Structured Query Language with Recursion

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Abstract:
- SQLR: Data retrieval language used for writing recursive queries for any relational database
- Java Package: Used to send recursive queries to a database (using the language presented), and receive the requested information from the database.

Advantages of using SQLR:
- Simple syntax for writing Recursive Queries.
- Due to the popularity of SQL, SQLR easy to learn
- Ability to use existing databases and run simple recursive queries on those databases
- Run recursive queries on databases that do not implement the SQL:1999 standard
- Widespread use in many industries

Logical Components:
- Database: This class takes care of all the database operations. It uses JDBC drivers to connect to a particular database and provides a medium to send and receive queries from the database.
- SimpleParser: This class is used to scan and parse the given input. It runs the query through the JLex Lexer and then parses it using CUP.
- TQL: This class is used to take the parsed input and actually run the query. It calls many other classes to process the Recurse and Path queries.
- TqlApi: This is the only class that the user needs to import from the package. TqlApi sets up a database connection using the Database class, it parses and compiles the query using the SimpleParser class and it runs the query, sending SQL queries to the actual database, by using the TQL class.

Examples of the Grammar:
- Recursive Query:
  ```sql
  SELECT cost
  FROM Flights
  WHERE cost < 200
  RECURSE (departure, 'Philadelphia', arrival)
  RECLIMIT 2;
  ```
- Path Query:
  ```sql
  SELECT *
  FROM flights
  PATH (departure, 'Philadelphia', arrival, 'Orlando')
  ```

User Interface:
- Command Line Interface: Command line is the most lightweight top layer. The interface prompts the user to enter their name and password, and then lets the user query the needed database, and outputs the result of the query to System.out.
- Graphical User Interface: Enables a user to see what database they are using, enter queries and see the results in the same window. Its advantage over the command line is that the user does not have to retype the whole query if they want to make a small correction to it.
- Web interface: Web interface includes a web form where a user can enter a query. On submitting the query, a servlet gets the data from a form, and sends it to the database. The web interface can be accessed at:
  http://fling-l.seas.upenn.edu:8080/cse330/cse330cc/WebTQL

Conclusions:
- We were able to create a query language that uses recursion and develop tools that use this language for several real world applications.
- This project has enabled us to learn several useful technical skills. We now understand the process involved in writing a grammar and parsing it. Since we have worked extensively with databases, this project has enabled us to learn the SQL grammar, and use it effectively to manipulate databases.
- Working on such a large project has many non-technical issues associated with it as well. We were able to learn from our experiences and use this knowledge in the future on other projects.