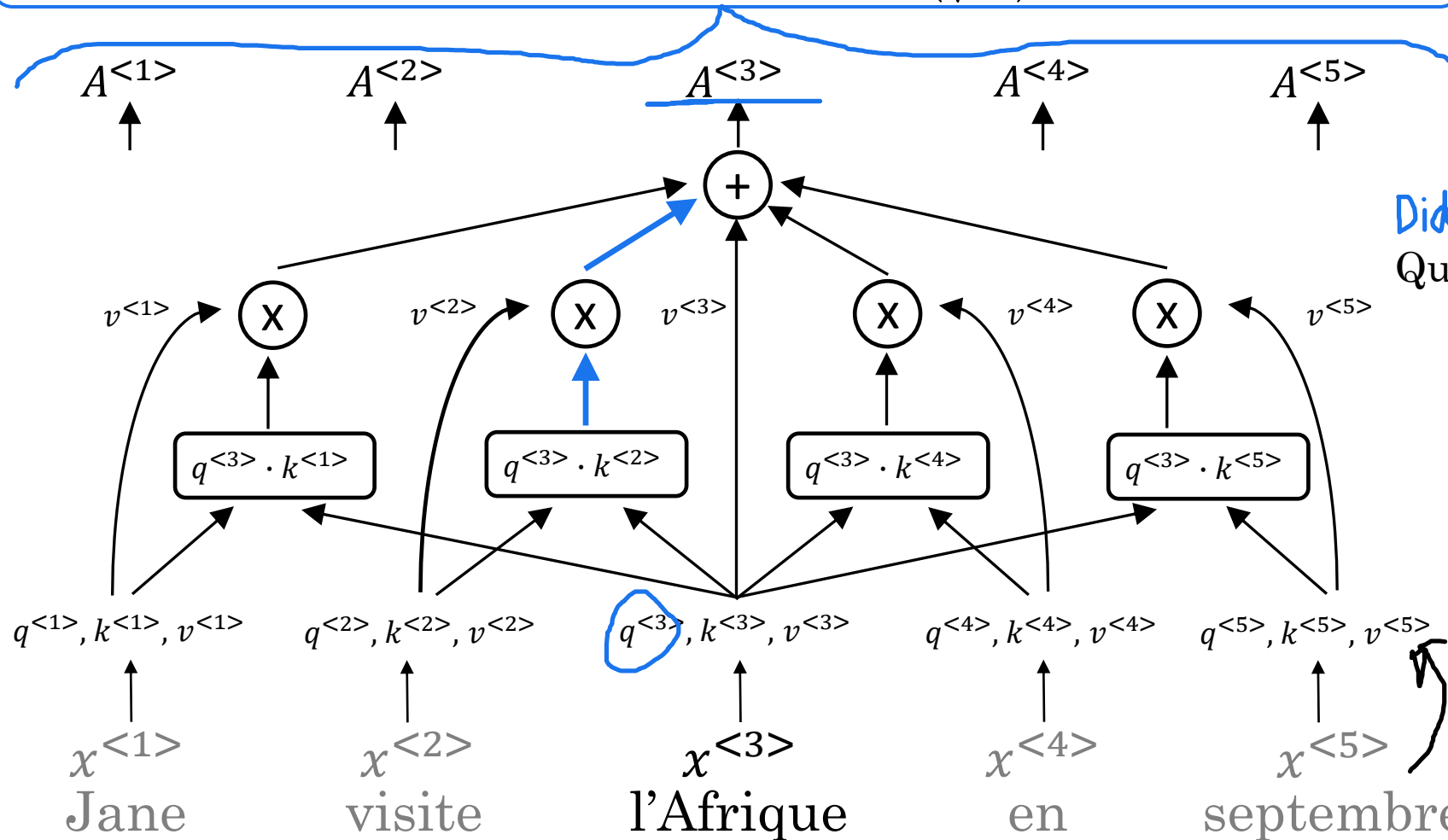
$$A(q, K, V) = \sum_i \frac{\exp(e^{<q \cdot k^{<i>}>})}{\sum_j \exp(e^{<q \cdot k^{<j>}>})} v^{<i>}$$

# Self-Attention

$$A(q, K, V) = \sum_i \frac{\exp(e^{q \cdot k^{<i>}})}{\sum_j \exp(e^{q \cdot k^{<j>}})} v^{<i>}$$

softmax

$$\text{Attention}(Q, K, V) = \text{softmax}\left(\frac{QK^T}{\sqrt{d_k}}\right)V$$



Did what?

Query (Q)

Key (K)

Value (V)

$q^{<1>}$

$k^{<1>}$

$v^{<1>}$

$q^{<2>}$

$k^{<2>}$

$v^{<2>}$

$q^{<3>}$

$k^{<3>}$

$v^{<3>}$

$q^{<4>}$

$k^{<4>}$

$v^{<4>}$

$q^{<5>}$

$k^{<5>}$

$v^{<5>}$

What's happening there?

person  
action  
visit

$W^Q, W^K, W^V$



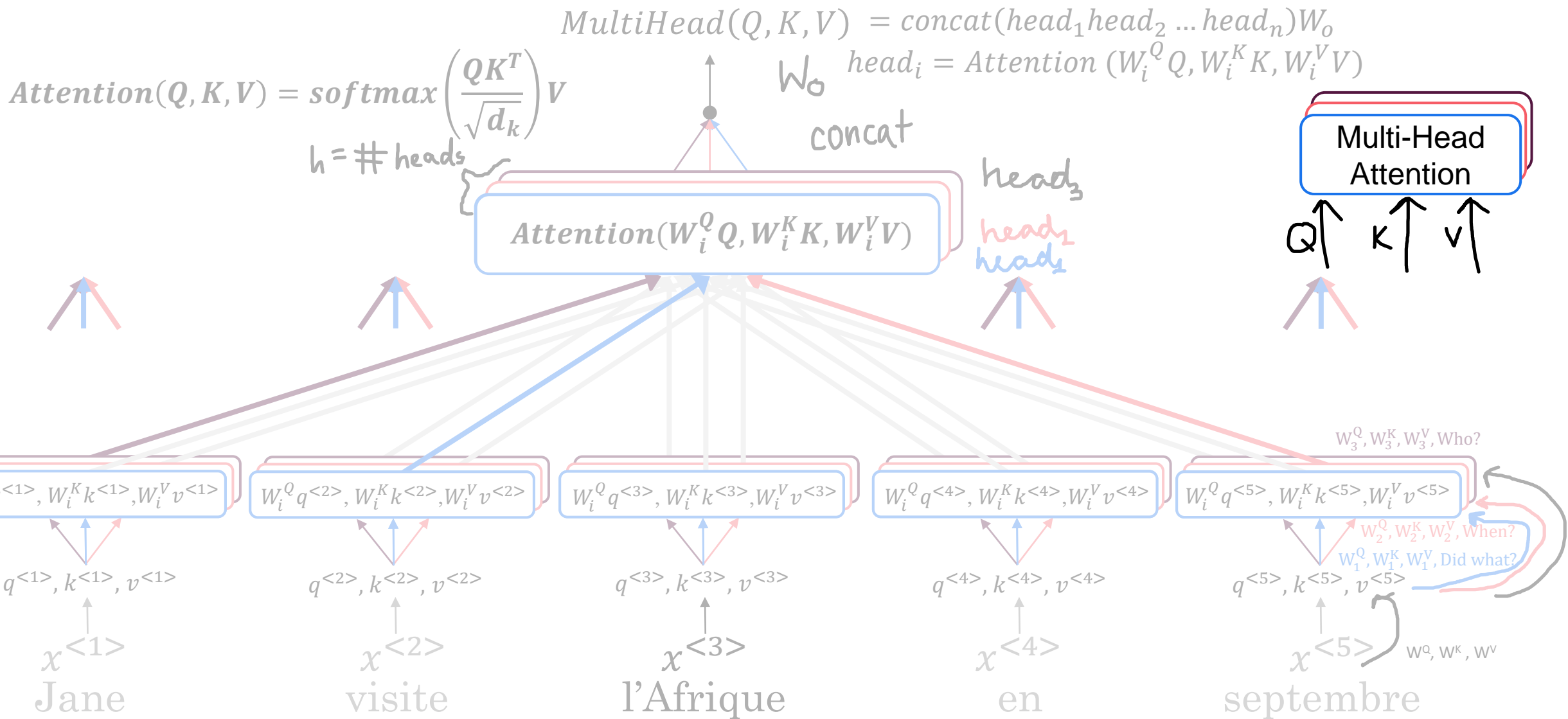
deeplearning.ai

# Sequence to sequence models

---

## Multi-Head Attention

# Multi-Head Attention







deeplearning.ai

Sequence to  
sequence models

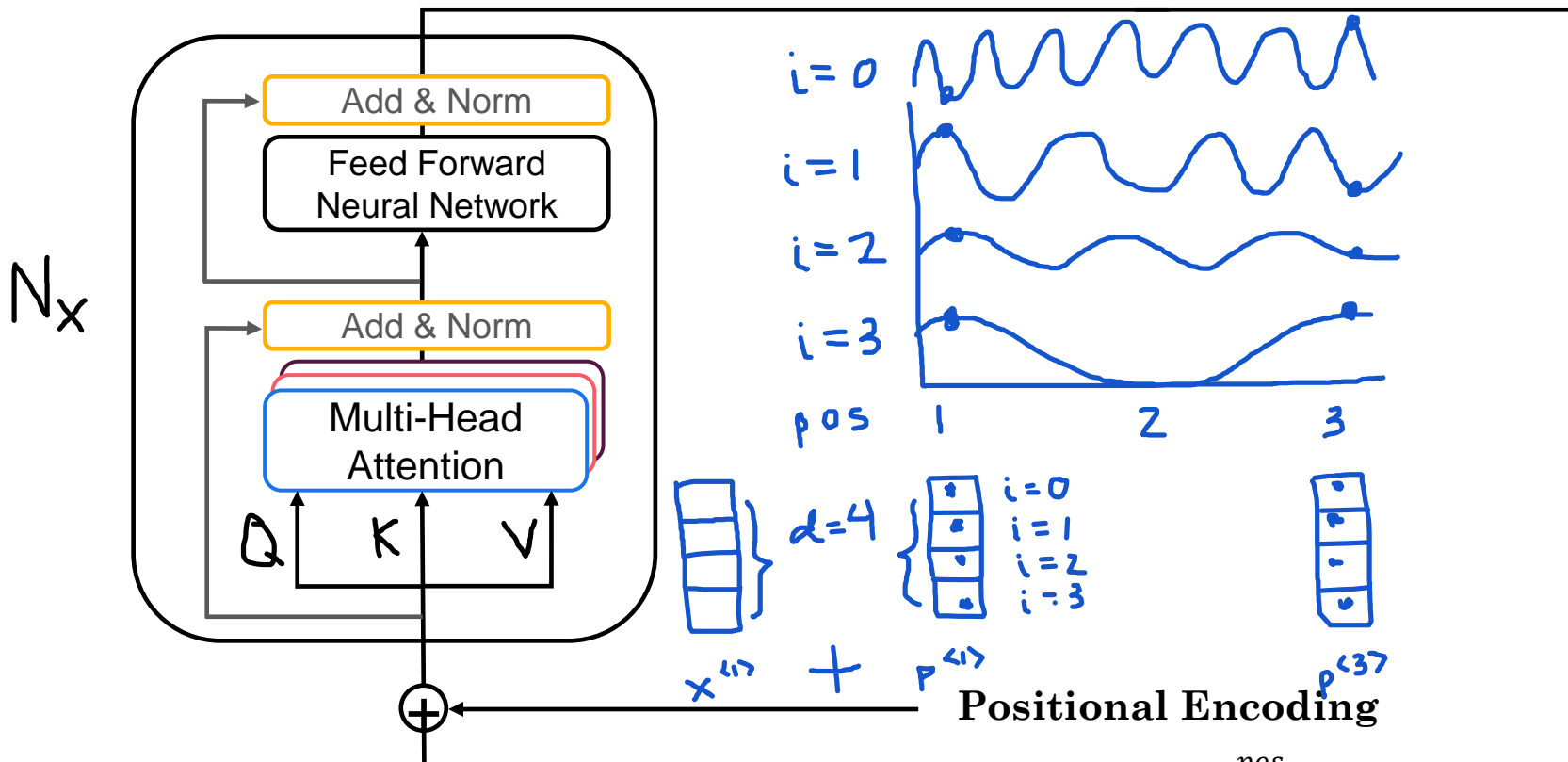
---

Transformers

# Transformer Details

<SOS> Jane visits Africa in September <EOS>

Encoder

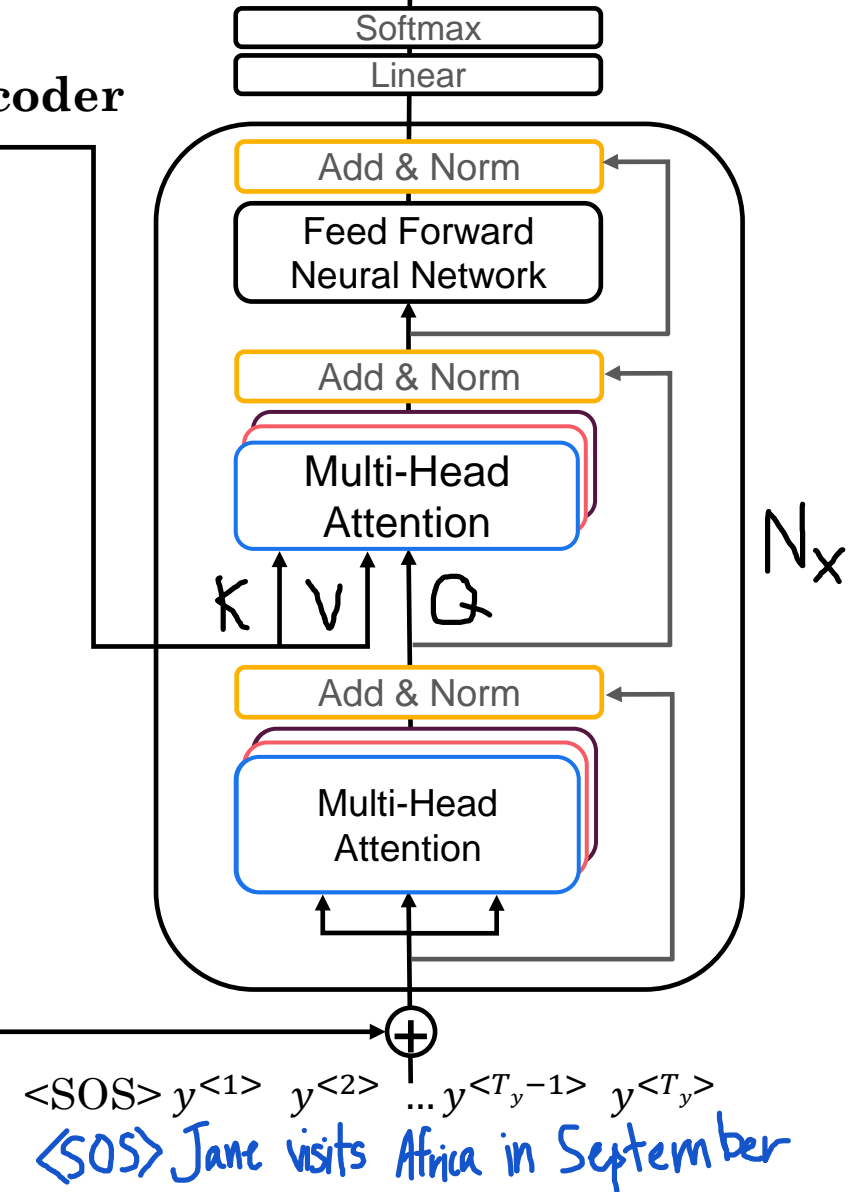


$\langle \text{SOS} \rangle x^{<1>} x^{<2>} \dots x^{<T_x-1>} x^{<T_x>} \langle \text{EOS} \rangle$   
Jane visite l'Afrique en septembre

$$PE_{(pos,2i)} = \sin\left(\frac{pos}{1000^{\frac{2i}{d}}}\right)$$

$$PE_{(pos,2i+1)} = \cos\left(\frac{pos}{1000^{\frac{2i}{d}}}\right)$$

Decoder



$\langle \text{SOS} \rangle y^{<1>} y^{<2>} \dots y^{<T_y-1>} y^{<T_y>}$   
<SOS> Jane visits Africa in September