

Rulex

THE AI THAT TELLS YOU WHY™

- Rulex was born as an ambitious research project, but is currently in daily production workflows of several big industries, among which a F50 CPG Manufacturer and some big banks.
- This means that every day Rulex is used both manually and automatically to perform daily operations, e.g. moving goods, detecting frauds...

Black Box AI Is a Growing Problem

D/SRUPTION

The Next Big Disruptive Trend in Business. . . Explainable AI

With so many different approaches to machine learning – neural networks, complex algorithms, probabilistic graphical models – it's getting increasingly difficult for humans to figure out how machines are coming to their conclusions.



Sure, A.I. Is Powerful—But Can We Make It Accountable?

Imagine you apply for insurance with a firm that uses a machine-learning system, instead of a human with an actuarial table, to predict insurance risk. After crunching your info—age, job, house location and value—the machine decides, nope, no policy for you. You ask the same question: "Why?"

Nobody can answer, because nobody understands how these systems—neural networks modeled on the human brain—produce their results.

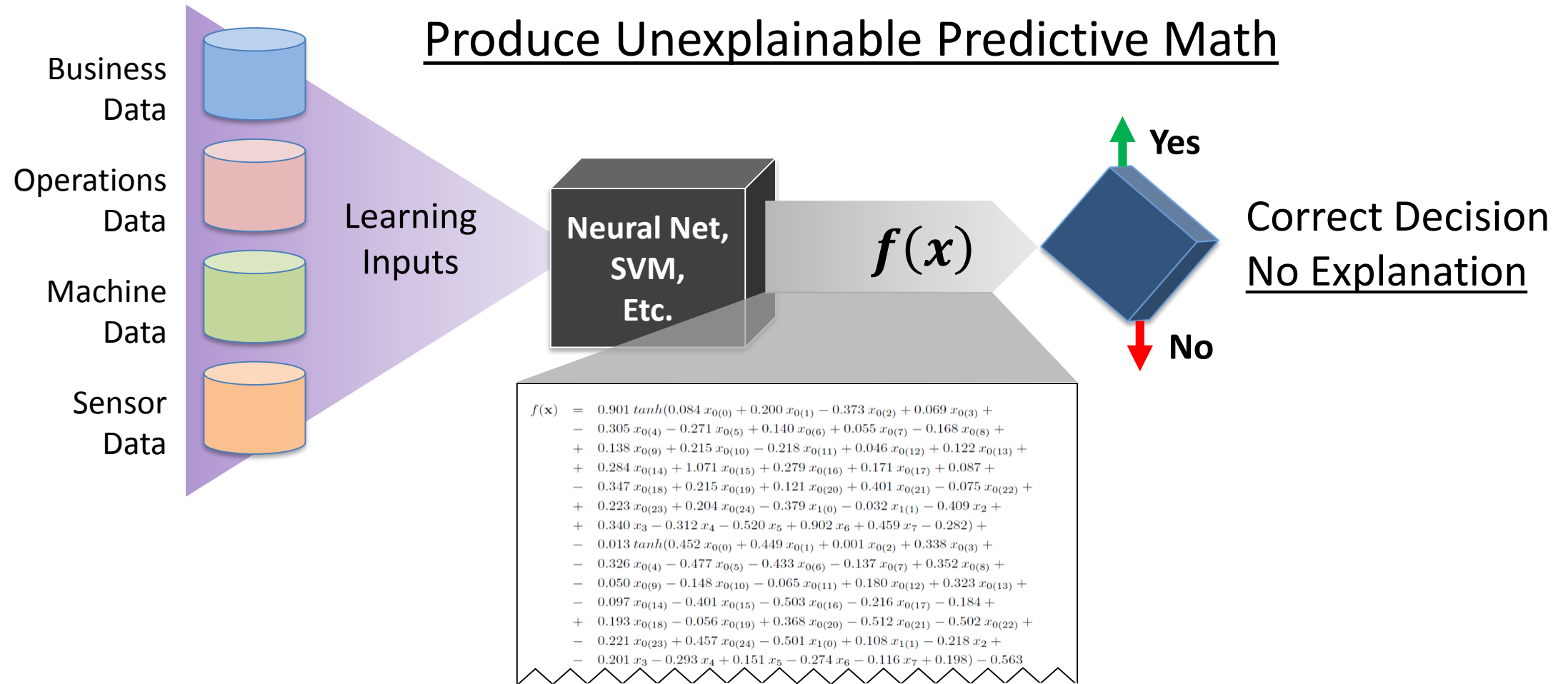
THE WALL STREET JOURNAL.

Capital One Pursues 'Explainable AI' to Guard Against Bias in Models

The effort aims to better understand how a machine-learning model comes to a logical conclusion.

Capital One Financial Corp. is researching ways that machine-learning algorithms could explain the rationale behind their answers, which could have far-reaching impacts in guarding against potential ethical and regulatory breaches as the firm uses more artificial intelligence in banking.

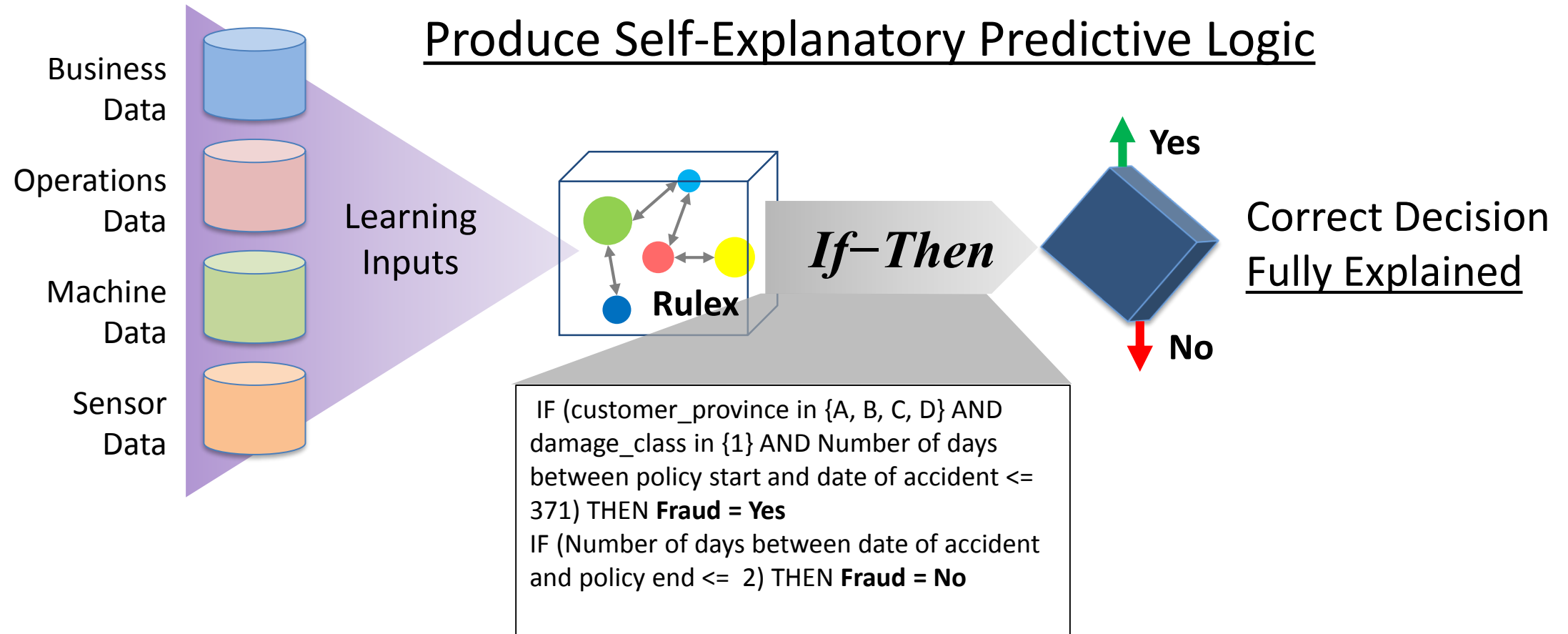
Black Box Machine Learning Algorithms



Consequences of Black Box AI

- Hidden Biases and Regulatory Exposure
 - Unseen misuse of Race, Gender, Age, etc.
- Correct Decision Actions Unknown
 - Churn Response, Fraud Investigation, Loan Performance
- Causes of Incorrect Decisions Unknown
 - False Positives (and Negatives), Untraceable Data Errors

Rulex Alternative: Clear Box Algorithms



Benefits of Logic-Based AI

- Reveals hidden knowledge for augmented management decisions.
- Easily integrated in business applications for automated process decisions.
- Can be used directly by IoT edge devices for autonomous real-time decisions.

```
IF (customer_province in {A, B, C, D} AND  
damage_class in {1} AND Number of days  
between policy start and date of accident <= 371) THEN Fraud = Yes
```

```
IF (customer_province in {E, B, C, F} AND  
Customer age > 48 AND Number of days  
between date of accident and complaint > 1)  
THEN Fraud = Yes
```

```
IF (customer_province in {G, H, I, J, K, L, M, N, B,  
O, P, Q, R, S}) THEN Fraud = No
```

```
IF (Number of days between date of accident  
and policy end <= 2) THEN Fraud = No
```

Rulex Founding Mission

- Commercialize unique IP for “clear box” prediction
- Capitalize on growing need for explainable AI
- Eliminate need for Data Science skills and processes
- Simplify AI applications development and integration
- Deliver early proof of business value and rapid ROI
- Focus on use cases where other AI has failed

Work processes that use if-then logical rules to determine the best human or software actions.

- Business
 - Fraud Investigation, Loan Approval, Customer Churn
- Operations
 - ERP Planning, Claim Processing, Maintenance Scheduling
- Infrastructure
 - Error Correction, Energy Management, Machine Control

Reduce time, cost, risk, and errors in rule-based decision making.

- Business
 - Descriptive rules for augmented human decisions
- Operations
 - Predictive rules for automated process decisions
- Infrastructure
 - Prescriptive rules for autonomous system decisions

Industries and applications with high volume or high value, standardized decision processes.

- Business
 - Banking, Insurance, Marketing Services
- Operations
 - Supply Chain, Manufacturing, Retail
- Infrastructure
 - Public Utilities, Industry 4.0, Smart Cities

Some Rulex Customers

- F50 CPG Manufacturer
 - Multi-year master vendor contract for 6-10 applications.
- Konica Minolta
 - CRM, IoT applications and strategic technology partner.
- Unipol and other EU insurers
 - Claims Fraud application resold through GFT and possibly PWC
- Banca Ifis and other EU banks
 - Non-Performing Loans application resold through GFT

New success stories, new challenges

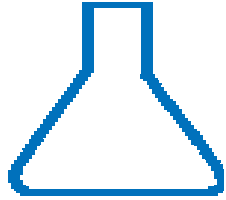
- The time required for computing must be compatible with the workflow: if your model needs 24 hours to run, it is not a good one
- Being in production workflows in some big industries leads to new challenges:
 - The functioning of the system must be guaranteed in any condition, 7/24. It is not sufficient to get good results once: you have to get them every day.
 - Problems with the software must be solved according to well-defined SLA; in case of critical errors (that block the operativity of the company in a region) you have to act in few hours.
- Having the full control of the software becomes a crucial point

Rulex is the AI for Large Enterprises



- Rapid Proof of Business Value
- Integrated with Existing Systems
- Global Solution Scalability
- ITIL-Compliant Help Desk

Rulex Company Timeline



2007

RULEX LAUNCHES OUT OF
MACHINE- LEARNING
RESEARCH AT CNR

Impara S.r.l.

Technology +
Command ILne
Tools



2009

INDUSTRIAL
EXPERIMENTATION,
CONSULTING &
CUSTOMIZATION
IN ITALY

Engine for OEM Applications



2011

ENTERPRISE
CONSULTING &
CUSTOMIZATION IN
E.U. and USA



2014

GLOBAL MARKET
STRATEGY IMPLEMENTED



Rulex GUI



2015

INITIAL TARGET
VERTICALS:

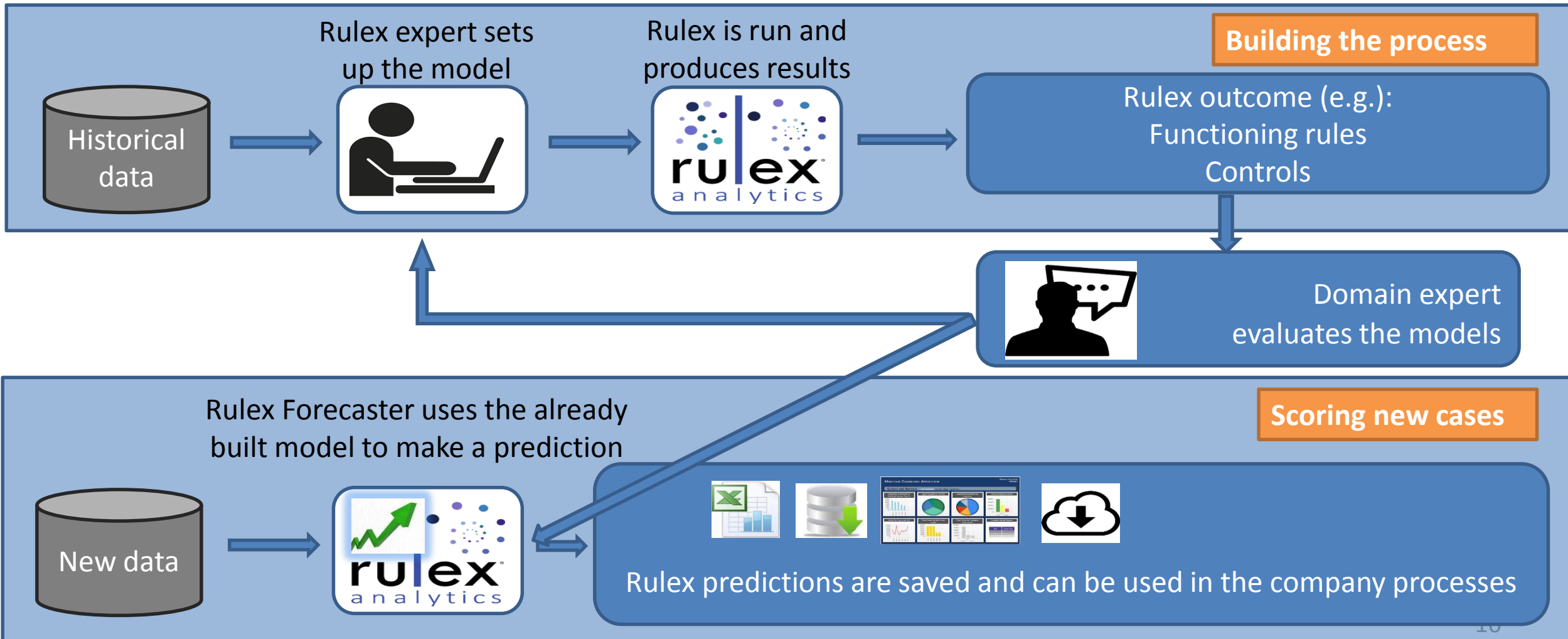
- BANKS
- AUTOMOTIVE
- RETAIL
- HEALTHCARE
- ENERGY

Rulex Applications

2016

**COGNITIVE
MACHINE
LEARNING**

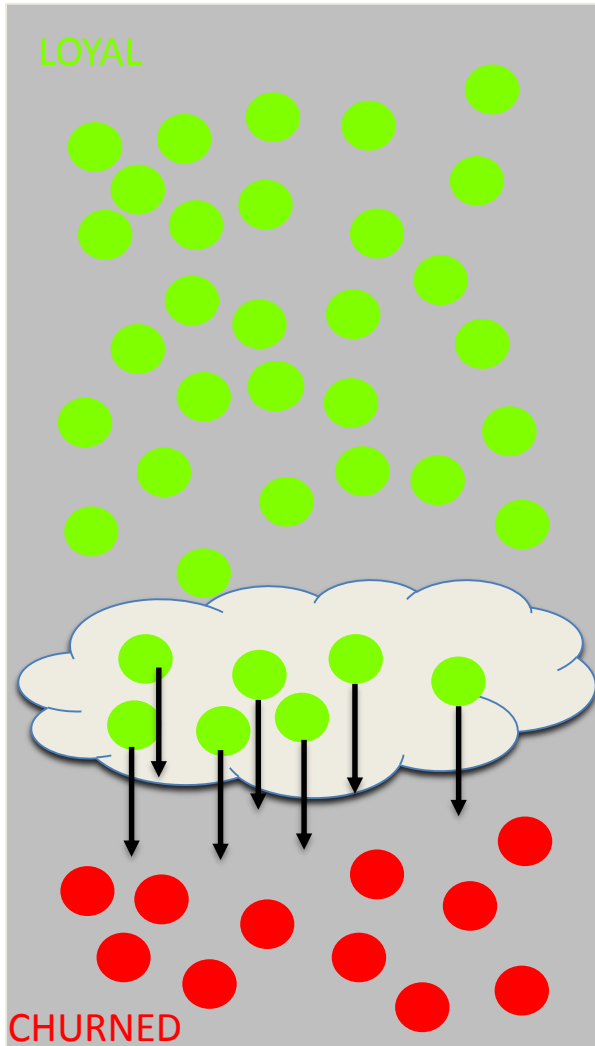
Rulex: cognitive approach



Real world applications - augmented decision

Problem of churn today (1/2)

pool of customers



Presently, the customer can only identify two kinds of customers:

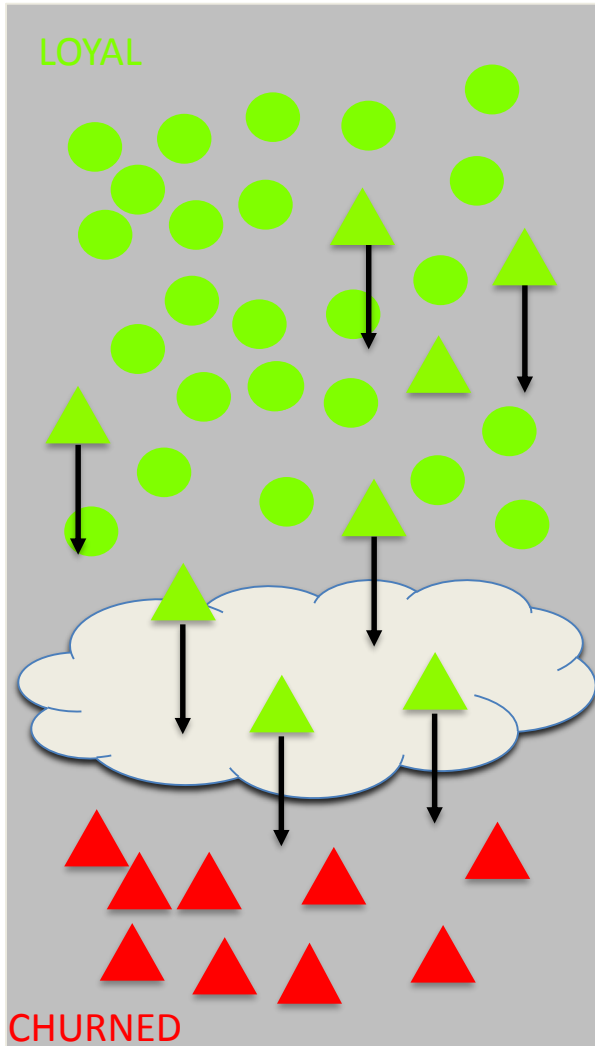
- Have a contract (called **Loyal**)
- Terminated/not renewed a contract (called **Churned**)

The problem:

Some labeled as Loyal now, will churn soon.

- Are actually not Loyal, they just haven't churned yet.
- Are preparing to churn, but have active contracts, so they appear Loyal.

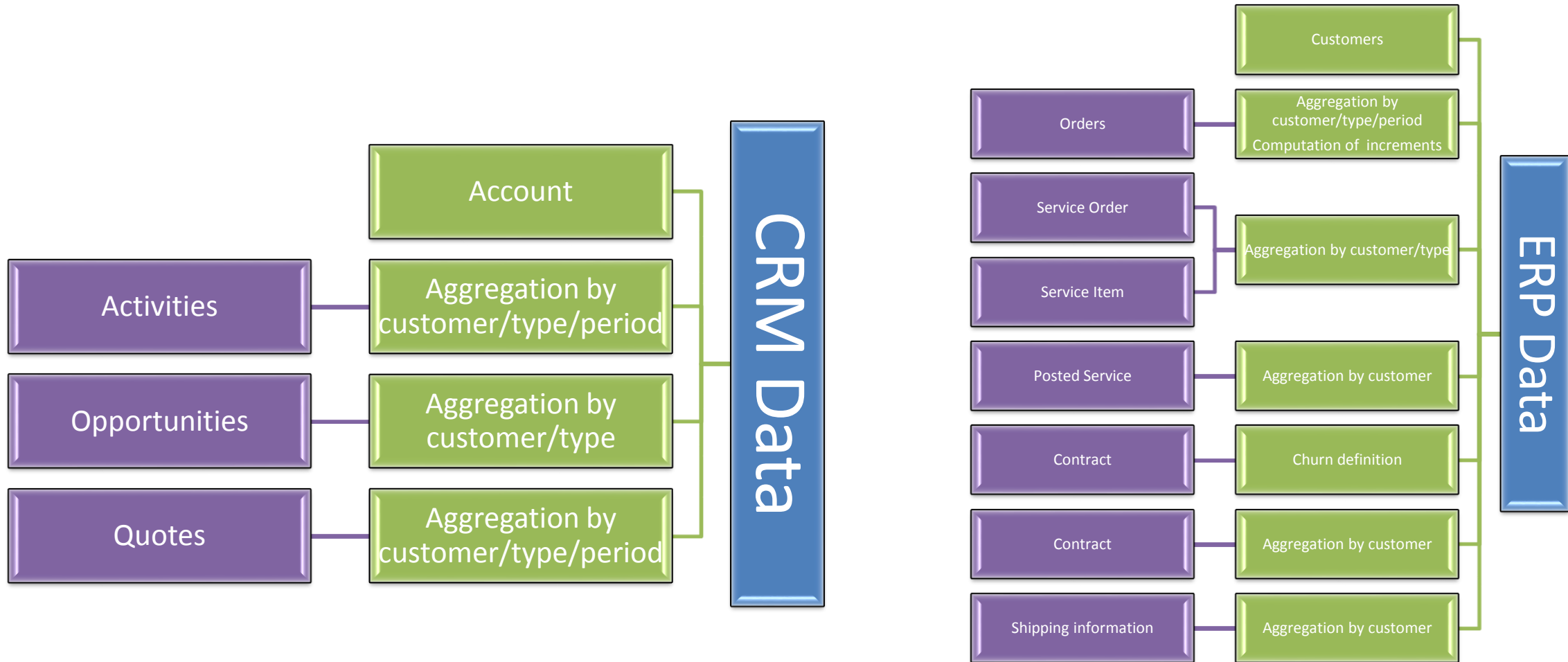
Problem of churn today (2/2)



Here we visualize this problem:

- Customers are characterized by colors and shapes.
 - Loyal are green and Churned are red.
 - Shapes represent patterns of behavior.
 - Circle = Truly Loyal
 - Triangle = Likely to Churn
- Currently, the customer can only see the colors, not the shapes.
- Rulex has identified the patterns (shapes) of apparently loyal customers that likely will churn tomorrow.

Available data



- From historical data about 4298 customers, Rulex has inferred a list of rules (i.e. the model) describing Loyal and Churned customers according to the standard classification. Each rule is a pattern of behavior.
- The best model today is made of 91 rules/patterns:
 - 56 describing customers who **churned** in the past.
 - 35 describing **loyal** (=active today) customers.
- Examples of the most relevant patterns/rules for **churned** customers:
 - Rule #36: IF *Quantity(other,0) <= 2.5* AND *Quantity(toner,0) <= 1.25* AND *Quantity(toner,1) <= 1.5* THEN **Churn = 1**
 - Rule #37: IF *Sales Group Code in {241, 243, 245}* AND *OPS Customer = 0* THEN **Churn = 1**
 - Rule #38: IF *Payment Method Code = C* AND *Sales District Code = 24002* AND *OPS Customer = 0* AND *Allow Estimation = 0* AND *max_ncontract <= 1* THEN **Churn = 1**
- Examples of the most relevant patterns/rules for **loyal** customers:
 - Rule #1: IF *max quantity(other,0) > 5.5* THEN **Churn = 0**
 - Rule #2: IF *Payment Method Code in {D, DB}* THEN **Churn = 0**
 - Rule #3: IF *Sales District Code in {24001, 24004}* AND *count(Email,1) > 1* THEN **Churn = 0**

A look back ...

- In 2017, 246 customers churned.
- At the end of 2016, they would have been classified as loyal.
- But, they were loyal customers which were very likely to churn.
- Rulex would have identified 191 (78%) of the 246.
- Using the Rulex rules
 - The customer could have taken preemptive retention actions for identified customers.
 - The customer could have corrected contributing factors to prevent future churns.

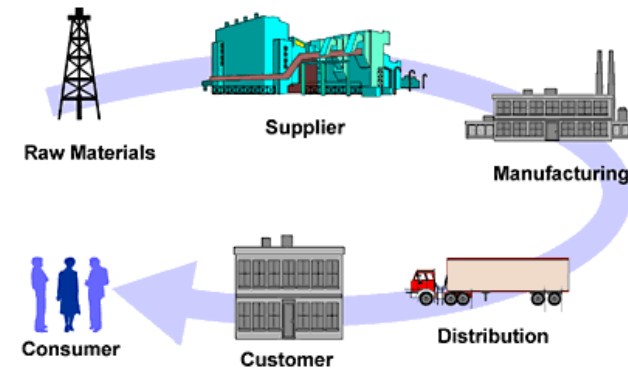
Business Validation of the Rules

- The customer can read and understand all the rules. It's a crucial point, since the model has to be significant from the business point of view.
- Do the rules have business meanings?
- How could they be improved?
 - Example: conditions on Order Quantity suggest to introduce order quantities which are relative to the size of the company, instead of absolute.
 - Is any external information on the customers available? Like the financial health, number of employees, etc.?
- The role of business experts in this phase is fundamental.

Real world applications – automatic decision

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 (*outliers*)
 - Records that contain wrong (combination of) values (*errors*)
- Only a human can recognize errors from outliers



- 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
...
■	★	⊙	★	X
■	✧	⊙	★	✓
⊙	◆	■	★	✓
⊙	◆	■	★	✓
⊙	✧	⊙	★	X
■	◆	⊙	★	✓
⊙	✧	■	+	X
■	◆	⊙	★	✓
■	◆	⊙	★	✓
...

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

Pattern Evaluation

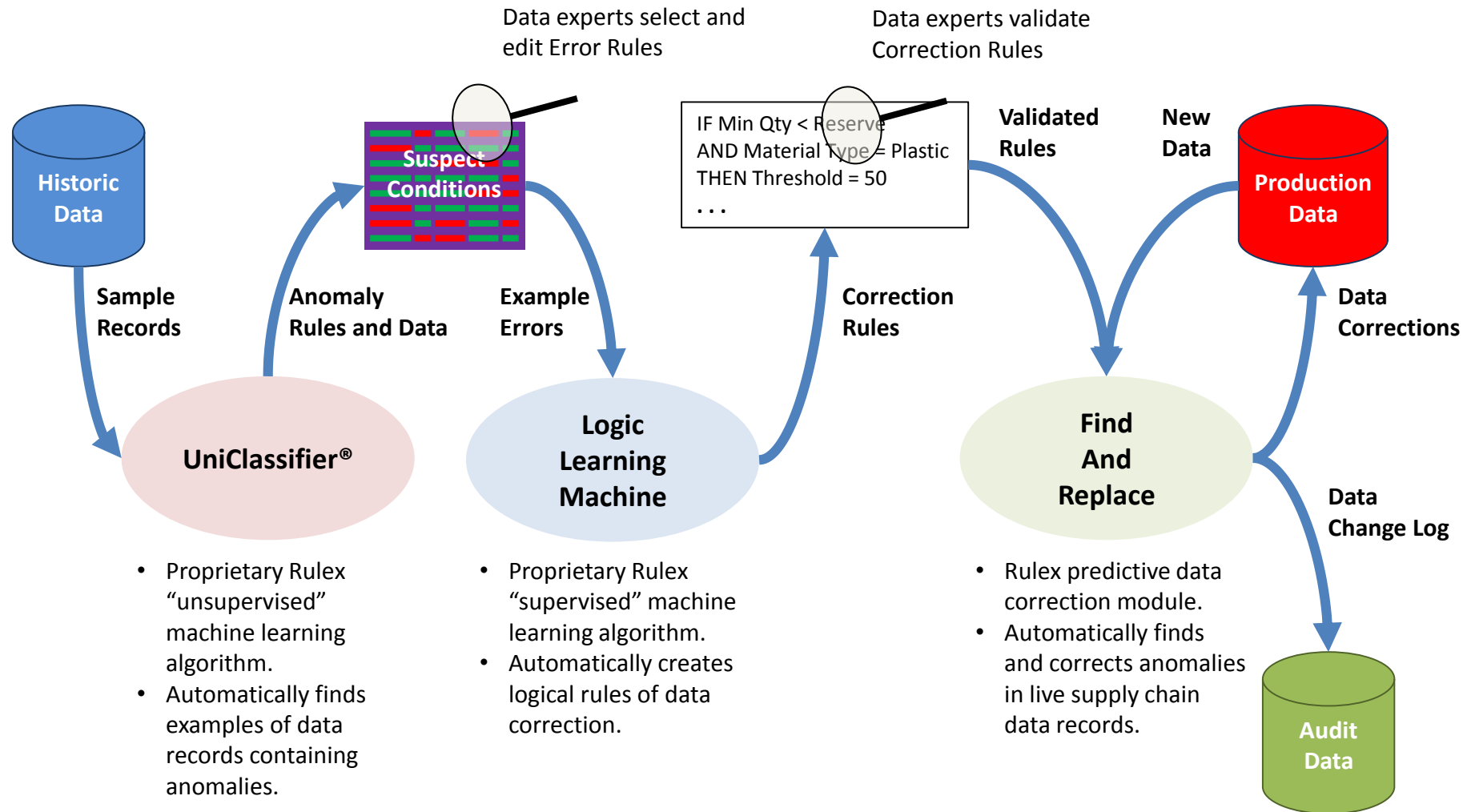
If Var2 = ★ then Anomaly
 If Var1= ⊙ AND Var3≠ ■ then Anomaly
 If Var4= + then Anomaly

....

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

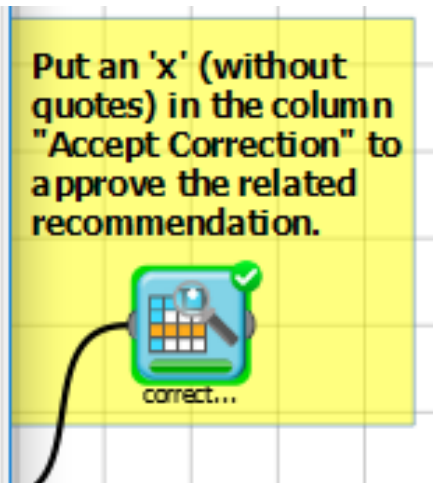


The Rulex (SC)² Solution



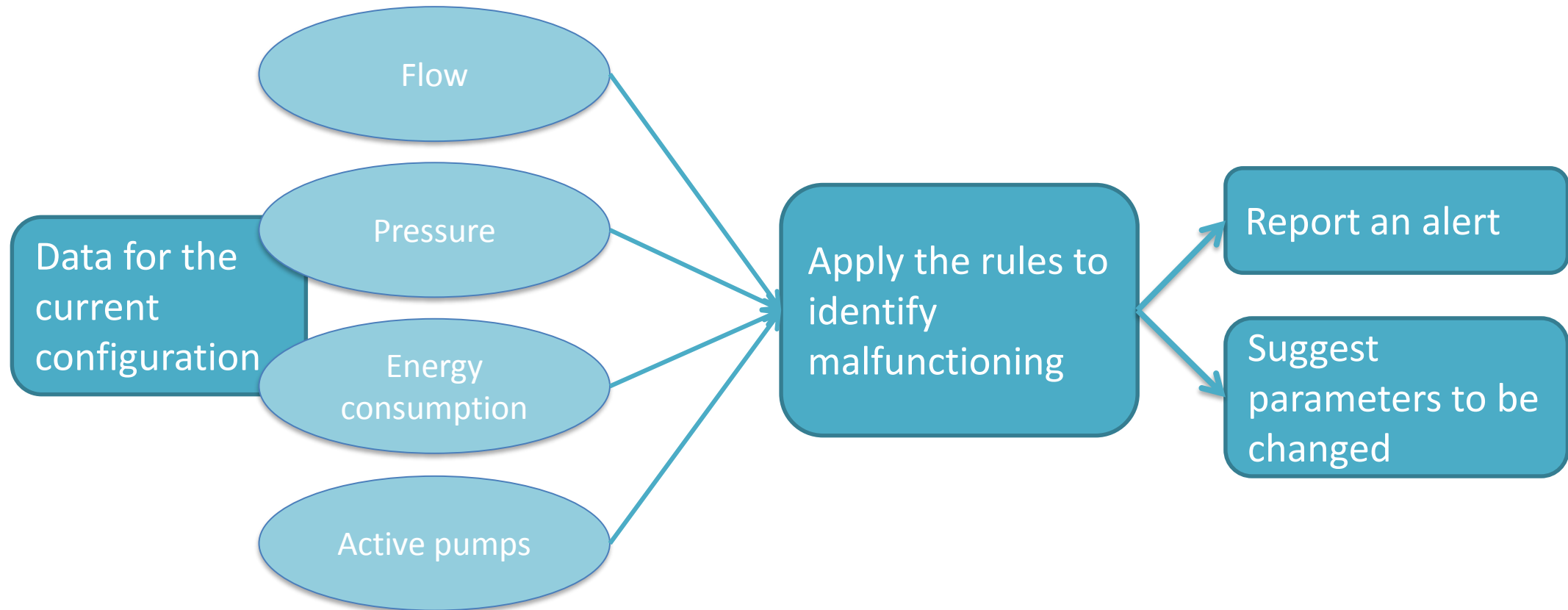
Daily operations

Attribute	Value	ProposedCorrect	IsRulexReco *	AmbiguityGroup	Accept Correctic	Rule
Forward interval	004	001	Yes	3	x	
Forward interval	004	001	Yes	3	x	
Forward interval	004	001	Yes	3	x	
Forward interval	004	001	Yes	3	x	

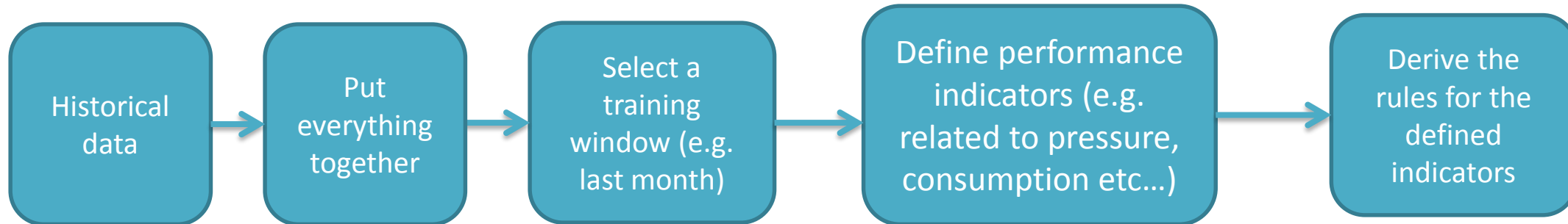


Real world applications – autonomous decision

The workflow for a watermain



Generating the model – a step back



- IF (time <= 20:40:30.000 AND N_Pumps(A01) > 0 AND N_Pumps(A04) > 2 AND N_Pumps(C03) > 0 AND N_Pumps(F01) > 0 AND N_Pumps(G01) > 0) THEN System_Status (after 15 min) = «Good efficiency»
- IF (time <= 06:28:30.000 AND N_Pumps(I01) <= 0) THEN System_Status (after 15 min) = «Violation of pressure constraints»
- IF (time > 21:59:30.000 AND N_Pumps(C05) > 0) THEN System_Status (after 15 min) = «Bad efficiency»

After having defined optimal pressure ranges for each network node and a measure of energy efficiency, Rulex automatically generated 146 rules

Control: apply corrections

...	N pompe A04	Time	Performance	Rule
...	1	15:00:00	Good Ok!	1
...	2	18:00:00	Good Ok!	1
...	3 2	05:00:00	Bad Needs correction	9
...	3	05:30:00	Constr. violation Needs correction	17

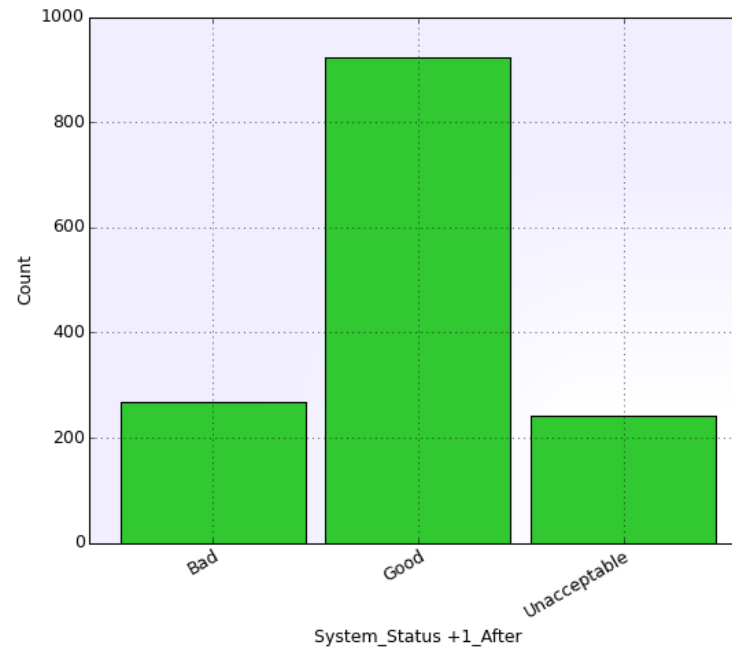
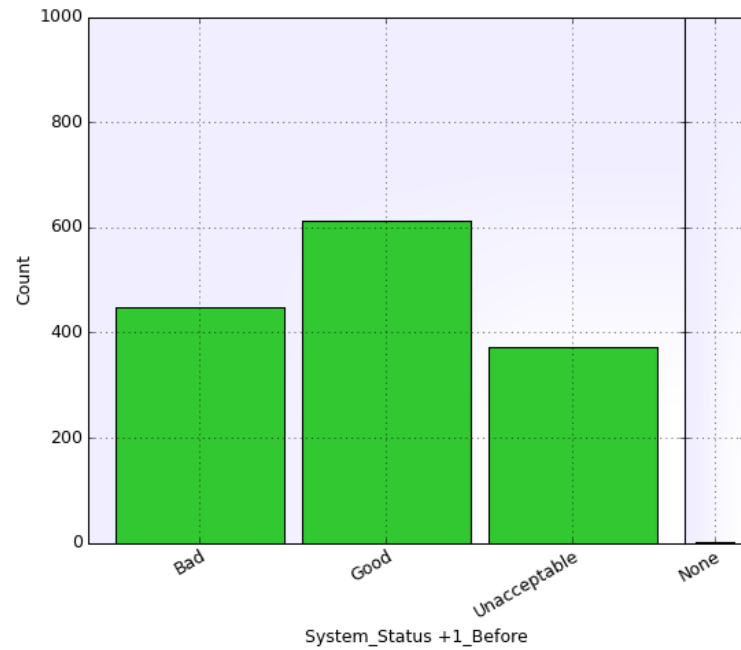
Rule 9: if $N_Pumps(A04) > 2$ AND $Time < 06:00:00$ then Performance = Bad

Thanks to the rules, the reason for inefficiency is clearly detectable.

Changing the number of pumps activated in the network node A04, the «Bad» rule is not fulfilled anymore.

All the patterns characterized by pressure range violations or by bad energy efficiency can be similarly addressed and corrected

Improvement estimate



After applying the Find & Replace, «Good» cases grows from around 600 to more than 900

Rulex

THE AI THAT TELLS YOU WHY™

