

Introduction to Knowledge Graphs and Semantic Web Technologies

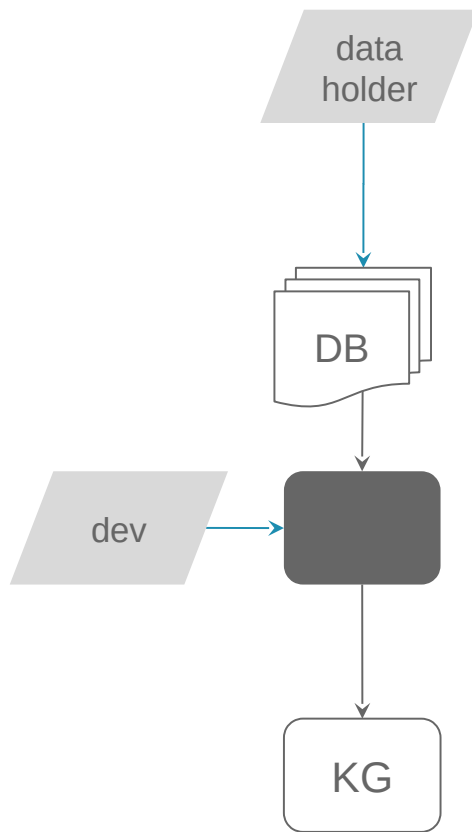
Mappings-based Knowledge Graph Construction

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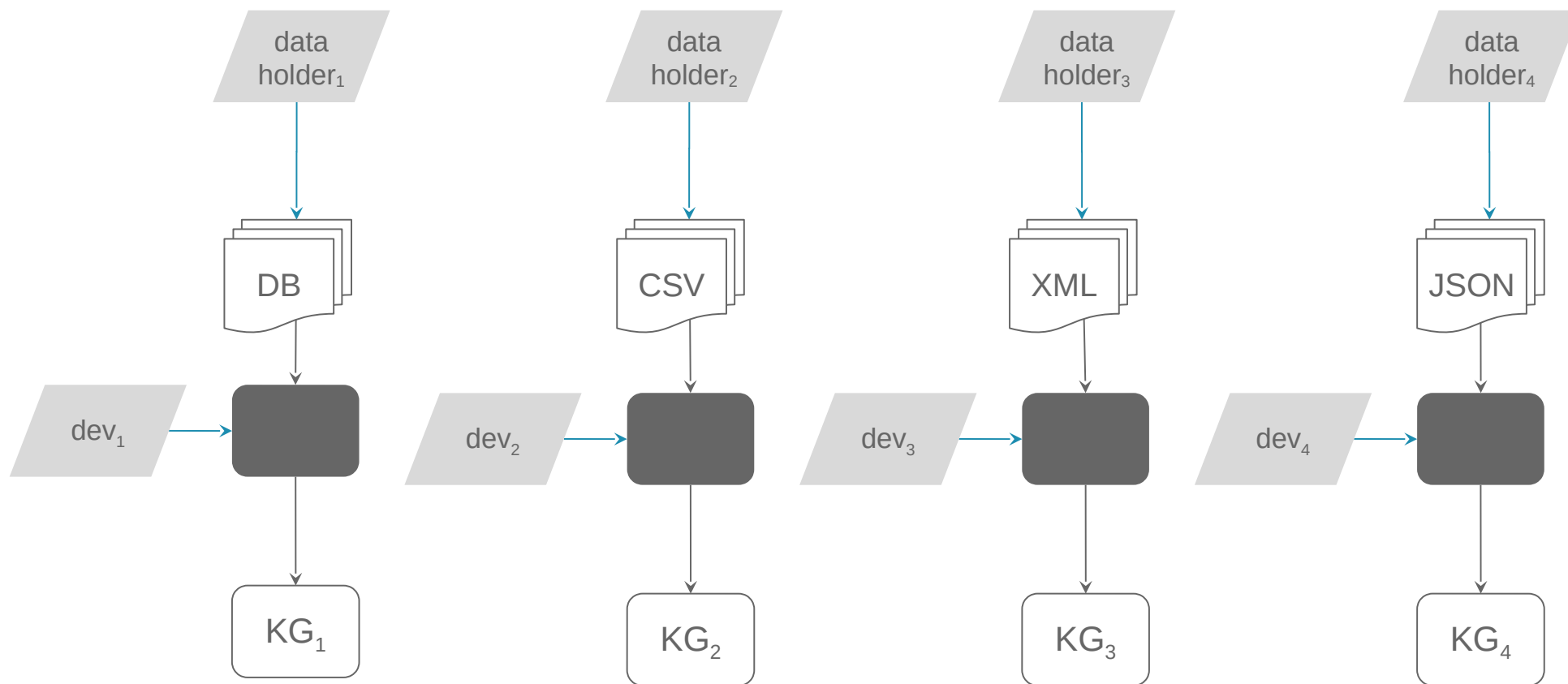
Acknowledgement: Many slides in this slide set are adaptations of slides of Anastasia Dimou (KU Leuven, Belgium)

Custom Dedicated Script for a Data Owner



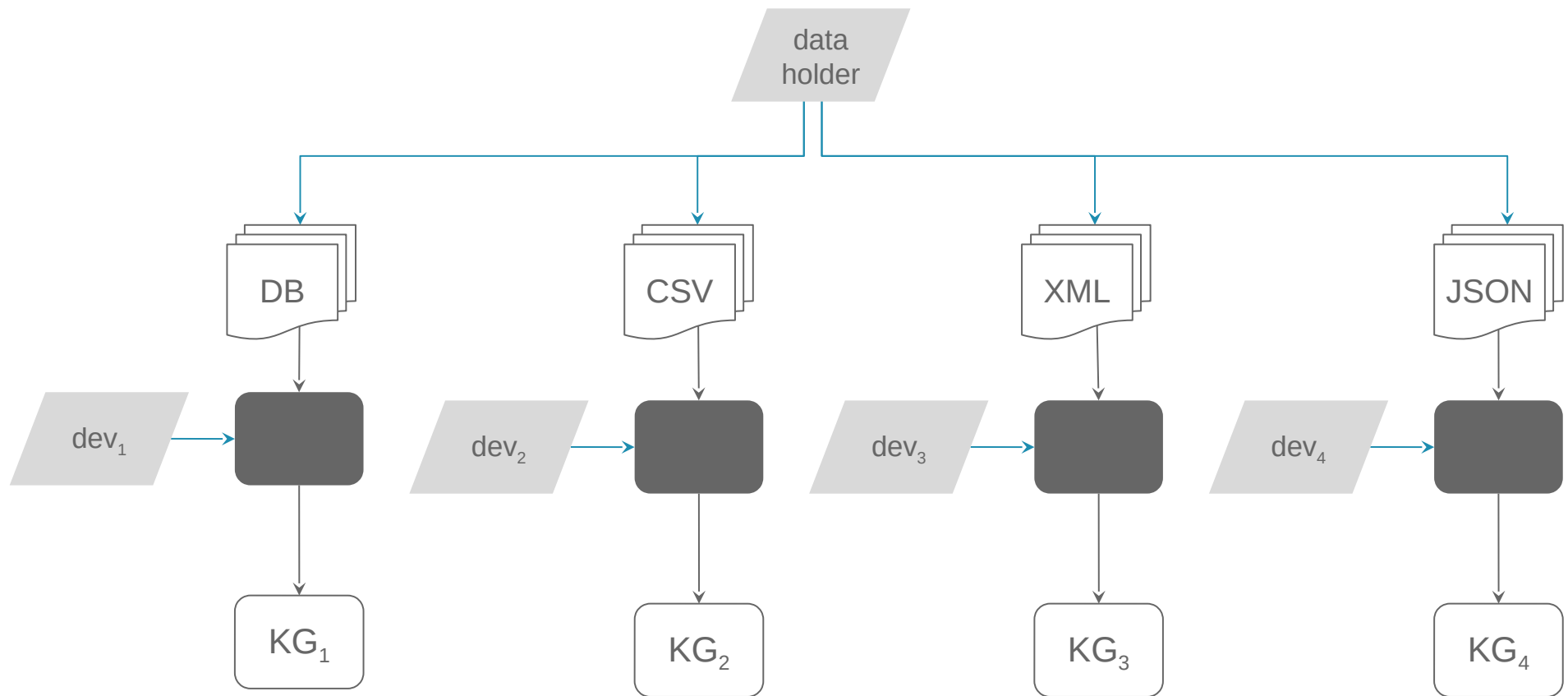
x New development cycle every time a modification is needed

Dedicated Tool for Certain Formats



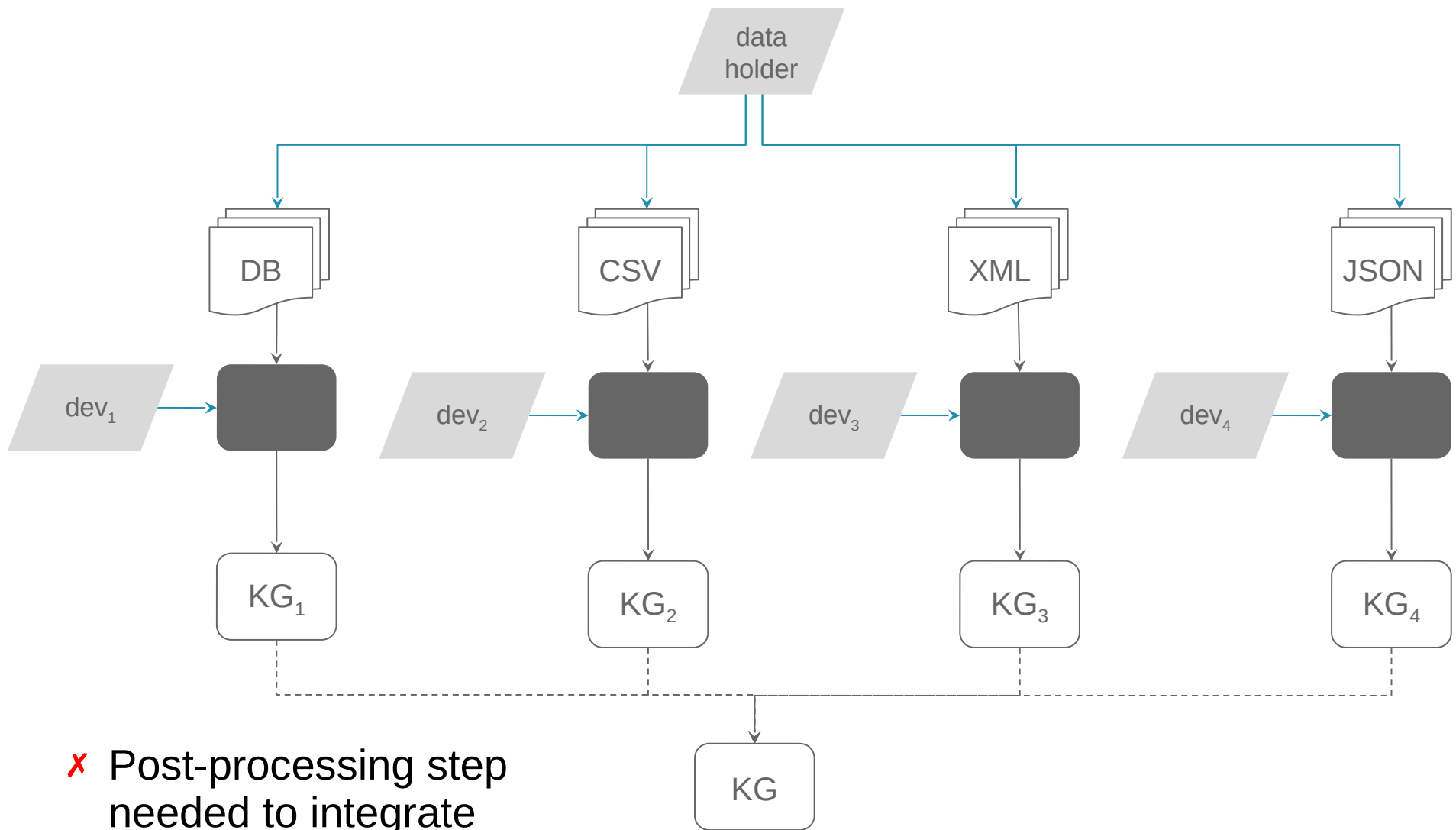
✓ Great solution if a data owner has data only in a certain format

Dedicated Tool for Certain Formats (cont'd)

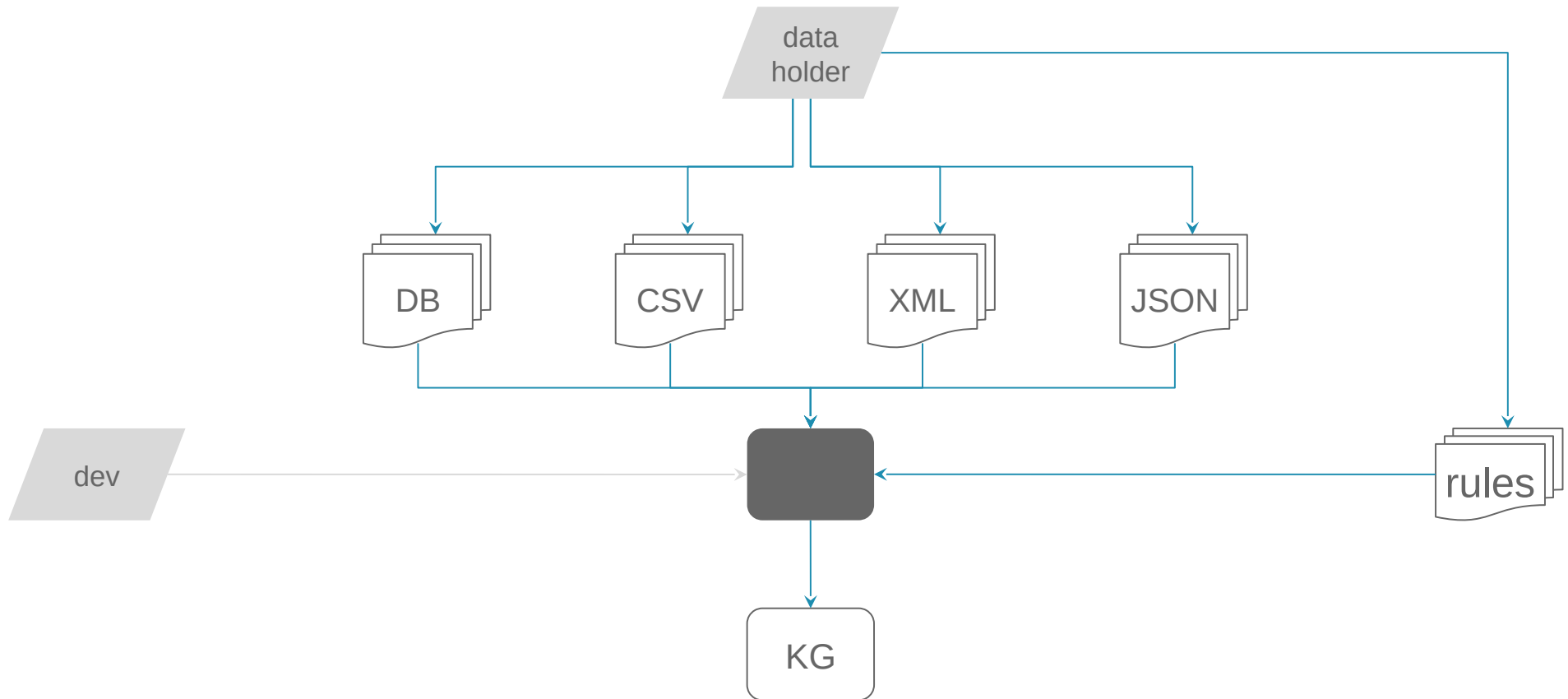


x Learn and maintain multiple tools if the data owner has data in different formats

Dedicated Tool for Certain Formats (cont'd)

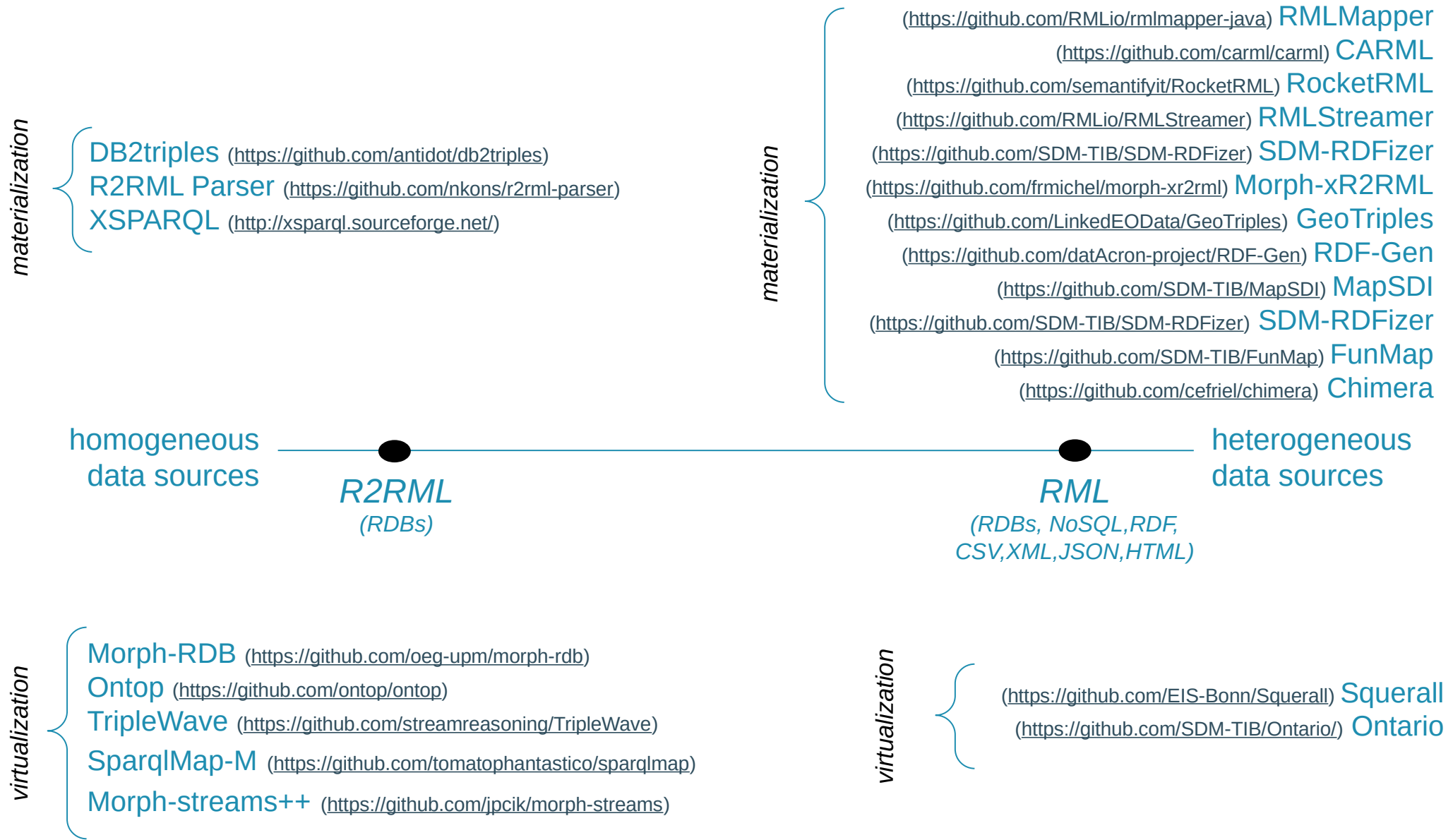


Tool for All Formats



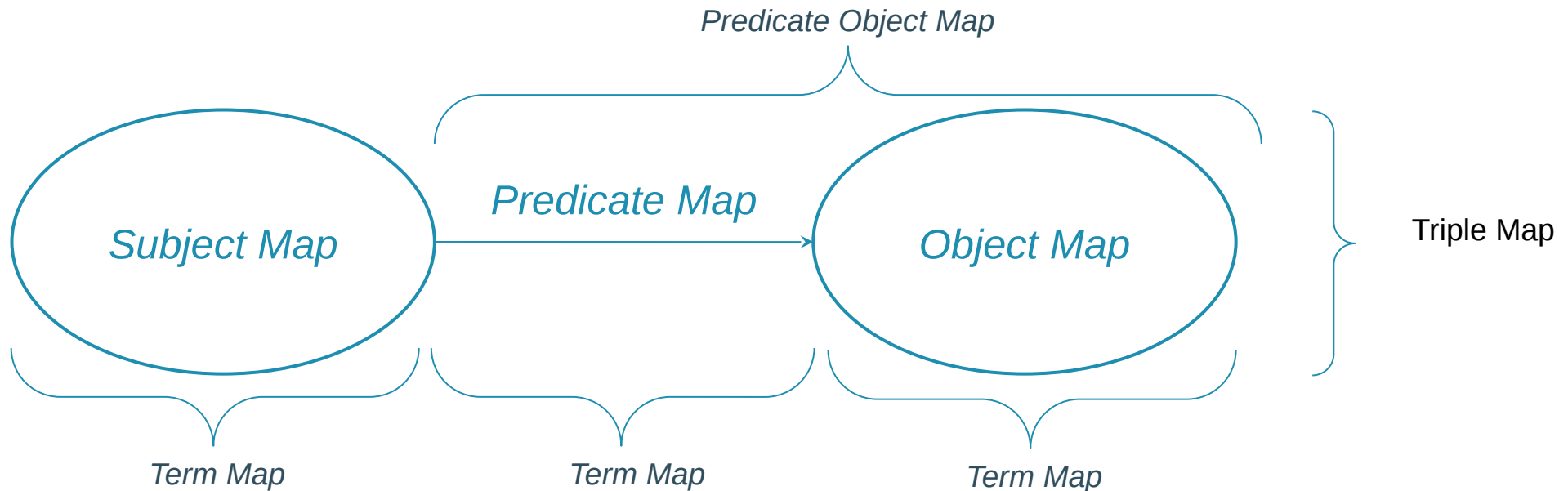
- ✓ Learn and maintain a single tool
- ✓ Configure the rules that define how a KG is generated

Mapping Languages and Tools



Main Concepts of R2RML and RML

```
ex:myFirstTriplesMap rr:subjectMap [ ... ];  
                    rr:predicateObjectMap [  
                        rr:predicateMap [ ... ];  
                        rr:objectMap [ ... ]  
                    ] .
```



RML Example

rank	name	nationality	mark
1	Anzhelika Sidorova	Russia	4.95
2	Sandi Morris	USA	4.90
3	Katerina Stefanidi	Greece	4.85
4	Holly Bradshaw	UK	4.80
5	Alysha Newman	Canada	4.80
6	Angelica Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap rr:subjectMap [ ... ];  
                    rr:predicateObjectMap [  
                      rr:predicateMap [ ... ];  
                      rr:objectMap [ ... ]  
                    ] .
```

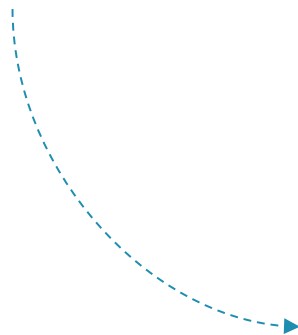


<http://ex.com/Anzhelika%20Sidorova> ex:score "4.95"^^xsd:decimal.
<http://ex.com/Sandi%20Morris> ex:score "4.90"^^xsd:decimal.
<http://ex.com/Katerina%20Stefanidi> ex:score "4.85"^^xsd:decimal.
<http://ex.com/Holly%20Bradshaw> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Alysha%20Newman> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Angelica%20Bengtsson> ex:score "4.80"^^xsd:decimal.

RML Example

rank	name	nationality	mark
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3	Katerina Stefanidi	Greece	4.85
4	Holly Bradshaw	UK	4.80
5	Alysha Newman	Canada	4.80
6	Angelica Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name}" ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:score];
    rr:objectMap [rml:reference "mark" ]].
```

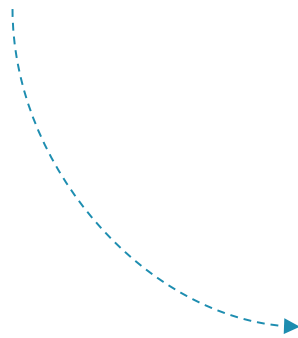


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<http://ex.com/Sandi%20Morris> ex:score "4.90"^^xsd:decimal.
<http://ex.com/Katerina%20Stefanidi> ex:score "4.85"^^xsd:decimal.
<http://ex.com/Holly%20Bradshaw> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Alysha%20Newman> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Angelica%20Bengtsson> ex:score "4.80"^^xsd:decimal.
```

RML Example

rank	name	nationality	mark
1	Anzhelika Sidorova	Russia	4.95
2	Sandi Morris	USA	4.90
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4	Holly Bradshaw	UK	4.80
5	Alysha Newman	Canada	4.80
6	Angelica Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:score];
    rr:objectMap [rml:reference "mark";
                  rr:datatype xsd:decimal] ] .
```

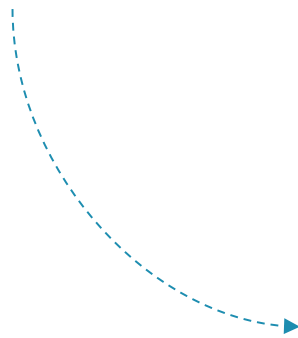


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<http://ex.com/Holly%20Bradshaw> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Alysha%20Newman> ex:score "4.80"^^xsd:decimal.
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```

RML Example

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2	Sandi Morris	USA	4.90
3	Katerina Stefanidi	Greece	4.85
4	Holly Bradshaw	UK	4.80
5	Alysha Newman	Canada	4.80
6	Angelica Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:score];
    rr:objectMap [rml:reference "mark";
                  rr:datatype xsd:decimal] ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant foaf:name];
    rr:objectMap [rr:template "{name}";
                  rr:termType rr:Literal;
                  rr:language "en"] ] .
```

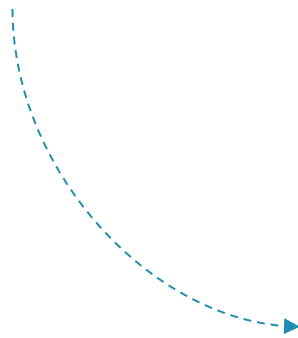


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<http://ex.com/Alysha%20Newman> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Angelica%20Bengtsson> ex:score "4.80"^^xsd:decimal.
```

RML Example

rank	name	surname	nationality	mark
1	Anzhelika	Sidorova	Russia	4.95
2	Sandi	Morris	USA	4.90
3	Katerina	Stefanidi	Greece	4.85
4	Holly	Bradshaw	UK	4.80
5	Alysha	Newman	Canada	4.80
6	Angelica	Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name} {surname}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:score];
    rr:objectMap [rml:reference "mark";
      rr:datatype xsd:decimal] ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant foaf:name];
    rr:objectMap [rr:template "{name} {surname}";
      rr:termType rr:Literal;
      rr:language "en"] ] .
```



```
<http://ex.com/Anzhelika%20Sidorova> ex:score "4.95"^^xsd:decimal.
<http://ex.com/Sandi%20Morris> ex:score "4.90"^^xsd:decimal.
<http://ex.com/Katerina%20Stefanidi> ex:score "4.85"^^xsd:decimal.
<http://ex.com/Holly%20Bradshaw> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Alysha%20Newman> ex:score "4.80"^^xsd:decimal.
<http://ex.com/Angelica%20Bengtsson> ex:score "4.80"^^xsd:decimal.
```

RML Example: Two Data Sources

rank	name	surname	nationality	mark
1	Anzhelika	Sidorova	Russia	4.95
2	Sandi	Morris	USA	4.90
3	Katerina	Stefanidi	Greece	4.85
4	Holly	Bradshaw	UK	4.80
5	Alysha	Newman	Canada	4.80
6	Angelica	Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name} {surname}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:country];
    rr:objectMap [ ... ] ].
```

```
<countries>
  <country continent="Europe">
    <country_abb>GR</country_abb>
    <country_name country_language="en">Greece</country_name>
    <country_name country_language="nl">Griekenland</country_name>
  </country>
  <country continent="Europe">
    <country_abb>UK</country_abb>
    <country_name country_language="en">United Kingdom</country_name>
    <country_name country_language="nl">Verenigd Koninkrijk</country_name>
  </country>
  <country continent="America">
    <country_abb>CA</country_abb>
    <country_name country_language="en">Canada</country_name>
    <country_name country_language="nl">Canada</country_name>
  </country>
  ...
</countries>
```

```
<http://ex.com/Anzhelika%20Sidorova> ex:country <http://ex.com/RU>.
<http://ex.com/Sandi%20Morris> ex:country <http://ex.com/US>.
<http://ex.com/Katerina%20Stefanidi> ex:country <http://ex.com/EL>.
<http://ex.com/Holly%20Bradshaw> ex:country <http://ex.com/UK>.
<http://ex.com/Alysha%20Newman> ex:country <http://ex.com/CA>.
<http://ex.com/Angelica%20Bengtsson> ex:country <http://ex.com/SE>.
```

RML Example: Two Data Sources

rank	name	surname	nationality	mark
1	Anzhelika	Sidorova	Russia	4.95
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3	Katerina	Stefanidi	Greece	4.85
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5	Alysha	Newman	Canada	4.80
6	Angelica	Bengtsson	Sweden	4.80

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name} {surname}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:country];
    rr:objectMap [ ... ] ];
  rml:logicalSource [
    rml:source "poleVaulters.csv";
    rml:referenceFormulation ql:CSV ] .
```

```
<countries>
  <country continent="Europe">
    <country_abb>GR</country_abb>
    <country_name country_language="en">Greece</country_name>
    <country_name country_language="nl">Griekenland</country_name>
  </country>
  <country continent="Europe">
    <country_abb>UK</country_abb>
    <country_name country_language="en">United Kingdom</country_name>
    <country_name country_language="nl">Verenigd Koninkrijk</country_name>
  </country>
  <country continent="America">
    <country_abb>CA</country_abb>
    <country_name country_language="en">Canada</country_name>
    <country_name country_language="nl">Canada</country_name>
  </country>
  ...
</countries>
```

```
ex:my2ndTM
  rml:logicalSource [
    rml:source "countries.xml";
    rml:referenceFormulation ql:Xpath;
    rml:iterator "countries/country" ] ] .
```

```
<http://ex.com/Anzhelika%20Sidorova> ex:country <http://ex.com/RU>.
<http://ex.com/Sandi%20Morris> ex:country <http://ex.com/US>.
<http://ex.com/Katerina%20Stefanidi> ex:country <http://ex.com/EL>.
<http://ex.com/Holly%20Bradshaw> ex:country <http://ex.com/UK>.
<http://ex.com/Alysha%20Newman> ex:country <http://ex.com/CA>.
<http://ex.com/Angelica%20Bengtsson> ex:country <http://ex.com/SE>.
```

RML Example: Two Data Sources

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```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name} {surname}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:country];
    rr:objectMap [ ... ] ];
  rml:logicalSource [
    rml:source "poleVaulters.csv";
    rml:referenceFormulation ql:CSV ] .
```

```
<countries>
  <country continent="Europe">
    <country_abb>GR</country_abb>
    <country_name country_language="en">Greece</country_name>
    <country_name country_language="nl">Griekenland</country_name>
  </country>
  <country continent="Europe">
    <country_abb>UK</country_abb>
    <country_name country_language="en">United Kingdom</country_name>
    <country_name country_language="nl">Verenigd Koninkrijk</country_name>
  </country>
  <country continent="America">
    <country_abb>CA</country_abb>
    <country_name country_language="en">Canada</country_name>
    <country_name country_language="nl">Canada</country_name>
  </country>
  ...
</countries>
```

```
ex:my2ndTM
  rml:logicalSource [
    rml:source "countries.xml";
    rml:referenceFormulation ql:Xpath;
    rml:iterator "countries/country" ] ];
  rr:subjectMap [
    rr:template "http://ex.com/{country_abb}" ] .
```

```
<http://ex.com/Anzhelika%20Sidorova> ex:country <http://ex.com/RU>.
<http://ex.com/Sandi%20Morris> ex:country <http://ex.com/US>.
<http://ex.com/Katerina%20Stefanidi> ex:country <http://ex.com/EL>.
<http://ex.com/Holly%20Bradshaw> ex:country <http://ex.com/UK>.
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<http://ex.com/Angelica%20Bengtsson> ex:country <http://ex.com/SE>.
```


RML Example: Two Data Sources

rank	name	surname	nationality	mark
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```
<countries>
  <country continent="Europe">
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  </country>
  <country continent="Europe">
    <country_abb>UK</country_abb>
    <country_name country_language="en">United Kingdom</country_name>
    <country_name country_language="nl">Verenigd Koninkrijk</country_name>
  </country>
  <country continent="America">
    <country_abb>CA</country_abb>
    <country_name country_language="en">Canada</country_name>
    <country_name country_language="nl">Canada</country_name>
  </country>
  ...
</countries>
```

```
ex:myFirstTriplesMap
  rr:subjectMap [
    rr:template "http://ex.com/{name} {surname}";
    rr:class foaf:Person ];
  rr:predicateObjectMap [
    rr:predicateMap [rr:constant ex:country];
    rr:objectMap [rr:parentTriplesMap ex:my2ndTM;
      rr:joinCondition [
        rr:parent "country_name";
        rr:child "nationality" ] ] ];
rml:logicalSource [ ... ] .
```

ex:my2ndTM

```
rml:logicalSource [
  rml:source "countries.xml";
  rml:referenceFormulation ql:Xpath;
  rml:iterator "countries/country" ] ];
rr:subjectMap [
  rr:template "http://ex.com/{country_abb}" ] .

<http://ex.com/Anzhelika%20Sidorova> ex:country <http://ex.com/RU>.
<http://ex.com/Sandi%20Morris> ex:country <http://ex.com/US>.
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<http://ex.com/Alysha%20Newman> ex:country <http://ex.com/CA>.
<http://ex.com/Angelica%20Bengtsson> ex:country <http://ex.com/SE>.
```

Summary RML

- Triples Map
 - MUST have one `rml:logicalSource` property
 - MUST have exactly one `rr:subjectMap` property
 - MAY have zero or more `rr:predicateObjectMap` properties
- Subject Map (`rr:SubjectMap`)
 - MAY have one or more `rr:class` properties
- PredicateObjectMap (`rr:PredicateObjectMap`)
 - Predicate Map (`rr:PredicateMap`)
 - Object Map (`rr:ObjectMap`)
 - Join condition (`rr:joinCondition`)
 - Child and parent (`rr:child` and `rr:parent`)
- More details: <https://rml.io/docs/>

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