



# Elaborazione delle immagini e Computer Vision

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# Indice

- Metodi classici e Deep Learning
- Manipolazione delle immagini con OpenCV
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- Supervised Machine Learning
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- Unsupervised Machine Learning
  - Autoencoders ed estrazione delle features
  - Generative Adversarial Networks (GAN)

# Metodi classici e Deep Learning

- **Metodi classici**

- Filtering
- Edge detection
- Color segmentation

- **Deep Learning**

- Classificazione immagini
- Object detection
- Semantic segmentation

# OpenCV

## Image processing



•General Image Processing



Transforms



Fitting



Optical Flow



Segmentation



## Video, Stereo, and 3D



Camera Calibration



Pose estimation



Features



Depth Maps



Object detection

# Hello world

## hello.cpp

```
#include <opencv2/core/core.hpp>
#include <opencv2/highgui/highgui.hpp>
#include <iostream>

int main()
{
    cv::Mat image = cv::imread("lena.bmp");
    if (image.empty())
    {
        std::cerr << "Could not load image";
        return 1;
    }

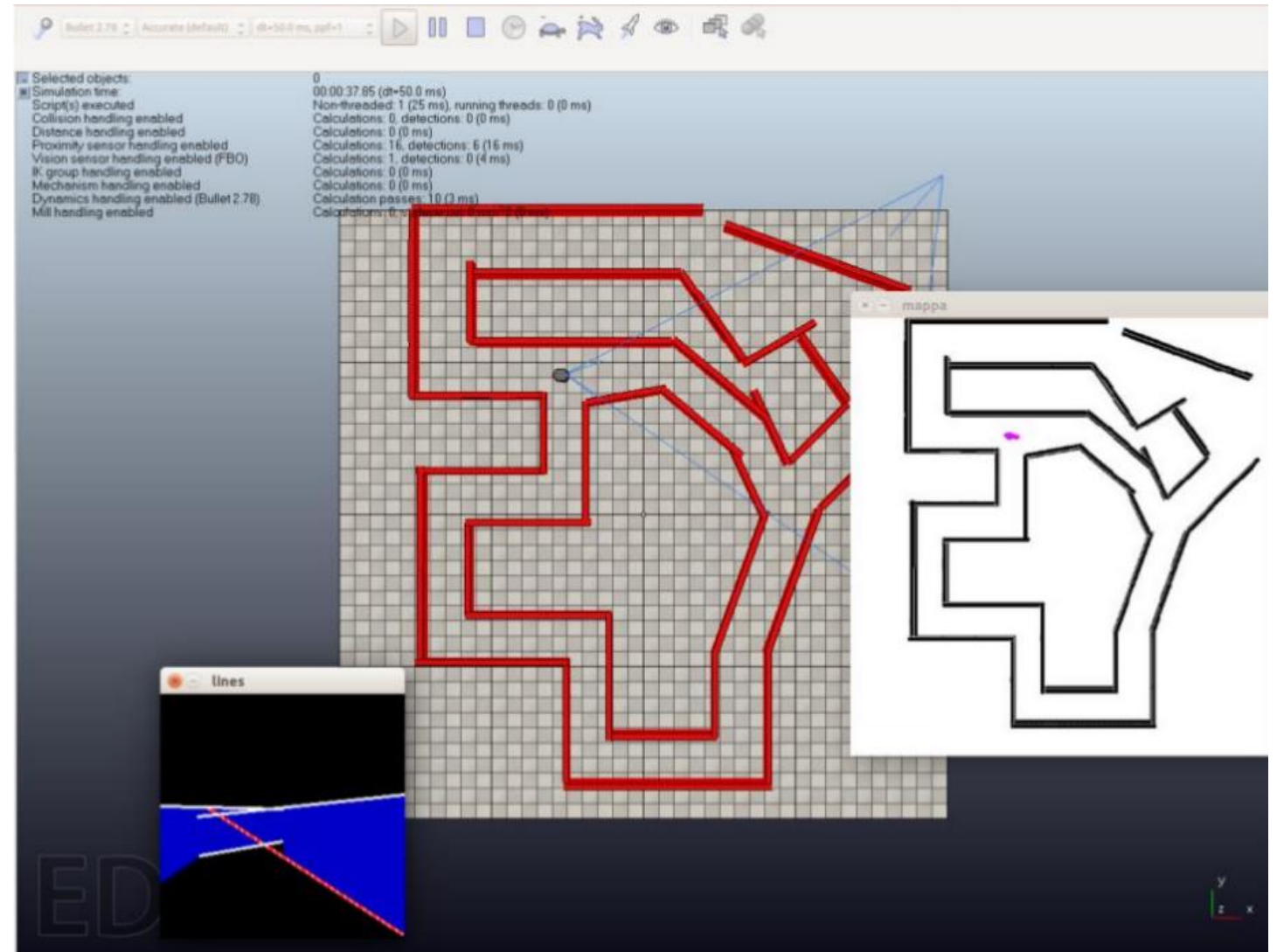
    cv::namedWindow("Image");
    cv::imshow("Image", image);
    cv::waitKey();
    return 0;
}
```

<-- includi la libreria OpenCV

<-- Leggi l'immagine dal file .bmp  
Questa funzione restituisce una **matrice di pixels** di dimensioni pari a (larghezza immagine, altezza immagine), ogni pixel è un vettore di 3 componenti **RGB**

<-- Mostra l'immagine in una finestra

# Esempio 1: Robot localization



# Image processing

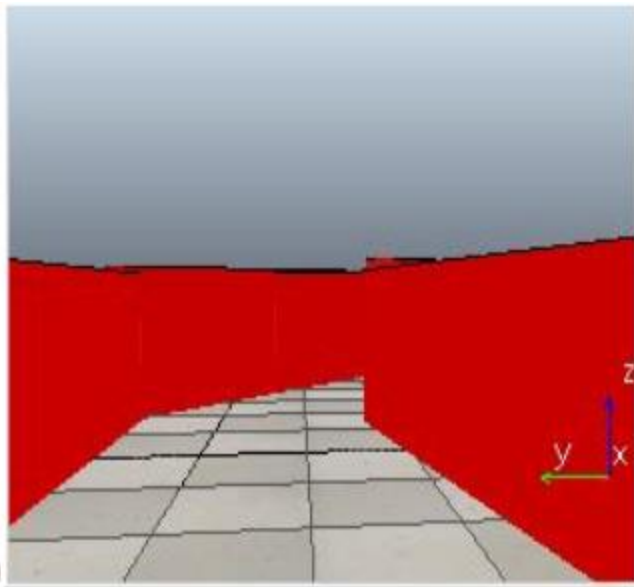
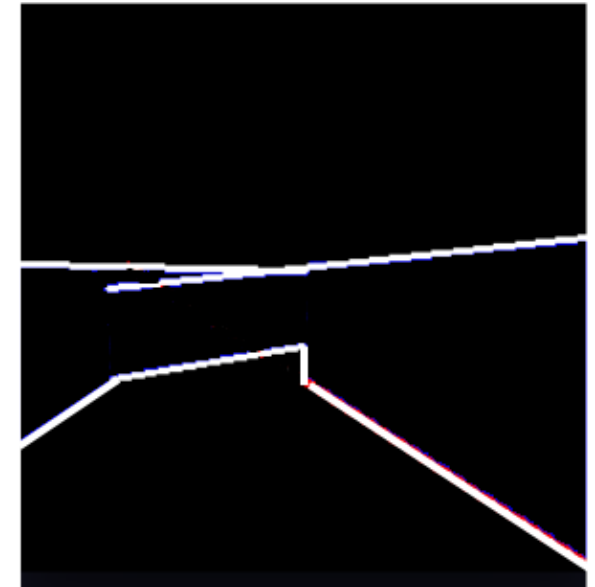


Immagine presa dalla  
camera del robot



Color segmentation



Edge detection

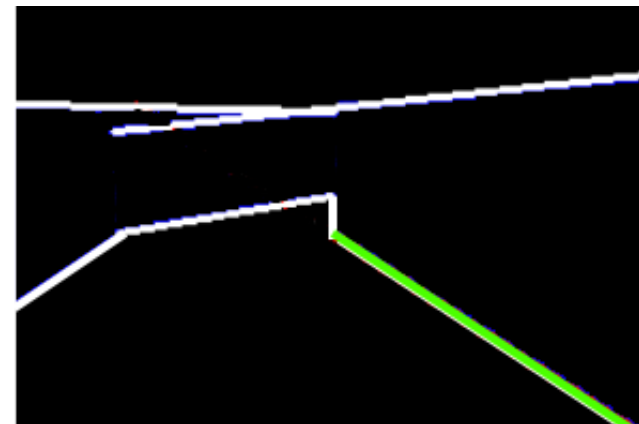


# Localizzazione nella mappa

Fra le linee di contorno vengono selezionate quelle che hanno più chance di corrispondere alle guide del corridoio.

Queste vengono proiettate sulla mappa e associate ai muri della mappa.

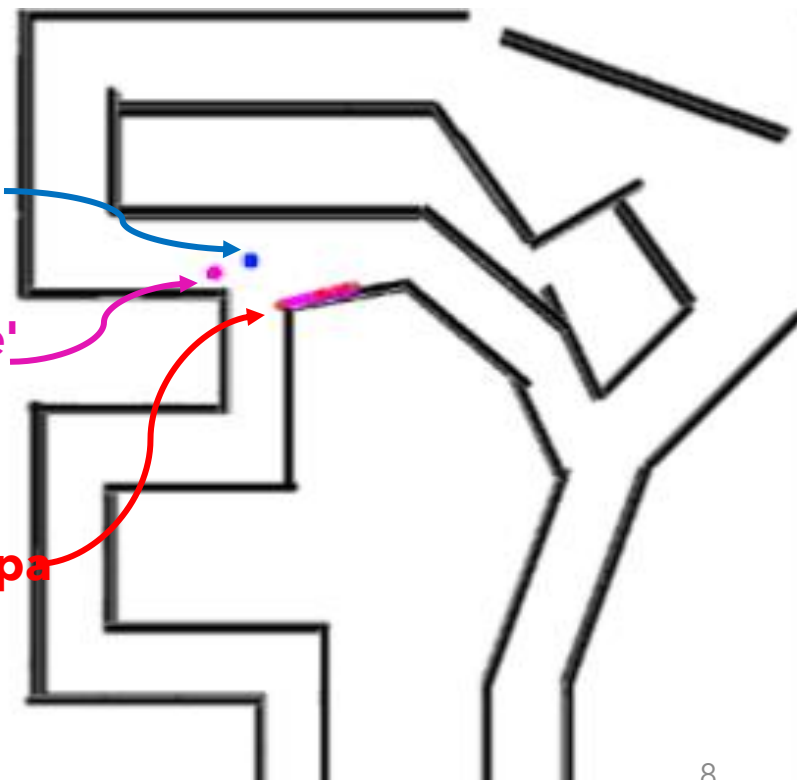
In base a questa associazione il robot si localizza all'interno del labirinto



**Dove il robot è  
realmente**

**Dove il robot 'crede'  
di essere**

**Guida del corridoio  
Proiettata sulla mappa**





# Esempio 2: generatore di hashtag per instagram

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#lmao  
#notevenmad  
#whatcanyoudo  
#toqueseason



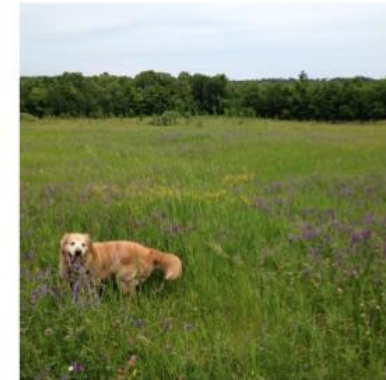
#camping  
#vancouverisland



#puppy  
#archer



#goodluckalgorithm  
#notmymathin-  
thebackground



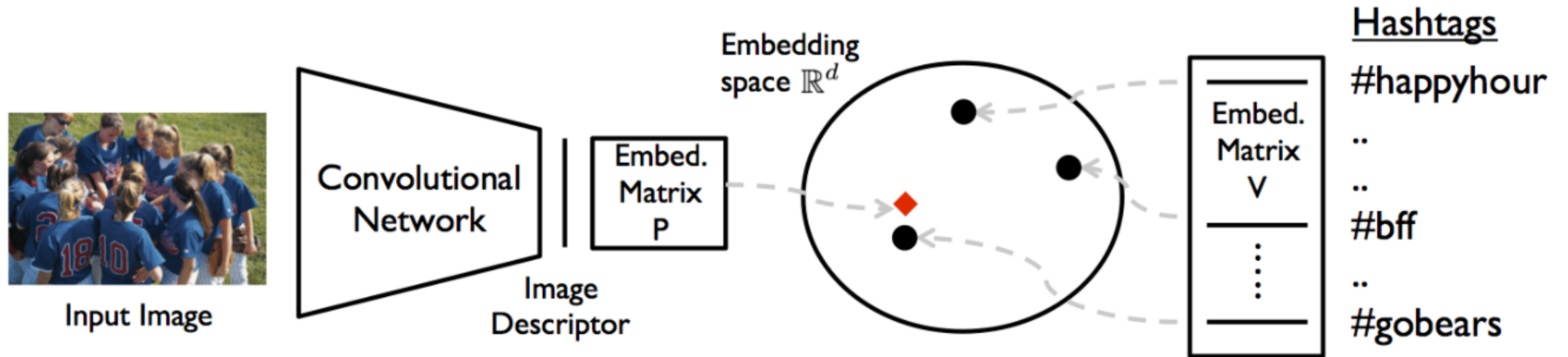
#farm  
#dog



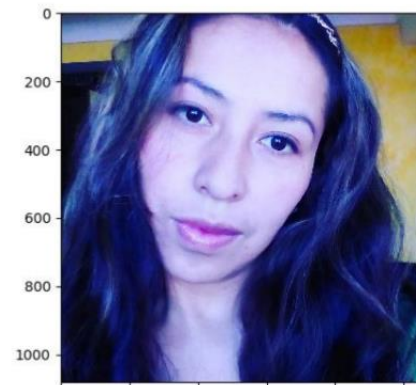
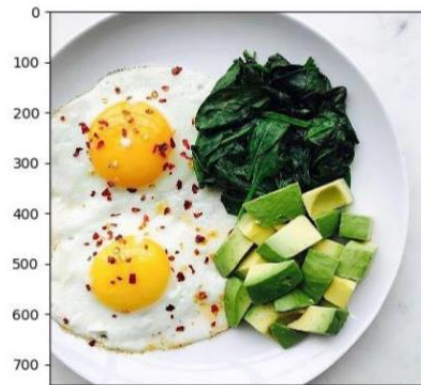
#toronto  
#craftbrew  
#OCW2014

# Come funziona

- L'immagine viene mappata in uno spazio d-dimensionale (**Embedding space**)
- Gli hashtag vengono mappati nello stesso spazio
- Le associazioni immagine-hashtag vengono fatte in base alla distanza dei punti nell'embedding space

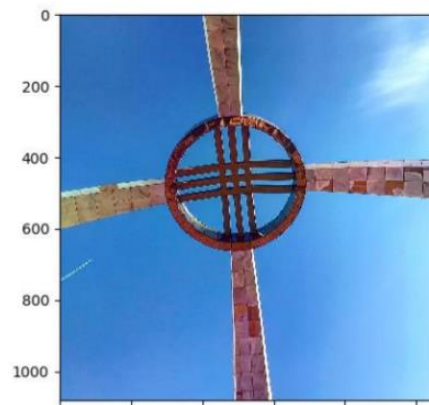


#instafood #yummy #food  
#foodporn #healthy  
#breakfast #goodmorning  
#sweet #picoftheday  
#amazing



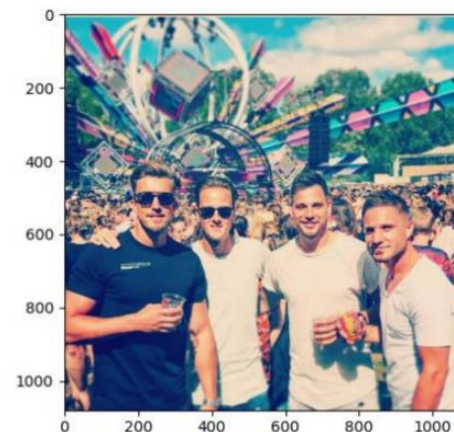
#fashion #selfie #cute  
#likeforfollow #model #girls  
#ootd #hair #likeforlike  
#instafollow

#instatravel #travelgram  
#sea #travelphotography  
#clouds #landscape  
#photooftheday #sunset  
#naturephotography  
#lifestyle



#travelphotography  
#instatravel #photo  
#clouds #like4like #sun  
#naturephotography

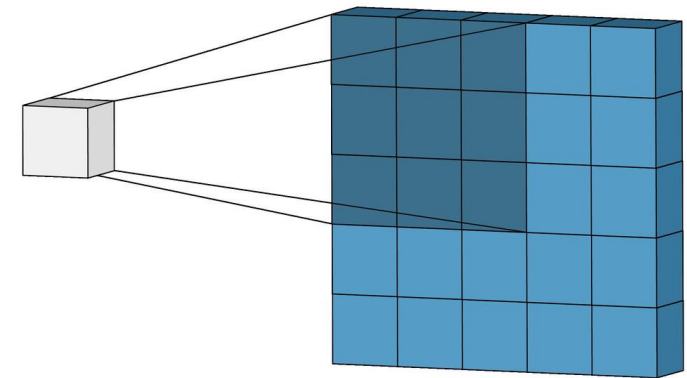
#likeforfollow #instatravel  
#swag #insta #followme  
#girls #beautiful #gym  
#follow4follow #instalike



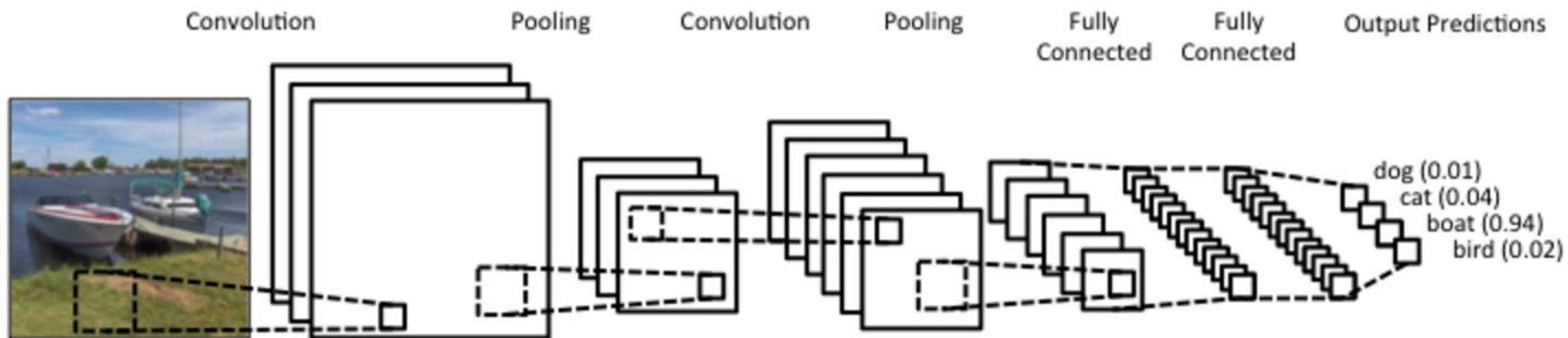
#clouds #landscape  
#sunset  
#naturephotography #sky  
#photography  
#nofilter #sea #amazing  
#instagood



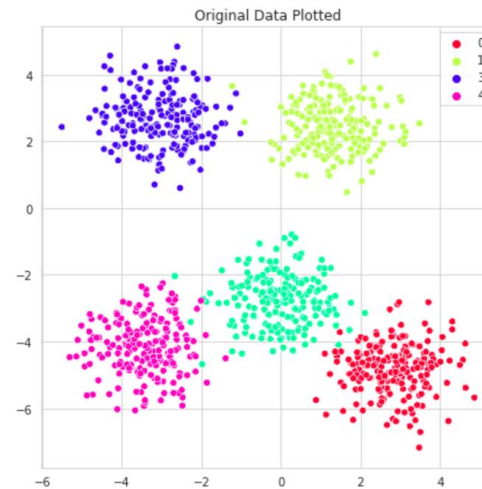
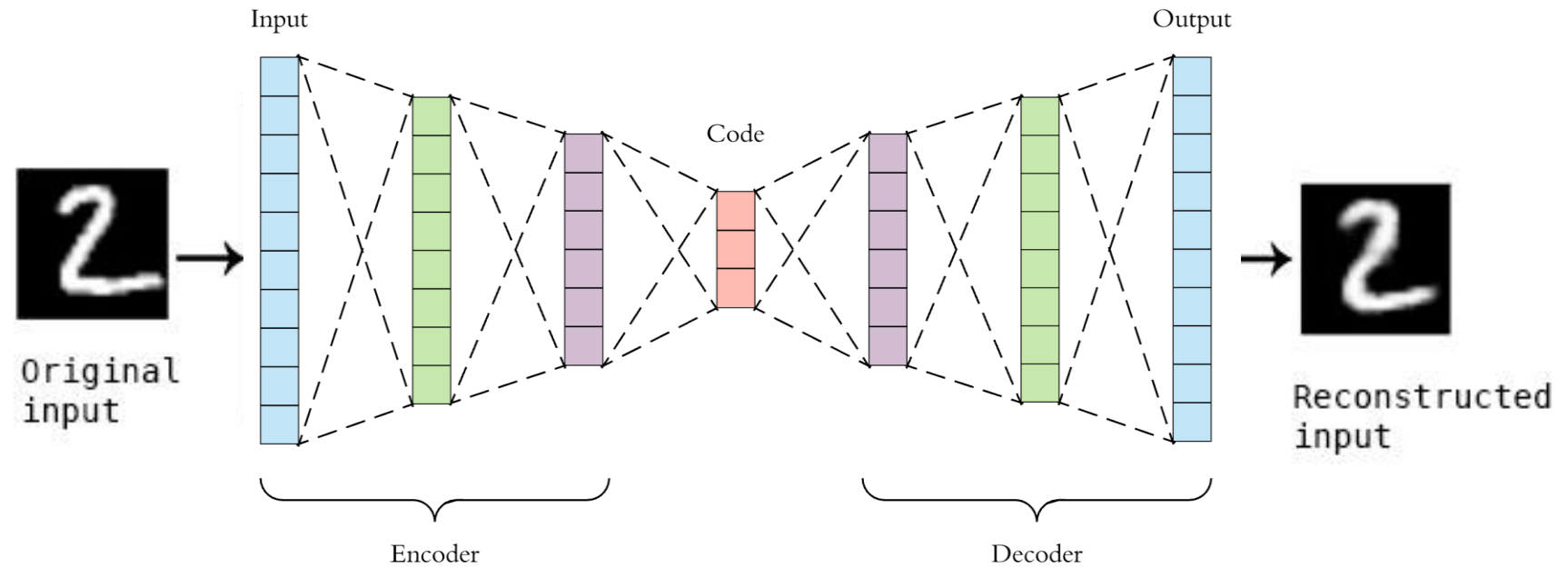
# Che cos'è una rete neurale convoluzionale



## Convoluzione

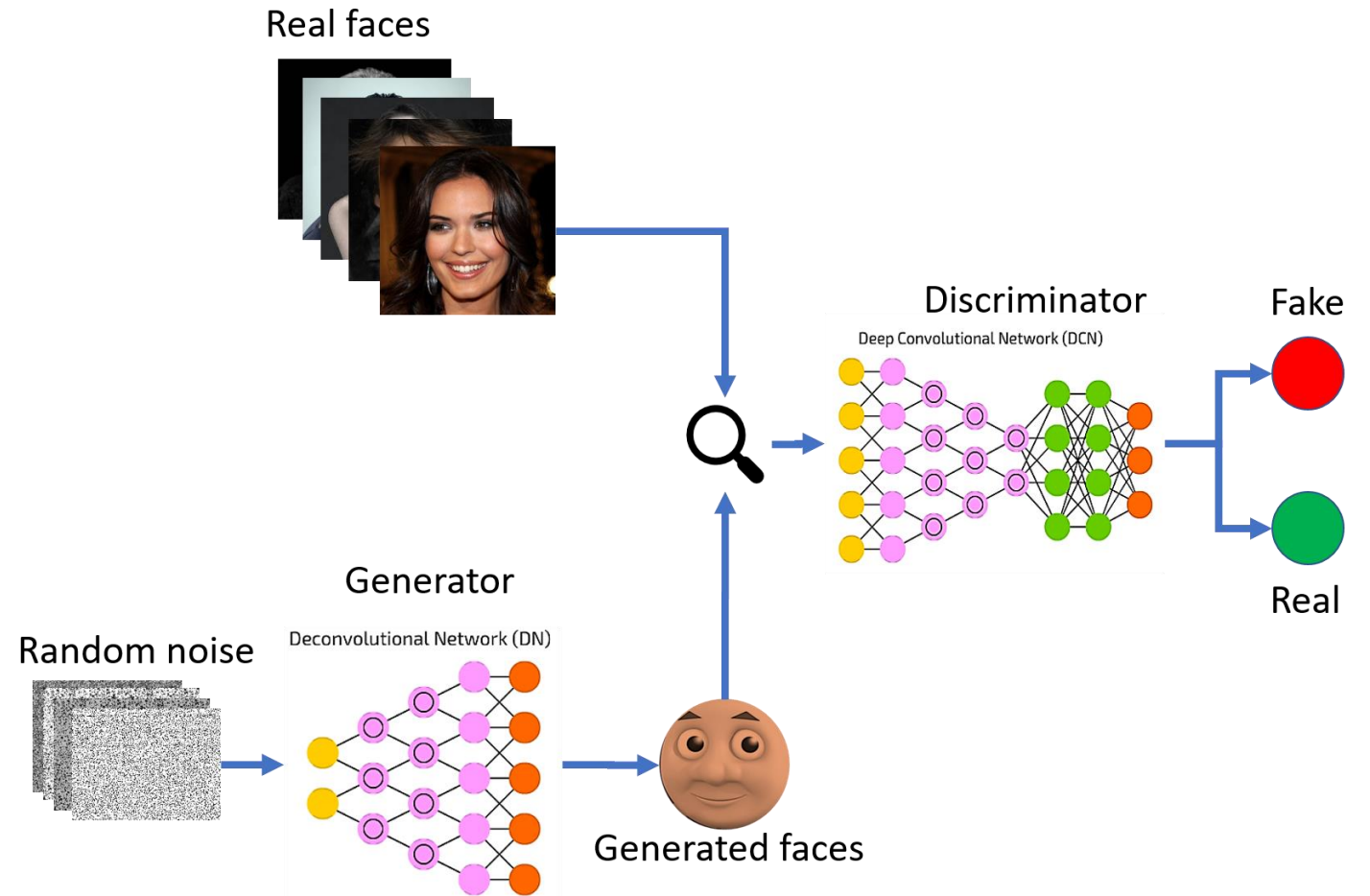


# Auto-encoders e feature extraction



# Modelli generativi

<https://www.thispersondoesnotexist.com/>



Deep fake

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# Face app

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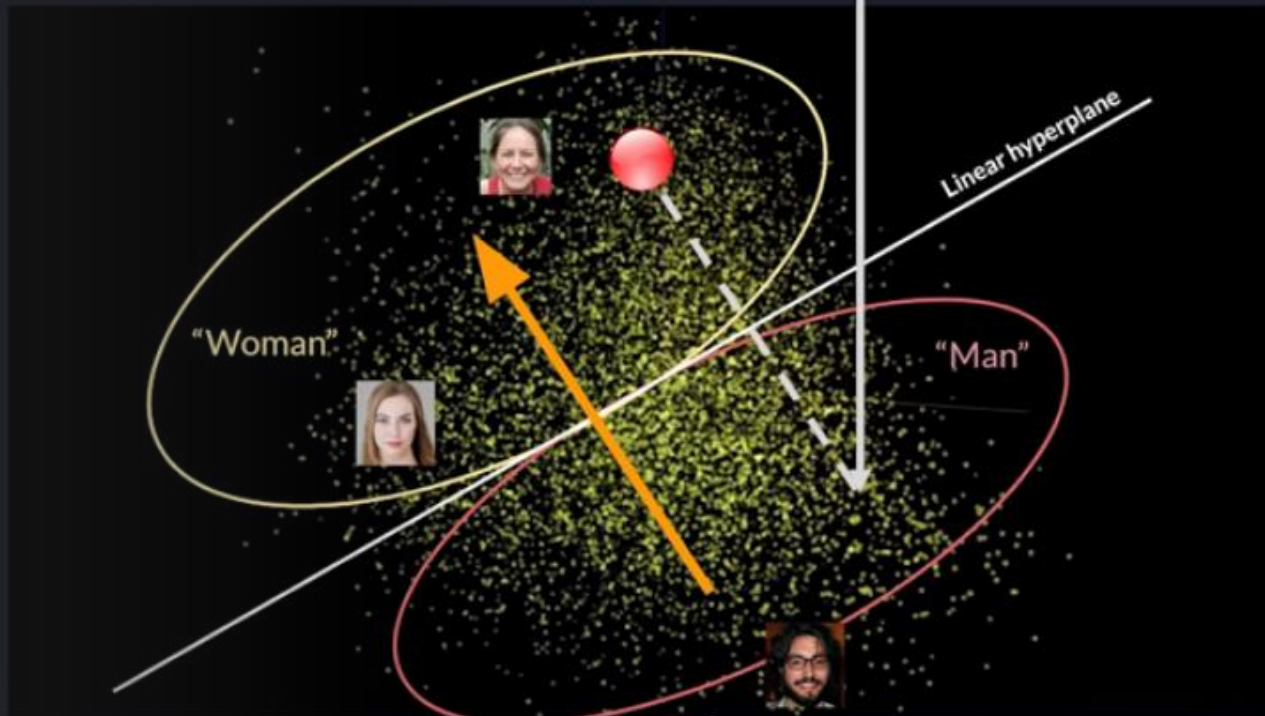
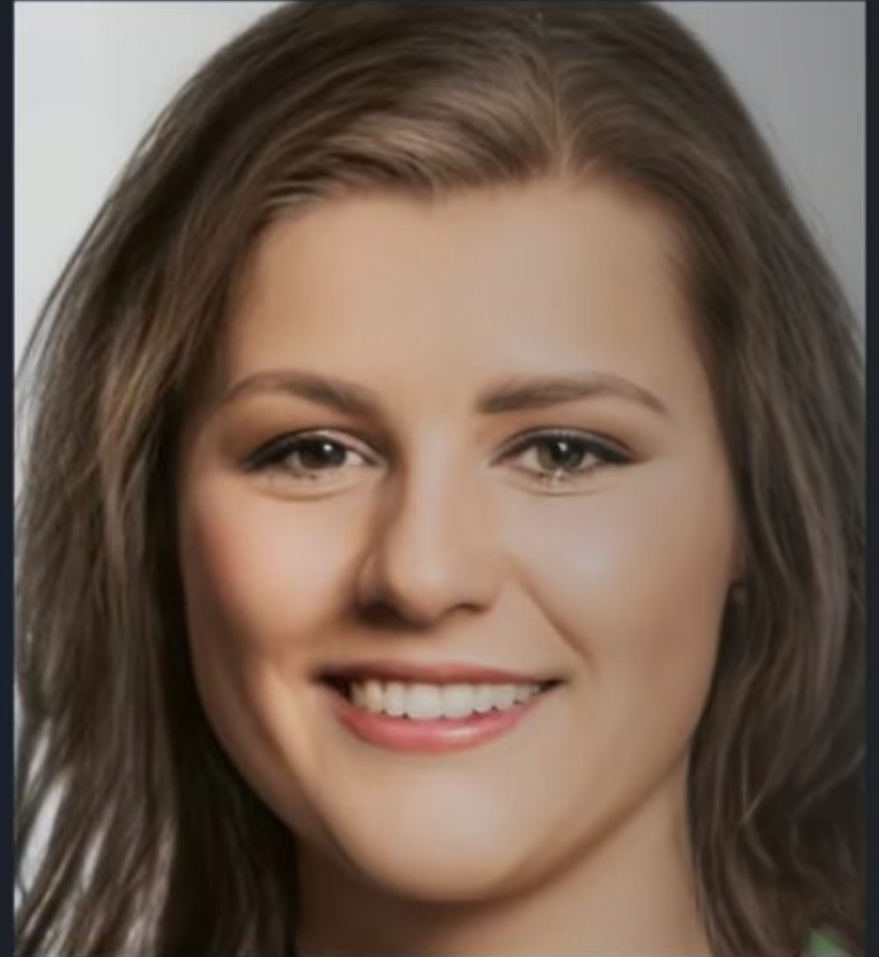
# Come funziona



Query Image

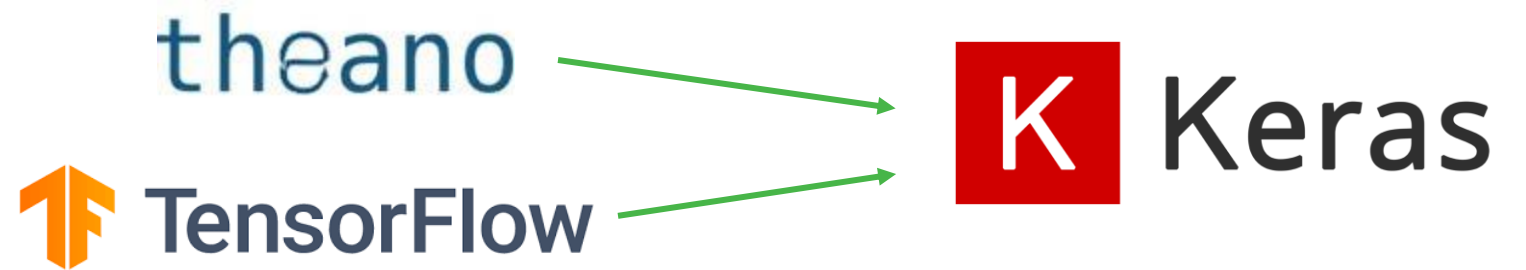


Latent code



# Librerie

- Per python



- Per C++

Caffe