Technische Universität Dresden

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Knowledge-Based Systems Group

Knowledge Graphs
Exercise Sheet 3: RDF and SPARQL

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Exercise 1

Consider a simple bipartite graph $G = \langle V, E \rangle$. Show that the following are equivalent:

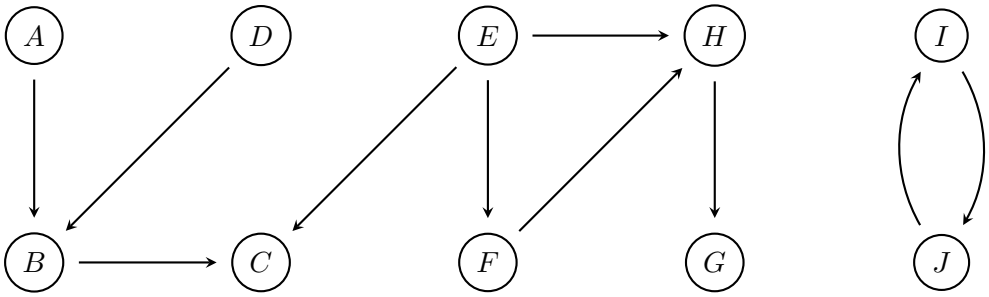
a) G has exactly two distinct 2-colourings

b) G is connected

Exercise 2

Let $G = \langle V, E \rangle$ be a directed graph. For two vertices $v, w \in V$, the *distance* $d(v, w)$ is the length of the shortest directed path from v to w (or ∞ if there is no such path). For a set $S \subseteq V$ of vertices, the *reachable set* is $R(S) \coloneqq \{\, v \in V \mid \exists w \in S.\ d(w, v) < \infty \,\}$. A *point base* of G is a minimal set $B \subseteq V$ such that $R(B) = V$.

Find a point base for the following graph. How does the point base change when adding the edge $\langle B, E \rangle$?



Exercise 3

Write a SPARQL query that counts the number of directed triangles along `eg:edge` edges. Which answer do you expect on the following graph?

```
_:1 eg:edge _:1, _:2, _:3, _:4 .
_:2 eg:edge _:1, _:3 .
_:3 eg:edge _:1, _:2 .
_:4 eg:edge _:1, _:4 .
```

Exercise 4

Consider the following graph.

```
eg:Arrival          eg:actorRole  eg:aux1, eg:aux2 ;
                    eg:director   "Denis Villeneuve" .
eg:aux1             eg:actor      eg:Adams ;
                    eg:character  "Louise Banks" .
eg:aux2             eg:actor      eg:Renner ;
                    eg:character  "Ian Donnelly" .
eg:Gravity          eg:actorRole  [ eg:actor eg:Bullock;
                                    eg:character "Ryan Stone" ] ;
                    eg:actorRole  [ eg:actor eg:Clooney;
                                    eg:character "Matt Kowalski" ] ;
                    eg:director   "Alfonso Cuarón" .
eg:AmericanHustle   eg:actorRole  eg:aux3, eg:aux4 ;
                    eg:director   "David Russell" .
eg:aux3             eg:actor      eg:Adams ;
                    eg:character  "Sydney Prosser" .
eg:aux4             eg:actor      eg:Renner ;
                    eg:character  "Carmine Polito" .
```

Write a SPARQL query that finds all pairs of actors that have co-starred in (at least) two movies. Which results do you expect?

Exercise 5

Write a program that reads a graph in N-Triples format and checks whether the graph is bipartite. Use it to decide whether `authorship.nt.gz`[1] and `coauthors.nt.gz`[1] are bipartite.

Hint: each of the uncompressed graphs is roughly 4 GiB in size. In Python, you can use `gzip.GzipFile`[2] to process the compressed file without decompressing it first. There is also `authorship-snippet.nt.gz`[1], a small part of the graph that you can use during development.

Please note: In order to get the correct data files, please install git-lfs[3] on your system, and then activate it in your local repository (git lfs install).

[1] https://github.com/knowsys/Course-Knowledge-Graphs/tree/main/data/dblp
[2] https://docs.python.org/3/library/gzip.html
[3] https://git-lfs.github.com/

Exercise 6

The bibliographic database DBLP[4] offers individual data records as RDF in N-Triples format. This data can be downloaded from the URL obtained by appending `.nt` to the URI. Use this interface to find all publications that have https://dblp.org/pid/s/RudiStuder.html as their only author.

- Download some RDF files in your browser to find out how this information is encoded.
- Write a program that crawls a small part of the data to answer the query.

Note: If your program sends too many requests in a short time, the server will deny the request and cancel the connection. Dirty trick: use `time.sleep(1)` before executing a request.

Hint: `requests`[5] provides a high-level API for making HTTP requests in Python, but you may need to install it, e.g., using `pip`.[6] A built-in alternative that provides a lower-level interface is `urllib.requests`.[7]

[4] https://dblp.org
[5] https://requests.readthedocs.io/en/latest/
[6] https://pypi.org/project/pip/
[7] https://docs.python.org/3/library/urllib.request.html