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

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CODE + DATA: https://github.com/raosudha89/ranking_clarification_questions
How long does it take to get a PhD?
Natural Language Understanding

How long does it take to get a PhD?

Give me a recipe for lasagna
Google
Yahoo!
bing

How long does it take to get a PhD?

Please bring me my coffee mug from the kitchen

Give me a recipe for lasagna
Human Interactions
Please bring me my coffee mug from the kitchen.
Human Interactions

Please bring me my coffee mug from the kitchen.
What color is your coffee mug?

Please bring me my coffee mug from the kitchen.
Teach Machines to Ask Clarification Questions
How long does it take to get a PhD?

In which field?
Teach Machines to Ask Clarification Questions

How long does it take to get a PhD?
In which field?

Give me a recipe for lasagna

Any dietary restrictions?
Teach Machines to Ask Clarification Questions

Google
Yahoo!
bing

How long does it take to get a PhD?
In which field?

Please bring me my coffee mug from the kitchen

What color is your coffee mug?

Give me a recipe for lasagna

Any dietary restrictions?
Teach Machines to Ask Clarification Questions

Google

Yahoo!

bing

How long does it take to get a PhD?
In which field?

Please bring me my coffee mug from the kitchen
What color is your coffee mug?

Context-aware questions about missing information

Give me a recipe for lasagna

Any dietary restrictions?
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.

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

- 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>`

- Bobrow., et al. "GUS, a frame-driven dialog system." Artificial intelligence 1977
- Williams, et al. The Dialog State Tracking Challenge” SIGDIAL 2013
- Bordes, et al. "Learning end-to-end goal-oriented dialog.” ICLR 2017
Other types of Question Generation


- 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


Talk Outline

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

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Clarification Questions Dataset

StackExchange Question-Answer Forum

Stack Overflow

Server Fault

Super User

Meta Stack Exchange

Web Applications

Webmasters

Seasoned Advice

Arqade

Geographic Information Systems

Mathematics

ToX - LaTeX

Unix & Linux

Ask Ubuntu

ask

Game Development

Photography

Cross Validated

Home Improvement

Personal Finance & Money

WordPress Development

English Language & Usage

Theoretical Computer Science

Role-playing Games

UX
How to configure path or set environment variables for installation?

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

I'm aiming to install ape, a simple code for pseudopotential generation. I'm having this error message while running `./configure`

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

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What version of ubuntu do you have?
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Updated Post

I'm aiming to install ape in Ubuntu 14.04 LTS, a simple code for pseudopotential generation. I'm having this error message while running ./configure
<error message>
So I have the library but the program installation isn't finding it. Any help? Thanks in advance!

Initial Post

What version of ubuntu do you have?

Question comment

Edit as an answer to the question
How to configure path or set environment variables for installation?

I'm aiming to install ape, a simple code for pseudopotential generation. I'm having this error message while running ./configure
<error message>
So I have the library but the program installation isn't finding it.
Any help? Thanks in advance!

What version of ubuntu do you have?

I'm aiming to install ape \textbf{in Ubuntu 14.04 LTS}, a simple code for pseudopotential generation. I'm having this error message while running ./configure
<error message>
So I have the library but the program installation isn't finding it.
Any help? Thanks in advance!
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.
Talk Outline

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

Post

How to configure path or set environment variables? ...
Problem Formulation: Question Ranking

Post

How to configure path or set environment variables? ...

Generate Question Candidates

What is the make of your wifi card?

What version of Ubuntu do you have?

What OS are you using?
Problem Formulation: Question Ranking

How to configure path or set environment variables? ...

Post

Generate Question Candidates

What is the make of your wifi card?
What version of Ubuntu do you have?
What OS are you using?

Rank the question candidates

What version of Ubuntu do you have?
What OS are you using?
What is the make of your wifi card?
How to configure path or set environment variables for installation?
I’m aiming to install ape, a simple code for pseudopotential generation. I’m having this error message while running ./configure
<error message>
So I have the library but the program installation isn’t finding it. Any help? Thanks in advance!

What version of Ubuntu do you have?

How are you installing ape?

Do you have GSL installed?

[Shortlist of useful questions]
Talk Outline

- Clarification Questions Dataset
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How to configure path or set environment variables for installation?
I'm aiming to install ape, a simple code for pseudopotential generation.
I'm having this error message while running ./configure
<error message>
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
Key Idea

How to configure path or set environment variables for installation?
I’m aiming to install ape, a simple code for pseudopotential generation. I’m having this error message while running ./configure
<error message>
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*
Key Idea

**How to configure path or set environment variables for installation?**
I'm aiming to install ape, a simple code for pseudopotential generation.
I'm having this error message while running ./configure
<error message>
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

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- Definition: Value of Perfect Information VPI (x)
  
  How much value does x add to a given information content c?

Expected Value of Perfect Information (EVPI) inspired model

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- Definition: Value of Perfect Information VPI (x)
  
  *How much value does x add to a given information content c?*

- Since we have not acquired x, we define its value in expectation

Expected Value of Perfect Information (EVPI) inspired model

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

- Definition: Value of Perfect Information VPI \( (x) \)

  \textit{How much value does } x \textit{ add to a given information content } c \textit{?}

- Since we have not acquired \( x \), we define its value in expectation.

\[
\text{Likelihood of } x \text{ given } c \quad \Downarrow
\]

\[
\text{EVPI} \left( x \mid c \right) = \sum_{x \in X} P \left( x \mid c \right) \text{Utility}(x, c) \quad \Uparrow
\]

Value of updating \( c \) with \( x \)

Expected Value of Perfect Information (EVPI) inspired model

EVPI formulation for our problem
**EVPI formulation for our problem**

\[
\text{EVPI} \left( q_i \mid p \right)
\]

- \( p \): given post
- \( q_i \): question from set of question candidates \( Q \)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

\[
EVP_{|p}(q_i | p) = P(a_j | p, q_i)
\]

- \( p \): given post
- \( q_i \): question from set of question candidates \( Q \)

Likelihood of \( a_j \) being the answer to \( q_i \) on post \( p \)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

\[
\text{EVPI} \left( \begin{bmatrix} q_i \end{bmatrix} \mid p \right) = \mathbf{P} \left( \begin{bmatrix} a_j \end{bmatrix} \mid p, q_i \right) \mathbf{U} \left( p + a_j \right)
\]

- **Likelihood of** \( a_j \) **being the answer to** \( q_i \) **on post** \( p \)

- **Utility of updating the post** \( p \) **with answer** \( a_j \)

**Symbols**:
- \( p \) : given post
- \( q_i \) : question from set of question candidates \( Q \)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

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

- **Likelihood of** \( a_j \) **being the answer to** \( q_i \) **on post** \( p \)
- **Utility of updating the post** \( p \) **with answer** \( a_j \)

\( p \): given post
\( q_i \): question from set of question candidates \( Q \)
\( a_j \): answer from set of answer candidates \( A \)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

We rank questions based on their EVPI value

\[
\text{EVPI} \left( q_i \mid p \right) = \sum_{a_j \in A} \mathbb{P} \left( a_j \mid p, q_i \right) \mathbb{U}(p + a_j)
\]

- **p**: given post
- **q_i**: question from set of question candidates Q
- **a_j**: answer from set of answer candidates A
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

\[
\text{EVPI} \left( q_i | p \right) = \sum_{a_j \in A} P \left( a_j | p, q_i \right) U \left( p + a_j \right)
\]

- **Likelihood of** \( a_j \) **being the answer to** \( q_i \) **on post** \( p \)
- **Utility of updating the post** \( p \) **with answer** \( a_j \)

**Notation:**
- \( p \): given post
- \( q_i \): question from set of \( Q \) question candidates
- \( a_j \): answer from set of \( A \) answer candidates
Expected Value of Perfect Information (EVPI) inspired model

EVPI formulation for our problem

\[ \text{EVPI} \left( q_i \mid p \right) = \sum_{a_j \in A} \mathbb{P} \left( a_j \mid p, q_i \right) \cdot \mathbb{U} \left( p + a_j \right) \]

1. \( q_i \): question from set of question candidates \( Q \)
2. \( a_j \): answer from set of answer candidates \( A \)
3. \( p \): given post
4. Likelihood of \( a_j \) being the answer to \( q_i \) on post \( p \)
5. Utility of updating the post \( p \) with answer \( a_j \)
**Expected Value of Perfect Information (EVPI) inspired model**

**EVPI formulation for our problem**

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

1. \(p\): given post
2. \(q_i\): question from set of question candidates \(Q\)
3. \(a_j\): answer from set of answer candidates \(A\)

Utility of updating the post \(p\) with answer \(a_j\)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

\[
\text{EVPI} (q_i | p) = \sum_{a_j \in A} P(a_j | p, q_i) U(p + a_j)
\]

1. \(p\): given post
2. \(q_i\): question from set of question candidates \(Q\)
3. \(a_j\): answer from set of answer candidates \(A\)

Answer Modeling

Utility of updating the post \(p\) with answer \(a_j\)
Expected Value of Perfect Information (EVPI) inspired model

**EVPI formulation for our problem**

\[
EVPI(q_i | p) = \sum_{a_j \in A} P(a_j | p, q_i) u(p + a_j)
\]

- **p**: given post
- **q_i**: question from set of question candidates Q
- **a_j**: answer from set of answer candidates A

Answer Modeling

Utility Calculator

1. **Answer Modeling**
2. **Utility Calculator**
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator

Dataset of (post, question, answer)

Post as Documents

Post p as query

Lucene Search Engine
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator

Dataset of (post, question, answer)

Post as Documents

Post p as query

Lucene Search Engine

Ten posts similar to given post p

\( p_1 \)

\( p_2 \)

... 

\( p_j \)

... 

\( p_{10} \)
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator

Dataset of (post, question, answer)

Post as Documents

Post p as query

Lucene Search Engine

Ten posts similar to given post p

Questions paired with those posts

p_1 → q_1

p_2 → q_2

... → ...

p_j → q_j

p_{10} → q_{10}
Expected Value of Perfect Information (EVPI) inspired model

### Question & Answer Candidate Generator

1. **Dataset of (post, question, answer)**

2. **Post as Documents**

3. **Post p as query**

4. **Lucene Search Engine**

5. **Ten posts similar to given post p**

6. **Questions paired with those posts**

7. **Answers paired with those posts**
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator

Dataset of (post, question, answer)

Post as Documents

Post p as query

Lucene Search Engine

Ten posts similar to given post p

Questions paired with those posts

Answers paired with those posts

- $p_1$ with $q_1$ and $a_1$
- $p_2$ with $q_2$ and $a_2$
- $p_j$ with $q_j$ and $a_j$
- $p_{10}$ with $q_{10}$ and $a_{10}$
Answer Modeling

\[ \text{EVPI} \left( q_i \mid p \right) = \sum_{a_j \in A} P \left( a_j \mid p, q_i \right) u \left( p + a_j \right) \]
Expected Value of Perfect Information (EVPI) inspired model

\[
P(a_j | p, q_i)
\]
Expected Value of Perfect Information (EVPI) inspired model

2

Answer Modeling

\[ P \left( a_j \mid p, q_i \right) \]

\[ P \]

\[ q_i \]

Post LSTM

Question LSTM

Word embedding module

\[ p \]

\[ q_i \]
Expected Value of Perfect Information (EVPI) inspired model

\[ \mathbf{P}(a_j | \mathbf{p}, q_i) \]

\[ \text{Emb}_{\text{ans}}(\mathbf{p}, q_i) \]
Answer Modeling

\[ P \left( a_j \mid p, q_i \right) \approx \text{cosine_sim} \left( \text{Emb}_{\text{ans}} \left( p, q_i \right), a_j \right) \]
Expected Value of Perfect Information (EVPI) inspired model

2 Answer Modeling

\[ P(\text{a}_j | \text{p}, \text{q}_i) \approx \text{cosine}_\text{sim}(\text{Emb}_{\text{ans}}(\text{p}, \text{q}_i), \text{a}_j) \]

Emb_{\text{ans}}(\text{p}, \text{q}_i) Training

Feedforward

Average

Word embedding module

Post LSTM

Question LSTM

\[ \text{Emb}_{\text{ans}}(\text{p}, \text{q}_i) \approx \text{cosine}_\text{sim}(\text{Emb}_{\text{ans}}(\text{p}, \text{q}_i), \text{a}_j) \]
2 \hspace{1cm} \textbf{Answer Modeling}

\[ p \left( \frac{a_j}{a_j} \right) \approx \text{cosine}_\text{sim}\left( \text{Emb}_{\text{ans}} \left( \frac{p}{p}, \frac{q_i}{q_i} \right), \frac{a_j}{a_j} \right) \]

\text{Training}

\text{Emb}_{\text{ans}} \left( \frac{p}{p}, \frac{q_i}{q_i} \right)

- Close to true \( a_i \) paired with \( p \)
- \( a_i : \text{Ubuntu 14.04 LTS} \)
- \( q_i : \text{Which version of Ubuntu do you have?} \)

\text{Feedforward}

\text{Average}

\text{Post LSTM}

\text{Question LSTM}

\text{Word embedding module}
Expected Value of Perfect Information (EVPI) inspired model

\[
P(\theta_j | p, q_i) \approx \text{cosine}_\text{sim}(\text{Emb}_{\text{ans}}(p, q_i), a_j)
\]

**Training**
- \(a_i: \text{Ubuntu 14.04 LTS}\)
- \(q_i: \text{Which version of Ubuntu do you have?}\)
- \(a_k: \text{Ubuntu 11.10}\)
- \(q_k: \text{What OS are you using?}\)

**Answer Modeling**

Feedforward

Word embedding module

Average

Close to true \(a_i\) paired with \(p\)

Close to \(a_k\) paired with \(q_k\) similar to true \(q_i\)
Expected Value of Perfect Information (EVPI) inspired model

\[ \text{EVPI} (q_i | p) = \sum \text{P} (a_j | p, q_i) u(p + a_j) \]

where \( a_j \in A \)
Expected Value of Perfect Information (EVPI) inspired model

\[ U(p + a_j) \]
Expected Value of Perfect Information (EVPI) inspired model

Utility Calculator

\[ U(p + a_j) \]

Value between 0 and 1

Word embedding module

Post LSTM  Question LSTM  Answer LSTM
Expected Value of Perfect Information (EVPI) inspired model

Utility Calculator

Value between 0 and 1

$U(p + a_j)$

Training

Feedforward

Word embedding module

Post LSTM

Question LSTM

Answer LSTM

$p$

$q_i$

$a_j$
Expected Value of Perfect Information (EVPI) inspired model

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

\( y = 1 \)

Word embedding module

Post LSTM

Question LSTM

Answer LSTM

Feedforward
Expected Value of Perfect Information (EVPI) inspired model

Training

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

\( q_j : \) What OS are you using?  
\( a_j : \) Ubuntu 11.10

\( q_k : \) What is the make of your wifi card?  
\( a_k : \) TP-Link TL-WDN4800

Label

\( y = 1 \)

\( y = 0 \)

\( y = 0 \)

Feedforward

\( U(p + a_j) \)

Value between 0 and 1
Utility Calculator

Expected Value of Perfect Information (EVPI) inspired model

Training (Minimize binary cross-entropy)

\begin{align*}
q_i & : \text{Which version of Ubuntu do you have?} \\
   & : \text{Ubuntu 14.04 LTS} \\
q_j & : \text{What OS are you using?} \\
   & : \text{Ubuntu 11.10} \\
q_k & : \text{What is the make of your wifi card?} \\
   & : \text{TP-Link TL-WDN4800}
\end{align*}

Label

\begin{align*}
y = 0 \\
y = 1
\end{align*}

Value between 0 and 1

\[
U(p + a_j)
\]

Feedforward

Word embedding module

Post LSTM

Question LSTM

Answer LSTM
Expected Value of Perfect Information (EVPI) inspired model

1. Question & Answer Candidate Generator
2. Answer Modeling
3. Utility Calculator
**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: 
   
   \[
   \text{loss}_{\text{ans}}(p, q, a, Q) + \text{loss}_{\text{util}}(y, p, q, a)
   \]
**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: \(\text{loss}_{\text{ans}}(p, q, a, Q) + \text{loss}_{\text{util}}(y, p, q, a)\)

**Test time behavior:** Given a post from our test set
1. Generate question candidates \((Q)\) and answer candidates \((A)\)
2. Calculate \(P(a_j | p, q_i)\) for each \(q_i \in Q\) using Answer Model
3. Calculate \(U(p + a_j)\) for each \(a_j \in A\) using Utility Calculator
4. Rank questions by \(\text{EVPI}(q_i | p) = \sum_{a_j \in A} P(a_j | p, q_i) U(p + a_j)\)
Talk Outline

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

Question Candidates

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?
4. What is the longest time you have let it run?
5. This may be a silly question but ... did you make your usb stick bootable?
6. Do your system were recently updated?
7. Why not have two ssds in raid 1 for redundancy?
8. Is that a `parted -- list` on the synology device?
9. Can you tell us a little about your configuration?
10. Did you turn hardware virtualization on in bios/efi?
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).

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 ?
4. What is the longest time you have let it run ?
5. This may be a silly question but ... did you make your usb stick bootable ?
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Evaluation

**Evaluation set creation process**

- We recruit 10 Unix admin experts using UpWork
- Given a post and the set of ten question candidates
  - Mark the one best question
  - Mark any other valid questions
Evaluation set creation process

- We recruit 10 Unix admin experts using UpWork
- Given a post and the set of ten question candidates
  - Mark the one best question
  - Mark any other valid questions
- We annotate a total of 500 posts from our test set
- Each post is annotated by two experts
**Evaluation**

**Evaluation set creation process**

- We recruit 10 Unix admin experts using UpWork
- Given a post and the set of ten question candidates
  - Mark the one best question
  - Mark any other valid questions
- We annotate a total of 500 posts from our test set
- Each post is annotated by two experts
- **Union of Bests**: Questions marked as best by either of the annotators
- **Intersection of Valid**: Questions marked as valid by both annotators

<table>
<thead>
<tr>
<th></th>
<th>Best</th>
<th>Valid</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A1</td>
<td>A2</td>
</tr>
<tr>
<td>A1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>A2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q1</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q2</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q3</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q4</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Q5</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

Union of Bests: \{ Q2, Q3 \}

Intersection of Valid: \{ Q1, Q3, Q5 \}
Baseline Models

1. **Random**: Randomly permute the 10 candidate questions
Baseline Models

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2. **Bag-of-ngrams**: Train linear classifier using bag-of-ngrams of p, q and a
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2. **Bag-of-ngrams**: Train linear classifier using bag-of-ngrams of p, q and a

3. **Community QA** (Nakov et al., 2017):
   - SemEval Task: Rank comments by relevance to post on Qatar Living
   - Winning model: Logistic regression trained with string similarity & word embedding based features (Nandi et al., 2017)
   - Our baseline: We retrain this model on our dataset
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4. **Neural ($p$, $q$)**

   ![Diagram of neural model](image)

   - Feedforward
   - Value between 0 and 1
   - Word embedding module
   - Post LSTM
   - Ques LSTM
   - $p$ $q_i$
Evaluation

Baseline Models

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4. **Neural** ($p$, $q$)

5. **Neural** ($p$, $q$, $a$)
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4. **Neural** \((p, q)\)

5. **Neural** \((p, q, a)\)

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

- EVPI
- Neural (p, q, a)
- Neural (p, q)
- Community QA
- Bag-of-ngrams
- Random

**Precision @1**

- Union of Best
# RESULTS

<table>
<thead>
<tr>
<th>Method</th>
<th>EVPI</th>
<th>Neural (p, q, a)</th>
<th>Neural (p, q)</th>
<th>Community QA</th>
<th>Bag-of-ngrams</th>
<th>Random</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>25.2</td>
<td>19.4</td>
<td></td>
<td>17.5</td>
<td></td>
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</tbody>
</table>

*Non-linear vs linear*
Evaluation

RESULTS

<table>
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<tr>
<th>Method</th>
<th>Precision @1</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVPI</td>
<td>0</td>
</tr>
<tr>
<td>Neural (p, q, a)</td>
<td>25.2</td>
</tr>
<tr>
<td>Neural (p, q)</td>
<td>21.9</td>
</tr>
<tr>
<td>Community QA</td>
<td>0</td>
</tr>
<tr>
<td>Bag-of-ngrams</td>
<td>19.4</td>
</tr>
<tr>
<td>Random</td>
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</table>

Explicitly modeling “answer” is useful
Evaluation

RESULTS

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<td>21.9</td>
</tr>
<tr>
<td>Community QA</td>
<td>23.1</td>
</tr>
<tr>
<td>Bag-of-ngrams</td>
<td>19.4</td>
</tr>
<tr>
<td>Random</td>
<td>17.5</td>
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</table>

Both use only (p, q)
Evaluation

RESULTS

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<thead>
<tr>
<th>Method</th>
<th>Precision @1</th>
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<tbody>
<tr>
<td>EVPI</td>
<td>27.7</td>
</tr>
<tr>
<td>Neural (p, q, a)</td>
<td>25.2</td>
</tr>
<tr>
<td>Neural (p, q)</td>
<td>21.9</td>
</tr>
<tr>
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<td>Bag-of-ngrams</td>
<td>19.4</td>
</tr>
<tr>
<td>Random</td>
<td>17.5</td>
</tr>
</tbody>
</table>

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

- **EVPI**: 27.7
- **Neural (p, q, a)**: 25.2
- **Neural (p, q)**: 21.9
- **Community QA**: 23.1
- **Bag-of-ngrams**: 19.4
- **Random**: 17.5

Mainly differ in their loss function

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

<table>
<thead>
<tr>
<th>Method</th>
<th>Intersection of Valid</th>
<th>Union of Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVPI</td>
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<td>36.1</td>
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<tr>
<td>Neural (p, q, a)</td>
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</tr>
<tr>
<td>Neural (p, q)</td>
<td>21.9</td>
<td>31.6</td>
</tr>
<tr>
<td>Community QA</td>
<td>23.1</td>
<td>33.6</td>
</tr>
<tr>
<td>Bag-of-ngrams</td>
<td>19.4</td>
<td>25.6</td>
</tr>
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RESULTS

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<th>Intersection of Valids</th>
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</tr>
</thead>
<tbody>
<tr>
<td>EVPI</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neural (p, q, a)</td>
<td>23.4</td>
<td>31.8</td>
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<tr>
<td>Neural (p, q)</td>
<td>20.9</td>
<td>30</td>
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<tr>
<td>Community QA</td>
<td>21.2</td>
<td>30.8</td>
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<tr>
<td>Bag-of-ngrams</td>
<td>19.4</td>
<td>27.6</td>
</tr>
<tr>
<td>Random</td>
<td>17.5</td>
<td>26.4</td>
</tr>
</tbody>
</table>

Not statistically significant
Talk Outline

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

- Create a dataset of ~77K clarification questions (and answers) with context
- Introduce novel model that integrates deep learning with classic notion of expected value of perfect information
- Create an evaluation set of size 500 with expert human annotations
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Key findings

- A context can have multiple good clarification questions
- Explicitly modeling the answer helps in identifying good questions
- EVPI formalism provides leverage over similarly expressive feedforward network
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Future work

- Sequence-to-sequence based question generation model
- Multi-turn question generation
- How to automatically evaluate performance?
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Future work

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- Multi-turn question generation
- How to automatically evaluate performance?

**CODE + DATA:** https://github.com/raosudha89/ranking_clarification_questions
Backup Slides
**RESULTS**

**Precision @ 1**

<table>
<thead>
<tr>
<th>Method</th>
<th>Intersection of Valid</th>
<th>Union of Best</th>
</tr>
</thead>
<tbody>
<tr>
<td>EVPI</td>
<td></td>
<td>36.1</td>
</tr>
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<td>Neural (p, q, a)</td>
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<tr>
<td>Neural (p, a)</td>
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<tr>
<td>Neural (p, q)</td>
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<td>31.6</td>
</tr>
<tr>
<td>Community QA</td>
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<td>33.6</td>
</tr>
<tr>
<td>Bag-of-n-grams</td>
<td>19.4</td>
<td>25.6</td>
</tr>
<tr>
<td>Random</td>
<td>17.5</td>
<td>26.4</td>
</tr>
</tbody>
</table>
RESULTS

**Precision @3**

- **EVPI**: Intersection of Valid: 23.4, Union of Best: 32.2
- **Neural (p, q, a)**: Intersection of Valid: 22.7, Union of Best: 31.8
- **Neural (p, a)**: Intersection of Valid: 23.5, Union of Best: 31.5
- **Neural (p, q)**: Intersection of Valid: 20.9, Union of Best: 30
- **Community QA**: Intersection of Valid: 21.2, Union of Best: 30.8
- **Bag-of-ngrams**: Intersection of Valid: 19.4, Union of Best: 27.6
- **Random**: Intersection of Valid: 17.5, Union of Best: 26.4
RESULTS

Mean Average Precision

- EVPI
- Neural (p, q, a)
- Neural (p, a)
- Neural (p, q)
- Community QA
- Bag-of-ngrams
- Random

Intersection of Invalids
Union of Best
Evaluation

RESULTS

- EVPI: 21.4
- Neural (p, q, a): 20.5
- Neural (p, q): 15.4
- Community QA: 18.5
- Bag-of-ngrams: 10.7
- Random: 10

Precision

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

<table>
<thead>
<tr>
<th>Model</th>
<th>Precision @1</th>
</tr>
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<tbody>
<tr>
<td>EVPI</td>
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</tr>
<tr>
<td>Neural (p, q, a)</td>
<td>22.2</td>
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<tr>
<td>Neural (p, a)</td>
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<tr>
<td>Bag-of-ngrams</td>
<td>16.3</td>
</tr>
<tr>
<td>Random</td>
<td>17.4</td>
</tr>
</tbody>
</table>

Not statistically significant
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).

<table>
<thead>
<tr>
<th>EVPI value</th>
<th>Ranking of Question Candidates</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.21</td>
<td>How much ram do you have installed? and what size is the swap disk partition</td>
</tr>
<tr>
<td>0.18</td>
<td>Can you tell us a little about your configuration?</td>
</tr>
<tr>
<td>0.17</td>
<td>What is the longest time you have let it run?</td>
</tr>
<tr>
<td>0.11</td>
<td>How is it slow exactly? boot time? hdd read/write? cpu time?</td>
</tr>
<tr>
<td>0.00</td>
<td>If you do not have any problem with getting a little techy may i suggest a method?</td>
</tr>
<tr>
<td>0.00</td>
<td>This may be a silly question but ... did you make your usb stick bootable?</td>
</tr>
<tr>
<td>0.00</td>
<td>Do your system were recently updated?</td>
</tr>
<tr>
<td>0.00</td>
<td>Why not have two ssds in raid 1 for redundancy?</td>
</tr>
<tr>
<td>0.00</td>
<td>Is that a <code>parted -- list</code> on the synology device?</td>
</tr>
<tr>
<td>0.00</td>
<td>Did you turn hardware virtualization on in bios/efi?</td>
</tr>
</tbody>
</table>
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?

Ranking of Question Candidates

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)**

\[ \bar{p}_i = \frac{1}{n} \sum_{k=0}^{n-1} o_k \]

---
