哈爾濱工業大學

HARBIN INSTITUTE OF TECHNOLOGY

Triple-based Background Knowledge Ranking for Document Enrichment

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HARBIN INSTITUTE OF TECHNOLOGY

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Our Task

To find and rank relevant background knowledge in the form of triple

Input: one source document and a large set of background Knowledge in the form of triple

Output: *Top N* relevant background knowledge

EXAMPLE

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The key is:

Background Knowledge!

But, these knowledge is available for human

NOT FOR COMPUTERS!

Our Aim!!!

Background Knowledge:

*“Saddam, **liveIn**, Baghdad”*

*“Iraqi, **hasCapital**, Baghdad”*

*“Saddam, **hasChild**, Qusay”*

……

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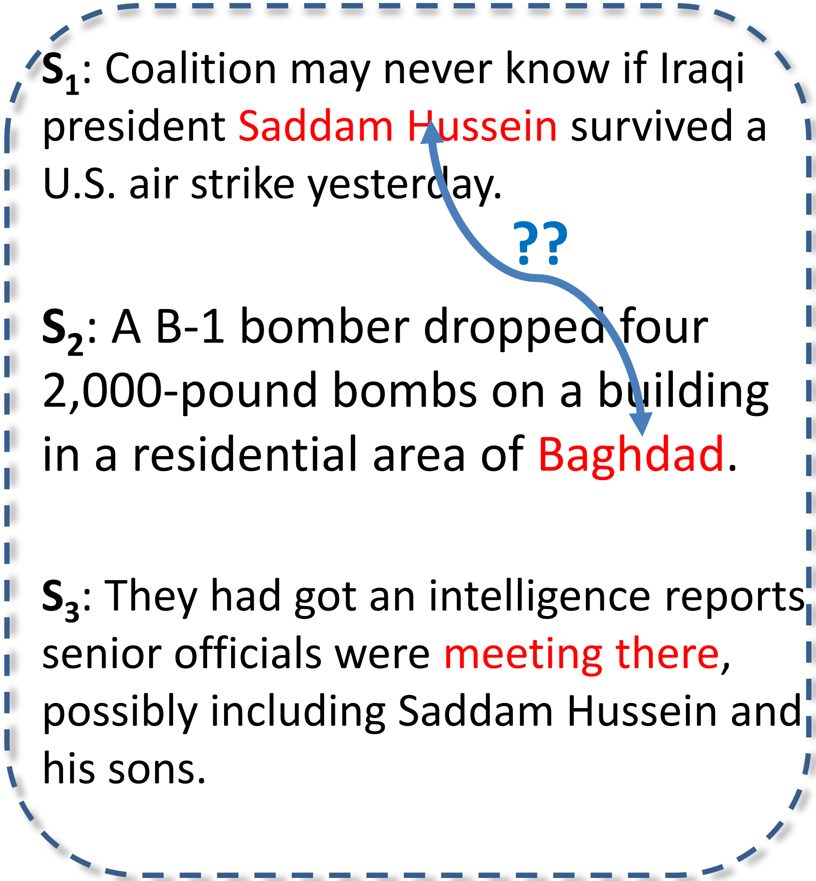
MOTIVATION

Previous researches



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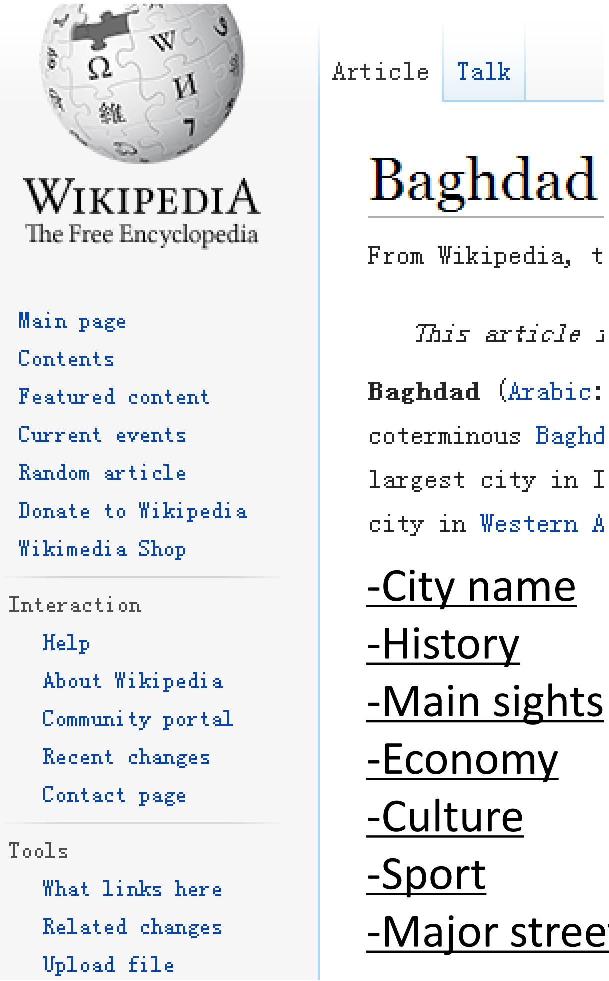

Baghdad

From Wikipedia, t

This article i

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-City name

-History

-Main sights

-Economy

-Culture

-Sport

-Major streets

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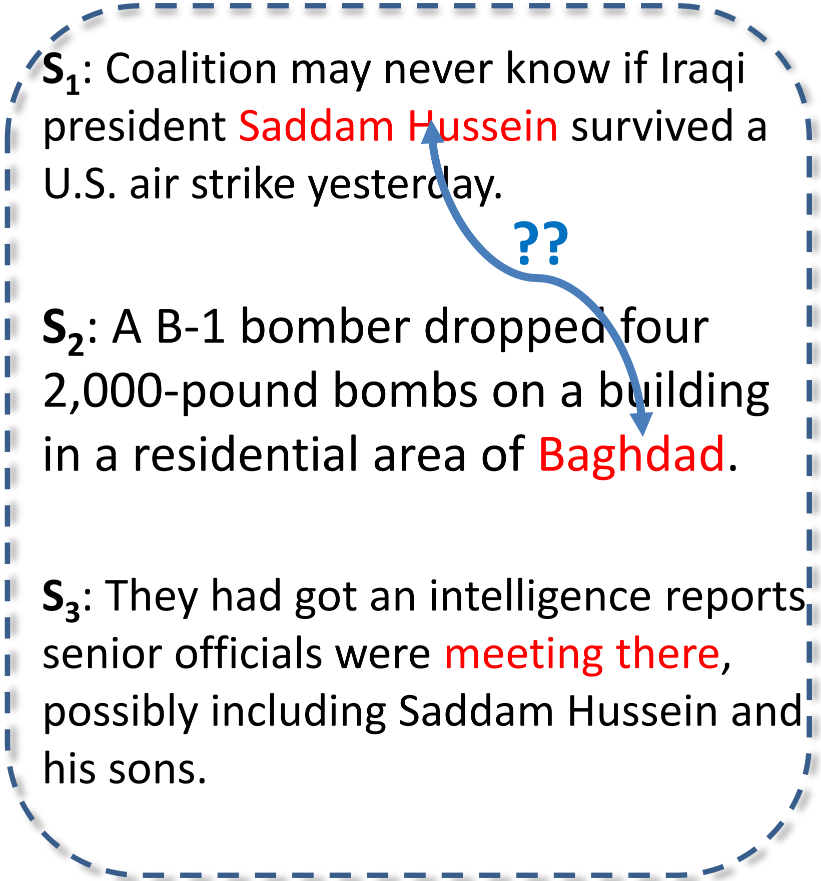

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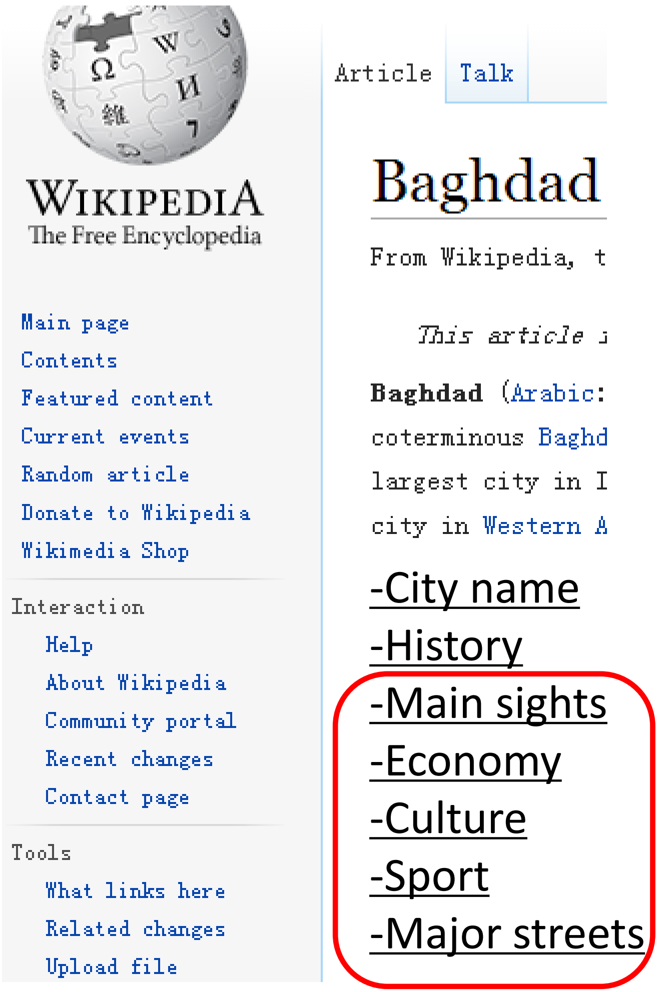

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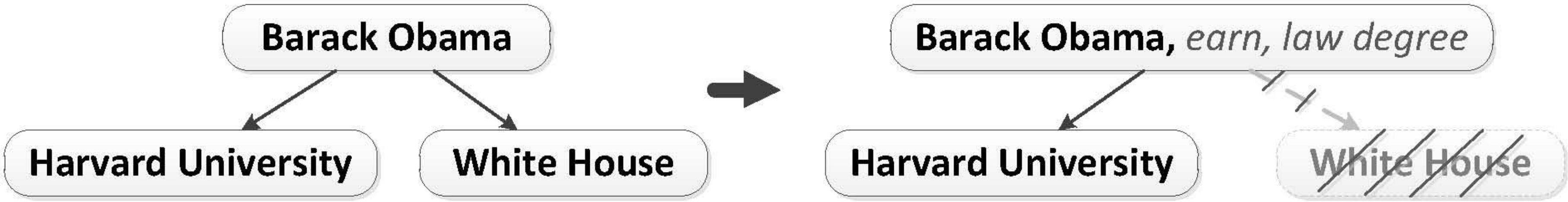
-City name
-History
-Main sights
-Economy
-Culture
-Sport
-Major streets

Not relevant

Why triple?

- We use background knowledge in the form of triple: ***"argument$_1$, predicate, argument$_2$"***



(a) Ambiguity

(b) Disambiguation

Less noise and less ambiguity

- So we focus on finding and ranking on these triples

OUR SOLUTION …

Questions

- Where knowledge comes from
- How to rank these knowledge

Where?

- Existing knowledge bases
  - YAGO (Hoffart et al., 2013)
  - 447,000,000 facts formed as “argument$_1$, predicate, argument$_2$” and partly manually edited
  - **E.g**. *“Iraqi, hasCapital, Baghdad”*

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  - **E.g**. *“Iraqi, hasCapital, Baghdad”*
- Automatically extracted knowledge
  - Reverb (Etzioni et al., 2011)
  - Take raw text as input and automatically extract knowledge formed as “argument$_1$, predicate, argument$_2$”
  - **E.g.** *“Saddam, return to live in, Baghdad”*

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We cannot treat all of them as candidates to be ranked. So, which to choose?

- YAGO: lexically matched facts
- Automatic extraction: knowledge extracted from relevant documents

Questions

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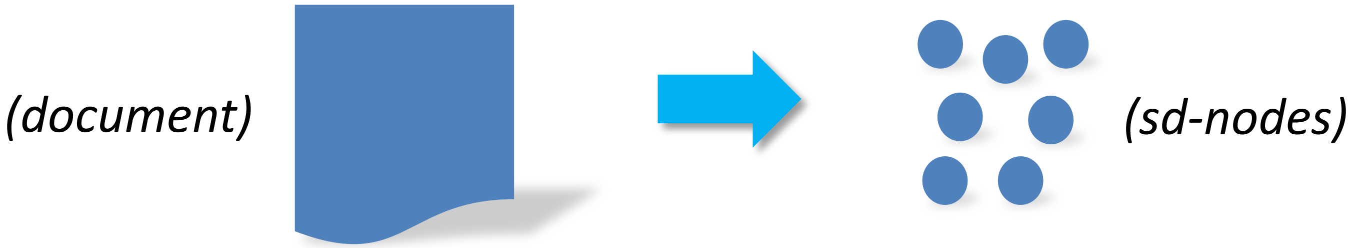
- How to rank these knowledge

Basic Idea

- Source document consists of multiple information, which can be extracted as triples



(document)

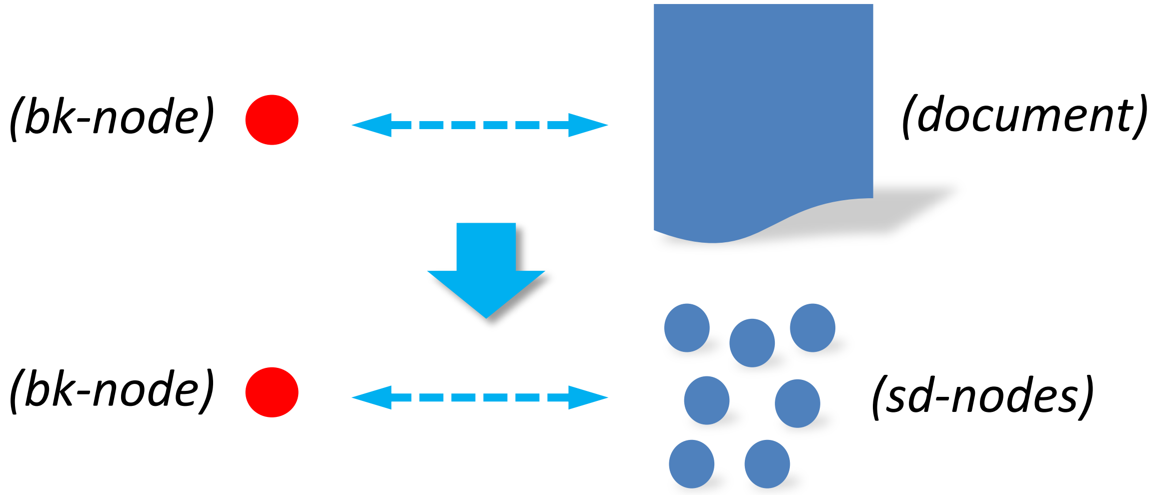
(sd-nodes)

sd-node: source document information

bk-node: background knowledge

Basic Idea

- For certain background knowledge in the form of triple (***bk-node***), the relevance to source document is converted into relevance to its ***sd-nodes***.



Basic Idea

- We present ***sd-nodes*** and ***bk-nodes*** together, then propagate relevance score from sd-nodes to bk-nodes

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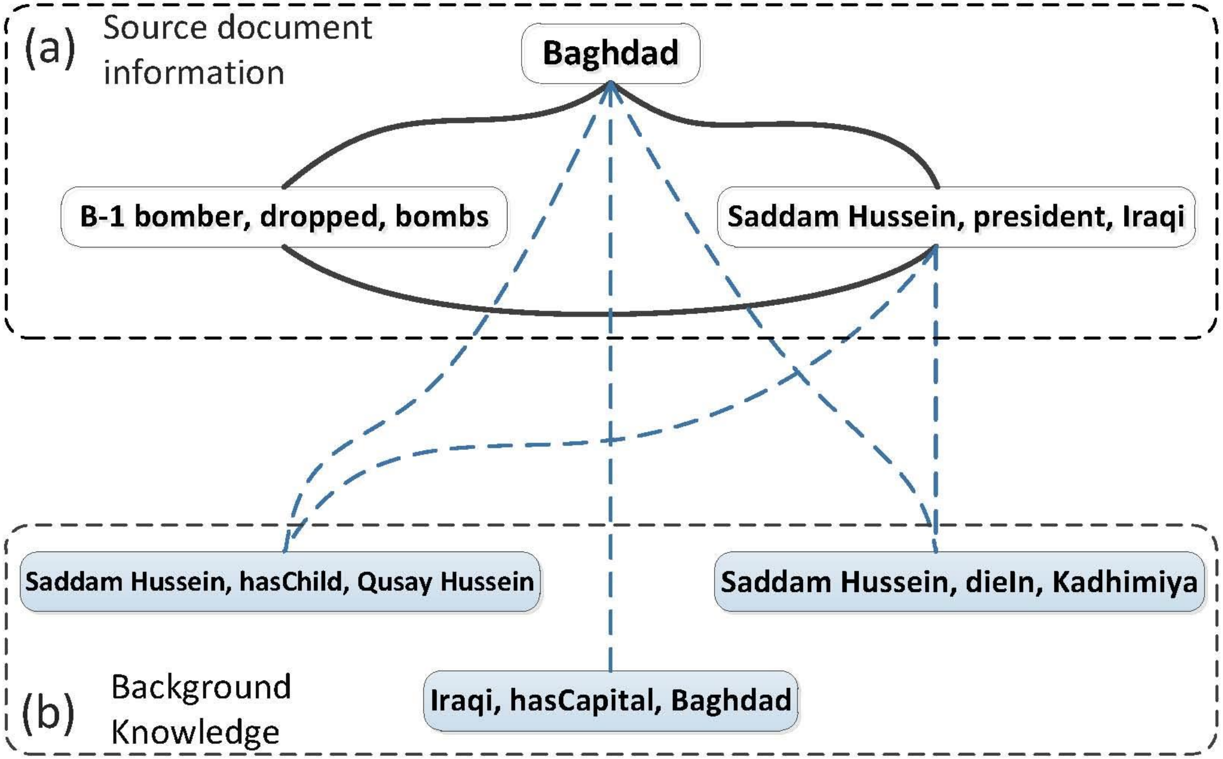
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sd-nodes

bk-nodes

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  - F2: How relevant is the ***bk-node*** to these ***sd-nodes***?
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  - F3: How important are these ***sd-nodes***?
    - More important -> more relevant

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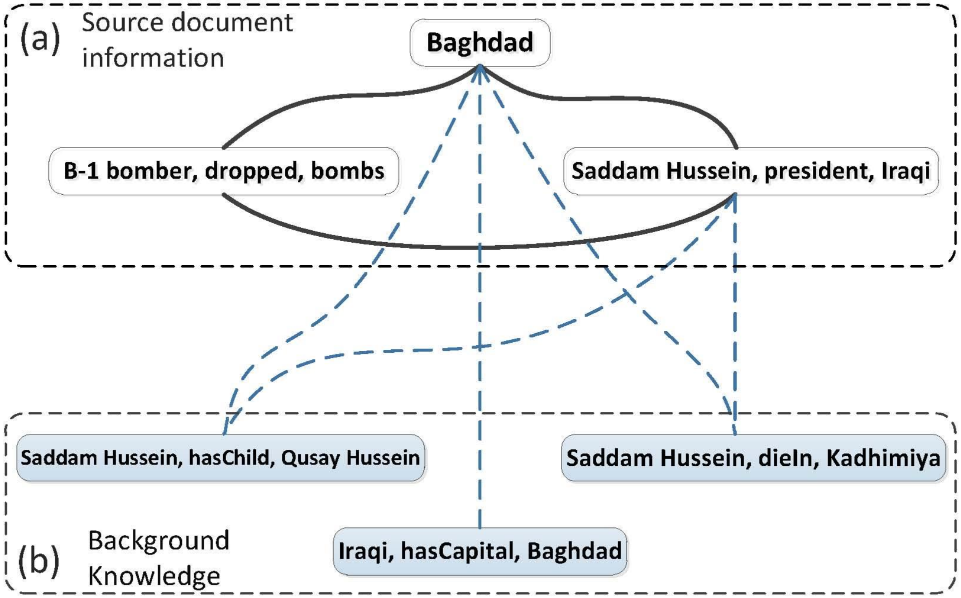
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graph structure

How to rank?

- F2: How relevant is the ***bk-node*** to these ***sd-nodes***?
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$$WebJaccard(p,q) = \begin{cases} 0 & \text{if } H(p \cap q) \le C \\ \frac{H(p\cap q)}{H(p)+H(q)-H(p\cap q)} & \text{otherwise.} \end{cases}$$

H(*P*) indicates the number of pages returned by search engine, given the query *P*.

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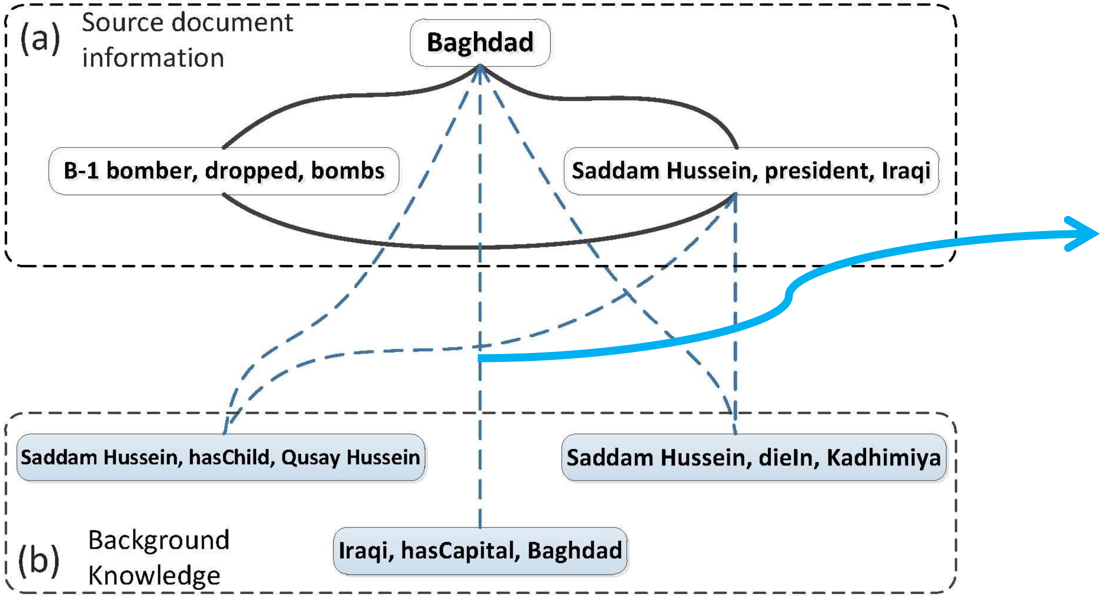
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weight of edges

How to rank?

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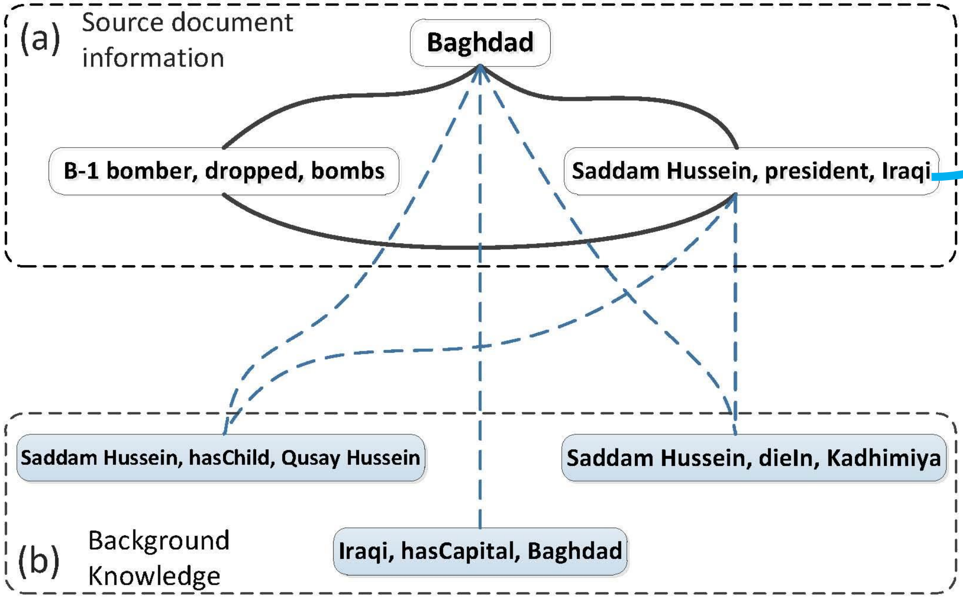

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initial value

How to rank?

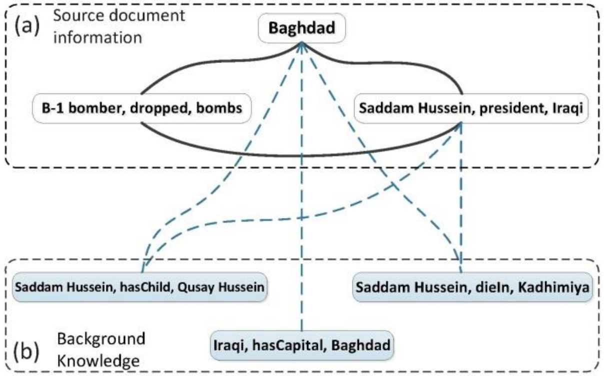
Combine them together…

How to rank?

- Iterative relevance propagation over the graph
  - Iterative propagation

$$\vec{W}' = \vec{W} \times P$$

$$= \vec{W} \times \begin{bmatrix} p(1,1) & p(1,2) & \cdots & p(1,n) \\ p(2,1) & p(2,2) & \cdots & p(2,n) \\ \cdots & \cdots & \cdots & \cdots \\ p(n,1) & p(n,2) & \cdots & p(n,n) \end{bmatrix}$$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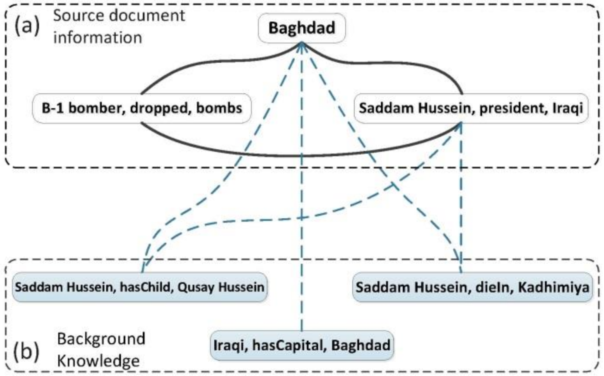

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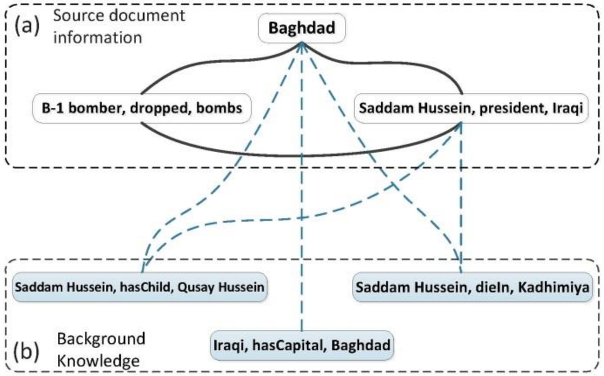
for every element

$$\begin{aligned} w_i' &= w_1 \cdot p(1,i) + w_2 \cdot p(2,i) + \cdots + w_n \cdot p(n,i) \\ &= \sum_{k \in N} w_k \cdot p(k,i) \\ &= \sum_{k \in N} w_k \cdot \left(\frac{r(i,j) \times \delta(i,j)}{\sum_{k \in N} r(k,j) \times \delta(k,j)} \right) \end{aligned}$$

How to rank?

- Iterative relevance propagation over the graph
  - Propagation probability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$$p(i,j) = \frac{r(i,j) \times \delta(i,j)}{\sum_{k \in N} r(k,j) \times \delta(k,j)}$$

where

$$\delta(i,j) = \begin{cases} 1 & \text{if } (i,j) \in E \\ 0 & \text{otherwise} \end{cases}$$

How to rank?

- Iterative relevance propagation over the graph
  - – Stop when a global stage is achieved
  - – Rank all the background knowledge according to their relevance scores
  - – Output the ranked list of background knowledge

EXPERIMENTS

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→ ***GOOD CONSISTENCE!***

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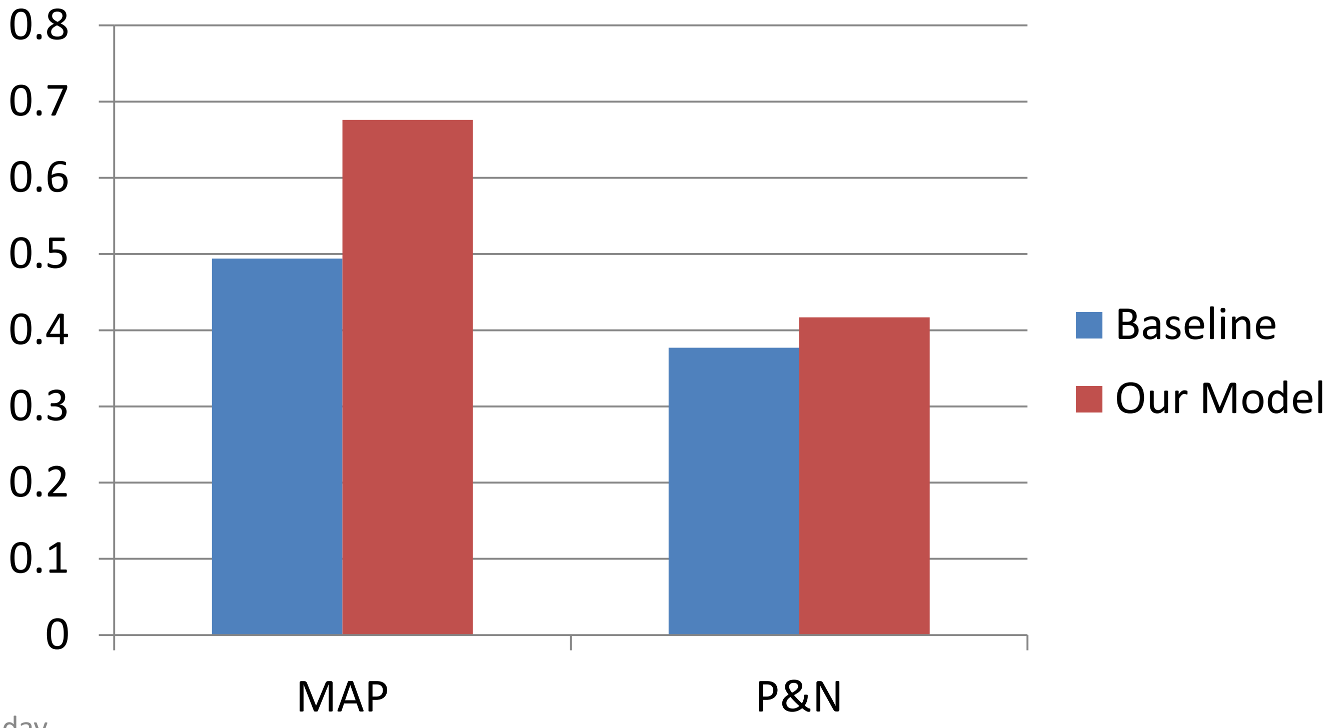

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- Different Setups
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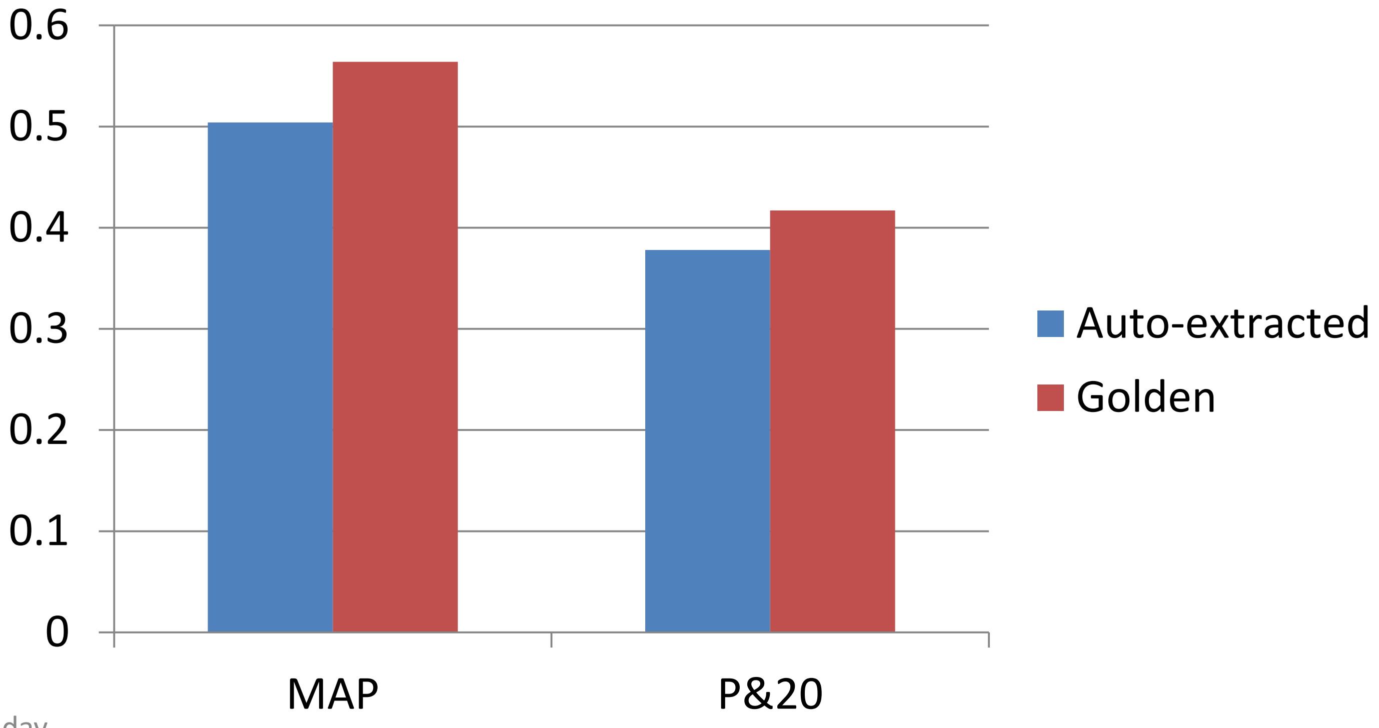

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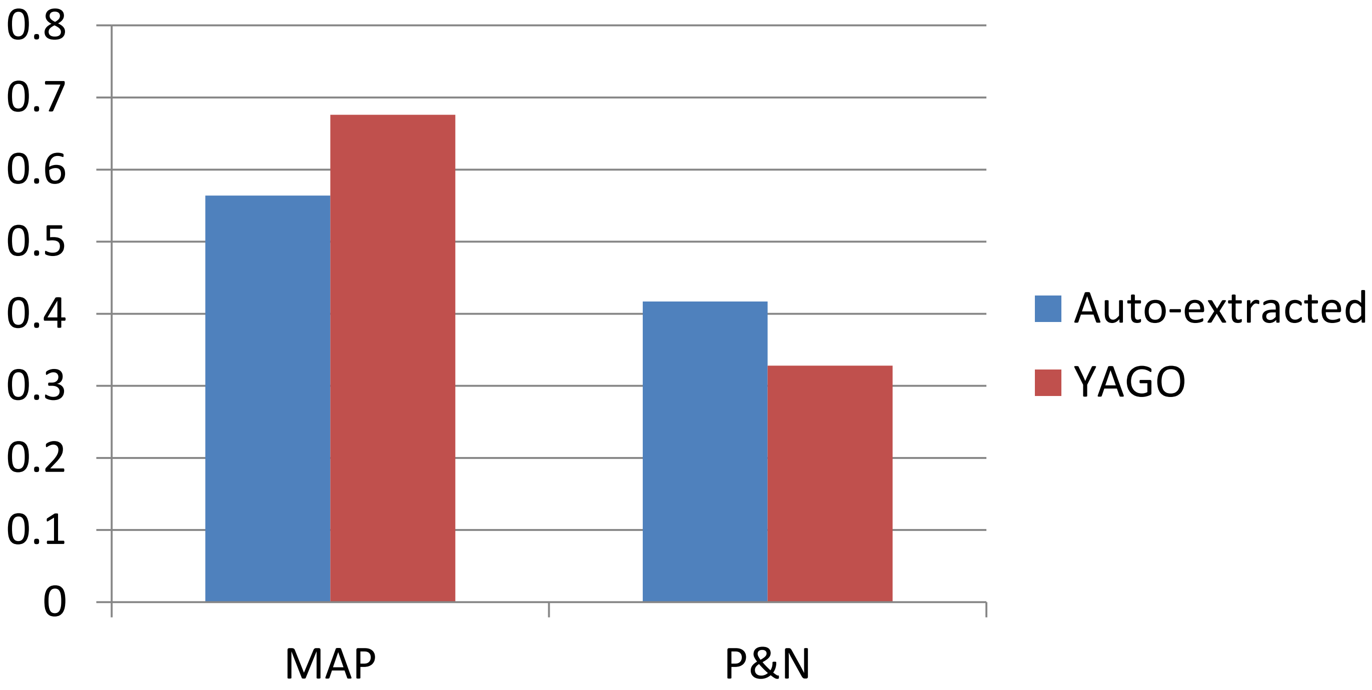

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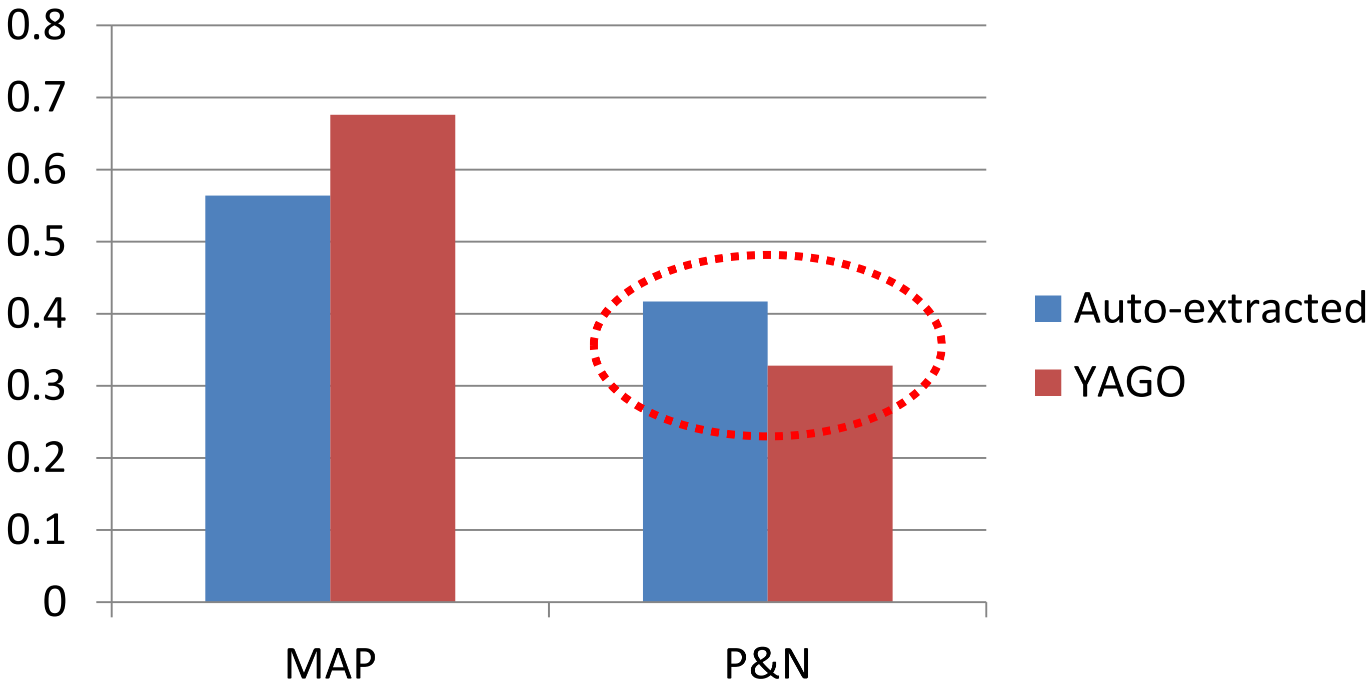

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- To further improve the ranking performance
- Automatic evaluation, instead of manual annotation
- To apply these background knowledge in real tasks

Thanks

Q&A