The Relational Algebra

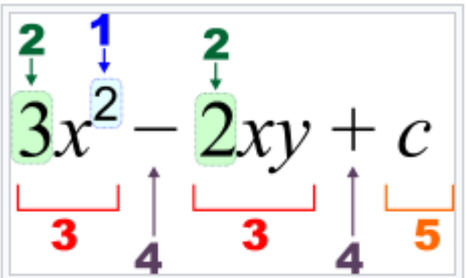
- A branch of Mathematics
- The foundation of the SQL language
- Operations against SETS of numbers
- The SET of numbers is a relation (rows & columns)

The Relational Algebra

It is kind of like like high school algebra:

doing operations with numbers and variables

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$



Algebraic expression notation:
1 – power (exponent)
2 – coefficient
3 – term
4 – operator
5 – constant term
x y c – variables/constants

The Relational Algebra

The “variables” are ***RELATIONS***

The operations:

- Union
- Intersection
- Difference
- Selection
- Projection
- Product
- Join

Set Operations

The operations are “Set” Operations

Think of each table as a “set” of data

Consider two tables: C and S

I can do the following set operations in R.A.

- C <union> S — all elements in C or S or both
- C <intersection> S — the set of elements in C and S
- C <difference> S — the set of elements in C but not in S

Example Union

Table C

CustomerID	CustomerName	ContactName	Address	City	PostalCode	Country
1	Alfreds Futterkiste	Maria Anders	Obere Str. 57	Berlin	12209	Germany
2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	05021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	05023	Mexico

Table S

SupplierID	SupplierName	ContactName	Address	City	PostalCode	Country
1	Exotic Liquid	Charlotte Cooper	49 Gilbert St.	London	EC1 4SD	UK
2	New Orleans Cajun Delights	Shelley Burke	P.O. Box 78934	New Orleans	70117	USA
3	Grandma Kelly's Homestead	Regina Murphy	707 Oxford Rd.	Ann Arbor	48104	USA

Example Union

C <union> S

1	Alfreds Futterkiste	Maria Anders	Obere Str. 57	Berlin	12209	Germany
2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	5021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	5023	Mexico
1	Exotic Liquid	Charlotte Cooper	49 Gilbert St.	London	EC1 4SD	UK
2	New Orleans Cajun Delights	Shelley Burke	P.O. Box 78934	New Orleans	70117	USA
3	Grandma Kelly's Homestead	Regina Murphy	707 Oxford Rd.	Ann Arbor	48104	USA

Projection

Produce a new relation that is a subset of columns from Table C

CustomerID	CustomerName	ContactName	Address	City	PostalCode	Country
1	Alfreds Futterkiste	Maria Anders	Obere Str. 57	Berlin	12209	Germany
2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	05021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	05023	Mexico

<projection> CustomerID, CustomerName, City (C)

1	Alfreds Futterkiste	Berlin
2	Ana Trujillo Emparedados y helados	México D.F.
3	Antonio Moreno Taquería	México D.F.

Selection

Produce a new relation that is a subset of rows from Table C based on a condition

CustomerID	CustomerName	ContactName	Address	City	PostalCode	Country
1	Alfreds Futterkiste	Maria Anders	Obere Str. 57	Berlin	12209	Germany
2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	05021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	05023	Mexico

<selection> <Country=Mexico> (C)

2	Ana Trujillo Emparedados y helados	Ana Trujillo	Avda. de la Constitución 2222	México D.F.	5021	Mexico
3	Antonio Moreno Taquería	Antonio Moreno	Mataderos 2312	México D.F.	5023	Mexico

Product

Produce a new relation that is the combination of every row in one table combined with every row in the other.

Table C

CustomerID	CustomerName
1	Howard Snyder
2	Yoshi Lattimer
3	John Steel
4	Jaime Yorres
5	Fran Wilson
6	Rene Phillips

Table O

OrderID	CustomerID	OrderTotal
10262	1	10556.22
10269	7	124.56
10278	8	105938.44
10304	12	1034.34
10307	2	15679.02
10322	17	9305.18

Product

CustomerID	CustomerName	OrderID	CustomerID	OrderTotal
1	Howard Snyder	10262	1	10556.22
1	Howard Snyder	10269	7	124.56
1	Howard Snyder	10278	8	105938.44
1	Howard Snyder	10304	12	1034.34
1	Howard Snyder	10307	2	15679.02
1	Howard Snyder	10322	17	9305.18
2	Yoshi Lattimer	10262	1	10556.22
2	Yoshi Lattimer	10269	7	124.56
2	Yoshi Lattimer	10278	8	105938.44
2	Yoshi Lattimer	10304	12	1034.34
2	Yoshi Lattimer	10307	2	15679.02
2	Yoshi Lattimer	10322	17	9305.18
3	John Steel	10262	1	10556.22
3	John Steel	10269	7	124.56
3	John Steel	10278	8	105938.44
3	John Steel	10304	12	1034.34
3	John Steel	10307	2	15679.02
3	John Steel	10322	17	9305.18
4	Jaime Yorres	10262	1	10556.22
4	Jaime Yorres	10269	7	124.56
4	Jaime Yorres	10278	8	105938.44
4	Jaime Yorres	10304	12	1034.34
4	Jaime Yorres	10307	2	15679.02
4	Jaime Yorres	10322	17	9305.18
5	Fran Wilson	10262	1	10556.22
5	Fran Wilson	10269	7	124.56
5	Fran Wilson	10278	8	105938.44
5	Fran Wilson	10304	12	1034.34
5	Fran Wilson	10307	2	15679.02
5	Fran Wilson	10322	17	9305.18
6	Rene Phillips	10262	1	10556.22
6	Rene Phillips	10269	7	124.56
6	Rene Phillips	10278	8	105938.44
6	Rene Phillips	10304	12	1034.34
6	Rene Phillips	10307	2	15679.02
6	Rene Phillips	10322	17	9305.18

Product

CustomerID	CustomerName	OrderID	CustomerID	OrderTotal
1	Howard Snyder	10262	1	10556.22
1	Howard Snyder	10269	7	124.56
1	Howard Snyder	10278	8	105938.44
1	Howard Snyder	10304	12	1034.34
1	Howard Snyder	10307	2	15679.02
1	Howard Snyder	10322	17	9305.18
2	Yoshi Lattimer	10262	1	10556.22
2	Yoshi Lattimer	10269	7	124.56
2	Yoshi Lattimer	10278	8	105938.44
2	Yoshi Lattimer	10304	12	1034.34
2	Yoshi Lattimer	10307	2	15679.02
2	Yoshi Lattimer	10322	17	9305.18
3	John Steel	10262	1	10556.22
3	John Steel	10269	7	124.56
3	John Steel	10278	8	105938.44
3	John Steel	10304	12	1034.34
3	John Steel	10307	2	15679.02
3	John Steel	10322	17	9305.18
4	Jaime Yorres	10262	1	10556.22
4	Jaime Yorres	10269	7	124.56
4	Jaime Yorres	10278	8	105938.44
4	Jaime Yorres	10304	12	1034.34
4	Jaime Yorres	10307	2	15679.02
4	Jaime Yorres	10322	17	9305.18
5	Fran Wilson	10262	1	10556.22
5	Fran Wilson	10269	7	124.56
5	Fran Wilson	10278	8	105938.44
5	Fran Wilson	10304	12	1034.34
5	Fran Wilson	10307	2	15679.02
5	Fran Wilson	10322	17	9305.18
6	Rene Phillips	10262	1	10556.22
6	Rene Phillips	10269	7	124.56
6	Rene Phillips	10278	8	105938.44
6	Rene Phillips	10304	12	1034.34
6	Rene Phillips	10307	2	15679.02
6	Rene Phillips	10322	17	9305.18

Natural Join

Produce a new relation that combines matching rows on a common attribute.

Table C

CustomerID	CustomerName
1	Howard Snyder
2	Yoshi Lattimer
3	John Steel
4	Jaime Yorres
5	Fran Wilson
6	Rene Phillips

Table O

OrderID	CustomerID	OrderTotal
10262	1	10556.22
10269	7	124.56
10278	8	105938.44
10304	12	1034.34
10307	2	15679.02
10322	17	9305.18

Natural Join

C <join> O

CustomerID	CustomerName	OrderID	CustomerID	OrderTotal
1	Howard Snyder	10262	1	10556.22
2	Yoshi Lattimer	10307	2	15679.02

Summary

- E. F. Codd used the concepts of Relational Algebra to define the concepts and operations of the Relational Database
- The SQL language directly incorporates Relational Algebra operations