Set Theory: Subsets

Let S and T be arbitrary sets.

Subset

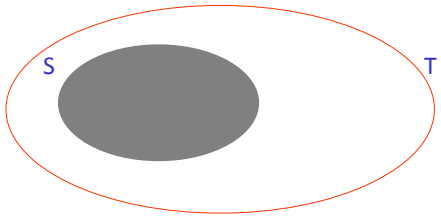
If the set S only contains elements of the set T(or equivalently doesn't contain any elements not in the set T) we say that S is a subset of T and write:

$$S \subseteq T$$

Set Theory: Picture of a Subset

Subset

If the set S only contains elements of the set T (or equivalently doesn't contain any elements not in the set T) we say that S is a subset of T and draw:



Set Theory: Subsets

Note:

One can create a subset of a set W by removing zero or more elements from W.

That is, a set is always a subset of itself, and the empty set is a subset of every set.

Set Theory: Power Set

Let S be an arbitrary set.

Power Set of a Set

The power set of a set is the set of all the subsets of the set and is written:

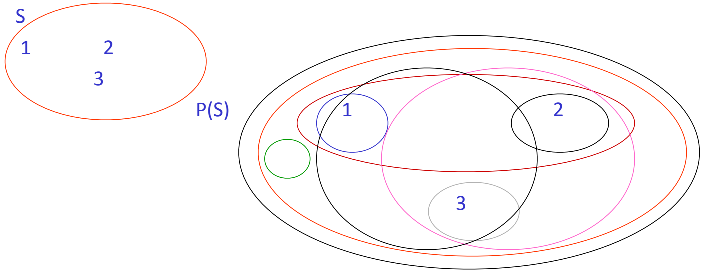
P (S)

Note: If the set S has n elements then the set P(S) has 2^n elements.

Set Theory: Picture of a Power Set

Power Set

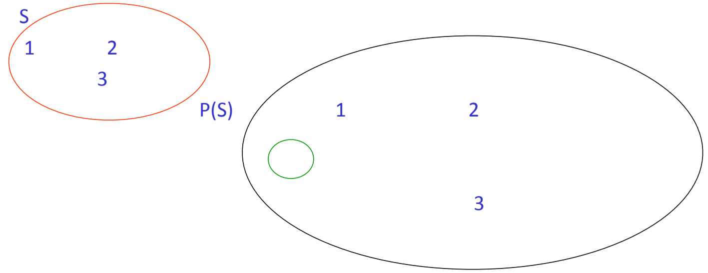
The power set of a set is the set of all the subsets of the set and is drawn:



Set Theory: Picture of a Power Set

Power Set

The power set of a set is the set of all the subsets of the set and is drawn:



Set Theory: Picture of a Power Set

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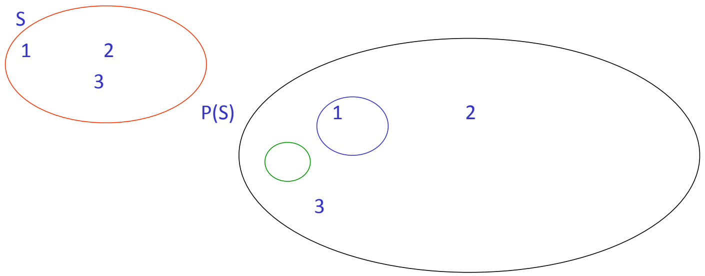

Set Theory: Picture of a Power Set

Power Set

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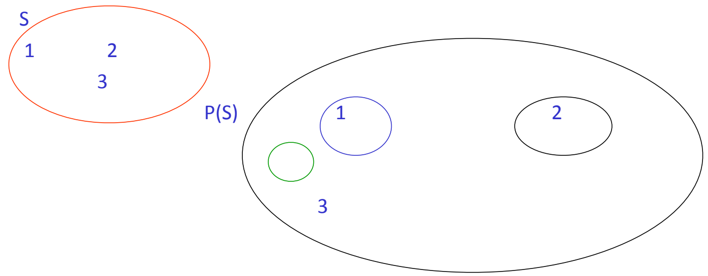

Set Theory: Picture of a Power Set

Power Set

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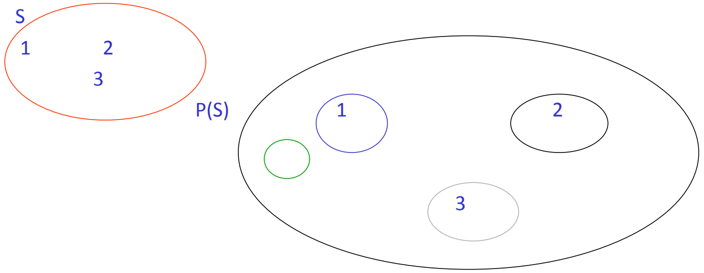
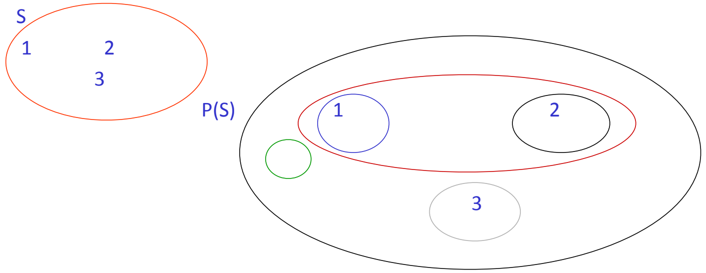


Set Theory: Picture of a Power Set

Power Set

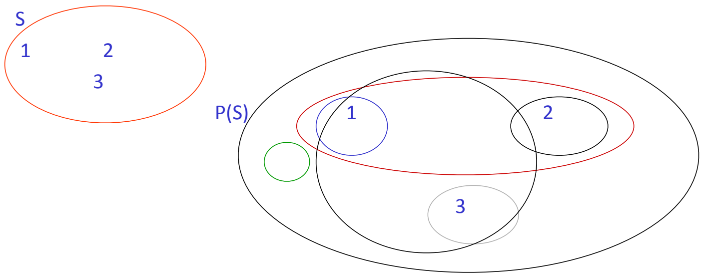
The power set of a set is the set of all the subsets of the set and is drawn:



Set Theory: Picture of a Power Set

Power Set

The power set of a set is the set of all the subsets of the set and is drawn:



Set Theory: Picture of a Power Set

Power Set

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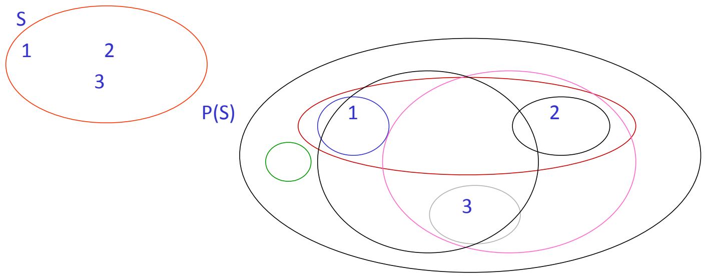
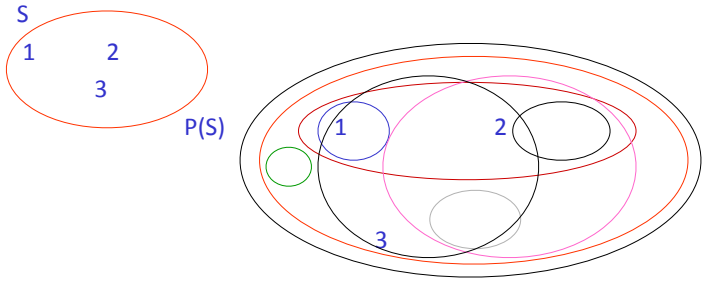


Set Theory: Picture of a Power Set

Power Set

The power set of a set is the set of all the subsets of the set and is drawn:



Null

Null is a value that we use when

Something will never have a value
Something will have a value in the future
Something had a value but doesn't at the moment

Null

Null is a reserved word in SQL and has special meaning

It is NOT the same as zero...

...consider the COMM attribute in the emp relation

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
405	MARCH	ADMIN	938	13/06/1997	18000		2
535	BYRNE	SALES	734	15/08/1997	26000	300	3
557	BELL	SALES	734	26/03/2000	22500	500	3
602	BIRD	MANAGER	875	31/10/1997	39750		2
690	AHMAD	SALES	734	05/12/1997	22500	1400	3

Null

Access uses a blank cell to indicate a NULL

EMPNO	ENAME	JOB	MGR	HIREDATE	SAL	COMM	DEPTNO
405	MARCH	ADMIN	938	13/06/1997	18000		2
535	BYRNE	SALES	734	15/08/1997	26000	300	3
557	BELL	SALES	734	26/03/2000	22500	500	3
602	BIRD	MANAGER	875	31/10/1997	39750		2
690	AHMAD	SALES	734	05/12/1997	22500	1400	3
734	COX	MANAGER	875	11/06/2002	38500		3
818	POLLARD	MANAGER	875	14/05/2000	34500		1
824	REES	ANALYST	602	05/03/2000	40000		2
875	PARKER	PRESIDENT		09/07/2002	60000		1
880	TURNER	SALES	734	04/06/2001	25000	0	3
912	HAYES	ADMIN	824	04/06/2001	21000		2
936	CASSY	ADMIN	734	23/07/2002	19500		3
938	GIBSON	ANALYST	602	05/12/1997	40000		2
970	BLACK	ADMIN	818	21/11/1997	23000		1

Note how Turner is allowed to earn commission, but hasn't yet

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff

```
select * or expression
from relations
[where expression]
```

table name goes here

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff


```
select * or expression
from emp
[where expression]
```

table name goes here

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff


```
select * or expression
from emp
[where expression]
```

projection expressions go here

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff


```
select ename, sal, comm, sal+comm
from emp
[where expression]
```

projection expressions go here

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff

```
select ename, sal, comm, sal+comm
from emp
[where expression]
```

selection expressions go here

Null

Problems arise when we try to perform mathematical operations on NULL in SQL

Find the total earnings (salary + commission) for staff

```
select ename, sal, comm, sal+comm
from emp
```

Null

Find the total earnings (salary + commission) for staff

```
select ename, sal, comm, sal+comm
from emp
```

ename	sal	comm	Expr1003
MARCH	18000		
BYRNE	26000	300	26300
BELL	22500	500	23000
BIRD	39750		
AHMAD	22500	1400	23900
COX	38500		
POLLARD	34500		
REES	40000		
PARKER	60000		
TURNER	25000	0	25000
HAYES	21000		
CASSY	19500		
GIBSON	40000		
BLACK	23000		

Null

Problem:

any value + null returns null

ename	sal	comm	Expr1003
MARCH	18000		
BYRNE	26000	300	26300
BELL	22500	500	23000
BIRD	39750		
AHMAD	22500	1400	23900
COX	38500		
POLLARD	34500		
REES	40000		
PARKER	60000		
TURNER	25000	0	25000
HAYES	21000		
CASSY	19500		
GIBSON	40000		
BLACK	23000		

Null

Solution: nz(attribute) function

Returns either zero or a value from the corresponding attribute

Use this on an attribute that may contain nulls before performing calculations

Null

Solution: nz(attribute) function

nz(null) → 0 — Returns zero, which we can then use in a calculation

nz(14) → 14 — Returns 14, which we can then use in a calculation

nz(comm) → comm values — Returns comm values, replacing nulls with 0

Null

Find the total earnings (salary + commission) for staff

```
select ename, sal, comm, sal+comm
from emp
```

ename	sal	comm	Expr1003
MARCH	18000		
BYRNE	26000	300	26300
BELL	22500	500	23000
BIRD	39750		
AHMAD	22500	1400	23900
COX	38500		
POLLARD	34500		
REES	40000		
PARKER	60000		
TURNER	25000	0	25000
HAYES	21000		
CASSY	19500		
GIBSON	40000		
BLACK	23000		

Null

Find the total earnings (salary + commission) for staff

```
select ename, sal, comm, sal+nz(comm)
from emp
```

ename	sal	comm	Expr1003
MARCH	18000		18000
BYRNE	26000	300	26300
BELL	22500	500	23000
BIRD	39750		39750
AHMAD	22500	1400	23900
COX	38500		38500
POLLARD	34500		34500
REES	40000		40000
PARKER	60000		60000
TURNER	25000	0	25000
HAYES	21000		21000
CASSY	19500		19500
GIBSON	40000		40000
BLACK	23000		23000

Relational Algebra operations

Selection	σ
Projection	π
Cartesian Product	×
Union	∪
Set Difference	-
Join	⋈
Intersection	∩
Division	÷

Relational Algebra operations

Selection	σ
Projection	π
Cartesian Product	×
Union	∪
Set Difference	-
Join	⋈
Intersection	∩
Division	÷

Relational Algebra operations

Selection	σ
Projection	π
Cartesian Product	×
Union	∪
Set Difference	-
Join	⋈
Intersection	∩
Division	÷

Choose particular columns

Relational Algebra operations

Selection	σ
Projection	π
Cartesian Product	×
Union	∪
Set Difference	-
Join	⋈
Intersection	∩
Division	÷

Choose particular rows

Relational Algebra operations

Selection	σ
Projection	π
Cartesian Product	×
Union	∪
Set Difference	-
Join	⋈
Intersection	∩
Division	÷

Combine relations

How to write RA expressions for dummies

Step 1: Identify the relations required and CP them together

Step 2: Add required selections to make the CP into an appropriate Join

Step 3: Add any other selections required for the query

Step 4: Add appropriate projections to get the required attributes for the query

RA example

Show the name, job, sal and location for all staff with a salary greater than £25,000

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RA example

Show the name, job and location for all staff with a salary greater than £25,000

Step 1: Identify the relations required and CP them together

Requires 2 tables EMP and DEPT

$emp \times dept$

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Step 2: Add required selections to make the CP into an appropriate Join

$emp \times dept$

RA example

Show the name, job and location for all staff with a salary greater than £25,000

Step 2: Add required selections to make the CP into an appropriate Join

$$\sigma_{emp.deptno=dept.deptno}(emp \times dept)$$

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$$\sigma_{emp.deptno=dept.deptno}(emp \times dept)$$

RA example

Show the name, job and location for all staff with a salary greater than £25,000

Step 3: Add any other selections required for the query

$$\sigma_{emp.deptno=dept.deptno}(emp \times dept)$$

$$\sigma_{sal>25000}(\sigma_{emp.deptno=dept.deptno}(emp \times dept))$$

Note

Alternatives here: could simply use an AND

$$\sigma_{sal>25000}(\sigma_{emp.deptno=dept.deptno}(emp \times dept))$$

Would be the same as

$$\sigma_{(emp.deptno=dept.deptno)\ AND\ sal>25000}(emp \times dept)$$

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$$\sigma_{sal>25000}(\sigma_{emp.deptno=dept.deptno}(emp \times dept))$$

RA example

Show the name, job and location for all staff with a salary greater than £25,000

Step 4: Add appropriate projections to get the required attributes for the query

$$\sigma_{sal>25000}(\sigma_{emp.deptno=dept.deptno}(emp \times dept))$$

$$\pi_{ename,\ job,\ loc}(\sigma_{sal>25000}(\sigma_{emp.deptno=dept.deptno}(emp \times dept)))$$

Important

Watch out for projections BEFORE selections - check they still work

$$\sigma_{sal>25000}(\pi_{ename, job, loc}(\sigma_{emp.deptno=dept.deptno}(emp \times dept)))$$

This produces an empty set (or an error result). Why?

How to write SQL expressions for dummies

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SQL example

Show the name, job and location for all staff with a salary greater than £25,000

Step 1: Identify the tables required and CP them together

Requires 2 tables EMP and DEPT

```
select * or expression          projections here
from table(s)                   CPs here
[where expression]              selections here
```

SQL example

Show the name, job and location for all staff with a salary greater than £25,000

Step 1: Identify the tables required and CP them together

Requires 2 tables EMP and DEPT

```
select * or expression          projections here
from emp, dept                  CPs here
[where expression]              selections here
```

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Step 2: Add required conditions to make the CP into an appropriate Join

```
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from emp, dept                  CPs here
[where expression]              selections here
```

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Show the name, job and location for all staff with a salary greater than £25,000

Step 2: Add required conditions to make the CP into an appropriate Join

```
select * or expression          projections here
from emp, dept                  CPs here
where emp.deptno=dept.deptno    selections here
```

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Step 3: Add any other conditions required for the query

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Show the name, job and location for all staff with a salary greater than £25,000

Step 3: Add any other conditions required for the query

```
select * or expression          projections here
from emp, dept                  CPs here
where emp.deptno=dept.deptno    selections here
```

SQL example

Show the name, job and location for all staff with a salary greater than £25,000

Step 3: Add any other conditions required for the query

```
select * or expression                  projections here
from emp, dept                          CPs here
where emp.deptno=dept.deptno            selections here
    and sal > 25000
```

How to write SQL expressions for dummies

Step 1: Identify the tables required and CP them together

Step 2: Add required conditions to make the CP into an appropriate Join

Step 3: Add any other conditions required for the query

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SQL example

Show the name, job and location for all staff with a salary greater than £25,000

Step 4: Add appropriate projections to get the required columns for the query

```
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from emp, dept                          CPs here
where emp.deptno=dept.deptno            selections here
    and sal > 25000
```

SQL example

Show the name, job and location for all staff with a salary greater than £25,000

Step 4: Add appropriate projections to get the required columns for the query

```
select ename, job, loc                  projections here
from emp, dept                          CPs here
where emp.deptno=dept.deptno            selections here
    and sal > 25000
```