

SEMANTIC ASSIGNMENT -3

SPARQL QUERIES, MERGING, CLUSTERING

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Machine.owl

```
1 <?xml version="1.0"?>
2 <rdf:RDF xmlns:rdfs="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
3     xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
4     xmlns:owl="http://www.w3.org/2002/07/owl#"
5     xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
6     xmlns:ml="http://example.org/ml#">
7
8     <!-- Ontology header -->
9     <owl:Ontology rdf:about="http://example.org/ml"/>
10
11     <!-- Define classes -->
12     <owl:Class rdf:about="http://example.org/ml#TrainingData">
13         <rdfs:label>TrainingData</rdfs:label>
14         <rdfs:comment>The data used to train a machine learning model</rdfs:comment>
15     </owl:Class>
16
17     <owl:Class rdf:about="http://example.org/ml#ModelParameters">
18         <rdfs:label>ModelParameters</rdfs:label>
19         <rdfs:comment>Parameters used in machine learning models for prediction</rdfs:comment>
20     </owl:Class>
21
22     <owl:Class rdf:about="http://example.org/ml#TrainingAlgorithm">
23         <rdfs:label>TrainingAlgorithm</rdfs:label>
24         <rdfs:comment>The algorithm used to train a model using training data</rdfs:comment>
25     </owl:Class>
26
27     <owl:Class rdf:about="http://example.org/ml#Hyperparameters">
28         <rdfs:label>Hyperparameters</rdfs:label>
29         <rdfs:comment>External configuration variables that influence the model's training process</rdfs:comment>
30     </owl:Class>
31
32     <!-- Define object properties -->
33     <owl:ObjectProperty rdf:about="http://example.org/ml#trainedBy">
34         <rdfs:label>trainedBy</rdfs:label>
35         <rdfs:domain rdf:resource="http://example.org/ml#TrainingData"/>
36         <rdfs:range rdf:resource="http://example.org/ml#TrainingAlgorithm"/>
37         <rdfs:comment>Indicates that training data is used by a training algorithm to train a model</rdfs:comment>
38     </owl:ObjectProperty>
39
40     <owl:ObjectProperty rdf:about="http://example.org/ml#hasParameter">
41         <rdfs:label>hasParameter</rdfs:label>
42         <rdfs:domain rdf:resource="http://example.org/ml#ModelParameters"/>
43         <rdfs:range rdf:resource="http://example.org/ml#Hyperparameters"/>
44         <rdfs:comment>Indicates that model parameters have associated hyperparameters</rdfs:comment>
45     </owl:ObjectProperty>
46
47     <!-- Define data properties -->
48     <owl:DatatypeProperty rdf:about="http://example.org/ml#learningRate">
49         <rdfs:label>learningRate</rdfs:label>
50         <rdfs:domain rdf:resource="http://example.org/ml#Hyperparameters"/>
51         <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#decimal"/>
52         <rdfs:comment>The learning rate used in the training process</rdfs:comment>
53     </owl:DatatypeProperty>
54
55     <owl:DatatypeProperty rdf:about="http://example.org/ml#batchSize">
56         <rdfs:label>batchSize</rdfs:label>
57         <rdfs:domain rdf:resource="http://example.org/ml#Hyperparameters"/>
58         <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#integer"/>
59         <rdfs:comment>The size of the batches used in the training process</rdfs:comment>
60     </owl:DatatypeProperty>
61
62 </rdf:RDF>
63
```

DataScience.owl

```
1 <?xml version="1.0"?>
2 <rdf:RDF xmlns:rdf="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
3   xmlns:rdfs="http://www.w3.org/2000/01/rdf-schema#"
4   xmlns:owl="http://www.w3.org/2002/07/owl#"
5   xmlns:xsd="http://www.w3.org/2001/XMLSchema#"
6   xmlns:ml="http://example.org/ml#"
7
8 <!-- Ontology header -->
9 <owl:Ontology rdf:about="http://example.org/ml"/>
10
11 <!-- Define classes -->
12 <owl:Class rdf:about="http://example.org/ml#TrainingData">
13   <rdfs:label>TrainingData</rdfs:label>
14   <rdfs:comment>The data used to train a machine learning model</rdfs:comment>
15 </owl:Class>
16
17 <owl:Class rdf:about="http://example.org/ml#ModelParameters">
18   <rdfs:label>ModelParameters</rdfs:label>
19   <rdfs:comment>Parameters used in machine learning models for prediction</rdfs:comment>
20 </owl:Class>
21
22 <owl:Class rdf:about="http://example.org/ml#TrainingAlgorithm">
23   <rdfs:label>TrainingAlgorithm</rdfs:label>
24   <rdfs:comment>The algorithm used to train a model using training data</rdfs:comment>
25 </owl:Class>
26
27 <owl:Class rdf:about="http://example.org/ml#Hyperparameters">
28   <rdfs:label>Hyperparameters</rdfs:label>
29   <rdfs:comment>External configuration variables that influence the model's training process</rdfs:comment>
30 </owl:Class>
31
32 <!-- Define object properties -->
33 <owl:ObjectProperty rdf:about="http://example.org/ml#trainedBy">
34   <rdfs:label>trainedBy</rdfs:label>
35   <rdfs:domain rdf:resource="http://example.org/ml#TrainingData"/>
36   <rdfs:range rdf:resource="http://example.org/ml#TrainingAlgorithm"/>
37   <rdfs:comment>Indicates that training data is used by a training algorithm to train a model</rdfs:comment>
38 </owl:ObjectProperty>
39
40 <owl:ObjectProperty rdf:about="http://example.org/ml#hasParameter">
41   <rdfs:label>hasParameter</rdfs:label>
42   <rdfs:domain rdf:resource="http://example.org/ml#ModelParameters"/>
43   <rdfs:range rdf:resource="http://example.org/ml#Hyperparameters"/>
44   <rdfs:comment>Indicates that model parameters have associated hyperparameters</rdfs:comment>
45 </owl:ObjectProperty>
46
47 <!-- Define data properties -->
48 <owl:DatatypeProperty rdf:about="http://example.org/ml#learningRate">
49   <rdfs:label>learningRate</rdfs:label>
50   <rdfs:domain rdf:resource="http://example.org/ml#Hyperparameters"/>
51   <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#decimal"/>
52   <rdfs:comment>The learning rate used in the training process</rdfs:comment>
53 </owl:DatatypeProperty>
54
55 <owl:DatatypeProperty rdf:about="http://example.org/ml#batchSize">
56   <rdfs:label>batchSize</rdfs:label>
57   <rdfs:domain rdf:resource="http://example.org/ml#Hyperparameters"/>
58   <rdfs:range rdf:resource="http://www.w3.org/2001/XMLSchema#integer"/>
59   <rdfs:comment>The size of the batches used in the training process</rdfs:comment>
60 </owl:DatatypeProperty>
61
62 </rdf:RDF>
63
```

Merge.py

```
1 import rdflib
2
3 g = rdflib.Graph()
4
5 g.parse("ds.owl",format = "xml")
6
7 g.parse("ml.owl",format = "xml")
8
9 g.serialize("merged.owl",format="xml")
```

```

1 <?xml version="1.0" encoding="utf-8"?>
2 <rdf:RDF
3   xmlns:ds="http://example.org/ds#"
4   xmlns:rdfs="http://www.w3.org/1999/02/22-rdf-syntax-ns#"
5   xmlns:xs="http://www.w3.org/2000/01/rdf-schema#"
6 >
7   <rdfs:Description rdfs:about="http://example.org/ds#batchSize">
8     <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
9     <rdfs:label batchSize/>
10    <rdfs:domain rdfs:resource="http://example.org/ml#Hyperparameters"/>
11    <rdfs:range rdfs:resource="http://www.w3.org/2001/XMLSchema#integer"/>
12    <rdfs:comment The size of the batches used in the training process/>
13  </rdfs:Description>
14  <rdfs:Description rdfs:about="http://example.org/ds#Algorithm1">
15    <rdfs:type rdfs:resource="http://example.org/ds#Algorithm"/>
16    <rdfs:label Random Forest/>
17  </rdfs:Description>
18  <rdfs:Description rdfs:about="http://example.org/ds#Model1">
19    <rdfs:type rdfs:resource="http://example.org/ds#Model"/>
20    <rdfs:label Iris Classifier/>
21    <ds:usesAlgorithm rdfs:resource="http://example.org/ds#Algorithm1"/>
22    <ds:executionTime rdfs:datatype="xsd:float">0.25/>
23  </rdfs:Description>
24  <rdfs:Description rdfs:about="http://example.org/ds#datasetSize">
25    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
26    <rdfs:domain rdfs:resource="http://example.org/ds#Dataset"/>
27    <rdfs:range rdfs:resource="xsd:integer"/>
28  </rdfs:Description>
29  <rdfs:Description rdfs:about="http://example.org/ds#trainedBy">
30    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
31    <rdfs:label trainedBy/>
32    <rdfs:domain rdfs:resource="http://example.org/ml#TrainingData"/>
33    <rdfs:range rdfs:resource="http://example.org/ml#TrainingAlgorithm"/>
34    <rdfs:comment Indicates that training data is used by a training algorithm to train a model/>
35  </rdfs:Description>
36  <rdfs:Description rdfs:about="http://example.org/ml#TrainingAlgorithm">
37    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
38    <rdfs:label TrainingAlgorithm/>
39    <rdfs:comment The algorithm used to train a model using training data/>
40  </rdfs:Description>
41  <rdfs:Description rdfs:about="http://example.org/ds#accuracy">
42    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
43    <rdfs:domain rdfs:resource="http://example.org/ds#Metric"/>
44    <rdfs:range rdfs:resource="xsd:float"/>
45  </rdfs:Description>
46  <rdfs:Description rdfs:about="http://example.org/ds#executionTime">
47    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
48    <rdfs:domain rdfs:resource="http://example.org/ds#Model"/>
49    <rdfs:range rdfs:resource="xsd:float"/>
50  </rdfs:Description>
51  <rdfs:Description rdfs:about="http://example.org/ds#dataset1">
52    <rdfs:type rdfs:resource="http://example.org/ds#Dataset"/>
53    <rdfs:label Iris Dataset/>
54    <ds:datasetSize rdfs:datatype="xsd:integer">150/>
55  </rdfs:Description>
56  <rdfs:Description rdfs:about="http://example.org/ds#visualization1">
57    <rdfs:type rdfs:resource="http://example.org/ds#Visualization"/>
58    <rdfs:label Scatter Plot/>
59    <ds:visualizes rdfs:resource="http://example.org/ds#dataset1"/>
60  </rdfs:Description>
61  <rdfs:Description rdfs:about="http://example.org/ds#visualizes">
62    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
63    <rdfs:domain rdfs:resource="http://example.org/ds#Visualization"/>
64    <rdfs:range rdfs:resource="http://example.org/ds#Dataset"/>
65  </rdfs:Description>
66  <rdfs:Description rdfs:about="http://example.org/ds#Dataset">
67    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
68    <rdfs:label Dataset/>
69    <rdfs:comment A collection of data used for analysis/>
70  </rdfs:Description>
71  <rdfs:Description rdfs:about="http://example.org/ml#learningRate">
72    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#DatatypeProperty"/>
73    <rdfs:label learningRate/>
74    <rdfs:domain rdfs:resource="http://example.org/ml#Hyperparameters"/>
75    <rdfs:range rdfs:resource="http://www.w3.org/2001/XMLSchema#decimal"/>
76    <rdfs:comment The learning rate used in the training process/>
77  </rdfs:Description>
78  <rdfs:Description rdfs:about="http://example.org/ds#evaluatedBy">
79    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
80    <rdfs:domain rdfs:resource="http://example.org/ds#Model"/>
81    <rdfs:range rdfs:resource="http://example.org/ds#Metric"/>
82  </rdfs:Description>
83  <rdfs:Description rdfs:about="http://example.org/ds#Model">
84    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
85    <rdfs:label Model/>
86    <rdfs:comment A predictive or descriptive data science model/>
87  </rdfs:Description>
88  <rdfs:Description rdfs:about="http://example.org/ds#Algorithm">
89    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
90    <rdfs:label Algorithm/>
91    <rdfs:comment An algorithm used for training a model/>
92  </rdfs:Description>
93  <rdfs:Description rdfs:about="http://example.org/ds#usesAlgorithm">
94    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
95    <rdfs:domain rdfs:resource="http://example.org/ds#Model"/>
96    <rdfs:range rdfs:resource="http://example.org/ds#Algorithm"/>
97  </rdfs:Description>
98  <rdfs:Description rdfs:about="http://example.org/ml">
99    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Ontology"/>
100  </rdfs:Description>
101  <rdfs:Description rdfs:about="http://example.org/ds#Visualization">
102    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
103    <rdfs:label Visualization/>
104    <rdfs:comment A graphical representation of data or results/>
105  </rdfs:Description>
106  <rdfs:Description rdfs:about="http://example.org/ml#Hyperparameters">
107    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
108    <rdfs:label Hyperparameters/>
109    <rdfs:comment External configuration variables that influence the model's training process/>
110  </rdfs:Description>
111  <rdfs:Description rdfs:about="http://example.org/ml#TrainingData">
112    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
113    <rdfs:label TrainingData/>
114    <rdfs:comment The data used to train a machine learning model/>
115  </rdfs:Description>
116  <rdfs:Description rdfs:about="http://example.org/ml#ModelParameters">
117    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
118    <rdfs:label ModelParameters/>
119    <rdfs:comment Parameters used in machine learning models for prediction/>
120  </rdfs:Description>
121  <rdfs:Description rdfs:about="http://example.org/ml#hasParameter">
122    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#ObjectProperty"/>
123    <rdfs:label hasParameter/>
124    <rdfs:domain rdfs:resource="http://example.org/ml#ModelParameters"/>
125    <rdfs:range rdfs:resource="http://example.org/ml#Hyperparameters"/>
126    <rdfs:comment Indicates that model parameters have associated hyperparameters/>
127  </rdfs:Description>
128  <rdfs:Description rdfs:about="http://example.org/ds#Metric1">
129    <rdfs:type rdfs:resource="http://example.org/ds#Metric"/>
130    <rdfs:label Accuracy Metric/>
131    <ds:accuracy rdfs:datatype="xsd:float">0.95/>
132  </rdfs:Description>
133  <rdfs:Description rdfs:about="http://example.org/ds">
134    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Ontology"/>
135  </rdfs:Description>
136  <rdfs:Description rdfs:about="http://example.org/ds#Metric">
137    <rdfs:type rdfs:resource="http://www.w3.org/2002/07/owl#Class"/>
138    <rdfs:label Metric/>
139    <rdfs:comment A metric used to evaluate a model/>
140  </rdfs:Description>
141 </rdf:RDF>
142

```

Mergequery.py

```
1 import rdflib
2
3 # Load the merged RDF graph
4 g = rdflib.Graph()
5 g.parse("merged.owl", format="xml")
6
7 # SPARQL query to retrieve all models and their algorithms
8 query = """
9 PREFIX ds: <http://example.org/ds#>
10 PREFIX ml: <http://example.org/ml#>
11
12 SELECT ?model ?algorithm WHERE {
13     ?model a ds:Model .
14     ?model ds:usesAlgorithm ?algorithm .
15 }
16 """
17
18 # Execute the query
19 results = g.query(query)
20
21 # Print the results
22 for row in results:
23     print(f"Model: {row['model']}, Algorithm: {row['algorithm']}")
24
```

OUTPUT:

```
- Focus folder in Explorer (Ctrl + Click) gAlgorithm
PS D:\sem5\semantic> python -u "d:\sem5\semantic\mergequery.py"
Model: http://example.org/ds#Model1, Algorithm: http://example.org/ds#Algorithm1
PS D:\sem5\semantic> █
```

Querying using sparql (ds.owl)

```
1 from rdflib import Graph
2
3 # Load the RDF graph
4 g = Graph()
5 g.parse("ds.owl") # Replace with the correct path to your RDF file
6
7 # 1. Query to Get Models with Their Algorithms and Execution Times
8 query_1 = ""
9 PREFIX ds: <http://example.org/ds#>
10
11 SELECT ?model ?algorithm ?executionTime
12 WHERE {
13     ?model a ds:Model .
14     ?model ds:usesAlgorithm ?algorithm .
15     ?model ds:executionTime ?executionTime .
16 }
17 ---
18 print("1. Models with Algorithms and Execution Times:")
19 results_1 = g.query(query_1)
20 for row in results_1:
21     print(f"Model: {row.model}, Algorithm: {row.algorithm}, Execution Time: {row.executionTime}")
22 print()
23
24 # 2. Query to Get Metrics with Accuracy Above a Threshold
25 query_2 = ""
26 PREFIX ds: <http://example.org/ds#>
27
28 SELECT ?metric ?accuracy
29 WHERE {
30     ?metric a ds:Metric .
31     ?metric ds:accuracy ?accuracy .
32     FILTER (?accuracy > 0.9)
33 }
34 ---
35 print("2. Metrics with Accuracy Above Threshold:")
36 results_2 = g.query(query_2)
37 for row in results_2:
38     print(f"Metric: {row.metric}, Accuracy: {row.accuracy}")
39 print()
40
41 # 3. Query to Get Visualizations Associated with a Specific Dataset
42 query_3 = ""
43 PREFIX ds: <http://example.org/ds#>
44
45 SELECT ?visualization ?label
46 WHERE {
47     ?visualization a ds:Visualization .
48     ?visualization ds:visualizes ?dataset .
49     ?dataset rdfs:label "Iris Dataset" .
50     ?visualization rdfs:label ?label .
51 }
52 ---
53 print("3. Visualizations Associated with 'Iris Dataset':")
54 results_3 = g.query(query_3)
55 for row in results_3:
56     print(f"Visualization: {row.visualization}, Label: {row.label}")
57 print()
58
59
60
61
62 # 6. Query to Get All Algorithms and the Models Using Them (Distinct Models)
63 query_6 = ""
64 PREFIX ds: <http://example.org/ds#>
65
66 SELECT DISTINCT ?algorithm ?model
67 WHERE {
68     ?model a ds:Model .
69     ?model ds:usesAlgorithm ?algorithm .
70 }
71 ---
72 print("6. Distinct Models Using Algorithms:")
73 results_6 = g.query(query_6)
74 for row in results_6:
75     print(f"Algorithm: {row.algorithm}, Model: {row.model}")
76 print()
77
78 # 7. Query to Get Models, Their Execution Times, and Associated Algorithms (With Sorting)
79 query_7 = ""
80 PREFIX ds: <http://example.org/ds#>
81
82 SELECT ?model ?algorithm ?executionTime
83 WHERE {
84     ?model a ds:Model .
85     ?model ds:usesAlgorithm ?algorithm .
86     ?model ds:executionTime ?executionTime .
87 }
88 ---
89 ORDER BY ?executionTime
90 ---
91 print("7. Models, Their Execution Times, and Associated Algorithms (Sorted by Execution Time):")
92 results_7 = g.query(query_7)
93 for row in results_7:
94     print(f"Model: {row.model}, Algorithm: {row.algorithm}, Execution Time: {row.executionTime}")
95 print()
96
```


OUTPUT:

```
PS D:\sem5\semantic> python -u "d:\sem5\semantic\query.py"
1. Models with Algorithms and Execution Times:
Model: http://example.org/ds#Model1, Algorithm: http://example.org/ds#Algorithm1, Execution Time: 0.25

2. Metrics with Accuracy Above Threshold:
Metric: http://example.org/ds#Metric1, Accuracy: 0.95

3. Visualizations Associated with 'Iris Dataset':
Visualization: http://example.org/ds#Visualization1, Label: Scatter Plot

6. Distinct Models Using Algorithms:
Algorithm: http://example.org/ds#Algorithm1, Model: http://example.org/ds#Model1

7. Models, Their Execution Times, and Associated Algorithms (Sorted by Execution Time):
Model: http://example.org/ds#Model1, Algorithm: http://example.org/ds#Algorithm1, Execution Time: 0.25

PS D:\sem5\semantic> █
```

Clustering merged ontologies:

OUTPUT:

```
PS D:\sem5\semantic> python -u "d:\sem5\semantic\tempCodeRunnerFile.py"
Class: http://example.org/ds#Metric is in cluster 0
Class: http://example.org/ds#Dataset is in cluster 0
Class: http://example.org/ds#Model is in cluster 0
Class: http://example.org/ds#Visualization is in cluster 0
Class: http://example.org/ds#Algorithm is in cluster 0
Class: http://example.org/ml#TrainingAlgorithm is in cluster 1
Class: http://example.org/ml#ModelParameters is in cluster 1
Class: http://example.org/ml#TrainingData is in cluster 1
Class: http://example.org/ml#Hyperparameters is in cluster 1

Cluster 0:
- http://example.org/ds#Metric
- http://example.org/ds#Dataset
- http://example.org/ds#Model
- http://example.org/ds#Visualization
- http://example.org/ds#Algorithm

Cluster 1:
- http://example.org/ml#TrainingAlgorithm
- http://example.org/ml#ModelParameters
- http://example.org/ml#TrainingData
- http://example.org/ml#Hyperparameters
PS D:\sem5\semantic> █
```

```

1 import rdflib
2 import numpy as np
3 from sklearn.feature_extraction.text import TfidfVectorizer
4 from sklearn.cluster import KMeans
5 from sklearn.metrics.pairwise import cosine_similarity
6
7 g1 = rdflib.Graph()
8 g2 = rdflib.Graph()
9
10 g1.parse("ds.owl", format="xml")
11 g2.parse("ml.owl", format="xml")
12
13 def get_classes(graph):
14     classes = set()
15     for s, p, o in graph:
16         if isinstance(o, rdflib.URIRef) and o.startswith("http://www.w3.org/2002/07/owl#Class"):
17             classes.add(s)
18     return list(classes)
19
20 classes1 = get_classes(g1)
21 classes2 = get_classes(g2)
22
23
24 all_classes = classes1 + classes2
25
26
27 class_texts = [str(cls) for cls in all_classes]
28
29
30 vectorizer = TfidfVectorizer(stop_words='english')
31 X = vectorizer.fit_transform(class_texts)
32
33 # Apply K-means clustering
34 num_clusters = 2
35 kmeans = KMeans(n_clusters=num_clusters, random_state=42)
36 kmeans.fit(X)
37
38 # Print the cluster assignments for each class
39 for idx, label in enumerate(kmeans.labels_):
40     print(f"Class: {all_classes[idx]} is in cluster {label}")
41
42 # Group the classes based on the clusters
43 clustered_classes = {i: [] for i in range(num_clusters)}
44 for idx, label in enumerate(kmeans.labels_):
45     clustered_classes[label].append(all_classes[idx])
46
47 # Now you have clustered classes from both ontologies
48 # Example of how to print them (or you could align them manually/semantically)
49 for cluster, classes in clustered_classes.items():
50     print(f"\nCluster {cluster}:")
51     for cls in classes:
52         print(f" - {cls}")

```