Learning to Ask Good Questions: Ranking Clarification Questions using Neural Expected Value of Perfect Information

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College Park

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New York

CODE + DATA: https://github.com/raosudha89/ranking_clarification_questions

Natural Language Understanding

Natural Language Understanding

How long does it take to get a PhD?

Natural Language Understanding

Google

YAHOO!

bing

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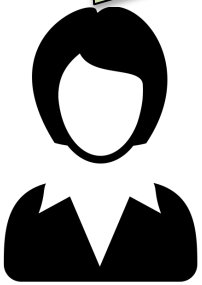

Human Interactions

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Teach Machines to Ask Clarification Questions

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How long does it take to get a PhD ?

In which field?

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Any dietary restrictions?

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What color is your coffee mug?

Teach Machines to Ask Clarification Questions

Context-aware questions about missing information

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Reading Comprehension Question Generation

My class is going to the movies on a field trip next week.
We have to get permission slips signed before we go.
We are going to see a movie that tells the story from a book we read.

Goal: Assess someone's understanding of the text

Q: What do the students need to do before going to the movies?

- Heilman. "Automatic factual question generation from text" Ph.D. thesis 2011
- Vasile, et al. "The first question generation shared task evaluation challenge." NLG 2010
- Olney, Graesser, and Person. "Question generation from concept maps." Dialogue & Discourse 2012
- Chali and Hasan. "Towards Topic-to-Question Generation." ACL 2015
- Serban, et al. "Generating Factoid Questions With Recurrent Neural Networks" ACL 2016
- Du, Shao & Cardie "Learning to ask: Neural question generation for reading comprehension" ACL 2017
- Tang et al. "Learning to Collaborate for Question Answering and Asking." NAACL 2018
- Mrinmaya and Xing. "Self-Training for Jointly Learning to Ask and Answer Questions." NAACL 2018

Question Generation for Slot Filling

USER:	I want to go to **Melbourne** on **July 14**
SYSTEM:	What **time** do you want to leave?
USER:	I must be in Melbourne by 11 am
SYSTEM:	Would you like a **Delta** flight that arrives at 10.15 am?
USER:	Sure
SYSTEM:	In what **name** should I make the reservation?

SLOTS

<origin city>
<departure city>
<origin time>
<departure time>
<airline>

- Goddeau, et al. "A form-based dialogue manager for spoken language applications." 1996
- Bobrow., et al. "GUS, a frame-driven dialog system." Artificial intelligence 1977
- Lemon, et al. "An ISU dialogue system exhibiting reinforcement learning of dialogue policies: generic slot-filling in the TALK in-car system." EACL 2006
- Williams, et al. The Dialog State Tracking Challenge" SIGDIAL 2013
- Young, et al. "Pomdp-based statistical spoken dialog systems: A review." IEEE 2013
- Dhingra, et al. "Towards End-to-End Reinforcement Learning of Dialogue Agents for Information Access." ACL 2017
- Bordes, et al. "Learning end-to-end goal-oriented dialog." ICLR 2017

Other types of Question Generation

- Liu, et al. "Automatic question generation for literature review writing support." International Conference on Intelligent Tutoring Systems. 2010
- Penas and Hovy, "Filling knowledge gaps in text for machine reading" International Conference on Computational Linguistics: Posters ACL 2010
- Artzi & Zettlemoyer, "Bootstrapping semantic parsers from conversations" EMNLP 2011
- Labutov, et al. "Deep questions without deep understanding" ACL 2015
- Mostafazadeh et al. "Generating natural questions about an image." ACL 2016
- Mostafazadeh et al. "Multimodal Context for Natural Question and Response Generation." IJCNLP 2017.
- Rothe, Lake and Gureckis. "Question asking as program generation" NIPS 2017.

Talk Outline

- Clarification Questions Dataset
- Problem Formulation: Question Ranking
- Expected Value of Perfect Information (EVPI) inspired model
- Evaluation
- Conclusion

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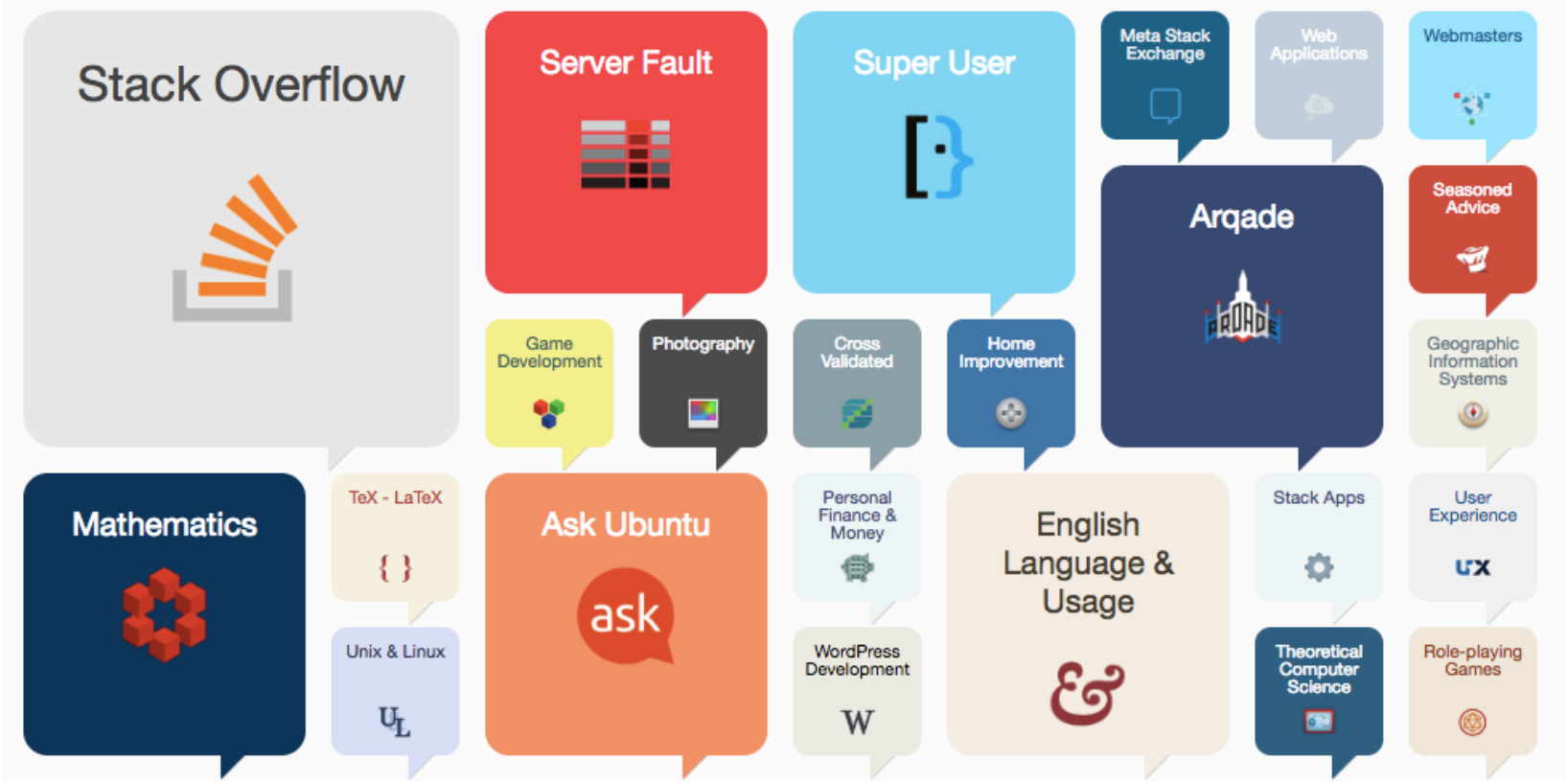
StackExchange Question-Answer Forum



Clarification Questions Dataset

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Finding: Questions go unanswered for a long time if they are not clear enough

Asaduzzaman, Muhammad, et al. "Answering questions about unanswered questions of stack overflow." Working Conference on Mining Software Repositories. IEEE Press, 2013.

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Question comment

What version of ubuntu do you have?

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← **Initial Post**

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← **Updated Post**

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← Edit as an answer to the question

← Updated Post

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Clarification Questions Dataset

Dataset Creation

(post , question , answer) triples

post — Original post

question — Clarification question posted in comments

answer — Edit made to the post in response to the question
OR author's reply to the question comment

Dataset Size: **~77 K triples**

Domains: Askubuntu, Unix, Superuser

Note: We identify a question using the question mark (?) token. We match the edit to the answer using timestamp & word embedding similarity based heuristics.

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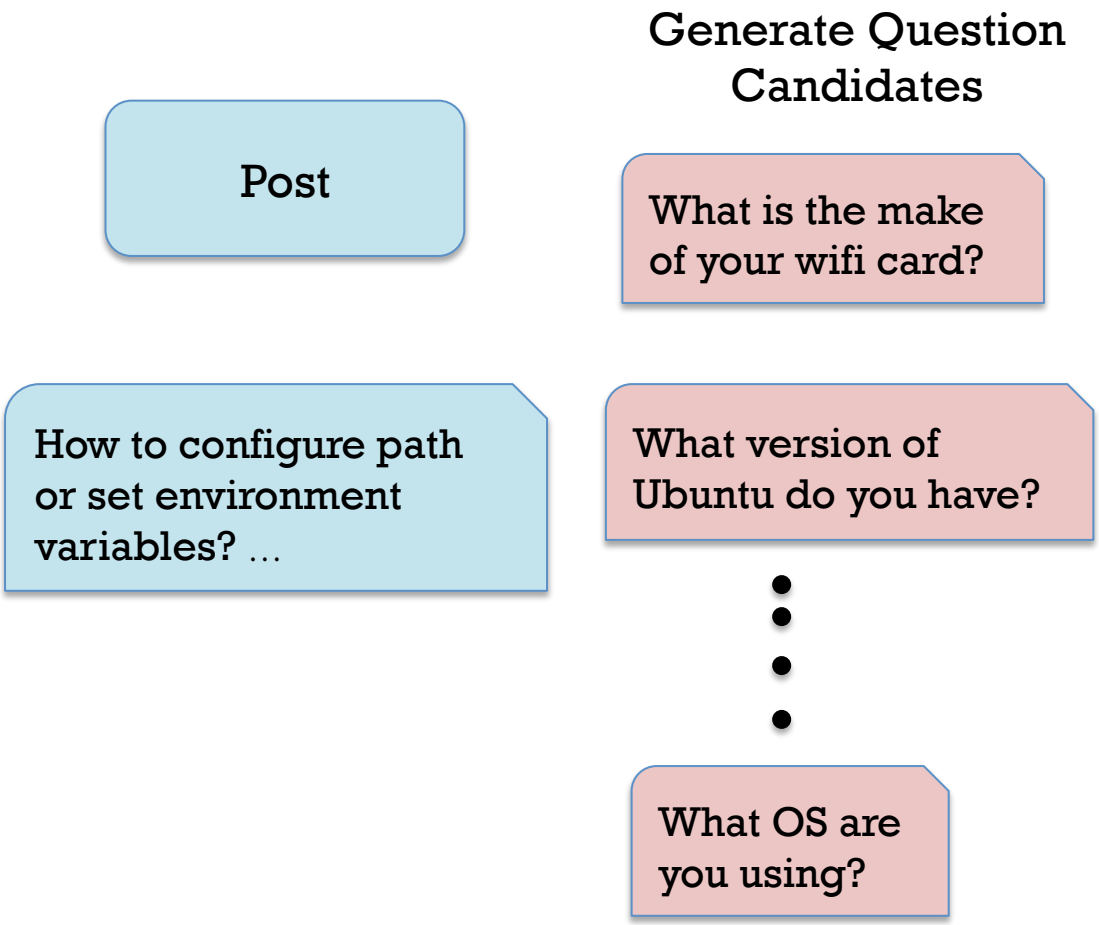
Problem Formulation: Question Ranking

Post

How to configure path or set environment variables? …

Problem Formulation: Question Ranking



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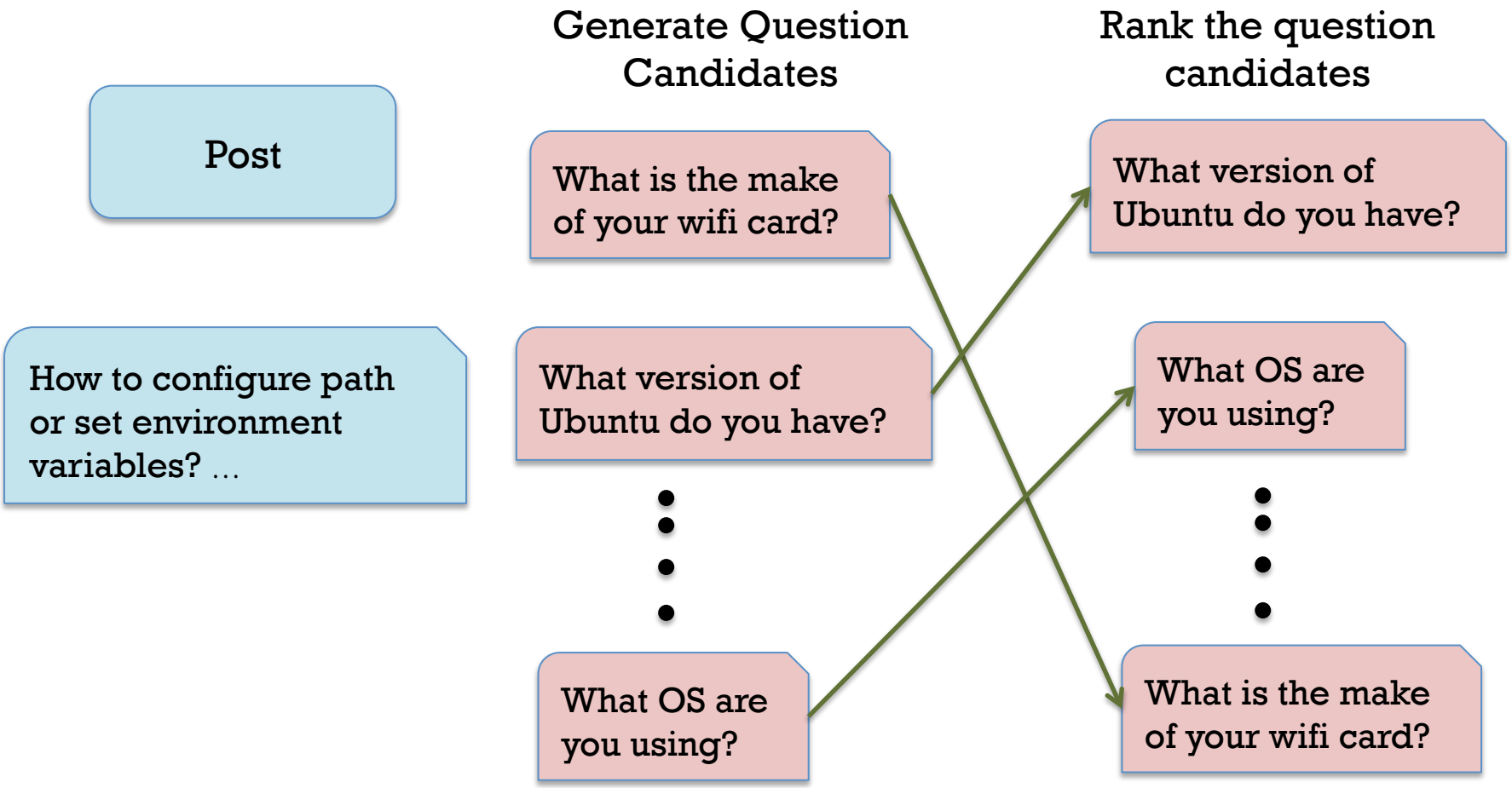

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What version of Ubuntu do you have?

How are you installing ape?

Do you have GSL installed?

Shortlist of useful questions

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Key Idea

How to configure path or set environment variables for installation?
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Possible questions

(a) What version of Ubuntu do you have? → **Just right**

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Possible questions

(a) *What version of Ubuntu do you have?* → **Just right**

(b) *What is the make of your wifi card?* → **Not useful**

Key Idea

How to configure path or set environment variables for installation?
I'm aiming to install ape, a simple code for pseudopotential generation.
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So I have the library but the program installation isn't finding it.
Any help? Thanks in advance!

Possible questions

(a) What version of Ubuntu do you have? → **Just right**

(b) What is the make of your wifi card? → **Not useful**

(c) Are you running Ubuntu 14.10 kernel 4.4.0-59-generic on an x86 64 architecture? → **Unlikely to add value**

Expected Value of Perfect Information (EVPI) inspired model

- Use EVPI to identify questions that add the most value to the given post

Avriel, Mordecai, and A. C. Williams. "The value of information and stochastic programming." Operations Research 18.5 (1970)

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- Definition: Value of Perfect Information VPI (x)

  How much value does x add to a given information content c?

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Likelihood of x given c

$$\text{EVPI}(x|c) = \sum_{x \in X} P(x|c)\ \text{Utility}(x, c)$$

Value of updating c with x

Avriel, Mordecai, and A. C. Williams. "The value of information and stochastic programming." Operations Research 18.5 (1970)

EVPI formulation for our problem

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EVPI (q_i | p)

p : given post

q_i : question from set of question candidates Q

EVPI formulation for our problem

Likelihood of a_j being the answer to q_i on post p

$$\mathbf{EVPI}(q_i \mid p) = \mathbf{P}(a_j \mid p, q_i)$$

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EVPI formulation for our problem

Likelihood of a_j being the answer to q_i on post p

$$EVPI(q_i \mid p) = P(a_j \mid p, q_i)\, U(p + a_j)$$

Utility of updating the post p with answer a_j

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EVPI formulation for our problem

Likelihood of a_j being the answer to q_i on post p

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EVPI formulation for our problem

We rank questions based on their EVPI value

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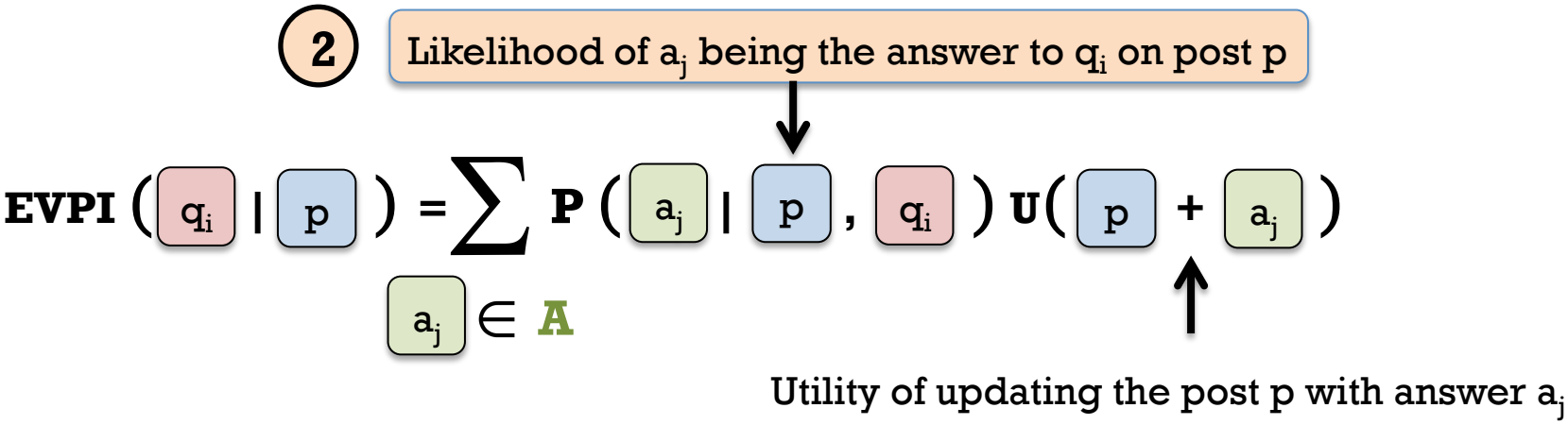
EVPI formulation for our problem



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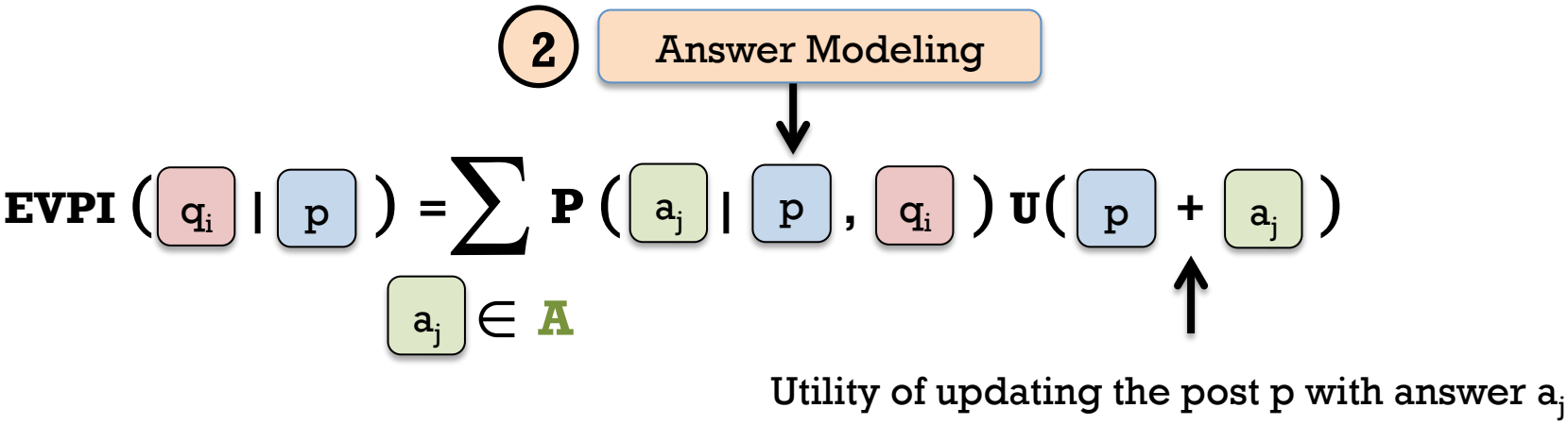

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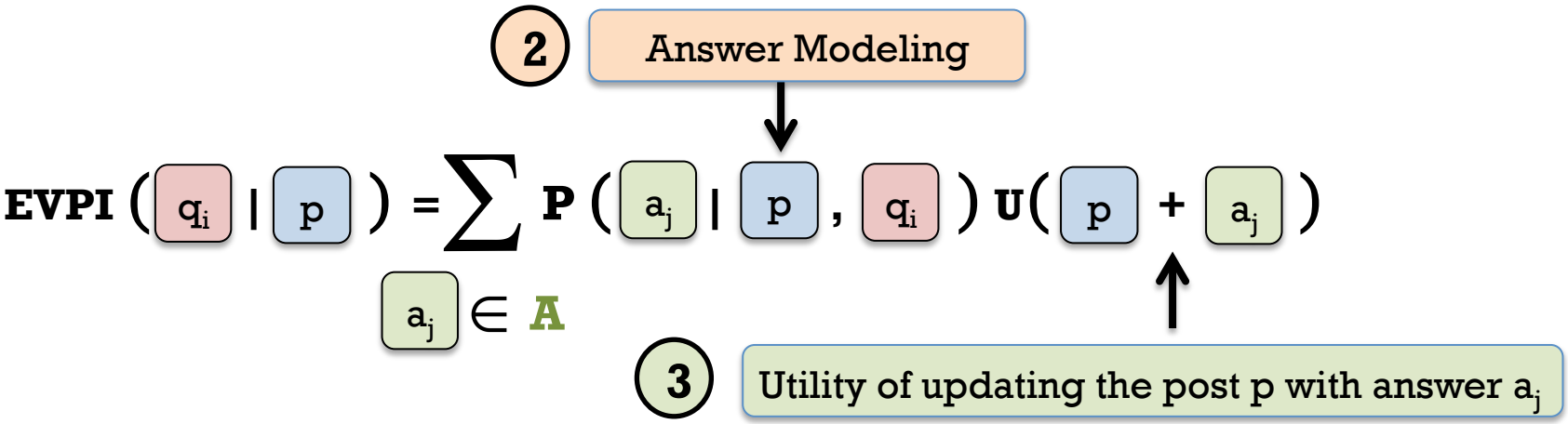

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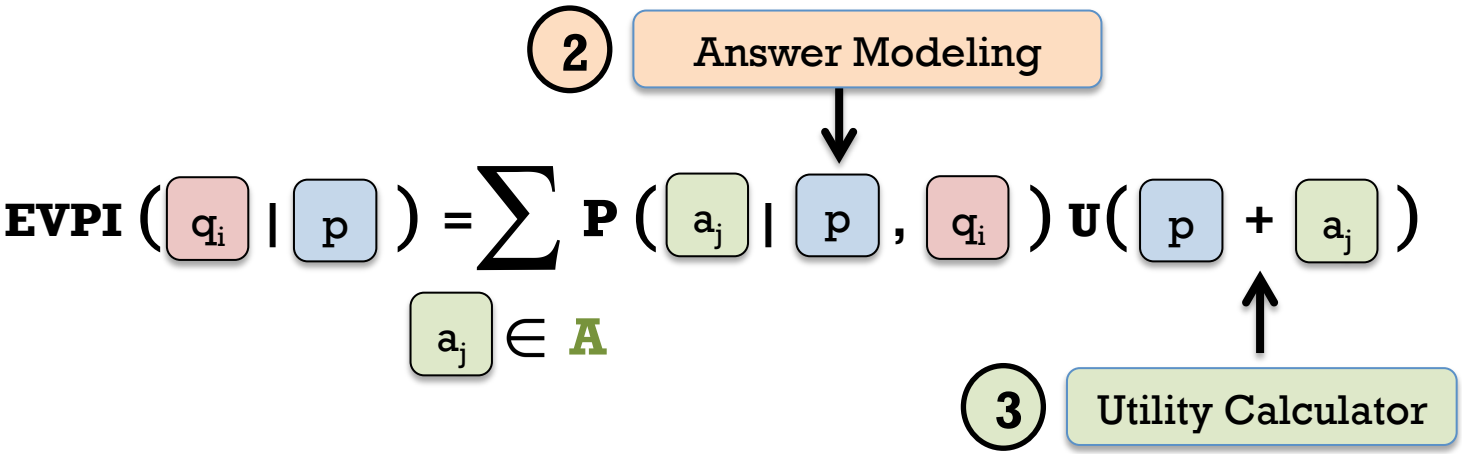

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Question & Answer Candidate Generator

Expected Value of Perfect Information (EVPI) inspired model

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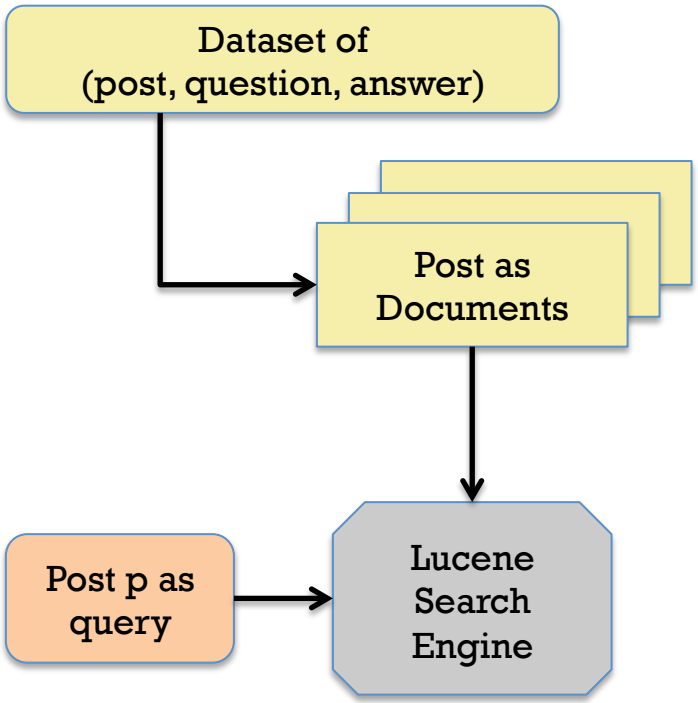

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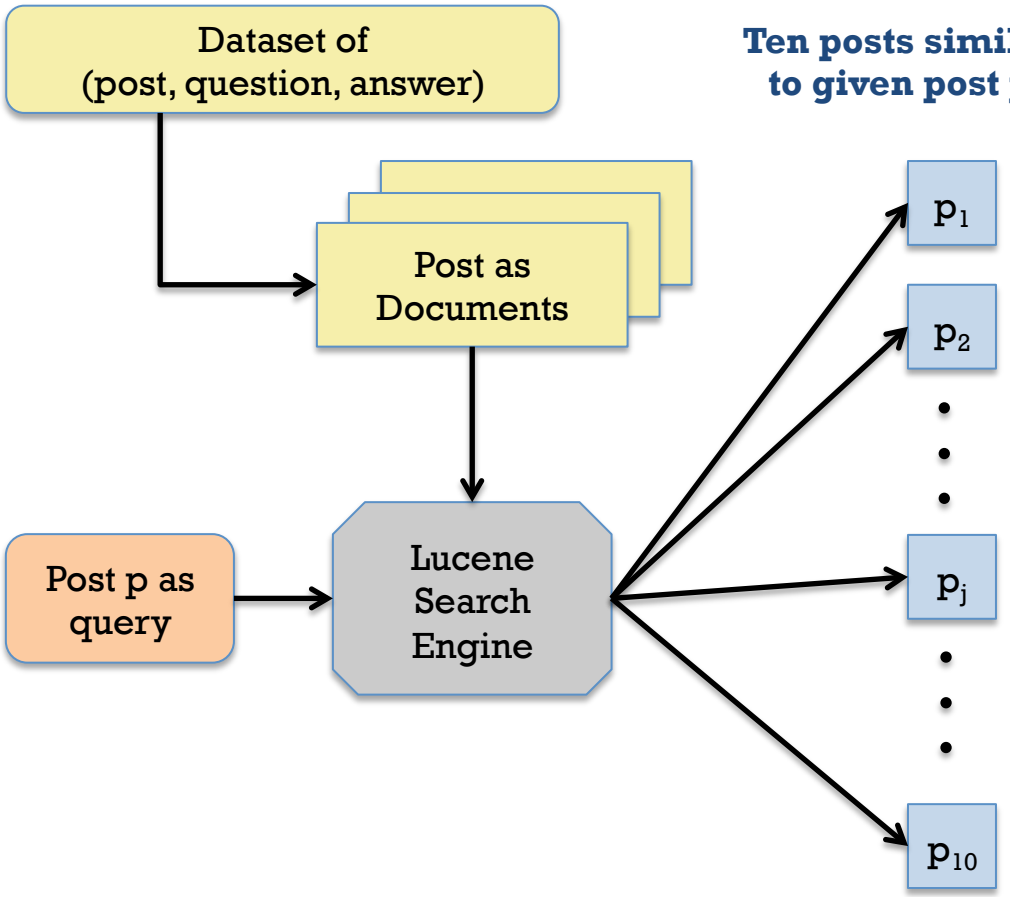

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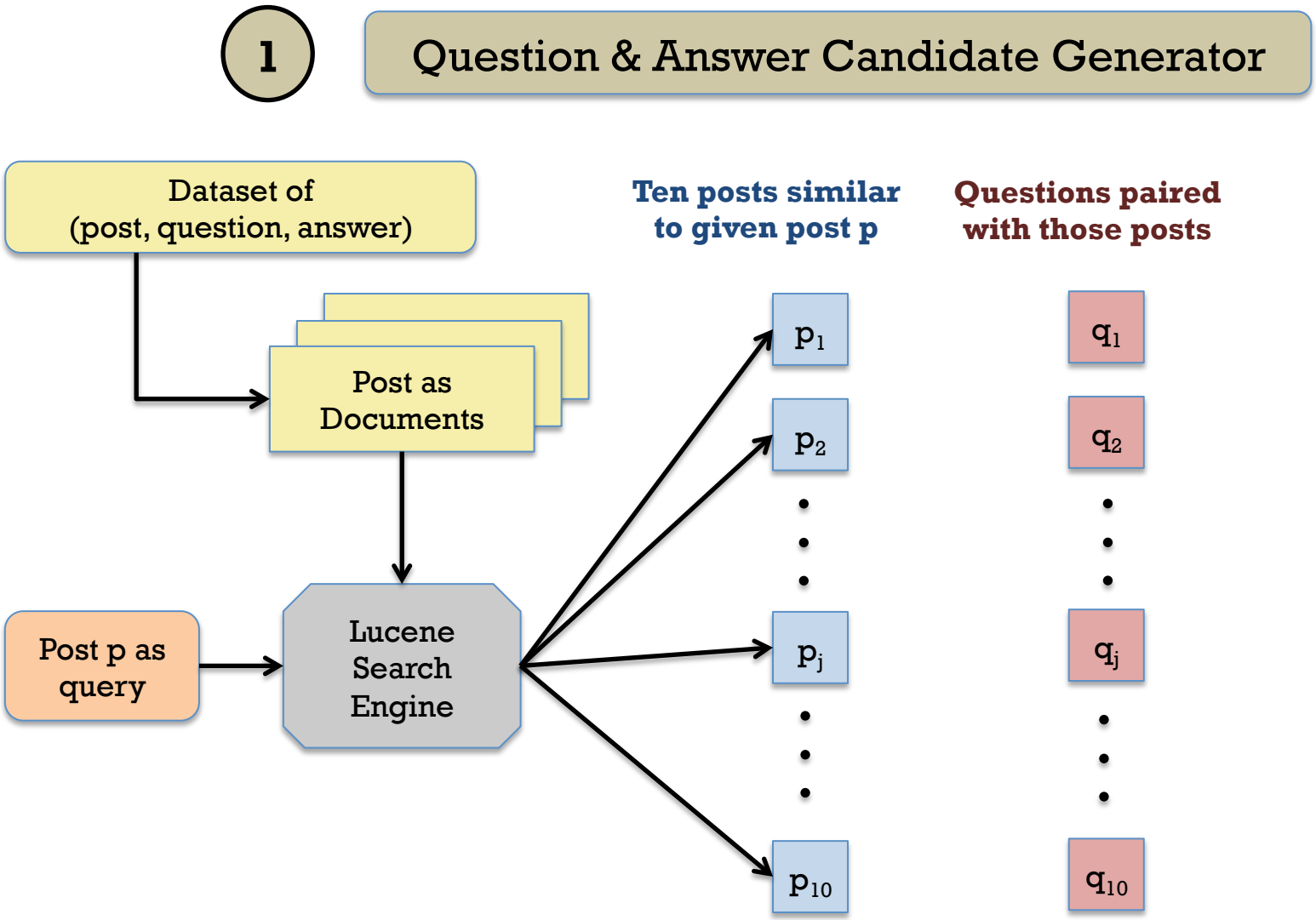

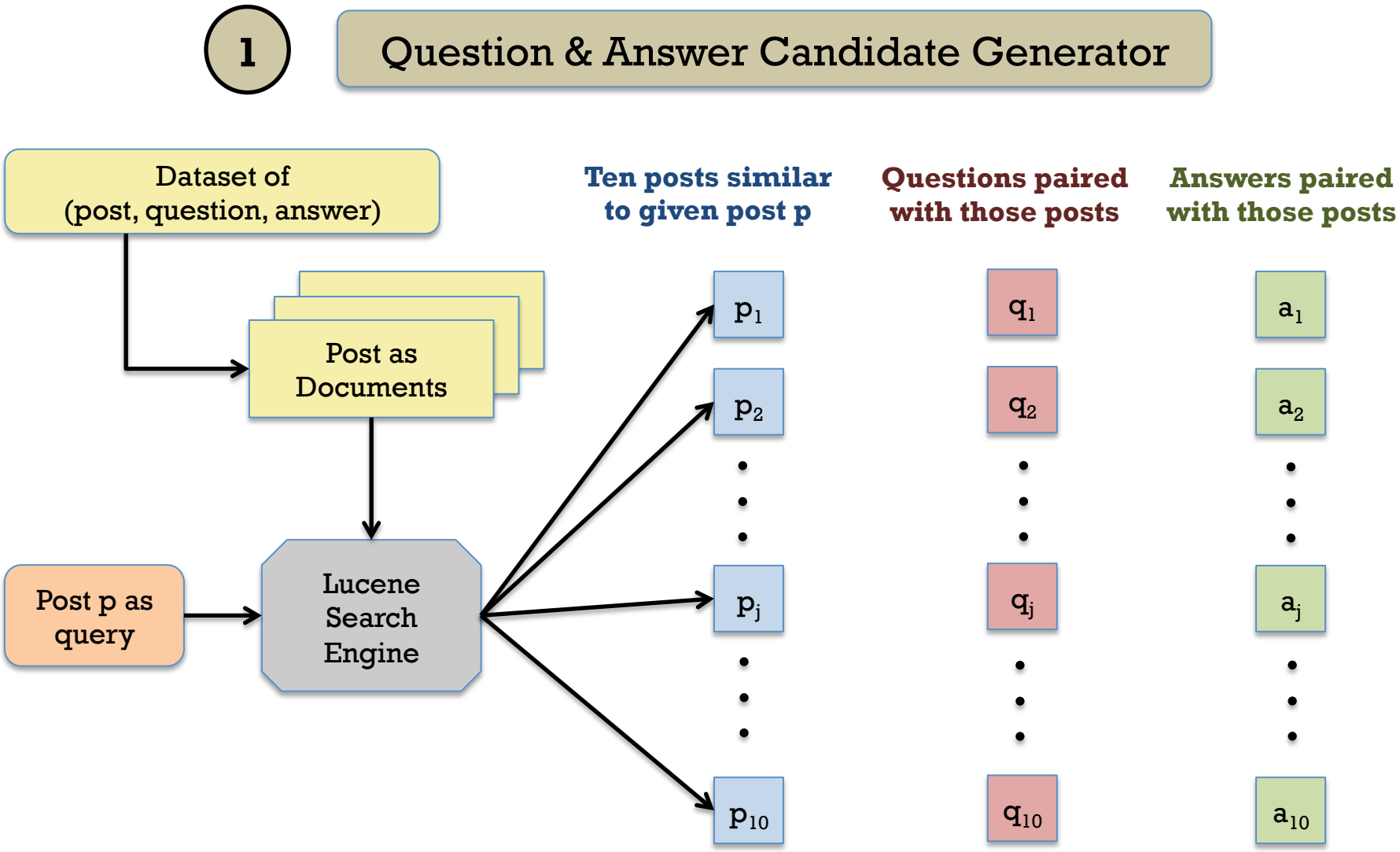
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Dataset of (post, question, answer)
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Post p as query
Lucene Search Engine
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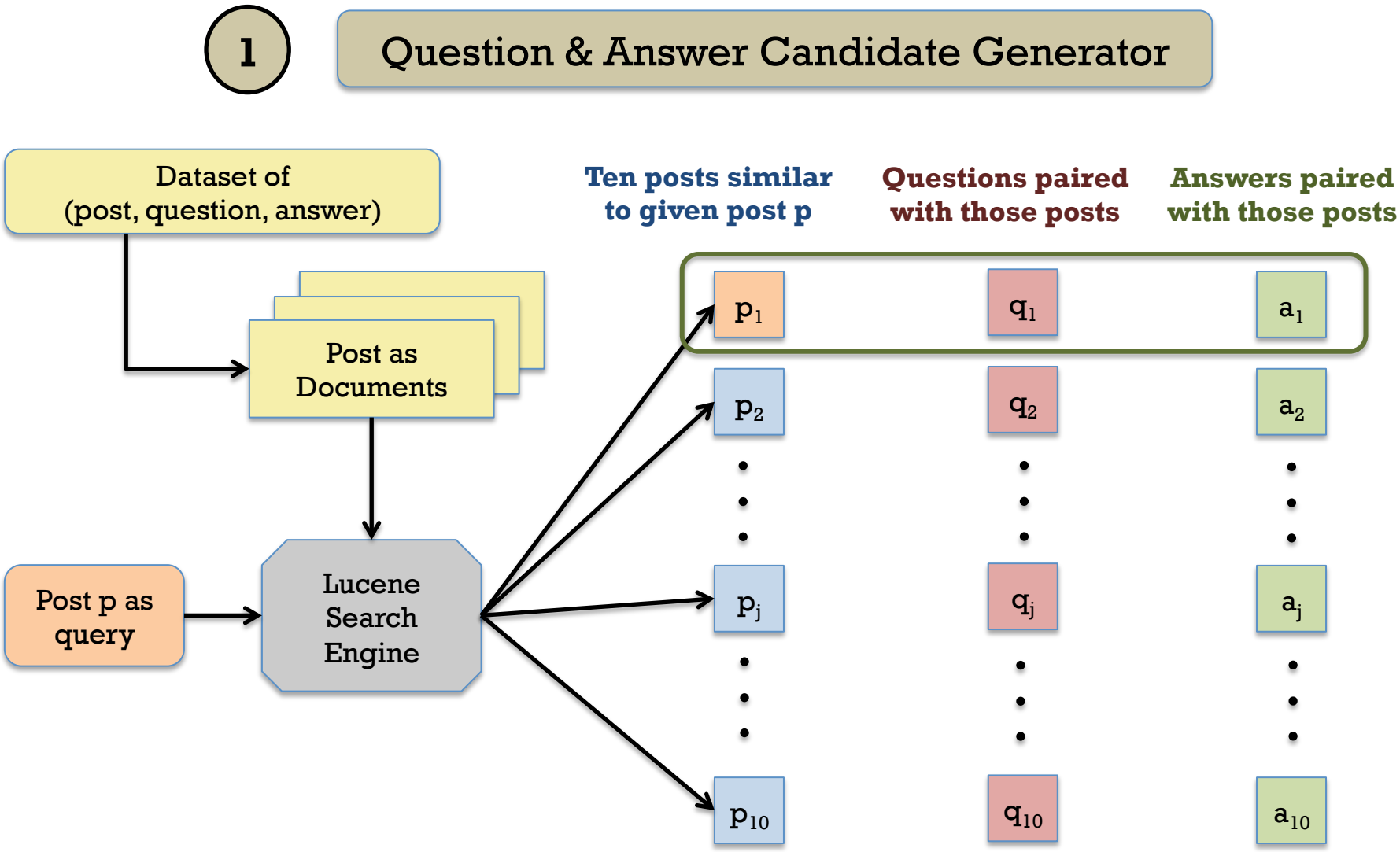
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Answer Modeling

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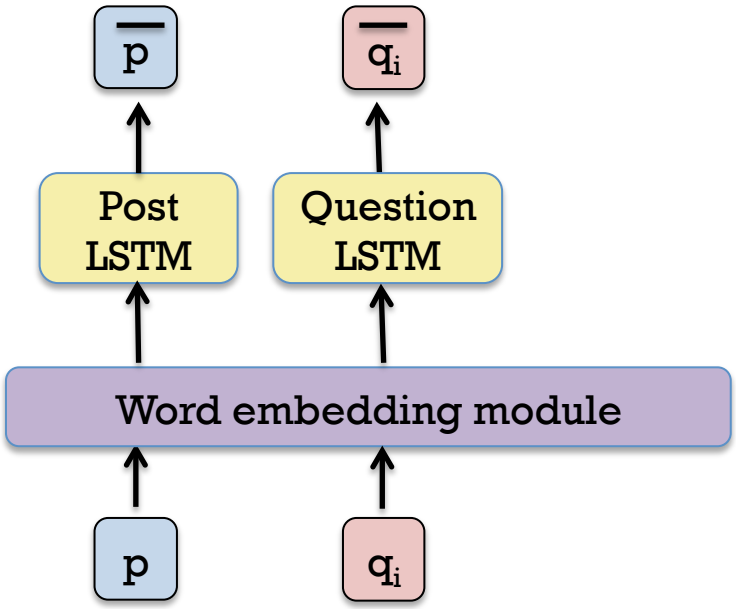
2

Answer Modeling

$$\mathbf{P}\left(a_j \mid p, q_i\right)$$

2 **Answer Modeling**

$$P(a_j \mid p, q_i)$$



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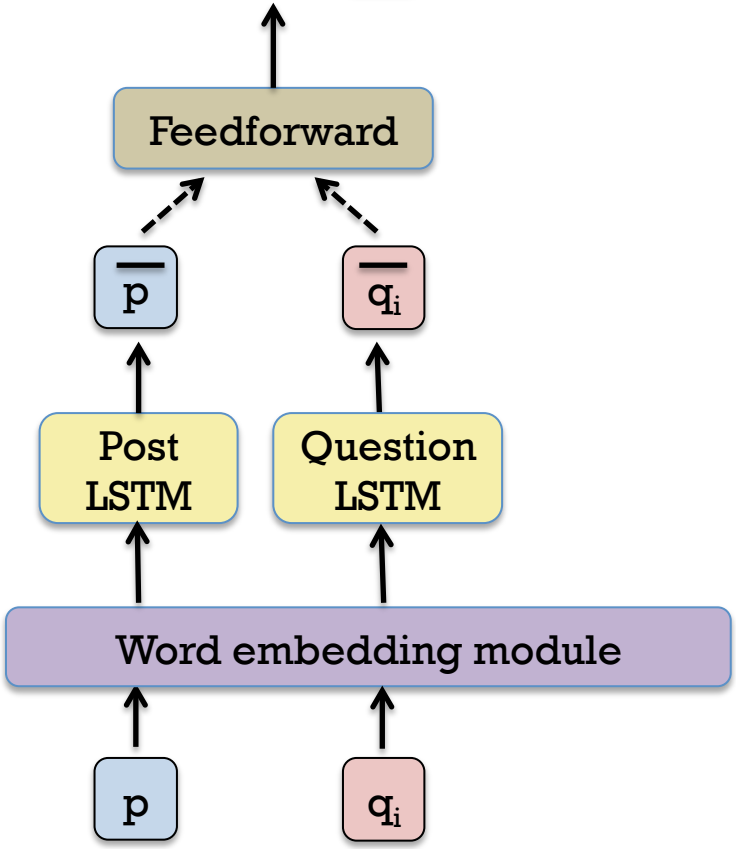
$$\mathbf{P}(a_j \mid p, q_i)$$

$$\text{Emb}_{\text{ans}}(p, q_i)$$



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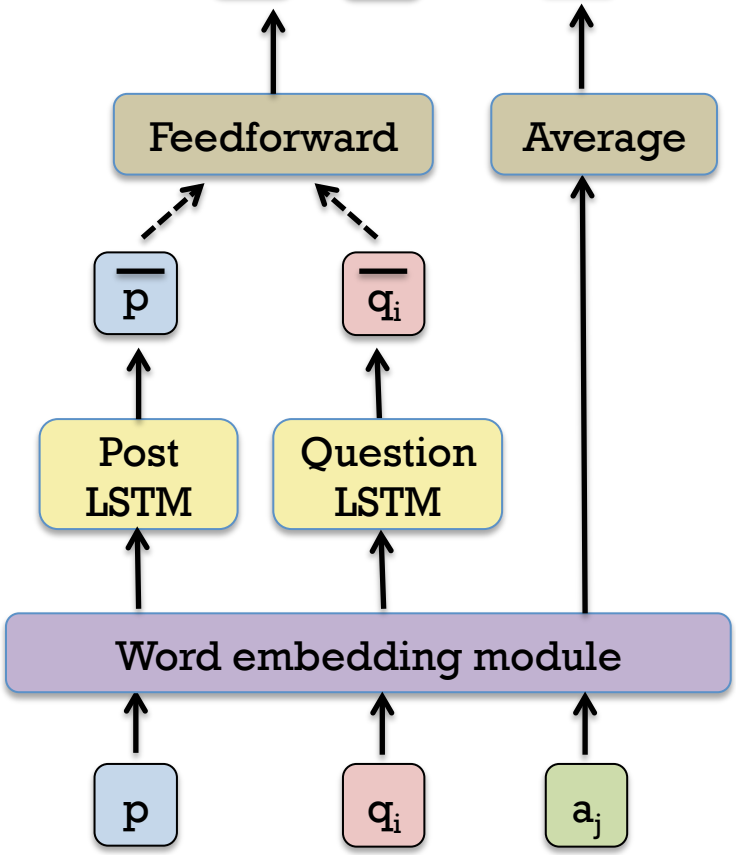

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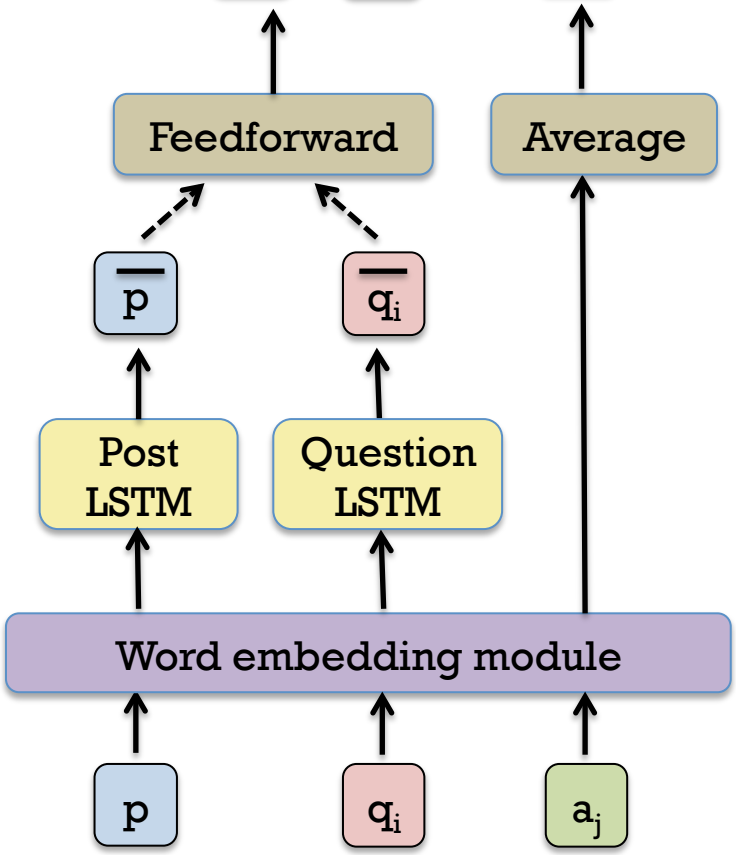
$\text{Emb}_{ans}(p, q_i)$ **Training**



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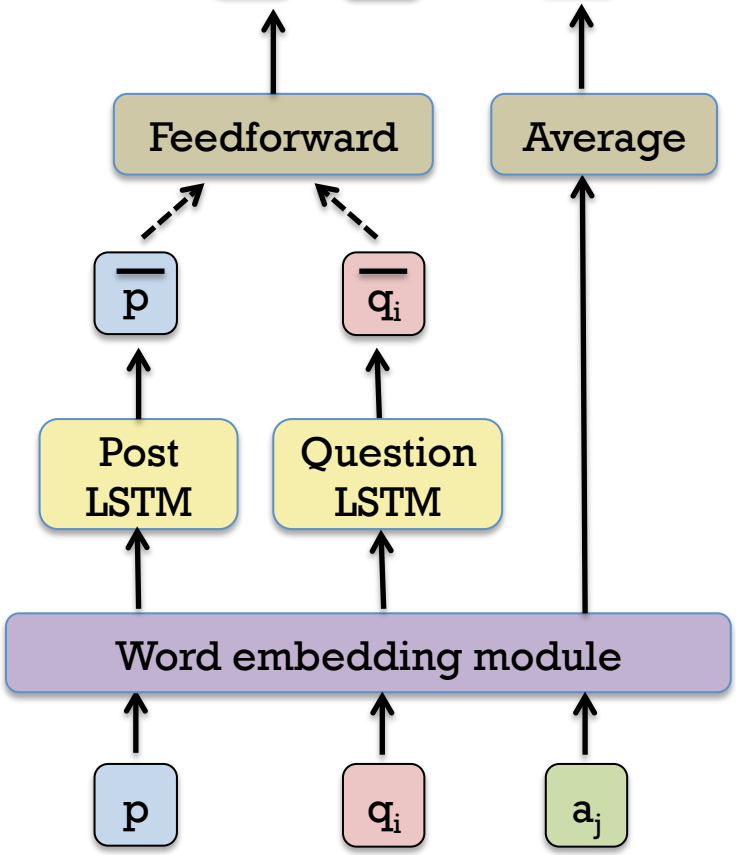
$\text{Emb}_{ans}(p, q_i)$

Training

Close to true a_i paired with p

a_i : Ubuntu 14.04 LTS

q_i : *Which version of Ubuntu do you have?*



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$\text{Emb}_{ans}(p, q_i)$

Close to true a_i paired with p

a_i : Ubuntu 14.04 LTS

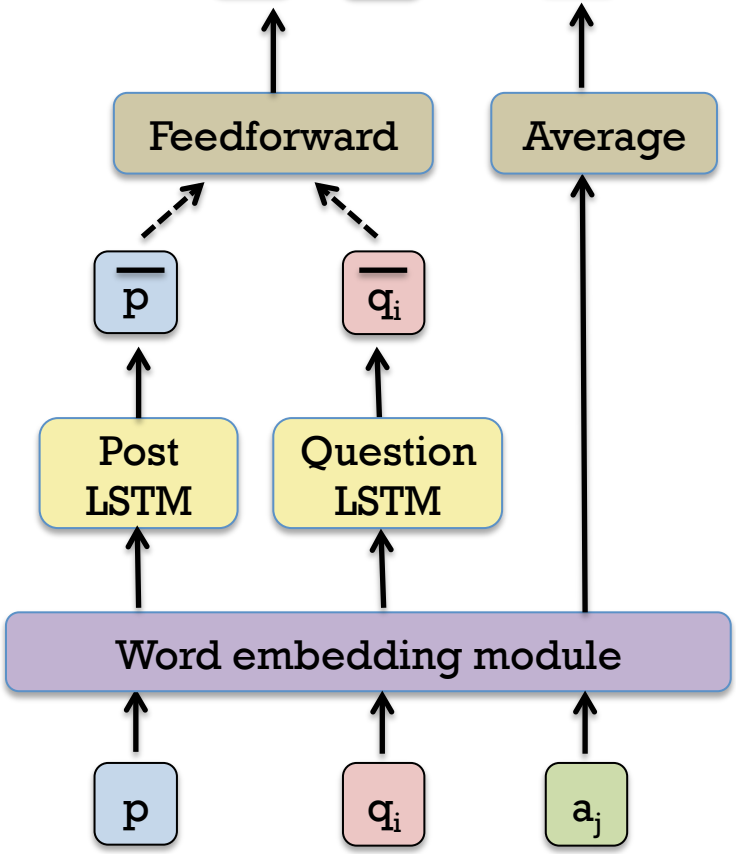
q_i : *Which version of Ubuntu do you have?*

Training

Close to a_k paired with q_k similar to true q_i

a_k : Ubuntu 11.10

q_K : *What OS are you using?*



Expected Value of Perfect Information (EVPI) inspired model

3

Utility Calculator

$$\mathbf{EVPI}\left(q_i \mid p\right) = \sum_{a_j \in A} \mathbf{P}\left(a_j \mid p, q_i\right) \mathbf{U}\left(p + a_j\right)$$

3

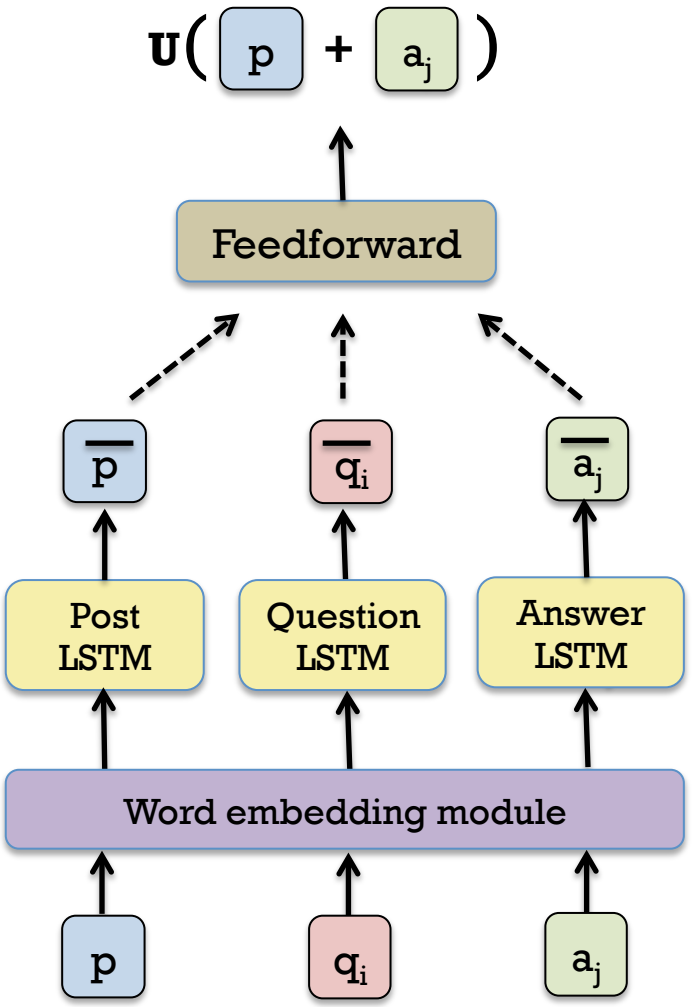
Utility Calculator

$$U(p + a_j)$$

3

Utility Calculator

Value between 0 and 1



3

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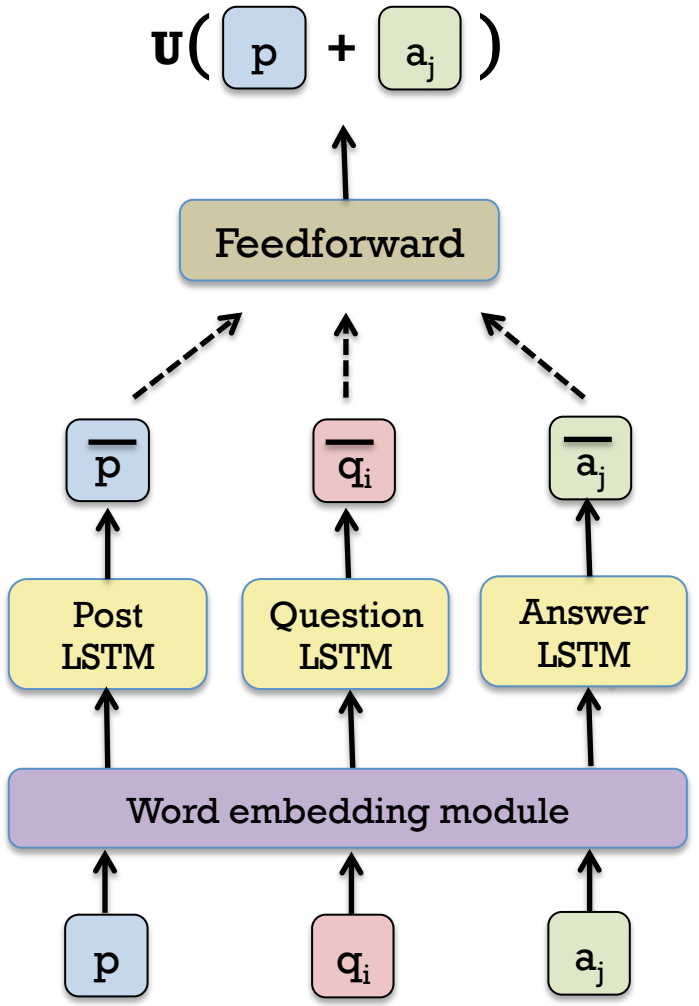

Training

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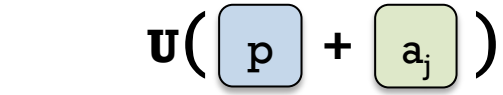
Utility Calculator

Value between 0 and 1

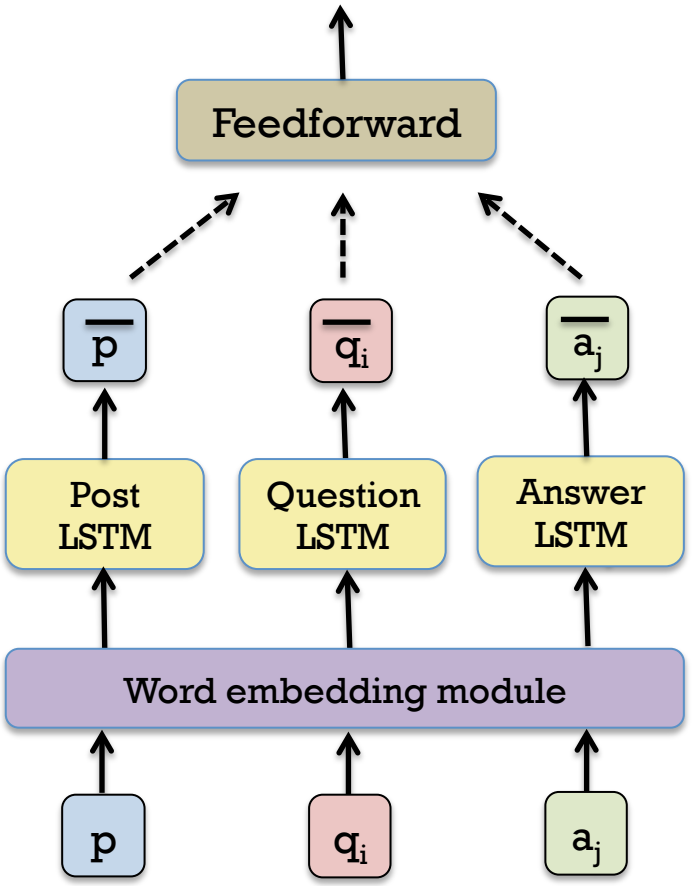


Training

q_i : Which version of Ubuntu do you have?
a_i : Ubuntu 14.04 LTS

Label

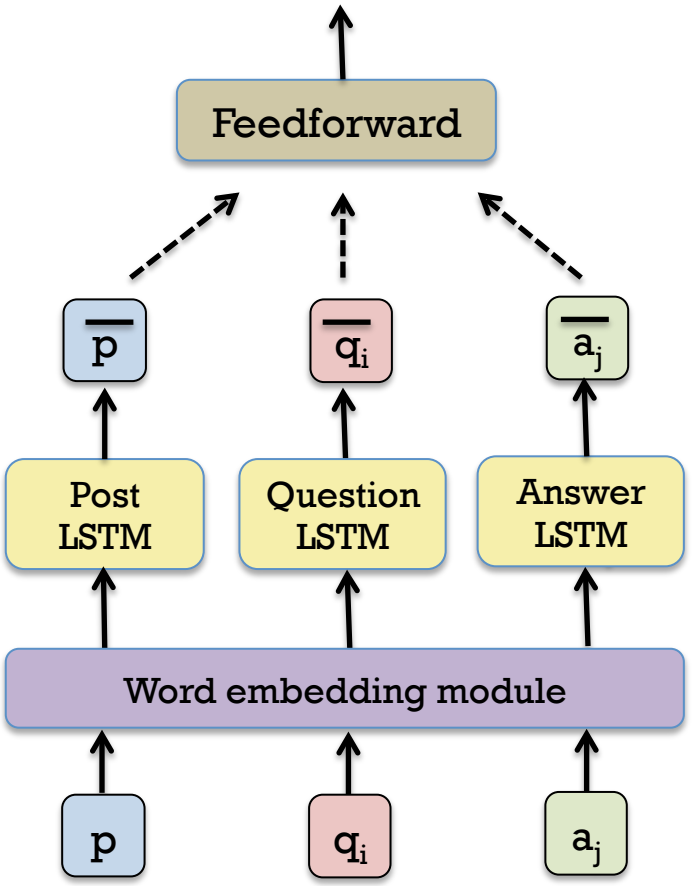
y = 1



3 **Utility Calculator**

Value between 0 and 1

$U(p + a_j)$



Training

	Label
q_i: Which version of Ubuntu do you have? a_i: Ubuntu 14.04 LTS	y = 1
q_j: What OS are you using? a_j: Ubuntu 11.10	y = 0
⋮	⋮
q_k: What is the make of your wifi card? a_k: TP-Link TL-WDN4800	y = 0

3 **Utility Calculator**

Value between 0 and 1

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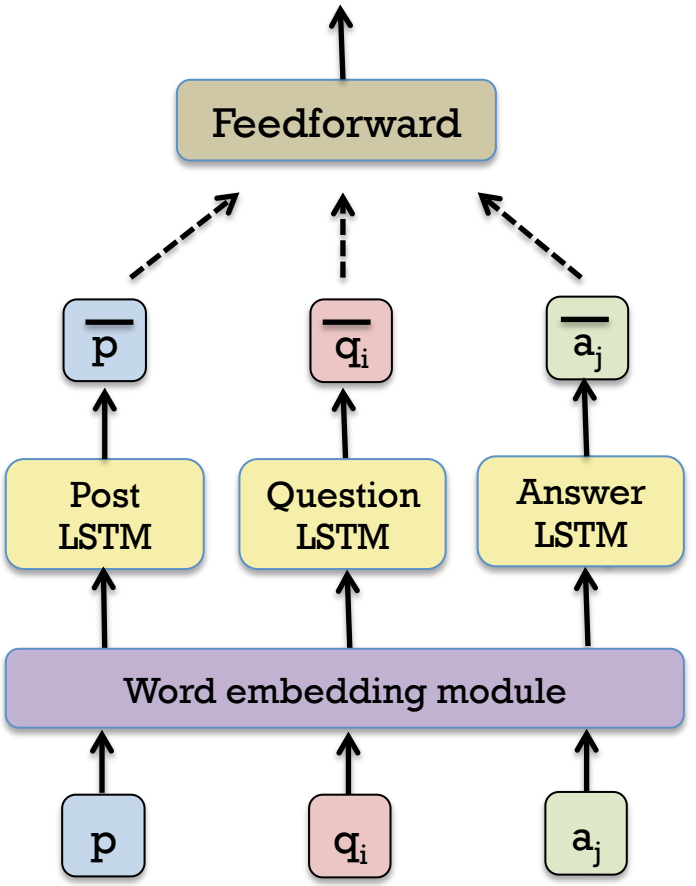

Training (Minimize binary cross-entropy)

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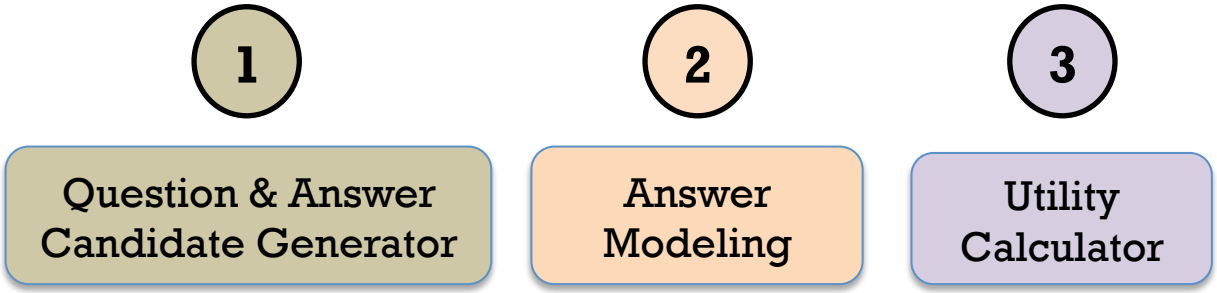
Expected Value of Perfect Information (EVPI) inspired model



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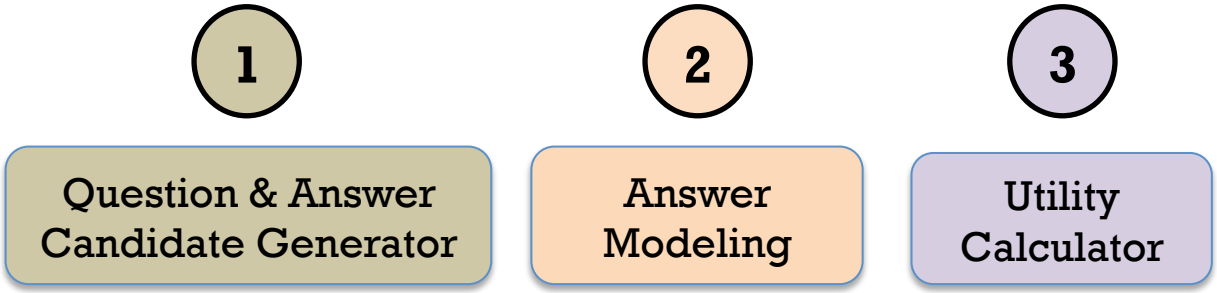

Train time behavior: For each (p, q, a) in our train set

1. Generate question candidates (Q) and answer candidates (A)
2. Train Answer Model and Utility Calculator

   using joint loss function : $\text{loss}_{\text{ans}}(p, q, a, Q) + \text{loss}_{\text{util}}(y, p, q, a)$

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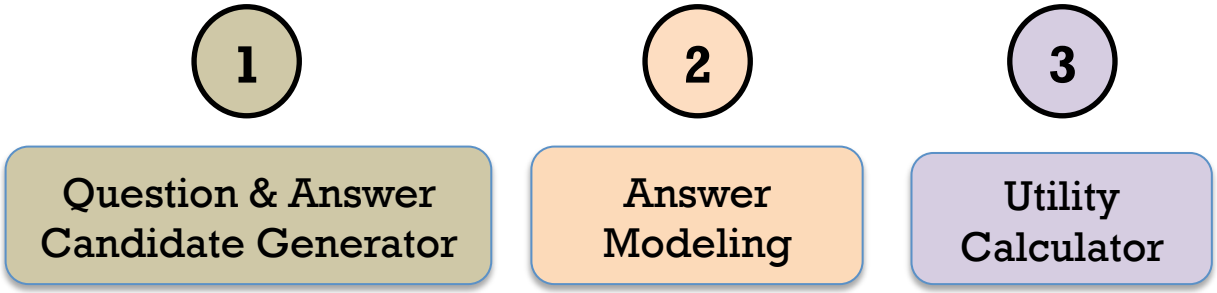

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Test time behavior: Given a post from our test set

1. Generate question candidates (Q) and answer candidates (A)
2. Calculate $P(a_j \mid p, q_i)$ for each $q \in Q$ using Answer Model
3. Calculate $U(p + a_j)$ for each $a \in A$ using Utility Calculator
4. Rank questions by EVPI $(q_i \mid p) = \sum_{a_j \in A} P(a_j \mid p, q_i)\, U(p + a_j)$

Talk Outline

- Clarification Questions Dataset
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Too much disk read/write when launching an application

I have Xubuntu 13.04 on an old Dell Inspiron.

When I launch an application it takes a pretty long time to be launched and I see a lot of disk read/write.

If the system was short on memory, this would be understandable as the system would use swap. But that's not the case in my situation (i.e. I have this problem even when the RAM is almost empty).

Post

Question Candidates

1. How much ram do you have installed ? and what size it the swap disk partition ?
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6. Do your system were recently updated ?
7. Why not have two ssds in raid 1 for redundancy ?
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Post

Question Candidates ← **Contains more than one good question!**

1. **How much ram do you have installed ? and what size it the swap disk partition ?**
2. If you do not have any problem with getting a little techy then may i suggest a method ?
3. **How is it slow exactly ? boot time ? hdd read/write ? cpu time ? graphics rendering ?**
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Evaluation set creation process

- We recruit 10 Unix admin experts using UpWork
- Given a post and the set of ten question candidates
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- **Union of Bests**: Questions marked as best by either of the annotators
- **Intersection of Valids**: Questions marked as valid by both annotators

	Best		Valid	
	A1	A2	A1	A2
Q1			✓	✓
Q2		✓	✓	
Q3	✓		✓	✓
Q4				✓
Q5			✓	✓

Union of Bests: { Q2, Q3 }

Intersection of Valids: { Q1, Q3, Q5 }

Baseline Models

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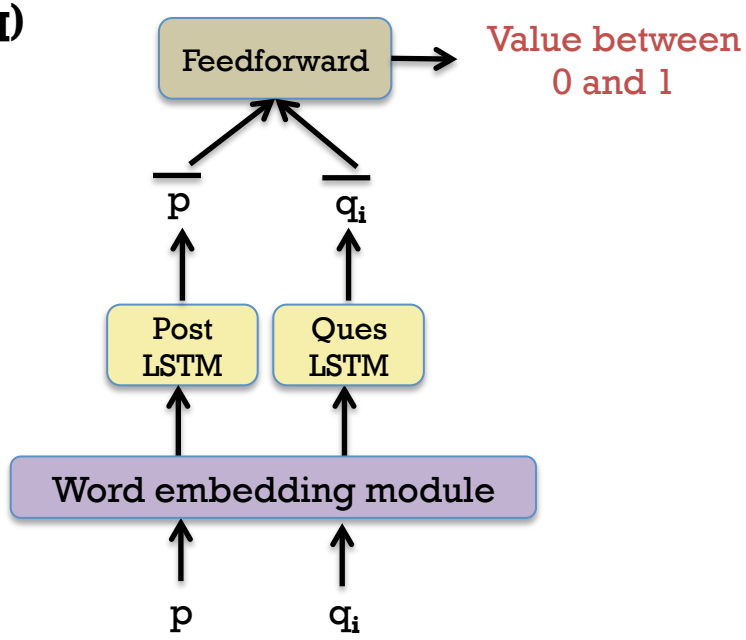

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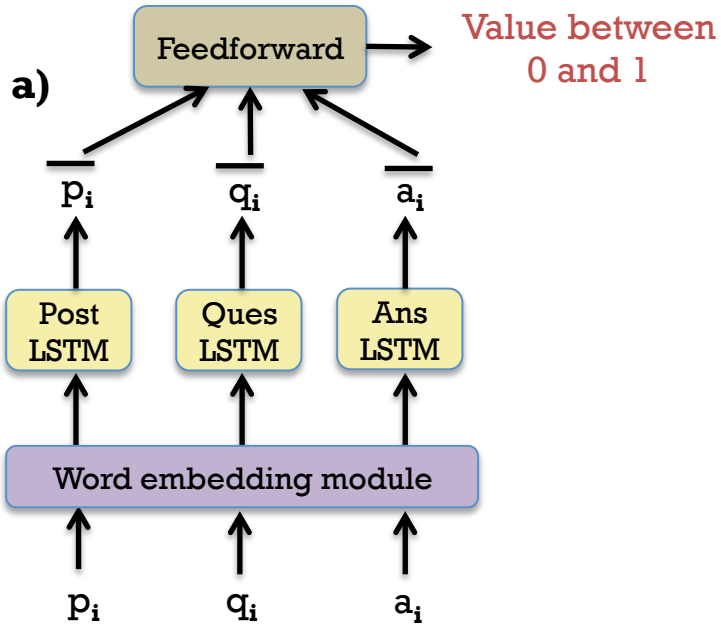

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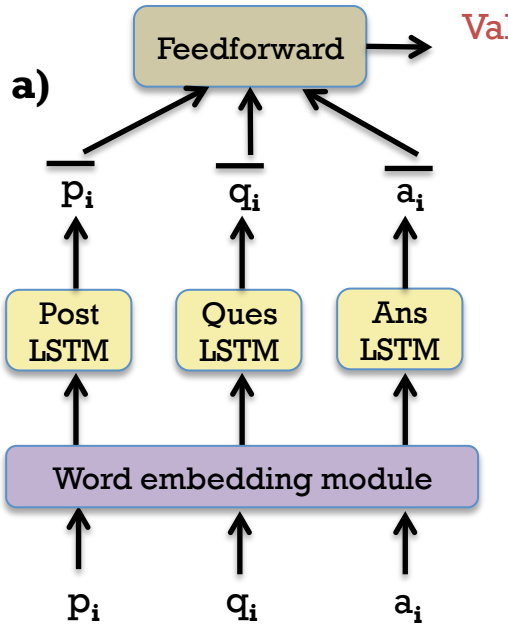
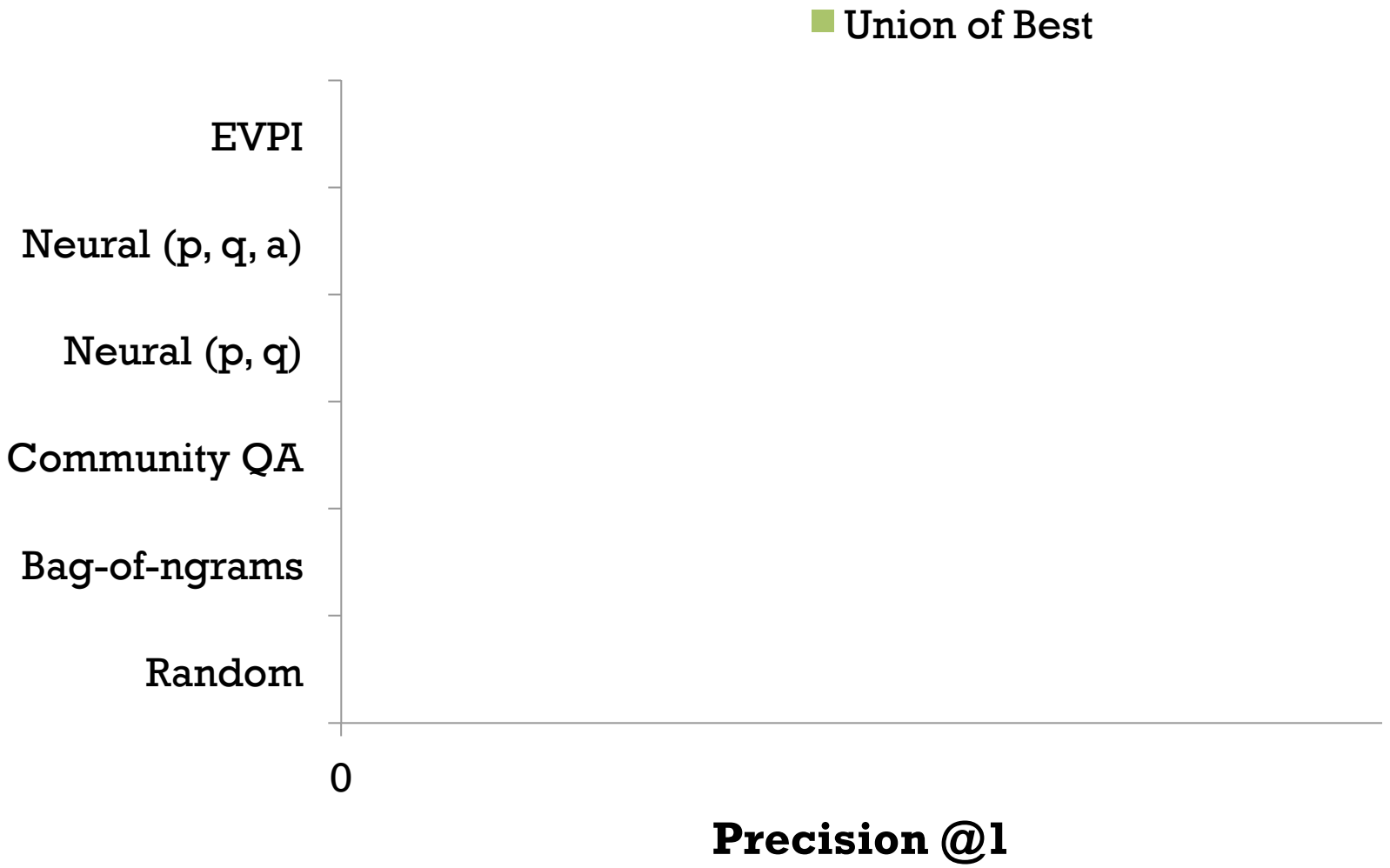
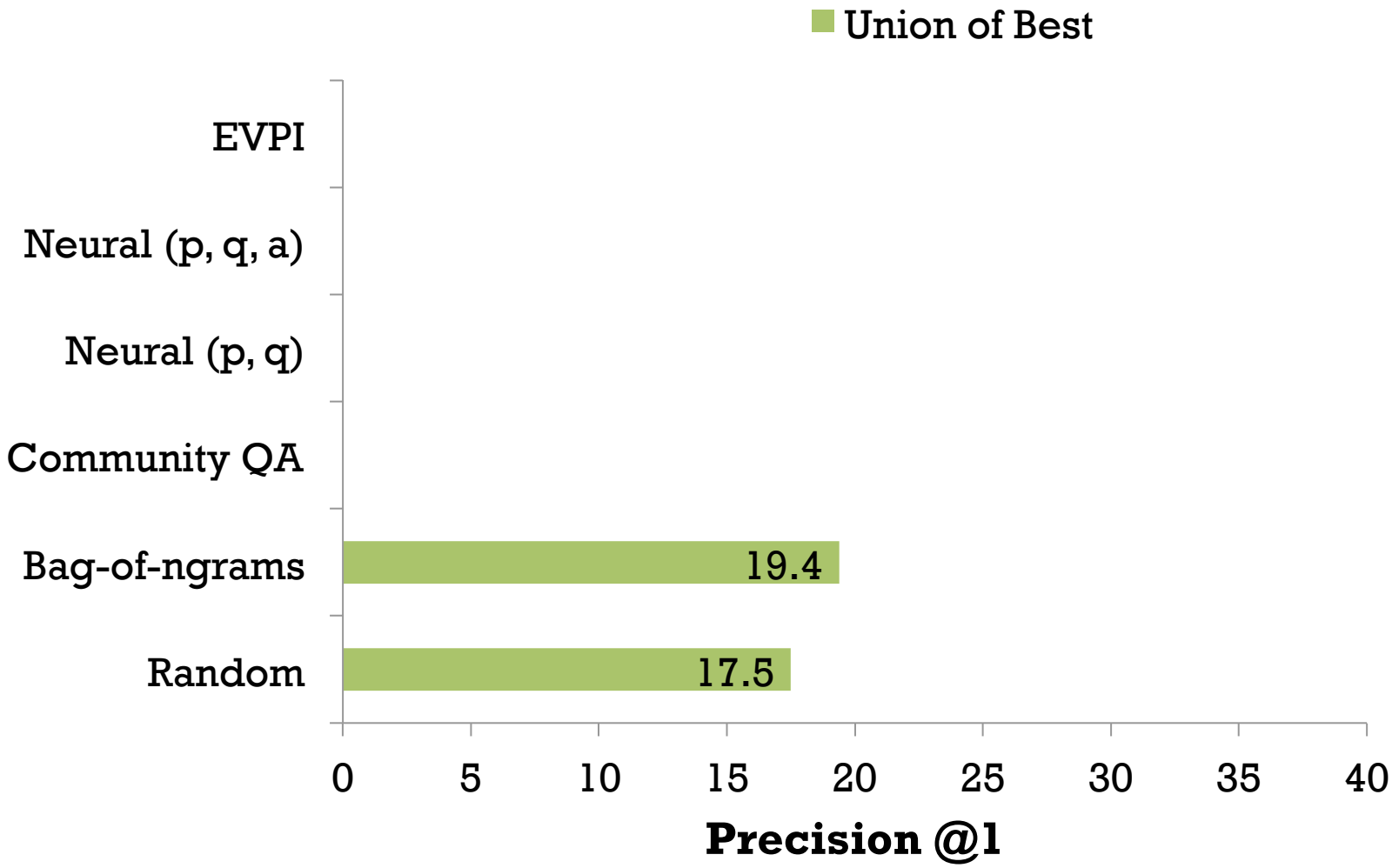


Both Neural (p, q, a) and EVPI (q | p, a) have similar no. of parameters

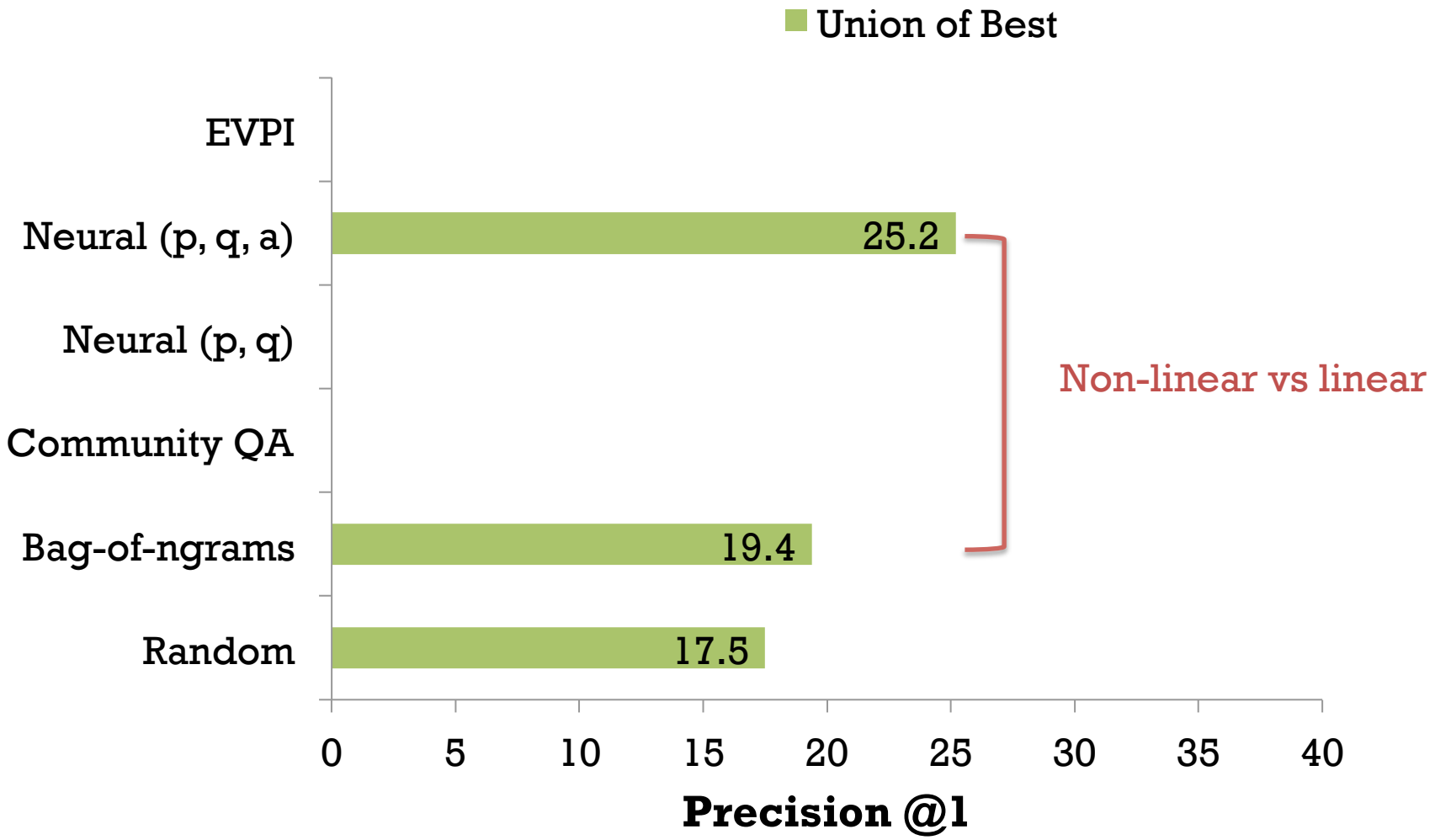
RESULTS


Union of Best
EVPI
Neural (p, q, a)
Neural (p, q)
Community QA
Bag-of-ngrams
Random
0
Precision @1

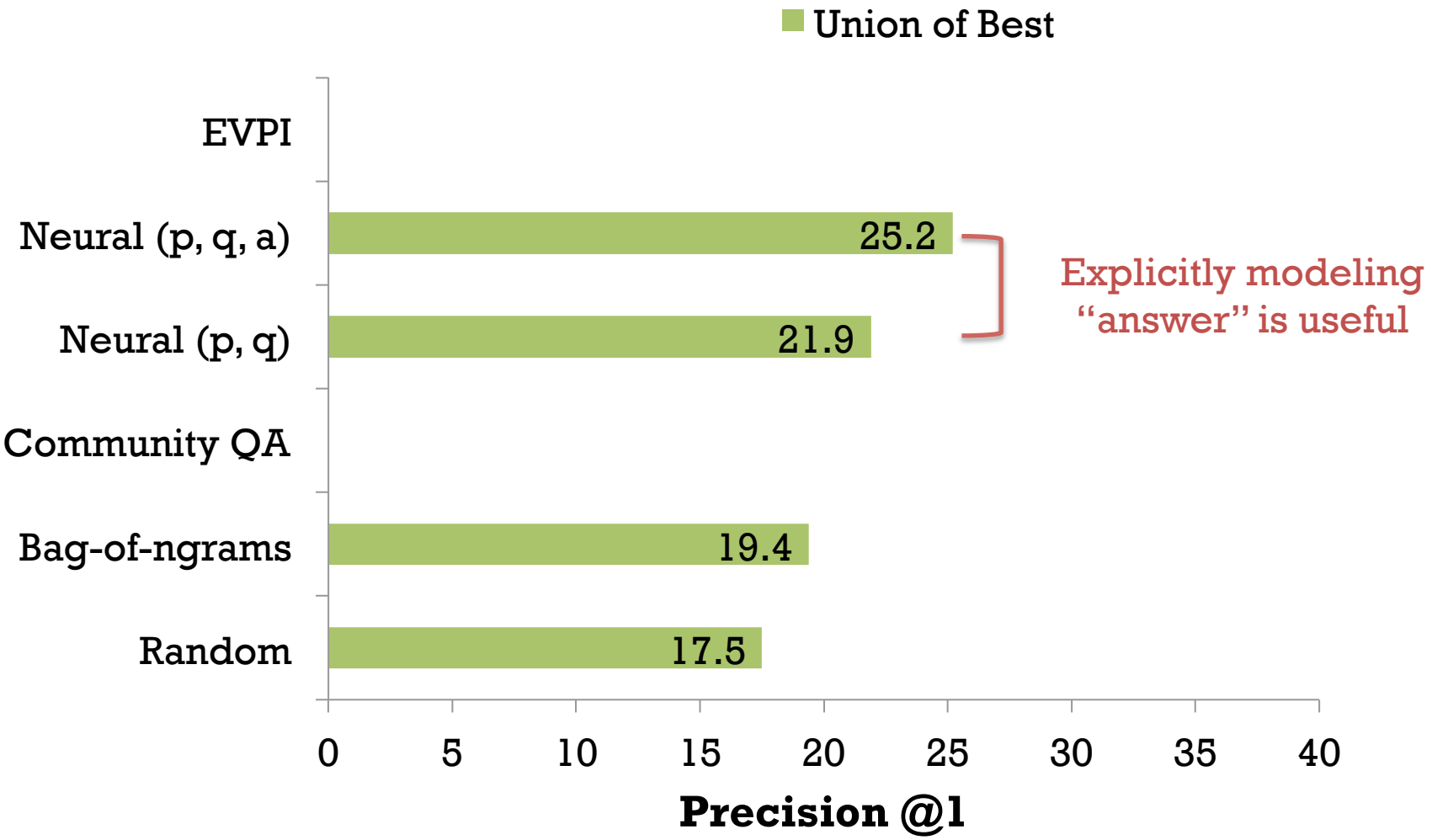
RESULTS


Union of Best
EVPI
Neural (p, q, a)
Neural (p, q)
Community QA
Bag-of-ngrams
Random
19.4
17.5
0
5
10
15
20
25
30
35
40
Precision @1

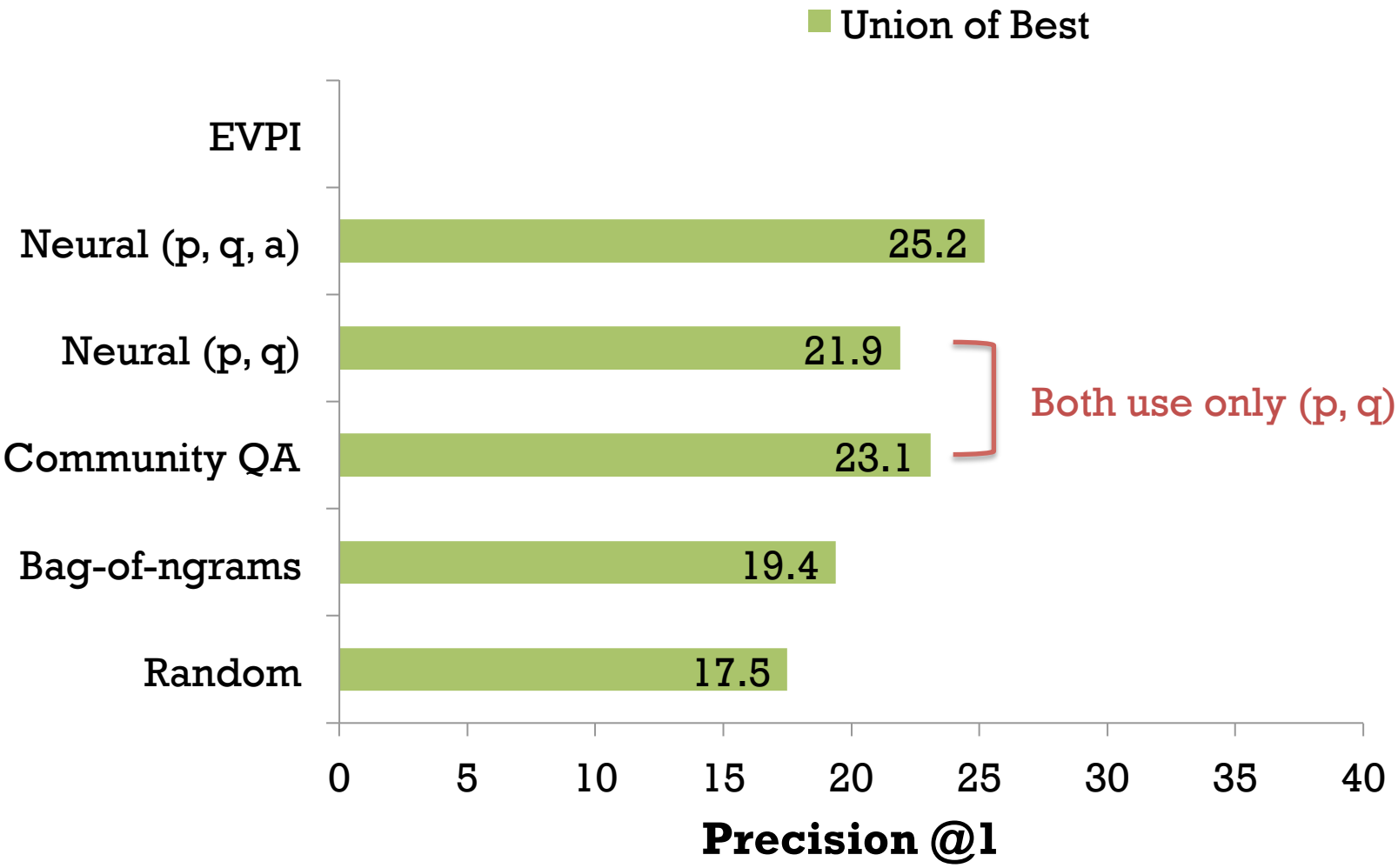
RESULTS


Union of Best
EVPI
Neural (p, q, a)
Neural (p, q)
Community QA
Bag-of-ngrams
Random
25.2
19.4
17.5
Non-linear vs linear
0
5
10
15
20
25
30
35
40
Precision @1

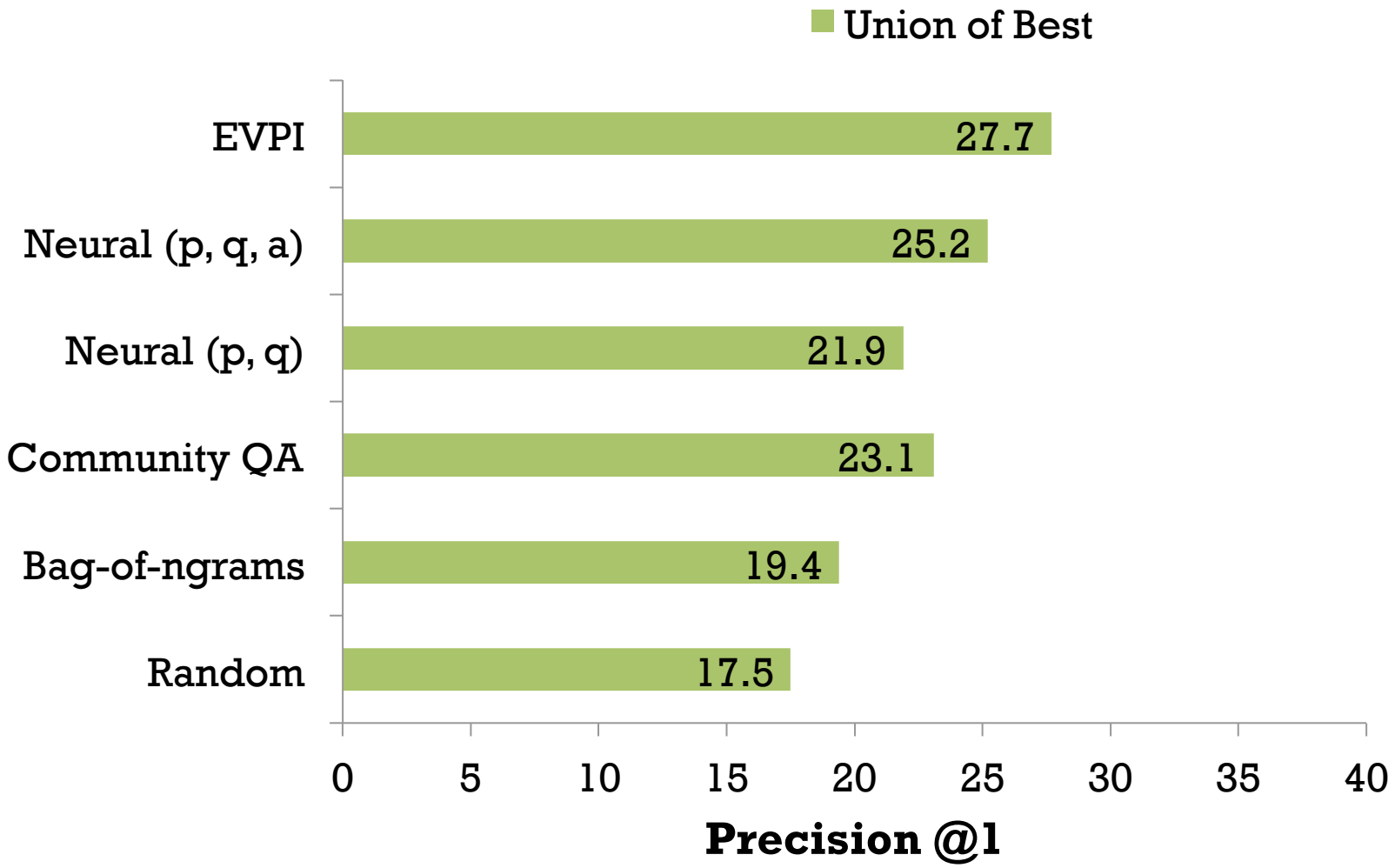
RESULTS


Union of Best
EVPI
Neural (p, q, a)
Neural (p, q)
Community QA
Bag-of-ngrams
Random
25.2
21.9
19.4
17.5
Explicitly modeling "answer" is useful
0
5
10
15
20
25
30
35
40
Precision @1

RESULTS


Union of Best
EVPI
Neural (p, q, a)
25.2
Neural (p, q)
21.9
Community QA
23.1
Bag-of-ngrams
19.4
Random
17.5
Both use only (p, q)
0
5
10
15
20
25
30
35
40
Precision @1

RESULTS



Note: Difference between EVPI and all baselines is statistically significant with $p < 0.05$

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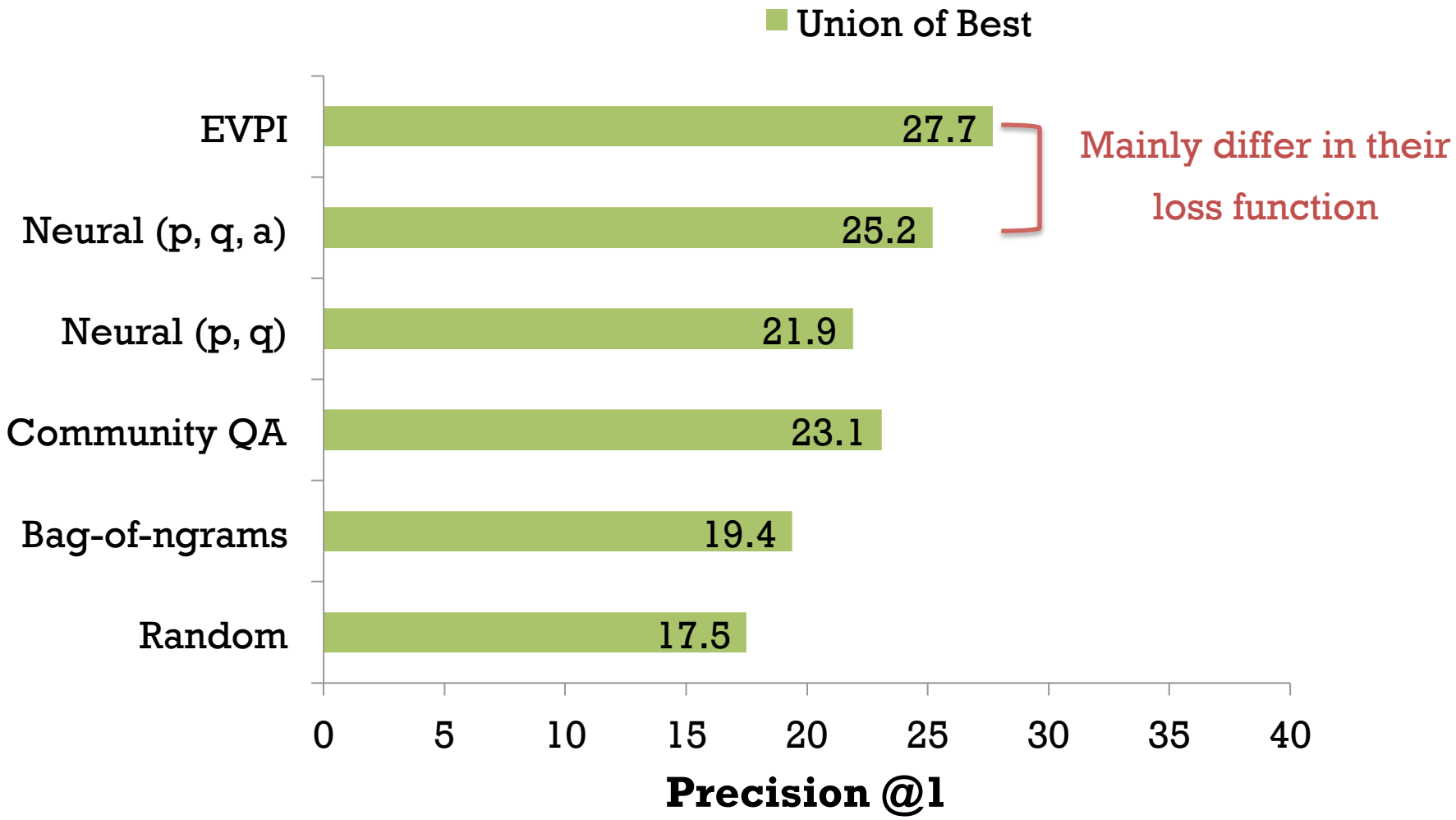

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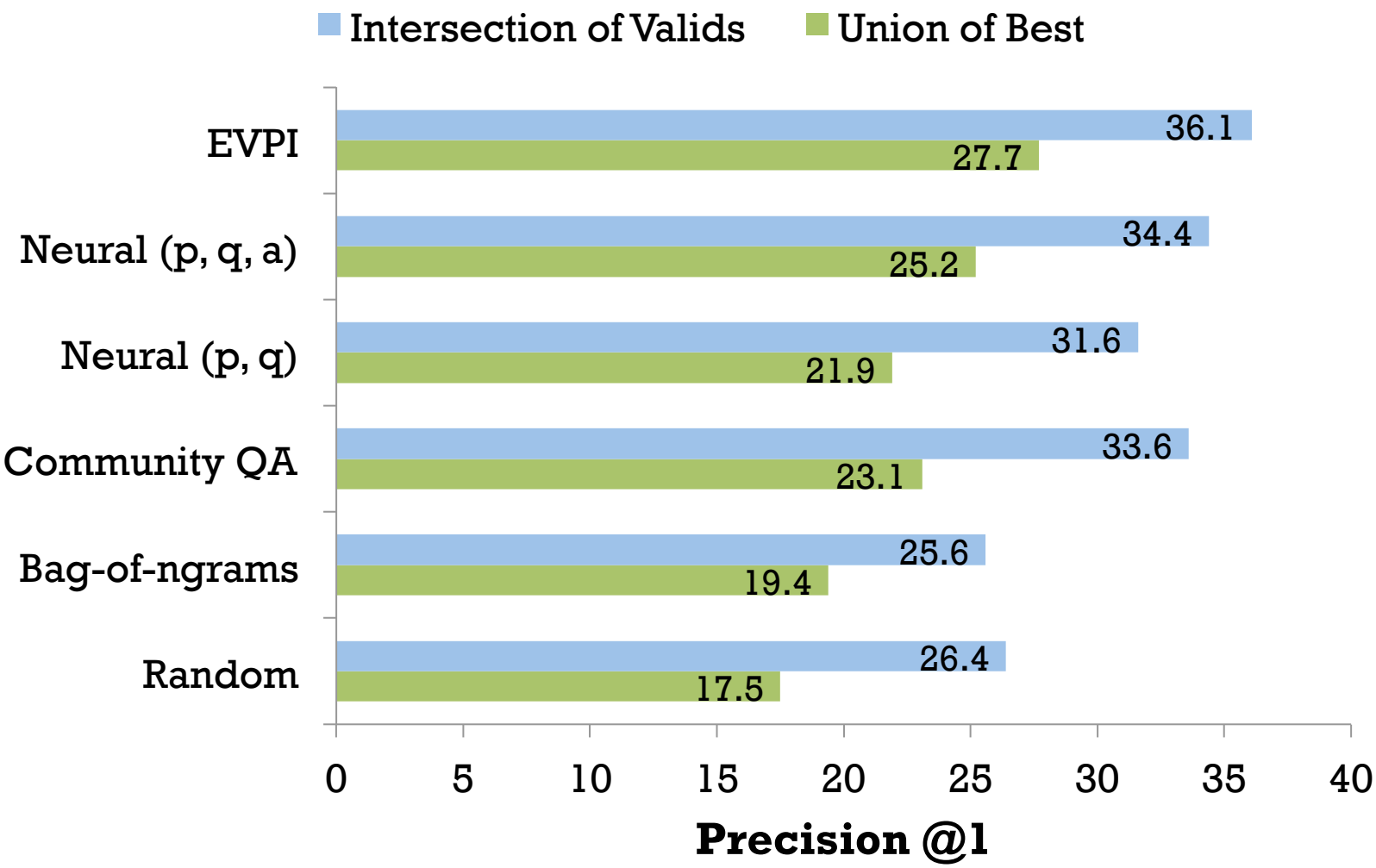

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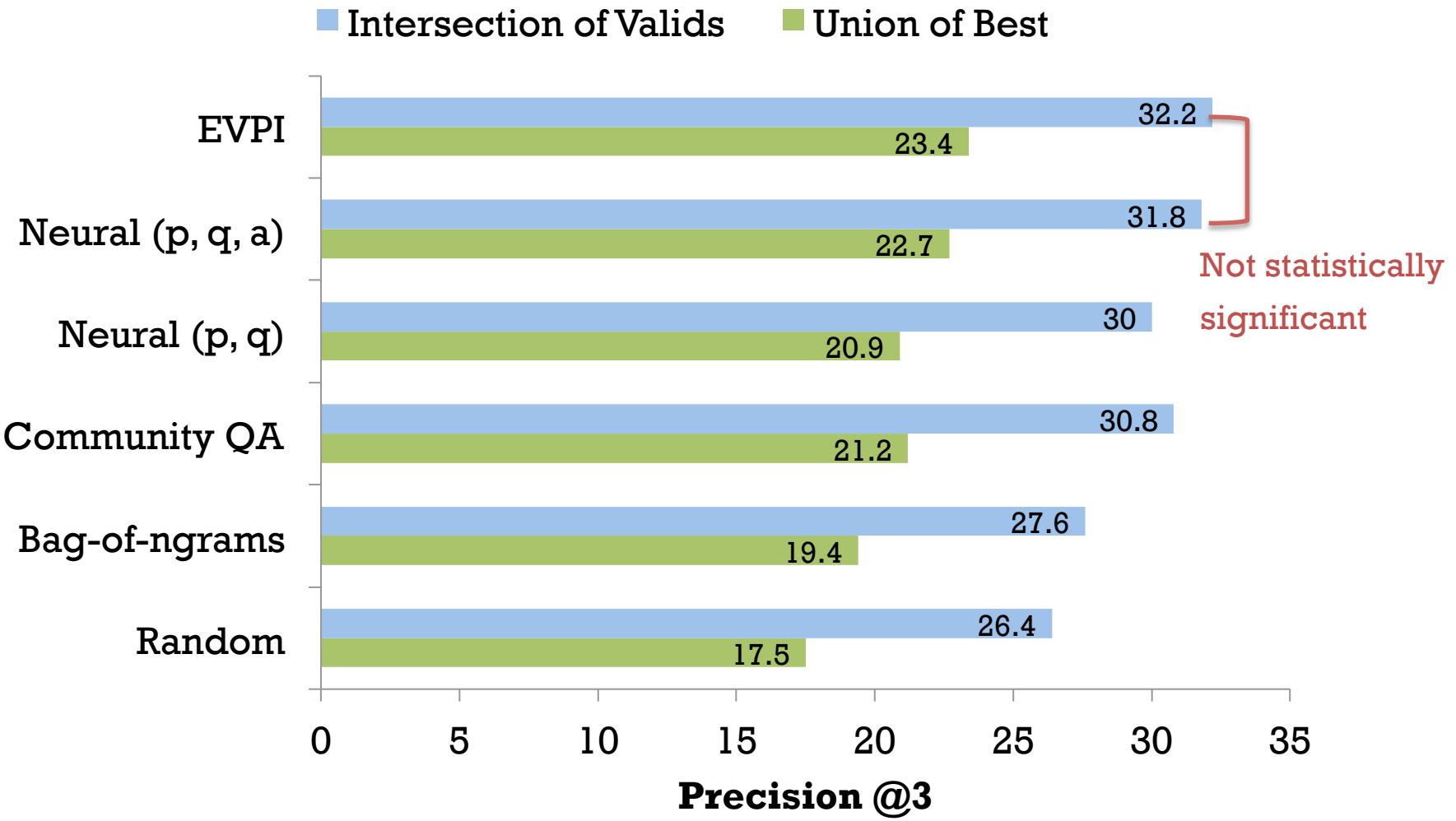
Intersection of Valids
Union of Best
EVPI
32.2
23.4
Neural (p, q, a)
31.8
22.7
Neural (p, q)
30
20.9
Community QA
30.8
21.2
Bag-of-ngrams
27.6
19.4
Random
26.4
17.5
Not statistically significant
0
5
10
15
20
25
30
35
Precision @3

Talk Outline

- Clarification Questions Dataset
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CONCLUSION

- ✓ **Key Contributions**
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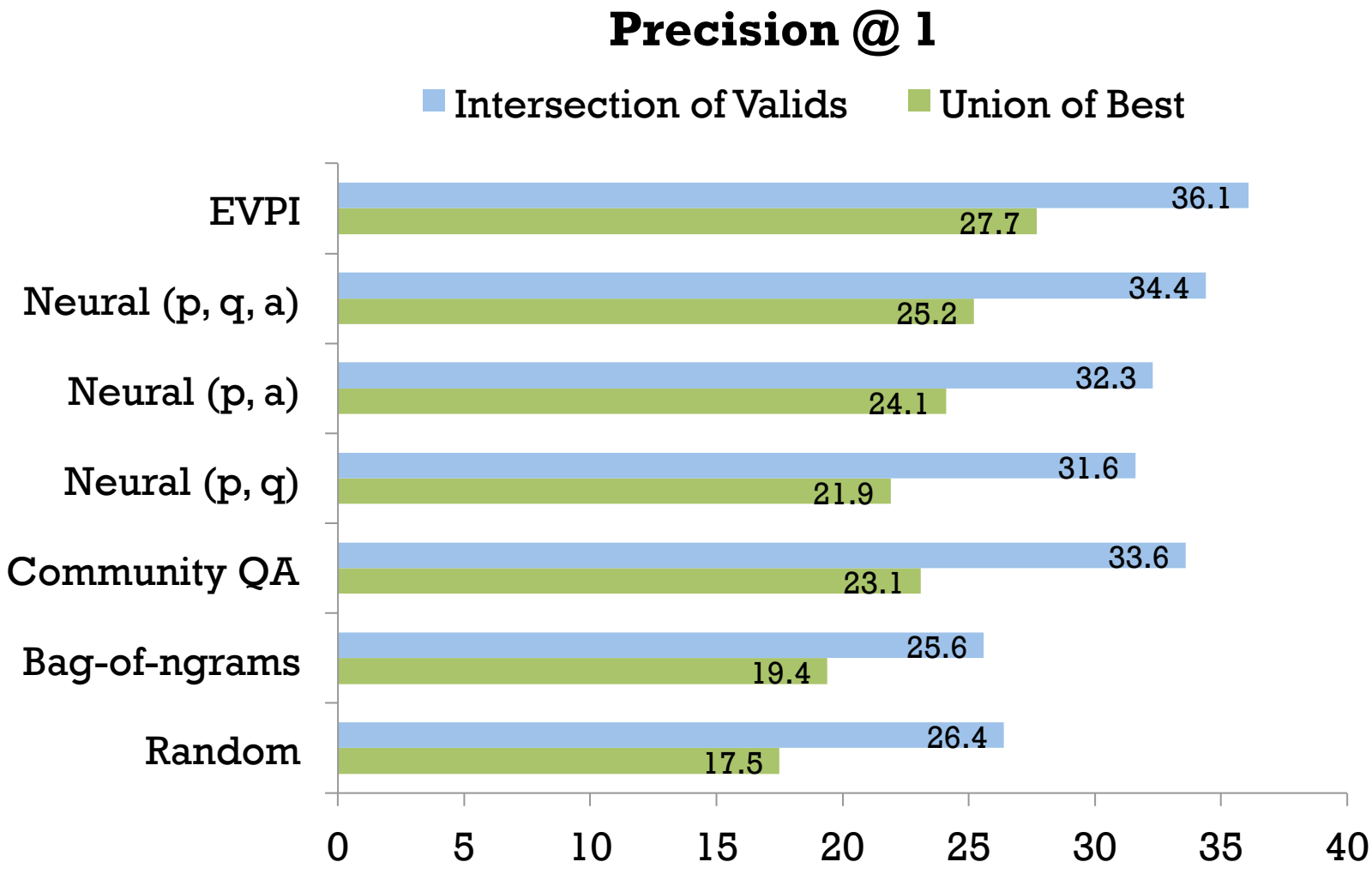
CODE + DATA: https://github.com/raosudha89/ranking_clarification_questions

Backup Slides

RESULTS


Precision @ 1
Intersection of Valids
Union of Best
EVPI
36.1
27.7
Neural (p, q, a)
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25.2
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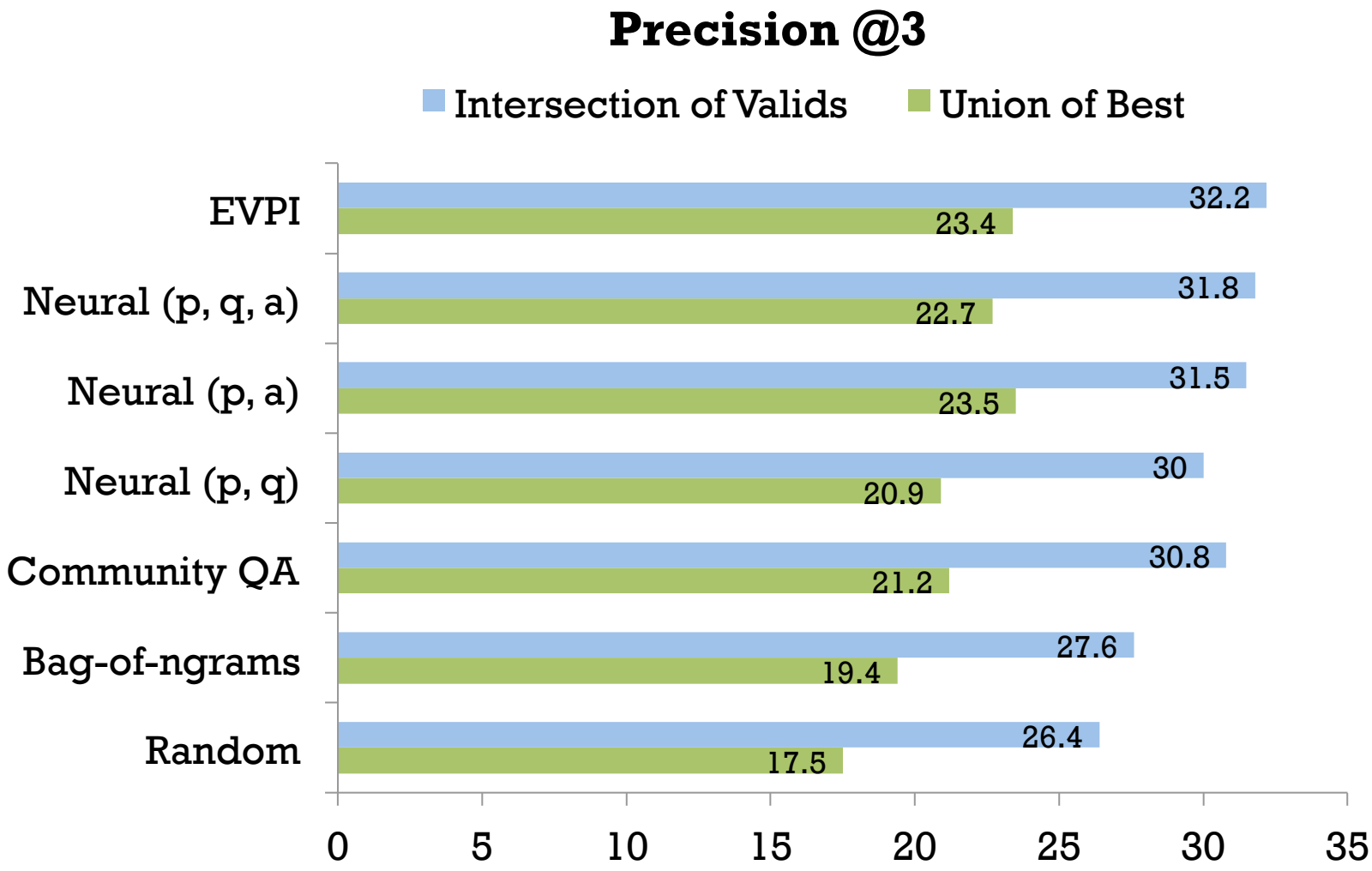
Precision @3
Intersection of Valids
Union of Best
EVPI
32.2
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31.8
22.7
Neural (p, a)
31.5
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25
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35

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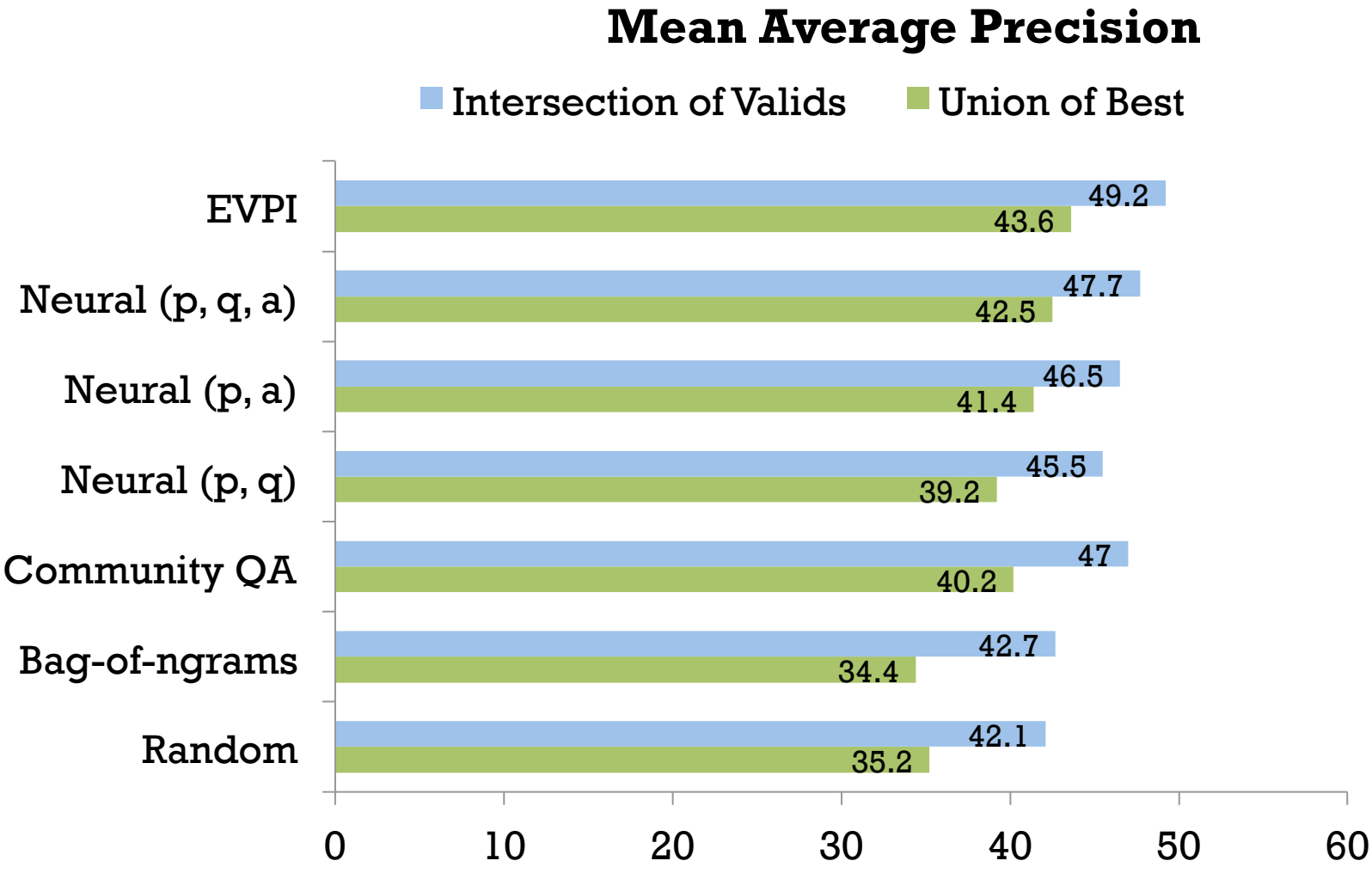
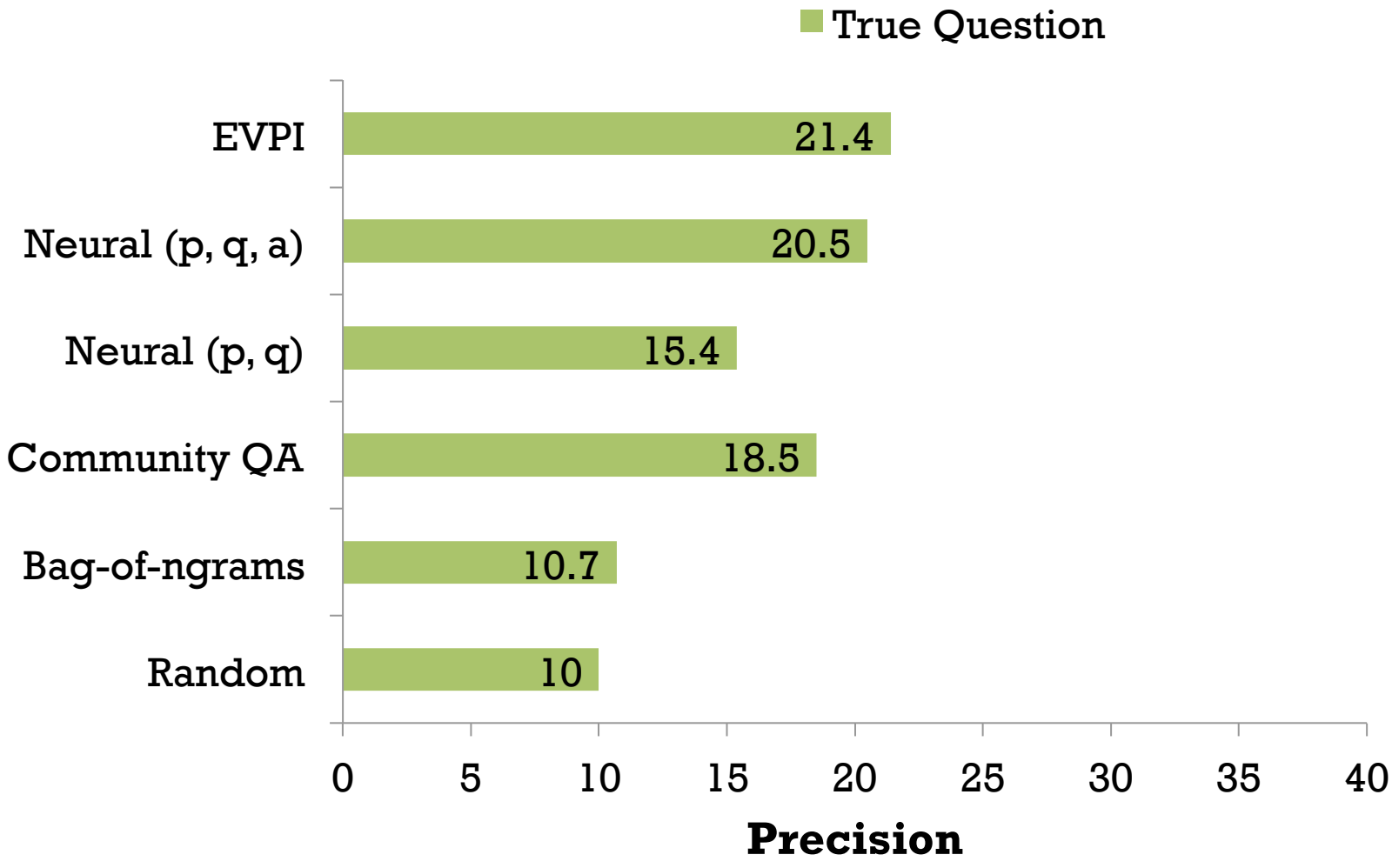

Mean Average Precision
Intersection of Valids
Union of Best
EVPI
49.2
43.6
Neural (p, q, a)
47.7
42.5
Neural (p, a)
46.5
41.4
Neural (p, q)
45.5
39.2
Community QA
47
40.2
Bag-of-ngrams
42.7
34.4
Random
42.1
35.2
0
10
20
30
40
50
60

RESULTS



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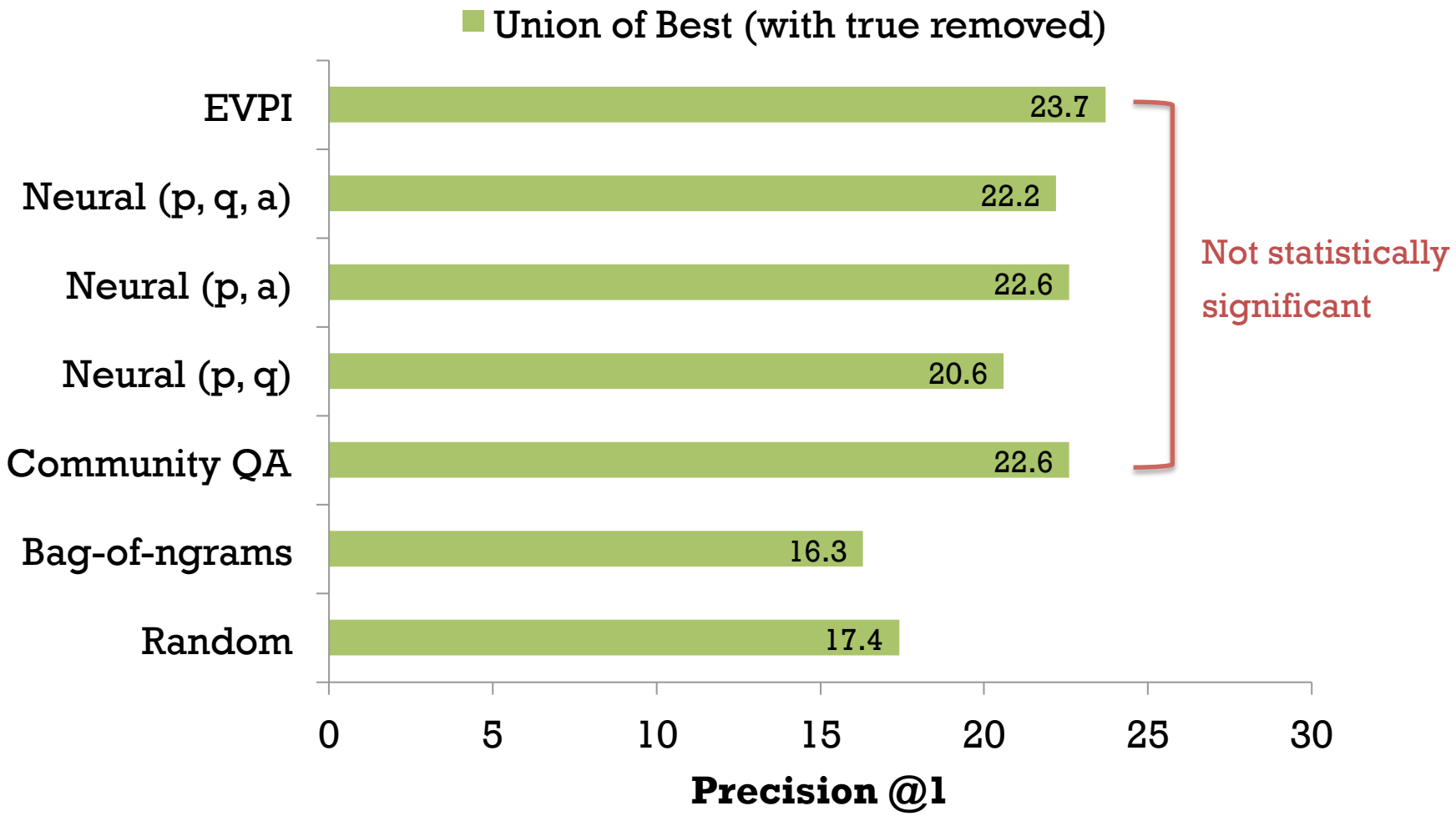
Union of Best (with true removed)
EVPI
Neural (p, q, a)
Neural (p, a)
Neural (p, q)
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Post

EVPI value **Ranking of Question Candidates** Best Valid

0.21	●	●	**How much ram do you have installed? and what size is the swap disk partition**
0.18		●	**Can you tell us a little about your configuration ?**
0.17			What is the longest time you have let it run ?
0.11	●	●	**How is it slow exactly ? boot time ? hdd read/write ? cpu time ?**
0.00			If you do not have any problem with getting a little techy may i suggest a method ?
0.00			This may be a silly question but ... did you make your usb stick bootable ?
0.00			Do your system were recently updated ?
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0.00			Is that a `parted -- list` on the synology device ?
0.00		●	**Did you turn hardware virtualization on in bios/efi ?**

SAMPLE OUTPUT

No wifi after restart in Ubuntu 16.04

After upgrading to 16.04, there is no wifi whenever I restart the system. My wireless interface of Ubuntu is RT3290 Wireless 802.11n 1T/1R PCIe

On iwconfig I got the following

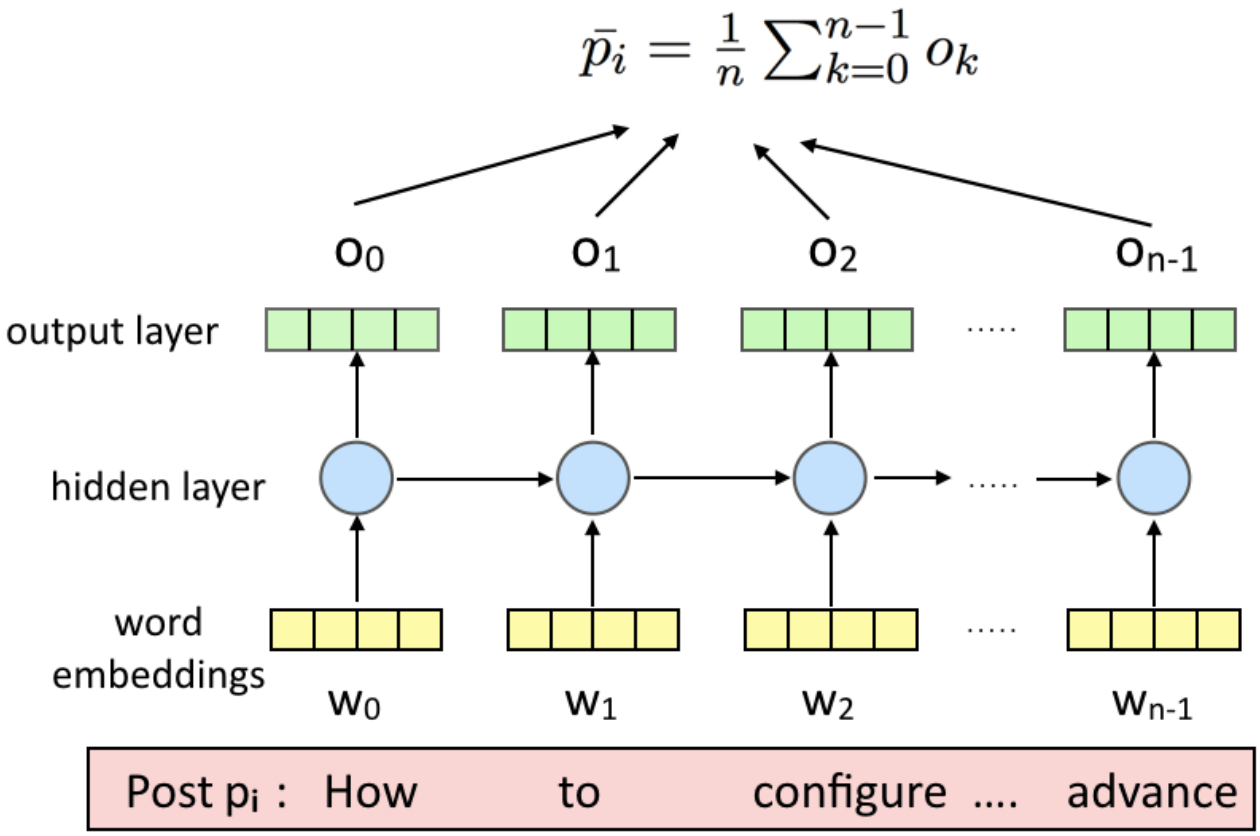
eth0 no wireless extensions….

Currently to start wifi again I have to shutdown, then boot the system again. How to fix the problem?

EVPI value **Ranking of Question Candidates** Best Valid

0.24	● ●	**I doubt it, shutdown and reboot are exactly identical! are you really rebooting?**
0.13	●	**Be clear about the problem. Is Ubuntu not showing them even though they are present?**
0.11		What is 4g wifi connection?
0.09	●	**Can you type `iwconfig` in terminal and paste what it returns here?**
0.09		What does this tell us?
0.08		If I post it as an answer, would you kindle mark as such?
0.06		Which Ubuntu 15?
0.06		What exactly do you mean by make fails?
0.05	● ●	**Welcome to ask Ubuntu! ; -) Is the wireless lan disabled in the bios?**
0.00	●	**Is Ubuntu detecting your wireless card ? **iwconfig** does list your card?**

LONG SHORT TERM MEMORY (LSTM)



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