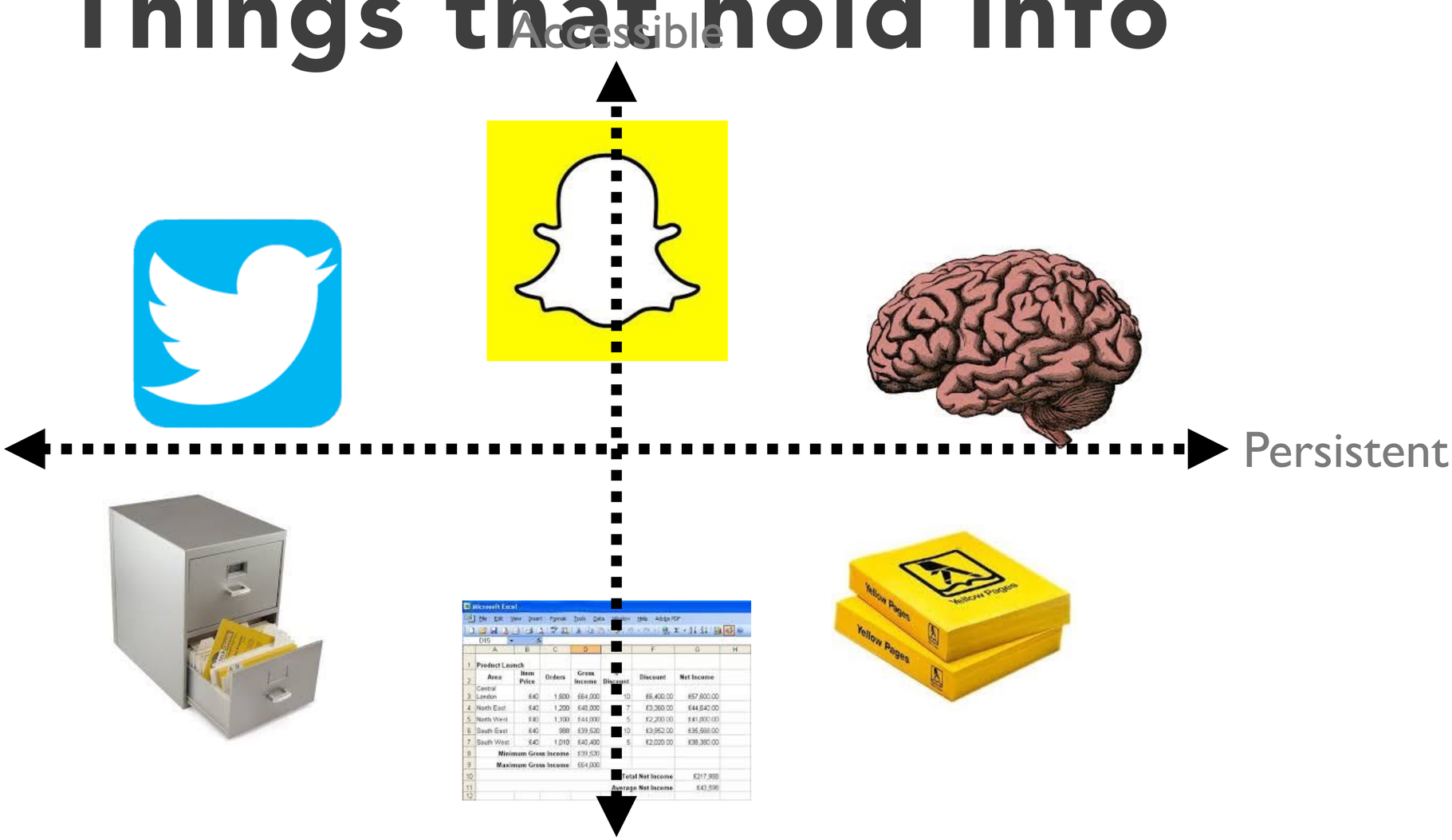
Intro to Databases

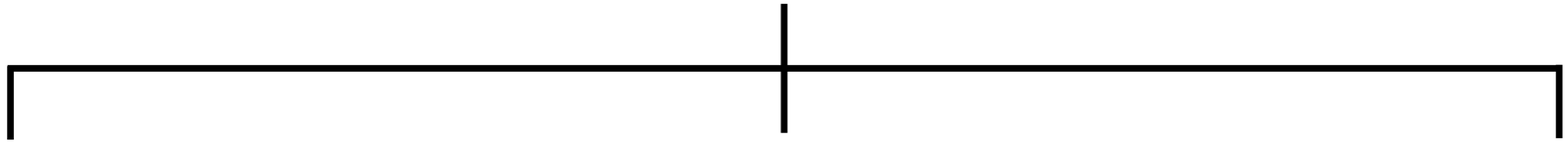
SQL

What is a database?

Things that hold info



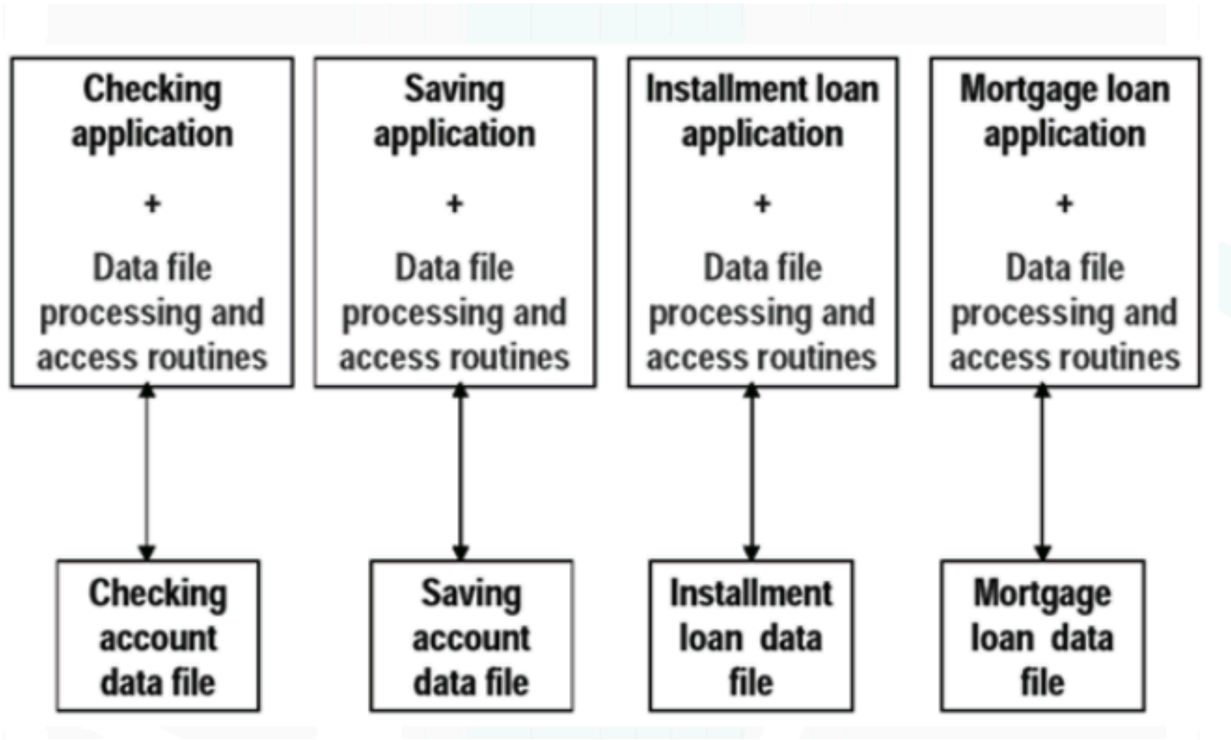
A database **persists** information and is **accessible** via code



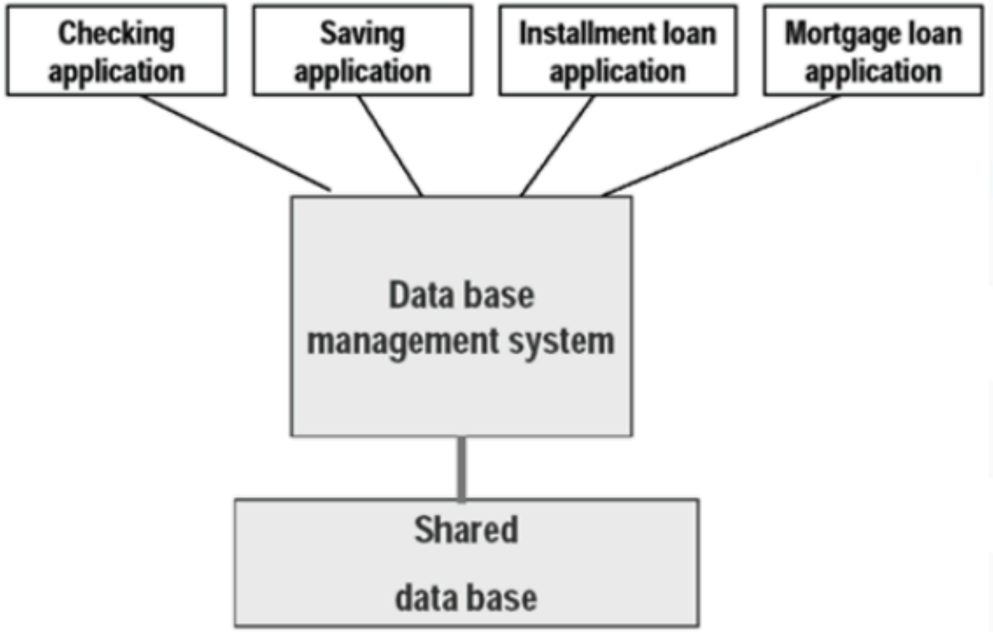
organized **queryable** **manageable**

Before Relational DBs (ca. < 1970s)

- Data stored in custom “data files”
- Queried via application-specific code
- Advantages
  - Middle layer not needed
  - Solutions customized for each application
- Disadvantages
  - Hard to change the system
  - Knowledge not compounding
  - Data-transfer is difficult



Database Management Systems (DBMS)

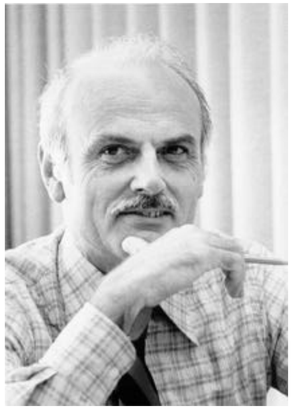


- One layer and language to store and access data
- Sold as a way for “non-technical people” to manage data

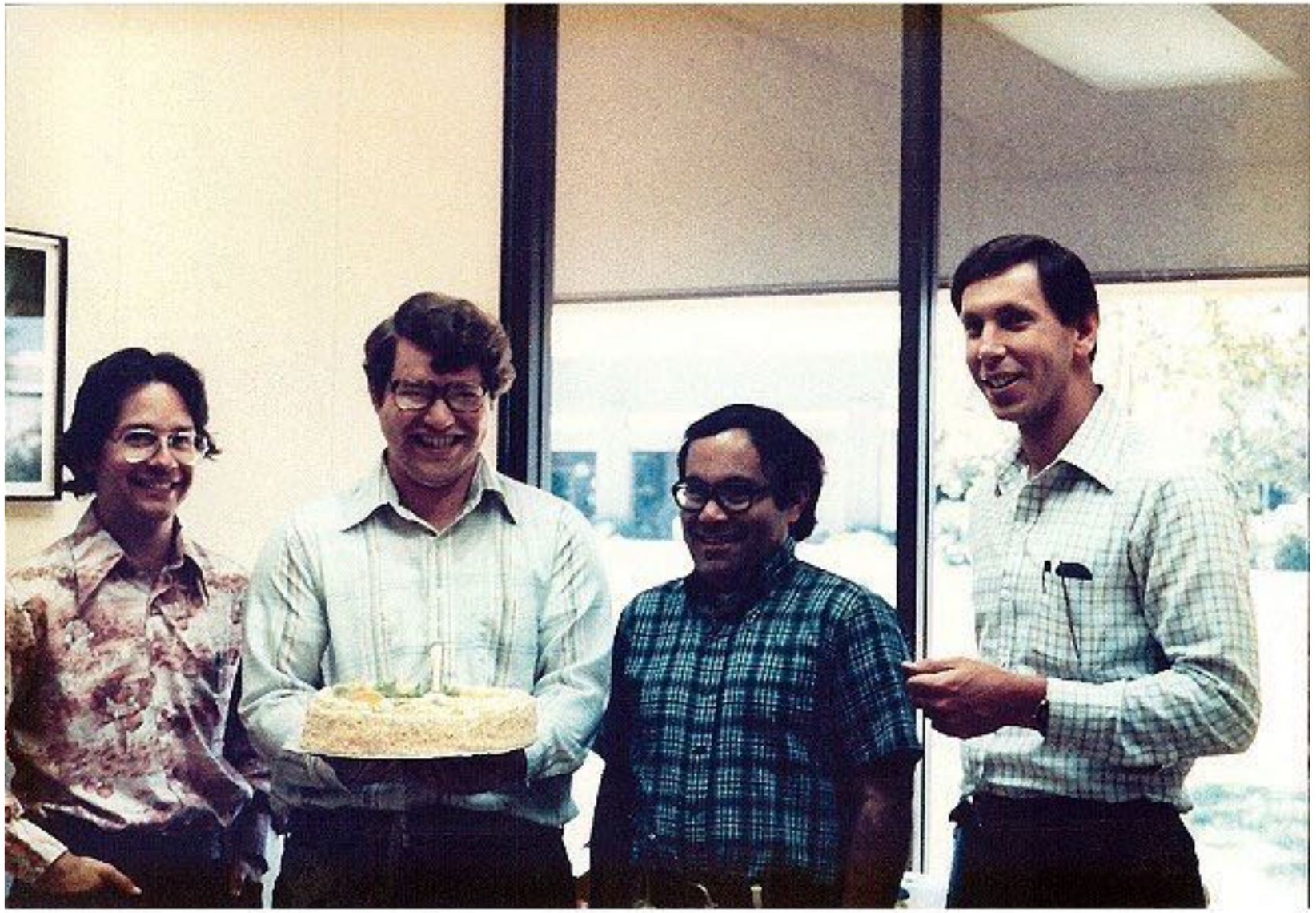
“Future users of large data banks must be protected from having to know how the data is organized in the machine (the internal representation).”

– E. F. CODD,
A RELATIONAL MODEL OF DATA FOR
LARGE SHARED DATA BANKS

Relational Databases & Logic



- **1969: Edgar Frank "Ted" Codd outlines *relational model* of data**
- **Wrote Alpha (never implemented) as a *query language***
- **IBM slow to adopt his ideas**
  - Competitors started to do so
  - IBM team formed without Codd, created **S**tructured **E**nglish **Qu**ery **L**ang
- **SEQUEL way better than what came before**
  - 1979: copied by Larry Ellison (from pre-launch papers / talks!) as "SQL"
- **SQL became the standard (ANSI 1986, ISO 1987)**
  - Codd continued to fault SQL compared to his theoretical model
  - The Third Manifesto: solve the *object-relational impedance mismatch*



Oracle

- Ed Oates
- Bruce Scott
- Bob Miner
- Larry Ellison

Appreciating Databases

- **Ubiquitous**
- **Standardized**
- **Complex / deep**
- **Powerful: database admins are**
  - Feared by developers
  - …but also taken for granted until things break
  - Befriended by business people
  - Contacted by the government for secret data (e.g. NSA)

RDBMS

- **Data is stored in relations (tables)**
- **A simple, structured query language: SQL**
  - Programmers can specify what answers a query should return, but not how the query is executed or where and how the data is stored
  - DBMS picks an execution strategy based on indexes, data, workload etc.
- **Multi-user, Multi-threaded**
  - Multiple processes can access database at same time

ACID Guarantees

- Atomicity
- Consistency
- Isolation
- Durability

Definitions in a Relational Database

- DBs are a collection of Tables (or relations)
- Tables have Columns (attributes) and Rows (instances or tuples)
- Duplicate rows are not allowed
- Rows often have a primary key (ID)

Schema and Content

- Schema: table's blueprint for data shape/format
- Content: actual data (a row) e.g. {1, "Bart S.", 10, "M"}
- A schema is used to validate incoming content

SQL

SQL is used to create/read/update/delete (CRUD) data from a database

- INSERT: Insert new rows into a table
- SELECT: Get data from a database
- UPDATE: Update existing rows in a table
- DELETE: Delete rows from a table
- CREATE: Make new tables/views/indexes

Example DB

Student

ID	Name	Age	Gender
1	Bart S.	10	M
2	Lisa S.	8	F
3	Jim F.	13	M
4	Joan B.	15	F

Enrollment

StudentID	SchoolID
1	1
2	1
3	2
4	3

School

ID	Name	Level
1	Springfield Elementary	E
2	Brook Middle	M
3	Springbrook High	H
4	Simpson Univ	U

SQL by Example — Select

Student

ID	Name	Age	Gender
1	Bart S.	10	M
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```
SELECT *
FROM Student
WHERE age > 12
```

ID	Name	Age	Gender
3	Jim F.	13	M
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SQL by Example — Select

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ID	Name	Age	Gender
1	Bart S.	10	M
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3	Jim F.	13	M
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```
SELECT name, age
FROM Student
WHERE age > 12
```

Name	Age
Jim F.	13
Joan B.	15

https://lol.browserling.com/tables.png

A more interesting select

Let's say we want to find **all students from Springfield Elementary**
The student table doesn't list the school.
We have to use the enrollment table. Will this take two steps?

Student

ID	Name	Age	Gender
1	Bart S.	10	M
2	Lisa S.	8	F
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A more interesting select

In fact, we can find all the students from Springfield Elementary (ID: 1) in one SQL statement using a JOIN
A SQL JOIN is used to combine rows from two or more tables, based on a common field between them.
Can you visualize it?

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SQL Joining

If we joined the **Student** and **School** tables using the data in the Enrollment table, here is how it could look

Student ID	Name	Age	Gender	School ID	School Name	Level
1	Bart S.	10	M	1	Springfield Elementary	E
2	Lisa S.	8	F	1	Springfield Elementary	E
3	Jim F.	13	M	2	Brook Middle	M
4	Joan B.	15	F	3	Springbrook High	H

```
SELECT *
FROM
    Student INNER JOIN Enrollment ON Student.id = Enrollment.StudentID
    INNER JOIN School ON Enrollment.SchoolID = School.id
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Student ID	Name	Age	Gender	School ID	School Name	Level
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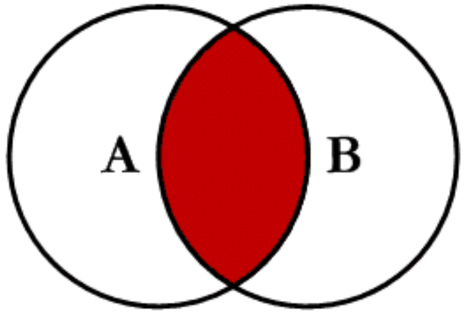
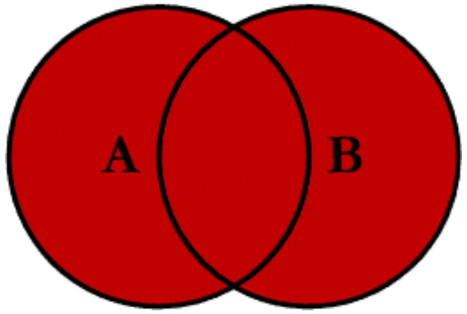
```
SELECT *
FROM
    Student INNER JOIN Enrollment ON Student.id = Enrollment.StudentID
    INNER JOIN School ON Enrollment.SchoolID = School.id
WHERE Enrollment.SchoolID = 1
```

Inner Join



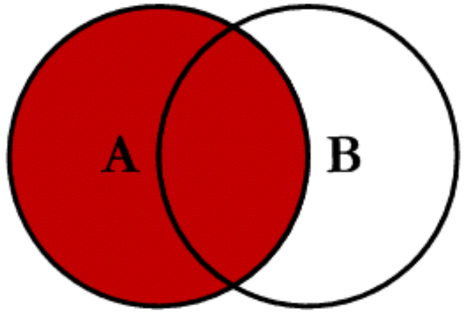

```
SELECT *
FROM A
INNER JOIN B
ON A.Key = B.Key
```

Outer Join



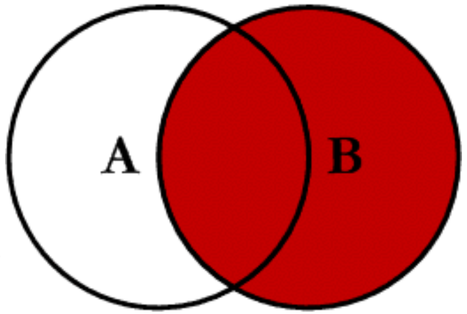

```
SELECT *
FROM A
FULL OUTER JOIN B
ON A.Key = B.Key
```

Left Join




```
SELECT *
FROM A
LEFT JOIN B
ON A.Key = B.Key
```

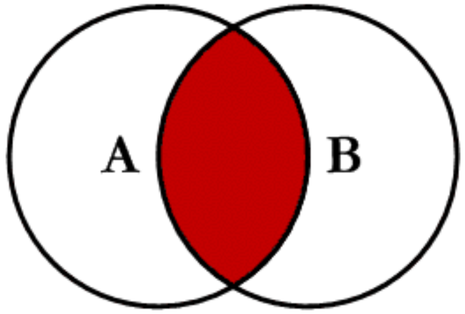
Right Join




```
SELECT *
FROM A
RIGHT JOIN B
ON A.Key = B.Key
```

http://www.codeproject.com/Articles/33052/Visual-Representation-of-SQL-Joins

Inner Join




```
SELECT pets.name, owners.name
FROM owners
INNER JOIN pets
ON pets.OwnerID = owners.ID
```

OWNERS

ID	name
1	Geordi
2	Janeway
3	Data
4	Spok

PETS

ID	ownerID	type	name
1	4	Monkey	Mittens
2	null	Lizard	Carol
3	1	Dog	Rufus
4	2	Cat	Fireball

pets.name	owners.name
Mittens	Spok
Rufus	Geordi
Fireball	Janeway

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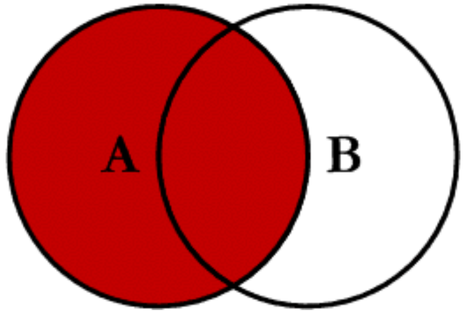


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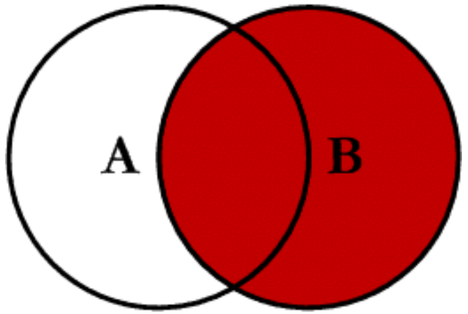


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Outer Join

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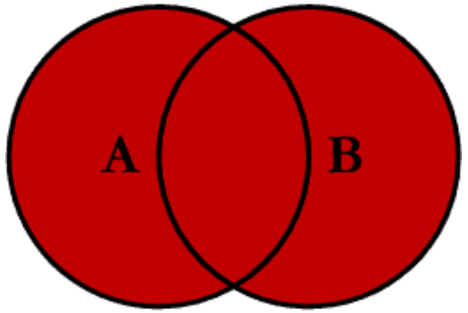


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WORKSHOP