TUTORS:
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QUESTIONS: Please don't hesitate to ask any questions. Questions help you and your peers.
PRINT: Please consider the environment before printing the exercise.

1 NNF Rules

$$A \Rightarrow B \;\rightarrow\; \neg A \vee B$$
$$A \Leftrightarrow B \;\rightarrow\; (\neg A \vee B) \wedge (A \vee \neg B)$$
$$\neg(A \vee B) \;\rightarrow\; \neg A \wedge \neg B$$
$$\neg(A \wedge B) \;\rightarrow\; \neg A \vee \neg B$$
$$\neg\neg A \;\rightarrow\; A$$
$$\neg\exists x A \;\rightarrow\; \forall x \neg A$$
$$\neg\forall x A \;\rightarrow\; \exists x \neg A$$

2 ALC to NNF

Convert the following ALC axioms into Negation Normal Form (NNF)

- $\neg(A \vee \neg B)$
  Solution:
  $NNF(\neg(A \vee \neg B))$
  $= NNF(\neg A) \wedge NNF(\neg\neg B)$
  $= NNF(\neg A) \wedge NNF(B)$
  $= \neg A \wedge B$

- $\neg(\neg(A \vee \neg B) \wedge \neg C)$
  Solution:
  $NNF(\neg(\neg(A \vee \neg B) \wedge \neg C))$
  $= NNF(\neg\neg(A \vee \neg B)) \vee NNF(\neg\neg C)$
  $= NNF(A \vee \neg B) \vee NNF(C)$
  $= NNF(A \vee \neg B) \vee C$
  $= NNF(A) \vee NNF(\neg B) \vee C$
  $= A \vee \neg B \vee C$

- $\neg(A \Rightarrow B) \vee (C \Rightarrow D)$
  Solution:
  $NNF(\neg(A \Rightarrow B) \vee (C \Rightarrow D))$
  $= NNF(\neg(\neg A \vee B) \vee (\neg C \vee D))$
  $= NNF(\neg(\neg A \vee B)) \vee NNF(\neg C \vee D))$
  $= NNF(\neg\neg A \wedge \neg B)) \vee NNF(\neg C \vee D))$
  $= NNF(\neg\neg A) \wedge NNF(\neg B) \vee NNF(\neg C) \vee NNF(D)$
  $= NNF(A) \wedge NNF(\neg B) \vee NNF(\neg C) \vee NNF(D)$
  $= A \wedge \neg B \vee \neg C \vee D$

- $\neg(\forall r.A \vee B)$
  Solution:
  $NNF(\neg(\forall r.A \vee B))$
  $= \exists r.NNF(\neg(A \vee B))$

3   SHACL Shapes

Consider the following SHACL shapes graph:

```
@prefix ex: <http://example.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .
@prefix sh: <http://www.w3.org/ns/shacl#> .

ex:PersonShape
    a               sh:NodeShape ;
    sh:targetClass  ex:Person ;
    sh:property     [   sh:path         ex:name ;
                        sh:datatype     xsd:string ;
                        sh:minLength    3 ;
                        sh:maxLength    20 ;
                    ] .
```

Based on the provided SHACL shapes graph, write an RDF data graph that conforms to the defined constraints.

Solution:
@prefix ex: <http://example.org/> .
@prefix rdf: <http://www.w3.org/1999/02/22-rdf-syntax-ns#> .

ex:Harry a ex:Person ; ex:name "Harry" .

ex:Ron a ex:Person ; ex:name "Ronald Weasley" .