

## 07 – Systems for Q&A, Code Generation



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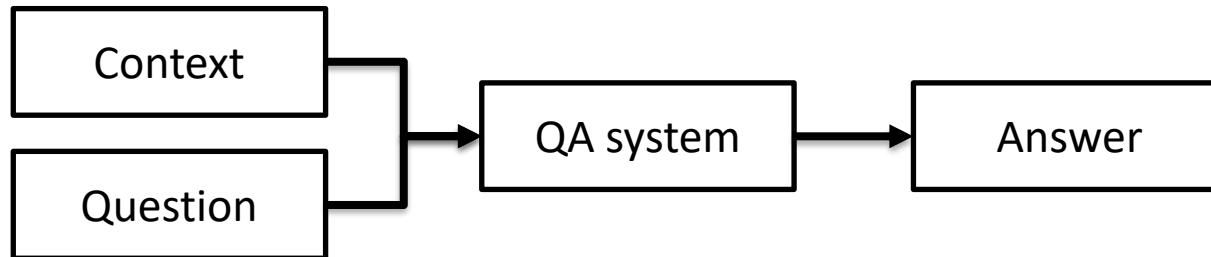
# Contents

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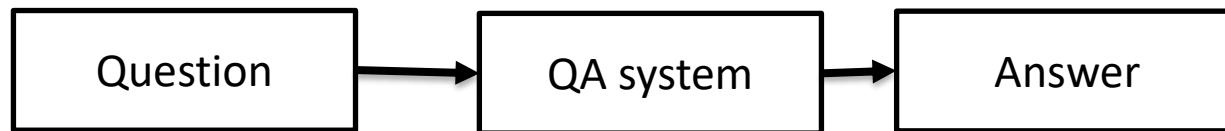
- ◆ Question and Answer System
- ◆ SQuAD Data Set
- ◆ Q&A Systems
- ◆ Q&A Systems using Different Word Embeddings
- ◆ Improving Q&A System using Ontology
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# Question and Answer System

## ◆ System Concept



- Based on question, QA system return answer.
  - This thesis QA system provides with answer and context.
  - Other some QA system do not provide with context.



# Q&A System

## ◆ QA system using context

- Given context and question.
- Context contains the contents to guide the answer.
- Search answer for context.

Context:

iPhone's operating system is iOS.

Question:

What is iPhone's operating system?

Answer:

iOS

# Question and Answer System

- ◆ Q&A System By BERT or GPT

## SQuAD

Stanford Question Answering Dataset (2016)

Southern California, often abbreviated SoCal, is a geographic and cultural region that generally comprises California's southernmost 10 counties. (...)

What is Southern California often abbreviated as?

# Question and Answer System

## ◆ SQuAD Dataset

- Stanford Question Answering Dataset (SQuAD) is a reading comprehension dataset, consisting of questions posed by crowdworkers on a set of Wikipedia articles, where the answer to every question is a segment of text, or span, from the corresponding reading passage, or the question might be unanswerable.
- SQuAD2.0 combines the 100,000 questions in SQuAD1.1 with over 50,000 unanswerable questions written adversarially by crowdworkers to look similar to answerable ones. To do well on SQuAD2.0, systems must not only answer questions when possible, but also determine when no answer is supported by the paragraph and abstain from answering.

# Question and Answer System

## ◆ Question and Answer Example in SQuAD Dataset

In meteorology, precipitation is any product of the condensation of atmospheric water vapor that falls under **gravity**. The main forms of precipitation include drizzle, rain, sleet, snow, **grau-**  
**pel** and hail... Precipitation forms as smaller droplets coalesce via collision with other rain drops or ice crystals **within a cloud**. Short, intense periods of rain in scattered locations are called “showers”.

What causes precipitation to fall?  
**gravity**

What is another main form of precipitation besides drizzle, rain, snow, sleet and hail?  
**graupel**

Where do water droplets collide with ice crystals to form precipitation?  
**within a cloud**

# Question and Answer System

## ◆ Several QA Datasets

Dataset	Question source	Formulation	Size
<b>SQuAD</b>	<b>crowdsourced</b>	<b>RC, spans in passage</b>	<b>100K</b>
MCTest (Richardson et al., 2013)	crowdsourced	RC, multiple choice	2640
Algebra (Kushman et al., 2014)	standardized tests	computation	514
Science (Clark and Etzioni, 2016)	standardized tests	reasoning, multiple choice	855
WikiQA (Yang et al., 2015)	query logs	IR, sentence selection	3047
TREC-QA (Voorhees and Tice, 2000)	query logs + human editor	IR, free form	1479
CNN/Daily Mail (Hermann et al., 2015)	summary cloze	RC, fill in single entity	1.4M
CBT (Hill et al., 2015)	cloze	RC, fill in single word	688K

# Question and Answer System

## ◆ User Interface for Cloudworker

### Paragraph 1 of 43

Spend around 4 minutes on the following paragraph to ask 5 questions! If you can't ask 5 questions, ask 4 or 3 (worse), but do your best to ask 5. Select the answer from the paragraph by clicking on 'Select Answer', and then highlight the smallest segment of the paragraph that answers the question.

Oxygen is a chemical element with symbol O and atomic number 8. It is a member of the chalcogen group on the periodic table and is a highly reactive nonmetal and oxidizing agent that readily forms compounds (notably oxides) with most elements. By mass, oxygen is the third-most abundant element in the universe, after hydrogen and helium. At standard temperature and pressure, two atoms of the element bind to form dioxygen, a colorless and odorless diatomic gas with the formula O<sub>2</sub>.

2. Diatomic oxygen gas constitutes 20.8% of the Earth's atmosphere. However, monitoring of atmospheric oxygen levels show a global downward trend, because of fossil-fuel burning. Oxygen is the most abundant element by mass in the Earth's crust as part of oxide compounds such as silicon dioxide, making up almost half of the crust's mass.

When asking questions, **avoid using** the same words/phrases as in the paragraph. Also, you are encouraged to pose **hard questions**.

Ask a question here. Try using your own words

Select Answer

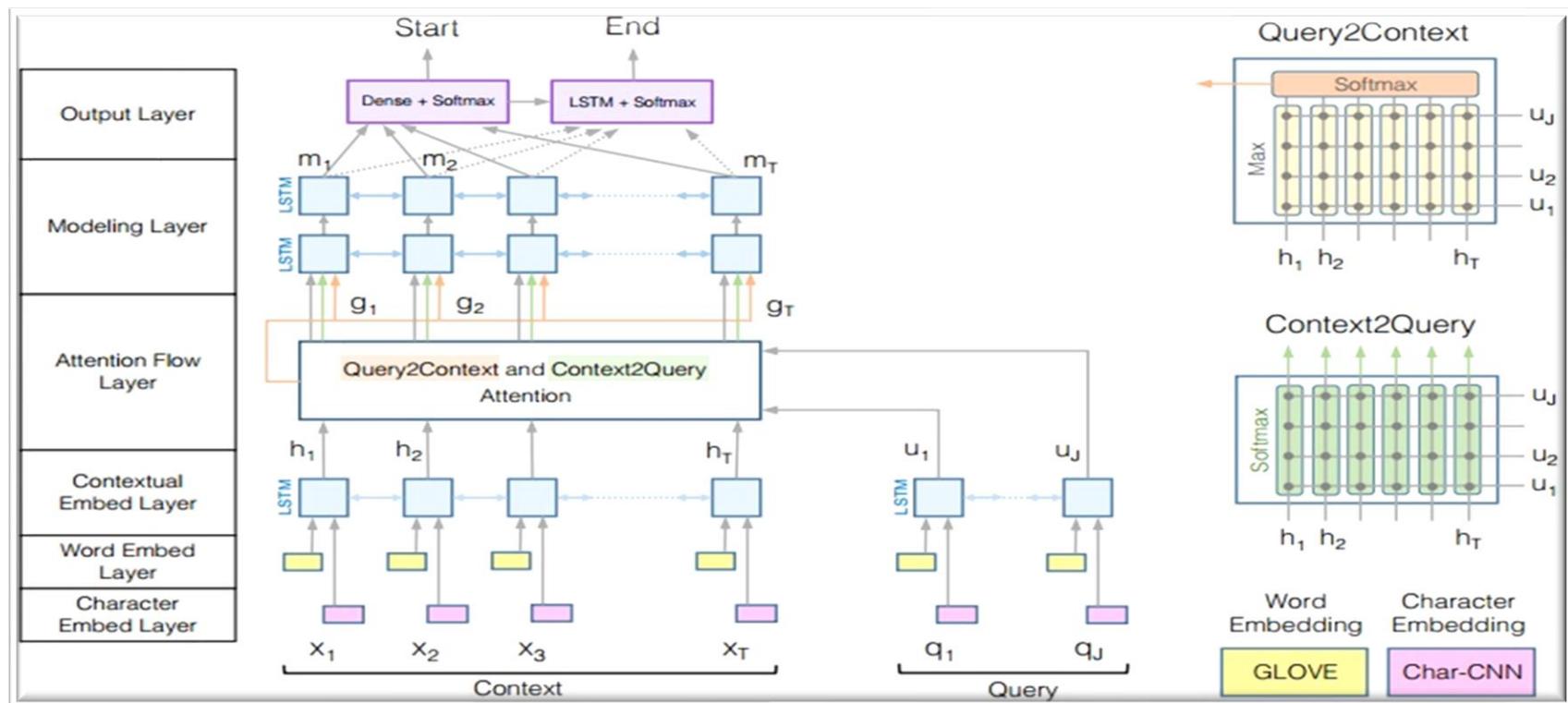
Ask a question here. Try using your own words

Select Answer

# Q&A System

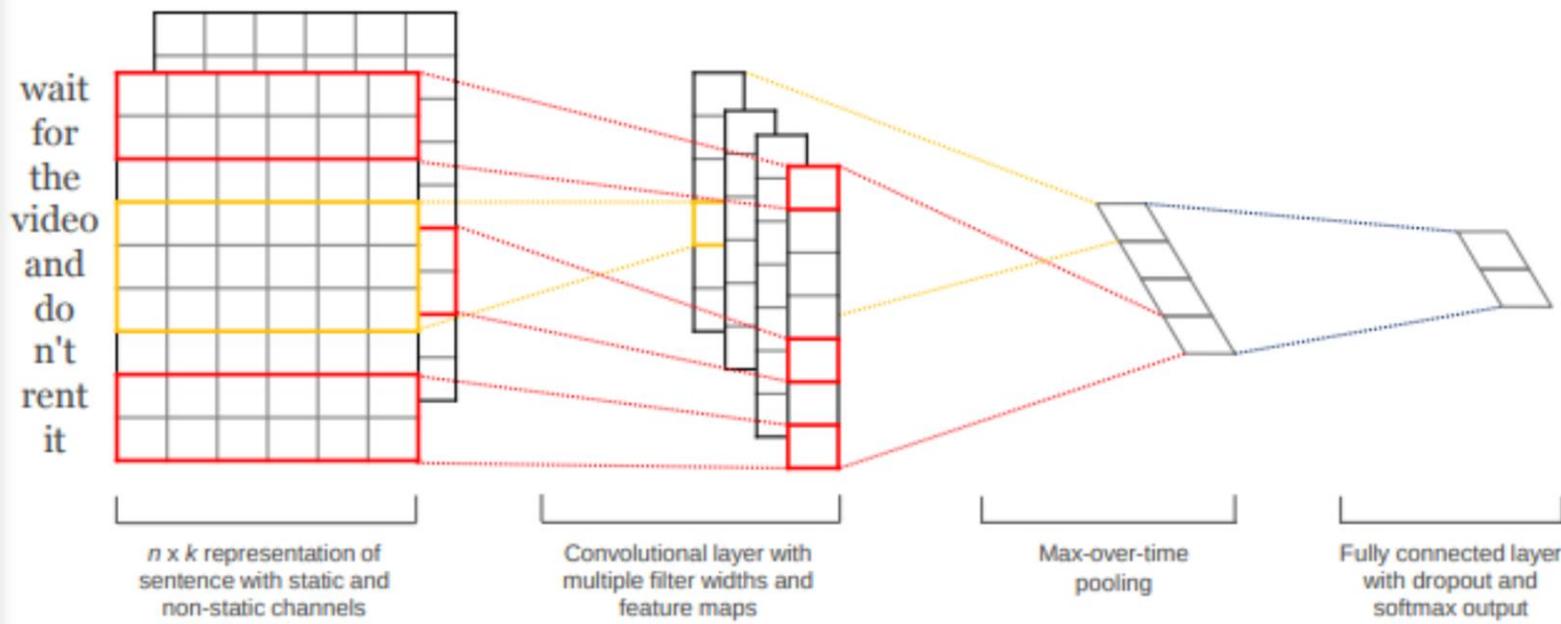
## ◆ BiDAF Architecture for Question And Answer System

Learning start and end of context for answer from the input of context and query.



# Q&A System

## ◆ Character Embedding layer



# Q&A System

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## ◆ Word Embedding layer

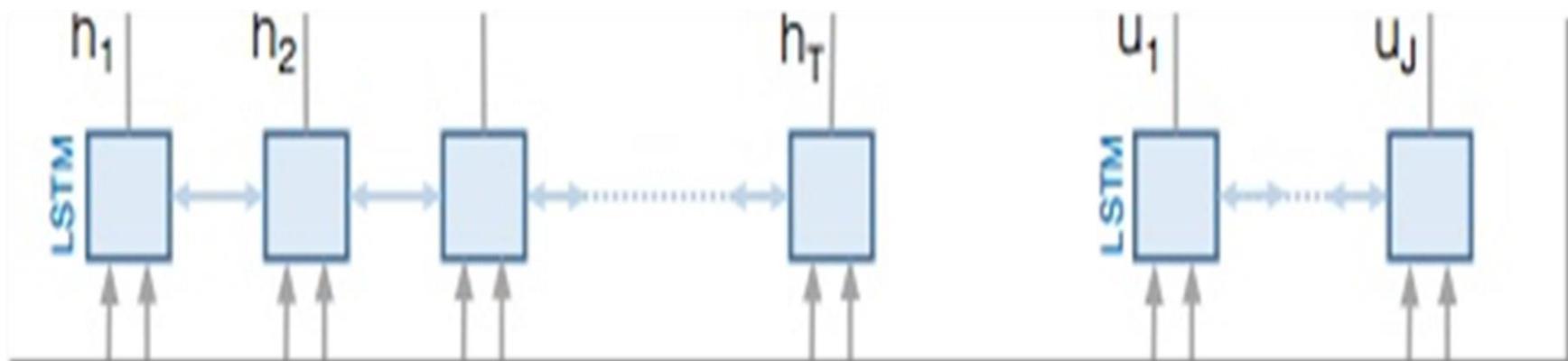
The role of word embedding layer is to directly use the pre-trained model to map the word content to vector, and then facilitate the subsequent work.

- Word2Vector
- GloVe
- BERT Embedding (Here, added..)

# Q&A System

## ◆ Contextual embedding layer

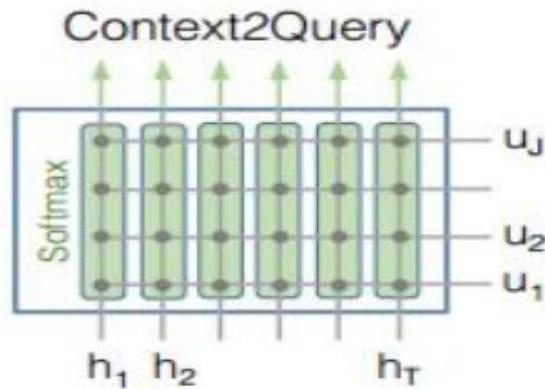
This layer is an encoder, which encodes the context and query obtained in the previous step respectively, encoding the internal relation of context and query sentences. This layer can consists of a bidirectional LSTM.



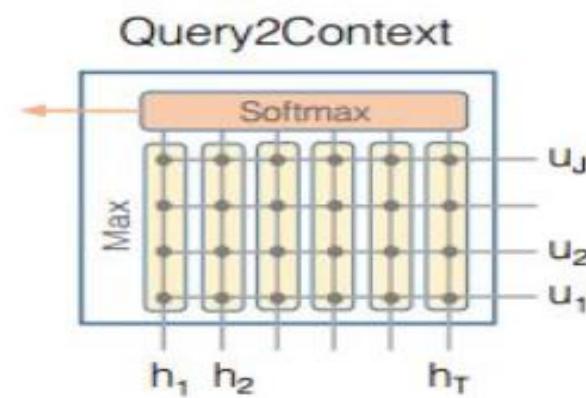
# Q&A System

## ◆ Attention flow layer

- ◆ For each word in the context, the relevancy of each word in the query to the current word  $t$  in the context is calculated.



- ◆ For each word in Query, calculate the relevancy of each word in the context to the current word  $j$  in Query.



# Q&A System

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## ◆ Modeling layer

- The input content of the modeling layer is the result of the output of the attention flow layer, then the context is encoded and passed.
- The model uses two bi-directional LSTM passes to the next layer and then predicts the answer through the output layer.
- Each vector here contains context information belonging to the word.

# Q&A System

## ◆ Output layer

- The output layer is used to predict where the answer will start and end.
- Start

$$p^1 = \text{softmax}(w_{(p^1)}^T [G, M])$$

- End

$$p^2 = \text{softmax}(w_{(p^2)}^T [G, M^2])$$

- Loss function (cross entropy)

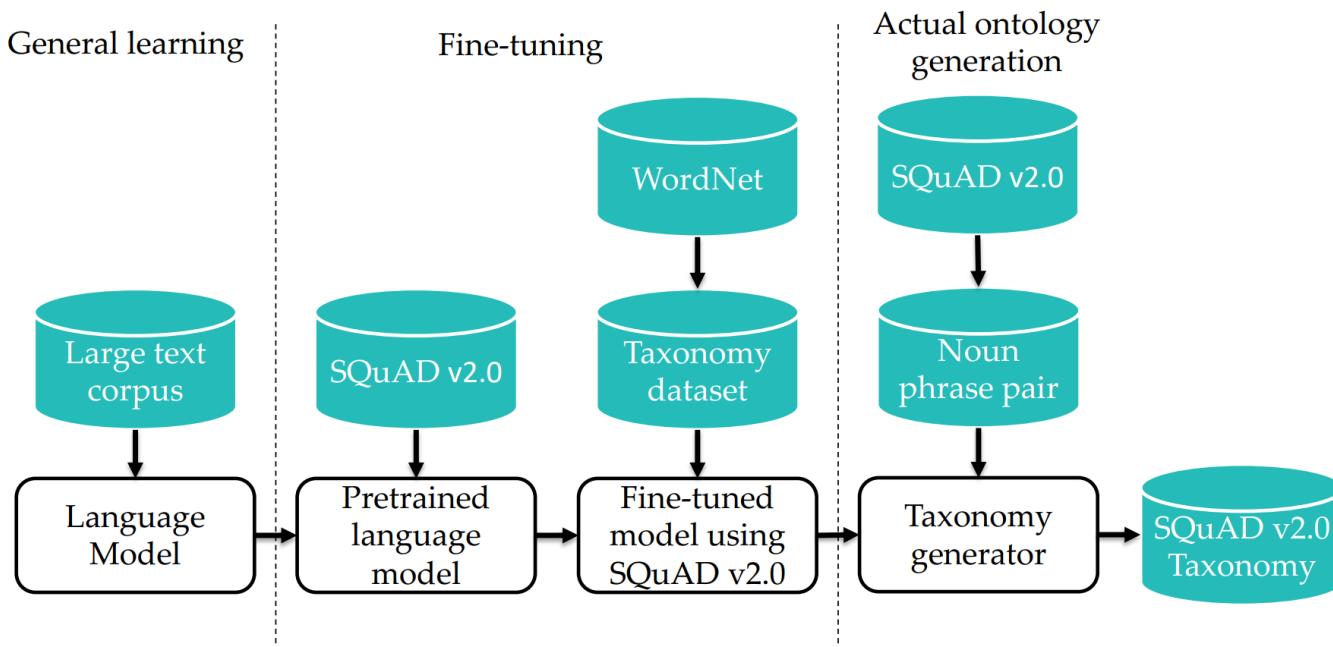
$$L(\theta) = -\frac{1}{N} \sum_{i=1}^N (\log(p_{y_i^1}) + \log(p_{y_i^2}))$$

# Improvement of Q&A System

## ◆ Using Ontology

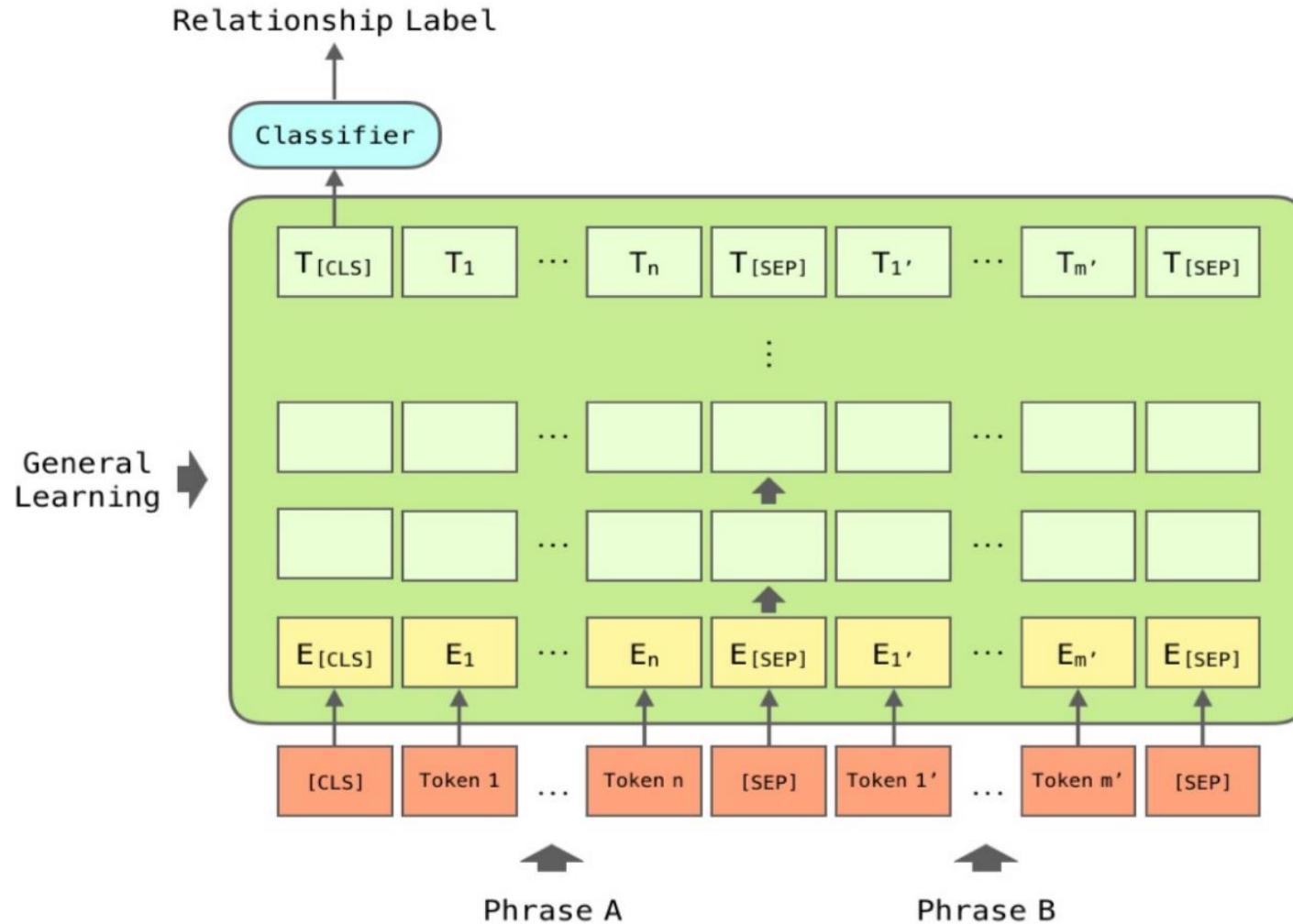
The overall architecture of our model.

- Pre-training(with large text corpus)
- Fine-tuning(with taxonomy dataset from WordNet)
- Actual Ontology Generation(using extracted NP)



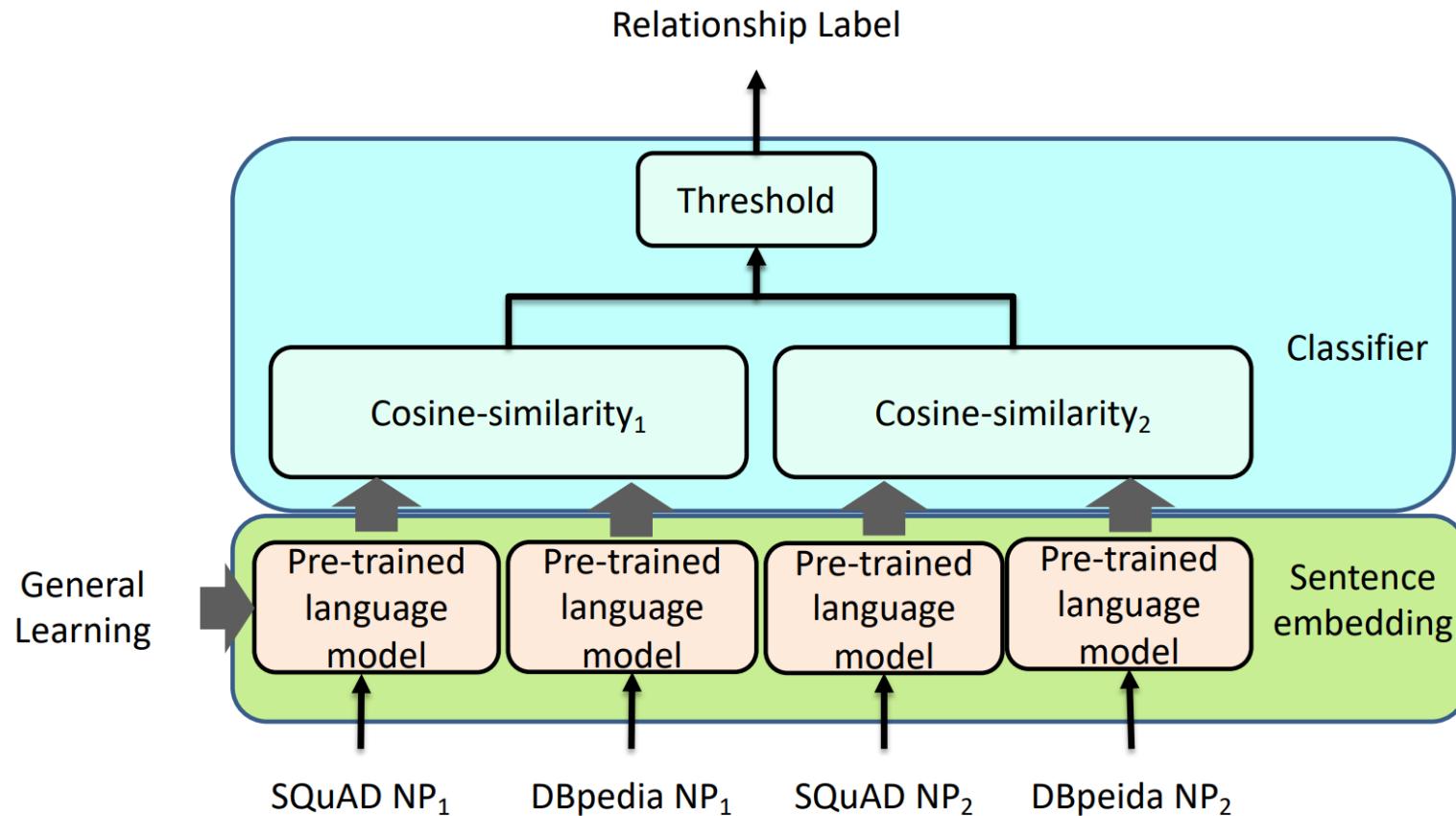
# Improvement of Q&A System

## ◆ Using BERT for Q&A



# Improvement of Q&A System

## ◆ Applying Ontology to the Model



# Improvement of Q&A System

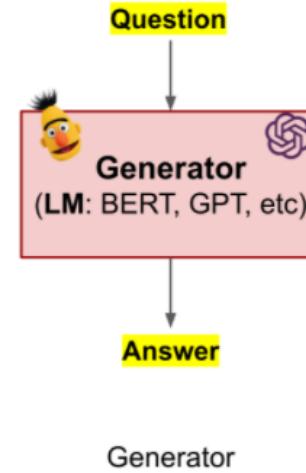
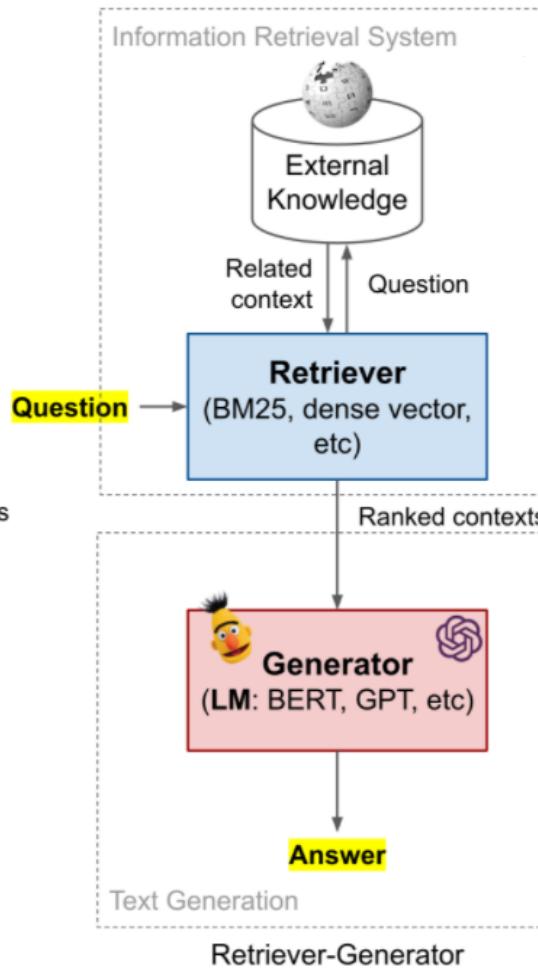
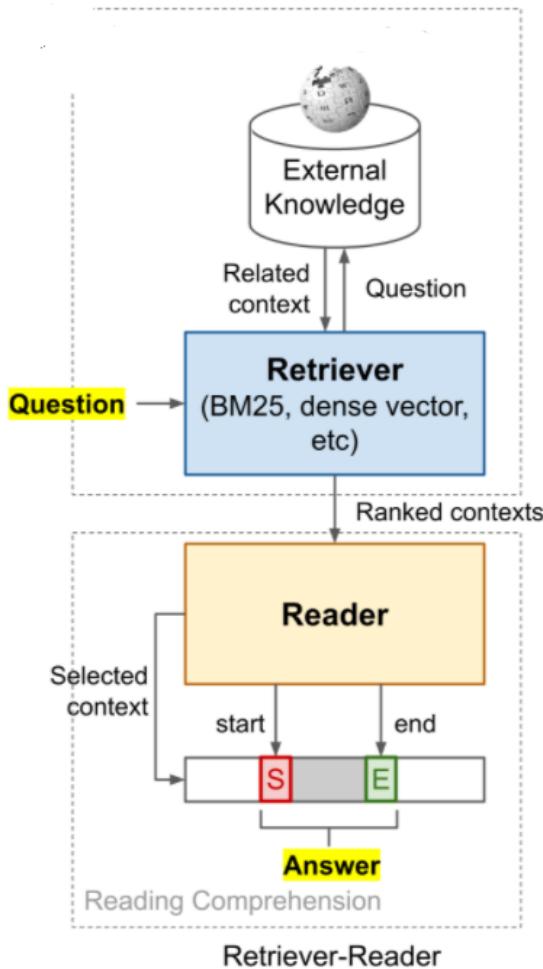
## ◆ Result Using Ontology

Table 6.1: Evaluation results)

Model	Dataset	Best F1	Best EM	Train run-time(s)
BERT base	Base	75.13	71.79	65563
	Ontology	76.07	72.48	65659
ALBERT base	Base	79.97	76.91	74601
	Ontology	80.05	76.76	74571
BiDAF	Base	63.53	60.56	6142
	Ontology	60.91	57.63	6698

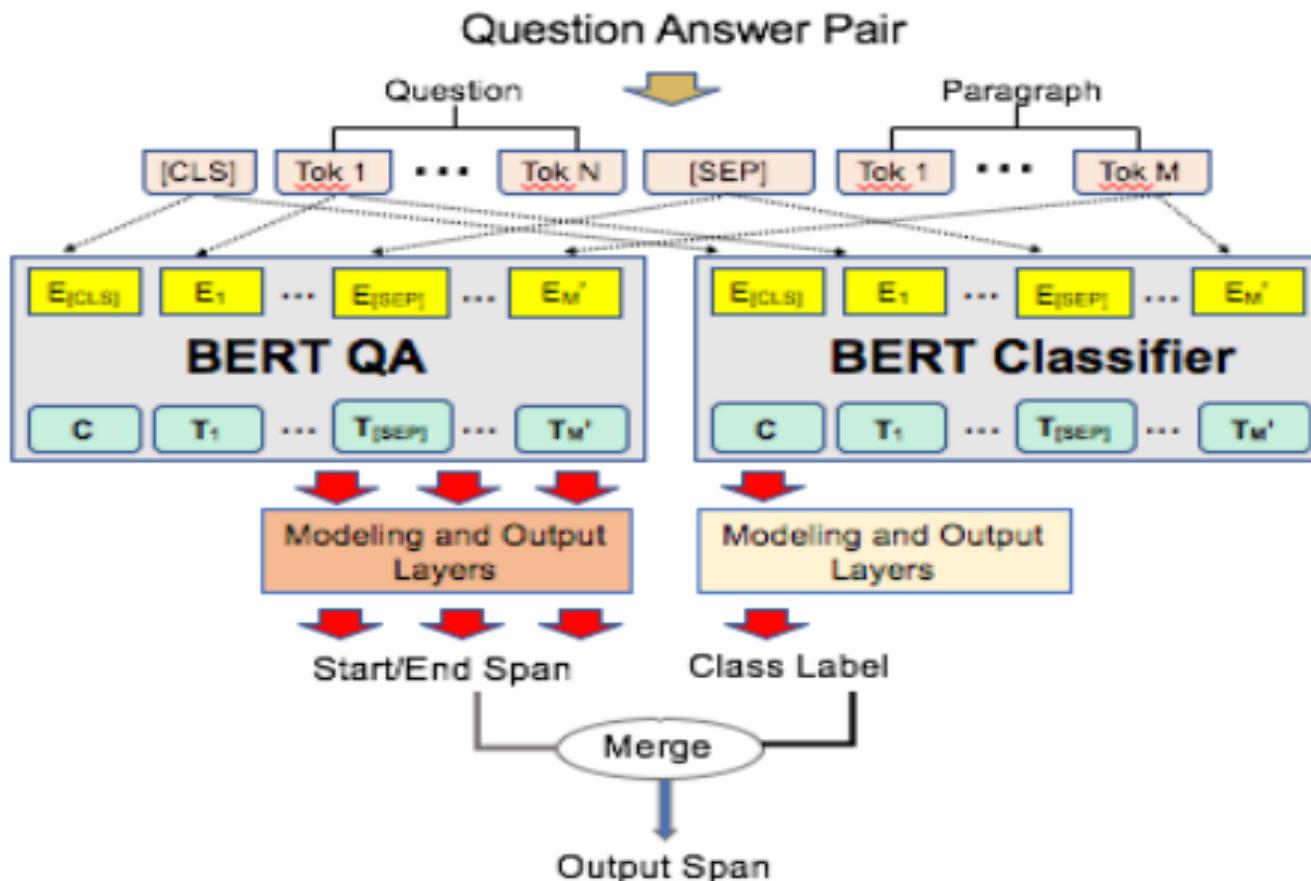
# Question and Answer System

## ◆ Q&A System By BERT or GPT



# Question and Answer System

- ◆ Q&A System By BERT or GPT

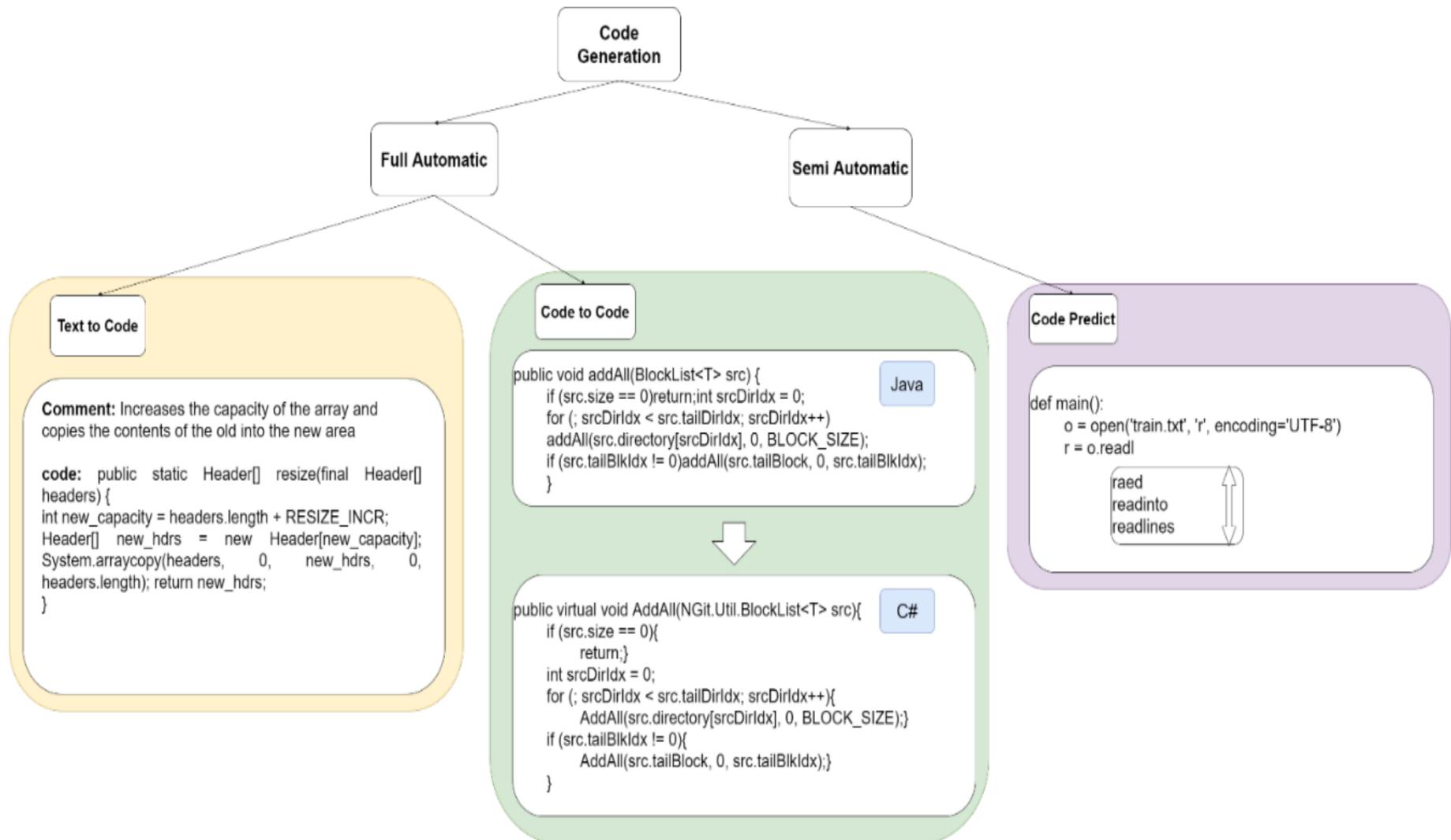


# Code Generation System

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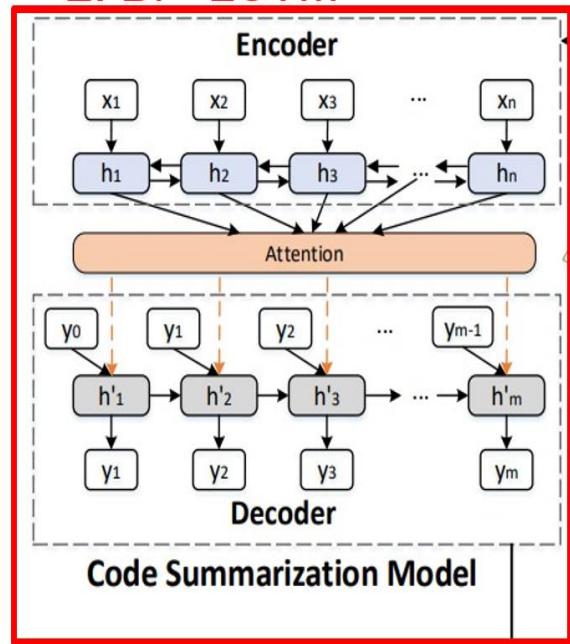
## Code Generation

# Code Generation

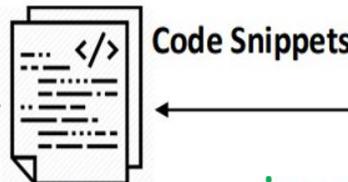


# Code Generation as a Dual Task of Code Summarizing

## 2. Bi-LSTM



1.



inverse conditional probabilities

3.

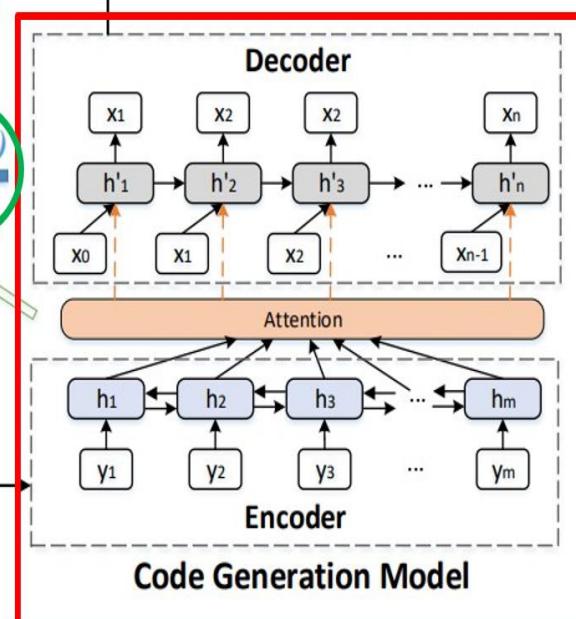
$\hat{P}(X)$   
Language model  
for code

Language model  
for comments

$P(Y|X)$

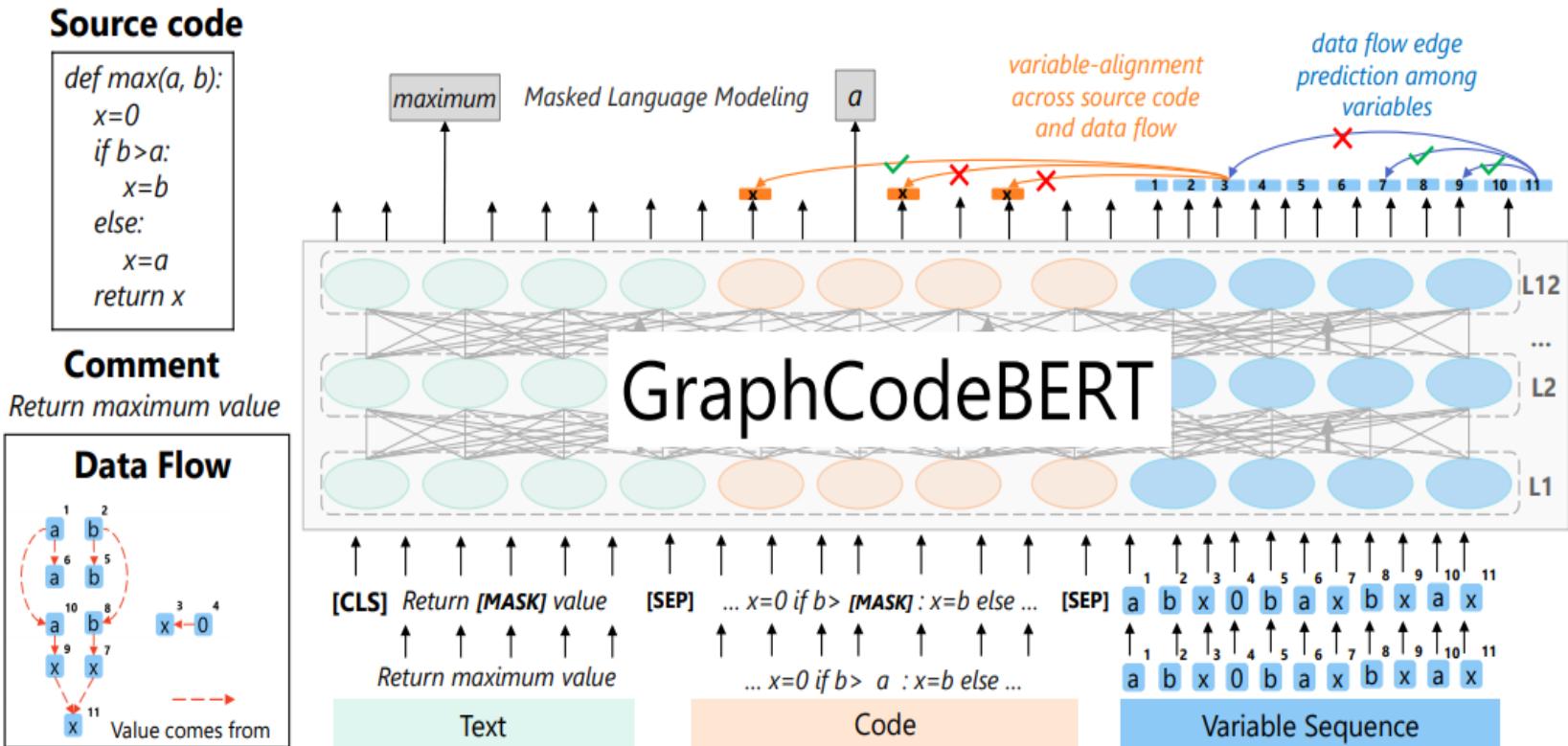
$P(X|Y)$

Code Comments



Code Generation Model

# GraphCodeBERT: Pre-Training Code Representations With Data Flow

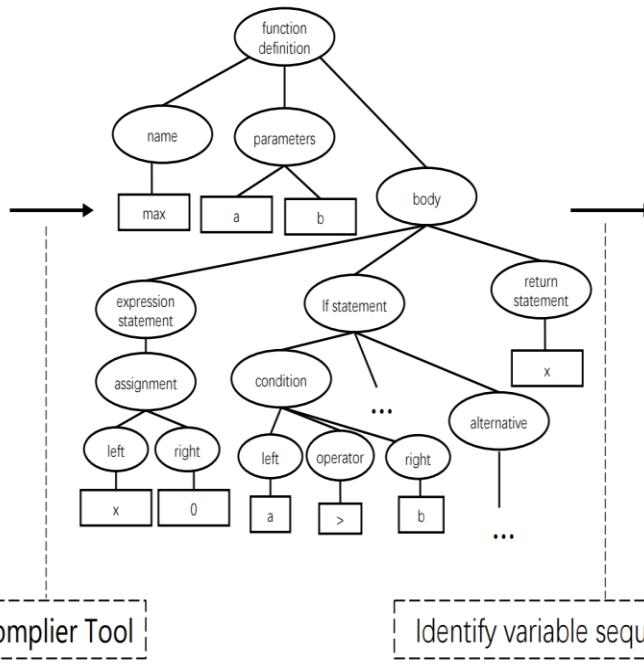


# Data Flow Graph for Code Training

Source code

```
def max(a, b):
    x=0
    if b>a:
        x=b
    else:
        x=a
    return x
```

Parse into AST

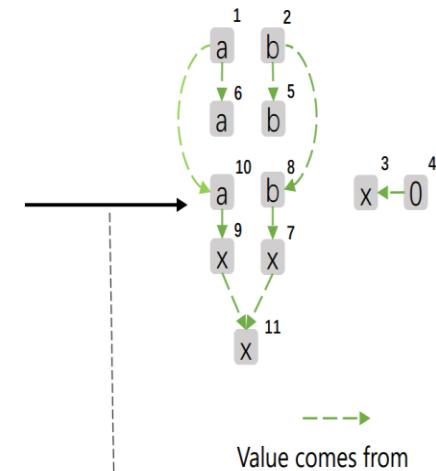


Identify variable sequence

```
def max(a, b):
    x=01
    if b>a:2
        x=b3
    else:4
        x=a5
    return x11
```

Variable relation

sequence



# Result of GraphCodeBERT

Model	Precision	Recall	F1
Deckard	0.93	0.02	0.03
RtvNN	0.95	0.01	0.01
CDLH	0.92	0.74	0.82
ASTNN	0.92	0.94	0.93
FA-AST-GMN	0.96	0.94	0.95
RoBERTa (code)	0.960	0.955	0.957
CodeBERT	0.967	0.963	0.965
GraphCodeBERT	<b>0.973</b>	<b>0.968</b>	<b>0.971</b>

Table 2: Results on code clone detection.

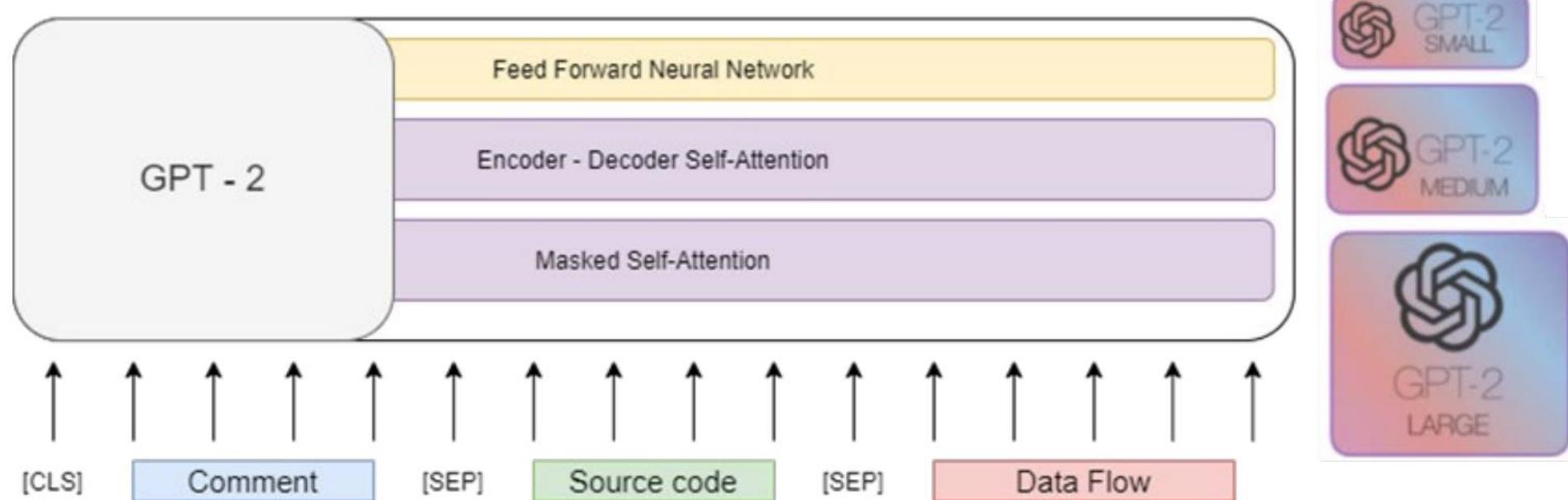
Method	Java→C#		C#→Java	
	BLEU	Acc	BLEU	Acc
Naive	18.54	0.000	18.69	0.000
PBSMT	43.53	0.125	40.06	0.161
Transformer	55.84	0.330	50.47	0.379
RoBERTa (code)	77.46	0.561	71.99	0.579
CodeBERT	79.91	0.590	72.13	0.580
GraphCodeBERT	<b>80.58</b>	<b>0.594</b>	<b>72.64</b>	<b>0.588</b>

Table 3: Results on code translation.

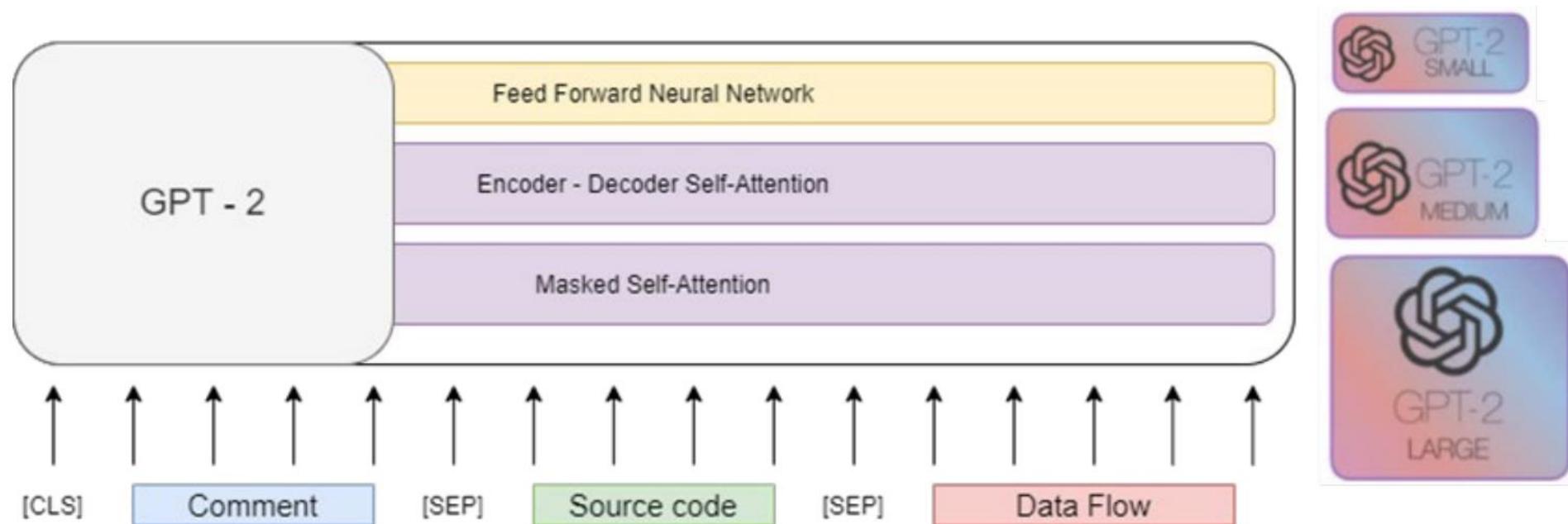
Method	small		medium	
	BLEU	Acc	BLEU	Acc
Naive	78.06	0.000	90.91	0.000
LSTM	76.76	0.100	72.08	0.025
Transformer	77.21	0.147	89.25	0.037
RoBERTa (code)	77.30	0.159	90.07	0.041
CodeBERT	77.42	0.164	90.07	0.052
GraphCodeBERT	<b>80.02</b>	<b>0.173</b>	<b>91.31</b>	<b>0.091</b>

Table 4: Results on code refinement.

# Code Graph GPT



# Code Graph GPT



# Result of Code Graph GPT

**Table 6.** BLEU and EM scores without code graph

	BLEU	EM
No Code Graph	87.11	79.2

**Table 11.** Comparison results of the pre-trained model from scratch with and without code graph

Models	Epochs		BLEU	EM
	Pre-Training	Fine-Tuning		
No Code Graph	3	30	10.2	22.44
	30		36.5	52.12
Variable_nosort	3	30	10.7	22.39
	30		45.6	59.15

# Result of Code Graph GPT

**Table 11.** Comparison results of the pre-trained model from scratch with and without code graph

Models	Epochs		BLEU	EM
	Pre-Training	Fine-Tuning		
No Code Graph	3	30	10.2	22.44
	30		36.5	52.12
Variable_nosort	3	30	10.7	22.39
	30		45.6	59.15

**Table 12.** Comparison results of the new pre-trained model with and without code graph

Examples	Model	Code
1	Gold	public static FastForward setup (InetAddress addr, int port) throws SocketException { final DatagramSocket socket = new DatagramSocket(); return new FastForward (addr, port, socket); }
		public static FastForward setup (InetAddress addr, int port) throws SocketException { (final DatagramSocket socket = new DatagramSocket()); return new FastForward (addr, port, null); }
	No Code Graph	public static FastForward setup (InetAddress addr, int port) throws SocketException { (final DatagramSocket socket = new DatagramSocket()); return new FastForward (addr, port, null); }
	Variable_nosort	public static FastForward setup (InetAddress addr, int port) throws SocketException { final DatagramSocket socket = new DatagramSocket(); return new FastForward (addr, port, socket); }
2	Gold	public final boolean defineSynthesizedProperty (String propertyName, JSType type, Node propertyNode) { return defineProperty (propertyName, type, false, propertyNode); }
		public void defineSynthesizedProperty (String propertyName, JSType type, Node propertyNode) { (return) defineProperty (propertyName, type, false, propertyNode); }
	No Code Graph	public final boolean defineSynthesizedProperty (String propertyName, JSType type, Node propertyNode) { (return) defineProperty (propertyName, type, false, propertyNode); }
	Variable_nosort	public final boolean defineSynthesizedProperty (String propertyName, JSType type, Node propertyNode) { return defineProperty (propertyName, type, false, propertyNode); }

# Comparison of Code Graph GPT and BERT

**Table 1: Comparison result of GPT with and without code graph**

Models	Epochs		BLEU
	Pre-Training	Fine-Tuning	
No Code Graph	200	10	71.26
		30	86.6
		10	72.75
		30	86.55
Code Graph			

**Table 2: Comparison result of BERT with and without code graph**

Models	Epochs		BLEU
	Pre-Training	Fine-Tuning	
No Code Graph	200	10	18.31
		30	40.53
		10	38.45
		30	76.42
Code Graph			

# Other Application Systems

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Other NLP Applications by DL

# Chat Bots

## ◆ Chatbot Example

###

**Human:** Hello I need support?

**AI:** I am an AI created by OpenAI. How can I help you today?

**Human:** I can't find the scarf im looking to buy

**AI:** Alright no worries! What color scarf?

**Human:** black

**AI:** What length is the scarf?

**Human:** 18 inches I think

**AI:** Ah! Here's a link to all of our black 18 inch scarfs

**Human:** awesome thanks!

**AI:** No worries! Anything else I can help with?

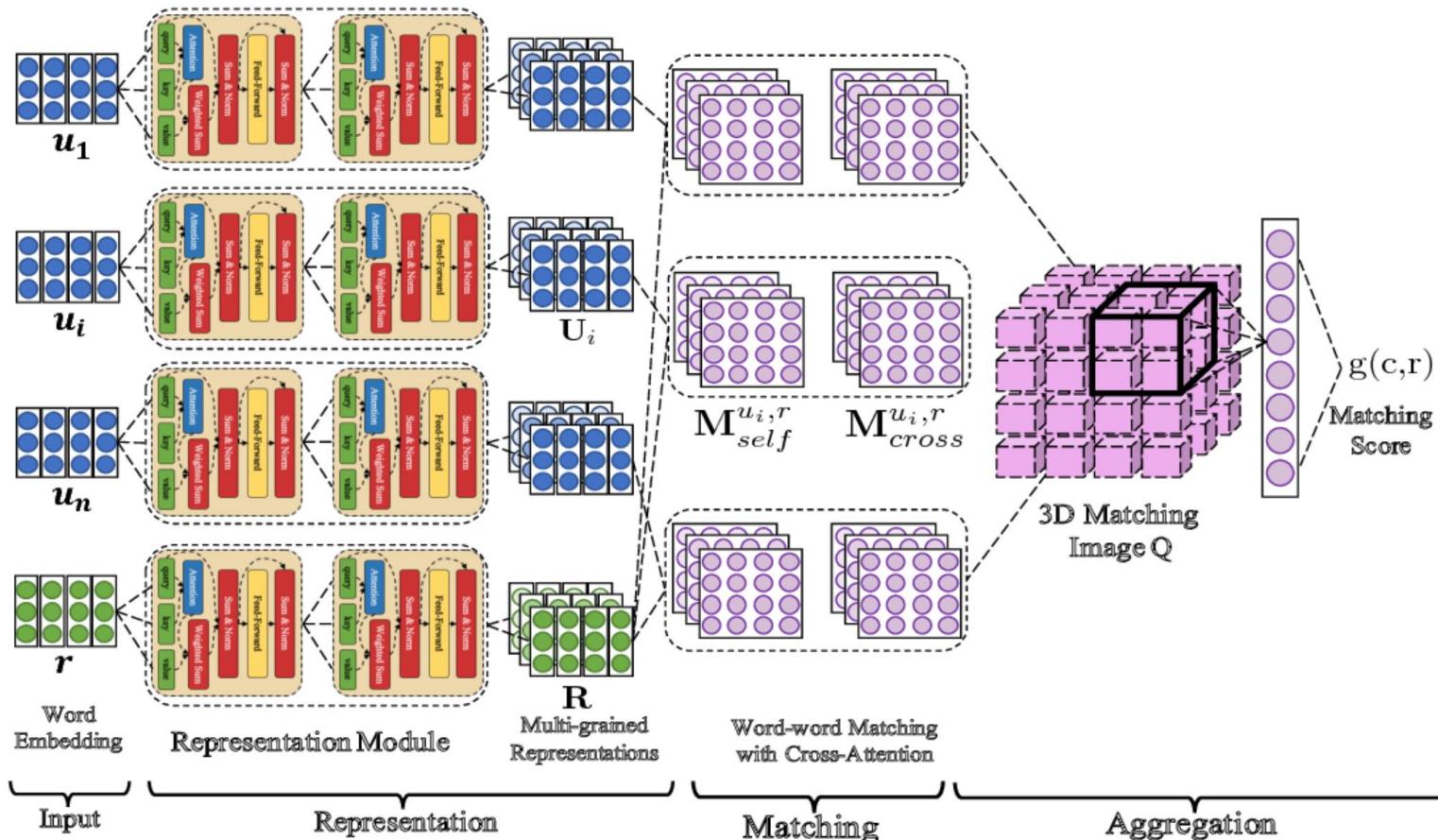
**Human:** Are there any sales right now that I could take advantage of?

**AI:** We have our current sales listed on our sale page [%sales\_page%]

###

# Chat Bots

## ◆ Chatbot Architecture

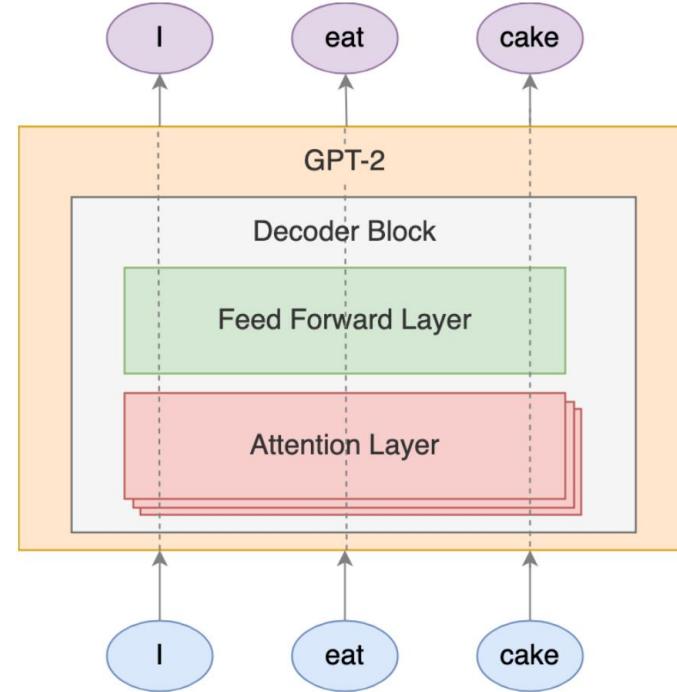
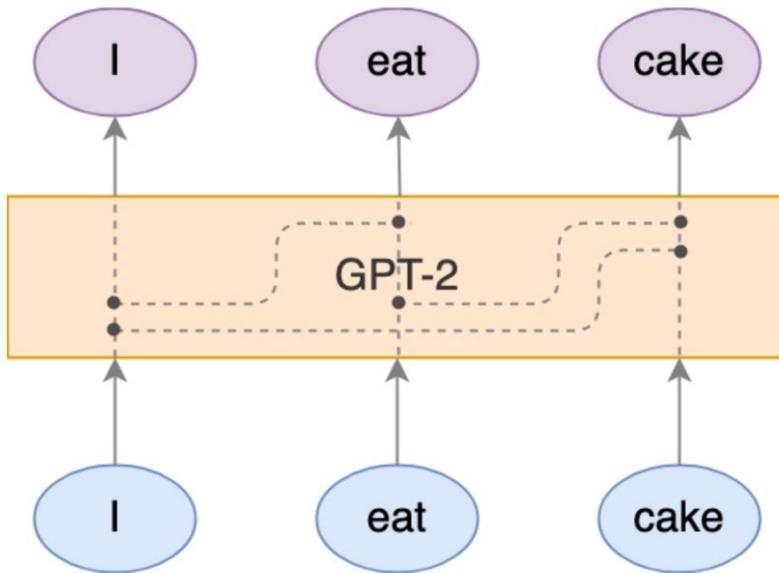


Multi-Turn Response Selection for Chatbots with Deep Attention Matching Network

# Sentence Generation

## ◆ Demonstration

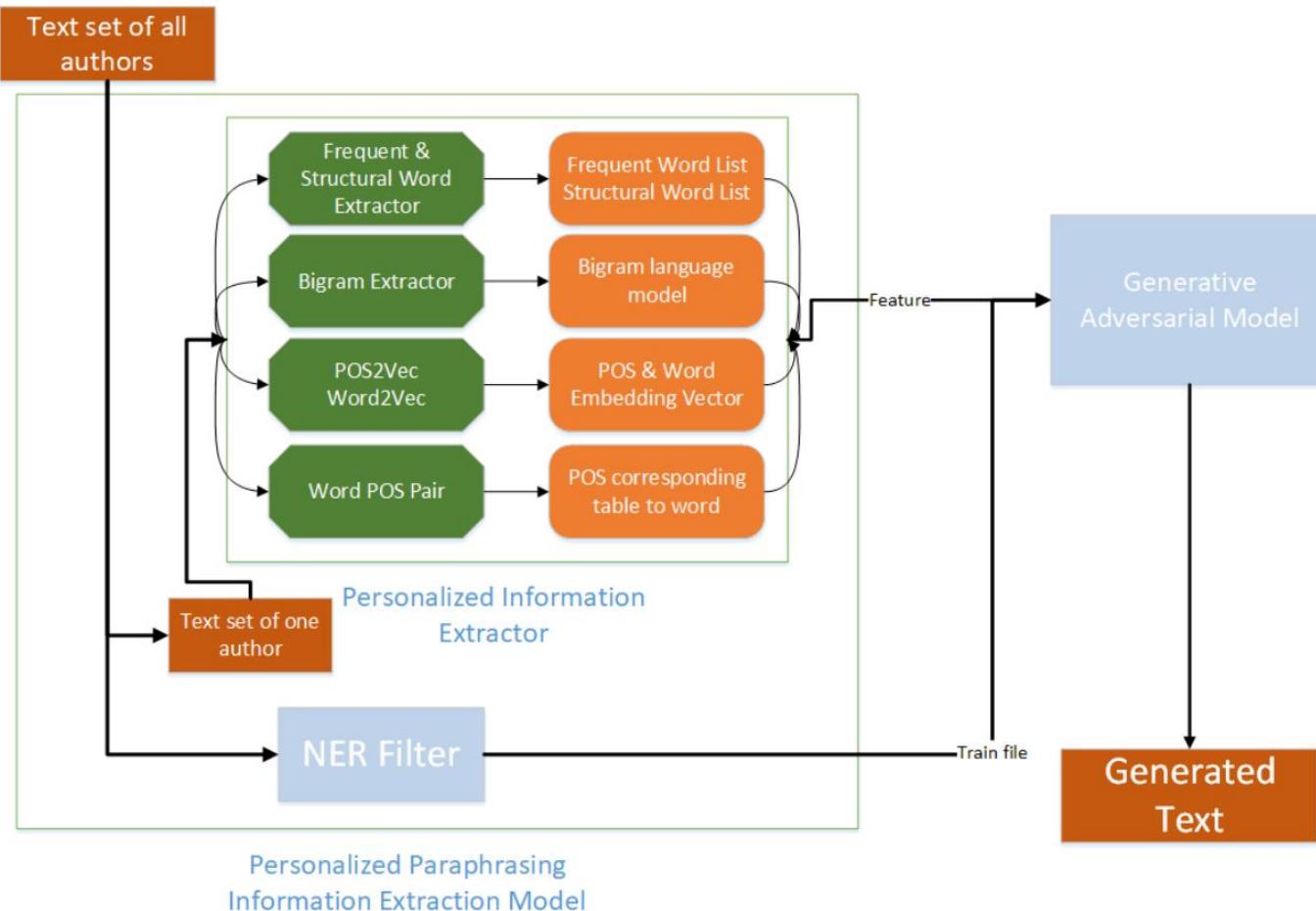
- <https://code.oursky.com/ai-text-generator-text-generation-with-a-gpt2-model/>



# Sentence Generation

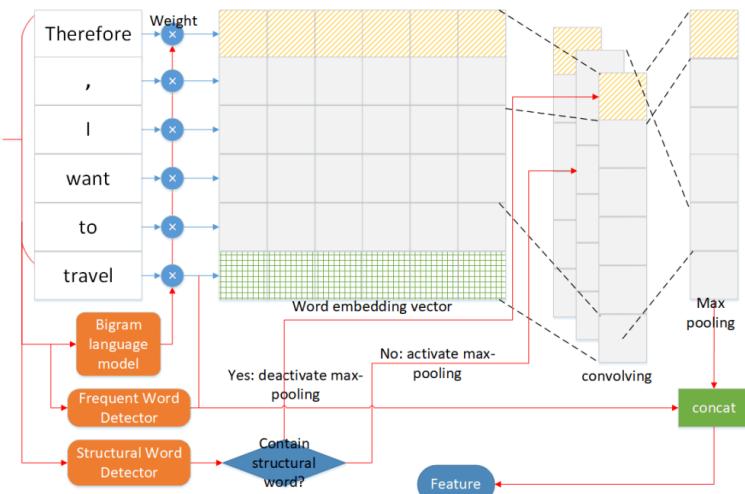
## ◆ Using GAN

- Personalized sentence generation using generative adversarial networks with author-specific word usage

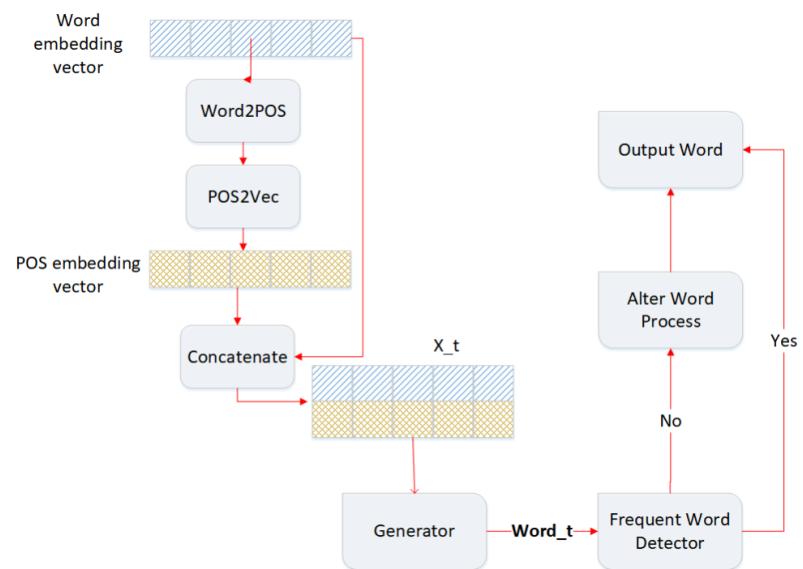


# Sentence Generation

## ◆ Using GAN



**Fig. 3.** The flowchart of the modified discriminator CNN.



**Fig. 4.** The flowchart of the modified sentence generator.



# Thank you!

# Questions?