Sequence Modeling

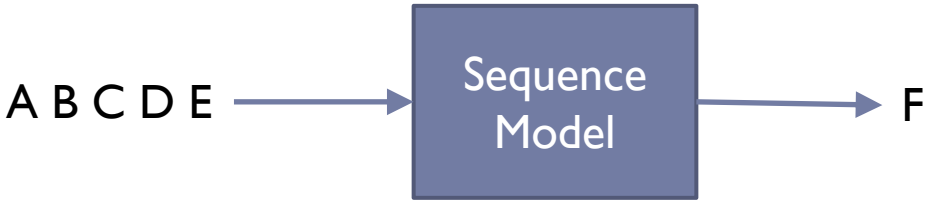
성균관대학교 소프트웨어학과
이 지 형

Sequential Data Modeling

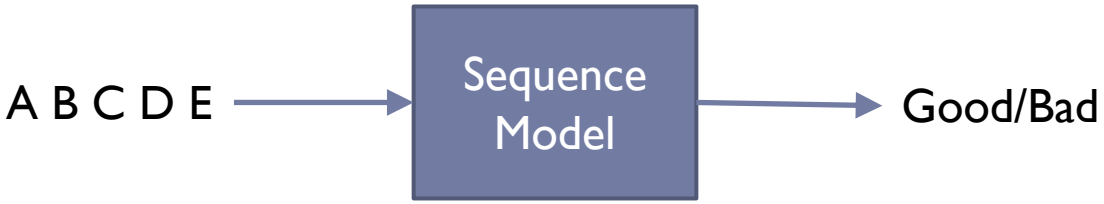
- **Sequential Data**
  - **Most of data are sequential**
  - **Speech, Text, Image, …**
- **Deep Learnings for Sequential Data**
  - **Convolutional Neural Networks (CNN)**
    - Try to find local features from a sequence
  - **Recurrent Neural Networks: LSTM, GRU**
    - Try to capture the feature of the past

Sequential Data Modeling

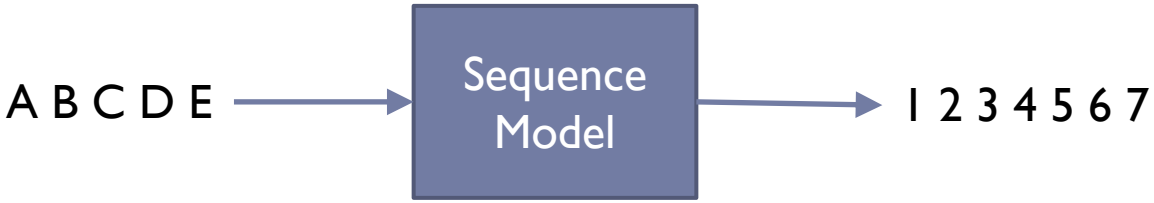
- Three Types of Problems
  - Next Step Prediction



  - Classification



  - Sequence Generation



Sequential Data Modeling

- **Sequence Generation**
  - **Machine Translation**

This is a very good wine → C'est un très bon vin

  - **Speech Recognition**

 → This is a very good wine

  - **Image Caption Generation**

 → A bird is flying

Types of Processes

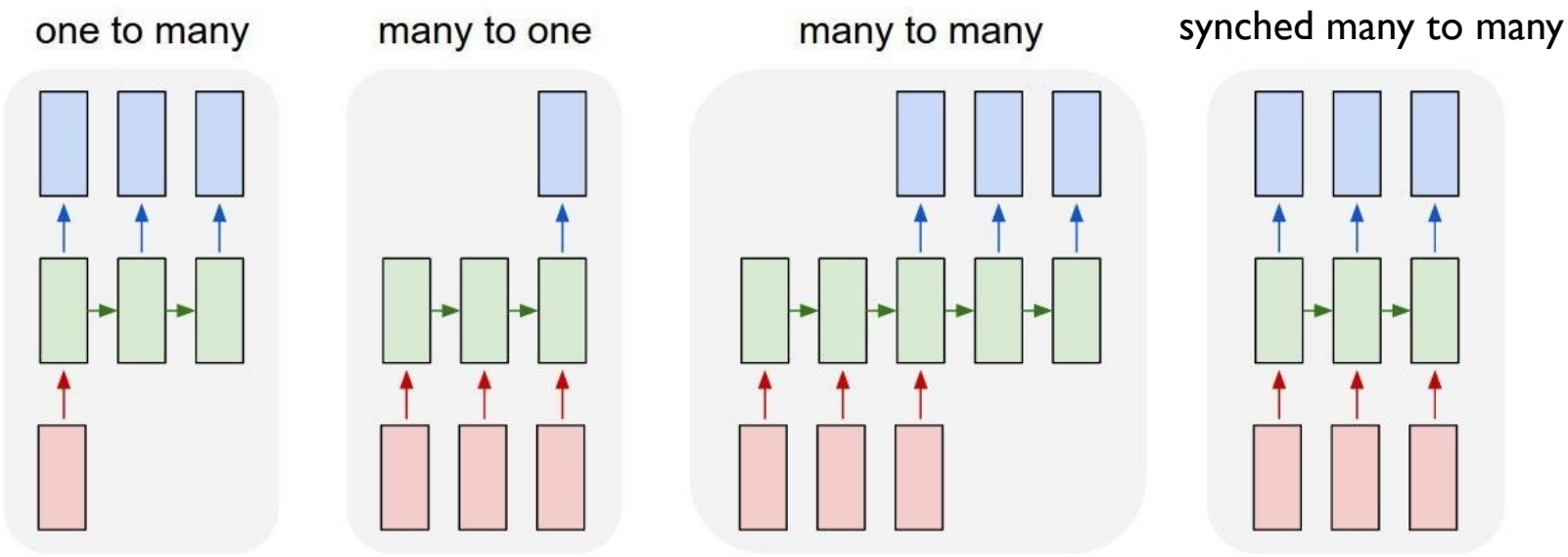
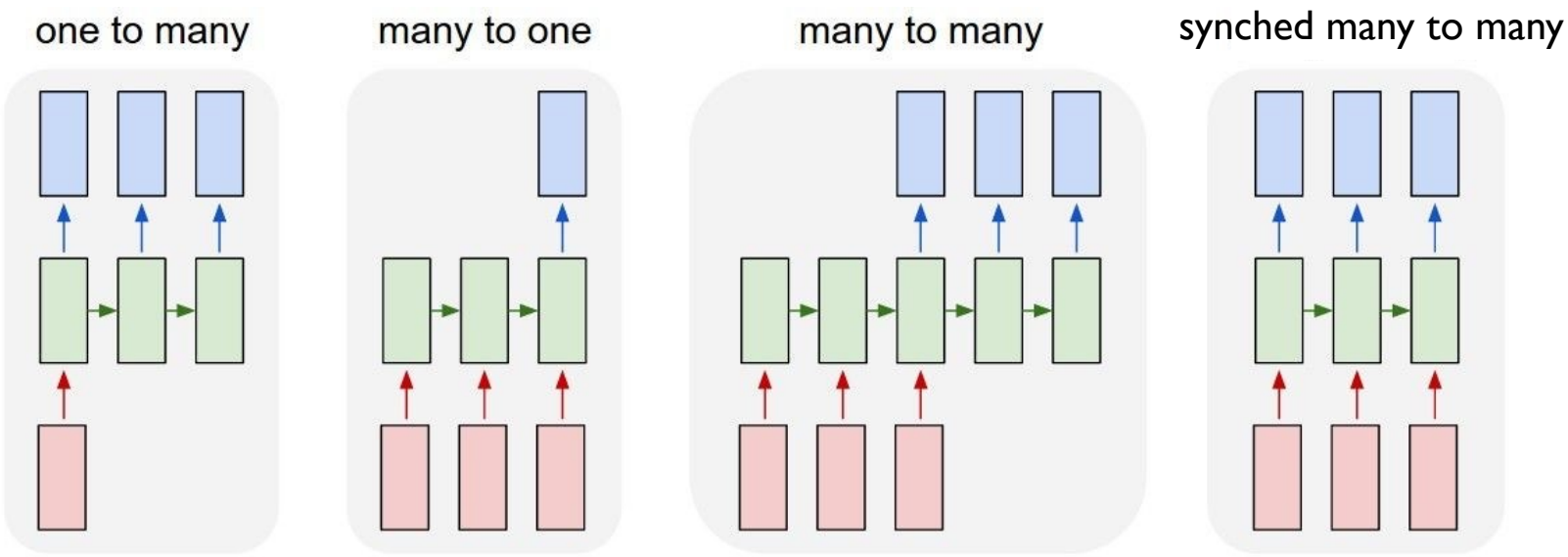


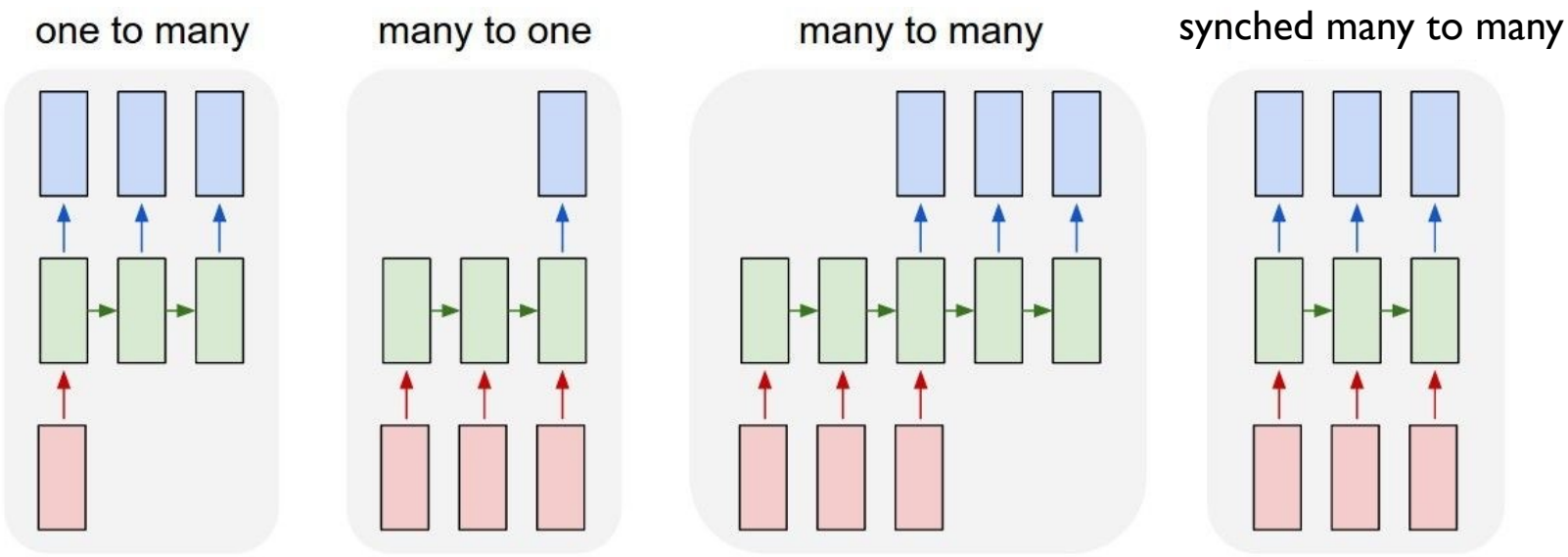
Image Captioning
Image → sequence of words

Types of Processes

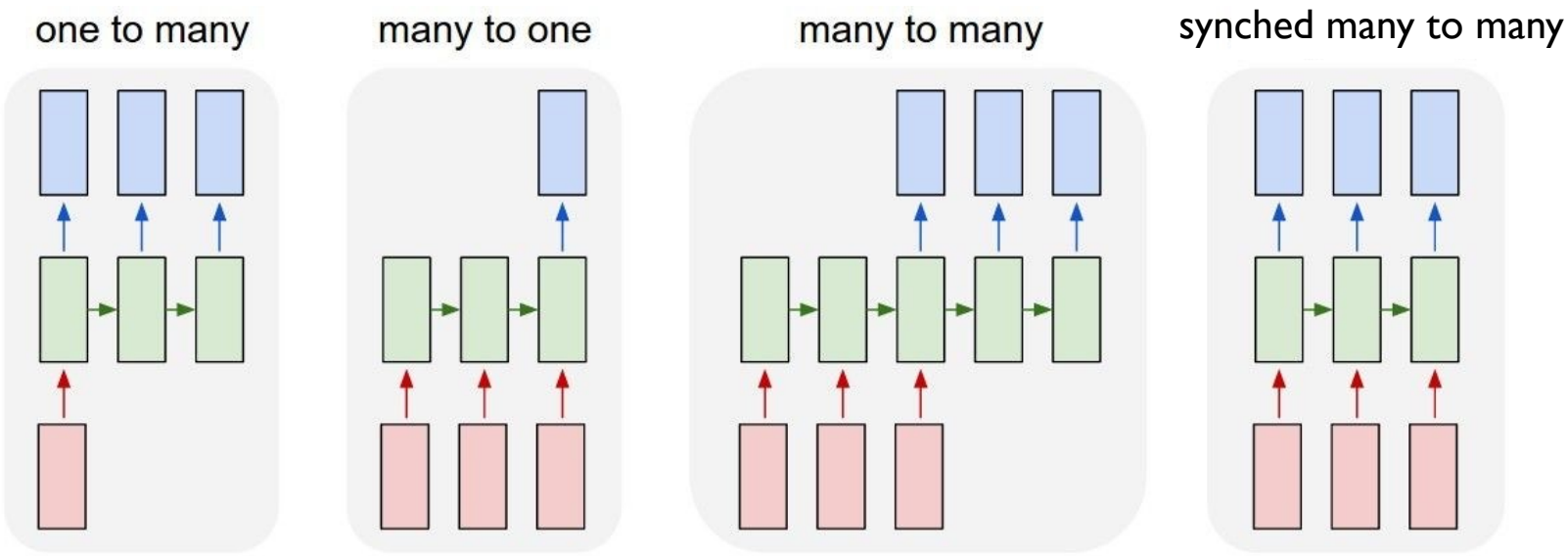


Sentiment Classification
sentence → sentiment

Types of Processes



Types of Processes

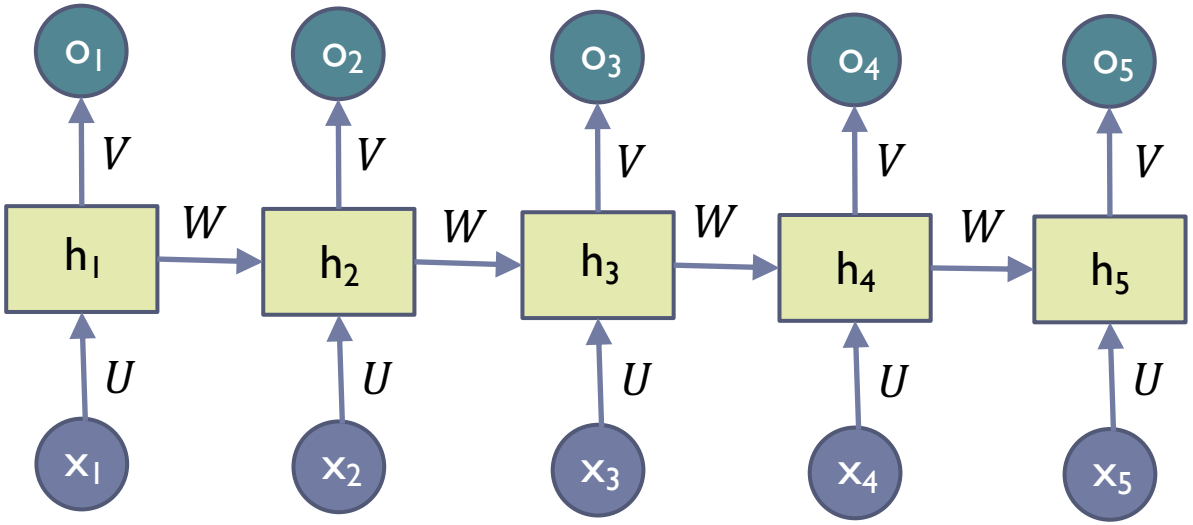


Stock Price Prediction,
Prediction of next word

Synced Many to Many

- **Training**

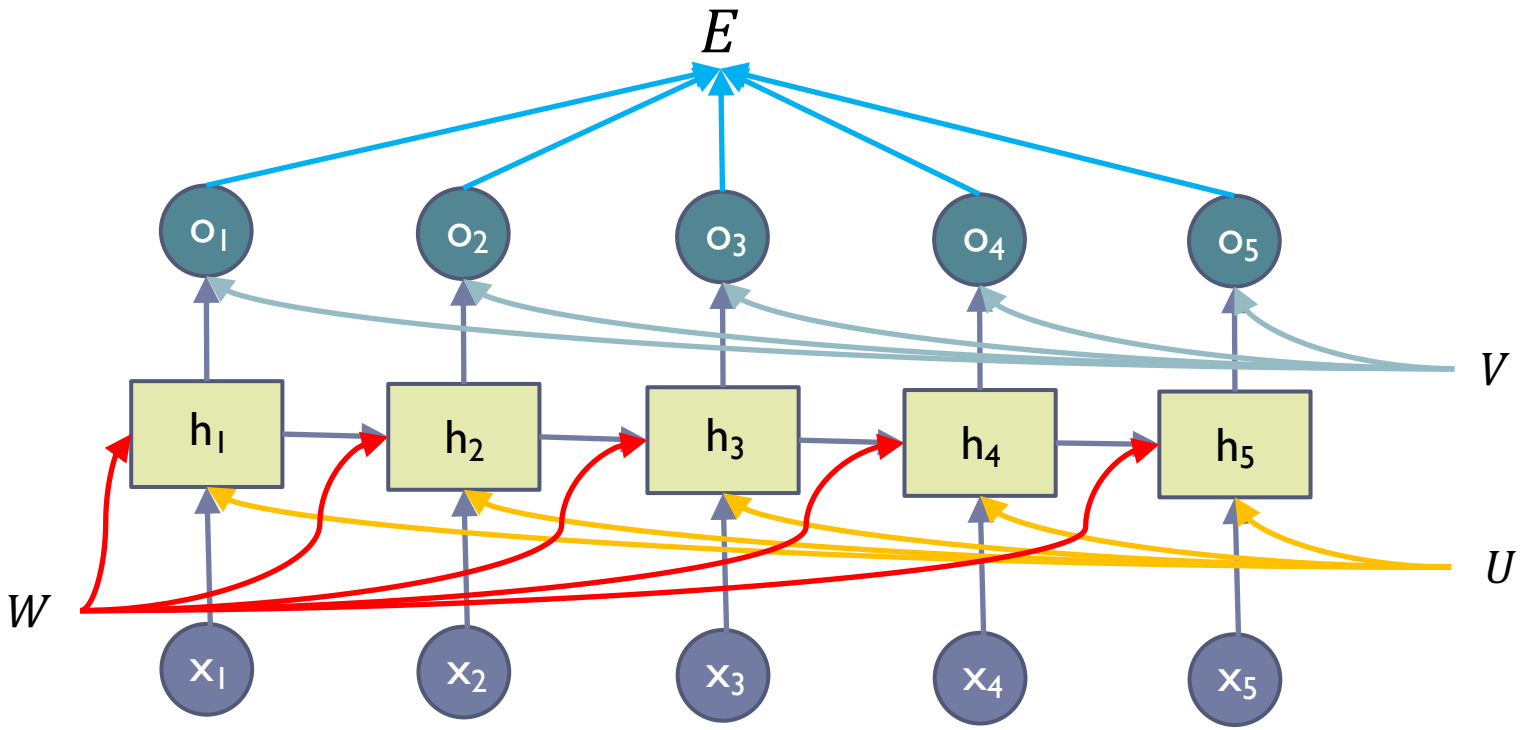
$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$



$$E = \sum_{i=1}^{n} (y_i - o_i)^2$$

Synced Many to Many

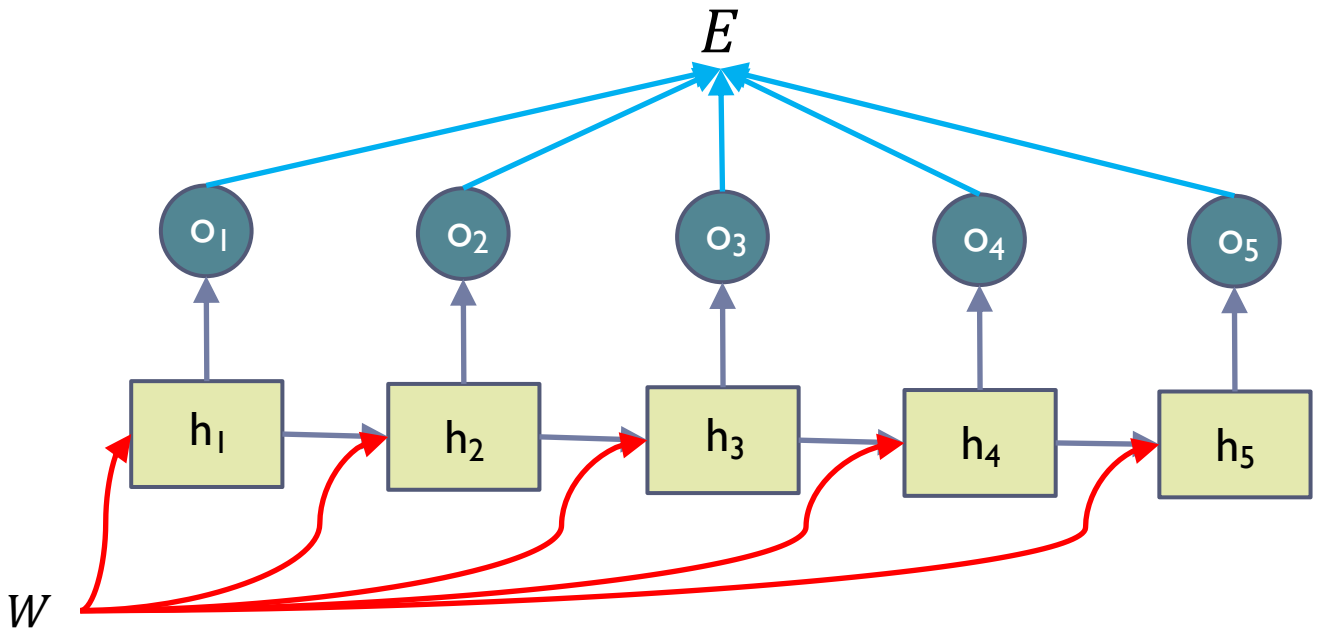
- Training



$$\frac{\partial E}{\partial w} = ?$$

Synced Many to Many

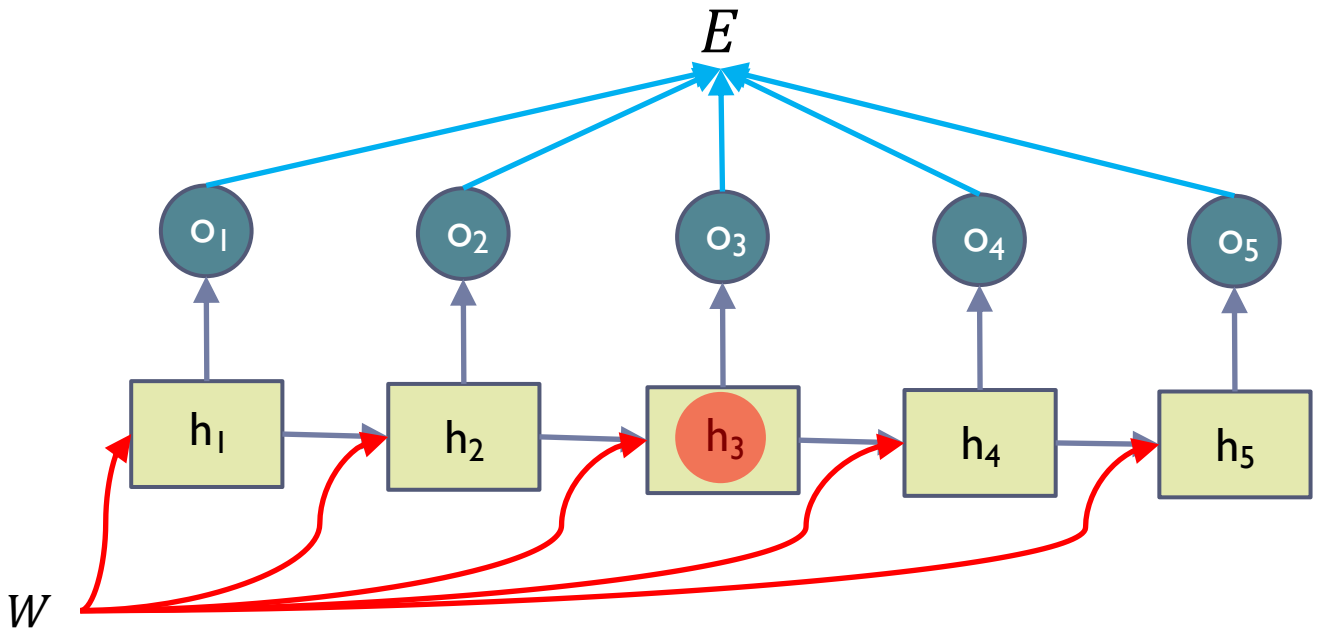
- Training



$$\frac{\partial E}{\partial w} = \sum_{i=1}^{n} \frac{\partial E}{\partial h_i} \frac{\partial h_i}{\partial w}$$

Synced Many to Many

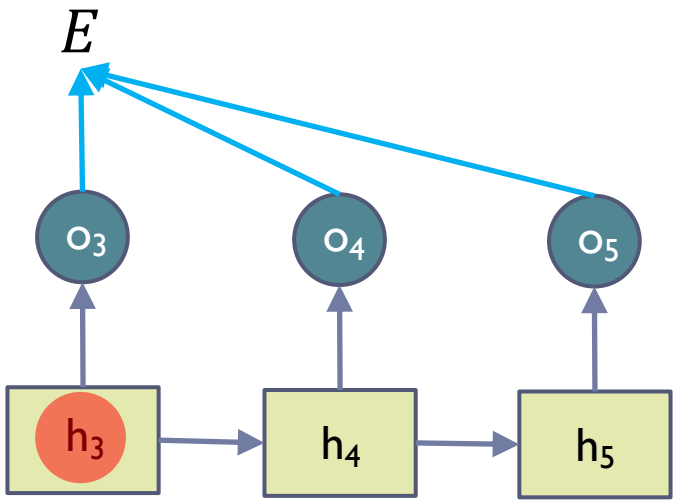
- Training



$$\frac{\partial E}{\partial w} = \sum_{i=1}^{n} \frac{\partial E}{\partial h_i} \frac{\partial h_i}{\partial w}$$

Synced Many to Many

- Training



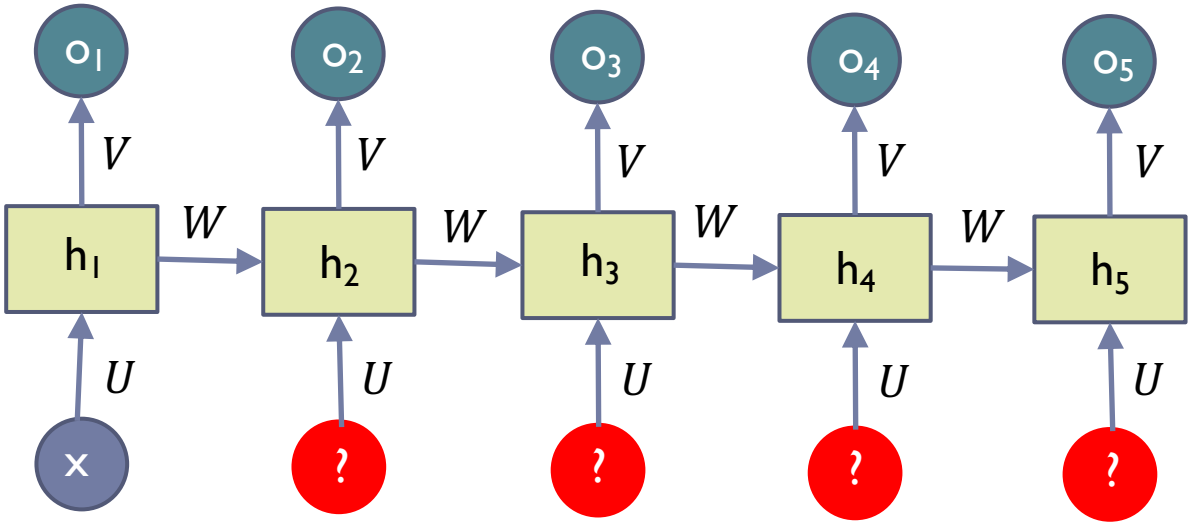
$$\frac{\partial E}{\partial h_i} = \frac{\partial E}{\partial o_i}\frac{\partial o_i}{\partial h_i} + \frac{\partial E}{\partial h_{i+1}}\frac{\partial h_{i+1}}{\partial h_i}$$

$$\frac{\partial E}{\partial w} = \sum_{i=1}^{n} \frac{\partial E}{\partial h_i}\frac{\partial h_i}{\partial w}$$

One to Many

- **Training**

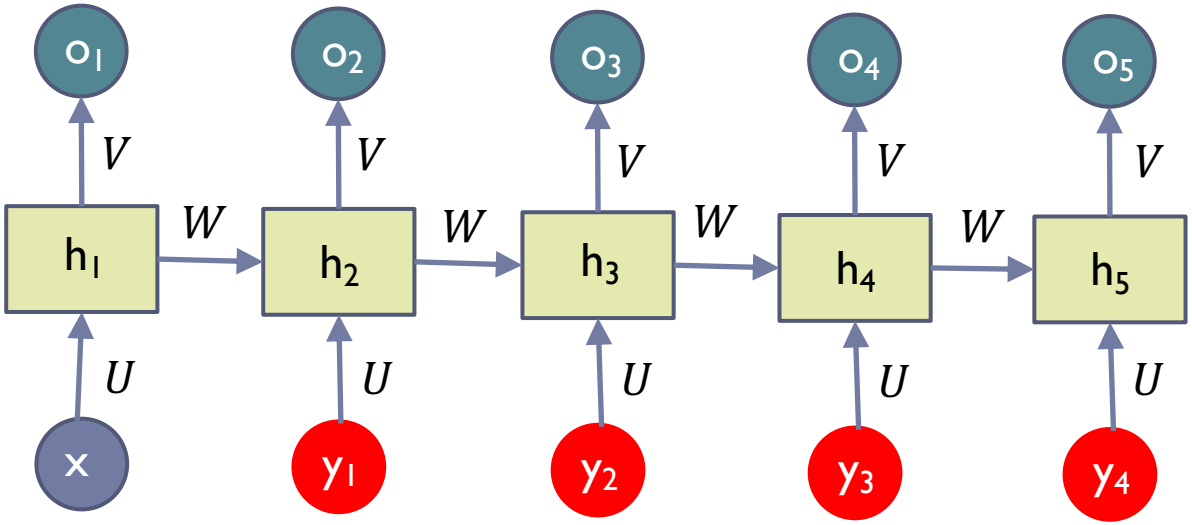
$$x \rightarrow y_1 y_2 y_3 \cdots y_n$$



One to Many

- **Training**

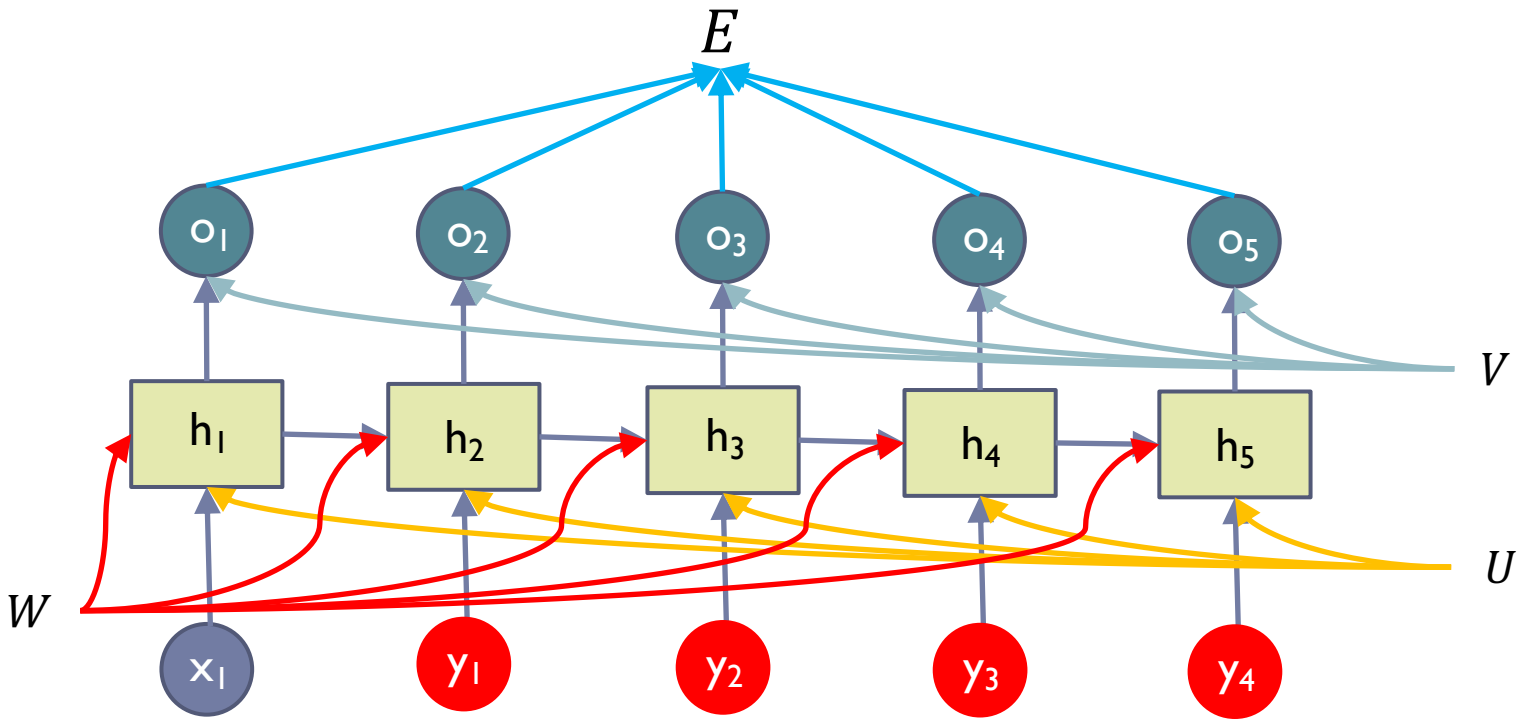
$$x \rightarrow y_1 y_2 y_3 \cdots y_n$$



$$E = \sum_{i=1}^{n} (y_i - o_i)^2$$

One to Many

- Training

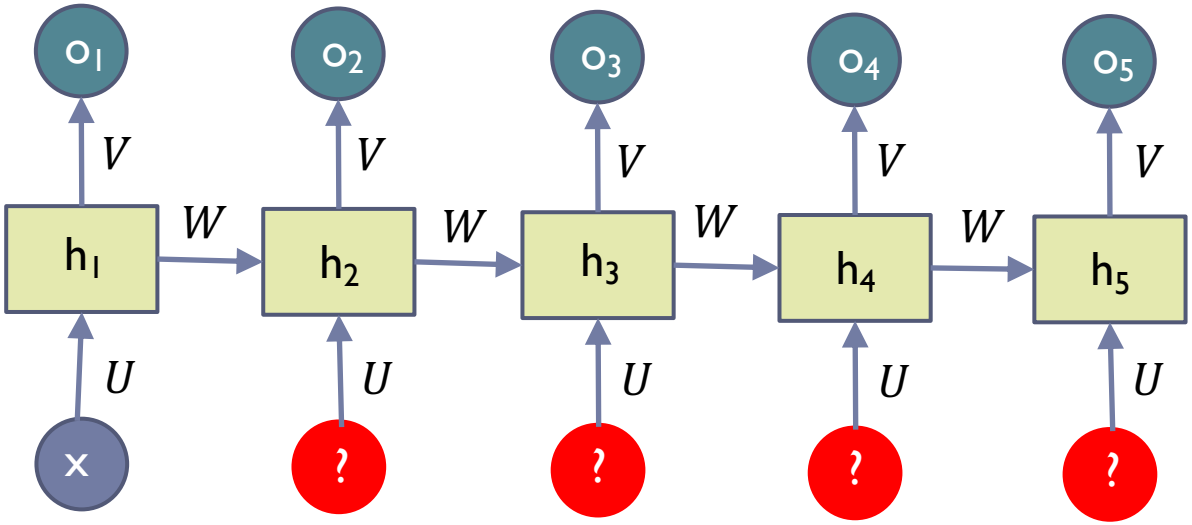


$$\frac{\partial E}{\partial w} = \sum_{i=1}^{n} \frac{\partial E}{\partial h_i} \frac{\partial h_i}{\partial w} \qquad \frac{\partial E}{\partial h_i} = \frac{\partial E}{\partial o_i} \frac{\partial o_i}{\partial h_i} + \frac{\partial E}{\partial h_{i+1}} \frac{\partial h_{i+1}}{\partial h_i}$$

One to Many

- Testing

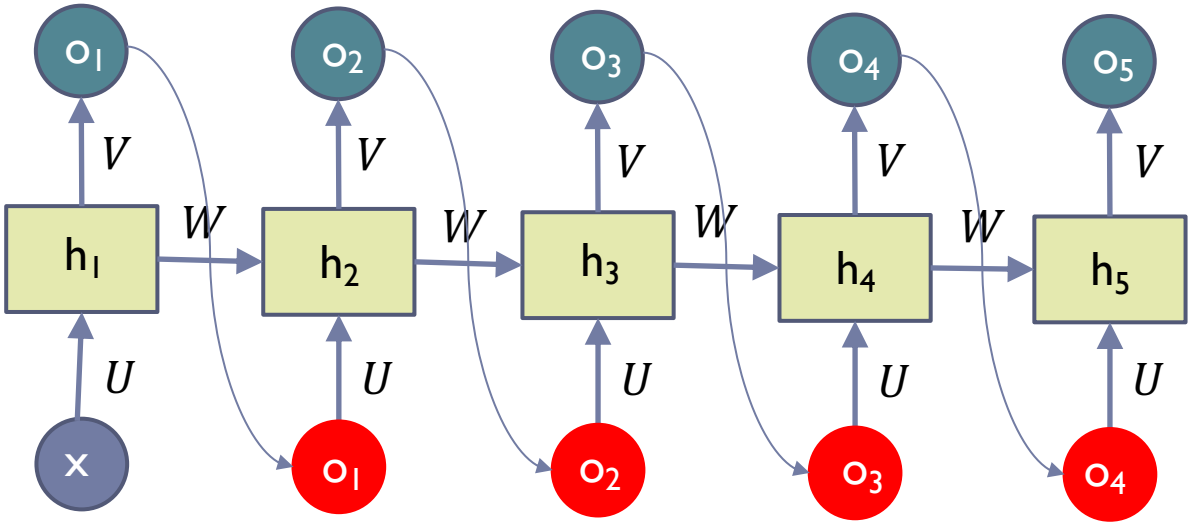
$$x \rightarrow ? ? ? ? ? ?$$



One to Many

- Testing

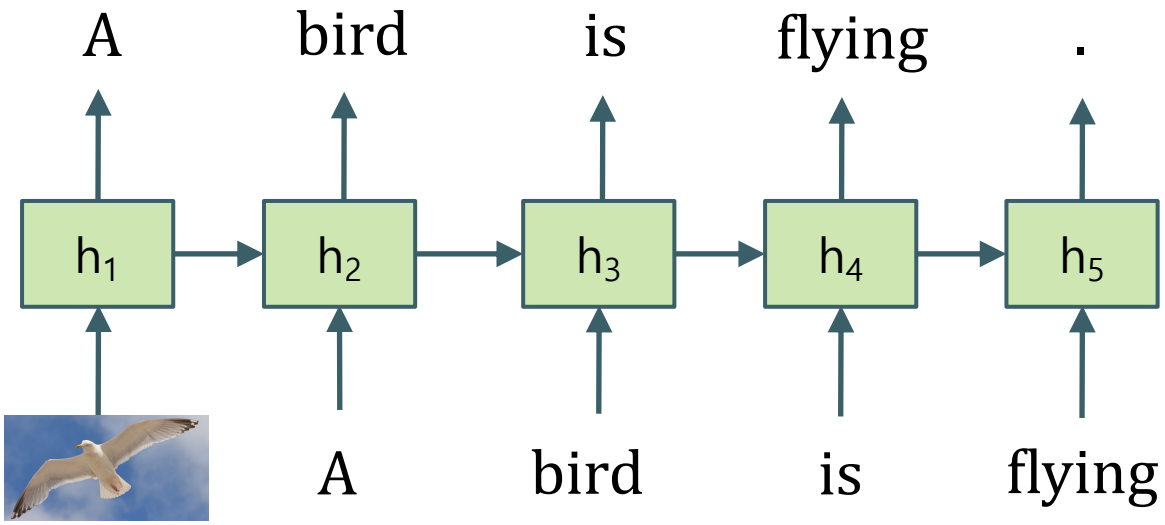
$$x \rightarrow ? ? ? ? ? ?$$



One to Many

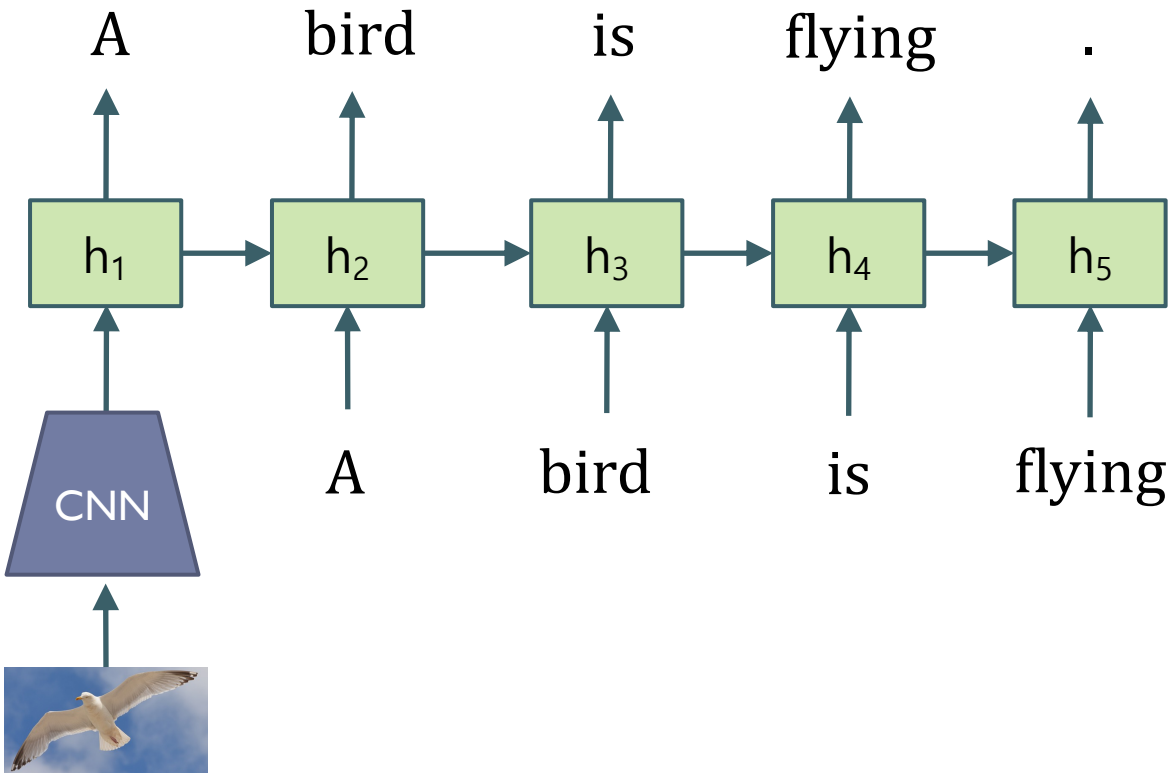
- **How to Handle Images and Texts**

→ A bird is flying.



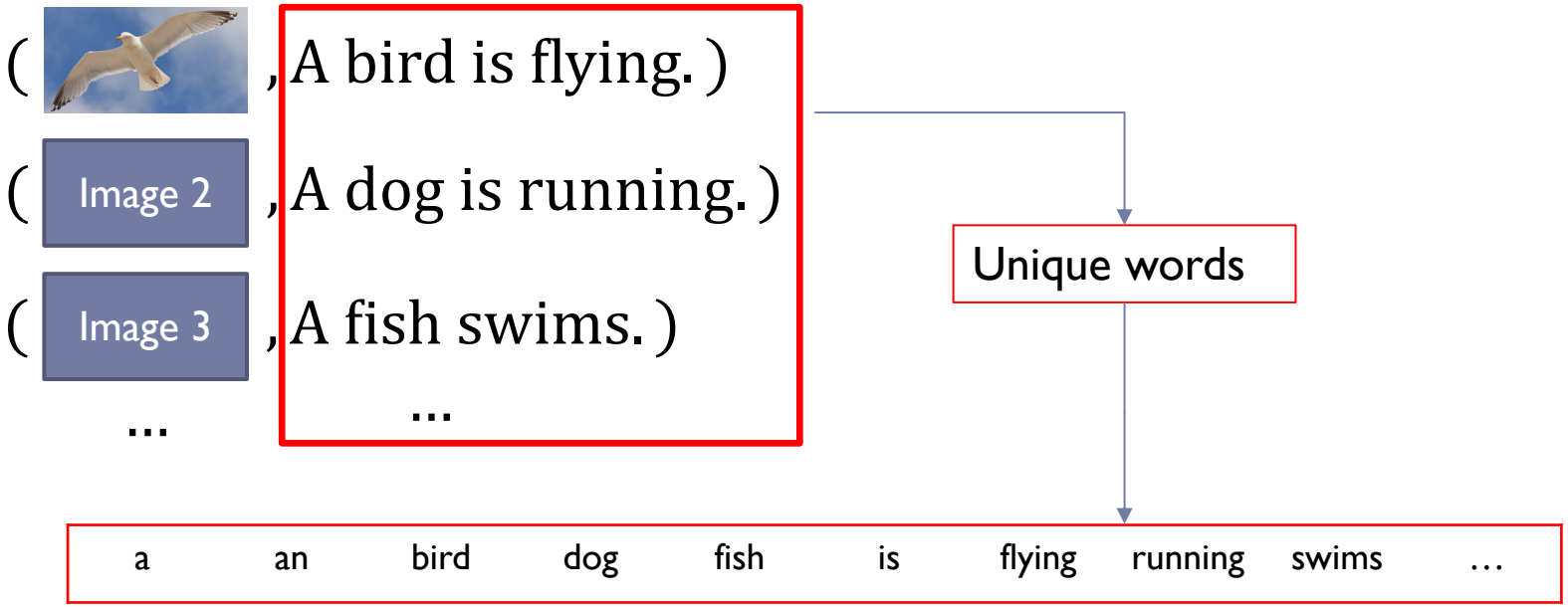
One to Many

- How to Handle Images and Texts



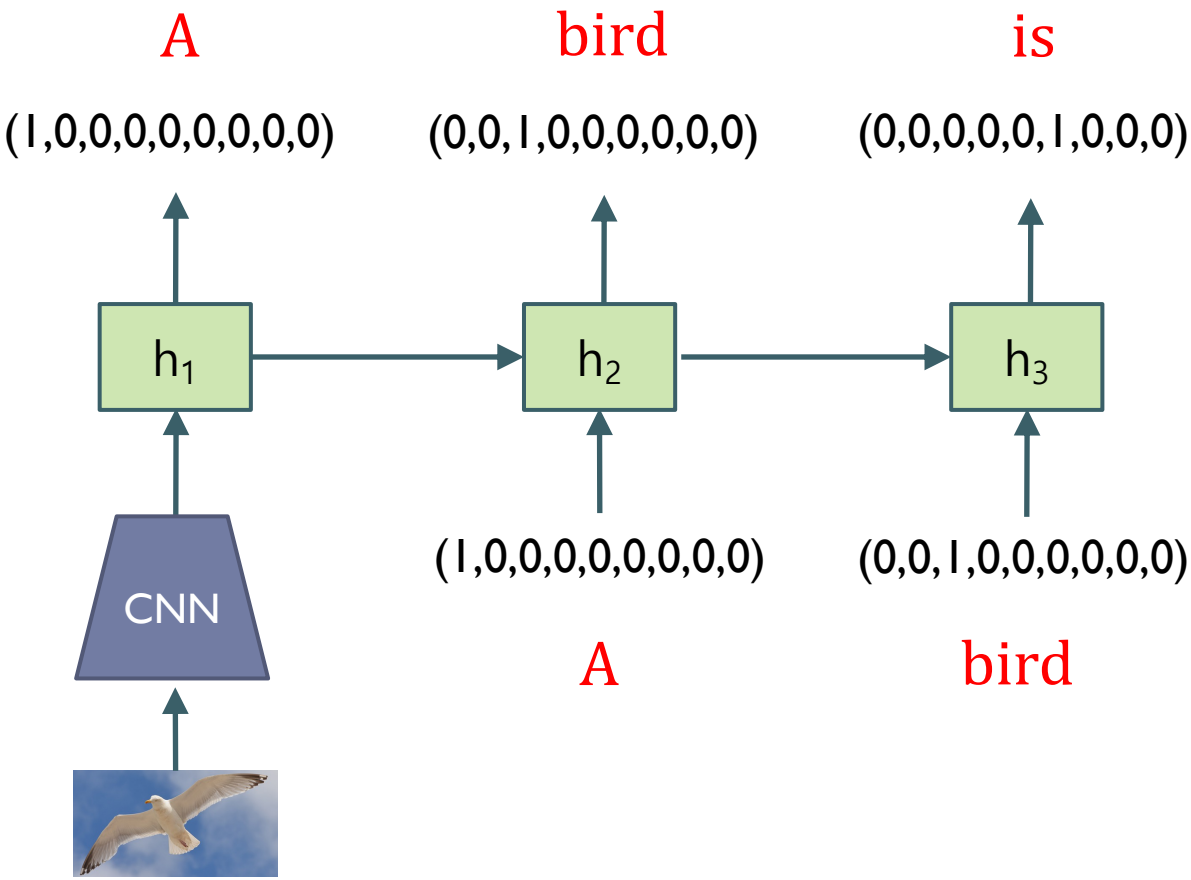
One to Many

- How to Handle Images and Texts



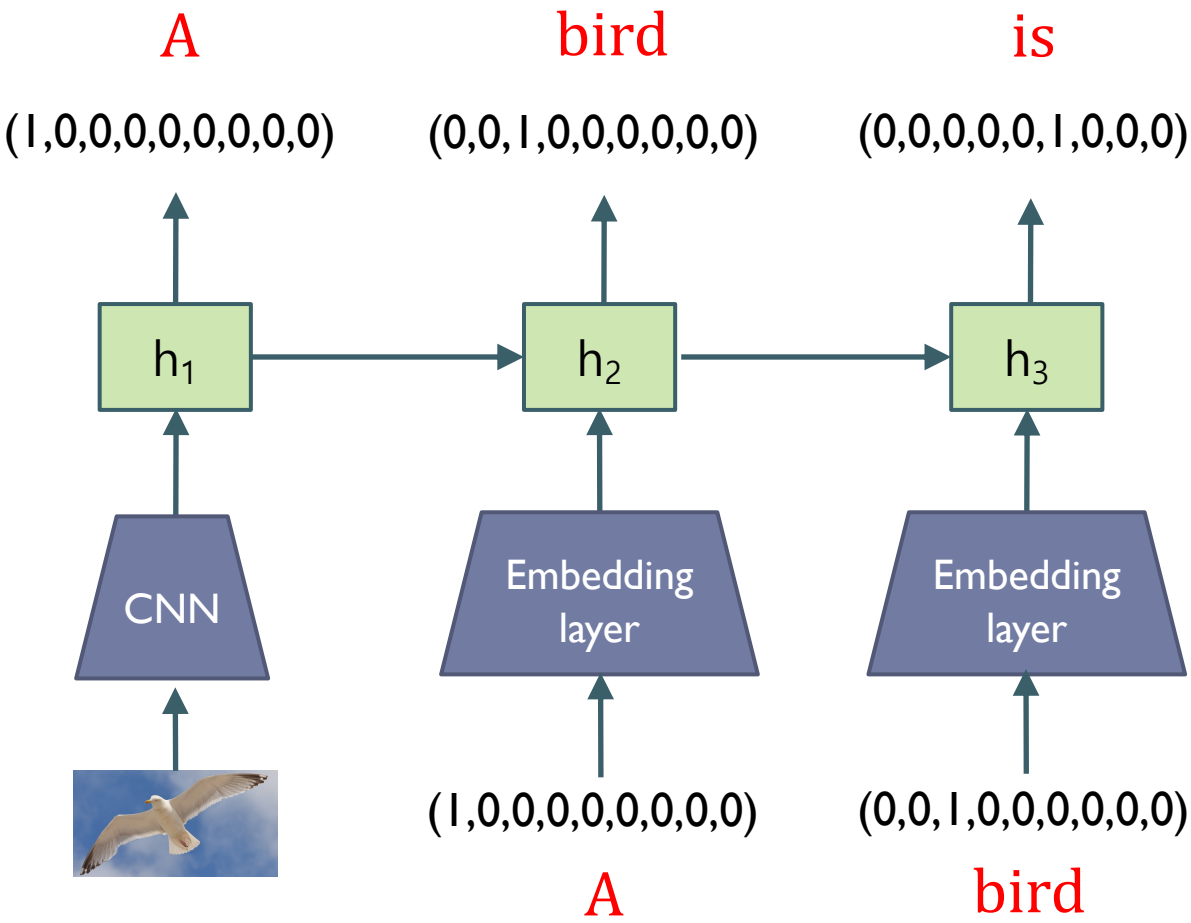
One to Many

- How to Handle Images and Texts



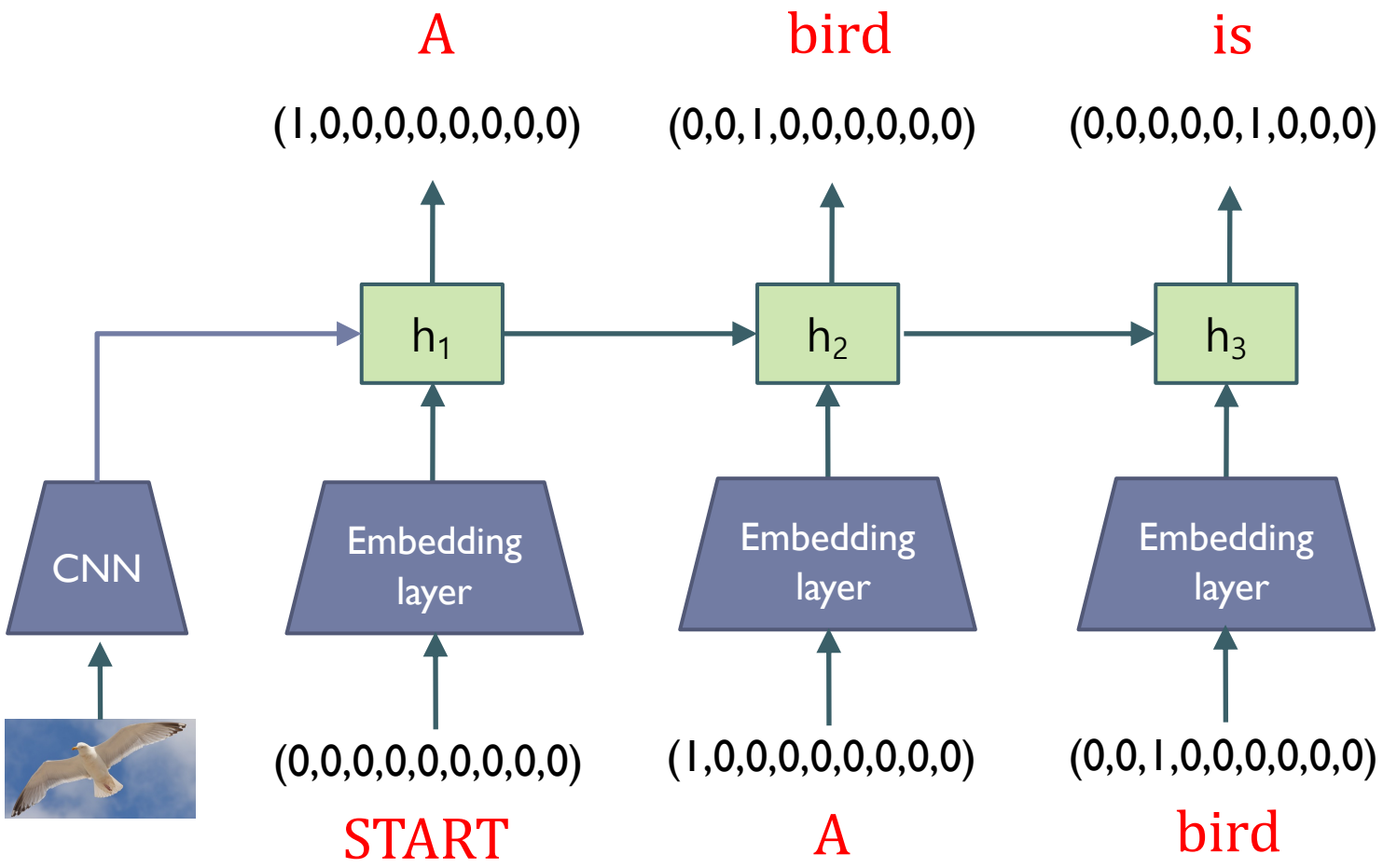
One to Many

- How to Handle Images and Texts



One to Many

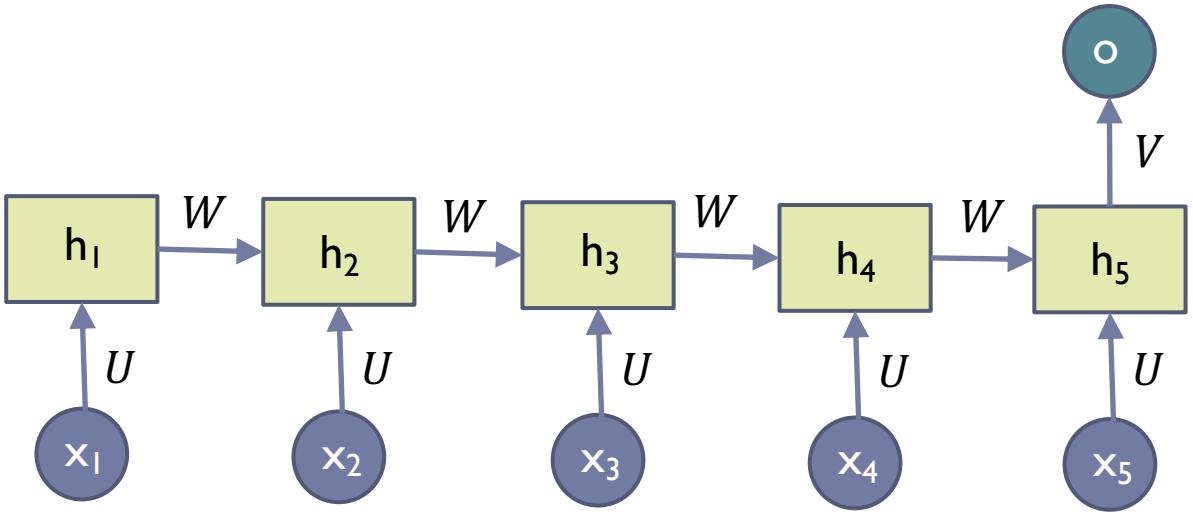
- How to Handle Images and Texts



Many to One

- **Training**

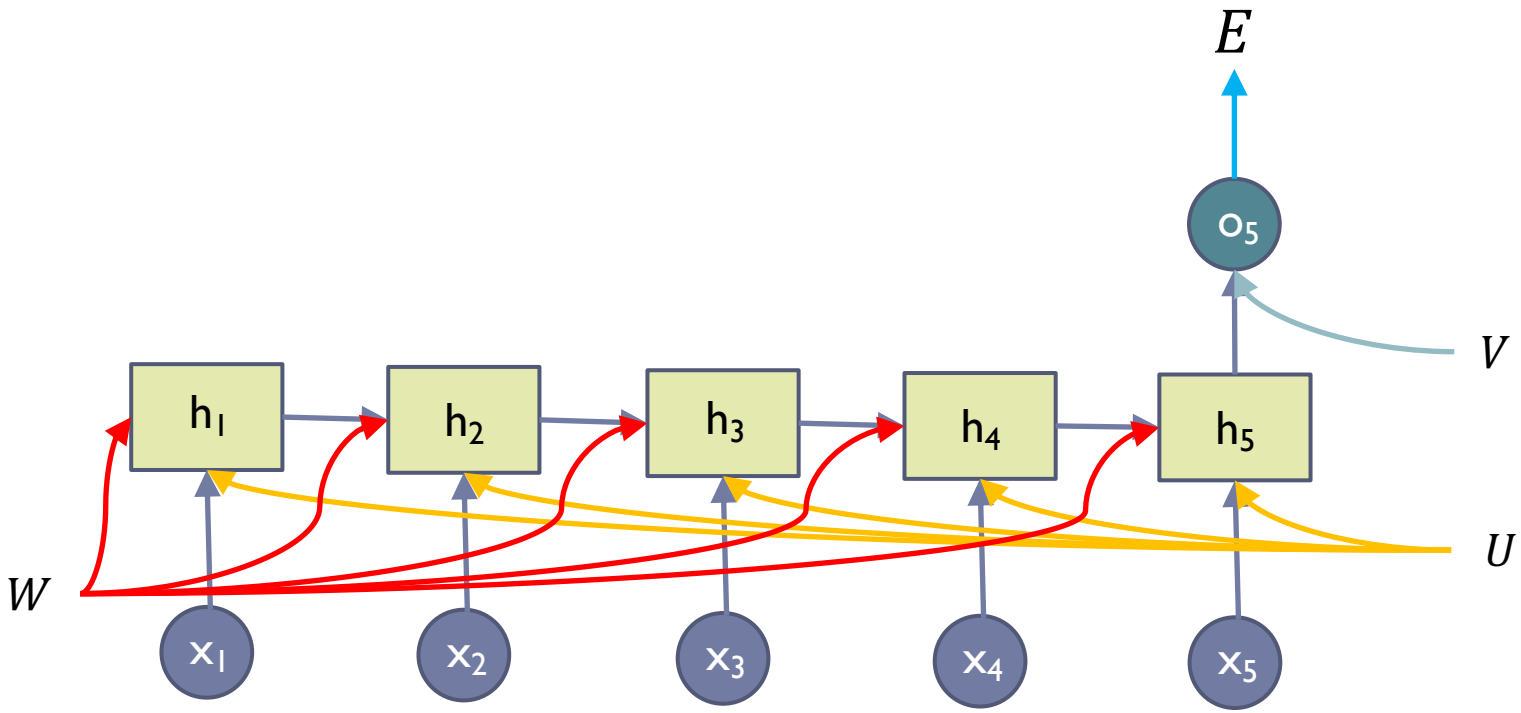
$$x_1 x_2 x_3 \cdots x_n \rightarrow y$$



$$E = (y - o)^2$$

Many to One

- Training

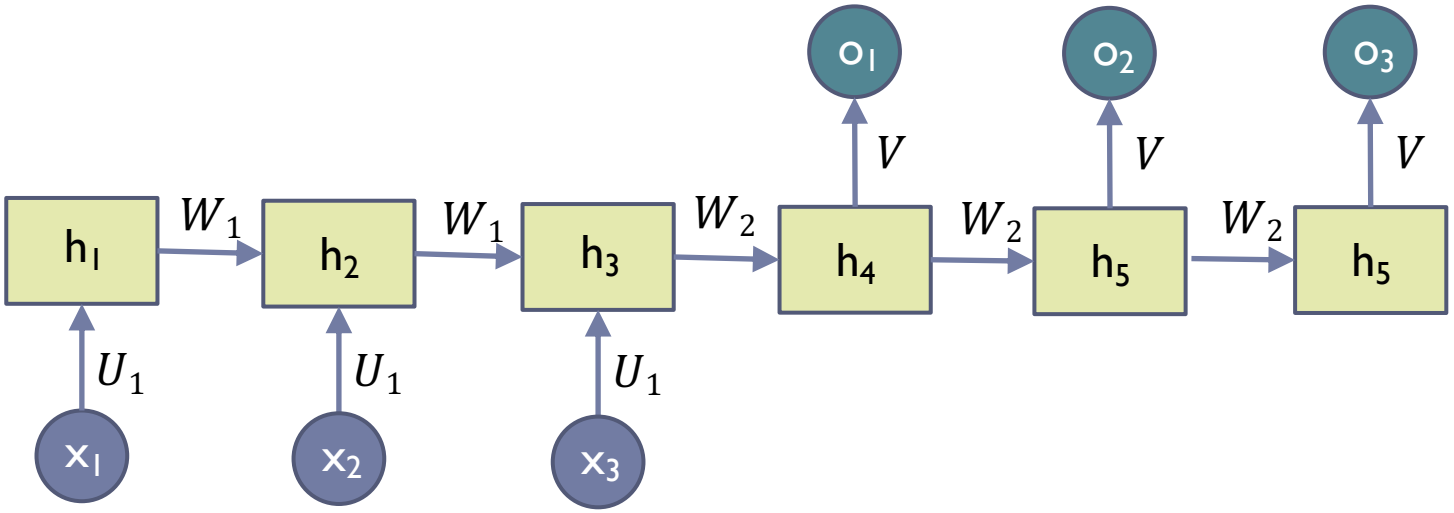


$$\frac{\partial E}{\partial w} = \sum_{i=1}^{n} \frac{\partial E}{\partial h_i} \frac{\partial h_i}{\partial w} \qquad \frac{\partial E}{\partial h_i} = \frac{\partial E}{\partial h_{i+1}} \frac{\partial h_{i+1}}{\partial h_i}$$

Many to Many

- **Training**

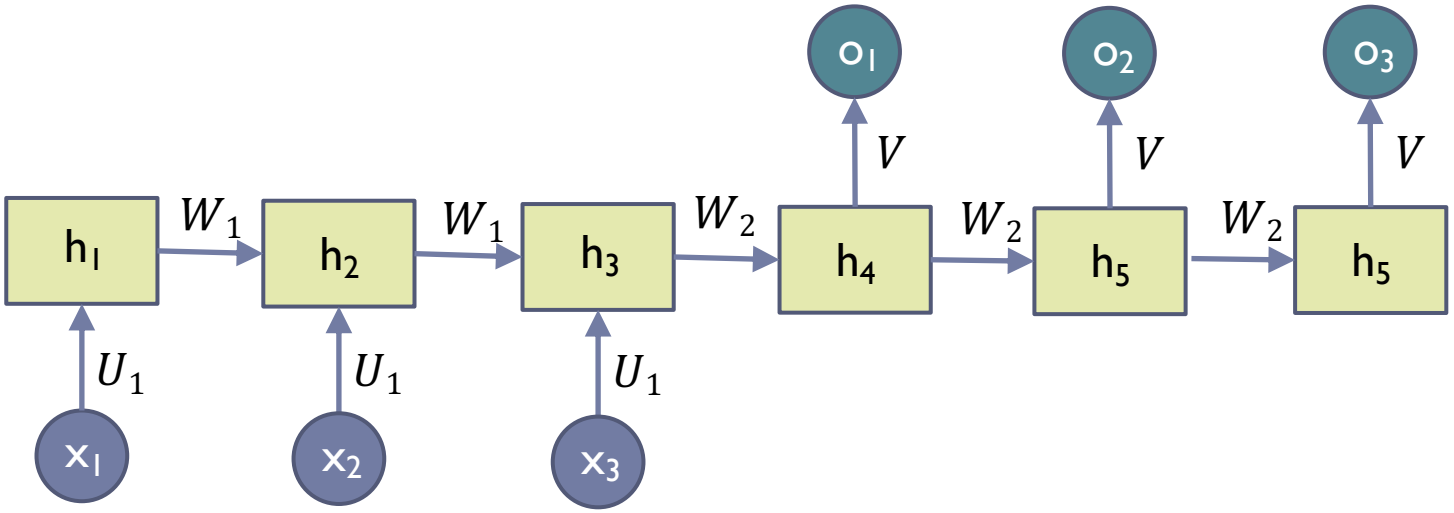
$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$



Many to Many

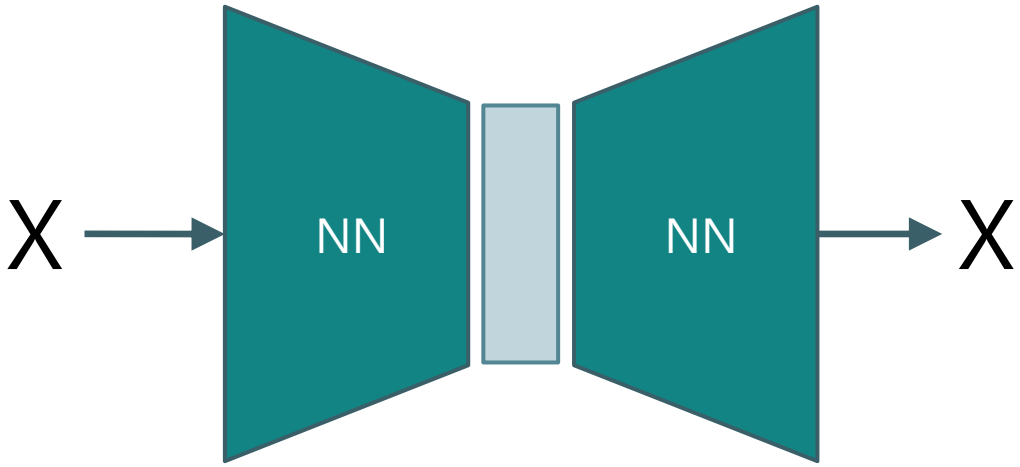
- **Training**

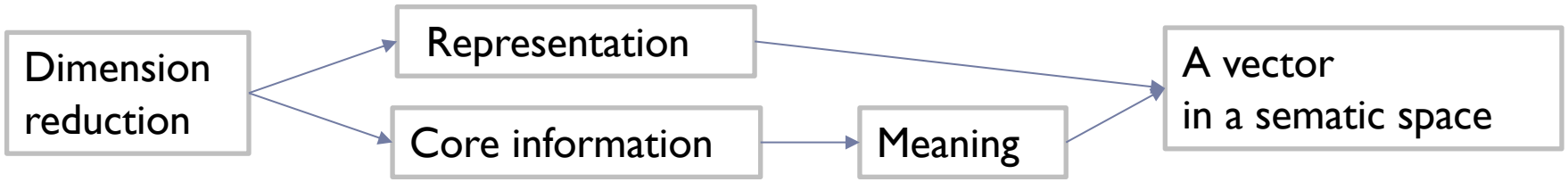
$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$



Many to Many

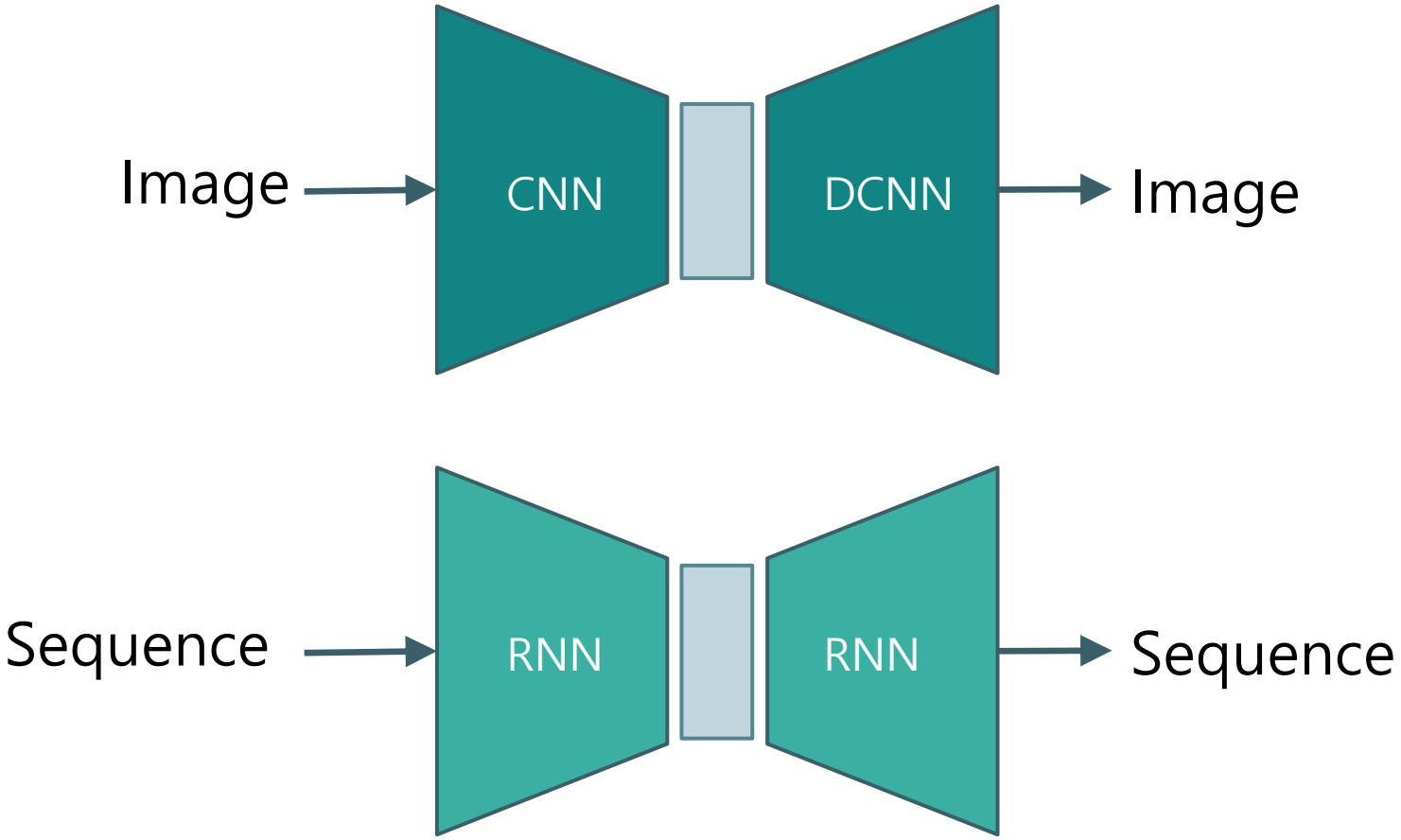
- **AutoEncoder**





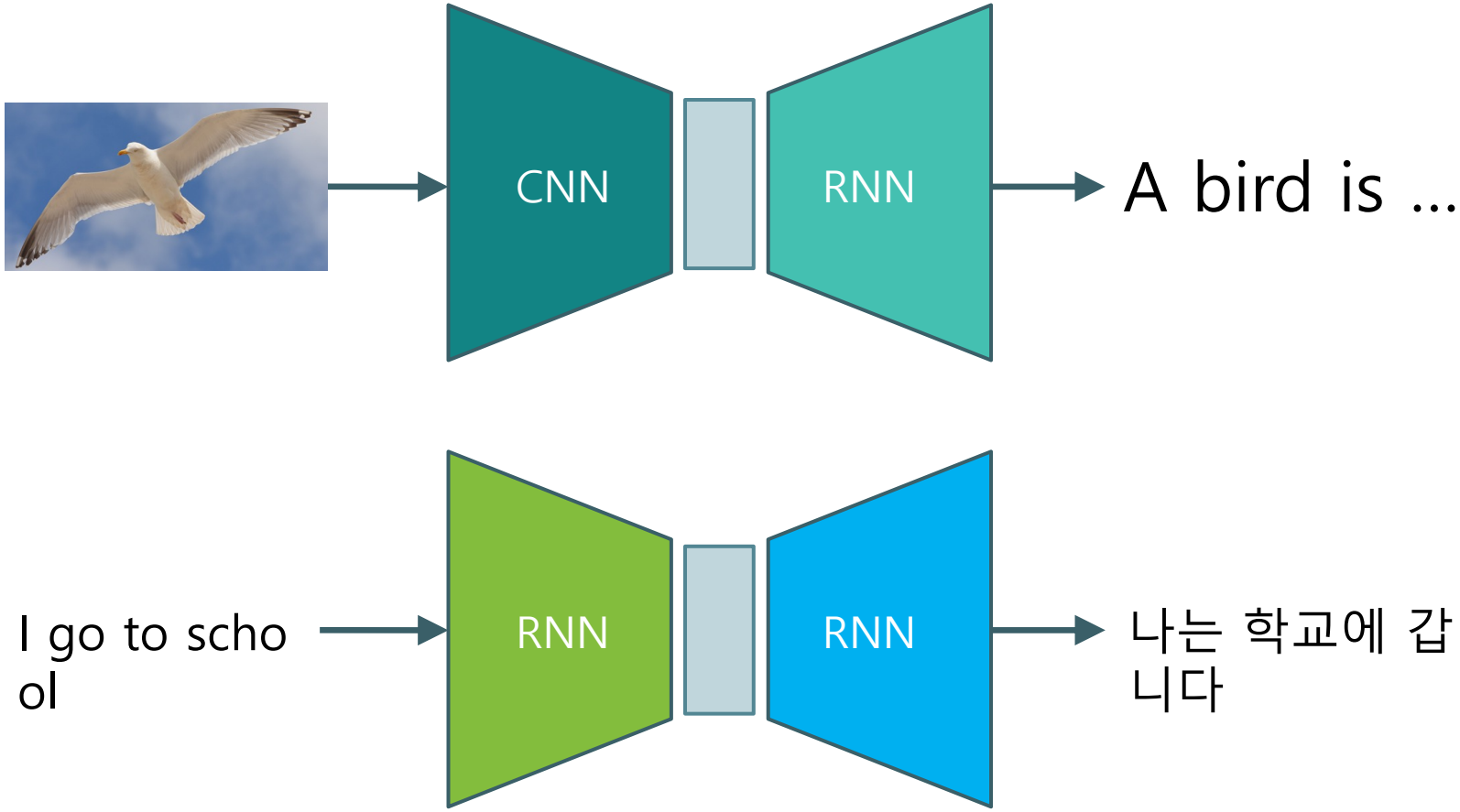
Many to Many

- **AutoEncoder**



Many to Many

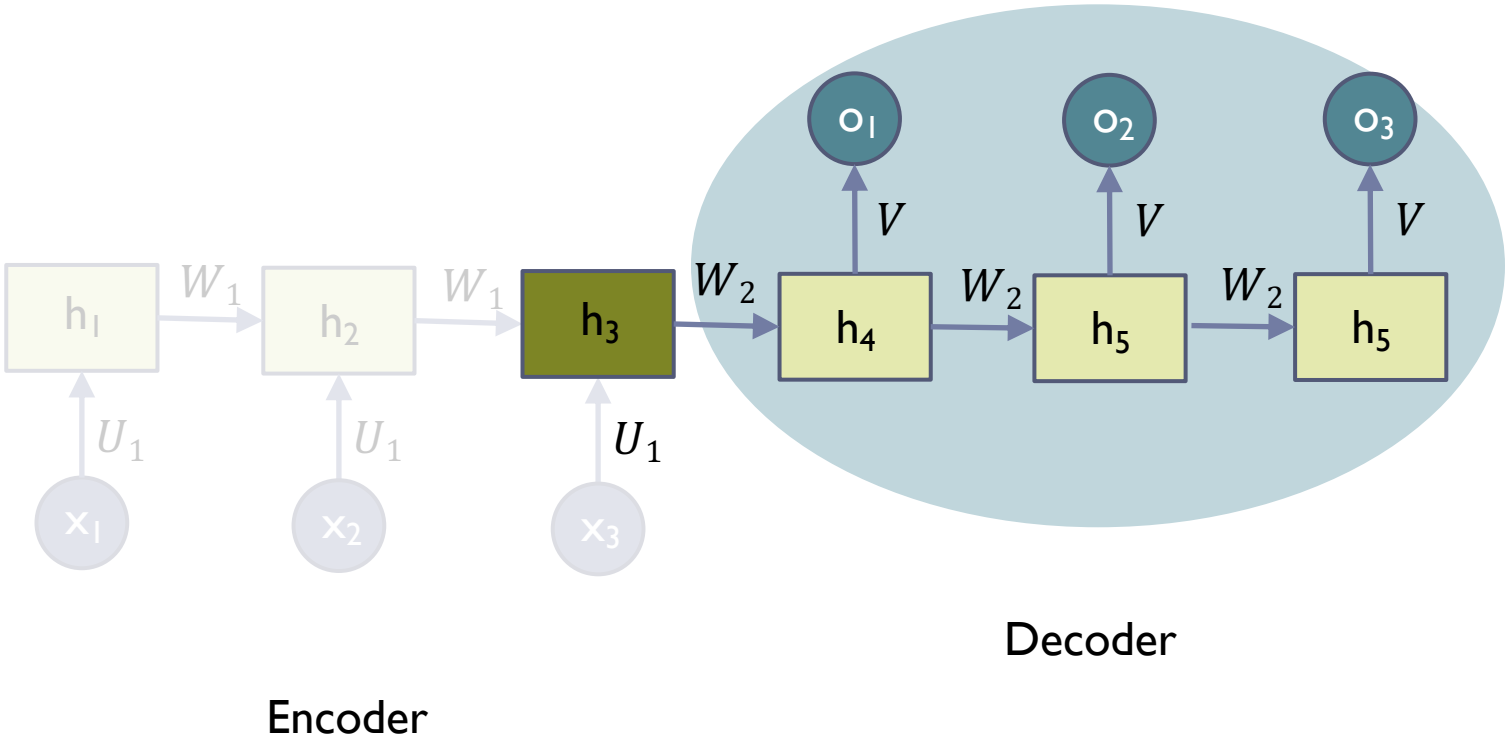
- **AutoEncoder**



Many to Many

- **Training**

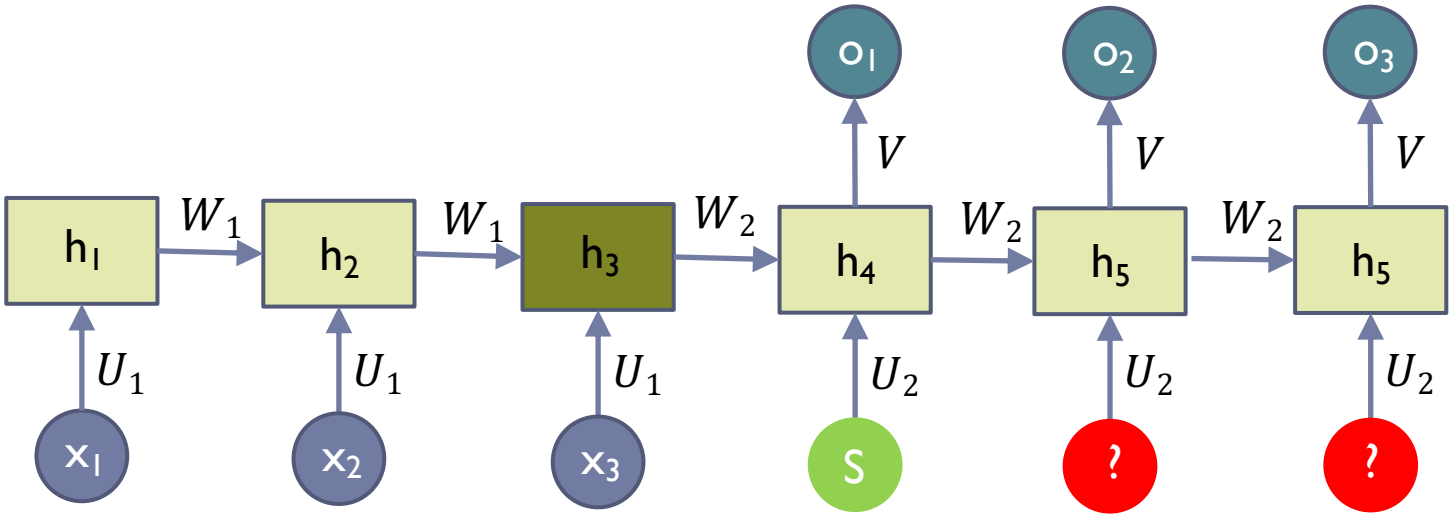
$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$



Many to Many

- **Training**

$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$

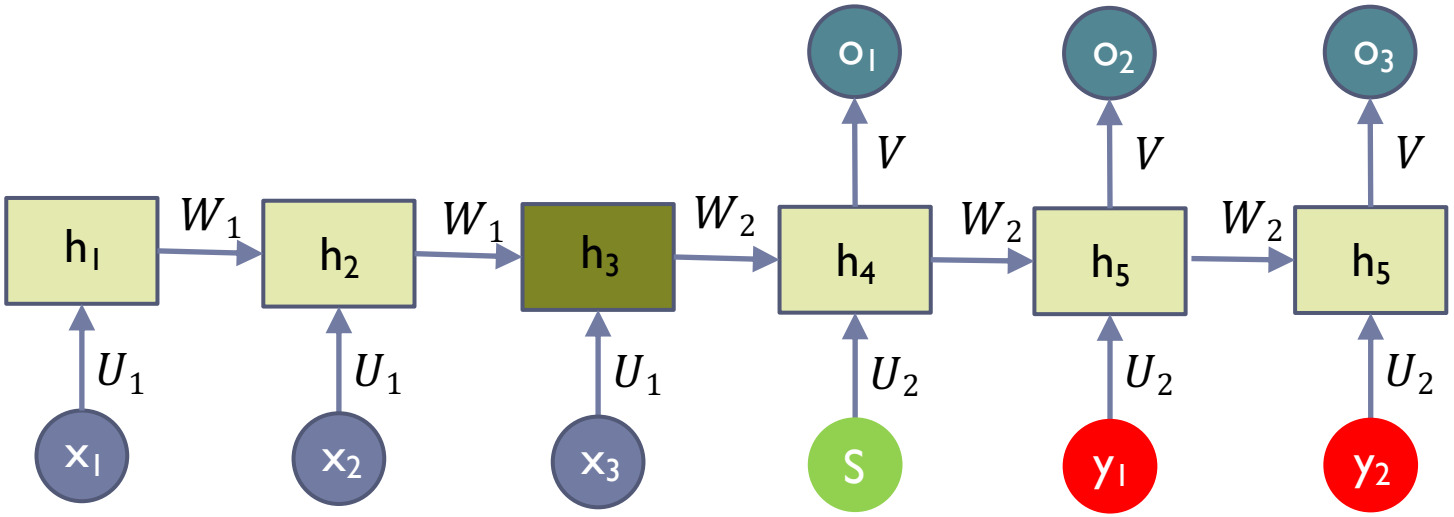


$$E = \sum_{i=1}^{n} (y_i - o_i)^2$$

Many to Many

- **Training**

$$x_1 x_2 x_3 \cdots x_n \rightarrow y_1 y_2 y_3 \cdots y_n$$



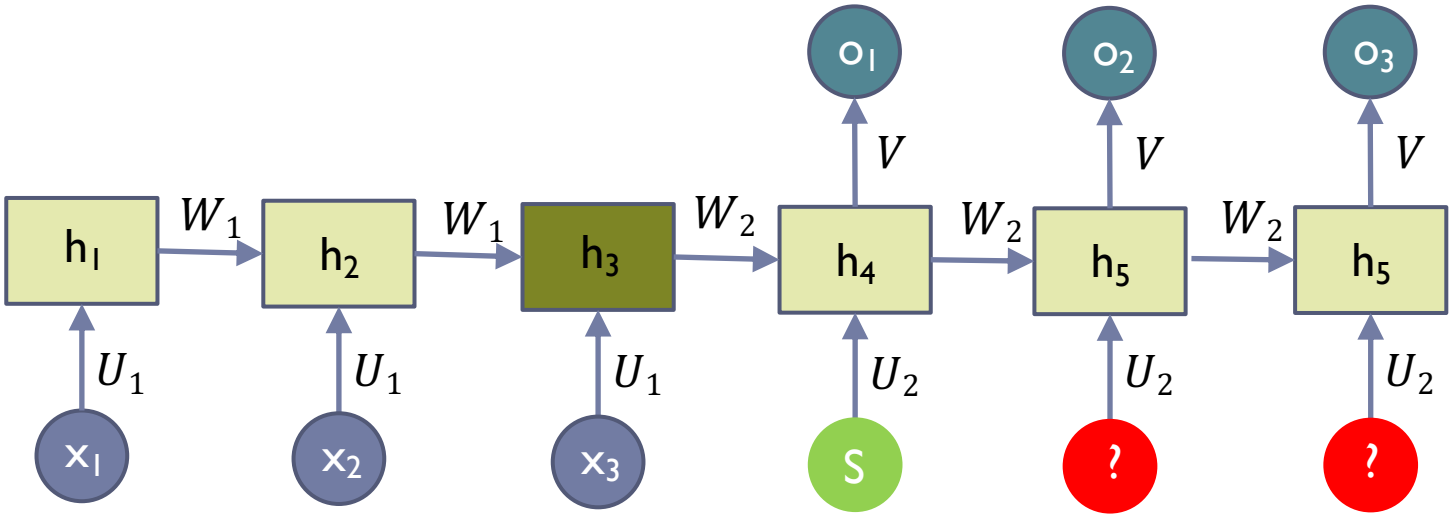
$$\frac{\partial E}{\partial w} = ??$$

Combination of [Many to One] and [One to Many]

Many to Many

- Testing

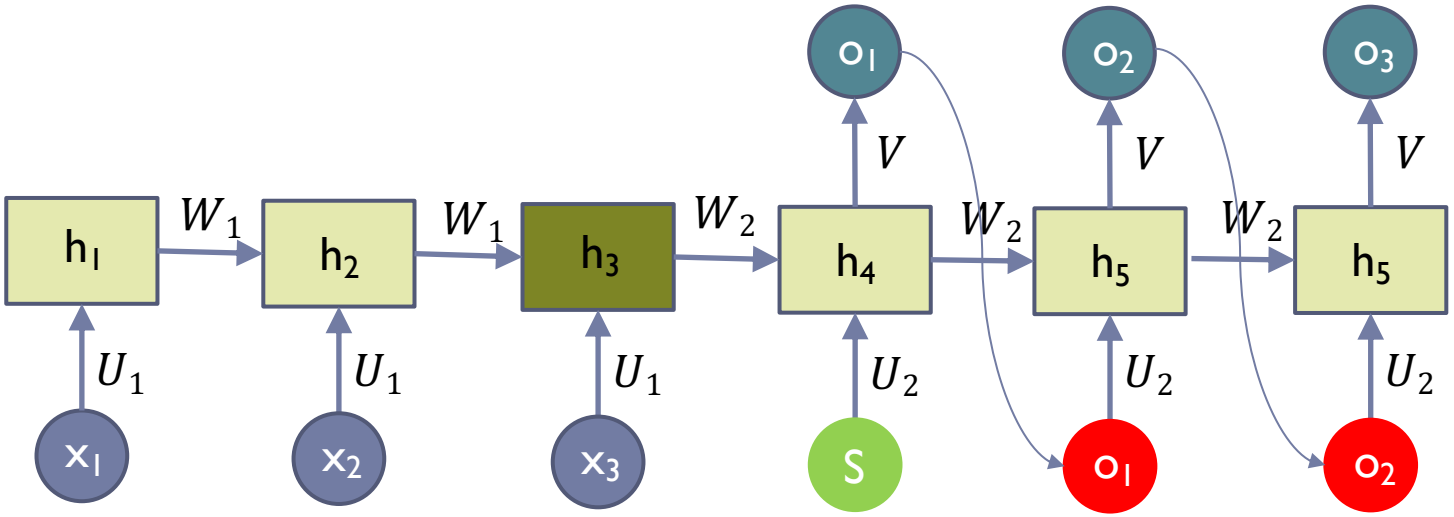
$$x_1 x_2 x_3 \cdots x_n \rightarrow ? ? ? ? ?$$



Many to Many

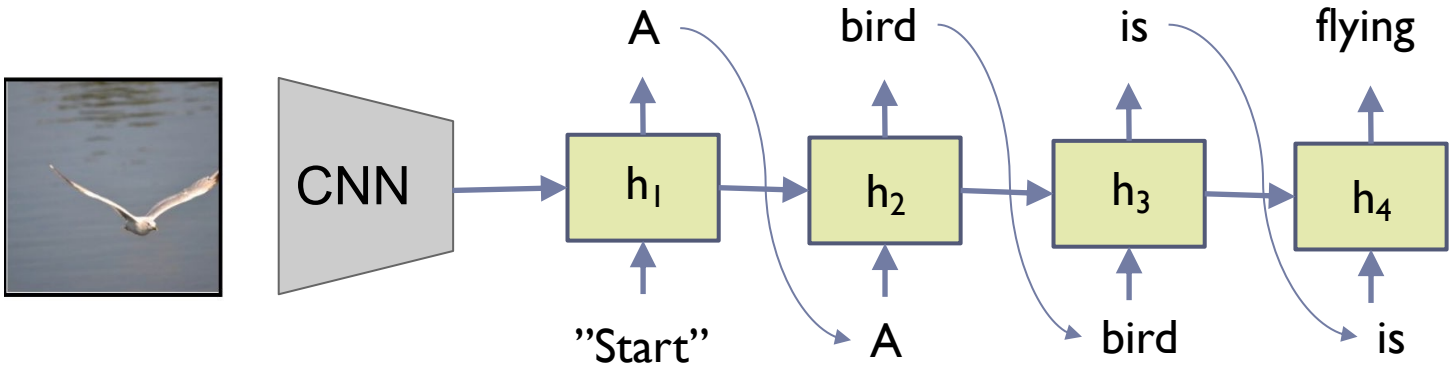
- Testing

$$x_1 x_2 x_3 \cdots x_n \rightarrow ? ? ? ? ?$$



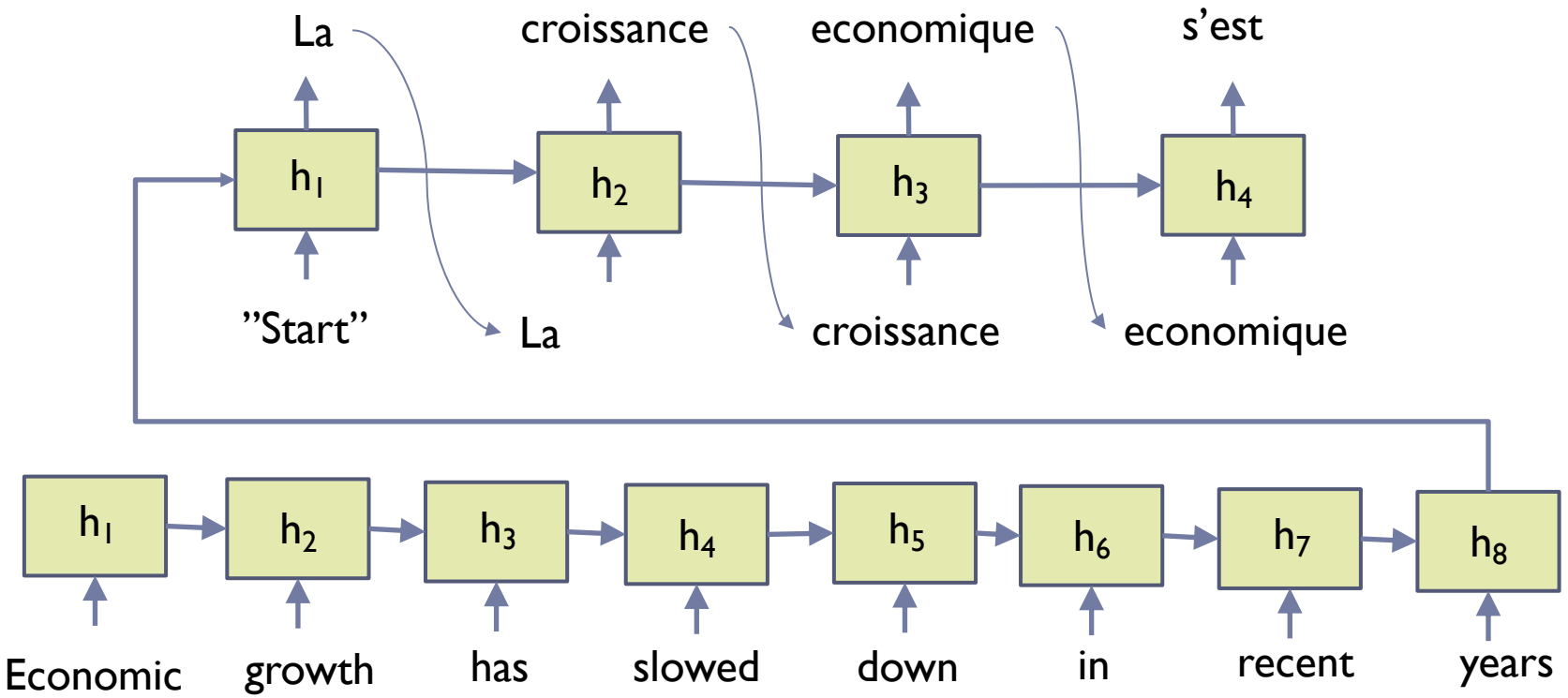
Example

- One to Many
  - Caption Generation
    - Image is represented by a CNN
    - Word Embedding at the input layer
    - Softmax at the output layer



Example

- Many to Many
  - Word Embedding



Question and Answer