ORACLE®
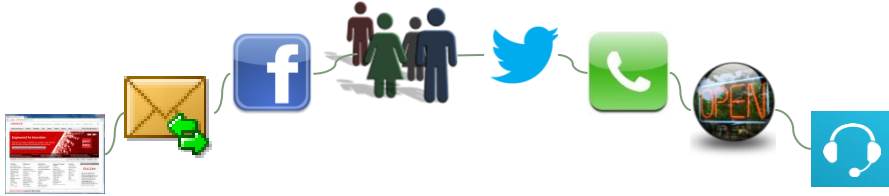
ORACLE®

Real-Time Decisions
Machine Learning for Automated Discovery and Decisioning

David Cressy, Senior Manager Sales Consulting

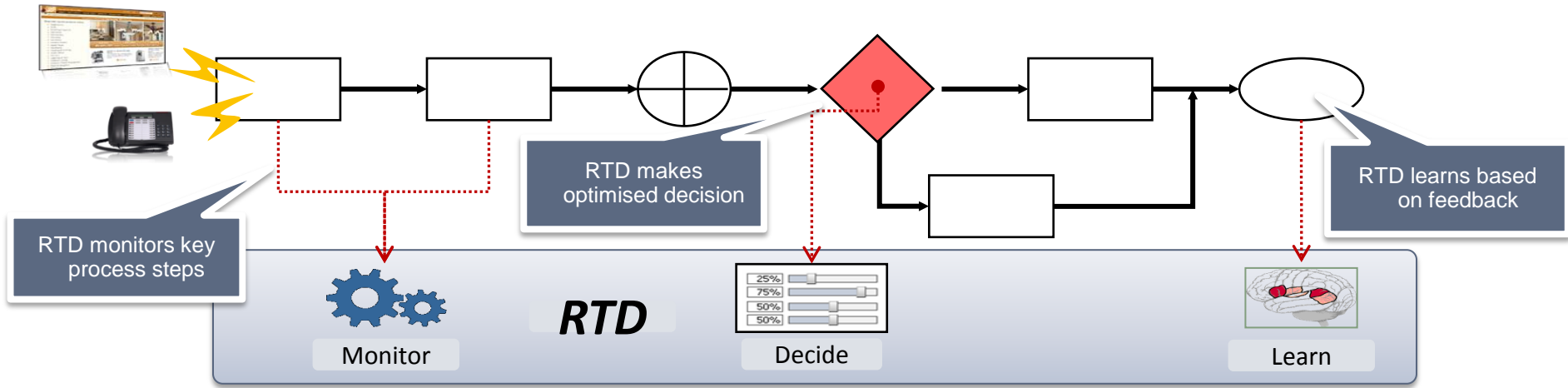# What is Real-Time Decisions (RTD)?

Real-Time Decisions

Decisions | Management | Learning

Platform to:

- **optimise** a business process by making **accurate decisions** in **real-time** using the most up to date information **consistently** and in **large volumes**

- **learn** from all available data and events to **automatically improve** all **future decisions**

ORACLE®

How does RTD optimise a business process?

RTD monitors key process steps

RTD makes optimised decision

RTD learns based on feedback

RTD

Monitor

Decide

Learn

Process Intelligence - Insights

- Monitors process steps
- Uses context plus other available data
- Provides real-time process analytics
- Learns from process events
- Fully automated modelling – no wait time

Process Optimisation - Actions

- Makes optimised decisions within process
- No time lag as decisions are real-time
- Continuously improves decisions over time
- Outcome of decisions captured for learning = "close the loop"
- Automatically adapts to any changes

ORACLE

Learn and Decide

Decision Management Interface

- Collaborative environment to manage Decision Management lifecycle
- Business user controls over decision optimization logic
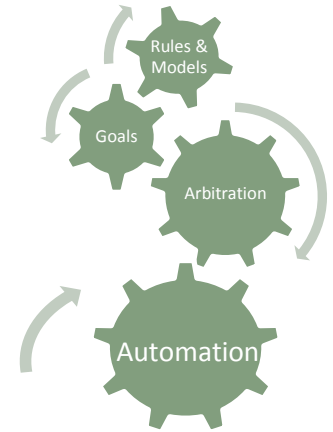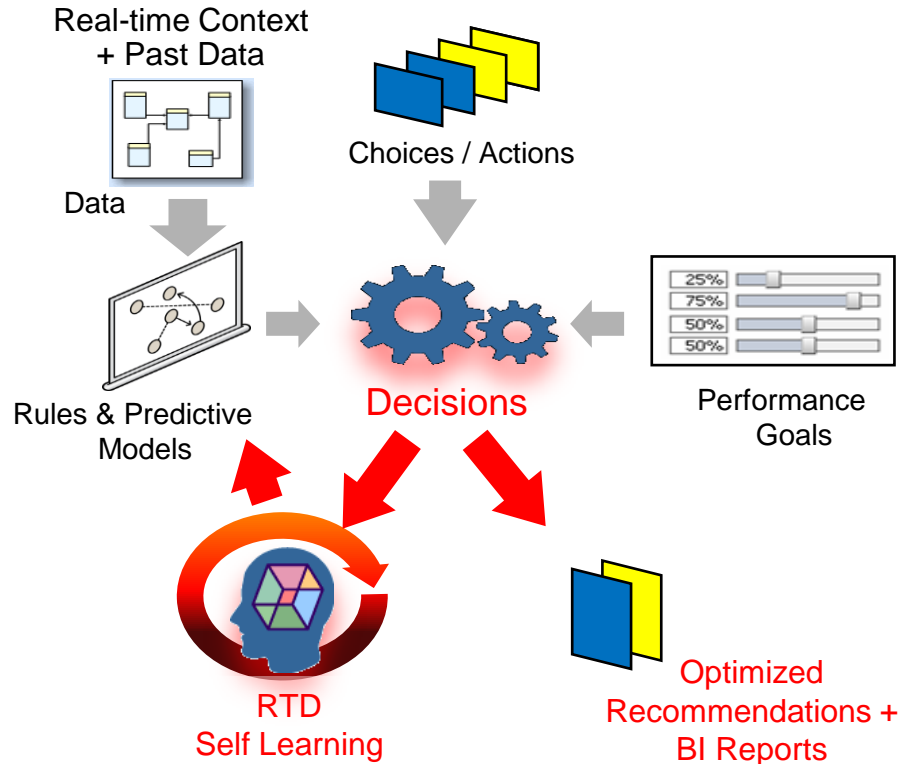- Cross-channel Customer Experience Management framework

Learning Engine

- Self-service user interface for on-demand predictive data discovery
- Automated machine learning from each transaction to discover important correlations in data
- Designed for Big Data volumes
- Deployed independently from Decision Engine
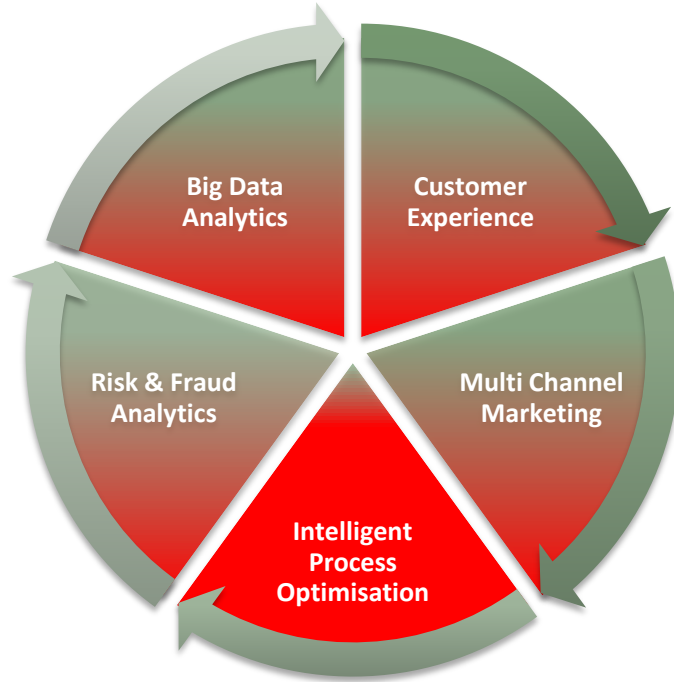
Decision Engine

- Test & Control Framework
- Support rules based & automated predictive models to define contextual and personalized decision logic
- Self-adjusting Decision Logic based on defined Performance Goals
- Designed for highly scalable Decision Services

ORACLE®

The RTD Framework

Real-time Context
+ Past Data

Data

Choices / Actions

Rules & Predictive
Models

Decisions

Performance
Goals

RTD
Self Learning

Optimized
Recommendations +
BI Reports

Rules &
Models

Goals

Arbitration

Automation

ORACLE®

Example use cases

Big Data Analytics

Customer Experience

Multi Channel Marketing

Intelligent Process Optimisation

Risk & Fraud Analytics

ORACLE

How does RTD fit with Traditional BI?

Degree of Automation

HIGH — LOW

Level of Collaboration

Number of Decisions

Strategic

Opera-tional

Tactical

LOW — HIGH

Scope of Decision / Level of Uncertainty
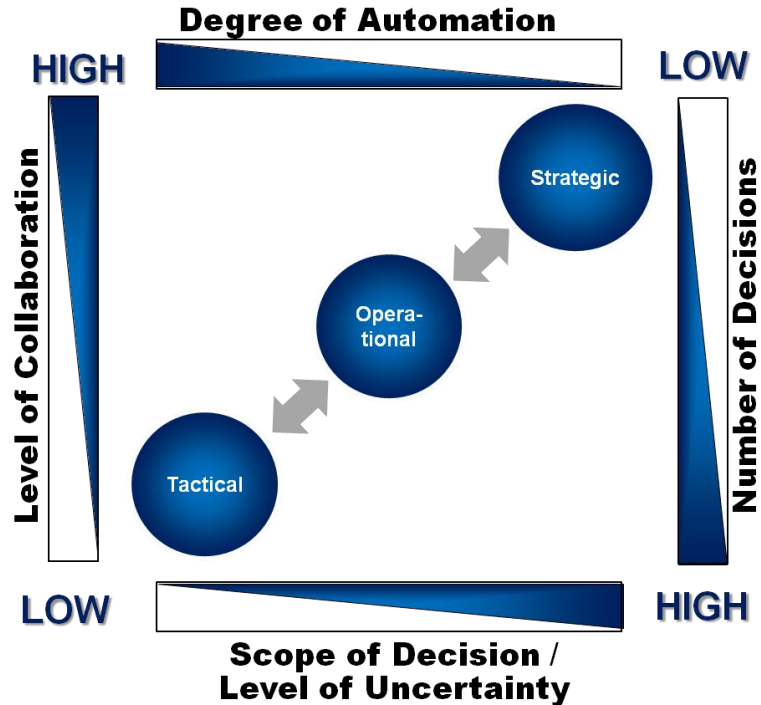
Source: IDC; Optimizing eCommerce Decisions at TIAA-CREF; Henry Morris

- Use BI for Strategic or Operational Decisions
  - Relatively few decisions (10s-100s)
  - High collaboration and human intervention needed
  - No or low automation possible
  - E.g. where to site a new factory; by how much to increase sales targets…

- Use RTD for Tactical Decisions
  - Many decisions (> 1000s)
  - No or low collaboration needed
  - High automation desirable
  - E.g. what offer to make to which customer…
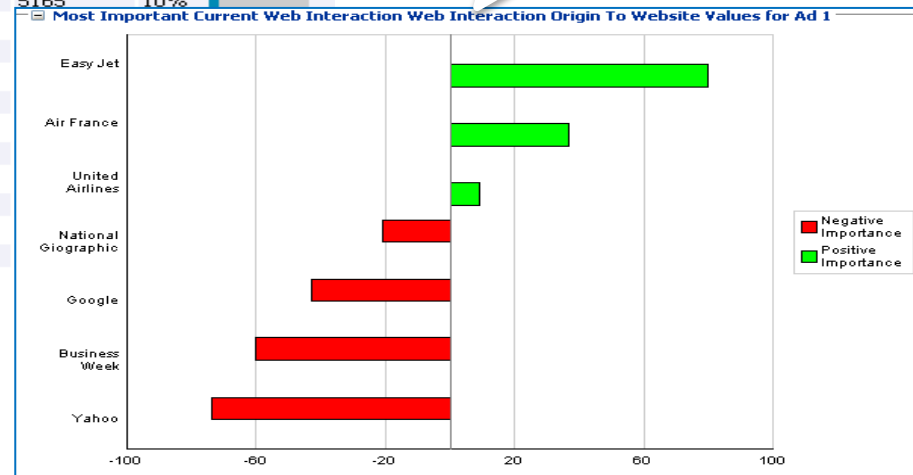
ORACLE

RTD Generates Valuable Insight

RTD automatically learns from each candidate offer based on one-to-one customer feedback

RTD reports on each key business event

RTD automatically identifies data attributes correlated with relevant business outcomes e.g. money spent on Google "Adwords" is wasted

Choices
- Ads
  - BANNER1
  - BANNER2
  - BANNER3
  - BANNER4
  - CARINSURANCE1
  - CREDITCARD1
  - GENERALOFFER1
  - GENERALOFFER2
  - GENERALOFFER3
  - HOMEINSURANCE1
  - HOMEINSURANCE2
  - LOAN1
  - LOAN2
  - LOAN3
  - MORTGAGE1
  - MORTGAGE2

Distribution ... ertisements

Advertisements	Choice Outcome	Count	%
Ad 1	Presented	47393	100%
	Interested	1164	2%
Ad 2	Presented	50750	100%
	Interested	3213	6%
Ad 3	Presented	51965	100%
	Interested	5165	10%
Ad 4	Presented		
	Interested		
Ad 5	Presented		
	Interested		
Ad 6	Presented		
	Interested		
Ad 7	Presented		
	Interested		
Ad 8	Presented		
	Interested		

Most Important Current Web Interaction Web Interaction Origin To Website Values for Ad 1

Easy Jet
Air France
United Airlines
National Geographic
Google
Business Week
Yahoo

-100 -60 -20 20 60 100

Negative Importance
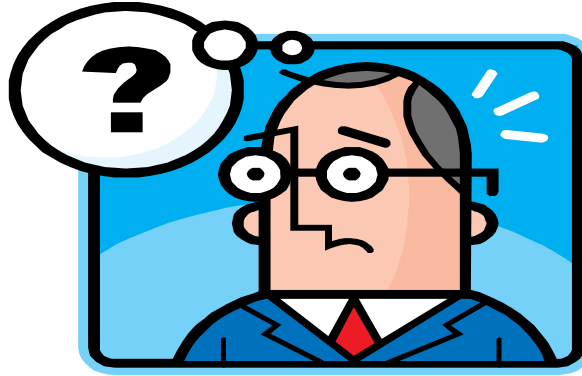Positive Importance

ORACLE

Remember That Infamous Quote?

Donald Rumsfeld, Feb. 12 2002
Department of Defense News Briefing

There are known knowns. These are things we know that we know.

There are known unknowns. That is to say, there are things that we know we don't know.

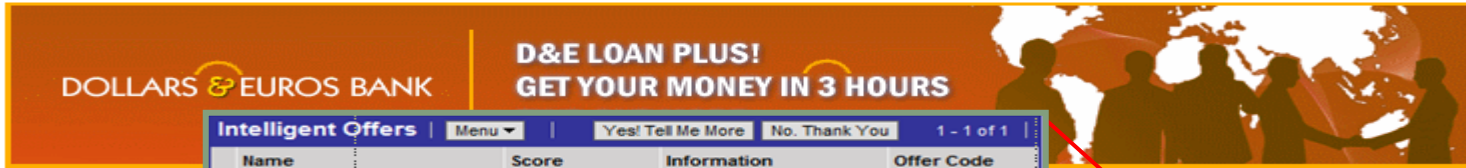But there are also unknown unknowns. These are things we don't know we don't know!

ORACLE

Can RTD help?

We need to

know the things

we don't know we don't know

 | Confidential – Oracle Internal

ORACLE

RTD for Automated Discovery and Machine Learning

Channel Of Interest

Predictiveness of Entity Attributes for Web

Attribute	Predictiveness
Customer Number Of Years Established	57.6
Current Web Interaction Previous Web Page	39.7
Current Web Interaction CurrentViewedProductId	36.5
Current Web Interaction Web Origin	35.7
Current Web Interaction Current Web Page	32.9
Customer Address State Province	30.1
Customer Line Of Business	
Customer MaritalStatus	
Customer Address Country	
Current Web Interaction Days Since	

Customer Retention

Count: 4758 — Model Quality: 99

Predictiveness of Entity Attributes for Un-Register

Attribute	Predictiveness
Current Web Interaction Previous Page	47
Customer Person Age	46
Current Web Interaction Current Page	43
Customer Purchase History Product Lines Owned	41
Current Web Interaction Web Interaction Origin To Website	40
Current Web Interaction Current Viewed Product Id	40
Customer Person Marital Status	40
Customer Address State Province	39
Customer Address Country	39
Customer Type	35

Automated Discovery of Predictive Drivers for …

Offers Of Interest

Predictiveness of Entity Attributes for LOAN1

Attribute	Predictiveness
Customer Data Income Level	42
Account Data Account Balance	37
Web Data Search Keywords	13
Web Data Pages Visited	11
Account Data Products	11
Web Data referer	9
Account Data Tenure	6
Customer Data Age	5

Interaction Abandonment

Count: 20094 — Model Quality: 100

Predictiveness of Entity Attributes for Abandoned

Attribute	Predictiveness
Customer Person Age	73
Current Web Interaction Web Interaction Origin To Website	55
Customer Purchase History Product Lines Owned	52
Current Web Interaction Current Page	51
Customer Address State Province	49
Customer Organization Number of Years Established	49
Customer Address Country	45
Current Web Interaction Current Viewed Product Id	44
Current Web Interaction Previous Page	42
Customer Person Marital Status	41

RTD automatically correlates hundreds of input attributes with all specified target business events

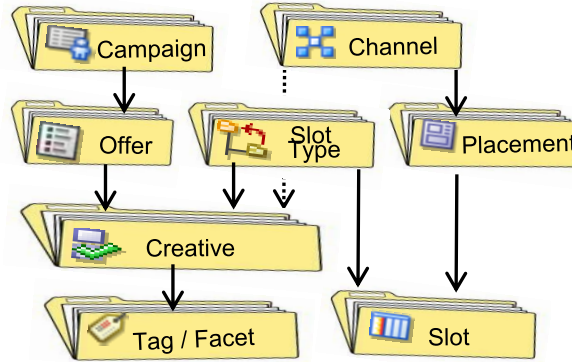# The "Learning Graph"

1 Customer Clicks

Welcome back Nicolas

Please give us back your share of the 20,000 tons of annual account statements

One click wildlife donation

Proceed to on-line banking

2 RTD Correlates Data With User Experience Business Events

Channel (Web), Offer / Product (Electronic Bill Payment), Creative (The Bear Cub image), Tags (Environmental, Wildlife, Donation, Provocative), Slot Type (Image), Slot (Recommended for you), Placement (Login Page).

Campaign → Offer → Creative → Tag / Facet

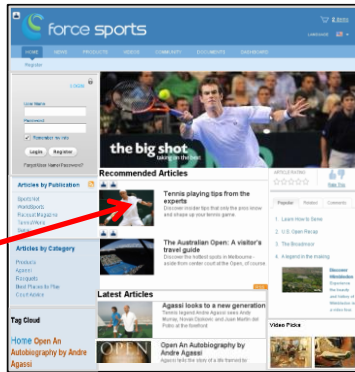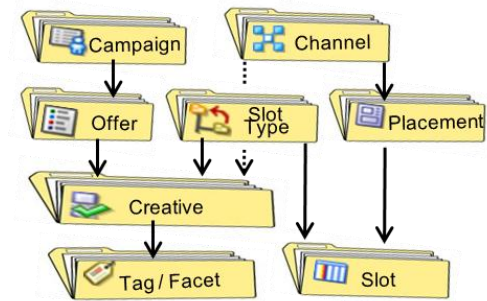Channel → Placement → Slot

Slot Type

3 RTD Reports on Discovered Insights

Predictive drivers of interest in "Environmental" theme "Provocative" marketing Electronic Bill Payment option "Personalized Interactions"

Attribute	Predictiveness
Customer Number Of Years Established	57.6
Current Web Interaction Previous Web Page	39.7
Current Web Interaction CurrentViewedProductId	36.5
Current Web Interaction Web Origin	35.7
Current Web Interaction Current Web Page	32.9
Customer Address State Province	30.1
Customer Line Of Business	26.3
Customer MaritalStatus	25.5
Customer Address Country	25.3
Current Web Interaction Days Since Last Inte...	5.8

ORACLE

RTD Learning Graph
Applied to consumer behaviour

1 click

Leads to multiple model updates
and discovery of associated
correlations across the graph

1. Channel: **Web**
2. Placement: **Homepage**
3. Creative-Content: "**Expert Tennis Tips**"
4. Slot Type: **Articles**
5. Slot: **Center Middle**
6. Offer: **Discount on Tennis Lessons**
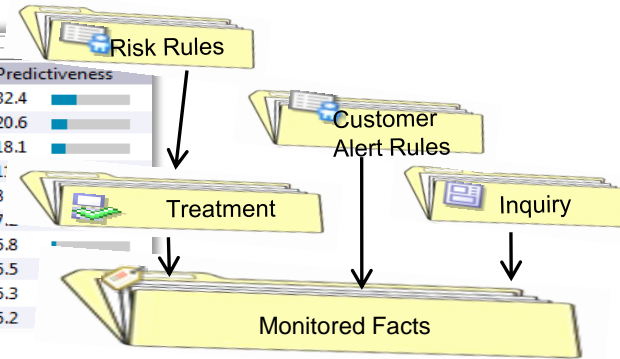7. Tags: **Tennis** | **Tips** | **Pros**

ORACLE

RTD Learning Graph

- Graph represents domain specific knowledge as a set of concepts and concepts relationships
- Graph is used to reason about events within that domain and discover insights
- Events propagate "predictive learning" throughout the graph
- One event updates multiple predictive models

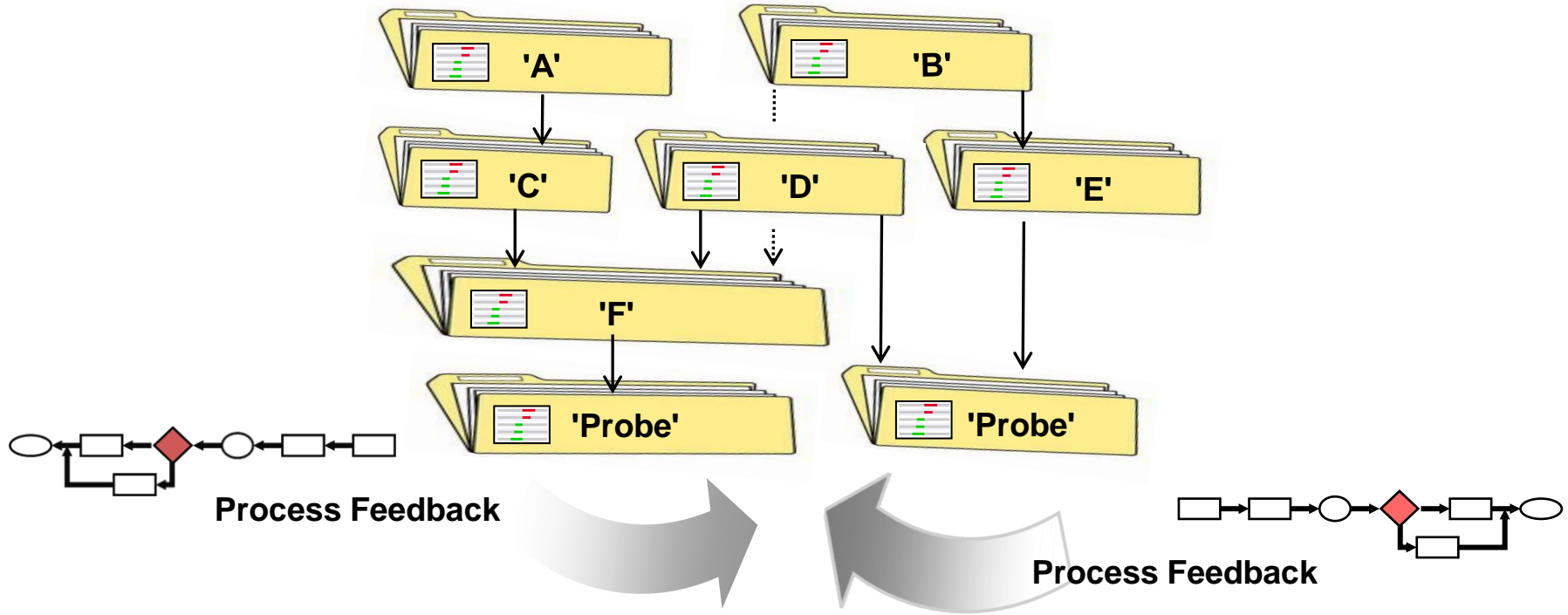Presentation / Click / Purchase as business events
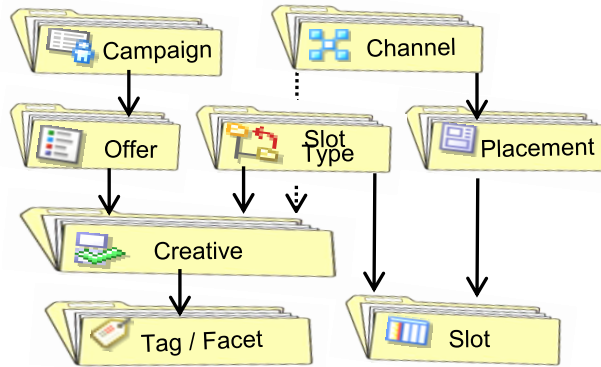
Claim Transactions as business events

Attribute	Predictiveness
Current Web Interaction Pages Visited	32.4
Customer Products Owned	20.6
Customer CallsLast6Months	18.1
Current Web Interaction Current Web	1
Customer Address Country	8
Current Web Interaction Web Origin	7
Customer MaritalStatus	6.8
Current Web Interaction Day	6.5
Customer Address State Province	6.3
Customer CardType	6.2

RTD Learning Model

Campaign, Channel, Offer, Slot Type, Placement, Creative, Tag / Facet, Slot

Risk Rules, Customer Alert Rules, Treatment, Inquiry, Monitored Facts

ORACLE

RTD Learning Graph

Discovery of correlations between any objects in a graph

Process Feedback

Process Feedback

RTD Learning Graph
Key Features

- RTD LEARNING GRAPH FEATURES
  - Objects & relationships defined as a relational data model
    - 1 to Many / Many to 1 / Many to Many
  - Predictive models & events are associated with objects
  - Instances can be added on the fly e.g. tags / probes
  - Single event can trigger learning across the Graph
  - Graphs can be configured and extended on a per implementation basis
  - Graphs can deal with very large volumes of learning

- RTD PREDICTIVE MODELS FEATURES
  - Fully automated lifecycle
    - Creation – Incremental Updates - Validation
  - Input attributes
    - Numeric (automated binning), Strings, Dates, String Arrays
  - Insight delivered through standard reporting
  - Can predict sequence of events
  - Built-in Time Windows & Partitions (Test / Control)
  - Compression ratio
    - Model size is typically 0.0025 % of original data
  - Velocity
    - Model scoring is sub-seconds

ORACLE

Machine   View   Devices   Help

ORACLE® Real-Time Decisions Manager

rtdadmin   Settings   Logout

Tag TEST TAG

View: Main Repository   Details   Audit Trail   Commit   Discard   New Project   View Projects

Search All   Advanced

TEST TAG

| Definition | Performance | Analysis | Audit Trail |

| Counts | History |

Report Settings

Time Window: Since Nov 4, 2012   Show Incomplete Time Window: ☐   Go

Counts

Tag	Choice Outcome	Count	%
TEST TAG	Presented	3388	100.0%
	Interested	422	12.5%
	Converted	175	5.2%

Export to Excel | Export to CSV

Tags

Tags and the Creatives that correspond.

▷ Aggressive Messaging
▷ Large Graphics
▷ Small Graphics
▷ TEST TAG

▷ Search Results

ORACLE Real-Time Decisions Manager

rtdadmin   Settings   Logout

Tag TEST TAG

View: Main Repository | Details | Audit Trail | Commit | Discard | New Project | View Projects

Search All

Advanced

TEST TAG

Tags

Tags and the Creatives that correspond.

▷ 🏷 Aggressive Messaging
▷ 🏷 Large Graphics
▷ 🏷 Small Graphics
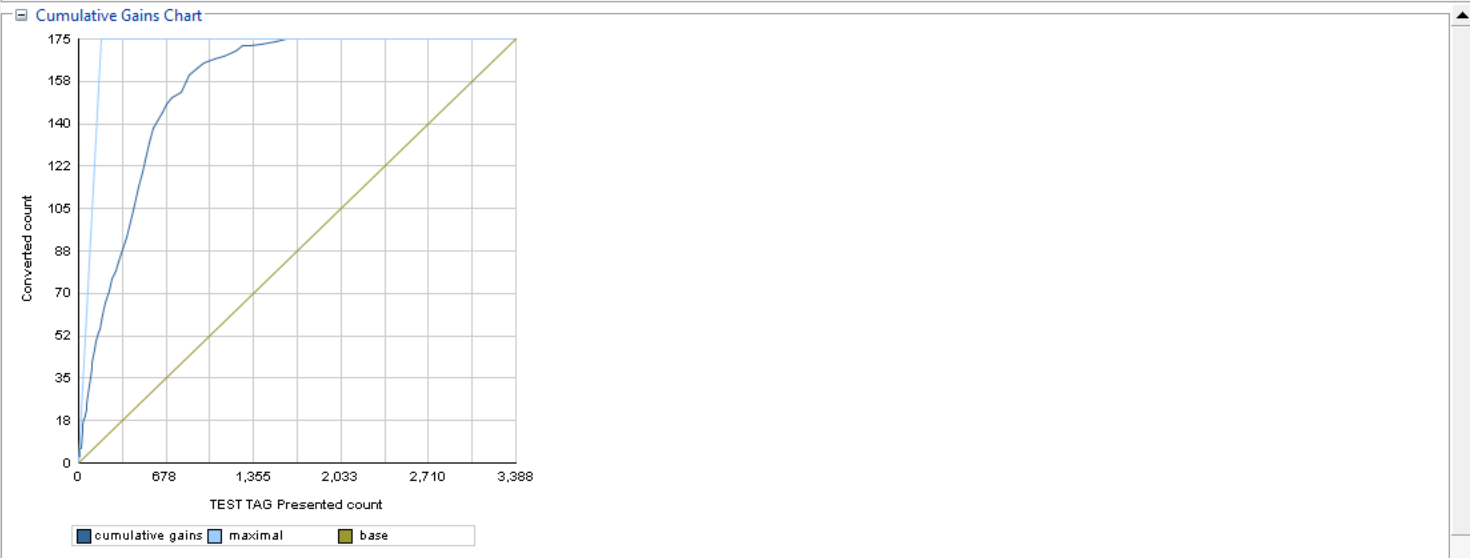▷ 🏷 TEST TAG

Definition | Performance | **Analysis** | Audit Trail

Best-fit | Drivers | Trends | **Quality**

Report Settings

Time Window: | Since Nov 4, 2012 | Show Incomplete Time Window: ☐

Choice Outcome: | Converted |

Count: 175   Model Quality: 98.2   Go

Cumulative Gains Chart

■ cumulative gains   ■ maximal   ■ base

Cumulative Gains Table

Model Errors

Mean Square Error (MSE)	Relative MSE	Root Mean Square Error (RMSE)	Relative RMSE	Mean Absolute Error (MAE)	Relative MAE	Mean Error (ME)	Relative ME

Search Results

Machine   View   Devices   Help

ORACLE® Real-Time Decisions Manager

rtdadmin   Settings   Logout

Tag TEST TAG

View: Main Repository   Details   Audit Trail   Commit   Discard   New Project   View Projects

Search All

Advanced

TEST TAG

| Definition | Performance | Analysis | Audit Trail |

| Best-fit | Drivers | Trends | Quality |

Tags

Tags and the Creatives that correspond.

▷ Aggressive Messaging
▷ Large Graphics
▷ Small Graphics
▷ TEST TAG

Report Settings

Time Window: Since Nov 4, 2012   Show Incomplete Time Window: ☐

Choice Outcome: Converted

Count: 175   Model Quality: 98.2   Go

Cumulative Gains Chart

Cumulative Gains Table

Model Errors

Mean Square Error (MSE)	Relative MSE	Root Mean Square Error (RMSE)	Relative RMSE	Mean Absolute Error (MAE)	Relative MAE	Mean Error (ME)	Relative ME
0.032	12.010	0.179	3.465	0.063	1.211	-0.005	-0.090

Export to Excel | Export to CSV

Glossary

Machine　View　Devices　Help

ORACLE Real-Time Decisions Manager

rtdadmin　Settings　Logout

Tag TEST TAG

View: Main Repository | Details | Audit Trail | Commit | Discard | New Project | View Projects

Search All

Advanced

Tags

Tags and the Creatives that correspond.

▷ Aggressive Messaging
▷ Large Graphics
▷ Small Graphics
▷ TEST TAG

Definition | Performance | **Analysis** | Audit Trail

TEST TAG

Best-fit | Drivers | Trends | **Quality**

Report Settings

Time Window: Since Nov 4, 2012 ▼　Show Incomplete Time Window: ☐

Choice Outcome: Converted ▼

Count: 175　　　Model Quality: 98.2 ▓▓▓　　　Go

Glossary

Actual likelihoods $\equiv p_i, i = 1, \ldots, n.$

Predicted likelihoods $\equiv p_i^*, i = 1, \ldots, n.$

Average actual likelihoods $\bar{p} = \sum_{i=1}^{n} p_i / n.$

Mean Square Error (MSE) $= \sum_{i=1}^{n} (p_i - p_i^*)^2 / n.$

Relative MSE $= MSE / \bar{p}^2, \bar{p} \neq 0.$

Root Mean Square Error (RMSE) $= \sqrt{\sum_{i=1}^{n} (p_i - p_i^*)^2 / n}.$

Relative RMSE $= RMSE / \bar{p}, \bar{p} \neq 0.$

Mean Absolute Error (MAE) $= \sum_{i=1}^{n} |p_i - p_i^*| / n.$

Relative MAE $= MAE / \bar{p}, \bar{p} \neq 0.$

Mean Error (ME) $= \sum_{i=1}^{n} (p_i - p_i^*) / n.$

Relative ME $= ME / \bar{p}, \bar{p} \neq 0.$

Define number of positive and total outcomes respectively as N_O, N .

Define areas under base curve and cumulative gains curve respectively as A_1, A_2 .

Model quality $q \equiv \max \left(2(A_2 - A_1), 0 \right)$. If $N_O \neq N, q \leftarrow q / (1 - N_0 / N)$. Finally, $q \leftarrow \sqrt{q(2 - q)}$.

Search Results

Machine   View   Devices   Help

ORACLE Real-Time Decisions Manager   rtdadmin   Settings   Logout

Tag TEST TAG

View: Main Repository   📋 Details   🗂 Audit Trail   ✏ Commit   ✖ Discard   📄 New Project   📋 View Projects   Search   All   🔍 Advanced

TEST TAG

Tags

Tags and the Creatives that correspond.

▷ 🏷 Aggressive Messaging
▷ 🏷 Large Graphics
▷ 🏷 Small Graphics
▷ 🏷 TEST TAG

| Definition | Performance | **Analysis** | Audit Trail |

| Best-fit | **Drivers** | Trends | Quality |

⊟ Report Settings

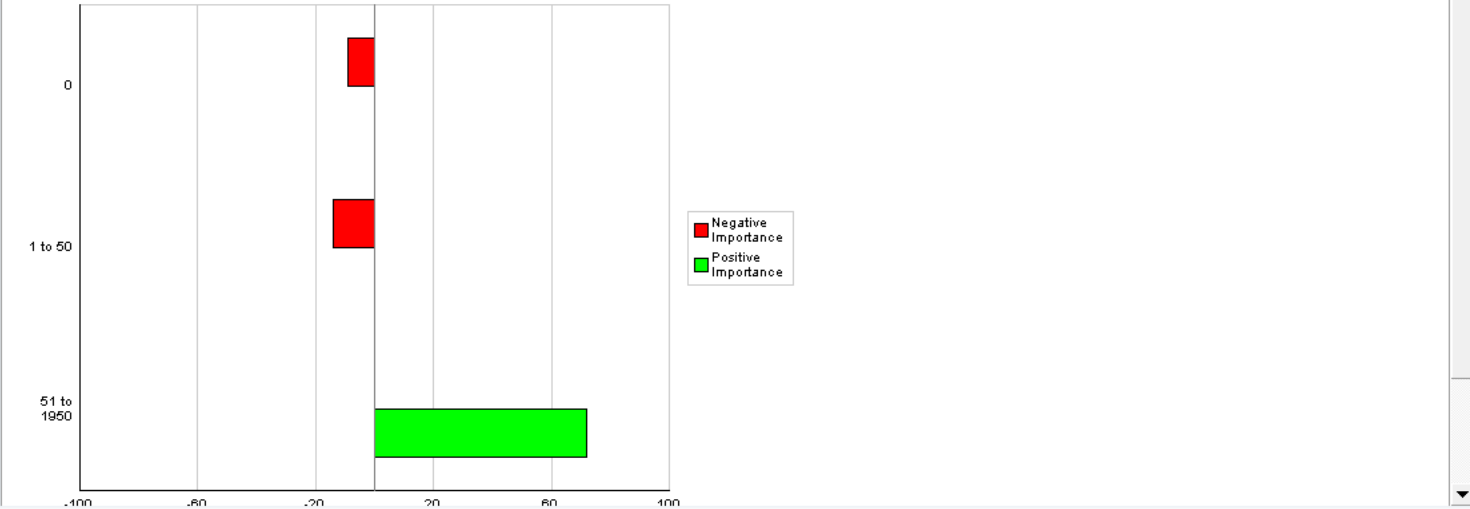| Time Window: | Since Nov 4, 2012 | Show Incomplete Time Window: | ☐ |
Choice Outcome:	Converted	Minimum Predictiveness:	5
		Number of bins:	3
		Maximum Number of Rows:	10

Count: 175   Model Quality: 98.2   ▬▬▬   Go

⊟ Predictiveness of Entity Attributes for TEST TAG

Attribute	Predictiveness
Current Web Interaction Pages Visited	35.9
Customer NumberOfChildren	19.1
Current Web Interaction Days Since Last Interaction	17.1
Customer CallsLast6Months	15.4
Customer MaritalStatus	15.3
Current Web Interaction Current Web Page	14.4
Customer Language	13.7
Customer Products Owned	13.7
Customer Tenure	13.6
Customer Address State Province	12.5

📊 Export to Excel | 📄 Export to CSV

▷ **Search Results**

Machine   View   Devices   Help

ORACLE® Real-Time Decisions Manager

Tag TEST TAG

View: | Main Repository ▼ | 📋 Details   📄 Audit Trail   📋 Commit   ✖ Discard   📋 New Project   📋 View Projects

Search | All ▼ | 🔵 Advanced

Tags

TEST TAG

| Definition | Performance | **Analysis** | Audit Trail |

| Best-fit | **Drivers** | Trends | Quality |

Tags and the Creatives that correspond.

▷ 🖼 Aggressive Messaging
▷ 🖼 Large Graphics
▷ 🖼 Small Graphics
▷ 🖼 TEST TAG

□ Report Settings

Time Window:	Since Nov 4, 2012 ▼	Show Incomplete Time Window:	☐
Choice Outcome:	Converted ▼	Minimum Predictiveness:	5
		Number of bins:	3
		Maximum Number of Rows:	10

Count: 175   Model Quality: 98.2   ▬▬▬ | Go |

⊞ Predictiveness of Entity Attributes for TEST TAG

⊟ Most Important Current Web Interaction Days Since Last Interaction Values for TEST TAG

■ Negative Importance
■ Positive Importance

▷ Search Results

Machine   View   Devices   Help

ORACLE Real-Time Decisions Manager

rtdadmin   Settings   Logout

Tag TEST TAG

View: | Main Repository ▾ | 📄 Details   📋 Audit Trail   📋 Commit   ✖ Discard   📋 New Project   📋 View Projects

Search | All ▾ | ▶ Advanced

TEST TAG

| Definition | Performance | **Analysis** | Audit Trail |

| Best-fit | **Drivers** | Trends | Quality |

Tags

Tags and the Creatives that correspond.

▷ 🏷 Aggressive Messaging
▷ 🏷 Large Graphics
▷ 🏷 Small Graphics
▷ 🏷 TEST TAG

⊟ Report Settings

Time Window:	Since Nov 4, 2012 ▾	Show Incomplete Time Window:	☐
Choice Outcome:	Converted ▾	Minimum Predictiveness:	5 ⬍
		Number of bins:	3 ⬍
		Maximum Number of Rows:	10 ⬍

Count: 175   Model Quality: 98.2 ▬▬▬ | Go |

⊞ Predictiveness of Entity Attributes for TEST TAG

⊞ Most Important Current Web Interaction Days Since Last Interaction Values for TEST TAG

⊟ Most Important Current Web Interaction Days Since Last Interaction Values for TEST TAG

Current Web Interaction Days Since Last Interaction	Actual Count	Expected Count	Difference	Importance	Input Count	Output Count	Total Count
0	9	13	-30.8%	▬▬▬	258	175	3388
1 to 50	119	151	-21.2%	▬▬▬	2931	175	3388
51 to 1950	47	10	370.0%	▬▬▬	199	175	3388

📊 Export to Excel | 📄 Export to CSV

⊞ Relative Distribution of Current Web Interaction Days Since Last Interaction Values

⊞ Pareto of Current Web Interaction Days Since Last Interaction Values

⊞ Pareto of Current Web Interaction Days Since Last Interaction for the Whole Population

▷ Search Results

Machine   View   Devices   Help

ORACLE Real-Time Decisions Manager

rtdadmin   Settings   Logout

Tag TEST TAG

View: Main Repository | Details | Audit Trail | Commit | Discard | New Project | View Projects

Search All | Advanced

TEST TAG

Tags

Tags and the Creatives that correspond.

▷ Aggressive Messaging
▷ Large Graphics
▷ Small Graphics
▷ TEST TAG

| Definition | Performance | Analysis | Audit Trail |

| Best-fit | Drivers | Trends | Quality |

Report Settings

Time Window: Since Nov 4, 2012 | Show Incomplete Time Window: ☐

Choice Outcome: Converted | Maximum Number of Rows: 10

Count: 175   Model Quality: 98.2   Go

Highest correlating attribute values for TEST TAG

Attribute	Value	Correlation
Current Web Interaction Days Since Last Interaction	1451 to 1950	
Customer Tenure	66 to 116	
Customer CallsLast6Months	12 to 16	
Customer NumberOfChildren	2 to 5	
Current Web Interaction Current Web Page	Home Page	
Customer Address State Province	NY	
Current Web Interaction Pages Visited	Privacy	
Current Web Interaction Web Origin	Google	
Customer CardType	American Express	
Customer Address Country	United States	

Export to Excel | Export to CSV

Search Results

RTD Learning Graph
Automated Discovery for Big Data

Billions of business events
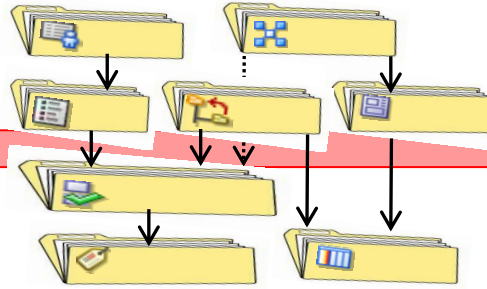
Learn

Domain Specific RTD Learning Graph

**Hundreds of RTD Learning Models**

Attribute	Predictiveness
Customer Number Of Years Established	57.6
Current Web Interaction Previous Web Page	39.7
Current Web Interaction CurrentViewedProductId	36.5
Current Web Interaction Web Origin	35.7
Current Web Interaction Current Web Page	32.9
Customer Address State Province	30.1
Customer Line Of Business	26.3
Customer MaritalStatus	25.5
Customer Address Country	25.3
Current Web Interaction Days Since Last Interaction	5.8

ORACLE

RTD Learn As You Go (LAYGO) Applications
Automated Discovery for Big Data

- RTD for predictive discovery automation

  - Business can discover predictive drivers within very large data sets

  - Business can discover relationships across data domains

- Learning immediacy and interactivity

  - Business can ask ad-hoc questions to the "Learning Graph"

- Learn & Act

  - Predictive models can be used for discovery-reporting and / or decision making

  - No dependency on statisticians as model lifecycle is fully automated

    - Creation – Validation – Updates – Recycling
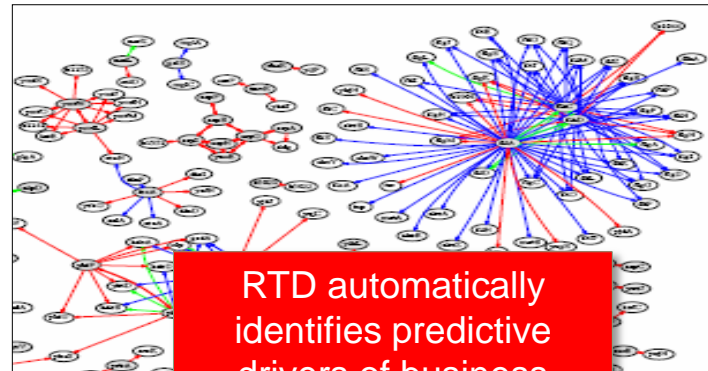
RTD automatically identifies predictive drivers of business events

Attribute	Predictiveness
Current Web Interaction Pages Visited	32.4
Customer Products Owned	20.6
Customer CallsLast6Months	18.1
Current Web Interaction Current Web Page	11.2
Customer Address Country	8.2
Current Web Interaction Web Origin	7.2
Customer MaritalStatus	6.8
Current Web Interaction Days Since Last Interaction	6.5
Customer Address State Province	6.3
Customer CardType	6.2

ORACLE

RTD and Big Data

LAYGO

RTD Learning Models

Oracle Big Data Appliance

Oracle Exadata

Oracle Exalytics

InfiniBand

InfiniBand

Optimize

CEP

RTD Decisions

Acquire | Organize & Discover | Analyze | Decide

ORACLE
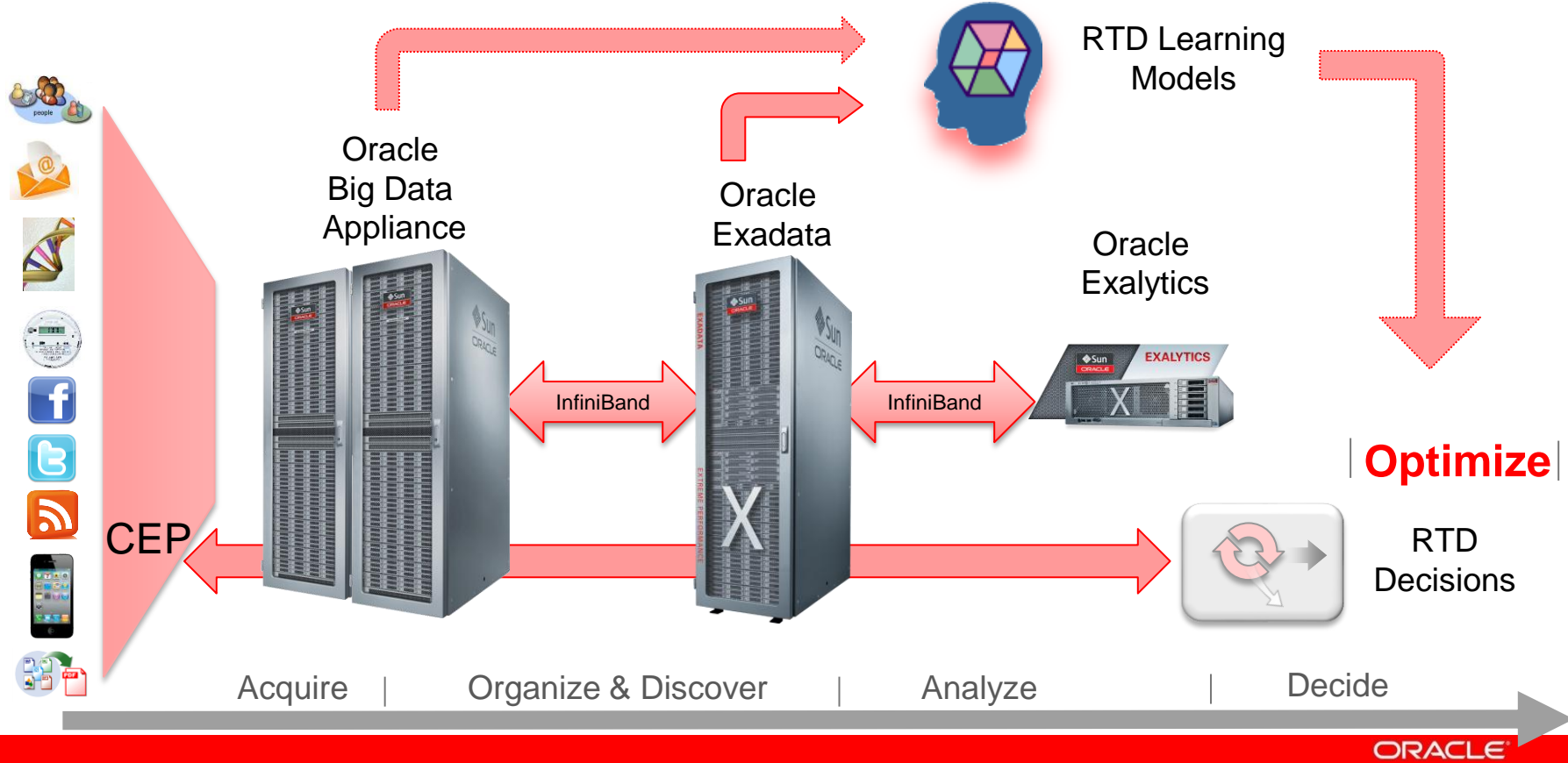
RTD Proof Point
Automated Discovery for Big Data

- RTD Predictive Models at Global Financial Services Institution
  - Have learned on 30 months of production data from .com / Facebook / Tablet / Mobile interactions
    - ~ 400M offers presented / month
    - ~ 220 variables used as predictive inputs per customer visit
    - ~ 436 offers / messages considered per visit
  - Number of learned correlations
    - **2.6 Trillion** (30 * 400,000,000 * 220)
  - Number of models scoring computations
    - **1.1 Quadrillion** (30 * 400,000,000 * 220 * 436)
- Business impact
  - "Lifted Conversion Rate by **43%** and Benefit Per Impression by **122%** over control group"

ORACLE

Oracle RTD for Codelco

Company Overview

- World's largest copper producer with 11% of global production
- 100% state owned and a strategic asset for Chile
- 58,000 direct job positions
- Sales: 13B USD

Challenges

- Vision is to move from "Traditional Mining" to "Intelligent Mining"
- Variation in the production volumes based on the production plan
- Opportunity to analyze and eliminate causes of variation
- Predictive maintenance

Solution

- Oracle Fusion Middleware
- Manufacturing Operations Center
- Oracle Business Intelligence
- Real Time Decisions

Results

- Implemented the solution at one mine site
- Improved visibility into mine operations and analysis of production variation
- Opportunity to expand to other processes and mines

ORACLE

8. Cockpit – Executive Panel
9. Management Reports

2. Production Flow Variability Analysis (historical and realtime)

3. Equipment availability and simultaneous use analysis
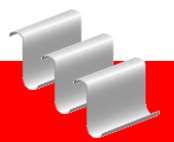
4. Daily Production Monitoring in realtime

5. Short term planning – collaborative and centralized
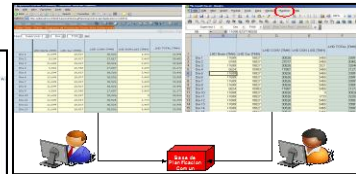
6. Event predictive analysis and causalities

7 . Mining Knowledge Management

Alerta de Cambio de Condición

Aceptar

Cuestionar

Pedir Ayuda

1. Process integration

Respositorio de Datos Comun Unificado

Inteligencia de negocios con herramientas de predicción en línea

Motor de aprendizaje operacional continuo

Facilidad para generar tableros de control y reportes

Realtime Services Platform

SGPA | DISPATCH | FIX | PI | Catia | SAP | Otras aplicaciones

CODELCO

Oracle RTD for Codelco