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PASSION FOR INNOVATION

# Il valore dei dati applicati a scenari di protezione civile per gestire calamità

## Data Science for Industrial and Societal Applications Research Area

FABRIZIO DOMINICI – HEAD OF DATA SCIENCE AREA

30 GIUGNO 2021





**Negli ultimi 5 anni i disastri causati da eventi naturali estremi innescati dai cambiamenti climatici hanno causato perdite per più di 350 $miliardi/anno nel mondo**




# Il nostro percorso di ricerca per ottenere soluzioni modulari e di impatto basate sullo sfruttamento di dati e AI

Aumentare la resilienza del territorio vuol dire sfruttare le informazioni lavorando prima, durante e dopo i disastri

Snowball iREACT FLOODIS SAFERS FASTER Shelter

## ALCUNI PASSI DA COMPIERE

- Analizzare il proprio target e le soluzioni esistenti a disposizione
- Disegnare un processo finalizzato al raggiungimento degli obiettivi prefissati
- Valutare gli strumenti disponibili e chi li può operare nel contesto di riferimento in modo coordinato (un emergenza provocata da disastri naturali non è quasi mai un problema di un singolo comune!)
- Prototipare gli strumenti non disponibili e valutarne l'integrabilità con le soluzioni esistenti


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# Sorgenti Dati

## EARTH OBSERVATIONS

- Big volumes
- Limited spatial resolution

- Global coverage
- No human need for generation

## UAV and IOT SENSORS

- Needs Humans to generate data
- Local coverage

- High spatial resolution

## FORECAST MODELS

- Uncertainty

- Availability
- Well structured

## HUMAN GENERATED

- Noisy
- Fake news
- Unstructured

- Direct field data
- Multiple media
- High temporal resolution

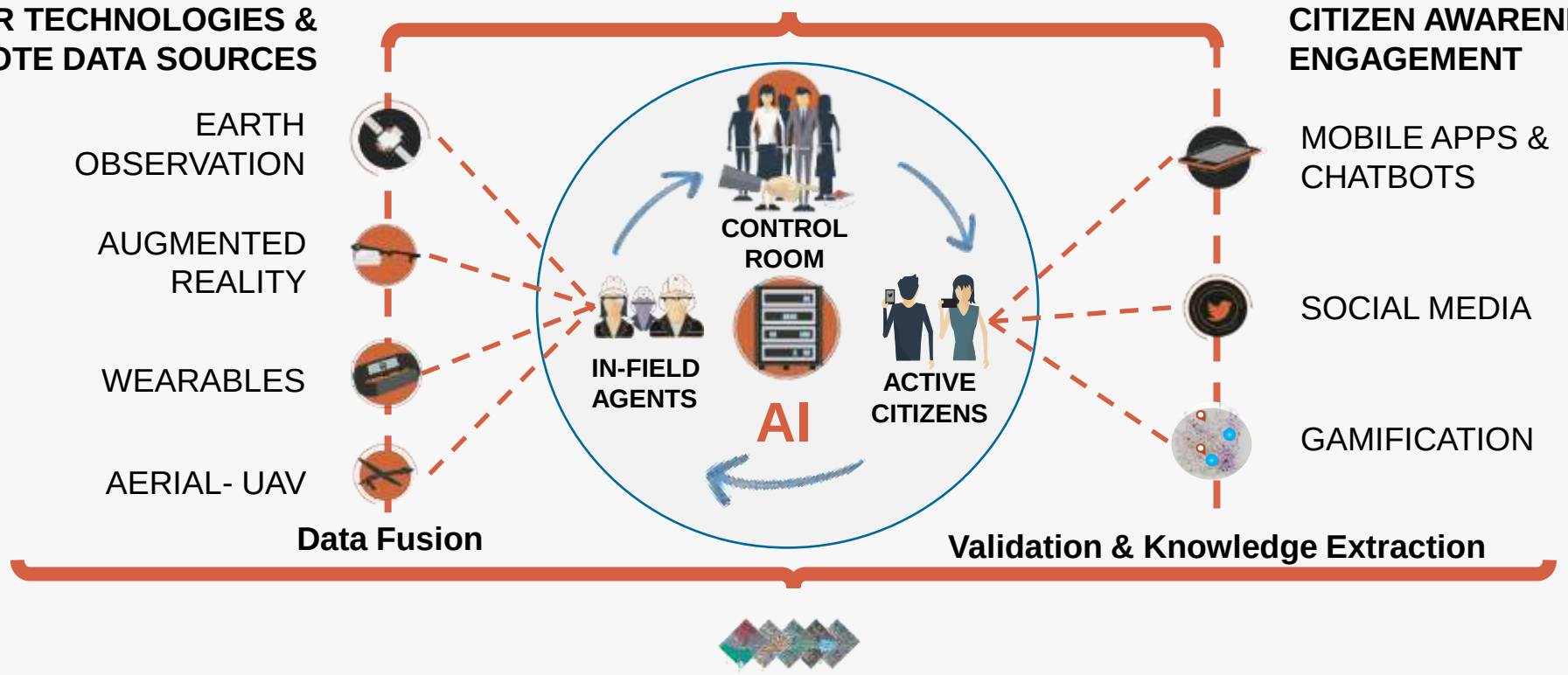


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# La centralità dei dati nel processo di aumento della resilienza

L'innovazione avviene facendo leva su **dati eterogenei** e su tecniche avanzate di AI per aumentare un awarness e forecasting

**+ RESILIENCE**







**DISASTER RISK MANAGEMENT INFORMATION (Risk, Delineation, Forecasting…)**

**DOMAINS**

- Natural hazards
- Risk analysis
- Emergency Management

**COMPETENCES**

Unsupervised Machine Learning – Deep Learning, Decision Trees, SVM, clustering

NLP, word embeddings

**FRAMEWORK/PROJECTS**

- FP7: Snowball, FLOODIS
- H2020: I-REACT, SHELTER, FASTER, SAFERS

FLOODIS I-REACT FASTER

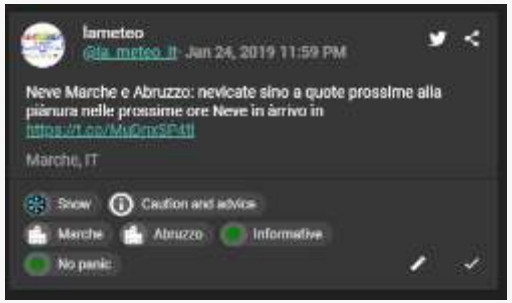


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# Human Generated Data

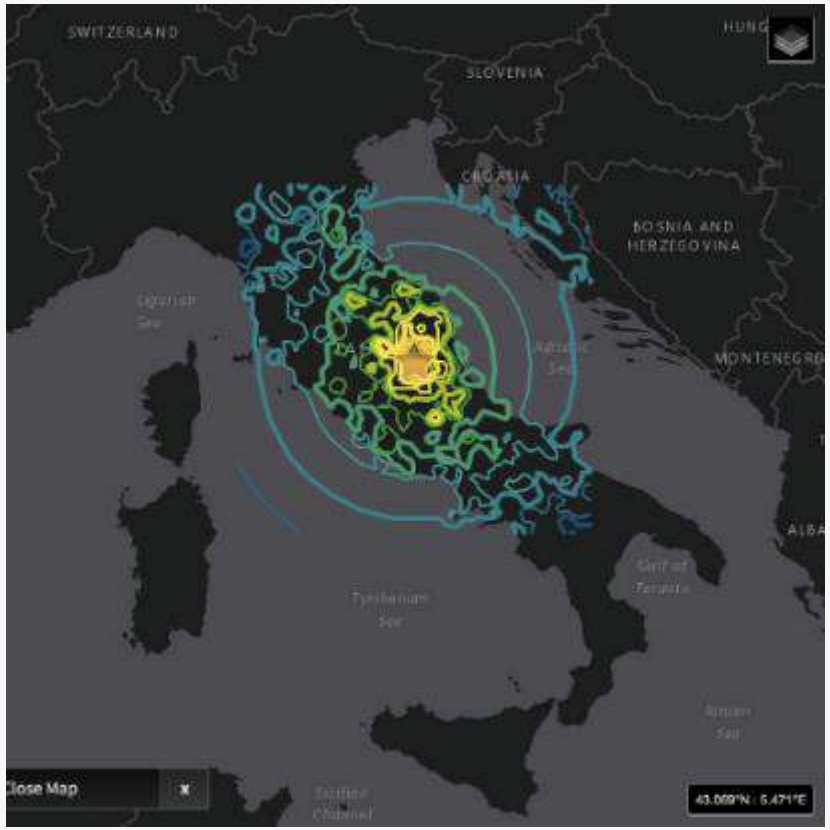
Dati proveninenti da social media usati per rilevare eventi e combinati con…

**CLASSIFICATION: NLP PLUS MACHINE LEARNING**




**Topic detection**
machine learning - clustering
**Informativeness**
binary classifier
**Panic**
sentiment analysis
**Information type**
multiclass classifier
**Named Entity Recognition**
Rule-based




AMATRICE EARTHQUAKE 24 AUGUST 2016


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# Mappatura aree bruciate

PRIMA




DOPO



AREA BRUCIATA




*Montebello Jonico, Calabria, Italy*

**#deeplearning**



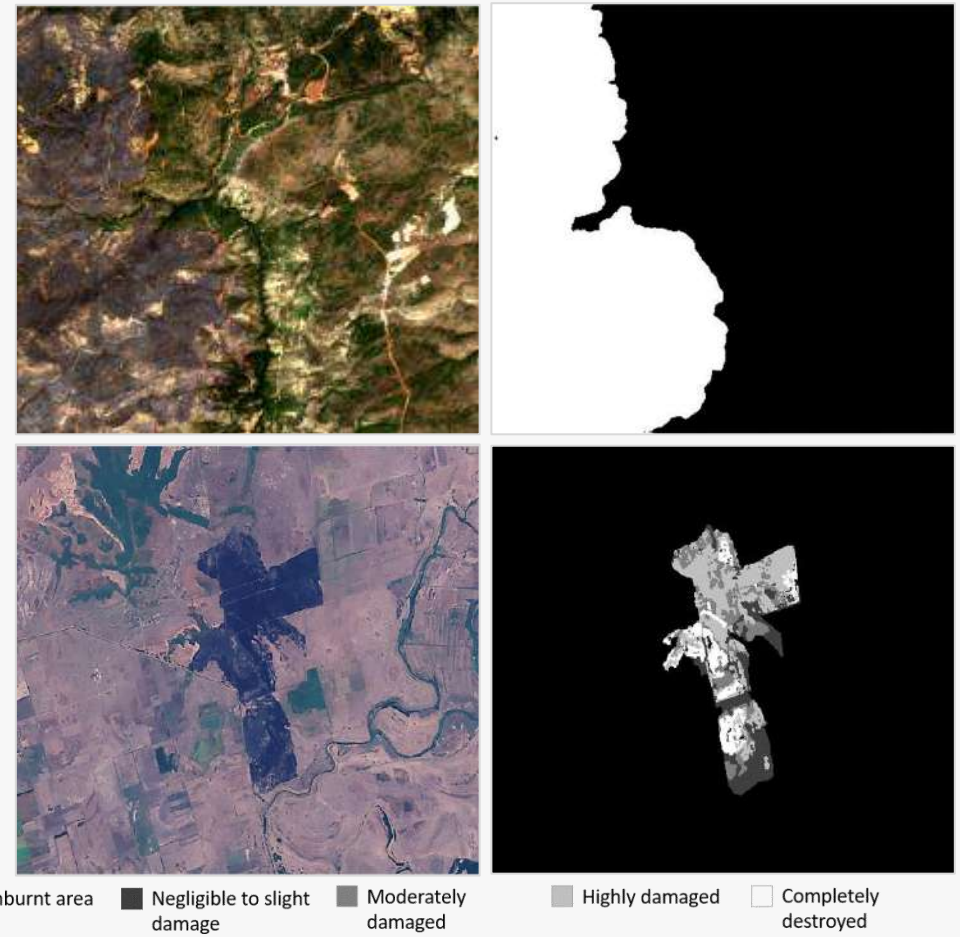
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# Mappature aree bruciate da satellite con AI

## Usando una combinazione di Sentinel-1 e Sentilel-2 Using Sentinel-2 per stimare la severità delle aree bruciate con AI

- **Data sources**
  - Copernicus Emergency Management System (manually validated masks)
  - Sentinel-2: 12 bands, 10m/pixel, 5-6 days revisit time

1. **Unsupervised ML**
   - Before *and* after-wildfire pictures, Image processing and Self-Organising Maps (SOM)
   - precision: **0.81** - recall: **0.66** - F1 score: **0.70**
2. **Supervised delineation**
   - After-wildfire only pictures, Deep Learning approach (U-Net)
   - precision: **0.89** - recall: **0.78** - F1 score: **0.81**
3. **Supervised severity estimation**
   - After-wildfire only pictures, DL approach (Double-Step U-Net)
   - precision: **0.80** - recall: **0.97** - F1 score: **0.88**




Burned Area Delineation - ISCRAM (2020)
Severity Estimation - Journal, MDPI (2020)

**DOMAINS**
- Climate Change
- Natural Hazards
- Emergency Management

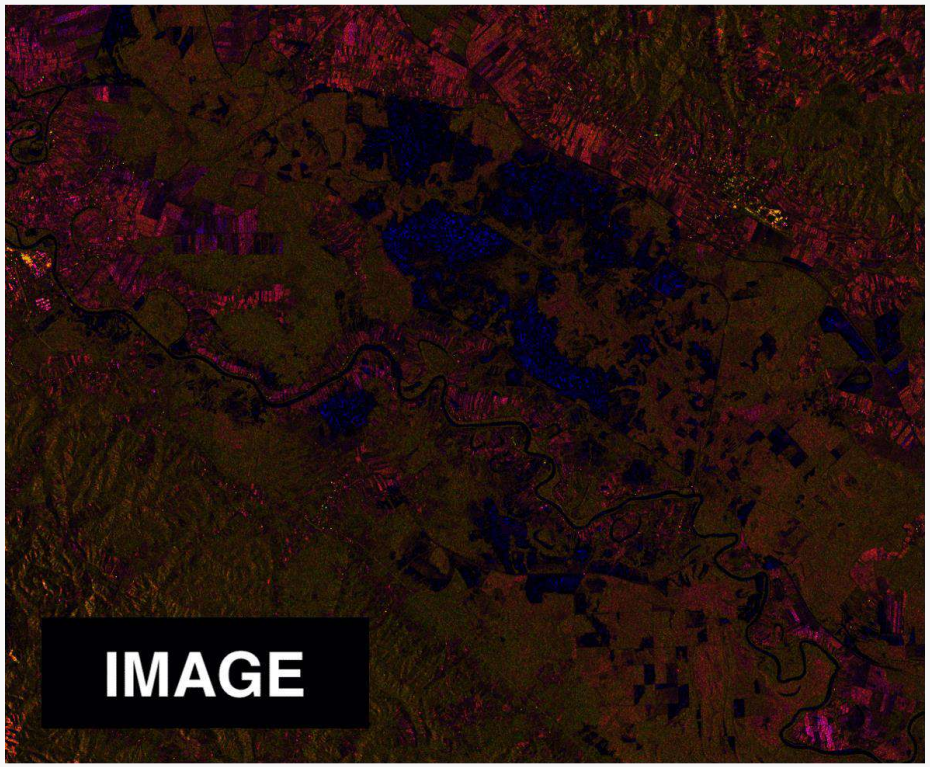
**COMPETENCES**
Unsupervised Machine Learning, clustering, **Deep Learning**, Computer Vision

**RELETED PROJECTS**
- FASTER
- SHELTER
- SAFERS


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# Delineating Flooded Areas from Satellite with AI

Using Sentinel-1 SAR data and Sentinel 2 images to delineate flooded areas through different AI model iterations




- **Data sources**
  - Copernicus EMS Sentinel-1: 2 bands, 30m/pixel, 5-6 days revisit time
  - Sen1Floods11 dataset composed of Sentinel-1 images of flooded areas

1. **Supervised delineation model – v1.0**
   - U-Net model trained on 48 images subset, with k-fold technique. Each fold consisted of 40 training images and 8 test images.
   - precision: **0.68** - recall: **0.83** - F1 score: **0.74**
2. **Supervised delineation model – v1.1**
   - U-Net model trained on an enlarged set of 196 images with a 0.75/0.25 split. Stronger data augmentation.
   - precision: **0.67** - recall: **0.83** - F1 score: **0.75**
3. **Supervised delineation model – v2.0**
   - U-Net model trained on Sen1Floods11 (available since Nov. 2020), 446 hand labeled images with a 0.75/0.25 split.
   - precision: **0.70** - recall: **0.50** - F1 score: **0.58**

**DOMAINS**
- Climate Change
- Natural Hazards
- Emergency Management

**COMPETENCES**

Supervised Machine Learning, clustering, **Deep Learning**, Computer Vision

**RELETED PROJECTS**
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# DECISORI



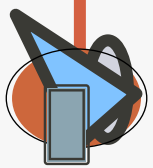
## DECISION SUPPORT SYSTEM

Help Decision makers in monitoring and quickly take decisions



## DATA FUSION

+ organization
+ integration
+ **machine learning** for **information filtering** and **pattern detection**



## SOURCES

**Extract value** from existing **public data repositories**

# SISTEMI DATA DRIVEN



*Artificial Intelligence*

*Variety / Volume of data*



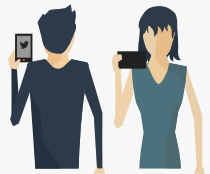
*Earth observation / UAV*



*IoT*



*Models*



*Human generated*



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# ALCUNE LEZIONI INTERCETTATE IN QUESTI ANNI

Sfruttare asset europei (es. Copernicus) e strumenti esistenti in una logica complementare sfruttando standard

Investire sulla multidisciplinarità e su tecnologie di frontiera come l'AI con uno sguardo alla manutenibilità delle soluzioni

Nel disegnare un prototipo considerare la sostenibilità di gestione e uso delle soluzioni



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