**Week 7: Transactions and Concurrency Control**

**Overview**

Database transactions provide the ability to group multiple operations into a single atomic operation. If any operation fails, the transaction is aborted and rolled back. This is one mechanism for preventing the database from entering an inconsistent state. For example, a banking application may need to initiate a money transfer between two accounts. This requires withdrawing money from one account and depositing the money into the other account. If a failure occurs after the withdrawal but before the deposit, the money will effectively disappear. By wrapping these operations in a transaction, we can ensure that no money is lost.

Transactions form the foundation for another feature of relational databases: concurrency control. The humble relational database is often used to store and manage all state in common web and desktop applications with multiple users. The applications do not need to worry about preventing conflicting operations, managing locks, etc. because all of that is provided by the database. Concurrency control mechanisms prevent conflicting changes from being applied to the database that would leave it in an inconsistent state. There are different mechanisms of achieving concurrency control, but "snapshot isolation" is one of the most commonly used. We will focus on that.

**Reflection Questions**

* Explain what each of the letters in the acronym ACID stands for.
* What does it mean if an execution schedule is serializable? What is a conflict?
* What are the different isolation levels specified by the SQL standard and what are the differences between them?
* What is the difference between shared and exclusive locks?
* Explain the steps of the 2-phase locking protocol. What modifications do the strict and rigorous variants make and why?
* What are lock conversions? When are they used?
* What is a lock manager?
* What is a deadlock? What are the differences between deadlock prevention, detection, and recovery? What is starvation?
* What is snapshot isolation? How is serializable snapshot isolation different?
* Explain how locks are used on indices (specifically B+-trees), specifically the crabbing protocol.