Matching with Transformers in MELT

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Joint Work

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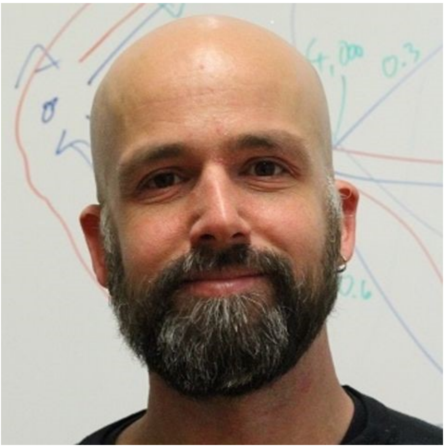

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Agenda

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- Motivation
- What is MELT
- Transformers in MELT
- Experiments
- Conclusion & Future Work

Motivation

Motivation

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- the transformer architecture achieved breakthrough results in various NLP domains
- this poses the question in how far transformers can be beneficial for the ontology matching domain

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What is MELT?

What is MELT?

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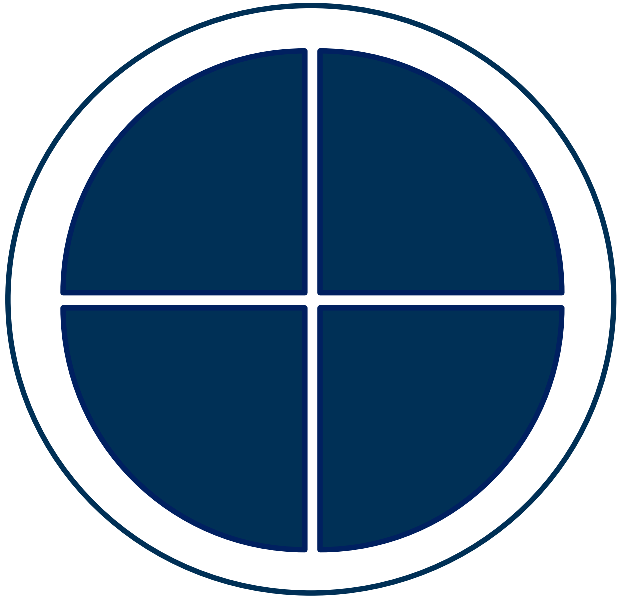
- **Easy** matcher development
- Re-Usable Matcher Componetns
- **Non-Java** matcher development
- **Maven** support

- Allow **for parameter optimization**



- Facilitate **matcher packaging** (SEALS, HOBBIT, Docker Web)
- Facilitate **matcher submission**

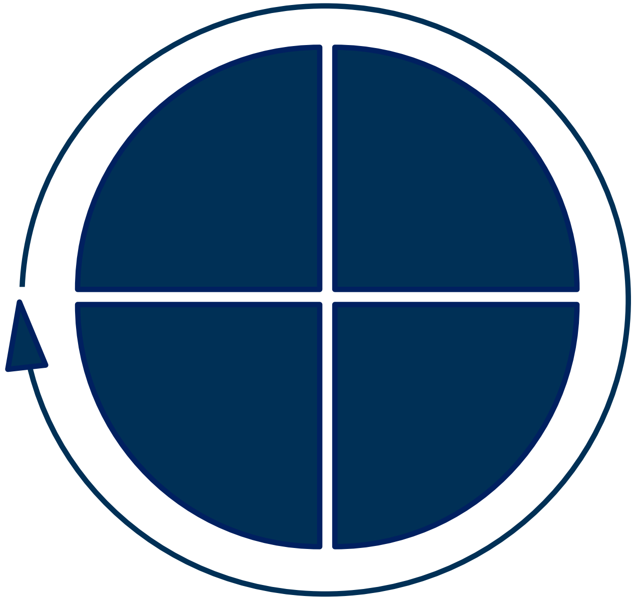
- **Advanced evaluation** capabilities
- **Evaluation before packaging**
- Allow for **interactive visualization**

- **Streamlined** development process
- **Integration** with existing tooling
- **OAEI support**
- **Extensibility**

What is MELT?

Matcher **Development** with **Transformers**

Matcher **Fine-Tuning**



Matcher **Submission**

Matcher **Evaluation**

There is MUCH more to MELT

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Multi-Threaded Matcher Execution

Ontology **Caching** Services

> 50 matchers

> 25 filters

Execution of SEALS, HOBBIT, WEB packages from within MELT

TRY IT!

MELT @GitHub

Alignment **Extensions**

OAEI-Track Organizer Tools

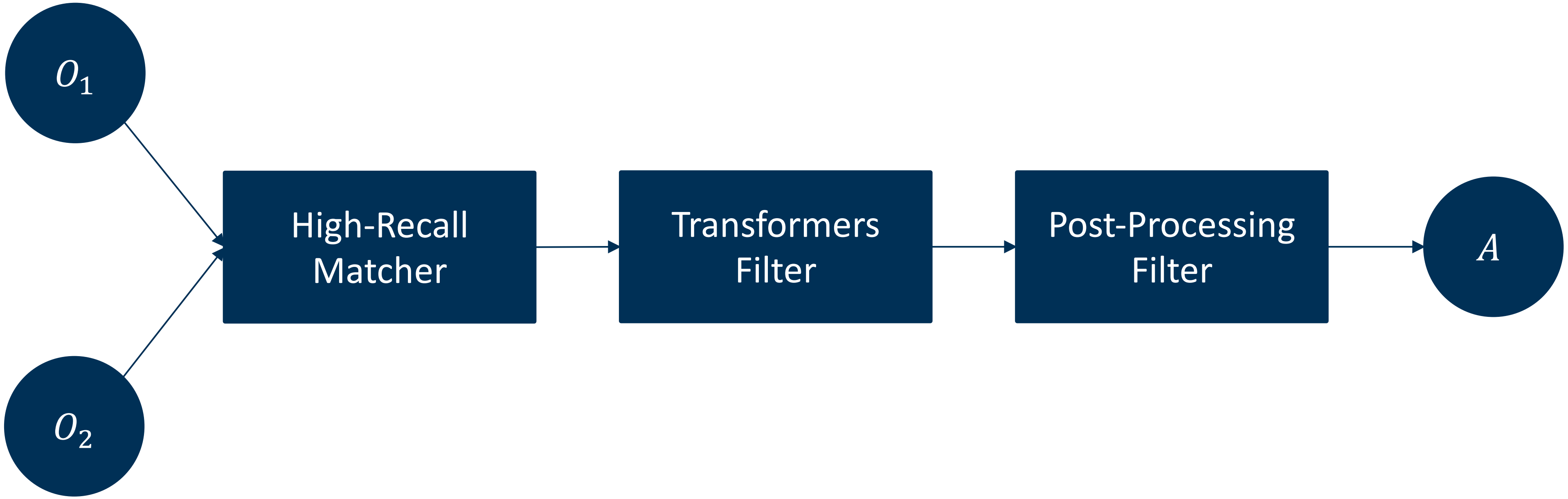
ExecutionResult **Indexing**

One-Time **Auto-Download** of OAEI Tracks

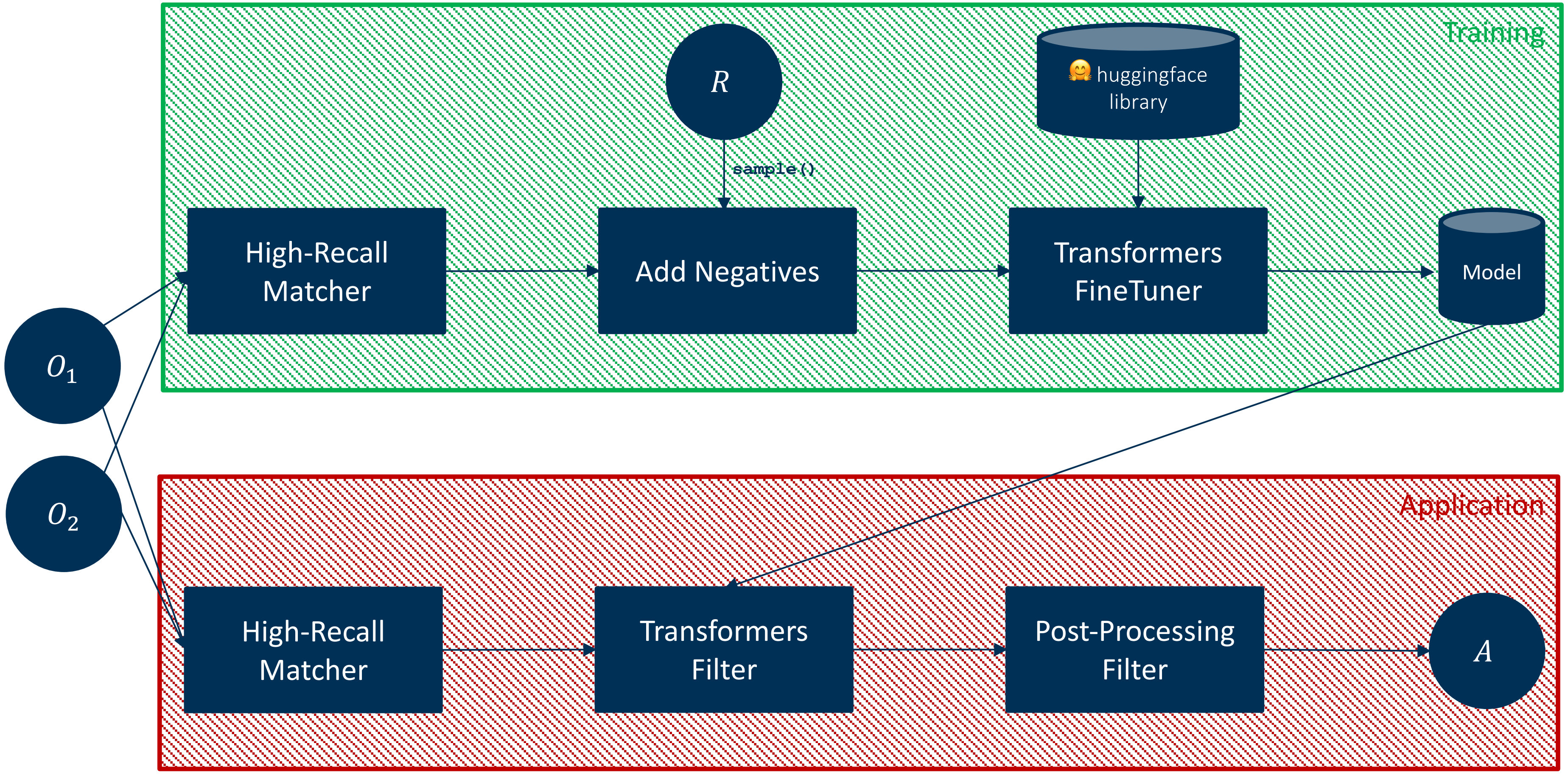
Matcher **Pipelining**

Transformers in MELT

The Transformer Pipeline



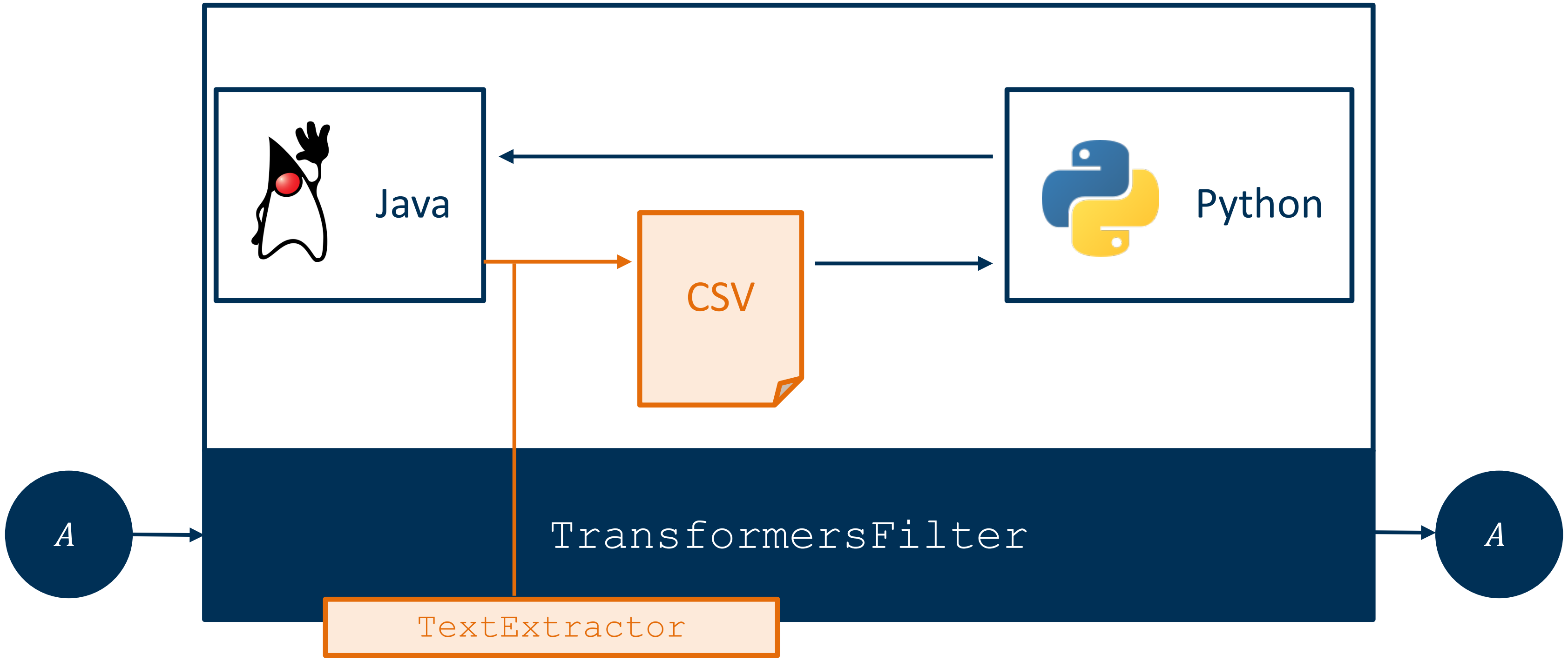
The Transformer Pipeline



Generating Negatives

- positives:
  - (1) reference
  - (2) high-precision sytem
- negatives
  - generate randomly (`AddNegativesRandomlyAbsolute`, `AddNegativesRandomlyShare`)
  - generate through one-to-one assumption, e.g. incomplete or unknown reference `AddNegativesRandomlyOneOneAssumption`
- all new strategies implement interface `AddNegatives`

TextExtractors & Technical Details



TextExtractors & Technical Details

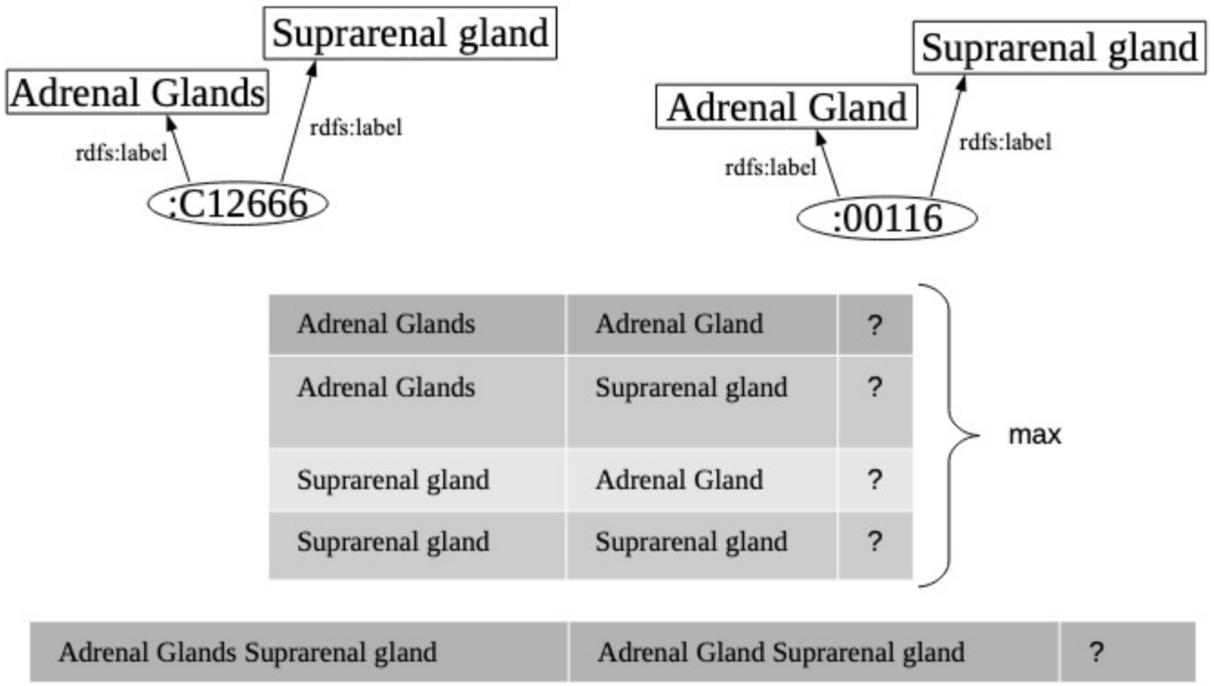


Fig. 2. Optional multi-text mechanisms implemented in class `TransformersFilter`.

Hyperparameter Optimization

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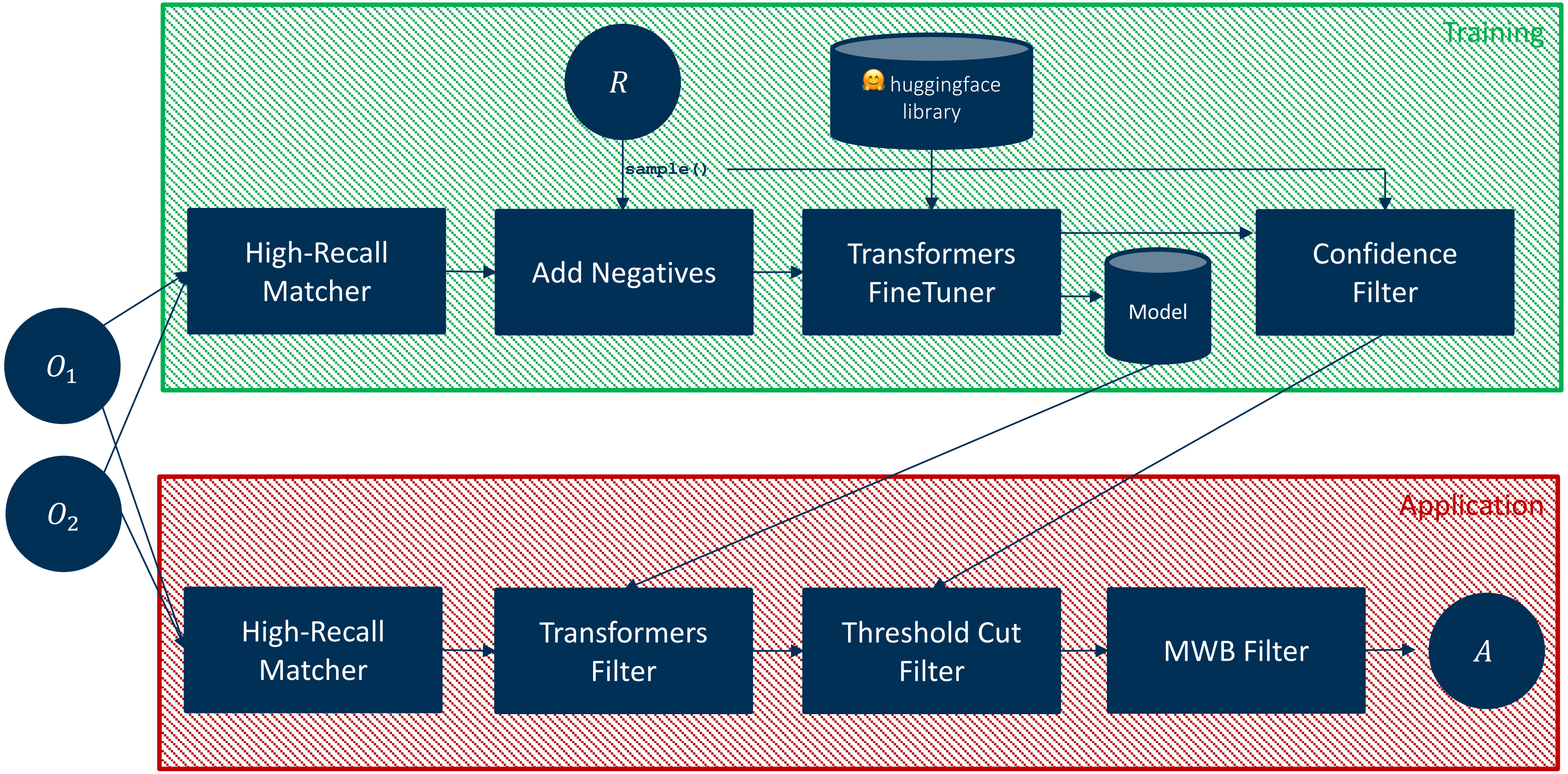
- via Ray Tune
- initial hyperparameter search space
  - learning rate: loguniform distribution between 10^{-6} and 10^{-4}
  - epochs: random choice between 1 and 5
  - seed: uniform distribution between 1 and 40
  - batch size: random choice of 4, 8, 16, 32, 64
    (max size autoamtically determined)
- optimizable metrics: loss, accuracy, F1, recall, precision, AUC
- class `TransformersFineTunerHpSearch`

It’s not complicated!

```
public class TransformerApplyExample extends MatcherPipelineYAAAJena {

    @Override
    protected List<MatcherYAAAJena> initializeMatchers() {
        List<MatcherYAAAJena> list = new ArrayList<>();

        // some recall matcher
        list.add(new RecallMatcher());

        // transformer filter
        list.add(new TransformersFilter(
                new TextExtractorAllLiterals(),
                "albert-base-v2"));

        // some post processing steps
        list.add(new ConfidenceFilter(0.75));
        list.add(new MaxWeightBipartiteExtractor());

        return list;
    }
}
```

Experiments

Experiments | Pipeline



Experiments

- tracks: *Anatomy*, *Confernce*, *Knowledge Graph*
- with and without fine-tuning
- sampling rate: `20%`
- models
  - `bert-base-cased`
  - `roberta-base`
  - `albert-base-v2`

Results

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		Conference			Anatomy			Knowledge Graph		
		P	R	F1	P	R	F1	P	R	F1
Baseline	**SimpleString**	0.710	0.498	0.586	0.964	0.708	0.816	0.909	0.727	0.808
	High Recall	0.450	0.561	0.179	0.037	0.942	0.071	0.167	0.915	0.283
Zero-Shot	**bert-base-cased (mrpc-tuned)**	0.650	0.548	**0.594**	0.531	0.817	0.644	0.739	0.714	0.726
Fine-Tuned (per Track)	**bert-base-cased**	0.748	0.361	0.487	0.726	0.689	0.707	0.941	0.789	**0.859**
	roberta-base	0.667	0.498	0.570	0.715	0.749	0.732	0.400	0.388	0.393
	albert-base-v2	0.812	0.397	0.533	0.854	0.825	**0.839**	0.687	0.665	0.676

Table 1. Results of non-fine-tuned and fine-tuned transformer models (multi-text) with 20% sampling from the reference alignment. As per OAEI customs, we report micro average scores for the conference and macro average scores for the KG track.

- fine-tuning increases performance
- `albert-base-v2` and `bert-base-cased` achieved best results
- minor improvements through hyperparameter tuning

Results

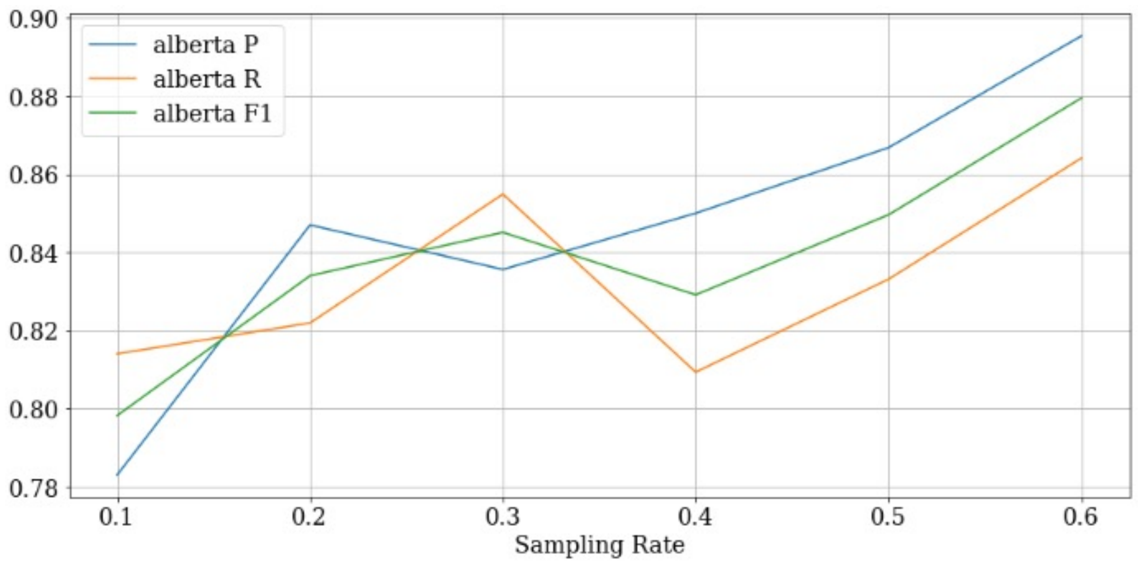

Fig. 4. `albert-base-v2` performance on the anatomy track using different reference sampling rates.

- performance increases with increasing sample rate
- low sampling (10-20%) is sufficient for good results

Conclusion and Future Work

Conclusion & Future Work

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- Transformers for MELT allow the broad usage of transformers without deep technical skills (out-of-the-box components)
- Tranformers are promising for the matching domain as shown in experiments
- in the future, we plan to
  - add further matching components (alignment repair)
  - include sentence transformers (transformers as matching component, not as filter)

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Thank you.

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