BigData/Analytics & Internet-of-Things in Products Life-Cycle Management

- From Theory to Practice

Big data e data Analytics - Sfide ed opportunità per piccole e grandi aziende

Department of Computer Science and Engineering
&
Department of Industrial Engineering
Alma Mater Studiorum, University of Bologna

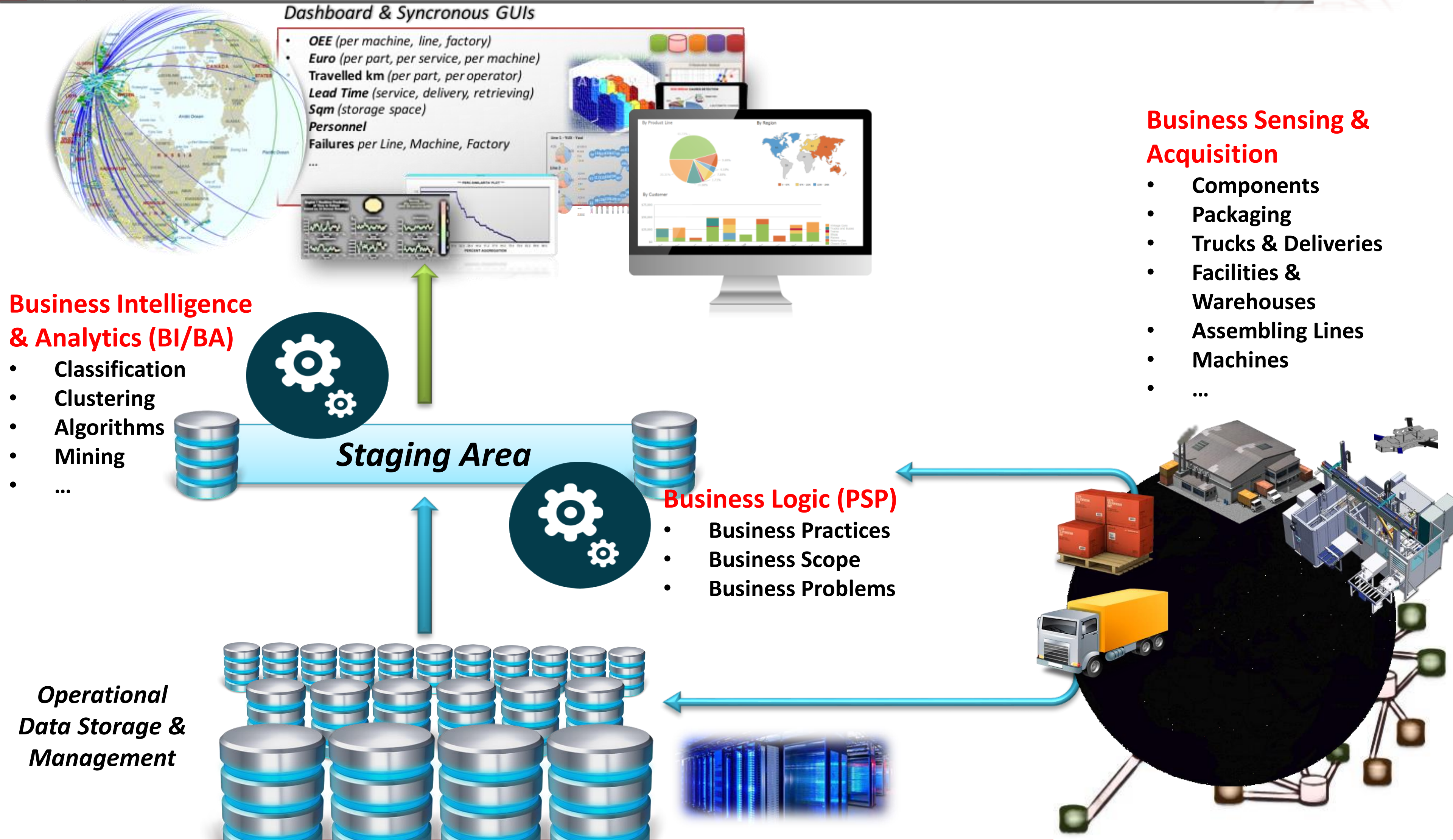
Eng. Riccardo Accorsi, Ph.D., Assistant Professor
Prof. Eng. Marco Patella, Professor

October, 12th, Cineca Building

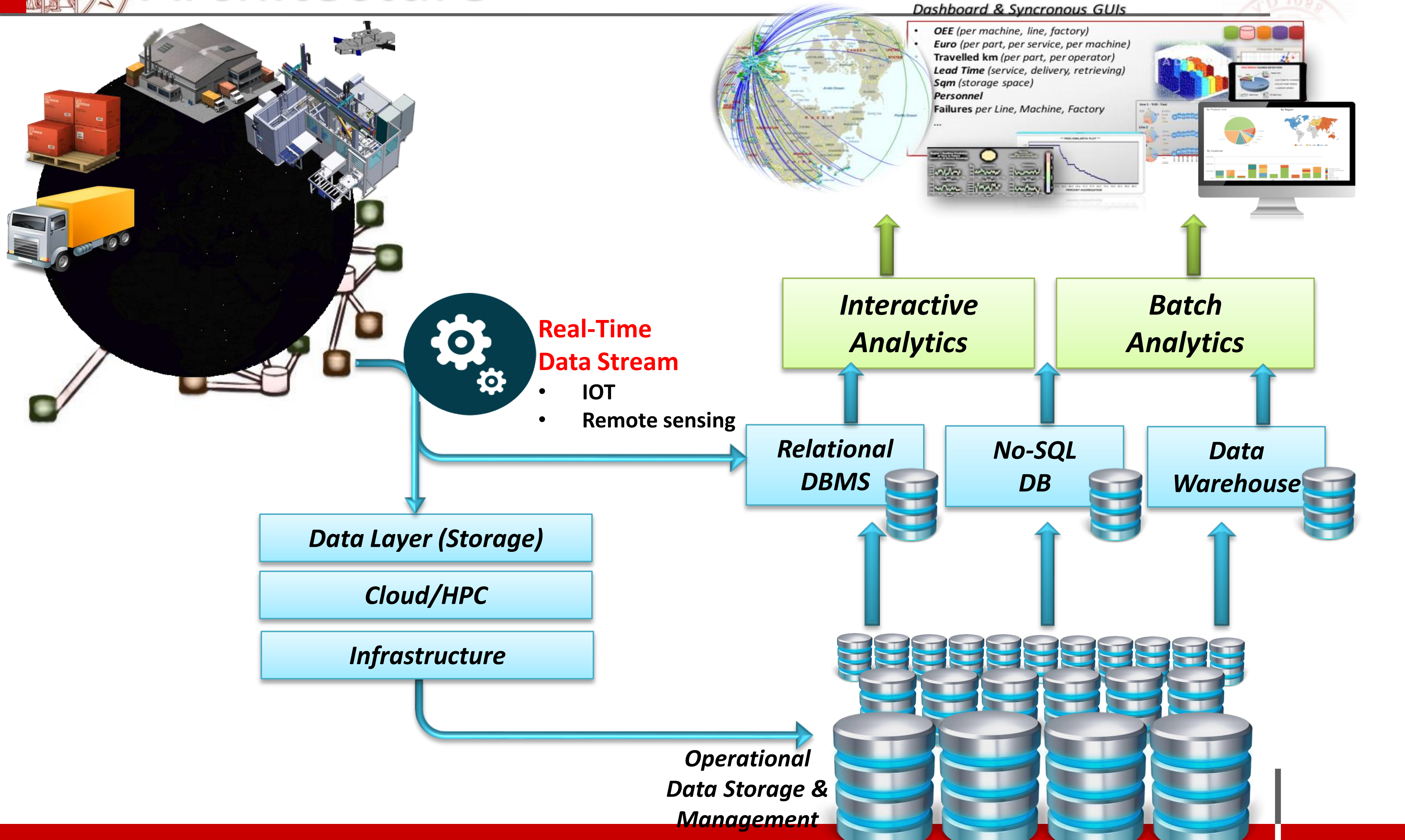
Agenda

- Business-Driven Analysis & Architecture
- Big Data System Architecture
- Computer Science & Industrial Engineering: Why together?
- Some Definitions
- From theory to practice:
  - Business Life-Cycle management (Automated Machine Industry)
  - Analytics in Dailure Diagnostic, Trouble Shooting and Condition-based Maintenance (Automated Machine Industry)

Business-Driven Analytics Architecture

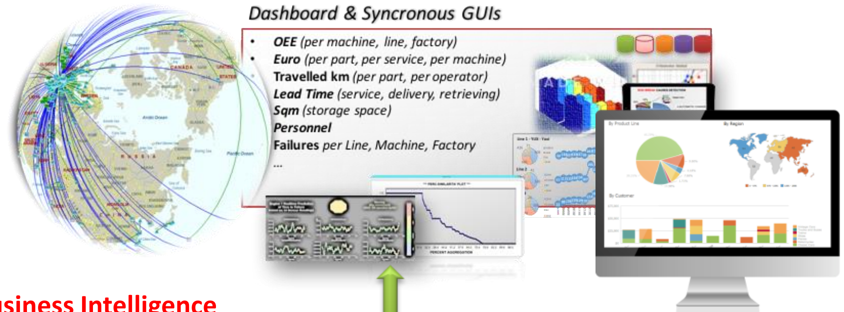


Business Driven Big Data Architecture



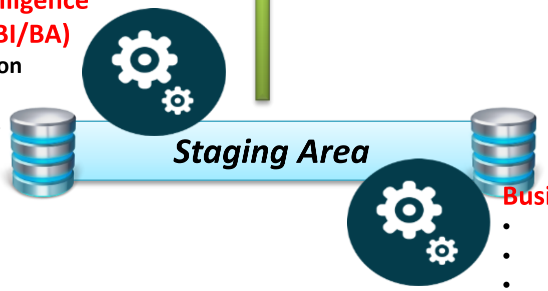
Industrial Engineering & Computer Science

Why together?



Business Intelligence & Analytics (BI/BA)

- **Classification**
- **Clustering**
- **Algorithms**
- **Mining**
- **…**



Business Logic (PSP)

- **Business Practices**
- **Business Scope**
- **Business Problems**

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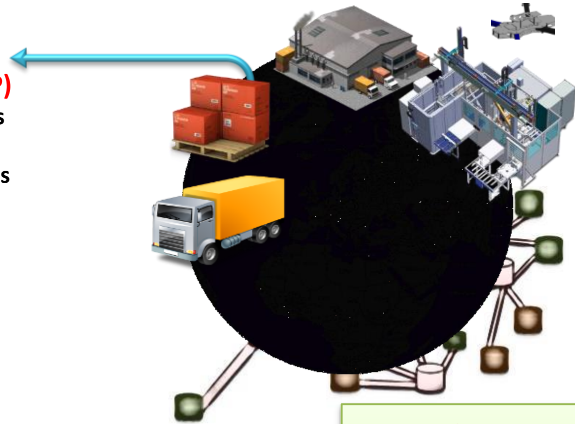
- **Operations management**
- **Manufacturing control**
- **Assembling system optimization**
- **Handling & Warehousing**
- **Distribution network design**
- **Event-driven Simulation**
- **Reliability & Maintenance Management**



- **Data Analytics**
- **Correlation Analysis**
- **Data Warehousing**
- **Data Mining**
- **Big data**

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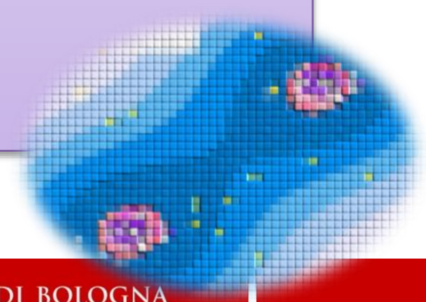
Business Logic Understanding

- **Do I really know my problem?**
- **Are there proper models to address my problem?**
- **Could I customize this model to work for me?**

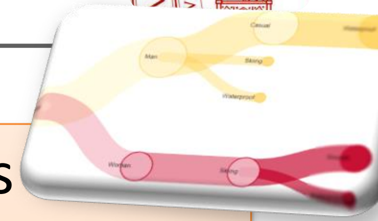
Data Analytics Techniques (i)

- Classification
  - Identifying to which sub-population a new item belongs on the basis of a training set of items whose sub-population is known
  - **App**: pattern recognition, biological/biometric classification
- Associative Rules
  - Discovering interesting relations between variables
  - **App**: pricing/product placement, intrusion detection

- Clustering
  - Grouping objects so that objects in the same group are more similar to each other than to those in other groups
  - **App**: market research, grouping of shopping items/customers
- Outlier Detection
  - Identification of items which do not conform to an expected pattern
  - **App**: intrusion/misuse detection, fraud discovery



Data Analytics Techniques (ii)

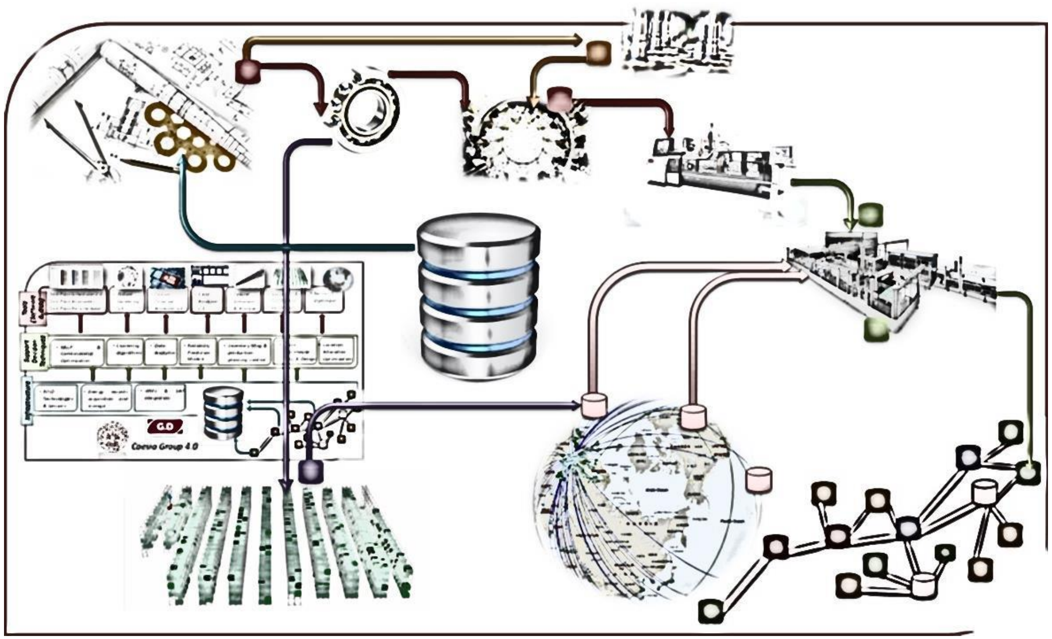


- Time Series Analysis
  - Analyzing time series data to extract meaningful statistics and other data characteristics
  - **App**: Forecasting, classification
- Text Mining
  - Deriving high-quality information from text
  - **App**: Indexing, customer relationship management

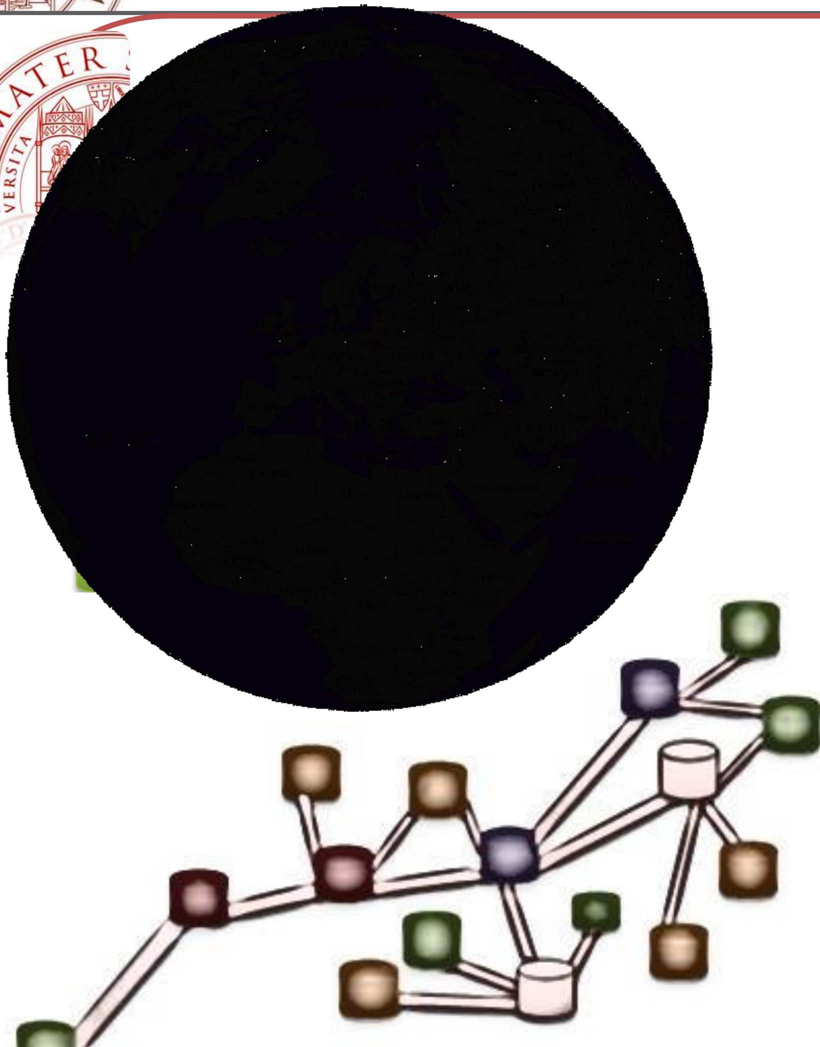
- Clickstream analysis
  - Recording of the parts of the screen a computer user clicks on while web browsing
  - **App**: Market research, employee productivity
- Sentiment analysis
  - Identifying and extracting subjective information in source materials
  - **App**: Enterprise/product reputation

From Theory to Practice

Business Life-Cycle Management



From IOT to IOLM
(Internet Of Logistics & Maintenance)



Factories

- *Lines & machines installation*
- *Training customer operators*
- *Ordinary and corrective maintenance*
- *Maintenance services & spare parts demand*

Regional Maintenance Service Provider (MSP)

- *Spare parts management and fulfillment*
- *Maintenance service delivery (Preventive, Corrective, etc.)*

Spare parts supplier

- *Spare parts manufacturing & supplying*
- *Spare inventory management*

Distribution center

- *Spare parts warehouse*
- *Order picking and storage efficiency*
- *Packaging issues*

Business Plant

- *Production system management*
- *Lot per lot/batching scheduling*
- *Personell management*

From IOT to IOLM
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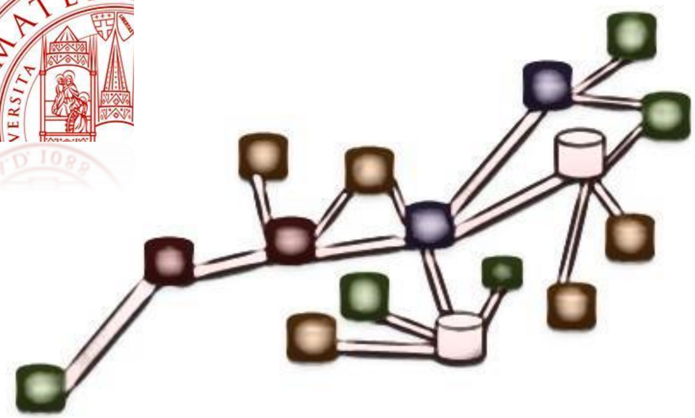


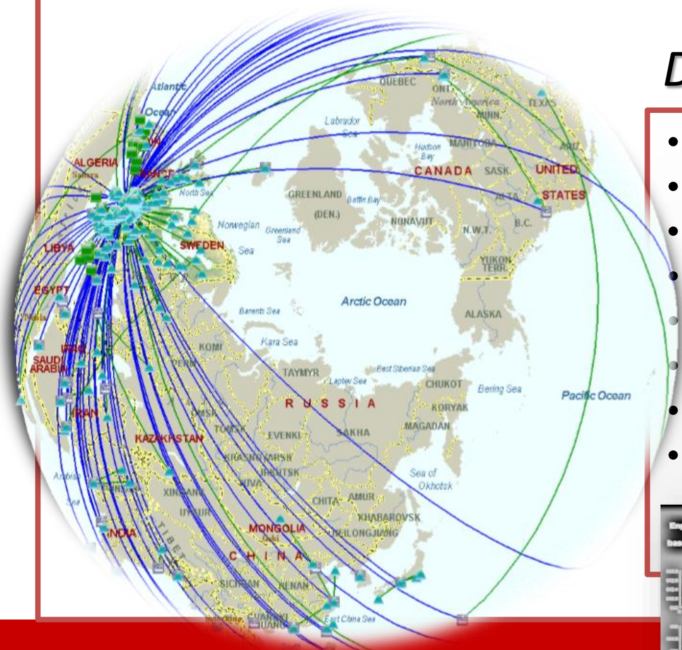
Factories

Regional Maintenance Service Provider (MSP)

Distribution center

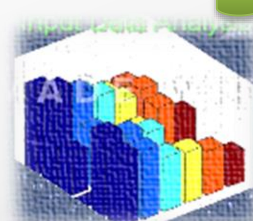
Spare parts supplier

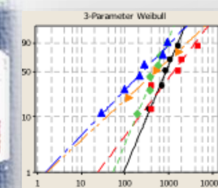
Business Plant

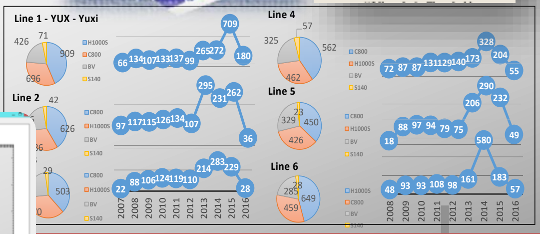


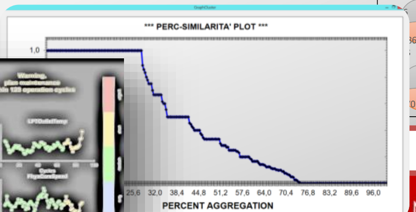
Dashboard & Syncronous GUIs

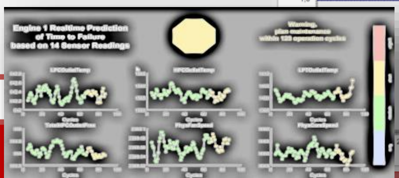
- ***OEE*** *(per machine, line, factory)*
- ***Euro*** *(per part, per service, per machine)*
- **Travelled km** *(per part, per operator)*
- ***Lead Time*** *(service, delivery, retrieving)*
- ***Sqm*** *(storage space)*
- ***Personnel***
- **Failures** *per Line, Machine, Factory*
- …



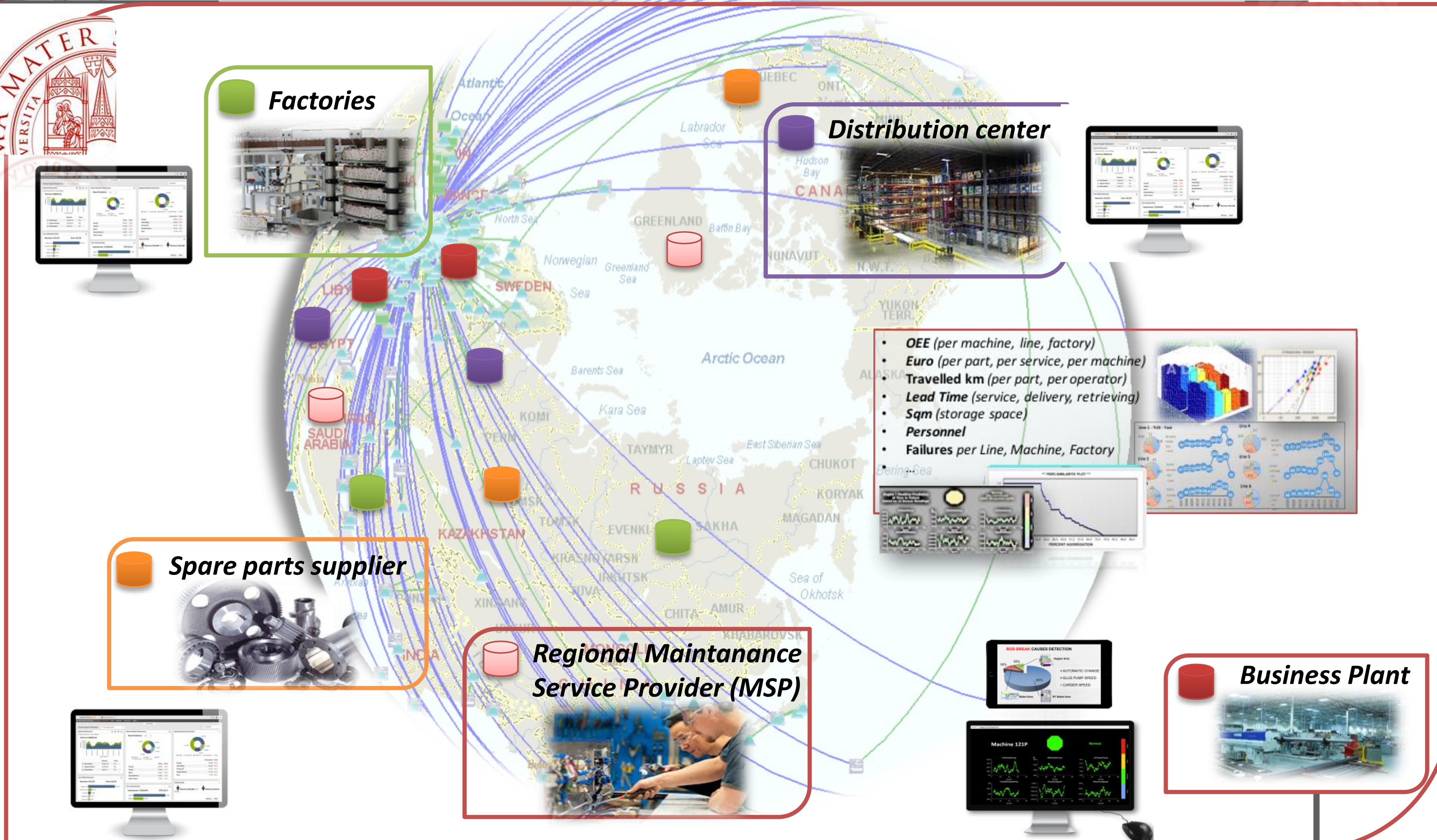




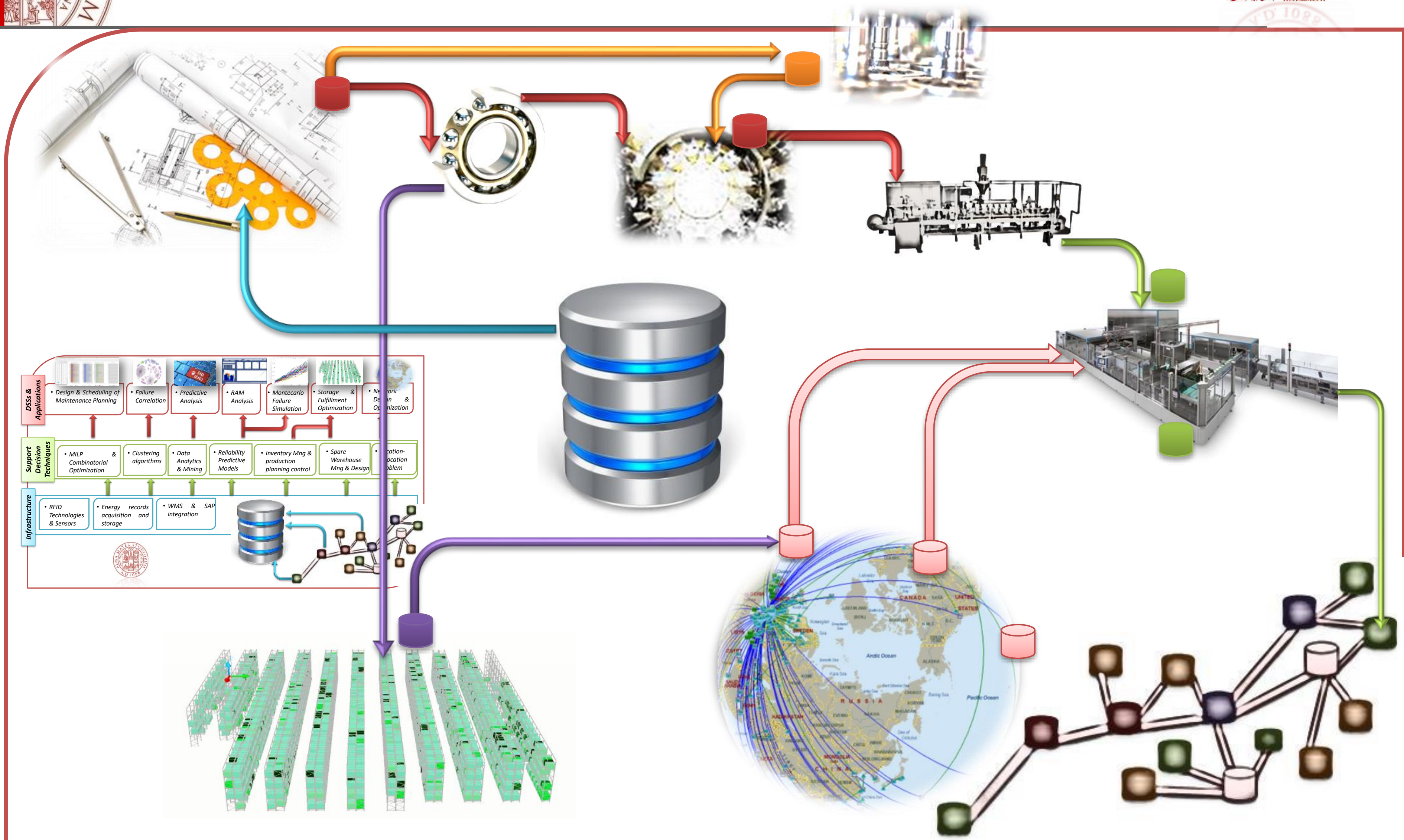




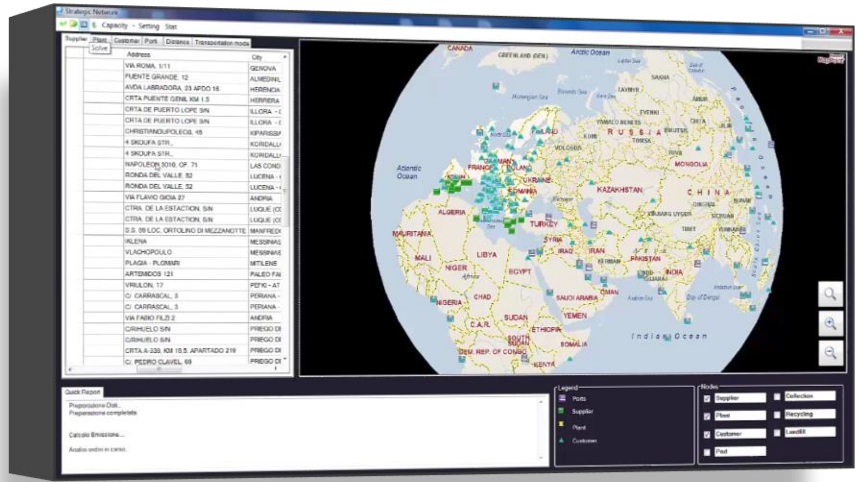
From IOT to IOLM
(Internet Of Logistics & Maintenance)

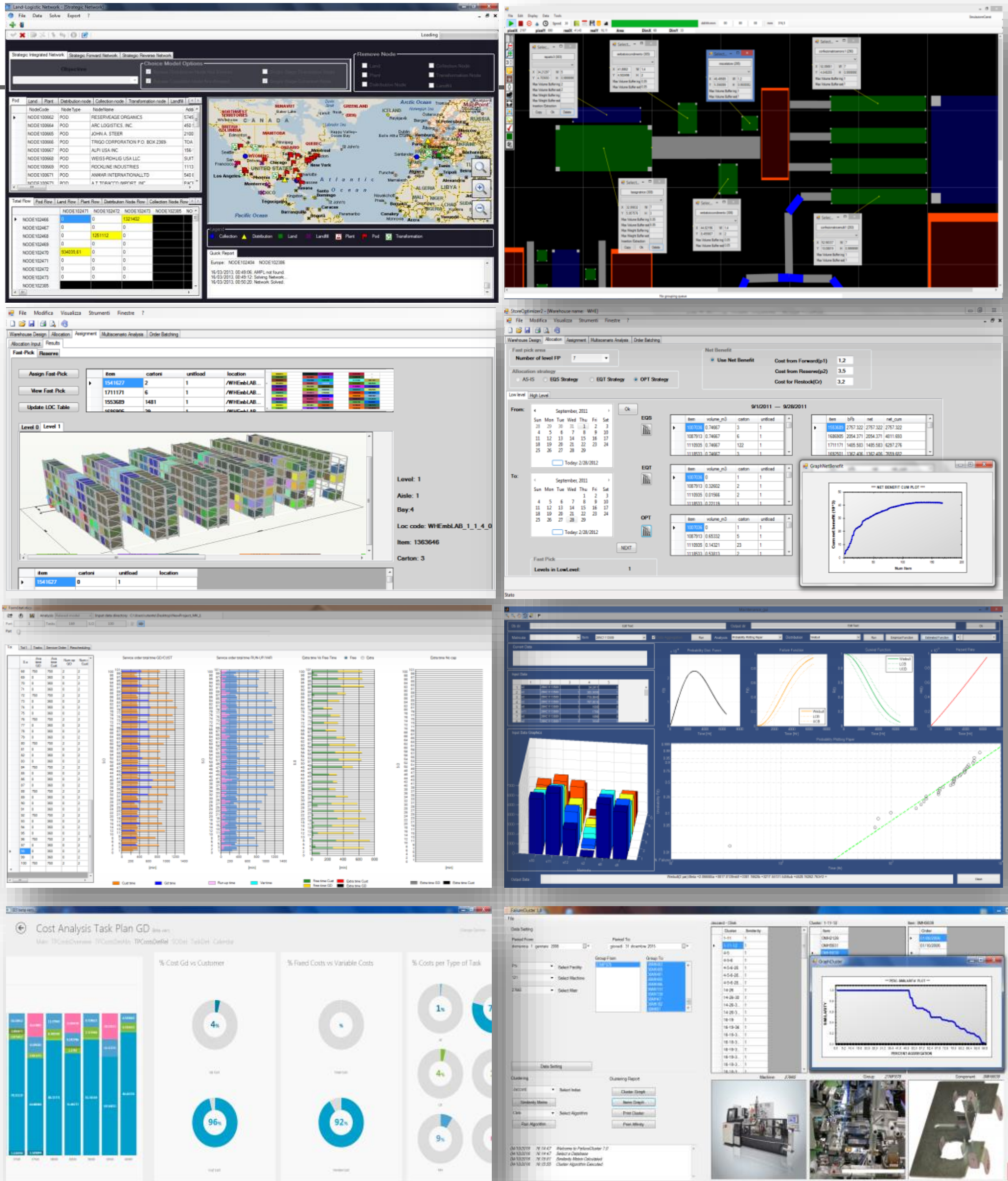


From IOT to IOLM – Accounting Component Life Cycle



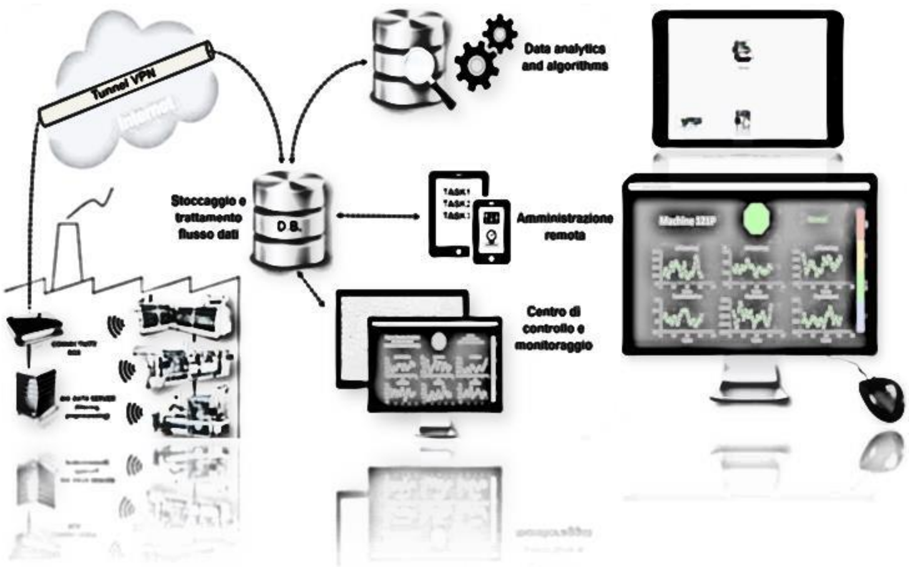
Tools & GUIs for Business Life Cycle Management





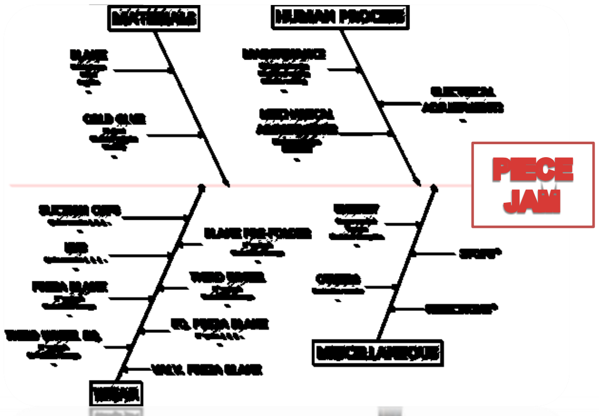
From Theory to Practice

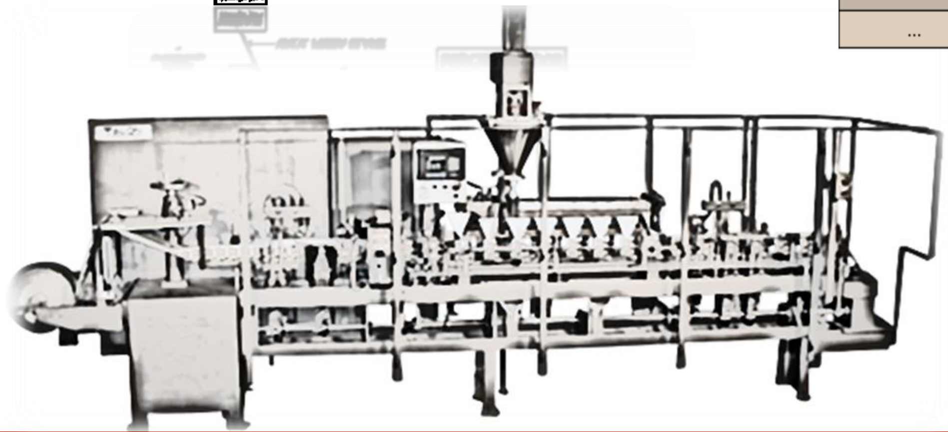
Analytics in Dailure Diagnostic, Trouble Shooting and Condition-based Maintenance



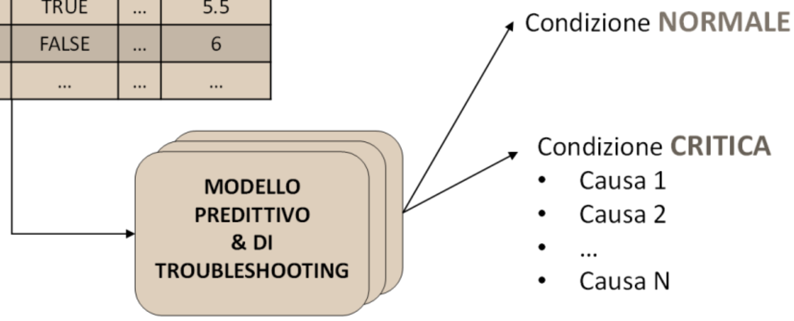
Scope

- Develop robust models to **Predict** failures and avoids stops, System **Diagnostic,** and aid **Troubleshooting.**
- Analyzing the **historical** machine working status to predict whether the machine status will be Normal or Critic in the next minute.





TIMESTAMP	VAR 1	VAR 2	...	VAR N
12:00:01	0.002	TRUE	...	5
12:00:02	0.003	TRUE	...	5.5
12:00:02	0.126	FALSE	...	6
...	...	...	...	...



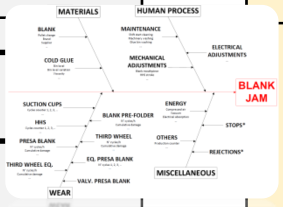
Step of Analysis

I Step
Problem Assessment

- Pick Target Machine
- Failures or Criticalities Identification
- Connection Stop - Failure

II Step
Identification of variables to be controlled

- Failure Fishbone Diagrams
- Machine Status & Associative Rules
- Parameter Analysis – Info Gain
- Energy Data Analysis – Info Gain



III Step
Predictive model Design

- Classification
- Validation

TIMESTAMP	VARIABILI DA DIAGRAMMA FISHBONE					VARIABILI DA REGOLE ASSOCIATIVE					PARAMETRI					VARIABILI DI ENERGY			
	A	B	C	D	E	A	B	C	D	E	1	2	3	4	5	A	B	C	D
12:00:01	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12:00:02	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12:00:02	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
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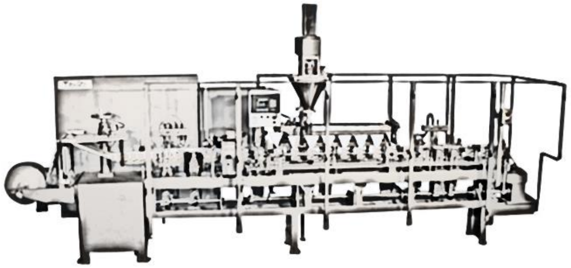
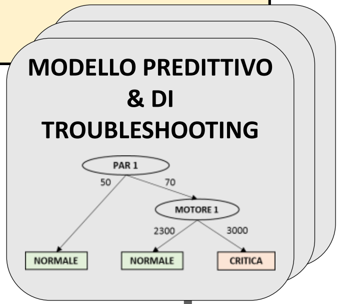
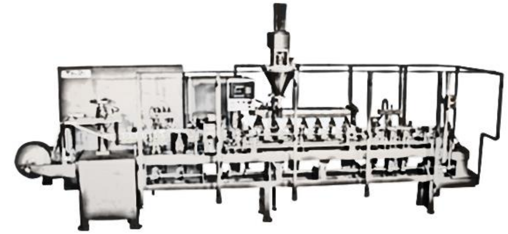
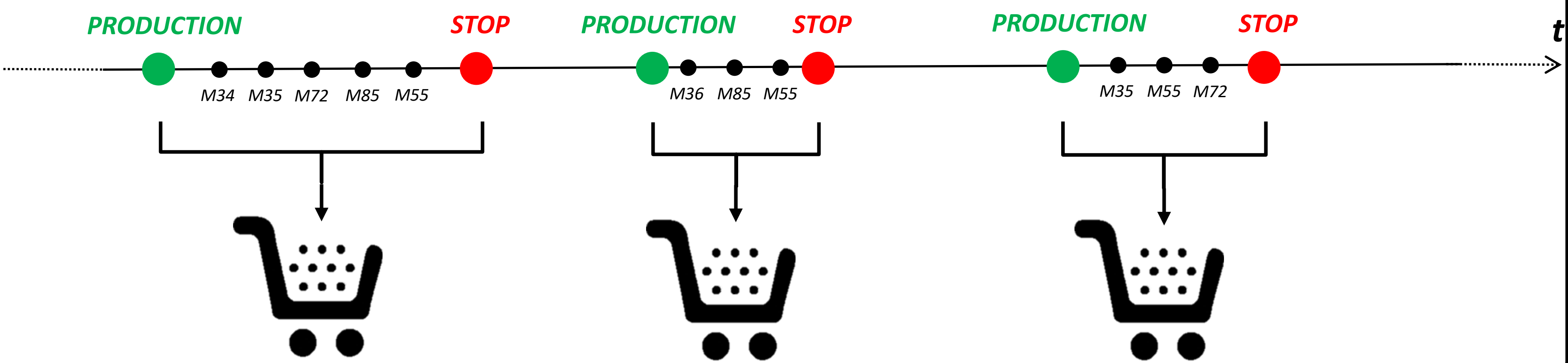




Associative Rules



Building «Basket» of Machine Status before Stops



OCCURENCES SEARCH (Apriori)

1. *Analysis of the unordered baskets.*
2. *Assessment of the obtained results with team of workers UT/PPO/GT*

Example

LOWER REEL RELEASED – MAKER -> ROD BREAK (45% dei RB totali)*

Relationship Cause-> Effect

EXCESSIVE PIECE REJECTION – CID -> ROD BREAK (89% dei RB totali)*

Relationship Effect-> Effect

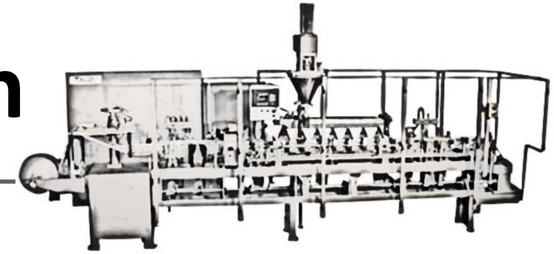
FREQUENT SEQUENCES SEARCH (GSP)

1. *Analysis of the ordered baskets.*
2. *Assessment of the obtained results with team of workers UT/PPO/GT*

Example

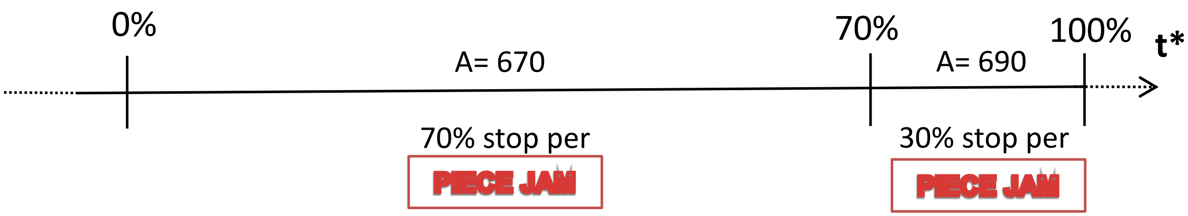
NOMINAL SPEED -> LOW PROD. SPEED -> PIECE JAM (16% dei BJ totali)*

Parameter Analysis – Info Gain



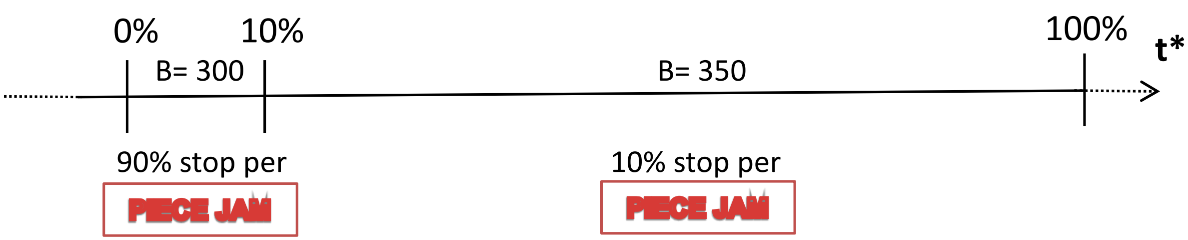
Example of Info-Gain:

- *Case 1:* parameter A



Low Info Gain

- *Case 2:* parameter B

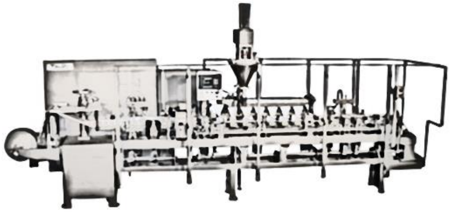


High Info Gain

Scopes:

- Identify those parameters presenting High Info Gain in order to not affect the analysis and increase the accuracy of the predictive model.
- Assess critical values for the identified parameters and aid machine settings accordingly.

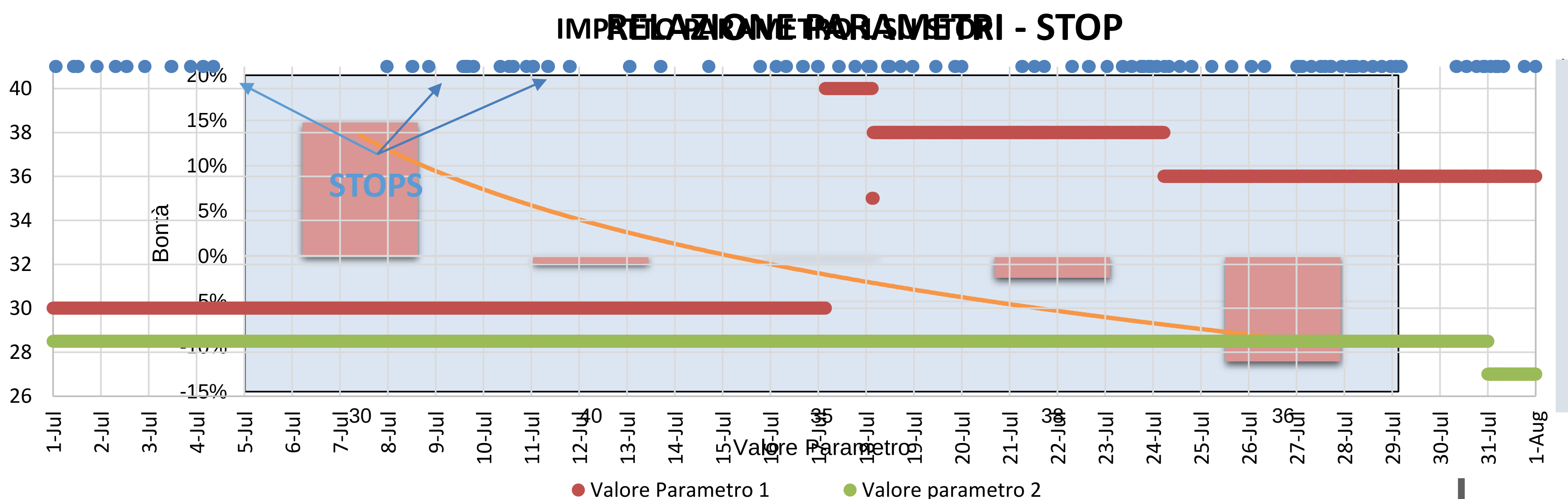
Parameter Analysis – Info Gain



PARAMETER	VALUE	START	PERIODS (Day)	%TIME	N° STOP	%STOPS	GOODNESS
Parameter 1	30	7/1/16 0:00	16.02	51.68%	381	36.92%	14.76%
Parametro 1	40	7/17/16 3:14	0.97233	3.50%	41	3.97%	-0.84%
Parametro 1	35	7/18/16 2:40	0.02488	0.09%	0	0.00%	0.09%
Parametro 1	38	7/18/16 3:16	6.08941	22.16%	226	21.90%	-2.54%
Parametro 1	36	7/24/16 5:24	6.99227	22.56%	353	34.21%	-11.65%
Parametro 2	2850	7/1/16 0:00	30.0045	96.79%	977	94.67%	2.12%
Parametro 2	2700	7/31/16 0:06	0.99553	3.21%	55	5.33%	-2.12%

Info Gain = 29,88 (Parametro 1)

Info Gain = 4,24 (Parametro 2)



- Parameter 1 is the best for the classification algorithms
- The value 36 of Parameter 1 is critical to the obsreved problem (Failure).

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ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Riccardo Accorsi, Ph.D

riccardo.accorsi2@unibo.it

Marco Patella, Prof.

marco.patella@unibo.it

Department of Industrial Engineering

Department of Computer Science and Engineering