# Perspectives on Evaluating Diverse Open Web Search Applications


IR Lab, March 22, Padua, Italy

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# Evaluating Diverse Open Web Search Applications with TIREx

## Motivation

# 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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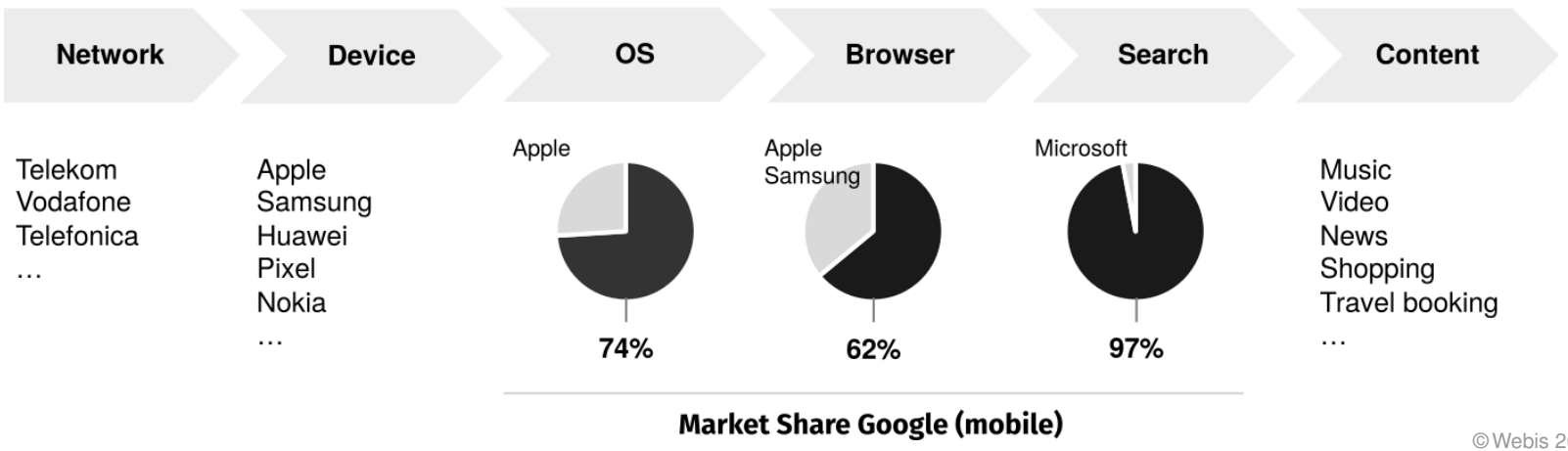
**Tech @ Cliqz**

search privacy web monopoly

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

The internet value chain:



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## What is Hindering a Diverse and Vibrant Search Ecosystem?

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**Solution not within our scope**
**Still, positive examples exist**

**Tech @ Cliqz**

search privacy web monopoly

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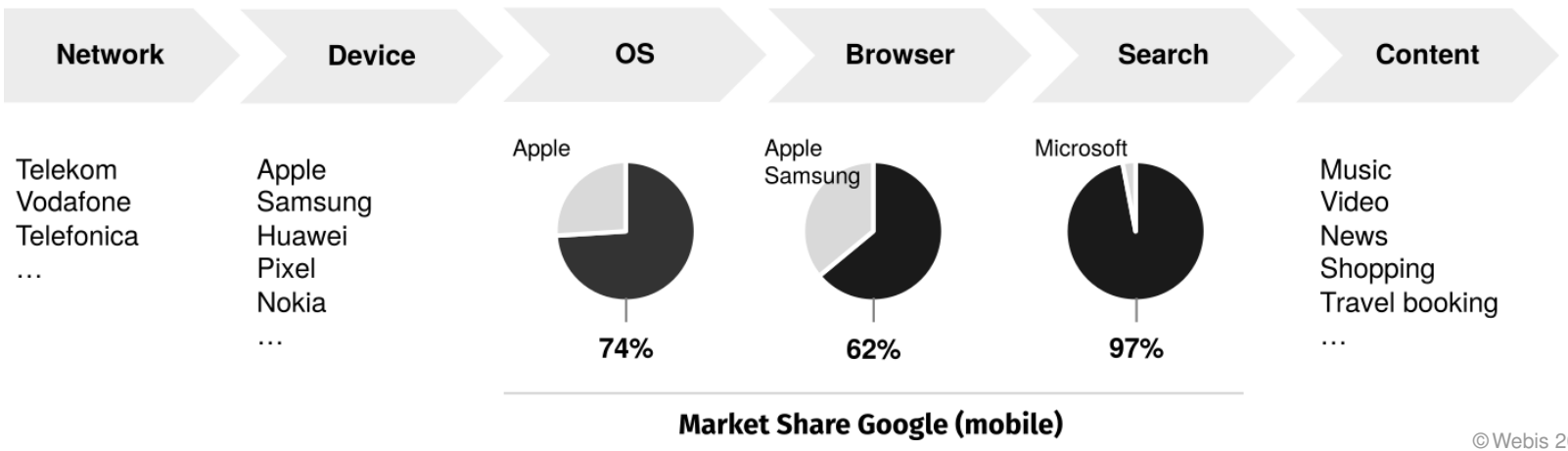

# Evaluating Diverse Open Web Search Applications with TIREx

## What Technology Enables a Diverse and Vibrant Search Ecosystem?

Indexing

Storage


Retrieval

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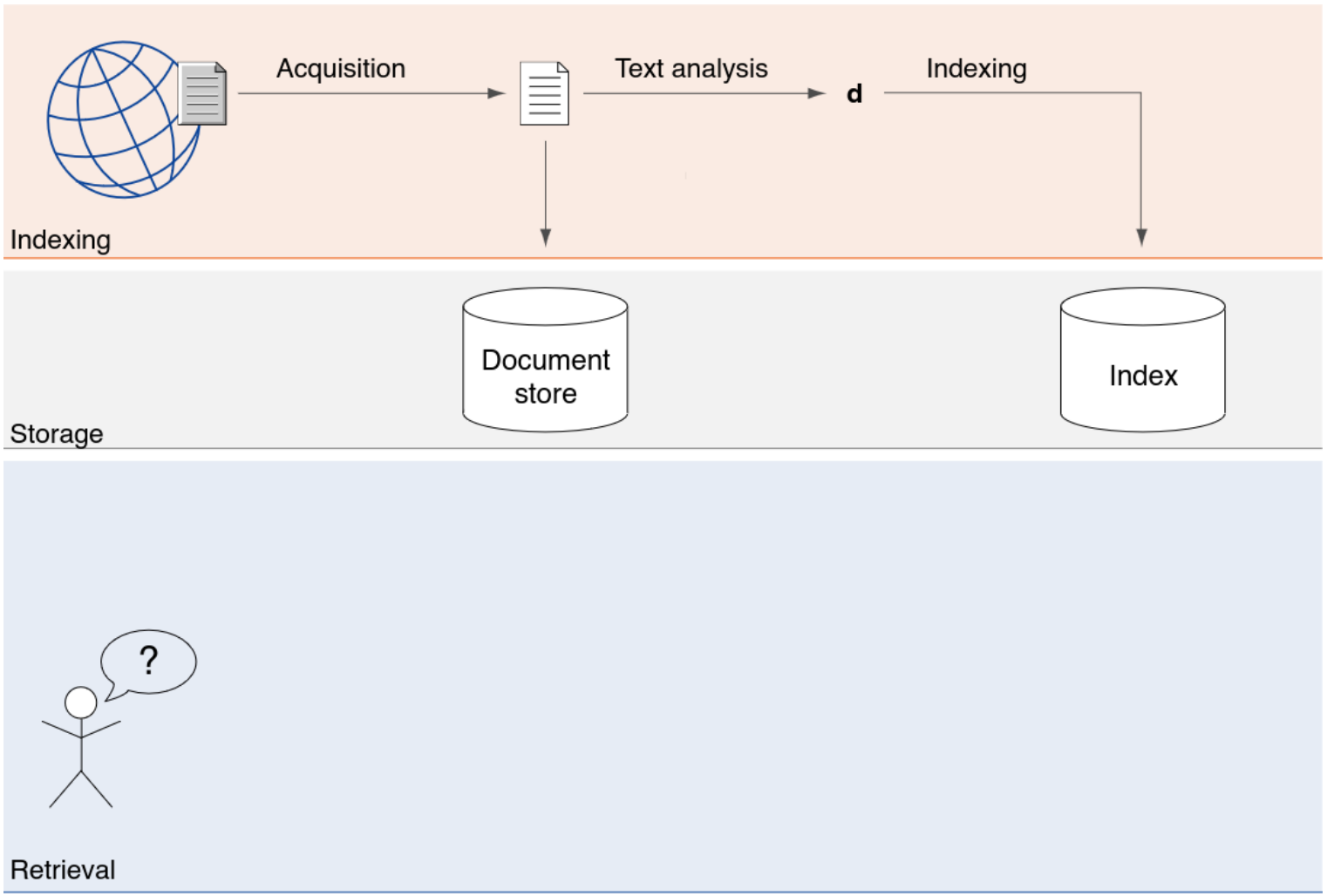

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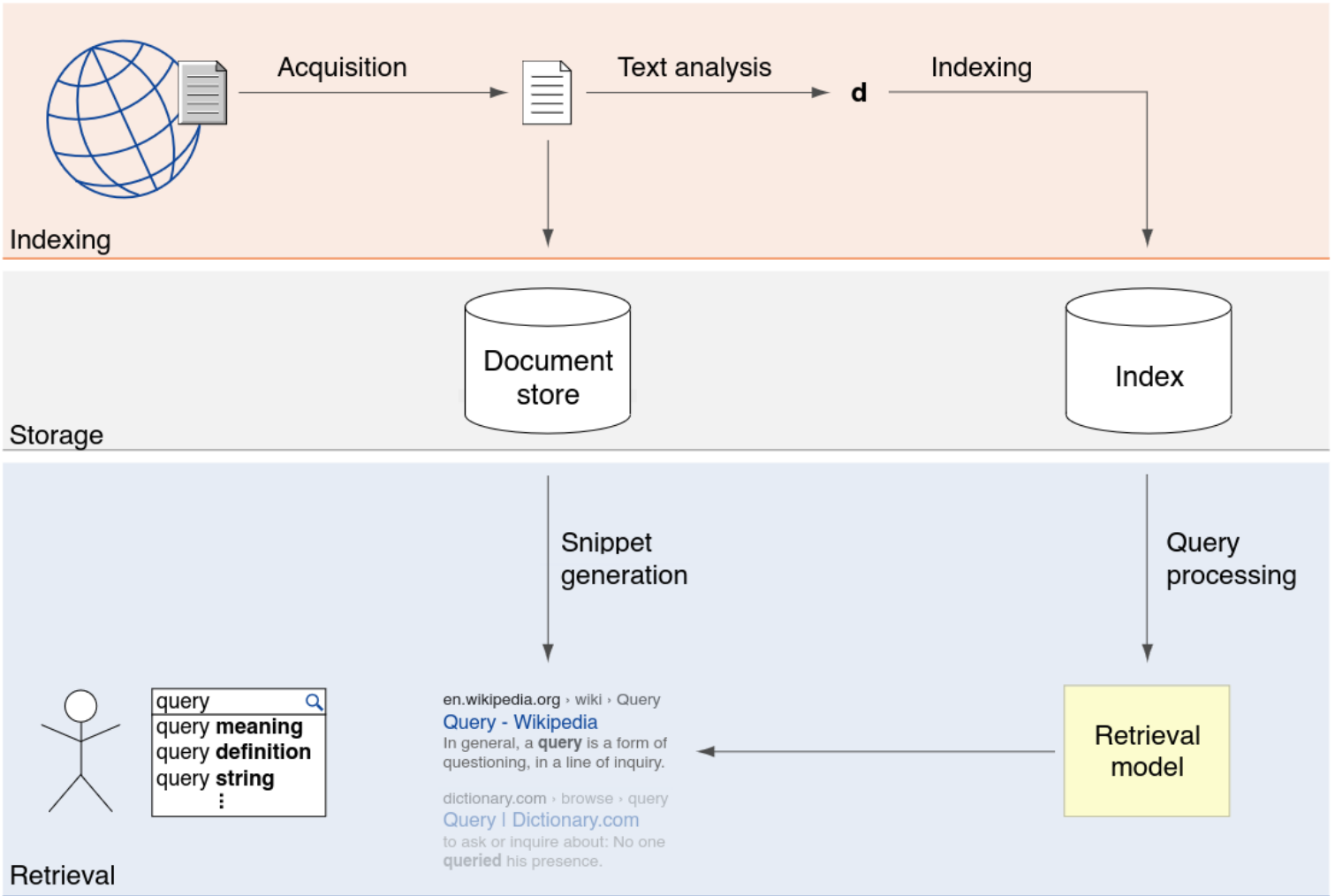

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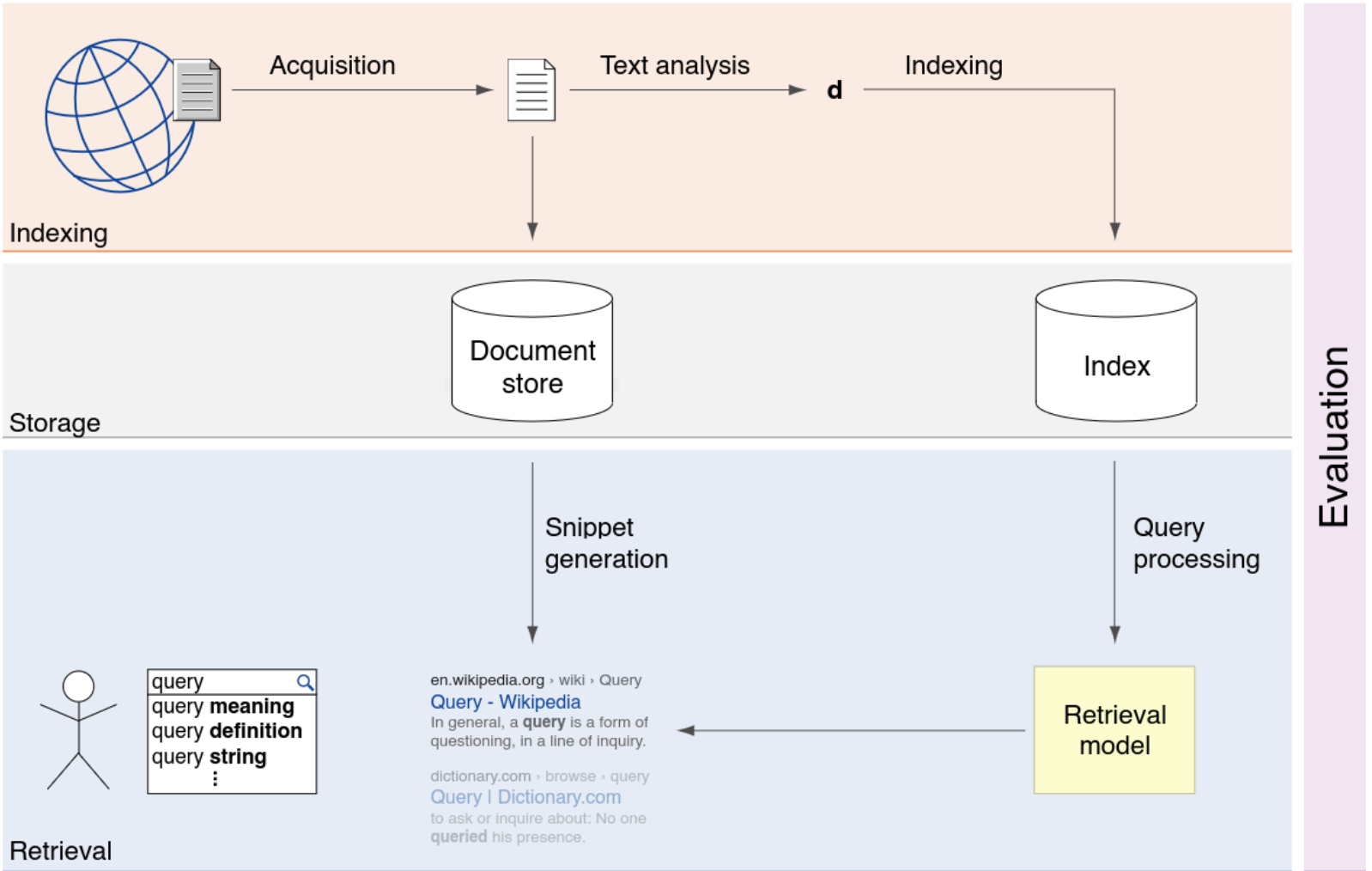


# Evaluating Diverse Open Web Search Applications with TIREx

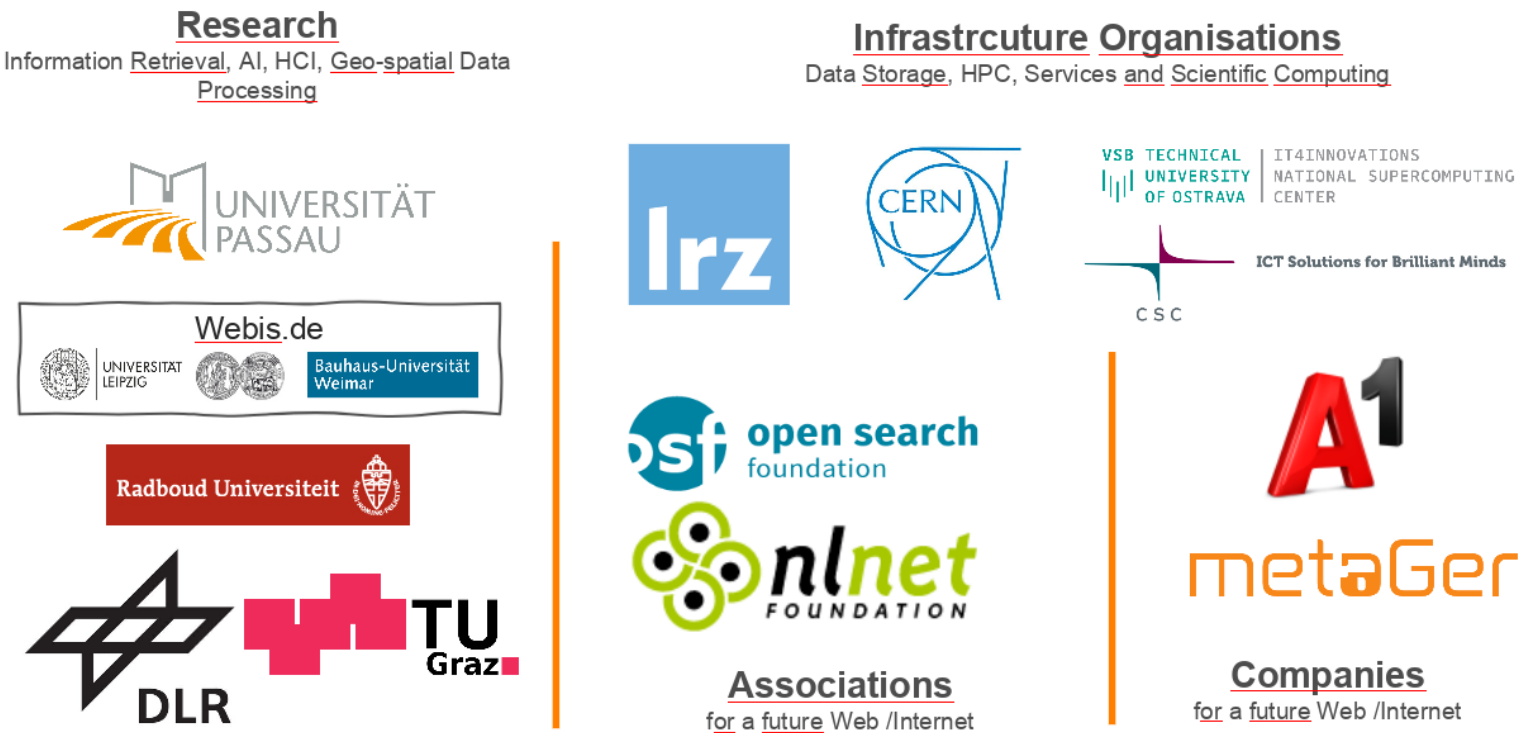
## The Open Web Index To the Rescue?

# 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



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## The Open Web Index: Overview of Partners

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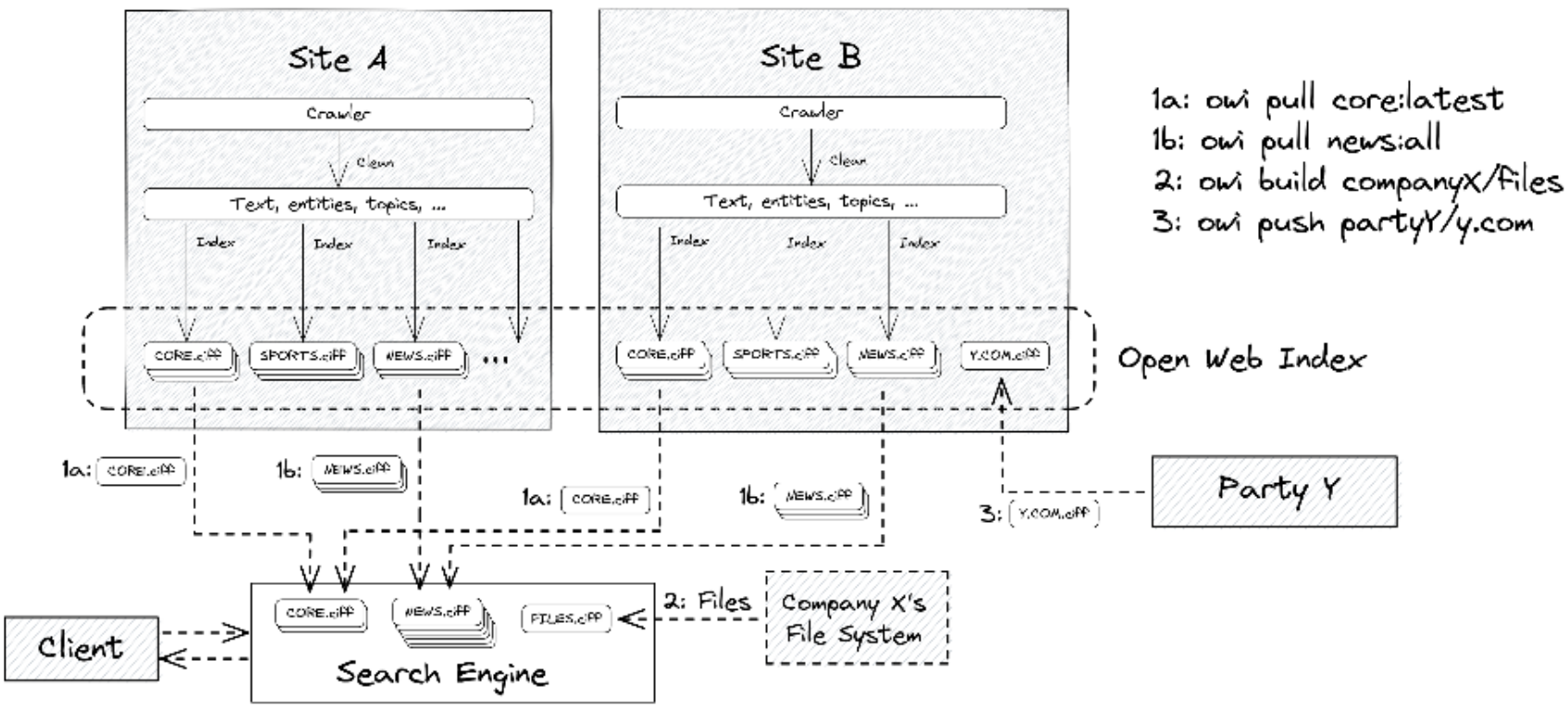
## Slicing and Dicing the Open Web Index for a Diverse Search Ecosystem



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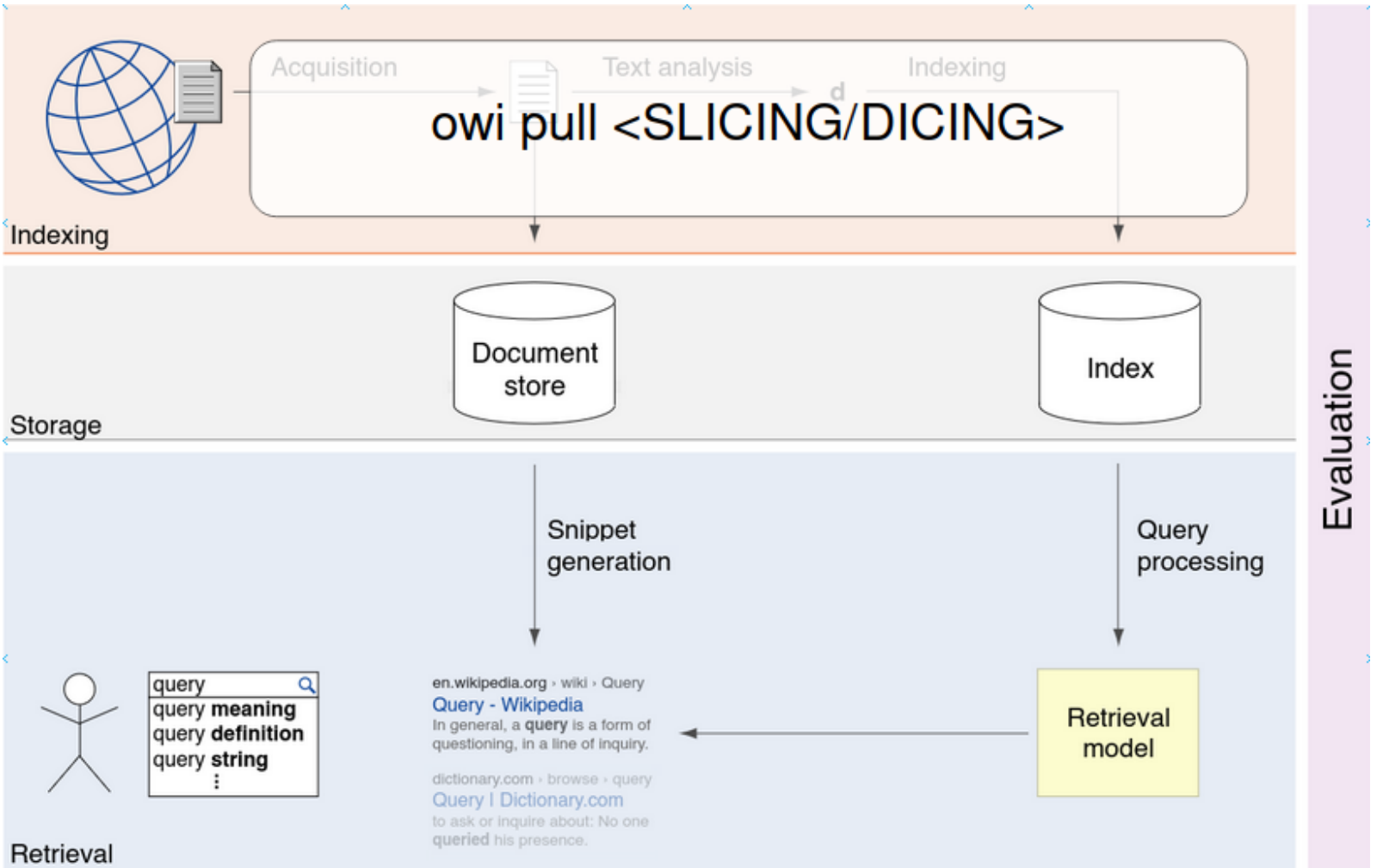

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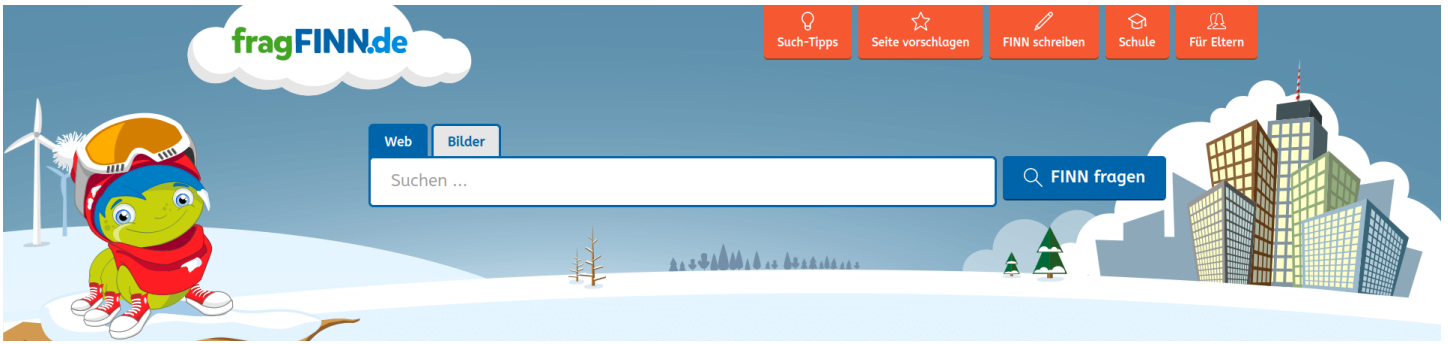
## A (biased) Selection of Use-Cases of Slicing and Dicing the Open Web Index

Search engine for kids:



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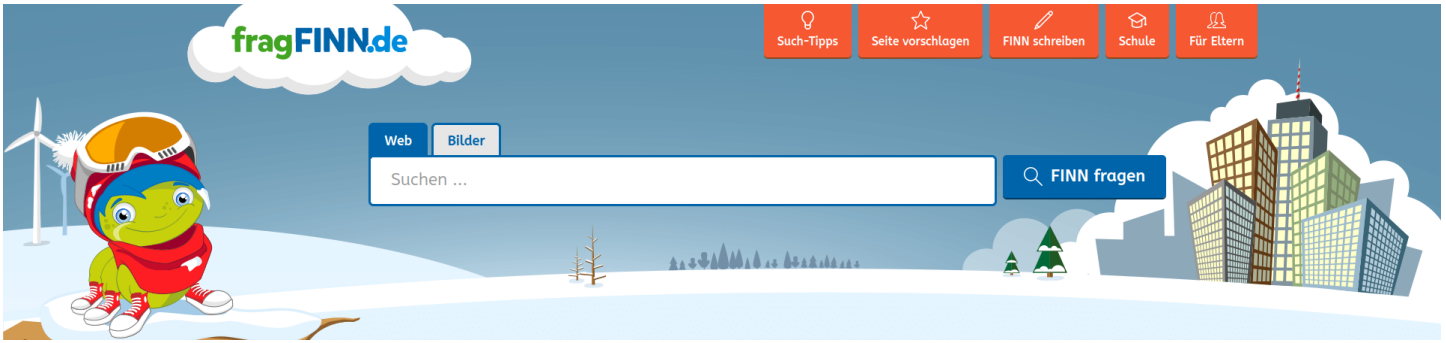



Substantial differences to commercial search:

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

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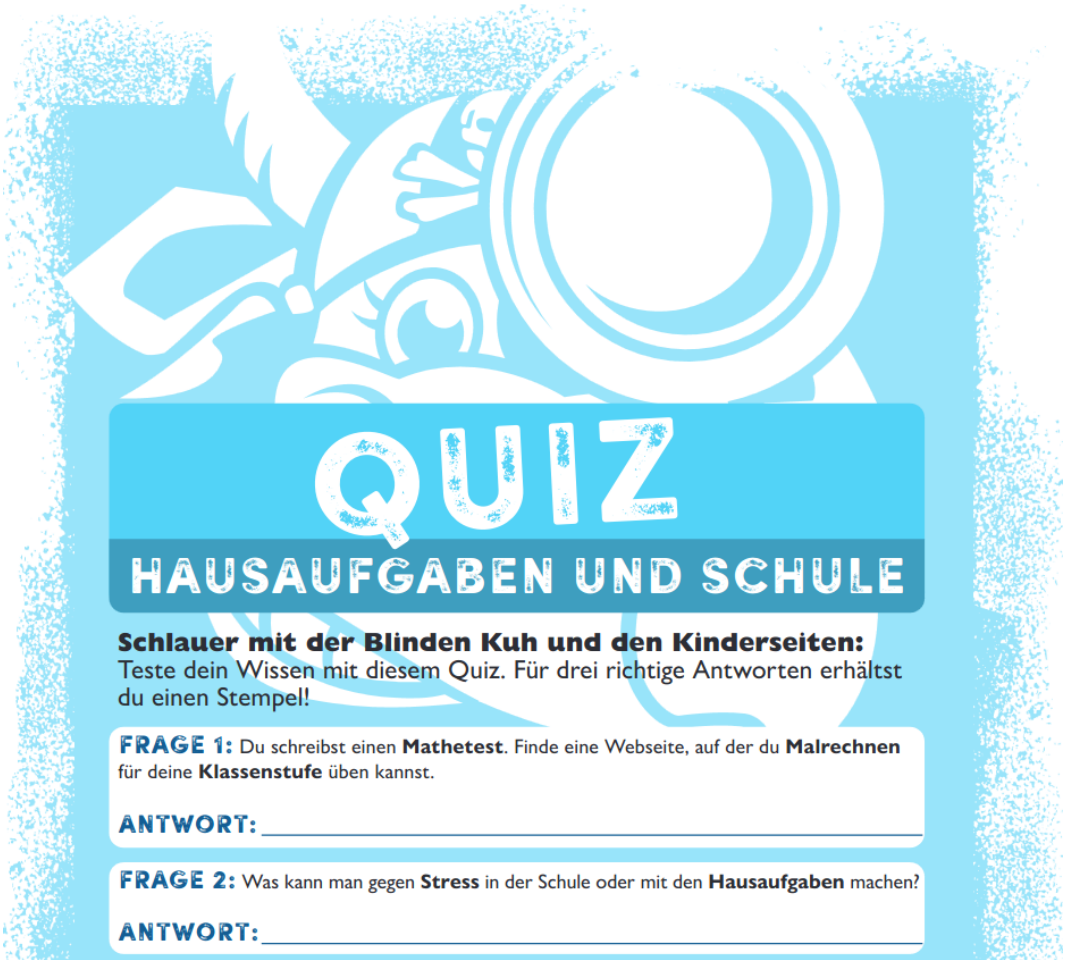


- We currently build a test collection

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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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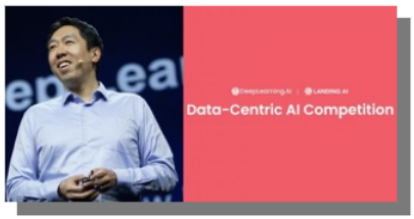
## Use Cases: The Web as Searchable Resource for AI

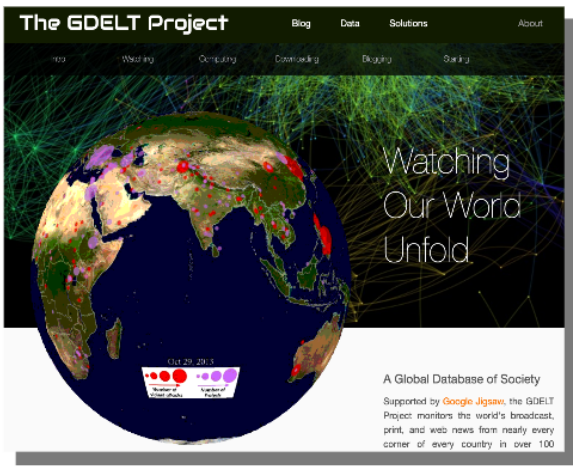
Web data drives innovation beyond search, particularly in AI





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


Not only AI:
GDELT: Web-scale Event Analytics



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## Evaluation is Key

- Different organizations with different goals interact on the same fundament

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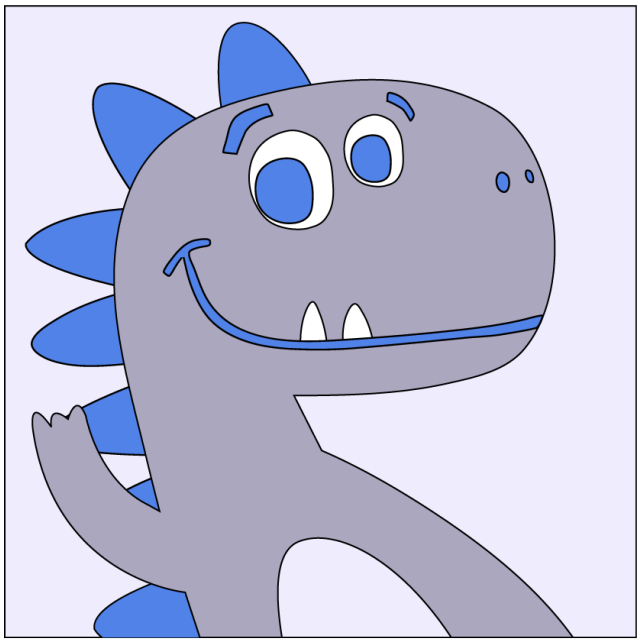
## Strong Collaborations to Evaluation Campaigns

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



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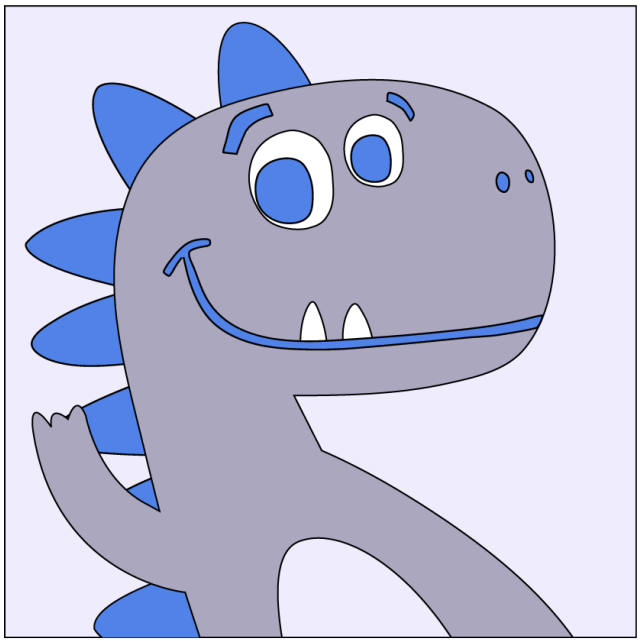


TIREx = TIRA + ir_datasets + PyTerrier

## TIRA

- Reproducible shared tasks: software submissions + blinded experiments

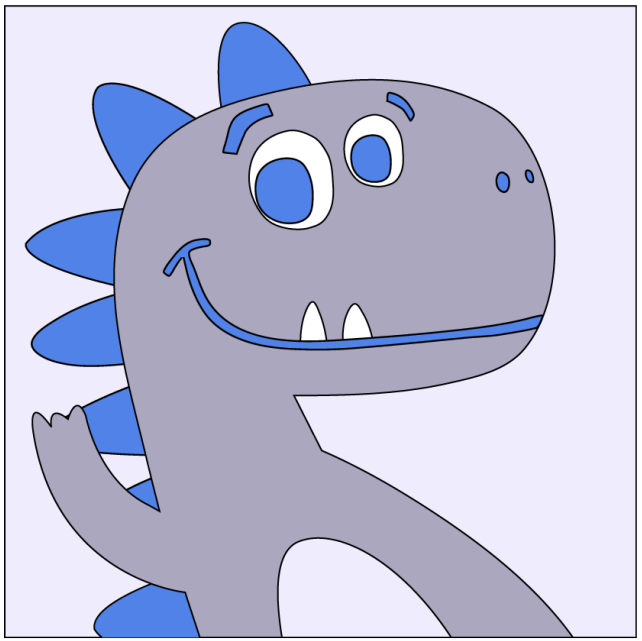
## ir_datasets

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

## PyTerrier

- Declarative pipelines

# TIREx for Evaluation



TIREx = TIRA + ir_datasets + PyTerrier

TIRA **Reproducibility + Caching** **Use Confidential Data**

- Reproducible shared tasks: software submissions + blinded experiments

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
  $\rightarrow$ blinded experimentation + caching + reproducibility
- More than 50 transferrable retrieval models
- 35 test collections (18 public + 17 private test)

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## Next Week at ECIR


- 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 |
| $\sum$ | 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!

# WOWS 2024: Student Hackathon at TU Dresden

Some OWSome impressions of the WOWS hackathon at Dresden:

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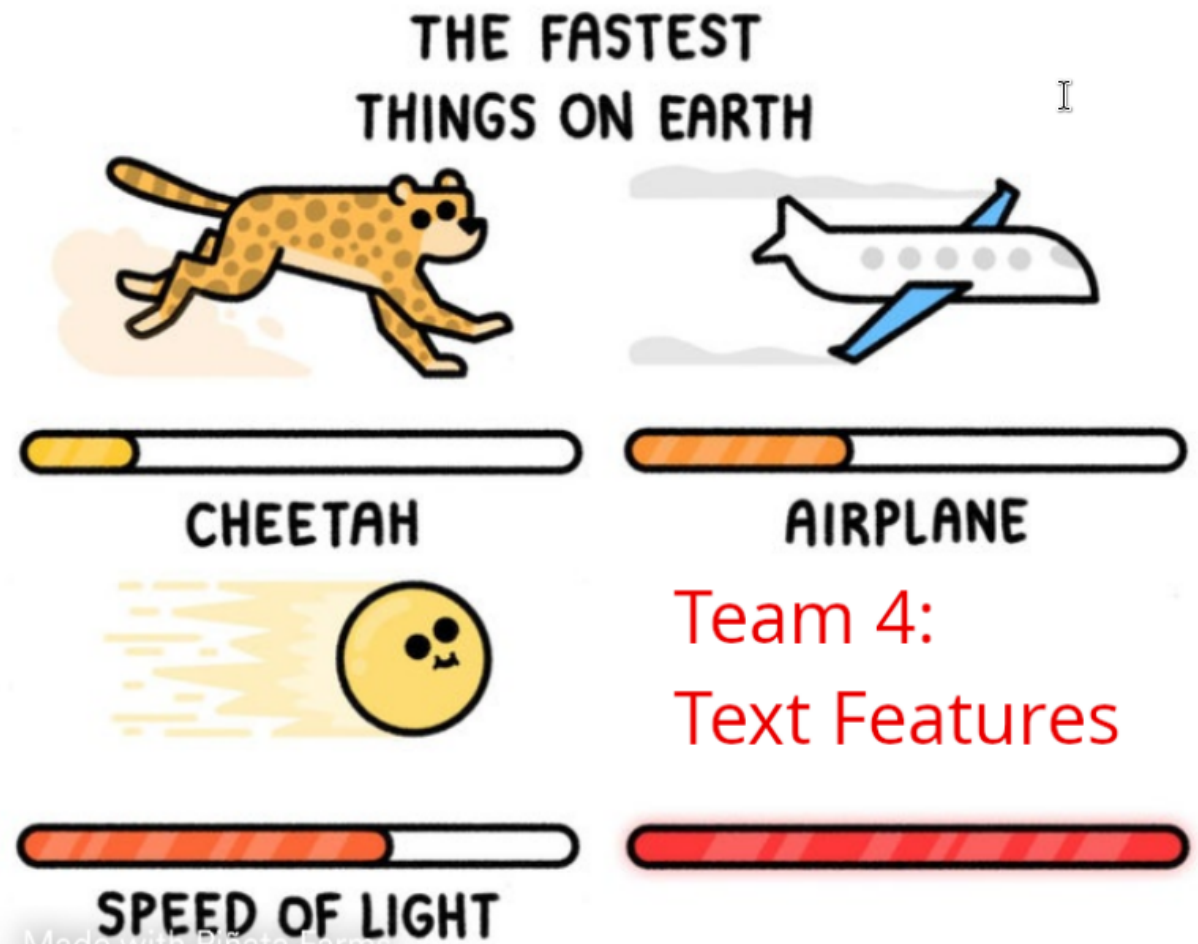


Team tu-dresden-04: First working submission on Day 1

# 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

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## Most Working Submissions


Team tu-dresden-01: 9 working submissions

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# WOWS 2024: Overview Components

## Some Example Components

Most fundamental: Loading some index :)

```
[5]
pt_dataset = pt.get_dataset('irds:antique/test')
```

```
[6]
index = tira.pt.index('ir-benchmarks/tira-ir-starter/Index (tira-ir-starter-pyterrier)', pt_dataset)
```

```
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
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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)

```python
# 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)
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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 |
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Note to self: use for-loops :)

# WOWS 2024: Overview Components

## Some Example Components: DocT5Query

```
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 DocT5Qery with other components?
  - On which corpora?
  - For which queries?
  - For which retrieval models?

# Workshop on Open Web Search

## The Short Term Perspectice: 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/

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## 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

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## 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...

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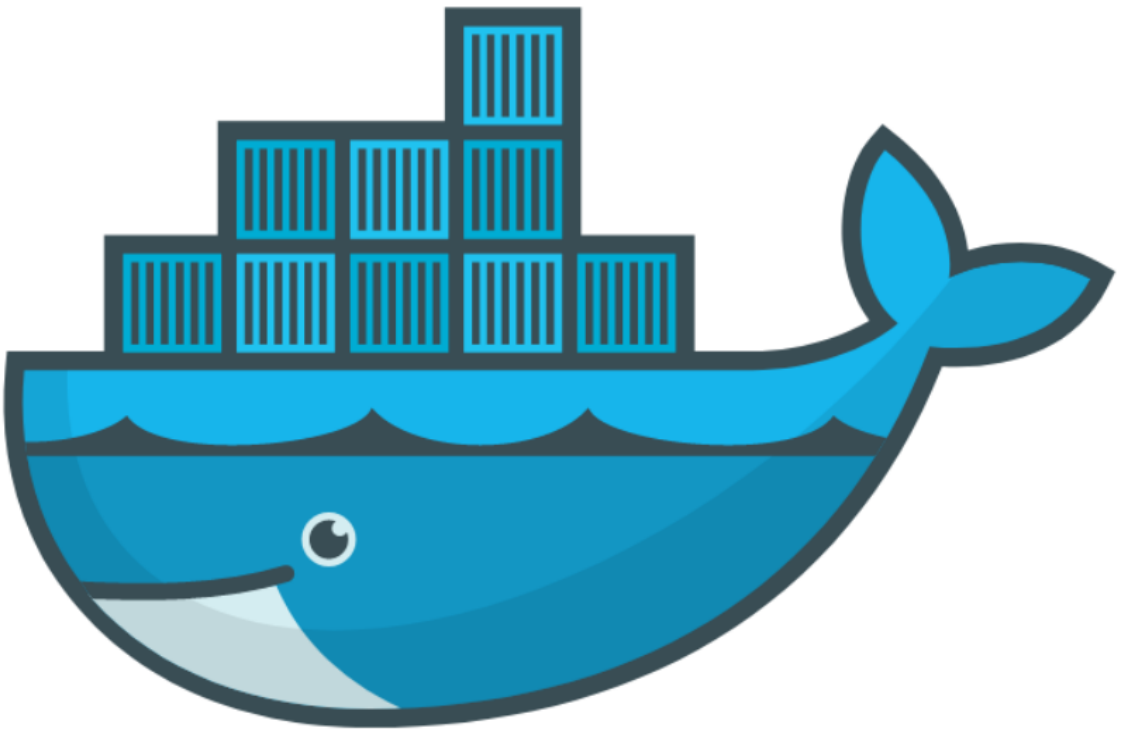
# IR Lab: Hands-on Session

## Aganda

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

# Docker Tutorial

## Docker Basics



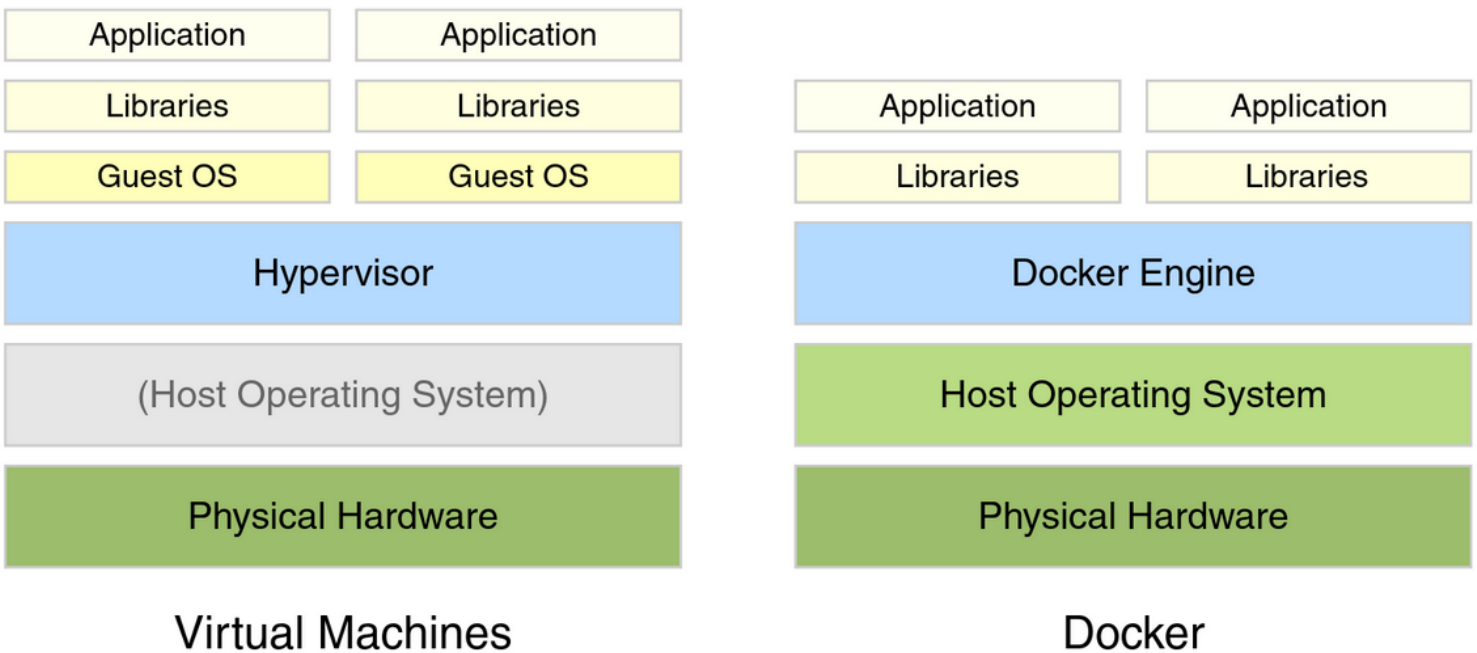
- Goal: Understand the basics behind dev containers
- https://docs.docker.com/get-docker/
- We will provide all required commands

# 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



# Docker Tutorial

## Example Docker Commands

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

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## Bash Image

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docker run --rm -ti bash
```

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

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## 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

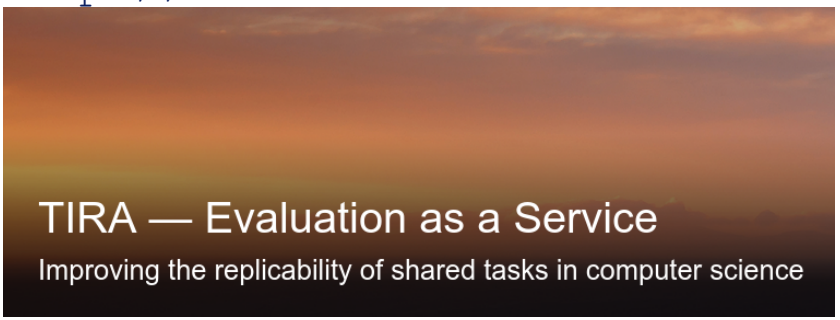
# Docker Tutorial

## 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
- 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

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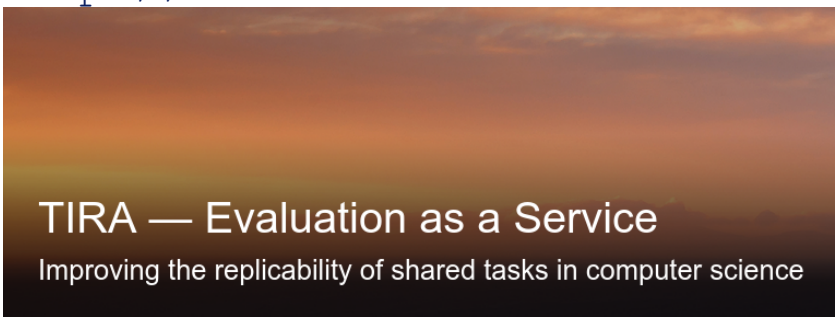


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## Typical workflow:

- 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!**