

## Interactive / complex / 1

|           |   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
|-----------|---|------------------------------------|---|---|--|---|--------------------|----|---|---|----------------------|----------------------|--------|---|----------------|---|--------------------|----------------|---|--|---|----------------------|------|---|--|---|--------------------------|----------|---|--|---|--------------------|--------|---|--|---|-------------------------|--------|---|--|---|------------------------|--------|---|--|---|-------------------|---------------|---|--|----|--------------------|----------|---|--|----|-------------------|--------|---|--|----|--------------|------------------------------------|---|---|----|-----------|------------------------------------|---|--|
| query     | Interactive / complex / 1   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| title     | Transitive friends with certain name  |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| pattern   | <pre>graph LR     P1[person: Person<br/>id = \$personId] -- knows*1..3 --&gt; P2[otherPerson: Person<br/>firstName = \$firstName<br/>id<br/>lastName<br/>birthday<br/>creationDate<br/>gender<br/>browserUsed<br/>locationIP<br/>email<br/>speaks]     P2 -- isLocatedIn --&gt; LC[locationCity: City<br/>name]     P2 -- «opt» workAt --&gt; C[company: Company<br/>name]     P2 -- «opt» studyAt --&gt; U[university: University<br/>name]     C -- isLocatedIn --&gt; CC[companyCountry: Country<br/>name]     U -- isLocatedIn --&gt; UC[universityCity: City<br/>name]</pre>   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| desc.     | Given a start Person, find Persons with a given first name (firstName) that the start Person is connected to (excluding start Person) by at most 3 steps via the knows relationships. Return Persons, including the distance (1..3), summaries of the Persons workplaces and places of study.   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| params    | <table><tr><td>1</td><td>personId</td><td>ID</td><td></td></tr><tr><td>2</td><td>firstName</td><td>String</td><td></td></tr></table>  |                                    |   |   |  | 1 | personId           | ID |   | 2 | firstName            | String               |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 1         | personId  | ID                                 |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 2         | firstName   | String                             |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| result    | <table><tr><td>1</td><td>otherPerson.id</td><td>ID</td><td>R</td><td></td></tr><tr><td>2</td><td>otherPerson.lastName</td><td>String</td><td>R</td><td></td></tr><tr><td>3</td><td>distanceFromPerson</td><td>32-bit Integer</td><td>C</td><td></td></tr><tr><td>4</td><td>otherPerson.birthday</td><td>Date</td><td>R</td><td></td></tr><tr><td>5</td><td>otherPerson.creationDate</td><td>DateTime</td><td>R</td><td></td></tr><tr><td>6</td><td>otherPerson.gender</td><td>String</td><td>R</td><td></td></tr><tr><td>7</td><td>otherPerson.browserUsed</td><td>String</td><td>R</td><td></td></tr><tr><td>8</td><td>otherPerson.locationIP</td><td>String</td><td>R</td><td></td></tr><tr><td>9</td><td>otherPerson.email</td><td>{Long String}</td><td>R</td><td></td></tr><tr><td>10</td><td>otherPerson.speaks</td><td>{String}</td><td>R</td><td></td></tr><tr><td>11</td><td>locationCity.name</td><td>String</td><td>R</td><td></td></tr><tr><td>12</td><td>universities</td><td>{&lt;String, 32-bit Integer, String&gt;}</td><td>A</td><td>{&lt;university.name, studyAt.classYear, universityCity.name&gt;}</td></tr><tr><td>13</td><td>companies</td><td>{&lt;String, 32-bit Integer, String&gt;}</td><td>A</td><td>{&lt;company.name, workAt.workFrom, companyCountry.name&gt;}</td></tr></table> |                                    |   |   |  | 1 | otherPerson.id     | ID | R |   | 2                    | otherPerson.lastName | String | R |                | 3 | distanceFromPerson | 32-bit Integer | C |  | 4 | otherPerson.birthday | Date | R |  | 5 | otherPerson.creationDate | DateTime | R |  | 6 | otherPerson.gender | String | R |  | 7 | otherPerson.browserUsed | String | R |  | 8 | otherPerson.locationIP | String | R |  | 9 | otherPerson.email | {Long String} | R |  | 10 | otherPerson.speaks | {String} | R |  | 11 | locationCity.name | String | R |  | 12 | universities | {<String, 32-bit Integer, String>} | A | {<university.name, studyAt.classYear, universityCity.name>} | 13 | companies | {<String, 32-bit Integer, String>} | A | {<company.name, workAt.workFrom, companyCountry.name>} |
| 1         | otherPerson.id  | ID                                 | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 2         | otherPerson.lastName  | String                             | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 3         | distanceFromPerson  | 32-bit Integer                     | C |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 4         | otherPerson.birthday  | Date                               | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 5         | otherPerson.creationDate  | DateTime                           | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 6         | otherPerson.gender  | String                             | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 7         | otherPerson.browserUsed   | String                             | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 8         | otherPerson.locationIP  | String                             | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 9         | otherPerson.email   | {Long String}                      | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 10        | otherPerson.speaks  | {String}                           | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 11        | locationCity.name   | String                             | R |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 12        | universities  | {<String, 32-bit Integer, String>} | A | {<university.name, studyAt.classYear, universityCity.name>} |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 13        | companies   | {<String, 32-bit Integer, String>} | A | {<company.name, workAt.workFrom, companyCountry.name>}      |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| sort      | <table><tr><td>1</td><td>distanceFromPerson</td><td>↑</td><td></td></tr><tr><td>2</td><td>otherPerson.lastName</td><td>↑</td><td></td></tr><tr><td>3</td><td>otherPerson.id</td><td>↑</td><td></td></tr></table>  |                                    |   |   |  | 1 | distanceFromPerson | ↑  |   | 2 | otherPerson.lastName | ↑                    |        | 3 | otherPerson.id | ↑ |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 1         | distanceFromPerson  | ↑                                  |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 2         | otherPerson.lastName  | ↑                                  |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| 3         | otherPerson.id  | ↑                                  |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| limit     | 20  |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| CPs       | 2.1, 5.3, 8.2   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |
| relevance | This query is a representative of a simple navigational query. It looks for paths of length 1..3 through the knows relation, starting from a given Person and ending at a Person with a given first name. It is interesting for several aspects. (1) It requires for a complex aggregation for returning the concatenation of universities, companies, languages and email information of the Person. (2) It tests the ability of the optimizer to move the evaluation of sub-queries functionally dependant on the Person, after the evaluation of the top-k. (3) Its performance is highly sensitive to properly estimating the cardinalities in each transitive path, and paying attention not to explore already visited Persons.   |                                    |   |   |  |   |                    |    |   |   |                      |                      |        |   |                |   |                    |                |   |  |   |                      |      |   |  |   |                          |          |   |  |   |                    |        |   |  |   |                         |        |   |  |   |                        |        |   |  |   |                   |               |   |  |    |                    |          |   |  |    |                   |        |   |  |    |              |                                    |   |   |    |           |                                    |   |  |