Attention Model

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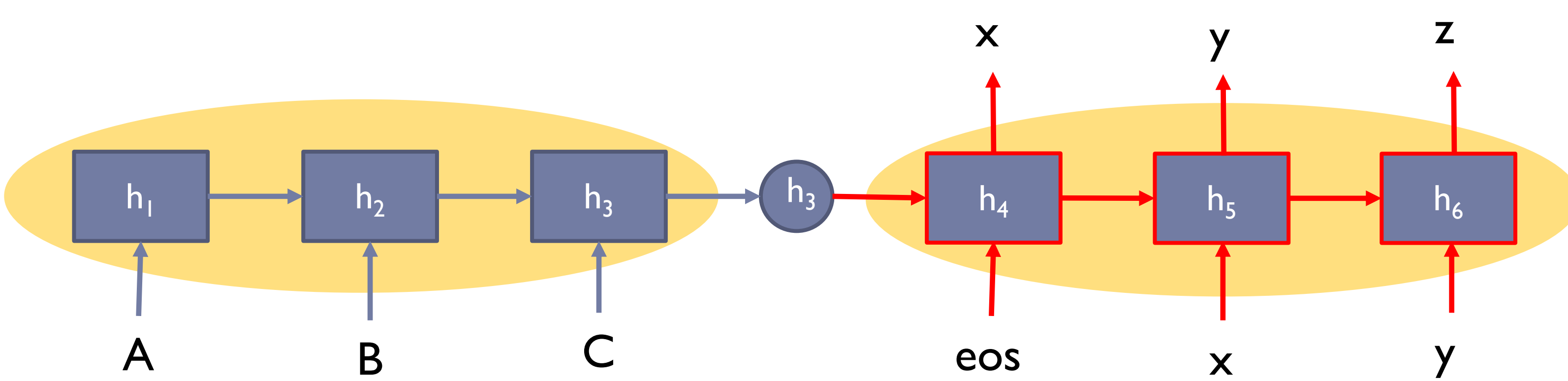
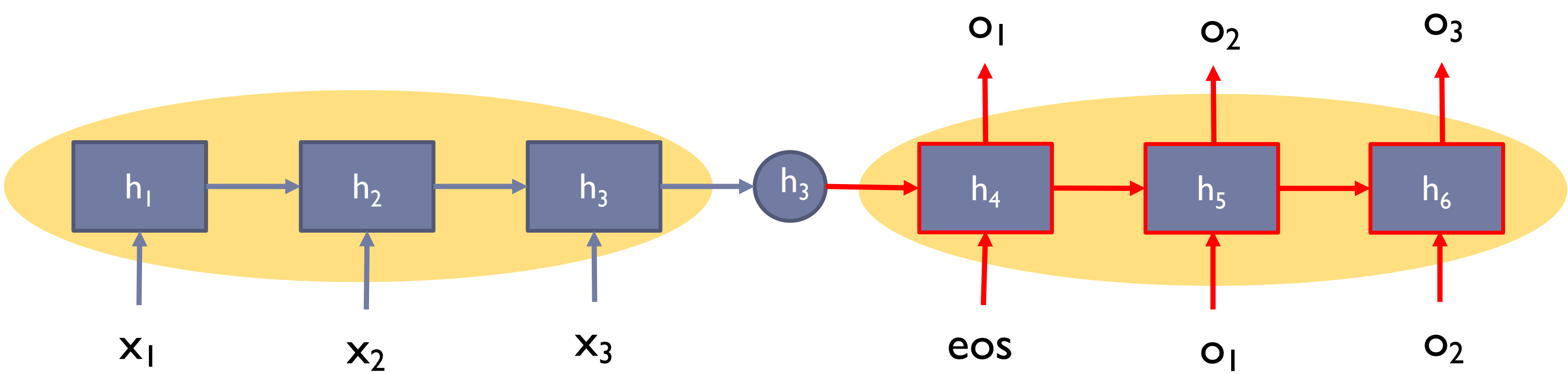
Sequence Generation

- **Encoder-Decoder Scheme**
  - **Encoder: compress input sequence into one vector**
    - h_3 is the vector representation of the given sequence
  - **Decoder: uses this vector to generate output**
    - It extracts necessary information only from the vector



Sequence Generation

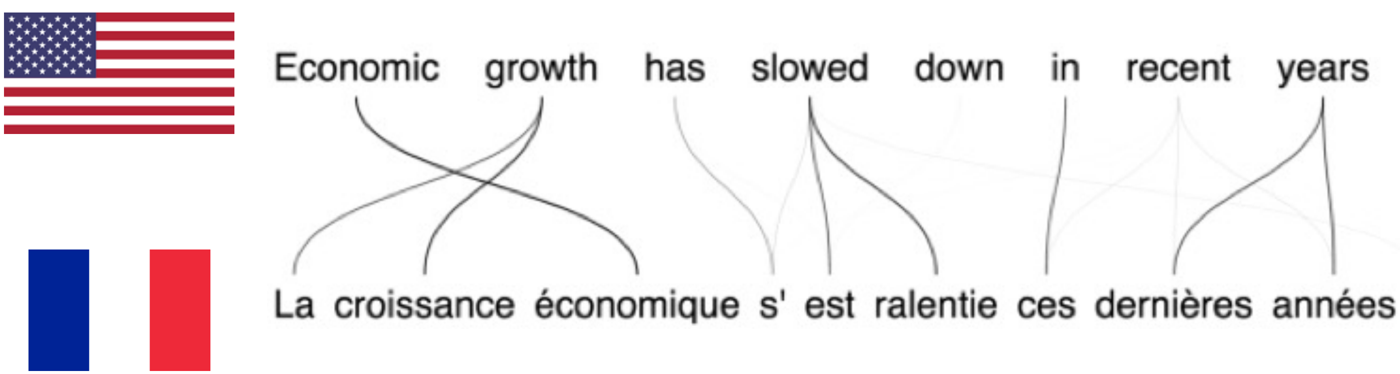
- **Challenges**
  - A single vector may not enough for decoder to generate correct words
  - Processing distance between input and output get longer as sequence becomes longer



Attention Model

- **Idea**
  - Remove the vector and Directly connect input to output + α

- **Observation**
  - At every step, all the inputs are not equally useful

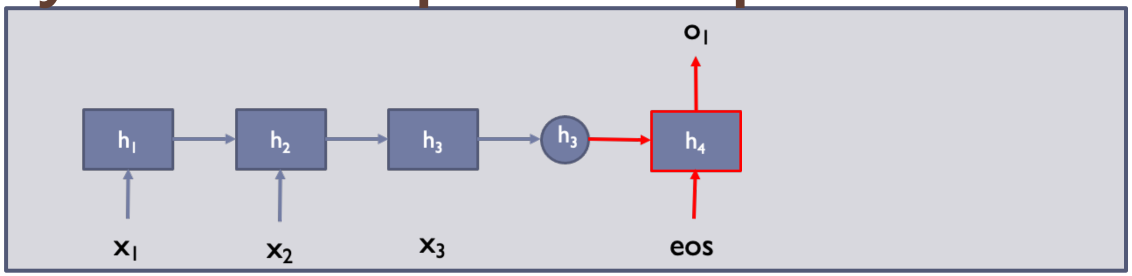


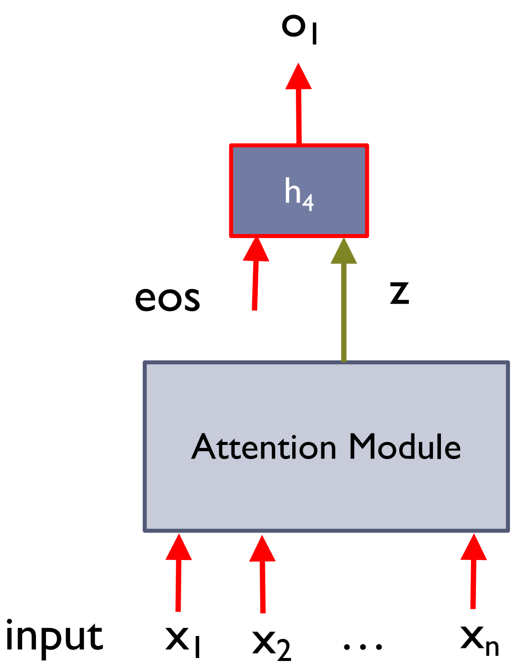
  - Inputs relevant to the context may be more useful

Kyunghyun Cho, "Introduction to Neural Machine Translation with GPUs" (2015)

Sequence Generation

- **Directly connect input to output + α**





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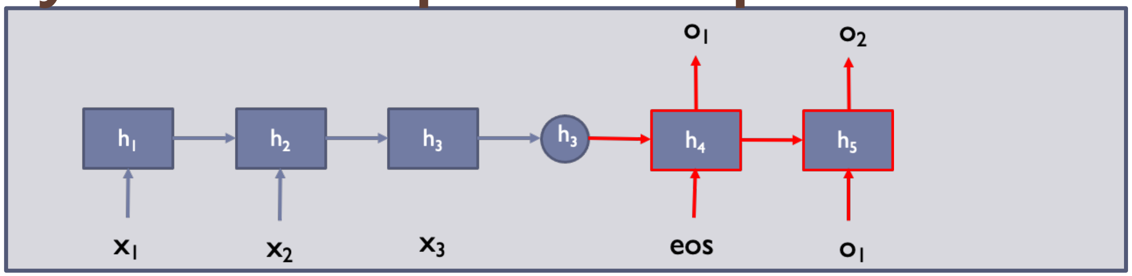
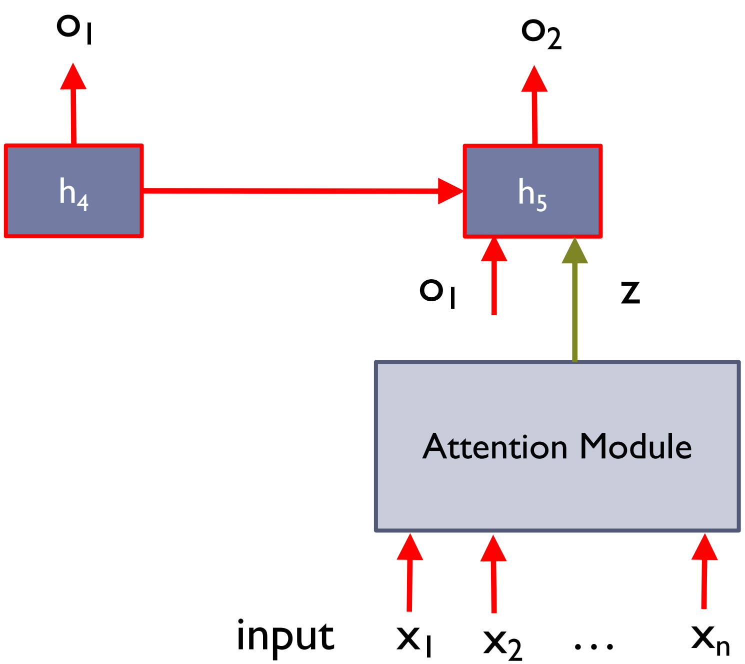
Sequence Generation

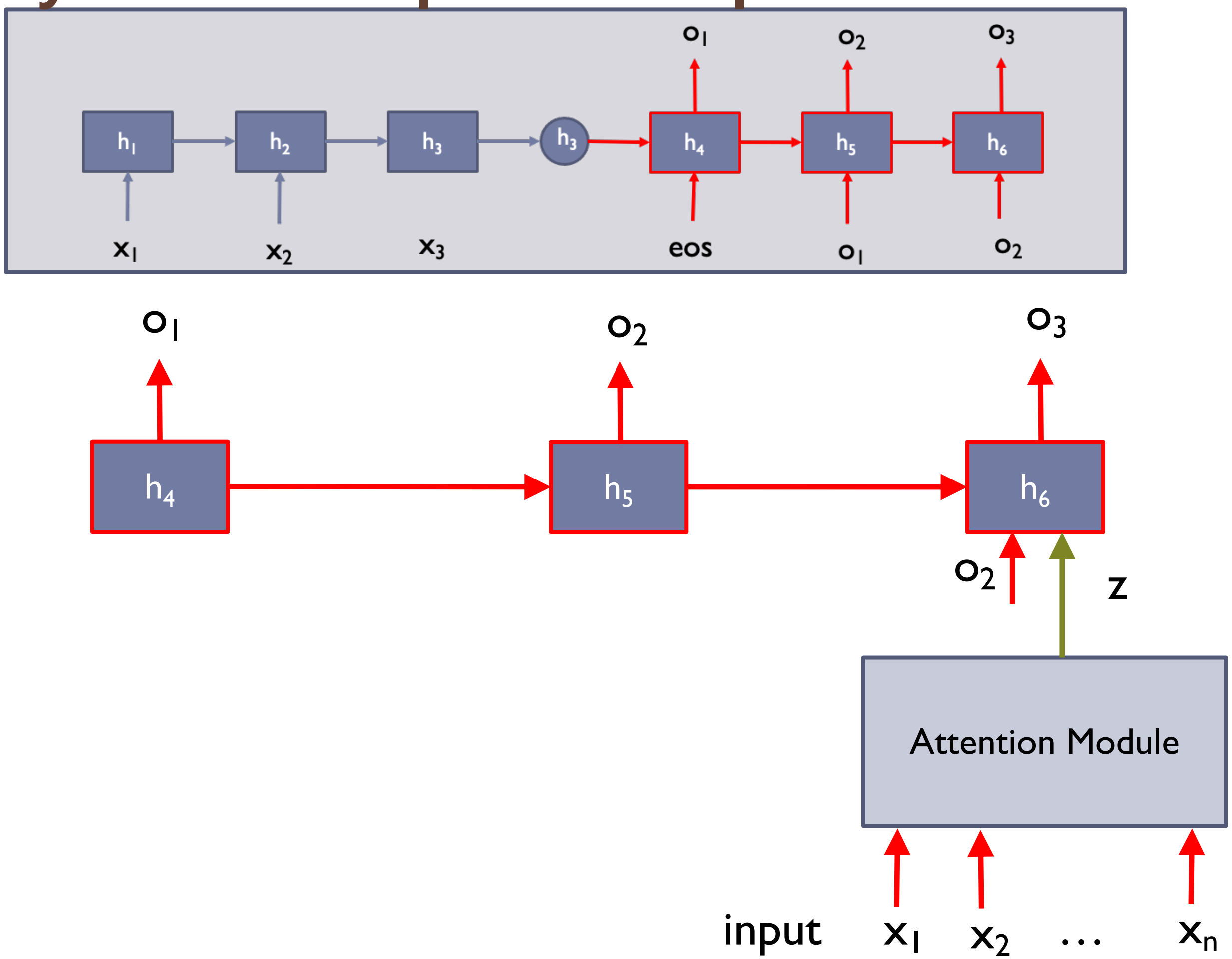
- **Directly connect input to output + α**





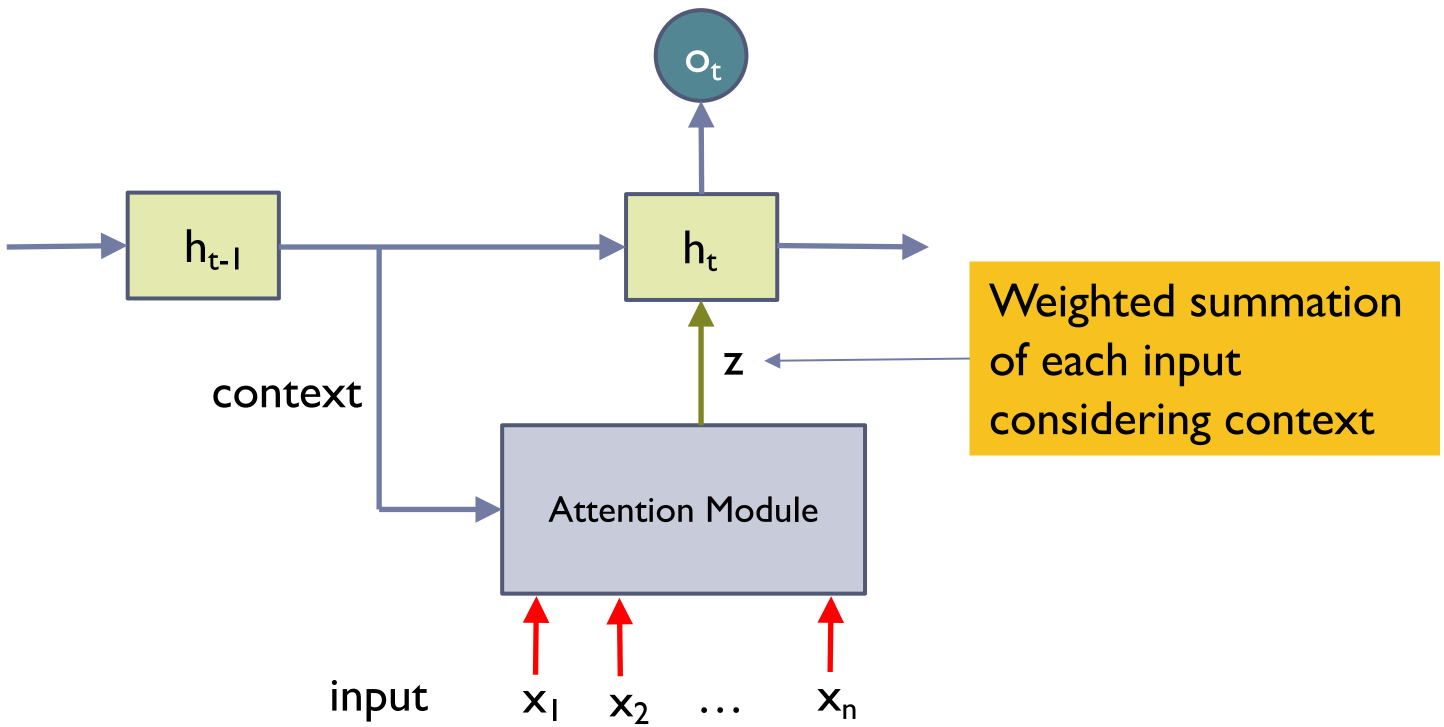
Sequence Generation

- **Directly connect input to output + α**



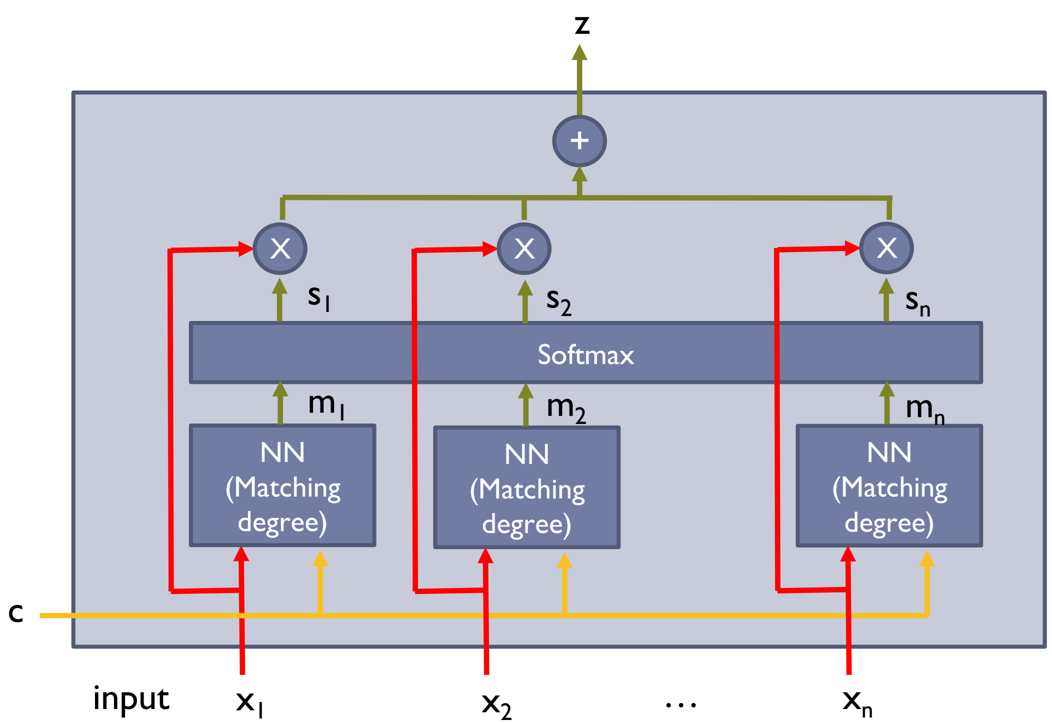
Attention Model

- **Overview**
  - Select the most important input to produce O_t



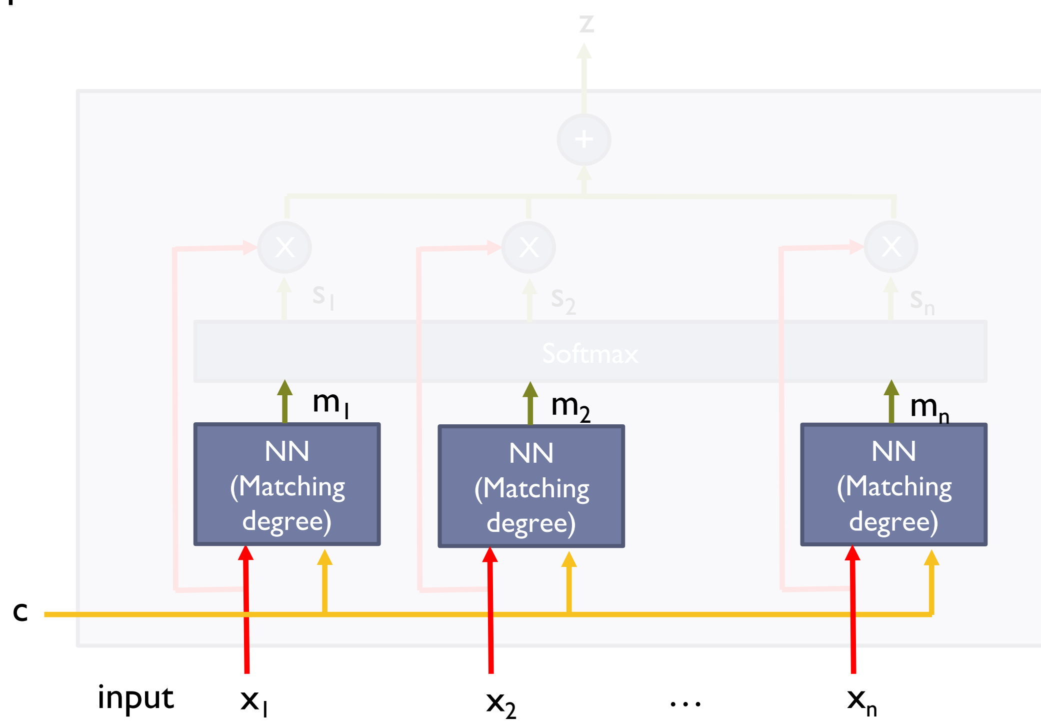
Attention Model

- ## Attention Module
  - All inputs share the same NN for matching degree



Attention Model

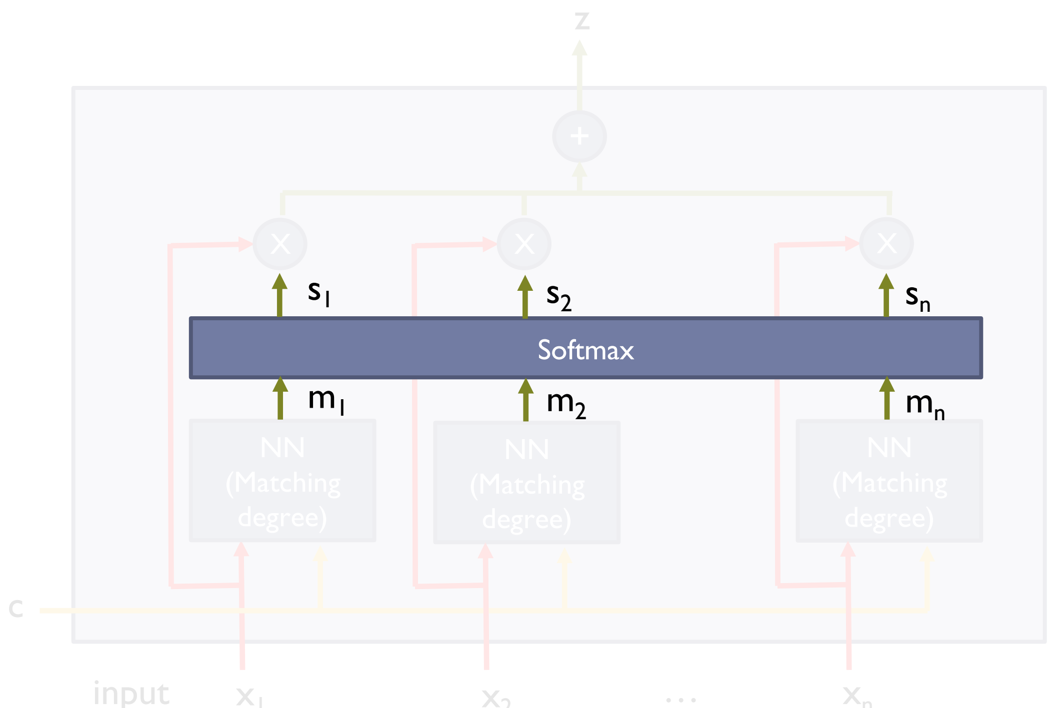
- ## Step 1: Evaluating Matching Degree
  - ### Evaluating matching degree of each input to the context
    - Produce scalar matching degree (Higher value is higher attention)
    - All inputs share the same NN



Attention Model

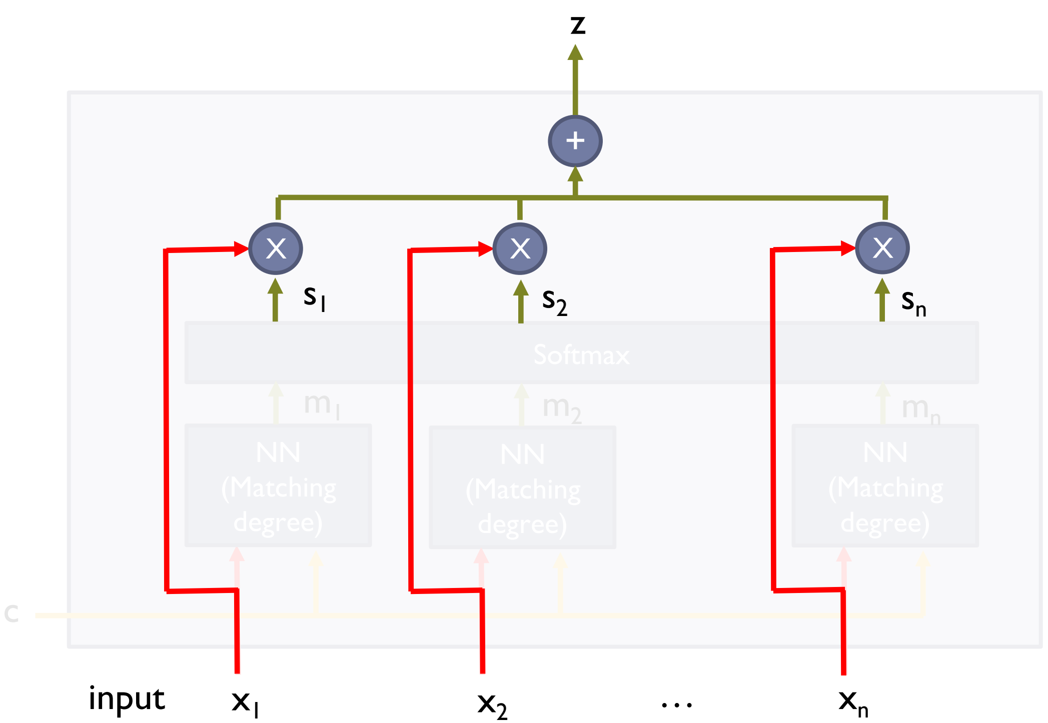
Step 2: Normalizing Matching Degree

$$s_i = \frac{\exp(m_i)}{\sum_j exp(m_j)}$$



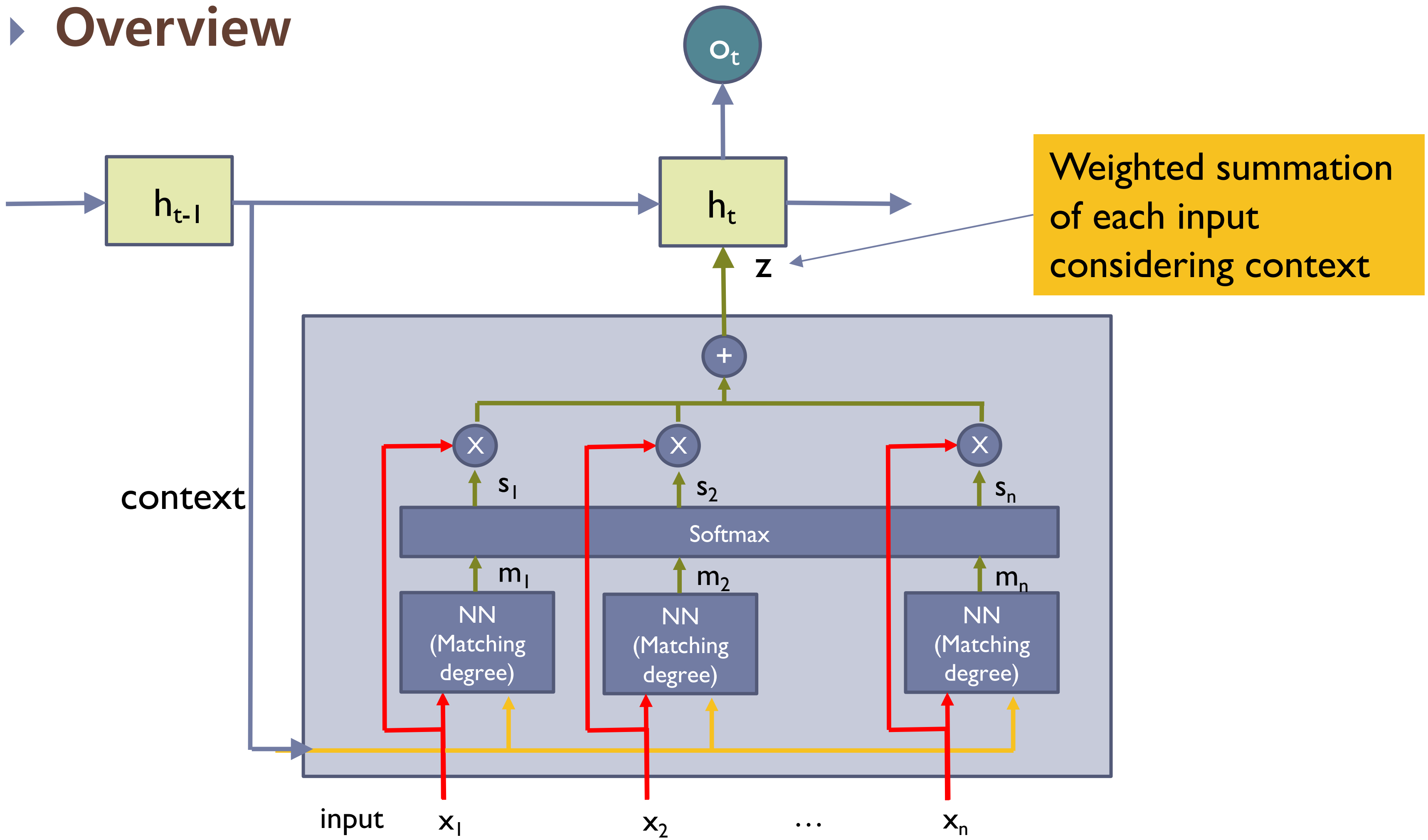
Attention Model

- **Step 3: Aggregating Inputs**
  - Each input is scaled by s_i and summed up into z
  - z is the input focused on the current context



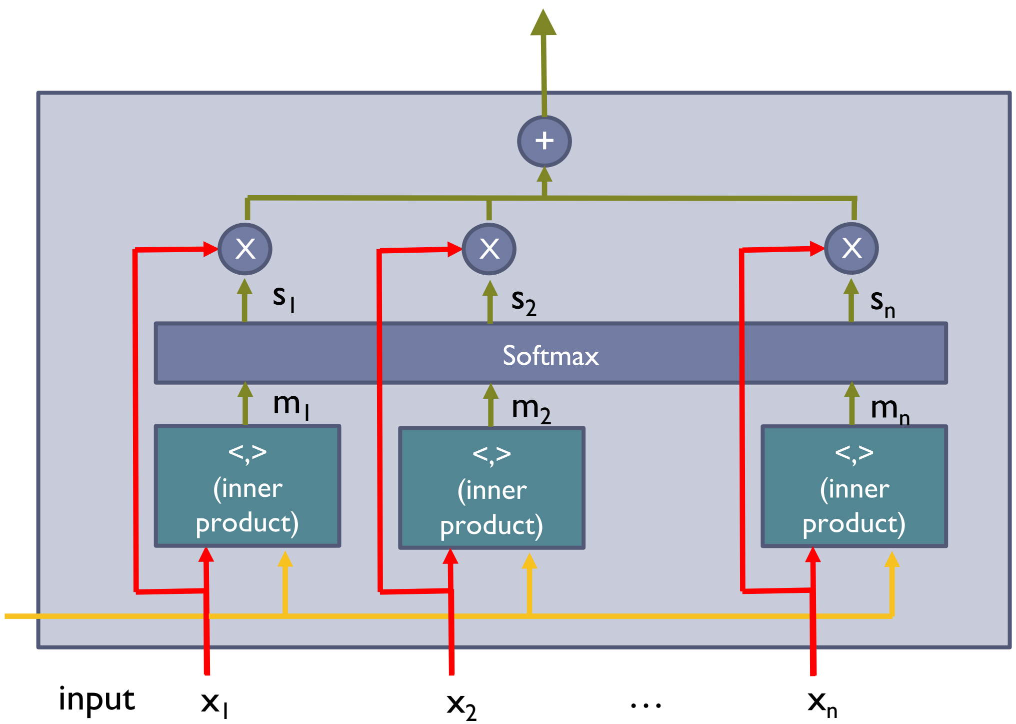
Attention Model

- **Overview**



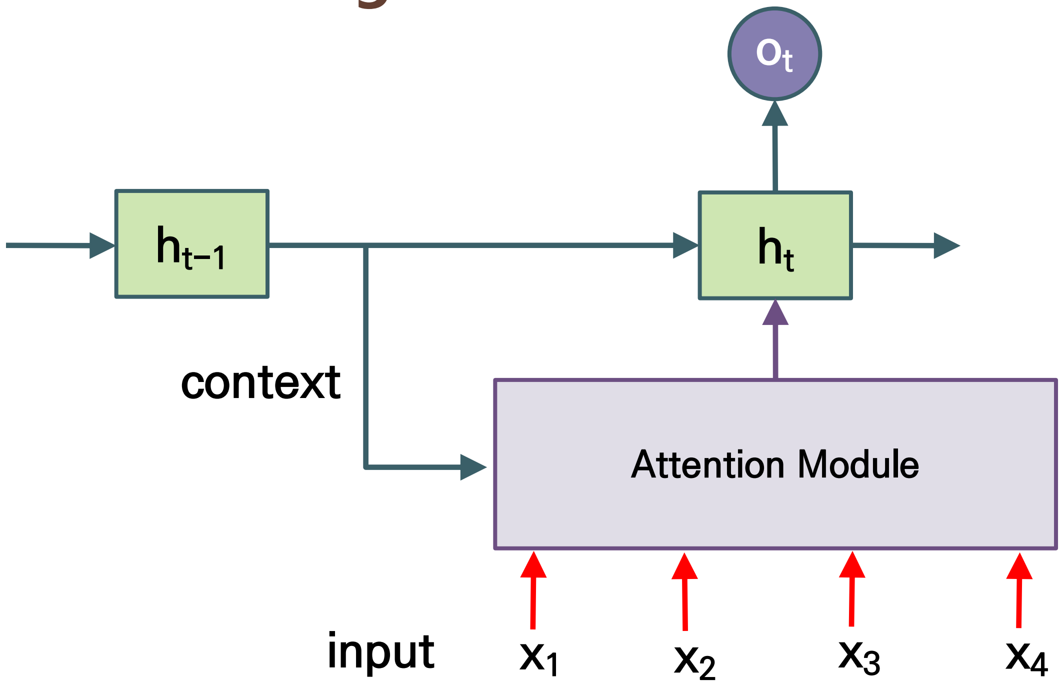
Attention Model

- **Variation**
  - Matching NN can be replaced with the inner products of inputs and context



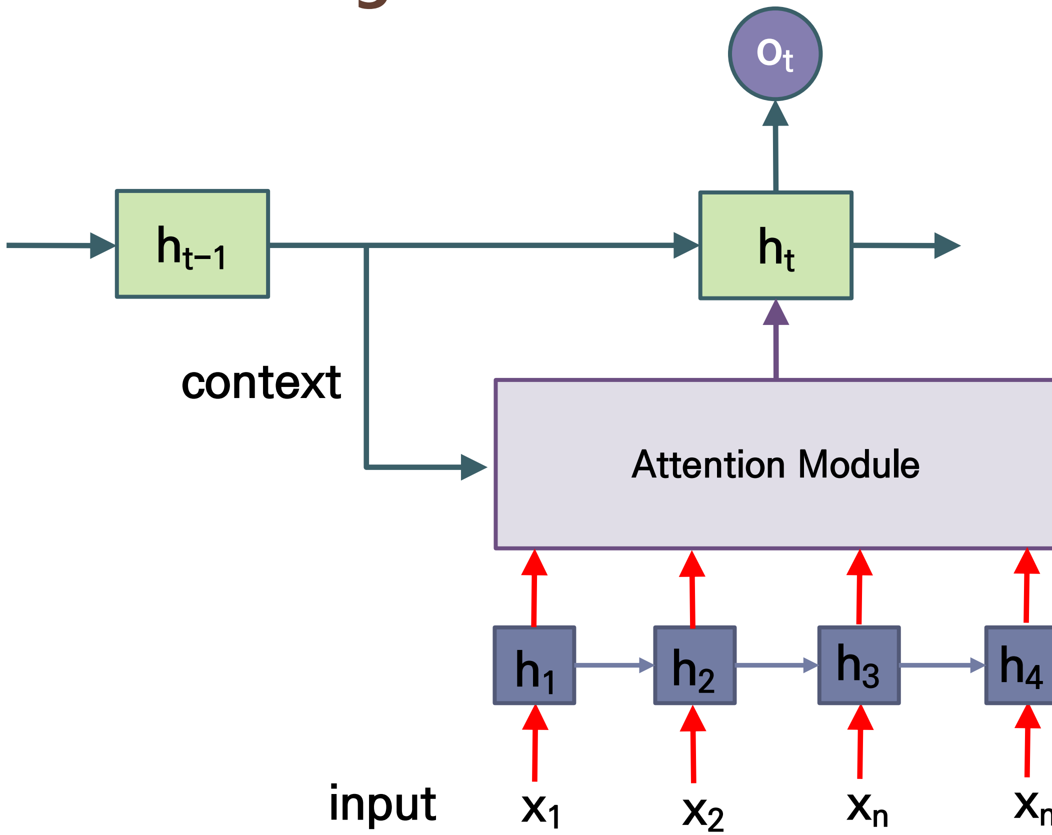
Attention Model

- Input Processing



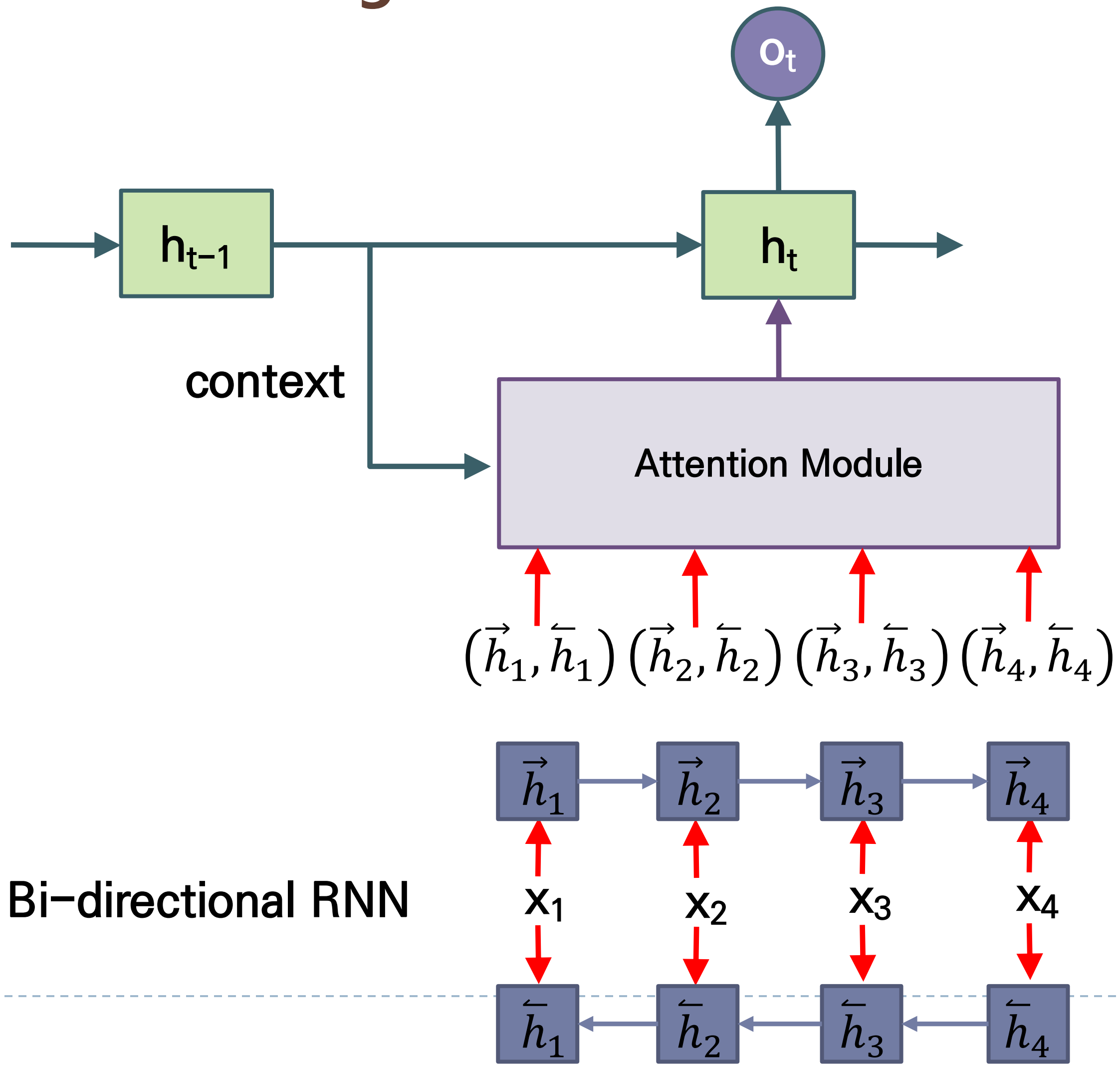
Attention Model

- ## Input Processing



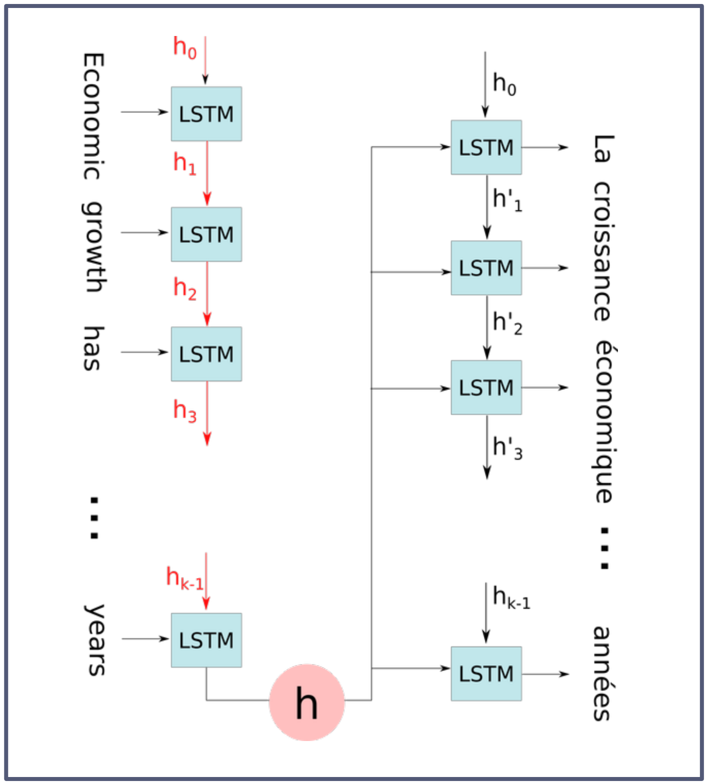
Attention Model

- ## Input Processing

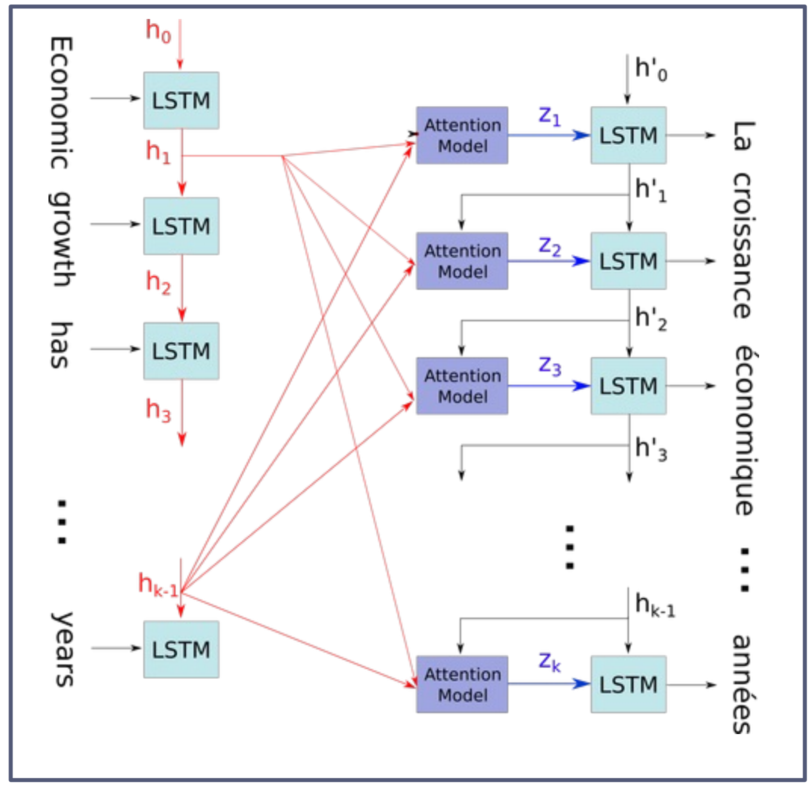


Attention Model

- **Example**



Encoder-decoder model

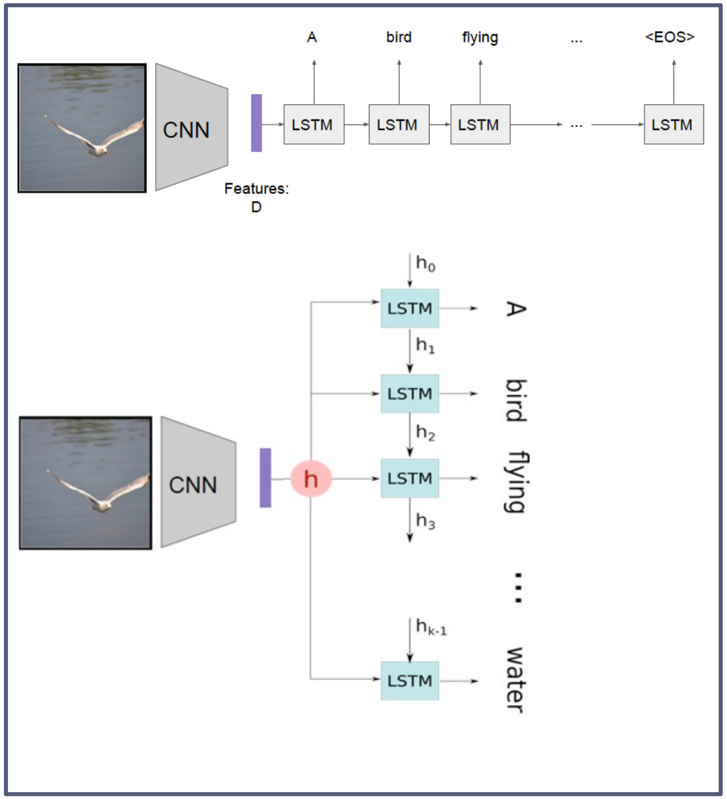


Attention based model

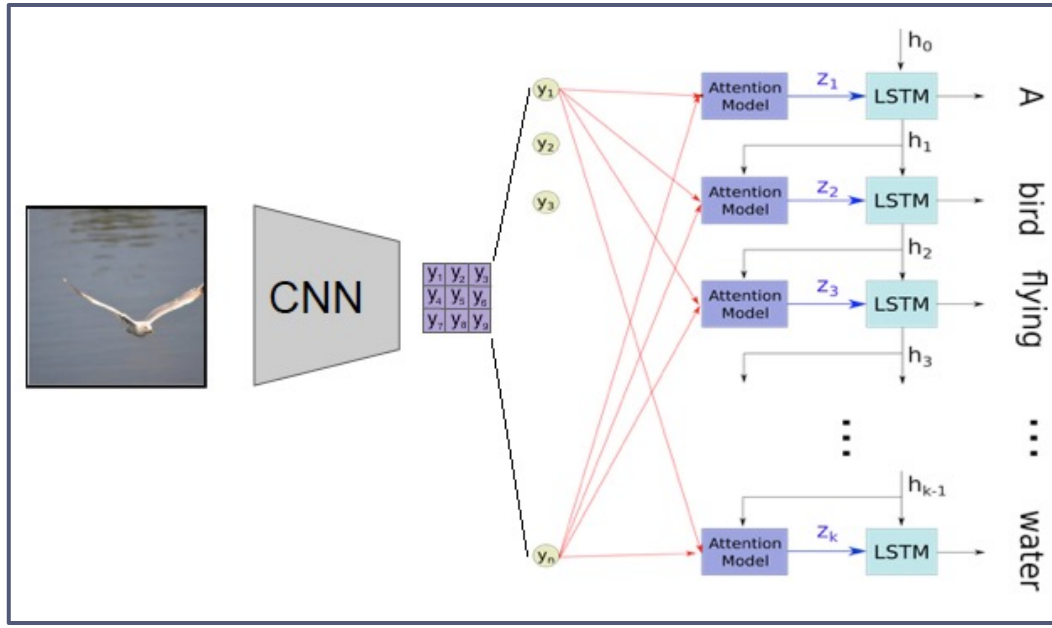
https://blog.heuritech.com/2016/01/20/attention-mechanism/

Attention Model

- **Example**



Encoder-decoder model

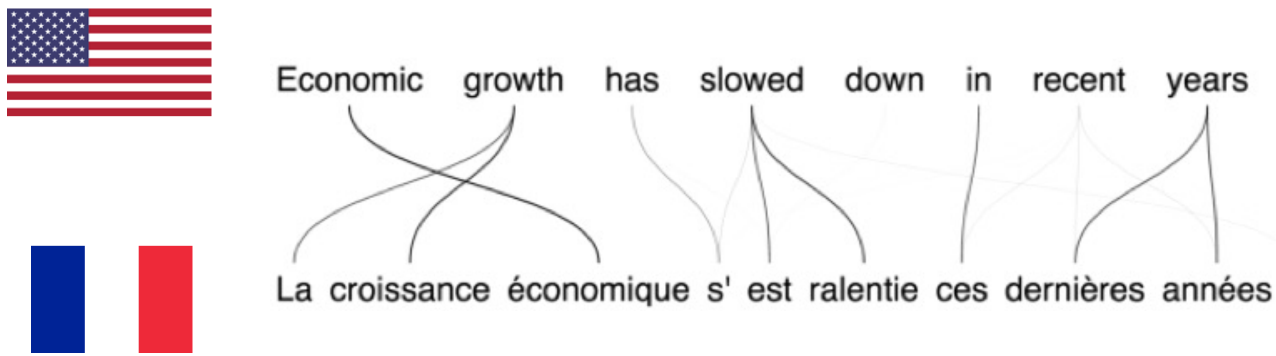


Attention based model

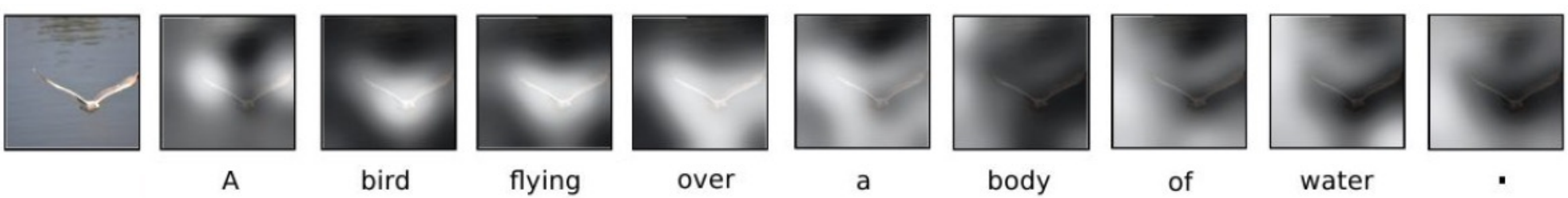
Attention Models, Amaia Salvador, 2017 https://blog.heuritech.com/2016/01/20/attention-mechanism/

Attention Model

- **One more advantage**
  - We can interpret and visualize what the model is doing



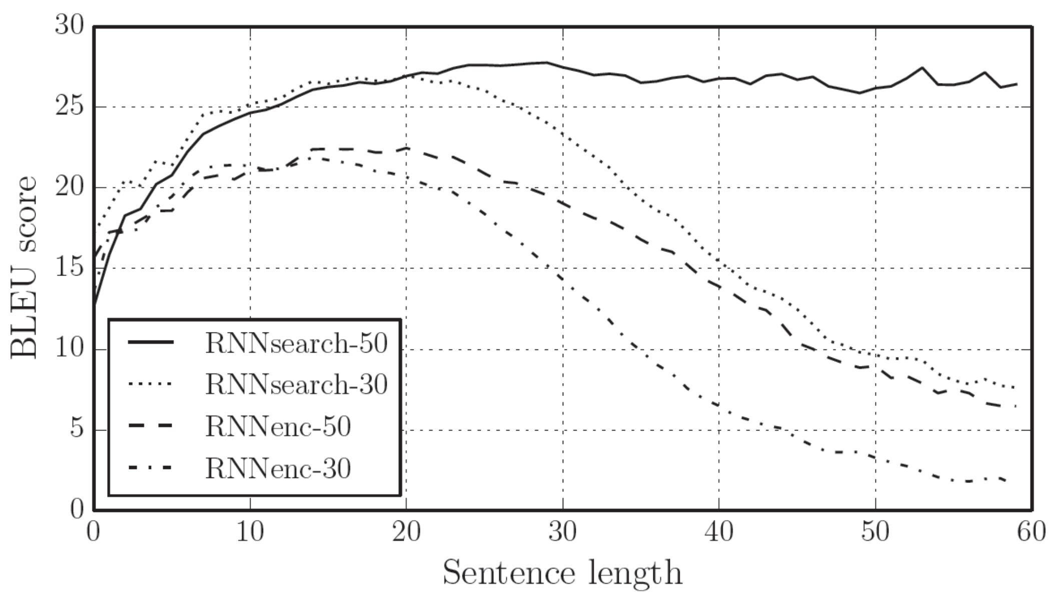
Kyunghyun Cho, "Introduction to Neural Machine Translation with GPUs" (2015)



Xu et al. Show, Attend and Tell: Neural Image Caption Generation with Visual Attention. ICML 2015

Attention is Great!

- **RNNsearch-50 is a neural machine translation model with the attention mechanism trained on all the sentence pairs of length at most 50.**
  - Dzmitry Bahdanau, KyungHyun Cho, Yoshua Bengio, "Neural Machine Translation by Jointly Learning to Align and Translate," ICLR 2015



Attention is Great!

- **Attention significantly improves NMT performance.**
  - It's very useful to allow decoder to focus on certain parts of the source.
- **Attention solves the bottleneck problem.**
  - Attention allows decoder to look directly at source; bypass bottleneck.
- **Attention helps with vanishing gradient problem.**
  - Provides shortcut to faraway states.
- **Attention provides some interpretability.**
  - By inspecting attention distribution, we can see what the decoder was focusing on.
  - We get alignment for free!
  - This is cool because we never explicitly trained an alignment system
  - The network just learned alignment by itself.

Question and Answer