Coursework 4

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526- Databases

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1 Question 1

(a) We design the following ER Schema given the specifications:

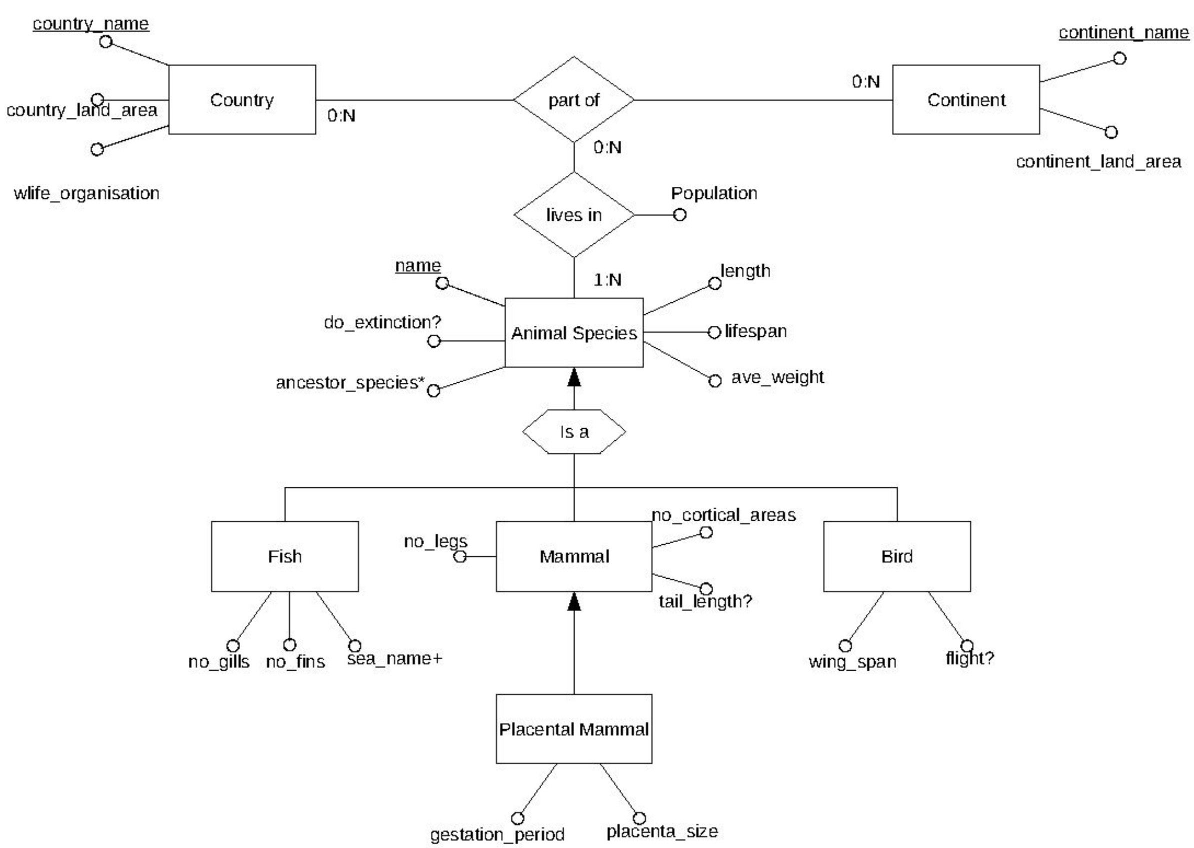

Figure 1: ER Schema to represent the given UoD

(b) We can the translate this ER Schema to an RA Schema. We get:

- animal_species($\underline{\text{name}}$, ave_weight,lifespan,do_extinction?)
- country($\underline{\text{country\_name}}$, country_land_area,wlife_organisation)
- continent($\underline{\text{continent\_name}}$,continent_land_area)
- fish($\underline{\text{name}}$,no_gills,no_fins)
- bird($\underline{\text{name}}$,wing_span,flight?)
- mammal($\underline{\text{name}}$,no_legs,no_cortical_areas,tail_length)
- placental_mammal($\underline{\text{name}}$,gestation_period,placenta_size)
- fish(name) $\overset{fk}{\Rightarrow}$ animal_species(name)
- bird(name) $\overset{fk}{\Rightarrow}$ animal_species(name)
- mammal(name) $\overset{fk}{\Rightarrow}$ animal_species(name)
- placental_mammal(name) $\overset{fk}{\Rightarrow}$ mammal(name)
- fish_seas($\underline{\text{sea\_name,name}}$)
- fish_seas(name) $\overset{fk}{\Rightarrow}$ fish(name)
- ancestor_species($\underline{\text{name, ancestor\_species}}$)
- ancestor_species(name) $\overset{fk}{\Rightarrow}$ animal_species(name)
- part_of($\underline{\text{country\_name,continent\_name}}$)
- part_of(country_name) $\overset{fk}{\Rightarrow}$ country(country_name)
- part_of(contient_name)$\overset{fk}{\Rightarrow}$continent(continent_name)
- lives_in($\underline{\text{country\_name,continent\_name,name}}$,population)
- lives_in(country_name,continent_name)$\overset{fk}{\Rightarrow}$ belongs_to(country_name, continent_name)
- lives_in(name)$\overset{fk}{\Rightarrow}$ animal_species(name)

2 Question 2

(a) We have :
S={AB→HB,E→GI,G→CDEFHI,EHB→CG,H→B,F→I}
Split the RHS of the FD's, we get:

S' ={AB→H,AB→B,E→G,E→I,G→C,G→D,G→E,G→F,G→H,G→I,EHB→C,EHB→G,H→B,F→I}

AB→B is self evident so remove.
Since EHB→C, H→B ⇒ EH→C .
Since E→G, G→H we get E→H and also EH→C ⇒ E→C .
Similarly, EHB→G ⇒ E→G , and since it is duplicated, remove.
So we get :

S" ={AB→H,E→G,E→I,G→C,G→D,G→E,G→F,G→H,G→I,E→C,H→B,F→I}

Now:

E→G,G→I , so remove E→I
E→G, G→C , so remove E→C
G→F, F→I, so remove G→I.

We can remove no other FD and still have the same closure as S.
So the minimal cover of S is:

$$\begin{aligned} Sc &= \{AB \to H, E \to G, G \to C, G \to D, G \to E, G \to F, G \to H, H \to B, F \to I\} \\ &= \{AB \to H, E \to G, G \to CDEFH, H \to B, F \to I\} \end{aligned}$$

(b) Start from the minimal cover and the Relation :
R(A,B,C,D,E,F,G,H,I) and Sc={AB→H,E→G,G→CDEFH,H→B,F→I}
Moreover,
G→CDEFH , H→B and F→ so G→BCDEFGHI. Also A→A.
So GA is a candidate minimal key of R.
Alternatively,
E→G ,G →CDEFH and H→B so E→BCDEFGHI.
So EA is also a candidate minimal key of R.
From the set S we can also see that there are no other candidate minimal keys for R.
So **EA** and **GA** are the candidate minimal keys of R.

(c) Starting from the minimal cover :
Sc={AB→H,E→G,G→CDEFH,H→B,F→I}
We have: BCDFHI are non prime using question 2)b).
Since AB→H, H→B violate 3NF, generate R_1(A,B,H).

Since G$\rightarrow$CDFH, violates 3NF generate $R_2(\underline{G}, CDFH)$.
Since F$\rightarrow$I violates 3NF, generate $R_3(\underline{F}, I)$.
We then have the 3NF of R is :

$$R_1(\underline{A, B}, H)R_2(\underline{G}, C, D, F, H)R_3(\underline{F}, I)R_4(\underline{A, B, E}, G) \tag{1}$$

Where:
R_1 contains AB$\rightarrow$H and H$\rightarrow$B ,
R_2 contains G$\rightarrow$CDFH,
R_3 contains F$\rightarrow$I,
R_4 contains E$\rightarrow$G and G$\rightarrow$E.

(d) Let's decompose the relation 1 into BCNF:
Since H$\rightarrow$B violates BCNF, generate $R_5(\underline{H}, B)$,
Since G$\rightarrow$E and E$\rightarrow$G violates BCNF, generate $R_6(\underline{G}, \underline{E})$.
We then get the BCNF form of R is:

$$R_1(\underline{A, H})R_2(\underline{G}, C, D, F, H)R_3(\underline{F}, I)R_4(\underline{A, B, E})R_5(\underline{H}, B)R_6(\underline{G}, \underline{E}) \tag{2}$$

Where:
R_2 contains G$\rightarrow$CDFH, and hence maintains functional dependencies
R_3 contains F$\rightarrow$I,and hence maintains functional dependencies
R_6 contains E$\rightarrow$G and G$\rightarrow$E, and hence maintains functional dependencies.
R_5 contains H$\rightarrow$B, and hence maintains functional dependencies.

As we can also see decomposition into R_1 and R_4 do not maintain functional dependencies. In particular, R_1 and R_4 do not contain any functional dependencies and AB$\rightarrow$H cannot be maintained while decomposing R into BCNF.