COMP3005

Database Management Systems (DBMS)

Instructors

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Associate Professor,
School of Computer Science, Carleton University

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Ph.D. Candidate,
School of Computer Science, Carleton University

What is a Database Management System (DBMS)?

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Program =

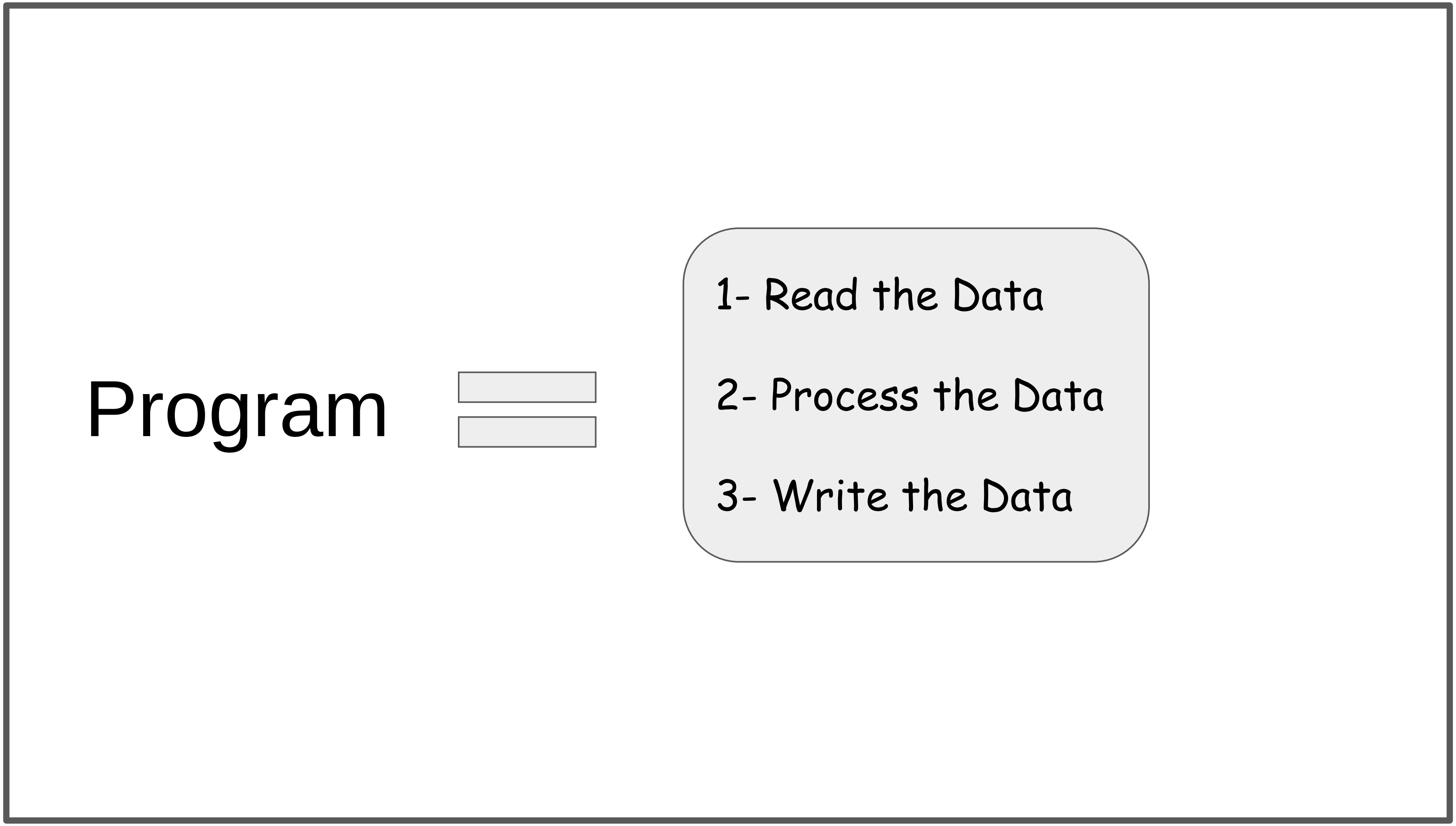
1- Read the Data

2- Process the Data

3- Write the Data

What is a Database Management System (DBMS)?

Computer = Microprocessor + RAM



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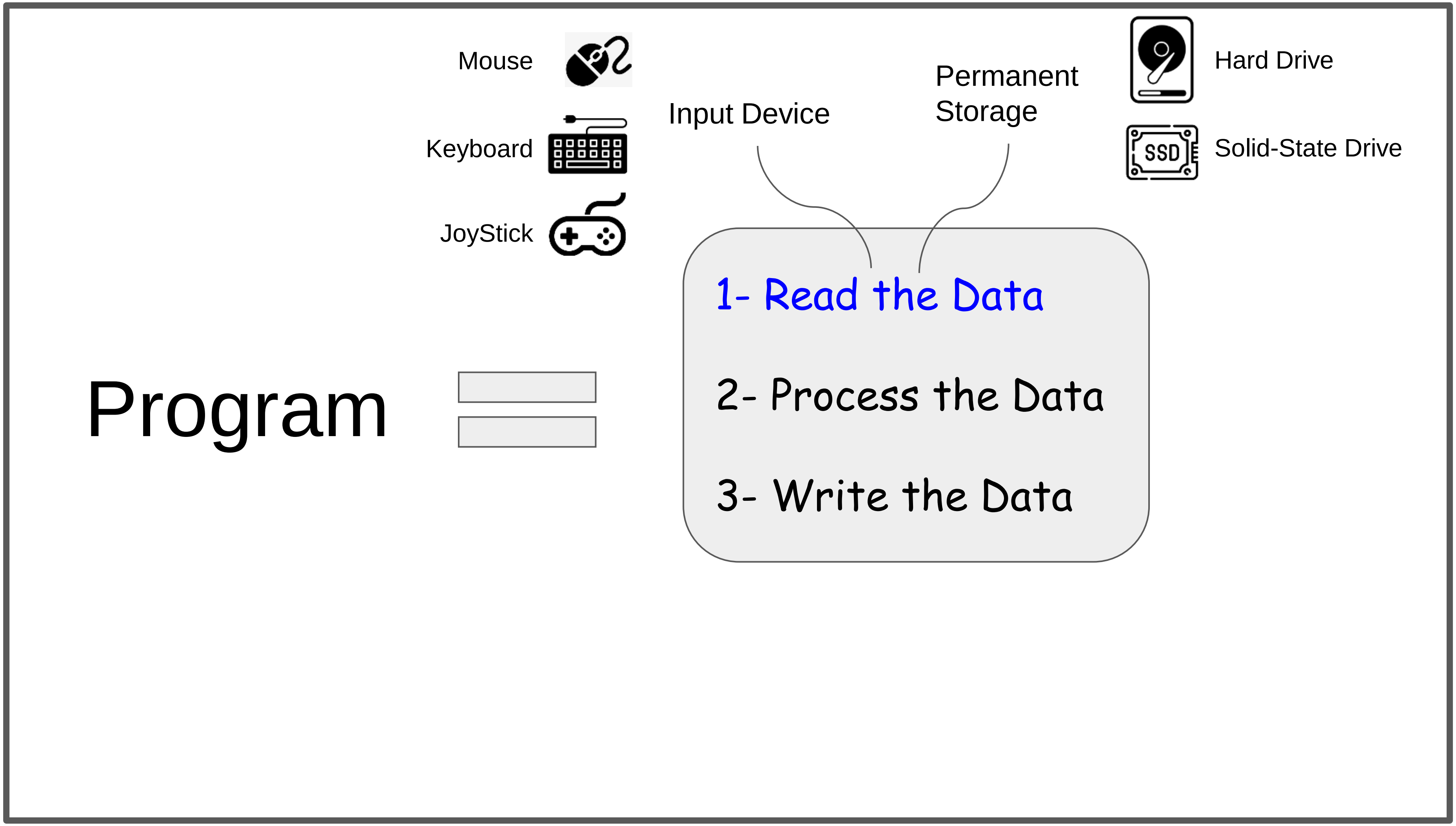

Mouse

Keyboard

JoyStick

Input Device

Permanent Storage

Hard Drive

Solid-State Drive

Program =

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Into

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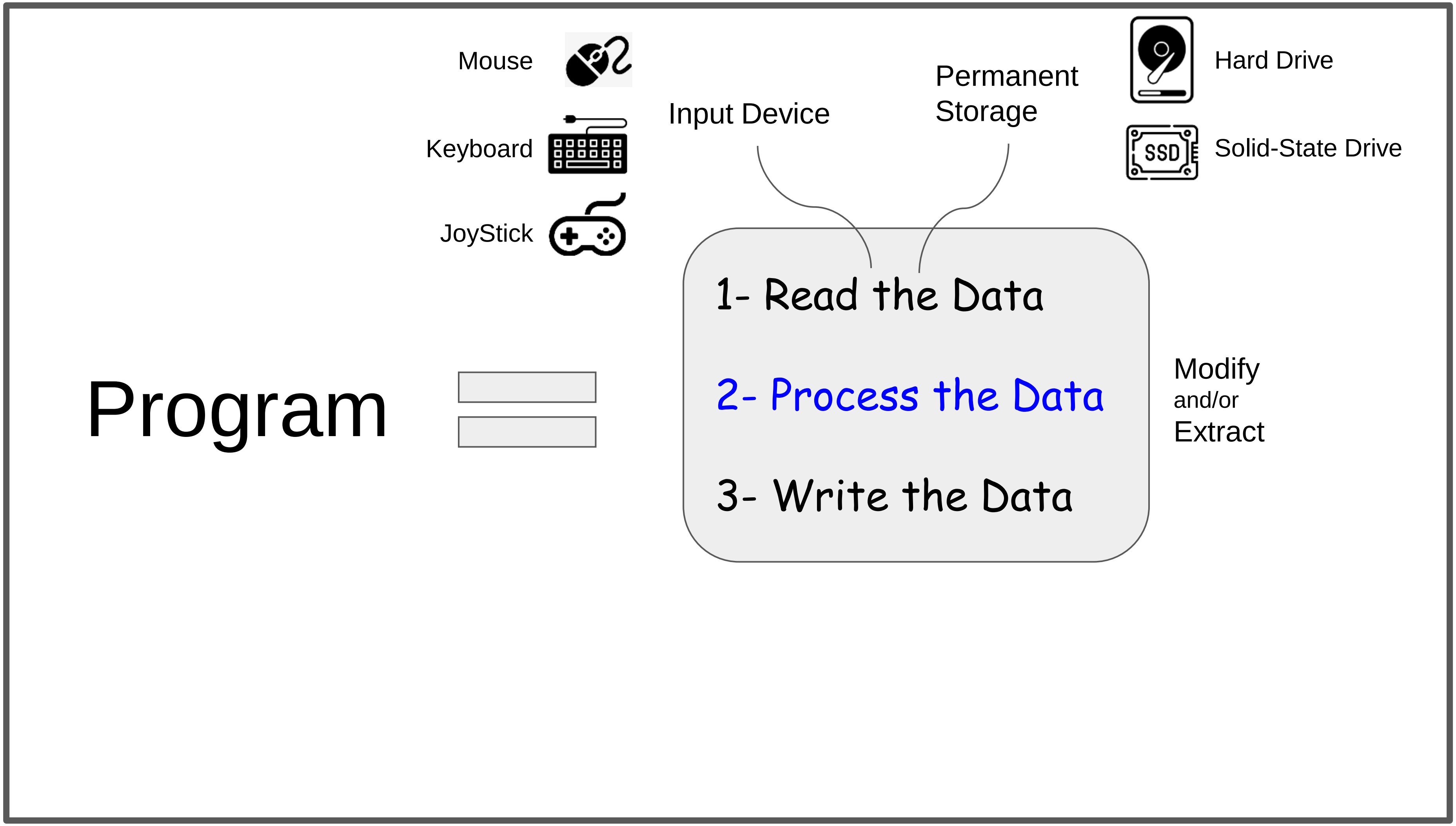

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Modify and/or Extract

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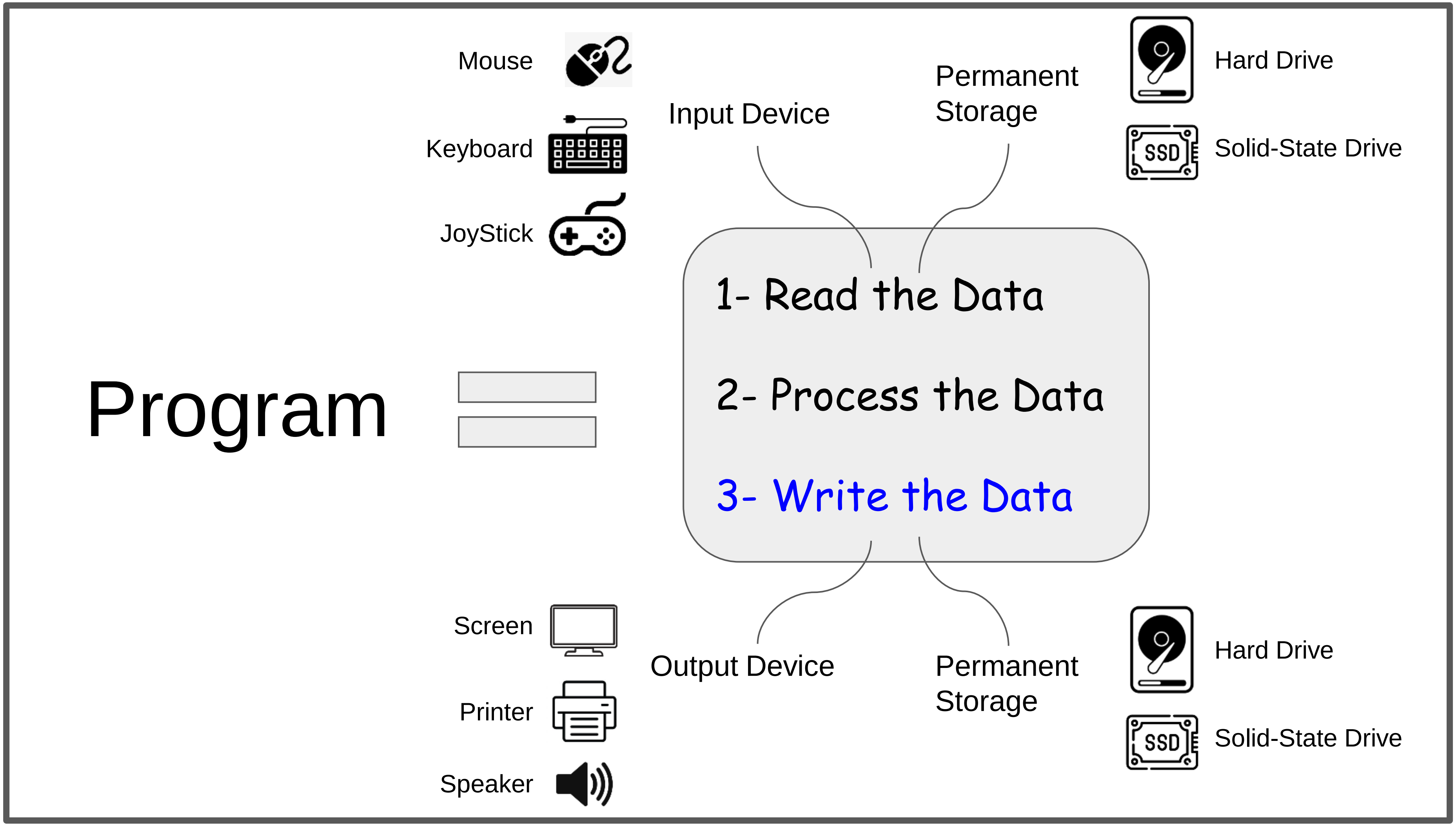

Program =

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Input Device

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Output Device

Screen

Printer

Speaker

Permanent Storage

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Solid-State Drive

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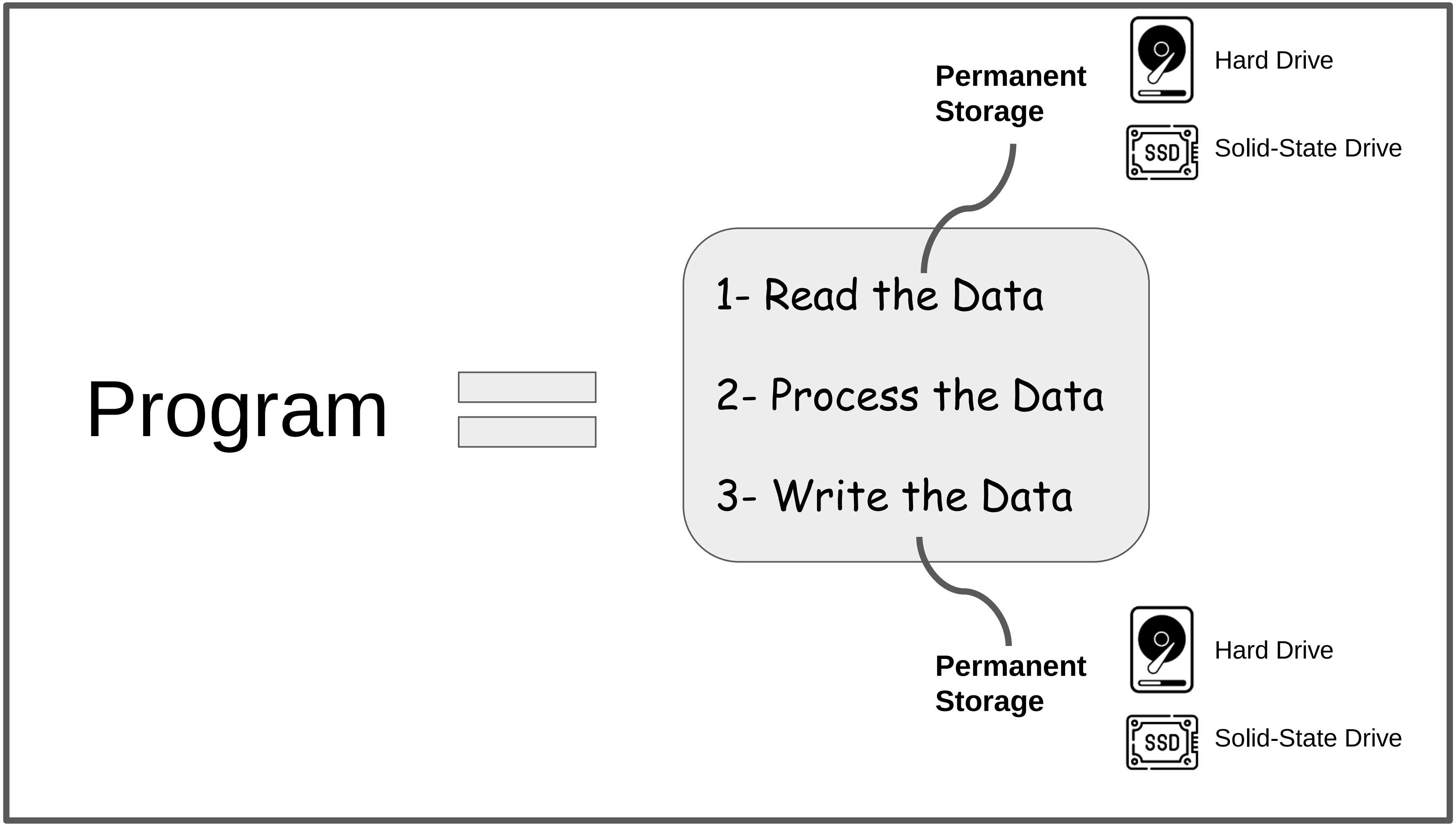

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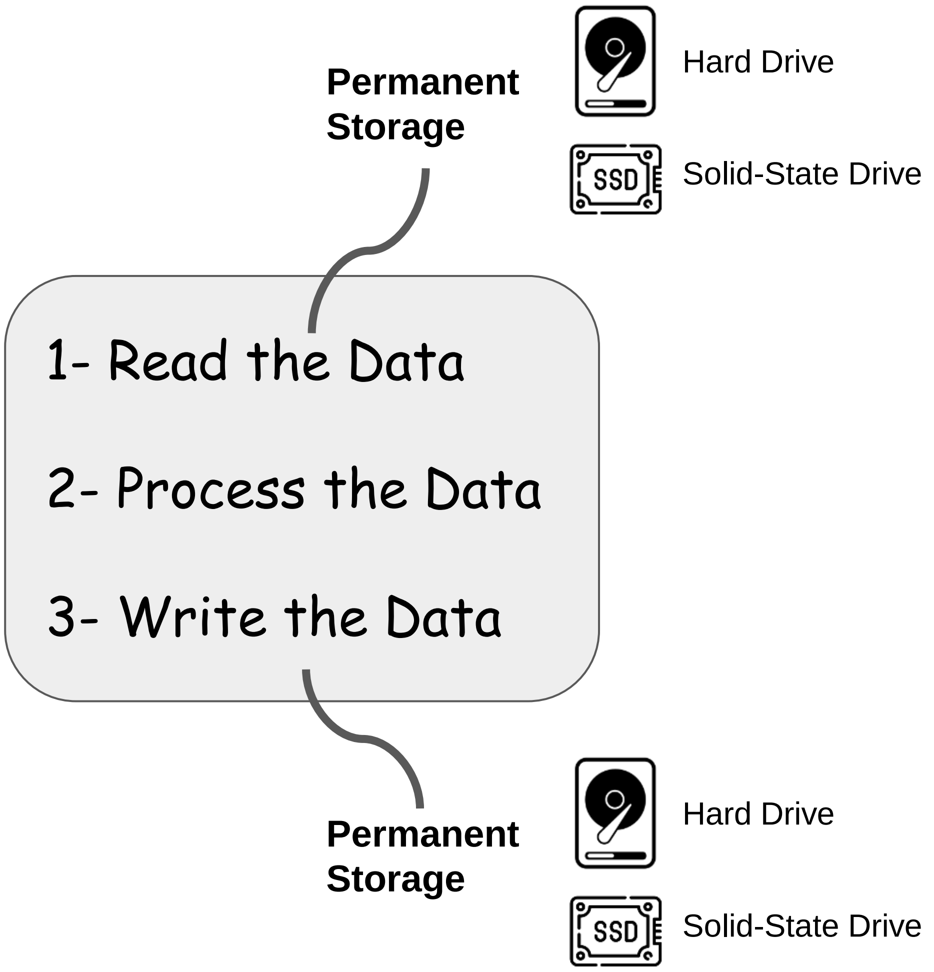
Traditional **file processing**

Each user defines and implements the files needed for a specific software application



Permanent Storage

Hard Drive

Solid-State Drive

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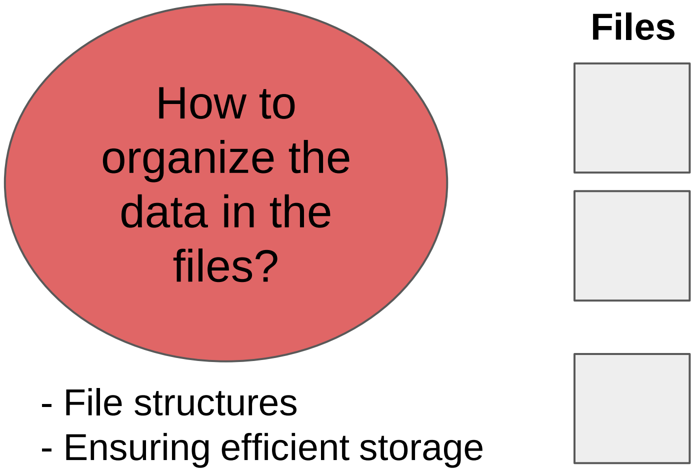
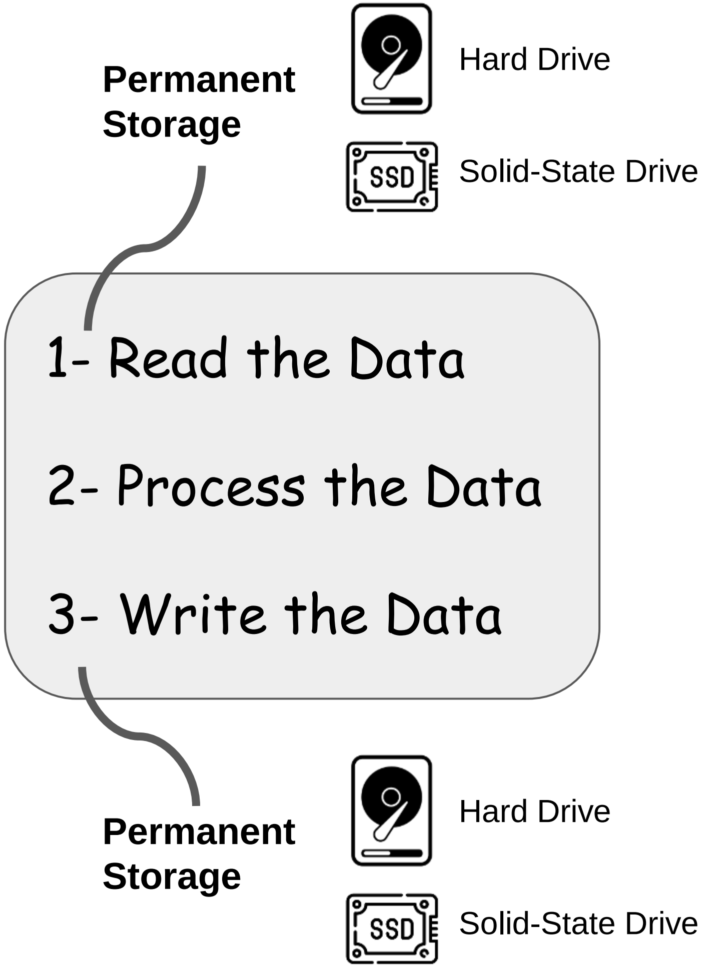


- File structures
- Ensuring efficient storage
- Ensuring efficient retrieval



Computer = Microprocessor + RAM

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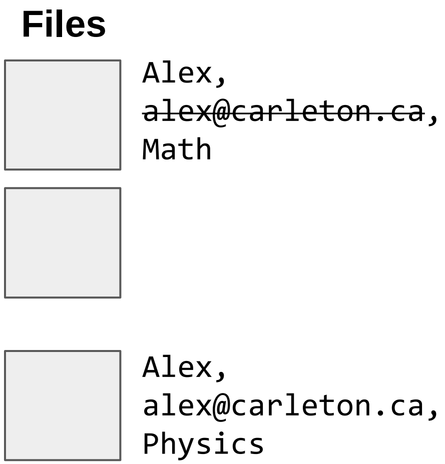
Each user defines and implements the files needed for a specific software application

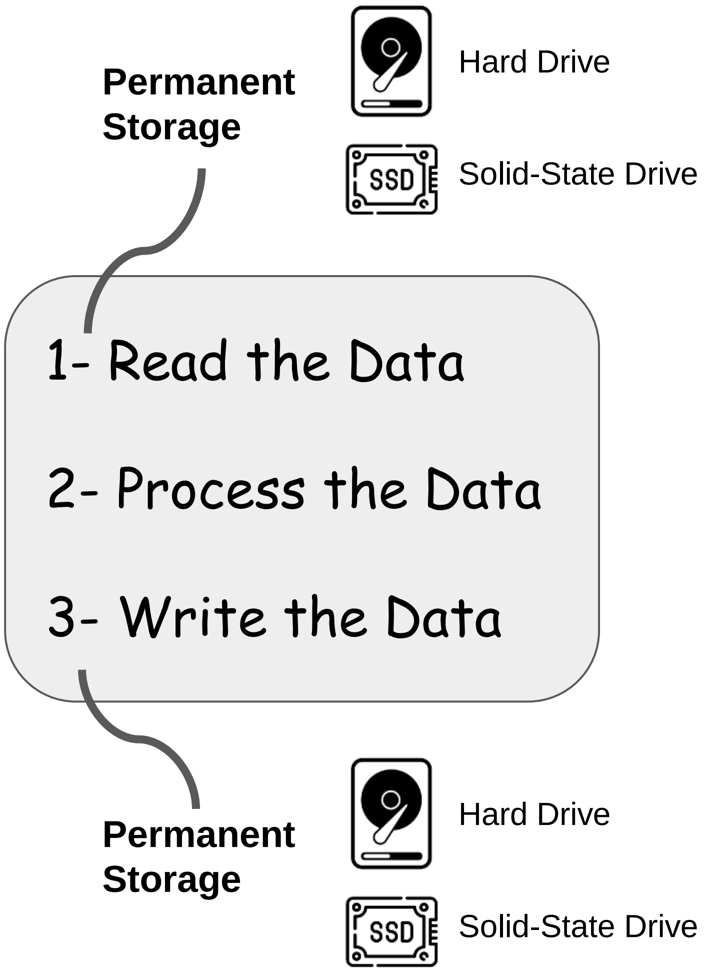
How to avoid data inconsistency

- Different copies of the same data.
- Lack of synchronization



Alex,
~~alex@carleton.ca~~,
Math

Alex,
alex@carleton.ca,
Physics



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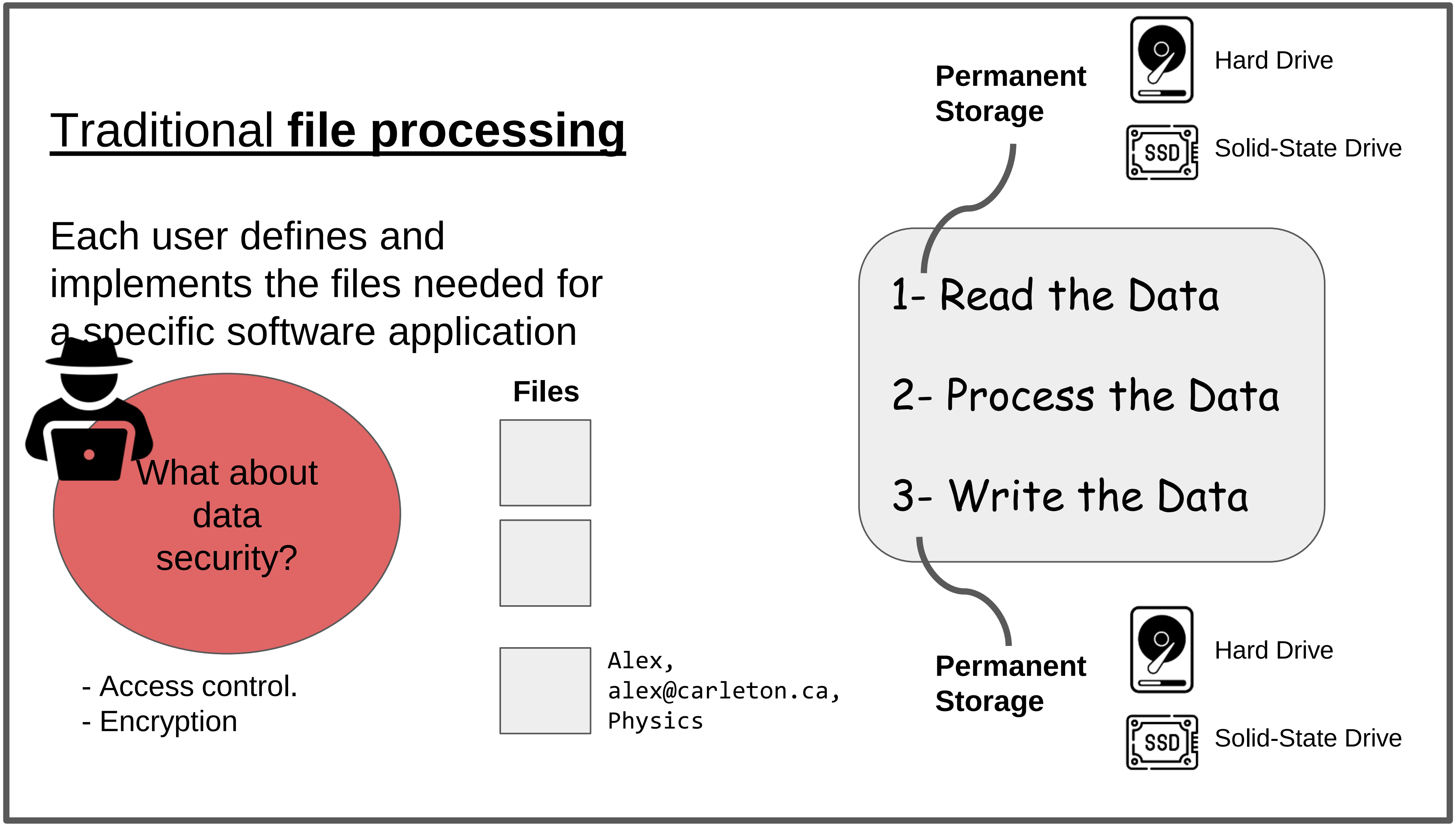

Traditional **file processing**

Each user defines and implements the files needed for a specific software application

What about data security?

- Access control.
- Encryption

Files

```
Alex,
alex@carleton.ca,
Physics
```

Permanent Storage

Hard Drive

Solid-State Drive

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Permanent Storage

Hard Drive

Solid-State Drive

What is a Database Management System (DBMS)?

Computer = Microprocessor + RAM

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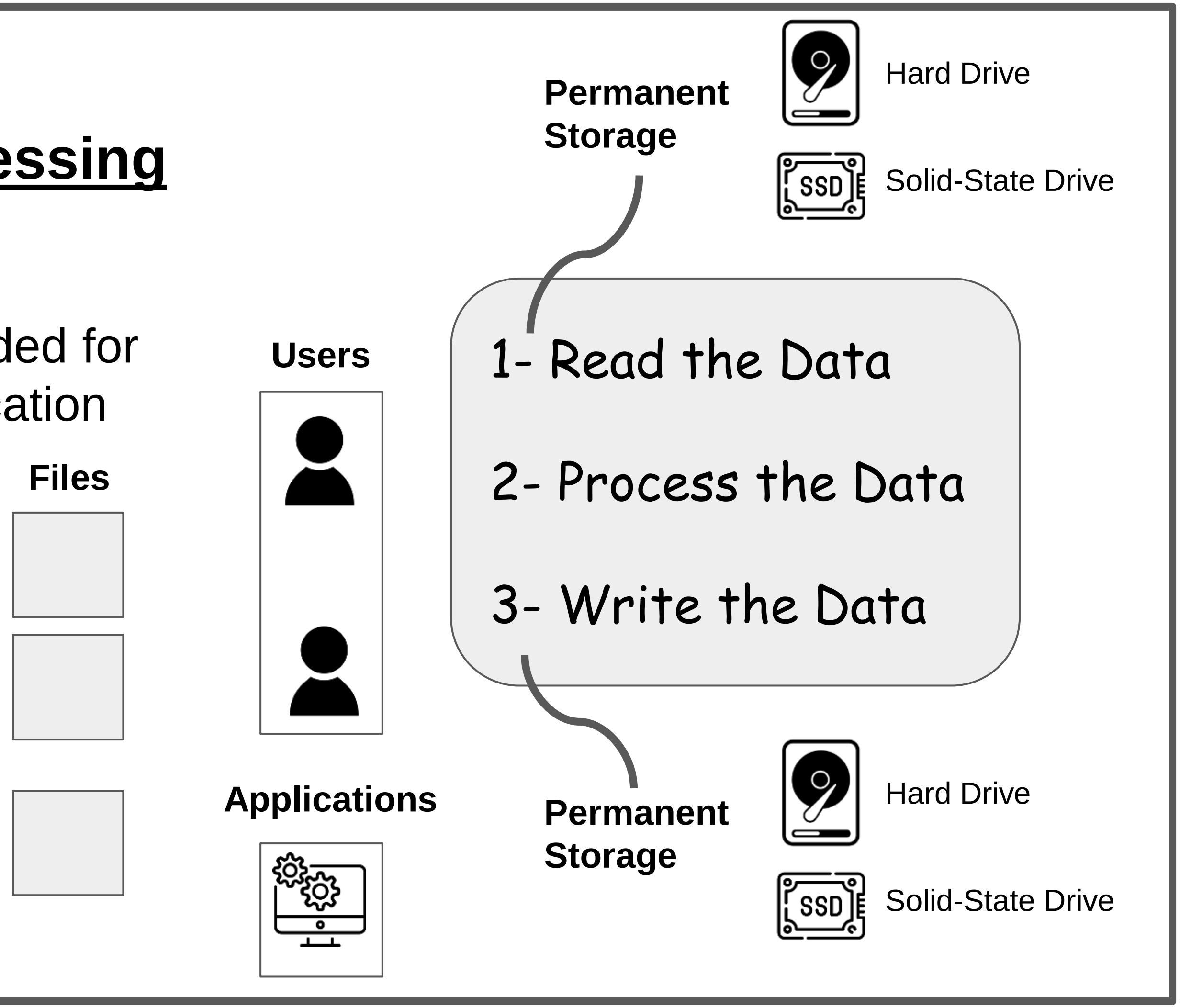
Each user defines and implements the files needed for a specific software application

What about data sharing?

- Permissions
(Who can access what?)



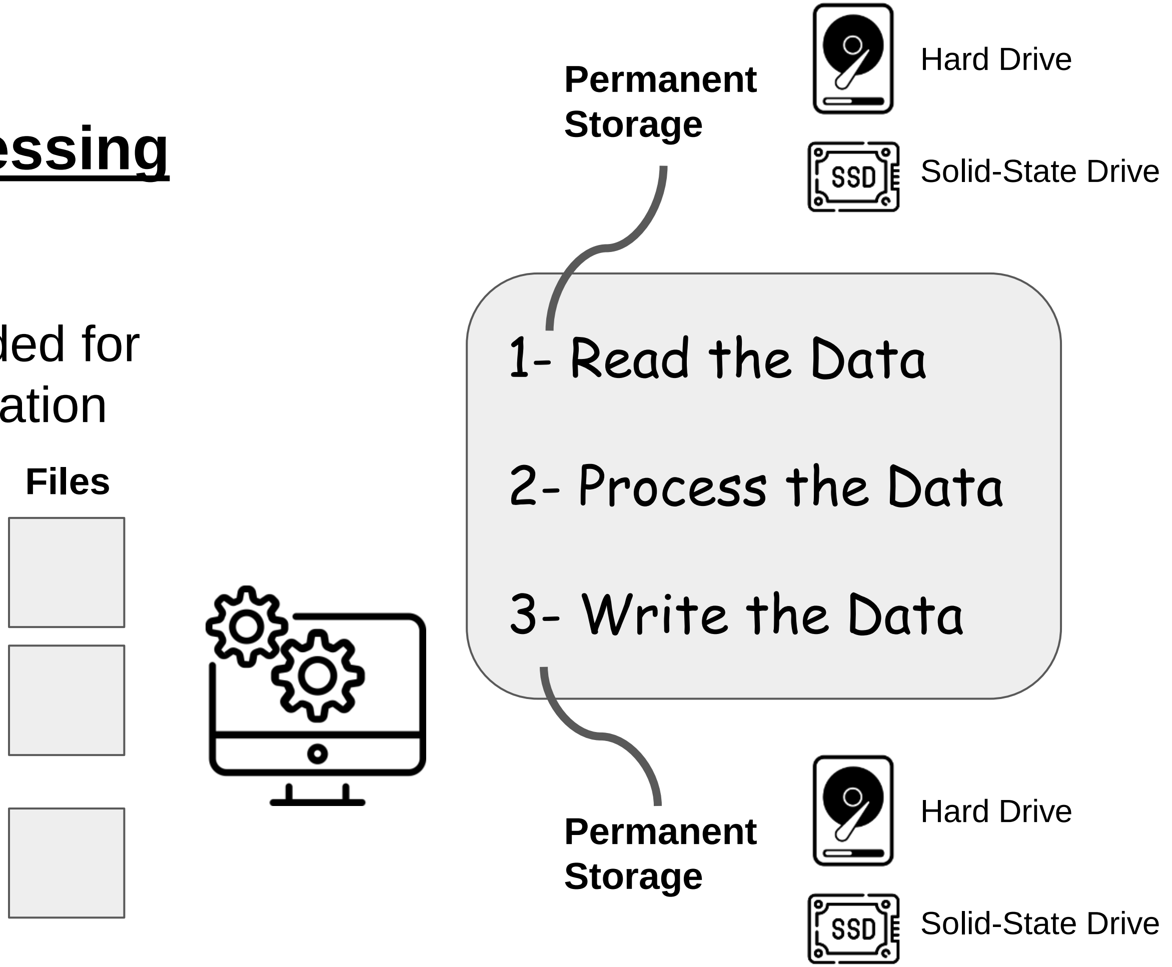
Computer = Microprocessor + RAM

Traditional **file processing**

Each user defines and implements the files needed for a specific software application

What about data independence ?

- Changes to the data structure require modifying all the associated programs.



Files

Permanent Storage

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Permanent Storage

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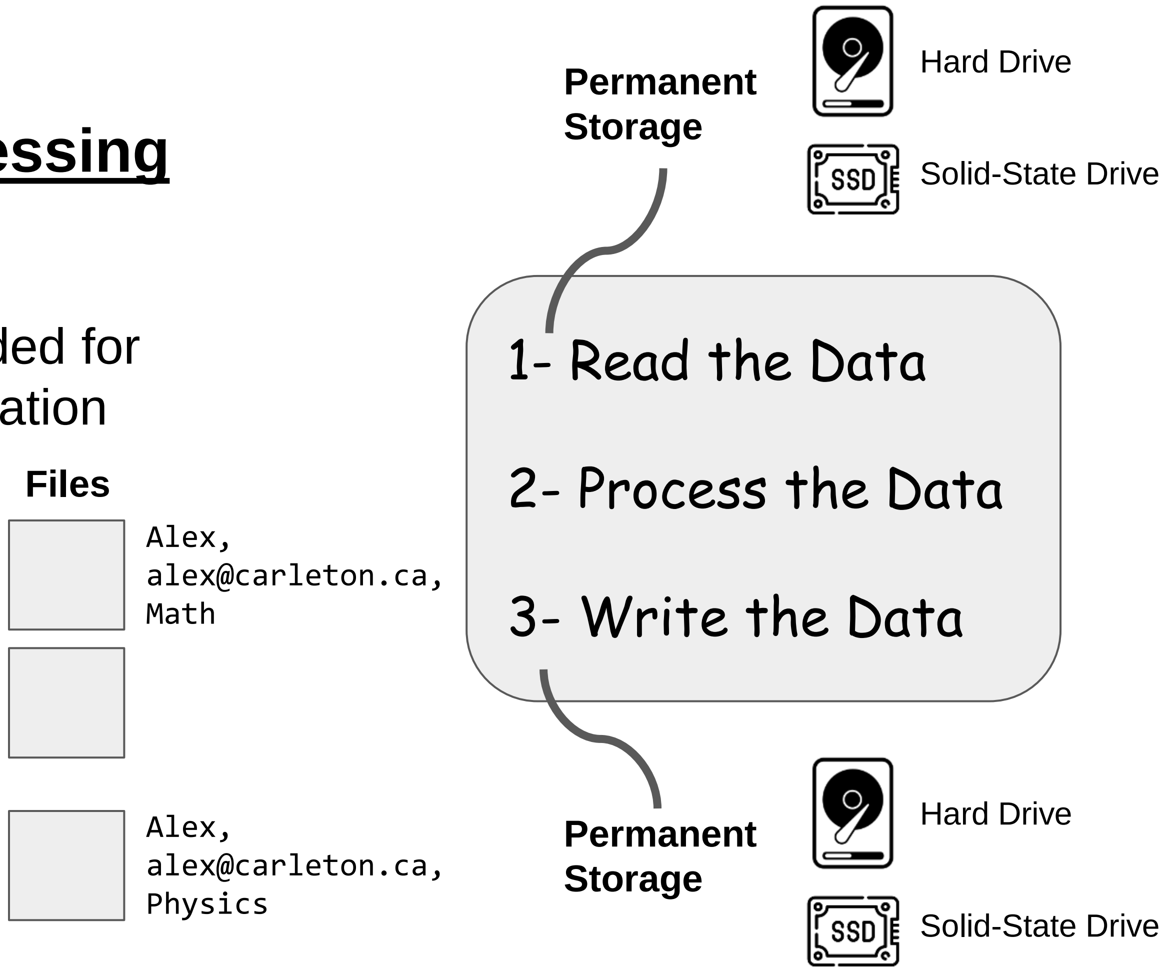
What about data access efficiency?

- Search for “Courses of Alex”.



Files

```
Alex,
alex@carleton.ca,
Math
```

```
Alex,
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Physics
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Permanent Storage

Permanent Storage

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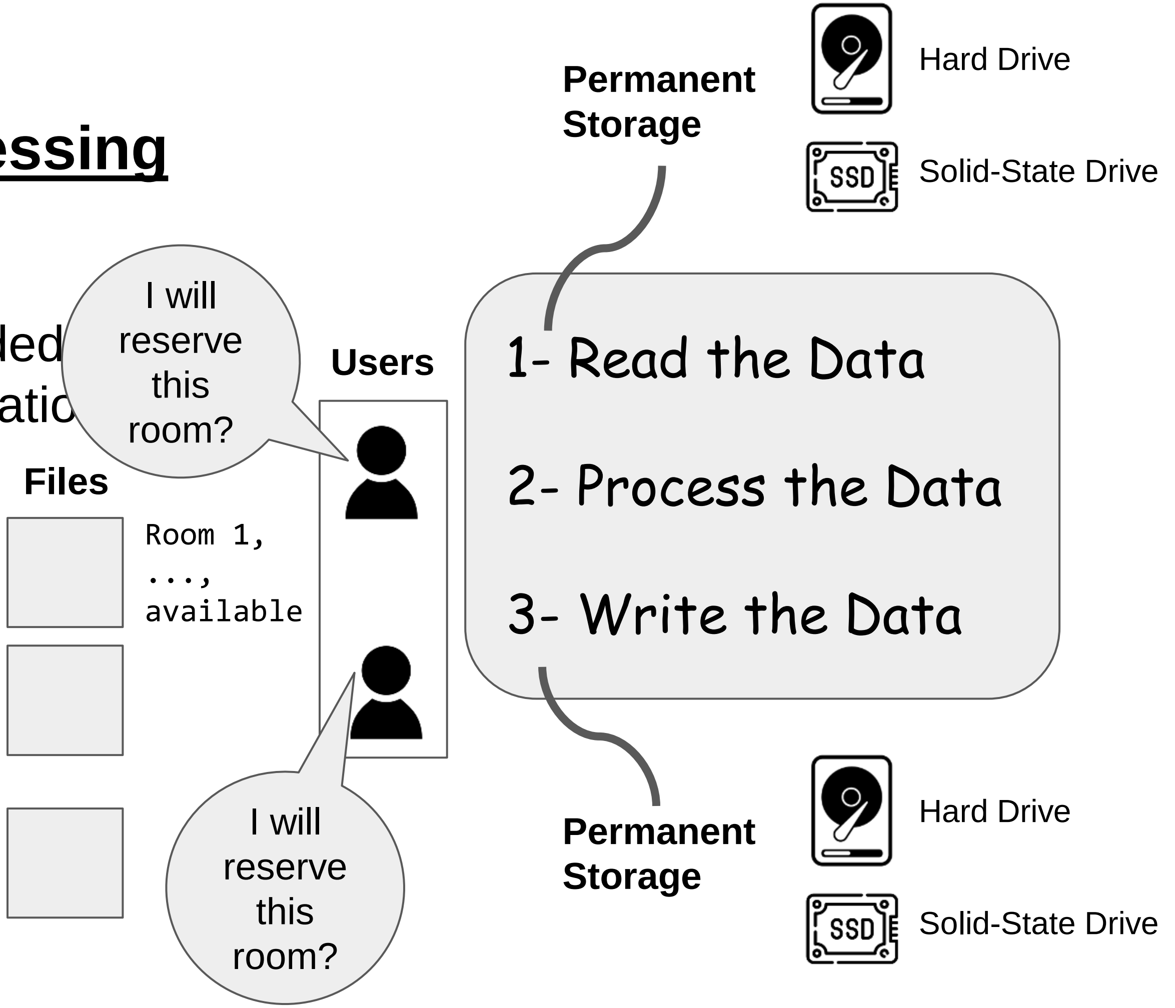
What about concurrent access control?

- Multiple users modifying the same data.



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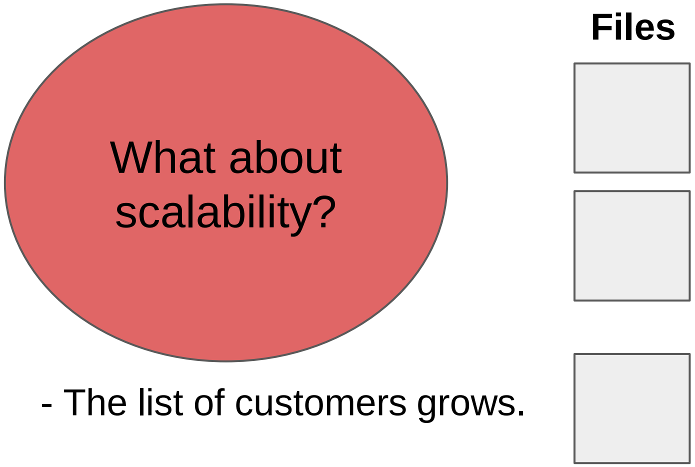
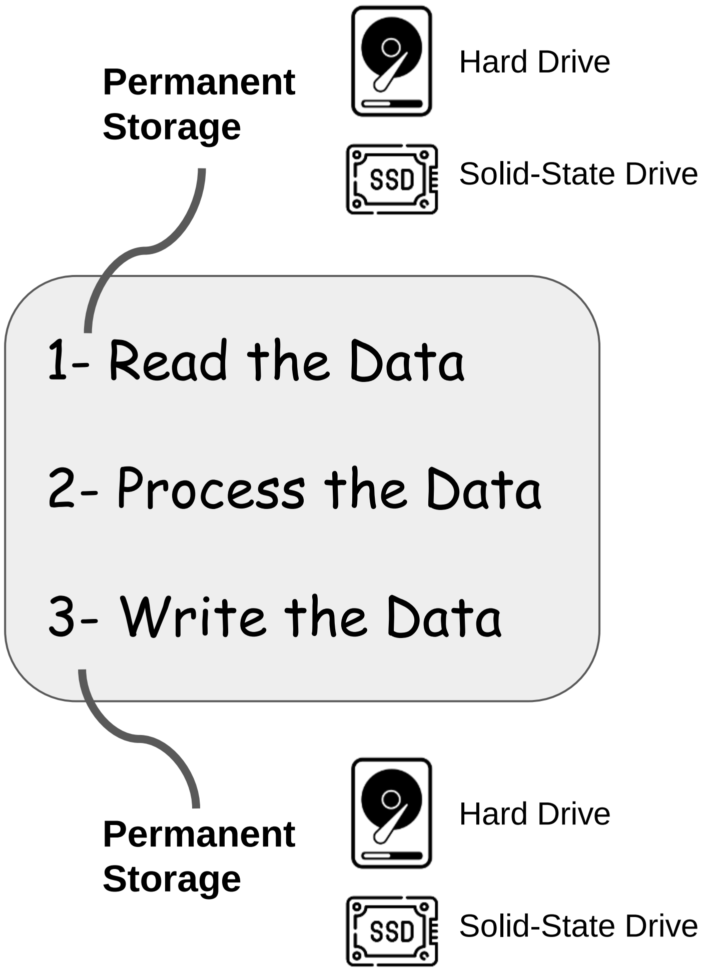


- The list of customers grows.



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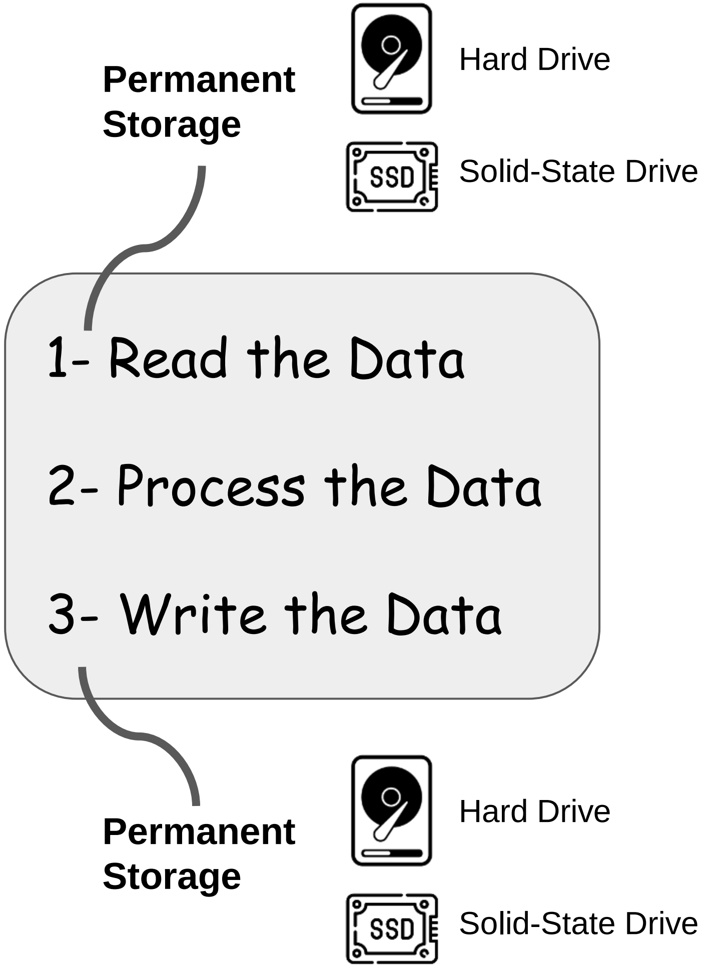
What is a Database Management System (DBMS)?

Computer = Microprocessor + RAM

Database approach

Single repository maintains data that is defined once and then accessed by various users



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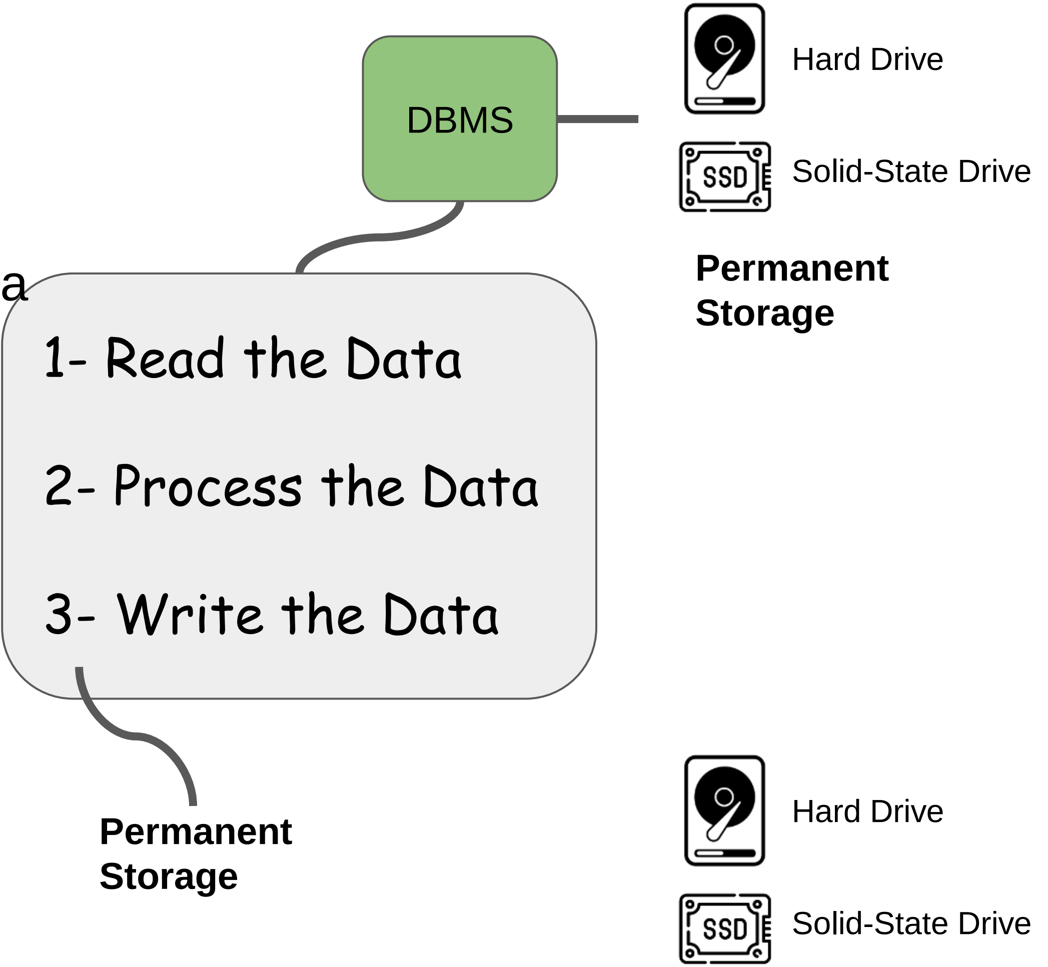

DBMS

Hard Drive

Solid-State Drive

Permanent Storage

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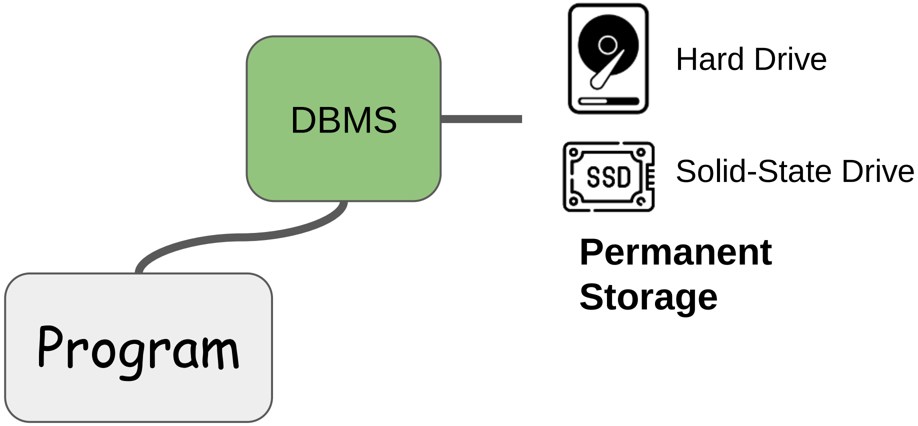
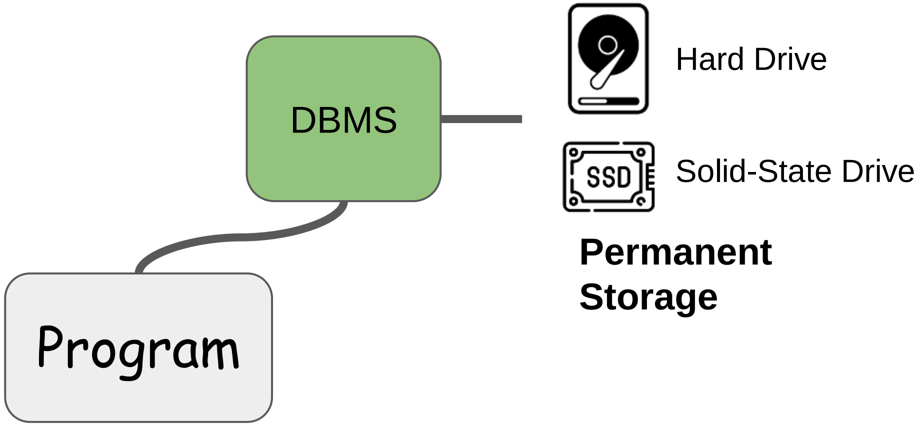


What is a Database Management System (DBMS)?

Data Model? **(How does DBMS organize the data)**

A data model is a conceptual representation of how data is organized, structured, and related within a database system



DBMS

Hard Drive

Solid-State Drive

Permanent Storage

Program

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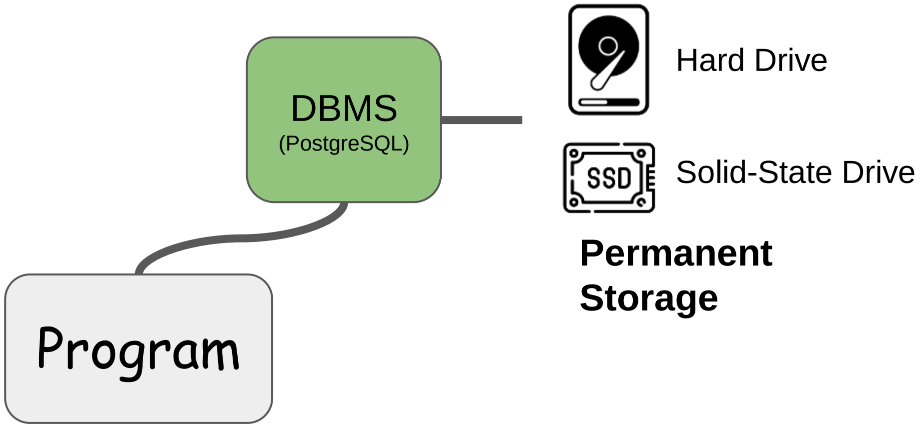


DBMS
(PostgreSQL)

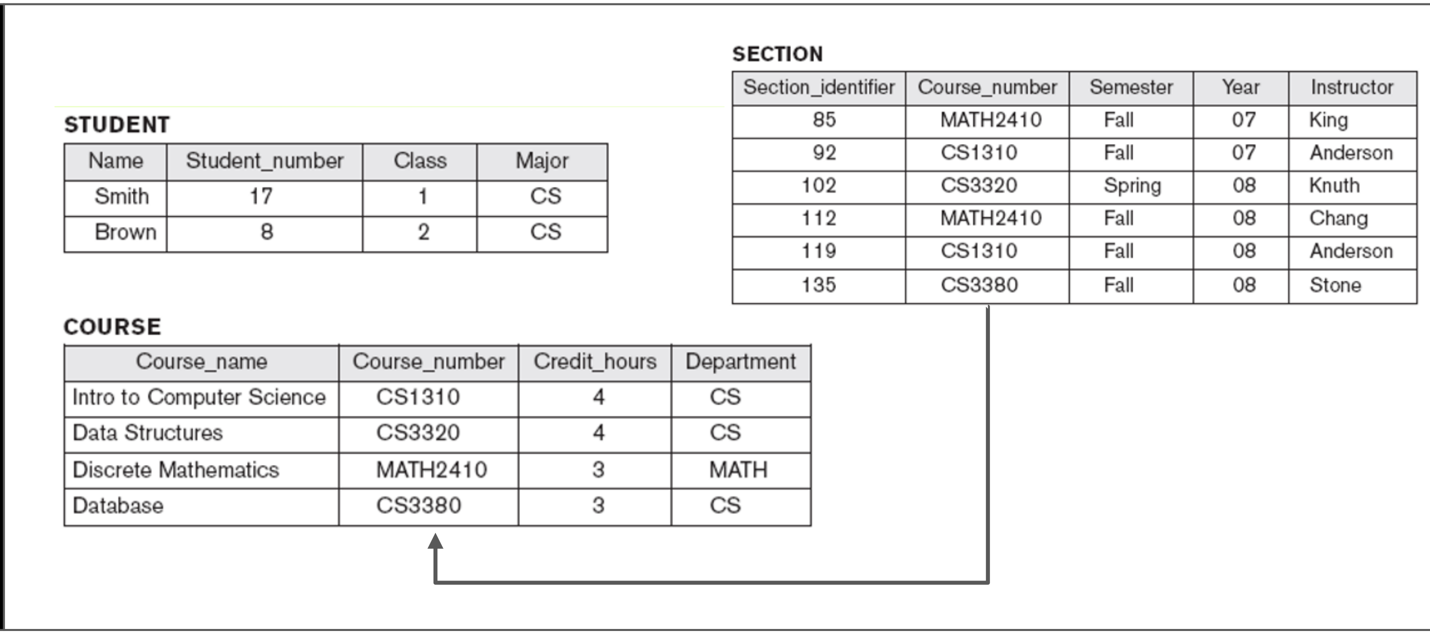
Program

Hard Drive

Solid-State Drive

Permanent Storage

Relational Data Model



STUDENT

Name	Student_number	Class	Major
Smith	17	1	CS
Brown	8	2	CS

SECTION

Section_identifier	Course_number	Semester	Year	Instructor
85	MATH2410	Fall	07	King
92	CS1310	Fall	07	Anderson
102	CS3320	Spring	08	Knuth
112	MATH2410	Fall	08	Chang
119	CS1310	Fall	08	Anderson
135	CS3380	Fall	08	Stone

COURSE

Course_name	Course_number	Credit_hours	Department
Intro to Computer Science	CS1310	4	CS
Data Structures	CS3320	4	CS
Discrete Mathematics	MATH2410	3	MATH
Database	CS3380	3	CS

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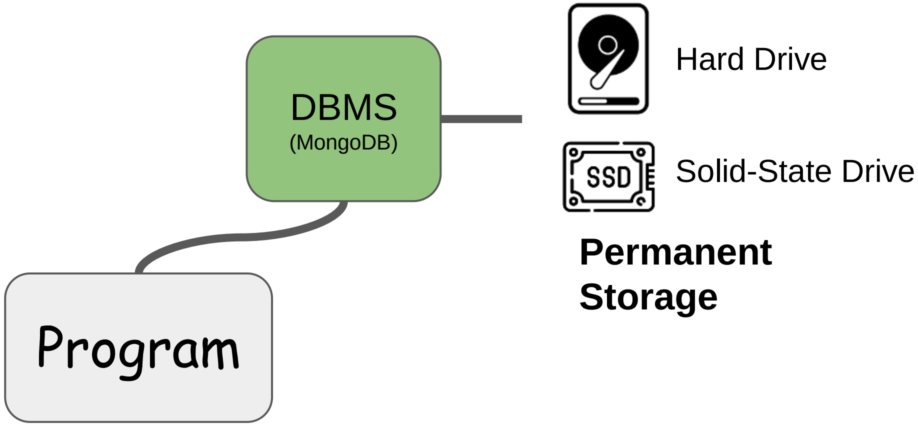

Permanent Storage

Document-based Data Model

```
{
  "student": {
    "name": "John Doe",
    "id": 12345,
    "courses": [
      {
        "courseName": "Mathematics",
        "courseCode": "MATH101",
        "instructor": "Professor Smith"
      },
      {
        "courseName": "Computer Science",
        ...
      }
    ]
  }
}
```

JSON

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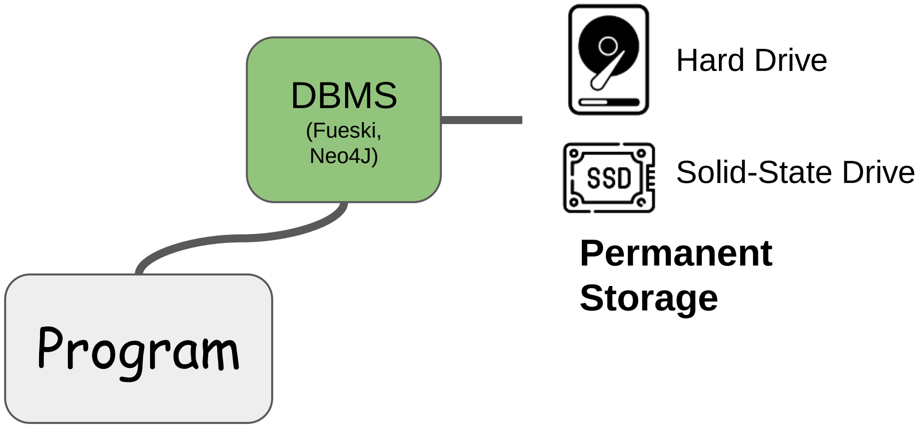
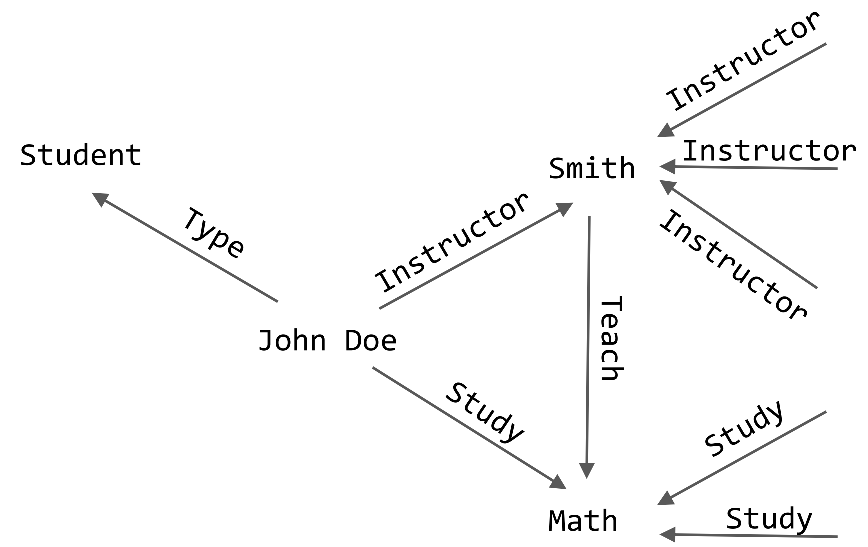


Graph-based Data Model



What can you expect to learn from this course?

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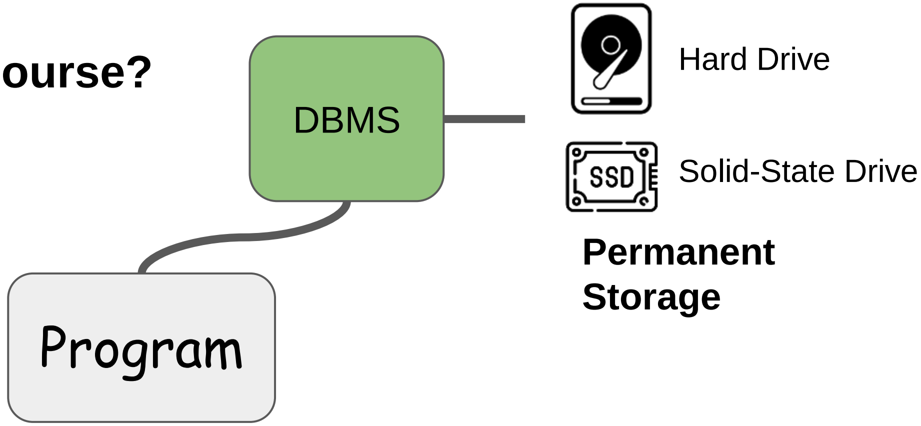

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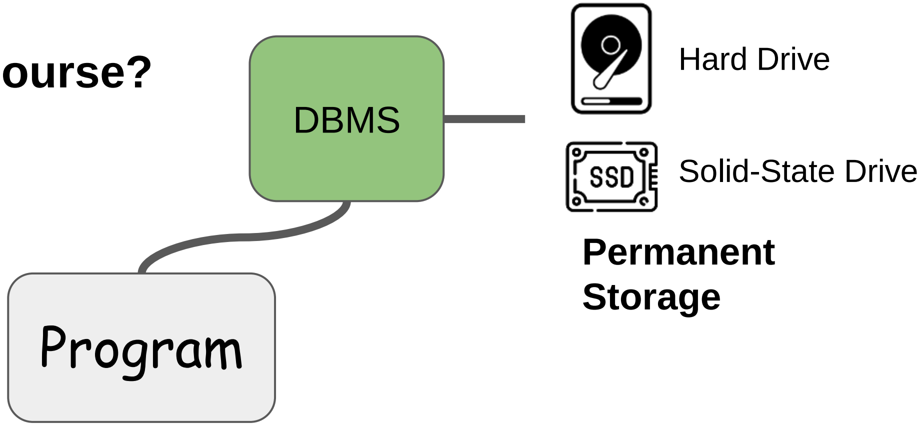

- **Relational** data model like PostgreSQL.
- **Document**-based data model like MongoDB.

Amazon DocumentDB

- **Graph**-based data model like Neo4J.

Which type of Databases is suitable for your use-case?

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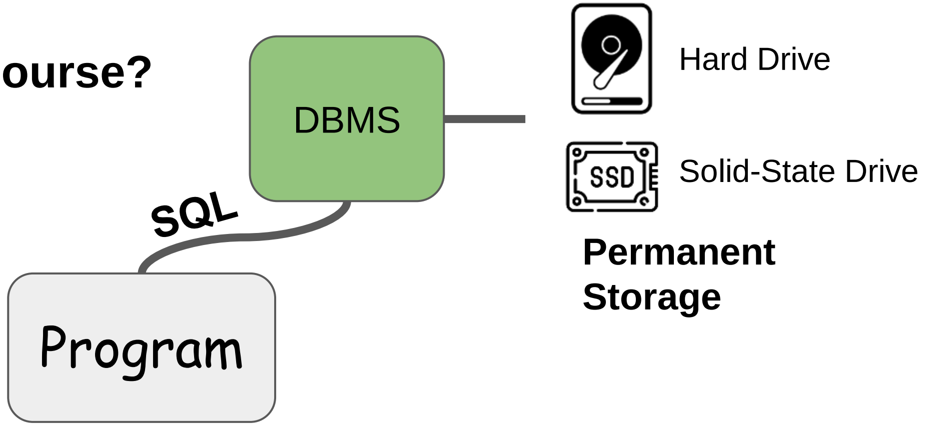

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Amazon DocumentDB

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Query Language

How does your software application interact with these DBMS systems?

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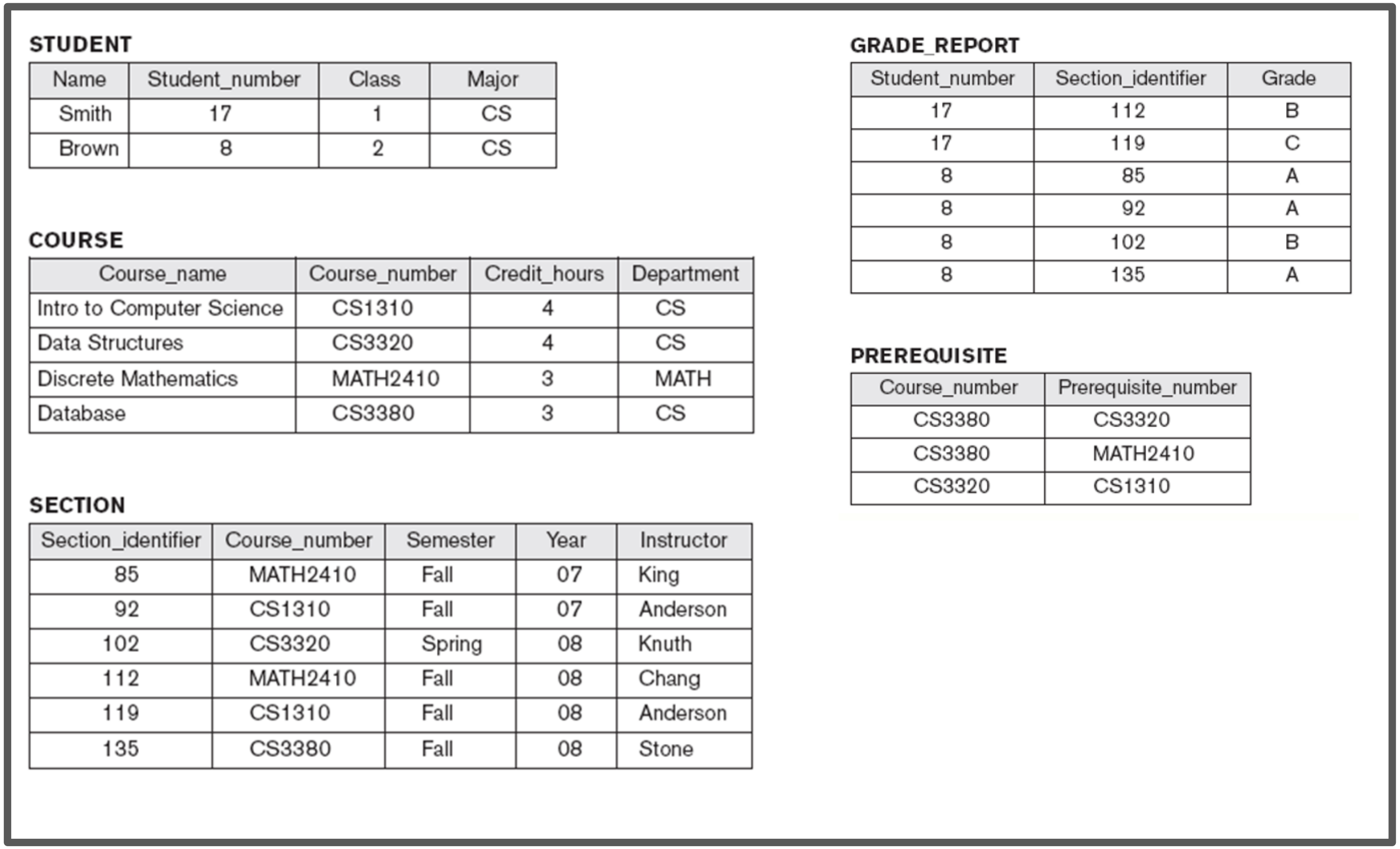
How to design a Database?



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GRADE_REPORT

Student_number	Section_identifier	Grade
17	112	B
17	119	C
8	85	A
8	92	A
8	102	B
8	135	A

PREREQUISITE

Course_number	Prerequisite_number
CS3380	CS3320
CS3380	MATH2410
CS3320	CS1310

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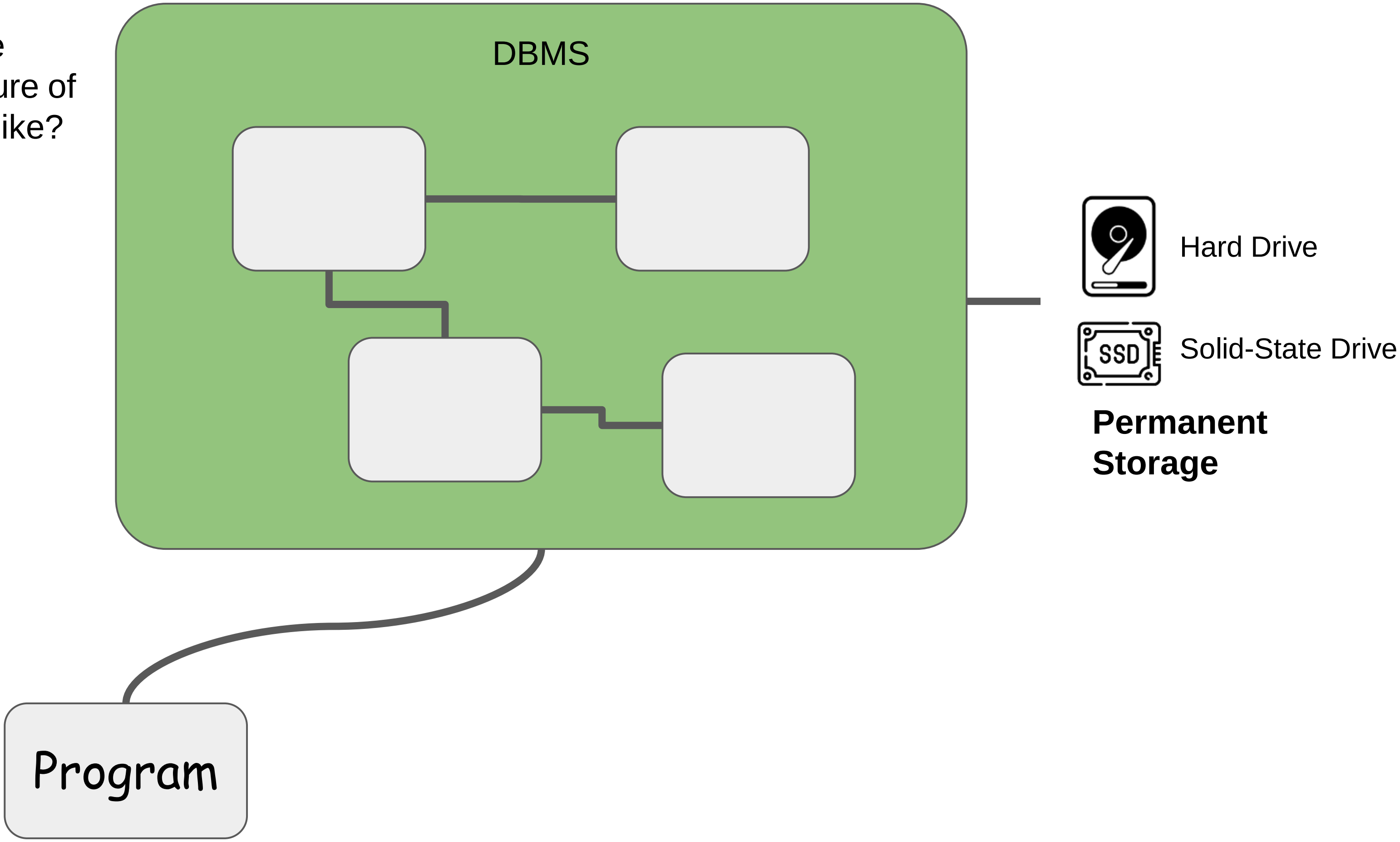
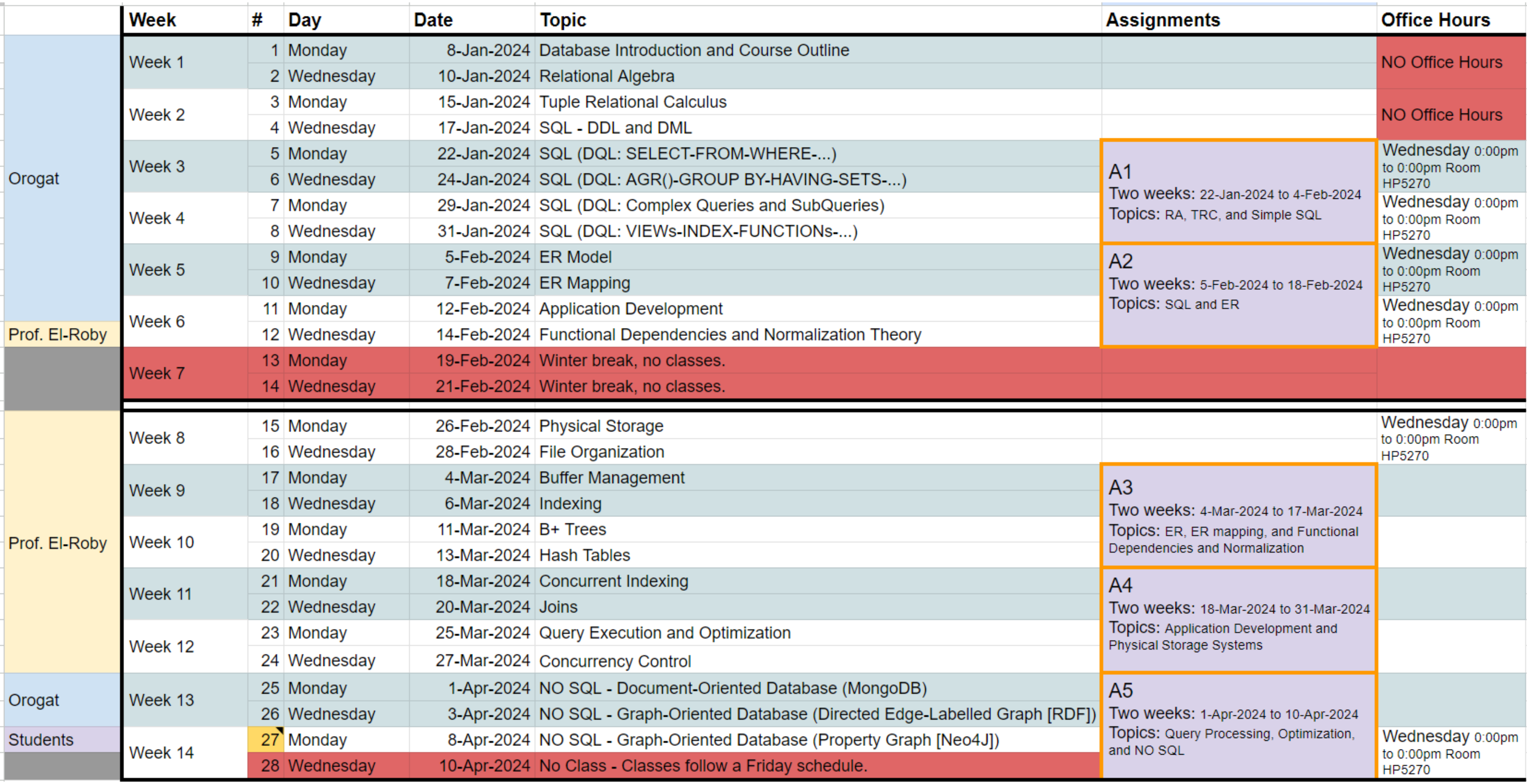
What does the internal structure of a DBMS look like?

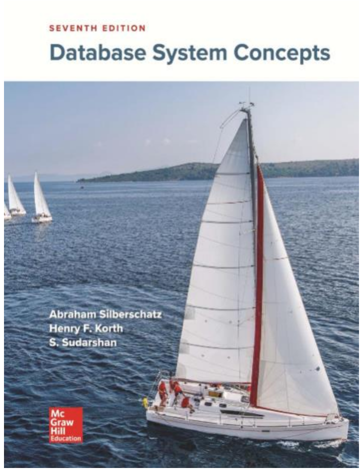


Into Course Outline

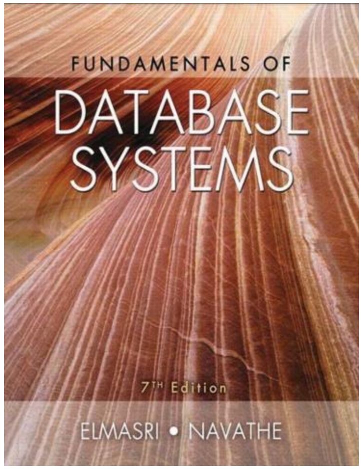


	Week	#	Day	Date	Topic	Assignments	Office Hours
Orogat	Week 1	1	Monday	8-Jan-2024	Database Introduction and Course Outline		NO Office Hours
		2	Wednesday	10-Jan-2024	Relational Algebra		
	Week 2	3	Monday	15-Jan-2024	Tuple Relational Calculus		NO Office Hours
		4	Wednesday	17-Jan-2024	SQL - DDL and DML		
	Week 3	5	Monday	22-Jan-2024	SQL (DQL: SELECT-FROM-WHERE-...)	A1 Two weeks: 22-Jan-2024 to 4-Feb-2024 Topics: RA, TRC, and Simple SQL	Wednesday 0:00pm to 0:00pm Room HP5270
		6	Wednesday	24-Jan-2024	SQL (DQL: AGR()-GROUP BY-HAVING-SETS-...)		
	Week 4	7	Monday	29-Jan-2024	SQL (DQL: Complex Queries and SubQueries)		Wednesday 0:00pm to 0:00pm Room HP5270
		8	Wednesday	31-Jan-2024	SQL (DQL: VIEWs-INDEX-FUNCTIONs-...)		
	Week 5	9	Monday	5-Feb-2024	ER Model	A2 Two weeks: 5-Feb-2024 to 18-Feb-2024 Topics: SQL and ER	Wednesday 0:00pm to 0:00pm Room HP5270
		10	Wednesday	7-Feb-2024	ER Mapping		
	Week 6	11	Monday	12-Feb-2024	Application Development		Wednesday 0:00pm to 0:00pm Room HP5270
Prof. El-Roby		12	Wednesday	14-Feb-2024	Functional Dependencies and Normalization Theory		
	Week 7	13	Monday	19-Feb-2024	Winter break, no classes.		
		14	Wednesday	21-Feb-2024	Winter break, no classes.		
Prof. El-Roby	Week 8	15	Monday	26-Feb-2024	Physical Storage		Wednesday 0:00pm to 0:00pm Room HP5270
		16	Wednesday	28-Feb-2024	File Organization		
	Week 9	17	Monday	4-Mar-2024	Buffer Management	A3 Two weeks: 4-Mar-2024 to 17-Mar-2024 Topics: ER, ER mapping, and Functional Dependencies and Normalization	
		18	Wednesday	6-Mar-2024	Indexing		
	Week 10	19	Monday	11-Mar-2024	B+ Trees		
		20	Wednesday	13-Mar-2024	Hash Tables		
	Week 11	21	Monday	18-Mar-2024	Concurrent Indexing	A4 Two weeks: 18-Mar-2024 to 31-Mar-2024 Topics: Application Development and Physical Storage Systems	
		22	Wednesday	20-Mar-2024	Joins		
	Week 12	23	Monday	25-Mar-2024	Query Execution and Optimization		
		24	Wednesday	27-Mar-2024	Concurrency Control		
Orogat	Week 13	25	Monday	1-Apr-2024	NO SQL - Document-Oriented Database (MongoDB)	A5 Two weeks: 1-Apr-2024 to 10-Apr-2024 Topics: Query Processing, Optimization, and NO SQL	
		26	Wednesday	3-Apr-2024	NO SQL - Graph-Oriented Database (Directed Edge-Labelled Graph [RDF])		
Students	Week 14	27	Monday	8-Apr-2024	NO SQL - Graph-Oriented Database (Property Graph [Neo4J])		Wednesday 0:00pm to 0:00pm Room HP5270
		28	Wednesday	10-Apr-2024	No Class - Classes follow a Friday schedule.		

Textbook



- Avi Silberschatz, Henry F. Korth, and S. Sudarshan. **Database System Concepts**. Seventh Edition.



- Ramez Elmasri and Shamkant B. Navathe: **Fundamentals of Database Systems**. Seventh Edition.

Systems Documentations

SQL-Based DBMS

- PostgreSQL

Document-Based DBMS

- MongoDB

Graph-Based DBMS

- Apache Jena Fuseki
- Neo4j

Grading

Grading Components	Weighting	Notes and Passing Criteria
Assignments	30%	Out of the 5 assignments, only the highest 4 scores will be considered.
Project	30%	The project groups will consist of **1 to 3 students**. Further information regarding the project will be provided later.
Final	40%	Need to score over **45%** of the exam to pass the course
Attendance	0%	Attending the lectures is crucial for your learning experience, even though they **won't be graded** for marks.

Assignments Rules

Grading Components	Weighting	Notes and Passing Criteria
Assignments	30%	Out of the 5 assignments, only the highest 4 scores will be considered.

- Five assignments
- Late submissions allowed within 24 hours with a 10% penalty
- No submissions allowed after these 24 hours. **(Do not ask for extensions)**
- The grades for the best four assignments will contribute to your overall assignments grade

Project Details

Grading Components	Weighting	Notes and Passing Criteria
Project	30%	The project groups will consist of **1 to 3 students**. Further information regarding the project will be provided later.

- More details will be posted later

Contacts

Discussion Forum

Questions related to the

- Lectures
- Assignments (General only)
- Exams

Office Hours

Instructor

Questions related to the

- Lectures
- Assignments
- Exams
- Any other

TAs

Questions related to the

- Lectures
- Assignments
- Programs Setup
- Running a Query or App

Starting on the week of **January 22nd**

- Every day of the week
- Posted on Brightspace
- Available slots both in-person and via Zoom

Email

Instructor

Questions related to the

- Mistake in the slides
- Feedback
- Urgent Situation

TAs

Questions related to the

- Grading Issue
- Quick Question

Grades Problems

- Contact the TA responsible for marking the question if you have any issues or concerns.
    - In the event of a disagreement with the TA, they will forward the situation to the instructor along with the relevant details.
    - The instructor will ultimately make the final decision regarding the matter.
- Please avoid contacting the instructors directly regarding grade-related matters.

PLAGIARISM

- Zero-tolerance policy!
- Not sure? Ask
- Refer to Academic Integrity at Carleton

Thank You

Thank you