

HAS-QA: Hierarchical Answer Spans Model for Open-domain Question Answering

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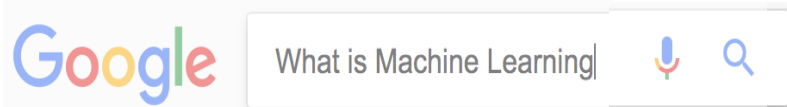
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I Background

Search Engine



[What is Machine Learning? - An Informed Definition - TechEmergence](https://www.techemergence.com/what-is-machine-learning/)
<https://www.techemergence.com/what-is-machine-learning/> ▼ 翻译此页
2018年10月29日 - We asked 6 **machine learning** experts (including **machine learning** "godfather" Dr. Yoshua Bengio) to define "**Machine Learning**" as simply as ...

Machine learning - Wikipedia

https://en.wikipedia.org/wiki/Machine_learning ▼ 翻译此页

Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn from data, without being ...

Active learning (machine ... · Boosting (machine learning) · Online machine learning

What is Machine Learning? A definition - Expert System

<https://www.expertsystem.com/machine-learning-definition/> ▼ 翻译此页

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being ...

What is machine learning (ML)? - Definition from WhatIs.com

<https://searchenterpriseai.techtarget.com/definition/machine-learning-ML> ▼ 翻译此页

Machine learning (ML) is a category of algorithm that allows software applications to become more accurate in predicting outcomes without being explicitly ...

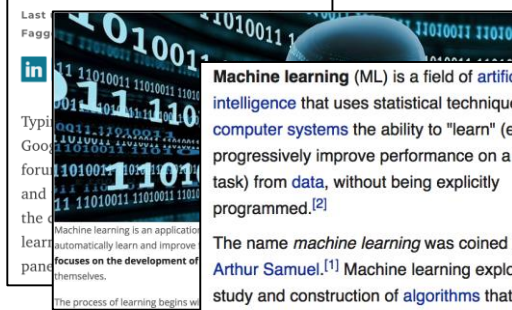
What is Machine Learning? - Introduction | Coursera

<https://www.coursera.org/.../machine-learning/what-is-machine-learning-Uj...> ▼ 翻译此页

Video created by Stanford University for the course "**Machine Learning**". Welcome to **Machine Learning**! In this module, we introduce the core idea of teaching a ...

Search

What is Machine Learning?



Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) from **data**, without being explicitly programmed.^[2]

The name *machine learning* was coined in 1959 by Arthur Samuel.^[1] Machine learning explores the study and construction of **algorithms** that can learn from and make predictions on **data**^[3] – such

Extract

Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" (e.g., progressively improve performance on a specific task) from **data**, without being explicitly programmed.^[2]

The name *machine learning* was coined in 1959 by Arthur Samuel.^[1] Machine learning explores the study and construction of **algorithms** that can learn from and make predictions on **data**^[3] – such algorithms overcome following strictly static program instructions by making data-driven predictions.

Machine learning (ML) is a field of artificial intelligence that uses statistical techniques to give computer systems the ability to "learn" from data, without being explicitly programmed.

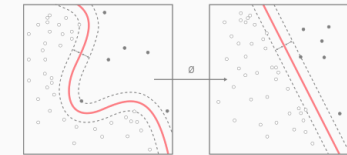
Knowledge Base



Machine learning

From Wikipedia, the free encyclopedia

Machine learning and data mining



Problems	[show]
Supervised learning (classification · regression)	[show]
Clustering	[show]
Dimensionality reduction	[show]
Structured prediction	[show]
Anomaly detection	[show]
Artificial neural networks	[show]
Reinforcement learning	[show]
Theory	[show]
Machine-learning venues	[show]
Glossary of artificial intelligence	[show]
Related articles	[show]
Machine learning portal	

Machine learning is intelligence that use computer systems to progressively improve task) from **data**, with programmed.^[2]

The name *machine learning* was coined in 1959 by Arthur Samuel.^[1] Machine learning explores the study and construction of algorithms that can learn from and make predictions on **data**^[3] – such algorithms overcome following strictly static program instructions by making data-driven predictions.

Machine learning is overlaps with) computer focuses on predictive computers. It has simulation optimization, which

High Question Diversity

Low Information Entropy

I Outline

- Open-domain Question Answering
- Formulation & HAS-QA
- Experiments
- Conclusion & Going Forward

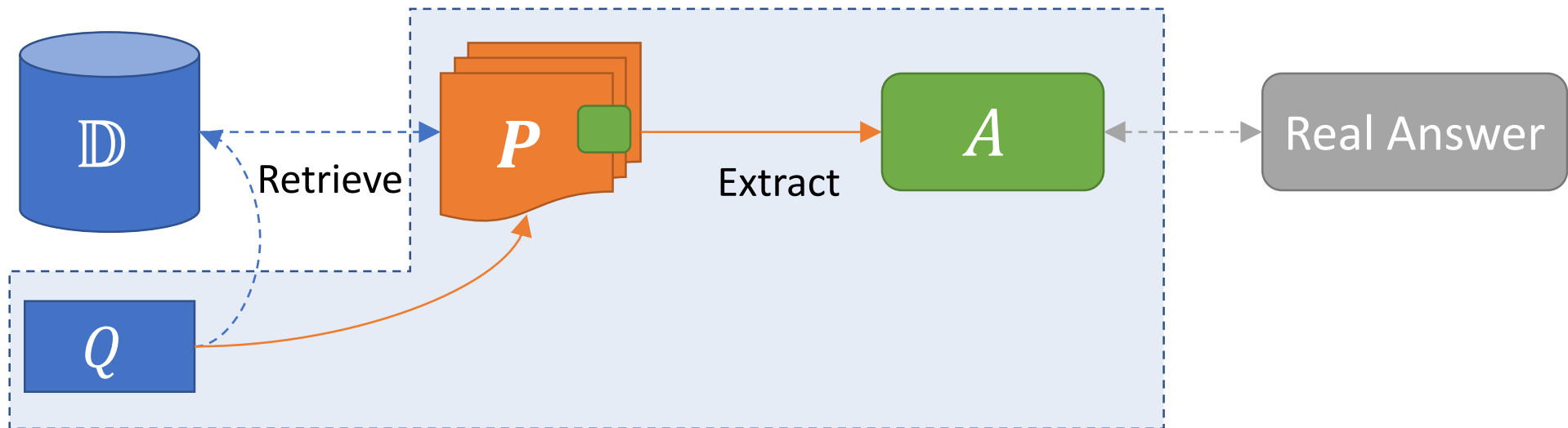
I OpenQA - Open-domain Question Answering

- **Input:**

- Q : real world question.
- \mathbb{D} : huge *unstructured text dataset*, such as **web page corpus** or **Wikipedia**.

- **Output:**

- A : answer text from text dataset, which can answer the input question



I Challenges

- 1 Sparsity of paragraphs contain answers
- 2 Uncertainty of answer spans
- 3 Conflict of span locations

I Challenges - Sparsity

新版五元人民币是什么花



百度一下

第五套人民币上面的花卉是些什么花?_百度知道



7个回答 - 回答时间: 2018年9月27日 - 40人觉得有用

最佳答案: 1、1元纸币——兰花 象征意义 风姿绰约 幽香远溢 兰为四君子之一,四季名花之司春使者,在...

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<https://zhidao.baidu.com/quest...> - 百度快照



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2个回答 - 回答时间: 2016年6月23日 - 39人觉得有用

最佳答案: 最新版的 100:人民大会堂 50:布达拉宫 20:桂林山水 10:长江三峡 5:泰山 1元:西湖十景之三潭印月 参考 第四套,即**新版人民币**,正面图案一是体现我国...

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人民币从一元钱到一百上面的图案都有花请问这些都是什么花?

1个回答 - 回答时间: 2008年04月26日

最佳答案: 第五套**人民币** 1元:水印和正面花团中的**花都是**兰花; 5元:水印和正面花团中的**花都是**水仙; 10元:水印和正面花团中的**花都是**月季; 20元:水印和正面花团中的**花都是**荷花...

<https://iask.sina.com.cn/b/124...> - 百度快照



新版5元人民币背面是什么图??? 爱问知识人

举报 新版**5元人民币** 背面是什么图??? 自-浮生未 分享: 全部答案 ...安迪出生的地方是一个小县城,安迪的妈妈是当地有名的花痴,因为疯了以后喜欢穿...

<https://iask.sina.com.cn/b/iR2...> - 百度快照



这张5元人民币,一定要记清楚,千万不要随便花!



2018年5月22日 - 2002年11月18日中国人民银行发行了99版**人民币**,虽然并不是1999年发行的,但是确定是属于99版人民币中...

baijiahao.baidu.com/s?... - 百度快照



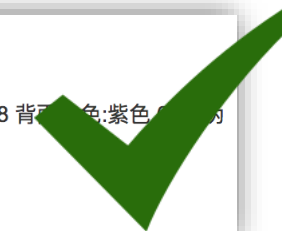
五元人民币上的水印花是什么花?_百度知道

1个回答 - 回答时间: 2016年6月16日

[专业] 答案:面额:5元 水印:水仙花 背景图案:泰山 发行时间:2002.11.18 背面主色:紫色 5元纸币的版:2005.08.31 正面图案:毛泽东头像 规格:116×56 正面主色:...

[更多关于新版五元人民币是什么花的问题>>](#)

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5元人民币有两个版本,出现这种号码,一定不要花掉!



2018年8月9日 - 第五套**人民币**是在1999年开始发行的,而面额5元的**人民币**也是在这个时期发行的,但是在第五套人民币中...

<https://baijiahao.baidu.com/s?...> - 百度快照



I Challenges - Uncertainty

新版五元人民币是什么花



百度一下

第五套人民币上面的花卉是些什么花?_百度知道



7个回答 · 回答时间: 2018年9月27日 · 40人觉得有用

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四君子之一,四季名花之司春使者,在...

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第五套人民币上面的花卉是些什么花?

我来答

2、5元纸币——水仙

象征意义

叶姿秀美,亭亭玉立,雅号“凌波仙子”,深受国人喜爱。每到农历春节,家家户户的厅堂中都要摆上一盆水仙花,黄蕊白被如金银的水仙总是会捎给人们新一年的喜气与财运。

I Challenges - Conflict



5元纸币 —— 水仙 象征意义 叶姿秀美，亭亭玉立，雅号“凌波仙子”，深

受国人喜爱。

每到农历春节，家家户户的厅堂中都要摆上一盆水仙花，黄蕊白被如金

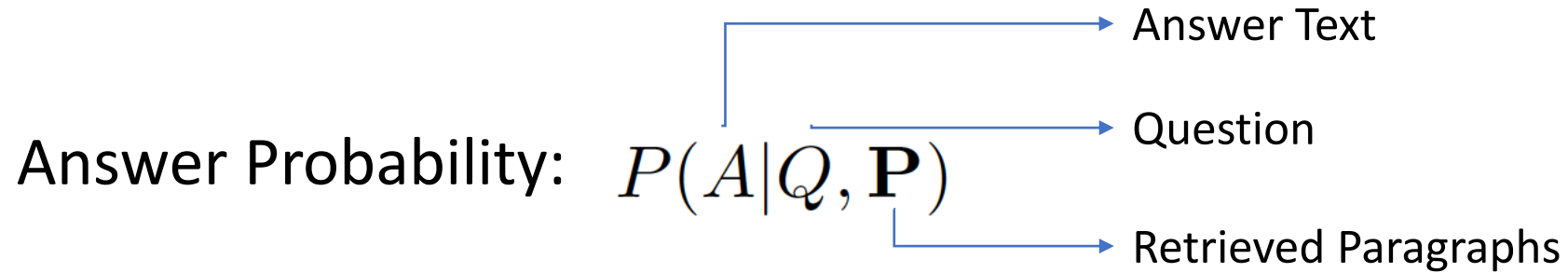
银的水仙总是会捎给人们新一年的喜气与财运。

I Outline

- Open-domain Question Answering
- **Formulation & HAS-QA**
- Experiments
- Conclusion & Going Forward

I Probabilistic Model – Target

- Target:



- Interpret:

- The probability of the text A is the answer text, given the question Q and retrieved paragraphs \mathbf{P} .

- Implement: HAS-QA Model

I Probabilistic Model – Challenge 1

○ Challenge 1:

Many paragraphs without the answer span are included in the data collection.

Answer Probability:
$$P(A|Q, \mathbf{P}) = \sum_{i=1}^K P(P_i|Q, \mathbf{P}) P(A|Q, P_i);$$

Conditional Answer Probability

Paragraph Probability

○ Interpret:

- **Paragraph Probability:** The probability of the paragraph P_i that contains answer text, given the question Q and retrieved paragraphs \mathbf{P} .
- **Conditional Answer Probability:** The probability of the text A is the answer text, given the question Q and paragraph P_i .

○ Implement: Paragraph Quality Estimator

I Probabilistic Model – Challenge 2

○ Challenge 2:

Multiple answer spans may exist within one given paragraph.

Conditional Answer $P(A|Q, P_i) := \mathcal{F}(\{P(L_j(A)|Q, P_i)\}_j),$

Probability:

$$j \in [1, |\mathcal{L}(A, P_i)|];$$

└──────────→ Span Probability

○ Interpret:

- **Span Probability:** The probability of the text span $L_j(A)$ is the answer span, given the question Q and paragraph P_i .
- \mathcal{F} is an aggregation function, such as MAX, SUM.
- There exist $|\mathcal{L}(A, P_i)|$ answer spans in paragraph P_i .

○ Implement: Multiple Span Aggregator

I Probabilistic Model – Challenge 3

○ Challenge 3:

The end position of an answer span is dependent with the start position.

Span Probability: $P(L_j(A)|Q, P_i) = P(L_j^s(A)|Q, P_i) \longrightarrow \text{Location Start Probability}$
 $\cdot P(L_j^e(A)|Q, P_i, L_j^s(A)).$

$\longrightarrow \text{Location End Probability}$

○ Interpret:

- **Location Start Probability:** The probability of the text span start location $L_j^s(A)$ is the answer span location.
- **Location End Probability:** The probability of the text span end location $L_j^e(A)$ is the answer span location, given start location $L_j^s(A)$.

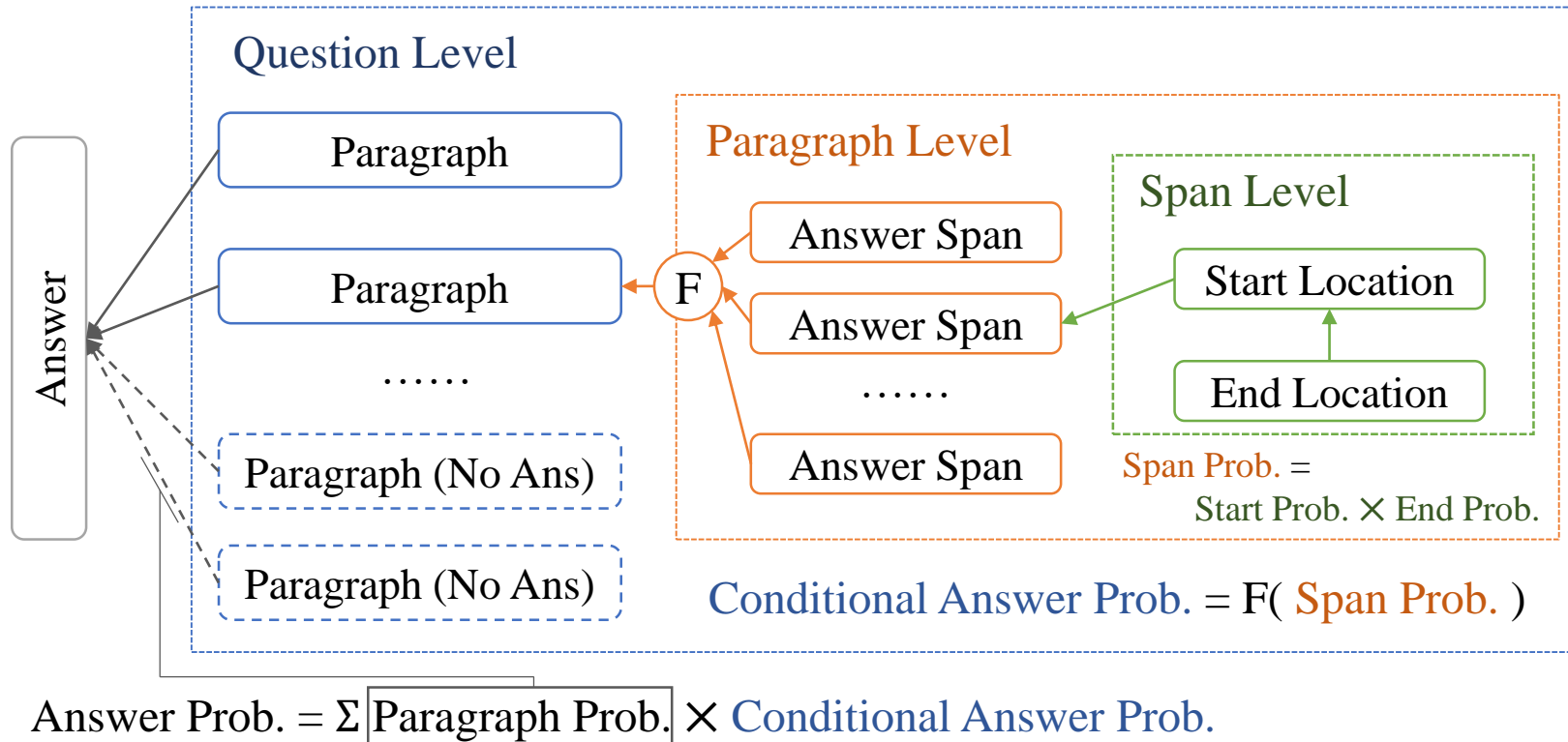
○ Implement: Conditional Span Predictor

I HAS-QA Model – OpenQA Task

- Target:

$$\text{Answer Probability: } P(A|Q, \mathbf{P})$$

- Model:



I HAS-QA Model – RC Task

For a **Reading Comprehension Task**

RC \subseteq OpenQA

○ **Object:** $P(A|Q, P^+)$.

○ **Model:** $P(A|Q, P^+) := P(L(A)|Q, P^+);$

$$P(L(A)|Q, P^+) = P(L^s(A)|Q, P^+) \\ \cdot P(L^e(A)|Q, P^+).$$

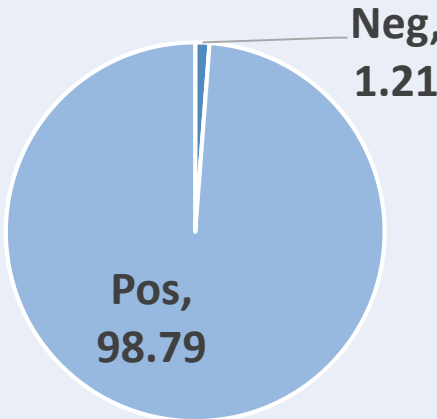
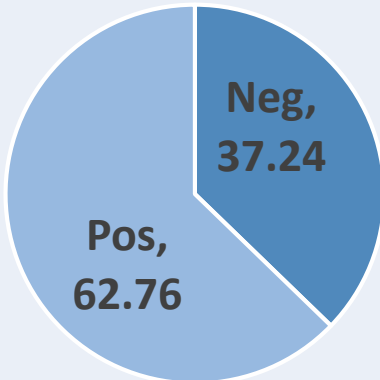
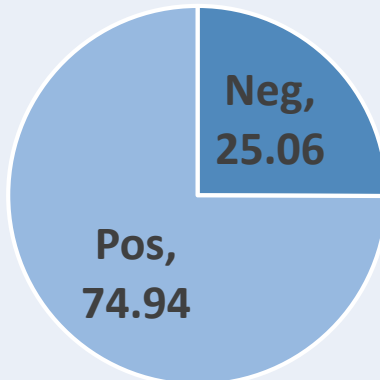
1. One paragraph
2. One answer span
3. Independence start and end location

I Outline

- Open-domain Question Answering
- Formulation & HAS-QA
- **Experiments**
- Conclusion & Going Forward

I Dataset

Three OpenQA Dataset

	QuasarT	TriviaQA	SearchQA												
Question Count	43K	95K	140K												
Negative Paragraph Ratio	 <table><tr><td>Pos,</td><td>98.79</td></tr><tr><td>Neg,</td><td>1.21</td></tr></table>	Pos,	98.79	Neg,	1.21	 <table><tr><td>Pos,</td><td>62.76</td></tr><tr><td>Neg,</td><td>37.24</td></tr></table>	Pos,	62.76	Neg,	37.24	 <table><tr><td>Pos,</td><td>74.94</td></tr><tr><td>Neg,</td><td>25.06</td></tr></table>	Pos,	74.94	Neg,	25.06
Pos,	98.79														
Neg,	1.21														
Pos,	62.76														
Neg,	37.24														
Pos,	74.94														
Neg,	25.06														
Average Answer Span Count	<div><div>SPAN</div><div>SPAN</div><div>SPAN</div></div>	<div><div>SPAN</div><div>SPAN</div></div>	<div><div>SPAN</div><div>SPAN</div><div>SPAN</div></div>												

Large Dataset

Noisy Paragraphs

Multiple Answer Spans

I Experiments

Model	QuasarT		TriviaQA		SearchQA	
	EM	F1	EM	F1	EM	F1
GA (Dhingra et al., 2017a)	0.264	0.264	-	-	-	-
BiDAF (Seo et al., 2016)	0.259	0.285	0.411	0.474	0.286	0.346
AQA (Buck et al., 2017)	-	-	-	-	0.387	0.456
DrQA (Chen et al., 2017)	0.377	0.445	0.323	0.383	0.419	0.487
R ³ (Wang et al., 2017a)	0.353	0.417	0.473	0.537	0.490	0.553
Shared-Norm (Clark and Gardner, 2017)	0.386	0.454	0.613	0.672	0.598	0.671
HAS-QA (MAX Ans. Span)	0.432	0.489	0.636	0.689	0.627	0.687

- 1) HAS-QA **outperforms** traditional RC baselines with a large gap, such as GA, BiDAF, AQA listed in the first part.
- 2) HAS-QA **outperforms** recent OpenQA baselines, such as DrQA, R3 and Shared-Norm listed in the second part.

I Outline

- Open-domain Question Answering
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I Conclusion

- A new probabilistic formulation of **OpenQA**, based on a three-level hierarchical structure, i.e., the question level, the paragraph level and the answer span level.
- HAS-QA Model
 - 1) a paragraph quality estimator makes it robust for the paragraphs without answer spans
 - 2) a multiple span aggregator points out that it is necessary to combine the contributions of multiple answer spans in a paragraph
 - 3) a conditional span predictor is proposed to model the dependence between the start and end positions of each answer span.

I Going Forward



Single Answer Spans Extraction



Multiple Answer Spans Extraction



Well-formed Answers Generation

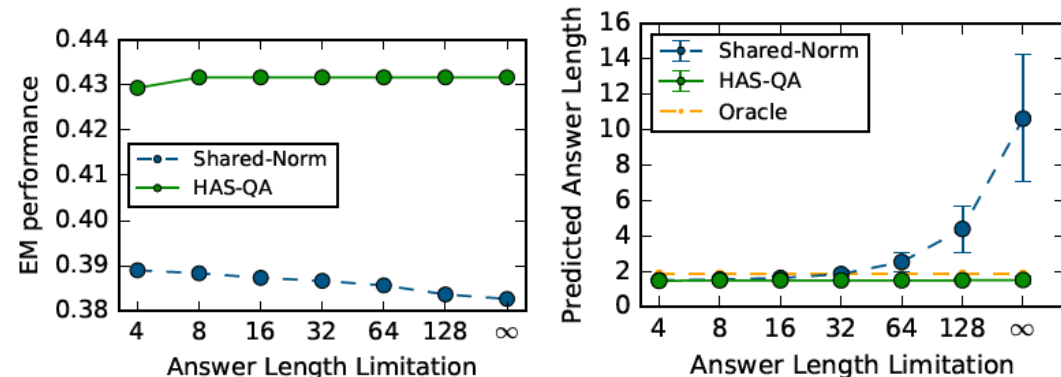
Thanks Q & A

Name: Liang Pang | Email: pangliang@ict.ac.cn

Experimental Analysis

○ Effects of Conditional Pointer Networks

1. The performance of Shared-Norm **decreases** when removing the answer length limitation, while the performance of HAS-QA first **increases** then becomes stable.
2. The average predicted answer length **increases** in Shared-Norm when removing the answer length limitation. However, HAS-QA stably **keeps** the about 1.8 average words, where the oracle average answer length is about 1.9 words.



Example:

About Celebrating the contributions of Louis Braille January 5th , 2009
On the 200th anniversary of Louis Braille 's birth , people around the
world are saluting a man whose tactile alphabet has provided a lifeline to
people with impaired vision .

Shared-Norm , HAS-QA

I Experimental Analysis

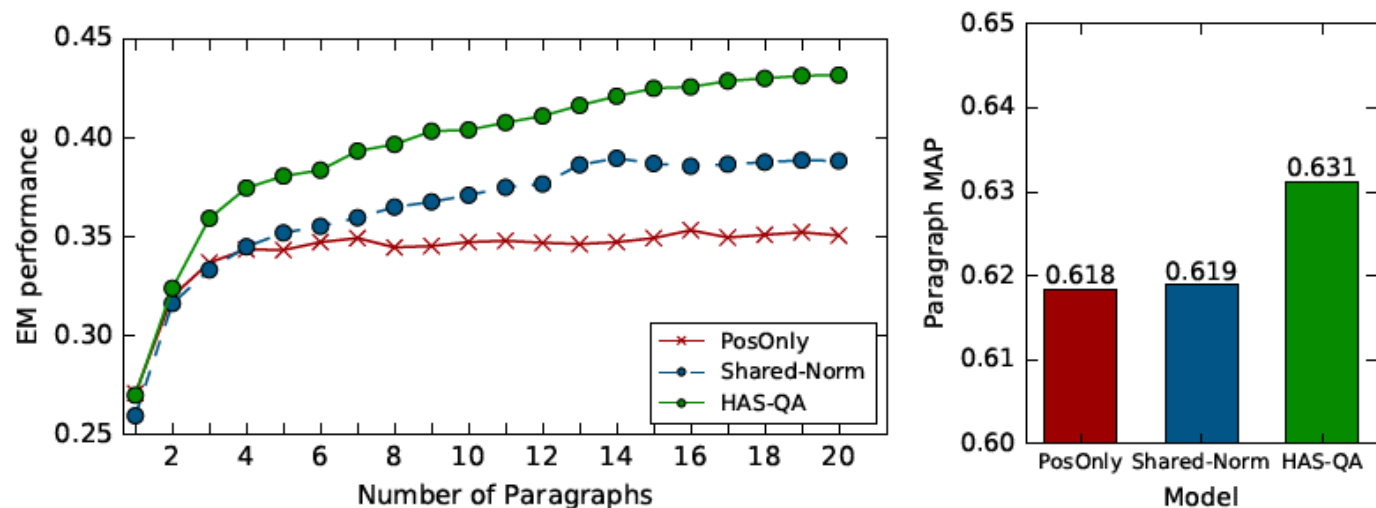
- Effects of Multiple Spans Aggregation

Model	EM	F1
HAS-QA (HEAD Ans. Span)	0.372	0.425
HAS-QA (RAND Ans. Span)	0.341	0.394
HAS-QA (SUM Ans. Span)	0.423	0.484
HAS-QA (MAX Ans. Span)	0.432	0.489

1. **SUM and MAX operations.** They take advantages of using multiple answer spans for training and improve about 6% - 10% in EM comparing to the **HEAD operation**.
2. The failure of **RAND operation**, mainly comes down to the conflicting training samples.

Experimental Analysis

○ Effects of Paragraph Quality



1. With the increasing number of given paragraphs which ordered by the rank of search engine, EM performance of HAS-QA **sustainably grows**.
2. The Mean Average Precision (MAP) score between the predicted scores and the label whether a paragraph contains answer spans, shows that HAS-QA can rank **the high quality paragraphs** in the front of the given paragraph list.