Ontology Languages (COMP321)
Exercise 7

1. In Exercise 6, we introduced the database instance $\mathcal{D}_{\mathsf{Nemo}}$ given by

$$\mathsf{Clownfish}(\mathsf{Nemo}), \quad \mathsf{Clownfish}(\mathsf{Karl})$$

$$\mathsf{Surgeonfish}(\mathsf{Dory}), \quad \mathsf{has\_friend}(\mathsf{Nemo}, \mathsf{Dory})$$

   Recall that under the closed world assumption we consider the interpretation $\mathcal{I} := \mathcal{I}_{\mathcal{D}_{\mathsf{Nemo}}}$ defined as follows:

   - $\Delta^{\mathcal{I}} = \{\mathsf{Nemo}, \mathsf{Karl}, \mathsf{Dory}\}$;
   - $\mathsf{Clownfish}^{\mathcal{I}} = \{\mathsf{Nemo}, \mathsf{Karl}\}$;
   - $\mathsf{Surgeonfish}^{\mathcal{I}} = \{\mathsf{Dory}\}$;
   - $\mathsf{has\_friend}^{\mathcal{I}} = \{(\mathsf{Nemo}, \mathsf{Dory})\}$.

   Consider now the TBox $\mathcal{T}$ given as:

$$\begin{array}{rcl} \mathsf{Clownfish} & \sqsubseteq & \mathsf{Fish} \\ \mathsf{Clownfish} \sqcap \mathsf{Surgeonfish} & \sqsubseteq & \bot \\ \top & \sqsubseteq & \forall \mathsf{has\_friend}.\mathsf{Fish} \\ \exists \mathsf{has\_friend}.\mathsf{Fish} & \sqsubseteq & \mathsf{Fish} \\ \mathsf{Fish} & \sqsubseteq & \exists \mathsf{has\_friend}.\top \end{array}$$

   Fill the table below with the answers “Yes”, “No”, or “Don’t know” to the Boolean queries.

Query	Answer for $\mathcal{I}$	Certain A for $\mathcal{D}_{\mathsf{Nemo}}$	Certain A for $(\mathcal{T}, \mathcal{D}_{\mathsf{Nemo}})$
$\mathsf{Clownfish}(\mathsf{Karl})$			
$\mathsf{Clownfish}(\mathsf{Dory})$			
$\mathsf{Fish}(\mathsf{Nemo})$			
$\neg\mathsf{Fish}(\mathsf{Nemo})$			
$\exists\mathsf{has\_friend}.\top(\mathsf{Nemo})$			
$\exists\mathsf{has\_friend}.\mathsf{Fish}(\mathsf{Nemo})$			
$\mathsf{Clownfish} \sqcap \neg\mathsf{Surgeonfish}(\mathsf{Karl})$			
$\mathsf{Fish}(\mathsf{Dory})$			
$\mathsf{Surgeonfish} \sqcap \neg\mathsf{Fish}(\mathsf{Dory})$			
$\exists\mathsf{has\_friend}.\mathsf{Clownfish}(\mathsf{Karl})$			

2. Consider the following non-Boolean queries F_i:

   - $F_1(x) = \mathsf{Clownfish}(x)$
   - $F_2(x) = \neg\mathsf{Surgeonfish}(x)$
   - $F_3(x, y) = \mathsf{has\_friend}(x, y)$
   - $F_4(x) = \mathsf{Clownfish}(x) \land \neg\mathsf{has\_friend}(x, \mathsf{Dory})$

   For each query F_i, give

   - $\mathsf{answer}(F_i, \mathcal{D}_{\mathsf{Nemo}})$;
   - $\mathsf{certanswer}(F_i, \mathcal{D}_{\mathsf{Nemo}})$;
   - $\mathsf{certanswer}(F_i, (\mathcal{T}, \mathcal{D}_{\mathsf{Nemo}}))$.

3. Consider the $\mathcal{EL}$ TBox $\mathcal{T}_0$:

$$
\begin{aligned}
\mathsf{Footballplayer} &\sqsubseteq \exists\mathsf{plays\_for}.\mathsf{Team} \\
\mathsf{Basketballplayer} &\sqsubseteq \exists\mathsf{plays\_for}.\mathsf{Team} \\
\mathsf{Handballplayer} &\sqsubseteq \exists\mathsf{plays\_for}.\mathsf{Team} \\
\mathsf{Team} &\sqsubseteq \exists\mathsf{managed\_by}.\mathsf{Manager} \\
\mathsf{Manager} &\sqsubseteq \mathsf{Employee} \\
\mathsf{Manager} &\sqsubseteq \exists\mathsf{managed\_by}.\mathsf{Manager}
\end{aligned}
$$

and the ABox $\mathcal{A}_0$:

$$\mathsf{Footballplayer(bob)}, \quad \mathsf{Basketballplayer(john)},$$

$$\mathsf{Handballplayer(peter)}, \quad \mathsf{Team(redsocks)}$$

$$\mathsf{managed\_by(redsocks, sue)}$$

Compute the interpretation $\mathcal{I}_{\mathcal{T}_0,\mathcal{A}_0}$ as described in the Comp321 Lecture Notes.

For $\mathcal{EL}$ concept queries, we know that $\mathcal{I}_{\mathcal{T}_0,\mathcal{A}_0}$ gives the answer "Yes" if, and only if, $(\mathcal{T}_0, \mathcal{A}_0)$ gives the certain answer "Yes". Check this for the queries:

- $\exists\mathsf{plays\_for.Team(peter)}$;
- $\exists\mathsf{managed\_by.Manager(peter)}$;
- $\exists\mathsf{plays\_for.}\exists\mathsf{managed\_by.Manager(peter)}$.

For more complex queries, $\mathcal{I}_{\mathcal{T}_0,\mathcal{A}_0}$ can give the answer "Yes" even if $(\mathcal{T}_0, \mathcal{A}_0)$ does not give the certain answer "Yes". Check this for

- $F(x, y) = \exists z.(\mathsf{plays\_for}(x, z) \wedge \mathsf{plays\_for}(y, z))$.
- $F = \exists x.\mathsf{managed\_by}(x, x)$.