CSCB20 - Databases and Web Applications

Assignment 1 Part A: Relational Algebra

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1. (40 points) This question involves the following relations:

```
Classes(class, type, country, numGuns, bore, displacement)
Ships(name, class, launched)
Battles(name, date)
Outcomes(ship, battle, result
```

Find the following using relational algebra, and resulting sample data from figures 1 to 4 on the assignment:

(a) "Give the class names and countries of the classes that carried guns of at least 16 inch bore"

$$BigBores := \pi_{class,\ country}(\sigma_{bore\ \geq\ 16}(Classes))$$

Resulting sample data:

class	country
Iowa	USA
North Carolina	USA
Yamato	Japan

(b) "Find the ships launched prior to 1921"

$$OldShips := \pi_{name}(\sigma_{launched\ <\ 1921}(Ships))$$

Resulting sample data:

name
Haruna
Hiei
Kirishima
Kongo
Ramillies
Renown
Repulse
Resolution
Revenge
Royal Oak
Royal Sovereign
Tennessee

(c) "Find the ships sunk in the battle of the Denmark Strait"

$$SunkInDenmark := \pi_{ship}(\sigma_{\substack{battle\ =\ `Denmark\ Strait` \\ AND\ result\ =\ `sunk`}}(Outcomes))$$

Resulting sample data:

ship
Bismarck
Hood

(d) "The "Treaty of Washington" in 1921 prohibited capital ships heavier than 35,000 tons. List the ships that violated the Treaty of Washington"

$$DetailedShips := Ships \bowtie \sigma_{displacement\ >\ 35000}(Classes)$$

$$ViolatedShips := \pi_{name}(DetailedShips)$$

Resulting sample data:

name
Iowa
Missouri
Musashi
New Jersey
North Carolina
Washington
Wisconsin
Yamato

(e) "List the name, displacement and number of guns of the ships engaged in the battle of Guadalcanal"

$$GuadaFighters(name, battle, result) = \sigma_{battle='Guadalcanal'}(Outcomes)$$

$$GuadaShips = \pi_{name,\ class}(GuadaFighters \bowtie ships)$$

$$GuadaAll = Classes \bowtie GuadaShips$$

$$GuadaRelevant = \pi_{name,\ displacement,\ numGuns}(GuadaAll)$$

Resulting sample data:

name	displacement	numGuns
Kirishima	32000	8

(f) "List all the capital ships mentioned in the database. (Remember that all these ships may not appear in the Ship relation."

$$FromOutcomes(shipName, battle, class) := Outcomes$$

$$FromShips(shipName, class, launched) := Ships$$

$$AllShips := \pi_{shipName}(FromOutcomes) \cup \pi_{shipName}(FromShips)$$

Resulting sample data (found in the next page):

shipName
Arizona
Bismarck
California
Duke of York
Fuso
Haruna
Hiei
Hood
Iowa
King George V
Kirishima
Kongo
Missouri
Musashi
New Jersey
North Carolina
Prince of Wales
Ramillies
Renown
Repulse
Resolution
Revenge
Rodney
Royal Oak
Royal Sovereign
Scharnhorst
South Dakota
Tennessee
Washington
West Virginia
Wisconsin
Yamashiro
Yamato

(g) "Find the classes that had only one ship as a member of that class"

$$MoreThanOne := \pi_{name,\ class}(Ships)$$

$$CopyMTO := \rho_{CopyMTO}(MoreThanOne)$$

$$MoreThanTwo := MoreThanOne \bowtie_{\substack{\text{class = CopyMTO.class} \\ \text{AND name<> CopyMTO.name}}} CopyMTO$$

$$OnlyOne := \pi_{class}(MoreThanOne) - \pi_{class}(MoreThanTwo)$$

Resulting sample data (all classes from the sample data had more than one ship of that class):

class

(h) "Find those countries that had both battleships and battle cruisers"

$$C1 := \rho_{C1}(Classes)$$

$$C2 := \rho_{C2}(Classes)$$

$$BothTypes := \pi_{C1.country}(C1 \bowtie_{\substack{C1.country\ =\ C2.country \\ AND\ C1.type='bb' \\ AND\ C2.type='bc'}} C2)$$

Resulting sample data:

C1.country
Japan
Gt. Britain

(i) "Find those ships that "lived to fight another day"; they were damaged in one battle, but later fought in another"

Assuming that the "date" attribute is type "date":

$$O1 := \rho_{O1}(Outcomes \bowtie Battles)$$

$$O2 := \rho_{O2}(Outcomes \bowtie Battles)$$

$$LivedToFight := \pi_{O1.ship}(O1 \bowtie_{\substack{O1.ship\ =\ O2.ship \\ AND\ O1.result\ =\ 'damaged' \\ AND\ O1.date<O2.date}} O2)$$

With the sample data given, it appears that there are only two different ships that were damaged, but both of these ships did not fight in other (future) battles, so we have an empty table.

O1.Ship