Oracle Advanced Analytics - Option to Oracle Database: Oracle R Enterprise and Oracle Data Mining

Data Warehouse Global Leaders
Winter 2013

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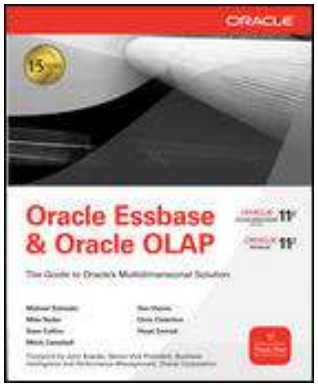
Dan Vlamis and Vlamis Software Solutions

- Vlamis Software founded in 1992 in Kansas City, Missouri
- Developed more than 200 Oracle BI systems
- Specializes in ORACLE-based:
  - Data Warehousing
  - Business Intelligence
  - Design and integrated BI and DW solutions
  - Training and mentoring
- Expert presenter at major Oracle conferences
- www.vlamis.com (blog, papers, newsletters, services)
- Developer for IRI (former owners of Oracle OLAP)
- Co-author of book “Oracle Essbase & Oracle OLAP”
- Beta tester for OBIEE 11g
- Reseller for Simba and Nokia map data for OBIEE
- HOL Coordinator for BIWA Summit 2013



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Oracle Essbase & Oracle OLAP: The Guide to Oracle's Multidimensional Solution

- Published by Oracle Press
  - Dan Vlamis
  - Chris Claterbos
  - Michael Nader
  - David Collins
  - Floyd Conrad
  - Mitchell Campbell
  - Michael Schrader

- Covers both Oracle Essbase and Oracle OLAP
- 500 Pages

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Tim Vlamis' Bio

- 20+ years experience in business modeling and valuation, forecasting, and scenario analyses
- Trainer for Oracle University Two-Day Data Mining Course
- Professional Certified Marketer (PCM) from AMA
- Active Member of NICO (Northwestern Institute on Complex Systems)
- Adjunct Professor of Business Benedictine College
- MBA Kellogg School of Management (Northwestern)
- BA Economics Yale University

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Mark Hornick's Bio

- Director, Oracle Advanced Analytics
  - Oracle's R Technologies: ORE, ORD, ROracle, ORAAH
  - Working with customers on POC/POV, training, applications
  - Joined Oracle Data Mining Technologies group in 1999 through acquisition of Thinking Machines Corp
- Recent publications through Oracle Press
  - "Using R to Unlock the Value of Big Data"
  - "Oracle Big Data Handbook"
- Blogger: blogs.oracle.com/R
- Twitter: @MarkHornick
- Connect on LinkedIn: Mark Hornick

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Presentation Overview

- Analytic options to the Oracle Database intro
- Oracle Advanced Analytics Overview (OBIEE demo)
  - Oracle Data Mining
  - Oracle R Enterprise
  - Apps
  - What is predictive analytics
- Oracle Data Mining Overview and Perspective
- Oracle R Enterprise Overview and Perspective
- Oracle Data Mining SQL Developer models demo
- Oracle R Enterprise demo
- Where to get started
  - Start by establishing a common foundation through training
  - Follow training with workshop and identification of POC project
  - Training outlines

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Analytical Options to Oracle Database

- Oracle OLAP
  - Defines a multi-dimensional data structure that allows information for highly complex calculations to done quickly
  - Fast query performance and incremental update
  - Simplified access to analytic calculations
- Oracle Advanced Analytics (Data Mining & R)
  - Delivers scalable, parallel in-database execution
  - In-database data mining algorithms and open source R algorithms
  - SQL, PL/SQL, R languages
  - Workflow GUI and IDEs
  - Targets wide range of users: business users, IT, and data scientists
  - Integrated component of Oracle Database enabling enterprise analytical applications
- Oracle Spatial
  - Provides the capability of relating data to geo positional coordinates, objects, and constructs
  - Allows the construction and analysis of network topologies

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Spectrum of Oracle DB BI & Analytics

OLAP

Summaries, hierarchies and dimensional data

"Analysis"

What is the average **income** of mutual fund buyers, **by** region, **by** year?

Data Mining & R

Knowledge discovery of hidden patterns

"Insight & Prediction"

Who is likely to purchase a mutual fund in the next 6 months and why?

Spatial

Spatial relationships between data

"Location"

Where were mutual funds purchased in the last 3 years?

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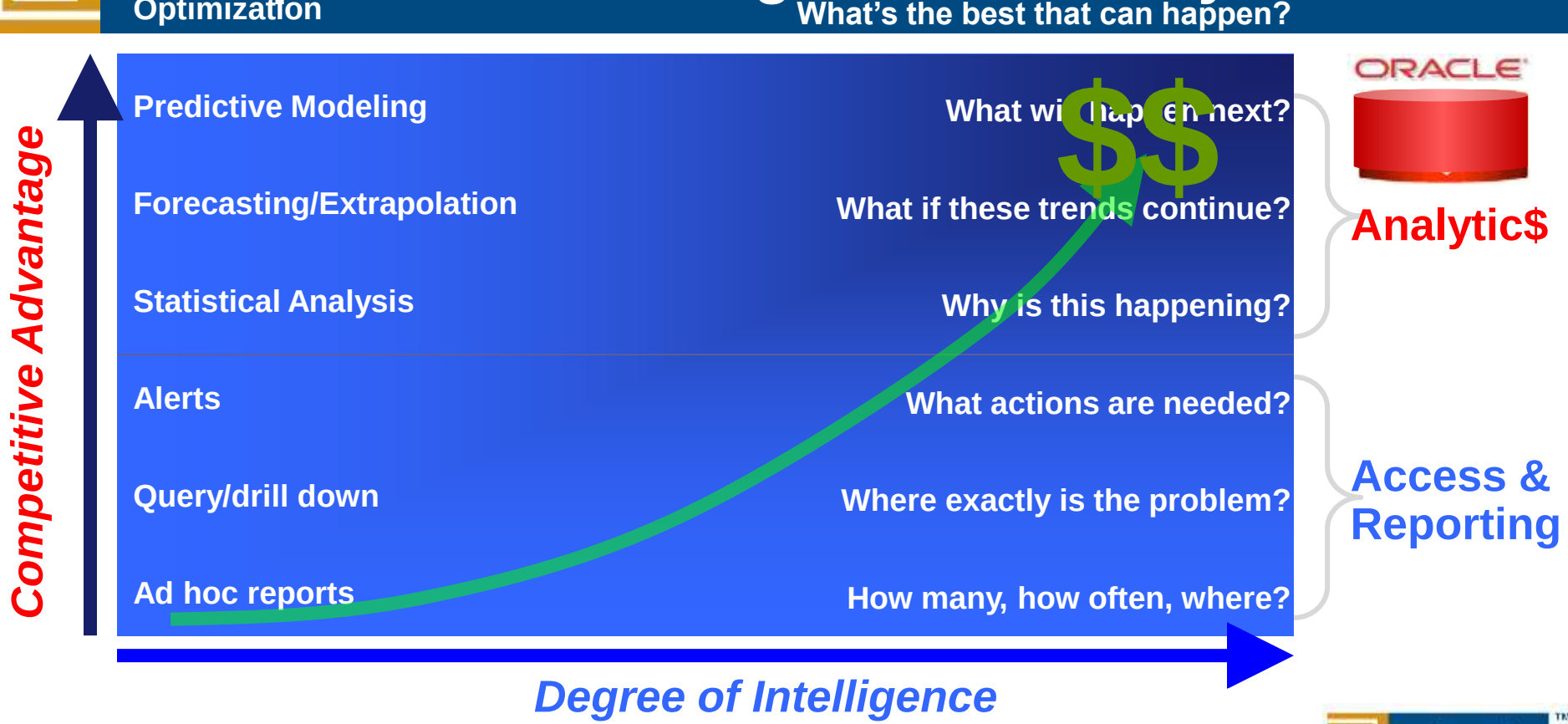
Competitive Advantage of BI & Analytics



Source: Competing on Analytics, by T. Davenport & J. Harris

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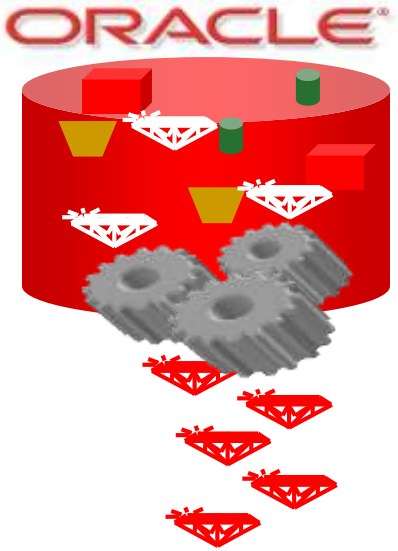
What is Data Mining?

- Automatically sifts through data to find hidden patterns, discover new insights, and make predictions



- Data Mining can provide valuable results:
  - Predict customer behavior *(Classification)*
  - Predict or estimate a value *(Regression)*
  - Segment a population *(Clustering)*
  - Identify factors more associated with a business problem *(Attribute Importance)*
  - Find profiles of targeted people or items *(Decision Trees)*
  - Determine important relationships and “market baskets” within the population *(Associations)*
  - Find fraudulent or “rare events” *(Anomaly Detection)*

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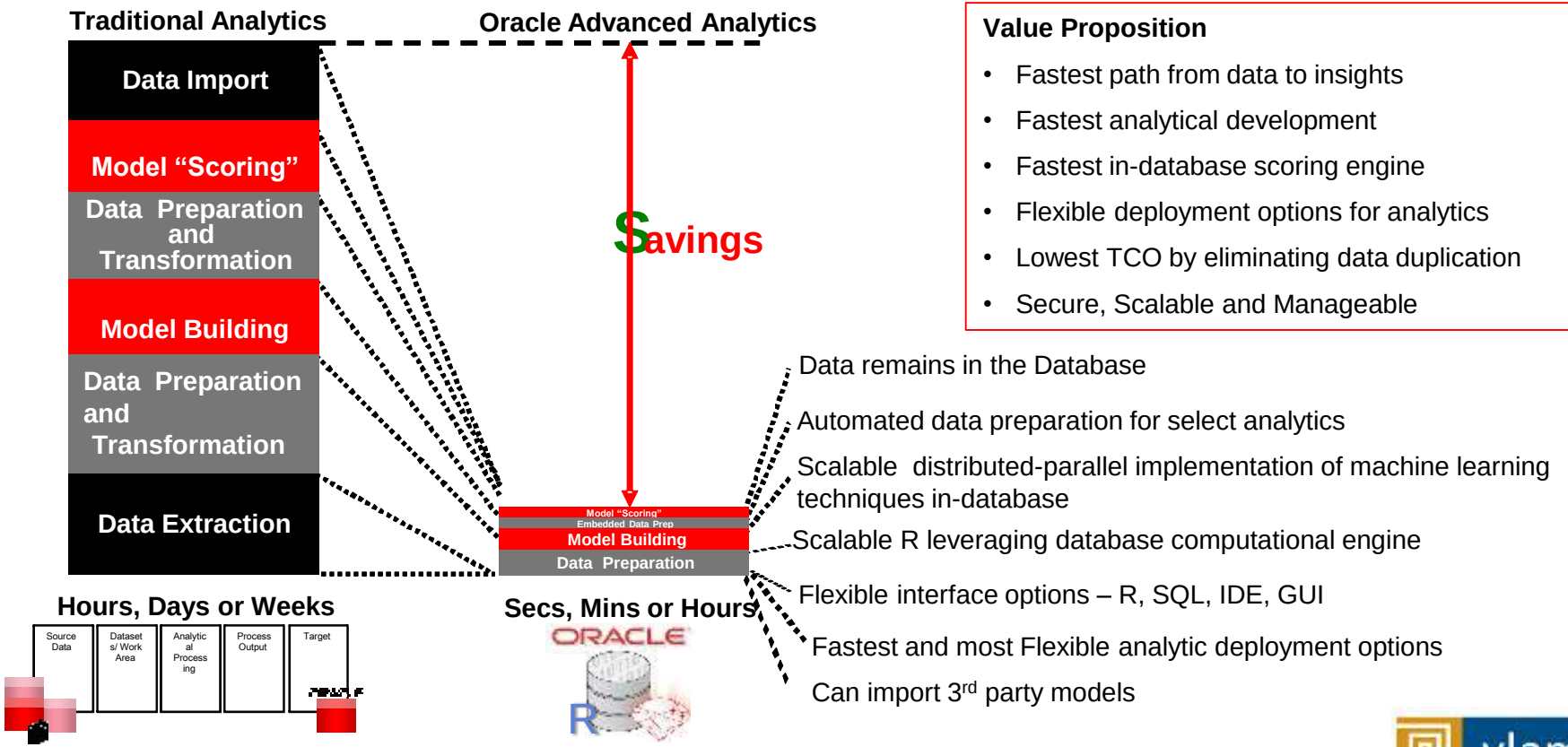
Oracle Advanced Analytics Value Proposition



Value Proposition

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

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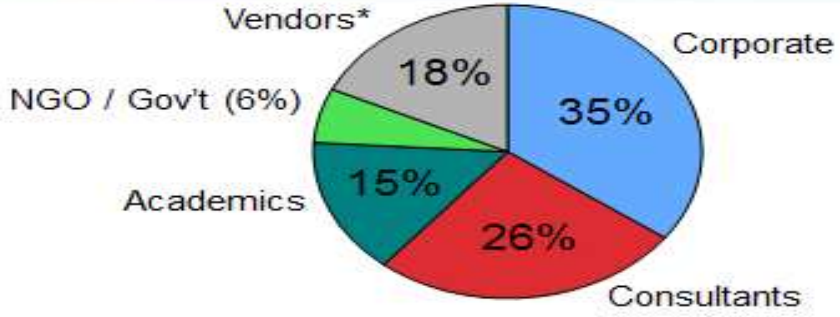
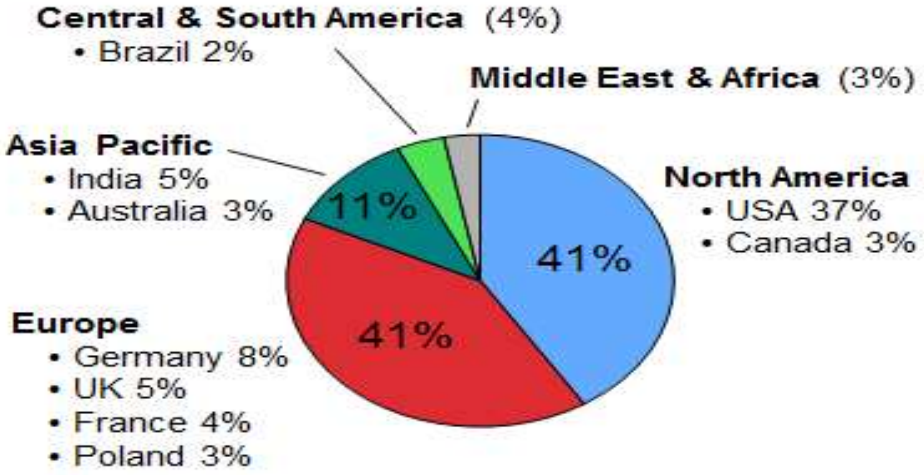
Rexer Analytics 2013 Data Miner Survey

Vendors are included in this analysis.

- 6th survey since 2007
- 68 questions
- 10,000+ invitations emailed, plus promoted by newsgroups, vendors, and bloggers
- Respondents: 1,259 data miners from 75 countries
- Data collected in first half of 2013

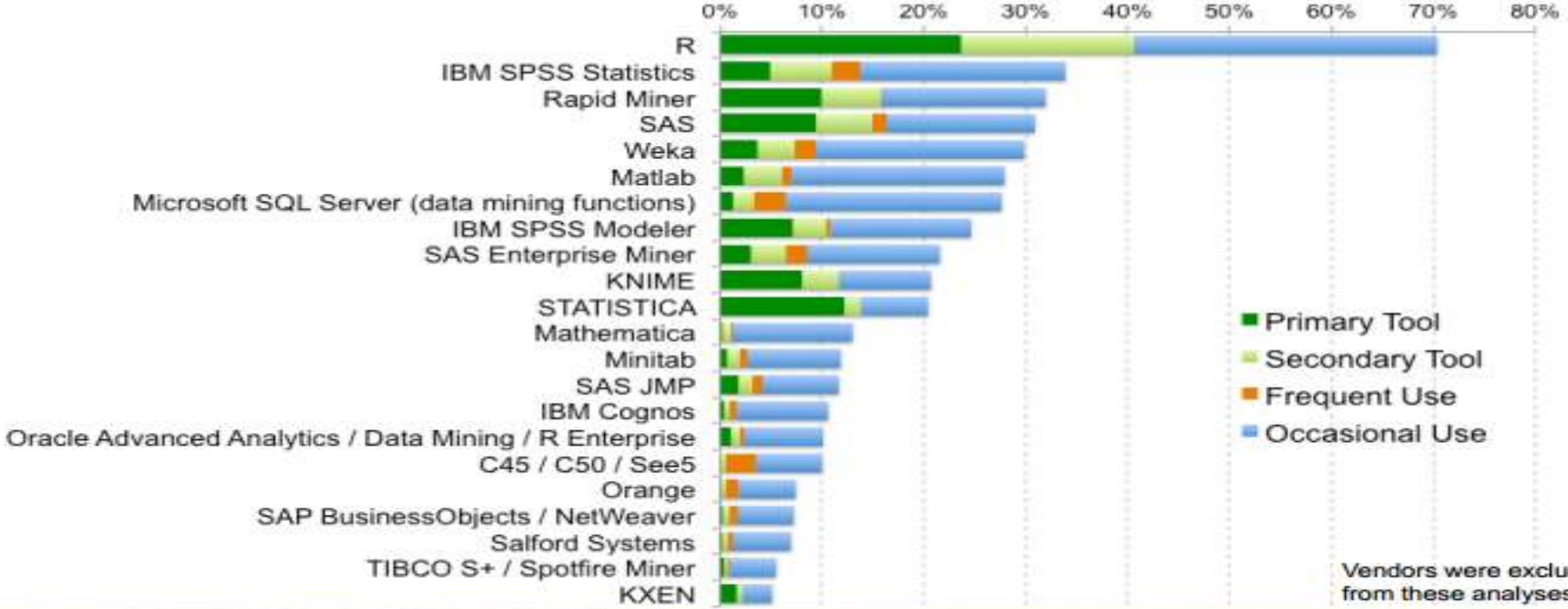




*Data from software vendors is excluded from analyses in this presentation unless otherwise noted.

The Tools We're Using – Ranked by Usage

- The average data miner reports using 5 software tools
- R is the tool used by the most data miners (70%)
- IBM SPSS Statistics, Rapid Miner, and SAS also have many users



Examples of Oracle Applications Using OAA

- **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 noncompliance and anomalies 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.

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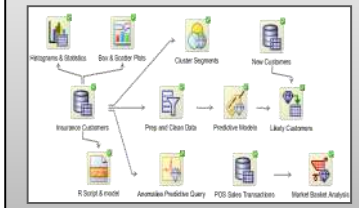
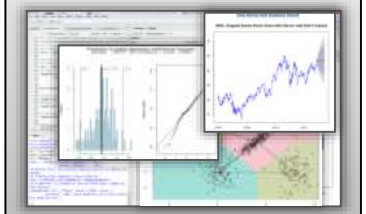
Oracle Advanced Analytics Architecture

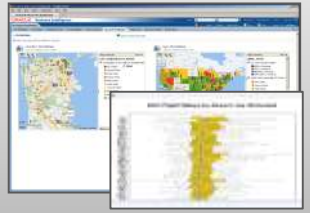
SQL Developer



R Client



OBIEE



Applications

Oracle Database Enterprise Edition

Oracle Advanced Analytics

Native SQL-PL/SQL Analytic Libraries plus high-performance R interface

Scalable, Distributed, Parallel Execution

Oracle R Distribution

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Oracle DB Statistics & SQL Analytics (Free)

- Ranking functions
  - rank, dense_rank, cume_dist, percent_rank, ntile
- Window Aggregate functions (moving and 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

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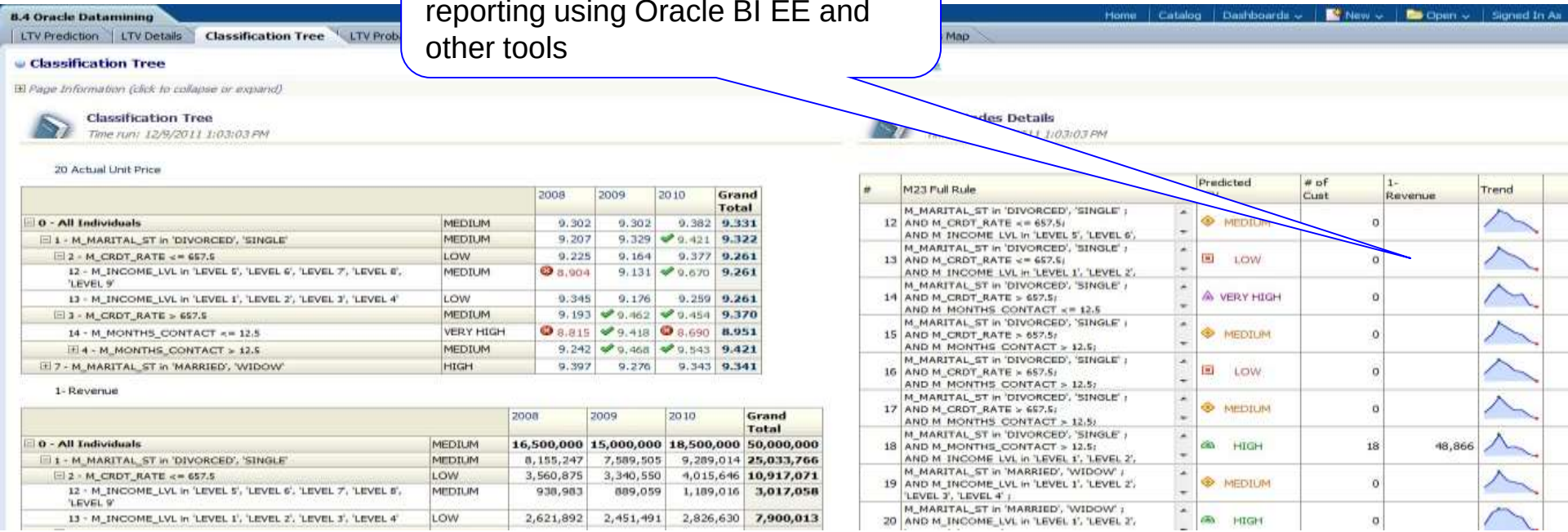
Oracle Advanced Analytics & OBI 11g Demo

ODM's predictions & probabilities are available in the Database for reporting using Oracle BI EE and other tools



8.4 Oracle Datamining

LTV Prediction | LTV Details | Classification Tree | LTV Prob | Map

Home | Catalog | Dashboards | New | Open | Signed In As

Classification Tree

Page Information (click to collapse or expand)

Classification Tree

Time run: 12/9/2011 1:03:03 PM

20 Actual Unit Price

		2008	2009	2010	Grand Total
0 - All Individuals	MEDIUM	9.302	9.302	9.382	9.331
1 - M_MARITAL_ST in 'DIVORCED', 'SINGLE'	MEDIUM	9.207	9.329	9.421	9.322
2 - M_CRDT_RATE <= 657.5	LOW	9.225	9.164	9.377	9.261
12 - M_INCOME_LVL in 'LEVEL 5', 'LEVEL 6', 'LEVEL 7', 'LEVEL 8', 'LEVEL 9'	MEDIUM	8.904	9.131	9.670	9.261
13 - M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2', 'LEVEL 3', 'LEVEL 4'	LOW	9.345	9.176	9.259	9.261
3 - M_CRDT_RATE > 657.5	MEDIUM	9.193	9.462	9.454	9.370
14 - M_MONTHS_CONTACT <= 12.5	VERY HIGH	8.815	9.418	8.690	8.951
4 - M_MONTHS_CONTACT > 12.5	MEDIUM	9.242	9.468	9.543	9.421
7 - M_MARITAL_ST in 'MARRIED', 'WIDOW'	HIGH	9.397	9.276	9.343	9.341

1- Revenue

		2008	2009	2010	Grand Total
0 - All Individuals	MEDIUM	16,500,000	15,000,000	18,500,000	50,000,000
1 - M_MARITAL_ST in 'DIVORCED', 'SINGLE'	MEDIUM	8,155,247	7,589,505	9,289,014	25,033,766
2 - M_CRDT_RATE <= 657.5	LOW	3,560,875	3,340,550	4,015,646	10,917,071
12 - M_INCOME_LVL in 'LEVEL 5', 'LEVEL 6', 'LEVEL 7', 'LEVEL 8', 'LEVEL 9'	MEDIUM	938,983	889,059	1,189,016	3,017,058
13 - M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2', 'LEVEL 3', 'LEVEL 4'	LOW	2,621,892	2,451,491	2,826,630	7,900,013

Details

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#	M23 Full Rule	Predicted	# of Cust	1-Revenue	Trend
12	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE <= 657.5; AND M_INCOME_LVL in 'LEVEL 5', 'LEVEL 6',	MEDIUM	0		
13	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE <= 657.5; AND M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2',	LOW	0		
14	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE > 657.5; AND M_MONTHS_CONTACT <= 12.5	VERY HIGH	0		
15	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE > 657.5; AND M_MONTHS_CONTACT > 12.5;	MEDIUM	0		
16	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE > 657.5; AND M_MONTHS_CONTACT > 12.5;	LOW	0		
17	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_CRDT_RATE > 657.5; AND M_MONTHS_CONTACT > 12.5;	MEDIUM	0		
18	M_MARITAL_ST in 'DIVORCED', 'SINGLE' ; AND M_MONTHS_CONTACT > 12.5; AND M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2',	HIGH	18	48,866	
19	M_MARITAL_ST in 'MARRIED', 'WIDOW' ; AND M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2', 'LEVEL 3', 'LEVEL 4' ;	MEDIUM	0		
20	M_MARITAL_ST in 'MARRIED', 'WIDOW' ; AND M_INCOME_LVL in 'LEVEL 1', 'LEVEL 2',	HIGH	0		

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Oracle Data Mining Perspective

- Bring the algorithms to the database kernel
- Focus on the business value of results rather than sources of error (glass is half full)
- Put predictive analytics into business processes
- Enable Oracle DB as an analytics engine for applications
- Lots of “smart” decisions have already been made
- Data Miner GUI is great for analysts

Oracle R Enterprise Perspective

- Provide a powerful statistical programming language for advanced analytics users
- Greatly reduce or eliminate R limitations: memory, parallelism, deployment
- Integrate comprehensive analytics into business processes
- Leverage Oracle Database has HPC engine
- Participate in and contribute to the R ecosystem
- Provide leadership in analytics strategy

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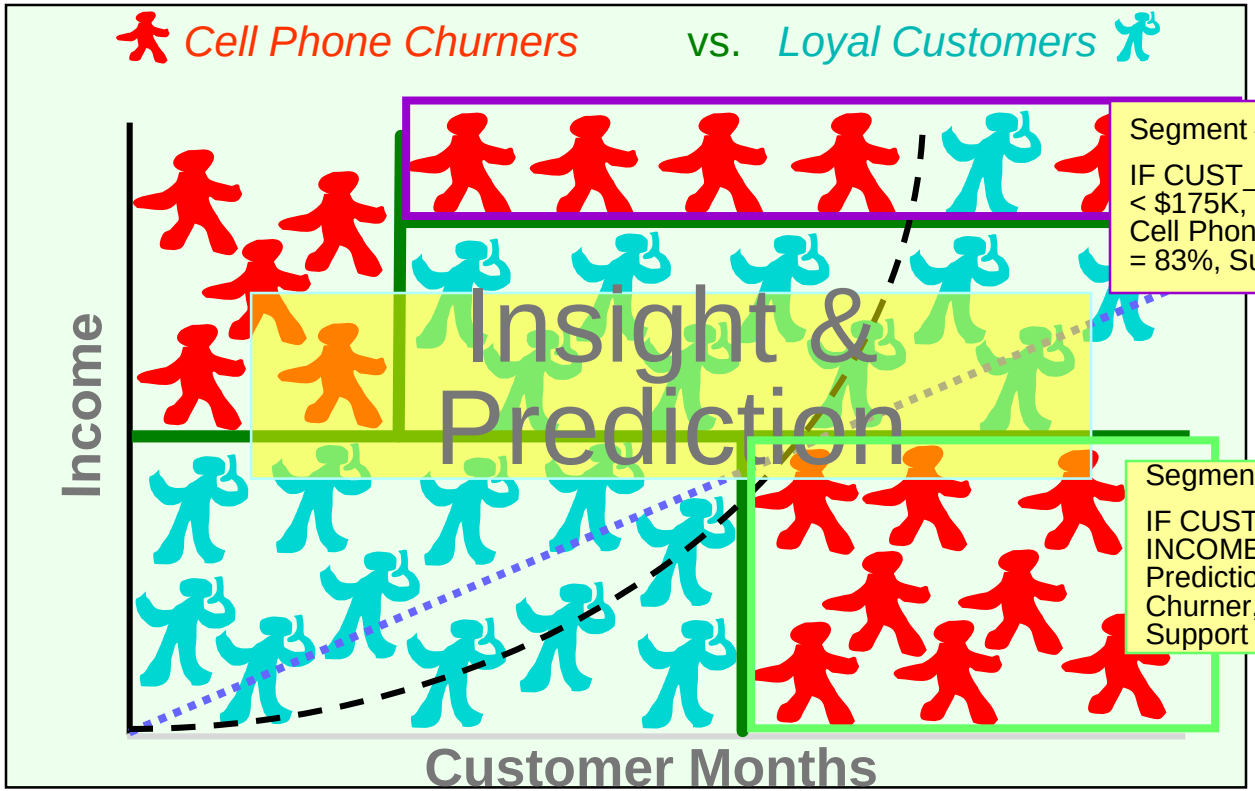
Oracle Data Mining

- Oracle Data Mining (ODM) is a component of the Oracle Advanced Analytics (OAA) option to Oracle Database EE
- A collection of APIs and specialized SQL functions
- Includes a large number of specialized algorithms and built-in procedures
- Makes use of many built-in capabilities of Oracle Database
- Provides a graphical user interface for creating analytical workflows

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

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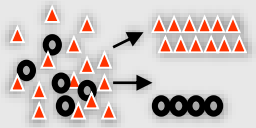
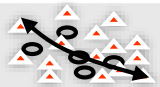
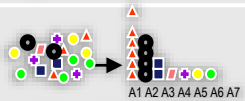
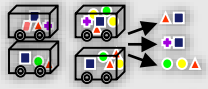
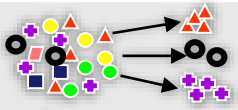
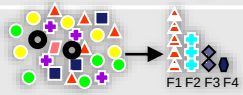
Oracle Data Mining Algorithms

		Algorithms	Applicability
Classification		Logistic Regression (GLM) Decision Trees Naïve Bayes Support Vector Machines (SVM)	Classical statistical technique Popular / Rules / transparency Embedded app Wide / narrow data / text
Regression		Linear Regression (GLM) Support Vector Machine (SVM)	Classical statistical technique Wide / narrow data / text
Anomaly Detection		One Class SVM	Unknown fraud cases or anomalies
Attribute Importance		Minimum Description Length (MDL) Principal Components Analysis (PCA)	Attribute reduction, Reduce data noise
Association Rules		Apriori	Market basket analysis / Next Best Offer
Clustering		Hierarchical k-Means Hierarchical O-Cluster Expectation-Maximization Clustering (EM)	Product grouping / Text mining Gene and protein analysis
Feature Extraction		Nonnegative Matrix Factorization (NMF) Singular Value Decomposition (SVD)	Text analysis / Feature reduction

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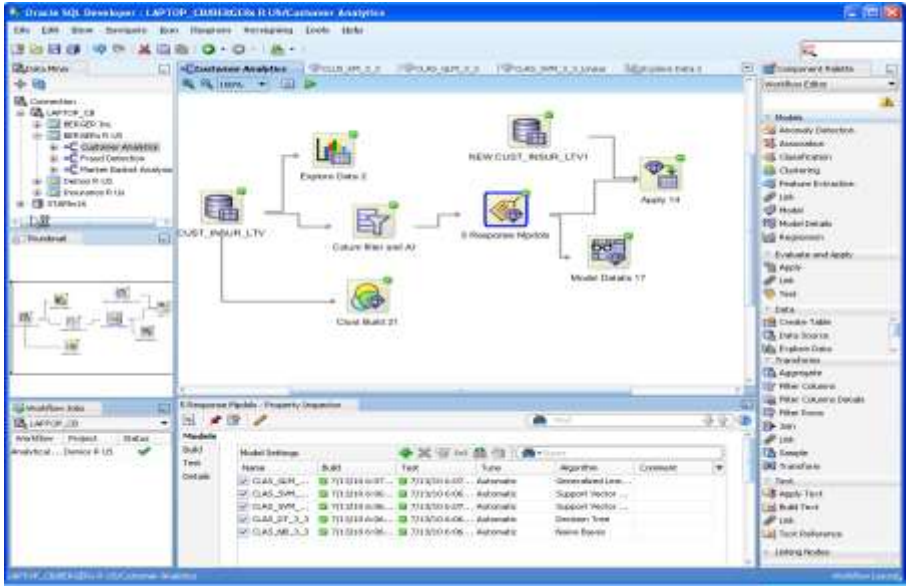
Oracle Data Miner



- Oracle Data Miner is a front end GUI for Oracle Data Mining
- Extension for Oracle SQL Developer, a free IDE from Oracle that facilitates database interaction
- Functions as an object oriented programing interface for designing data mining processes and procedures

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Oracle R Enterprise

- Oracle R Enterprise (ORE) is a component of the Oracle Advanced Analytics (OAA) option to Oracle Database EE
- Provides transparent access to database-resident data from R
- Execute R scripts at the database machine managed by Oracle Database with data and task parallelism
- Execute R scripts from SQL
- Integrates R into the IT software stack
- Extends and enhances open source R

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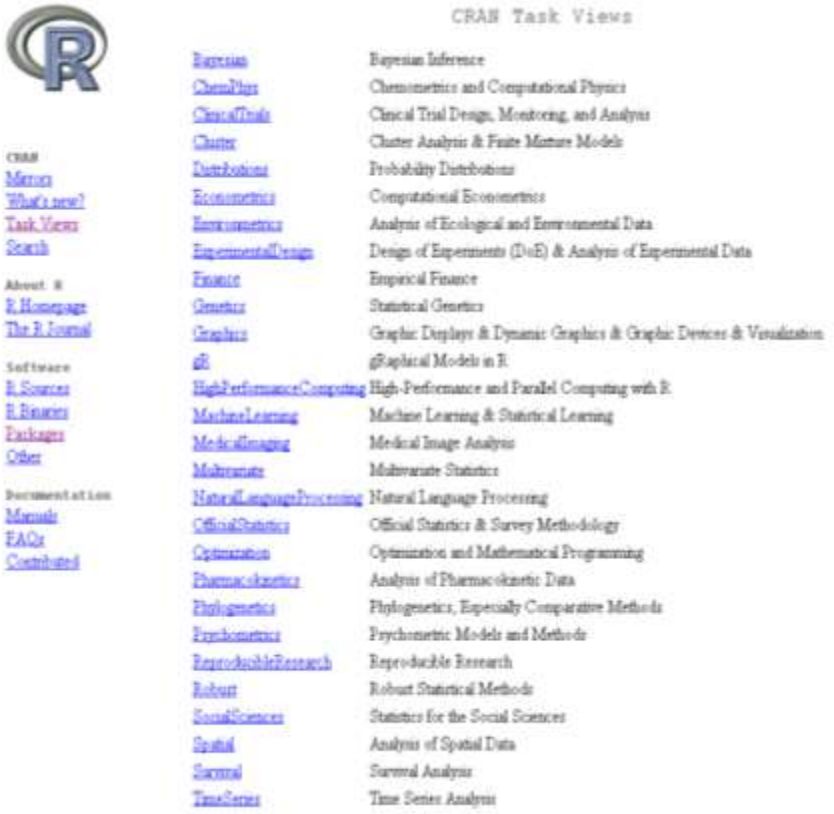
What is R?

- **R is an Open Source scripting language and environment for statistical computing and graphics**
  http://www.R-project.org/
- **Alternative to SAS, SPSS, et al.**
- **The R environment**
  - R is an integrated suite of software facilities for data manipulation, calculation and graphical display
- **Around 2 million R users worldwide**
  - Widely taught in Universities
  - Many Corporate Analysts and Data Scientists know and use R
- **Thousands of open sources packages**
  - Bioinformatics with R
  - Spatial Statistics with R
  - Financial Market Analysis with R
  - Linear and Non Linear Modeling



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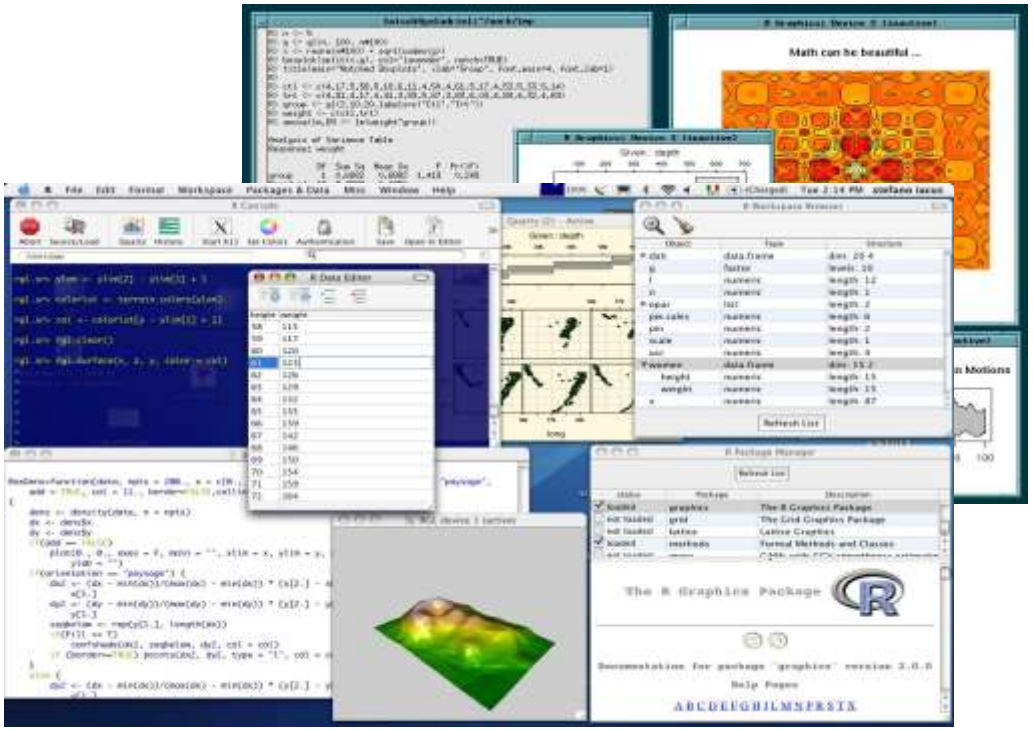
Why statisticians | data analysts | data scientists use R

R is a statistics language similar to Base SAS or SPSS statistics

R environment is ..

- Powerful
- Extensible
- Graphical
- Extensive statistics
- OOTB functionality with many ‘knobs’ but smart defaults
- Ease of installation and use
- ***Free***

  http://cran.r-project.org/



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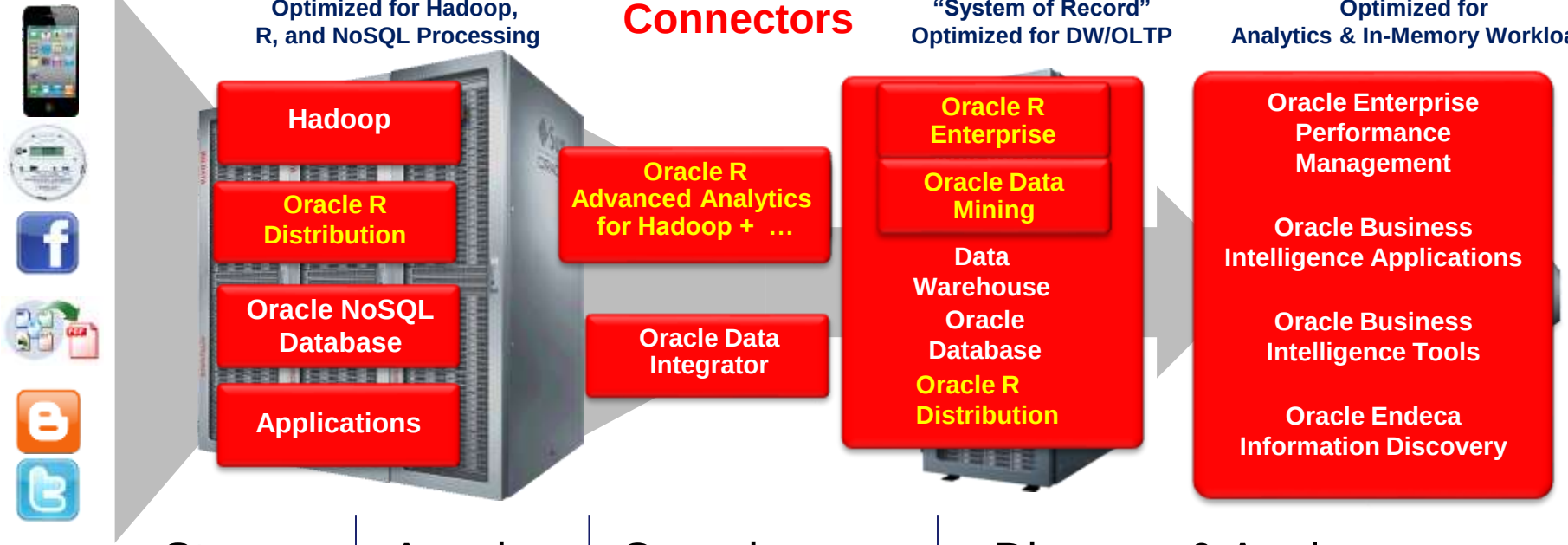
Oracle's R Technologies

- Oracle R Distribution
- ROracle

Software available to R Community for free

- Oracle R Enterprise
- Oracle R Advanced Analytics for Hadoop

Oracle Big Data Platform



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Oracle R Distribution

ability to dynamically load:
Intel Math Kernel Library (MKL)
AMD Core Math Library
Solaris Sun Performance Library

Oracle Support

- Improve scalability at client and database for embedded R execution
- Enhanced linear algebra performance using Intel's MKL, AMD's ACML, and Sun Performance Library for Solaris
- Enterprise support for customers of Oracle Advanced Analytics option, Big Data Appliance, and Oracle Linux
- Free download
- Oracle to contribute bug fixes and enhancements to open source R

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Oracle's R Technologies

- ROracle
  - R package enabling connectivity to Oracle Database
    - Open source, publicly available on CRAN, free to R community
  - Execute SQL statements from R interface
  - Oracle Database Interface (DBI) for R based on OCI for high performance
  - Supports **Oracle R Enterprise** database connectivity
- Oracle R Advanced Analytics for Hadoop (ORAAH)
  - Provide transparent access to Hadoop Cluster
  - Manipulate data in HDFS, database, and file system - all from R
  - Write and execute MapReduce jobs with R leveraging CRAN R packages
  - Provide pre-packaged advanced analytics algorithms

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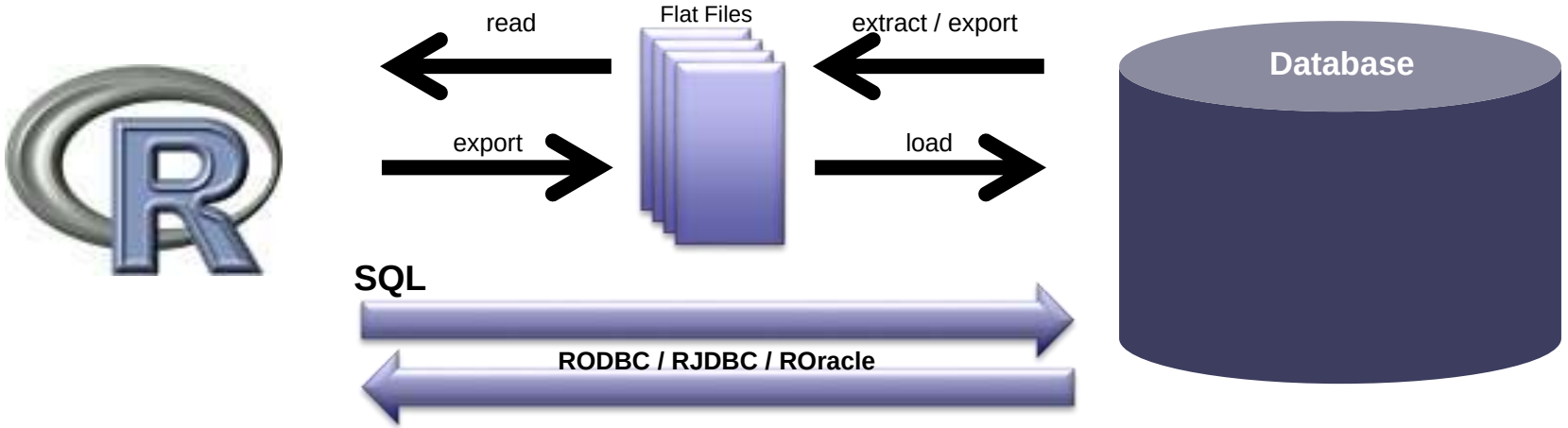
Traditional R and Database Interaction



R script
cron job

- Paradigm shift: R → SQL → R
- R memory limitation – data size, call-by-value
- R single threaded
- Access latency, backup, recovery, security…?
- Ad hoc script execution

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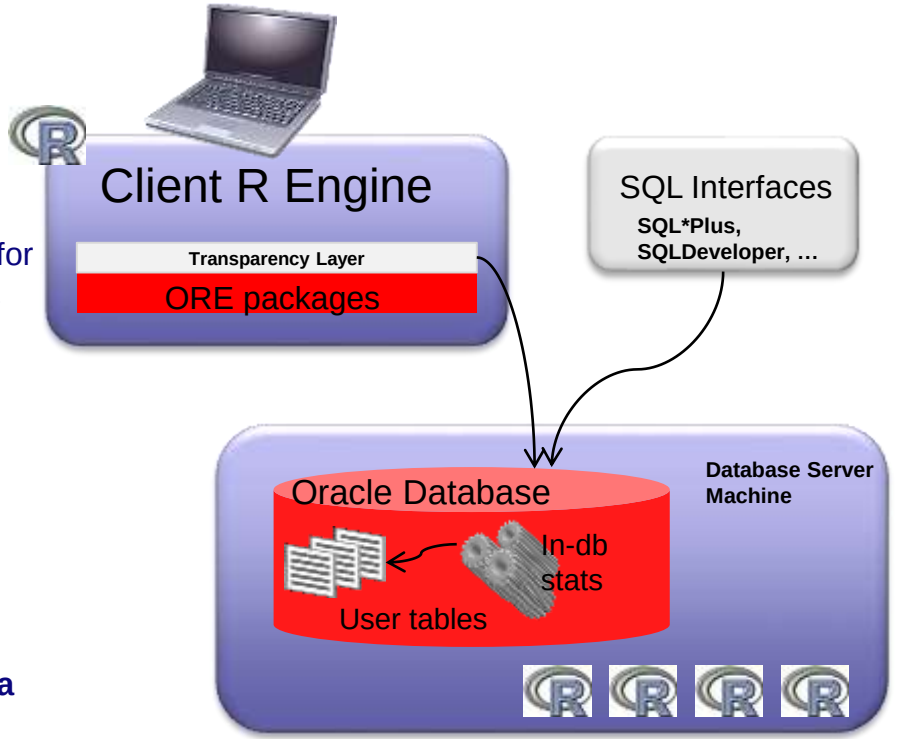
Oracle R Enterprise

- A comprehensive, database-centric environment for end-to-end analytical processes in R, with immediate deployment to production environments
- Operationalize entire R scripts in production applications – eliminate porting R code
- Seamlessly leverage Oracle Database as an HPC environment for R scripts, providing data parallelism and resource management
- Avoid reinventing code to integrate R results into existing applications
- Transparently analyze and manipulate data in Oracle Database through R using versatile and customizable R functions
- Eliminate memory constraint of client R engine
- Score R models in Oracle Database
- Execute R scripts through Oracle Database server machine for scalability and performance
- **Get maximum value from your Oracle Database and Exadata**
- Enable integration and management through SQL
- Integrate R into the IT software stack, e.g. OBIEE



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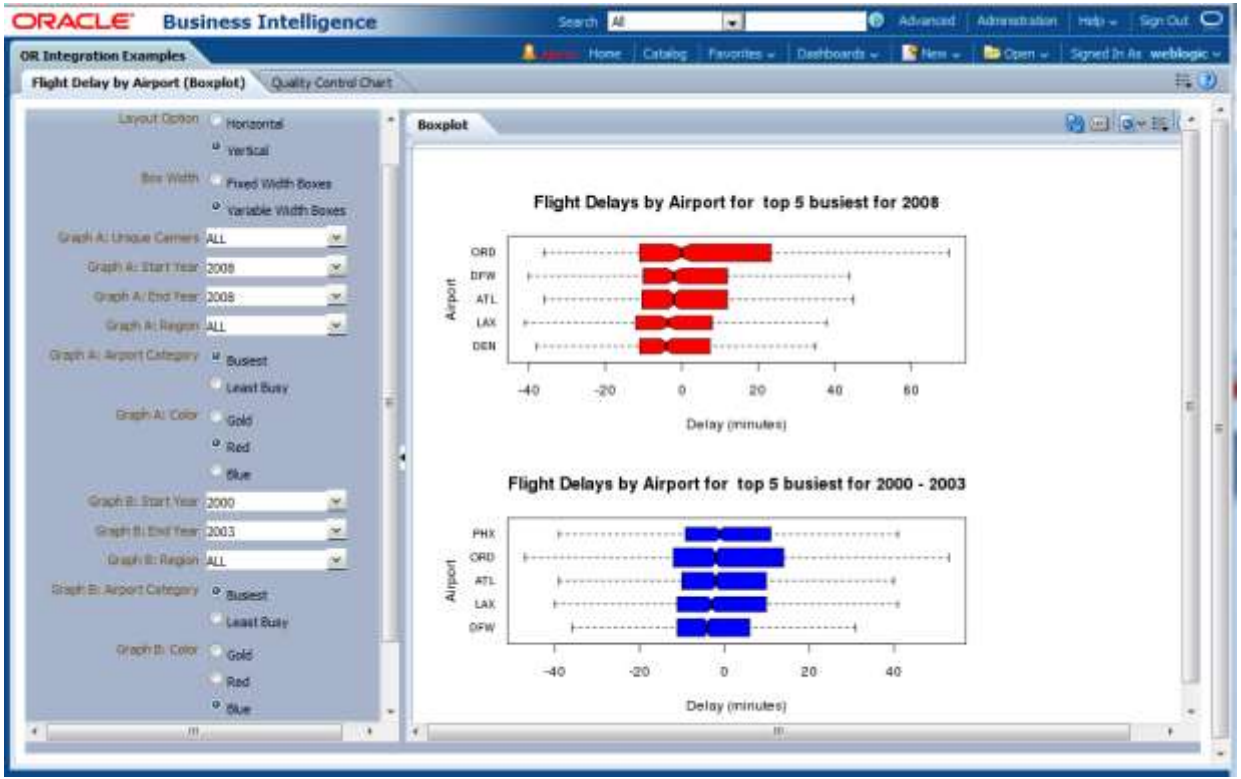
OBIEE Dashboard Integration

Parameterized analytics and graph customization



Improve time to insight

Accommodate diverse consumption paths

Deliver analytics that scale with data volumes, variables, techniques

Integrate readily with IT infrastructure and software stack

Leverage CRAN packages at database server

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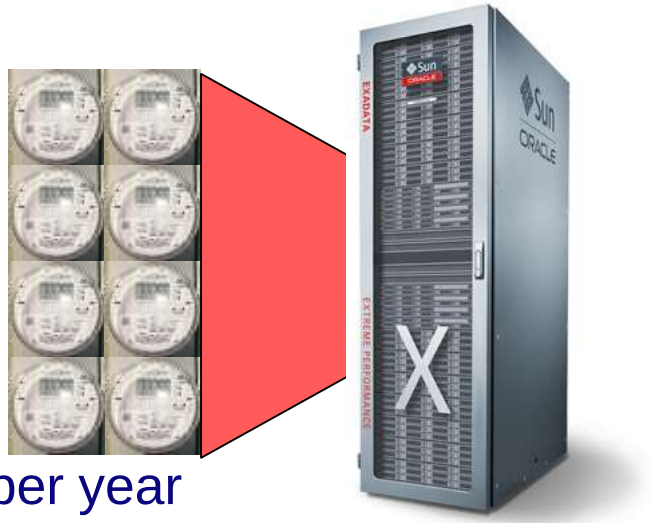
Sensor Data Analysis



- 200K households, each with a utility "smart meter"
- 1 reading/meter/hour
- 200K x 8760 hours/year ➔ 1.752B readings per year
- 3 years worth of data ➔ 5.256B readings
- Each customer has 26280 readings
- Build one model per customer to understand/predict customer monthly usage
- If each model takes 10 seconds to build, 556 hours (23+ days) …with 128 DOP ➔ 4.4 hours

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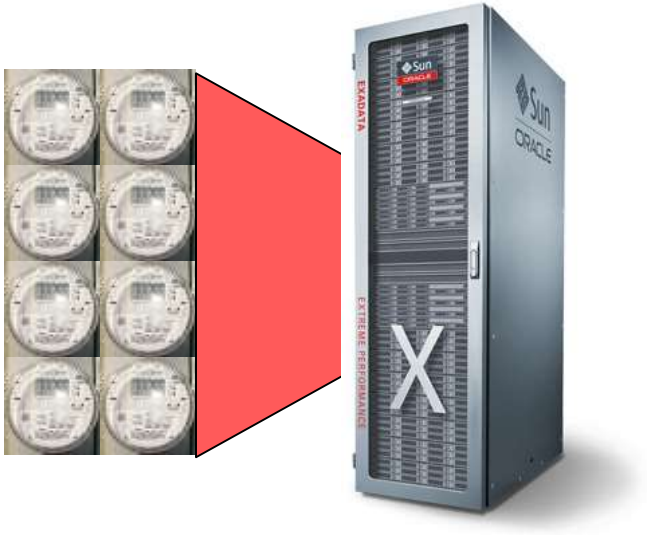
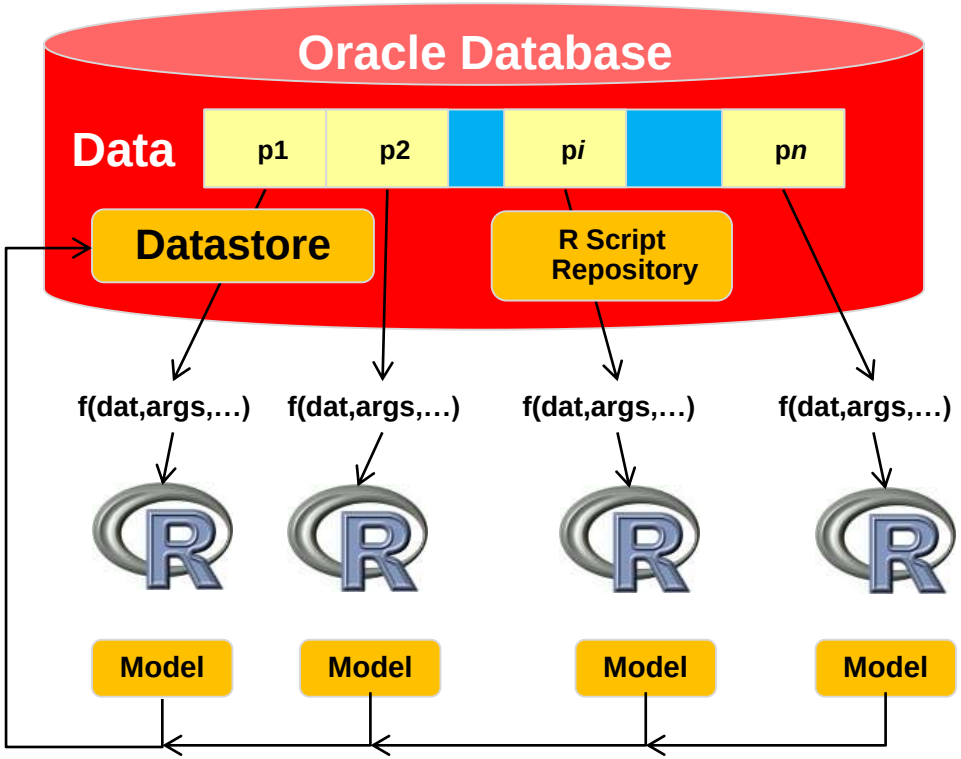
Smart Meter scenario



f(dat,args,…) {

R Script build model

}



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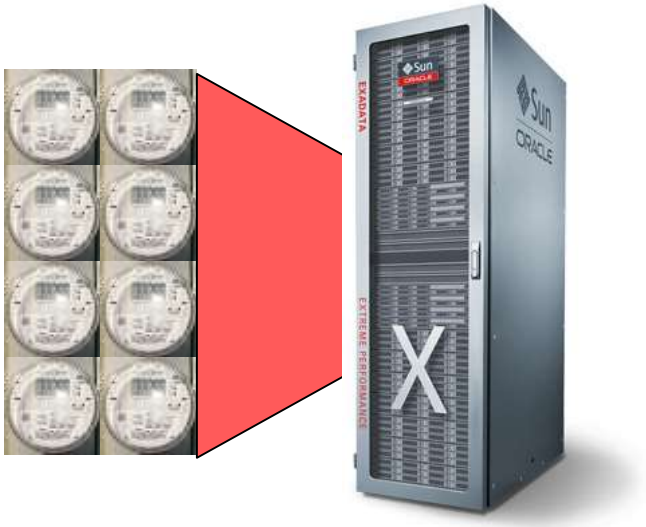
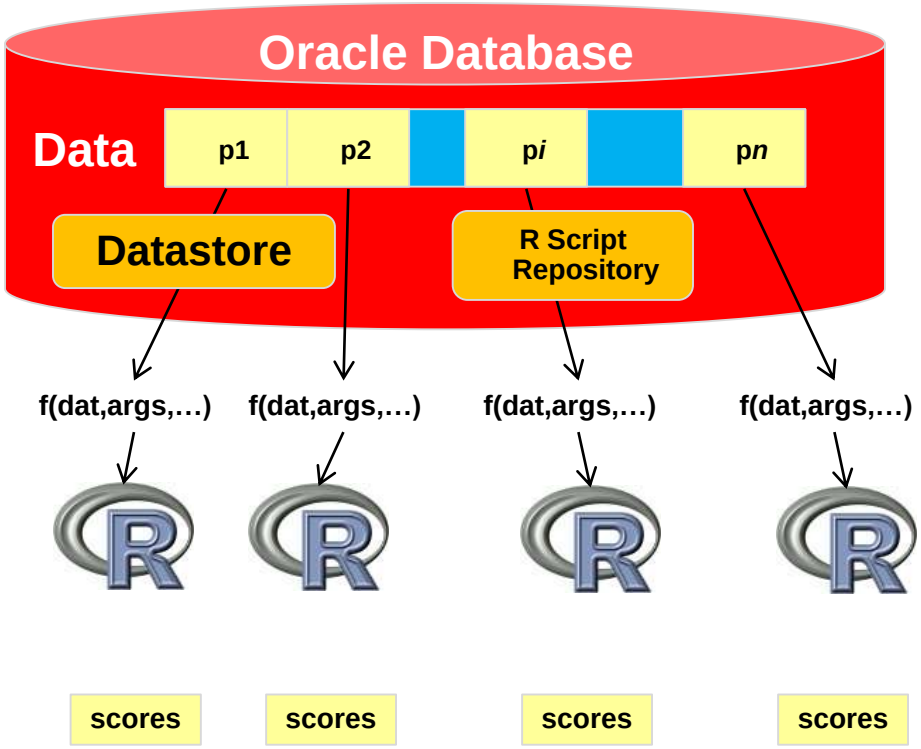
Smart Meter scenario



```
f(dat,args,…) {
    R Script
    score
    data
}
```



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Build 200K models stored in database, partition on CUST_ID

```
ore.groupApply (CUST_USAGE_DATA,
                CUST_USAGE_DATA$CUST_ID,
  function(x, ds.name) {
    cust_id <- x$CUST_ID[1]
    mod <- lm(Consumption ~ . -CUST_ID, x)
    mod$effects <- mod$residuals <- mod$fitted.values <- NULL
    name <- paste("mod", cust_id,sep="")
    assign(name, mod)
    ds.name1 <- paste(ds.name,".",cust_id,sep="")
    ore.save(list=paste("mod",cust_id,sep=""), name=ds.name1, overwrite=TRUE)
    TRUE
  },
  ds.name="myDatastore", ore.connect=TRUE, parallel=TRUE
 )
```

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Score 200K customers in database, partition on CUST_ID

```
ore.groupApply(CUST_USAGE_DATA_NEW,
               CUST_USAGE_DATA_NEW$CUST_ID,
  function(dat, ds.name) {
       cust_id <- dat$CUST_ID[1]
       ds.name1 <- paste(ds.name,".",cust_id,sep="")
       ore.load(ds.name1)
       name <- paste("mod", cust_id,sep="")
       mod <- get(name)
       prd <- predict(mod, newdata=dat)
       prd[as.integer(rownames(prd))] <- prd
       res <- cbind(CUST_ID=cust_id, PRED = prd)
       data.frame(res)
  },
  ds.name="myDatastore", ore.connect=TRUE, parallel=TRUE,
  FUN.VALUE=data.frame(CUST_ID=numeric(0), PRED=numeric(0))
 )
```

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How to get started

- Lots of internal experts and lots of people who would like to be involved and learn
- Lots of people intimidated by what they don’t know
- Start by “level setting” and establishing a strong foundation with basic training (2 days)
- Immediately conduct a workshop (JAD style session) investigation of possibilities
- Decide on pilot projects and who works on it
- Start simple and return value quickly

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Oracle Data Mining Training (2 days)

- Introduction
- Data Mining Concepts and Terminology
- The Data Mining Process
- Introducing Oracle Data Miner 11*g* Release 2
- Using Classification Models
- Using Regression Models
- Using Clustering Models
- Performing Market Basket Analysis
- Performing Anomaly Detection
- Deploying Data Mining Results

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Oracle R Enterprise Training (2 Days)

- Oracle R Enterprise technologies introduction
- Introduction to R hands-on
- ORE transparency layer with hands-on exercises
- ORE embedded R execution with hands-on exercises
- ORE predictive analytics with hands-on exercises
- Using ROracle
- Overview of ORE with OBIEE

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Comparison of Training Courses

Oracle Data Mining

- Organized by algorithm
- Intro to data mining
- MBAs, BI Admin, DBAs
- Focused on business issues
- Uses GUI
- Approachable for new users

Oracle R Enterprise

- Organized by process
- Intro to Oracle R Enterprise
- Data Scientists, BI Admin, DBAs
- Focused on executing R in Oracle Database
- Uses R scripts
- Technical

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Oracle Test Drive

- Free to try out Oracle BI and Analytic Options
- Go to www.vlamis.com/td
- Runs off of Amazon AWS
- Hands-on Labs based on Collaborate 2012 HOLs
- Test Drives for:
  - Oracle BI
  - BI Publisher
  - Map Views in OBIEE
  - Microsoft Excel against Oracle OLAP
  - Oracle Data Mining
  - Oracle R Enterprise
- Once sign up, you have private instance for 3 hours
- Available now

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Thank You!

Analytic Options to the Oracle Database: R and Data Mining

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