Is Your Web Server Suffering from Undue Stress due to Duplicate Requests?

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June 18th, 2014
Motivation for Detecting Duplicated Requests

• What is a duplicated request?
  – A web-click resulting in the same HTTP request twice or more

• Consequences
  – Cause extra server load
  – Corrupt server state

• Frequency of Occurrence
  – Top sites CNN, YouTube
  – At-least 22 sites out of top 98 Alexa sites (Chrome)
Root Causes of Duplicated Web Requests

- **Missing resource cause**

```
1  Var img = new Image();
2  img.src = "" //Code resolving to empty

5 - <img src='<?php echo $slide->mainImage; ??"' alt='<?php echo $slide->altTitle; ?>' />
6 + <span style="background:url(media/system/images/cc_button.jpg) no-repeat;">
7 +  <img src="media/system/images/cc_button.jpg" alt='<?php echo $slide->altTitle; ?>' />
8  </span>
9  </a>
```

- **Manifestation in browser**
Root Causes of Duplicated Web Requests

• *Duplicate Script Cause*

1 `<script src="B.js"></script>`
2 `<script src="B.js"></script>`

• *Manifestation in Browser*
  – None
Problem Statement and Design Goals

• How to automatically detect duplicated web-requests?
• Design goals
  – General purpose solution
  – Low overhead
  – Low false-positive
  – High detection accuracy
  – Scope for diagnosis
Griffin’s High-level Detection Scheme

1. Trace Synchronously

2. Extract Function-Call Depth Signal

3. Compute Autocorrelation and Detect on Threshold

1: Application Function Calls

2: Function-call-depth Signal

3: Auto-correlation of Function-call-depth Signal
Function-call-depth to Autocorrelation Example

Autocorrelation => \textit{shift} + \textit{multiply} + \textit{sum}

\begin{align*}
C_0 &= 1 \times 1 + 2 \times 2 + \ldots + 1 \times 1 + 0 \times 0 = 28 & R_0 &= C_0/C_0 = 1 \\
C_1 &= 1 \times 2 + 2 \times 3 + \ldots + 2 \times 1 + 1 \times 2 = 24 & R_1 &= C_1/C_0 = 0.85 \\
& \vdots & & \vdots \\
C_{10} &= 1 \times 0 + 2 \times 0 + \ldots + 2 \times 0 + 1 \times 0 = 0 & R_{10} &= 0/C_0 = 0.0
\end{align*}

1: Application Function Calls
Autocorrelation Example with Duplicate requests

\[ C_0 = 1 \times 1 + 2 \times 2 + \ldots + 1 \times 1 + 0 \times 0 = 56 \]
\[ R_0 = \frac{C_0}{C_0} = 1 \]

\[ C_{10} = 1 \times 1 + 2 \times 2 + \ldots + 1 \times 1 + 0 \times 0 = 28 \]
\[ R_{10} = \frac{C_{10}}{C_0} = 0.5 \]

\[ C_{20} = 1 \times 0 + 2 \times 0 + \ldots + 2 \times 0 + 1 \times 0 = 0 \]
\[ R_{20} = \frac{0}{C_0} = 0.0 \]
Detection Algorithm Example in NEEShub

\[ R_{xx}[t] = \frac{C_t}{C_0} \text{ where } t=0,\ldots,n \]

\[ C_t = \frac{1}{n} \sum_{s=\max(1,-t)}^{\min(n-t,n)} [X_{s+t} - \bar{X}][X_s - \bar{X}] \]

\[ R_{xx}[0]=C_0/C_0=1 \quad \text{R}_{xx}[40000]=C_{40000}/C_0=0.49 \]
Evaluation

- **HUBZERO**: Infrastructure for building dynamic websites
  - [www.nees.org](http://www.nees.org) (web server, backend database)

- **Accuracy**

  \[
  \frac{True\_Positives + True\_Negatives}{True\_Positives + True\_Negatives + False\_Positives + False\_Negatives}
  \]

- **Precision**

  \[
  \frac{True\_Positives}{True\_Positives + False\_Positives}
  \]

- **Overhead**
  - Percentage Tracing Overhead
  - Detection Latency (seconds)
Definitions

• Web-request
  – GET, POST

• Web-click
  – mouse clicks generating multiple web-requests
  – Homepage, Login, LoggingIn

• Http-transaction
  – Multiple web-clicks by a human user
  – Homepage ➔ Login ➔ LoggingIn (size=3)
  – Homepage ➔ Register (size=2)
Detection Results

- Tested 60 unique http-transactions
  - 20 http-transactions of size 1,2,3
- Ground-truth established by manual testing from browser
  - Duplicate requests found in seven unique web-clicks

<table>
<thead>
<tr>
<th></th>
<th>Accuracy</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>one-click</td>
<td>90% = (\frac{18}{20})</td>
<td>100% = (\frac{3}{3})</td>
</tr>
<tr>
<td>two-clicks</td>
<td>70% = (\frac{14}{20})</td>
<td>100% = (\frac{4}{4})</td>
</tr>
<tr>
<td>three-clicks</td>
<td>75% = (\frac{15}{20})</td>
<td>0% = (\frac{0}{4})</td>
</tr>
</tbody>
</table>

- Tracing Overheard
  - 1.29X
- Detection Latency: < 30 sec for sequence length of 100K
GRiffin’s Summary

• General solution for duplicate detection using autocorrelation
  – Trace function calls and returns
  – Extract function call-depth signal
  – Autocorrelation-based detection using only one threshold (0.4)

• Zero-false positives with 78% accuracy
• Low-overhead of tracing and detection
QUESTIONS ?