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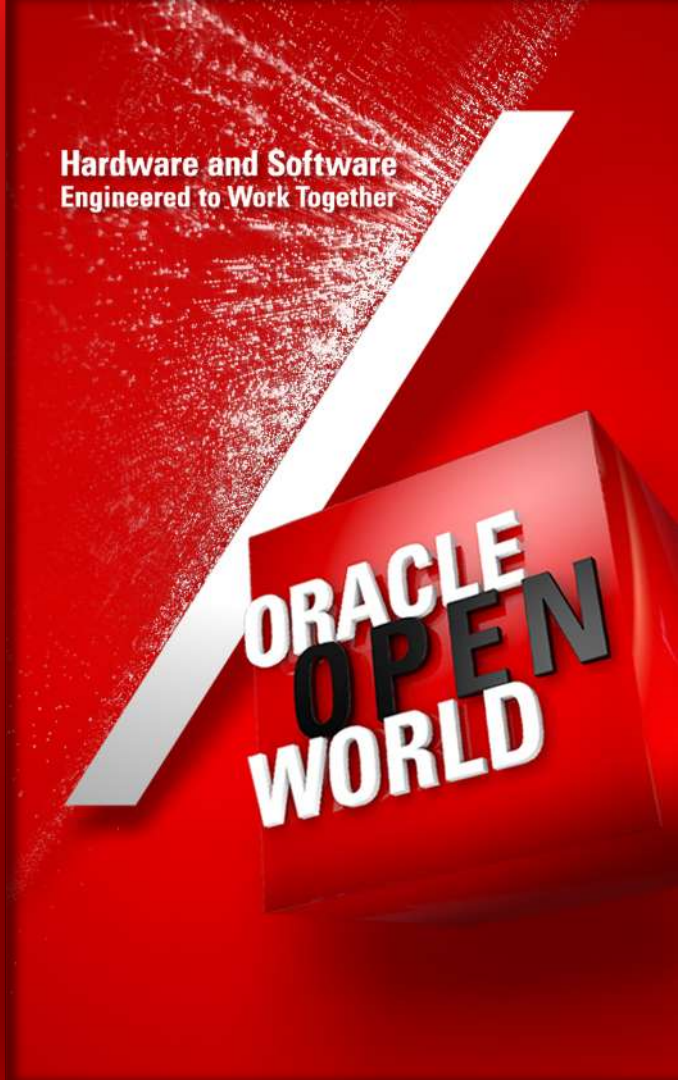
Finding Gold in Your Data Warehouse: Oracle Advanced Analytics



Charlie Berger
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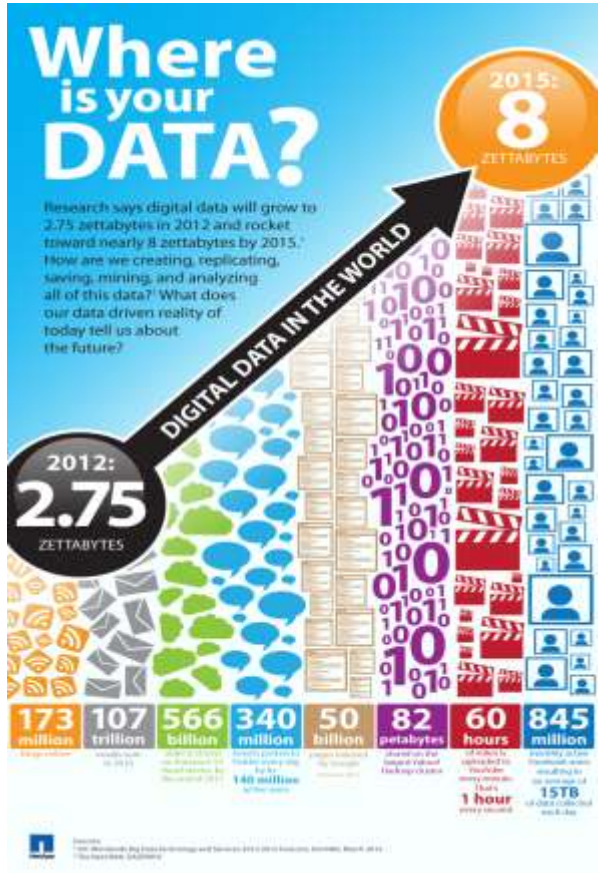
The following is intended to outline our general product direction. It is intended for information purposes only, and may not be incorporated into any contract. It is not a commitment to deliver any material, code, or functionality, and should not be relied upon in making purchasing decisions.
The development, release, and timing of any features or functionality described for Oracle's products remains at the sole discretion of Oracle.

Program Agenda

- Big Data & Big Data Analytics
- Oracle Advanced Analytics
- Details
- Demos & Applications
- Pointers & Summary

“Big Data” is Growing

- 383+ Million Twitter accounts
- 835+ Million Facebook subscribers
- 1.2+ Billion Mobile Web users
- Machine and sensor data
- Over 6 million OnStar subscribers

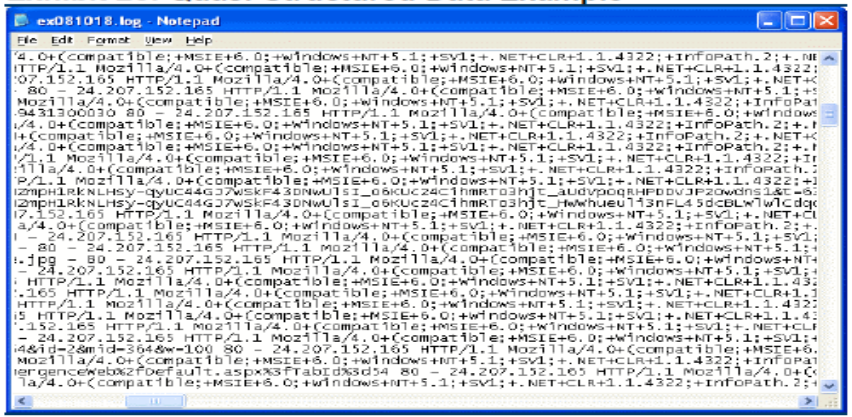


“Big Data”= Structured & Unstructured Data

Exhibit 25: Structured Data Example

Name	Thread pitch (mm)	Minor diameter tolerance	Nominal diameter (mm)	Head shape	Price for 50 screws	Available at factory outlet?	Number in stock	Flat or Phillips head?
M4	0.7	4g	4	Pan	$10.08	Yes	276	Flat
M5	0.8	4g	5	Round	$13.89	Yes	183	Both
M6	1	5g	6	Button	$10.42	Yes	1043	Flat
M8	1.25	5g	8	Pan	$11.98	No	298	Phillips
M10	1.5	6g	10	Round	$16.74	Yes	488	Phillips
M12	1.75	7g	12	Pan	$18.26	No	998	Flat
M14	2	7g	14	Round	$21.19	No	235	Phillips
M16	2	8g	16	Button	$23.57	Yes	292	Both
M18	2.1	8g	18	Button	$25.87	No	664	Both
M20	2.4	8g	20	Pan	$29.09	Yes	486	Both
M24	2.55	9g	24	Round	$33.01	Yes	982	Phillips
M28	2.7	10g	28	Button	$35.66	No	1067	Phillips
M36	3.2	12g	36	Pan	$41.32	No	434	Both
M50	4.5	15g	50	Pan	$44.72	No	740	Flat

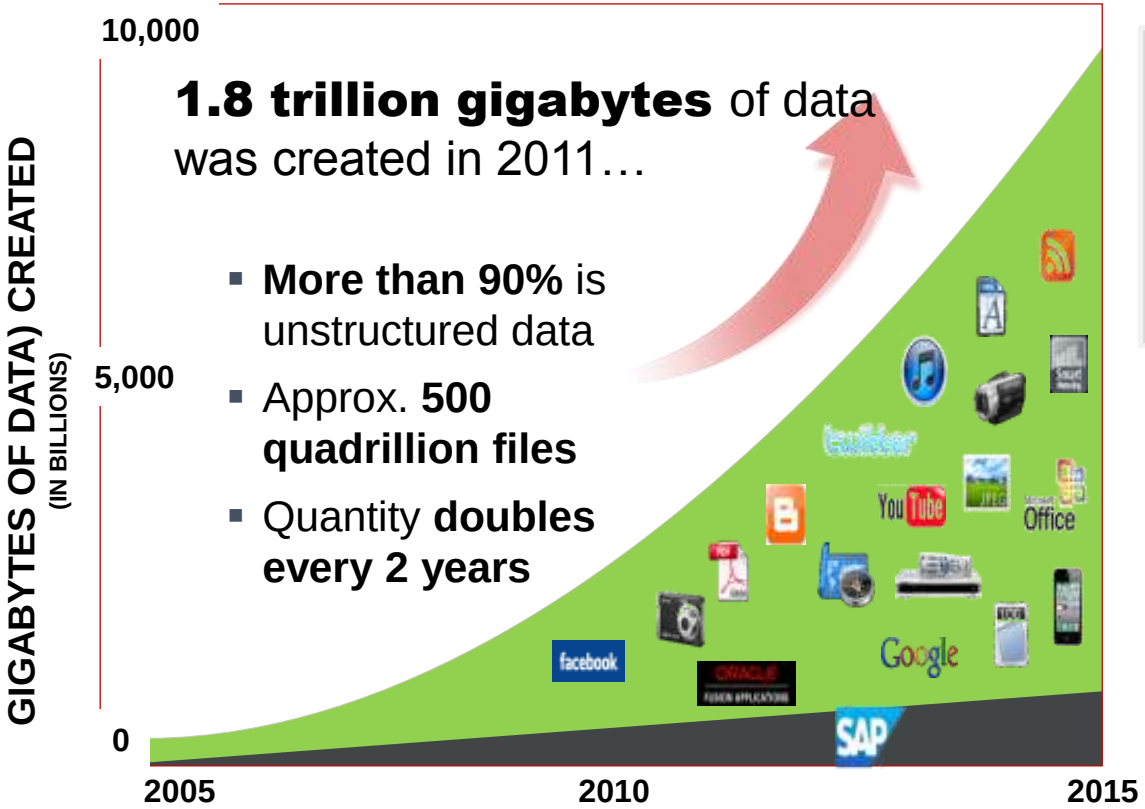
Exhibit 26: Quasi-Structured Data Example



Structured data from applications.

Semi-structured “Big Data” from social media and logs, sensors, feeds, etc.

“Big Data” ➔ “Big Data Analytics”



“There was 5 exabytes of information created between the dawn of civilization through 2003, but that much information is now created every 2 days, and the pace is increasing.”

- Google CEO Eric Schmidt

Requires capability to rapidly:

- ✓ **Collect and integrate data**
- ✓ ***Understand data & their relationships***
- ✓ ***Respond and take action***

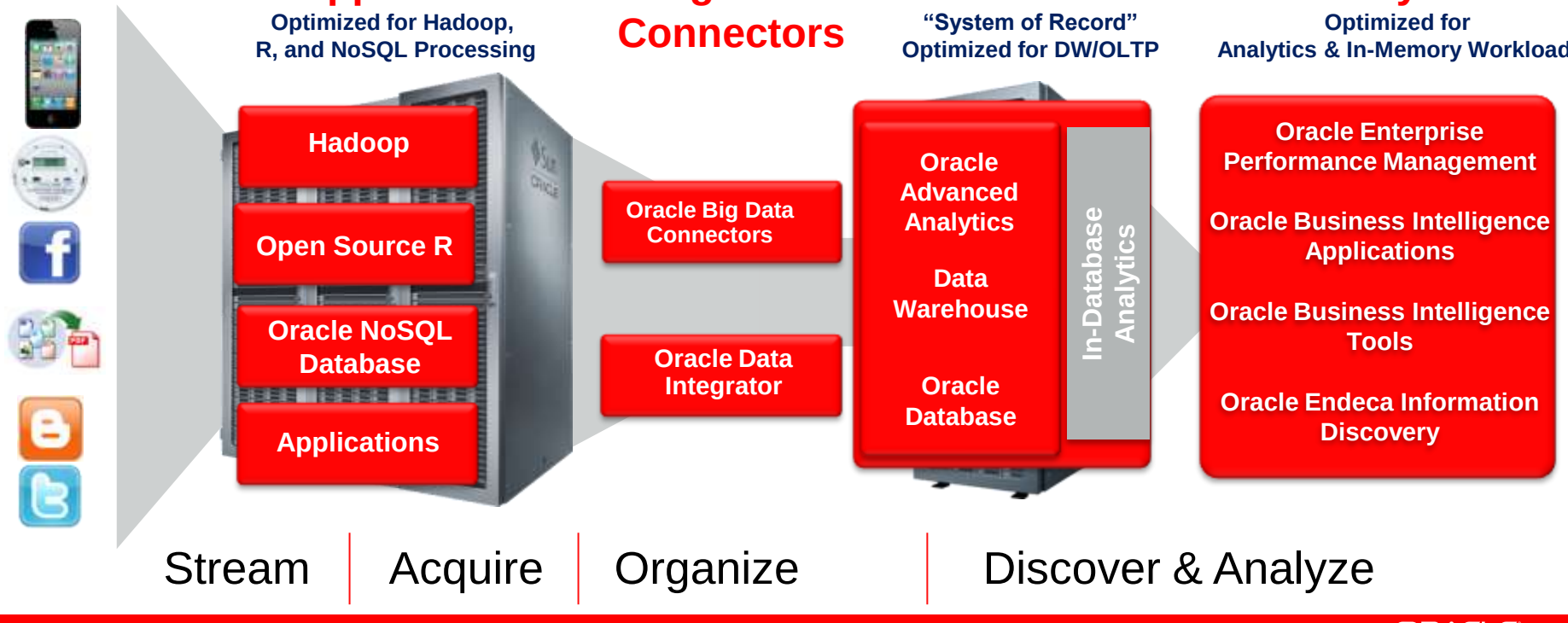
Source: IDC 2011

STRUCTURED DATA

UNSTRUCTURED DATA

Content Provided By Cloudera

Oracle Big Data Platform



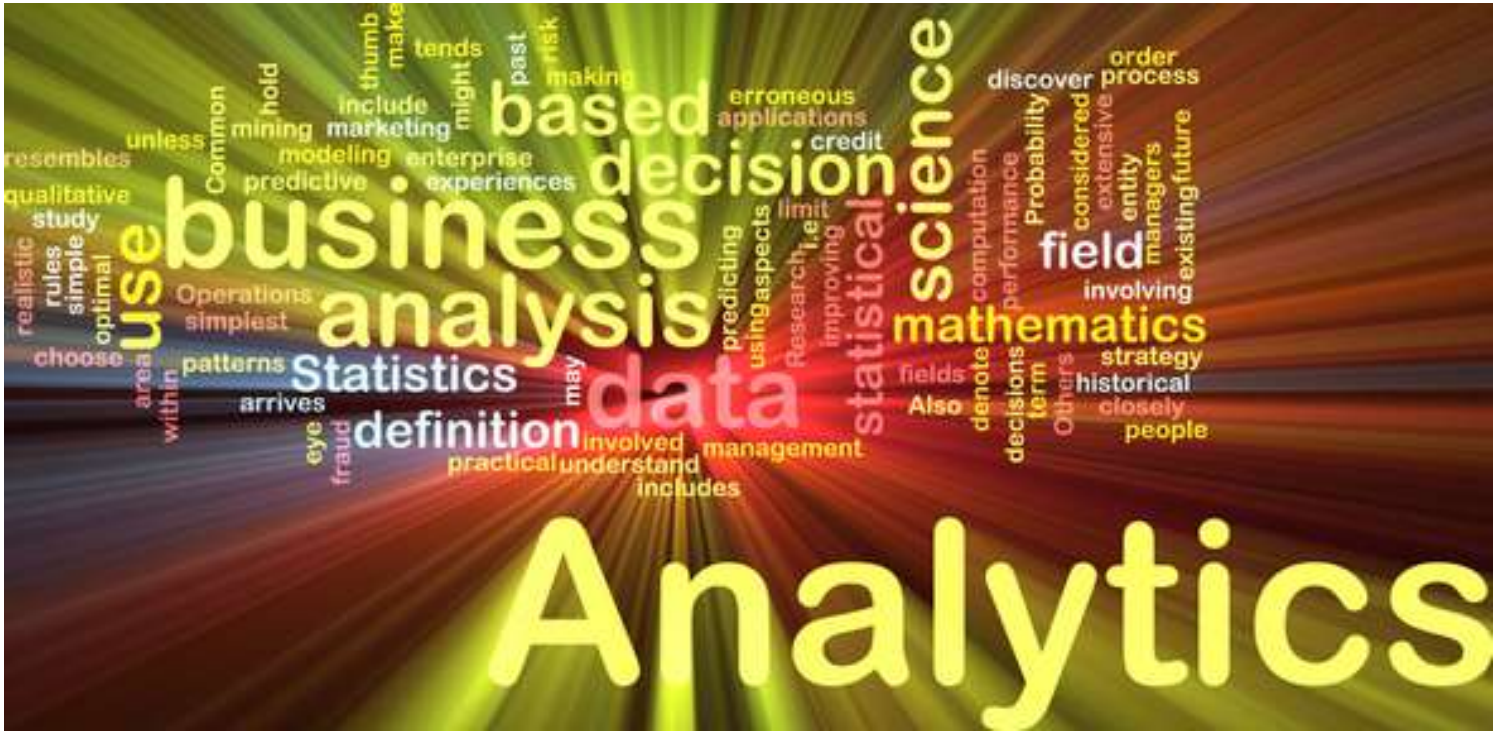
"Without *proper analysis*, it's just data; …not useful actionable information …something that you can exploit today …something that your competitor may *not* have yet discovered."

Charlie Berger

Sr. Director, Product Management, Oracle Data Mining and Advanced Analytics
Oracle Corporation

Advanced Analytics

Wide range of meanings and interpretations

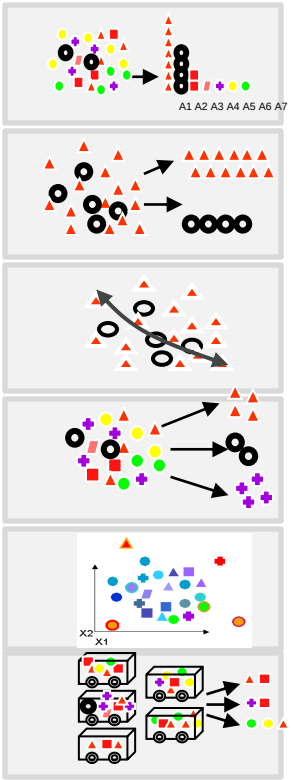


Source for graphic: http://www.informationweek.com/healthcare/electronic-medical-records/7-big-data-solutions-try-to-reshape-heal/240144641?pgno=1

What is Data Mining?

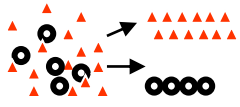
Automatically sifting through large amounts of data to find previously hidden patterns, discover valuable new insights and make predictions

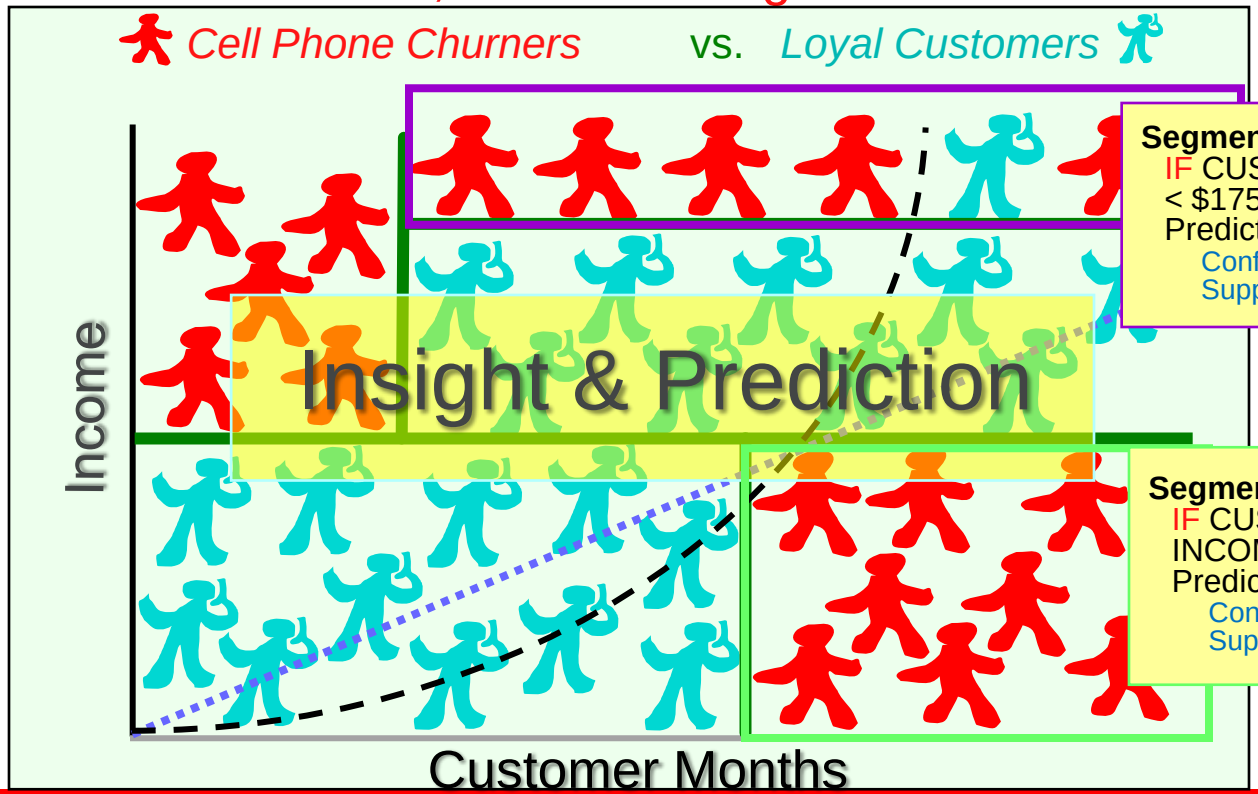
- Identify most important factor *(Attribute Importance)*
- Predict customer behavior *(Classification)*
- Predict or estimate a value *(Regression)*
- Find profiles of targeted people or items *(Decision Trees)*
- Segment a population *(Clustering)*
- Find fraudulent or “rare events” *(Anomaly Detection)*
- Determine co-occurring items in a “baskets” *(Associations)*



Data Mining Provides

Better Information, Valuable Insights and Predictions





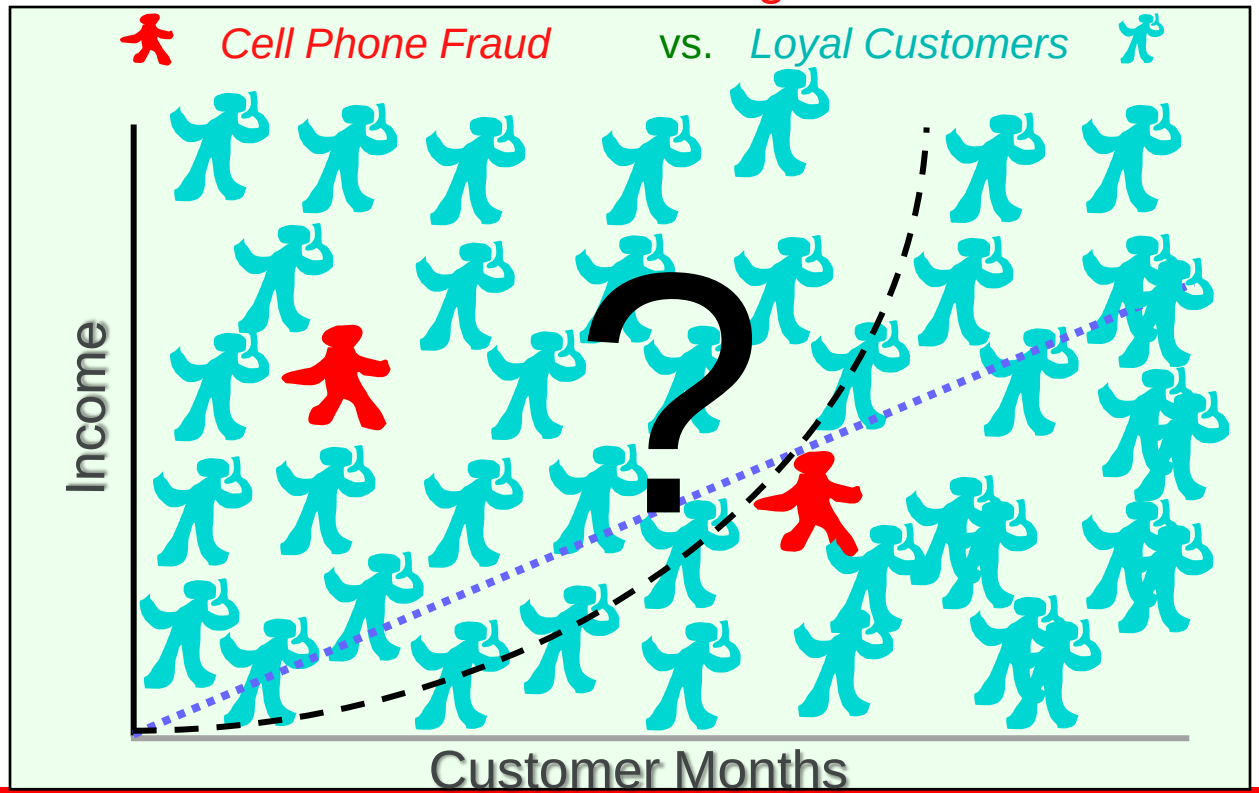
Segment #3
IF CUST_MO > 7 AND INCOME < $175K, *THEN*
Prediction = Cell Phone Churner,
Confidence = 83%
Support = 6/39

Segment #1
IF CUST_MO > 14 AND INCOME < $90K, *THEN*
Prediction = Cell Phone Churner
Confidence = 100%
Support = 8/39

Source: Inspired from *Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management* by Michael J. A. Berry, Gordon S. Linoff

Data Mining Provides

Better Information, Valuable Insights and Predictions

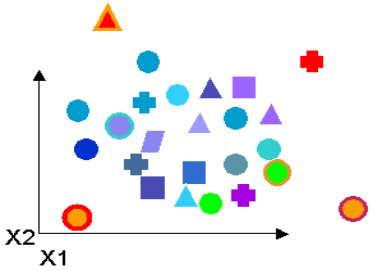


Source: Inspired from *Data Mining Techniques: For Marketing, Sales, and Customer Relationship Management* by Michael J. A. Berry, Gordon S. Linoff

Finding Needles in Haystacks

- Haystacks are usually BIG
- Needles are typically *small* and rare

Look for What is "*Different*"



A Real Fraud Example

My credit card statement—Can you see the fraud?

	May 22	1:14 PM	FOOD	Monaco Café	$127.38
	May 22	7:32 PM	WINE	Wine Bistro	$28.00
	…	Gas Station?			
→	June 14	2:05 PM	MISC	Mobil Mart	$75.00
→	June 14	2:06 PM	MISC	Mobil Mart	$75.00
→	June 15	11:48 AM	MISC	Mobil Mart	$75.00
→	June 15	11:49 AM	MISC	Mobil Mart	$75.00
	May 28	6:31 PM	WINE	Acton Shop	$31.00
	May 29	8:39 PM	FOOD	Crossroads	$128.14
→	June 16	11:48 AM	MISC	Mobil Mart	$75.00
→	June 16	11:49 AM	MISC	Mobil Mart	$75.00

Total purchases exceeds time period average

Monaco?

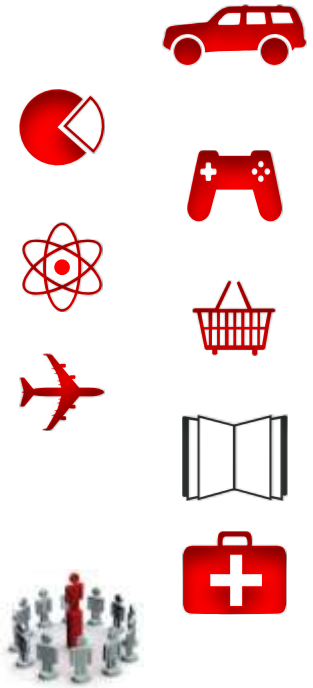
Pairs of $75?

All same $75 amount?

Data Mining & Predictive Analytics

Typical Use Cases

- Targeting the right customer with the right offer
- How is a customer likely to respond to an offer?
- Finding the most profitable growth opportunities
- Finding and preventing customer churn
- Maximizing cross-business impact
- Security and suspicious activity detection
- Understanding sentiments in customer conversations
- Reducing medical errors & improving quality of health
- Understanding influencers in social networks

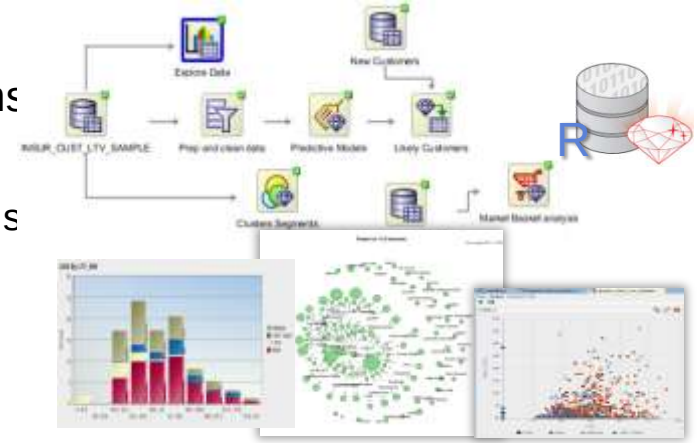


Oracle Advanced Analytics Details

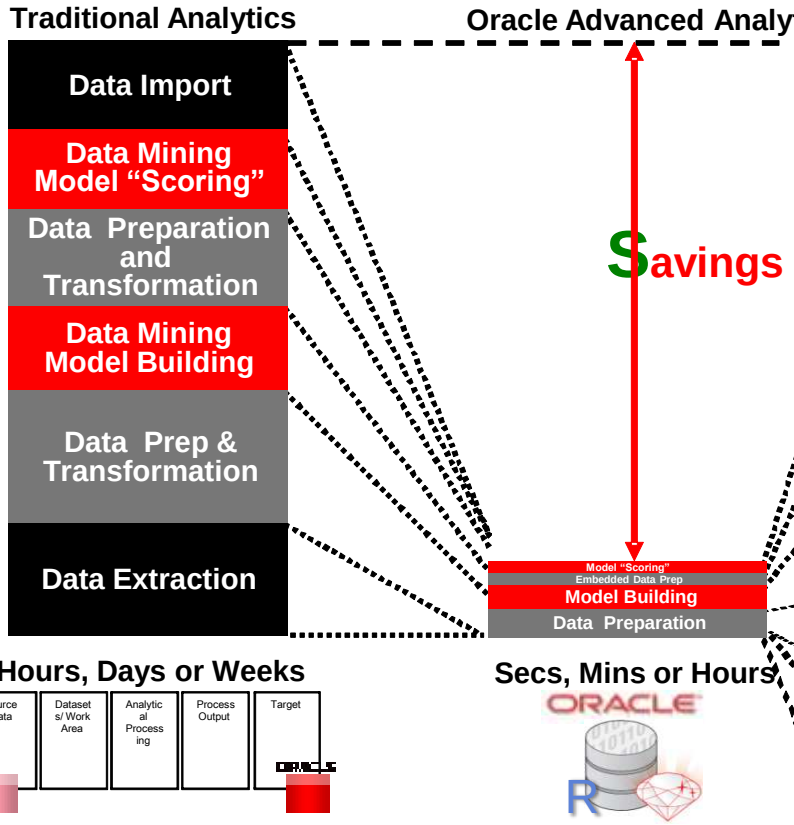
Oracle Advanced Analytics Option

Fastest Way to Deliver Scalable Enterprise-wide Predictive Analytics

- Powerful
  - Combination of in-database data mining algorithms and open source R algorithms
  - Accessible via SQL, PL/SQL, R and database APIs
  - Scalable, parallel in-database execution
- Easy to Use
  - Range of GUI and IDE options for business users to data scientists
- Enterprise-wide
  - Integrated feature of the Oracle Database
  - Seamless support for enterprise analytical applications and BI environments



Oracle Advanced Analytics Value Proposition



Value Proposition

- Fastest path from data to insights
  - Fastest analytical development
  - Fastest in-database scoring engine on the planet
- Flexible deployment options for analytics
- Lowest TCO by eliminating data duplication
- Secure, Scalable and Manageable

Data remains in the Database

Data preparation for analytics is automated

Scalable distributed-parallel implementation of machine learning techniques in the database

Scalable implementation of R programming language in-database

Flexible interface options – SQL, R, IDE, GUI

Fastest and most Flexible analytic deployment options

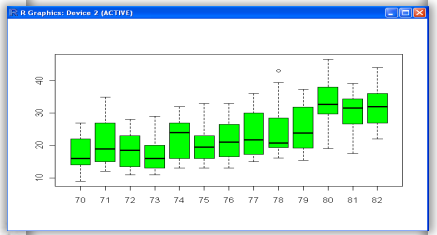
Can import 3rd party models

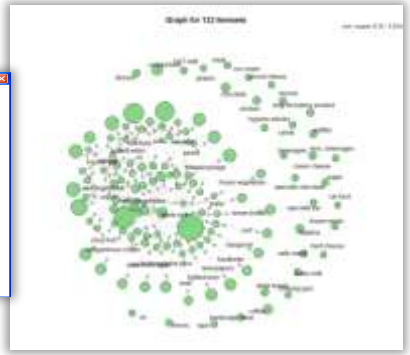
Oracle Advanced Analytics

Target Audiences

- **"Information Consumers"**
  - CEOs, CMOs, CFOs, CIOs, VPs, Directors/Mgrs of lines of operations, etc.

- **"Information Producers"**
  - Data analysts, Marketing analysts, Business Managers, Statisticians, Data Scientists, DBAs, Application Developers

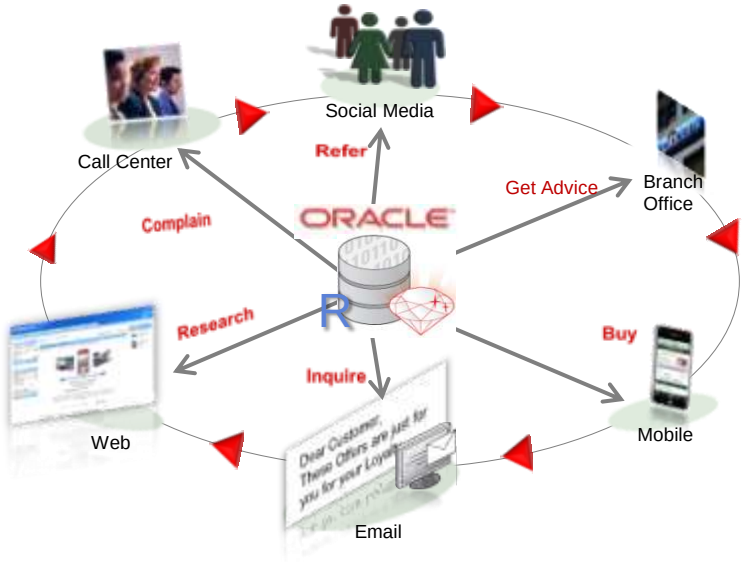




Oracle Advanced Analytics

More Details

- Advanced Analytic scoring tasks can now be executed in batch or real-time in CRM systems where customers can be contacted via targeted call-center/websites/e-mail offers



OAA's predictive models can "*power*" any real-time environments and deliver personalized predictions, clustering, recommendations, etc.

Likelihood to respond:

Query Result

SQL | All Rows Fetched: 1 in 0 seconds

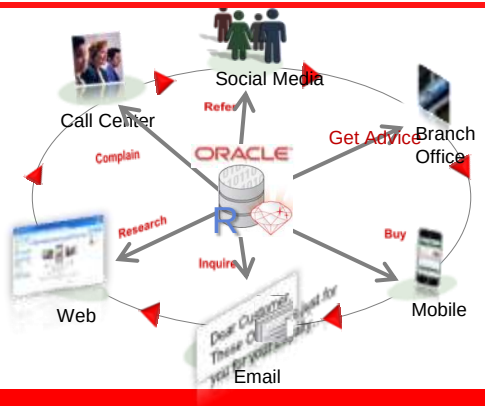
PREDICTION_PROB...
0.8382936507936...

Oracle Advanced Analytics

More Details

- On-the-fly, single record apply with new data (e.g. from call center)

```
Select prediction_probability(CLAS_DT_1_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_MONTLY_OVERDRAWN, 1 as house_ownership)
from dual;
```



Likelihood to respond:

Query Result

SQL | All Rows Fetched: 1 in 0 seconds

PREDICTION_PROB...
0.8382936507936...

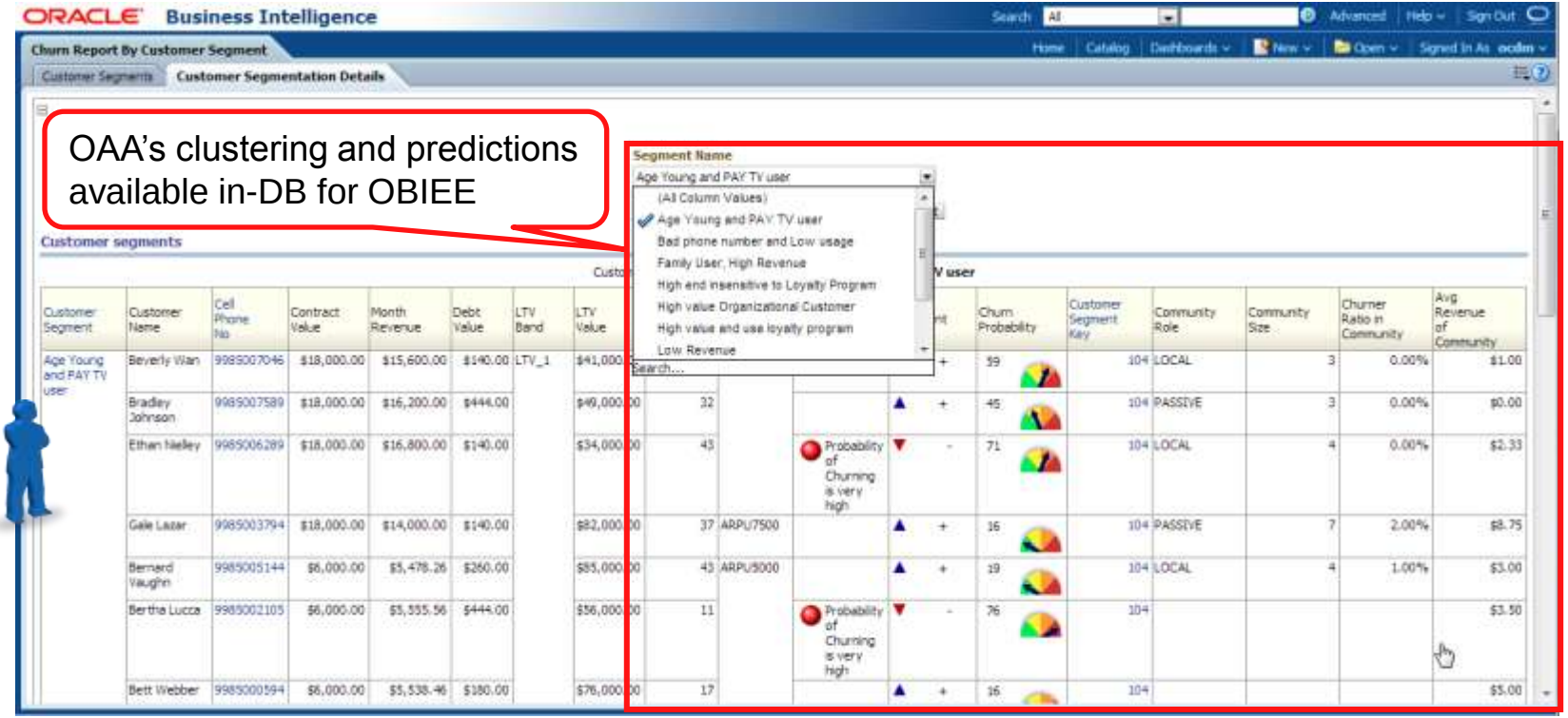
Enabling Predictive Applications

Example Applications Using Oracle Advanced Analytics

- **Human Capital Management**
  - **Predictive Workforce**—employee turnover and performance prediction and “What if?” analysis
- **CRM**
  - **Sales Prediction Engine**--prediction of sales opportunities, what to sell, amount, timing, etc.
- **Supply Chain Management**
  - **Spend Classification**—real-time flagging of possible noncompliance in expense submissions
- **Identity Management**
  - **Oracle Adaptive Access Manager**—real-time security and fraud analytics
- **Retail Analytics**
  - **Oracle Retail Customer Analytics**—”shopping cart analysis” and next best offers
- **Customer Support**
  - **Predictive Incident Monitoring (PIM)** Customer Service offering for Database customers
- **Manufacturing**
  - Response surface modeling in chip design
- **Predictive capabilities in Oracle Industry Data Models**
  - **Communications Data Model** implements churn prediction, segmentation, profiling, etc.
  - **Retail Data Model** implements loyalty and market basket analysis
  - **Airline Data Model** implements analysis frequent flyers, loyalty, etc.

Oracle Communications Industry Data Model

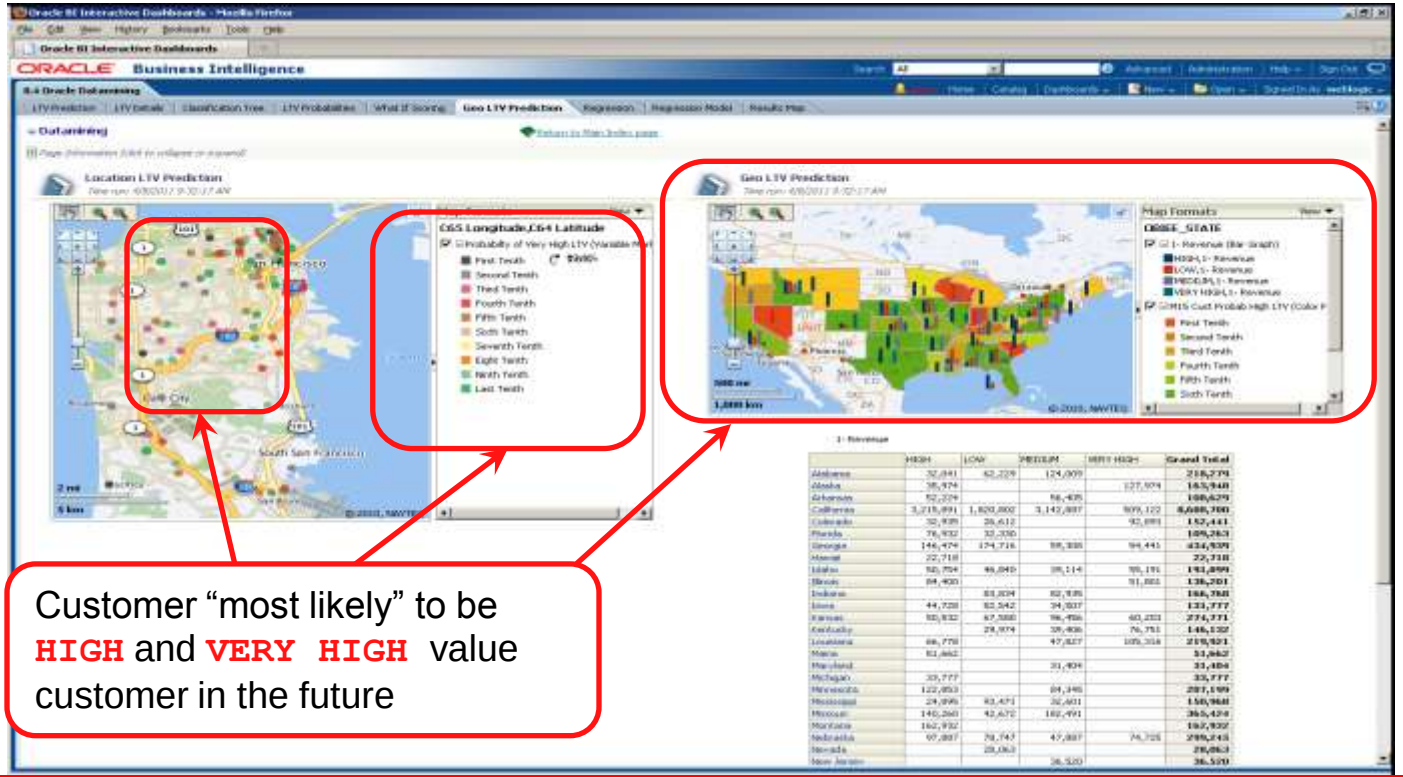
Fastest Way to Deliver Scalable Enterprise-wide Predictive Analytics



Integrated Business Intelligence

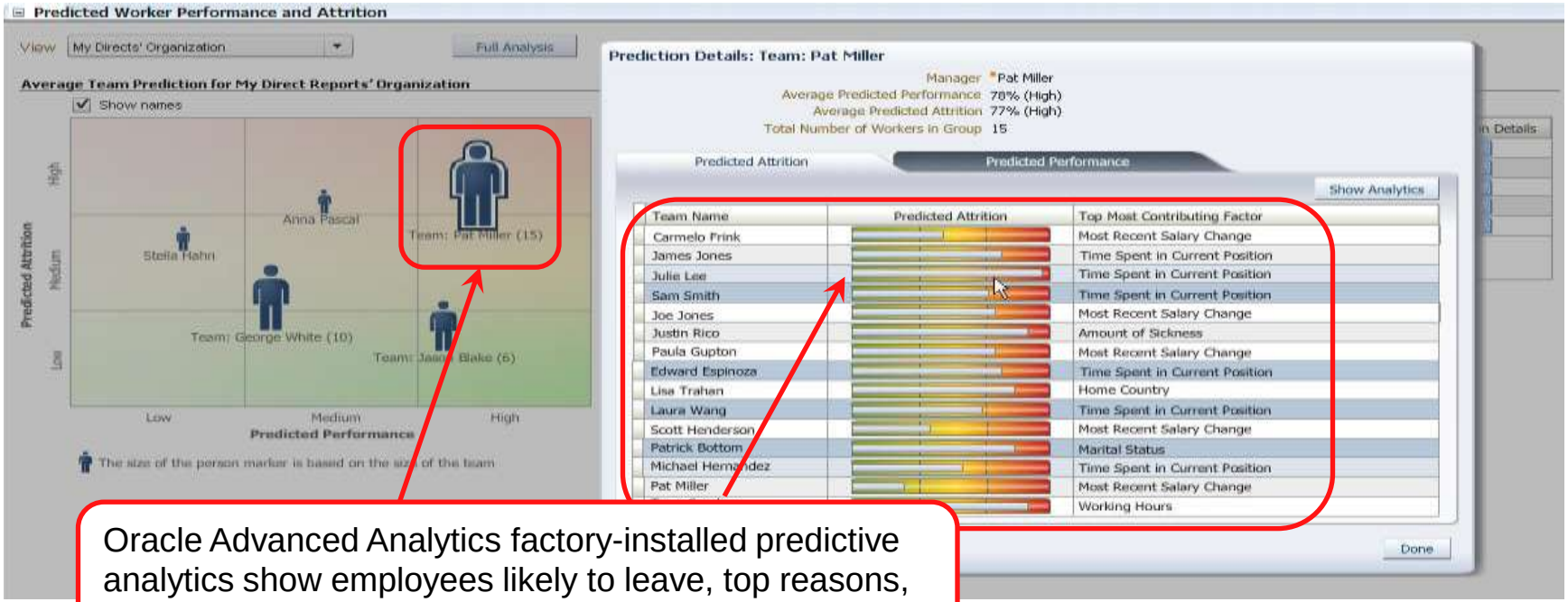
Integrate a range of in-DB SQL & R Predictive Analytics & Graphics

- In-database construction of predictive models that predict customer behavior
- OBIEE's integrated spatial mapping shows where



Fusion HCM Predictive Analytics

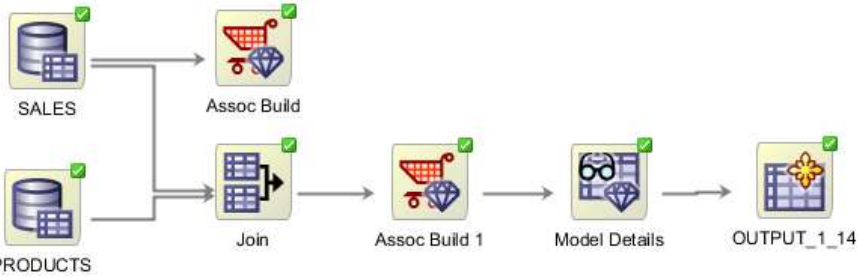
Built-in Predictive Analytics



Oracle Advanced Analytics factory-installed predictive analytics show employees likely to leave, top reasons, expected performance and real-time *"What if?"* analysis

Retail GBU

Market Basket Analysis



Market Basket Analysis to identify co-occurring items found in “baskets” and potential product bundles

Rules | Itemsets | Settings

Sort by: Lift Descending

Fetch Size: 1,000

Rule Content: Name,Subname

Rules: 1,000 out of 20,988

ID	Antecedent	Consequent	Lift	Confidence(%)	Support(%
17313	PROD_ID.137 AND PROD_ID.143 AND PROD_ID.138	PROD_ID.144	29.1235	70.8661	1.0689
17849	PROD_ID.138 AND PROD_ID.143 AND PROD_ID.139	PROD_ID.144	28.7389	69.9304	1.0528
17673	PROD_ID.137 AND PROD_ID.143 AND PROD_ID.142	PROD_ID.144	28.3021	68.8675	1.1003
20557	PROD_ID.139 AND PROD_ID.143 AND PROD_ID.142	PROD_ID.144	27.8527	67.7739	1.0975
17314	PROD_ID.137 AND PROD_ID.144 AND PROD_ID.138	PROD_ID.143	27.8265	77.5469	1.0689
18071	PROD_ID.138 AND PROD_ID.146 AND PROD_ID.144	PROD_ID.143	27.5925	76.8947	1.0207
17942	PROD_ID.138 AND PROD_ID.144 AND PROD_ID.140	PROD_ID.143	27.5082	76.6599	1.0486
18075	PROD_ID.138 AND PROD_ID.148 AND PROD_ID.144	PROD_ID.143	27.4991	76.6346	1.0563

Rule Details:

```
ID: 17313
IF
    PROD_ID.137 AND
    PROD_ID.143 AND
    PROD_ID.138
THEN
    PROD_ID.144
```

Lift	29.1235
Confidence(%)	70.8661
Support(%)	1.0689
Antecedent Support(%)	2.4333
Consequent Support(%)	1.5083
Item Count	3

Big Data Analytics in Retail

- Leverage all customer touch-point information
  - Consider each customer's demographics and past and recent POS behavior
  - POS data—shifting "market basket" items
  - Identify customer segments ("Country Squires", "Green", "New Empty Nests")

- Deploy real-time predictive models
  - 1:1 Marketing—treat each customer as an individual relationship
  - Look for opportunities to combine multiple touch points
  - Geo-location provides opportunity for site specific recommendations
  - Changing consumption, provide opportunities for cross-selling/up-selling

Big Data Analytics in Financial Services

- 360º View of Customer
  - Integrate silos of multi-business CRM data within large corporations
  - Combine data from multiple sources: investments, retail banking, mortgages
  - Gain 360º perspective of all touch points with a customer
  - Develop “best” customer profiles and sell them the right product at the right time

- Identify and combat fraud
  - Real-time fraud detection
  - Transactional data combine with demographic data
  - Monitor velocity of recent purchases and checks written vs. hist. averages
  - Flag transactions and individuals that appear “different” from normal behavior

Big Data Analytics High Performance Operations

- Learn from manufacturing, warranty, service data
  - Devices report back product's performance: analyze part failure correlations and patterns
  - Identify new strategies for improved product design and service plans
  - Increase product uptime, performance and quality

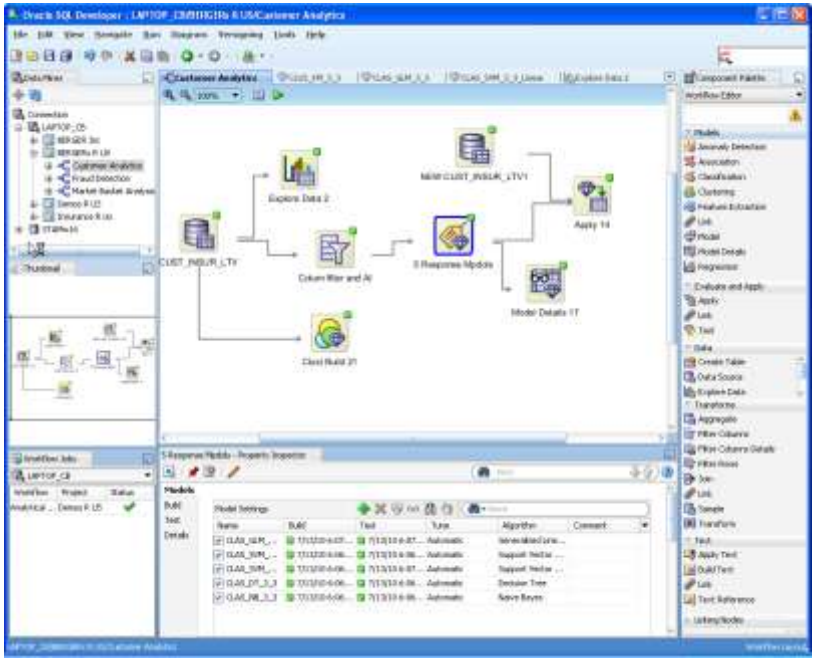
- Characterize and understand all performance scenarios
  - Streaming data from multiple sensors, weather, water, etc.
  - Clustering and response modeling to optimize each scenario

"The USA holds 250 sensors to collect raw data: pressure sensors on the wing; angle sensors on the adjustable trailing edge of the wing sail .... But collecting data was only the beginning. BMW ORACLE Racing also had to manage that data, analyze it, and present useful results. The team turned to Oracle Data Mining in Oracle Database 11g."

Oracle Data Miner GUI

SQL Developer 3.2 Extension—*Free OTN Download*

- Easy to Use
  - Oracle Data Miner GUI for data analysts
  - Explore data—discover new insights
  - “Work flow” paradigm for analytical methodologies
- Powerful
  - Multiple algorithms & data transformations
  - Runs 100% in-DB
  - Build, evaluate and apply data mining models
- Automate and Deploy
  - Generate and deploy SQL scripts for automation
  - Share analytical workflows

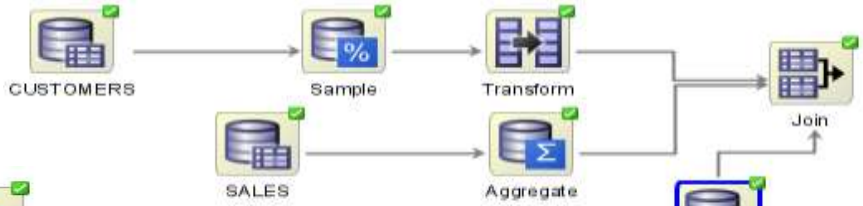


Oracle Data Miner GUI

Oracle Data Miner Nodes — *Partial List*

Tables and Views

Transformations



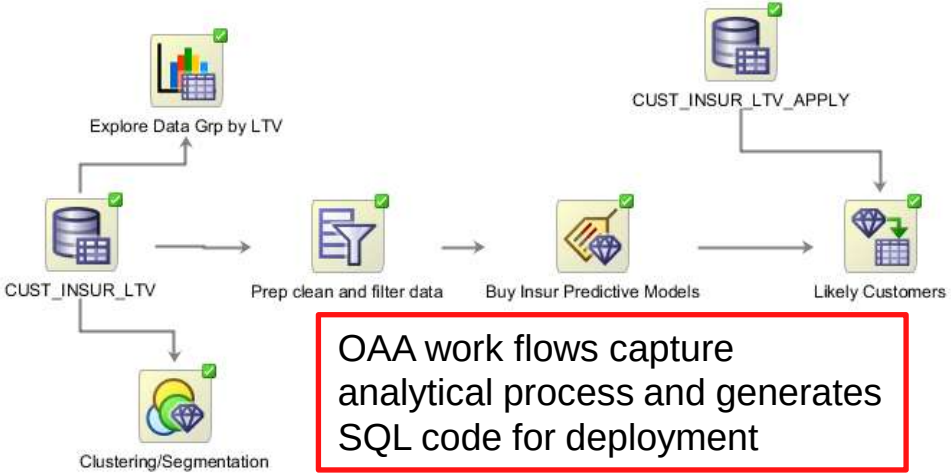
Explore Data

Modeling

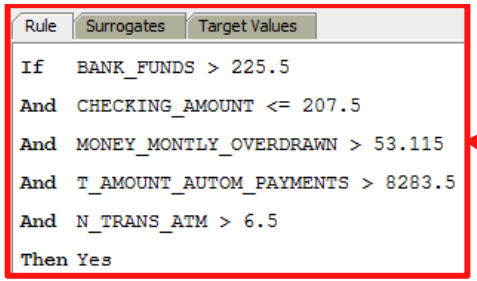
Text

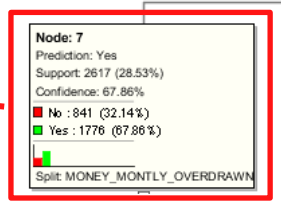
Insurance

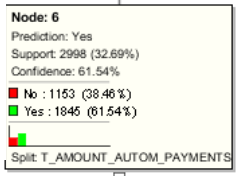
Identify “Likely Insurance Buyers” and their Profiles

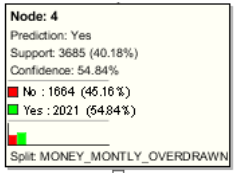


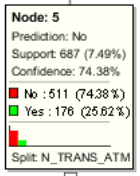
OAA work flows capture analytical process and generates SQL code for deployment

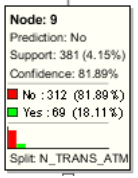


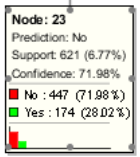


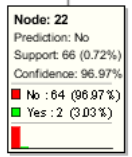








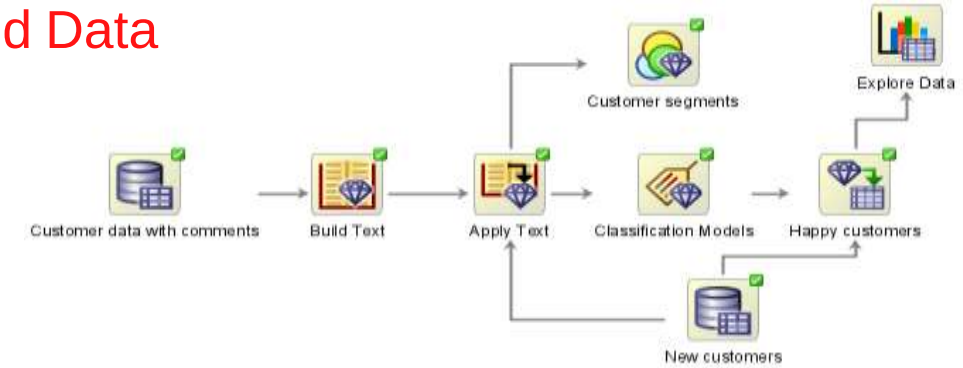


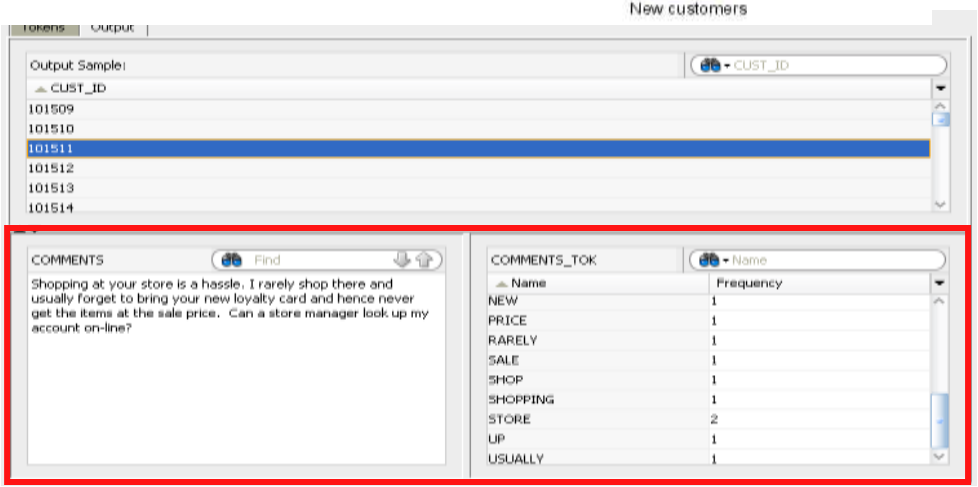


Oracle Advanced Analytics

Data Mining Unstructured Data

- Mines unstructured i.e. “text” data
- Include text and comments in models
- Cluster and classify documents
- Oracle Text used to preprocess unstructured text





Fraud Prediction Demo


```
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;
```

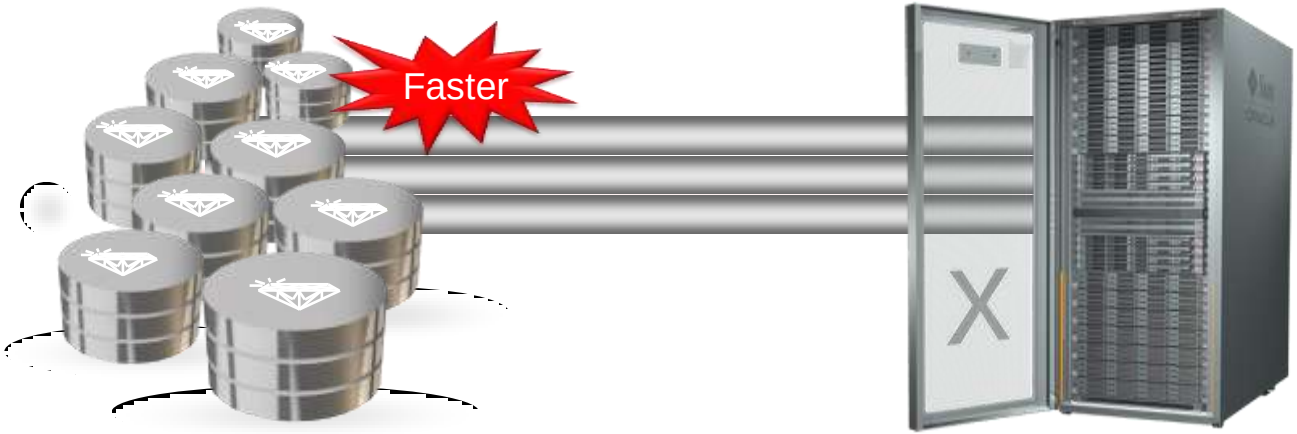
POLICYNUMBER	PERCENT_FRAUD	RNK
6532	64.78	1
2749	64.17	2
3440	63.22	3
654	63.1	4
12650	62.36	5

Automated Monthly "Application"! *Just add:*

```
Create
View CLAIMS2_30
As
Select * from CLAIMS2
Where mydate > SYSDATE – 30
```

Exadata + Data Mining 11g Release 2

Data Mining Model ”Scoring” Pushed to Storage



- SQL predicates and OAA models are pushed to storage level for execution

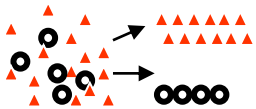
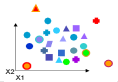
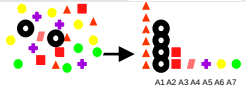
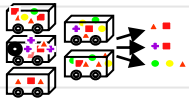
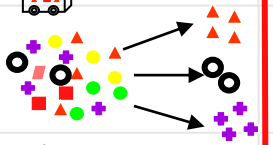
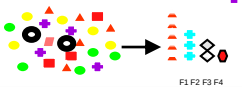
For example, find the US customers likely to churn:

```
select cust_id
from customers
where region = 'US'
and prediction_probability(churnmod,'Y' using *) > 0.8;
```

Exadata “smart scan” SQL function scoring

Oracle Advanced Analytics

SQL Data Mining Algorithms

Problem	Algorithms	Applicability
Classification 	Logistic Regression (GLM) Decision Trees Naïve Bayes Support Vector Machine	Classical statistical technique Popular / Rules / transparency Embedded app Wide / narrow data / text
Regression 	Multiple Regression (GLM) Support Vector Machine	Classical statistical technique Wide / narrow data / text
Anomaly Detection 	One Class SVM	Lack examples of target field
Attribute Importance 	Minimum Description Length (MDL)	Attribute reduction Identify useful data Reduce data noise
Association Rules 	Apriori	Market basket analysis Link analysis
Clustering 	Hierarchical K-Means Hierarchical O-Cluster	Product grouping Text mining Gene and protein analysis
Feature Extraction 	Nonnegative Matrix Factorization	Text analysis Feature reduction

Oracle Advanced Analytics

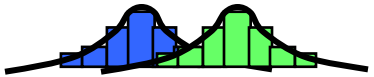
SQL Statistics and SQL Analytics

- **Ranking functions**
  - rank, dense_rank, cume_dist, percent_rank, ntile
- **Window Aggregate functions**
  (moving & cumulative)
  - Avg, sum, min, max, count, variance, stddev, first_value, last_value
- **LAG/LEAD functions**
  - Direct inter-row reference using offsets
- **Reporting Aggregate functions**
  - Sum, avg, min, max, variance, stddev, count, ratio_to_report
- **Statistical Aggregates**
  - Correlation, linear regression family, covariance
- **Linear regression**
  - Fitting of an ordinary-least-squares regression line to a set of number pairs.
  - Frequently combined with the COVAR_POP, COVAR_SAMP, and CORR functions
- **Descriptive Statistics**
  - DBMS_STAT_FUNCS: summarizes numerical columns of a table and returns count, min, max, range, mean, median, stats_mode, variance, standard deviation, quantile values, +/- n sigma values, top/bottom 5 values
- **Correlations**
  - Pearson's correlation coefficients, Spearman's and Kendall's (both nonparametric).
- **Cross Tabs**
  - Enhanced with % statistics: chi squared, phi coefficient, Cramer's V, contingency coefficient, Cohen's kappa
- **Hypothesis Testing**
  - Student t-test , F-test, Binomial test, Wilcoxon Signed Ranks test, Chi-square, Mann Whitney test, Kolmogorov-Smirnov test, One-way ANOVA
- **Distribution Fitting**
  - Kolmogorov-Smirnov Test, Anderson-Darling Test, Chi-Squared Test, Normal, Uniform, Weibull, Exponential

Note: Statistics and SQL Analytics are included in Oracle Database Standard Edition and Enterprise Edition

Independent Samples T-Test

(Pooled Variances)



- Query compares the mean of AMOUNT_SOLD between MEN and WOMEN within CUST_INCOME_LEVEL ranges. Returns observed t value and its related two-sided significance

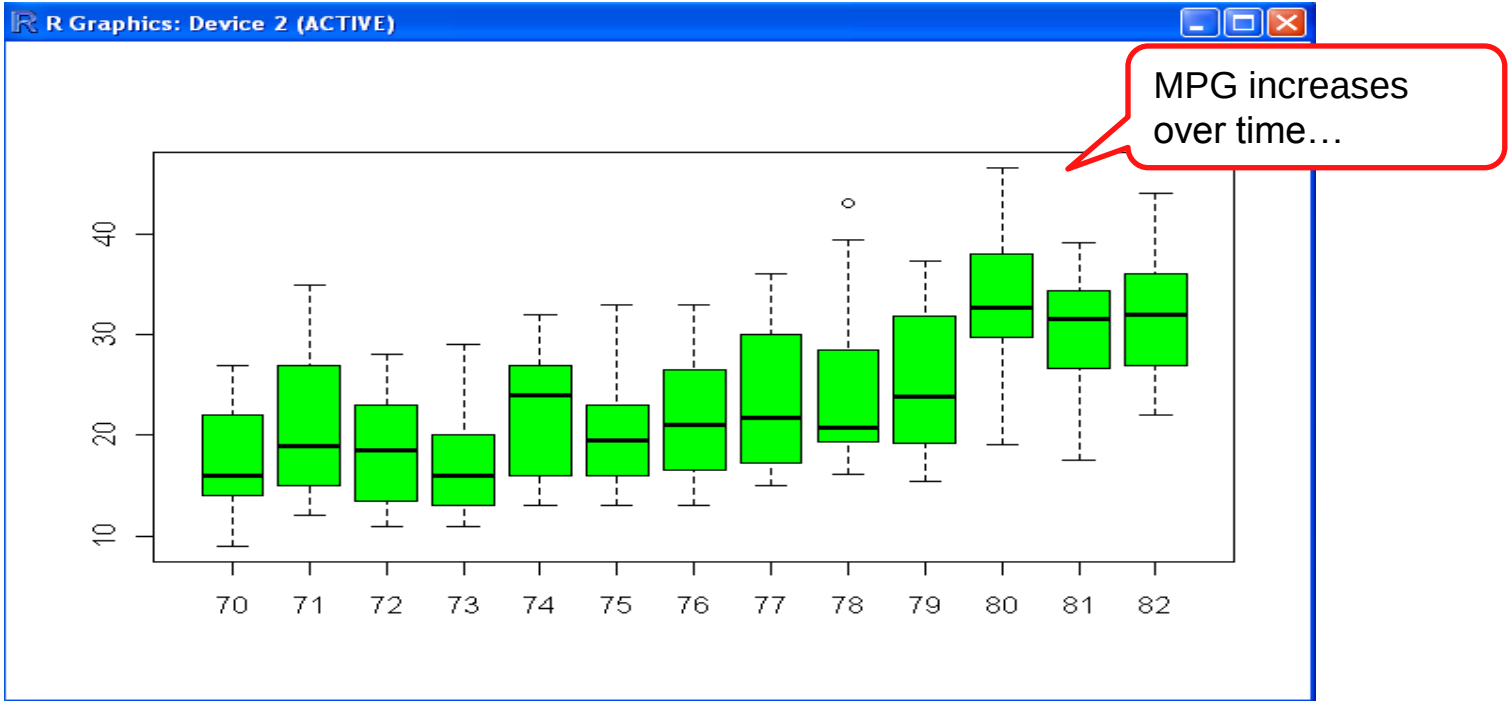
```
SELECT substr(cust_income_level,1,22) income_level,
  avg(decode(cust_gender,'M',amount_sold,null)) sold_to_men,
  avg(decode(cust_gender,'F',amount_sold,null)) sold_to_women,
  stats_t_test_indep(cust_gender, amount_sold, 'STATISTIC','F')
  t_observed,
  stats_t_test_indep(cust_gender, amount_sold) 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;
```

SQL Plus

Oracle Advanced Analytics

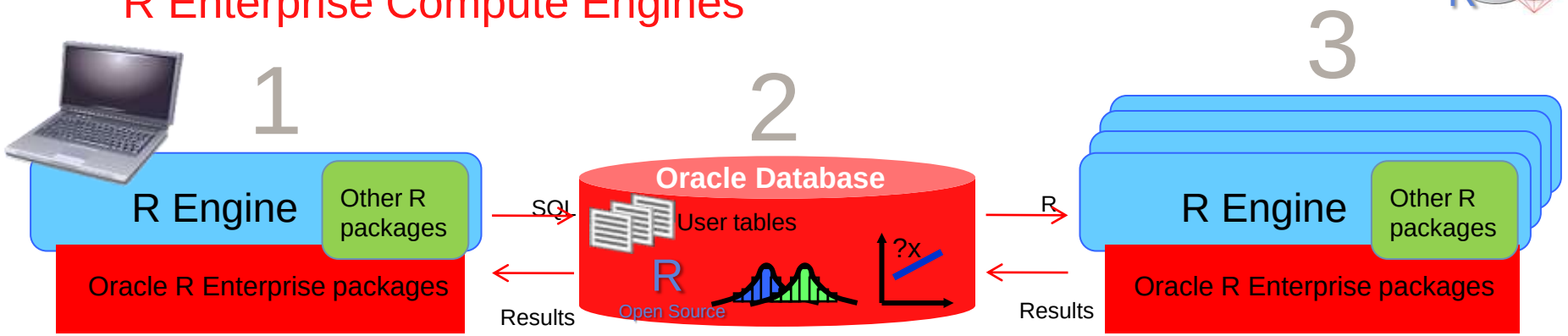
R Graphics Direct Access to Database Data

```
R> boxplot(split(CARSTATS$mpg, CARSTATS$model.year), col = "green")
```



Oracle Advanced Analytics

R Enterprise Compute Engines



User R Engine on desktop

- R-SQL Transparency Framework intercepts R functions for scalable in-database execution
- Function intercept for data transforms, statistical functions and advanced analytics
- Interactive display of graphical results and flow control as in standard R
- Submit entire R scripts for execution by database

Database Compute Engine

- Scale to large datasets
- Access tables, views, and external tables, as well as data through DB LINKS
- Leverage database SQL parallelism
- Leverage new and existing in-database statistical and data mining capabilities

R Engine(s) spawned by Oracle DB

- Database can spawn multiple R engines for database-managed parallelism
- Efficient data transfer to spawned R engines
- Emulate map-reduce style algorithms and applications
- Enables “lights-out” execution of R scripts

Oracle Advanced Analytics Example

Use of All 3 ORE Engines Within 1 R Script

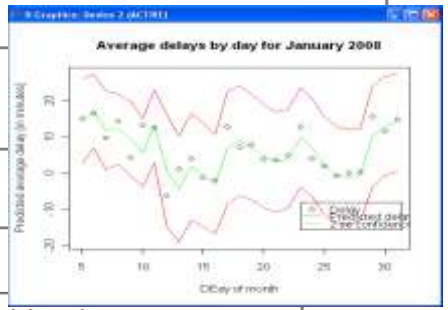
The following example illustrates use of all 3 engines from within 1 R script.

```
narx = relational_table_1;
nary = relational_table_2;
m3 <- merge(narx, nary, by="ID", all.y=T) /* Join */
summary(m3) /* Summary */
tabulate(m3)
aggregate(m3$ID, by=list(age=AGE, gen=GEN), FUN=median))
BP <- boxplot(list(age=AGE), plot=FALSE)
ore.corr(m3, 'AGE, CLASS', group.by='COUNTRY','EDUCATION')
filtered_set<-m3[AGE==17 & !is.na(AGE) && COUNTRY IN ('USA', "France'), c(1,4,5)]
```

Data preparation/analysis/joins/visualization/summarization/correlation/cross tabulation -> completely shipped to database for execution.

```
x = ore.pull(filtered_set)
library(arima)
y=arima(ore.pull)
```

Local pull of filtered subset for processing by an open source package – arima in this case. Result of processing added to database object m3 as a derived column -> Local R engine on user's desktop




```
m3$newcolumn = y;
library(biglm)
res <- ore.tableApply(m3[,c("ARRDELAY", "DISTANCE", "newcolumn")],
                      function(dat) {
                       library(biglm)
                       biglm(ARRDELAY ~ DISTANCE + newcolumn, dat)
                      })
class(mod)
mean(res$PRED, na.rm = TRUE)
c(res, BP); /* object returned from the script */
```

Embedded R engine invoked to build a model on the prepared/augmented data using yet another open source package biglm in this case

You Can Think of OAA 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 & R)

- Automated knowledge discovery, model building and deployment
- Domain expertise to assemble the "*right*" data to mine/analyze

- **Analytical** "Verbs"
  - `PREDICT`
  - `DETECT`
  - `CLUSTER`
  - `CLASSIFY`
  - `REGRESS`
  - `PROFILE`
  - `IDENTIFY FACTORS`
  - `ASSOCIATE`

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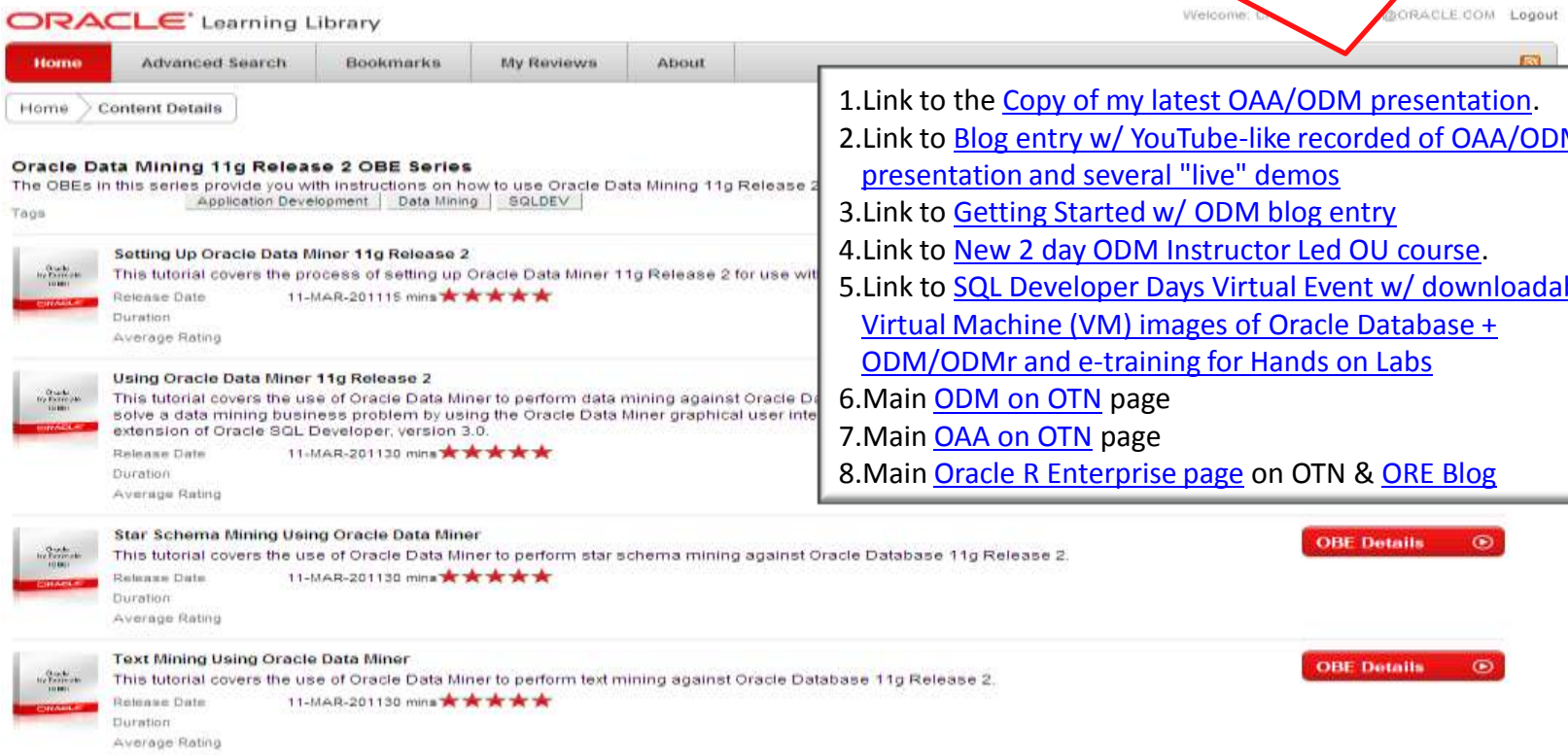

1. Link to the Copy of my latest OAA/ODM presentation.
2. Link to Blog entry w/ YouTube-like recorded of OAA/ODM presentation and several "live" demos
3. Link to Getting Started w/ ODM blog entry
4. Link to New 2 day ODM Instructor Led OU course.
5. Link to SQL Developer Days Virtual Event w/ downloadable Virtual Machine (VM) images of Oracle Database + ODM/ODMr and e-training for Hands on Labs
6. Main ODM on OTN page
7. Main OAA on OTN page
8. Main Oracle R Enterprise page on OTN & ORE Blog


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