

Relational Algebra Exercises

Use the schema below

Product (maker , model , type)

PC (model , speed , ram , hd , price)

Laptop (model , speed , ram , hd , screen , price)

Printer (model , color , type , price)

| <i>maker</i> | <i>model</i> | <i>type</i> |
|--------------|--------------|-------------|
| A | 1001 | pc |
| A | 1002 | pc |
| A | 1003 | pc |
| A | 2004 | laptop |
| A | 2005 | laptop |
| A | 2006 | laptop |
| B | 1004 | pc |
| B | 1005 | pc |
| B | 1006 | pc |
| B | 2007 | laptop |
| C | 1007 | pc |
| D | 1008 | pc |
| D | 1009 | pc |
| D | 1010 | pc |
| D | 3004 | printer |
| D | 3005 | printer |
| E | 1011 | pc |
| E | 1012 | pc |
| E | 1013 | pc |
| E | 2001 | laptop |
| E | 2002 | laptop |
| E | 2003 | laptop |
| E | 3001 | printer |
| E | 3002 | printer |
| E | 3003 | printer |
| F | 2008 | laptop |
| F | 2009 | laptop |
| G | 2010 | laptop |
| H | 3006 | printer |
| H | 3007 | printer |

| <i>model</i> | <i>speed</i> | <i>ram</i> | <i>hd</i> | <i>price</i> |
|--------------|--------------|------------|-----------|--------------|
| 1001 | 2.66 | 1024 | 250 | 2114 |
| 1002 | 2.10 | 512 | 250 | 995 |
| 1003 | 1.42 | 512 | 80 | 478 |
| 1004 | 2.80 | 1024 | 250 | 649 |
| 1005 | 3.20 | 512 | 250 | 630 |
| 1006 | 3.20 | 1024 | 320 | 1049 |
| 1007 | 2.20 | 1024 | 200 | 510 |
| 1008 | 2.20 | 2048 | 250 | 770 |
| 1009 | 2.00 | 1024 | 250 | 650 |
| 1010 | 2.80 | 2048 | 300 | 770 |
| 1011 | 1.86 | 2048 | 160 | 959 |
| 1012 | 2.80 | 1024 | 160 | 649 |
| 1013 | 3.06 | 512 | 80 | 529 |

(a) Sample data for relation PC

| <i>model</i> | <i>speed</i> | <i>ram</i> | <i>hd</i> | <i>screen</i> | <i>price</i> |
|--------------|--------------|------------|-----------|---------------|--------------|
| 2001 | 2.00 | 2048 | 240 | 20.1 | 3673 |
| 2002 | 1.73 | 1024 | 80 | 17.0 | 949 |
| 2003 | 1.80 | 512 | 60 | 15.4 | 549 |
| 2004 | 2.00 | 512 | 60 | 13.3 | 1150 |
| 2005 | 2.16 | 1024 | 120 | 17.0 | 2500 |
| 2006 | 2.00 | 2048 | 80 | 15.4 | 1700 |
| 2007 | 1.83 | 1024 | 120 | 13.3 | 1429 |
| 2008 | 1.60 | 1024 | 100 | 15.4 | 900 |
| 2009 | 1.60 | 512 | 80 | 14.1 | 680 |
| 2010 | 2.00 | 2048 | 160 | 15.4 | 2300 |

(b) Sample data for relation Laptop

Figure 2.20: Sample data for Product

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| <i>model</i> | <i>color</i> | <i>type</i> | <i>price</i> |
|--------------|--------------|-------------|--------------|
| 3001 | true | ink-jet | 99 |
| 3002 | false | laser | 239 |
| 3003 | true | laser | 899 |
| 3004 | true | ink-jet | 120 |
| 3005 | false | laser | 120 |
| 3006 | true | ink-jet | 100 |
| 3007 | true | laser | 200 |

(c) Sample data for relation **Printer**

- Write expressions of relational algebra to answer the following queries. You may use the linear notation.
 - What PC models have a speed of at least 3.00?
 - Which manufacturers make laptops with a hard disk of at least 100 GB ?
 - Find the model number and price of all products (of any type) made by manufacturer B .
 - Find the model numbers of all color laser printers .
 - Find those manufacturers that sell Laptops , but not PC ' s .
- Draw expression trees for each of your expressions.
- This exercise is similar to 1 concerning World War II capital ships. Ships are built in "classes " from the same design , and the class is usually named for the first ship of that class . The relation **Classes** records the name of the class , the type (' bb ' for battleship or ' bc ' for battlecruiser) , the country that built the ship , the number of main guns , the bore (diameter of the gun barrel , in inches) of the main guns , and the displacement (weight , in tons) . Relation **Ships** records the name of the ship , the name of its class , and the year in which the ship was launched . Relation **Battles** gives the name and date of battles involving these ships , and relation **Outcomes** gives the result (sunk , damaged , or ok) for each ship in each battle . It involves the following relations :

Classes (class , type , country , numGuns , bore , displacement)

Ships (name , class , launched)

Battles (name , date)

Outcomes (ship , battle , result)

| <i>class</i> | <i>type</i> | <i>country</i> | <i>numGuns</i> | <i>bore</i> | <i>displacement</i> |
|----------------|-------------|----------------|----------------|-------------|---------------------|
| Bismarck | bb | Germany | 8 | 15 | 42000 |
| Iowa | bb | USA | 9 | 16 | 46000 |
| Kongo | bc | Japan | 8 | 14 | 32000 |
| North Carolina | bb | USA | 9 | 16 | 37000 |
| Renown | bc | Gt. Britain | 6 | 15 | 32000 |
| Revenge | bb | Gt. Britain | 8 | 15 | 29000 |
| Tennessee | bb | USA | 12 | 14 | 32000 |
| Yamato | bb | Japan | 9 | 18 | 65000 |

(a) Sample data for relation Classes

| <i>name</i> | <i>date</i> |
|----------------|-------------|
| Denmark Strait | 5/24-27/41 |
| Guadalcanal | 11/15/42 |
| North Cape | 12/26/43 |
| Surigao Strait | 10/25/44 |

(b) Sample data for relation Battles

| <i>ship</i> | <i>battle</i> | <i>result</i> |
|-----------------|----------------|---------------|
| Arizona | Pearl Harbor | sunk |
| Bismarck | Denmark Strait | sunk |
| California | Surigao Strait | ok |
| Duke of York | North Cape | ok |
| Fuso | Surigao Strait | sunk |
| Hood | Denmark Strait | sunk |
| King George V | Denmark Strait | ok |
| Kirishima | Guadalcanal | sunk |
| Prince of Wales | Denmark Strait | damaged |
| Rodney | Denmark Strait | ok |
| Scharnhorst | North Cape | sunk |
| South Dakota | Guadalcanal | damaged |
| Tennessee | Surigao Strait | ok |
| Washington | Guadalcanal | ok |
| West Virginia | Surigao Strait | ok |
| Yamashiro | Surigao Strait | sunk |

(c) Sample data for relation Outcomes

| <i>name</i> | <i>class</i> | <i>launched</i> |
|-----------------|----------------|-----------------|
| California | Tennessee | 1921 |
| Haruna | Kongo | 1915 |
| Hiei | Kongo | 1914 |
| Iowa | Iowa | 1943 |
| Kirishima | Kongo | 1915 |
| Kongo | Kongo | 1913 |
| Missouri | Iowa | 1944 |
| Musashi | Yamato | 1942 |
| New Jersey | Iowa | 1943 |
| North Carolina | North Carolina | 1941 |
| Ramillies | Revenge | 1917 |
| Renown | Renown | 1916 |
| Repulse | Renown | 1916 |
| Resolution | Revenge | 1916 |
| Revenge | Revenge | 1916 |
| Royal Oak | Revenge | 1916 |
| Royal Sovereign | Revenge | 1916 |
| Tennessee | Tennessee | 1920 |
| Washington | North Carolina | 1941 |
| Wisconsin | Iowa | 1944 |
| Yamato | Yamato | 1941 |

Figure 2.23: Sample data for relation Ships

Figures above give some sample data for these four relations . Note that , unlike the data for previous problem, 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 . You may use the linear notation . For the data above, show the result of your query

- Give the class names and countries of the classes that carried guns of at least 16 - inch bore .
- Find the ships launched prior to 1921 .
- Find the ships sunk in the battle of the Denmark Strait .
- The treaty of Washington in 1921 prohibited capital ships heavier than 35,000 tons . List the ships that violated the treaty of Washington.
- List the name , displacement , and number of guns of the ships engaged in the battle of Guadalcanal .
- List all the capital ships mentioned in the database . (Remember that all these ships may not appear in the Ships relation.)