PCSG: Pattern-Coverage Snippet Generation for RDF Datasets

ISWC 2021

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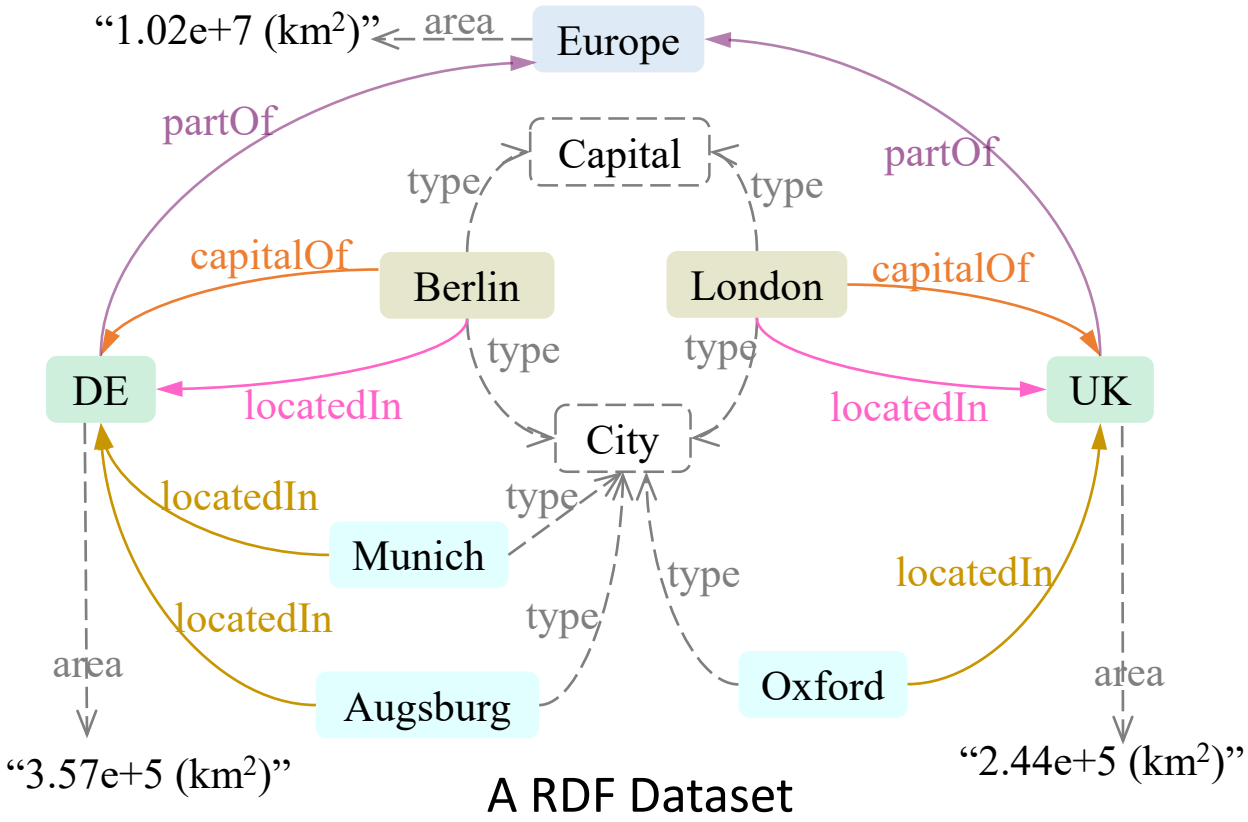
Background

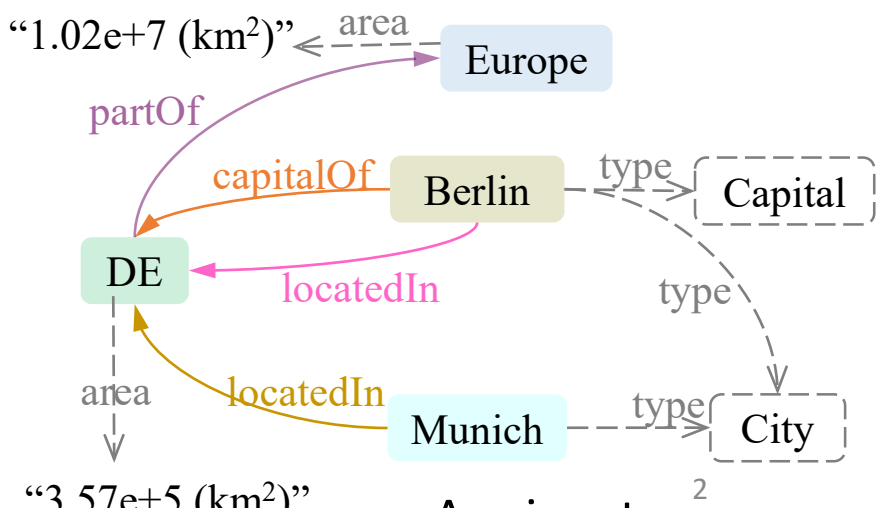
To ease the comprehension of large complex RDF structure:

- RDF summary: representative schema-level elements or patterns
- **RDF snippet**: a connected subgraph containing frequent classes and properties



A RDF Dataset

Generation

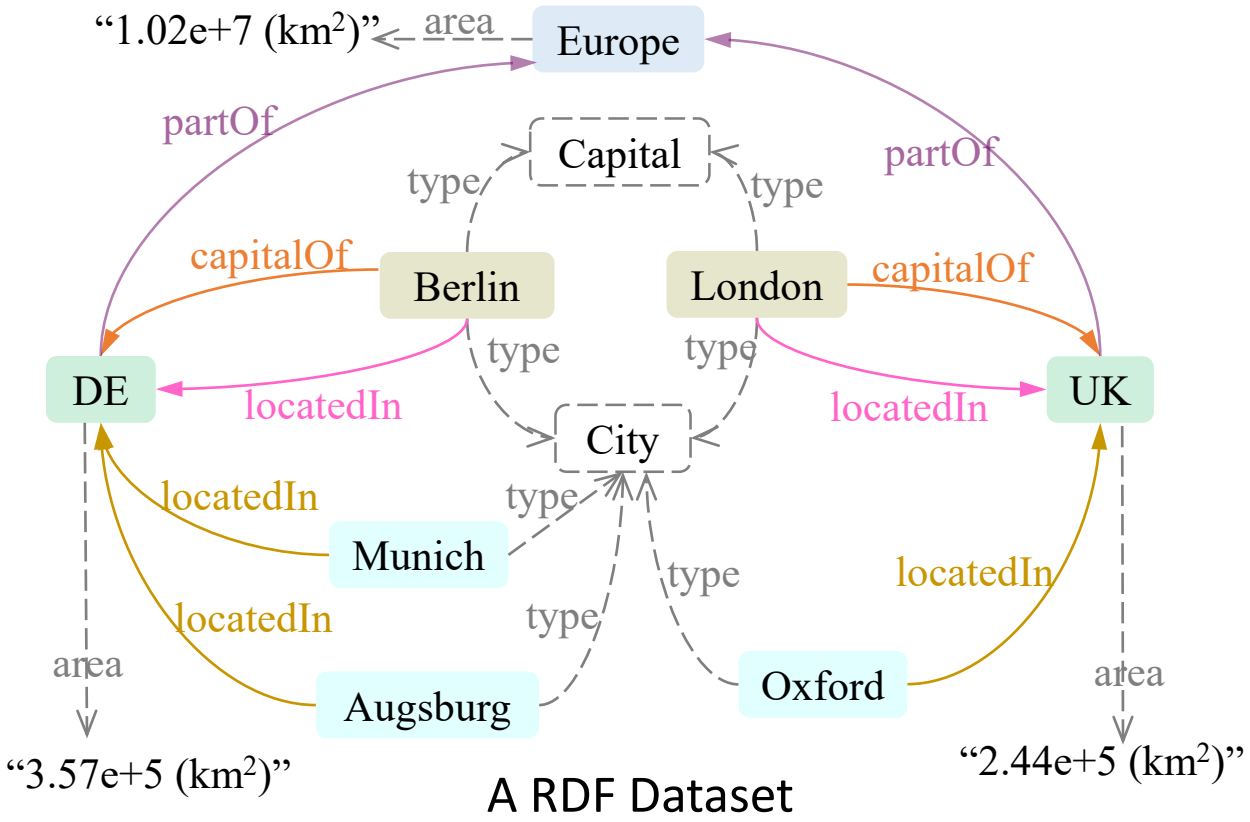


A snippet

Motivation and Contribution

Research Questions:

1. How to generate pattern-coverage snippets?
2. How to jointly consider all connected components?
3. How to be biased towards keyword queries?



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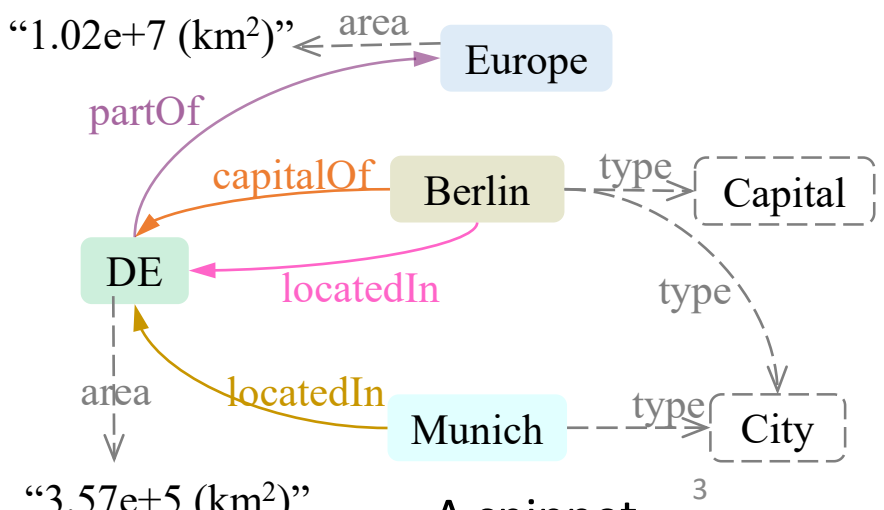

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- Alg. PCSG: merging Basic results among components
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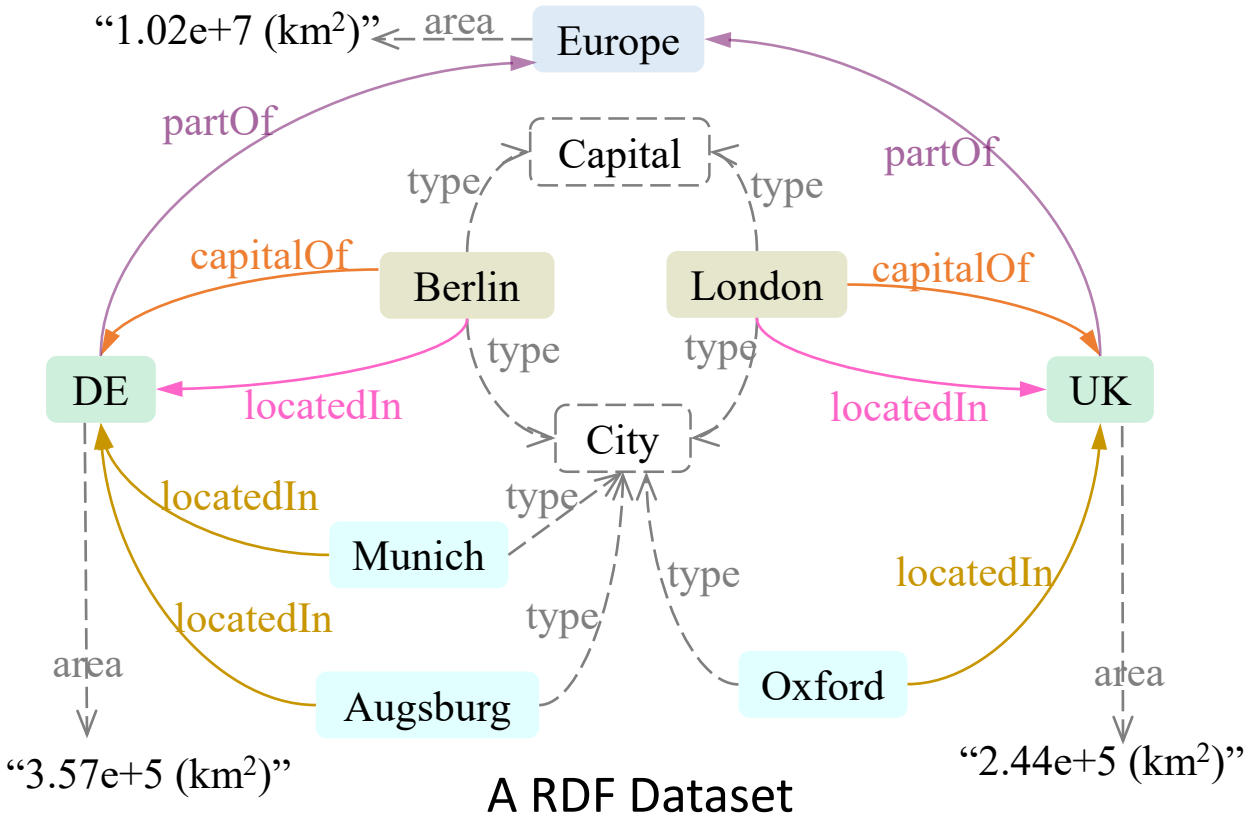

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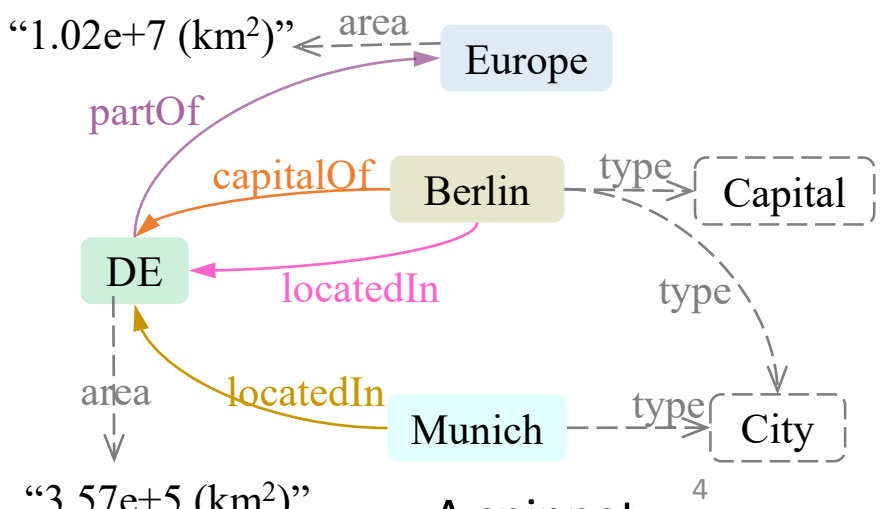
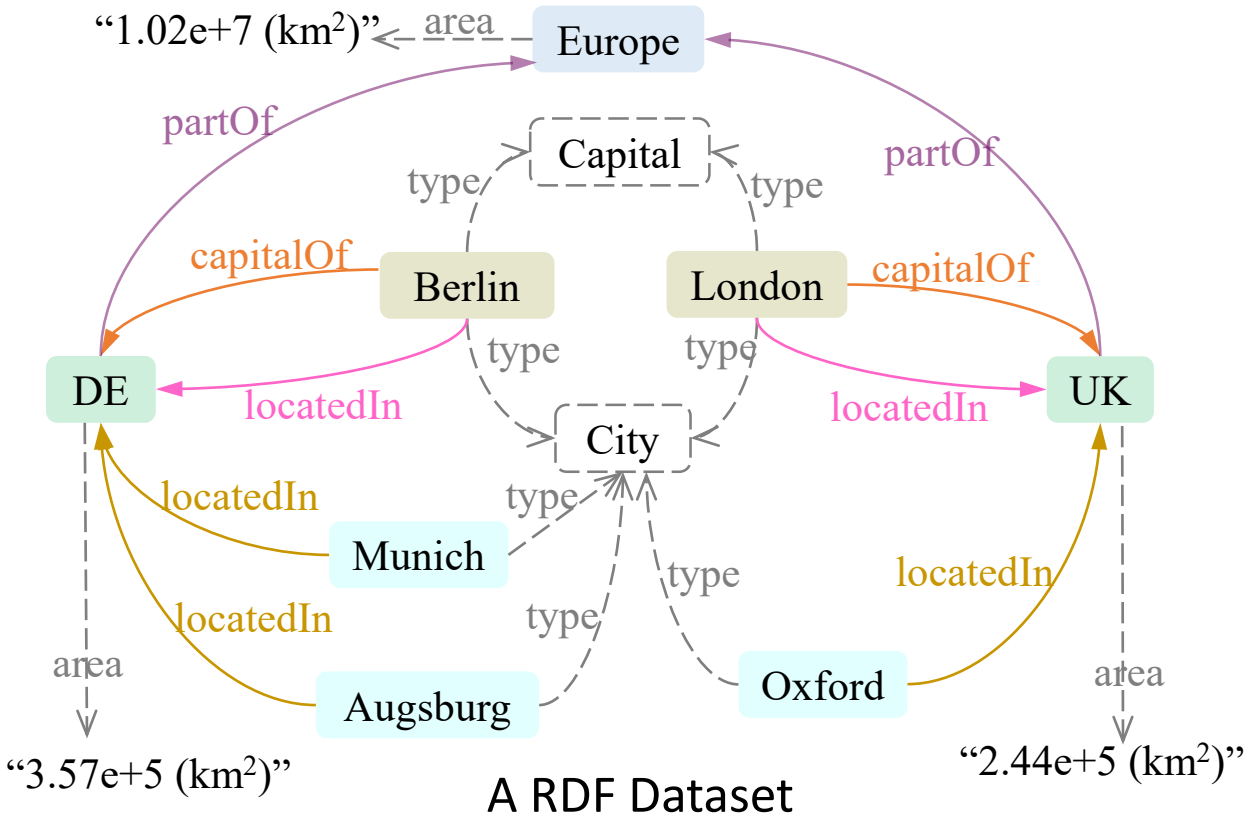


A snippet

Problem Formulation

Given a RDF dataset:



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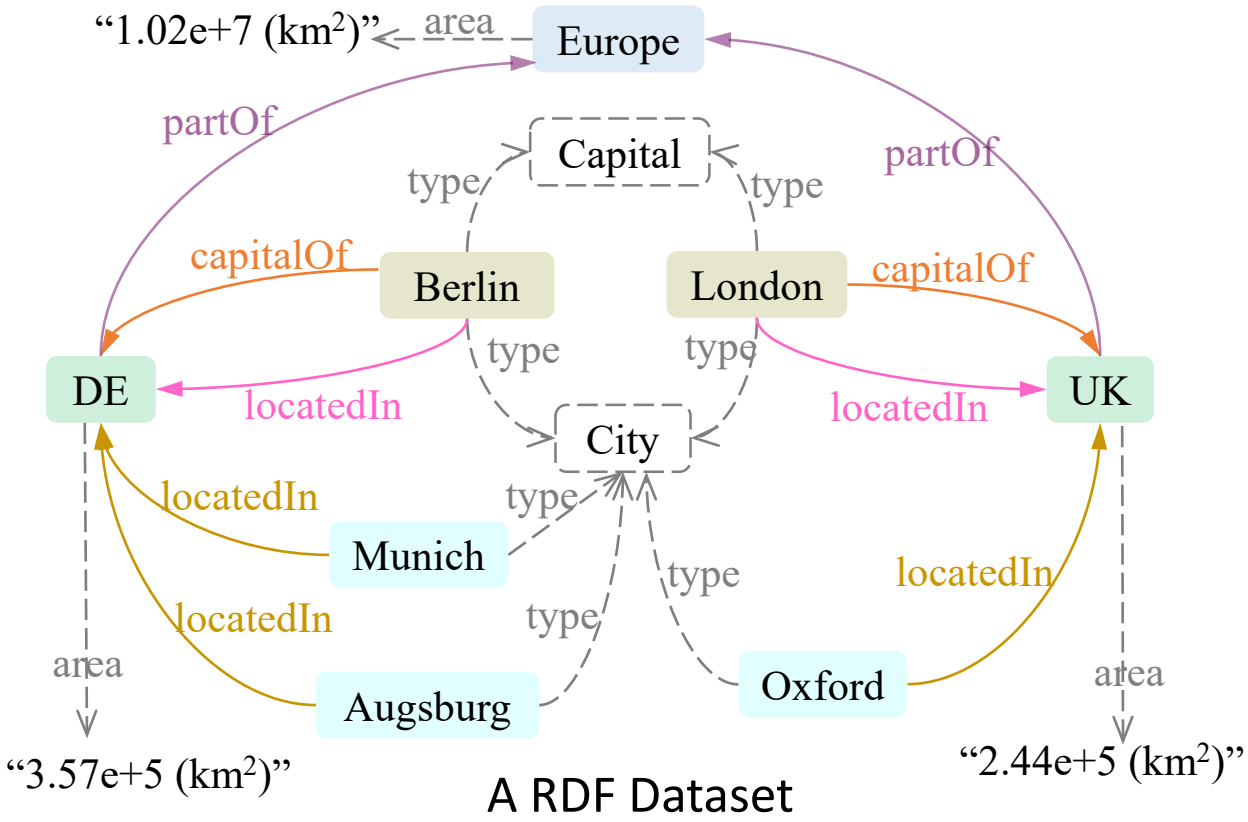
Given a RDF dataset:

- Entity Description Pattern (EDP): the set of classes, forward properties and backward properties



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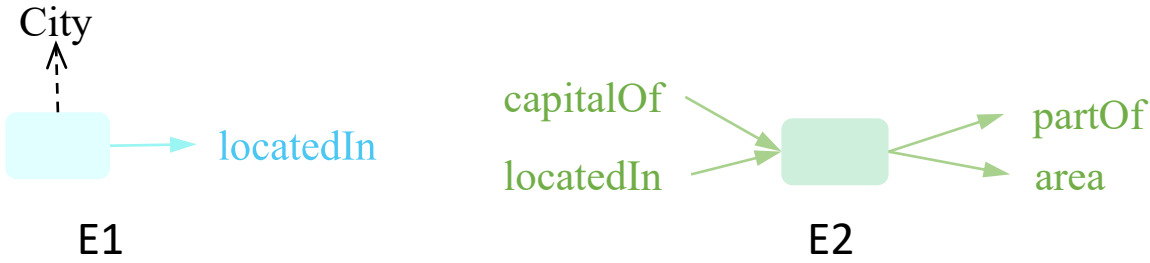

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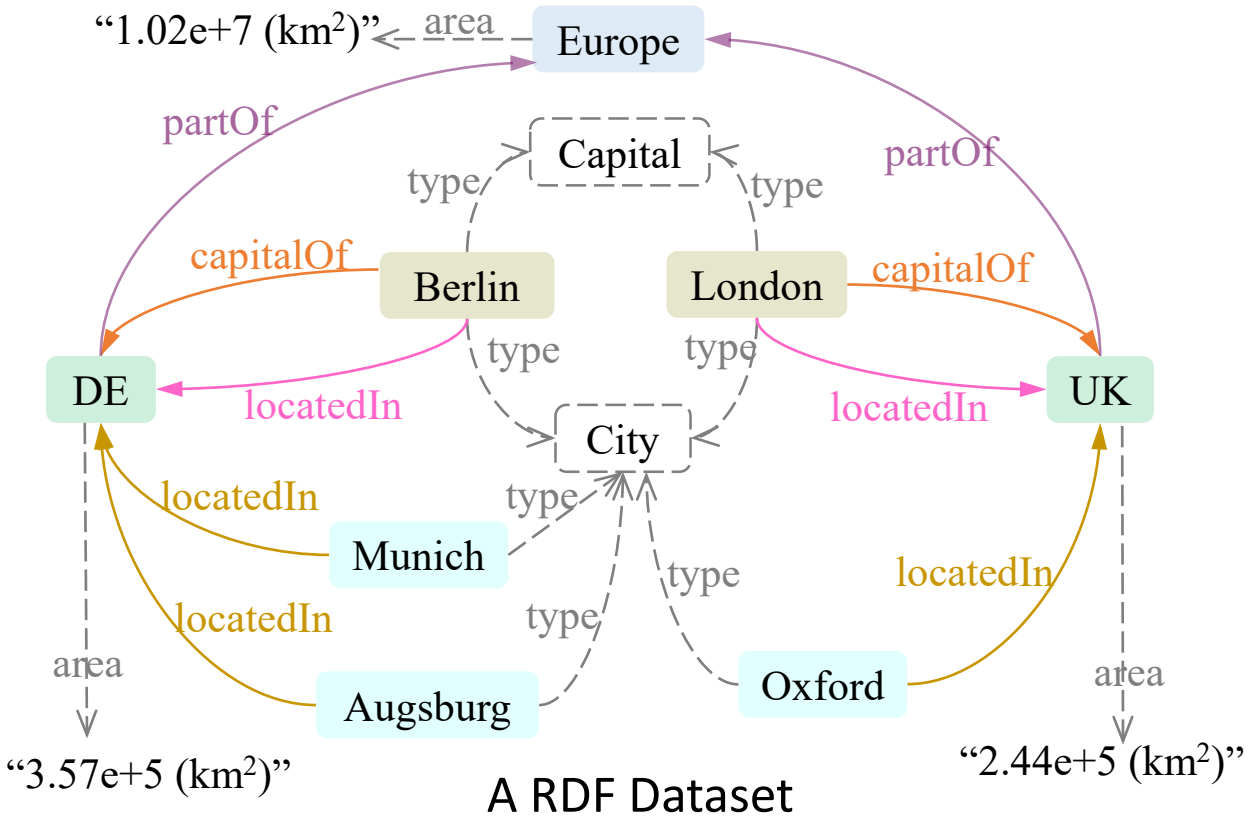
Given a RDF dataset:

- Entity Description Pattern (EDP): the set of classes, forward properties and backward properties
- Link Pattern (LP): the property and the two EDPs linked by it



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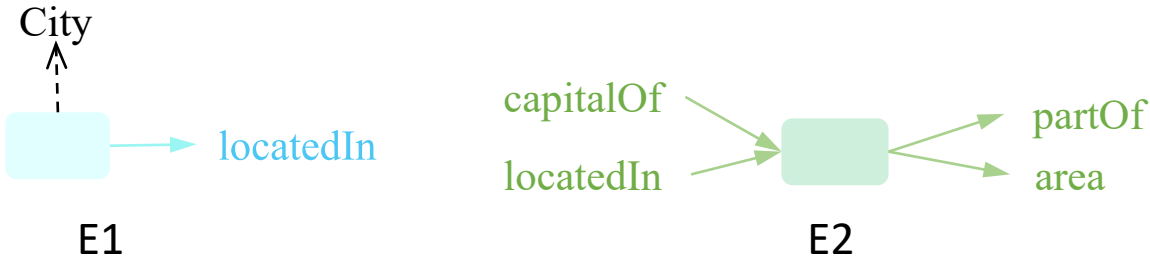

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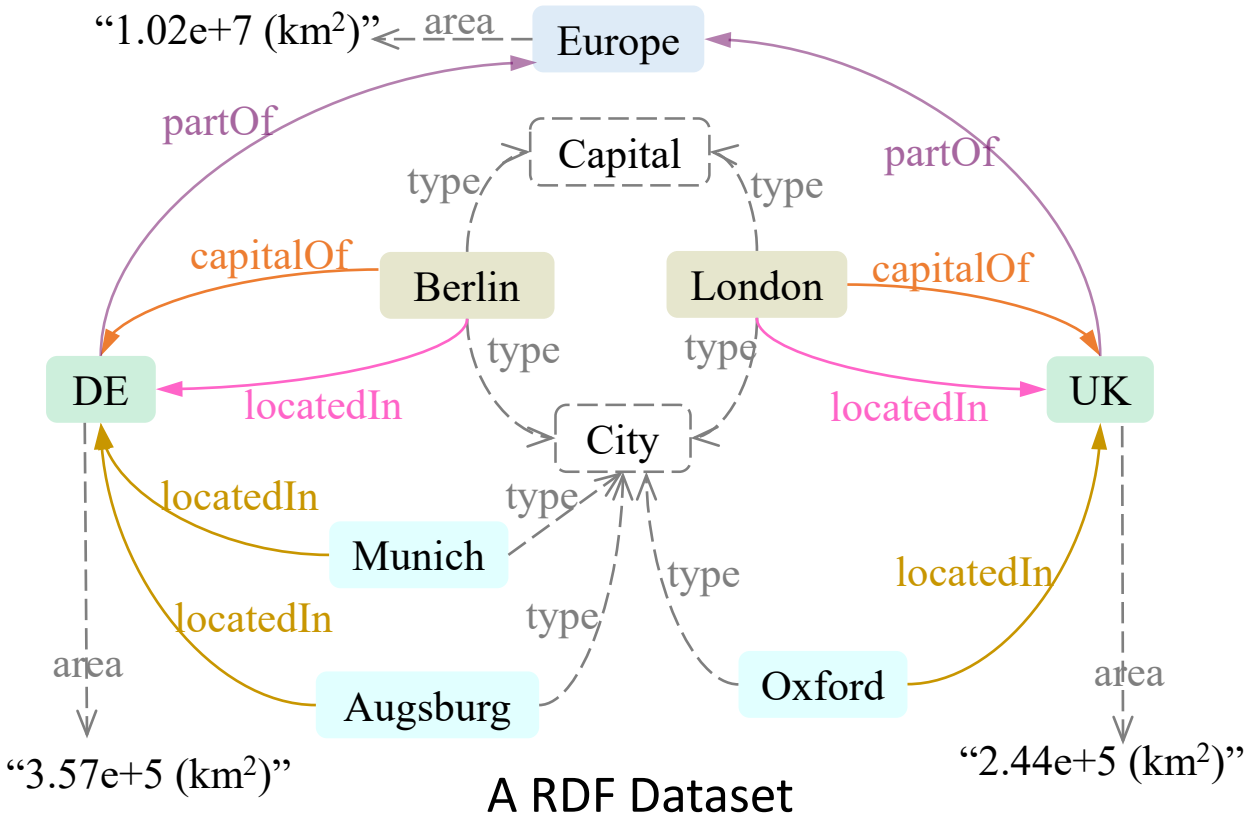

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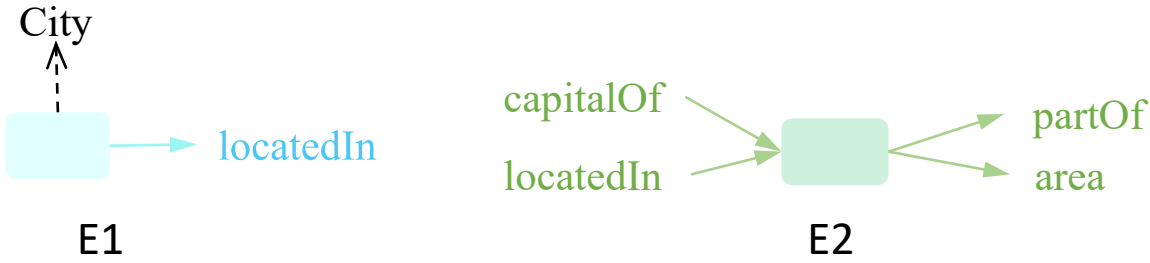

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Problem Formulation

Given a RDF dataset: ... as Input

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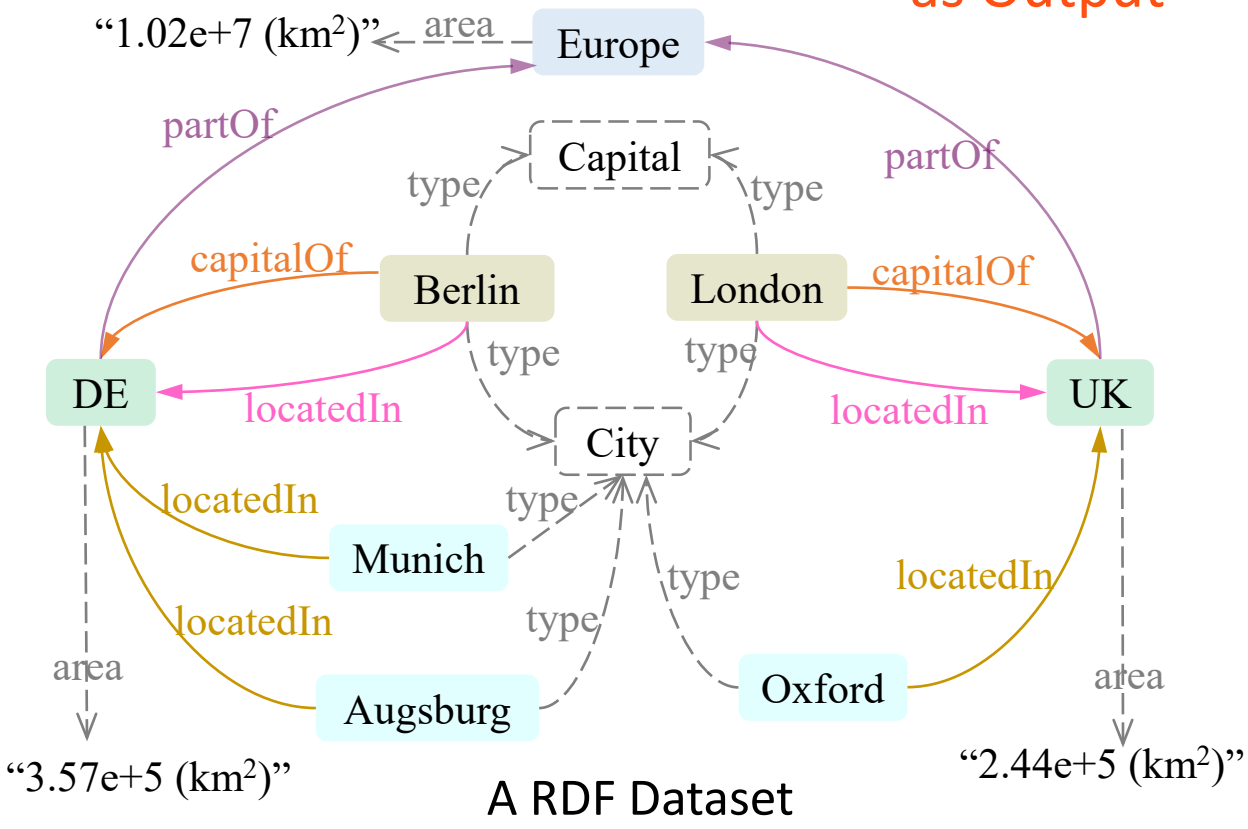

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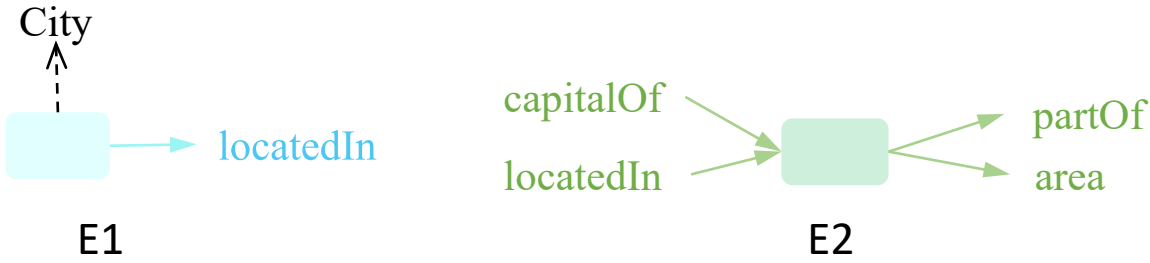
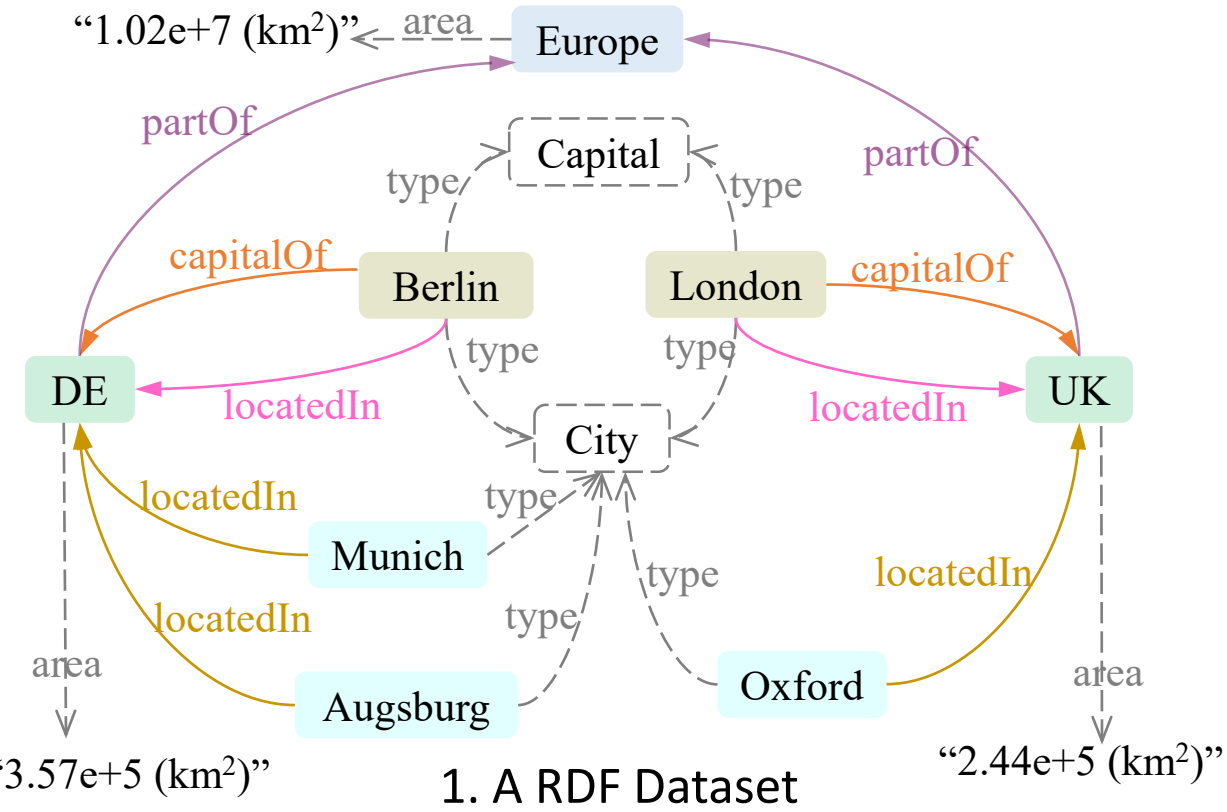


Link Pattern (LP)

Methods - Alg. Basic

For a connected RDF graph:

- Each entity is mapped to an EDP, each property (link of two entities) is mapped to a LP



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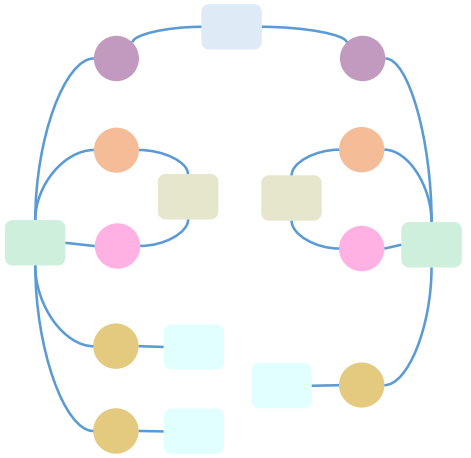

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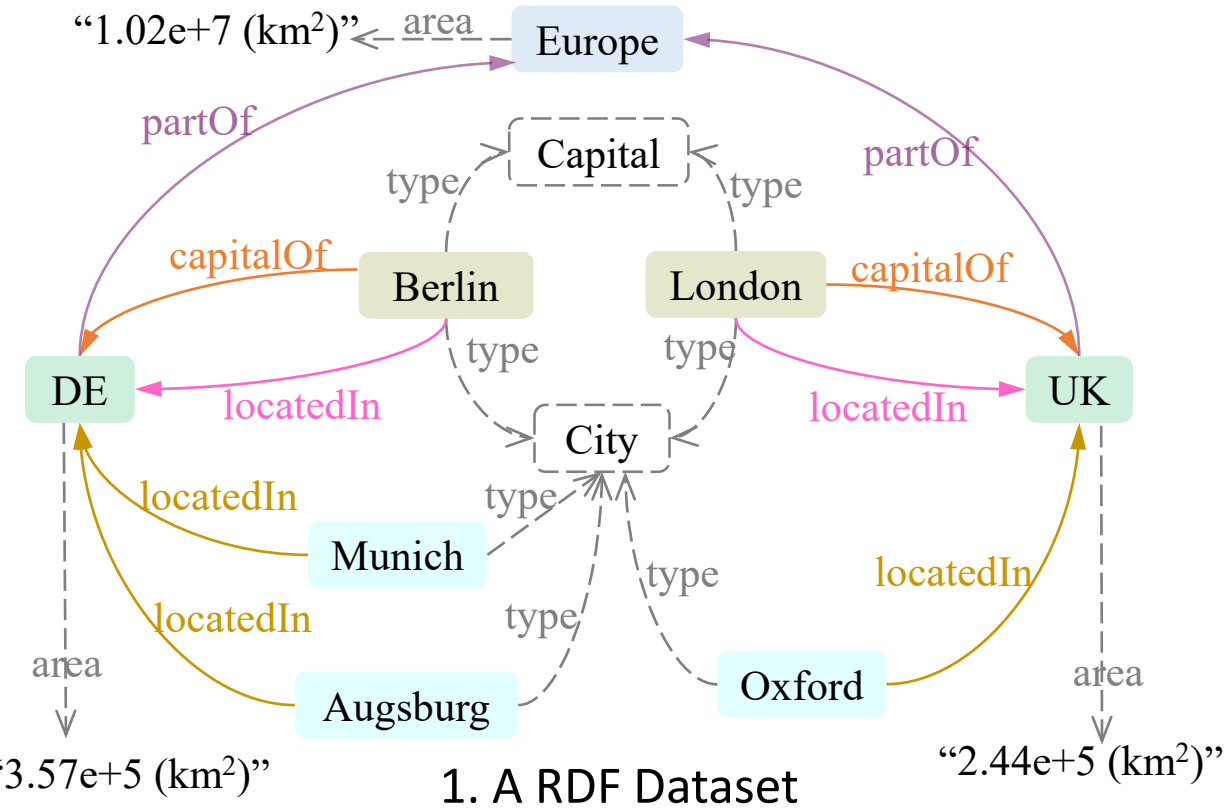
→ Using all EDPs and LPs as keys, to find a GST as snippet



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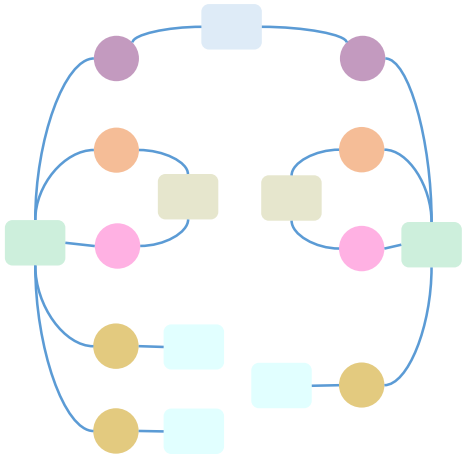

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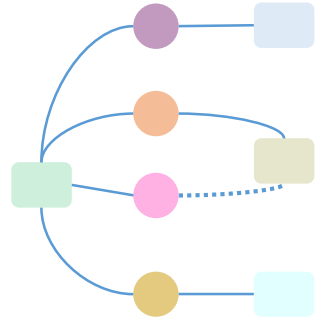

3. Group Steiner Tree

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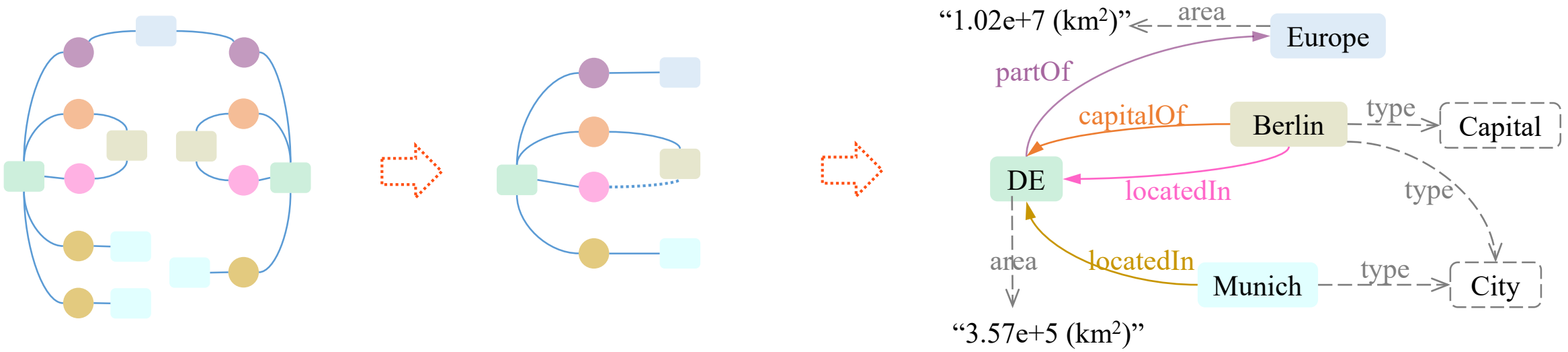

2. Entity-Link Graph

3. Group Steiner Tree

4. Pattern-Coverage Snippet

Methods - Alg. PCSG and Alg. QPCSG

Research Questions:

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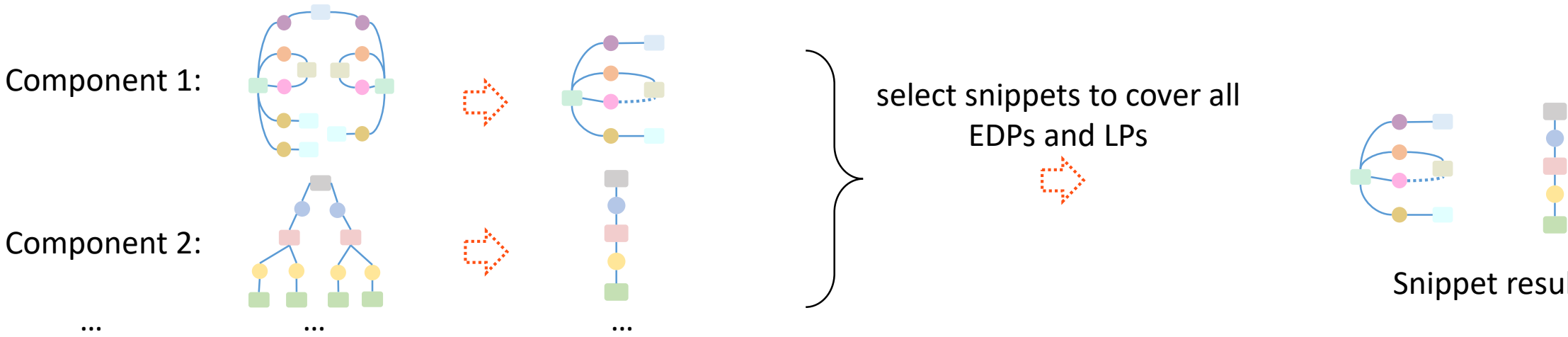
PCSG:

- Executing Basic on each connected component, then merge results as a Set Cover problem
- Extended to PCSG-τ for highly heterogeneous graphs as a relaxation to cover only frequent patterns



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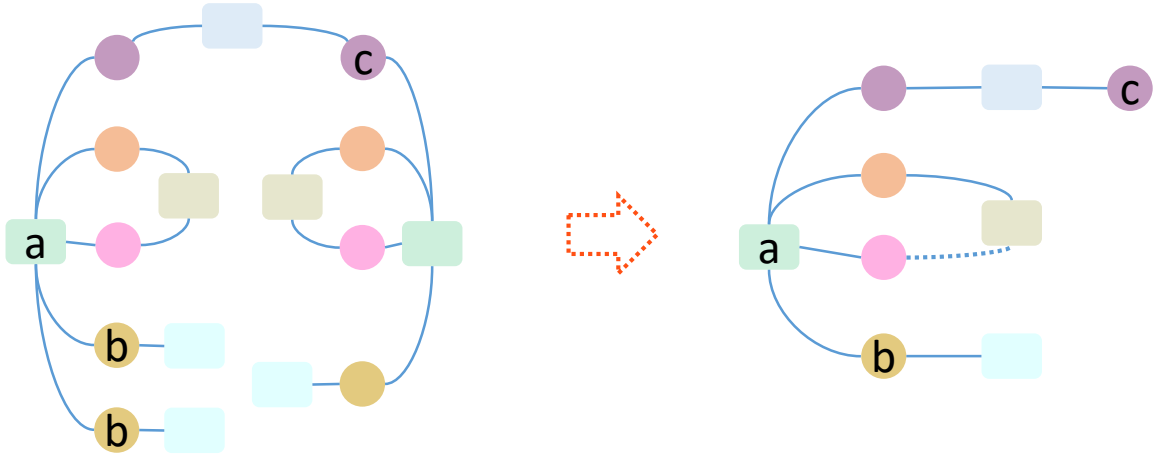
QPCSG:

- Apart from EDPs and LPs, also adding query keywords as keys in the Group Steiner Tree



e.g., Keywords: a, b, c

Snippet result

The result tree should not only cover all EDPs and LPs, but also all the keywords

Experiments

Datasets: 9,544 real-world RDF datasets from two open data portals

Portal	#RDF datasets	#triples		#classes		#properties		#EDPs		#LPs	
		Median	Max	Median	Max	Median	Max	Median	Max	Median	Max
DataHub.io	311	1,272	20,968,879	3	2,030	16	3,982	15	270,224	27	156,722
Data.gov	9,233	4,000	6,343,524	1	2	13	545	3	500	2	1,103
Overall	9,544	4,000	20,968,879	1	2,030	14	3,982	3	270,224	2	156,722

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Exp-1:

- Compare with SOTA snippet generation methods by automatic metrics

Exp-2:

- Compare with SOTA snippet generation methods by human ratings

Exp-3:

- Compare with RDF summaries in assisting human user with SPARQL query completion

Experiment - 1

Compare with SOTA snippets by automatic metrics:

- Baseline:

  IlluSnip extracts a connected snippet containing frequent classes, properties and central entities

Results:

- PCSG(-τ) achieved higher coverage rates, with shorter running time

Table 2: Schema coverage rates (mean ± SD).

	Class	Property	EDP	LP
PCSG	1.000 ± 0.000	1.000 ± 0.000	1.000 ± 0.000	1.000 ± 0.000
IlluSnip	0.993 ± 0.079	0.999 ± 0.011	0.822 ± 0.285	0.790 ± 0.320
PCSG-90%	0.999 ± 0.019	0.999 ± 0.006	0.981 ± 0.030	0.976 ± 0.035
IlluSnip-90%	0.991 ± 0.092	0.999 ± 0.013	0.794 ± 0.310	0.762 ± 0.344
PCSG-80%	0.999 ± 0.025	0.998 ± 0.010	0.957 ± 0.061	0.947 ± 0.071
IlluSnip-80%	0.982 ± 0.131	0.998 ± 0.017	0.784 ± 0.317	0.751 ± 0.353

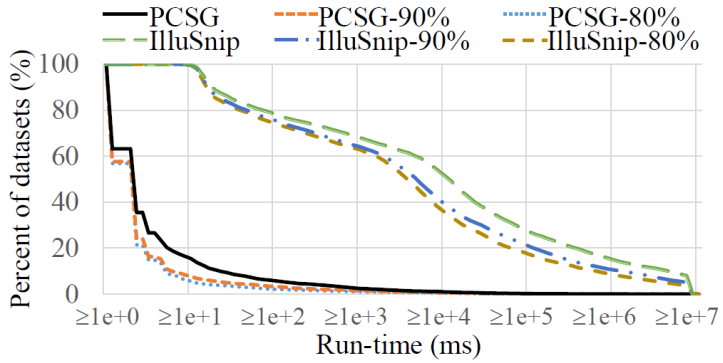


Fig. 6: Cum. distributions of run-time.

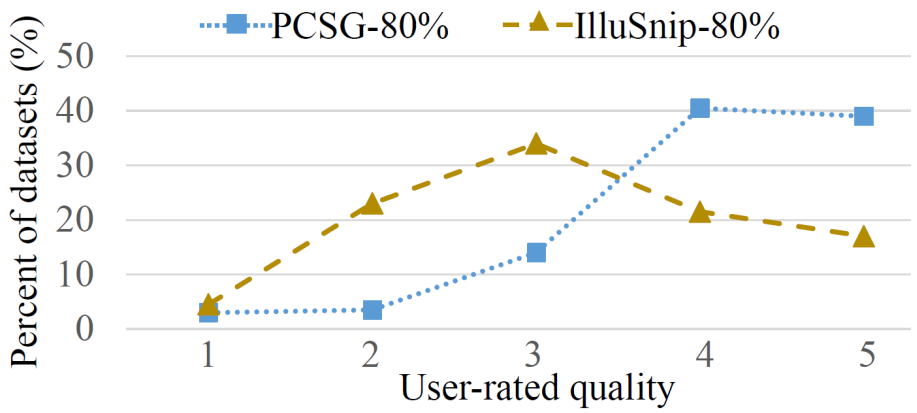
Experiment - 2

Compare PCSG with IlluSnip by human ratings:

- Randomly given a dataset with its metadata, classes, properties, EDPs and LPs
- Invite human users to rate two snippets on a 1 – 5 scale

Results:

- On 200 cases, PCSG got higher average score than IlluSnip



Experiment - 3

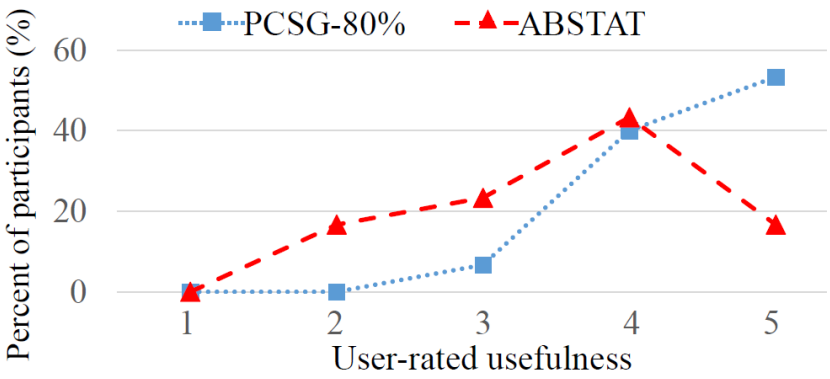
Compare PCSG with RDF Summary ABSTAT:

- ABSTAT: providing triple patterns as summary
- Task: Completing SPARQL query patterns assisted by the summary or snippet
- Dataset: DBpedia 2016-10

Results:

- With PCSG, users achieved higher accuracy in shorter time, giving higher rating of satisfaction

	Accuracy			Time (seconds)		
	Simple Task	Complex Task	Overall	Simple Task	Complex Task	Overall
PCSG-80%	0.900 ± 0.300	0.900 ± 0.300	0.900 ± 0.300	85.9 ± 39.0	164.0 ± 84.6	124.9 ± 76.6
ABSTAT	0.933 ± 0.249	0.833 ± 0.373	0.883 ± 0.321	117.6 ± 51.1	214.3 ± 154.1	166.0 ± 124.6



Conclusion

1. Presenting snippet generation methods PCSG and QPCSG
2. Demonstrating their effectiveness and timeliness
3. Receiving higher scores of user rating and comparison with summary method

In the future:

- Better visualization methods for snippets
- Comprehensive comparison between snippets and summaries

Thanks for your time!

Q & A

Contact: xxwang@smail.nju.edu.cn