Moxoff @ Cineca

HPC Methods for Engineering Workshop

June 17th-19th, 2015

MOX-OFF
MATHEMATICS FOR INNOVATION

HPC-based SaaS tools for design and development in engineering applications

Matteo Longoni

- **MOXOFF**: spinoff of PoliMI Math Department
  - Technology & Know how transfer (push)
  - Market scouting to provide more stimulus (pull)
- **MOXOFF**: company focused on applied mathematical services
  - Consultancy and custom solutions
  - New vertical products for specific markets
- **MOXOFF**: continuous and strong synergy with research center
  - Engineering service provider for PoliMI Math Department & Sissa mathLab
  - Relationship with many other math research centers and spinoff

Who we are?

MOX-OFF
MATHEMATICS FOR INNOVATION

17 people

10 Ing Math

13 Ing Math or PhD or researcher

>80% *of people coming with math specialization*

Luca **Formaggia** (professor @PoliMI and MOX Director)

Piercesare **SECCHI** (professor @PoliMI and Math Department Director)

Alfio **Quarteroni** (professor @EPFL and CMCS Director)

are our **Scientific Committee**

>50 of "***math projects***"

over 4 years

Where's math?


PROTECTS
Tetra Pak
WHAT'S GOOD™


cavanna
Packaging Group


OSPEDALE
SAN RAFFAELE


ZUCCHETTI
CENTRO SISTEMI
LE SOLUZIONI CHE CREANO SUCCESSO


CAMERON


Eni


energeya
moving horizons


ARISTONCAVI


iwt
a TECNIPLAST company


EDISON


ITMS


INGV


Enixs


Filippi


saes
group
ETC
a SAES Group company


DELCONCA
il Pavimento in Ceramica


NOLAN


Whirlpool


STARA
GLASS


pixartprinting


RADICI
GROUP


saipem


SIEMENS


FIPAV
Federazione
Italiana
Pallavolo


desmet ballestra


BLM GROUP
ADIGE


TECNIPLAST
Innovation through passion™


ParkinGO

Our skills

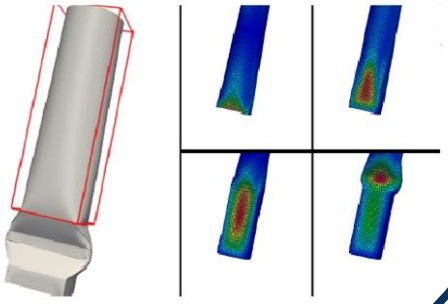
Lo spin-off opera con la matematica

I modelli MoxOff l'ultima new entry

Modelli matematici da applicare a processi, prodotti e servizi per individuare so- nanziari. Non ultimo, l'impegno nell'a ve i model

Sole 24 ORE

Modelling Intelligence



Simulation & Optimization

INTERNATIONAL CAE POSTER AWARD

A reward to the genius of young researchers

As part of the CAE Conference, a prize has been awarded to the top six innovative ideas in the field of simulation. Amongst the winners, the University of Padua, the Mario Negri Institute and the Polytechnic of Milan

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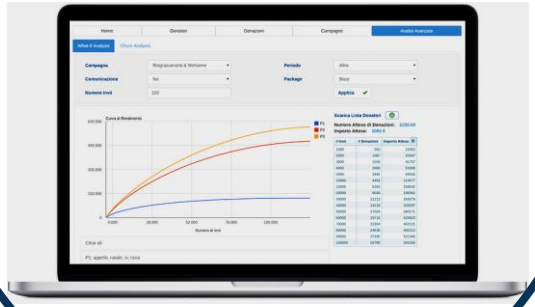
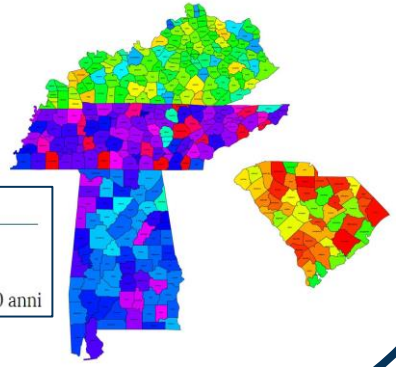
Data Intelligence



Software Engineering



LA STAMPA ECONOMIA

"Italia addio, negli Usa si corre"

La fabbrica di piastrelle di Del Conca aperta in 10 mesi. A Rimini aspetta da 10 anni

Volley La nazionale maschile in Polonia userà elaborazioni realizzate da una società legata al Politecnico di Milano

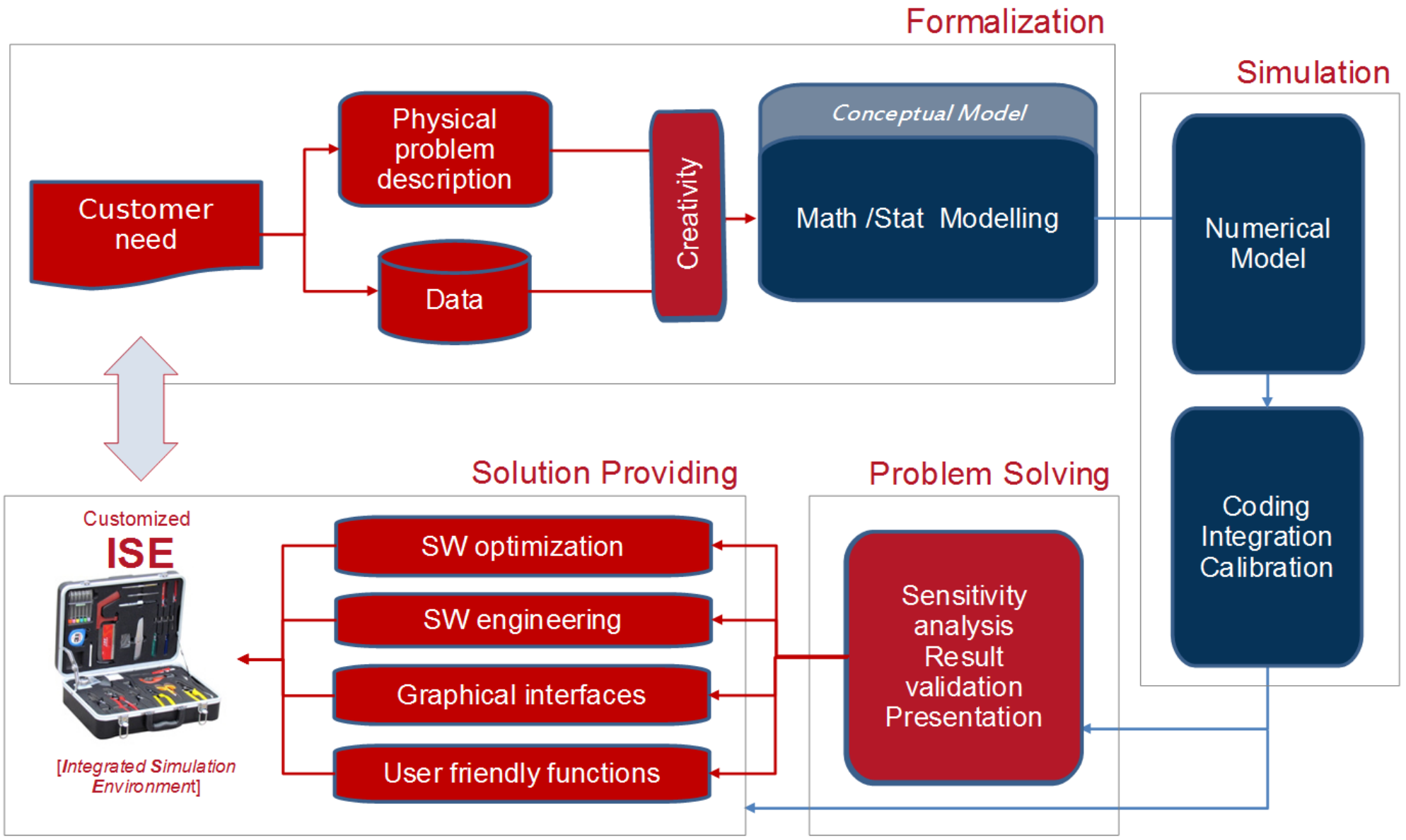
L'Italia al Mondiale schiaccia con la matematica

DAL NOSTRO INVIATO

CAVALESE — Per provare a vincere un Mondiale di volley

«La matematica ci aiuta a ricercare i criteri ideali della prestazione, da adattare ai singoli giocatori» spiega Andrea Biro- fre, calcoli, diagrammi. Cavalese, mille metri di quota e un fresco ancora più nitido in un'estate che non c'è mai stata. namenti open), che si lega al territorio con iniziative a sfondo sociale e che sarà degna di lotta- re per il titolo solo se supererà cipali manifestazioni. Si insegue l'oro, un «mostro di fine livello» fin qui sfuggito alla cattura. La sala pesi (personalizzata) deve

How we work?


Formalization
Simulation
Customer need
Physical problem description
Data
Creativity
Conceptual Model
Math /Stat Modelling
Numerical Model
Coding
Integration
Calibration
Solution Providing
Problem Solving
Customized
ISE
[Integrated Simulation Environment]
SW optimization
SW engineering
Graphical interfaces
User friendly functions
Sensitivity analysis
Result validation
Presentation


Pattern
Data
Methods
High
Imagee
Shapes
Clustering
Analysis
Statistical
Algorithms
Repeated
Assimilation
Functions
Classification
Longitudinal
Biostatistics
Data-Mining
Dimensional
Bayesian
recognition
measures


SW
Engineering
Control
Integration
optimization
In-house
softwares
Evolutionary
Development
Computational
libraries
Maintenance
Commercial
Tools
Solutions
customization
system
GUI
FOSS

Where's math?

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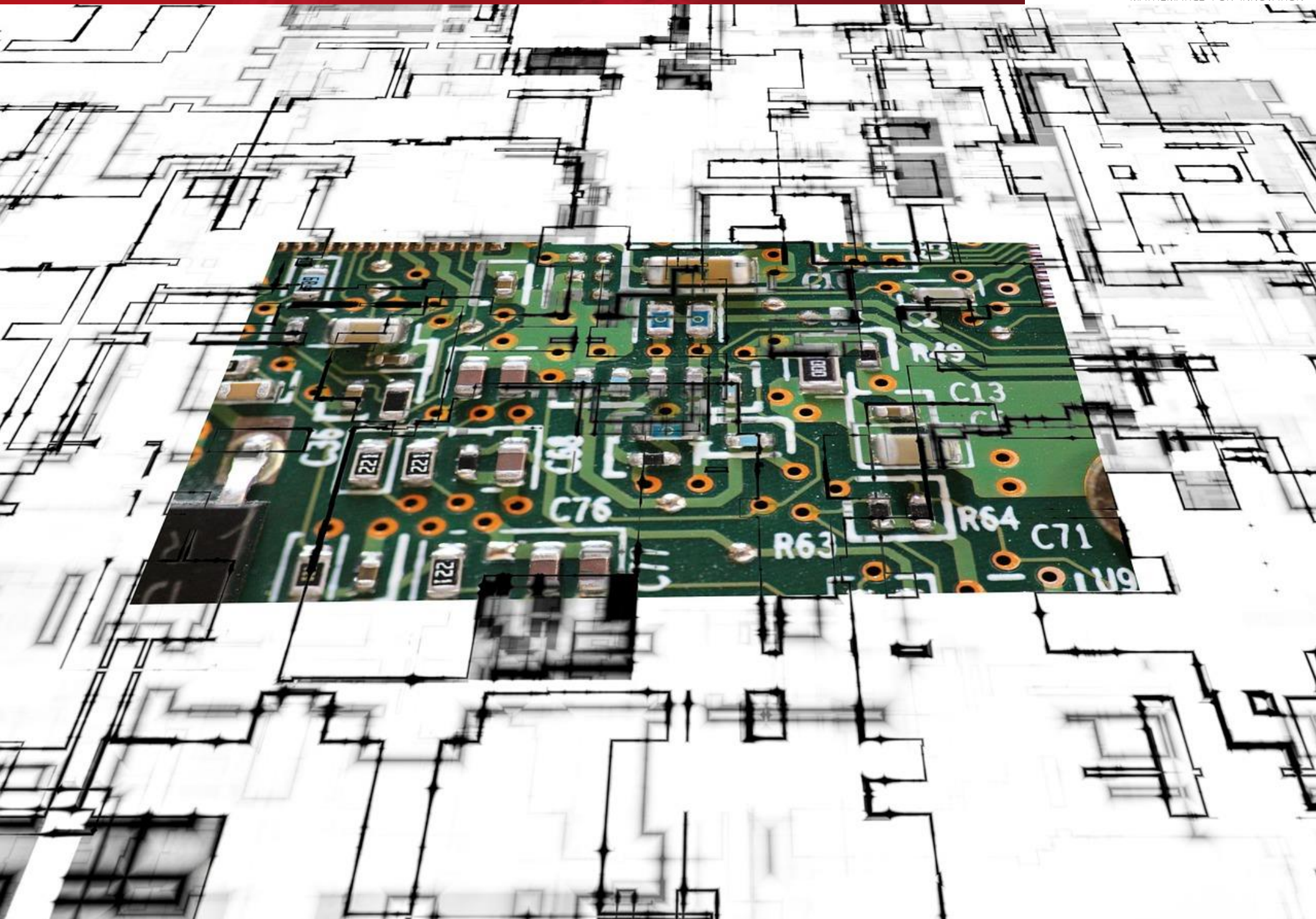

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Use of Big Data, from the Analyses of Preventative Diagnoses to the Maintenance of a System

OMISSIS

Need:

Identifying trends and classifying the states of a system through the analysis of data recorded real-time by electronic sensors.

Output:

- Robust and user-friendly software.
- Advanced statistical analysis.
- Automatic monitoring of the system.
- Identification of characteristic trends.
- Alerts in case of anomalous events.

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Math "core"

- C++, R, Scala, Spark
- Signal processing
- Data Smoothing
- Descriptive Statistics
- Variance analysis
- Logistic regression models
- Functional Analysis
- Classification and Clustering

HPC opportunity

- Approx **1TB raw data**
- Data smoothing and descriptive statistics on **800GB test case database**
- Computational time: **3 days on 8 cores**
- Real time algorithm to control the system
- **>1.5TB data** to be considered
- **Cloud database** for data collection
- **Webapp** for **data processing** and **visualization**

Where's math?

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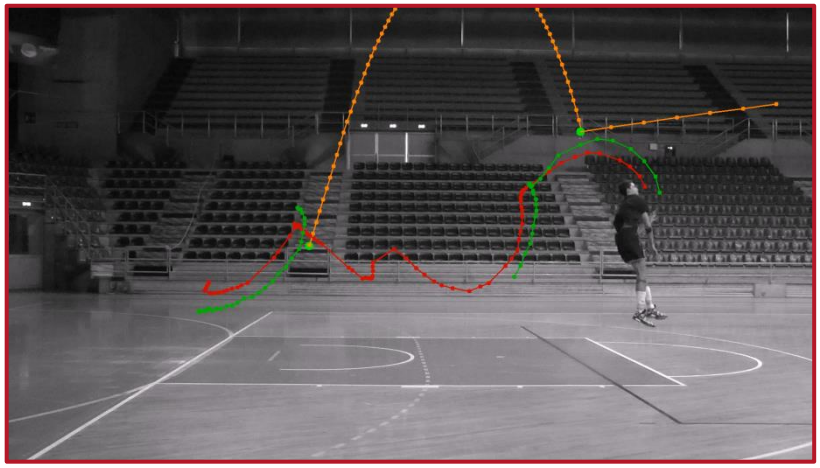
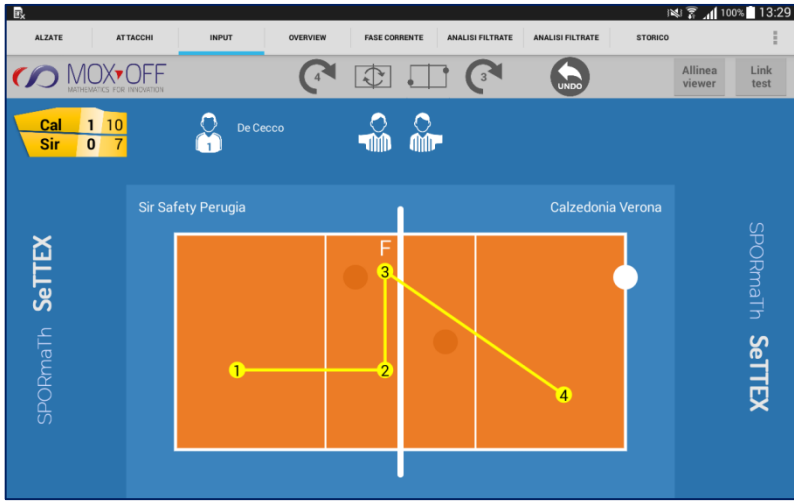


Video Analysis

- Automatic extraction of trajectories from video recordings.
- Tracking of points of interests.
- Transformation of the visual observation into measurements that quantify and monitor an athlete's individual characteristics.

Analysis of the opponent's game

- Interactive view of real-time setter distribution
- Touch-based app for visual data entry
- Generation and use of statistical during matches
- Easy comparation with the expected beahviour
- Integration with scouting system



Second touch tactical exploration

- Tactical analysis of the opponent's game
- Simulation, Scenario analysis, Setter forecast

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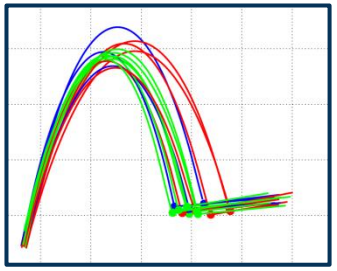
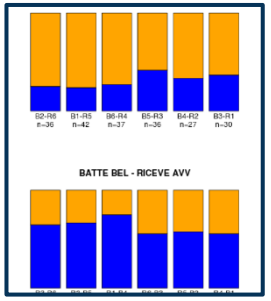
Math "core"

- Data Smoothing
- Descriptive Statistics
- Variance analysis
- Regression models
- Classification
- Functional Analysis
- Data pre-processing
- KPI measurements
- Forecast





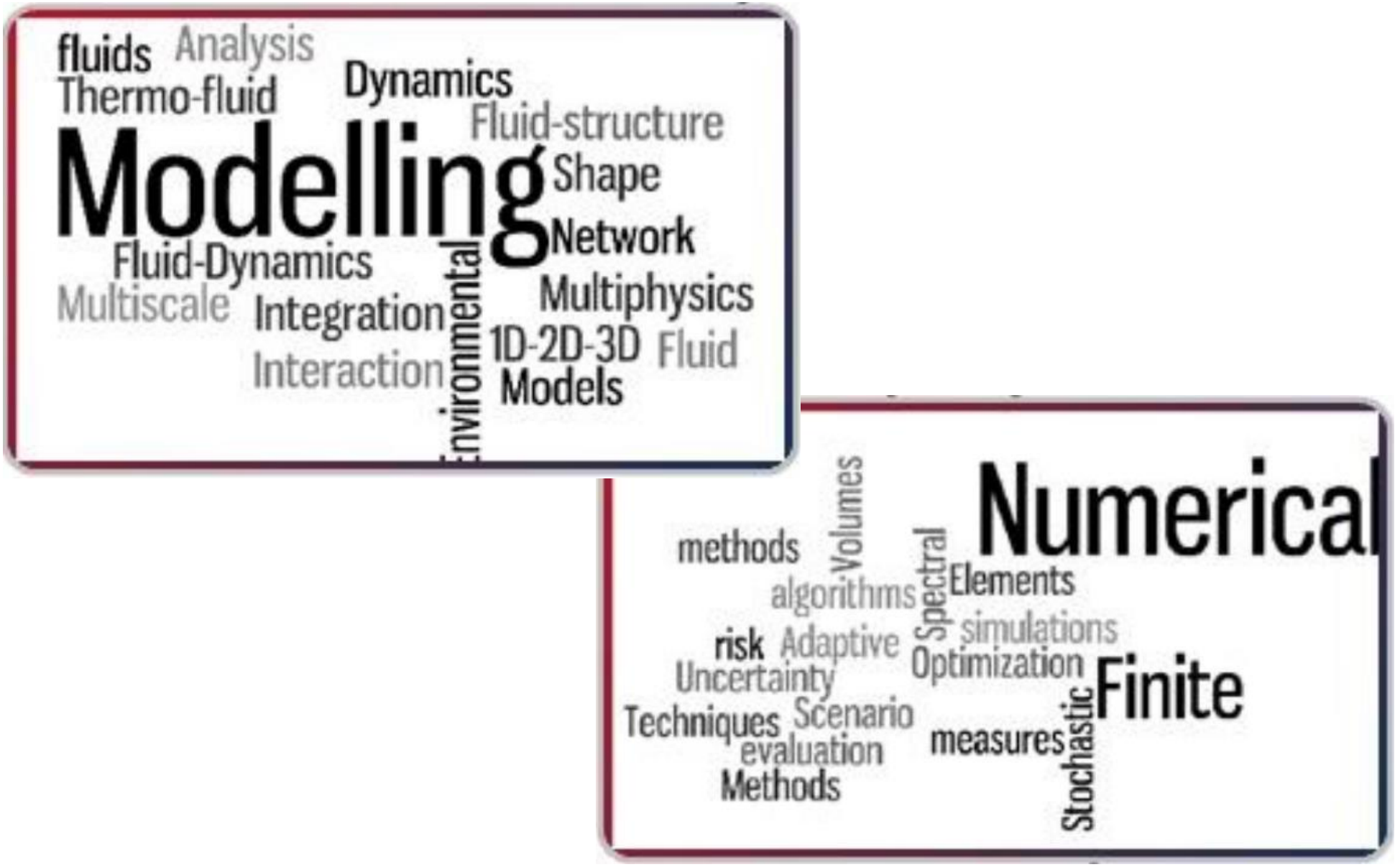
- Interactive view of real-time setter distribution
- Touch-based app for visual data entry
- Generation and use of statistical during matches
- Easy comparison with the expected behavior
- Integration with scouting system

HPC opportunity

- 20 videos (approx. 200 images) per player per training to be processed
- **20GB per training** (2 cameras)
- **400 analyses per training** (players, markers trajectories):
  - superimposed math model: approx 1min computational time per analysis
  - optimization problem: approx 1min computational time per analysis

- Data processing to tactic forecasting
- **100K models** elaborated for each match
- Offline computational time: up to **24h @ 160 cores** in parallel
- Unique global **Cloud database**

Mathematical and Numerical Modelling



Where's math?

A “mathematically” comfortable helmet

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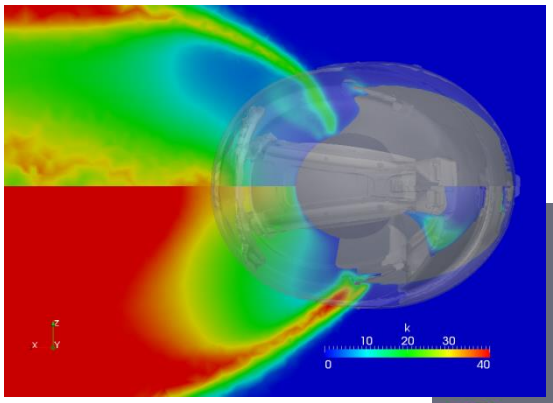
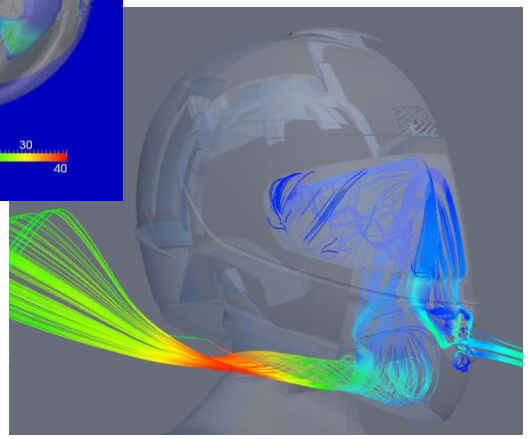
3D External Aerodynamics 3D

Project carried out in collaboration with

MOX
MODELLISTICA E CALCOLO SCIENTIFICO
MODELING AND SCIENTIFIC COMPUTING



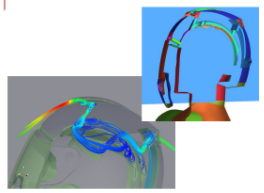


OpenFOAM

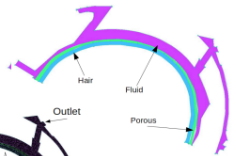
Thermofluid dynamics model for ventilation system analysis

FreeFem++

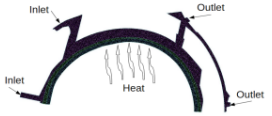
Multiphysics



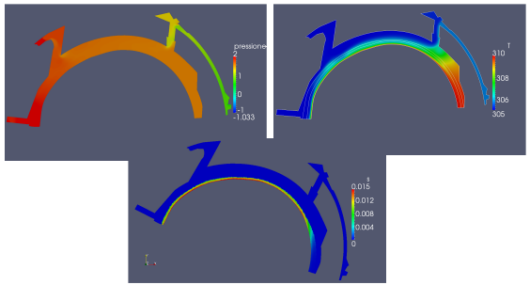
from CAD and Aero 3D...



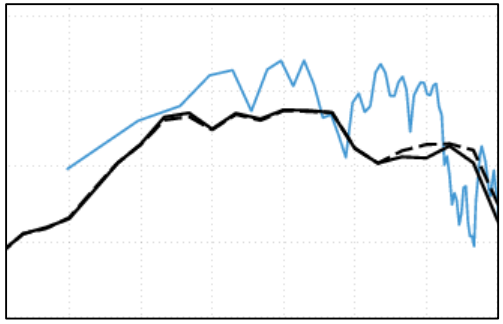
...to coupled multiphysics simulations



- Aerodynamics
- ThermoFluid dynamics
- Two-phase (vapour/sweat)
- Porous media (air/hair)
- Human head sweating model



Vibroacoustic model for noise propagation



Software: SPEED

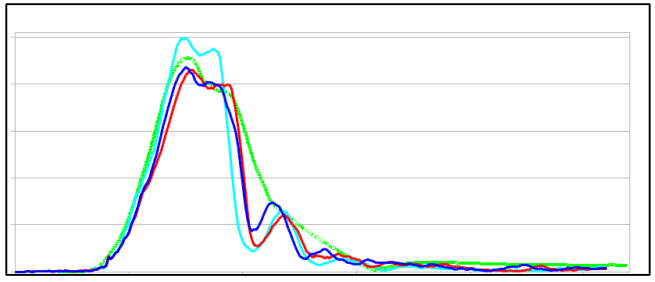
PRACE project

P.F.Antonietti, I.Mazzieri, A.Quarteroni,F.Rapetti: Non-conforming high order approximation of the elastodynamics equation, CMAME, 2012

http://speed.mox.polimi.it/SPEED/Home.html

Non-linear structural dynamics model for crash

LS-Dyna



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Aerodynamics simulations

- approx 10M elements mesh
- approx 200h simulation time per helmet
- typically 45 configurations per helmets

Thermofluid dynamics simulations

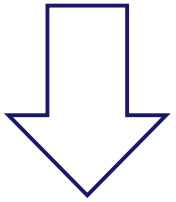
- approx 24h per simulation
- typically 25 configurations per helmet
- parametric analyses (approx 10)

Vibroacoustic simulations

- time-dependent simulations
- approx 1500h simulation time per helmet
- typically 25 configurations per helmets

Crash simulations

- time-dependent simulations
- approx 60h simulation time per helmet
- typically 25 configurations per helmets



HPC opportunity:
Approx **50K hours** simulation time per helmet

Moxoff join the **FORTISSIMO** Project:

Moxoff

Objective

- Porting the platform on a HPC infrastructure
- Simulation and analyses speed-up
- Development of a **web-based Saas on-demand** service for simulations

Partnership

Partner

CINECA

- HPC Expertise
- HPC resources

Industrial

- User Experience
- End User Validation

Innovative Products & Services

MoxOff

Spin-off of the MOX laboratory
Politecnico di Milano

Headquarter:

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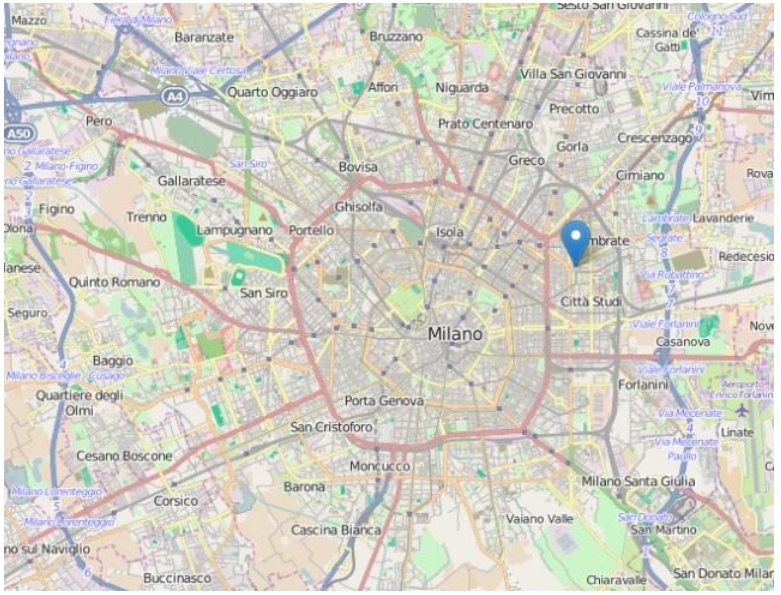
Ph: +39 02 3675 4853



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