

LUCA COVIELLO

Consortium
GARR

THE ITALIAN
EDUCATION
& RESEARCH
NETWORK



MPBA
PREDICTIVE MODELS
FOR BIOMEDICINE & ENVIRONMENT



Multimodal Deep Neural Networks and Precision Agriculture for Food Quality Monitoring

**GIORNATA DI INCONTRO
BORSE DI STUDIO GARR
"ORIO CARLINI"
06 DICEMBRE 2018
ROMA**



Problems in Agriculture

Demand for food
+50% between
2012 and 2050

Only few opportunities
for expanding the
agricultural area

Growth in yields
has slowed
significantly

**Producing more with
less** is a key challenge
for the future



Precision Agriculture and Big Data

From: pre packaging quality control

Melinda sceglie Cherry Vision 2 di Unitec: cresce l'efficienza e qualità garantita per i consumatori di ciliegie

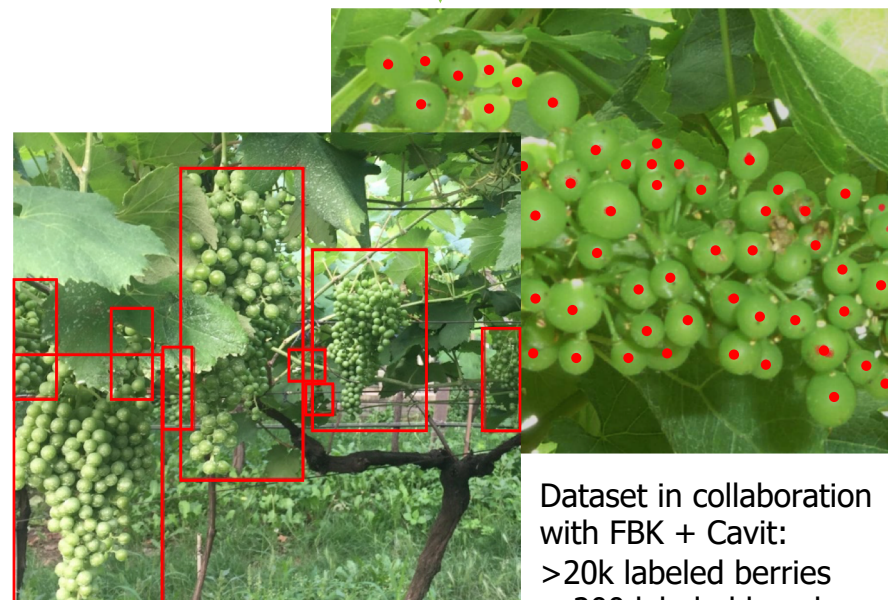
19 Luglio 2016



High throughput data
from QC with
Spectroscopy

Source: <http://www.freshplaza.it/article/4083881/melinda-sceglie-cherry-vision-di-unitec-cresce-l-efficienza-e-qualita-garantita-per-i-consumatori-di-ciliegie/>

To: in field machine learning



Dataset in collaboration
with FBK + Cavit:
>20k labeled berries
> 200 labeled bunches







Example Work: Crop Yield Estimation

Photo: <https://www.outstandingdrone.com/dji-phantom-1-review/>



Image acquisition using
smartphones or other
(automatic) acquisition systems

Work led in
collaboration with
CAVIT and FBK



Coviello L., Cristoforetti, M., Jurman G., Furlanello C. (2018). *In field grape berries counting for yield estimation using Multi-column CNNs*. Manuscript submitted for publication.





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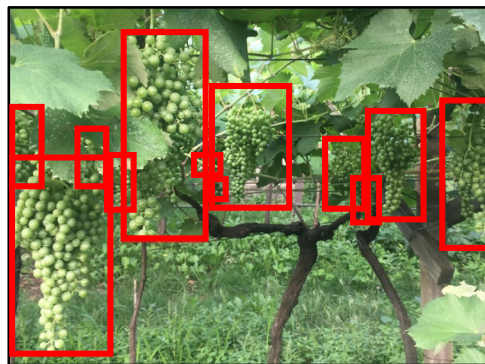
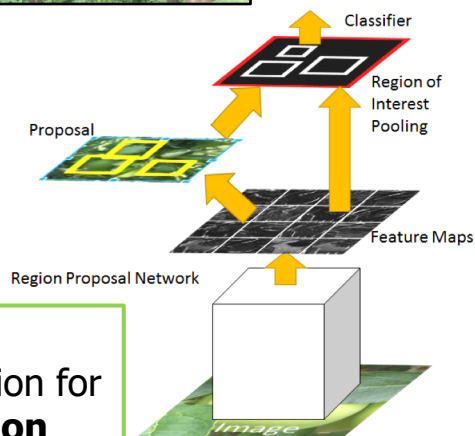


Image acquisition using smartphones or other (automatic) acquisition systems

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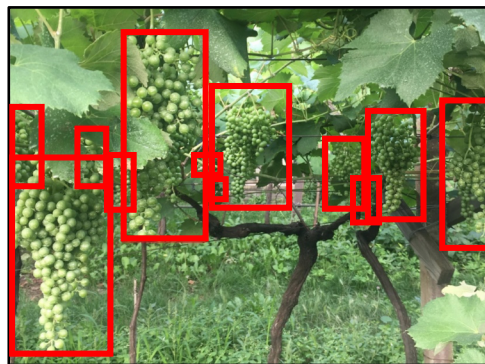
Deep Learning: Image segmentation for fruit identification





Example Work: Crop Yield Estimation

Photo: <https://www.outstandingdrone.com/dji-phantom-1-review/>



Deep Learning:
Crowd counting density map CNN for
berries count and **weight estimation**

Multi-column CNN

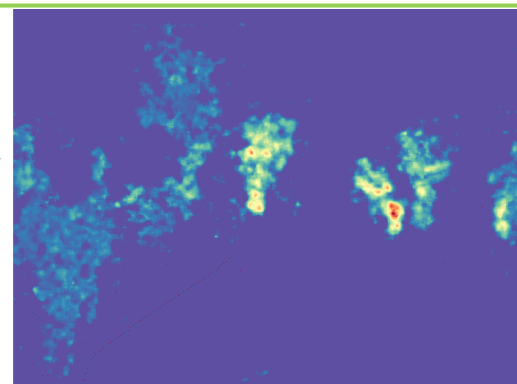
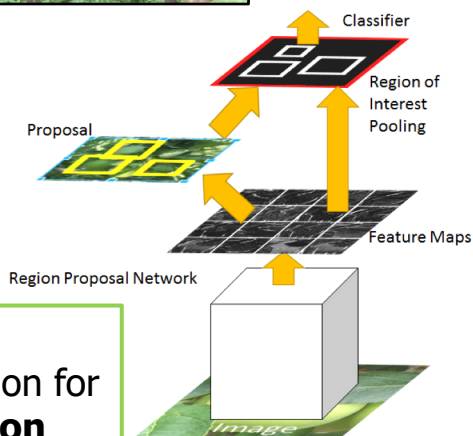


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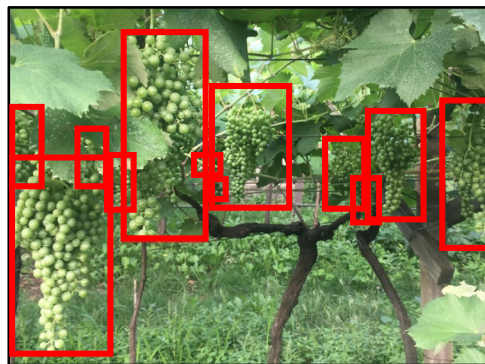
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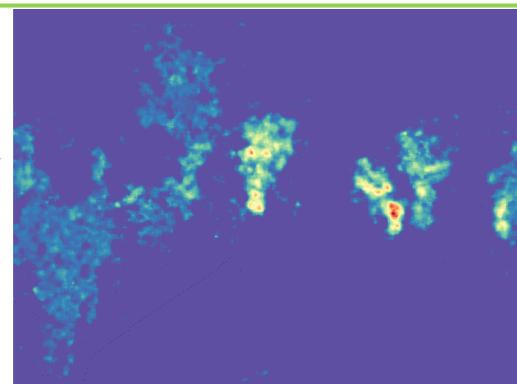


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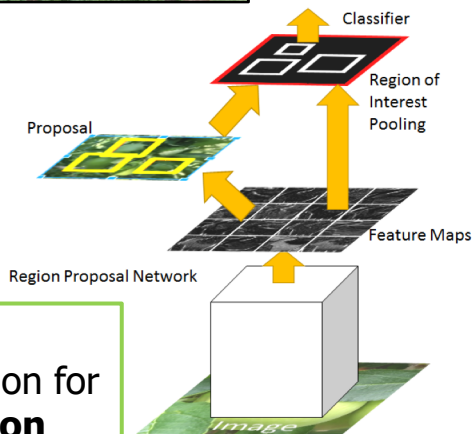


Multi-column CNN

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Deep Learning:
Image segmentation for
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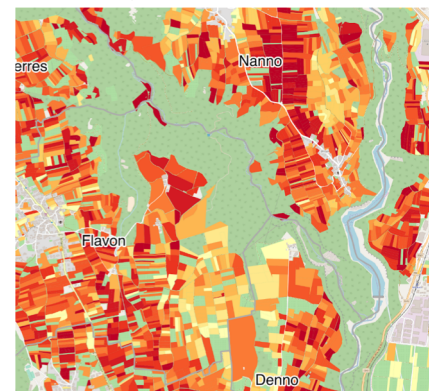
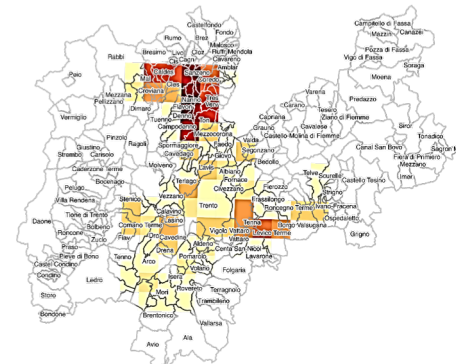
Training:
2 hours on Azure Cloud with
PyTorch
2 GPUs with **12GB RAM** each
>130k parameters to learn

Dataset: >20k labeled berries

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Example Work: Apple Frost Damage Risk Prediction



Data courtesy of Co.Di.Pr.A





Example Work: Apple Frost Damage Risk Prediction

geoRDB



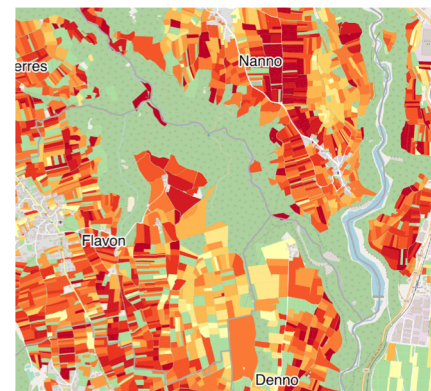
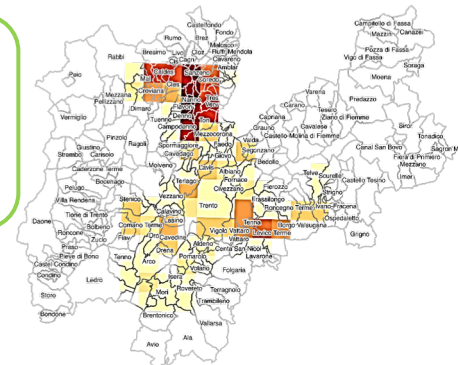
Geodatabase
integrato di Rischio

Deep Learning for:

- Climate
- Risk
- Hazard

**With different
resolution levels:**

- 5 km
- 1 km
- **cadastral parcel**



Data courtesy of Co.Di.Pr.A





Example Work: Apple Frost Damage Risk Prediction

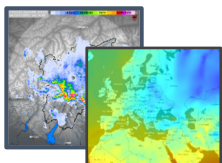
Data sources



Structured files,
XML, csv, ...



cadastral, DTM, ...



Temperature,
radar, satellite, ...



geoRDB



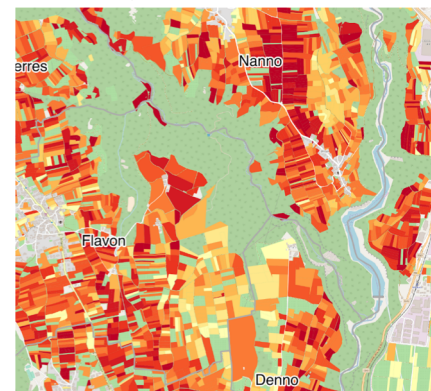
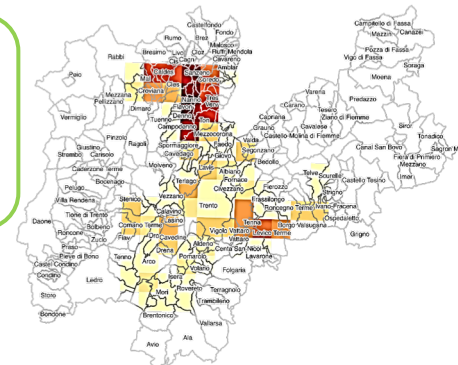
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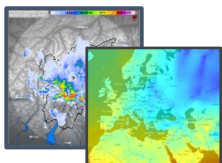


Structured files,
XML, csv, ...

SHP



cadastral, DTM, ...



Temperature,
radar, satellite, ...



geoRDB



Geodatabase
integrato di Rischio



libelium

Deep Learning for:

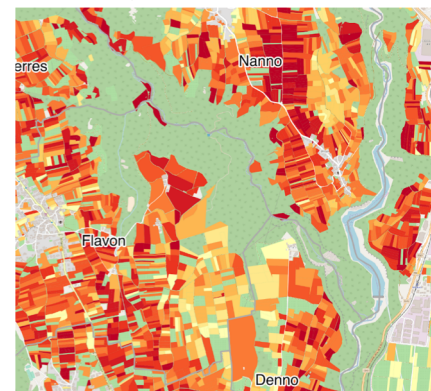
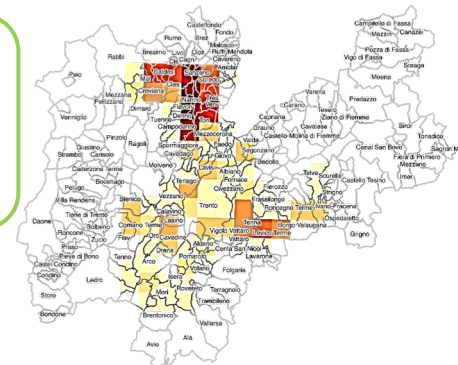
- Climate
- Risk
- Hazard

With different resolution levels:

- 5 km
- 1 km
- cadastral parcel

Available data:

- Soil moisture
- Temperature
- Humidity
- Leaf Wetness
- Atmospheric Pressure



Deep Learning:

Multimodal Neural Network for
Phenology Prediction

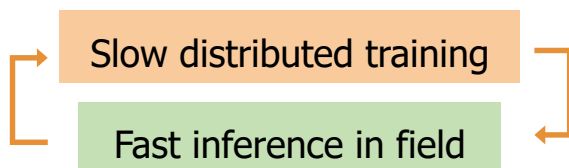
Data courtesy of Co.Di.Pr.A





Goal: upscale DL for precision agriculture

**DL Models are GPU
Expensive**



Finding the **right** model takes **time**:

- 3 Preprocessing techniques
- 3 architectures
- 5-fold validation
- DL Meta parameters

Using the **right** model
takes **power** or
bandwidth



Goal: upscale DL for precision agriculture

**DL Models are GPU
Expensive**

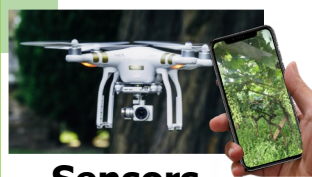
Slow distributed training

Fast inference in field

Finding the **right** model takes **time**:

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- 5-fold validation
- DL Meta parameters

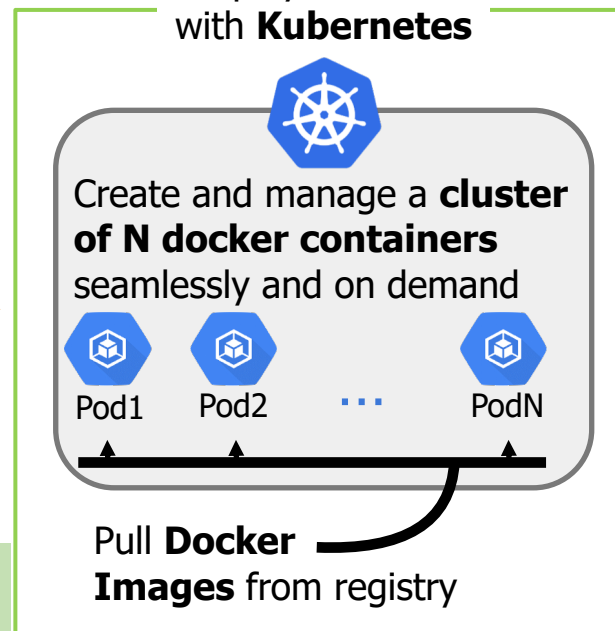
Using the **right** model
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Sensors

Need of **connecting**
in **field sensors** with
computing power

Deploy in **Cloud**
with **Kubernetes**

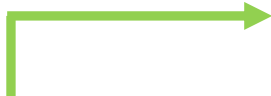


DL at the edge with
Movidius Neural
Compute Stick

Photo: <https://www.outstandingdrone.com/dji-phantom-1-review/>



Goal: upscale DL for precision agriculture (2nd)



krasnevsky @CC / Cropped

LoRa and LoRaWAN Infrastructure

Long Range (Wide Area Network)

Why LoRa:

- Scalable
- Extremely Economical
- Long distance
- Low power
- Secure (AES128)



Easily install networks of
IoT devices in rural areas
without internet coverage

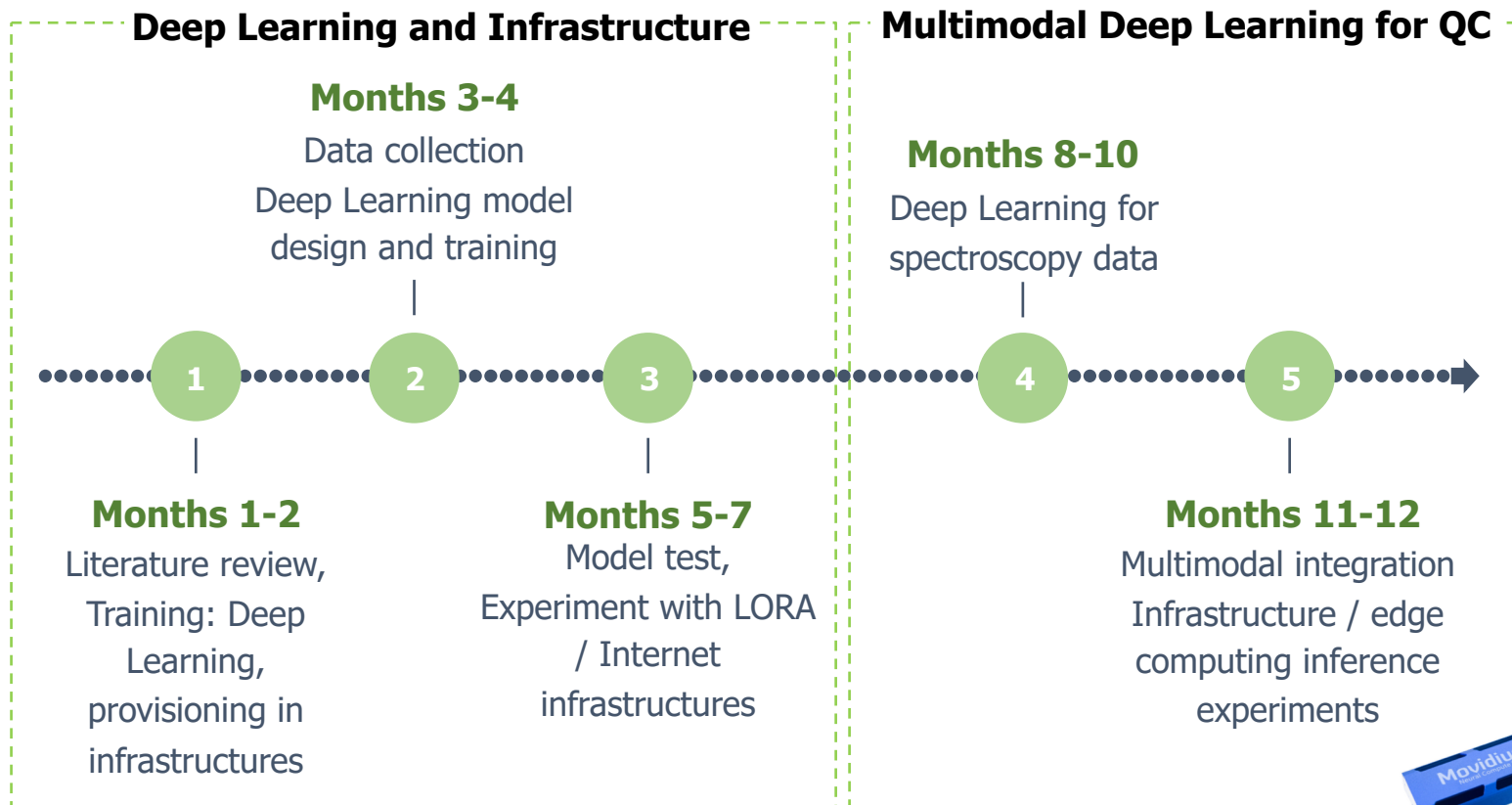


Wikimedia Commons / CC BY-SA

Photo: <https://www.outstandingdrone.com/dji-phantom-1-review/>



Activity Planning





Thank You

Luca
Coviello



Working Experience

Scientific Developer @ Fondazione Bruno Kessler (2013 - 2016) MPBA Lab: Cesare Furlanello

Experience in **Innovation** and **Entrepreneurship** (StartUps: NewsU, Chameleononline, Billy)

Interested in combining **research** and **innovation** to **agriculture** and **climate changes**

Education

MSc in **Data Science** and **I&E** @ EIT Digital (Madrid, Nice)
thesis in **Deep Learning applied to Smart Agriculture** + **I&E** minor

BSc in **Computer Science** @ UniTN, Intern @ FBK, Data Science (Prog. Min. Salute)
thesis in **Deep Learning** for Sentiment Analysis and Vaccine Confidence Monitoring