Information Organization and Retrieval  Class, Berkeley
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An Ideal E-Commerce Architecture for Building Web Sites
Supporting Analysis and Personalization

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Overview

⚠ Warning: Your mileage may vary

Introduction - the vision

⚠ Webstore (interact with customers)
⚠ Analysis (understand)
⚠ Action (target)

Architecture

⚠ Requirements
⚠ The unfair advantage

Summary
Warnings

- Ronny Kohavi’s biased view
  Your mileage may vary (standard disclaimers)

- Real-life problems
  - Need effective solutions, not clean/beautiful solutions.
    Examples:
    - Engine noise in planes
    - Nomad robots at Stanford hospital
    - Structured data, not information extraction (when we can)

- Efficiency is paramount - software must be designed to run fast and scale well
  - Start quickly with small/inefficient solutions, make sure it can grow.
    Measure with a micrometer; Mark with chalk; Cut with an axe.
    Design ideal architecture; Implement pieces; Code and ship, improve.
  - Use efficient algorithms (low complexity: \( O(n \log n) \) for \( n \) records).
Vision: enterprise software application that allows companies to interact with, understand, and target customers

- **Enterprise** - allows integration (expensive)
- **Interact** - on the web and possibly through other “touch points” (e.g., phones)
- **Understand** - Analyze data (e.g., data mining)
- **Target** - personalize (web, e-mail)

*International Data Corporation (IDC) reported in 1999 that (large) web sites costs $5.9M to assemble and $4.3M annually to maintain.*
Understand Customer Behavior

Motivation: Improve the site over time
- How many visitors?
- Conversion rates (buyers to visitors) for products?
- How are they traversing the site?
  Killer pages
- Where are they coming from?
  Which ads are effective?
- Failed searches?

Solutions:
- Reports
- Data Mining and visualizations
Using hits and page views to judge site success is like evaluating a musical performance by its volume

-- Forrester Report, 1999

- A key metric in e-commerce sites is the conversion rate (buyers to browsers)
- Especially useful by referrer (e.g., ad)
- What is a typical conversion rate (e.g., dell.com)
On one of our sites, we saw the following in their initial rampup period:

<table>
<thead>
<tr>
<th>Referrer</th>
<th># Sessions</th>
<th>% of traffic</th>
<th># Sales</th>
<th>Conv rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>ShopNow</td>
<td>16,178</td>
<td>6.9%</td>
<td>6</td>
<td>0.04%</td>
</tr>
<tr>
<td>FashionMall</td>
<td>19,685</td>
<td>8.4%</td>
<td>17</td>
<td>0.09%</td>
</tr>
<tr>
<td>MyCoupons</td>
<td>2,052</td>
<td>0.9%</td>
<td>170</td>
<td>8.28%</td>
</tr>
</tbody>
</table>

Conversion rates differ by a factor of over 200!
What is Data Mining

More Data Mining and Viz at 11 today
Elevator description (purple)

For future predictions  Actionable

The non-trivial process of identifying valid, novel, potentially useful, and ultimately understandable patterns in data.

-- Fayyad, Piatetsky-Shapiro, Smyth [1996]
Examples of Patterns (real)

- **Data from a legcare/legware e-retailer.**
- **Patterns for heavy purchasers:**
  - Not an AOL user (defined by browser)
  - Came to site from print-ad or news, not friends & family (reg form)
  - Very high and very low income
  - High home market value, owners of luxury vehicles
  - Repeat visitors (four or more times)
  - Visits to specific areas of site

- **Patterns for shoppers**
  - Those that came with a discount coupon (code)
  - Those that did not come from winnie-cooper.com
  - Who is Winnie Cooper? 🏈 🏈
Who is Winnie Cooper?

- Winnie-cooper is a 31 year old guy who wears pantyhose
- He has a pantyhose site
- 8,700 visitors came from his site to our legware/legcare site in three days (half the traffic at the time)
Analysis through data mining and visualization yields insight

Insight leads to action

Examples:

- Targeted campaigns - offer people what they are likely to want/buy
- Personalize site (fewer images for modem users)
- Different merchandise for different users
- Jumbo pantyhose for visitors that come from Winnie-Cooper.com
Personalization Benefits

- Increase Conversion
- Increase Basket Size
- Increase Customer Retention

Name: Joe Smith
Income: $50,000-$75,000
Attitude: Extreme
Gender: Male

Name: Anonymous
Interact - Touch Points

- Interact with customers across touch point
  - Webstore
  - Phone
  - Wireless
  - Bricks-and-mortar

- We want consistent messages across
  Example: same promotions and cross-sells on webstore, wireless PDA, and phone call to purchase
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Summary
Business logic must be shared across channels (webstore, customer service, etc)

- Everything must be stored in a database
- Web pages use API calls to access database.
- Rules store logic for recommendations, promotions.
- On the web, use Java Server pages (JSP), which consists of HTML with embedded Java code.

For example, the following displays the home page image, which may be different for each user:

```html
<% homeImage=webstore.getCollectionRecommendation("Images") %>
<img src="<%= homeImageObject.getPath() %>" align="center">
```
Attributes everywhere

Every object should support description through any number of attributes

Examples of attributable object:
- Customers (name, address, age, gender, income)
- Product (short & long description, waterproof, ....)
- Order header (customer, ship address, price, coupon)
- Order line (product, quantity, color, size)
- Web page template (site area, designer)
- Image (size, image/drawing, caption)

Why?
- Multiple attributes for different touch points (e.g., long description for web, short for wireless PDA)
- Structured data - makes data mining easier
Hierarchies everywhere (trees)

Examples:
- Product arranged in hierarchy
- Assortments (collection of products) are hierarchical
- Promotions
- Analyses

Why?
- Manageability - humans can’t deal with lists
  Much better at traversing trees/hierarchies
- Inheritance - Children inherit properties from parents.
  For example, all children of “Jeans” automatically inherit properties from parent
- Abstraction levels for data mining patterns
  Diapers and Beer sell together, but there is no specific diaper that sells with a specific beer
Site Versioning

- Site must be up while the next site is being designed
- Switch from old to new site must be smooth
- Architecture must support multiple versions
  - Deployment of new site
  - Users who are in mid session continue to see “old site.”
  - New users see new site
Clickstream Collection

- Track user actions on site for analysis
- Web logs insufficient
  - Don’t know what they typed during search
  - HTTP is stateless - need to sessionize visits
  - URLs are meaningless in changing sites
  - Dynamic sites / personalized sites show different content for same URL

- Solution:
  - Create our own clickstream log
  - Very rich, including meta data (e.g., what was on the page).
Efficiency/Scalability

Site must be efficient/distributed

- Multiple web servers and application servers (application servers control the logic and generate the HTML pages; webservers just serve them)
- Requires data replication

Solution:

- Site definition and design done against an inefficient database schema that is easy to work with
- “Staging” process transforms data to a very efficient (time-wise) format for deployment
  Deployment format can change over time as we find more tricks to improve efficiency
Analysis must never be done at the webstore, which is an OLTP system (On-Line Transaction Processing)

- Data must be copied, joined with external data, transformed, cleaned: a Data Warehouse

- Reporting, data mining, and visualizations, are all done against data warehouse
Integrated Architecture

- Business Data Definition
- Stage Data
- Customer Interaction
- Deploy Results
- Analysis
- Build Data Warehouse
Integrated Architecture

- Business Data Definition
- Stage Data
- Customer Interaction
- Deploy Results
- Build Data Warehouse
- Analysis
- Business facing
  - Products, content
  - Attributes
  - Shared meta-data

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Integrated Architecture

Business Data Definition

Stage Data

Customer Interaction

Deploy Results

Build Data Warehouse

Analysis

Build store

Test before production

Transform for efficiency

Zero down-time
Integrated Architecture

Business Data Definition

Stage Data

Customer Interaction

Deploy Results

Build Data Warehouse

Analysis

Customer facing
Multiple Touchpoints
Integrated Data Collection
Integrated Architecture

Business Data Definition

Stage Data

Customer Interaction

Deploy Results

Analysis

Build Data Warehouse

Build warehouse

Automated using meta-data

Reduces pre-processing

Transform for analysis
Integrated Architecture

Business Data Definition

Stage Data

Customer Interaction

Deploy Results

Build Data Warehouse

Analysis

Data transformations
Exploration
Modeling
Integrated Architecture

Business Data Definition

Stage Data

Customer Interaction

Deploy Results

Analysis

Build Data Warehouse

Close the loop

Transfer scores, models
Personalize
Warning: Your mileage may vary

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The unfair advantage ⇔
The integrated system provides much more than each component alone

Summary
Trackers in the Real World

Experiments in bricks-and-mortar stores are hard. Here is an excerpt from *Why We Buy: the Science of Shopping* describing a “log”:

She's in the bath section. She's touching towels. Mark this down -- she's petted one, two, three, four of them so far. She just checked the price tag on one. Mark that down, too. Careful, her head's coming up -- blend into the aisle. She's picking up two towels from the tabletop display and is leaving the section with them. Get the time. Now, tail her into the aisle and on to her next stop.

EnviroSell Inc. goes through 14,000 hours of store videotapes a year to do behavioral research

The web changes everything: clickstreams
The Web Advantage

In e-commerce it is easy to change a site and measure the *effect* of changes

- One can easily set control groups on a web site
- Easy to offer cross-sells or up-sells
- Contrast with changing actual store layouts

Response to e-mails and surveys is days, not weeks and months

Data is clean (unlike legacy data)
A bank discovered that almost 5% of their customers were born on the exact same date.

Why?

Hint: 11 Nov 1911
80% of the time spent in data analysis is typically spent transforming data.

An integrated architecture can:
- Automate transfer of data from webstore environment to data warehouse
- Provide data transformation UI
- Provide “canned” transformations for common business problems
Humans have terrible intuition when there is a lot of data

Example:

400,000 Americans/year die from cigarette smoking

Quick, how many fully-loaded Jumbo 747 planes crashes is this equivalent to?

3 crashes every day, 365 days a year
A person invests $100,000 in a volatile stock
Each year it either rises by 60% or falls by 40%
After 100 years, what is the
- Expected value = \$1,378,061,234 (over $1B) = 100K \times 1.1^{100}
- Mode (most likely value) = \$13,000 = 100K \times (1.6)^{50} \times (0.6)^{50}
- Median (half the people will earn less than this, half more than this) = \$13,000 (same as mode)
Many sites spend millions of dollars in maintenance because they lack a good architecture

Architect your solution early

Think of scalability and efficiency

Think ahead:

Many sites are beautiful but it’s all CGI, which doesn’t scale

Analysis is key - what are customers doing? Failed searches. Killer pages. Referrer pages/ads

Close the loop. Analysis without action has no ROI
Clickstream data available for research/educational purposes at http://www.ecn.purdue.edu/KDDCUP/

More questions?
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