Notes on SQL Programming and Injection Attack

Introduction to Databases
CompSci 316 Fall 2020
• You have been using SQL programming for your class projects
• This is to discuss “SQL Injection Attack” and “sanitizing inputs” briefly that your code should adhere to
  • Some systems automatically take care of such attacks
  • Remember to mention in your final project report how you handled SQL Injection Attack
    • If you used “Prepared” statement as an optimization, mention it too
Working with SQL through an API

- E.g.: Python psycopg2, JDBC, ODBC (C/C++/VB)
  - All based on the SQL/CLI (Call-Level Interface) standard

- The application program sends SQL commands to the DBMS at runtime
- Responses/results are converted to objects in the application program
Example API: Python psycopg2

```python
import psycopg2
conn = psycopg2.connect(dbname='beers')
cur = conn.cursor()

# list all drinkers:
cur.execute('SELECT * FROM Drinker')
for drinker, address in cur:
    print(drinker + ' lives at ' + address)

# print menu for bars whose name contains “a”:
cur.execute('SELECT * FROM Serves WHERE bar LIKE %s', ('%a%',))
for bar, beer, price in cur:
    print('{} serves {} at ${:,.2f}'.format(bar, beer, price))

cur.close()
conn.close()
```

You can iterate over `cur` one tuple at a time

Placeholder for query parameter

Tuple of parameter values, one for each `%s` (note that the trailing “,” is needed when the tuple contains only one value)
# More psycopg2 examples

# “commit” each change immediately—need to set this option just once at the start of the session

```python
conn.set_session(autocommit=True)
```

# ...

```python
bar = input('Enter the bar to update: ').strip()
beer = input('Enter the beer to update: ').strip()
price = float(input('Enter the new price: '))
```

```python
try:
    cur.execute('''
UPDATE Serves
SET price    = %s
WHERE bar = %s AND beer = %s'', (price, bar, beer))
    if cur.rowcount != 1:
        print('{} row(s) updated: correct bar/beer?\n        .format(cur.rowcount))
```  

```python
except Exception as e:
    print(e)
```

# of tuples modified

Exceptions can be thrown (e.g., if positive-price constraint is violated)
while True:

    # Input bar, beer, price...

    cur.execute('''
    UPDATE Serves
    SET price = %s
    WHERE bar = %s AND beer = %s'', (price, bar, beer))

    # Check result...

• Every time we send an SQL string to the DBMS, it must perform parsing, semantic analysis, optimization, compilation, and finally execution

• A typical application issues many queries with a small number of patterns (with different parameter values)

• Can we reduce this overhead?
Prepared statements: example

```
cur.execute(""
PREPARE update_price AS UPDATE Serves
SET price = $1
WHERE bar = $2 AND beer = $3"")
```

```
while True:
    # Input bar, beer, price...
    cur.execute('EXECUTE update_price(%s, %s, %s)',
                (price, bar, beer))  # Note the switch back to %s for parameter placeholders.
    # Check result...

- The DBMS performs parsing, semantic analysis, optimization, and compilation only once, when it “prepares” the statement
- At execution time, the DBMS only needs to check parameter types and validate the compiled plan
- Most other API’s have better support for prepared statements than psycopg2
  - E.g., they would provide a cur.prepare() method

See /opt/dbcourse/examples/psycopg2/ on your VM for a complete code example
“Exploits of a mom”

• The school probably had something like:
  
  ```python
  cur.execute("SELECT * FROM Students " + 
              "WHERE (name = " + name + ")")
  ```

  where `name` is a string input by user

• Called an **SQL injection attack**
Guarding against SQL injection

• Escape certain characters in a user input string, to ensure that it remains a single string
  • E.g., ',', which would terminate a string in SQL, must be replaced by "" (two single quotes in a row) within the input string
• Luckily, most API’s provide ways to “sanitize” input automatically (if you use them properly)
  • E.g., pass parameter values in psycopg2 through %s’s
If one fails to learn the lesson...

... P.S. To Ashley Madison’s Development Team: You should be embarrassed [sic] for your train wreck of a database (and obviously security), not sanitizing your phone numbers to your database is completely amateur, it’s as if the entire site was made by Comp Sci 1XX students.

— Creators of CheckAshleyMadison.com

https://en.wikipedia.org/wiki/Ashley_Madison