Big Data Predictive Analytics and Machine Learning Strategy and Roadmap

Making Big Data + Analytics *Simple*

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Big Data Predictive Analytics and Machine Learning Strategy and Roadmap Agenda

1. Overview  Oracle Advanced Analytics and Machine Learning
2. Oracle Data Miner Quick Demo
3. Example Customer Successes
4. OAA/Oracle R Enterprise
5. Oracle R Advanced Analytics for Hadoop
5. New Features: OAA 12.2, ODM’r 2.6, etc.
6. ...One More Thing 😊
Predictive Analytics 101

- Data, data everywhere – explosive growth
- Growth of data exponentially greater than growth of data analysts!

The Useful Data GAP

12%

Executives who feel they understand the impact data will have on their organizations

Produce

Data

Use

Data

Machine Learning/Data Analysis platforms requirements:

- Be extremely powerful and handle large data volumes
- Be easy to learn
- Be highly automated & enable deployment

http://www.delphianalytics.net/more-data-than-analysts-the-real-big-data-problem/
Machine Learning/Analytics + Data Warehouse + Hadoop

• Platform Sprawl
  – More Duplicated Data
  – More Data Movement Latency
  – More Security challenges
  – More Duplicated Storage
  – More Duplicated Backups
  – More Duplicated Systems
  – More Space and Power
Vision

• Big Data + Machine Learning/Analytics Platform for the Era of Big Data and Cloud
  — Make Big Data + **ML/Analytics** Model Discovery *Simple*
    • Any data size, on any computer infrastructure—on-premise and/or cloud
    • Any variety of data (structured, unstructured, transactional, geospatial), in any combination
  — Make Big Data + **ML/Analytics** Model Deployment *Simple*
    • As a service, as a platform, as an application
    • On-premise and/or cloud
What is Machine Learning, Data Mining & Predictive Analytics?

**Automatically** sifting through large amounts of data to create models that find previously hidden patterns, discover valuable new insights and make predictions.

- Identify most important factor *(Attribute Importance)*
- Predict customer behavior *(Classification)*
- Predict or estimate a value *(Regression)*
- Find profiles of targeted people or items *(Decision Trees)*
- Segment a population *(Clustering)*
- Find fraudulent or “rare events” *(Anomaly Detection)*
- Determine co-occurring items in a “baskets” *(Associations)*
### Classification
- Decision Tree
- Logistic Regression (GLM)
- Naive Bayes
- Support Vector Machine (SVM)
- Random Forest

### Regression
- Multiple Regression (GLM)
- Support Vector Machine (SVM)
- Stepwise Linear Regression
- Linear Model
- Generalized Linear Model
- Multi-Layer Neural Networks

### Anomaly Detection
- 1-Class Support Vector Machine

### Clustering
- Hierarchical k-Means
- Orthogonal Partitioning Clustering
- Expectation-Maximization

### Attribute Importance
- Minimum Description Length
- Unsupervised pair-wise KL div.

### Market Basket Analysis
- Apriori – Association Rules

### Text Mining
- All OAA/ODM SQL ML support
- Explicit Semantic Analysis

### Predictive Queries
- Clustering
- Regression
- Anomaly Detection
- Feature Extraction

### Feature Extraction & Creation
- Nonnegative Matrix Factorization
- Principal Component Analysis
- Singular Value Decomposition

### Time Series
- Single & Double Exp. Smoothing

### Open Source R Algorithms
- Ability to run any R package (9,000+) via Embedded R mode

+ Ability to Mine Unstructured, Structured & Transactional data
+ Partitioned Models
Oracle’s Advanced Analytics

Fastest Way to Deliver Scalable Enterprise-wide Predictive Analytics

Key Features

- Parallel, scalable data mining algorithms and R integration
- In-Database + Hadoop—Don’t move the data
- Data analysts, data scientists & developers
- Drag and drop workflow, R and SQL APIs
- Extends data management into powerful advanced/predictive analytics platform
- Enables enterprise predictive analytics deployment + applications
Google “Oracle Advanced Analytics”
Oracle’s Advanced Analytics

Fastest Way to Deliver Scalable Enterprise-wide ML/Predictive Analytics

**Major Benefits**

- Data remains in Database & Hadoop
  - Model building and scoring occur in-database
  - Use R packages with data-parallel invocations
- Leverage investment in Oracle IT
  - Eliminate data duplication
  - Eliminate separate analytical servers
- Deliver enterprise-wide applications
  - GUI for ML/Predictive Analytics & code gen
  - R interface leverages database as HPC engine

**Oracle Advanced Analytics**

*Fastest Way to Deliver Scalable Enterprise-wide ML/Predictive Analytics*

**Traditional Analytics**

- Data Import
- Data Mining
- Model Building
- Data Prep. & Transformation
- Data Extraction

*Hours, Days or Weeks*

**Oracle Advanced Analytics**

- Data Import
- Data Mining
- Model “Scoring”
- Data Prep. & Transformation
- Data Preparation

*Secs, Mins or Hours*

**Savings**

- Data Extraction
- Data Prep.
- Data Mining
- Model Building
- Model “Scoring”
- Embedded Data Prep

**Fastest Way to Deliver Scalable Enterprise-wide ML/Predictive Analytics**

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Oracle’s Advanced Analytics (Machine Learning Platform)
Multiple interfaces across platforms — SQL, R, GUI, Dashboards, Apps

<table>
<thead>
<tr>
<th>Information Producers</th>
<th>Information Consumers</th>
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<tbody>
<tr>
<td>R programmers</td>
<td>Data &amp; Business Analysts</td>
</tr>
<tr>
<td>SQL Developer/Oracle Data Miner</td>
<td>OBIEE</td>
</tr>
<tr>
<td>R Client</td>
<td>Applications</td>
</tr>
</tbody>
</table>

Users

R programmers | Data & Business Analysts | Business Analysts/Mgrs | Domain End Users

Platform

Hadoop

ORAAH Parallel, distributed algorithms

Oracle Database Enterprise Edition

Oracle Advanced Analytics - Database Option
SQL Data Mining, ML & Analytic Functions + R Integration for Scalable, Distributed, Parallel in-DB ML Execution

Oracle Cloud

Advanced Analytics

Oracle Database 12c

Information Producers

Information Consumers

ORACLE

R

HQL

Hadoop
You Can Think of Oracle Advanced Analytics Like This...

**Traditional SQL**
- “Human-driven” queries
- Domain expertise
- Any “rules” must be defined and managed

**SQL Queries**
- SELECT
- DISTINCT
- AGGREGATE
- WHERE
- AND OR
- GROUP BY
- ORDER BY
- RANK

**SQL Statistical Functions - SQL & R**
- Automated knowledge discovery, model building and deployment
- Domain expertise to assemble the “right” data to mine/analyze

**Statistical SQL “Verbs”**
- MEAN, STDEV
- MEDIAN
- SUMMARY
- CORRELATE
- FIT
- COMPARE
- ANOVA

FREE!
Independent Samples T-Test

- **A/B offer testing**
  - Query compares the mean of AMOUNT_SOLD between MEN and WOMEN Grouped By CUST_INCOME_LEVEL ranges
  - Returns observed t value and its related two-sided significance (<.05 = significant)

```sql
SELECT substr(cust_income_level,1,22) income_level,
    avg(decode(cust_gender,'M',amount_sold,null)) sold_to_men,
    avg(decode(cust_gender,'F',amount_sold,null)) sold_to_women,
    stats_t_test_indep(cust_gender, amount_sold, 'STATISTIC','F') t_observed,
    stats_t_test_indep(cust_gender, amount_sold) two_sided_p_value
FROM sh.customers c, sh.sales s
WHERE c.cust_id=s.cust_id
GROUP BY rollup(cust_income_level)
ORDER BY 1;
```
You Can Think of Oracle’s Advanced Analytics Like This...

Traditional SQL
- “Human-driven” queries
- Domain expertise
- Any “rules” must be defined and managed

SQL Queries
- SELECT
- DISTINCT
- AGGREGATE
- WHERE
- AND OR
- GROUP BY
- ORDER BY
- RANK

Oracle Advanced Analytics - SQL &
- Automated knowledge discovery, model building and deployment
- Domain expertise to assemble the “right” data to mine/analyze

Analytical SQL “Verbs”
- PREDICT
- DETECT
- CLUSTER
- CLASSIFY
- REGRESS
- PROFILE
- IDENTIFY FACTORS
- ASSOCIATE

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Oracle Advanced Analytics
How Oracle R Enterprise Compute Engines Work

1. R-> SQL Transparency “Push-Down”
   - R language for interaction with the database
   - R-SQL Transparency Framework overloads R functions for scalable in-database execution
   - Function overload for data selection, manipulation and transforms
   - Interactive display of graphical results and flow control as in standard R
   - Submit user-defined R functions for execution at database server under control of Oracle Database

2. In-Database Adv Analytical SQL Functions
   - 15+ Powerful data mining algorithms (regression, clustering, AR, DT, etc.)
   - Run Oracle Data Mining SQL data mining functioning (ORE.odmSVM, ORE.odmDT, etc.)
   - Speak “R” but executes as proprietary in-database SQL functions—machine learning algorithms and statistical functions
   - Leverage database strengths: SQL parallelism, scale to large datasets, security
   - Access big data in Database and Hadoop via SQL, R, and Big Data SQL

3. Embedded R Package Callouts
   - R Engine(s) spawned by Oracle DB for database-managed parallelism
   - ore.groupApply high performance scoring
   - Efficient data transfer to spawned R engines
   - Emulate map-reduce style algorithms and applications
   - Enables production deployment and automated execution of R scripts
Structured and Unstructured Data Growth

IDC Study: Structured Versus Unstructured Data: The Balance of Power Continues to Shift

“80% of business-relevant information originates in unstructured form, primarily text.”

Structured Versus Unstructured Data: The Balance of Power Continues to Shift

Unstructured Data
Opportunity for Better Insights and Better Actionable Analytics

• Missing from most predictive models
  – Customer comments
  – Emails
  – Customer Service Rep notes
  – Pdfs, Ppts, Word documents, etc.
  – Tweets
  – Physician and Nurse notes
  – Article abstracts
  – Explanations
  – Free form written information that describes more about a situation e.g. a customer’s interest in “discount” and “sale” items, etc. than structured data possibly can.

Absolutely! You bet unstructured data can help!

http://www.zdnet.com/article/unstructured-data-challenge-or-asset/
Oracle Text is a native capability of every Oracle Database.

- Oracle Text uses standard SQL to index, search, and analyze text and documents stored in the Oracle database, in files, and on the web.
- Oracle Text supports multiple languages and uses advanced relevance-ranking technology to improve search quality.
- Oracle Advanced Analytics uses Oracle Text to pre-process ("tokenize") unstructured data for the OAA SQL data mining functions.

Example:

**Comments**
Shopping at your store is a hassle. I rarely shop there and usually forget to bring your new loyalty card and hence never get the items at the sale price. Can a store manager look up my account on-line?

**Comments_Tok**

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Rapidly Build, Evaluate & Deploy Analytical Methodologies
Leveraging a Variety of Data Sources and Types

Consider:
- Demographics
- Past purchases
- Recent purchases
- Comments & tweets

SQL Joins and arbitrary SQL transforms & queries – power of SQL

Transactional POS data

Modeling Approaches

Unstructured data also mined by algorithms

Generates SQL scripts and workflow API for deployment

Advanced Analytics

Oracle
Oracle Advanced Analytics—On Premise or Cloud

100% Compatibility Enables Easy Coexistence and Migration

CoExistence and Migration

Same Architecture
Same ML/Analytics
Same Standards

Transparently move workloads and ML/analytical methodologies between On-premise and public cloud
Manage and **Analyze All Data**—SQL & Oracle Big Data SQL

**Structured and Unstructured Data Reservoir**
- JSON data
- HDFS / Hive
- NoSQL
- Spatial and Graph data
- Image and Video data
- Social Media

**Store business-critical data in Oracle**
- Customer data
- Transactional data
- Unstructured documents, comments
- Spatial and Graph data
- Image and Video data
- Social Media

**Data analyzed via SQL / R / GUI**
- R Clients
- SQL Clients
- Oracle Data Miner

**Oracle Big Data SQL + Advanced Analytics**

Oracle Big Data Appliance ↔ Oracle Database 12c ↔ SQL / R
More Data Variety—Better Predictive Models

• Increasing sources of relevant data can boost model accuracy

Model with “Big Data” and hundreds -- thousands of input variables including:
• Demographic data
• Purchase POS transactional data
• “Unstructured data”, text & comments
• Spatial location data
• Long term vs. recent historical behavior
• Web visits
• Sensor data
• etc.

Engineered Features – Derived attributes/variable that reflect domain knowledge—key to best models
Oracle Advanced Analytics
Brief Demos
Oracle Data Miner GUI

Easy to Use for “Citizen Data Scientist”

• Easy to use to define analytical methodologies that can be shared
• SQL Developer Extension
• Workflow API and generates SQL code for immediate deployment
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Results of Oracle Advanced Analytics ML/Predictive Models
PREDICTION_COUNT 751.00
FULL_SIMPLE_RULE (BANK_FUNDS > 248) AND (CHECKING_AMOUNT <= 292) AND (CREDIT_BALANCE <= 2445) AND (MONTHLY_OVERDRAWN > 54,095) AND (T_AMOUNT_AUTOM_PAYMENTS <= 14992)
PREDICTION Yes
Sharing, Automation and Deployment
Immediately Go to “Productionization” of Analytical Methodologies

• Share ODMr workflows
• Workflow API for 100% automation
  • Immediate deployment of data analyst’s methodologies
• SQL Script Generation
  • Deploy methodology as SQL scripts
drop table CLAIMS_SET;
exec dbms_data_mining.drop_model('CLAIMSMODEL');
create table CLAIMS_SET (setting_name varchar2(30), setting_value varchar2(4000));
insert into CLAIMS_SET values ('ALGO_NAME','ALGO_SUPPORT_VECTOR_MACHINES');
insert into CLAIMS_SET values ('PREP_AUTO','ON');
commit;
begin
  dbms_data_mining.create_model('CLAIMSMODEL', 'CLASSIFICATION', 'CLAIMS', 'POLICYNUMBER', null, 'CLAIMS_SET');
end;
/

-- Top 5 most suspicious fraud policy holder claims
select * from
(select POLICYNUMBER, round(prob_fraud*100,2) percent_fraud,
  rank() over (order by prob_fraud desc) rnk from
(select POLICYNUMBER, prediction_probability(CLAIMSMODEL, '0' using *) prob_fraud
  from CLAIMS
  where PASTNUMBEROFCLAIMS in ('2to4', 'morethan4'))
where rnk <= 5
order by percent_fraud desc;

Automated Monthly “Application”! Just add:
Create View CLAIMS2_30
As
Select * from CLAIMS2
Where mydate > SYSDATE – 30

Time measure: set timing on;
Oracle Advanced Analytics
Real-Time Scoring, Predictions and Recommendations
• On-the-fly, single record apply with new data (e.g. from call center)

```
Select prediction_probability(FRAUD_1_SVM_1, 'Yes'
    USING 7800 as bank_funds, 125 as checking_amount, 20 as credit_balance, 55 as age, 'Married' as marital_status, 250 as MONEY_MONLY_OVERDRAWN, 1 as house_ownership)
from dual;
```

Likelihood to respond:
Oracle’s Advanced Analytics

Example Customer References
Objectives

- Prevent $200M in losses every year using data to monitor, understand and anticipate fraud

Solution

- We installed OAA analytics for model development during 2014
- When choosing the tools for fraud management, speed is a critical factor
- OAA provided a fast and flexible solution for model building, visualization and integration with production processes

"When choosing the tools for fraud management, speed is a critical factor. Oracle Advance Analytics provided a fast and flexible solution for model building, visualization and integration with production processes."

– Miguel Barrera, Director of Risk Analytics, Fiserv Inc.
– Julia Minkowski, Risk Analytics Manager, Fiserv Inc.

Oracle Advanced Analytics

- 3 months to run & deploy Logistic Regression (using SAS)
- 1 month to estimate and deploy Trees and GLM
- 1 week to estimate, 1 week to install rules in online application
- 1 day to estimate and deploy Trees + GLM models (using Oracle Advanced Analytics)
UK National Health Service

Combating Healthcare Fraud

Objectives

- Use new insight to help identify cost savings and meet goals
- Identify and prevent healthcare fraud and benefit eligibility errors to save costs
- Leverage existing data to transform business and productivity

Solution

- Identified up to GBP100 million (US$156 million) potentially saved through benefit fraud and error reduction
- Used anomaly detection to uncover fraudulent activity where some dentists split a single course of treatment into multiple parts and presented claims for multiple treatments
- Analyzed billions of records at one time to measure longer-term patient journeys and to analyze drug prescribing patterns to improve patient care

“Oracle Advanced Analytics' data mining capabilities and Oracle Exalytics' performance really impressed us. The overall solution is very fast, and our investment very quickly provided value. We can now do so much more with our data, resulting in significant savings for the NHS as a whole”

– Nina Monckton, Head of Information Services, NHS Business Services Authority
Objectives

- Cloud-based solution
- Increase revenue
- Reduce time-to-market

Solution

The company considered only two solution vendors -- SAS and Oracle to host its consumer data. SAS offered to help build the IT infrastructure from scratch and helped develop a one-year plan. But when they looked at the number of personnel needed to manage the infrastructure including administrators, security specialists and analysts as well as Security & HIPPA compliance needed, Oracle’s DBCS solution looked far more attractive. Hence, they decided to go with Oracle. Oracle’s solution offered:

- Scalability
- Built in analytical tools including data mining.
- Built in HIPPA compliance and security features.
- Required fewer resources -- only two analysts – Data Engineer and an expert in Predictive Analytics who now manage the entire ecosystem.

“Time to market has significantly improved from 4-6 weeks to less than a week with the result the company can bring new clients on board faster. This has helped boost revenues by 25% in the six months since using Oracle's DBCS..”

– DX Marketing

DX Marketing Expands Customer Acquisition with Oracle Cloud – YouTube video
Zagrebačka Bank (biggest bank in Croatia)

Increases Cash Loans by 15% Within 18 Months of Deployment

Objectives

- Needed to speed up entire advanced analytics process; data prep was taking 3 days; model building 24 hours
- Faster time to “actionable analytics” for Credit Risk Modeling and Targeted Customer Campaigns

Solution

- Zaba migrated from SAS to the Oracle Advanced Analytics platform for statistical modeling and predictive analytics
- Increased prediction performance by leveraging the security, reliability, performance, and scalability of Oracle Database and Oracle Advanced Analytics for predictive analytics—running data preparation, transformation, model building, and model scoring within the database

“With Oracle Advanced Analytics we execute computations on thousands of attributes in parallel—impossible with open-source R. Analyzing in Oracle Database without moving data increases our agility. Oracle Advanced Analytics enables us to make quality decisions on time, increasing our cash loans business 15%.”

– Jadranka Novoselovic, Head of BI Dev., Zagrebačka Bank

“We chose Oracle because our entire data modeling process runs on the same machine with the highest performance and level of integration. With Oracle Database we simply switched on the Oracle Advanced Analytics option and needed no new tools,”

– Sinisa Behin, ICT coordinator at BI Dev. Zagrebačka Bank

ZabaBank Oracle Customer Snapshot on OTN
An Post

Boosts Retail & Postal Services with Big Data & Analytics Platform

Objectives

- Provide a scalable big data and analytics platform to manage millions of daily transactions, facilitate new postal services, and align with market needs and the growth in post office retail services

Solution

- Deployed a big data and analytics platform using Oracle Exadata Database Machine, Oracle Advanced Analytics, ... to ..., combat fraud, and enable readily-available enterprise wide business ... within core areas such as mails, parcels, and retail
- Enabled An Post to rapidly analyze and respond ... using Oracle Advanced Analytics...
- Vertice (partner) provided expert services including ... in-depth product and data mining expertise services

"With our Oracle solution for Big Data and Analytics we now have an analytics platform that has completely transformed our service delivery model. It provides An Post with a single source of truth while automatically consolidating data from all post offices nationwide."

– John Cronin, Group Chief Information Officer, An Post Limited

https://www.siliconrepublic.com/enterprise/2016/02/05/an-post-oracle-john-cronin-five-minute-cio

"Big data is a vital part of our future," says John Cronin, CIO of Ireland’s postal network.

“With our Oracle solution for Big Data and Analytics we now have an analytics platform that has completely transformed our service delivery model. It provides An Post with a single source of truth while automatically consolidating data from all post offices nationwide.”

– John Cronin, Group Chief Information Officer, An Post Limited
Oracle Advanced Analytics
OAA/Oracle R Enterprise (R integration)
R—Widely Popular
R is a statistics language similar to Base SAS or SPSS statistics

R environment

• Strengths
  – Powerful & Extensible
  – Graphical & Extensive statistics
  – Free—open source

• Challenges
  – Memory constrained
  – Single threaded
  – Outer loop—slows down process
  – Not industrial strength
R: Transparency via function overloading

Invoke in-database aggregation function

```r
aggdata <- aggregate(ONTIME_S$DEST, 
+ by = list(ONTIME_S$DEST), 
+ FUN = length)
```

```
> class(aggdata)
[1] "ore.frame"
attr("package")
[1] "OREbase"
> head(aggdata)
  Group.1 x
1    ABE 237
2    ABI  34
3   ABQ 1357
4   ABY   10
5   ACK    3
6   ACT   33
```
R: Transparency via function overloading
Invoke in-database Data Mining model (Support Vector Machine)

```r
> svm_mod <- ore.odmSVM(BUY~INCOME+YRS_CUST+MARITAL_STATUS, data=CUST, 
> "classification", kernel="linear")
```

```sql
BEGIN
DBMS_DATA_MINING.CREATE_MODEL(
    model_name => 'SVM_MOD',
    mining_function => dbms_data_mining.classification
)
```

```r
> summary(svm_mod)
```

Call:
```r
ore.odmSVM(formula = BUY ~ INCOME + YRS_CUST + MARITAL_STATUS, data = CUST, 
  type = "classification", kernel.function = "linear")
```

Settings:
```r
prep.auto on
active.learning al.enable
complexity.factor 46.044899
conv.tolerance 1e-04
kernel.function linear
```

Coefficients:
```r
table
  class variable     value      estimate
  1     0        INCOME 5.204561e-05
  2     0  MARITAL_STATUS M -4.531359e-05
  3     0  MARITAL_STATUS S  4.531359e-05
  4     0        YRS_CUST 1.264948e-04
  5     0    (Intercept) 9.999269e-01
  6     1        INCOME 2.032340e-05
  7     1  MARITAL_STATUS M  2.636552e-06
  8     1  MARITAL_STATUS S -2.636555e-06
  9     1        YRS_CUST -1.588211e-04
 10     1    (Intercept) -9.999324e-01
```

Oracle Database
In-db Mining Model
Oracle Advanced Analytics ORE Client Packages
Oracle PL/SQL
Oracle Database Server
library(ORC)

ore.connect("dmuser", "oral12c", "localhost", "dmuser", all=TRUE)

ore.ls()

Help.start()

names(CARSTATS)

summary(CARSTATS)

hist(CARSTATS$MPG, col="red", breaks=25)

plot(CARSTATS, col="red")

hist(CARSTATS$MPG, col="red", breaks=25)

plot(CARSTATS,)

hist(CARSTATS$MPG, col="red", breaks=25)

ore.ls()

Help.start()

summary(CARSTATS)

plot(CARSTATS)

demo(odm_svm)

demo(odm_kmeans)

demo(CARSTATS)

names(CARSTATS)$claims

> svm.mod2 <- NULL
> svm.mod2 <- ore.odmSVM(Y~X, dat, "regression")
> summary(svm.mod2)

call:
ore.odmSVM(formula = Y ~ X, data = dat, type = "regression")

Settings:

  value
  prep.auto  on
  active.learning.al.enable
  complexity.factor  0.014396
  conv.tolerance  1e-04
  epsilon  0.002761
  kernel.cache.size  20000000
  kernel.function  gaussian
  std.dev  0.004980

Residuals:

  Min. 1st Qu. Median Mean 3rd Qu. Max.  
-0.310900 -0.147100 -0.012980 -0.008530 -0.117000 0.532100

Coefficients:

  (Intercept)        X  
  1.3394883  0.8573087

[1] No coefficients with gaussian kernel

> svm.res2 <- predict(svm.mod2, dat, supplemental.cols="X")
> plot(dat, main="Comparing ODM Model Results")

"Returns to see next plot:"
Oracle Advanced Analytics for Hadoop

Predictive algorithms that execute in a parallel/distributed manner on Hadoop with data in HDFS
Oracle R Advanced Analytics for Hadoop

Using Hadoop and HIVE Integration, plus R Engine and Open-Source R Packages

Hadoop Cluster
with Oracle R Advanced Analytics for Hadoop (ORAAH)

- R interface to HQL Basic Statistics, Data Prep, Joins and View creation
- Parallel, distributed algorithms:
  - MLP Neural Nets*, GLM*, LM, PCA, k-Means, NMF, LMF
  * Spark-Caching enabled
- Use of Open-source R packages via custom R Mappers / Reducers

R Client
R Analytics
Oracle R Advanced Analytics for Hadoop

Oracle Database
with Advanced Analytics option

SQL Client
SQL Developer
Other SQL Apps

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## Oracle R Advanced Analytics for Hadoop

**AA Algorithms in a Hadoop Cluster: Map-Reduce and Spark (2.6)**

<table>
<thead>
<tr>
<th>Classification</th>
<th>Regression</th>
<th>Feature Extraction</th>
<th>Attribute Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>GLM ORAAH</td>
<td>MLP Neural Networks ORAAH</td>
<td>Non-negative Matrix Factorization</td>
<td></td>
</tr>
<tr>
<td>Logistic Regression ORAAH</td>
<td>Ridge Regression Spark MLlib</td>
<td>Collaborative Filtering (LMF)</td>
<td></td>
</tr>
<tr>
<td>Random Forests</td>
<td>Support Vector Machines Spark MLlib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Decision Trees</td>
<td>Random Forest Spark MLlib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Support Vector Machines</td>
<td>Linear Regression Spark MLlib</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clustering</td>
<td></td>
<td>Principal Components Analysis</td>
<td></td>
</tr>
<tr>
<td>K-Means</td>
<td>Basic Statistics</td>
<td>Principal Components Analysis</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Correlation/Covariance</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Invoke ORAAH custom parallel distributed GLM Model using Spark Caching

ORAAH: Machine Learning in Spark against HDFS data

> spark.connect("yarn-client", memory="24g")

> # Attaches the HDFS file for use within R
> ont1bi <- hdfs.attach("/user/oracle/ontime_1bi")

> # Formula definition: Cancelled flights (0 or 1) based on other attributes
> form_oraah_glm2 <- CANCELLED ~ DISTANCE + ORIGIN + DEST + F(YEAR) + F(MONTH) +
> + F(DAYOFMONTH) + F(DAYOFWEEK)

> system.time(m_spark_glm <- orch.glm2(formula=form_oraah_glm2, ont1bi))

ORCH GLM: processed 6 factor variables, 25.806 sec
ORCH GLM: created model matrix, 100128 partitions, 32.871 sec
ORCH GLM: iter 1, deviance 1.38433414089348300E+09, elapsed time 9.582 sec
ORCH GLM: iter 2, deviance 3.39315388583931150E+08, elapsed time 9.213 sec
ORCH GLM: iter 3, deviance 2.06855738812683250E+08, elapsed time 9.218 sec
ORCH GLM: iter 4, deviance 1.75868100359263200E+08, elapsed time 9.104 sec
ORCH GLM: iter 5, deviance 1.70023181759611580E+08, elapsed time 9.132 sec
ORCH GLM: iter 6, deviance 1.69476890425481350E+08, elapsed time 9.124 sec
ORCH GLM: iter 7, deviance 1.69467574351380850E+08, elapsed time 9.077 sec
ORCH GLM: iter 8, deviance 1.69467586045954760E+08, elapsed time 9.164 sec

user system elapsed
84.107  5.606 143.591
Oracle’s Advanced Analytics

Predictive Applications + OBIEE Integration
Enabling “Predictive” Enterprise Applications
Oracle Applications Using Oracle Advanced Analytics—Partial List

• **Oracle HCM Fusion**
  – Employee turnover and performance prediction and “What if?” analysis

• **Oracle CRM Fusion**
  – Prediction of sales opportunities, what to sell, amount, timing, etc.

• **Oracle Industry Data Models**
  – **Communications Data Model** churn prediction, segmentation, profiling, etc.
  – **Retail Data Model** loyalty and market basket analysis
  – **Airline Data Model** analysis frequent flyers, loyalty, etc.
  – **Utilities Data Model** customer churn, cross-sell, loyalty, etc.

• **Oracle Retail Insights Cloud Services**
  – Market Basket Analysis Insights
  – Customer Insights & Clustering

• **Oracle Customer Support**
  – Predictive Incident Monitoring (PIM)

• **Oracle Spend Classification**
  – Real-time and batch flagging of noncompliance and anomalies in expense submissions

• **Oracle FinServ Analytic Applications**
  – Customer Insight, Enterprise Risk Management, Enterprise Performance, Financial Crime and Compliance

• **Oracle Adaptive Access Manager**
  – Real-time security and fraud analytics
HCM Predictive Workforce
Predictive Analytics Applications

Human Capital Management
Powered by OAA

- Oracle Advanced Analytics factory-installed predictive analytics
- Employees likely to leave and predicted performance
- Top reasons, expected behavior
- Real-time "What if?" analysis
HCM Predictive Workforce
Predictive Analytics Applications

Human Capital Management
Powered by OAA

- Oracle Advanced Analytics factory-installed predictive analytics
- Employees likely to leave and predicted performance
- Top reasons, expected behavior
- Real-time "What if?" analysis
Sales Predictor helps sales reps answer critical sales questions:

• Which products should be offered to a customer?
• Who are the customers buying products?
• What are the reasons a product is being bought?

Sales Predictor offers product recommendations that have a higher likelihood of being converted to a win.

Link to Oracle CRM SPE on O.com
Oracle Communications Industry Data Model
Example Predictive Analytics Application

Pre-Built Predictive Models

• Fastest Way to Deliver Scalable Enterprise-wide Predictive Analytics
• OAA’s clustering and predictions available in-DB for OBIEE
• Automatic Customer Segmentation, Churn Predictions, and Sentiment Analysis

Link to OCDM on OTN
Oracle Communications Data Model

Pre-Built Data Mining Models

1. Churn Prediction
2. Customer Profiling
3. Customer Churn Factor
4. Cross-Sell Opportunity
5. Customer Life Time Value
6. Customer Sentiment
7. Customer Life Time Value

Link to OCDM on OTN
Oracle Advanced Analytics 12.2, Oracle Data Miner 4.2 and ORAAH 2.6
New Features + Road Map
Oracle Advanced Analytics 12.2
New Oracle Database Features

• **Major Performance Improvements for Algorithms**
  – New parallel model build / apply infrastructure to enable faster algorithm introduction
  – Scale to larger data volumes found in big data and cloud use cases

• **Unsupervised Feature Selection**
  – Uses unsupervised pair-wise Kullback-Leibler Divergence (KLD - correlations analysis - numeric and categorical attributes) to find highest “information containing” attributes

• **Association Rules Enhancements**
  – Adds calculation of values associated with AR rules such as sales amount to indicate the value of co-occurring items in baskets

• **Partitioned Models**
  – Instead of building, naming and referencing 10s or 1000s of models, a partitioned model will organize and represent these multiple models as partitions in a single model entity
New Oracle Database Features

• **Explicit Semantic Analysis (ESA) algorithm**
  
  – Useful technique for extracting meaningful, interpretable features, better than LDA
  
  – Use ESA for document similarity and topic identification
  
  – Wikipedia provides a large corpus of existing documents to provide sensible features and topics
  
  – Document 1
    
    – *Senior members of the Saudi royal family paid at least $560 million to Osama bin Laden terror group and the Taliban for an agreement his forces would not attack targets in Saudi Arabia, according to court documents. The papers, filed in a $US3000 billion ($5500 billion) lawsuit in the US, allege the deal was made after two secret meetings between Saudi royals and leaders of al-Qa ida, including bin Laden. The money enabled al-Qa ida to fund training camps in Afghanistan later attended by the September 11 hijackers. The disclosures will increase tensions between the US and Saudi Arabia.*
  
  Document 2
    
    – *The Saudi Interior Ministry on Sunday confirmed it is holding a 21-year-old Saudi man the FBI is seeking for alleged links to the Sept. 11 hijackers. Authorities are interrogating Saud Abdulaziz Saud al-Rasheed *"and if it is proven that he was connected to terrorism, he will be referred to the sharia (Islamic) court,"* the official Saudi Press Agency quoted an unidentified ministry official as saying.*

**ESA Similarity 0.62**
Oracle Advanced Analytics 12.2
New Oracle Database Features

• Extensibility for R Models
  – Register R models as in-database models for build, apply, settings, and viewing
  – Supports data with “nested” attributes, handling text and aggregated transactional data for open source R packages
  – Extends ease of advanced analytics development from R to Oracle Database
  – Enables R users to roll out new analytics and more rapidly take advantage of existing R packages
### Oracle Advanced Analytics DB Option

**In-Database Machine Learning Algorithms** — SQL & GUI Access

<table>
<thead>
<tr>
<th><strong>Classification</strong></th>
<th><strong>Clustering</strong></th>
<th><strong>Predictive Queries</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Decision Tree</td>
<td>• Hierarchical k-Means</td>
<td>• Clustering</td>
</tr>
<tr>
<td>• Logistic Regression (GLM)</td>
<td>• Orthogonal Partitioning Clustering</td>
<td>• Regression</td>
</tr>
<tr>
<td>• Naive Bayes</td>
<td>• Expectation-Maximization</td>
<td>• Anomaly Detection</td>
</tr>
<tr>
<td>• Support Vector Machine (SVM)</td>
<td></td>
<td>• Feature Extraction</td>
</tr>
<tr>
<td>• Random Forest</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Regression</strong></th>
<th><strong>Attribute Importance</strong></th>
<th><strong>Market Basket Analysis</strong></th>
<th><strong>Text Mining</strong></th>
<th><strong>Feature Extraction &amp; Creation</strong></th>
<th><strong>Time Series</strong></th>
<th><strong>Open Source R Algorithms</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Multiple Regression (GLM)</td>
<td>• Minimum Description Length</td>
<td>• Apriori – Association Rules</td>
<td>• All OAA/ODM SQL ML support</td>
<td>• Nonnegative Matrix Factorization</td>
<td>• Single &amp; Double Exp. Smoothing</td>
<td>• Ability to run any R package (9,000+) via Embedded R mode</td>
</tr>
<tr>
<td>• Support Vector Machine (SVM)</td>
<td>• Unsupervised pair-wise KL div.</td>
<td></td>
<td>• Explicit Semantic Analysis</td>
<td>• Principal Component Analysis</td>
<td></td>
<td>+ Ability to Mine Unstructured, Structured &amp; Transactional data</td>
</tr>
<tr>
<td>• Stepwise Linear Regression</td>
<td></td>
<td></td>
<td></td>
<td>• Singular Value Decomposition</td>
<td></td>
<td>+ Partitioned Models</td>
</tr>
<tr>
<td>• Linear Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Generalized Linear Model</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Multi-Layer Neural Networks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* + Ability to Mine Unstructured, Structured & Transactional data
  + Partitioned Models
The way to read their results is that they compare 2 chips: X5 (Intel and Linux) and T7 (Sparc and Solaris). They are measuring scalability (time in seconds) with increase degree of parallelism (dop). The data also has high cardinality categorical columns, which translates in 9K mining attributes (when algorithms require explosion). There are no comparisons to 12.1 and it is fair to say that the 12.1 algorithms could not run on data of this size.

### OAA 12.2 Algorithms

<table>
<thead>
<tr>
<th>Algorithm</th>
<th>Rows (Ms)</th>
<th>T7-4 (Sparc &amp; Solaris) Model Build Time (Secs / Degree of Parallelism)</th>
<th>X5-4 (Intel and Linux) Model Build Time (Secs / Degree of Parallelism)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attributes Importance</td>
<td>640</td>
<td>28s / 512</td>
<td>44s / 72</td>
</tr>
<tr>
<td>K Means Clustering</td>
<td>640</td>
<td>161s / 256</td>
<td>268s / 144</td>
</tr>
<tr>
<td>Expectation Maximization</td>
<td>159</td>
<td>455s / 512</td>
<td>588s / 144</td>
</tr>
<tr>
<td>Naive Bayes Classification</td>
<td>320</td>
<td>17s / 256</td>
<td>23s / 72</td>
</tr>
<tr>
<td>GLM Classification</td>
<td>640</td>
<td>154s / 512</td>
<td>363s / 144</td>
</tr>
<tr>
<td>GLM Regression</td>
<td>640</td>
<td>55s / 512</td>
<td>93s / 144</td>
</tr>
<tr>
<td>Support Vector Machine (IPM solver)</td>
<td>640</td>
<td>404s / 512</td>
<td>1411s / 144</td>
</tr>
<tr>
<td>Support Vector Machine (SGD solver)</td>
<td>640</td>
<td>84s / 256</td>
<td>188s / 72</td>
</tr>
</tbody>
</table>

**Wow! That’s Fast!**
Oracle Data Miner

4.2 New Features
Oracle Data Miner 4.2

New Features for OAA

• Add/Expose all 12.2 features in Oracle Data Miner UI
Oracle Data Miner 4.2
New Features for OAA

• Add/Expose all 12.2 features in Oracle Data Miner UI
  – Partitioned Models
  – Association Rules filter items (before & after model build) & aggregation Columns
  – Unsupervised Feature Selection & unsupervised pair-wise dependencies/correlations
  – Explicit Feature Extraction node & viewer (tag cloud like output) w/ sample Wiki table
  – Feature Compare Node - compare two data flows for similarity using FE node (explicit & latent). Data flow can be a single record entered manually
  – R Build Node - Build, Score and Model Detail functions are defined by selecting an existing R script registered in DB
  – In-Memory performance options with existing Parallel options
Oracle Data Miner 4.2

New Features for OAA

• Miscellaneous Improvements based on customer use cases/feedback
  – Workflow Scheduler
    • Wide selection of scheduling options available
    • Integration with Email Notification for a workflow start/stop/failure events
    • Users can now view workflow details completely when a workflow is running or scheduled to run (Access was restricted in prior releases)
  – Aggregation Node supports Date, TimeStamp aggregations
  – Tables, Views, User, Column Names, etc. changed from 30 to 128 characters (configurable to remain at 30)
  – Optimized workflow polling frequency
  – Greater DBA control of workflow execution and behavior
  – Accept RAW, ROWID, UROWID, URITYPE data types
Previewing a 4.2 Feature

Workflow Scheduler

NEW IN 4.2
NEW IN 4.2: Workflow Scheduler
Oracle R Advanced Analytics for Hadoop

New Features

• Support for R Transparency processing of many summarization and statistic functions for HIVE and HIVE on Spark
• Support for and creation of Spark DataFrames from HDFS
• High Performance R Formula and Model Matrix processing, custom built to run on Spark transparently
• Support for select SparkMLlib algorithms directly from R, with multiple Data Sources
• High-performance Platform for running R on Spark
• Exclusive High-performance algorithms for Deep Learning – Convolutional Neural Networks
Getting started
Getting started: OAA Links and Resources

Oracle Advanced Analytics Overview:
- OAA presentation — Big Data Analytics with Oracle Advanced Analytics — or just watch Watch YouTube video presentation and demo(s)
- Big Data Analytics with Oracle Advanced Analytics: Making Big Data and Analytics Simple white paper on OTN
- Oracle Internal OAA Product Management Wiki and Workspace
- Oracle Advanced Analytics Customer Successes

YouTube recorded OAA Presentations and Demos:
- Oracle Advanced Analytics and Data Mining at the YouTube Movies (6 + OAA “live” Demos on ODM’r 4.0 New Features, Retail, Fraud, Loyalty, Overview, etc.)

Getting Started:
- Link to OAA/Oracle Data Miner Workflow GUI Online (free) Tutorial Series on OTN
- Link to OAA/Oracle R Enterprise (free) Tutorial Series on OTN
- Link to Free Oracle Advanced Analytics "Test Drives" on Oracle Cloud via Vlamis Partner
- Link to Getting Started w/ ODM blog entry
- Link to New OAA/Oracle Data Mining 2-Day Instructor Led Oracle University course.
- Oracle Data Mining Sample Code Examples

Additional Resources:
- Oracle Advanced Analytics Option on OTN page
- OAA/Oracle Data Mining on OTN page, ODM Documentation & ODM Blog
- OAA/Oracle R Enterprise page on OTN page, ORE Documentation & ORE Blog
- Oracle SQL based Basic Statistical functions on OTN
- Oracle R Advanced Analytics for Hadoop (ORAAH) on OTN
- Business Intelligence, Warehousing & Analytics— BIWA Summit’17, Jan 31, Feb 1 & 2, 2017 at Oracle HQ Conference Center (w/ links to customer presentations)

Send email now to charlie.berger@oracle.com and you’ll get my “away message” with these links.
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• Step 1—Fill out request
  – Go to http://www.vlamis.com/td/
• Step 2—Connect
  – Connect with Remote Desktop
• Step 3—Start Test Drive!
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  – Oracle Advanced Analytics Option
  – SQL Developer/Oracle Data Miner GUI
  – Demo data for learning
  – Follow Tutorials

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+ YESSQL SUMMIT

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