Evaluating the Effect of Semantic Enrichment on Entity Embeddings of IoT Knowledge Graphs

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Introduction

Setting the scene

- Ongoing effort to collect IoT data
  - For example in IoT Knowledge Graphs
- There are benefits to learning over KGs
- Can we learn directly over the IoT KG?
  - Or do IoT KGs require changes?

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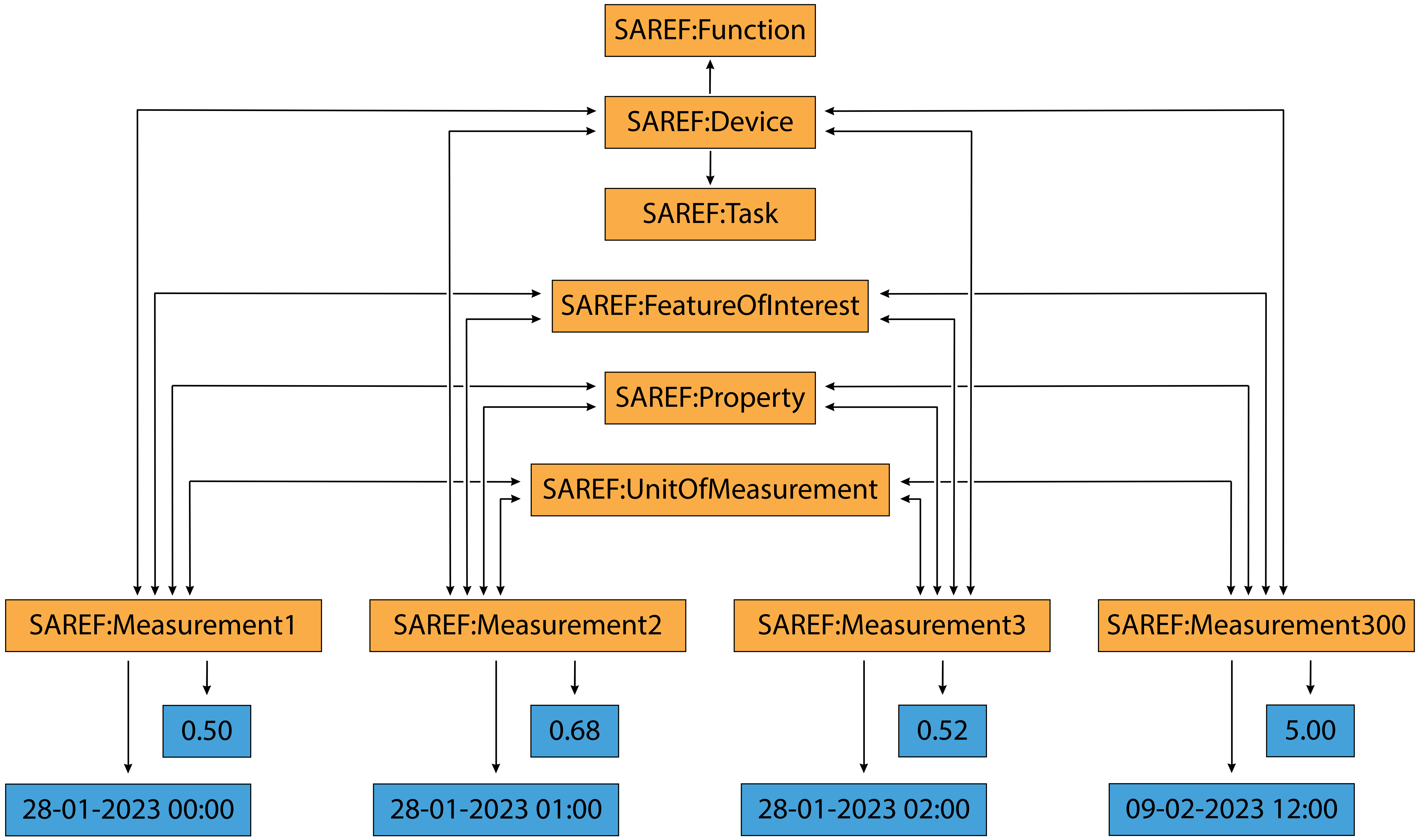
What is the effect of semantically enriching an IoT KG, based on the quality of entity embeddings learned from it?

Introduction

What is an IoT KG?

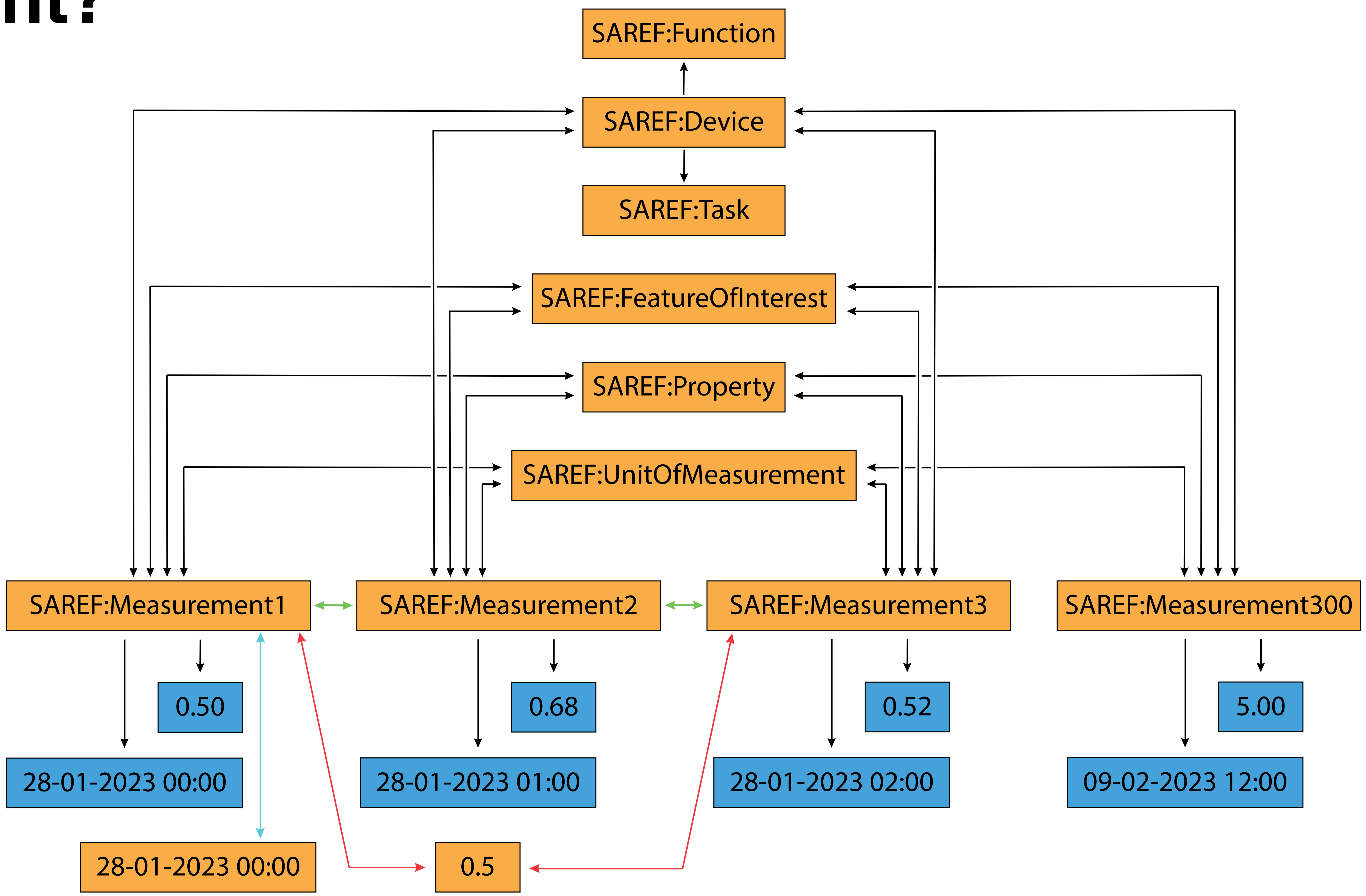
- Represent IoT measurement data
- "Wide" Graph
- *Many measurements*



Introduction

What is Semantic Enrichment?

- Making implicit information explicitly available



Introduction

What are Entity Embeddings?

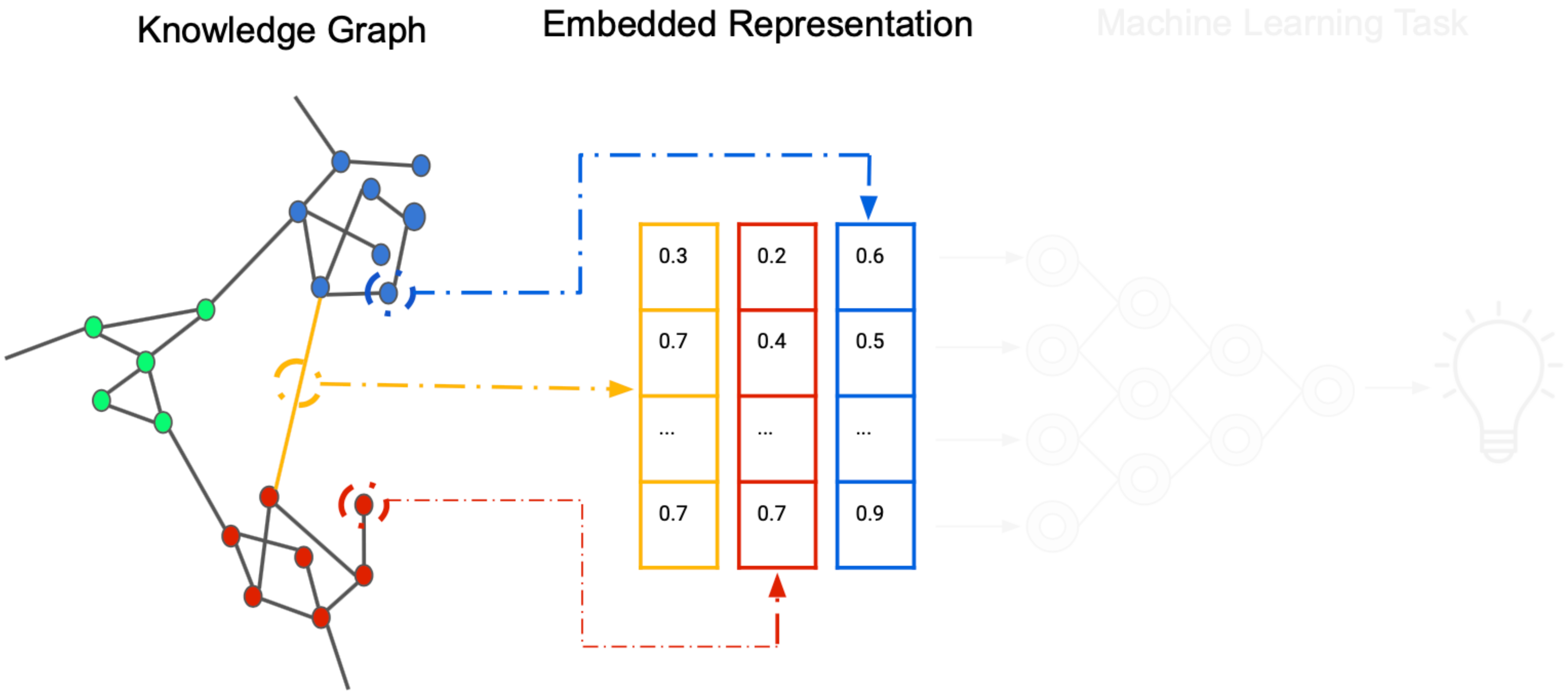
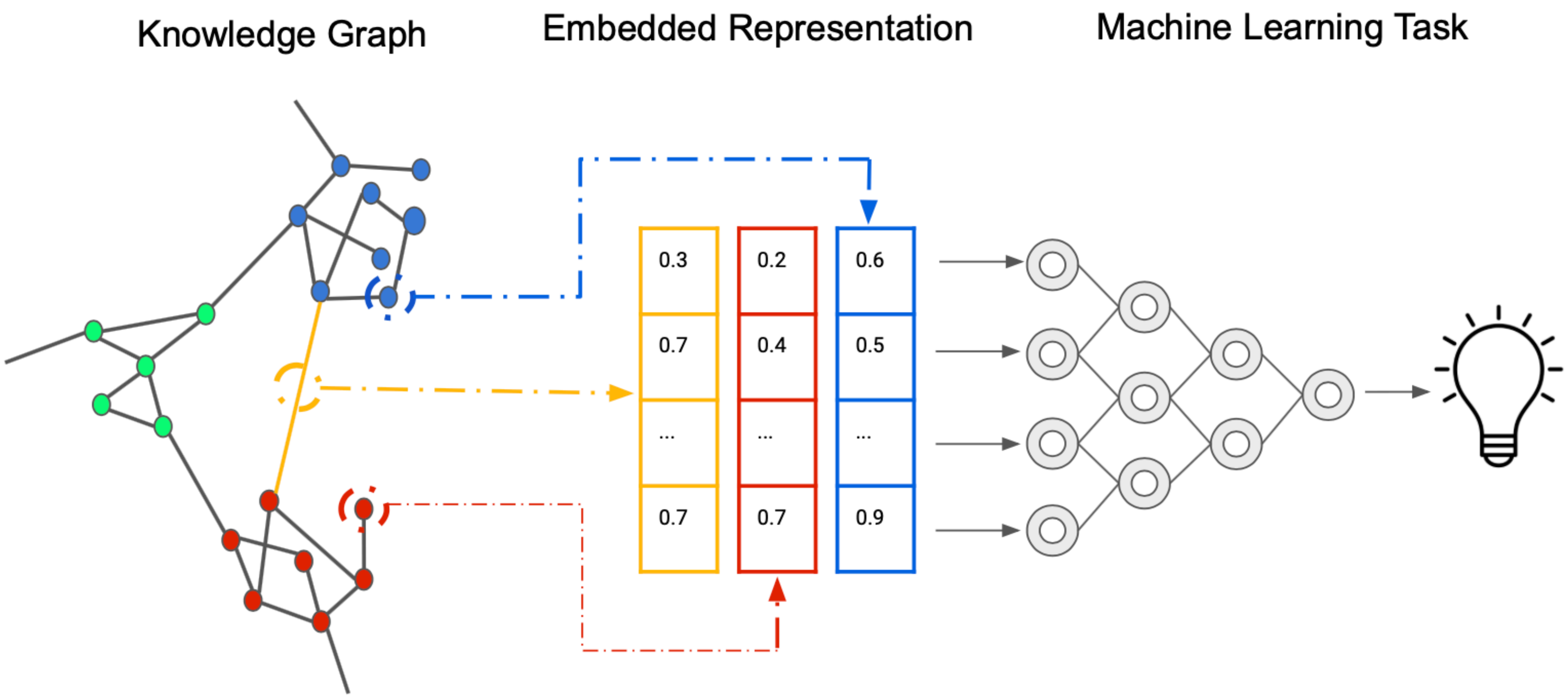


Image taken from Wikipedia: https://upload.wikimedia.org/wikipedia/commons/3/3f/KnowledgeGraphEmbedding.png

Introduction

Why do we need Entity Embeddings?



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Introduction

Research question

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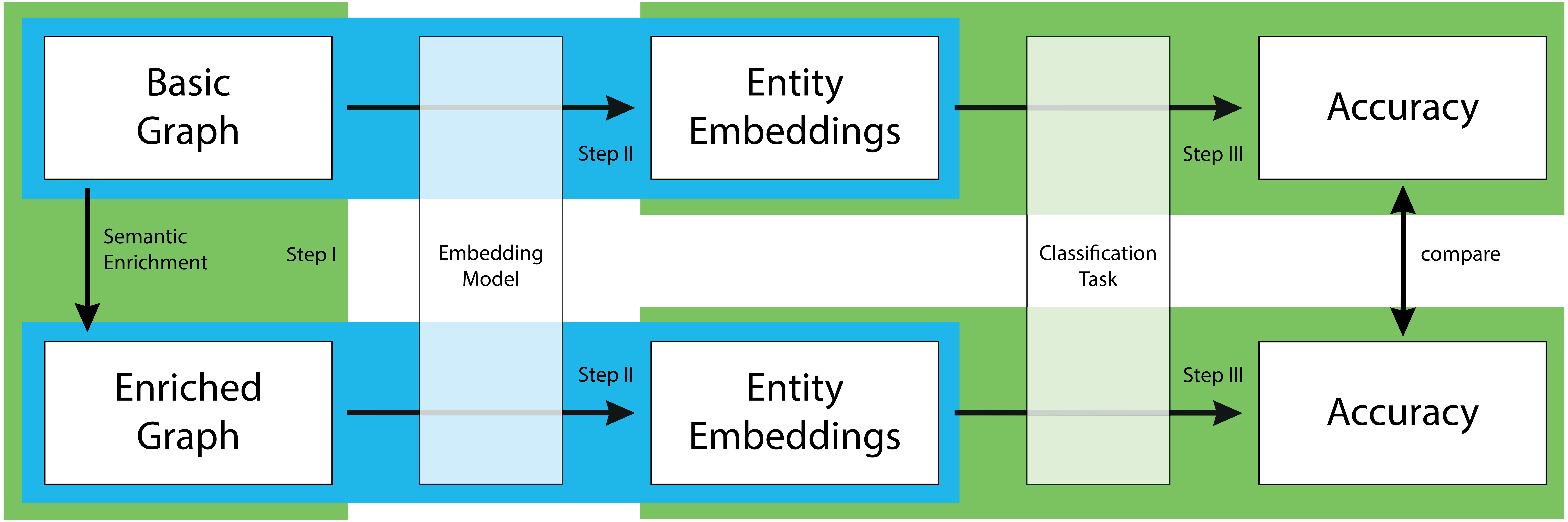
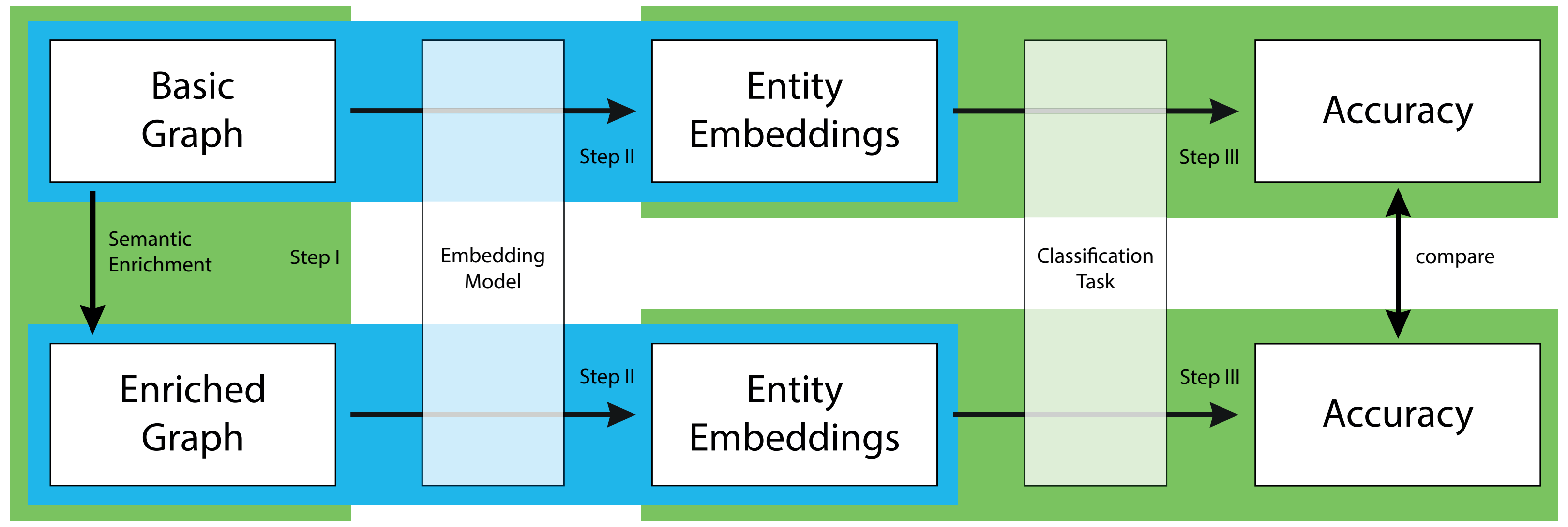
Experimental Pipeline

Overview



Experimental Pipeline

Overview



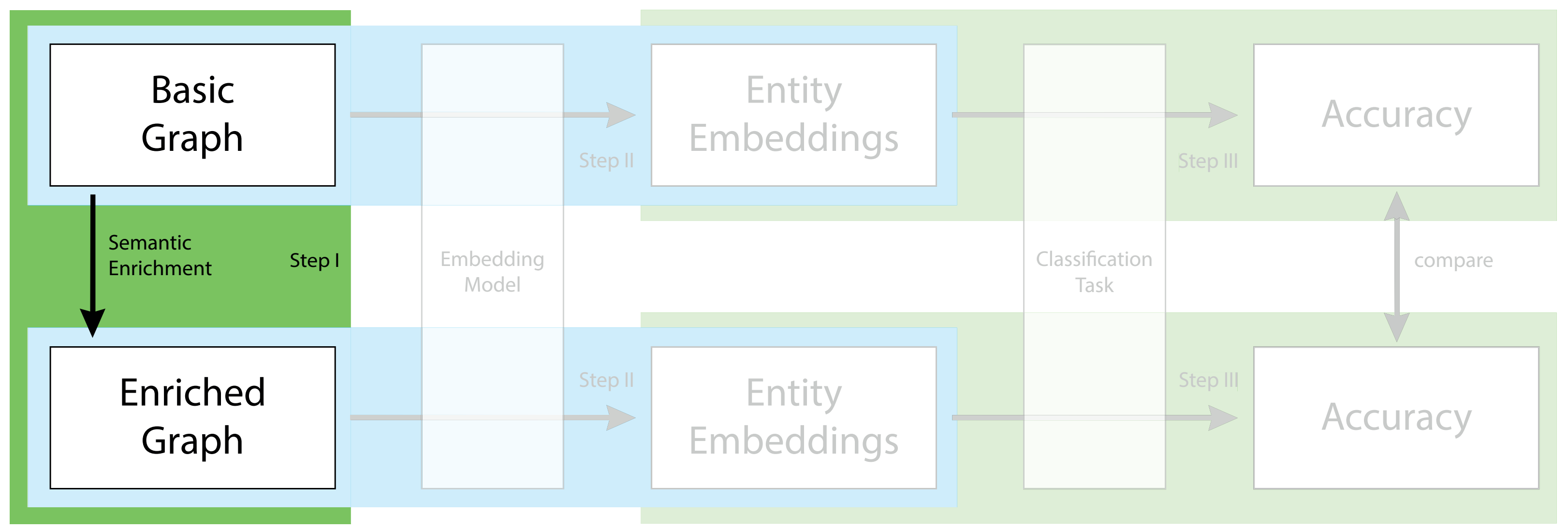
- Step 1: Semantic Enrichment

- Step 2: Embedding

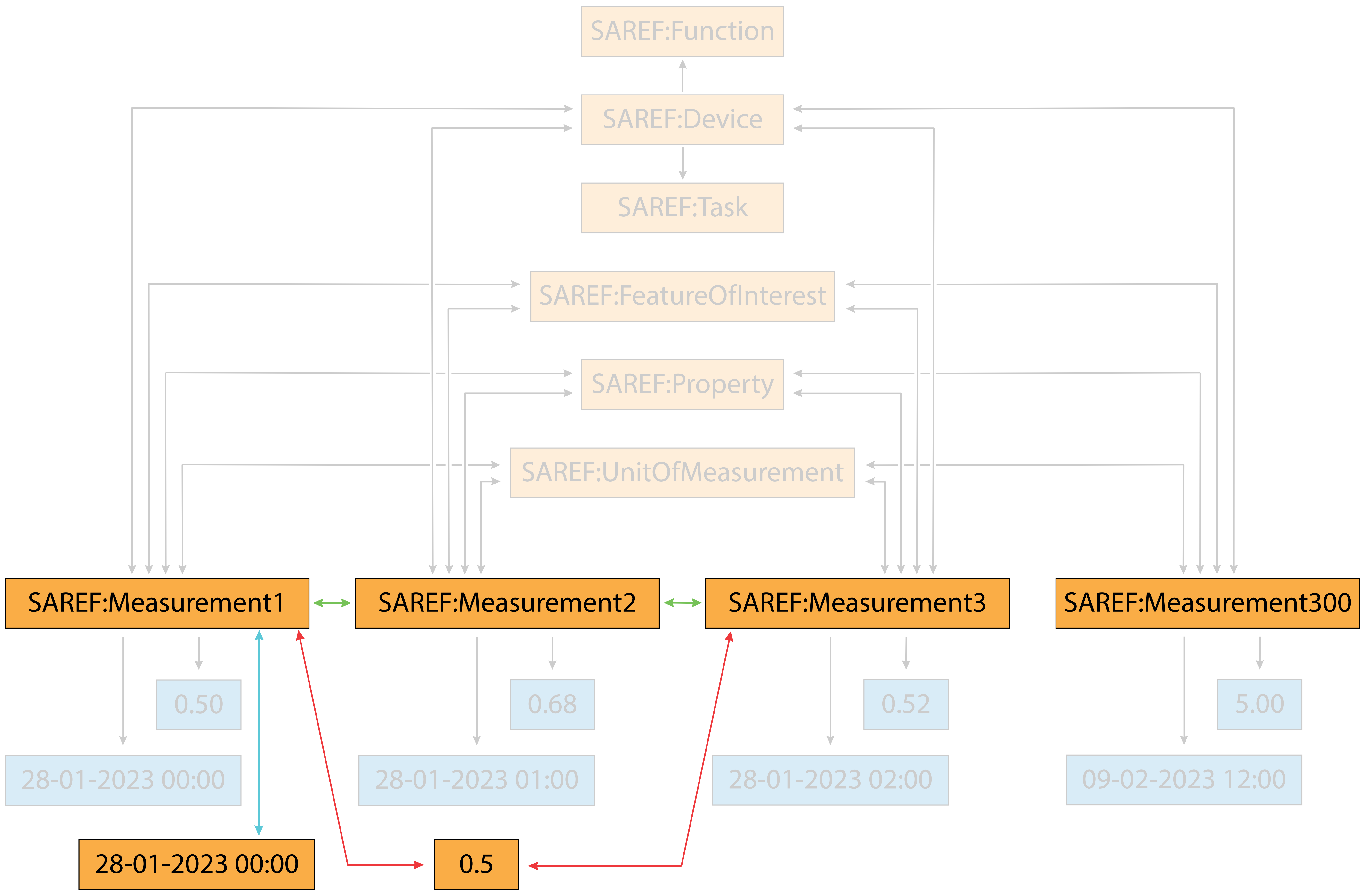
- Step 3: Evaluation

Experimental Pipeline

Semantic Enrichment step

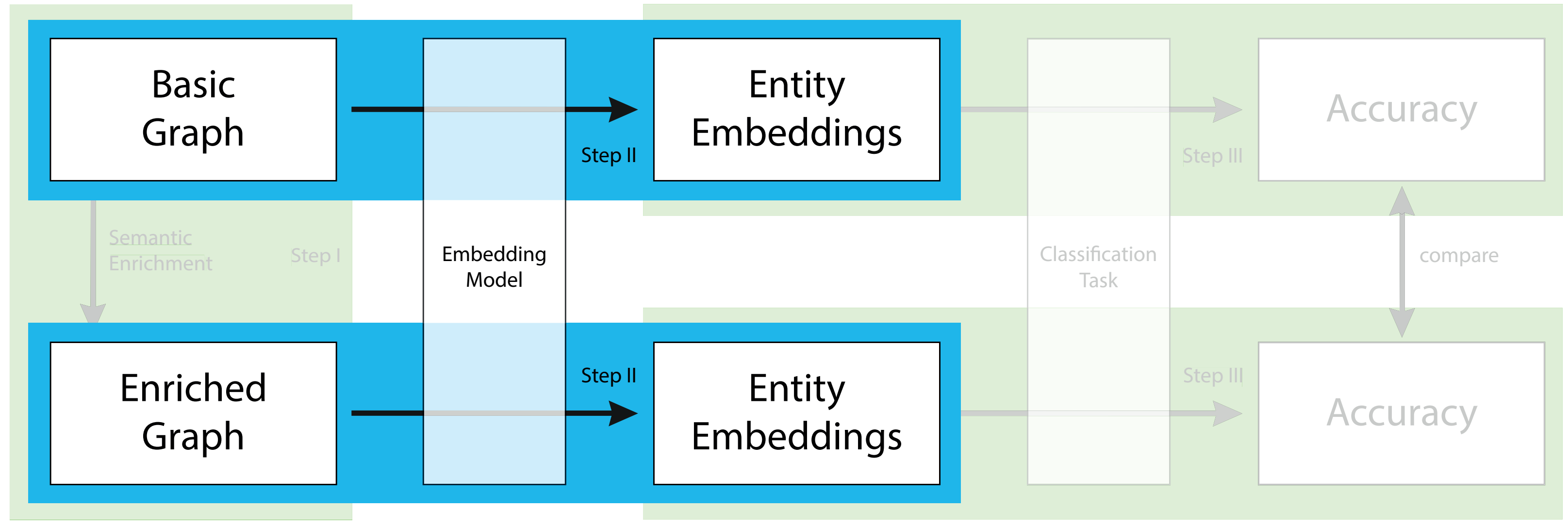


- Rounded value
- Sequence links
- Timestamp

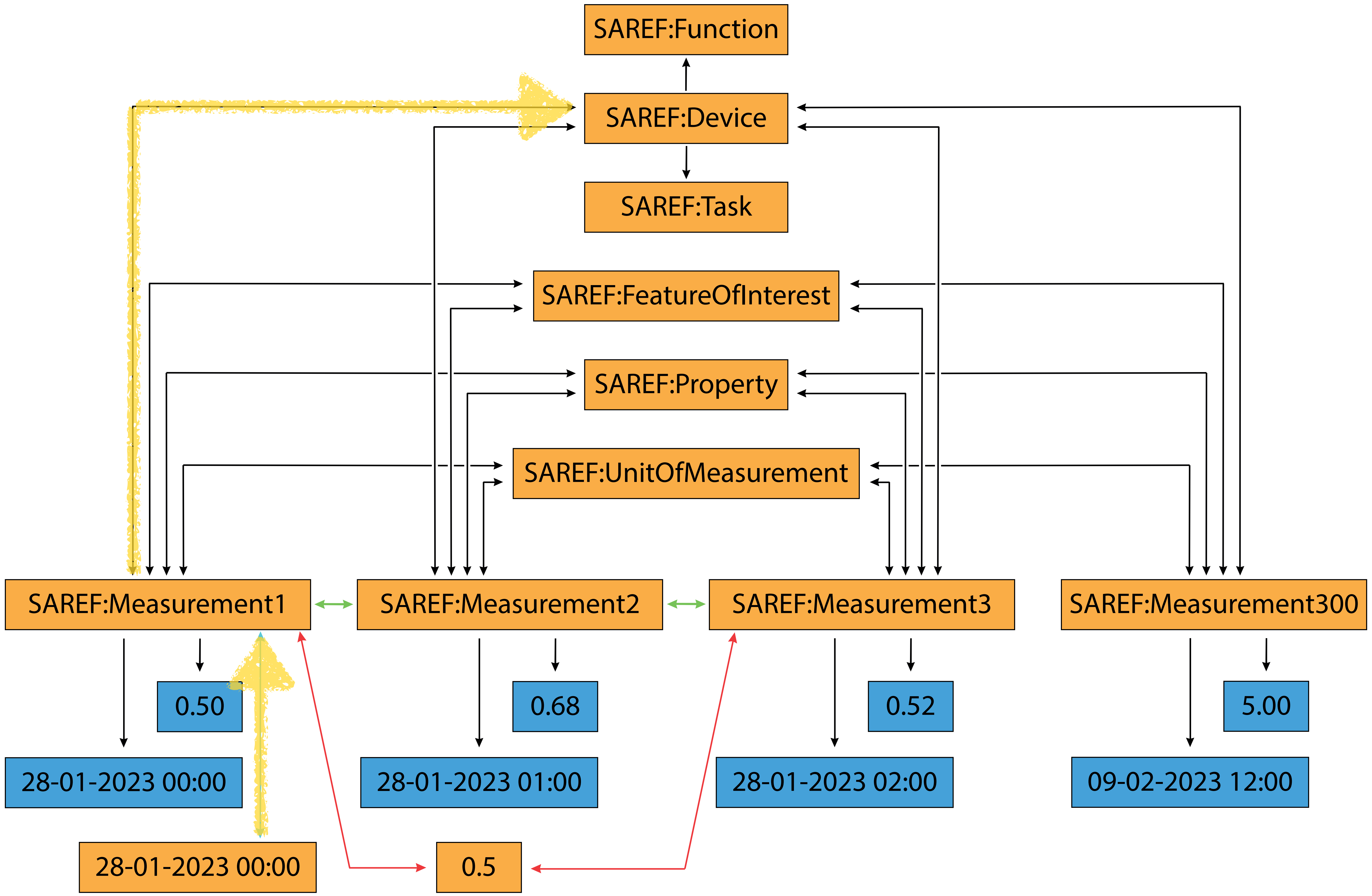


Experimental Pipeline

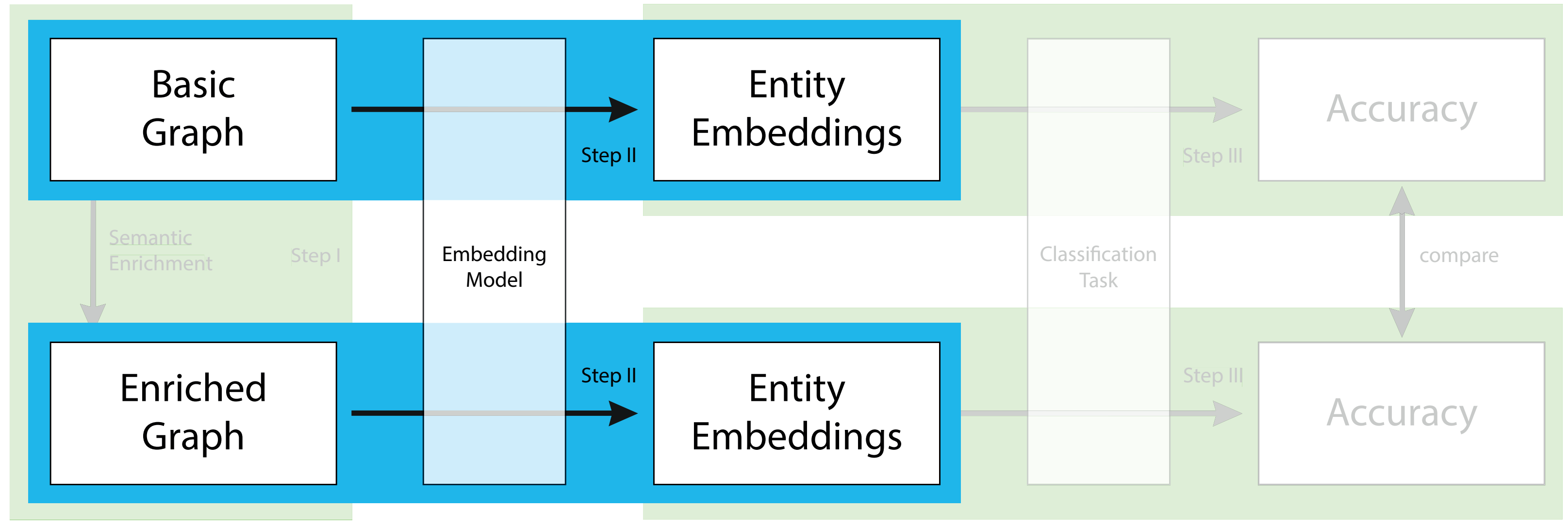
Embedding step



- RDF2vec
- Walk length of 2
- 25 walks per entity



Experimental Pipeline
Embedding step



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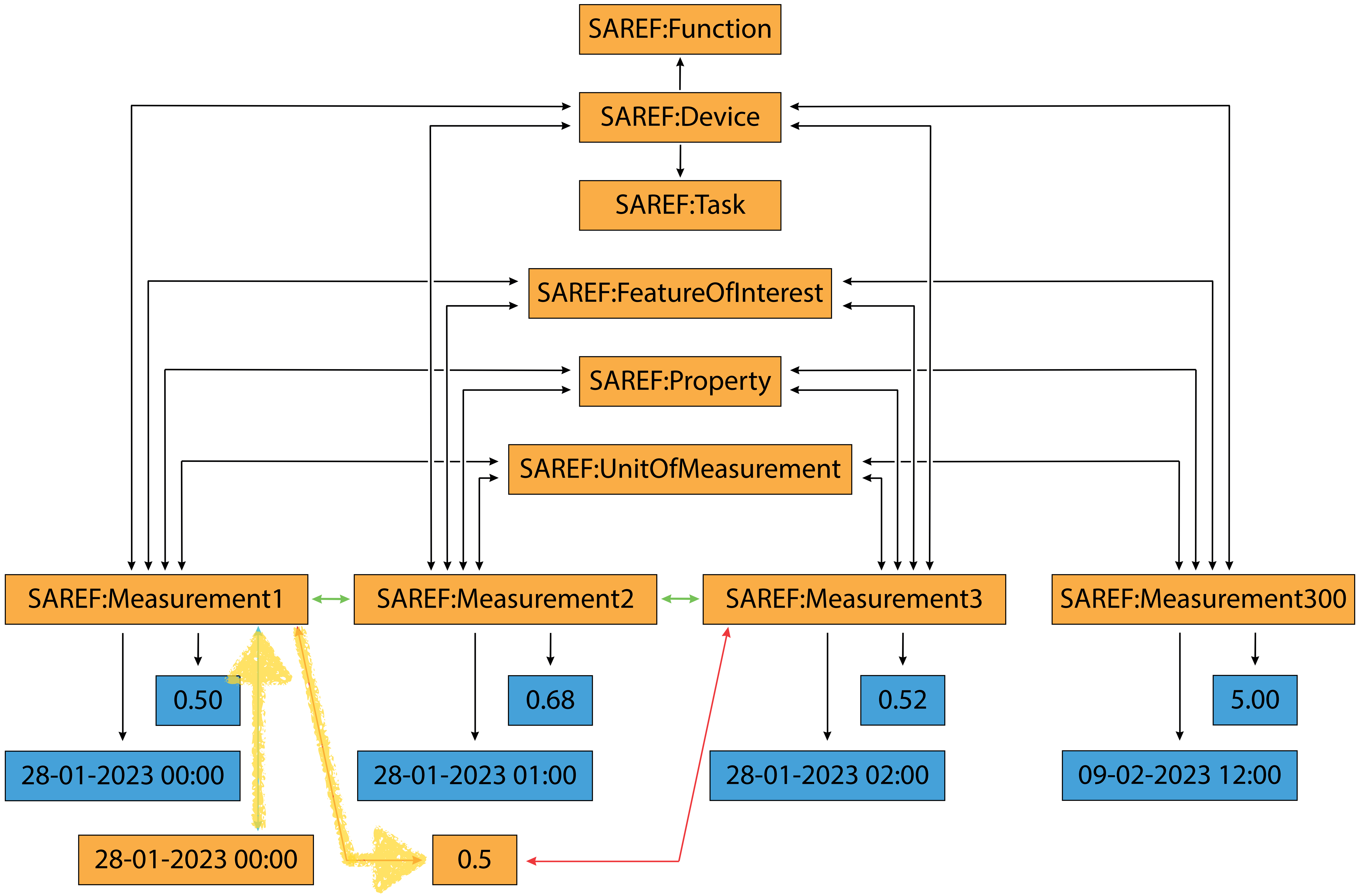
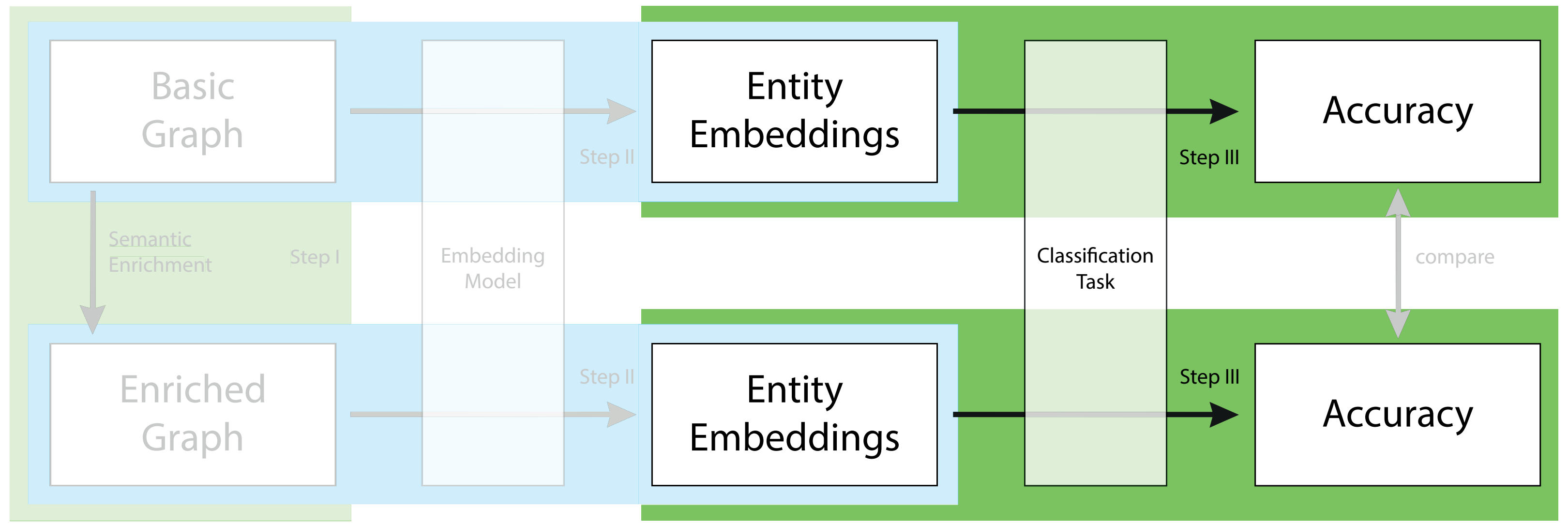
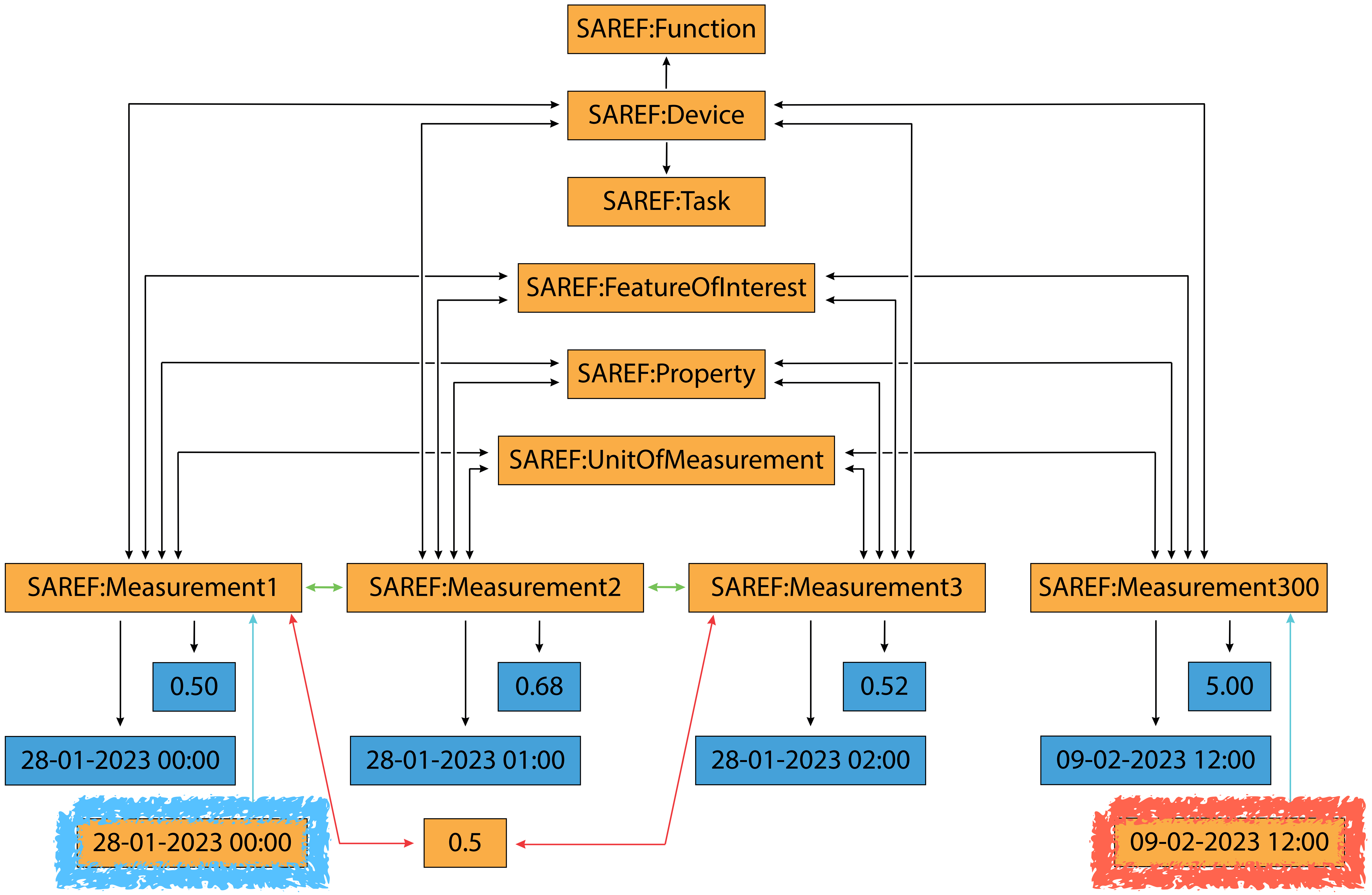


Experimental Pipeline

Evaluation step - Classification Task

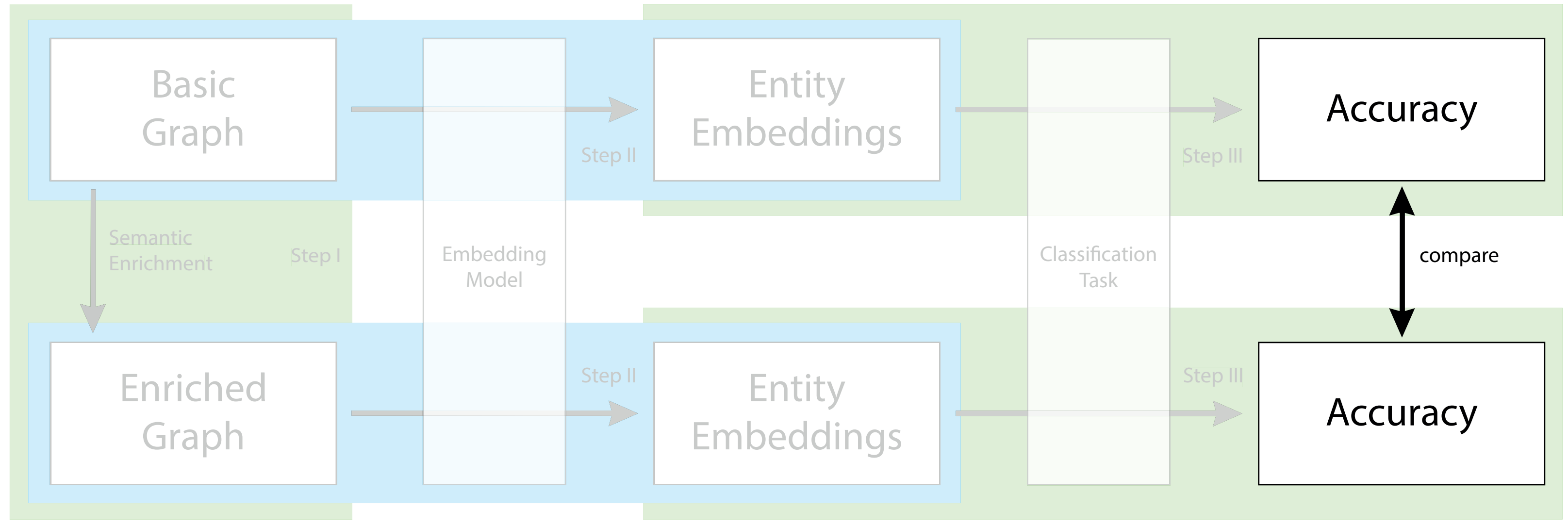


- Separated all timepoints based on outside temperature
- Labeled warmest half “warm” & coldest half “cold”
- Trained a MLP to classify timepoints based on label



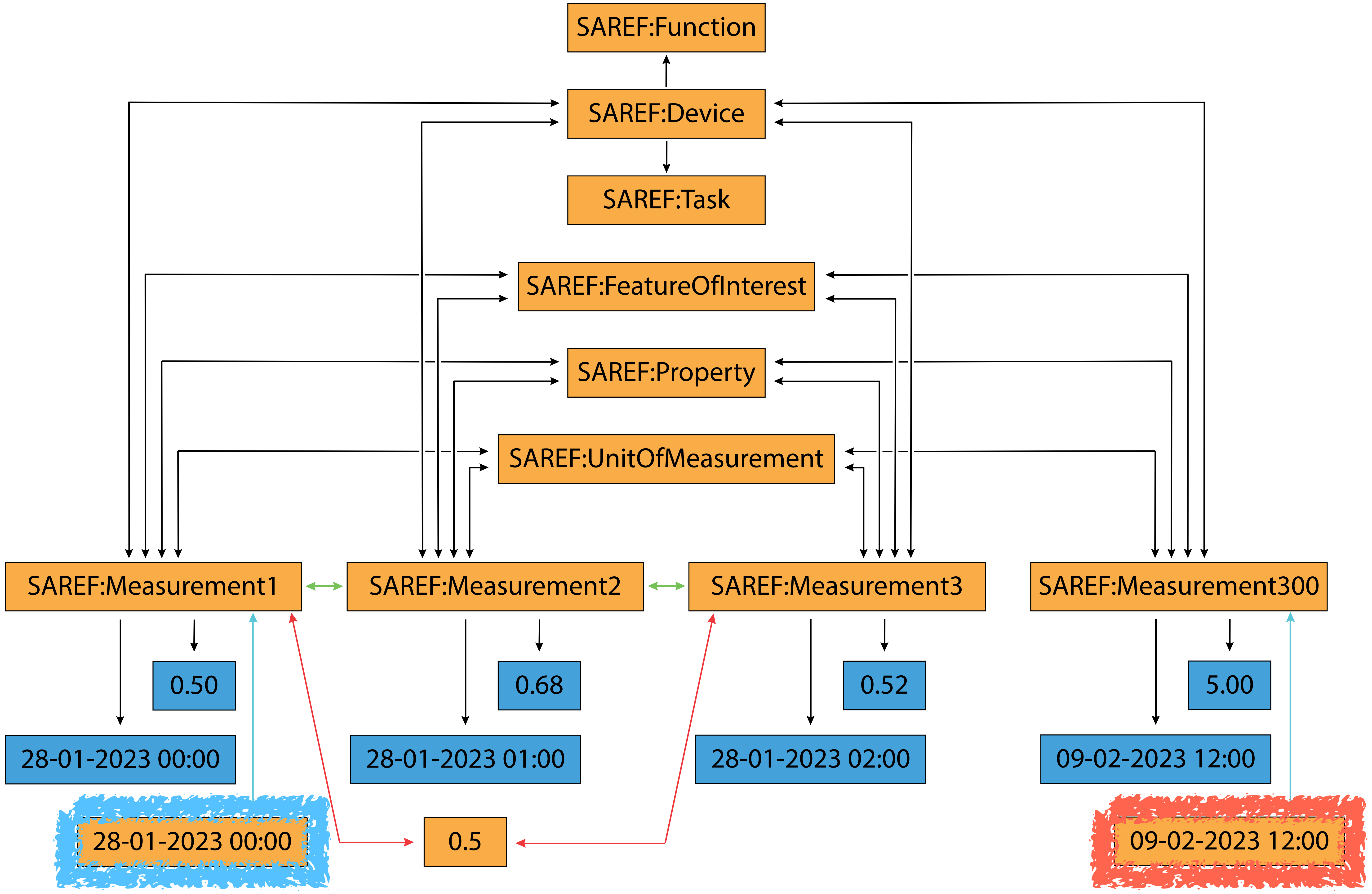
Experimental Pipeline

Evaluation step - Accuracy comparison

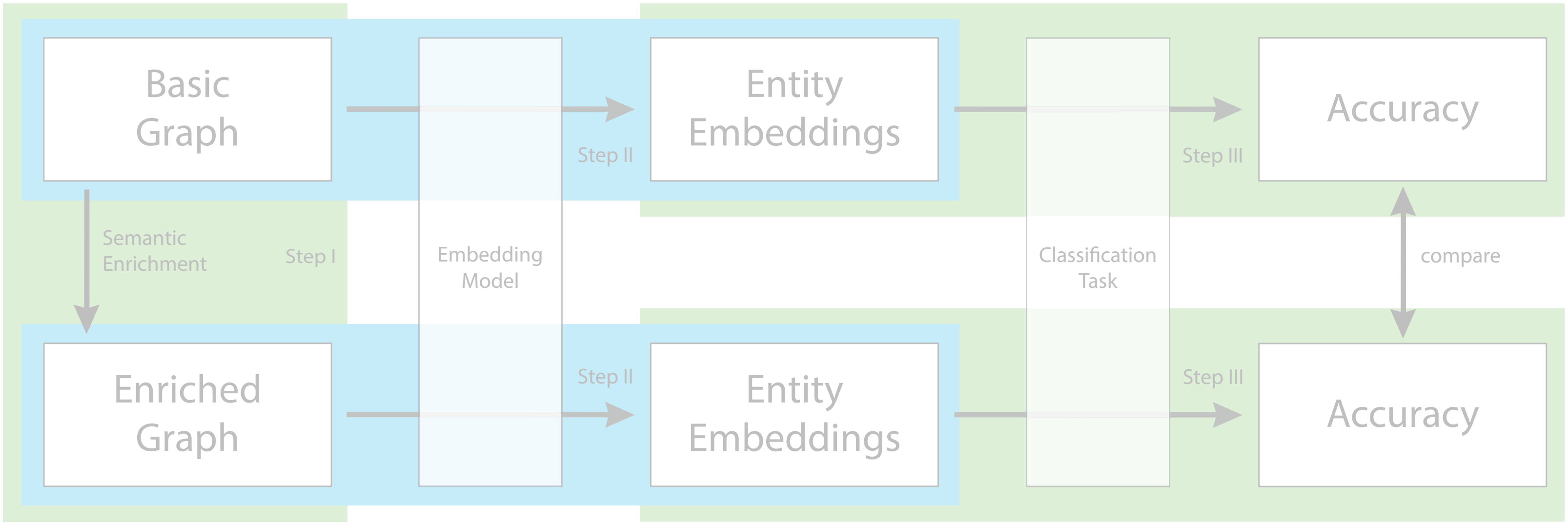


- Experiment is performed with both the original graph and enriched graph

- Accuracies are compared



Experimental Pipeline
Dataset

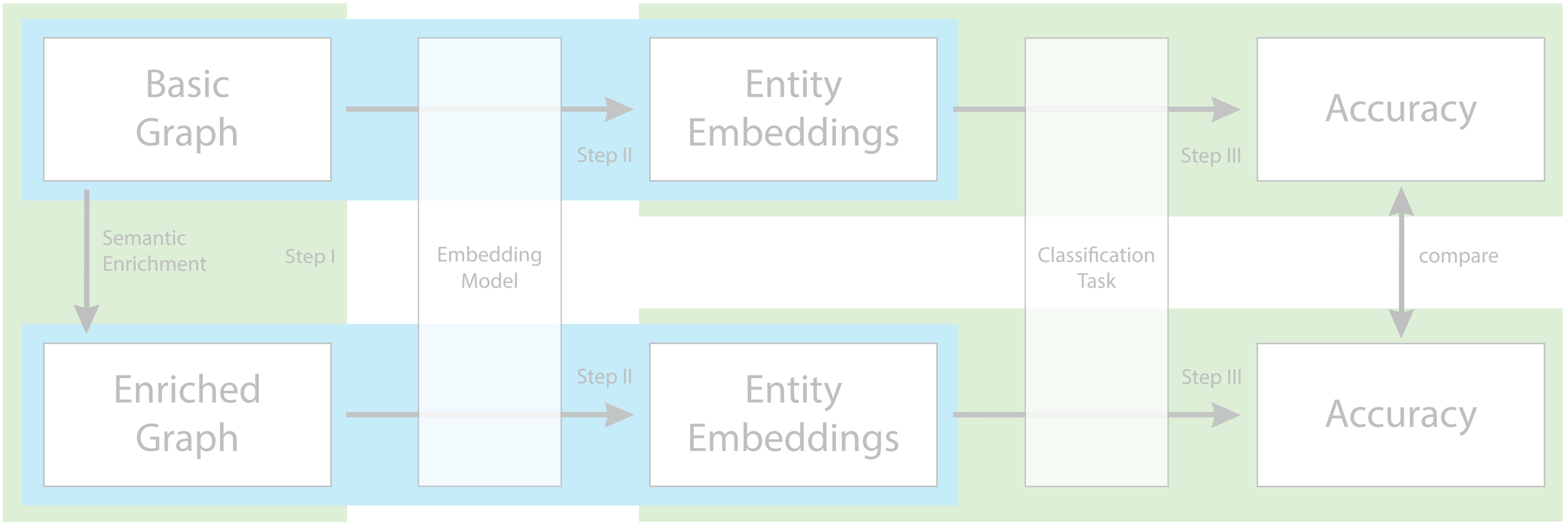


- OPSD Household dataset
- Hourly measurements
- 8133 timepoints (±11 months)
- Made into a IoT KG

	device types										
residence id	grid import	grid export	pv	dishwasher	ev	refridgerator	freezer	heat pump	washing machine	circulation pump	total
res1	1		1	1			1	1	1		6
res2	1			1			1		1	1	5
res3	1	1	1	1		1	1		1	1	8
res4	1	1	1	1	1	1	1	1	1		9
res5	1			1		1			1		4
res6	1	1	1	1			1		1	1	7
total	6	3	4	6	1	3	5	2	6	3	39

https://data.open-power-system-data.org/household_data/2020-04-15

Experimental Pipeline
Dataset



- **res1dev1:**
  1 device from 1 residence
- **res1devA**
  All devices from 1 residence
- **resAdevA**
  All devices from All residences

	device types										
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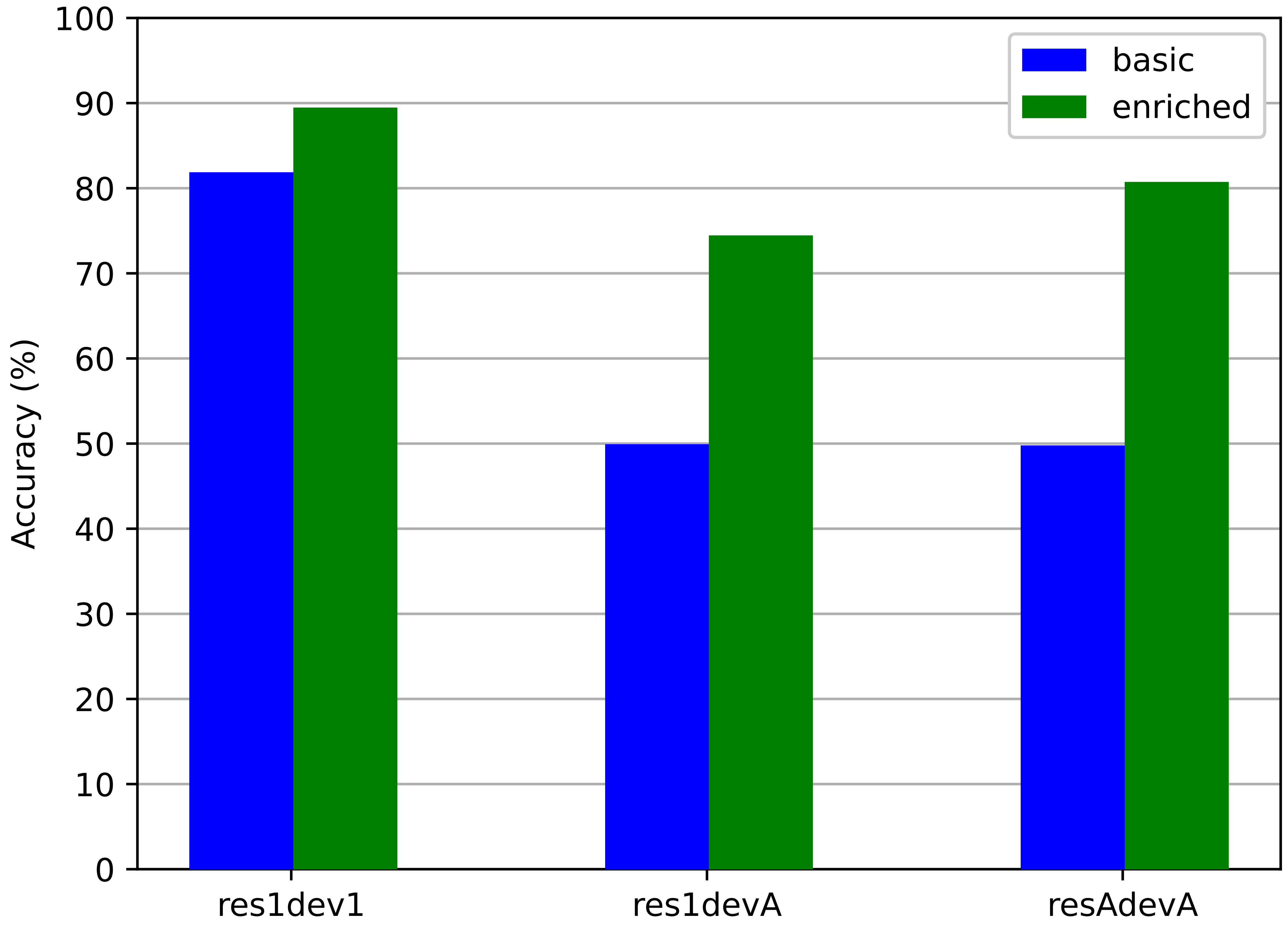
Results

Average accuracies of the classifiers

- Enriched outperforms basic every time
- More “useless” devices have a negative impact
- More “useful” devices have a positive impact



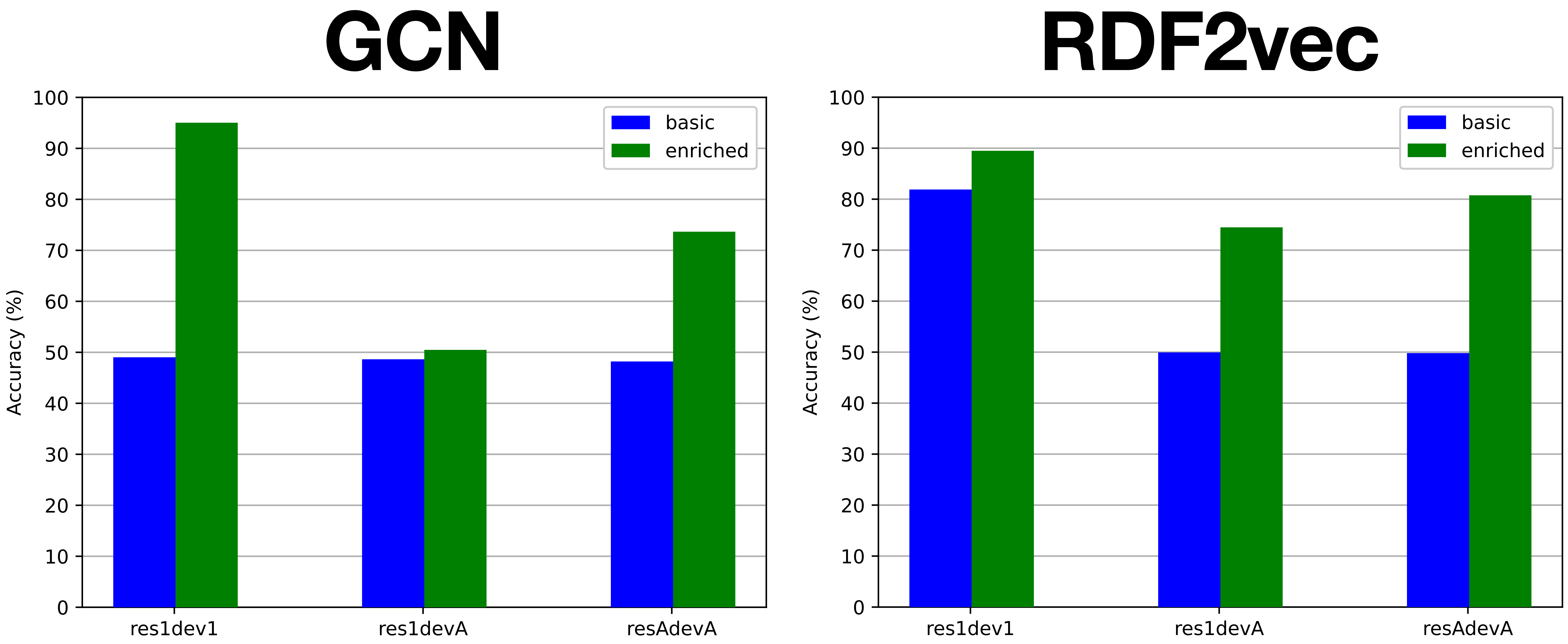
Discussion

Ongoing Research

- Using a different evaluation task
    - Value prediction
- Using a different embedding method
    - GCN
- Using different datasets
    - Pecan street (American consumption data)

Ongoing Research

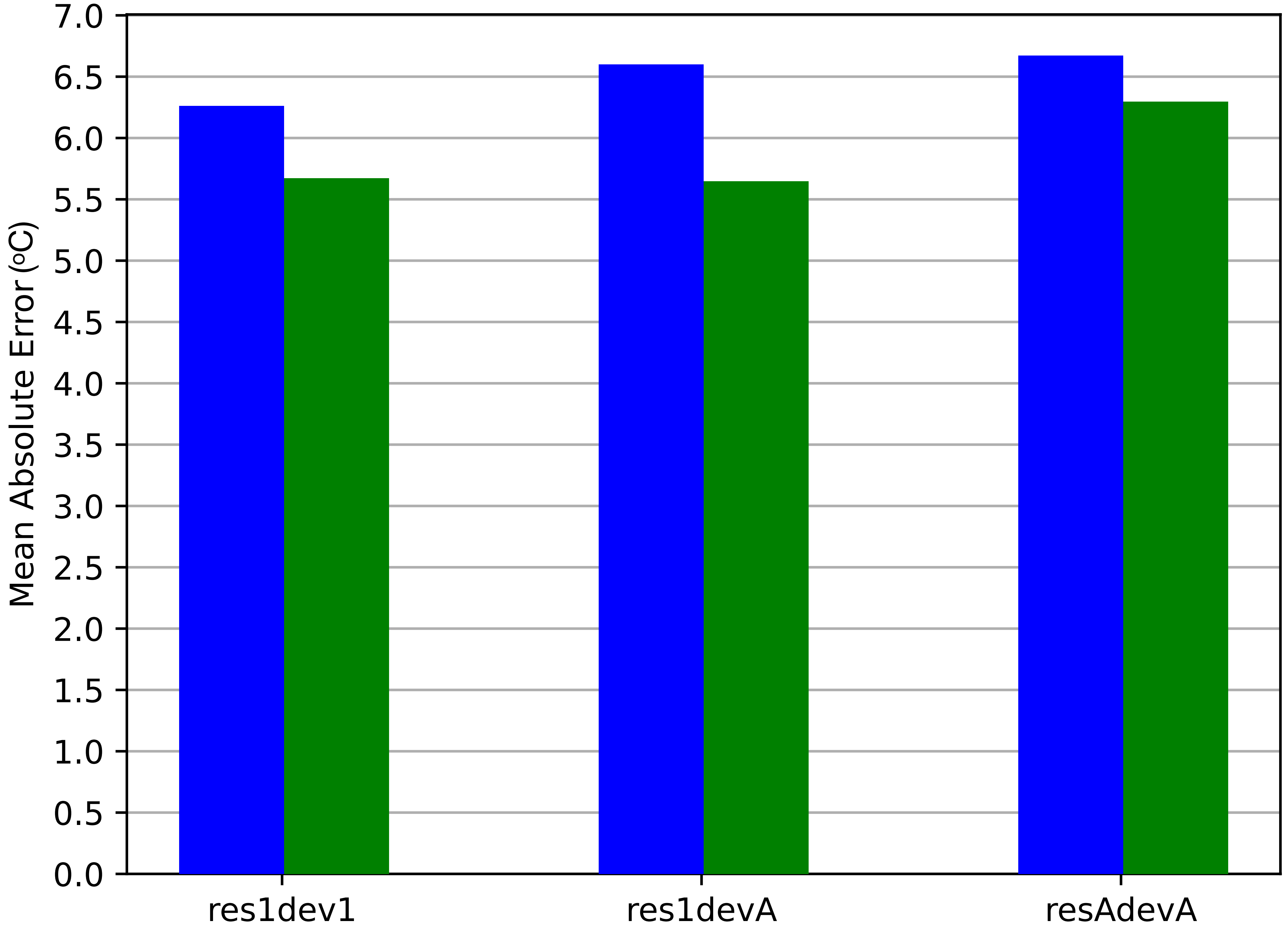
Average accuracies of the classifiers - RDF2vec & GCN



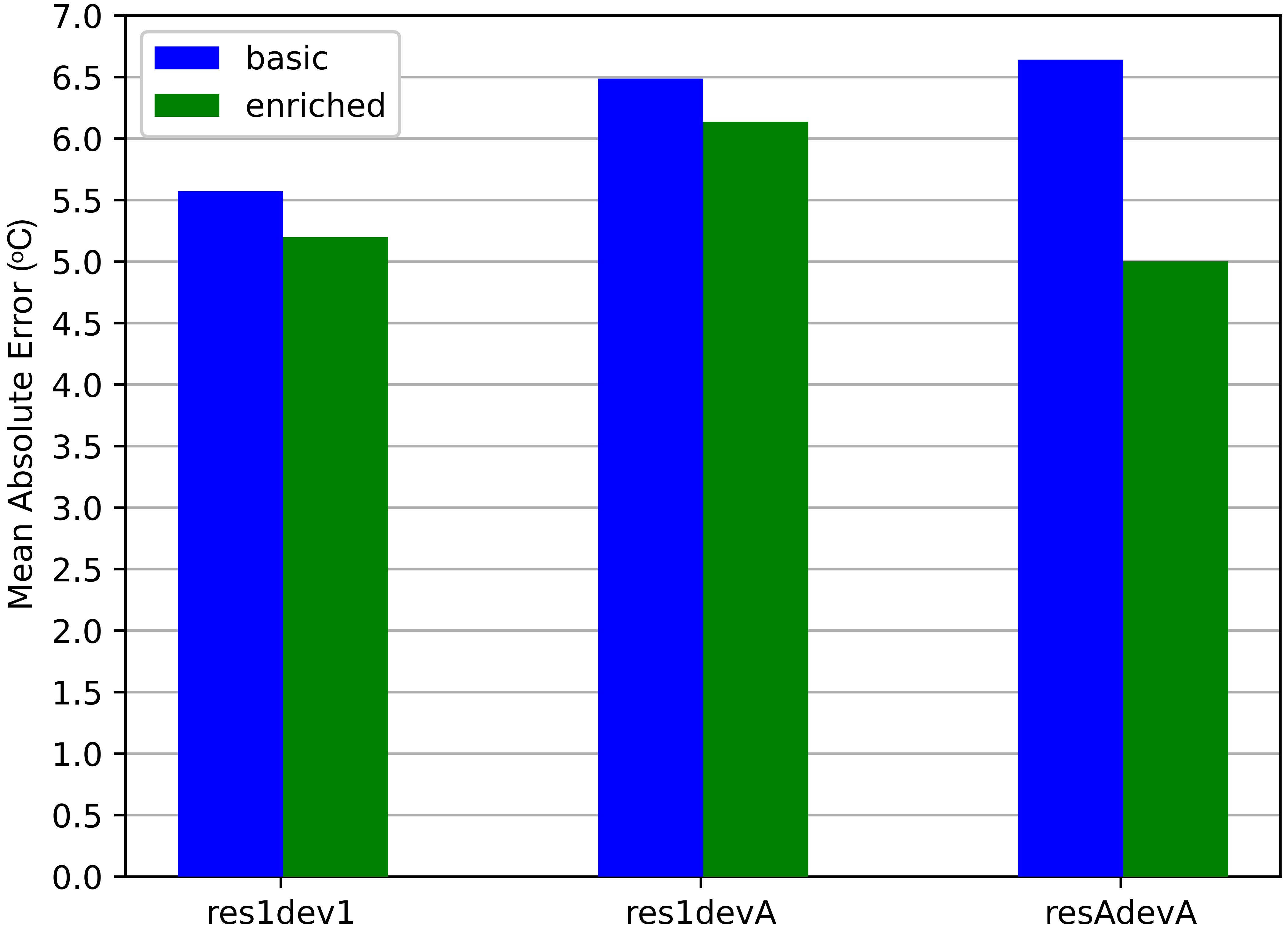
Ongoing Research

Average accuracies of the VALUE PREDICTOR - RDF2vec & GCN

GCN



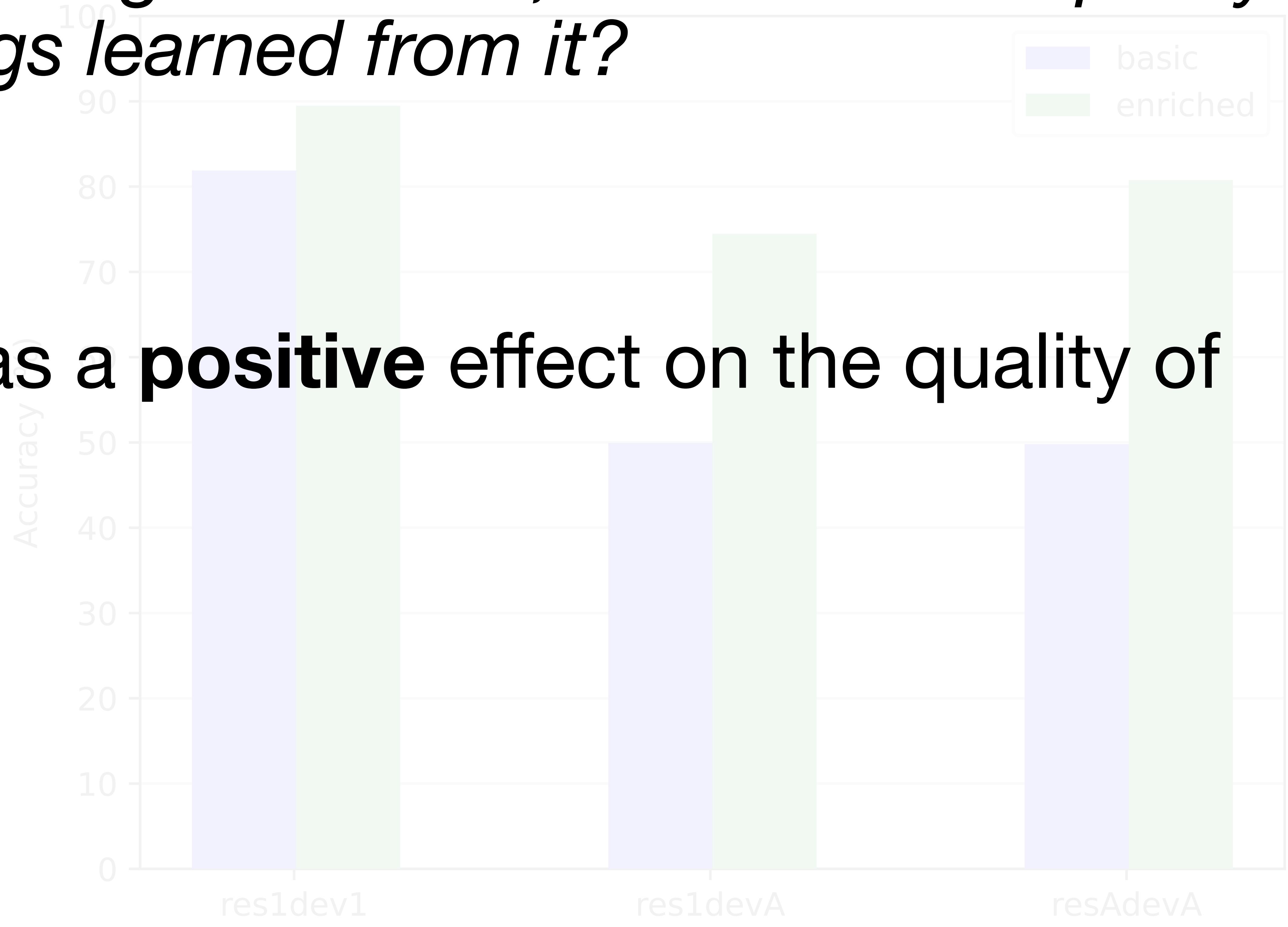
RDF2vec



Conclusion

What is the effect of semantically enriching an IoT KG, based on the quality of entity embeddings learned from it?

- In this setting, enriching an IoT KG has a **positive** effect on the quality of entity embeddings learned from it



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Thank you for listening