

Understanding Search Queries in Natural Language

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KONICA MINOLTA

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What do office people do

Find the email I sent to Peter a week ago. I was about meeting in Copenhagen.

I cannot find the picture of Eiffel tower I shared with Julia a few weeks ago.

Find me a presentation of the new BMW.

I need to book a hotel in Brussels at the end of November.

Where are the charts of Adidas jacket sales?

Where is documentation to project Watchtower?

Find a cheap flight to Madrid in the second half of January.

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Office people search something very often

1 Search in natural language

2 Recognition of user intent

3 Text analysis

4 Building the search query

5 Summary

Search in natural language



- user says what she looks for
- the voice is transformed into text
- the text is **understood**
- the system gives feedback to the user
- the system provides search results

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Understanding natural language

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find an image:

a file with MIME type `image/jpeg`

the content of the image has to be Eiffel tower:

it has to have tag `Eiffel tower`

the file was shared with Julia:

a person whose first name or last name is Julia

the file was shared within a time period:

`2018/12/01–2018/12/07`

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Understanding natural language

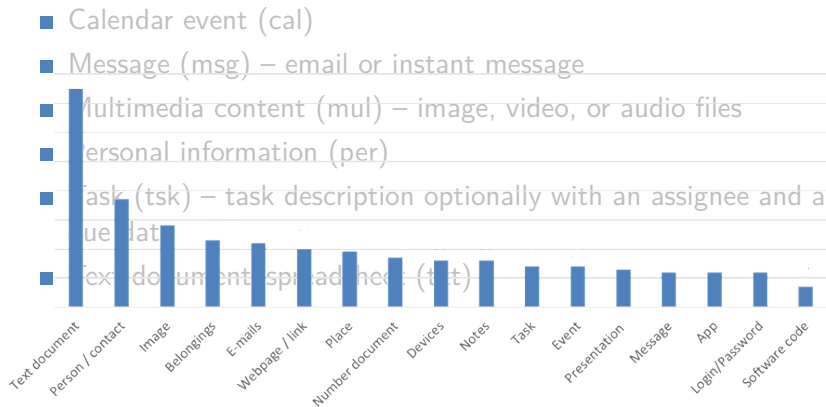
I need the picture of Eiffel tower I shared with Julia a week ago.

- recognize user's context (who, when, where)
- recognize user's intent (what)
- analyze the text
- build the search query

Recognition of user intent

- Calendar event (cal)
- Message (msg) – email or instant message
- Multimedia content (mul) – image, video, or audio files
- Personal information (per)
- Task (tsk) – task description optionally with an assignee and a due date
- Text document/spreadsheet (txt)

Recognition of user intent



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support vector machine (SVM) model with features:

- Average vectors of all words of the query
- Average of vectors of first k words of the query

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Successful in distinguishing intents in sentences such as:

*find **document** with picture of a **video** camera*
*I need **video** about how to take **pictures***
*where is a **picture** of a **document***

Evaluation of the intent classifier

Category	Precision	Recall	F-1	Support
cal	1.00	0.94	0.97	36
msg	0.90	0.84	0.87	32
mul	1.00	0.96	0.98	26
per	0.94	0.96	0.95	48
tsk	1.00	1.00	1.00	10
txt	0.90	0.96	0.93	69
weighted avg	0.94	0.94	0.94	221

Text analysis

semantic role labeling → predicate + arguments

recognition of entities in the arguments

rule-based argument parsing

Semantic role labeling

I **need** the picture of Eiffel tower I **shared** with Julia a week ago.

- predicate: need(doer, object)
- predicate: share(doer, object, involved person, time)

Semantic role labeling

I need the **picture of Eiffel tower** I shared with **Julia** a week ago.

- predicate: need(doer, object)
- predicate: share(doer, object, involved person, time)
- arg0 (doer): I
- arg1 (what is needed): picture of Eiffel tower
- arg1 (what is shared): picture of Eiffel tower
- arg2 (involved person): Julia

Semantic role labeling

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- time: a week ago

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DeepSRL [3]

Sentence analysis

- SpaCy¹ with large English model:
 - named entity recognition: Eiffel
 - phrase detection: Eiffel tower, team building
- Rule-based argument parsing (constraints on the content):
 - intent modifiers: **recent** CV
 - keyword-based: **picture** of a banana
 - syntactic: picture **of** a banana = banana picture
- External knowledge base querying (ConceptNet², DBPedia³)
 - check that the phrases were detected correctly
 - possibility to expand query by synonyms

¹<http://spacy.io>

²<http://conceptnet.io>

³<http://wiki.dbpedia.org/lookup>

Evaluation of the text analysis

Manual evaluation on 80 example sentences:

- 41 sentences were parsed completely and correctly
- in 11 sentences, a relevant token was missing
- in 28 sentences, an irrelevant token was included in the search subgraph
- in 6 sentences, the relation was not detected correctly

Building the search query

interpret entities (named and unnamed):

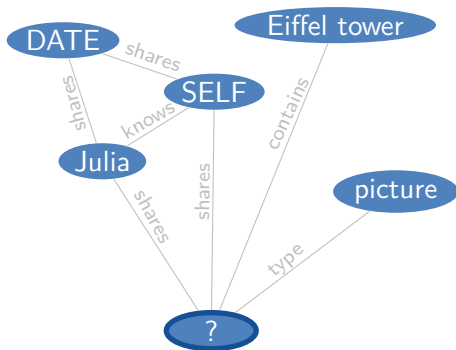
- Julia (person)
- a week ago (between 2018/12/01 and 2018/12/07)

interpret relations between entities:

- Julia (person sharing something)
- a week ago (something was shared between 2018/12/01 and 2018/12/07)

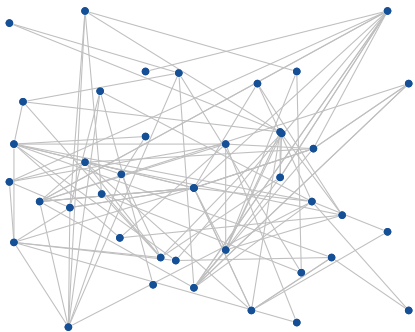
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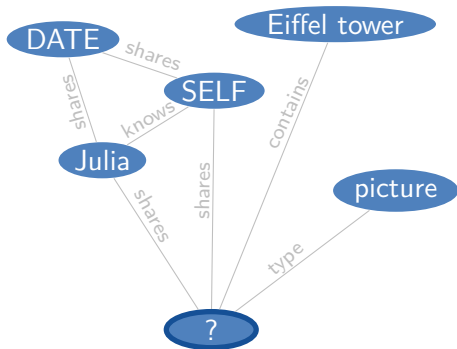


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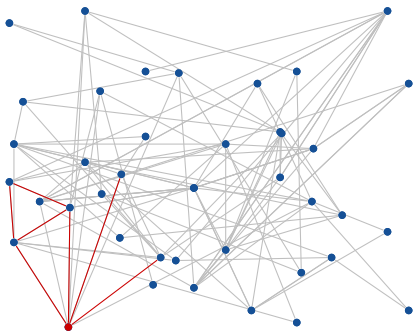


knowledge base

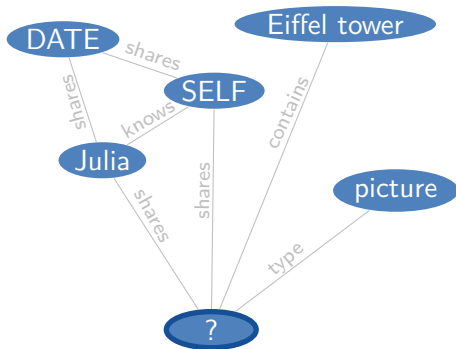


Building the search query

I need the picture of Eiffel tower I shared with Julia a week ago.



knowledge base



Kimi the assistant

▲ I need the picture of Eiffel tower I shared with Julia a week ago.

Search for



type

image

Contains



text



image

Eiffel tower

Relates to



people

Julia



time





2018/10/15-2018/10/17



source

Summary

- the goal is to **understand** queries in natural language
- combination of ML + rule-based methods + knowledge-based methods
- machine learning used for
 - recognition of user **intent**
 - **semantic role labeling**
 - **named entity recognition**
- rule-based methods for
 - interpretation of the relations
- knowledge-based methods used for
 - interpretation of the entities
 - query expansion
- search text is translated to graph query

-  Cortes, C., Vapnik, V.: Support-vector networks. Mach. Learn. **20**(3), 273–297 (Sep 1995)
-  Grave, E., Mikolov, T., Joulin, A., Bojanowski, P.: Bag of tricks for efficient text classification. In: In Proceedings of the 15th Conference of the European Chapter of the Association for Computational Linguistics. pp. 427—431 (2017), <http://arxiv.org/abs/1607.01759>
-  He, L., Lee, K., Lewis, M., Zettlemoyer, L.: Deep Semantic Role Labeling: What Works and What's Next. In: Proceedings of the Annual Meeting of the Association for Computational Linguistics (2017)
-  Tunkelang, D.: Search Results Presentation (Feb 2018), <https://queryunderstanding.com/search-results-presentation-7d6c6c384ec1>