CSE460/560 DATA MODELS AND QUERY LANGUAGES

Structured Query Language (SQL) – Advanced

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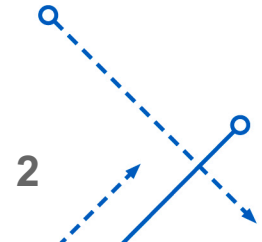
Outline

1. Recursion
2. Transaction
3. Indexes



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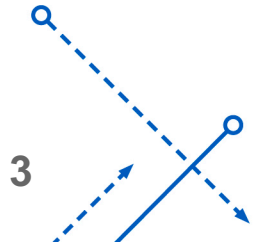
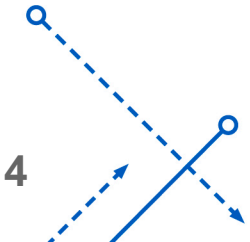
1. **Recursion**
2. Transaction
3. Indexes



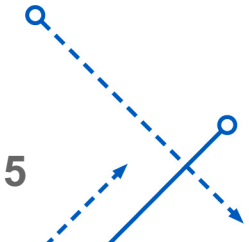
Recursion

- Limitations of Relational Query Languages
  - Cannot express queries involving transitive closure of binary relations
    - List all the ancestors of David
    - Find all the buildings reachable from Davis Hall without going outside
- Solution
  - Recursion



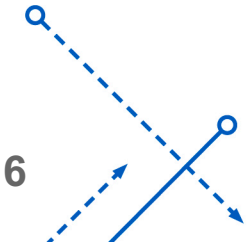
Recursion

- A relations *R* depends on a relation *S* if *S* is used, directly or indirectly, in the definition of *R*
  - In a recursive definition, **a relation may depend on itself!**
- Recursive Views in SQL
  - SQL3 supported only in some DBMS
  - Recursively defined relations should be preceded by RECURSIVE
  - Syntax
    - Given Q1, Q2, Q3 are SQL Query
    - WITH RECURSIVE cte_tbl_name (col1, col2, …) AS (
      Q1
      UNION (ALL|DISTINCT)
      Q2
) Q3



Recursion (Algorithm)

- Initially, the contents of all view are empty
- Evaluate the non-recursive term
- Compute the new-contents of views
  - Using database relations and current contents of the views
    - As the working table is not empty, evaluate the recursive term
- Repeat the previous step until no changes in view contents occur



Recursion (Example)

- Parent(parent, child): Find all the ancestors of David
- WITH RECURSIVE Anc(Upper, Lower) AS (
  (SELECT * FROM Parent)
  UNION ALL
  (SELECT P.parent, A.Lower
  FROM Parent P, Anc A
  WHERE P.child=A.upper))
  SELECT Anc. Upper
  FROM Anc
  WHERE Aanc.Lower='David')
- Run until no view can depend on itslf through EXCEPT or aggregation

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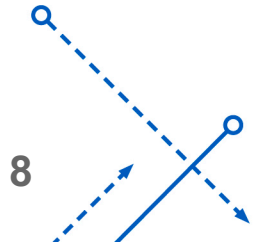
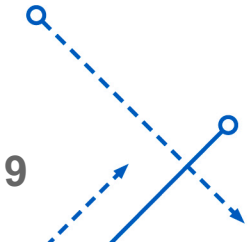


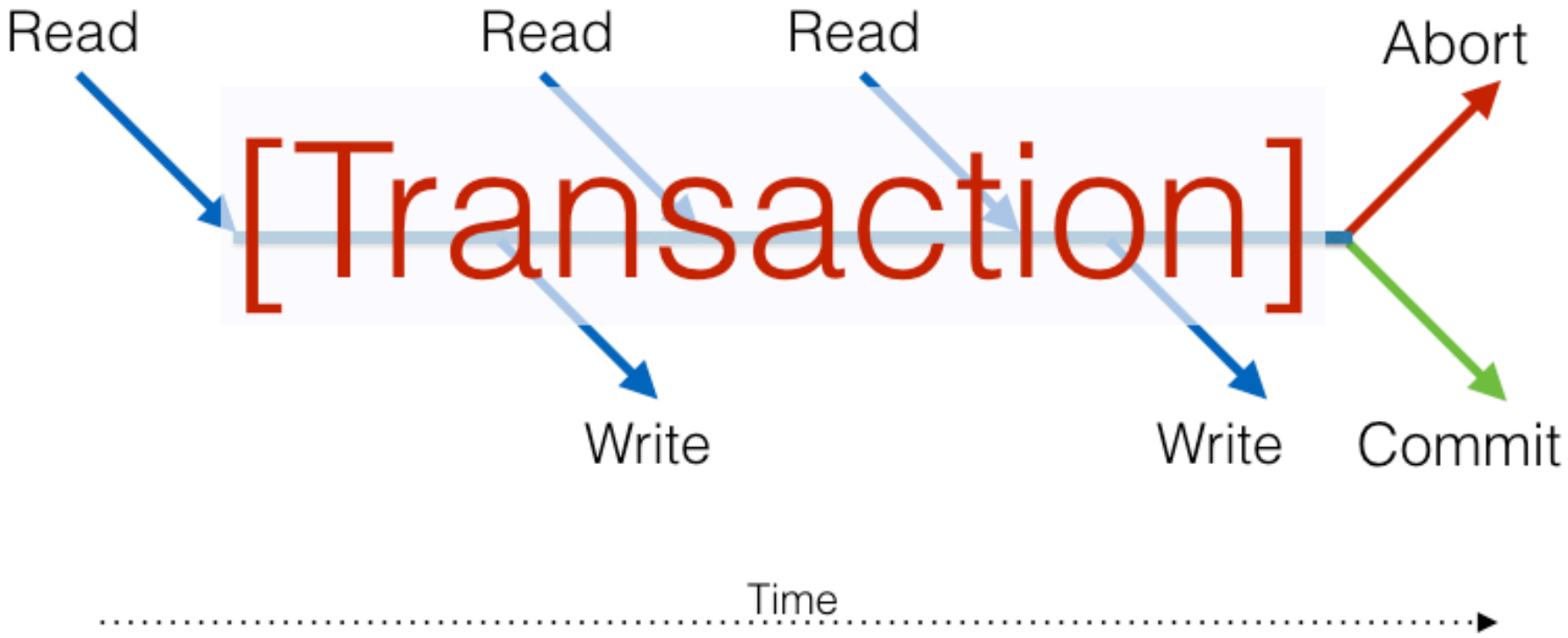
Correctness

- Data Correctness (Constraints)
- Query Correctness (Plan Rewrites)
- Update Correctness (Transactions)

- What could go wrong?
  - Parallelism: What happens if two updates modify the same data?
  - Persistence: What happens if something breaks during an update?



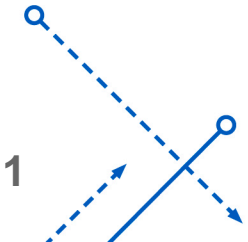
Transaction



A transaction is a collection of one or more operations on the database.

Transaction Correctness

- From a user's perspective
  - Execute fully or none at all (**A**tomicity)
  - Preserve integrity constraints (**C**orrectness)
  - Execute as if on their own (**I**solation)
  - Have their outputs persisted (**D**urability)



Transaction (Example)

- Account(aid, balance)
  - Assume (A, 50) (B, 250)
  - To transfer $100 from B to A
    1. B = B – 100
    2. A = A + 100
  1. In SQL
     1. UPDATE Account SET balance = balance - 100 WHERE aid = 'B';
     2. UPDATE Account SET balance = balance + 100 WHERE aid = 'A';
  - What are possible errors if we use two transfers running concurrently?
    - Ideally (A, 250) (B, 50)
    - Read the same balance of B
      - (A, 250), (B, 150)
    - Read the same balance of A
      - (A, 150), (B, 50)

Transaction (Example)

- Account(aid, balance)
  - Solution – Transaction
  - BEGIN TRANSACTION;
    UPDATE Account SET balance = balance - 100 WHERE aid = 'B';
    UPDATE Account SET balance = balance + 100 WHERE aid = 'A';
    COMMIT;

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Indexes

- A data structure that takes the value of one or more fields
- Makes efficient to find records with a value
- Can be “primary” (unique value) or “secondary” (non-unique value)
- Syntax
  - CREATE INDEX idx-name
    ON reln-name(attr1, attr2, ...);
- Example
  - CREATE INDEX idx_pname
    ON Student (LastName, FirstName);

Recommended Reading

Database Systems: The Complete Book
Chapter 6.1 – 6.5