Exercise Sheet 2: Resource Description Framework
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Exercise 2.1. A *bipartite graph* is a simple graph $G = \langle V, E \rangle$, where V can be partitioned into two sets X, Y (i.e., $X \cup Y = V$, and $X \cap Y = \varnothing$), such that every edge $\{a, b\} \in E$ coincides with both X and Y, i.e., $\{a, b\} \cap X \neq \varnothing$ and $\{a, b\} \cap Y \neq \varnothing$.

Show that the following are equivalent:

1. $G = \langle V, E \rangle$ is bipartite.

2. G is *2-colourable*, i.e., there is a map $c : V \to \{0, 1\}$ such that no two adjacent vertices a, b have the same colour, i.e., $c(a) \neq c(b)$ for all $\{a, b\} \in E$.

3. G does not contain a cycle $v_1 \xrightarrow{e_1} v_2 \xrightarrow{e_2} \cdots \xrightarrow{e_{n-1}} v_n \xrightarrow{e_n} v_1$ of odd length.

Exercise 2.2. Write a program that reads a graph in N-Triples format and checks whether the graph is bipartite. Use this program 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.

Exercise 2.3. From the `coauthors.nt.gz` graph[1], extract the *connected component* containing <http://dblp.uni-trier.de/pers/s/Studer:Rudi>, i.e, extract the induced subgraph that

- contains <http://dblp.uni-trier.de/pers/s/Studer:Rudi>,

- contains all nodes reachable from <http://dblp.uni-trier.de/pers/s/Studer:Rudi> by some path, and

- contains all edges that are present in the full graph between these nodes.

Hint: `authorship-snippet.nt.gz`[1] contains <http://dblp.uni-trier.de/pers/s/Studer:Rudi> and can be used for testing during development.

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