

08/03/2016

Luca Turconi

Mathematics for Innovation



 www.moxoff.com

 [@MOXOFF_MathXInn](https://twitter.com/MOXOFF_MathXInn)

 [/mathematicsforinnovation](https://facebook.com/mathematicsforinnovation)



About Moxoff

Spinoff of MOX
Laboratory for Modeling
and Scientific Computing



Politecnico di Milano





About Moxoff



Ottavio CRIVARO
MOXOFF CEO



Alfio QUARTERONI
EPFL CMCS Director



Piercesare SECCHI
PoliMI Math Department Director



Luca FORMAGGIA
PoliMI MOX Director

Management team



~ 20 Engineers & Data Scientists



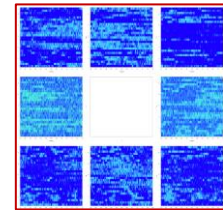
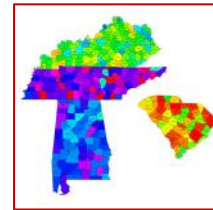
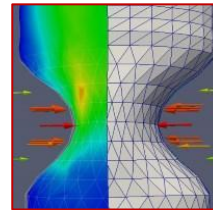
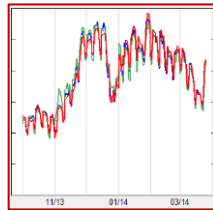
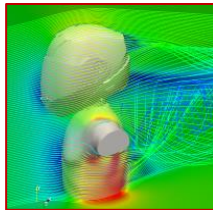
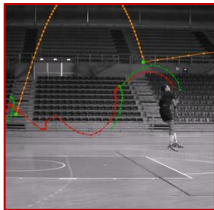
Skills & Services

Our Skills

- Data Intelligence
- Modeling
- Simulation/Optimization
- Software Engineering

Our Services

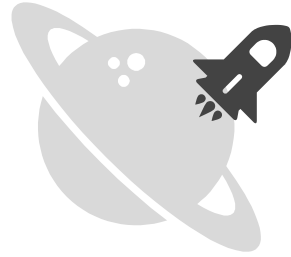
- Consulting
- Research
- SW solutions
- SW maintenance
- Training





Partners & Clients





INNOVATION



Sport



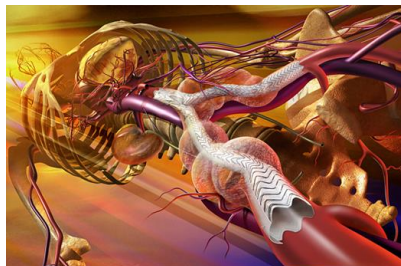
Oil & Gas



Manufacturing



MATH IS EVERYWHERE



Healthcare

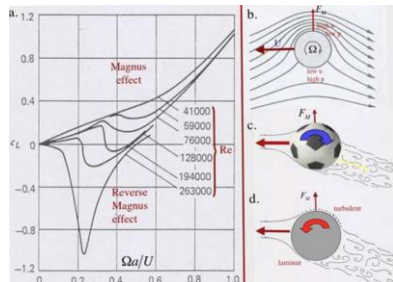


Digital & Social Networks



Big Data

Sport



Oil & Gas

$$\begin{cases} \vec{\nabla} \cdot \vec{\sigma}(\mu, \vec{u}) - \vec{\nabla} P + \rho \vec{g} = 0 & \text{in } \Omega \times [0, T], \\ \vec{\nabla} \cdot \vec{u} = \Phi(\phi) & \text{in } \Omega \times [0, T], \\ \frac{\partial \lambda_i}{\partial t} + (\vec{u} - \vec{u}_g) \cdot \vec{\nabla} \lambda_i = 0 & \text{in } \Omega \times (0, T], \\ \frac{\partial \psi}{\partial t} + (\vec{u} - \vec{u}_g) \cdot \vec{\nabla} \psi = 0 & \text{in } \Omega \times (0, T], \\ \vec{\sigma} = \mu(\vec{u}, \psi, \xi_i)(\vec{\nabla} \vec{u} + (\vec{\nabla} \vec{u})^T) & \text{in } \Omega \times (0, T], \\ \lambda_i = \bar{\lambda}_i, \quad \psi = \bar{\psi} & \text{in } \Omega \times \{0\}, \\ \vec{u} = \bar{\vec{u}} & \text{on } \Gamma_B, \\ (\vec{\sigma} - P \vec{I}) \cdot \hat{n} = 0 & \text{on } \Gamma_S, \\ u_1 = \bar{u}_1, \quad u_2 = \bar{u}_2, \quad ((\vec{\sigma} - P \vec{I}) \cdot \hat{n}) \cdot \hat{x}_3 = 0 & \text{on } \Gamma_L, \end{cases}$$

Manufacturing

$$\begin{cases} \rho \partial_{tt} \mathbf{u} - \nabla \cdot \underline{\sigma}(\mathbf{u}) = \mathbf{f}, & \text{in } \Omega \times [0, T] \\ \mathbf{u} = \mathbf{0}, & \text{on } \Gamma_D \times [0, T] \\ \underline{\sigma}(\mathbf{u}) \cdot \mathbf{n} = \mathbf{t}, & \text{on } \Gamma_N \times [0, T] \\ \text{non-reflecting b.c.}, & \text{on } \Gamma_{NR} \times [0, T] \\ \partial_t \mathbf{u} = \mathbf{u}_1, & \text{in } \Omega \times \{0\} \\ \mathbf{u} = \mathbf{u}_0, & \text{in } \Omega \times \{0\} \end{cases}$$

MATH IS HARD

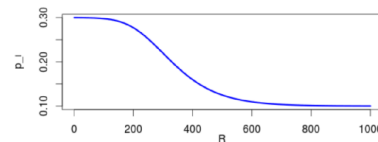
$$\begin{cases} \rho_f \partial_t \mathbf{u}|_{\mathbf{x}_0} + \rho_f (\mathbf{u} - \mathbf{w}) \cdot \nabla \mathbf{u} - \nabla \cdot \mathbf{T}_f = \mathbf{f}_f \\ \nabla \cdot \mathbf{u} = 0 \\ \rho_s \frac{\partial \hat{\eta}^2}{\partial t^2} - \nabla \cdot \hat{\mathbf{T}}_s = \hat{\mathbf{f}}_s \\ \mathbf{u} = \frac{\partial \mathbf{u}}{\partial t} \\ \mathbf{T}_s \cdot \mathbf{n}_s + \mathbf{T}_f \cdot \mathbf{n}_f = 0 \end{cases}$$

Healthcare

$$\begin{aligned} L(\mathbf{B}|\theta) &= \prod_{n=1}^{N_i} \prod_{i=1}^I \prod_{j=1}^J \sum_{k=1}^{2^J-1} P(C_i = H_k | \alpha, \Sigma) \times \left[\frac{b_{ijn1}^{B_{ijn}} b_{ijn0}^{(1-B_{ijn})}}{b_{ijn1}^{B_{ijn}} b_{ijn0}^{(1-B_{ijn})}} \right] \\ b_{ijn1} &= P(V_{in} = j | C_i; \beta, \mu, \tau) P(B_{ijn} = 1 | C_i, V_{in} = j; \gamma, \lambda) \\ b_{ijn0} &= P(V_{in} = j | C_i; \beta, \mu, \tau) [1 - P(B_{ijn} = 1 | C_i, V_{in} = j; \gamma, \lambda)]. \end{aligned}$$

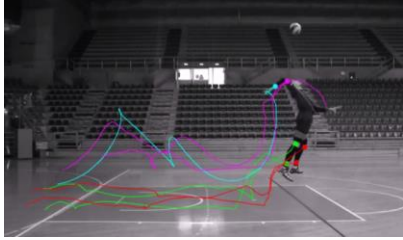
Digital & Social Networks

$$p_i = \beta_0 + \frac{\beta_0 - \beta_1}{(1 + \beta_2 \cdot e^{-\beta_3 \cdot (x_i - \beta_4)})^{1/\beta_5}}$$

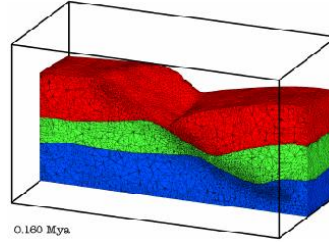


Big Data

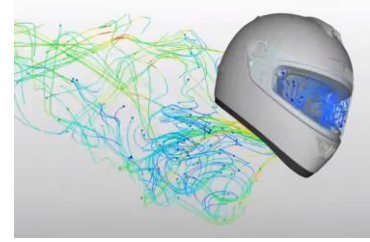
Performance Optimization



Simulation & Control

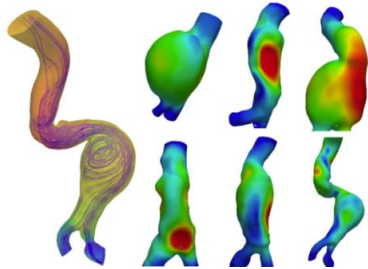


Product Optimization

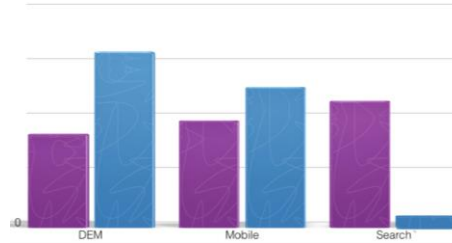


MOXOFF
MATHEMATICS FOR INNOVATION

makes it simple



Risk Management

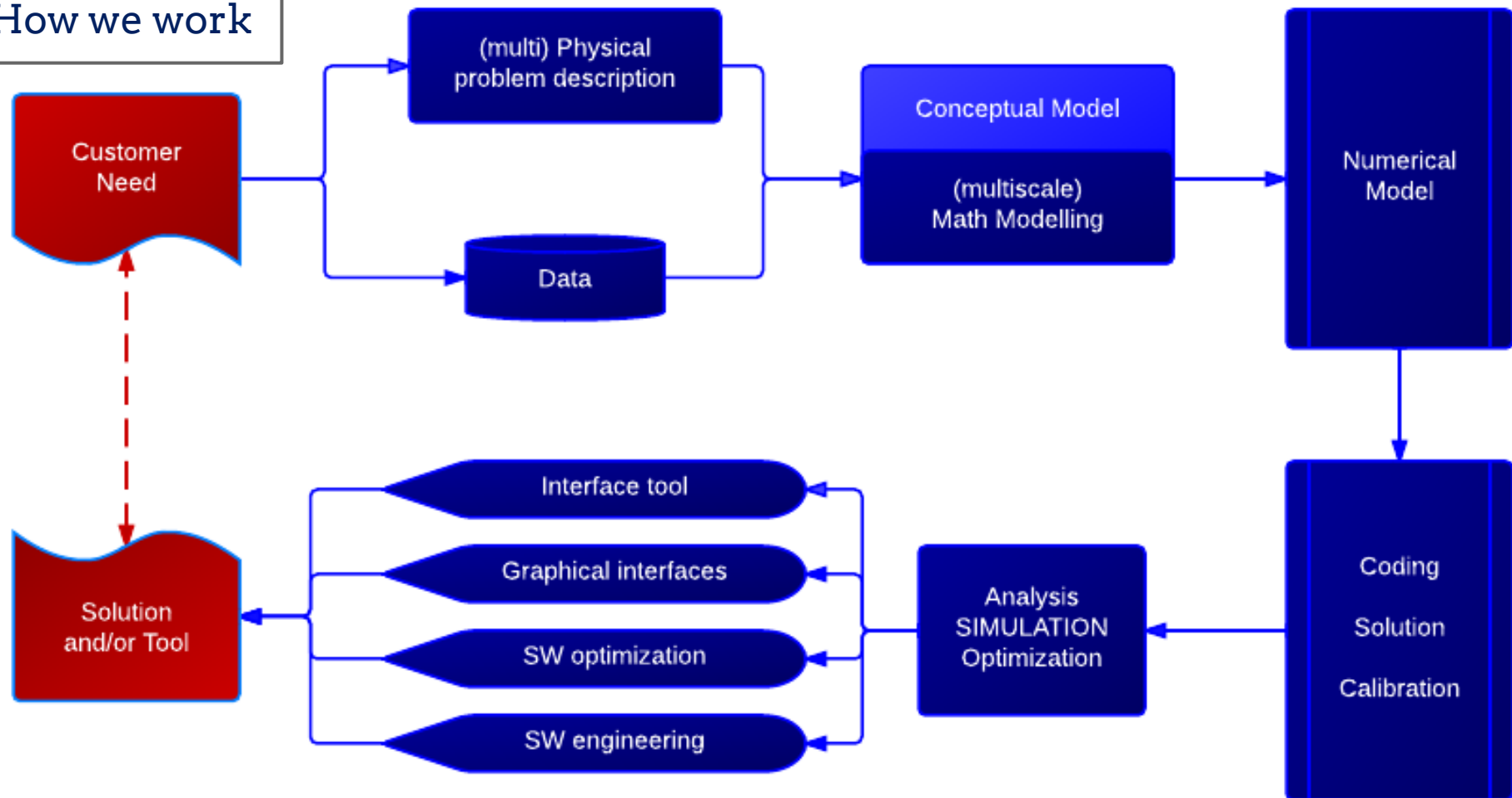


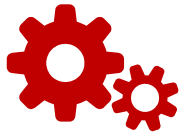
Data Intelligence



Demand Management&Planning

How we work



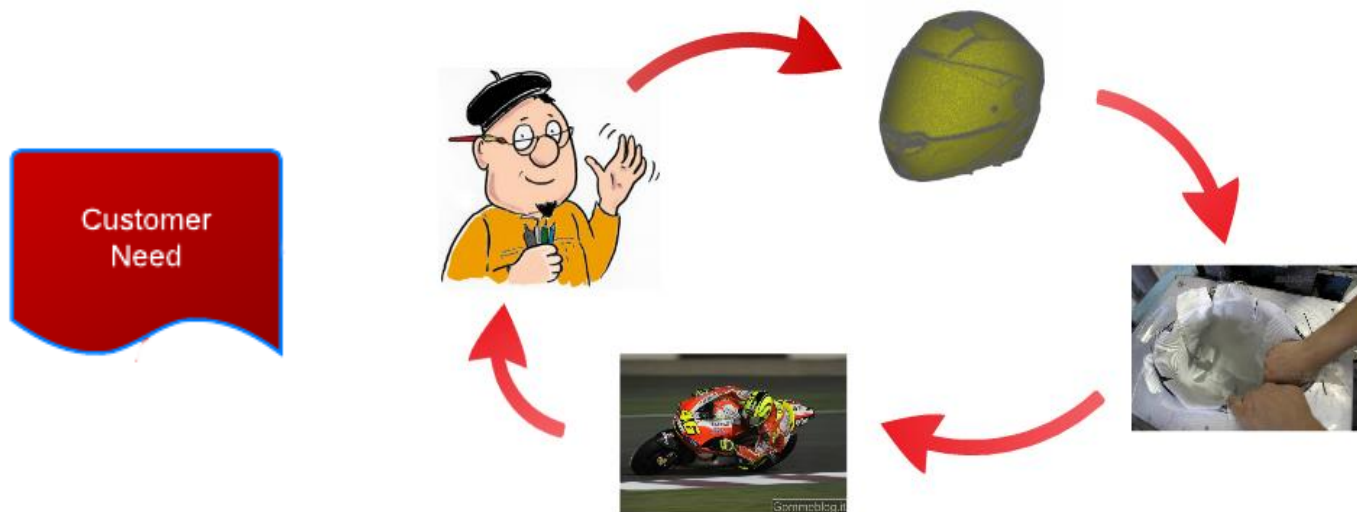


Is it possible to use mathematics to improve the comfort of a motorcycle helmet?





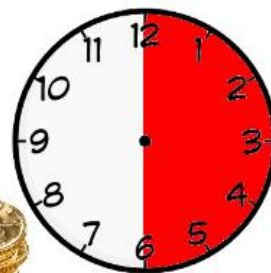
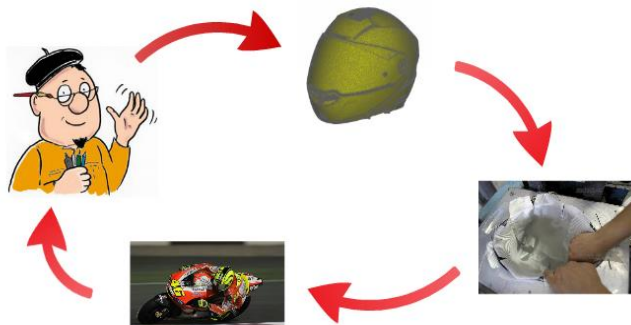
A Mathematically Comfortable Helmet





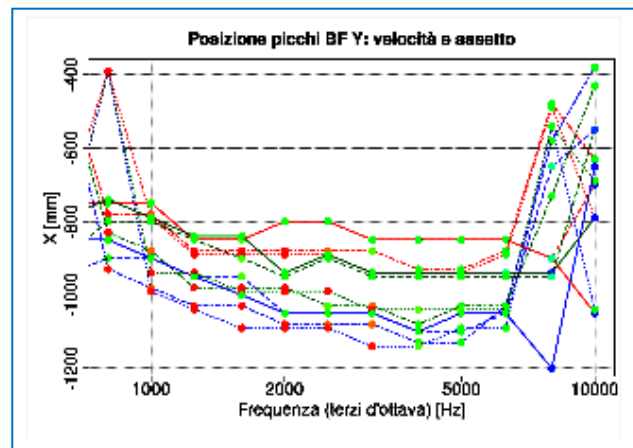
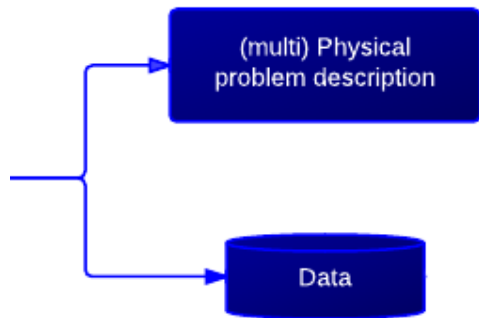
A Mathematically Comfortable Helmet

Customer
Need





A Mathematically Comfortable Helmet





A Mathematically Comfortable Helmet

Conceptual Model

(multiscale)
Math Modelling

ThermoFluid dynamic problem

- Navier–Stokes coupled with Darcy–Forchheimer: Penalized NS

$$\rho \left(\frac{\partial \mathbf{u}}{\partial t} + (\mathbf{u} \cdot \nabla) \mathbf{u} \right) - \mu \Delta \mathbf{u} + \nabla p + \left(\frac{\mu}{k} \mathbf{u} + \frac{\rho C_F}{\sqrt{k}} |\mathbf{u}| \mathbf{u} \right) \chi_{\Omega_p} = \mathbf{0}$$

- Temperature T : $\frac{\partial T}{\partial t} + C_f \mathbf{u} \cdot \nabla T = \nabla \cdot (\lambda_p \nabla T) - l_e s(h, w, T)$

- Humidity h :

- Sweat content

- Evaporation

f, p, w = fluid, porous, wet domain

ρ = air density

\mathbf{u} = flow velocity

t = time

μ = dynamic viscosity

p = pressure

k = permeability

Vibroacoustic model

- Elastodynamics equations:

$$\begin{cases} \rho \partial_{tt} \mathbf{u} - \nabla \cdot \boldsymbol{\sigma}(\mathbf{u}) = \mathbf{f}, & \text{on } \Omega \times (0, T) \\ \mathbf{u} = \mathbf{0} & \text{in } \Gamma_N \times (0, T) \\ \boldsymbol{\sigma}(\mathbf{n}) = \mathbf{t}, & \text{on } \Gamma_{NR} \times (0, T) \\ \text{non-reflecting b.c.}, & \text{on } \Gamma \times (0, T) \\ \partial_t \mathbf{u} = \mathbf{u}_1, & \text{on } \Omega \times \{0\} \\ \mathbf{u} = \mathbf{u}_0, & \text{on } \Omega \times \{0\} \end{cases}$$

\mathbf{u} = displacement

t = time

\mathbf{n} = unit normal

$\boldsymbol{\sigma}$ = stress tensor

\mathbf{u}_1 = initial velocity

\mathbf{f} = external force

Ω = 3D domain

Γ = boundaries

- DG formulation

- time domain

- 3D hexa mesh





A Mathematically Comfortable Helmet

Numerical
Model

```
// *****  
// *****  
// Risoluzione del problema fluidodinamico  
// *****  
// *****  
cout << "RISOLUZIONE PROBLEMA FLUIDODINAMICO" << endl << endl;
```

```
// Definizione degli spazi funzionali  
fespace Vh(Th,P2); // Spazio per le componenti della velocita'  
fespace Wh
```

```
/* Risoluzione iterativa delle equazioni di Navier-Stokes  
real cpu;  
real normah1duinit;
```

```
// Definizione  
for (int i=1; i<=iterazioni; i++) {  
Vh u1, u2;  
Wh p;  
cout << "ITERAZIONE: " << i << endl;
```

```
// Definizione delle variabili associate al passo precedente  
Vh u1old, u2old;  
Wh pold;  
u1old = u1;  
u2old = u2;  
pold = p;
```

Coding

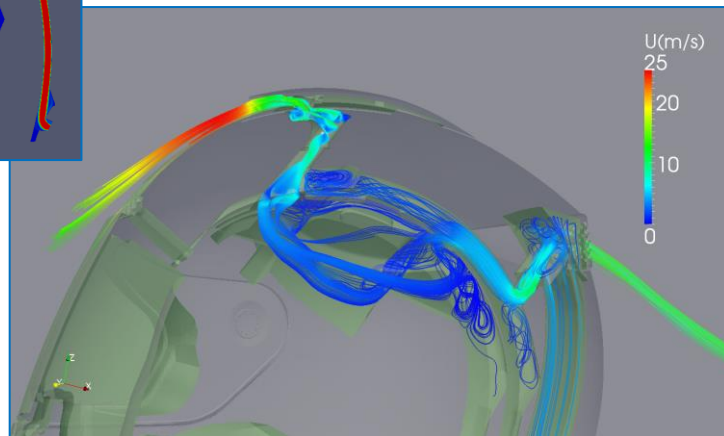
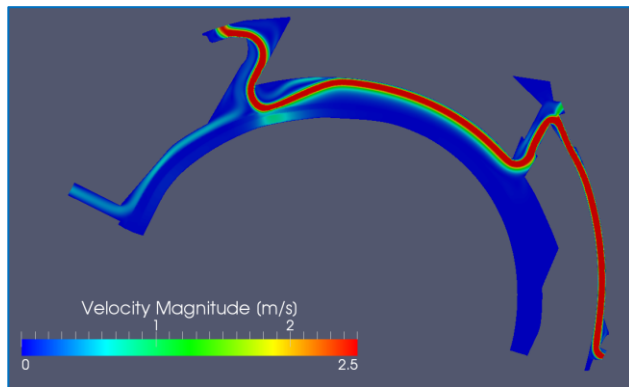
Solution

Calibration



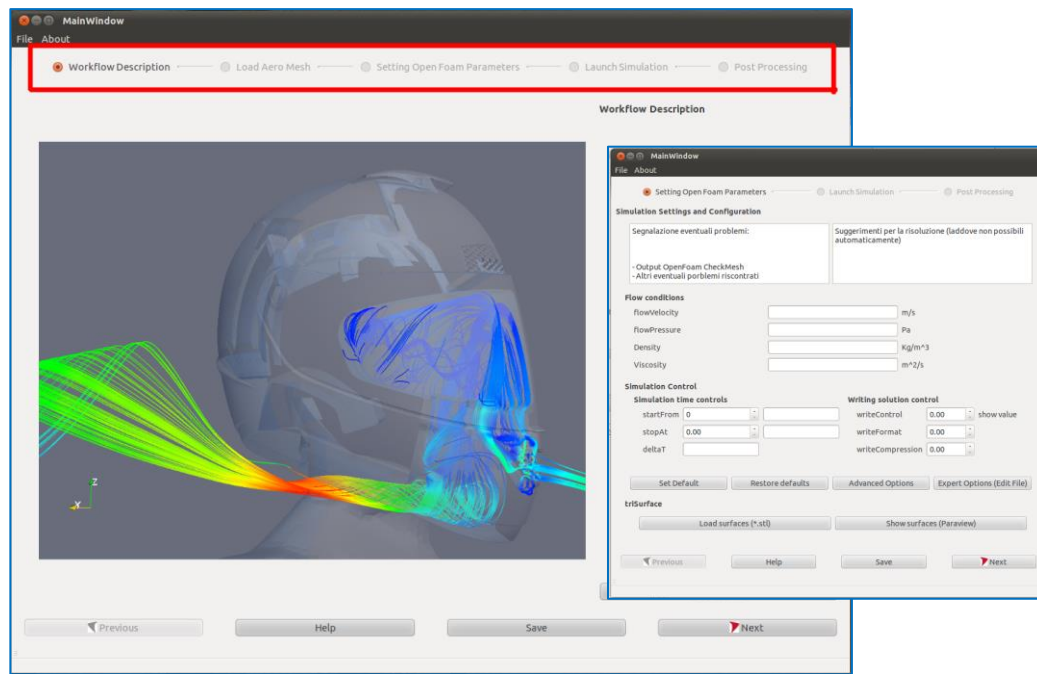
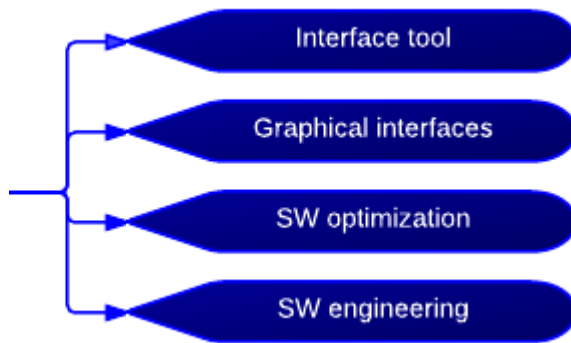
A Mathematically Comfortable Helmet

Analysis
SIMULATION
Optimization



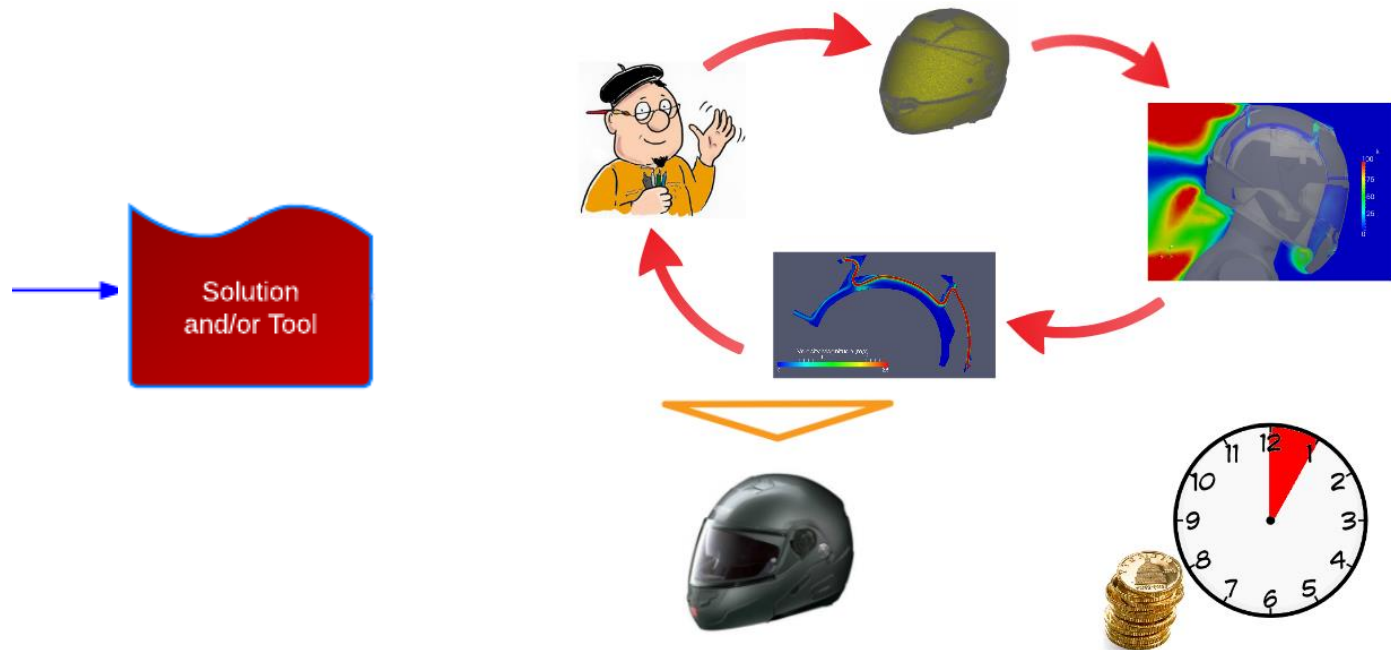


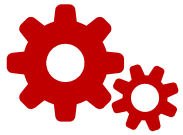
A Mathematically Comfortable Helmet





A Mathematically Comfortable Helmet

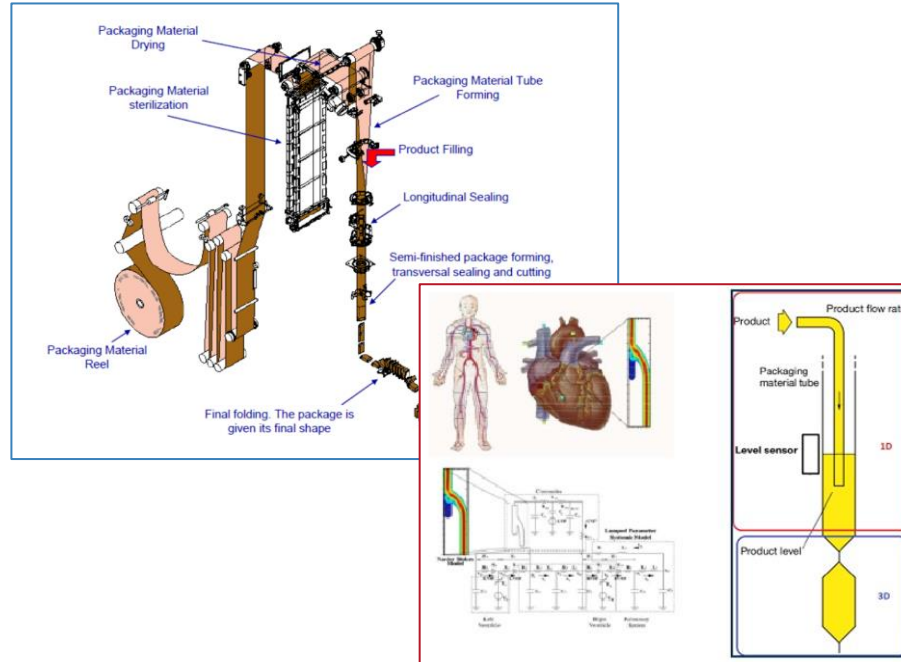




Is it possible to improve a packaging system by using the fluid dynamic models of blood?



Hemodynamic and industrial automation



Need:

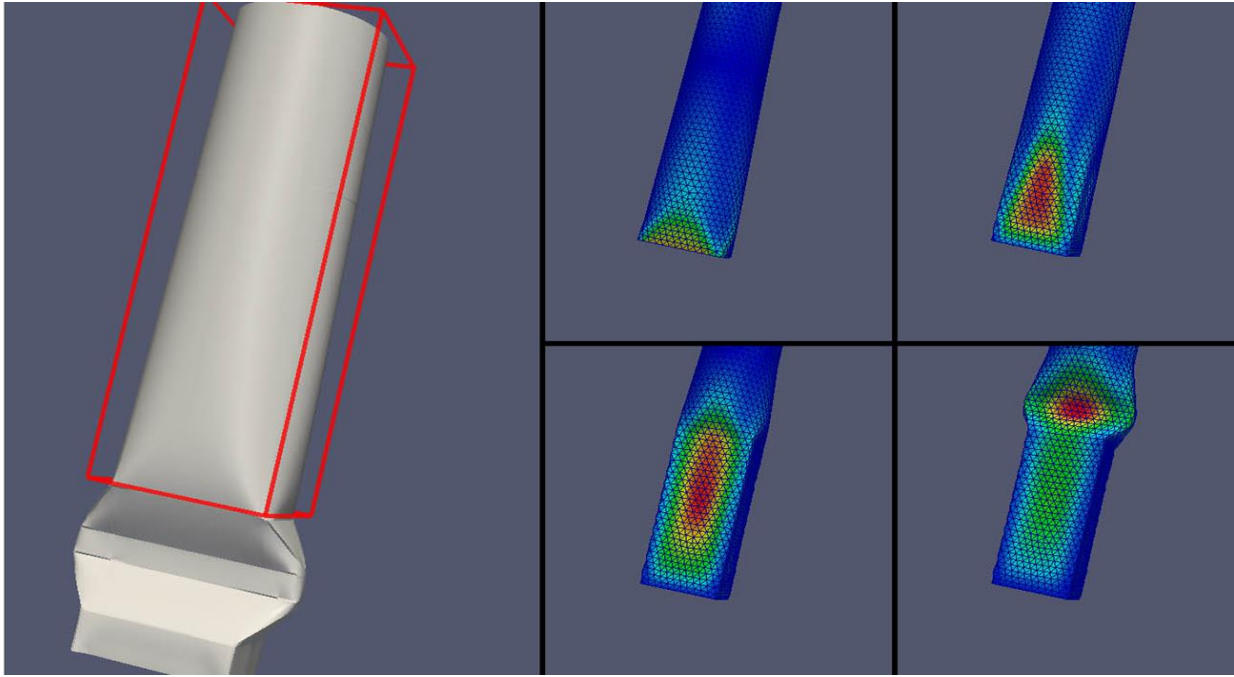
Improving control of the formation and filling phases of a packet in a packaging system, preserving the integrity of the package and the accuracy of the fill.

Skills:

- Multiscale modeling
- Multiphysics modeling
- Model integration
- Fluid-structure interaction
- Software integration and validation

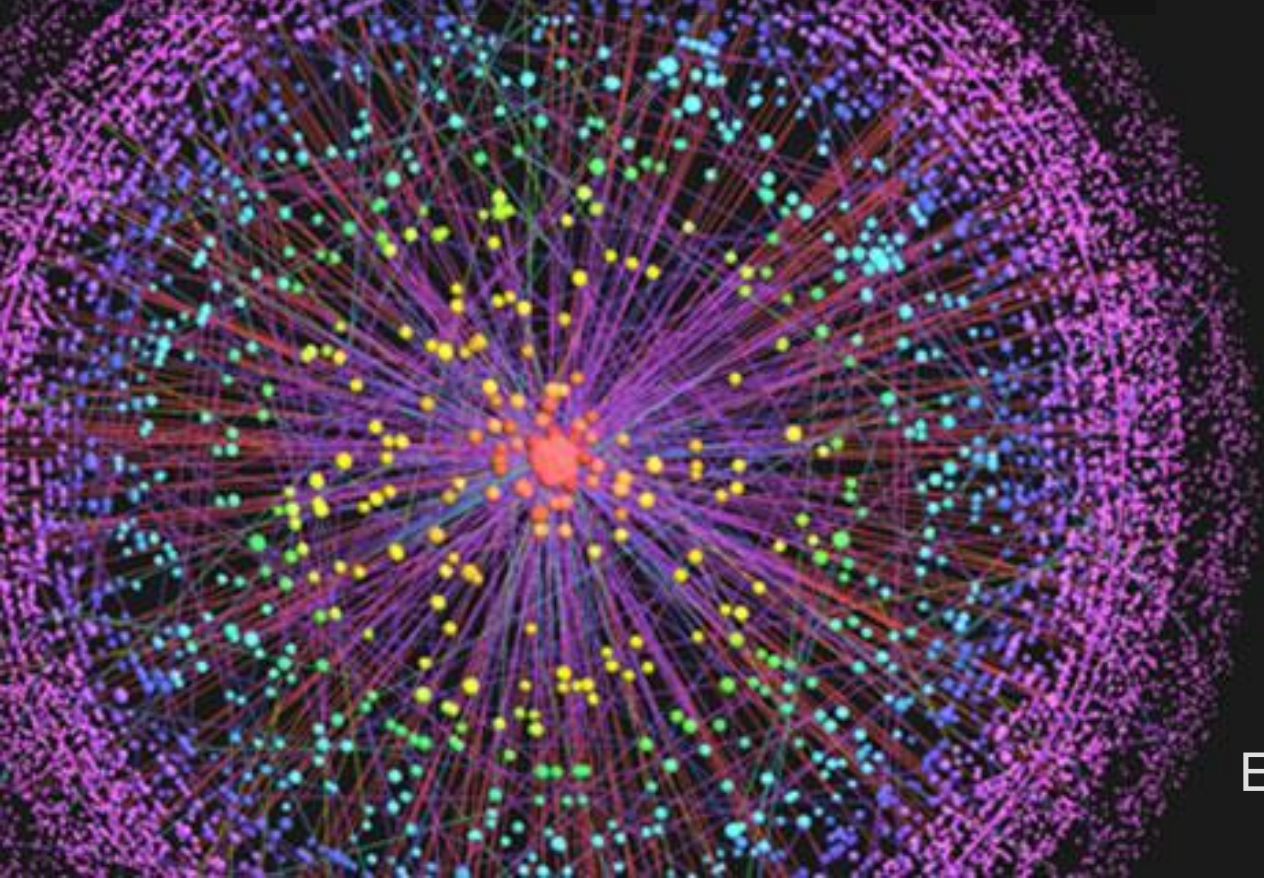


Hemodynamic and industrial automation



Big Data

the next challenge for statistics

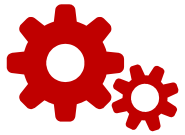


Product design

Marketing & adv

Customers behavior

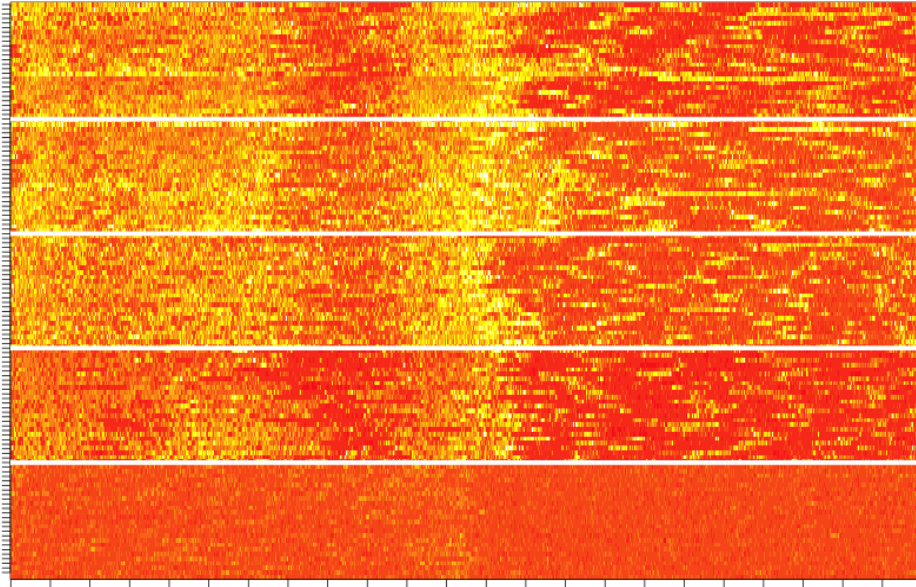
Employee management



Is it possible to use Big Data, for Preventative
Diagnosis and Maintenance?



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



Need:

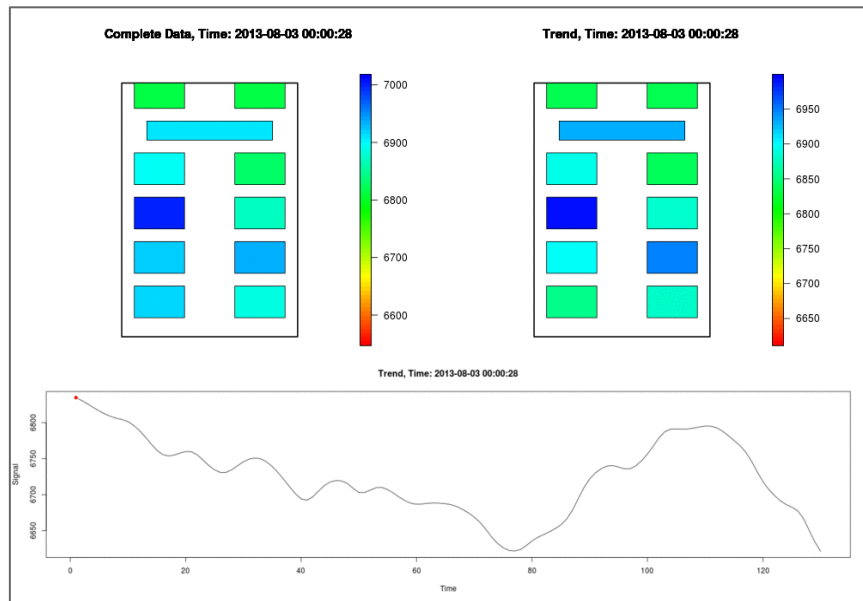
Identifying trends and classifying the states of a system through the analysis of data recorded real-time by electronic sensors.

Skills:

- Classification and clustering.
- Functional data analysis.



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



Output:

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



Our Products

SmartAID

SeTTEx
Second Touch Tactical EXploration

MOVIDA



mathesia

Innovative platform to optimize fundraising campaigns

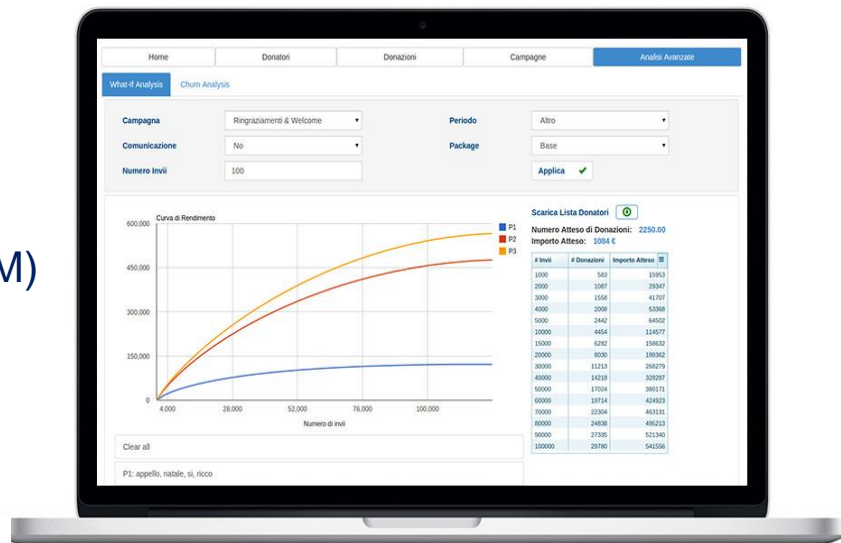




SmartAID: Mathematics for Fundraising

The innovative data analysis platform designed to organize fundraising and facilitate fundraiser's choices.

- Segmentation on donors' behavior (RFM)
- Life time value
- Filtering on a geographical basis
- Forecast & "what if" analysis
- Churn analysis



FONDAZIONE
IVO DE CARNERI ONLUS

Per la promozione dei piani di lotta alle
malattie parassitarie nei Paesi in via di sviluppo
e l'incremento degli studi di Parasitologia



Terre des hommes
Proteggiamo i bambini insieme



aiutare i bambini
ogni giorno, davvero

www.smartaid.it

Movement optimization and advanced
statistical analysis for **sport**





MOVIDA

(Movement's Optimization, through Video and Data Analysis)

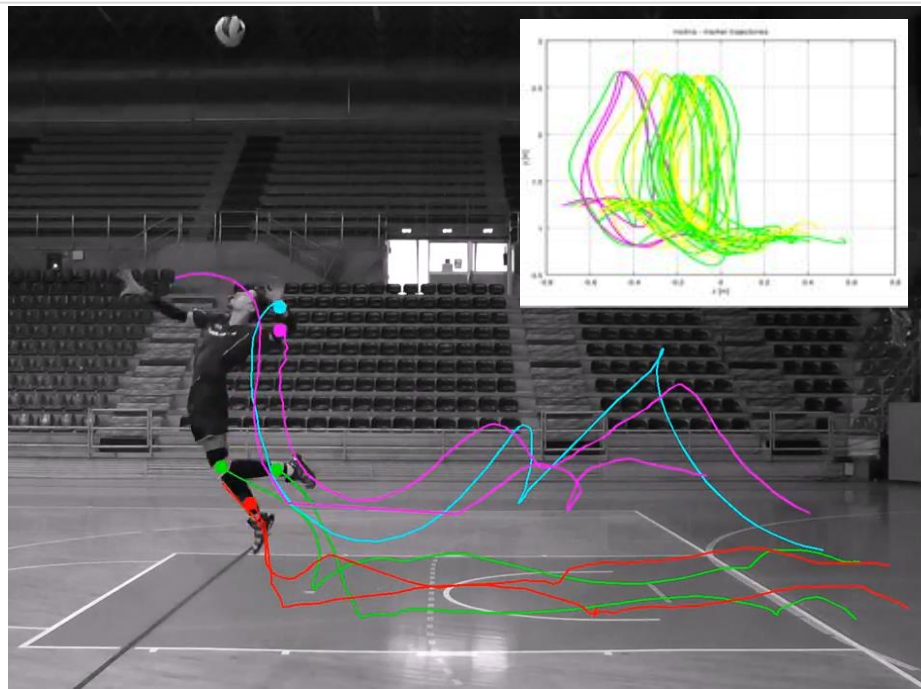
- Analysis of athletic movement based on specific technical and physical characteristics of the individual athlete.
- Video processing of movements and automatic data extraction.
- Data analysis to find correlations and optimal gesture.



CONI

ISTITUTO DI MEDICINA
E SCIENZA DELLO SPORT

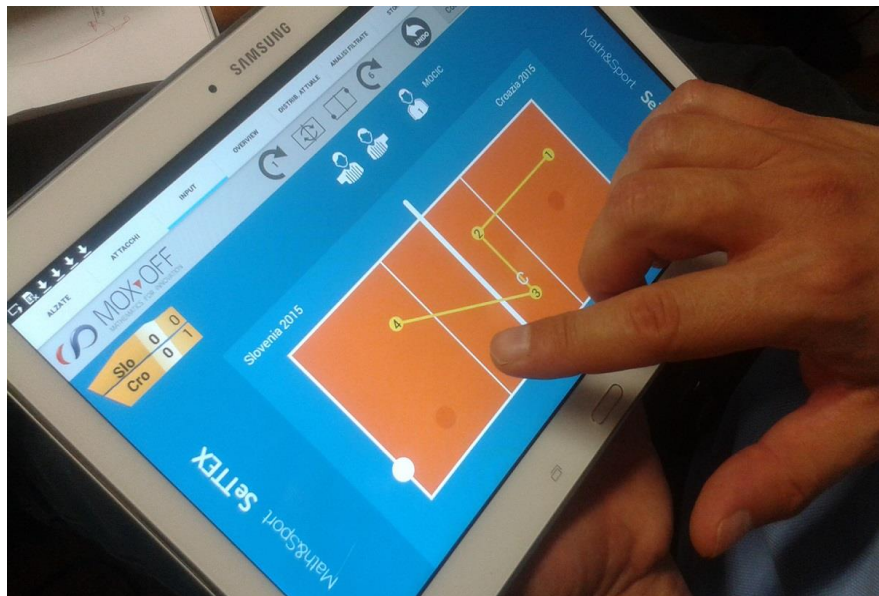
GESTIONE CONI SERVIZI





SeTTEX (Second Touch Tactical Exploration)

- Advanced statistical analysis of opponent's game.
- Interactive view of real-time setter distribution
- Touch-based app for visual data entry
- Generation and use of statistical during matches



Italian Volleyball Federa
National Teams 2014/21

Official Consultant

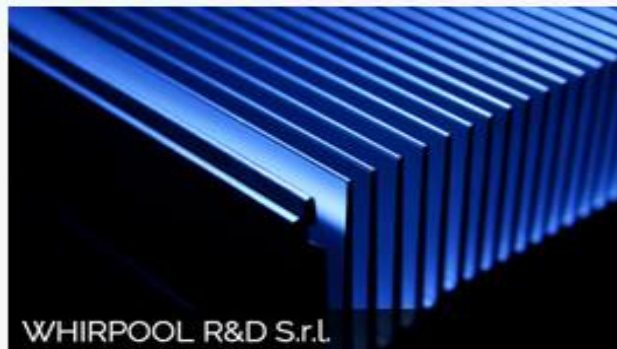
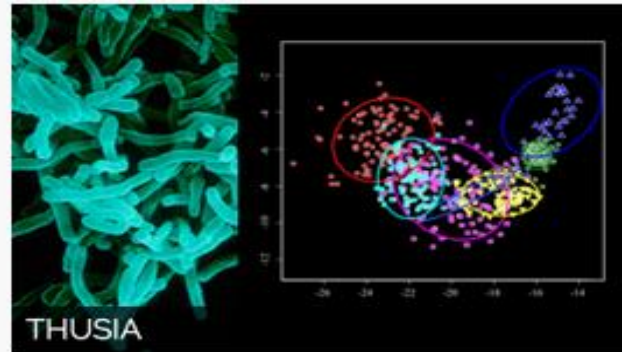
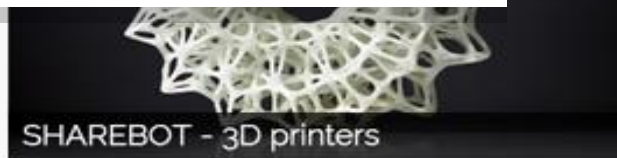


www.mathandsport.com



Get it on
Google play

The first **crowdsourcing** platform dedicated to applied mathematics





Mathesia: the land where math creates innovation

PITCHER



A company with a new idea
or a business challenge



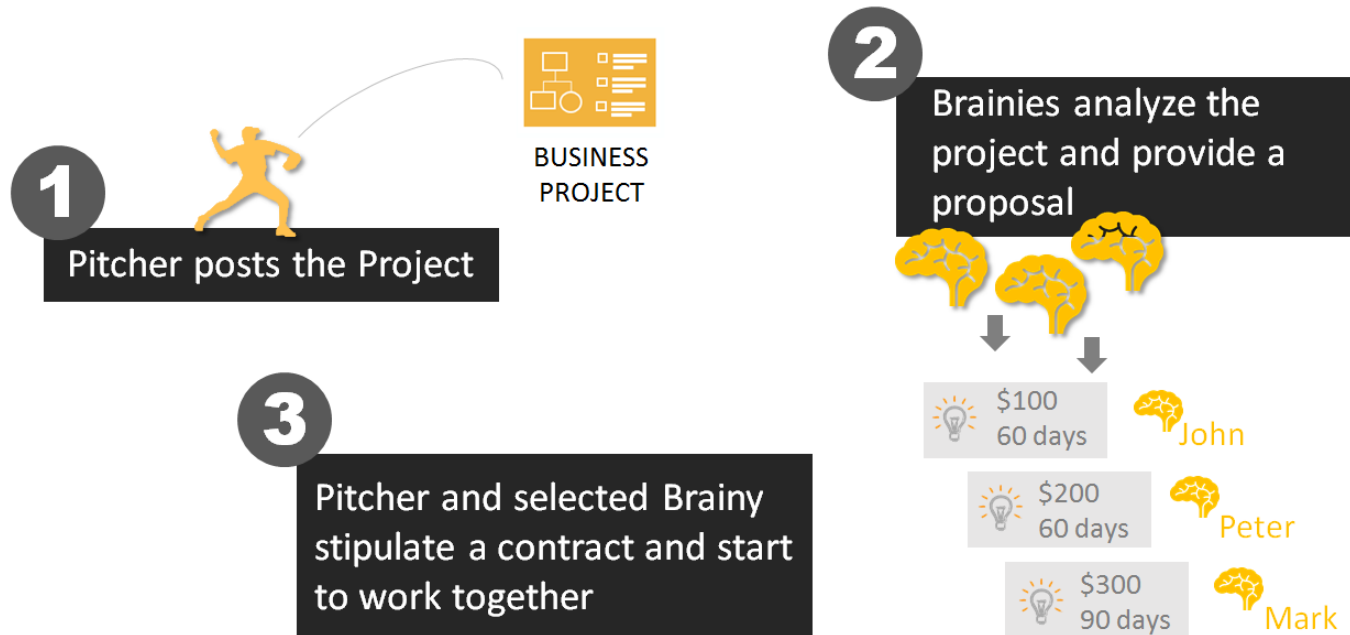
BRAINIES



Researchers, scientists
consultants & engineers



Mathesia: the land where math creates innovation





Mathesia Call 4 Talents... **COMING SOON**

DATA SCIENCE

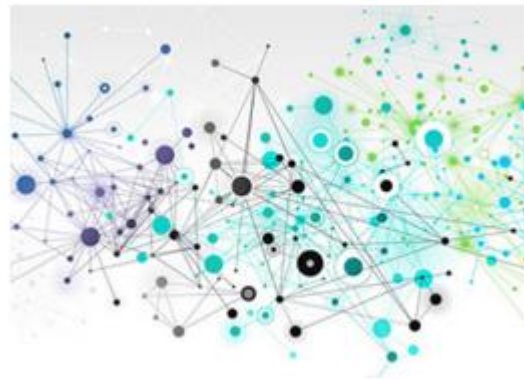
JOB POSITION: SENIOR DATA SCIENTIST

AREA: Rome, Italy

If you are a young data scientist with know-how in Network Analysis, Machine Learning and Predictive and Statistical analysis; if you are looking to enhance your professional experience by working in a dynamic environment, then you might be the one we are looking for!

By applying and solving our talent scouting project you will automatically become one the top candidates for the position. Take up our challenge now!

[LEARN MORE](#)





Mathesia – Brainies & Pitchers

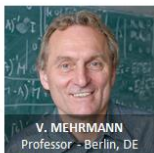


2000 BRAINIES



BRAINY PROFILE

36% RESEARCHER, PHD
32% PROFESSOR
24% FREELANCER
8% STUDENT



PITCHERS ALREADY ONBOARD



GOMMA INDUSTRIALE





Mathesia – Apply as Brainy



ARE YOU A MATH SPECIALIST?

Then you are ready to be a MATHESIA BRAINY!

APPLY AS BRAINY

www.mathesia.com



Thanks!

✉ luca.turconi@moxoff.com

🏠 www.moxoff.com

🐦 @MOXOFF_MathXInn

📘 /mathematicsforinnovation