

**Exercise Sheet 12: More OWL & Datalog**  
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**Exercise 12.1.** Consider the following SHACL schema:

```
eg:PersonShape rdf:type sh:NodeShape ;
  sh:targetClass eg:Person ;
  sh:property [
    sh:path eg:ssn ;
    sh:maxCount 1 ;
    sh:datatype xsd:string ;
  ] ;
  sh:property [
    sh:path eg:worksFor ;
    sh:nodeKind sh:IRI ;
    sh:class eg:Company
  ] ;
```

Give an equivalent OWL ontology.

**Exercise 12.2.** Which of the following graph patterns are expressible as OWL property or class expressions (all predicates mentioned are binary)? Explain your answer by either giving an OWL property/class expression or by arguing why there is none. If there is none, can the encoding of the graph be modified to support this pattern?

1. Find nodes that are connected by an edge path of length  $\geq 100$
2. Find nodes that are connected by an edge path of length  $\leq 100$
3. Find nodes that are connected by an edge path of length  $\neq 100$
4. Find nodes that are not connected by an edge path of length 100
5. In a graph with a parent property, find nodes with a common ancestor
6. In a graph with a parent property, find nodes that are cousins (of any degree)
7. Find nodes that are connected by `predA` but not by `predB`
8. Find nodes that are connected by an `predA` path, but not by an `predB` path
9. Find nodes that are connected by a path of nodes as in 7
10. Find nodes connected by an arbitrary path
11. Find nodes connected by an arbitrary path of even length
12. Check if the graph contains an even number of nodes

**Exercise 12.3.** Consider the following ontology  $O$ :

```
SubClassOf(  
  eg:Road  
  ObjectHasValue( eg:leadsTo eg:rome )  
)  
SubClassOf( eg:Highway eg:Road )  
ClassAssertion( eg:Highway eg:a1 )
```

Give an equivalent Datalog program.

**Exercise 12.4.** Consider the following Datalog program.

```
related( $x, y$ ) :- mother( $x, y$ )  
related( $x, y$ ) :- father( $x, y$ )  
related( $x, y$ ) :- child( $x, y$ )  
playsOrgan( $x$ ) :- instrument( $x, \text{Organ}$ )  
relatedViaOrganists( $x, y$ ) :- related( $x, y$ ), playsOrgan( $x$ ), playsOrgan( $y$ )  
relatedViaOrganists( $x, z$ ) :- relatedViaOrganists( $x, y$ ), relatedViaOrganists( $y, z$ )  
relatedOrganistsOfBach( $x$ ) :- relatedViaOrganists(Bach,  $x$ )
```

Give an equivalent OWL ontology.

\* **Exercise 12.5.** Let  $G = \langle V, E \rangle$  be an undirected graph. Show that if  $G$  is triangle-free (i.e., there are no triangles in  $G$ ), then

$$|E| \leq \left\lfloor \frac{|V|^2}{4} \right\rfloor.$$