

Perspectives on Evaluating Diverse Open Web Search Applications



IR Lab, March 22, Padua, Italy

Maik Fröbe

Friedrich-Schiller-Universität Jena

Evaluating Diverse Open Web Search Applications with TIREx

Motivation

Michael Granitzer

Leiter OpenWebSearch.eu



"I want to
choose my
search engine
like my daily
newspaper"

Evaluating Diverse Open Web Search Applications with TIREx

What is Hindering a Diverse and Vibrant Search Ecosystem?

Sociological factors:

“Competition is just one click away.”

Eric Schmidt, former CEO of Google

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Tech @ Cliqz

search privacy web monopoly

**Google—Competition is just one click and
27 billion US dollars away**

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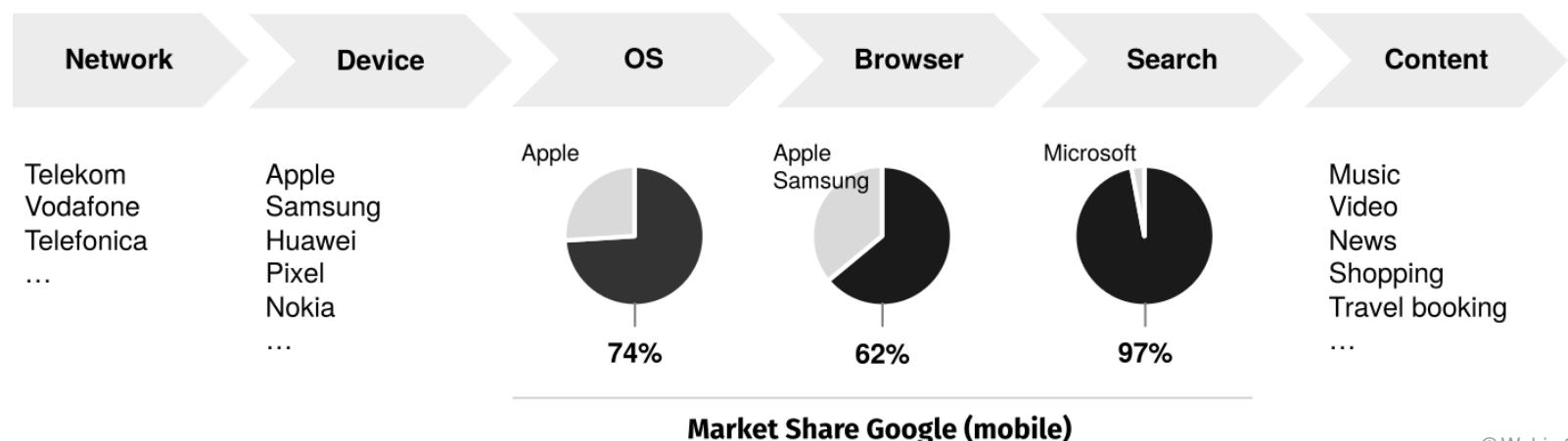
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The internet value chain:



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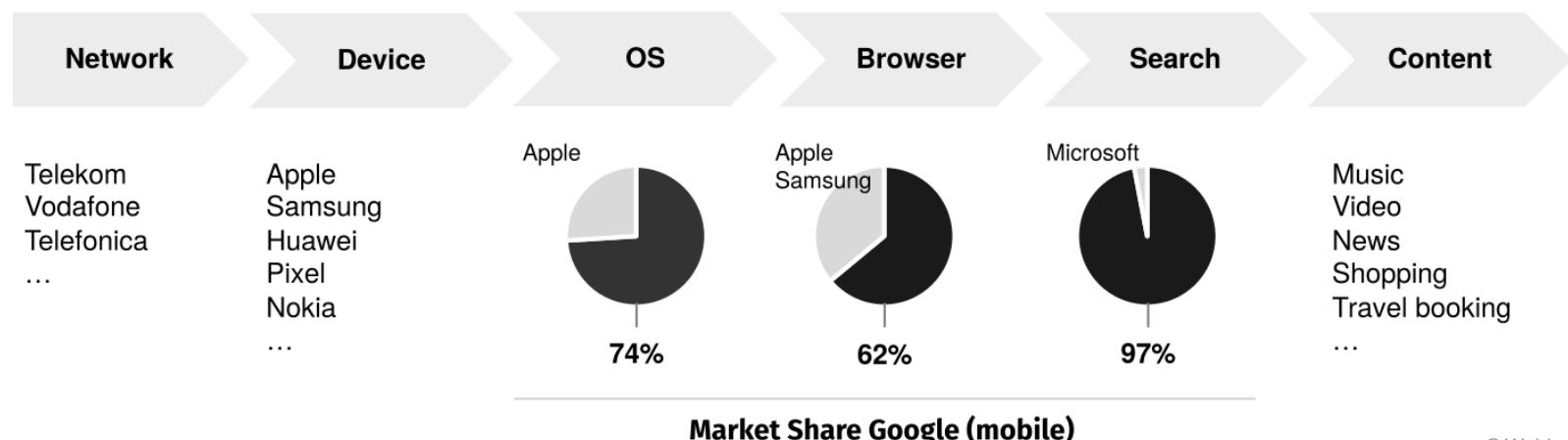
Solution not within our scope
Still, positive examples exist

Tech @ Cliqz

search privacy web monopoly

Google—Competition is just one click and 27 billion US dollars away

The internet value chain:



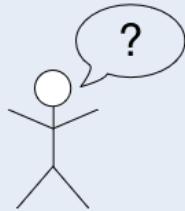
Evaluating Diverse Open Web Search Applications with TIREx

What Technology Enables a Diverse and Vibrant Search Ecosystem?



Indexing

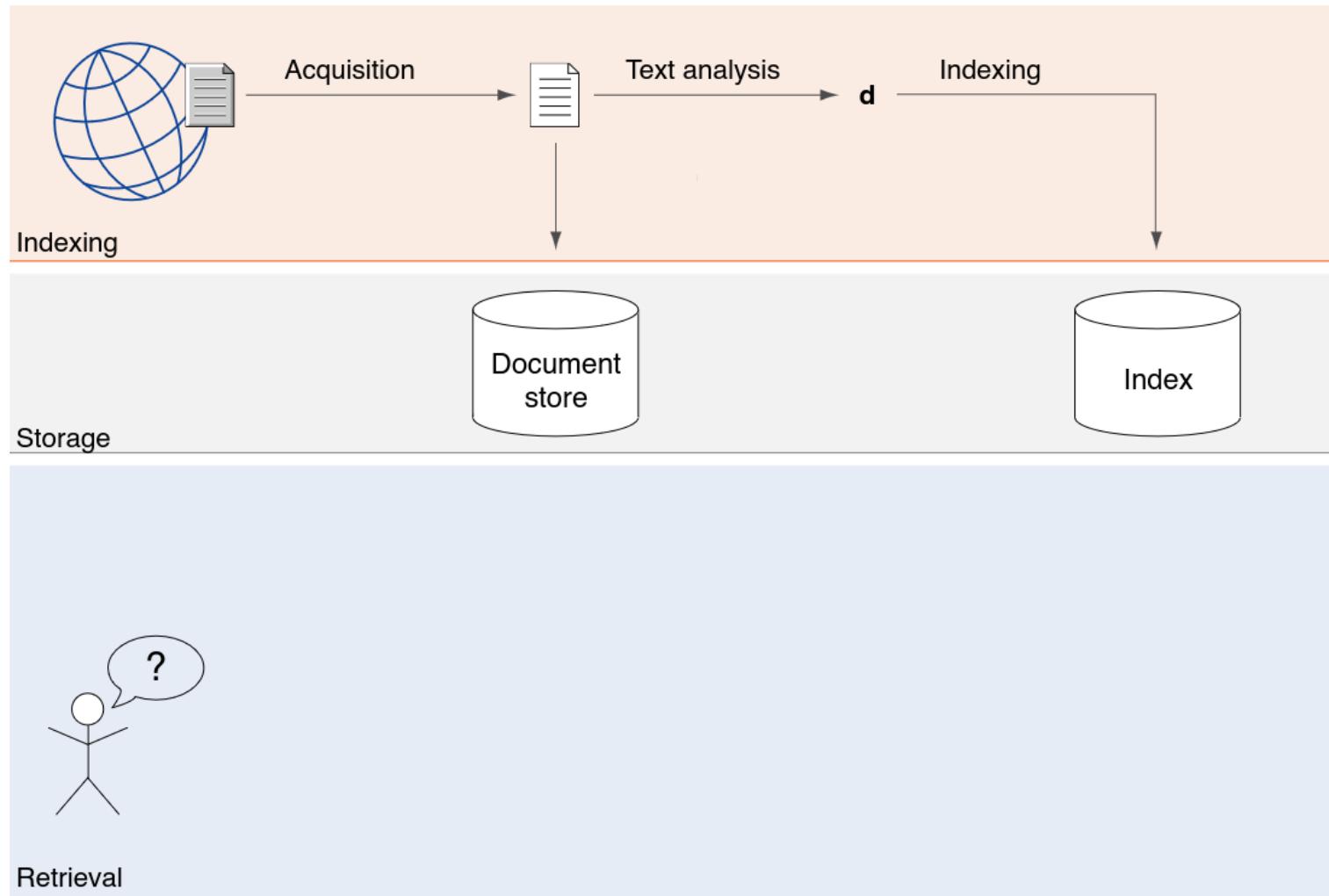
Storage



Retrieval

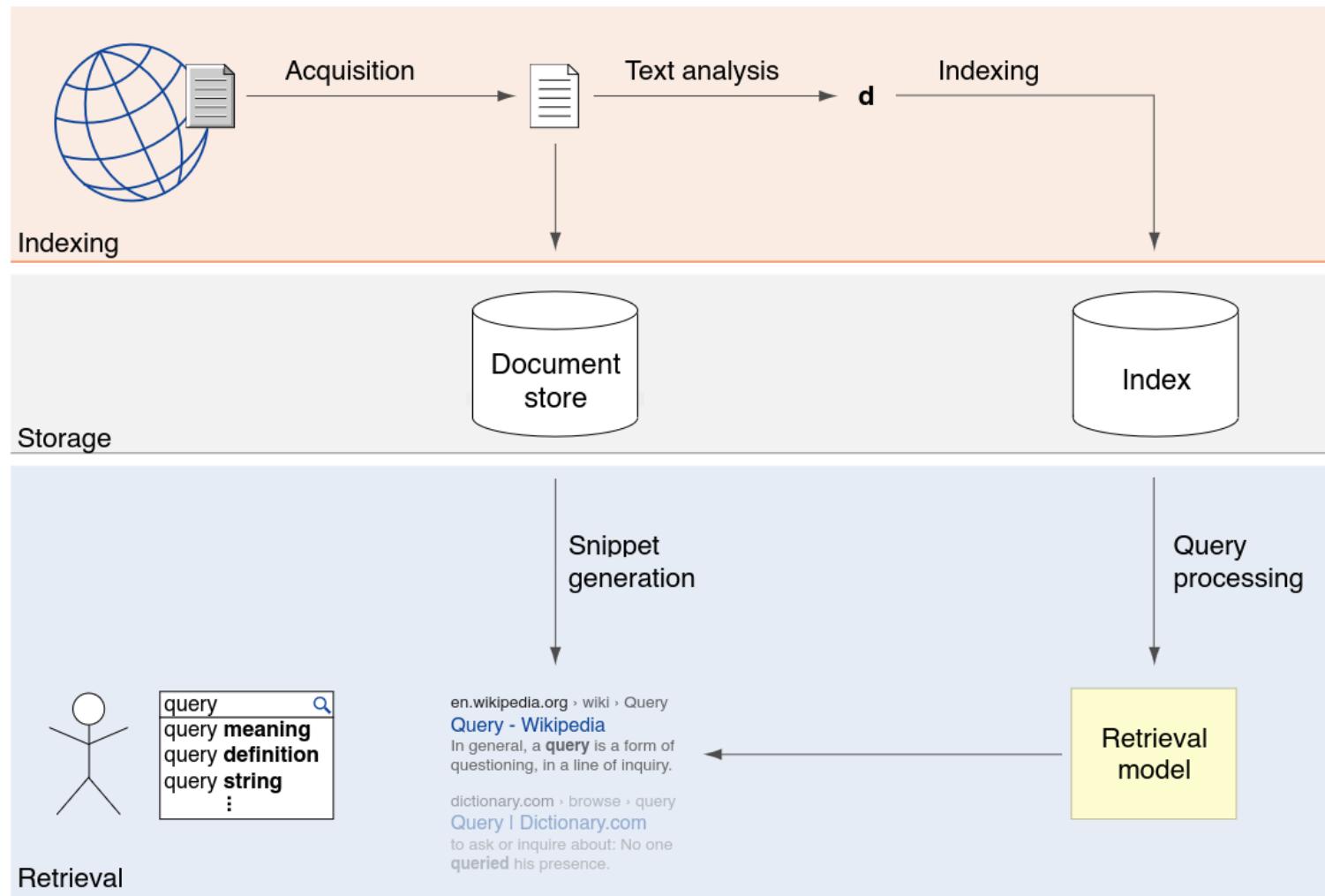
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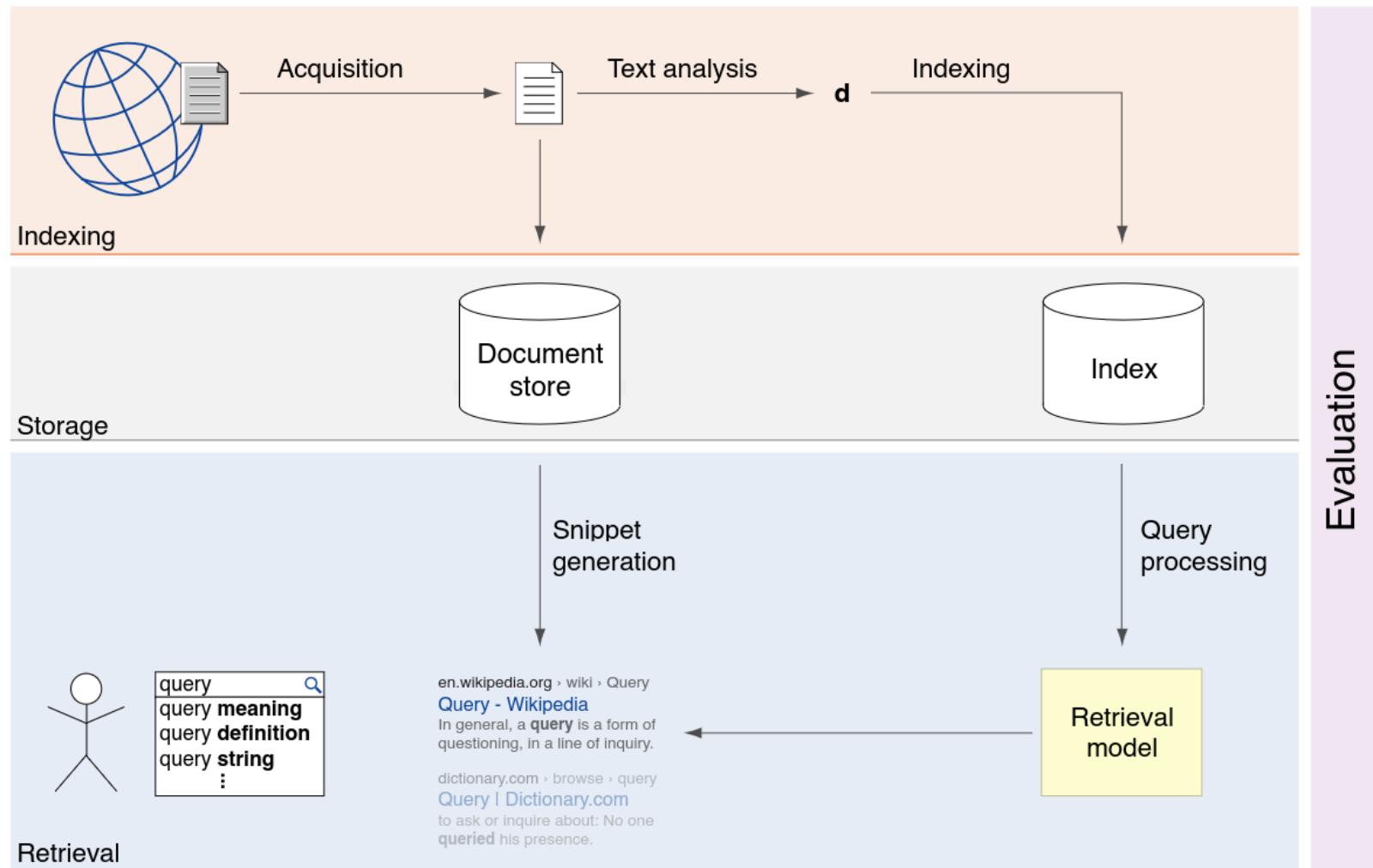
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What Technology Enables a Diverse and Vibrant Search Ecosystem?



Evaluating Diverse Open Web Search Applications with TIREx

The Open Web Index To the Rescue?



Evaluating Diverse Open Web Search Applications with TIREx

The Open Web Index: Overview of Partners

14 partners + 3rd party calls

- Research, infrastructure, industry, and NGOs

Research

Information Retrieval, AI, HCI, Geo-spatial Data Processing



Infrastructure Organisations

Data Storage, HPC, Services and Scientific Computing



Associations
for a future Web /Internet



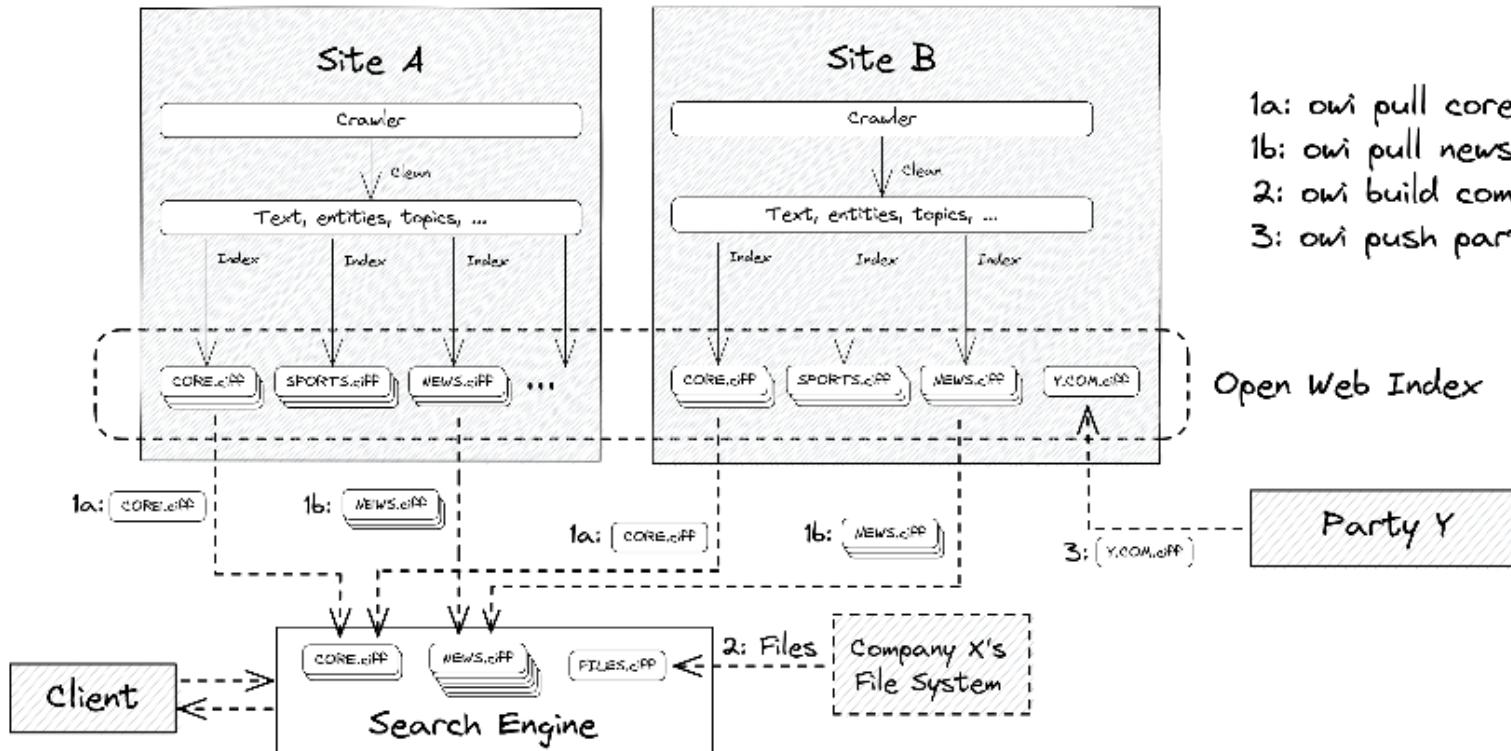
Evaluating Diverse Open Web Search Applications with TIREx

The Open Web Index: Overview of Partners



Evaluating Diverse Open Web Search Applications with TIREx

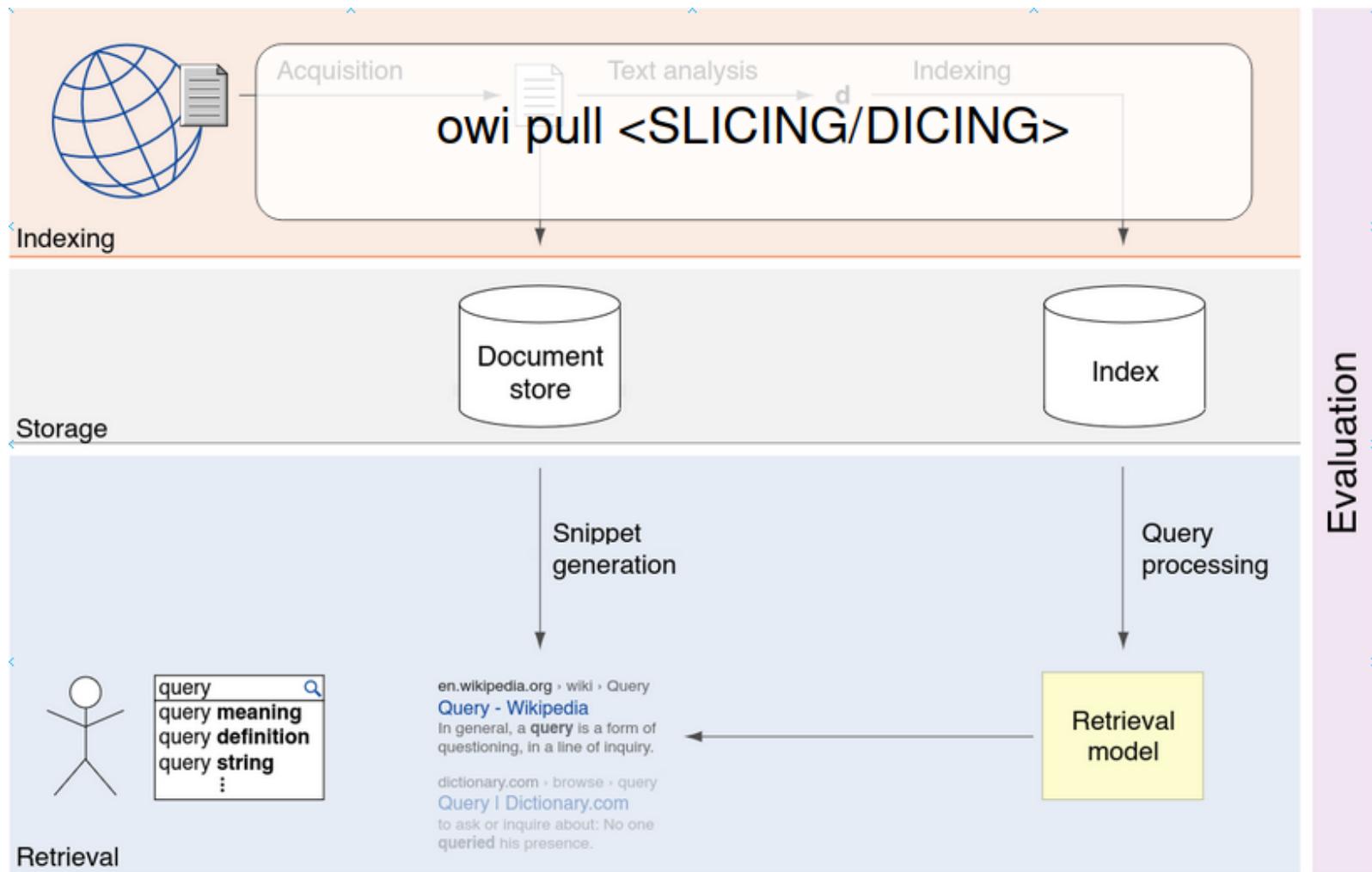
Slicing and Dicing the Open Web Index for a Diverse Search Ecosystem



- 1a: owl pull core:latest
- 1b: owl pull news:all
- 2: owl build companyX/files
- 3: owl push partyY/y.com

Evaluating Diverse Open Web Search Applications with TIREx

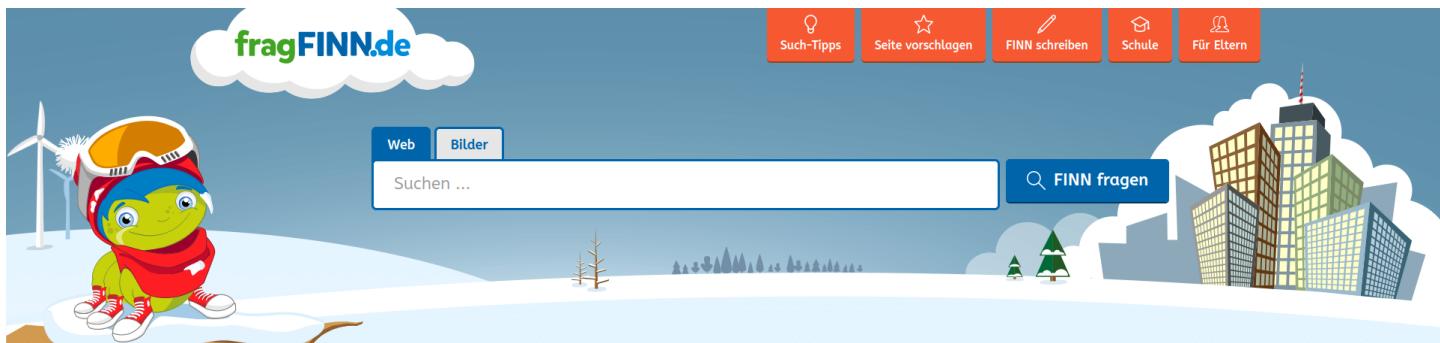
Slicing and Dicing the Open Web Index for a Diverse Search Ecosystem



Evaluating Diverse Open Web Search Applications with TIREx

A (biased) Selection of Use-Cases of Slicing and Dicing the Open Web Index

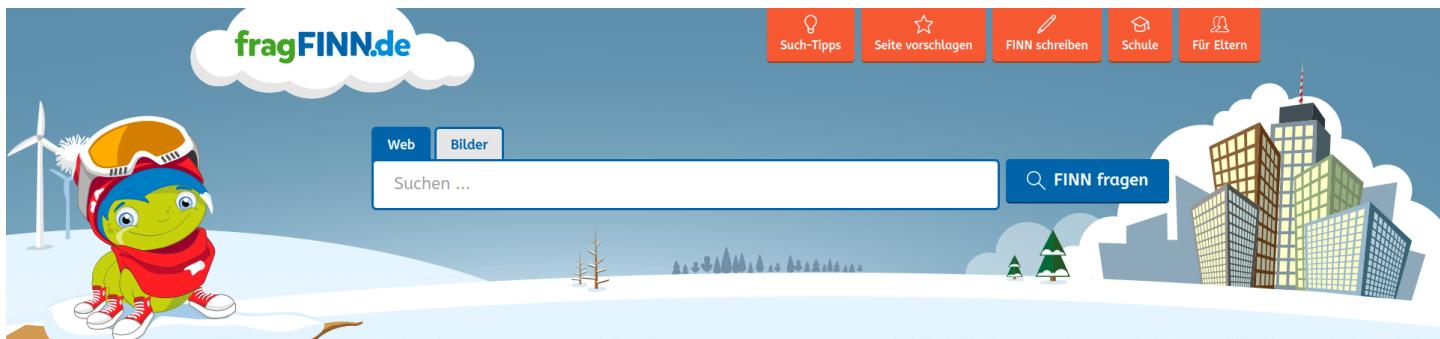
Search engine for kids:



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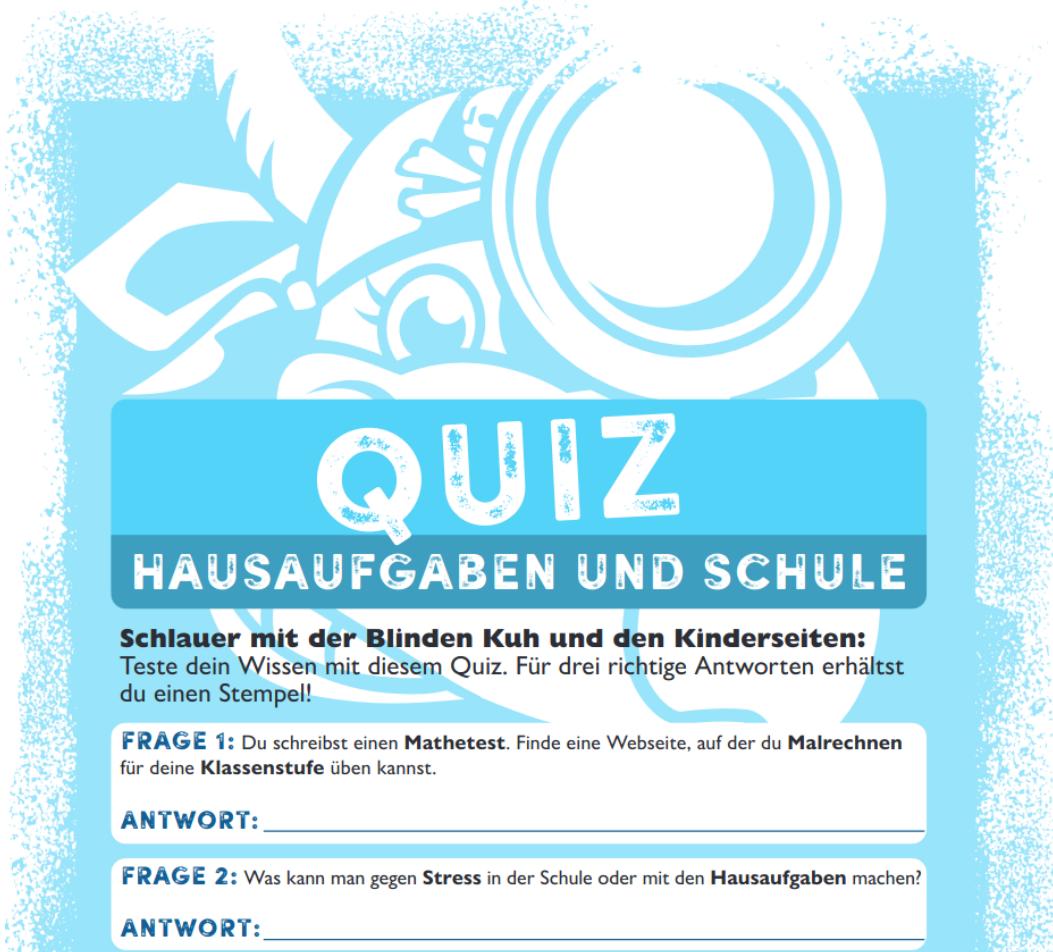
Substantial differences to commercial search:

- Index size: 1GB
- Encoded values, guidance, manual curation, ...

Evaluating Diverse Open Web Search Applications with TIREx

A (biased) Selection of Use-Cases of Slicing and Dicing the Open Web Index

Search engine for kids:



- We currently build a test collection

Evaluating Diverse Open Web Search Applications with TIREx

A (biased) Selection of Use-Cases of Slicing and Dicing the Open Web Index

More Ideas than time

- ❑ Build your own Pokemon search engine, or Harry Potter, etc.
- ❑ A climate change search engine (upcoming MANILA'24 workshop at SIGIR)
- ❑ A search engine to support financial experts, lawyers, etc.

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Use Cases: The Web as Searchable Resource for AI

Web data drives innovation beyond search, particularly in AI

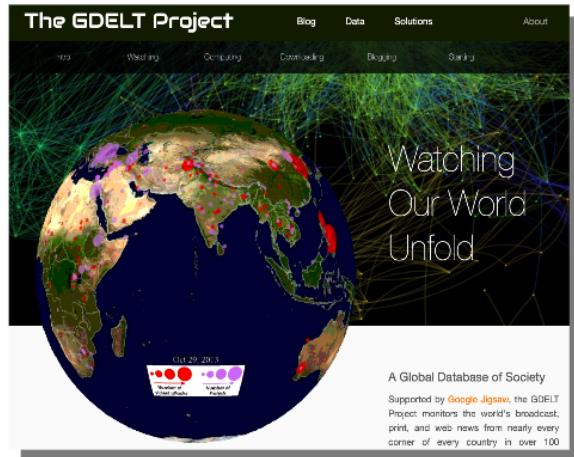


GPT-3: 80% of training data was
Web data

DALL-E 2

DALL-E 2 is an AI system that can create realistic images and art from a description in natural language.

Not only AI:
GDELT: Web-scale Event Analytics



Evaluating Diverse Open Web Search Applications with TIREx

Summary

- ❑ The OpenWebSearch.eu project aims to provide an Open Web Index
- ❑ The Open Web Index aims to enable a diverse search ecosystem

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Evaluation is Key

- ❑ Different organizations with different goals interact on the same fundamental

“ You don’t want that the client calls you at night.”

Arjen de Vries, OWS.eu

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- ❑ Good evaluation = good sleep :)

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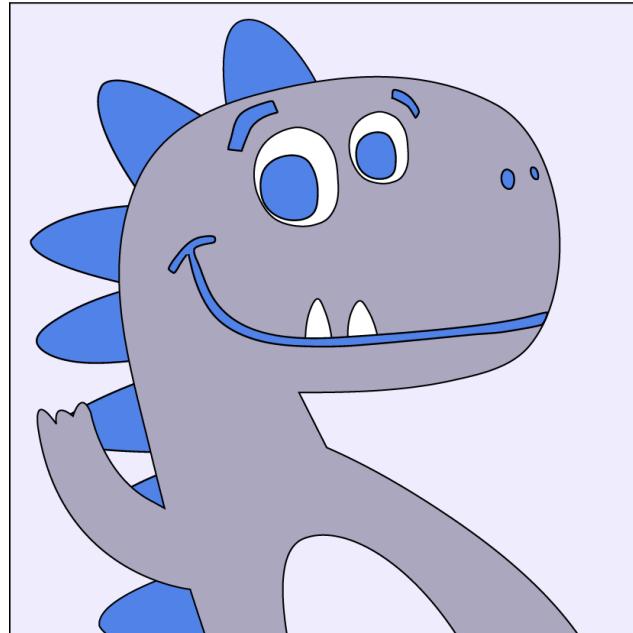
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Strong Collaborations to Evaluation Campaigns

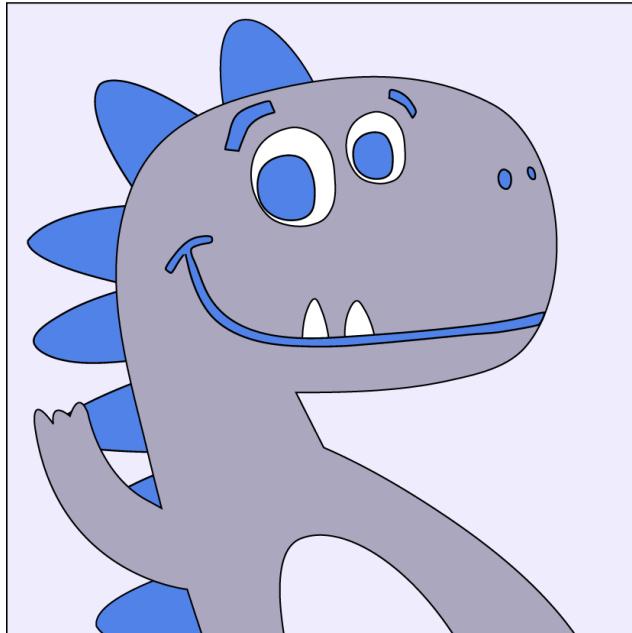
Example: Workshop on Open Web Search at ECIR 2024 (next week)

- ❑ We collaboratively develop and evaluate retrieval systems
- ❑ Collect standardized retrieval components
- ❑ Collect standardized evaluations (new test collection for Mastodon)
- ❑ Ensures diverse use cases are possible

TIREx for Evaluation



TIREx for Evaluation



TIREx = TIRA + ir_datasets + PyTerrier

TIRA

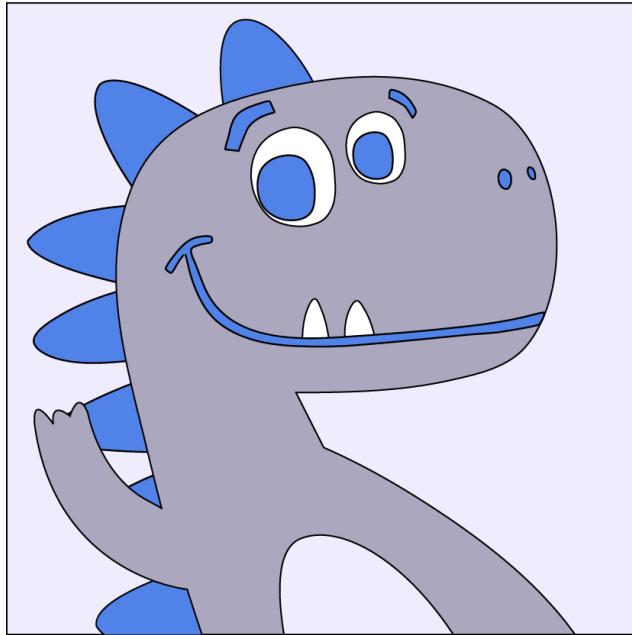
- ❑ Reproducible shared tasks: software submissions + blinded experiments

ir_datasets

- ❑ Unified + random data access: documents + queries + judgments

PyTerrier

- ❑ Declarative pipelines



TIREx = TIRA + ir_datasets + PyTerrier

TIRA

Reproducibility + Caching

- Reproducible shared tasks: software submissions + blinded experiments

Use Confidential Data



ir_datasets

Including new Evaluations

- Unified + random data access: documents + queries + judgments

PyTerrier

- Declarative pipelines

TIREx: Overview

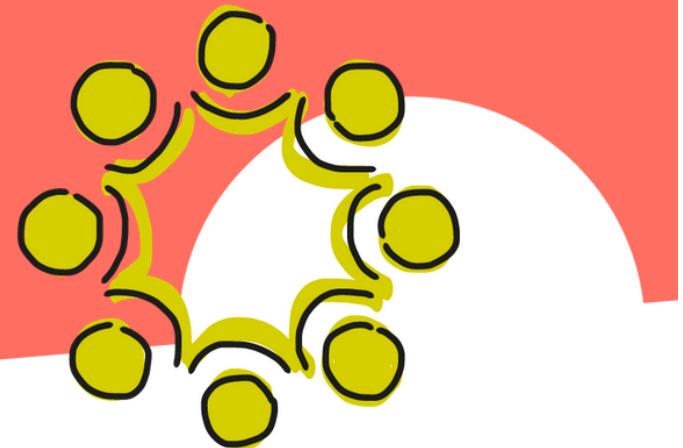
- ❑ Each approach implemented in Docker image
- ❑ Executed in a sandbox
 - blinded experimentation + caching + reproducibility
- ❑ More than 50 transferrable retrieval models
- ❑ 35 test collections (18 public + 17 private test)

TIREx: Overview

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Next Week at ECIR

1st International
Workshop on Open
Web Search
#wows2024



- ❑ We hope that the collected resources are useful to you

WOWS 2024: Overview Retrieval Components

Type	Team	Retrieval Component	
		Description	#
Re-Ranking	h2oloo	Citadell (In progress)	1
	naverlabseurope	Splade	1
	tu-dresden-02	Snippet Extraction	2
Query	QPPTK	Query Performance Prediction	12
	qspell	Spelling Correction	4
	salamander	Comparative Query Classification	1
	tu-dresden-03	LLM Query Expansion	9
	OWS	Query Segmentation (baseline)	6
	marcel-gohsen	Eintity Linking / Query Interpretation	2
	dossier	Query Intent Prediction	2
Document	fschlatt	Health Classification	2
	seanmacavaney	Corpus Graph	1
	seanmacavaney	DocT5Query	1
	tu-dresden-01	Genre Classification	3
	tu-dresden-04	Readability/Quality/Coherence Features	2
Σ	12		42

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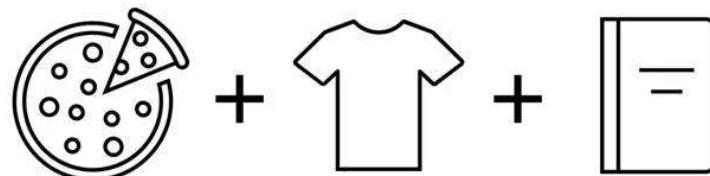
WOWS 2024: Student Hackathon at TU Dresden

- 12 Students registered, covering Bachelor and Master students
- Students get credits + pizza + t-shirt
- Workflow: 1 week to read paper + 1 week hackathon + 0.5 weeks writing
- Big thanks to Anja Reusch, Julius Gonsior, and Wolfgang Lehner!



IR Hackathon @ APB

- Team-Projekt (2 – 5 Leute)
- Eine kleine IR Komponente entwickeln
 - Dauer: 1 – 4 Tage je nach Lust und Zeit ☺



Pizza

T-Shirt

Anrechenbar
im Studium



Kontakt: Anja Reusch &
Julius Gonisor

WOWS 2024: Student Hackathon at TU Dresden

Some OWSome impressions of the WOWS hackathon at Dresden:

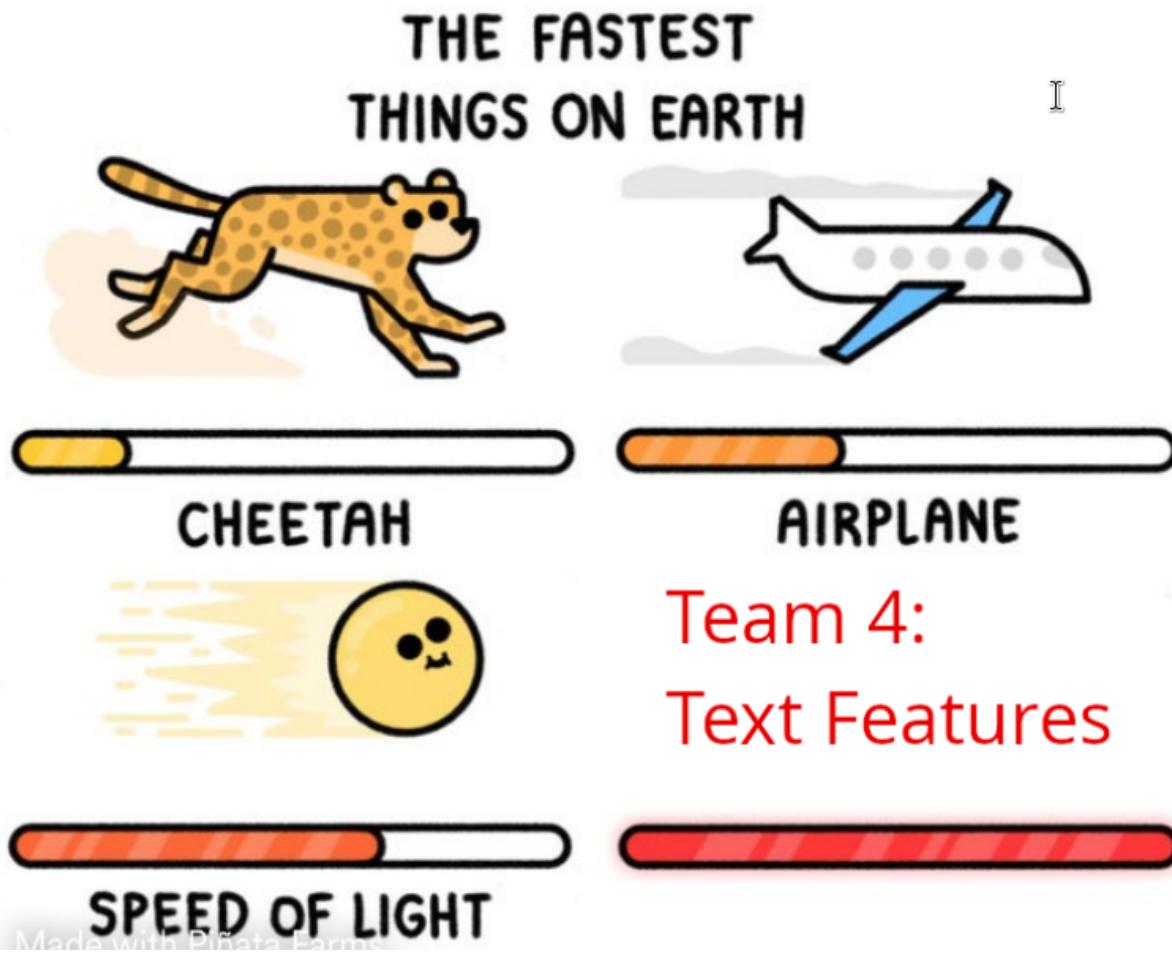


WOWS 2024: Student Hackathon at TU Dresden

We had four teams, so we had four prizes...

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Team tu-dresden-04: First working submission on Day 1

WOWS 2024: Student Hackathon at TU Dresden

We had four teams, so we had four prizes...



Team tu-dresden-03: 39,542 additions and 272 deletions

WOWS 2024: Student Hackathon at TU Dresden

We had four teams, so we had four prizes...

Most commits :)



Team tu-dresden-02: 153 commits in one week

WOWS 2024: Student Hackathon at TU Dresden

We had four teams, so we had four prizes...

Most Working Submissions



Team tu-dresden-01: 9 working submissions

WOWS 2024: Overview Components

Some OWSome impressions of the WOWS hackathon at Dresden:



WOWS 2024: Overview Components

Some OWSome impressions of the WOWS hackathon at Dresden:



WOWS 2024: Overview Components

Some Example Components

Most fundamental: Loading some index :)

▷ ▾

```
pt_dataset = pt.get_dataset('irds:antique/test')
```

[5]

```
index = tira.pt.index('ir-benchmarks/tira-ir-starter/Index (tira-ir-starter-pyterrier)', pt_dataset)
```

[6]

```
... Download from Zenodo: https://zenodo.org/records/10743990/files/2023-01-07-13-40-04.zip?download=1
```

```
Download: 100%|██████████| 31.1M/31.1M [00:02<00:00, 12.8MiB/s]
```

```
Download finished. Extract...
```

```
Extraction finished: /root/.tira/extracted\_runs/ir-benchmarks/antique-test-20230107-training/tira-ir-starter
```

WOWS 2024: Overview Components

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Most fundamental: Loading some index :)

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[6] index = tira.pt.index('ir-benchmarks/tira-ir-starter/Index (tira-ir-starter-pyterrier)', pt_dataset)
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Download: 100%[██████████] 31.1M/31.1M [00:02<00:00, 12.8MiB/s]
Download finished. Extract...
Extraction finished: /root/.tira/extracted\_runs/ir-benchmarks/antique-test-20230107-training/tira-ir-starter
```

- Load a PyTerrier index created in TIRA from Zenodo
- The final “owi pull” might substantially differ, still:
 - Comparison to many alternative indexing pipelines important
 - Test collections rarely change, this index can be used for years
 - Open and transparent evaluations ⇒ informed decision

WOWS 2024: Overview Components

Some Example Components: Genre Classification

```
pt_dataset = pt.get_dataset('irds:clueweb09/en/trec-web-2009')
topics = pt_dataset.get_topics('query')

bm25 = tira.pt.from_submission('ir-benchmarks/tira-ir-starter/BM25 Re-Rank (tira-ir-starter-pyterrier)', pt_dataset)
```

✓ 1.0s

```
genre_mlp_classifier = tira.pt.transform_documents('ir-benchmarks/tu-dresden-01/genre-mlp', pt_dataset)
```

✓ 4.8s

Download: 2.66MiB [00:00, 19.7MiB/s]

Download finished. Extract...

Extraction finished: [/root/.tira/extracted_runs/ir-benchmarks/clueweb09-en-trec-web-2009-20230107-training/tu-dresden-01](#)

```
(bm25 >> genre_mlp_classifier)(topics[topics['qid'] == '21']).head(5)
```

✓ 0.0s

	qid	query	rank	docno	predicted_label	probability_Shop	probability_Linklists	probability_Protrait non private
0	21	volvo	1	clueweb09-zh0015-47-11207	Shop	0.430557	0.050686	0.303563
1	21	volvo	2	clueweb09-en0035-03-39670	Shop	0.566059	0.035091	0.255652
2	21	volvo	3	clueweb09-zh0033-92-44184	Protrait non private	0.225574	0.050969	0.553595
3	21	volvo	4	clueweb09-ja0009-84-31373	Shop	0.525040	0.071335	0.173629
4	21	volvo	5	clueweb09-en0028-06-13844	Shop	0.429051	0.043311	0.389856

WOWS 2024: Overview Components

Some Example Components: Query Expansion with LLMs (Only the gist)

```
# Baselines
bm25 = pt.BatchRetrieve(index, wmodel="BM25")
bm25_rm3 = bm25 >> pt.rewrite.RM3(index) >> bm25
bm25_kl = bm25 >> pt.rewrite.KLQueryExpansion(index) >> bm25

# llm expansions with gpt
gpt_cot = tira.pt.transform_queries('workshop-on-open-web-search/tu-dresden-03/qe-gpt3.5-cot', dataset)
gpt_sq_fs = tira.pt.transform_queries('workshop-on-open-web-search/tu-dresden-03/qe-gpt3.5-sq-fs', dataset)
gpt_sq_zs = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-gpt3.5-sq-zs', dataset)

# llm expansions with llama
llama_cot = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-llama-cot', dataset)
llama_sq_fs = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-llama-sq-fs', dataset)
llama_sq_zs = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-llama-sq-zs', dataset)

# llm expansions with flan
flan_cot = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-flan-ul2-cot', dataset)
flan_sq_fs = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-flan-ul2-sq-fs', dataset)
flan_sq_zs = tira.pt.transform_queries('ir-benchmarks/tu-dresden-03/qe-flan-ul2-sq-zs', dataset)

pt.Experiment(
    [bm25, bm25_rm3, bm25_kl, pipeline_gpt_cot, pipeline_gpt_sq_fs, pipeline_gpt_sq_zs, pipeline_llama_cot, pip
    names=['BM25', 'BM25+RM3', 'BM25+KL', 'BM25+GPT-COT', 'BM25+GPT-SQ-FS', 'BM25+GPT-SQ-ZS', 'BM25+Llama-COT',
    topics=pt_dataset.get_topics('query'),
    qrels=pt_dataset.get_qrels(),
    eval_metrics=['recall_1000'],
    verbose=True
)
```

	name	recall_1000
0	BM25	0.751156
1	BM25+RM3	0.799385
2	BM25+KL	0.793911
3	BM25+GPT-COT	0.846802
4	BM25+GPT-SQ-FS	0.759494
5	BM25+GPT-SQ-ZS	0.770243
6	BM25+Llama-COT	0.810467
7	BM25+Llama-SQ-FS	0.761412
8	BM25+Llama-SQ-ZS	0.778425

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pt.Experiment(
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    verbose=True
)
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	name	recall_1000
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8	BM25+Llama-SQ-ZS	0.778425

Note to self: use for-loops :)

WOWS 2024: Overview Components

Some Example Components: DocT5Query =>

*doc e modello di trasformazione
in input*

```
bm25 = tira.pt.from_submission('ir-benchmarks/tira-ir-starter/BM25 Re-Rank (tira-ir-starter-pyterrier)', dataset)
docT5Query = tira.pt.transform_documents('ir-benchmarks/seanmacavaney/DocT5Query', dataset)
[7] ✓ 29.2s
...
Download: 2.15MiB [00:00, 14.8MiB/s]
Download finished. Extract...
Extraction finished: /root/.tira/extracted_runs/ir-benchmarks/antique-test-20230107-training/tira-ir-starter
Download from the Incubator: https://files.webis.de/data-in-production/data-research/tira-zenodo-dump-preparation/doc-t5-query/2024-03-19-18-06-23.zip
This is only used for last spot checks before archival to Zenodo.
Download: 100%|██████████| 16.8M/16.8M [00:00<00:00, 47.5MiB/s]
Download finished. Extract...
Extraction finished: /root/.tira/extracted_runs/ir-benchmarks/antique-test-20230107-training/seanmacavaney
```

- Saves between a few hours and multiple days GPU compute
- Exploration of diverse pipelines now easy:
 - How to combine DocT5Query with other components?
 - On which corpora?
 - For which queries?
 - For which retrieval models?

Riduce distanza utente - doc

Workshop on Open Web Search

The Short Term Perspective: Teaching Initiatives

- Wilhelm von Humboldt: Good teaching is cutting edge research
- Super strong story for the OpenWebSearch.eu project:
 - Hackathon at TU Dresden in Germany
 - Two weeks later, potential re-use of components: IR Lab at the University of Padua for LongEval at CLEF 2024
- Accessibility (main challenge):
<https://tira-io.github.io/teaching-ir-with-shared-tasks/>

Workshop on Open Web Search

The Short Term Perspective: Teaching Initiatives

- Wilhelm von Humboldt: Good teaching is cutting edge research
- Super strong story for the OpenWebSearch.eu project:
 - Hackathon at TU Dresden in Germany
 - Two weeks later, potential re-use of components: IR Lab at the University of Padua for LongEval at CLEF 2024
- Accessibility (main challenge): <https://tira-io.github.io/teaching-ir-with-shared-tasks/> *↗ tasks condive per insegnare IR*

The Mid Term Perspective

For each new Open Web Search scenario, we re-run all components and combinations to make informed decisions how a suitable search engine would look for this scenario.

- The “client” has full transparency to re-use or re-implement components

Workshop on Open Web Search

Conclusions

- We collected 42 re-usable retrieval components
- We gained experience in collaboratively building retrieval systems
- Upcoming teaching initiatives with potential for creative exploration:
 - How to combine components?
 - What is missing, what is popular?
 - Fast research-oriented prototyping: minutes instead of hours/days
 - Connected to shared tasks => *e.g. LongEnd*

Workshop on Open Web Search

Conclusions

- ❑ We collected 42 re-usable retrieval components
- ❑ We gained experience in collaboratively building retrieval systems
- ❑ Upcoming teaching initiatives with potential for creative exploration:
 - How to combine components?
 - What is missing, what is popular?
 - Fast research-oriented prototyping: minutes instead of hours/days
 - Connected to shared tasks

Future Work

- ❑ Integrate OpenWebSearch.eu scenarios: search for children is upcoming
- ❑ Teaching initiatives super much fun, makes sense to grow this
- ❑ Finalize archival of cached public outputs to Zenodo
- ❑ Monthly reproducibility checks with ReproduceMeGit
- ❑ Joint SIGIR Forum paper: experiences, concepts, and perspectives

Fast Forward: Your IR Lab at LongEval@CLEF

Now we get our fingers dirty...



Fast Forward: Your IR Lab at LongEval@CLEF

Now we get our fingers dirty...



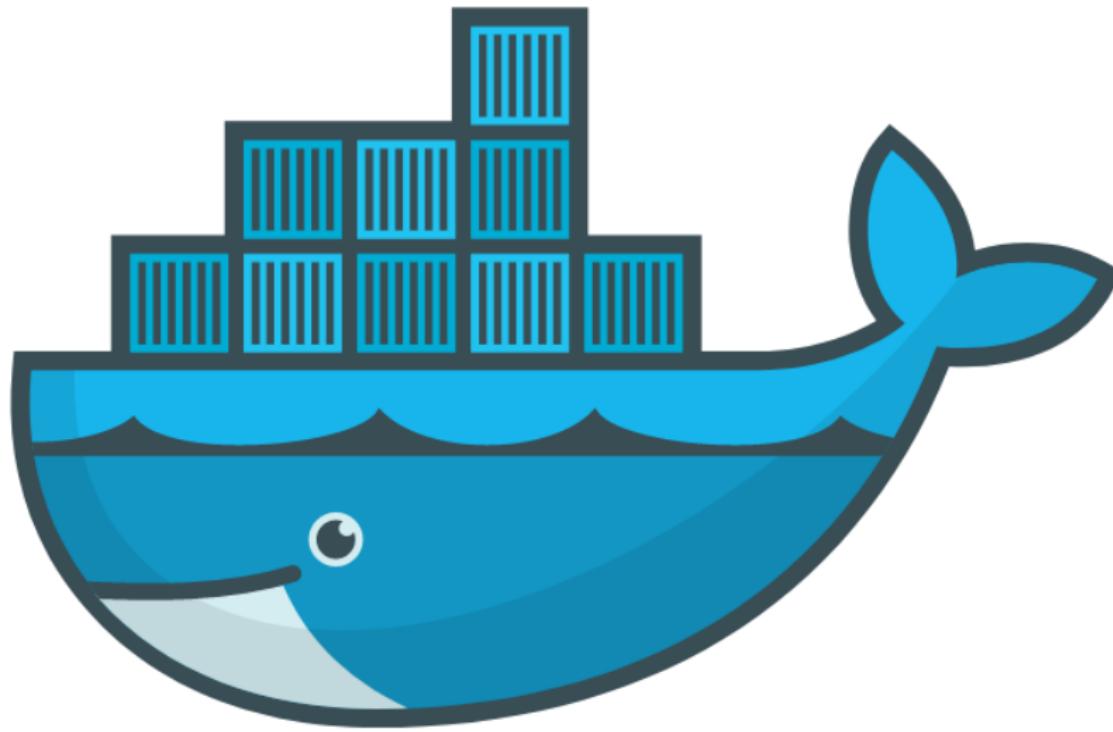
IR Lab: Hands-on Session

Aganda

- ❑ Docker
- ❑ Devcontainer
- ❑ ir_datasets
- ❑ Re-using outputs of TIREx components

Docker Tutorial

Docker Basics



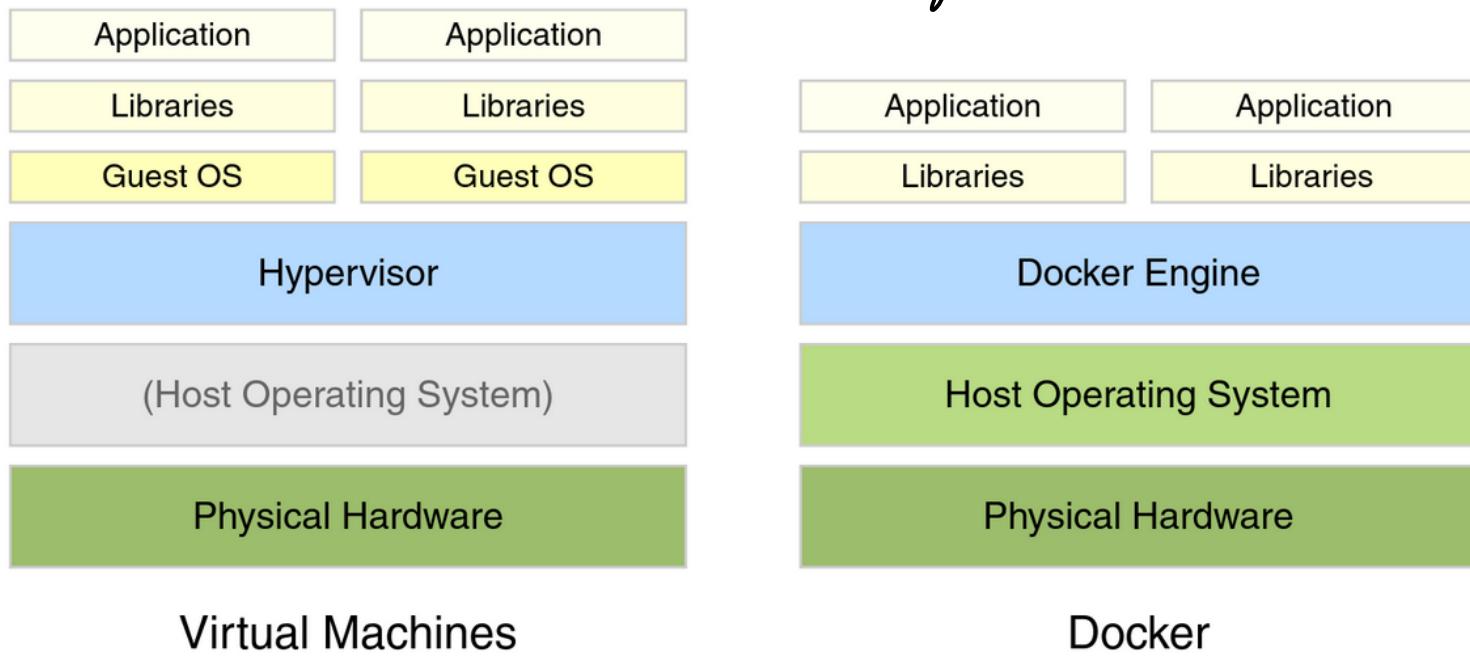
- ❑ Goal: Understand the basics behind dev containers
- ❑ <https://docs.docker.com/get-docker/>
- ❑ We will provide all required commands

Docker Tutorial

Use Cases for Docker

- ❑ Run guest systems as containers
- ❑ Shipping and running micro services as portable images
- ❑ Exploring and experimenting with new technologies
- ❑ Encapsulation mechanism to deploy applications in parallel without conflicts

Virtual Machines vs Docker \Rightarrow simile a VM + leggero



Docker Tutorial

Example Docker Commands

- Visit hub.docker.com => esempi di immagini
- We use the `bash` and `webis/ir-lab-wise-2023:0.0.4` images


shell

Docker Tutorial

Example Docker Commands

- Visit hub.docker.com
- We use the `bash` and `webis/ir-lab-wise-2023:0.0.4` images

Bash Image

`docker run --rm -ti bash` \Rightarrow in terminal

- `--rm`: Remove container after completion
- `-ti`: Attach stdin and stdout
- ToDo: Run above command without `-ti`. What happens?
- ToDo: Write text to some file, restart the container. What happens?

per vedere cosa sta andando: `docker ps`
se confronto leah image e shell di sistema, cambiano
programmi in esecuzione
in uscita, parola file roots con immagine

Docker Tutorial

Example Docker Commands

- ❑ Visit hub.docker.com
- ❑ We use the `bash` and `webis/ir-lab-wise-2023:0.0.4` images

Bash Image

```
docker run --rm -ti bash
```

- ❑ `--rm`: Remove container after completion
- ❑ `-ti`: Attach stdin and stdout
- ❑ ToDo: Run above command without `-ti`. What happens?
- ❑ ToDo: Write text to some file, restart the container. What happens?

Bash Image With Volume Mounts

```
docker run --rm -ti -v $PWD:/bla bash
```

- ❑ `-v <HOST_PATH>:<CONTAINER_PATH>`: Mount the directory `<HOST_PATH>` on the system to the directory `<CONTAINER_PATH>` within the container
- ❑ ToDo: Write text to some file so that it is persistent.

Docker Tutorial

Now We repeat this with Dev-Containers in VS Code

- Clone the repository

<https://bitbucket.org/frrncl/se-homework-template>

- Run both programs

- Show how to add new libraries

anche in repo di gruppo

avviso VScode: run in container



viene caricata immagine

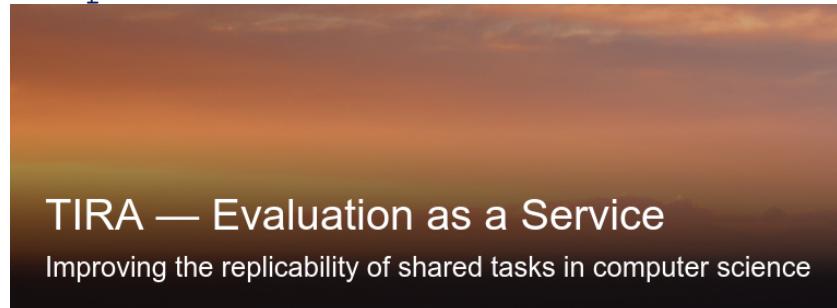
Docker Tutorial

Some Suggestions on Using TIREx/WOWS components as additional inputs

- ❑ <https://github.com/tira-io/teaching-ir-with-shared-tasks/blob/main/tutorials/tutorial-data-access-from-java.ipynb>

Submissions to TIRA

<http://tira.io>



Step-by-Step Guide

- Step 1: Develop your System(s) on the training data *lqf, train.sh*
- Step 2: Get your system to run in a Docker image on your machine
- Step 4: Upload the working Docker image to TIRA
- Step 5: Execute your Approach in TIRA

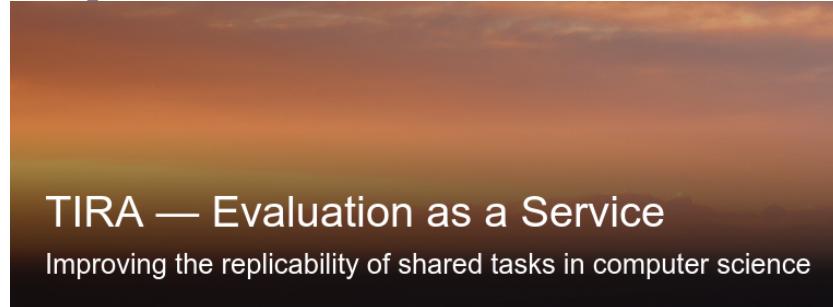
da DOCKERFILE dato, creare proprio -> va bene per TIRA
in pagina per submit trovo istruzioni per creare immagini -> seguire quelle
e le istruzioni in "cat DOCKERFILE"

PRIMA COSA: su hello-tipster, configurarlo per docker, provare a
caricarlo in task

docker build
docker push

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Typical workflow:

- ❑ Indexing: Documents \Rightarrow Index
 - ❑ Retrieval: Queries + Index \Rightarrow run
 - ❑ Re-Rankign: Query-Document pairs \Rightarrow run
- Tutorial: github.com/tira-io/teaching-ir/tutorial-re-ranking.ipynb

Thats all, have fun!

- Please do not hesitate to contact me in case of problems or questions
- Next Steps: register to <https://www.tira.io/task-overview/ir-lab-padua-2024>
- I can provide some early feedback, maybe in two weeks?

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Thank you!