Introduction to a Recommender System for Apache OFBiz™

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Information Engineering

Apache OFBiz

http://ofbiz.apache.org/

– “Apache OFBiz™ is an open source product for the automation of enterprise processes that includes framework components and business applications for

ERP (Enterprise Resource Planning),

CRM (Customer Relationship Management),

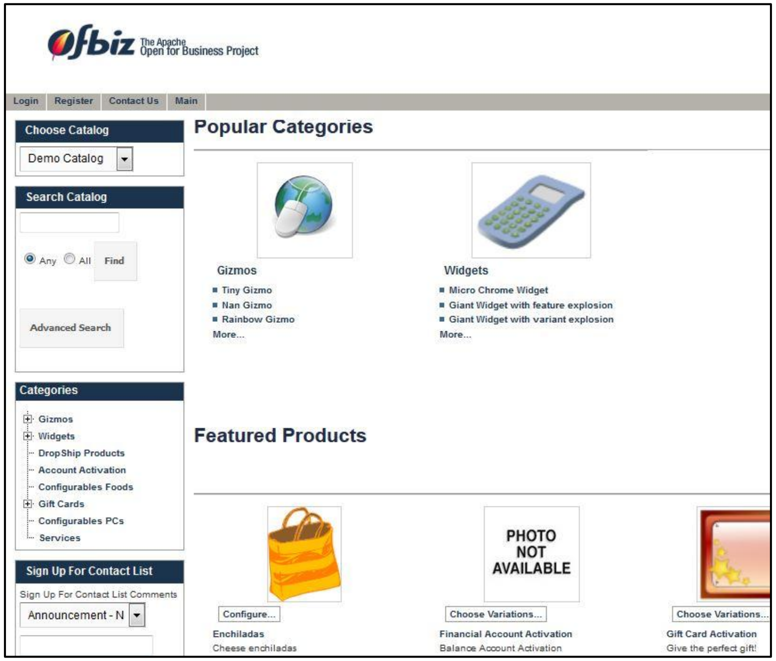
E-Business / E-Commerce,

SCM (Supply Chain Management),

MRP (Manufacturing Resource Planning),

MMS/EAM (Maintenance Management System/Enterprise Asset Management),

POS (Point Of Sale).”



The Apache Open for Business Project

Login | Register | Contact Us | Main

Choose Catalog

Demo Catalog

Search Catalog

● Any ○ All Find

Advanced Search

Categories

- Gizmos
- Widgets
- DropShip Products
- Account Activation
- Configurables Foods
- Gift Cards
- Configurables PCs
- Services

Sign Up For Contact List

Sign Up For Contact List Comments

Announcement - N

Popular Categories

Gizmos
- Tiny Gizmo
- Nan Gizmo
- Rainbow Gizmo

More...

Widgets
- Micro Chrome Widget
- Giant Widget with feature explosion
- Giant Widget with variant explosion

More...

Featured Products

Configure...
Enchiladas
Cheese enchiladas

PHOTO NOT AVAILABLE
Choose Variations...
Financial Account Activation
Balance Account Activation

Choose Variations...
Gift Card Activation
Give the perfect gift!

OFBiz demo e-commerce site

– Currently OFBiz doesn’t include any service that generates Recommendations for online shoppers

Outline

- Introduction
  - Recommendations
  - Product Association Recommendations
- A Product Association Recommender for OFBiz
  - Out of the box support for Product Association
  - Recommender based approach to Product Association
  - Prototype of a Product Association Recommender
  - Demo
- From the prototype to a production-ready component
  - Summary of the main prototype features
  - Improvements and automation strategies

Introduction

Introduction

Recommendations (1/2)

- **Context**
  - **System** (e-commerce site, web-radio, etc.) **that provides a service** (selling, streaming, etc.) **on some products** (books, music, films, etc.)
  - **Set of users' that interact with the system** (browse, rate, click, etc.) **and utilize the service** (buy a book, listen to a song, etc.)

- **Recommendation**
  - Information given to the users to support their choices (suggestions about products to buy, etc.)
  - Based on
    - Users' preferences (preferred literary genre, preferred music genre, etc.)
    - Historical data (about past purchases, products' ratings, etc.)

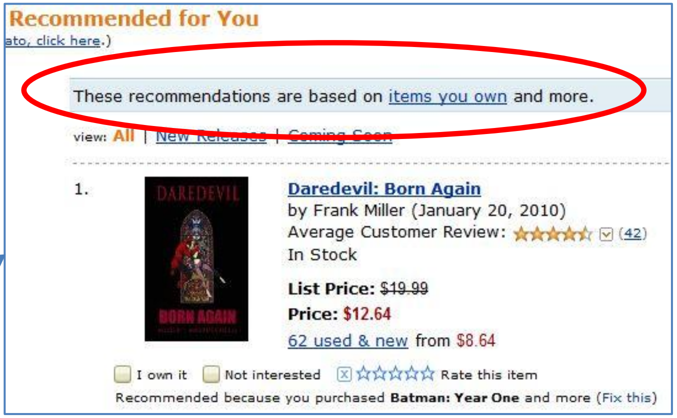
Introduction

Recommendations (2/2)

- **Examples of Recommendations**

  – **Personalized:** takes into account historical data or specific preferences of the user who is receiving the recommendation

    - Collaborative filtering (User-user, Item-item, Dimensionality reduction)
    - Content-based filtering



Recommended for You

ato, click here.)

These recommendations are based on items you own and more.

view: All | New Releases | Coming Soon

1. Daredevil: Born Again
by Frank Miller (January 20, 2010)
Average Customer Review: ★★★★☆ (42)
In Stock

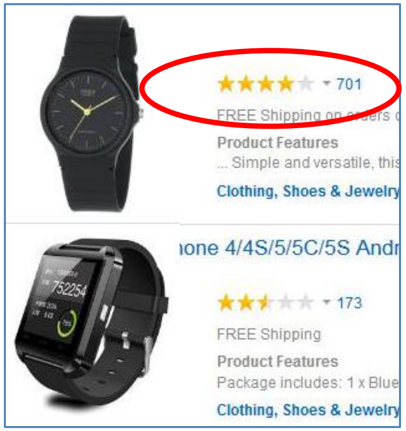
List Price: ~~$19.99~~
Price: $12.64
62 used & new from $8.64

□ I own it □ Not interested ☒ ☆☆☆☆☆ Rate this item

Recommended because you purchased **Batman: Year One** and more (Fix this)

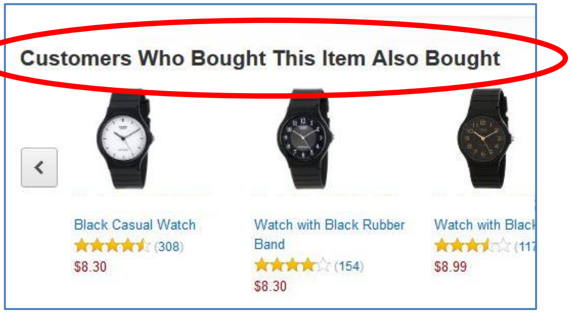
  – **Non personalized**: does not take into account historical data or preferences of the user who is receiving the recommendation

    - Summary statistics (aggregated opinion recommenders)
    - **Non personalized Product Association Recommendation** (*Ephemerally personalized*: takes into account the current activity of the user, e.g., the product that is being checked out or is being viewed, etc.)



★★★★☆ ▾ 701
FREE Shipping on orders o
Product Features
... Simple and versatile, this
Clothing, Shoes & Jewelry

ione 4/4S/5/5C/5S Andr
★★½☆☆ ▾ 173
FREE Shipping
Product Features
Package includes: 1 x Blue
Clothing, Shoes & Jewelry



Customers Who Bought This Item Also Bought

Black Casual Watch
★★★★½ (308)
$8.30

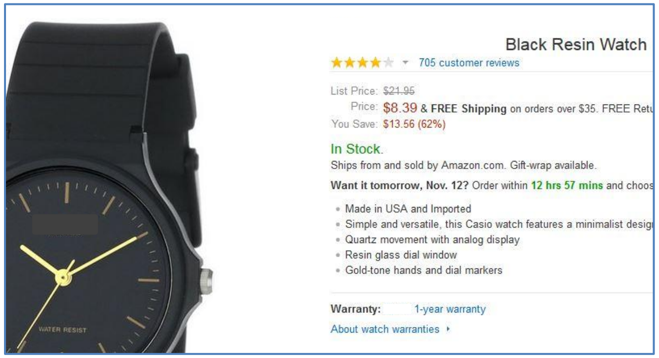
Watch with Black Rubber Band
★★★★☆ (154)
$8.30

Watch with Black
★★★½☆ (117
$8.99

Introduction

Non personalized Product Association Recommender (1/4)

- **Key concept**
  - – People who did X (bought some product, listened to a song, etc.) also did Y



Black Resin Watch

★★★★☆ 705 customer reviews

List Price: ~~$21.95~~

Price: $8.39 & **FREE Shipping** on orders over $35. FREE Retu

You Save: $13.56 (62%)

In Stock.

Ships from and sold by Amazon.com. Gift-wrap available.

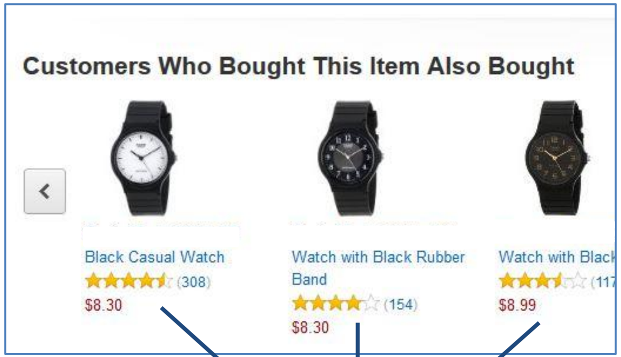
Want it tomorrow, Nov. 12? Order within 12 hrs 57 mins and choos

- Made in USA and Imported
- Simple and versatile, this Casio watch features a minimalist desig
- Quartz movement with analog display
- Resin glass dial window
- Gold-tone hands and dial markers

Warranty: 1-year warranty

About watch warranties ›

People who bought X…



Customers Who Bought This Item Also Bought

Black Casual Watch ★★★★★ (308) $8.30

Watch with Black Rubber Band ★★★★☆ (154) $8.30

Watch with Black ★★★★☆ (117 $8.99

… also bought Y

- **Key question**
  - Given **X**, what are the products **Y** whose purchase is related ('associated') to the purchase of X?

Introduction

Non personalized Product Association Recommender (2/4)

- **Naïve algorithm**
  - **X**: product for which we want Product Association Recommendations
  - Recommend Y if most of the people who bought X also bought Y
    - **Maximization of P[Y|X]** (read: probability of Y given X)
  - **Drawback** : recommend popular products that are not related to X
  - **Example**
    - **X**: ice-cream
    - **Y**: popular barbecue sauce
    - Most of the people who bought the ice-cream also bought the barbecue sauce → **high P[Y | X]** → **recommend the barbecue sauce**

Introduction

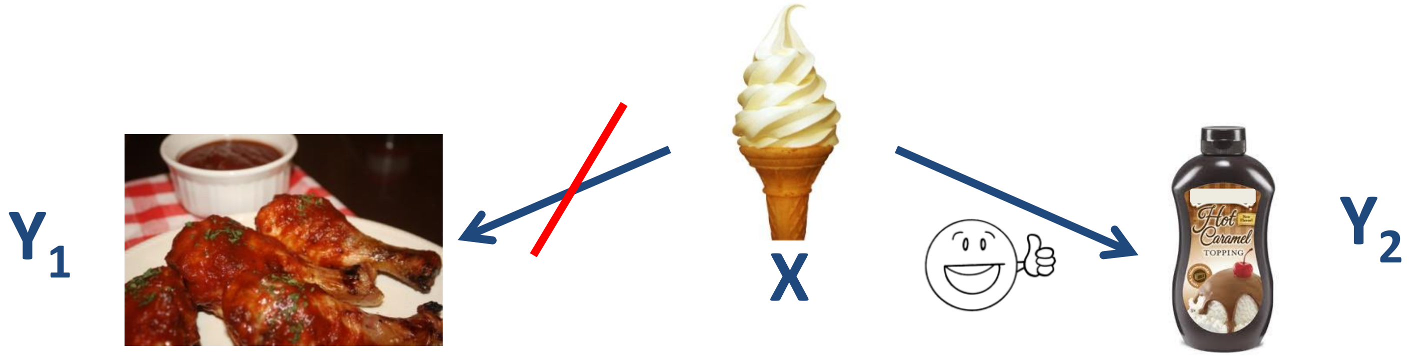
Non personalized Product Association Recommender (3/4)

- **Proper algorithm**
  - **X**: product for which we want Product Association Recommendations
  - **Recommend Y if the purchase of X increases the probability of buying Y**
    - **P[Y|X] > P[Y|~X]** (read: probability of Y given not X)

Introduction

Non personalized Product Association Recommender (4/4)

- Proper approach
  - **Example**
    - **X**: ice-cream
    - **Y_1**: popular barbecue sauce; **Y_2**: caramel topping for ice-creams
    - **Y_1**: most of the people who bought the ice-cream also bought the barbecue sauce → **high $P[Y_1 | X]$**, but also most of the people who have never bought an ice-cream bought barbecue sauce → **same high $P[Y_1 | \sim X]$**
      - **$P[Y_1 | X]=P[Y_1 | \sim X]$ → Y_1 NOT recommended**
    - **Y_2**: most of the people who bought the ice-cream also bought the caramel topping → **high $P[Y_2 | X]$**, but very few people among those who have never bought an ice-cream bought a caramel topping → **low $P[Y_2 | \sim X]$**
      - **$P[Y_2 | X]> P[Y_2 | \sim X]$ →Y_2 recommended!**

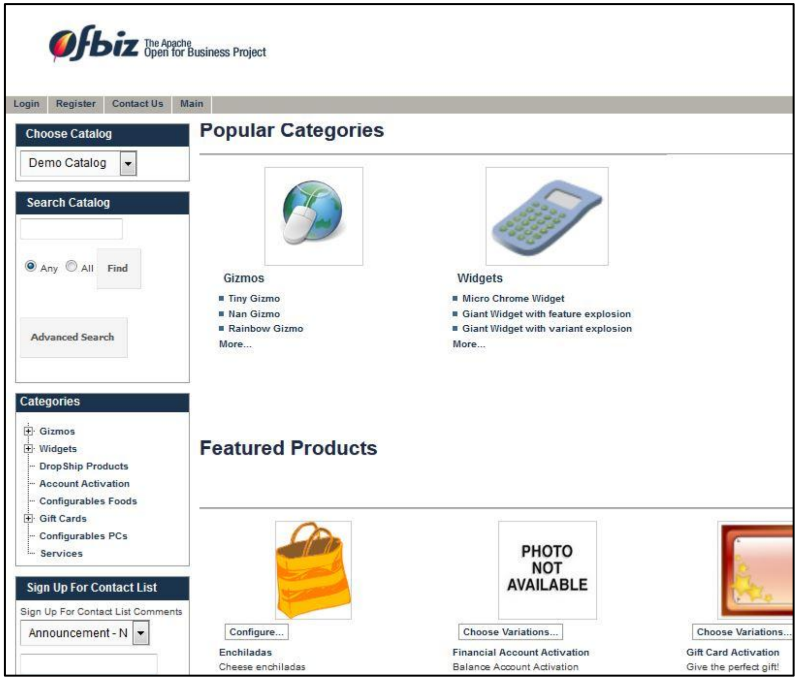


A Product Association Recommender for Apache OFBiz

A Product Association Recommender for OFBiz

Out of the box support for Product Association (1/2)

- **Demo ecommerce site** (http://localhost:8080/ecommerce/)
- **Product detail page**



Popular Categories

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- Tiny Gizmo
- Nan Gizmo
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More...

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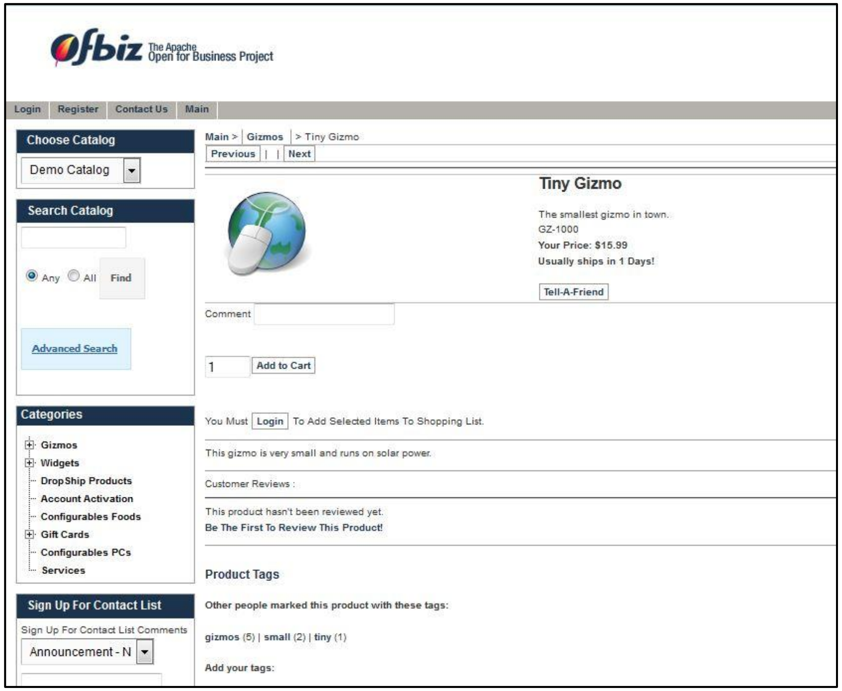
Cheese enchiladas

Financial Account Activation
Balance Account Activation

Gift Card Activation
Give the perfect gift!



Tiny Gizmo

The smallest gizmo in town.
GZ-1000
Your Price: $15.99
Usually ships in 1 Days!

Comment

1

You Must Login To Add Selected Items To Shopping List.

This gizmo is very small and runs on solar power.

Customer Reviews :

This product hasn't been reviewed yet.
Be The First To Review This Product!

Product Tags

Other people marked this product with these tags:

gizmos (5) | small (2) | tiny (1)

Add your tags:

A Product Association Recommender for OFBiz

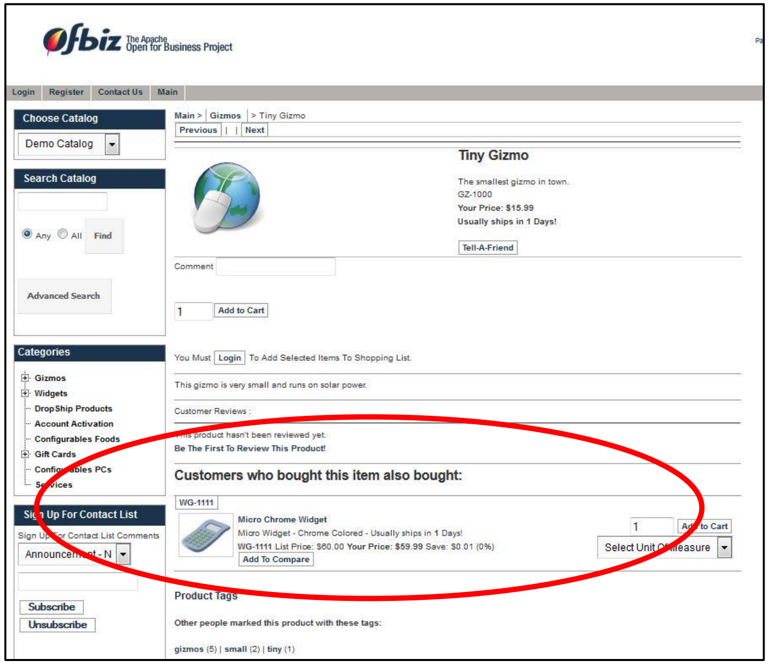
Out of the box support for Product Association (2/2)

– Manual insertion of a record in the ProductAssoc entity with productAssocTypeId set to “ALSO_BOUGHT”

```
<entity-engine-xml>

    <ProductAssoc
     productId=“GZ-1000"
     productIdTo="WG-1111"
     productAssocTypeId="ALSO_BOUGHT"
     fromDate="2014-09-02 12:00:00.000"/>

</entity-engine-xml>
```



Tiny Gizmo

The smallest gizmo in town.
GZ-1000
Your Price: $15.99
Usually ships in 1 Days!

Comment

1 Add to Cart

You Must Login To Add Selected Items To Shopping List.

This gizmo is very small and runs on solar power.

Customer Reviews :

This product hasn't been reviewed yet.
Be The First To Review This Product!

Customers who bought this item also bought:

WG-1111

Micro Chrome Widget
Micro Widget - Chrome Colored - Usually ships in 1 Days!
WG-1111 List Price: $60.00 Your Price: $59.99 Save: $0.01 (0%)

1 Add to Cart

Product Tags

Other people marked this product with these tags:

gizmos (5) | small (2) | tiny (1)

- **Drawbacks**
  - – Requires manual maintenance
  - – Not based on any Product Association recommender algorithm

A Product Association Recommender for OFBiz

Recommender based approach

- **Procedure**

  1) Generation of associations based on Product Association algorithm

  - **X :** product for which we want Recommendations
  - **recommend Y if the purchase of X increases the probability of buying Y**

  P[Y|X] > P[Y|~X]

  2) Storage of associations in ProductAssoc entity

- **Implementation of Product Association algorithm**

  - **Y:** items bought together with X in the same orders
  - **Computation of P[Y|X] and P[Y|~X]**

    - $\hat{P}[Y \mid X]$ = (# of orders containing Y and X)/(# of orders containing X)
    - $\hat{P}[Y \mid \sim X]$ = (# of orders containing Y but not X)/(# of orders not containing X)

  - **Assessment of P[Y|X] > P[Y|~X]**

    - $\hat{P}[Y \mid X] > \hat{P}[Y \mid \sim X]$ and
    - Log-likelihood ratio hypothesis test

      - Null hypothesis P[Y|X] equal to P[Y|~X]

Prototype of a Product Association Recommender (1/2)

- **"Recommender" component** (https://cwiki.apache.org/confluence/x/OYPfAg)
  - **getRecommendedAssociatedProducts** Java service
    - **Input**
      - product ID (**X**) for which we want to provide Recommendations
      - N max number of recommended products to return
    - **Output**
      - list of recommended products for X
    - **Main steps:**
      1) Finds the products ordered together (items in the same sales orders) with X
      2) For each 'co-ordered' product Y, computes the conditional probabilities and collect the products that pass the test
      3) Returns the first N (highest scores) recommended products and stores them in ProductAssoc entity (productAssocTypeId = '"ALSO_BOUGHT")

Prototype of a Product Association Recommender (2/2)

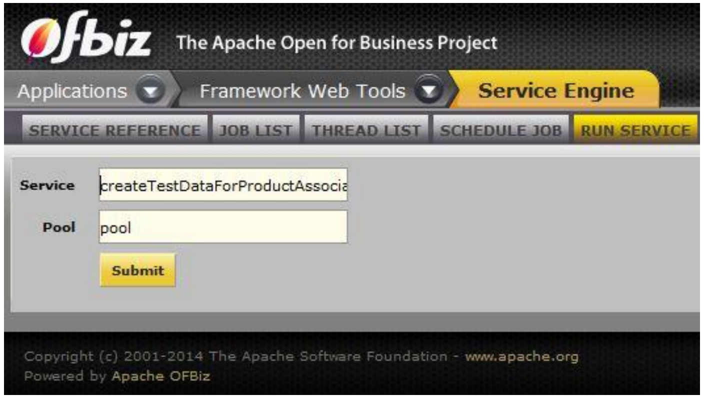
– **createTestDataForProductAssociationRecommender** Java service: creates sales orders that simulate purchases with known conditional probabilities

- **Input**
  - N number of orders
- **Products**
  - LED TV (**X**)
  - USB PEN DRIVE (**Y_1**) (**$P[Y_1 | X]=P[Y_1|\sim X]$**)
  - TV AUDIO SYSTEM (**Y_2**) (**$P[Y_2 | X] > P[Y_2 |\sim X]$**)
- **Conditional probabilities**
  - P[LED TV] = 0.5
  - P[TV AUDIO SYSTEM|LED TV] = 0.7; P[TV AUDIO SYSTEM|~LED TV] = 0.1
  - P[USB PEN DRIVE|LED TV] = 0.9; P[USB PEN DRIVE|~LED TV] = 0.9

A Product Association Recommender for OFBiz
Demo (1/2)

- Install the “Recommender” component under the hot-deploy folder
- Load demo products (ant load-demo)
- Run OFBiz (%OFBIZ_HOME\tools\startofbiz.bat or %OFBIZ_HOME\tools\startofbiz.sh)
- Web Tools (http://localhost:8080/webtools/control/main) -> Run Service

1)



Service: createTestDataForProductAssocia

Pool: pool

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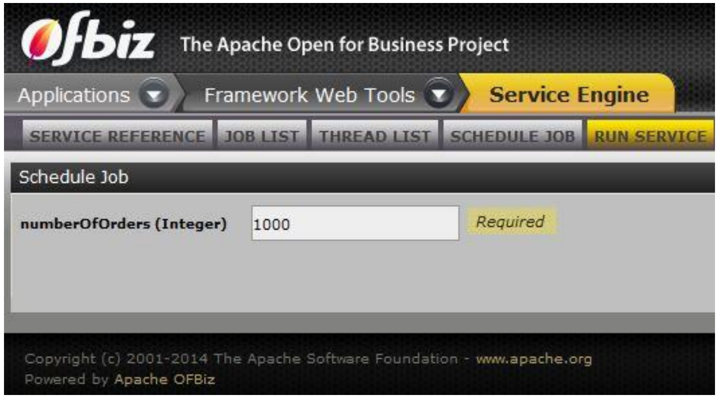
Powered by Apache OFBiz



numberOfOrders (Integer): 1000

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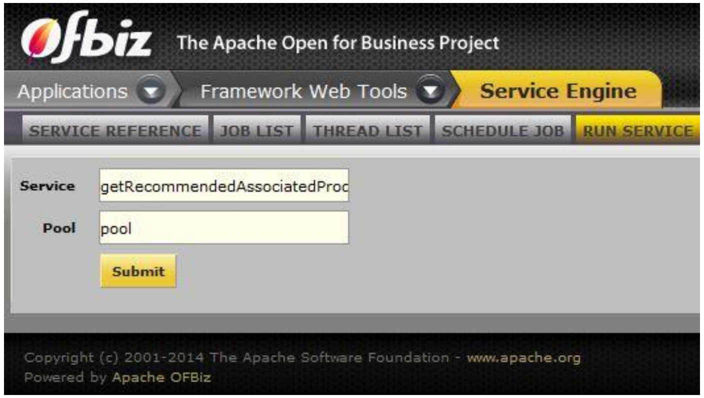
2)



Service: getRecommendedAssociatedProc

Pool: pool

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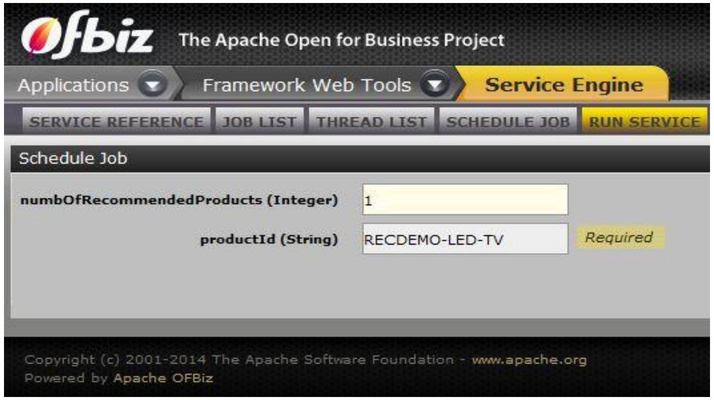

numbOfRecommendedProducts (Integer): 1

productId (String): RECDEMO-LED-TV

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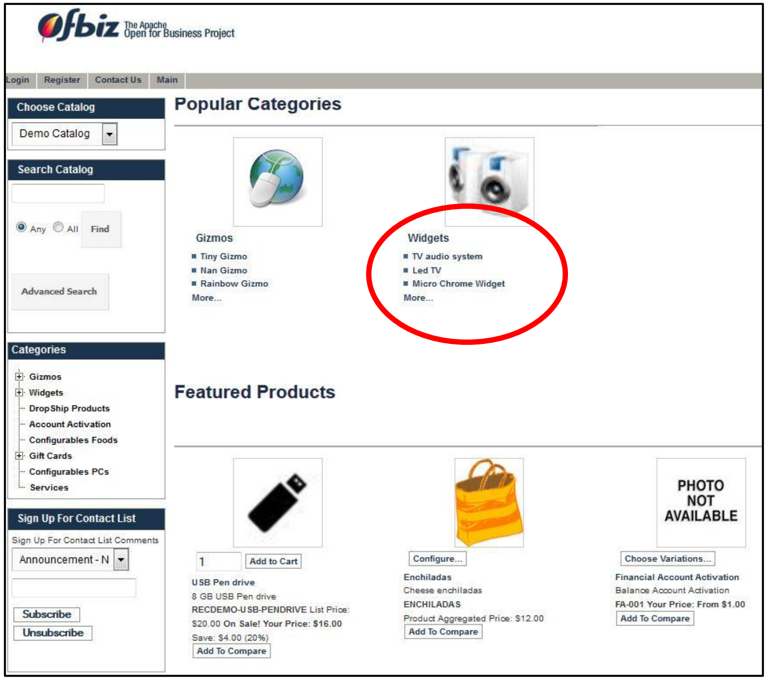
A Product Association Recommender for OFBiz

Demo (2/2)

- **Demo ecommerce site** (http://localhost:8080/ecommerce/)



Popular Categories

Gizmos
- Tiny Gizmo
- Nan Gizmo
- Rainbow Gizmo

More...

Widgets
- TV audio system
- Led TV
- Micro Chrome Widget

More...

Featured Products

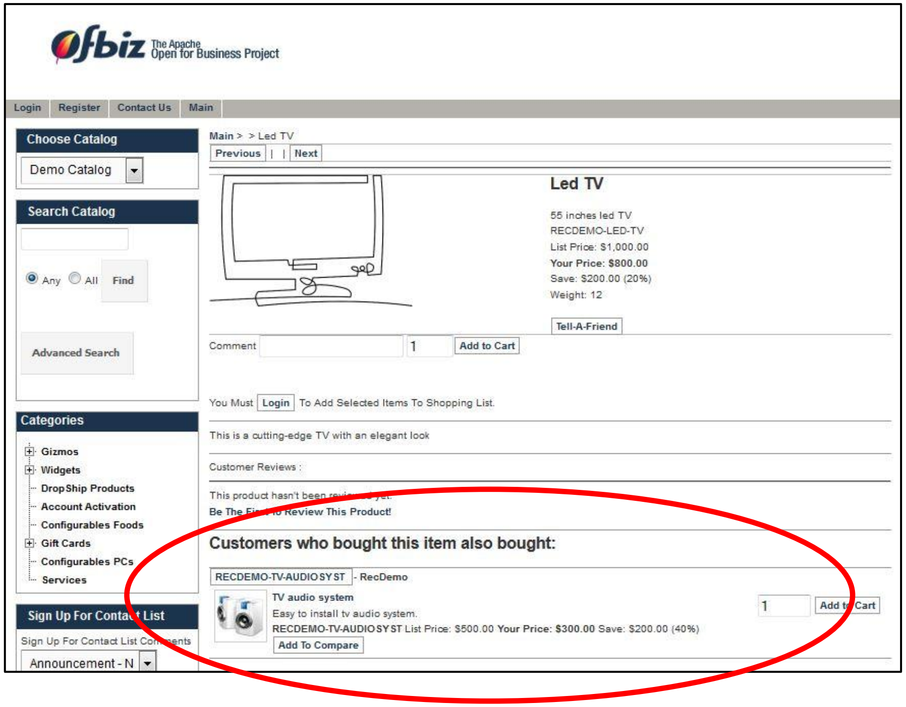
1 Add to Cart

USB Pen drive
8 GB USB Pen drive
RECDEMO-USB-PENDRIVE List Price: $20.00 On Sale! Your Price: $16.00
Save: $4.00 (20%)
Add To Compare

Configure...
Enchiladas
Cheese enchiladas
ENCHILADAS
Product Aggregated Price: $12.00
Add To Compare

Choose Variations...
Financial Account Activation
Balance Account Activation
FA-001 Your Price: From $1.00
Add To Compare

- **Led TV detail page**



Main > > Led TV

Previous | | Next

Led TV

55 inches led TV
RECDEMO-LED-TV
List Price: $1,000.00
Your Price: $800.00
Save: $200.00 (20%)
Weight: 12

Tell-A-Friend

Comment 1 Add to Cart

You Must Login To Add Selected Items To Shopping List.

This is a cutting-edge TV with an elegant look

Customer Reviews :

This product hasn't been reviewed yet.
Be The First To Review This Product!

Customers who bought this item also bought:

RECDEMO-TV-AUDIOSYST - RecDemo

TV audio system
Easy to install tv audio system.
RECDEMO-TV-AUDIOSYST List Price: $500.00 **Your Price: $300.00** Save: $200.00 (40%)
Add To Compare

1 Add to Cart

From the prototype to a production-ready component

From the prototype to a production-ready component

Summary of the prototype main features

– ‘Recommender’ hot-deploy component for the generation of Product Association Recommendations (downloadable from https://cwiki.apache.org/confluence/x/OYPfAg)

– Services

- getRecommendedAssociatedProducts
- createTestDataForProductAssociationRecommender
- removeRecommenderTestData

– Products ‘bought together’ ↔ in the same order

– Product Association algorithm based on computation of conditional probabilities and log-likelihood statistical hypothesis testing

From the prototype to a production-ready component

Improvements and automation strategies

– Introduction of a configurable time-window for considering products as “bought together”

– Bulk processing (all products, categories, etc.)

– Load-testing (on hundreds of products and thousands of orders) and performance improvements

– Automation strategies

- service triggered, e.g., by the creation of an order (e.g., ECA)
- scheduled job (every night, week, etc.)

– Integration of business rules

–Community feedback and contributions are very welcome!

References

-OFBiz website http://ofbiz.apache.org/

- Product Association Recommender for OFBiz:

  - https://cwiki.apache.org/confluence/x/OYPfAg

- Recommendations

  -*Recommender Systems Handbook*, F. Ricci, L.Rokach, B. Shapira, P.B. Kantor, eds, 2011. Springer Science+Business Media, LLC: 233 Spring Street, New York.
  -J.A. Konstan and J. Riedl, *Deconstructing Recommender Systems, How Amazon and Netflix predict your preferences and prod you to purchase.* IEEE Spectrum, Sep, 2014.

- Log-likelihood ratio hypothesis testing

  - http://en.wikipedia.org/wiki/Likelihood-ratio_test
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  - T. Dunning, *Accurate Methods for the Statistics of Surprise and Coincidence.* Computational Linguistic, vol. 19, 1993.

About me

- short bio
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