Patient History

patientNo	name	address	date	time	drNo	drName	visitCode	description
P0001	Johnson	12 Sturt St, Balwyn	12/11/2008	9:00am	D0003	Kelly	VC034	Allergy Desensitisation Injection
P0002	Singh	5 Willow Ave, Box Hill	14/11/2008	9:00am	D0003	Kelly	VC015	Suspected Glandular Fever – tests ordered
P0003	Hatzis	18 High St, Ringwood	14/11/2008	9:30am	D0001	Able	VC006	Stomach Complaint
P0001	Johnson	12 Sturt St, Balwyn	19/11/2008	2:00pm	D0003	Kelly	VC034	Allergy Desensitisation Injection
P0004	Ong	16 Plum St, Bulleen	23/11/2008	4:30pm	D0003	Kelly	VC034	Allergy Desensitisation Injection
P0005	Jacobson	2 Apple Tce, Balwyn	25/11/2008	10:00am	D0001	Able	VC098	Flu Vaccination
P0001	Johnson	12 Sturt St, Balwyn	26/11/2008	11:30am	D0003	Kelly	VC034	Allergy Desensitisation Injection
P0003	Hatzis	18 High St, Ringwood	03/12/2008	10:00am	D0002	Jones	VC098	Flu Vaccination
P0001	Johnson	12 Sturt St, Balwyn	03/12/2008	3:00pm	D0002	Jones	VC034	Allergy Desensitisation Injection

To solve the problem using **Third Normal Form (3NF)**, let's break down the process step by step based on the provided patient history table. The goal is to eliminate redundancy while preserving data integrity.

Steps to Achieve 3NF:

1. **Identify Functional Dependencies:**

- **PatientNo** determines **name** and **address**. (A patient number is unique to a specific person and their address).

- **DrNo** determines **drName**. (Each doctor has a unique doctor number).

- **VisitCode** determines **description**. (Each visit code is associated with a specific medical procedure).

- **PatientNo, DrNo, Date, Time** determines the entire row. (The combination of these attributes uniquely identifies an appointment).

2. **Remove Partial Dependencies (2NF):**

A table is in **2NF** if it is in **1NF** and there are no partial dependencies. This means that every non-prime attribute should be fully functionally dependent on the primary key.

The primary key in this case could be a composite key of **PatientNo, DrNo, Date, Time** (this combination uniquely identifies an appointment).

So, we need to separate attributes that are only dependent on part of this composite key.

Tables after 2NF:

- **Patient Table**:

PatientNo	Name	Address
P0001	Johnson	12 Sturt St, Balwyn
P0002	Singh	5 Willow Ave, Box Hill
P0003	Hatzis	18 High St, Ringwood
P0004	Ong	16 Plum St, Bulleen
P0005	Jacobson	2 Apple Tce, Balwyn

- **Doctor Table**:

DrNo	DrName
D0001	Able
D0002	Jones
D0003	Kelly

- **Visit Table**:

VisitCode	Description
VC034	Allergy Desensitisation Injection
VC015	Suspected Glandular Fever – tests ordered
VC006	Stomach Complaint
VC098	Flu Vaccination

3. **Remove Transitive Dependencies (3NF):**

A table is in **3NF** if it is in **2NF** and all the non-prime attributes are non-transitively dependent on the primary key.

Now, the only transitive dependency we need to consider is that the **description** of a visit depends on the **visitCode**, not directly on the primary key. However, this was already addressed when creating the **Visit Table**.

Final 3NF Tables:

- **Patient Table** (stores unique patient information):

PatientNo	Name	Address
P0001	Johnson	12 Sturt St, Balwyn
P0002	Singh	5 Willow Ave, Box Hill
P0003	Hatzis	18 High St, Ringwood
P0004	Ong	16 Plum St, Bulleen
P0005	Jacobson	2 Apple Tce, Balwyn

- **Doctor Table** (stores unique doctor information):

DrNo	DrName
D0001	Able
D0002	Jones
D0003	Kelly

- **Visit Table** (stores visit codes and descriptions):

VisitCode	Description
VC034	Allergy Desensitisation Injection
VC015	Suspected Glandular Fever – tests ordered
VC006	Stomach Complaint
VC098	Flu Vaccination

- **Appointment Table** (stores the actual appointment details):

PatientNo	DrNo	Date	Time	VisitCode
P0001	D0003	12/11/2008	9:00am	VC034
P0002	D0003	14/11/2008	9:00am	VC015
P0003	D0001	14/11/2008	9:30am	VC006
P0001	D0003	19/11/2008	2:00pm	VC034
P0004	D0003	23/11/2008	4:30pm	VC034
P0005	D0001	25/11/2008	10:00am	VC098
P0001	D0003	26/11/2008	11:30am	VC034
P0003	D0002	03/12/2008	10:00am	VC098
P0001	D0002	03/12/2008	3:00pm	VC034

Explanation:

- **Patient Table** holds unique information about each patient (no redundant address).

- **Doctor Table** holds unique information about each doctor.

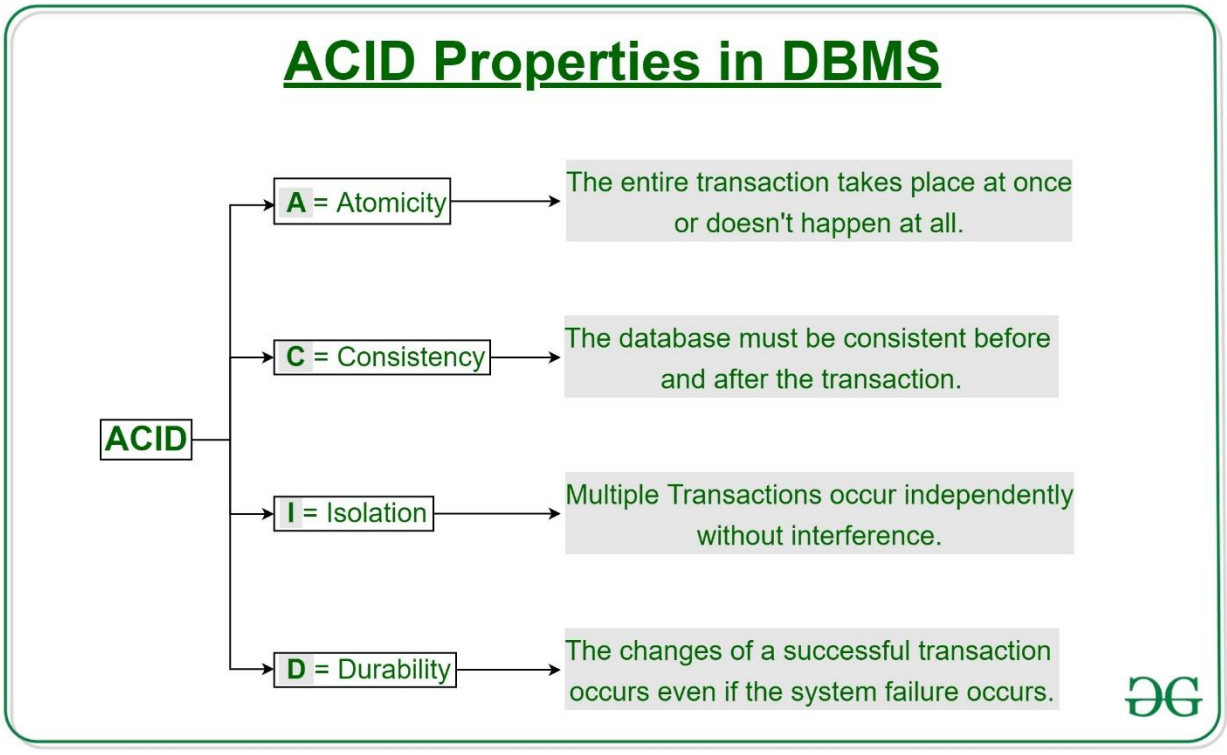
- **Visit Table** holds unique visit codes and descriptions.

- **Appointment Table** records appointments using the foreign keys **PatientNo**, **DrNo**, and **VisitCode** without redundancy.

This solution eliminates redundancy, preserves data integrity, and ensures that the database is in **3NF**.

ACID

A **transaction** is a single logical unit of work that accesses and possibly modifies the contents of a database. Transactions access data using read-and-write operations. To maintain consistency in a database, before and after the transaction, certain properties are followed. These are called **ACID** properties.



Atomicity:

By this, we mean that either the entire transaction takes place at once or doesn't happen at all. There is no midway i.e. transactions do not occur partially. Each transaction is considered as one unit and either runs to completion or is not executed at all. It involves the following two operations.
— **Abort** : If a transaction aborts, changes made to the database are not visible.
— **Commit** : If a transaction commits, changes made are visible.
Atomicity is also known as the 'All or nothing rule'.

Consider the following transaction **T** consisting of **T1** and **T2** : Transfer of 100 from account **X** to account **Y** .

Before: X : 500	Y: 200
Transaction T	
T1	**T2**
Read (X) X: = X − 100 Write (X)	Read (Y) Y: = Y + 100 Write (Y)
After: X : 400	Y : 300

If the transaction fails after completion of **T1** but before completion of **T2** .(say, after **write(X)** but before **write(Y)**), then the amount has been deducted from **X** but not added to **Y** . This results in an inconsistent database state. Therefore, the transaction must be executed in its entirety in order to ensure the correctness of the database state.

Consistency:

This means that integrity constraints must be maintained so that the database is consistent before and after the transaction. It refers to the correctness of a database. Referring to the example above,
The total amount before and after the transaction must be maintained.
Total **before T** occurs = **500 + 200 = 700** .
Total **after T occurs** = **400 + 300 = 700** .
Therefore, the database is **consistent** . Inconsistency occurs in case **T1** completes but **T2** fails. As a result, T is incomplete.

Isolation:

This property ensures that multiple transactions can occur concurrently without leading to the inconsistency of the database state. Transactions occur independently without interference. Changes occurring in a particular transaction will not be visible to any other transaction until that particular change in that transaction is written to memory or has been committed. This property ensures that the execution of transactions concurrently will result in a state that is equivalent to a state achieved these were executed serially in some order.

Let **X** = 500, **Y** = 500.
Consider two transactions **T** and **T".**

T	T''
Read (X) X: = X*100 Write (X) Read (Y) Y: = Y – 50 Write (Y)	Read (X) Read (Y) Z: = X + Y Write (Z)

Suppose **T** has been executed till **Read (Y)** and then **T''** starts. As a result, interleaving of operations takes place due to which **T''** reads the correct value of **X** but the incorrect value of **Y** and sum computed by
T'': (X+Y = 50, 000+500=50, 500)
is thus not consistent with the sum at end of the transaction:
T: (X+Y = 50, 000 + 450 = 50, 450) .
This results in database inconsistency, due to a loss of 50 units. Hence, transactions must take place in isolation and changes should be visible only after they have been made to the main memory.

Durability:

This property ensures that once the transaction has completed execution, the updates and modifications to the database are stored in and written to disk and they persist even if a system failure occurs. These updates now become permanent and are stored in non-volatile memory. The effects of the transaction, thus, are never lost.

Some important points:

Property	**Responsibility for maintaining properties**
Atomicity	Transaction Manager
Consistency	Application programmer
Isolation	Concurrency Control Manager
Durability	Recovery Manager

The **ACID** properties, in totality, provide a mechanism to ensure the correctness and consistency of a database in a way such that each transaction is a group of operations that acts as a single unit, produces consistent results, acts in isolation from other operations, and updates that it makes are durably stored.

ACID properties are the four key characteristics that define the reliability and consistency of a transaction in a Database Management System (DBMS). The acronym ACID stands for Atomicity, Consistency, Isolation, and Durability. Here is a brief description of each of these properties:

1. **Atomicity:** Atomicity ensures that a transaction is treated as a single, indivisible unit of work. Either all the operations within the transaction are completed successfully, or none of them are. If any part of the transaction fails, the entire transaction is rolled back to its original state, ensuring data consistency and integrity.
2. **Consistency:** Consistency ensures that a transaction takes the database from one consistent state to another consistent state. The database is in a consistent state both before and after the transaction is executed. Constraints, such as unique keys and foreign keys, must be maintained to ensure data consistency.
3. **Isolation:** Isolation ensures that multiple transactions can execute concurrently without interfering with each other. Each transaction must be isolated from other transactions until it is completed. This isolation prevents dirty reads, non-repeatable reads, and phantom reads.
4. **Durability:** Durability ensures that once a transaction is committed, its changes are permanent and will survive any subsequent system failures. The transaction's changes are saved to the database permanently, and even if the system crashes, the changes remain intact and can be recovered.

Overall, ACID properties provide a framework for ensuring data consistency, integrity, and reliability in DBMS. They ensure that transactions are executed in a reliable and consistent manner, even in the presence of system failures, network issues, or other problems. These properties make DBMS a reliable and efficient tool for managing data in modern organizations.

Advantages of ACID Properties in DBMS

1. **Data Consistency:** ACID properties ensure that the data remains consistent and accurate after any transaction execution.
2. **Data Integrity:** ACID properties maintain the integrity of the data by ensuring that any changes to the database are permanent and cannot be lost.
3. **Concurrency Control:** ACID properties help to manage multiple transactions occurring concurrently by preventing interference between them.

4. **Recovery:** ACID properties ensure that in case of any failure or crash, the system can recover the data up to the point of failure or crash.

Disadvantages of ACID Properties in DBMS

1. **Performance:** The ACID properties can cause a performance overhead in the system, as they require additional processing to ensure data consistency and integrity.
2. **Scalability:** The ACID properties may cause scalability issues in large distributed systems where multiple transactions occur concurrently.
3. **Complexity:** Implementing the ACID properties can increase the complexity of the system and require significant expertise and resources.
   Overall, the advantages of ACID properties in DBMS outweigh the disadvantages. They provide a reliable and consistent approach to data management, ensuring data integrity, accuracy, and reliability. However, in some cases, the overhead of implementing ACID properties can cause performance and scalability issues. Therefore, it's important to balance the benefits of ACID properties against the specific needs and requirements of the system.

Conclusion

In conclusion, ACID properties involve four properties i.e. Atomicity, Consistency, Isolation and Durability that are responsible for data consistency, integrity and reliability in DBMS. Atomicity ensures that a transaction is rolled back if any part of it fails. Consistency ensures that the database remains consistent before and after the transaction. Isolation ensures that one transaction is not affected by the other. Durability ensures that the changes introduced by a particular transaction persist even after a system failure.