

1 SPARQL query

The SPARQL Protocol and RDF Query Language is a powerful tool designed for querying, manipulating, and extracting data stored within the Resource Description Framework (RDF) format. Positioned as an essential component of the Semantic Web stack, SPARQL allows for complex queries over diverse data sources that conform to the RDF standard, enabling the retrieval of specific pieces of information from vast, interconnected datasets. Such functionality proves particularly advantageous in the domains of ontology management and semantic data processing, where data structures and relationships are frequently intricate and multi-faceted.

A SPARQL query consists of a SELECT clause, delineating the variables to be returned, followed by a WHERE clause defining the pattern to be matched against the RDF data. This pattern can include various RDF triples, optional matches, and filters to refine the query results. SPARQL also supports alternative query forms, such as ASK, DESCRIBE, and CONSTRUCT, each serving different purposes. These range from posing boolean inquiries about the data to transforming the query results into new RDF graphs.

To effectively query an ontology using SPARQL, it is essential to define the PREFIX bindings at the beginning of each query. These PREFIXes act as shorthand for the namespaces used within the ontology, simplifying the query syntax and making it more readable. The PREFIX section of a SPARQL query might include bindings for common RDF and OWL vocabularies, as well as specific ontologies relevant to the domain of interest. For instance, in our study, we use PREFIXes such as `rdf`, `owl`, `rdfs`, `xsd` for standard vocabularies, and `ocd` for the namespace specific to our OCD ontology.

The PREFIX is as follows:

```
PREFIX java: <http://evolizer.org/ontologies/seon/2009/06/java.owl#>
PREFIX rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#>
PREFIX owl: <http://www.w3.org/2002/07/owl#>
PREFIX rdfs: <http://www.w3.org/2000/01/rdf-schema#>
PREFIX xsd: <http://www.w3.org/2001/XMLSchema#>
PREFIX obo: <http://purl.obolibrary.org/obo#>
PREFIX ocd: <http://www.semanticweb.org/OCD#>
```

Table 1: Competency Questions with SPARQL Queries and Explanations

SPARQL Query	Explanation
CQ1. What causes OCD?	
<pre>SELECT * WHERE { ?subject ocd:hasRiskFactor ? riskFactor . ?subject rdf:type ocd: Obsessive_Compulsive_Disorder }</pre>	<p>This query retrieves OCD instances and their associated risk factors, listing all OCD class instances and their associated risk factors. The 'rdf:type' is used to ensure that the subjects retrieved are indeed instances of the OCD class.</p>

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SPARQL Query	Explanation
CQ2. What is the difference between obsessions and compulsions?	

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SPARQL Query	Explanation
<pre> SELECT ?instance ?emotion ? impairment ?duration WHERE { { ?instance rdf:type ocd: Obsession. FILTER (?instance rdf:type ocd: IntrusiveThought ?instance rdf:type ocd: IntrusiveImage ?instance rdf:type ocd: IntrusiveUrge) } UNION { ?instance rdf:type ocd: Thought. ?instance ocd: hasAssociatedEmotion ? emotion. ?instance ocd: hasAssociatedImpairment ? impairment. ?instance ocd: hasAssociatedDuration ? duration. FILTER EXISTS { ?emotion rdf :type ocd:NegativeEmotion. } FILTER EXISTS { ?impairment rdf:type ocd:Impairment. } FILTER EXISTS { ?duration rdf:type ocd: SeverityDurataionLevel. }} SELECT ?instance ?emotion ? impairment ?duration WHERE { { ?instance rdf:type ocd: Compulsion. FILTER (?instance rdf:type ocd: Behavior ?instance rdf:type ocd: Activity) } UNION { ?instance rdf:type ocd: Activity. ?instance ocd: hasAssociatedEmotion ? emotion. ?instance ocd: hasAssociatedImpairment ? impairment. ?instance ocd: hasAssociatedDuration ? duration. FILTER EXISTS { ?emotion rdf :type ocd:NegativeEmotion. } FILTER EXISTS { ?impairment rdf:type ocd:Impairment. } FILTER EXISTS { ?duration rdf:type ocd: SeverityDurationLevel. } } } </pre>	<p>The two SPARQL queries provided illustrate the fundamental differences between obsession and compulsion as conceptualised within the OCD ontology. The query for obsession targets instances classified under intrusive thoughts, intrusive images, or intrusive urges. Alternatively, it identifies instances of thoughts, images, or urges that maintain specific associations, namely, negative emotion, impairment, and duration. Conversely, the query for compulsion focuses on retrieving instances classified as compulsive behaviors or activities, encompassing the physical or observable actions individuals feel compelled to perform in response to an obsession. Together, these queries and their distinctions underline the interplay between obsessions and compulsions components of OCD.</p>

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SPARQL Query	Explanation
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SPARQL Query	Explanation
CQ3. Is OCD a brain disease?	
<pre> SELECT ?Instance ?class ? parentClass WHERE { ?Instance rdf:type ?class . OPTIONAL { ?class rdfs: subClassOf ?parentClass . } FILTER (?class = ocd:OCD ? parentClass = ocd:Mnetal Disorder) } </pre>	<p>The SPARQL query crafted to extract instances of OCD along with their hierarchy within an ontology directly addresses the competency question (CQ3) of whether OCD is a brain disease. By retrieving instances classified under OCD and exploring their placement within the ontological structure, the query illuminates the nature of OCD as conceptualised within the ontology's framework.</p>
CQ4. Do persons with OCD experience changes in sleeping or eating habits?	
<pre> SELECT ?subject ?symptom WHERE { ?subject rdf:type ocd:OCD . ?subject ocd:hasSymptom ? symptom . ?symptom rdf:type/rdfs: subClassOf* symp: SYMP_0000462 . } </pre>	<p>The SPARQL query helps to answer the CQ4 by identifying individuals with OCD and their associated symptom. By retrieving instances that meet these criteria, the query provides evidence of the manifestation of general symptoms such as change in eating habit among individuals with OCD, thereby addressing the question of whether changes in sleeping or eating habits are experienced by persons with OCD.</p>
CQ5. Do individuals with OCD frequently experience intrusive thoughts disrupting social activities?	
<pre> SELECT ?subject ?impairment WHERE { ?subject rdf:type ocd: IntrusiveThought . ?subject ocd: hasAssociatedImpairment ? impairment . ?impairment rdf:type/rdfs: subClassOf* ocd: Functional_Impairment . } </pre>	<p>The SPARQL query designed to address CQ5 identifies individuals with OCD who are affected by intrusive thoughts and whose social engagements are adversely impacted. By querying for instances that meet both criteria—having intrusive thoughts and experiencing social impairment—this query reveals how intrusive thoughts disrupt social activities among those with OCD.</p>

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SPARQL Query	Explanation
CQ6. Do you ever experience unwanted, repetitive, and persistent thoughts that cause you anxiety?	
<pre> SELECT ?subject WHERE { ?subject rdf:type ocd: IntrusiveThought . } or SELECT ?subject WHERE { ?subject rdf:type ocd:Thought . ?subject ocd: hasAssociatedEmotion ocd: NegativeEmotion . } </pre>	<p>These queries are designed to retrieve specific instances that reflect the criteria described in CQ6 . Query 1 straightforwardly fetches instances classified under Intrusive Thought, directly addressing the concept of persistent and unwanted thoughts. Query 2, on the other hand, takes a broader approach by looking for instances of Thought that are specifically linked to NegativeEmotion, encapsulating the emotional distress aspect associated with such thoughts. Both approaches effectively demonstrate how the ontology can answer the question about experiencing distressing, repetitive thoughts.</p>
CQ7. Do you experience intrusive thoughts that are aggressive (i.e., harm to yourself or others) or about taboo topics such as porn?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: AggressiveThought . } UNION { ?subject rdf:type ocd: MorbidThought . } } </pre>	<p>This query is designed to retrieve specific instances reflective of aggressive or morbid thoughts.</p>

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SPARQL Query	Explanation
<p>CQ8. Do you spend at least one hour a day thinking obsessive thoughts or performing ritualistic behavior in an attempt to avoid angst? If so, how often?</p> <pre> SELECT ?individual WHERE { { ?subject rdf:type ocd: IntrusiveThought . ?subject rdf:type ocd: CompulsiveBehavior . ?subject ocd: hasAssociatedDuration ? duration . ?duration a ocd: Severity_Duration_Level . } }</pre>	<p>This query is constructed to extract instances of both Intrusive Thought and Compulsive Behavior that are linked with a duration classified as Severity Duration Level, indicating a severe impact on daily functioning, consistent with spending a significant part of the day engaged in these behaviors or thoughts. The inclusion of the hasAssociatedDuration property, coupled with the filter for Severity DurationLevel, specifically targets those instances that reflect a substantial time investment in these activities, aligning with the criteria specified in the competency question. By executing this query, we can identify instances where individuals experience intrusive thoughts and engage in compulsive behaviors for extended periods.</p>

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SPARQL Query	Explanation
CQ9. Do people with OCD believe their irrational thoughts?	
<pre> SELECT ?subject ?thoughtClass WHERE { ?subject rdf:type ? thoughtClass . ?thoughtClass rdfs:subClassOf* ocd:Thought . ?subject ocd: hasAssociatedAppraisal ? thoughtClass . ?appraisal rdf:type ? appraisalType . ?appraisalType rdfs:subClassOf* ocd:ThoughtAppraisal . } </pre>	<p>This query targets instances identified as type of thought. The <code>rdfs:subClassOf*</code> pattern is employed to ensure inclusivity of all sub-classes derived from the <code>Thought</code> class, capturing a wide range of thought types associated with OCD. The key aspect of this query is the <code>hasAssociatedAppraisal</code> property, which connects each thought instance to a specific appraisal, signifying the individual's evaluation or belief regarding the thought. The <code>?appraisal rdf:type ?appraisalType</code> and subsequent <code>?appraisalType rdfs:subClassOf* ocd:ThoughtAppraisal</code> patterns are critical for identifying the nature of this appraisal, ensuring that it falls within the spectrum of <code>ThoughtAppraisal</code> or any of its sub-classes. Essentially, 'ThoughtAppraisal' is about evaluating thoughts—whether one believes in them or questions them.</p>

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SPARQL Query	Explanation
CQ10. Do individuals with OCD excessively worry about dirt, germs, or chemicals?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: Contamination_Thought . ?subject ocd: hasAssociatedEmotion ? emotion . ?subject ocd:hasDuration ? duration . } UNION { ?subject rdf:type ocd: Contamination_Intrusive_Thought . } } </pre>	<p>The query is structured to achieve two main objectives: the first segment of the query targets instances of Contamination thought and further filters these instances based on associated emotional responses and the duration of these thoughts. The inclusion of ?individual ocd:hasAssociatedEmotion ?emotion and ?individual ocd:hasDuration ?duration criteria aims to capture not just the presence of such thoughts but also their emotional significance and persistence. This mirrors the "excessive" aspect by highlighting thoughts that not only occur but linger and evoke strong emotional reactions.</p>
CQ11. Is there a concern with symmetry and order in OCD individuals?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: SymmetryThought . } UNION { ?subject rdf:type ocd: SymmetryMentalImage . } UNION { ?subject rdf:type ocd: SymmetryUrge . } } </pre>	<p>This query retrieves instances that are explicitly related to the theme of symmetry; by targeting instances of Symmetry thought, Symmetry mental image, and Symmetry urge.</p>

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SPARQL Query	Explanation
CQ12. Do you ever fear contamination (i.e., germs) from people or the environment and engage in excessive cleaning? If so, how often?	
<pre> SELECT ?subject WHERE { ?subject rdf:type ocd: ContaminationThought . ?subject rdf:type ocd: Compulsive_Cleaning . } </pre>	<p>This query identifies instances representing individuals who harbor thoughts of contamination as well as those who exhibit compulsive cleaning behaviors; by the extraction of individuals categorised under Contamination thought and Compulsive cleaning.</p>
CQ13. Do you have unwanted thoughts of a sexual nature that you find inappropriate?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: Intrusive_Sexual_Thought } } </pre>	<p>By specifying the <code>rdf:type</code> as <code>ocd:Intrusive_Sexual_Thought</code>, the query directly targets and retrieves all instances that are classified under this specific type within the ontology.</p>
CQ14. Do individuals with OCD encounter distressing, unwanted mental images?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: Intrusive_Mental_Image . } } </pre>	<p>This query is crafted to retrieve individuals who are categorised under class of intrusive mental image.</p>

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SPARQL Query	Explanation
CQ15. Do individuals with OCD struggle with uncontrollable urges consuming significant time?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd:Urge . ?subject ocd:hasDuration ? duration . ?duration rdf:type ocd: Severity_Duration_Level } } </pre>	<p>This query is formulated to identify individuals with OCD who encounter uncontrollable urges that occupy a considerable amount of time, addressing Competency Question 15. By targeting instances of the class <code>ocd:Urge</code>, it focuses on those subjects experiencing urges, a common symptom in individuals with OCD. The inclusion of the property <code>ocd:hasDuration</code> associated with <code>?duration</code> and further specifying that <code>?duration</code> belongs to the class <code>ocd:Severity_Duration_Level</code> ensures that only urges that are both uncontrollable and time-consuming are considered.</p>
CQ16. How challenging is it to resist OCD thoughts?	
<pre> SELECT ?subject WHERE { { ?subject rdf:type ocd: Thought ?subject ocd: hasResistanceLevel ? resistance . ?resistance rdf:type ocd: Severity_Resistance_Level } } </pre>	<p>This query seeks to identify the degree of difficulty individuals with OCD experience in resisting their intrusive thoughts. It focuses on instances identified as <code>ocd:Thought</code>, indicating subjects afflicted by thoughts characteristic of OCD. It examines the <code>ocd:hasResistanceLevel</code> property associated with each thought instance, linking it to a <code>?resistance</code> value that is categorised within the class <code>ocd:Severity_Resistance_Level</code>.</p>

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SPARQL Query	Explanation
<p>CQ17. Do Intrusive thoughts or repetitive behavior significantly interfere with normal routine, occupational, or academic functioning?</p> <pre> SELECT ?subject ?impairment WHERE { { ?subject rdf:type ocd: Intrusive_Thought . ?subject rdf:type ocd: Compulsive_Behavior ?subject ocd: hasAssociatedImpairment ?impairment . ?impairment rdf:type ocd: FunctionalImpairment . } </pre>	<p>This query is designed to explore the impact of intrusive thoughts and compulsive behaviors on individuals' daily functions. It selects subjects identified as having either <code>ocd:Intrusive.Thought</code> or <code>ocd:Compulsive.Behavior</code>. A key to this query is the linkage to the <code>ocd:hasAssociatedImpairment</code> property, which connects each subject to their respective <code>?impairment</code>. This impairment is further defined within the <code>ocd:FunctionalImpairment</code> class, denoting significant disruptions to normal, occupational, or academic activities due to OCD symptoms.</p>

CQ18. Do Intrusive thought or repetitive behavior significantly interfere with normal routine, occupational, or academic functioning?

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SPARQL Query	Explanation
<pre> SELECT ?individual WHERE { { ?individual rdf:type ocd: IntrusiveThought . ?individual ocd: hasAssociatedImpairment ?impairment . ?impairment rdf:type ocd: FunctionalImpairment . } UNION { ?individual rdf:type ocd: CompulsiveBehavior . ?individual ocd: hasAssociatedImpairment ?impairment . ?impairment rdf:type ocd: FunctionalImpairment . } } </pre>	<p>This query is designed to identify individuals who either have intrusive thoughts (ocd:IntrusiveThought) or engage in compulsive behaviors (ocd:CompulsiveBehavior) that lead to significant impairment in their normal routine, occupational, or academic functioning. It does so by checking for an association (ocd:hasAssociatedImpairment) between these individuals and any instance of functional impairment (ocd:FunctionalImpairment).</p>

CQ19. Is the behaviour or mental act aimed at preventing or reducing distress or preventing some dreaded event or situation?

<pre> SELECT ?individual WHERE { ?individual rdf:type ocd: Behavior . ?individual ocd:type ? obsession . ?obsession rdf:type ocd: Obsession . } UNION { { ?individual rdf:type ocd: MentalAct . ?individual ocd:type ? obsession . ?obsession rdf:type ocd: Obsession . } } </pre>	<p>This query aims to extract individuals engaged in behaviors (ocd:Behavior) or mental acts (ocd:MentalAct) that are classified under the type of obsession (ocd:Obsession). The query elucidates that these individuals already have obsessions, and the behaviors or mental acts are employed as strategies to prevent or reduce the distress or anxiety provoked by these obsessions or to avoid situations that the individuals dread.</p>
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SPARQL Query	Explanation
<p>CQ20. Do you experience the need to constantly check on something (i.e., repeatedly checking to be sure doors are locked, light switches, and/or appliances are off) or arrange the order of things (a shelf in a bedroom or a kitchen cabinet, for example)?</p>	
<pre> SELECT ?reassuranceBehavior ? thoughtClass WHERE { ?reassuranceBehavior rdf:type ocd:ReassuranceBehavior . ?reassuranceBehavior rdf:type ?thought . ?thought rdf:type ? thoughtClass . FILTER(?thoughtClass != owl: NamedIndividual) } </pre>	<p>To identify common thought patterns among OCD individuals exhibiting reassurance-seeking behaviors, we queried for "ReassuranceBehavior" instances and their related thought classes.</p>

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SPARQL Query	Explanation
<p>CQ21. What thought/image/urge patterns are common in OCD individuals?</p> <pre> SELECT ?individual ?type WHERE { { ?individual rdf:type ocd: Thought . ?individual rdf:type ?type . FILTER EXISTS { ?type rdfs: subClassOf* ocd:Thought } } UNION { ?individual rdf:type ocd: Urge . ?individual rdf:type ?type . FILTER EXISTS { ?type rdfs: subClassOf* ocd:Urge } } UNION { ?individual rdf:type ocd: MentalImage . ?individual rdf:type ?type . FILTER EXISTS { ?type rdfs: subClassOf* ocd: MentalImage } } } </pre>	<p>This query is designed to retrieve instances that are classified as thoughts, urges, or mental images, including their respective sub-classes within the OCD ontology. By selecting individuals and their specific types (?type), where these types are direct subclasses of ocd:Thought, ocd:Urge, or ocd:MentalImage, the query aims to capture a broad spectrum of thought, image, and urge patterns encountered in OCD</p>
<p>CQ22. How does OCD impact life quality?</p> <pre> SELECT ?individual ? functionalImpairment WHERE { ?individual rdf:type ocd:OCD . ?individual ocd: hasAssociatedImpairment ? functionalImpairment . ?functionalImpairment rdf:type ocd:FunctionalImpairment . } </pre>	<p>This query retrieves individuals diagnosed with OCD (ocd:OCD) and identifies any functional impairments (ocd:FunctionalImpairment) associated with them through the ocd:hasAssociatedImpairment property. By focusing on the linkage between OCD instances and functional impairments, the query aims to highlight the direct impact of OCD on individuals' daily lives, particularly in areas such as work, social interaction, and personal care.</p>

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SPARQL Query	Explanation
CQ23. What psychological disorders often co-occur with OCD?	
<pre> SELECT ?individual ? comorbidityType WHERE { ?individual rdf:type ocd:OCD. ?individual ocd:hasComorbidity ?comorbidity. ?comorbidity rdf:type ? comorbidityType. FILTER EXISTS { ? comorbidityType rdfs: subClassOf* ocd: MentalDisorder } } </pre>	<p>We examined the prevalence of co-occurring psychological disorders with OCD by identifying OCD instances and their comorbidities. This exploration into "OCD" individuals having "Comorbidity" with different "MentalDisorder" classes illuminated the complex interplay between OCD and other mental health challenges.</p>

CQ24. Are thoughts, impulses, or images self-generated?

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SPARQL Query	Explanation
<pre> SELECT ?subject ?trigger WHERE { { ?subject rdf:type ocd: Thought . ?subject ocd:hasTrigger ? trigger . ?trigger rdf:type/rdfs: subClassOf* ocd:Trigger . } UNION { ?subject rdf:type ocd: MentalImage . ?subject ocd:hasTrigger ? trigger . ?trigger rdf:type/rdfs: subClassOf* ocd:Trigger . } UNION { ?subject rdf:type ocd:Urgent . ?subject ocd:hasTrigger ? trigger . ?trigger rdf:type/rdfs: subClassOf* ocd:Trigger . } } </pre>	<p>This query aims to identify individuals experiencing thoughts (ocd:Thought), mental images (ocd:MentalImage), or urges (ocd:Urgent) and the triggers (ocd:hasTrigger) associated with these experiences.</p>