Relational Algebra:

Selection (σ):
Selects tuples that satify certain conditions.
Operators: −, =, ≠, ≥, <, >, ≤ Connectors: *and*, *or*, *not*

$\sigma_{sentiment > 0.9}$ (Chirp) — Selects Chirps with sentiment less than 0.9.
$\sigma_{last\_name = 'Trump'}$ (Bird) — Selects Birds whose last name is Trump.

Projection (π):
Projects a subset of a table's columns.

$\pi_{btag,\ first\_name}$ (Bird) — Projects the tag and first name of all Birds

***Cross-Product (×):**
Combines two relations with every possible combination of tuples.

R

A	1
B	2
D	3
F	4
E	5

S

A	1
C	2
D	3
E	4

R CROSS S

A	1	A	1
A	1	C	2
A	1	D	3
A	1	E	4
B	2	A	1
B	2	C	2
B	2	D	3
B	2	E	4
D	3	A	1
D	3	C	2
D	3	D	3
D	3	E	4
F	4	A	1
F	4	C	2
F	4	D	3
F	4	E	4
E	5	A	1
E	5	C	2
E	5	D	3
E	5	E	4

***Difference (−):**
Selects tuples that are present in one relation but not the other.

R

A	1
B	2
D	3
F	4
E	5

S

A	1
C	2
D	3
E	4

R DIFFERENCE S

B	2
F	4
E	5

S DIFFERENCE R

C	2
E	4

***Union (U):**
Selects tuples that are present in both relations.

R

A	1
B	2
D	3
F	4
E	5

S

A	1
C	2
D	3
E	4

R UNION S

A	1
B	2
C	2
D	3
E	5
F	4
E	4

Natural Join (⋈):
Combines two relations by finding a common attribute between them

Employee

Name	EmpId	DeptName
Harry	3415	Finance
Sally	2241	Sales
George	3401	Finance
Harriet	2202	Sales

Dept

DeptName	Manager
Finance	George
Sales	Harriet
Production	Charles

Employee ⋈ Dept

Name	EmpId	DeptName	Manager
Harry	3415	Finance	George
Sally	2241	Sales	Harriet
George	3401	Finance	George
Harriet	2202	Sales	Harriet

Conditional Join ($\bowtie_c$):
Combines two relations similar to cross product but with a condition

Car

CarModel	CarPrice
CarA	20,000
CarB	30,000
CarC	50,000

Boat

BoatModel	BoatPrice
Boat1	10,000
Boat2	40,000
Boat3	60,000

$Car \bowtie_{CarPrice \geq BoatPrice} Boat$

CarModel	CarPrice	BoatModel	BoatPrice
CarA	20,000	Boat1	10,000
CarB	30,000	Boat1	10,000
CarC	50,000	Boat1	10,000
CarC	50,000	Boat2	40,000

Division (÷):
Reduces a relation by performing the opposite of a cartesian product

Completed

Student	Task
Fred	Database1
Fred	Database2
Fred	Compiler1
Eugene	Database1
Eugene	Compiler1
Sarah	Database1
Sarah	Database2

DBProject

Task
Database1
Database2

Completed ÷ *DBProject*

Student
Fred
Sarah

*Must be union compatible: 1) Same number of columns 2) Corresponding columns are of the same variable type

Relational Calculus [Examples]:
`Sailors(sid, sname, rating, age), Reserves(sid, bid, date), Boats(bid, bname, color)`

1. Find sailors with a rating > 7
   $\{s \mid s \in Sailors \wedge s.rating > 7\}$
2. Find names of sailors who've reserved a red boat
   $\{t(sname) \mid \exists s \in Sailors(t.sname = s.sname \wedge \exists r \in Reserves(r.sid = s.sid \wedge \exists b \in Boats(b.bid = r.bid \wedge b.color = 'red')))\}$
3. Find the names of sailors who've reserved all "Interlake" boats
   $\{t(sname) \mid \exists s \in Sailors(t.sname = s.sname \wedge \forall b \in Boats(b.bname = 'Interlake' \rightarrow (\exists r \in Reserves(r.sid = s.sid \wedge b.bid = r.bid))))\}$