

COSC 4820, Spring 2023  
Homework 2, Relational Algebra

This assignment briefly covers the relational algebra from Chapter 2 of the text. There are two problems, each with multiple parts. document is a copy of the handout I gave in class.

Use the following alternative syntax when you type the algebra.

<i>operation</i>	<i>notation</i>
union	$R \text{ UNION } S$
intersection	$R \text{ INTERSECT } S$
difference	$R \text{ DIFF } S$
projection	$\text{PROJECT}(\text{attribute\_list})\{R\}$
selection	$\text{SELECT}(\text{conditional})\{S\}$
cartesian product	$\text{PRODUCT}\{R, S\}$
natural join	$\text{JOIN}\{R, S\}$
theta join	$\text{THETA}(\text{conditional})\{R, S\}$
renaming	$\text{RENAME}(\text{new\_relation\_name})(\text{attribute\_list})\{R\}$

$R$  and  $S$  each stand for some relation. In the listing above *attribute\_list* is  $(a_1, a_2, \dots, a_n)$  and *conditional* is one of  $a > b$ ,  $a < b$ ,  $a = b$ ,  $a \neq b$ ,  $a \geq b$ ,  $a \leq b$ , or  $\neg a$ . Multiple conditionals may be joined with **AND**, **OR**, and **NOT** in the usual manner. Parentheses should be used in the conditional statements for grouping and disambiguation.

**Question 1: [45 points]**

More about World War II ships. There is some data for these relations on pages 56 and 57 of the text. Note: there are some “dangling tuples” in this data, e.g., ships mentioned in **Outcomes** that are not mentioned in **Ships**.

Write expressions of relational algebra to answer the following queries. Your queries should run on these relations REGARDLESS of the data in them. For the first 3 (a, b, and c) ALSO give the results of the queries in a tabular format.

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

**Note:** For clarification, “capital ship” is an ambiguous term usually meaning the largest, most powerful ship in a fleet. We will take it to mean Battleship (bb), Battlecruiser (bc), and Aircraft Carrier (cv). There is a complete list of the ship types at the end of this document. It contains more entries than the **Classes** table on page 56.

- (a) [5 points] Give the class names and countries of the classes that carried guns of at least 16-inch bore.
- (b) [5 points] Find the ships launched prior to 1920.

- (c) [5 points] Find the ships sunk in the battle of the Surigao Strait.
- (d) [5 points] The treaty of Washington in 1921 prohibited capital ships heavier than 35,000 tons. List the ships that violated the treaty of Washington.
- (e) [5 points] list the name, displacement, and number of guns of the ships engaged in the battle of Denmark Strait.
- (f) [5 points] list all the Capital ships mentioned in the database. Remember that all these ships may NOT appear in the **Ships** relation.
- (g) [5 points] Find the classes that had only one ship as a member of that class.
- (h) [5 points] Find those countries that had both battleships and battlecruisers.
- (i) [5 points] Find those ships that were damaged in one battle, but later fought in another.

**Question 2: [20 points]**

Suppose relations  $R$  and  $S$  have  $n$  tuples and  $m$  tuples respectively. Give the maximum numbers of tuples that the results of the following expressions can have.

- (a) [5 points]  $R \cup S$ .
- (b) [5 points]  $R \bowtie S$ .
- (c) [5 points]  $\sigma_C(R) \times S$ , for some condition  $C$ .
- (d) [5 points]  $\pi_L(R) - S$ , from some list of attributes  $L$ .

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Ship designations possibly used in “Classes”.

Acronym	Type
ah	Hospital Ship
apa	Attack Transport
av	Seaplane Tender
bb	Battleship
bc	Battlecruiser
ca	Heavy Cruiser
cl	Light Cruiser
cv	Aircraft Carrier
cve	Escort (Aircraft) Carrier
cvl	Light (Aircraft) Carrier
dd	Destroyer
ddc	Corvette
dde	Escort Destroyer
mv	Merchant Vessel