

- ▶ “Which restaurants in Heidelberg are wheelchair-accessible?”
- ▶ “What’s the distance from Moritzbastei in Leipzig to the closest shoemaker?”
- ▶ In principle, answerable using knowledge from OpenStreetMap

NLMaps: A Natural Language Interface for OpenStreetMap

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Introduction and Background

NL queries in Google



Figure: Google result for “wheelchair-accessible restaurants in Heidelberg”



Figure: Google result for “Which restaurants in Heidelberg are wheelchair-accessible?”

OpenStreetMap



Figure: OpenStreetMap Logo

- ▶ Crowdsourced map data available under the Open Database License
- ▶ Used by most non-Google map providers
- ▶ Queryable through various interfaces including
 - ▶ Nominatim, e.g. via <https://openstreetmap.org/>
 - ▶ Overpass API, e.g. via <https://overpass-turbo.eu/>

Overpass Turbo

Overpass QL for wheelchair-accessible restaurants in Heidelberg

```
(area[name=Heidelberg];) -> .a;  
nwr[amenity=restaurant][wheelchair=yes](area.a);  
out;
```



Figure: Overpass result for the Overpass QL query above

NLMaps

- ▶ Dataset published by Haas and Riezler (2016) containing
 - ▶ English and German natural language (NL) queries and
 - ▶ translations into a custom machine-readable language (MRL)
- ▶ 2380 examples
- ▶ Proposed goal: Parsing an NL query into an MRL query

NLMaps v2

- ▶ English-only Expansion of NLMaps
- ▶ Published by Lawrence and Riezler (2018)
- ▶ 28609 Examples
- ▶ Auto-generated with templates

NLMaps MRL

NL: "Which restaurants in Heidelberg are wheelchair-accessible?"

MRL

```
query(  
  area(keyval('name', 'Heidelberg')),  
  nwr(  
    keyval('amenity', 'restaurant'),  
    keyval('wheelchair', 'yes')  
  ),  
  findkey(name)  
)
```

Overpass QL

```
(area[name="Heidelberg"];) -> .a;  
nwr  
  ["amenity"="restaurant"]["wheelchair"="yes"]  
  (area.a);  
out;
```

Linearized NLMaps MRL

MRL

```
query(  
  area(keyval(name, 'Heidelberg')),  
  nwr(  
    keyval('amenity', 'restaurant'),  
    keyval('wheelchair', 'yes')  
  ),  
  findkey(name)  
)
```

Translating NL to MRL

- ▶ Use NMT treating NL as source and MRL as target language
- ▶ Token-based model + NER by Lawrence and Riezler (2018): 90 % accuracy
- ▶ Character-based model by Staniek (2020): 94 % accuracy
- ▶ Solved? No.
- ▶ Evaluation of char model on freshly written queries drops to under 10 %.
- ▶ Discrepancy explained by several issues in NLMaps v2

M.A. Mission

1. Fix the issues in NLMaps v2
2. Train decent model as a starting point
3. Build web-based system for online learning

Data Improvement

NLMaps v2 Problems

NLMaps v2 has several problems, including:

- ▶ Little linguistic variety on the NL side
- ▶ Little variety w.r.t. location names

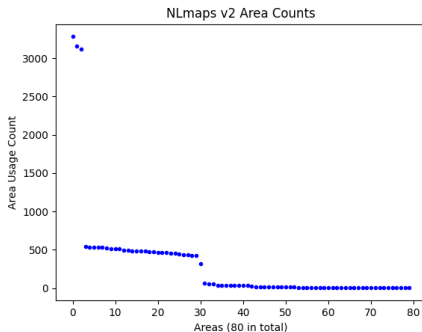
Lack of Linguistic Variety

10 random NLMaps v2 queries

```
where theaters in Edinburgh  
How many Doctor in Manchester  
Is there Farm Shop in Lille  
how many kindergarten in Edinburgh  
Garden Centres near École maternelle La Bruyère in Lille  
Is there Museums in Nice  
Is there close by Public Building from Bramley Street in Bradford  
Is there close by Fish Shop from Wohldorfer Schleuse in Hamburg in walking distance  
Where Ferry Terminals near sapin noel in Nantes  
How many Book Shop in Nice
```

- ▶ Limited number of patterns (“Is there ...”, never “Does LOC have ...”)
- ▶ Little variation within a pattern (“Is there close by ...”, never “Is there any close by ...”)

Lack of Variety in NEs



- ▶ Names are very simple (“Paris” instead of “Slatina u Hradce Králové”)

NLMaps v3

- ▶ Generate new dataset with ...
 - ▶ more patterns
 - ▶ more variations within patterns
 - ▶ better named entity (NE) distribution
 - ▶ more area variety
 - ▶ better OSM tag distribution
- ▶ Using probabilistic templates built with Jinja
- ▶ Adding noise to simulate typing errors

Example Template

► Example of a very simple template

opening-hours-when_visit.jinja2

```
when
{{ choose(['can I', 'can we', 'to'], [0.3, 0.3, 0.4]) }}
{{ choose(['visit', 'go to'], [0.6, 0.4]) }}
{% if plural %}
    {{ choose(['the', 'all', 'all the', ''], [0.2, 0.2, 0.2, 0.4]) }}
{% else %}
    {{ choose(['a', 'some', 'any', '']) }}
{% endif %}
{{ thing_plural if plural else thing_singular }}
{% include 'meta/in_location.jinja2' %}
{{ optional('?') }}
```

NLMaps v3 Sample

10 random NLMaps v3 queries with noise

what bathrooms in Záluží are around Zur Stöpe?
what preschools in Sadek are in walking distance from Gasthaus Tannengarten?
Do some veterinary surgeries exist east of Studna in Montgeron (canton de Draveil)?
Give me any department store around ROBOT in Neue Vahr Südost
which service road in Bardzice is south of Le Cîrê Jaune?
show me the opening times of all the monorail in the area of The KPH in Świecie
Which viewpoint is there in Miño de San Esteban?
In Grabowiec, what are the opening hours of all the boatyards less than 80 kilometres
away from MakroMueble
Indicate the coordinates of all byways in přírodní památka Branžov.
Are there parks east of Tigery?

- ▶ Names for areas and POIs are selected from different regions across Europe, South and North America.
- ▶ Still somewhat eurocentric

Web Interface

Web Interface Demo

Demo: Correct Parse – Query

“Which are the opening times of places in Heidelberg to buy outdoor equipment?”


NLMaps Web

[Query](#) [Feedback List](#) [Train Status](#) [Log Out](#) [admin](#)

▼ NLMaps Introduction

▲ Query

NL Query



Demo: Correct Parse – Answer

▲ MRL Info

Which are the opening times of places in Heidelberg to buy outdoor equipment?

Question Class Thing in Area

Target Tags shop=outdoor

Area Heidelberg

QType findkey(opening_hours)

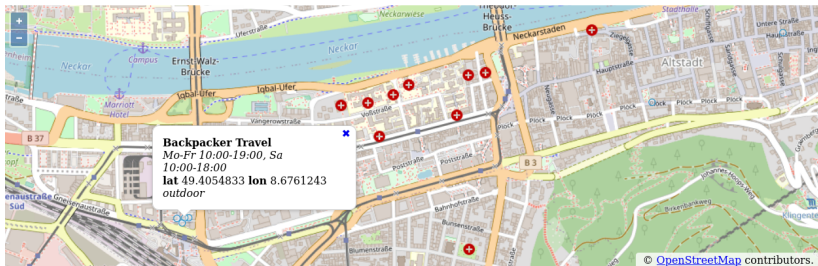
```
query(area(keyval('name','Heidelberg')),nwr(keyval('shop','outdoor')),qtype(findkey('opening_hours')))
```

That's correct! Adjust

▲ Answer

Mo-Fr 10:00-19:00, Sa 10:00-18:00, Mo-Fr 10:00-19:00, Sa 10:00-18:00, Mo-Fr 13:00-19:00, Sa 10:00-20:00, Mo-Fr 10:00-19:00, Sa 10:00-18:00, Mo-Fr 10:00-19:00, Sa 10:00-18:00, Mo-Sa 10:00-19:00, Su, PH off

Demo: Correct Parse – Map



Demo: Incorrect Parse – Query

“show me the wind converters in Thüringen”

▲ Query

NL Query

▲ Log

Parsing query ...
Parsed query.
Diagnosing potential MRL problems...
Retrieving result ...
Retrieved 0 results.

▲ MRL Info

show me the wind converters in Thüringen

Question Class	Thing in Area
Target Tags	craft=wind
Area	Thüringen
QType	latlong

```
query(area(keyval('name','Thüringen')),nwr(keyval('craft','wind')),qtype(latlong))
```

Demo: Incorrect Parse – Help

Area

Found 1 results for area "Thüringen".

Similar Tags

craft=wind

Count: 0 (Unused)

Tag candidates for "converters"

Tag candidates for "wind"

[generator:source=wind](#)

Wind turbine

Count: 277036



[generator:method=wind turbine](#)

Methode to convert kinetic energy from the wind into electrical power

Count: 197527



[man_made=windmill](#)

A traditional windmill, historically used to mill grain with wind power.

Count: 8857



Demo: Incorrect Parse – Form

Query Class	Thing in Area
Target Tags	<div><div>craft=wind</div><div>Or</div></div>
	And
Area	Thüringen
QType	latlong
Cardinal Direction	
Resubmit	

Querying Architecture

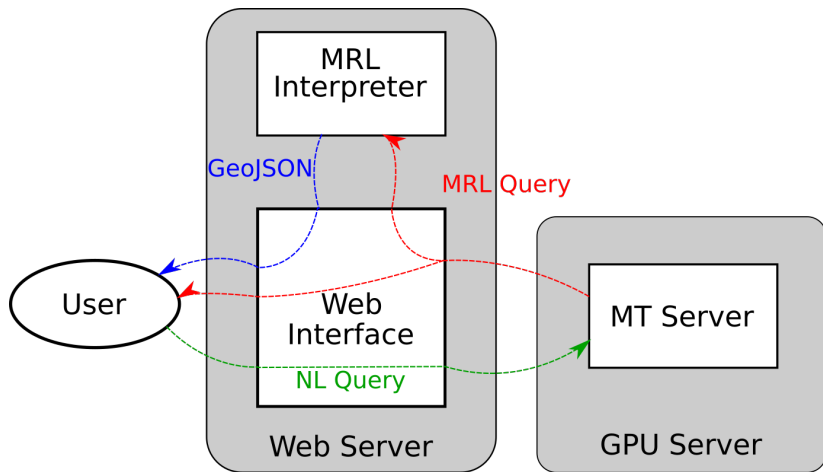


Figure: System Architecture for Querying

Feedback and Learning Architecture

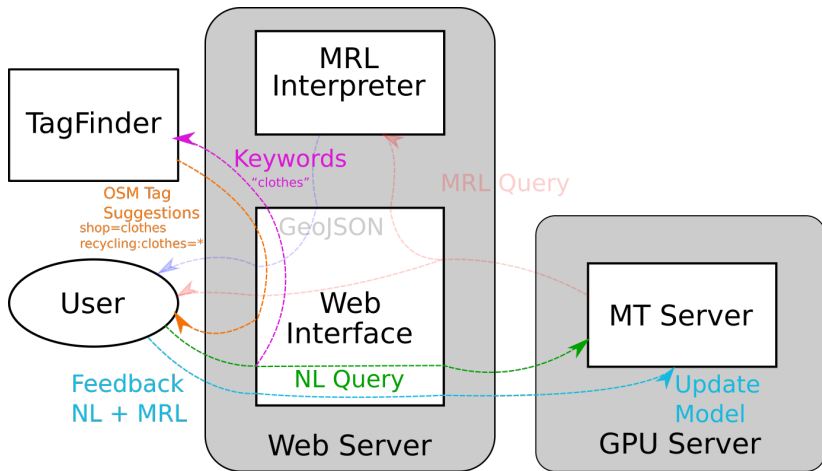


Figure: System Architecture for Feedback and Learning

Extracting Keywords for TagFinder

- ▶ “What is the closest 2 star restaurant from Alexanderplatz in Berlin?”
- ▶ Goal: Find content words
- ▶ Method
 - ▶ Delete tokens recognized as NEs (e.g. “Alexanderplatz”)
 - ▶ Get TF-IDF scores for remaining tokens, with queries in NLMaps v2+NLMaps v3 as documents
 - ▶ Select tokens with score over a manually chosen threshold

Experiments

Annotation Experiment

- ▶ Actual user queries needed for evaluation of models
- ▶ Hire annotators via OSM talk mailing list and OSM subreddit
- ▶ They use the web interface issuing 4152 queries
- ▶ 3773 queries after eliminating duplicates and queries without MRL
- ▶ Manual corrections by me

Annotator Profiles

#Annotations	Nationality	Native Language	OSM Experience	Gender
442	Poland	Polish	Extensive	Male
414	Germany	German	Extensive	Male
405	Turkey	Turkish	Medium	Male
404	UK	English	Medium	Male
404	Hungary	Hungarian	Extensive	Male
400	India	Hindi	Little	Male
400	Turkey	Turkish	Little	Male
393	Germany	German	Little	Male
318	Germany	German	Extensive	Male
253	Brazil	Portuguese	Little	Male
253	Nepal	Nepalese	Extensive	Male
26	Philippines	English, Filipino, Cebuano	Extensive	Male
40	<i>Various untracked people without login</i>			

Results of Different Models

- ▶ Train same character-based attentional encoder-decoder as Staniek (2020)
- ▶ NLMaps v2.1: Fixed version of NLMaps v2
- ▶ NLMaps v3: NLMaps v2 + new synthetic queries from probabilistic templates
- ▶ NLMaps v4: Newly collected user queries

Train \ Test			
	v2.1	v3	v4
v2.1	0.913	0.471	0.069
v3	0.913	0.874	0.289
v3 \rightarrow v3 + v4	0.914	0.865	0.588

Online Learning Setup

Online Learning Requirements

- ▶ Learn from user feedback
- ▶ Update quickly for user motivation
- ▶ Don't deteriorate performance on existing examples
- ▶ Generalize to new similar examples

Online Learning Setup

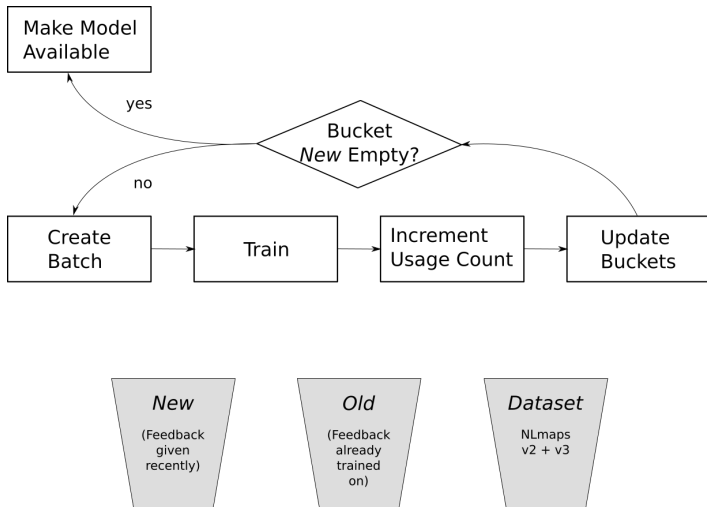


Figure: Training loop after user gives feedback

Online Learning Setup

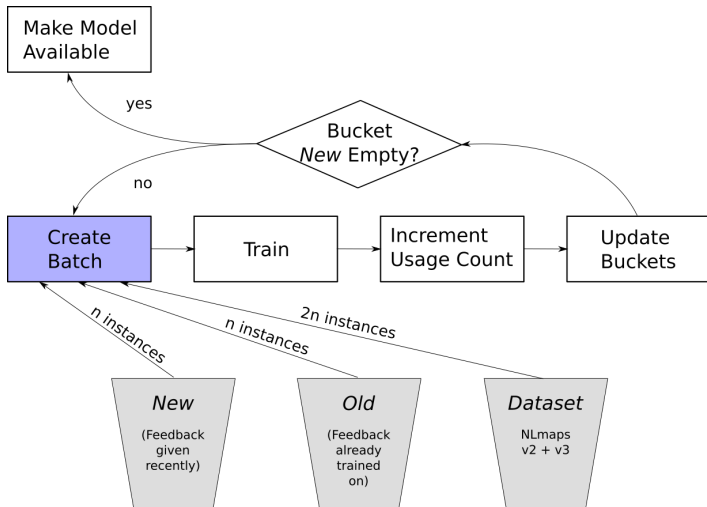


Figure: Training loop after user gives feedback

Online Learning Setup

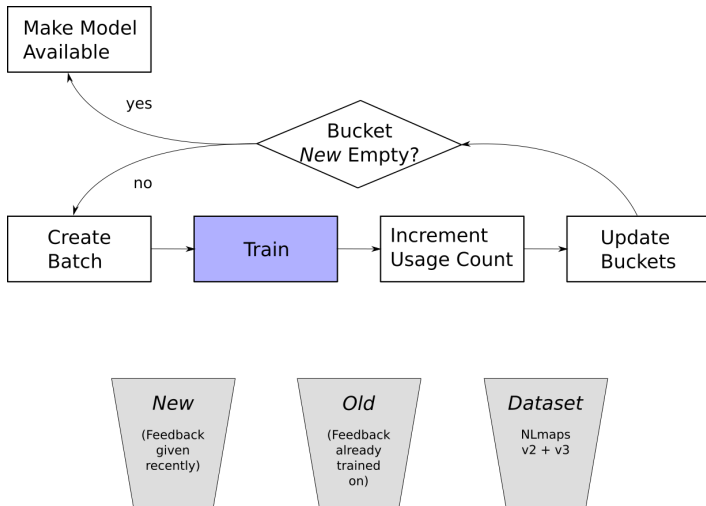


Figure: Training loop after user gives feedback

Online Learning Setup

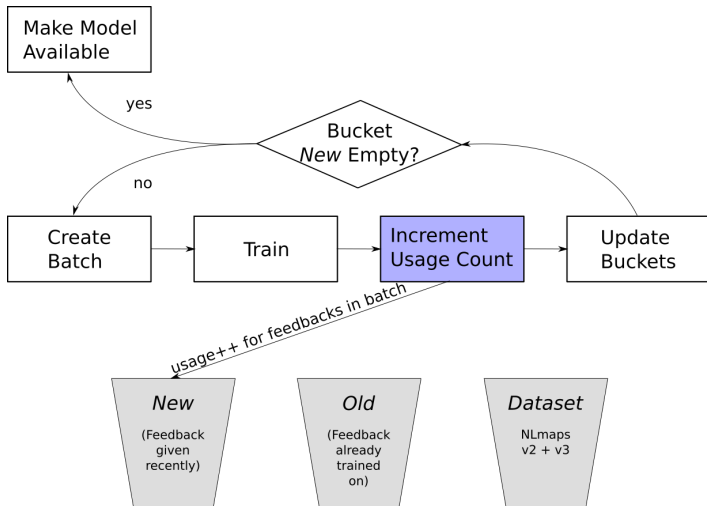


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Online Learning Setup

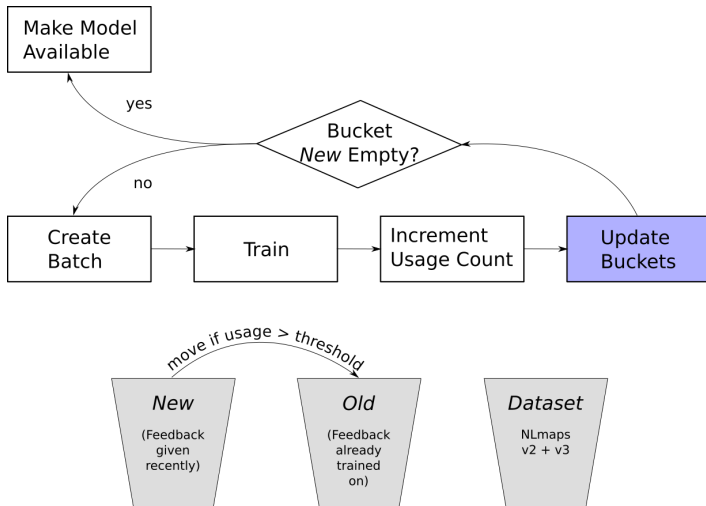


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Online Learning Setup

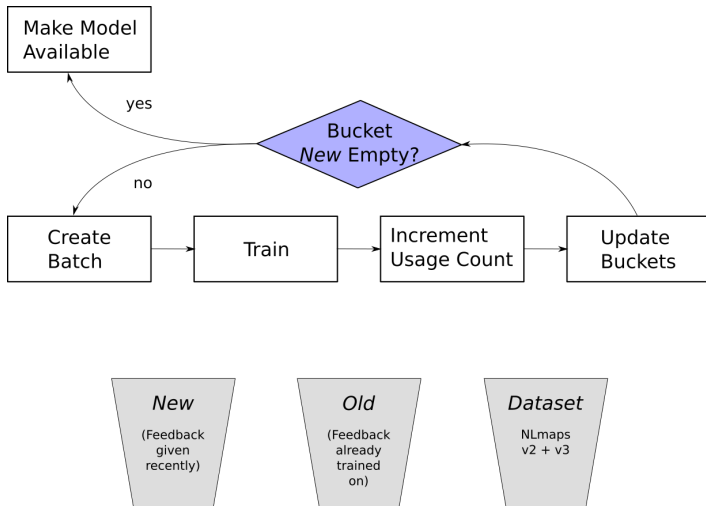


Figure: Training loop after user gives feedback

Online Learning Learning Curve

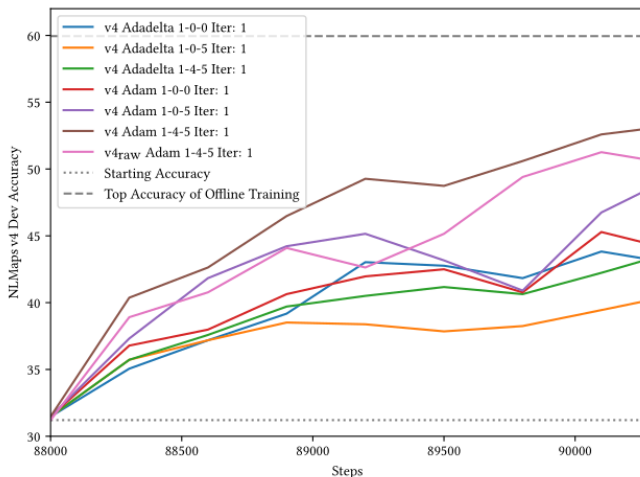


Figure: Learning curves of various online learning configurations

Conclusion

What I Did




- ▶ Fixed NLMaps v2
- ▶ Generated new dataset with larger linguistic variety
- ▶ Collected dataset of actual user queries
- ▶ Built web interface for using and improving NLMaps

What's Next?

- ▶ Extend MRL, e.g. allow referring to user's standpoint
- ▶ Train model based on subword units and with pointer mechanism (See, Liu, and Manning 2017) for copying names
- ▶ Make use of word representations, e.g. BART (Lewis et al. 2020)
- ▶ Make available in other languages, e.g. by translating the NL queries

Ideas, Questions, etc.

References I

-  Haas, Carolin and Stefan Riezler (2016). “A Corpus and Semantic Parser for Multilingual Natural Language Querying of OpenStreetMap”. In: *Proceedings of the 2016 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies*. NAACL (San Diego, CA, USA), pp. 740–750.
-  Lawrence, Carolin and Stefan Riezler (2018). “Improving a Neural Semantic Parser by Counterfactual Learning from Human Bandit Feedback”. In: *Proceedings of the 56th Annual Meeting of the Association for Computational Linguistics*. ACL (Melbourne, Australia), pp. 1820–1830.
-  Lewis, Mike et al. (2020). “BART: Denoising Sequence-to-Sequence Pre-training for Natural Language Generation, Translation, and Comprehension”. In: *Proceedings of the 58th Annual Meeting of the Association for Computational Linguistics* (Online), pp. 7871–7880.

References II



See, Abigail, Peter J. Liu, and Christopher D. Manning (2017). “Get To The Point: Summarization with Pointer-Generator Networks”. In: *Proceedings of the 55th Annual Meeting of the Association for Computational Linguistics*. ACL (Vancouver, Canada), pp. 1073–1083.



Staniek, Michael (2020). “Towards Error-Aware Interactive Semantic Parsing”. M.A. Thesis. Heidelberg University.