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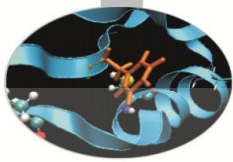
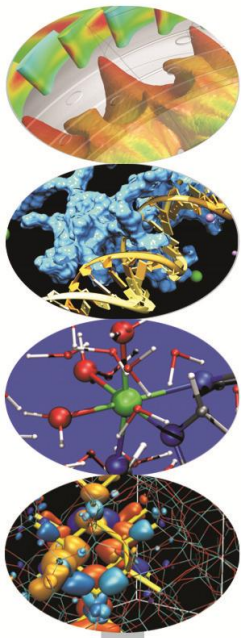
SuperComputing Applications and Innovation



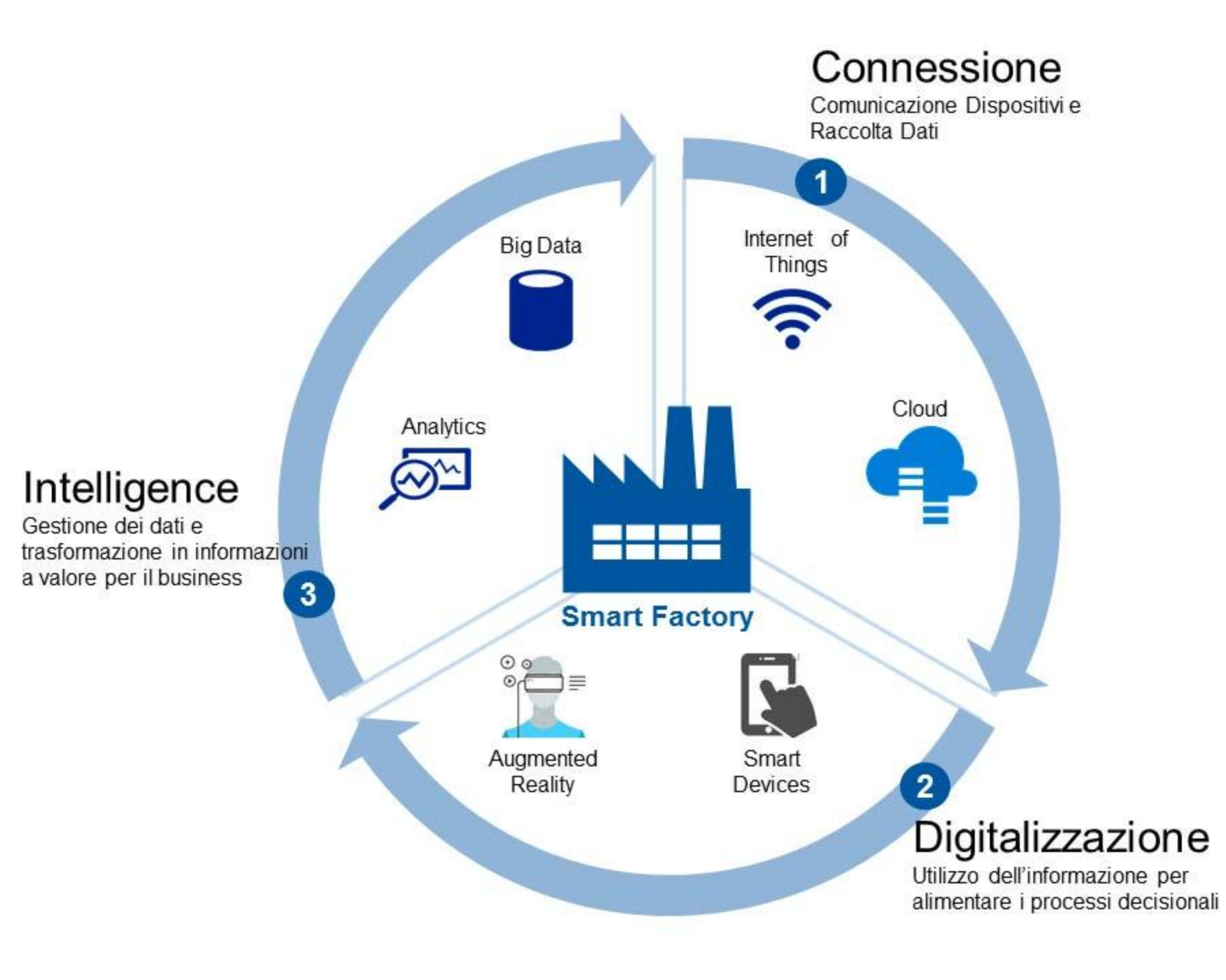


5 Aprile 2017

Soluzioni innovative per il 4.0
Big Data e Data Analytics

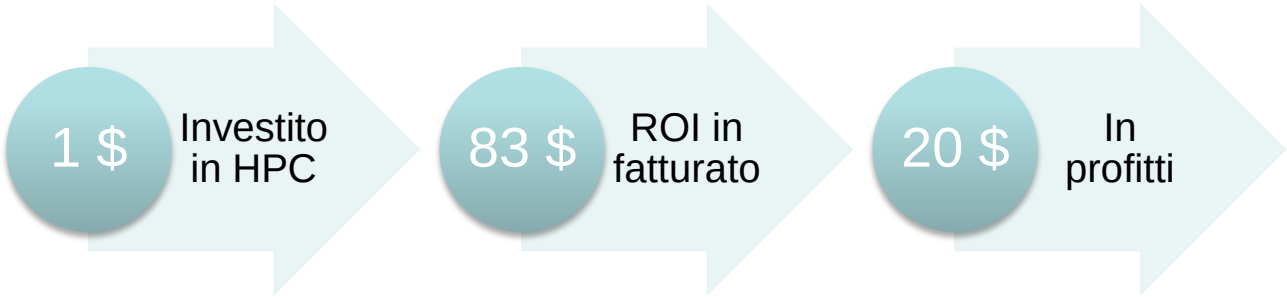
Gabriella Scipione, CINECA
Roberta Turra, CINECA

CINECA

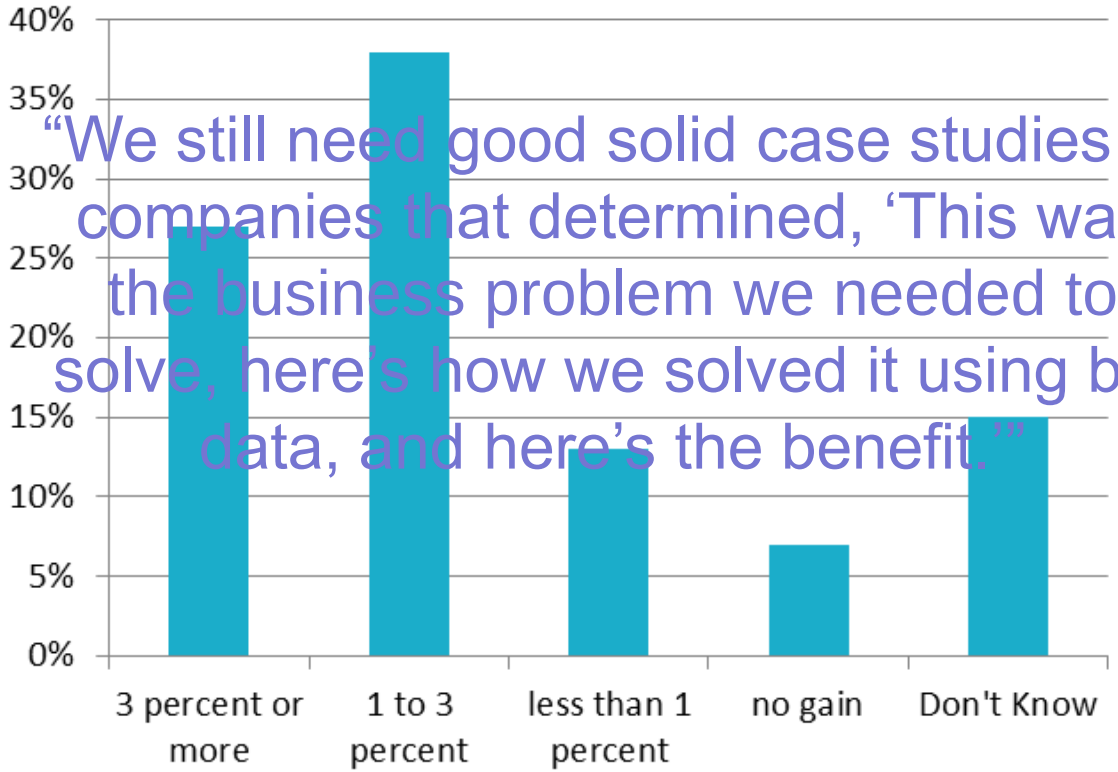

Connessione
Comunicazione Dispositivi e Raccolta Dati
1
Internet of Things
Cloud
Big Data
Analytics
Intelligence
Gestione dei dati e trasformazione in informazioni a valore per il business
3
Smart Factory
Augmented Reality
Smart Devices
2
Digitalizzazione
Utilizzo dell'informazione per alimentare i processi decisionali

Big data analytic's impact on revenues according to Teradata's survey

HPC



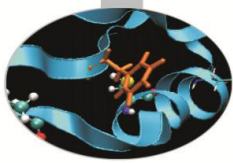
Big Data



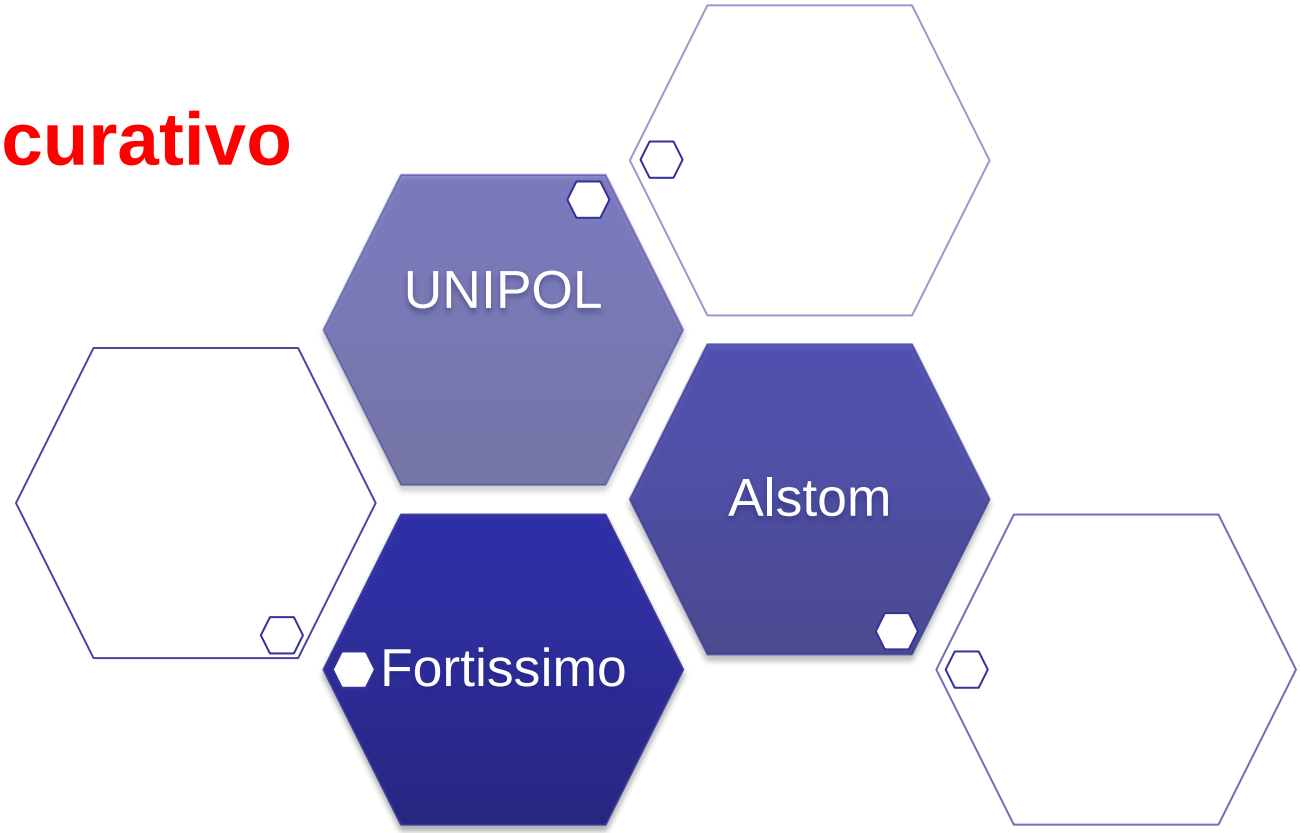
"We still need good solid case studies of companies that determined, 'This was the business problem we needed to solve, here's how we solved it using big data, and here's the benefit.'"

https://www.datanami.com/2015/09/08/wheres-the-roi-in-big-data/

Quali sono i problemi industriali che Big Data e Data Analytics permettono di affrontare



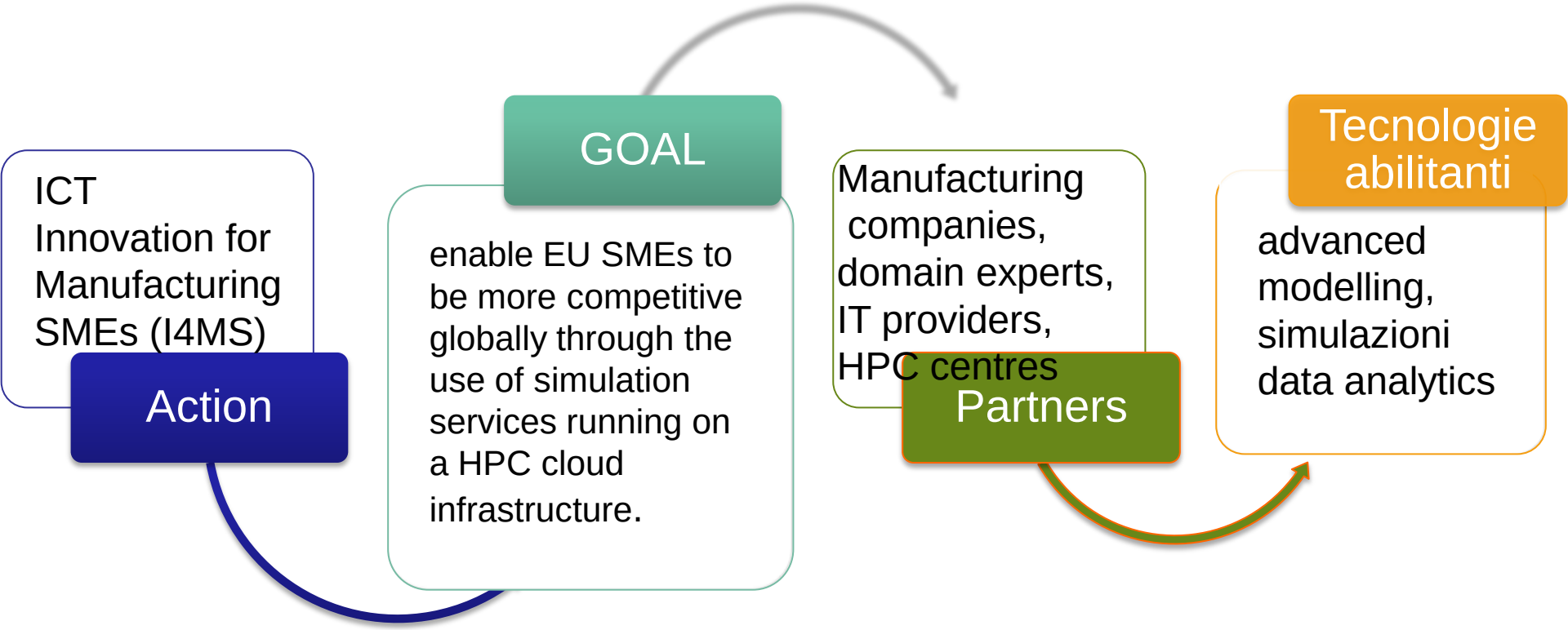
Assicurativo



Automobilistico / Manifatturiero

Solutions and services for manufacturing SMEs to help grow your business.

FORTISSIMO



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FORTISSIMO

PRESERVE: PREdictive diagnosis SERvices for automotiVE industry

TEXA: specializzata nella progettazione e realizzazione di strumenti diagnostici per il settore automotive

TEXA: specializzata nella progettazione e realizzazione di strumenti diagnostici per il settore automotive

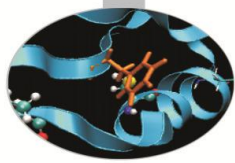
CINECA: coinvolgimento di specialisti in HPC:

- **per diminuire i tempi di elaborazione**
- **per miglioramento degli algoritmi per l'estrazione informazioni dai dati e trattamento dei dati stessi e per le analisi predittive**

TEXA CINECA t4i I4MS

CINECA

UNIPOL



Simulazione

Simulazione dell'evoluzione del **market risk**

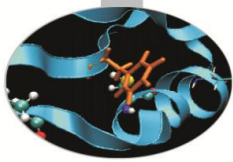
Solvency II, Art. 44 (1) stabilisce che le imprese di assicurazione e di riassicurazione abbiano in atto un sistema di gestione dei rischi

Big Data Lab

- Personalizzazioni delle Polizze assicurative per gli utenti
- Diminuzione delle frodi assicurative

Sviluppo di PoC

Presidio Tecnologico

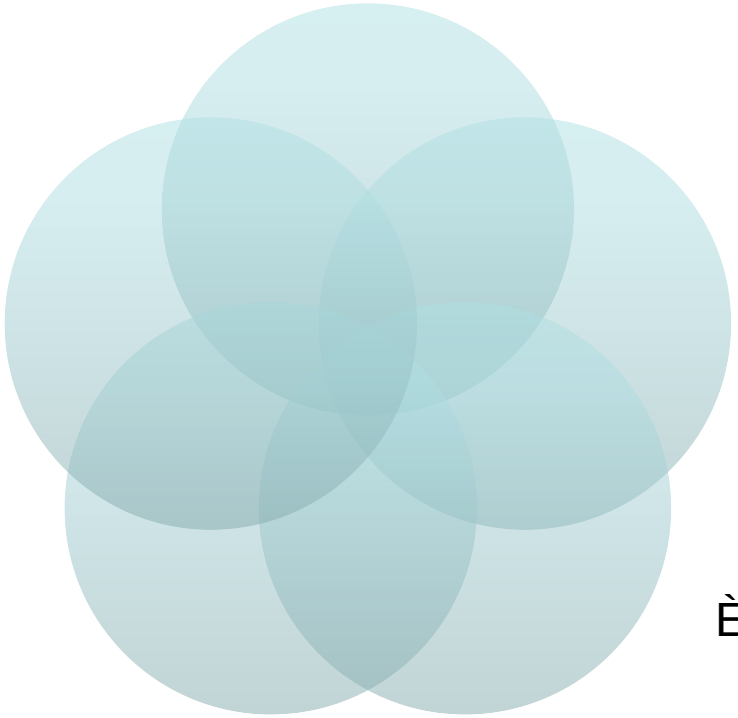


Le PMI e le principali sfide

Partire può essere costoso

Mancano le storie di successo che aiutini a convincere i decision maker dell'azienda

Il progetto viene a collocarsi nella voce di costo dell'azienda (R&D)



Le competenze sono difficili da trovare

È difficile scegliere ed accedere alle giuste risorse di calcolo e software

CINECA SCAI
SuperComputing Applications and Innovation

CINECA è un consorzio interuniversitario senza scopo di lucro al servizio della ricerca nazionale.

Nasce nel ’69 con lo scopo di promuovere l’utilizzo dei più avanzati sistemi di elaborazione dell’informazione a favore della ricerca tecnologica e scientifica.

Punto di riferimento per il sistema accademico nazionale.
…ma anche per le imprese

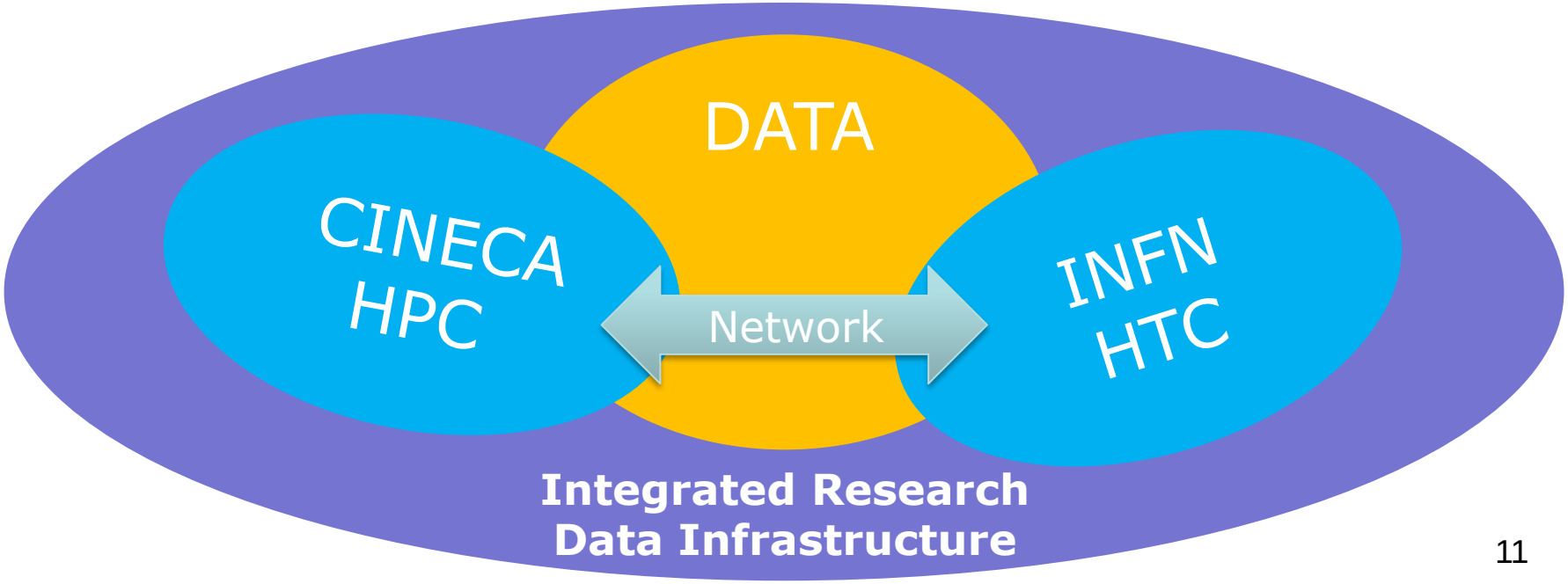
CINECA con la sua infrastruttura si posiziona:
- MARCONI 12 posto Top500 per sistemi di calcolo dedicati alla ricerca e big data
- 6 posto dopo Cina, USA, …

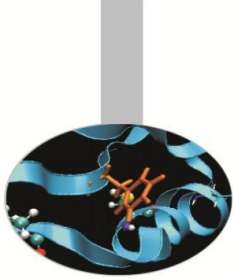
CERN LHC produce circa 15 PB di dati all’anno.
Luglio 2012 CERN ha prodotto 200 PB di data dagli 800 trillioni di collisioni per arrivare alla scoperta del bosone di Higgs

Infrastruttura Nazionale Big Data Science Park Bologna

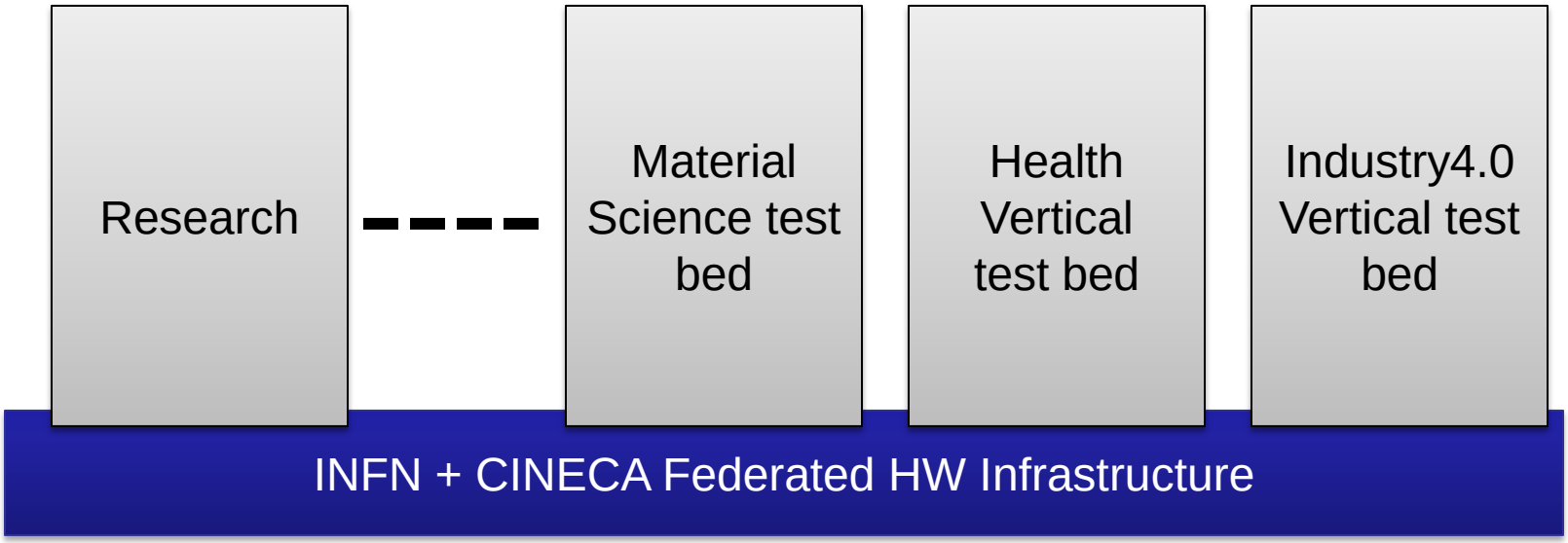
Integrazione dell'infrastruttura computazionale CINECA-HPC e INFN-HTC per fornire servizi per :

- Ricerca istituzionale di base e applicata
- P.A.
- Proof of Concept e innovazione per industrie e organizzaizoni private





ER Big-data Framework Project



The European perspective: EuroHPC

60 ROME DIGITAL DAY

Rome, 23 March 2017

Who

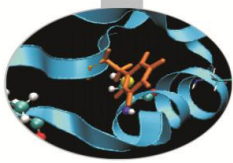
- 7 paesi europei (Italia, Francia, Germania, Lussemburgo, Paesi Bassi, Portogallo e Spagna)

What

- firmano la dichiarazione sul "supercalcolo",
- creazione EuroHPC, che sarà messa a disposizione delle comunità scientifiche, dell'industria e del settore pubblico in tutta l'UE

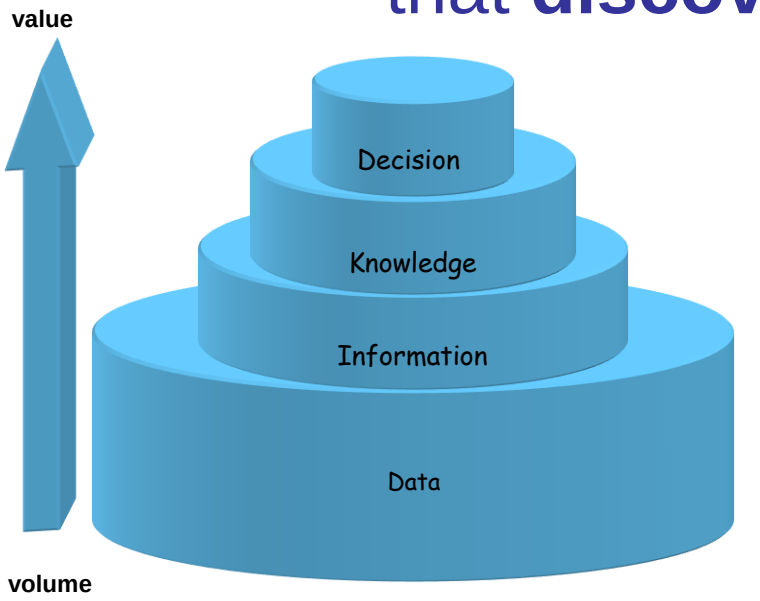
Why

- che potrà accrescere le capacità scientifiche e la competitività industriale dell'Europa.

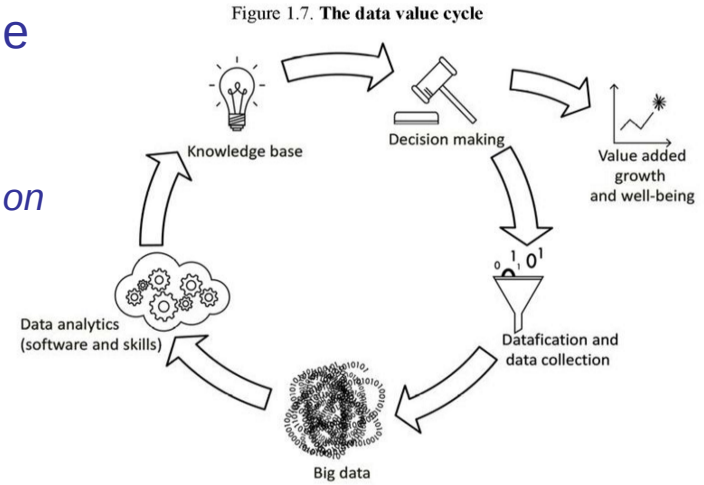


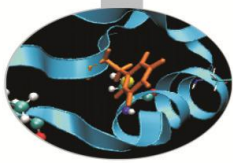
Data analytics

The **process** of extracting useful insights from raw data using algorithms that **discover** hidden patterns

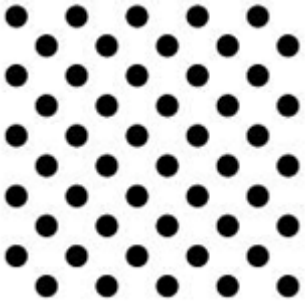
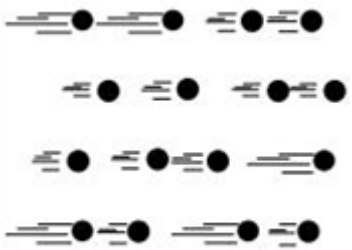
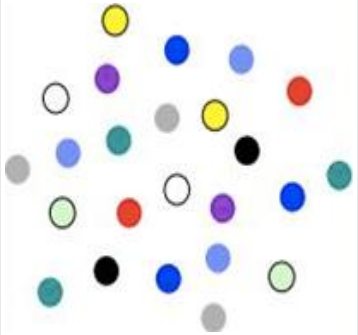


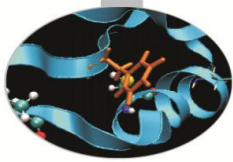
A step in the data value cycle
(OECD report on Data Driven Innovation)





Why is it challenging

Volume	Velocity	Variety
		
Data at Rest	**Data in Motion**	**Data in Many Forms**
Terabytes to exabytes of existing data to process	**Streaming data, requiring mseconds to respond**	**Structured, unstructured, text, multimedia,…**

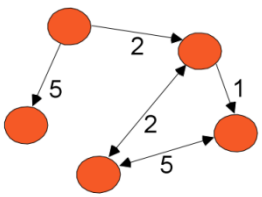


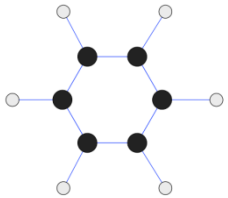
Data typologies

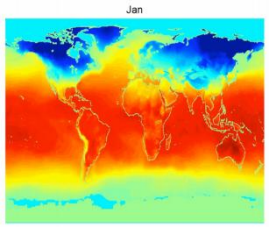
- structured data
  - data matrix
  - transactional data
- graph
  - web and social networks
  - molecular structures
- ordinal data
- spatial data
- time series
- sequences
  - genetic sequences
- unstructured data
  - textual documents
  - images
  - audio and videos (multimodal)

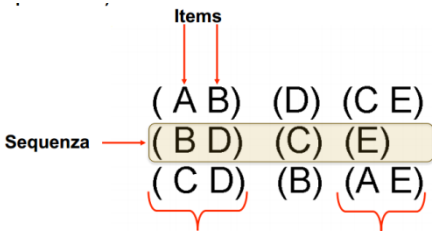
Tid	Refund	Marital Status	Taxable Income	Cheat
1	Yes	Single	125K	No
2	No	Married	100K	No
3	No	Single	70K	No
4	Yes	Married	120K	No
5	No	Divorced	95K	Yes
6	No	Married	60K	No
7	Yes	Divorced	220K	No
8	No	Single	85K	Yes
9	No	Married	75K	No
10	No	Single	90K	Yes

TID	Items
1	Bread, Coke, Milk
2	Beer, Bread
3	Beer, Coke, Diaper, Milk
4	Beer, Bread, Diaper, Milk
5	Coke, Diaper, Milk

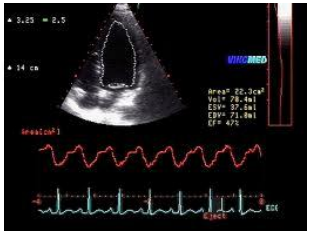


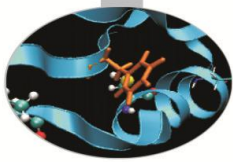






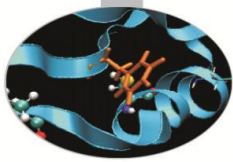

```
GGTTCCGCCTTCAGCCCCGCGCC
CGCAGGGCCCGCCCCGCGCCGTC
GAGAAGGGCCCGCCTGGCGGGCG
GGGGGAGGCGGGGCCGCCCGAGC
CCAACCGAGTCCGACCAGGTGCC
CCCTCTGCTCGGCCTAGACCTGA
GCTCATTAGGCGGCAGCGGACAG
GCCAAGTAGAACACGCGAAGCGC
TGGGCTGCCTGCTGCGACCAGGG
```





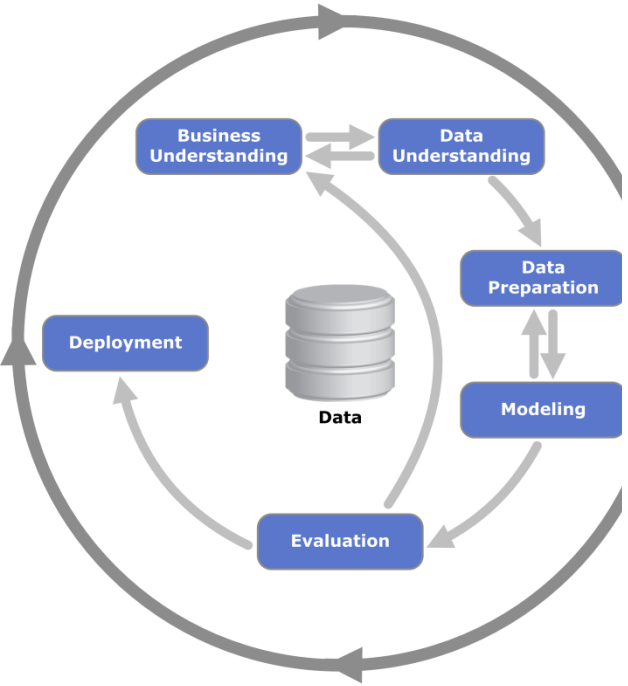
Data as an infrastructure

Data has become the key infrastructure for 21st century knowledge economies. Data are not the “new oil”, they are rather an infrastructure and capital good that can be used across society for a theoretically unlimited range of productive purposes, without being depleted.



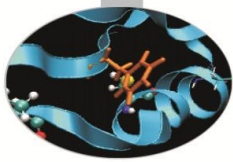
CRISP-DM reference model

Cross Industry Standard Process for Data Mining

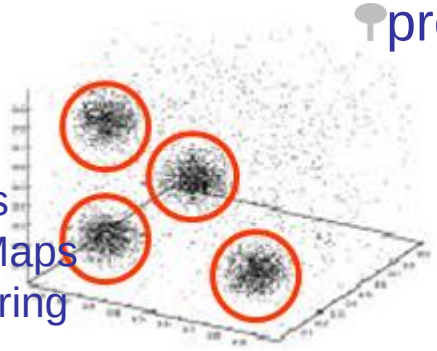


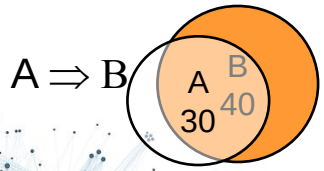
Business Understanding	Data Understanding	Data Preparation	Modeling	Evaluation	Deployment
Determine Business Objectives *Background* *Business Objectives* *Business Success Criteria*	**Collect Initial Data** *Initial Data Collection Report*	**Select Data** *Rationale for Inclusion/ Exclusion*	**Select Modeling Techniques** *Modeling Technique* *Modeling Assumptions*	**Evaluate Results** *Assessment of Data Mining Results w.r.t. Business Success Criteria* *Approved Models*	**Plan Deployment** *Deployment Plan*
Assess Situation *Inventory of Resources* *Requirements, Assumptions, and Constraints* *Risks and Contingencies* *Terminology* *Costs and Benefits*	**Describe Data** *Data Description Report*	**Clean Data** *Data Cleaning Report*	**Generate Test Design** *Test Design*	**Review Process** *Review of Process*	**Plan Monitoring and Maintenance** *Monitoring and Maintenance Plan*
Determine Data Mining Goals *Data Mining Goals* *Data Mining Success Criteria*	**Explore Data** *Data Exploration Report*	**Construct Data** *Derived Attributes* *Generated Records*	**Build Model** *Parameter Settings* *Models* *Model Descriptions*	**Determine Next Steps** *List of Possible Actions* *Decision*	**Produce Final Report** *Final Report* *Final Presentation*
Produce Project Plan *Project Plan* *Initial Assessment of Tools and Techniques*	**Verify Data Quality** *Data Quality Report*	**Integrate Data** *Merged Data*	**Assess Model** *Model Assessment* *Revised Parameter Settings*		**Review Project** *Experience Documentation*
		Format Data *Reformatted Data* *Dataset* *Dataset Description*			

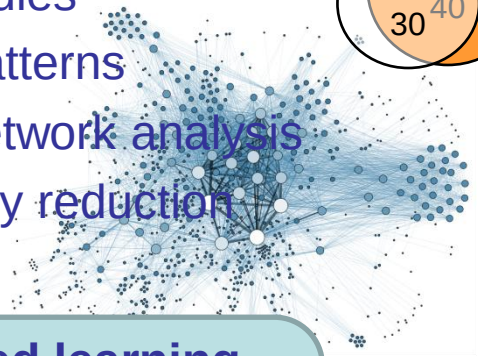
Tasks and techniques



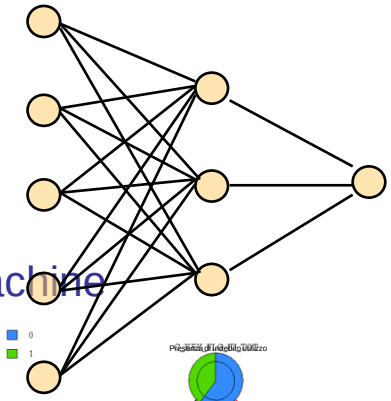
- descriptive
  - clustering
    - k-means
    - relational analysis
    - Self Organizing Maps
    - hierachical clustering
    - mixture model
    - …
  - association rules
  - sequential patterns
  - graph and network analysis
  - dimensionality reduction
  - …

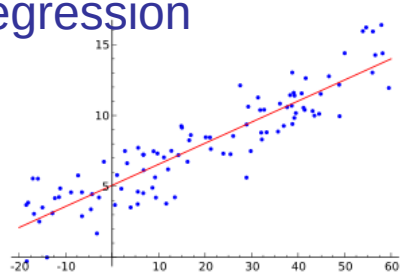


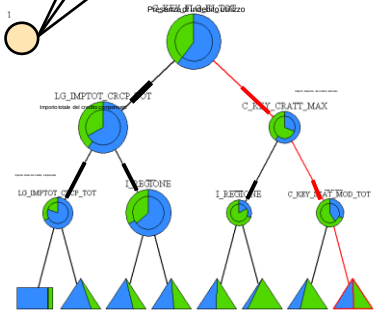




- predictive
  - classification (machine learning)
    - Naive Bayes
    - Decision Trees
    - Neural Networks
    - KNN
    - Rocchio
    - Support Vectors Machine
    - …
  - regression







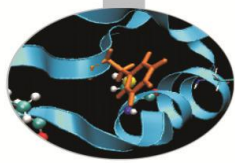
Unsupervised learning

training samples have no class information
guess classes or clusters in the data
we are given inputs but no outputs (unlabeled data)
we learn the "latent" labels

Supervised learning

use training samples with known classes to classify new data
we are given examples of inputs and associated outputs
we learn the relationship between them

Caso Alstom



Obiettivo

Valutare in modo automatico se una segnalazione di guasto attivata dal sistema di monitoraggio, sia effettivamente da segnalare all'area di manutenzione

Tecniche di Machine Learning utilizzate

- Decision Tree
- Random Forest
- Neural Networks
- Gradient Boosting Machine

Variabili per ogni evento osservato: 300 var. delle 2.000 disponibili (eventi di diagnostica)

last_run_id	ISSUE	1__CAB_A_1__SERV_T1__EB_ANTENNA_SWITCH			…	2__CAB_A_2__SERV_T2__EB_ANTENNA_SWITCH			…	3__CAB_A_3__SERV_T3__EB_ANTENNA_SWITCH			vero/falso
		ON	ETTO		….	ON	ETTO		….	ON	ETTO		
1559453	1	30	50	25		6	41	28		29	51	17	0
1561388	2	17	55	16		23	33	28		12	52	25	1
1561966	1	13	67	11		30	50	26		5	41	27	1
1593270	3	15	67	14		29	45	24		7	45	28	1
1656659	2	16	72	30		27	43	21		9	49	32	0
1656661	2	16	72	32		27	43	21		9	49	32	0
1656676	1	21	72	47		27	43	21		9	49	32	0
1699514	1	19	97	12		22	80	13		20	83	15	1
1704569	1	13	66	15		16	103	14		24	56	15	1
1748299	1	23	78	10		26	80	15		14	40	14	0
1783005	1	32	42	16		17	61	24		15	108	14	0
1817617	1	27	67	13		21	42	11		16	52	10	0
1653170	1	20	35	18		37	66	28		39	32	17	1
1658885	1	23	61	12		18	30	14		43	69	36	1

all'evento

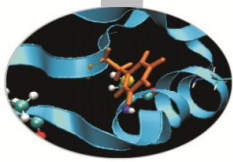
500 Km dall'evento

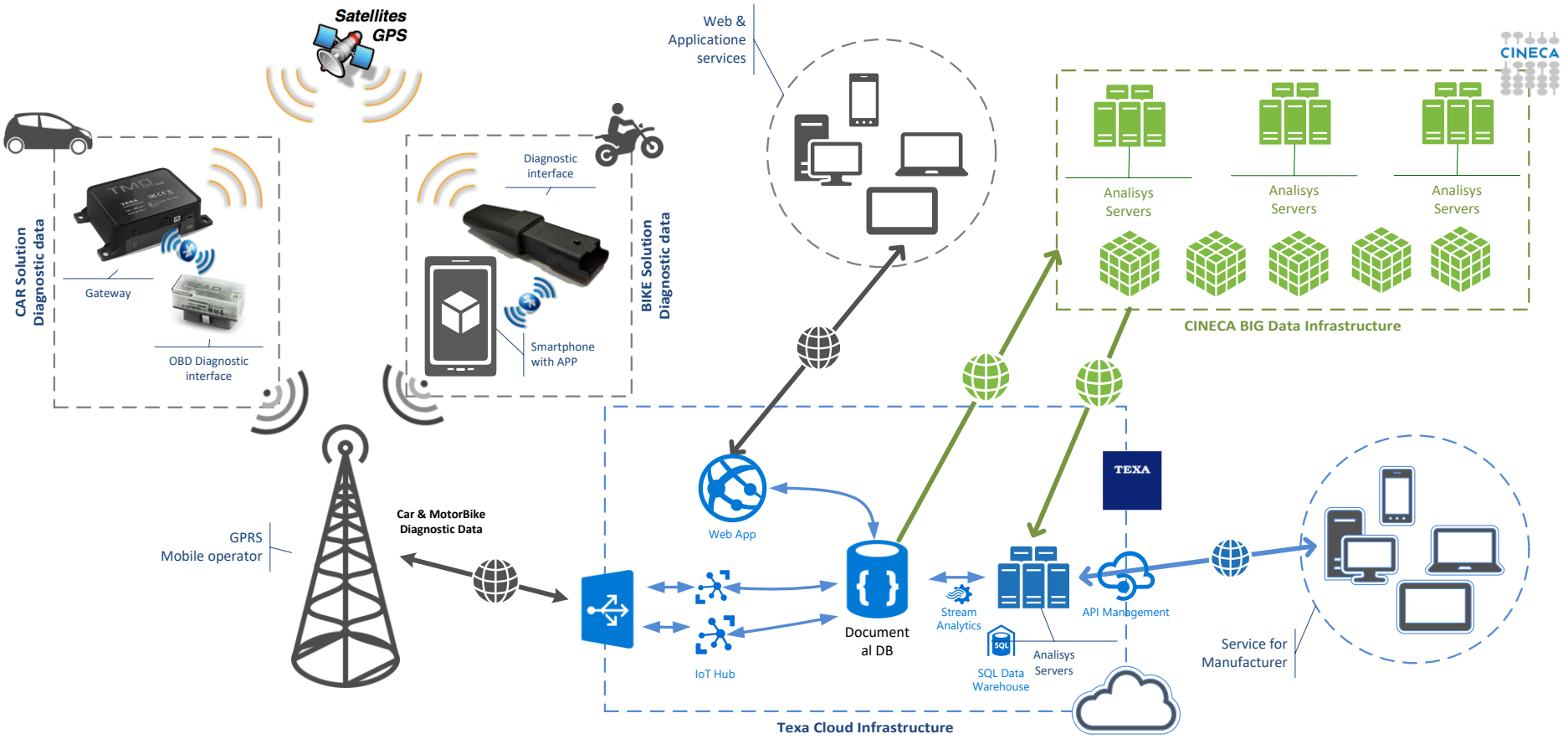
1000 Km dall'evento

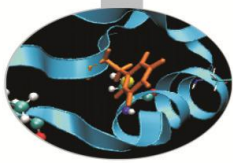
Risultati riduzione fino al 25% delle false segnalazioni di guasti, che potrebbe tradursi in una riduzione dell'impiego del personale di manutenzione

Sfruttando le medesime informazioni si è poi riusciti ad individuare possibili guasti in alcune apparati di terra (boe di segnalazione di transito del treno)

Caso Texa





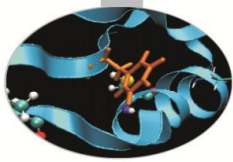


Modalità di accesso

Accesso alle risorse di calcolo e a competenze di tipo computazionale e/o di data science (Machine Learning)

- Convenzioni / accordi quadro
- Finanziamento da progetti EU (Fortissimo)
- Open Innovation (progetto di ricerca congiunta co-finanziato)

Training in 2016



20 courses – 37 editions
including
4 schools – 5 editions
2 workshops
761 students

50 teachers

150 days of lectures

761 post-graduated students

20 courses
4 schools
2 workshop

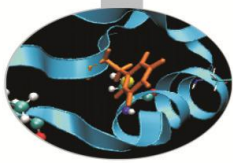
37 editions
5 editions

Alternating training

Stage and traineeships

CINECA SCAI
SuperComputing Applications and Innovation

Training in 2017



Schools:

- 26th Summer School on Parallel Computing
- 13th Advanced School on Parallel Computing (*)
- 3rd School on Scientific Data Analytics and Visualization (*)
- 13th Advanced School on Computer Graphics for Cultural Heritage

Courses:

- Introduction to modern Fortran
- Introduction to Scientific and Technical Computing in C (*)
- Introduction to Scientific and Technical Computing in C++
- Python for computational science
- Debugging and Optimization of Scientific Applications (*)
- Introduction to Parallel Computing with MPI and OpenMP
- HPC Numerical Libraries
- Programming paradigms for GPU devices
- Tools and techniques for massive data analysis
- Parallel I/O and management of large scientific data
- High Performance Molecular Dynamics
- Scientific Visualization for Computational Chemistry
- Material Science codes on innovative HPC architectures: targeting exascale (*)
- High Performance Bioinformatics (*)
- Introduction to R for data analytics

Workshop:

- HPC Methods fot Engineering Applications (*)
- HPC methods for Computational Fluid Dynamics and Astrophysics (*)
- Introduction to Marconi KNL cluster, for users and developers (*)
- Introduction to PRACE-PCP pilot (*)

(*) are in the PATC (Prace Advanced Training Center)

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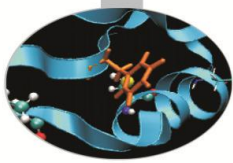
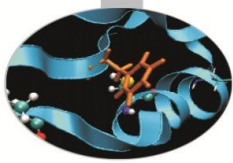


Training in collaborazione

- BBS – Open Program Big Data Analytics
- BBS – Master in Data Science
- Course on Data Analytics and Visualization – Università Modena e Reggio Emilia
- Dottorato in Data Science and Computation – Università di Bologna e fondazione Golinelli



Grazie!

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