Exercise 5.1. Use the Wikidata query service (WDQS) \(^1\) to find all people that have returned from two spaceflights operated by organisations from different countries and the amount of time they have spent in space. You can expect Q255764 (“Yelena Kondakova”) in the results.

**Hint:** For all the exercises using the WDQS, you can use the SQID \(^2\) to explore the schema.

Exercise 5.2. Use WDQS to find all people that have received more than one Nobel Prize. Does your query find all four persons that have won two Nobel prizes? Why/Why not?

Exercise 5.3. An instance of 4 × 4-Sudoku is a partially-filled table as illustrated below. The goal is to fill the remaining cells with values 1, 2, 3, and 4 such that no value occurs twice in a row, in a column, or in one of the four 2 × 2 blocks.

\[
\begin{array}{cccc}
1 & & & \\
2 & & & \\
& & & \\
4 & & & 3 \\
\end{array}
\]

Use SPARQL to solve this problem: find a query that returns all admissible ways of filling the grid as its answers.

1. First, define a suitable SPARQL query and underlying RDF graph to solve the problem.
2. Then show that your query can be modified to work using WDQS over the RDF data of this system.

Exercise 5.4. A \(k\)-clique in a simple graph \(G = \langle V, E \rangle\) is a set \( C = \{v_1, v_2, \ldots, v_k\} \) of \(k\) vertices, where any two vertices \(v, w \in C\) are adjacent, i.e., \(\{v, w\} \mid v, w \in C\} \subseteq E\). Recall that a simple path from vertex \(s\) to vertex \(t\) is a sequence of vertices \(p_0, p_1, \ldots, p_\ell\) with \(\ell > 0\) and \(s = p_0 \xrightarrow{e_1} p_1 \xrightarrow{e_2} \cdots \xrightarrow{e_\ell} p_\ell = t\) such that if \(p_i = p_j\) for some \(i \neq j\), then \(\{i, j\} = \{0, \ell\}\).

Compute the function \(f : \mathbb{N} \to \mathbb{N}\) that maps a number \(k\) to the number of distinct simple paths \(f(k)\) in a \(k\)-clique. What is \(f(5)\)?

Exercise 5.5. Use the WDQS to check for the existence of a 5-clique in the P3373 (“sibling”) property.

Exercise 5.6. Use the WDQS to compute the top 25 universities that employed the most professors that have been educated at the same university (Q16188175 (“Ingerid Dal”) is one such professor).

\(^1\)https://query.wikidata.org
\(^2\)https://tools.wmflabs.org/sqid/
Exercise 5.7. Use the WDQS to compute the top 10 musical instruments played by people who are composers by occupation or have composed something (Q1339 (“Johann Sebastian Bach”) is a good starting point to explore the schema).

Exercise 5.8. Use the WDQS to compute the top 30 composers with the most musical works whose English label is longer than the average English label of musical works.

Exercise 5.9. Use the WDQS to compute the top 15 bands and musicians by the number of bands and musicians they have influenced (you can expect both Q1299 (“The Beatles”) and Q5928 (“Jimi Hendrix”) to be among the results).

Exercise 5.10. Use the WDQS to compute for every sovereign state (Q3624078), the music genre(s) with the most bands or musicians from this state.