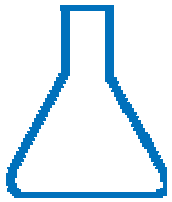
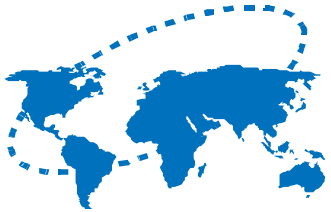
Rulex Analytics: the AI that tells you why

ML Crash Course
Genoa, 2017-06-28

Enrico Ferrari, R&D Manager, Rulex Inc.

Rulex Growth: Europe & USA





2007 | 2009 | 2011 | 2014 | 2015 | 2016

2007 — RULEX LAUNCHES OUT OF MACHINE-LEARNING RESEARCH AT CNR

Impara S.r.l.

2009 — INDUSTRIAL EXPERIMENTATION, CONSULTING & CUSTOMIZATION IN ITALY

2011 — ENTERPRISE CONSULTING & CUSTOMIZATION IN E.U. and USA

2014 — GLOBAL MARKET STRATEGY IMPLEMENTED

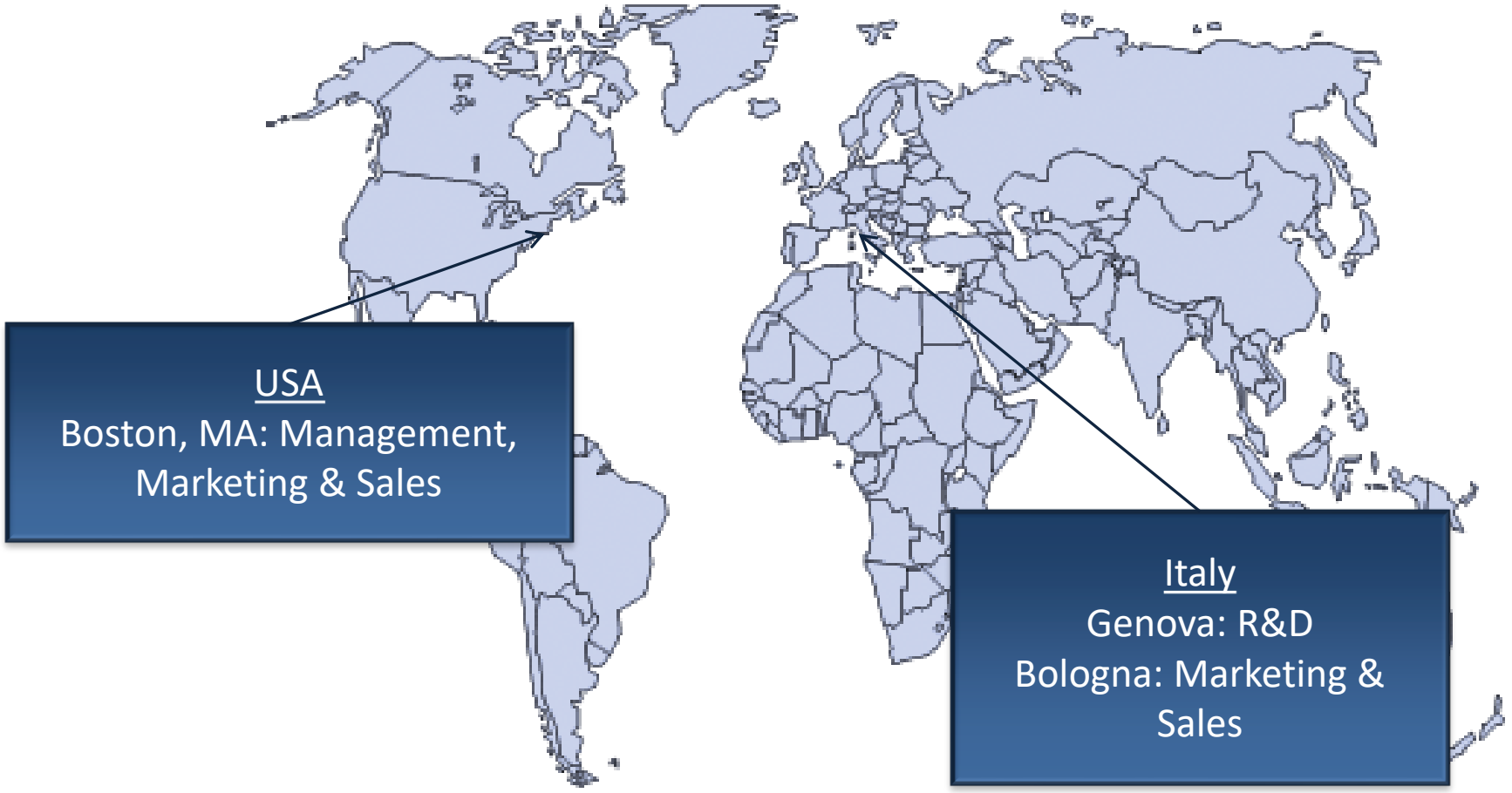
2015 — INITIAL TARGET VERTICALS:

- BANKS
- AUTOMOTIVE
- RETAIL
- HEALTHCARE
- ENERGY

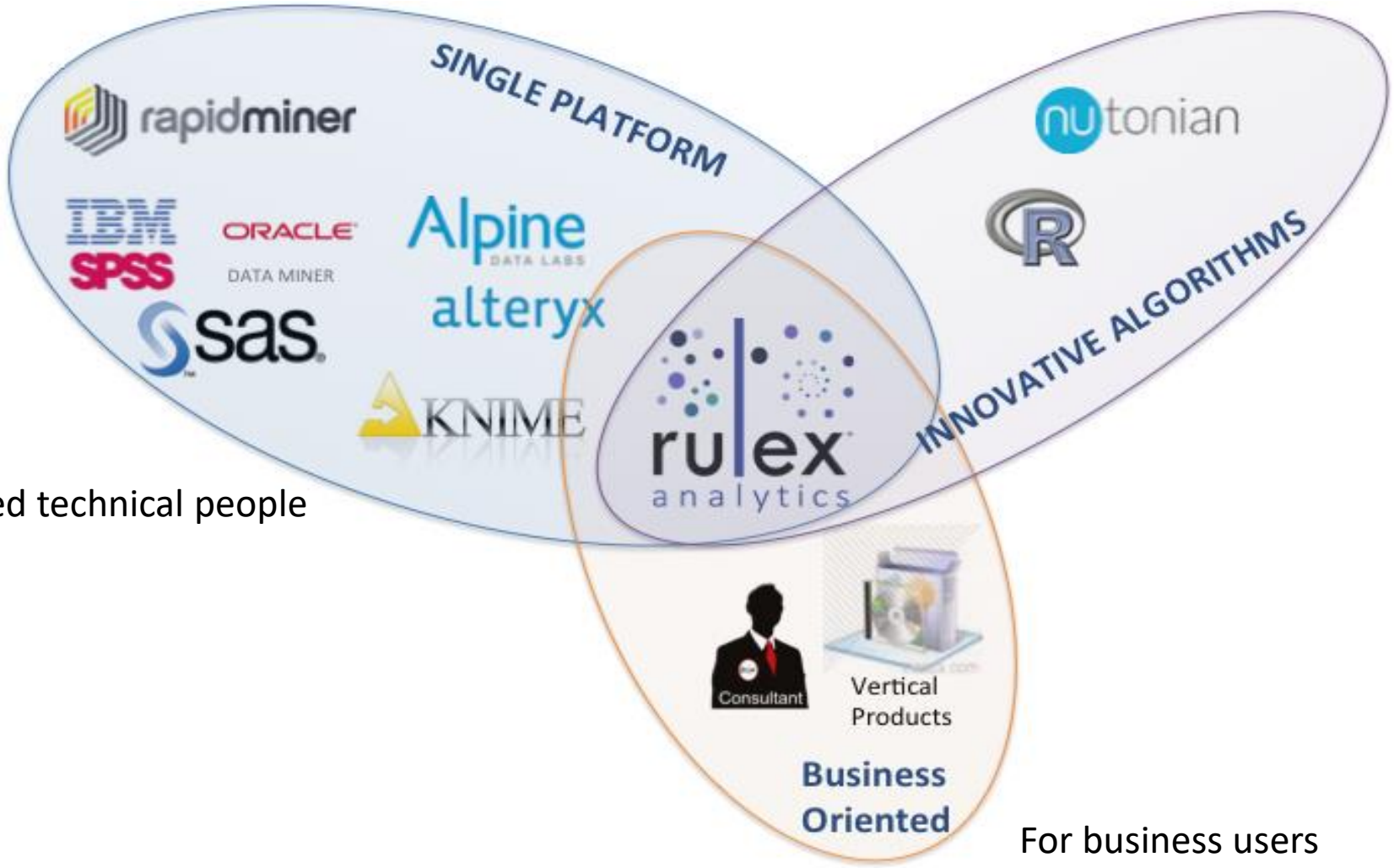
2016 — **COGNITIVE MACHINE LEARNING**

Technology + Command line tools	Engine for OEM applications	Rulex GUI	Rulex Solutions

Where we are



What is Rulex



Skilled technical people

For business users

Rulex Logic Learning Machine

Rulex's Logic Learning Machines are the only pattern recognition engine that provides **if-then prescriptions rules** in complex data environments, automatically.

Rulex is the **choice-enabling tool** for business decisions makers.

- No a priori assumptions
- Innate big data approach

Conventional vs. Cognitive Machine Learning

- Conventional ML models are computational; Rulex models are logical.
- Rulex models can be created, edited, understood by domain experts.

Equivalent NN and Rulex models for Kaggle Election Prediction case

$$
\begin{aligned}
f(x) = {} & 0.293\, tanh(0.113\, x_0 + 0.337\, x_1 - 0.329\, x_2 + 0.251\, x_3 - 0.288\, x_4 - 0.297\, x_5 + 0.436\, x_6 + \\
+ {} & 0.166\, x_7 - 0.184\, x_8 + 0.219\, x_9 + 0.483\, x_{10} - 0.222\, x_{11} + 0.173\, x_{12} + 0.012\, x_{13} + \\
+ {} & 0.352\, x_{14} + 0.259\, x_{15} + 0.176\, x_{16} + 0.345\, x_{17} + 0.314\, x_{18} + 0.177\, x_{19} - 0.329\, x_{20} + \\
- {} & 0.363\, x_{21} + 0.216\, x_{22} - 0.148\, x_{23} - 0.043\, x_{24} + 0.316\, x_{25} - 0.068\, x_{26} - 0.421\, x_{27(0)} + \\
+ {} & 0.15\, x_{27(1)} - 0.289\, x_{27(2)} - 0.241\, x_{28} + 0.16\, x_{29} + 0.199\, x_{30} - 0.111\, x_{31} - 0.164\, x_{32} + \\
+ {} & 0.117\, x_{33} + 0.466\, x_{34} + 0.457\, x_{35} + 0.133\, x_{36} + 0.331\, x_{37} - 0.362\, x_{38} - 0.43\, x_{39} + \\
- {} & 0.491\, x_{40} - 0.155\, x_{41} + 0.371\, x_{42} - 0.05\, x_{43} - 0.177\, x_{44} - 0.044\, x_{45} + 0.225\, x_{46} + \\
+ {} & 0.328\, x_{47} - 0.118\, x_{48} - 0.3) + \\
- {} & 1.934\, tanh(-0.233\, x_0 + 0.174\, x_1 - 0.252\, x_2 - 0.501\, x_3 - 0.125\, x_4 + 0.311\, x_5 - 0.573\, x_6 + \\
- {} & 0.299\, x_7 + 1.123\, x_8 + 0.318\, x_9 - 1.169\, x_{10} + 0.105\, x_{11} - 0.429\, x_{12} - 0.075\, x_{13} + \\
- {} & 0.143\, x_{14} + 0.146\, x_{15} - 0.531\, x_{16} + 0.077\, x_{17} - 0.133\, x_{18} - 0.122\, x_{19} + 0.162\, x_{20} + \\
- {} & 0.08\, x_{21} - 0.496\, x_{22} - 0.21\, x_{23} - 0.113\, x_{24} + 0.485\, x_{25} + 0.575\, x_{26} - 0.126\, x_{27(0)} + \\
+ {} & 0.135\, x_{27(1)} + 0.022\, x_{27(2)} - 0.352\, x_{28} - 0.693\, x_{29} + 0.379\, x_{30} + 0.409\, x_{31} - 0.109\, x_{32} + \\
+ {} & 0.228\, x_{33} + 0.292\, x_{34} + 0.161\, x_{35} - 0.086\, x_{36} - 0.3\, x_{37} - 0.089\, x_{38} + 0.163\, x_{39} + \\
- {} & 0.074\, x_{40} + 0.31\, x_{41} - 0.849\, x_{42} + 0.14\, x_{43} + 0.754\, x_{44} + 0.291\, x_{45} - 0.533\, x_{46} + 0.273\, x_{47} + \\
- {} & 0.285\, x_{48} - 0.286) + 0.252
\end{aligned}
$$

Neural Network Model

1. IF (White alone, percent, 2014 <= 71.100) **THEN party = Democrat**

2. IF (High school graduate or higher, percent of persons age 25+, 2009-2013 > 90.450) **THEN party = Democrat**

1. IF (High school graduate or higher, percent of persons age 25+, 2009-2013 <= 88.650 AND White alone, not Hispanic or Latino, percent, 2014 > 73.950) **THEN party = Republican**

2. IF (Persons per household, 2009-2013 > 2.615 AND White alone, percent, 2014 > 62.300 AND White alone, not Hispanic or Latino, percent, 2014 > 32.500) **THEN party = Republican**

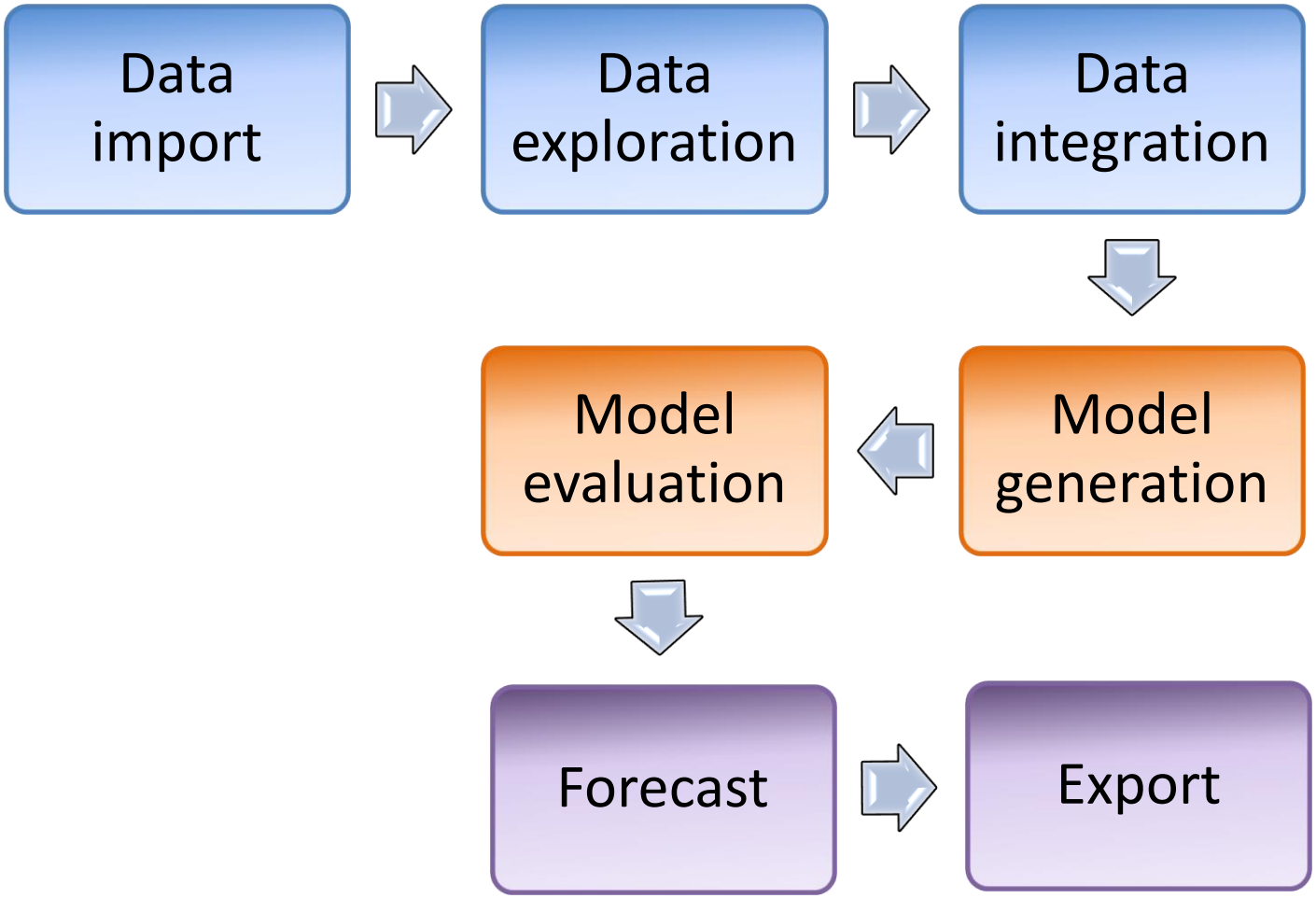
3. IF (Persons 65 years and over, percent, 2014 > 19.850 AND High school graduate or higher, percent of persons age 25+, 2009-2013 <= 90.850 AND White alone, not Hispanic or Latino, percent, 2014 > 57.350) **THEN party = Republican**

4. IF (724908 < Manufacturers shipments, 2007 ($1,000) <= 16640803 AND Asian alone, percent, 2014 <= 6.350 AND White alone, not Hispanic or Latino, percent, 2014 > 63.000) **THEN party = Republican**

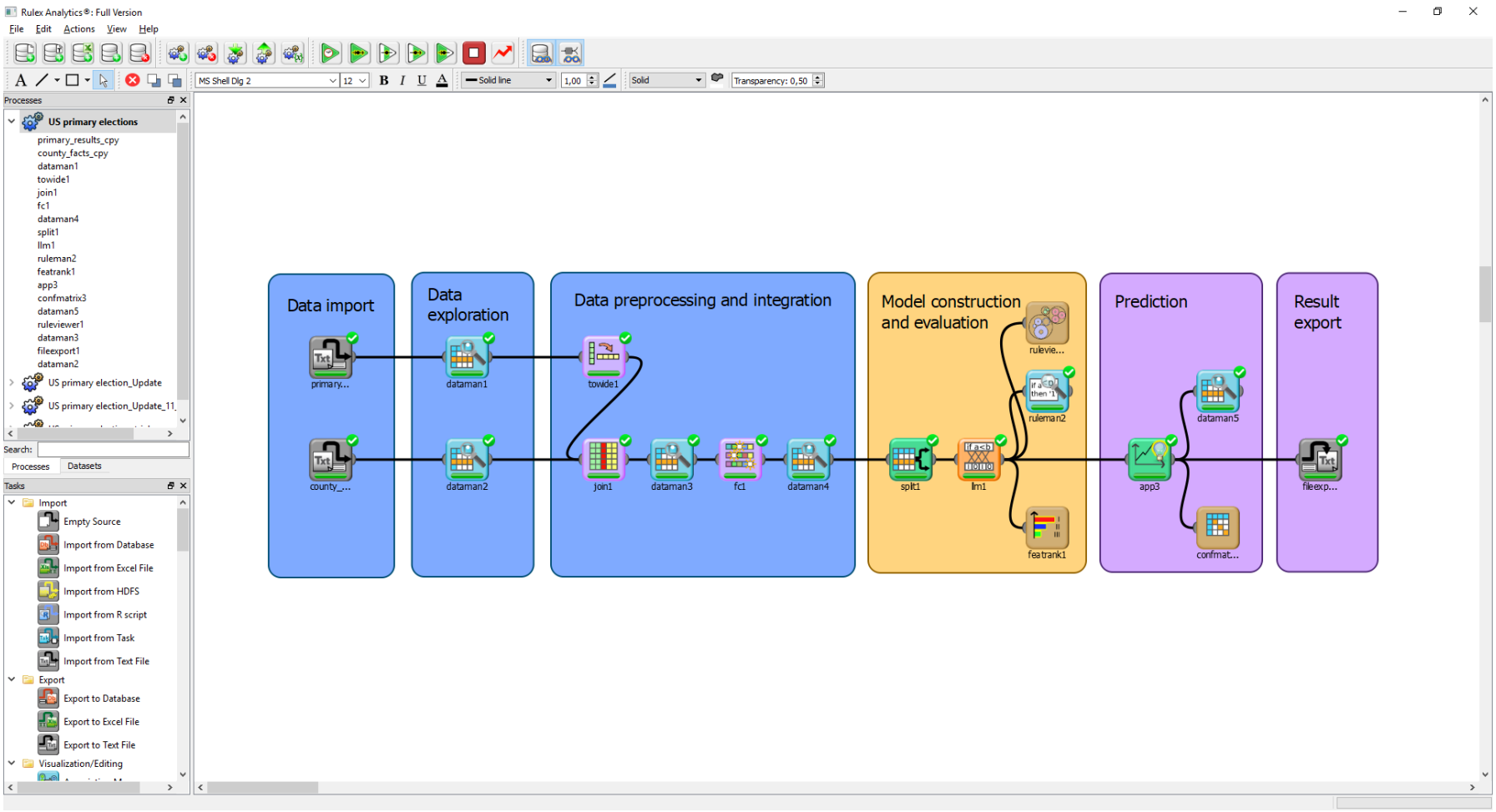
5. IF (Private nonfarm establishments, 2013 <= 289 AND Population per square mile, 2010 > 14.550 AND 56.150 < White alone, percent, 2014 <= 98.750) **THEN party = Republican**

Logic Learning Machine Model

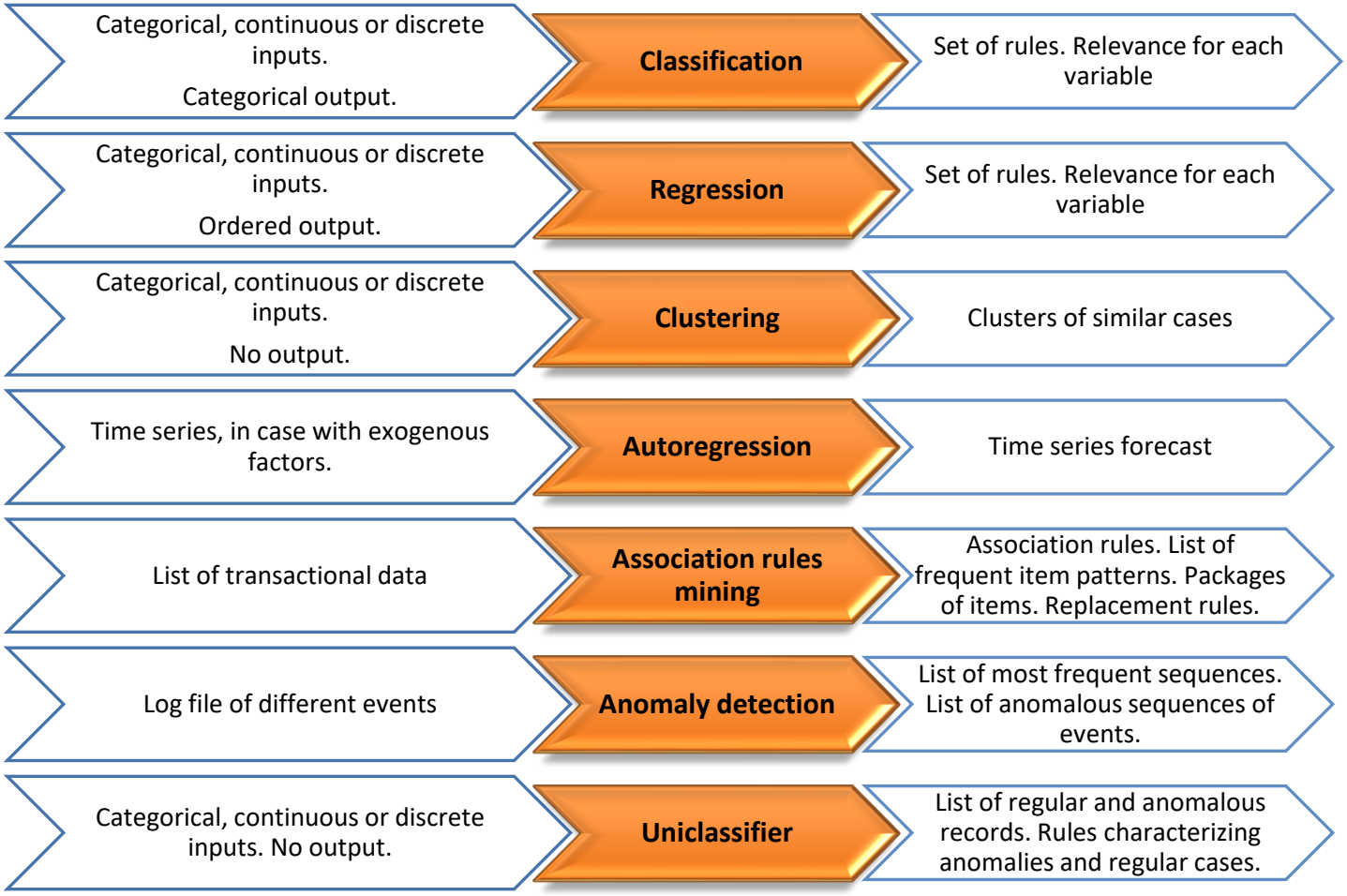
A Rulex workflow from data to results



Rulex easy to use interface



Rulex: one software, many challenges



Some applications by sector / 1

Automotive

1. Drivers Segmentation
2. Predictive Maintenance
3. Complexity reduction
4. Marketing effectiveness

Banking

1. Churn in Retail Banks
2. Bank Product cross-selling
3. Investments forecasting
4. Financial Indexes forecasting
5. Stock Indexes forecasting
6. Optimizing Business Models in Banks

Supply chain

1. Demand forecast during promotions
2. Understanding Supermarket customer Behavior & Sales

E-Commerce

1. New product introduction
2. Sales Predictions
3. Automatic discounts

Education

1. Students Behavior

Energy

1. Solar power plant performance
2. Gas consumption forecasting

Healthcare

1. Neuroblastoma Diagnosis Support
2. Quality of live in chronical patients
3. Identification of risk factors for problematic gambling or other dependences
4. Medical Imaging

Some applications by sector / 2

Industrial Plants

1. Preventive Maintenance
2. Network optimization

Insurance

1. Fraud detection
2. Customer Behavior
3. Churn Analysis

Retail

1. Shrinkage Analytics
2. Customer Behavior
3. Assortment Optimization
4. Showroom Optimization
5. Marketing effectiveness
6. Showroom Format Definition
7. Basket Analysis with CRM
8. OTC Products Optimization

Security

1. Anomaly Detection

Society, Politics & Economy

1. USA Election
2. Sustainable Development

Sport

1. Under/Over forecast

Telco

1. Network Optimization
2. Customer segmentation

Tourism

1. Visitor Behavior

Industry Acknowledgments

Awarded as **One of the 10 Most Disruptive Technologies** by MIT Sloan CIO Symposium 2016.

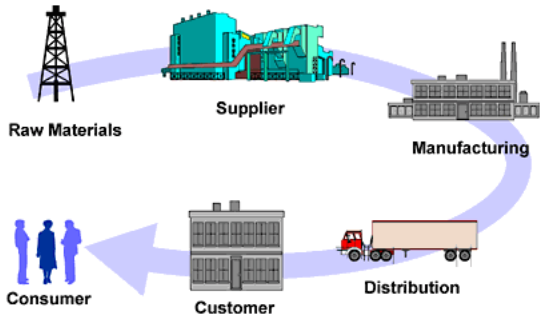
Business Partner of Konica Minolta for Leading Edge Technologies.

Winner of the 2015 EY Start-Up Challenge for Big Data Analytics in Supply Chain and Customer Intelligence.

Scientific Partner of the Massachusetts General Hospital.

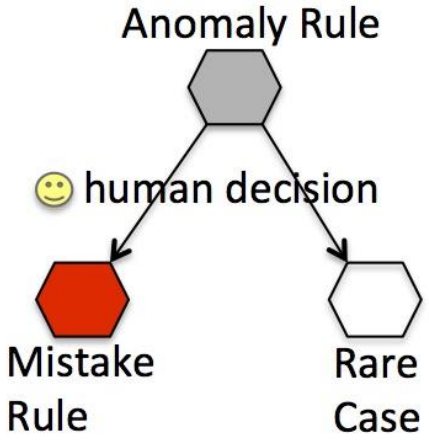
An application: Self-Correcting Supply Chain

- The new solution proposed by Rulex for automating the identification and correction of anomalies in supply chain data.

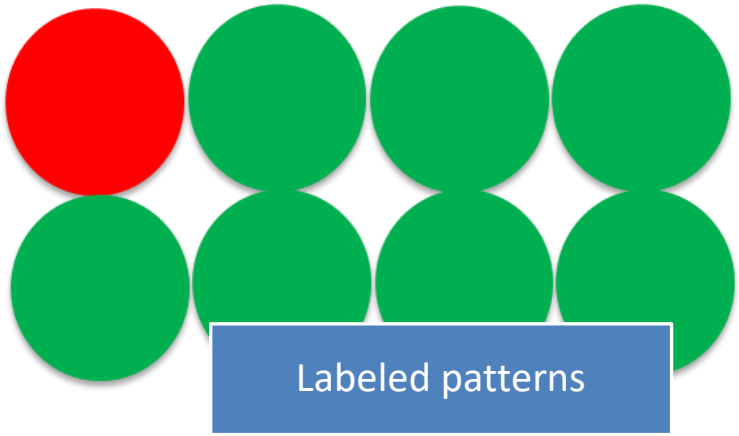


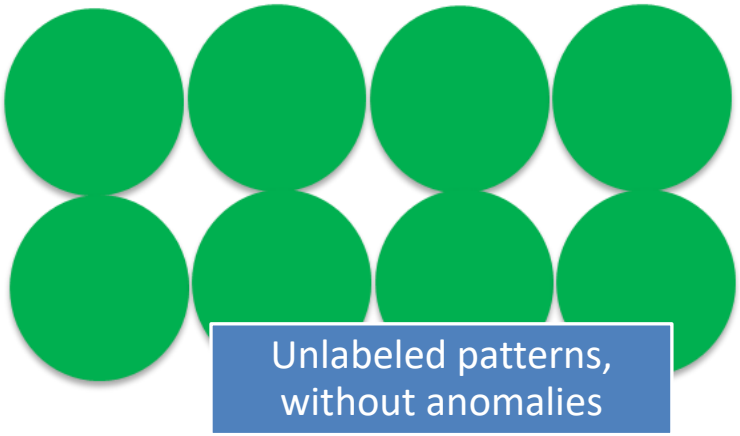
- Supply chain data may include:
  - Records that occur very seldom (*rare cases*)
  - Records that contain wrong (combination of) values (*mistake cases*)
- Only a human can recognize mistakes

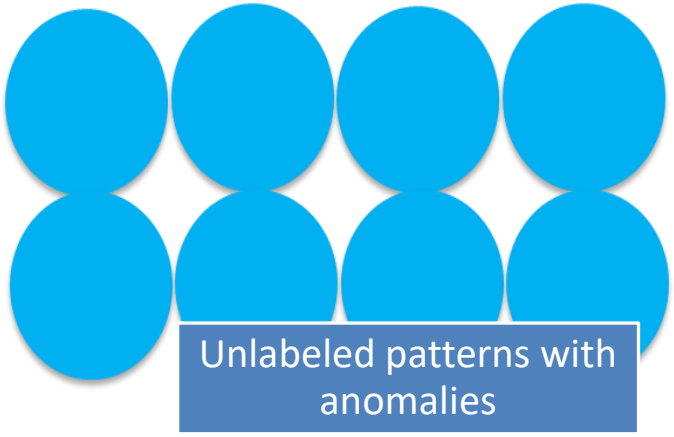
from rare cases



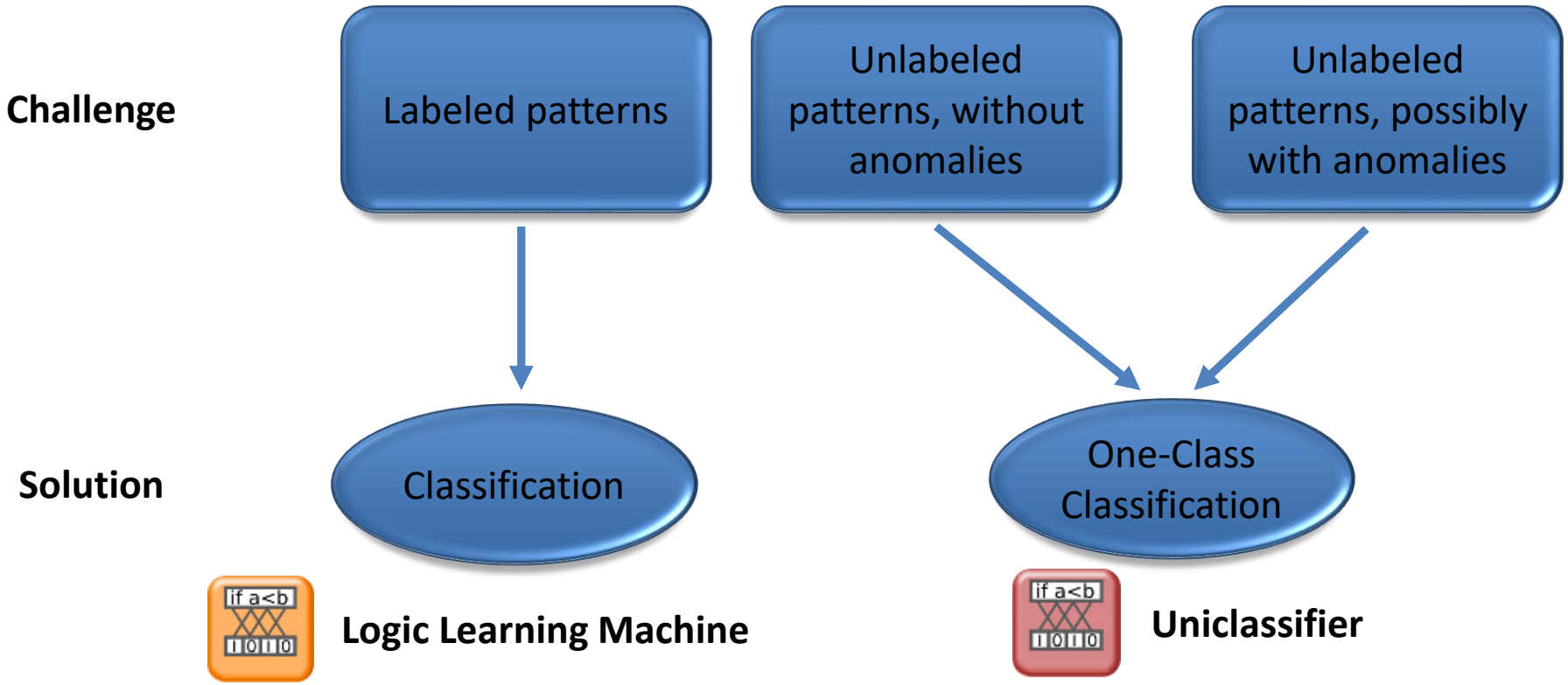
Possible situations







Rulex approach



Typical Anomaly Detection/Correction Process

- Planners and other subject matter experts (SME) identify sample errors for use by machine learning algorithms.
- Data scientists build model to predict anomalies in new data.
- SMEs eliminate outliers from and correct erroneous records.
- SMEs define and submit database record corrections.

From Data Inspection to Pattern Evaluation

Data Inspection

Var1	Var2	Var3	Var4	Normal
…	…	…	…	…
■	✪	⊙	★	✗
■	❖	⊙	★	✓
⊙	◆	■	✪	✓
⊙	◆	■	★	✓
⊙	❖	⊙	✪	✗
■	◆	⊙	★	✓
⊙	❖	■	✚	✗
■	◆	⊙	✪	✓
■	◆	⊙	✪	✓
…	…	…	…	…

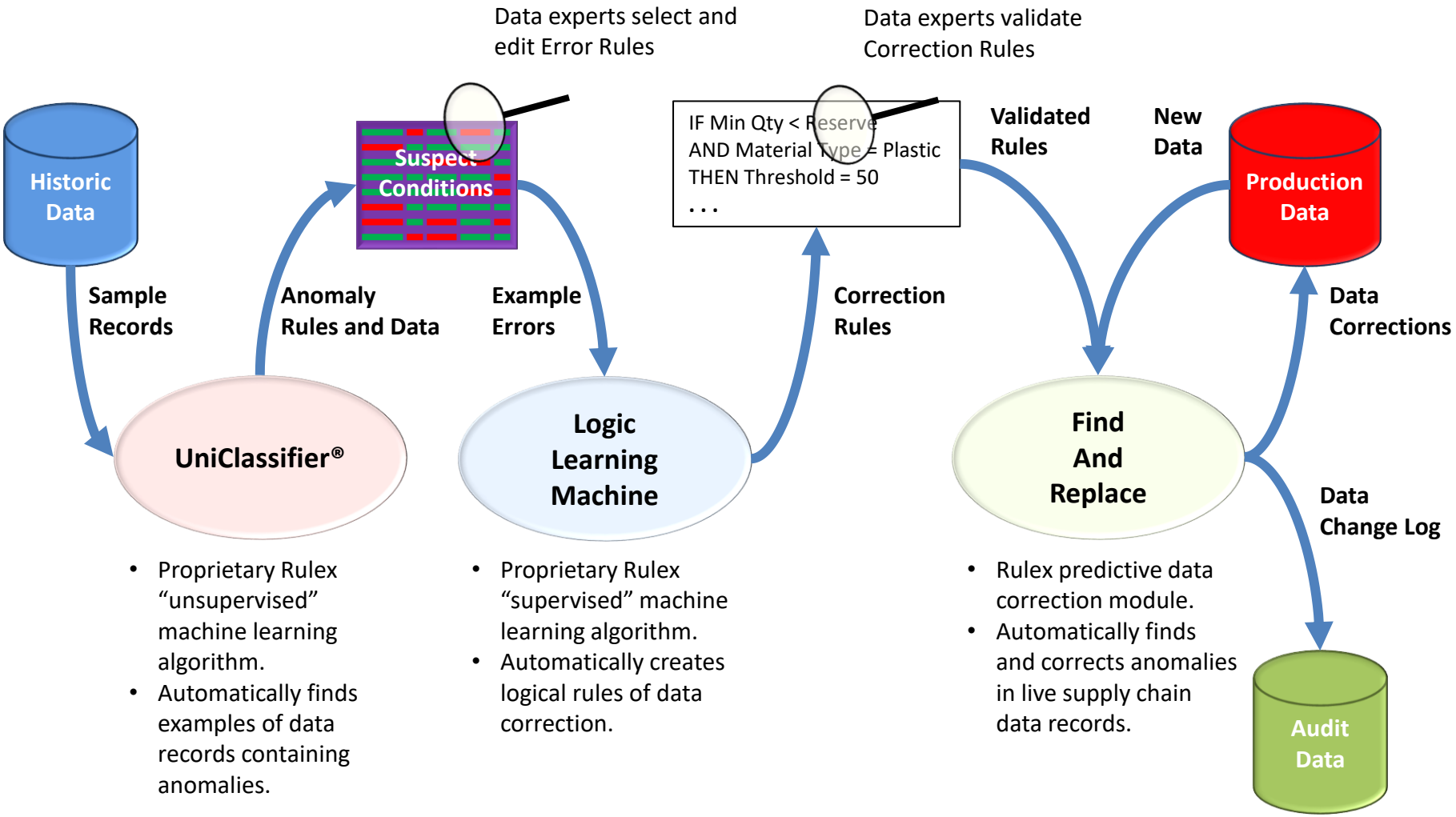
- Lengthy, costly procedural process.
- Difficult to understand why anomalies are generated.

Pattern Evaluation

If Var2 = ✪ then Anomaly
If Var1= ⊙ AND Var3≠ ■ then Anomaly
If Var4= ✚ then Anomaly
….

- Only a few patterns to review (resource and time saving)
- Clear meaning of the anomaly (logic approach).

The Rulex $(SC)^2$ Solution



- Proprietary Rulex "unsupervised" machine learning algorithm.
- Automatically finds examples of data records containing anomalies.

- Proprietary Rulex "supervised" machine learning algorithm.
- Automatically creates logical rules of data correction.

- Rulex predictive data correction module.
- Automatically finds and corrects anomalies in live supply chain data records.

Thank you!

www.rulex.ai
e.ferrari@rulex.ai