CURRENCY RECOGNITION: COMPUTER VISION AND MACHINE LEARNING

Visão Computacional

2018/2019

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Need & Pipeline

"Deploy an user-friendly application where users could take a picture from any banknote and then receive the value and currency as an output"

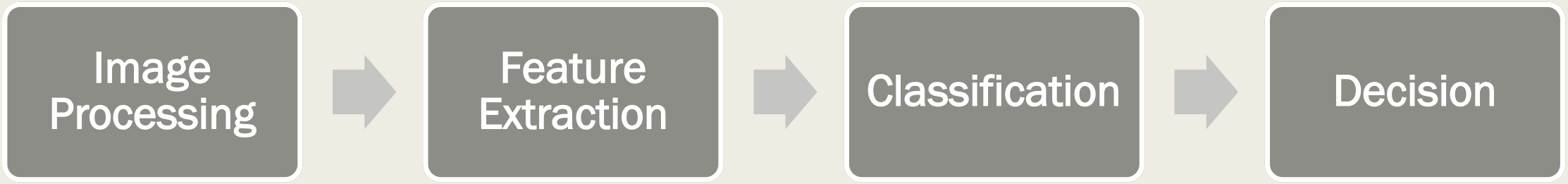
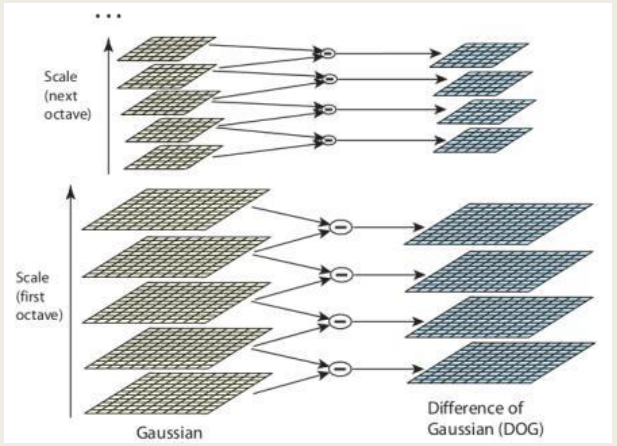


Image Processing

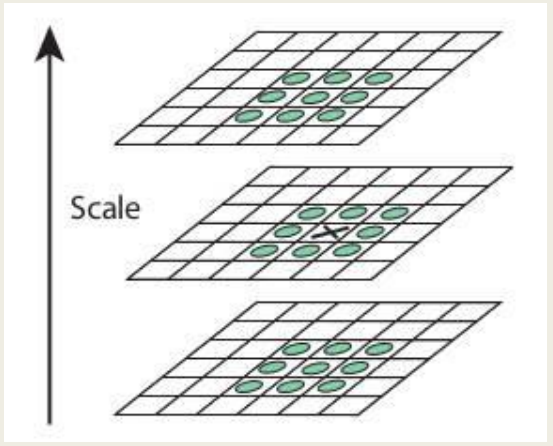
- **Bilateral Filter** for **Noise Reduction**
- Contrast Limited Adaptive Histogram Equalization (**CLAHE**) to **increase image contrast**

Feature Extraction: SIFT

- Scale Invariant Feature Transform Algorithm (**SIFT**) to **detect important keypoints** and **extract meaningful descriptors**

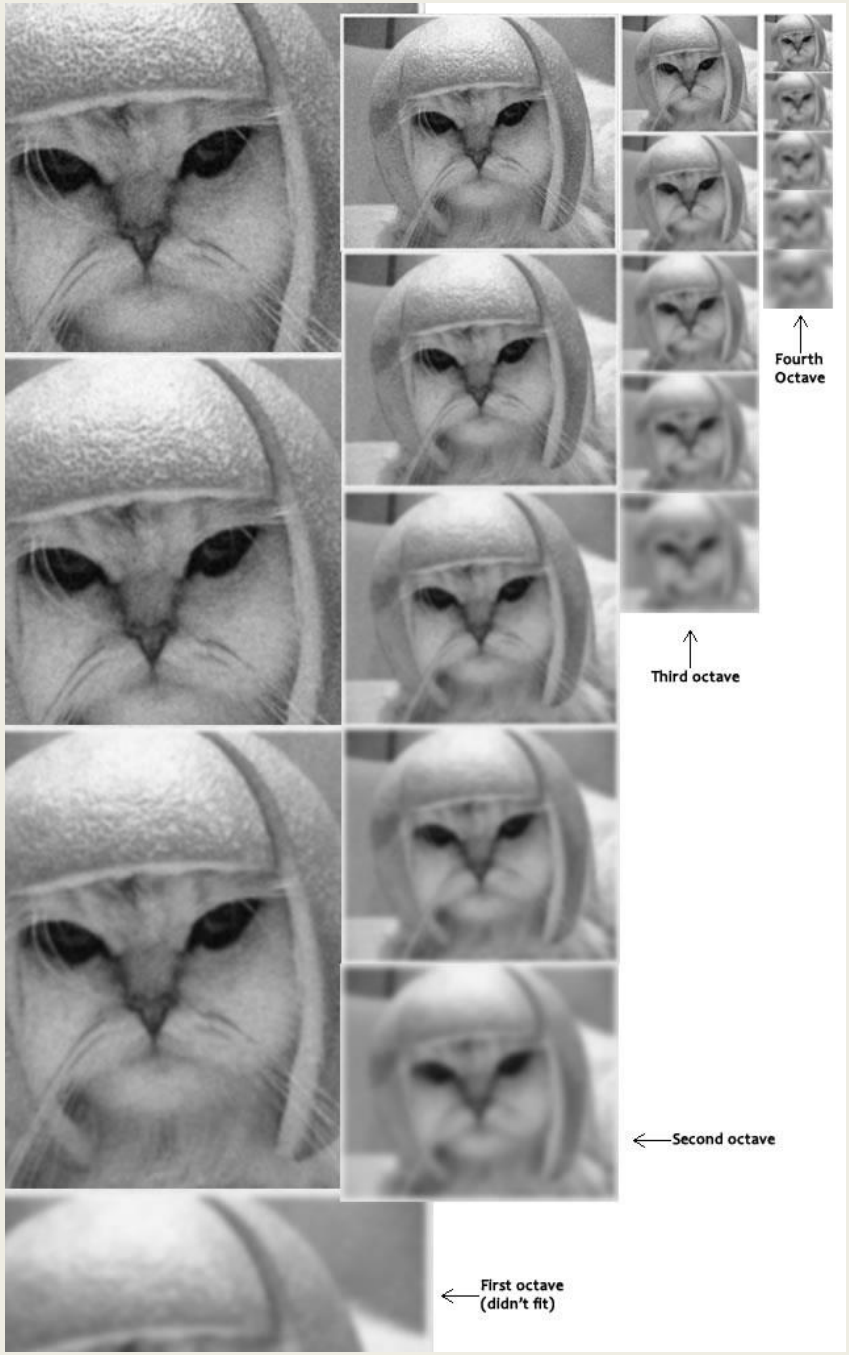


Source: OpenCV

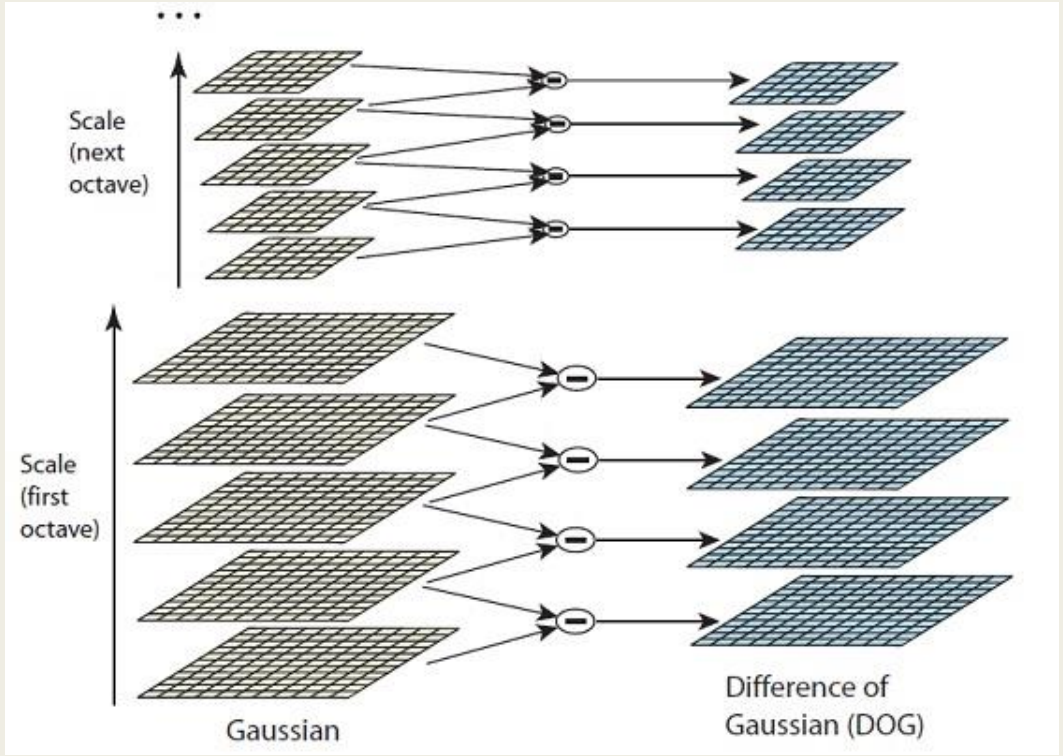


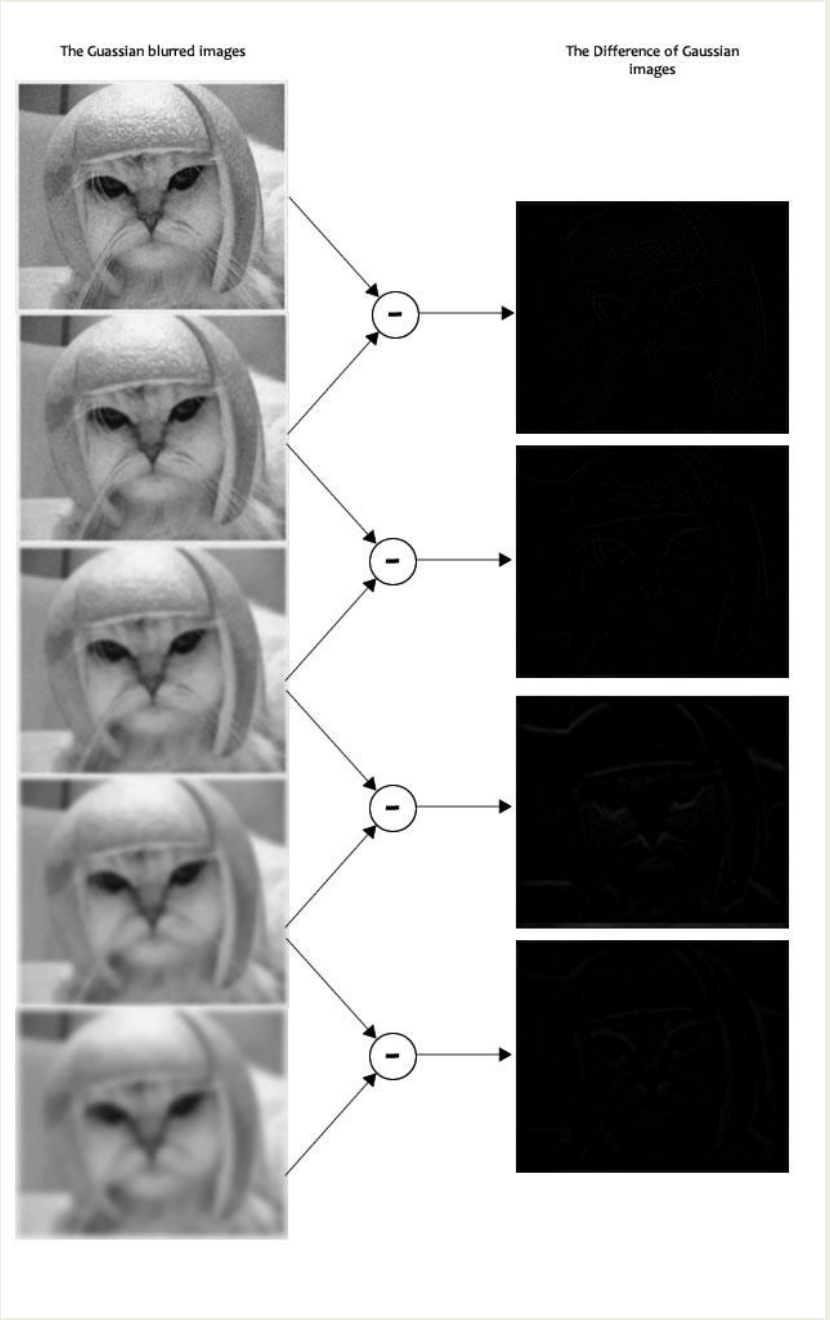
Source: OpenCV

SIFT: Blurring

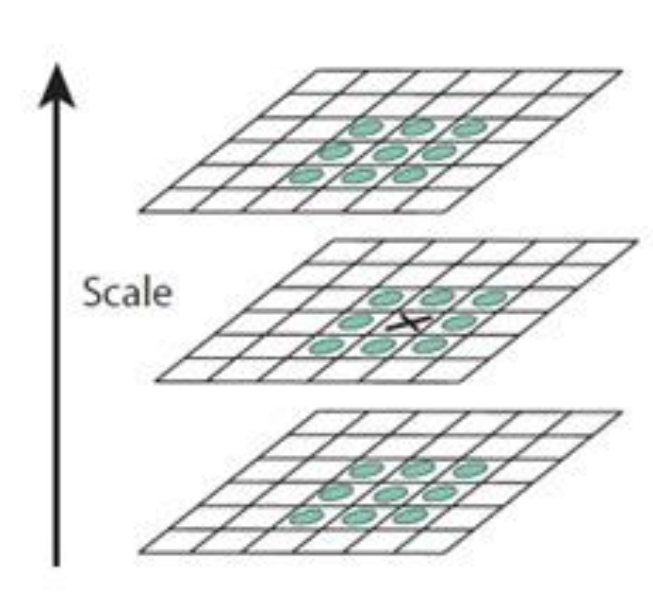


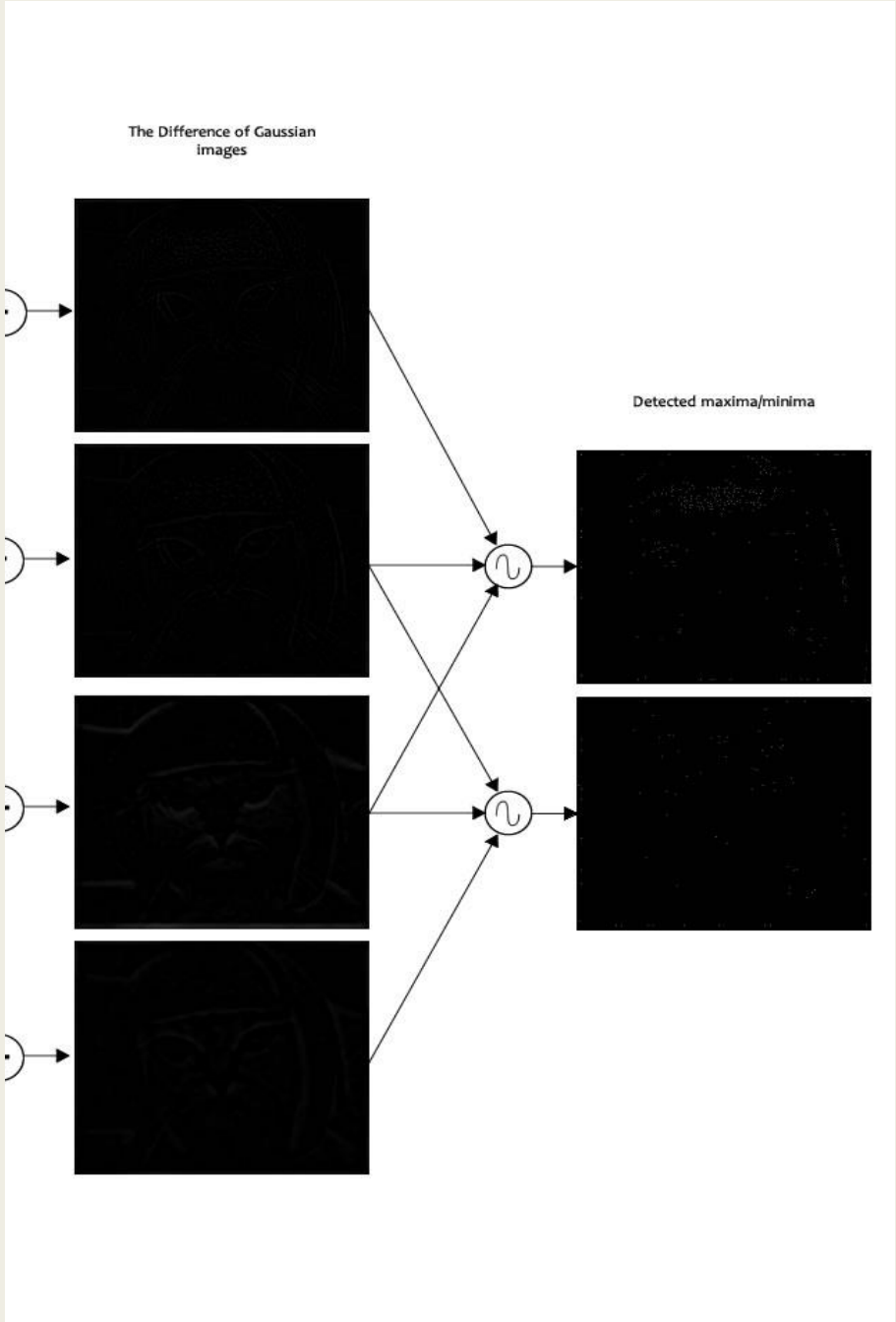
SIFT: LaplacianOfGaussian



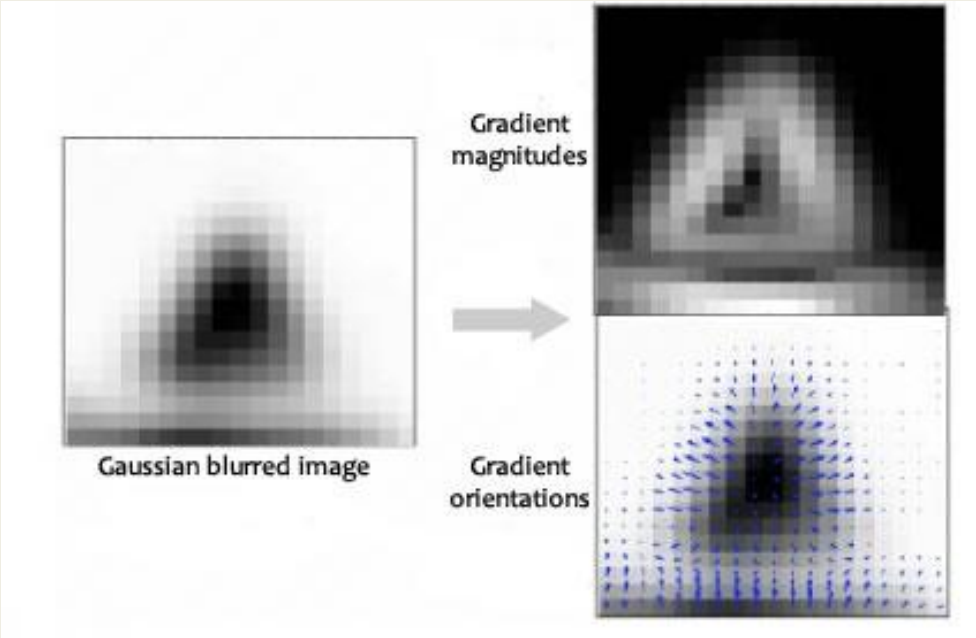


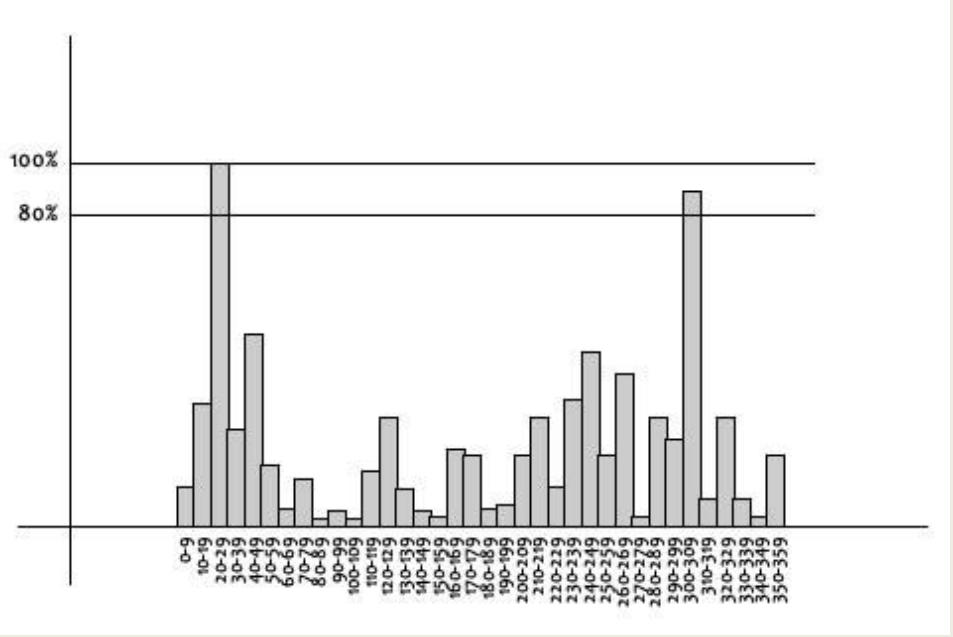
SIFT: Keypoints



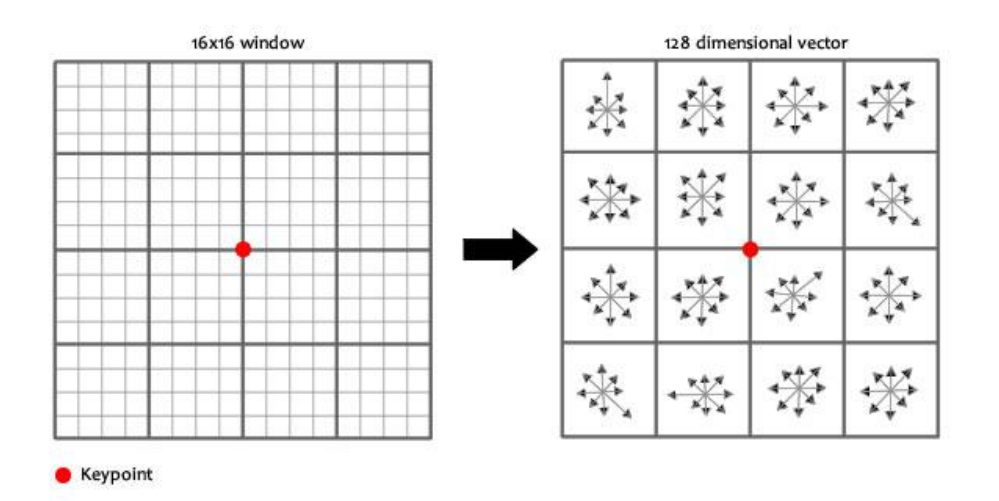


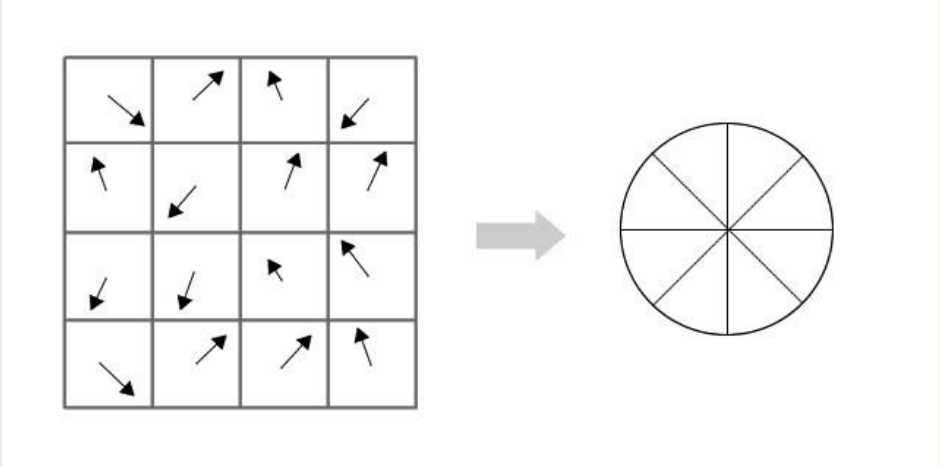
SIFT: Keypoints Orientations

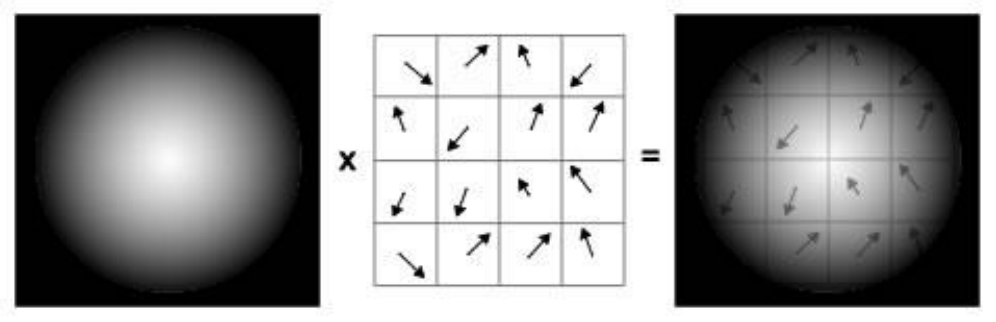




SIFT: Keypoints Orientations





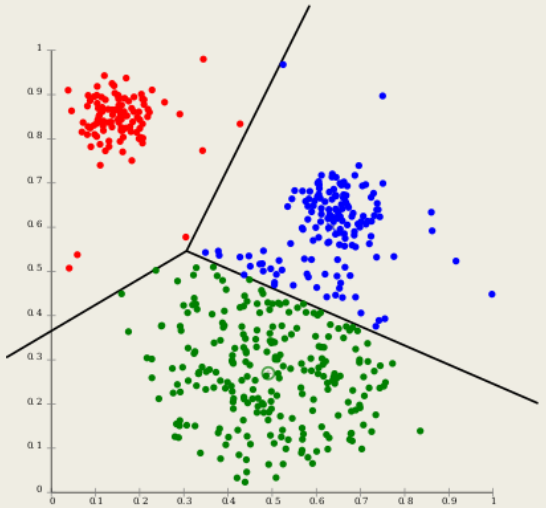


Classification & Decision: Computer Vision Approach

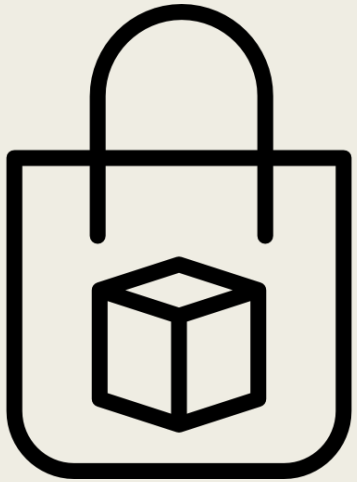
- This **approach directly compares** descriptors between the train image and the query image
- Fast Library for Approximate Nearest Neighbours (**FLANN**), based on **distance measurements to assess similarity between descriptors** (**e.g. K-NN Algorithm**)

Feature Extraction: Bag of Visual Words

- Create **clusters of descriptors with K-Means Algorithm**, using the train set
- **Apply our model to each individual descriptor set** from the train images and obtain **clusters of descriptors for each image**
- Count occurrences in each cluster (**obtain histogram**) and **get the Bag of Visual Words** for each image



Source: Wikipedia

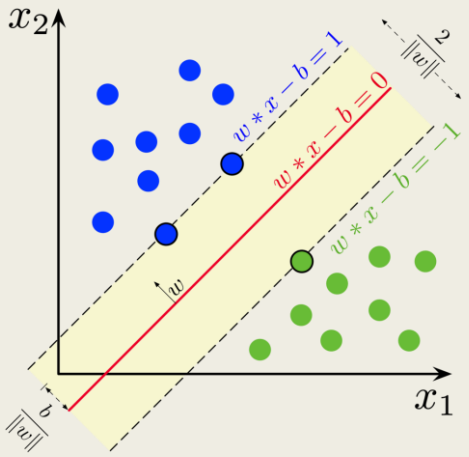


Classification & Decision: Machine Learning Approach

- This approach uses the **Bag of Visual Words as input feature vector** for the training algorithm
- Three machine learning algorithms and classifiers were tested: **Support Vector Machines, Multilayer Perceptron and Logistic Regression**

Classification & Decision: Machine Learning Approach

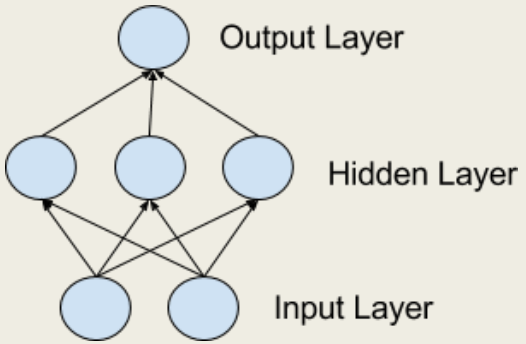
- **Support Vector Machines**: learns how to separate different classes based on a hyperplane



Source: Wikipedia

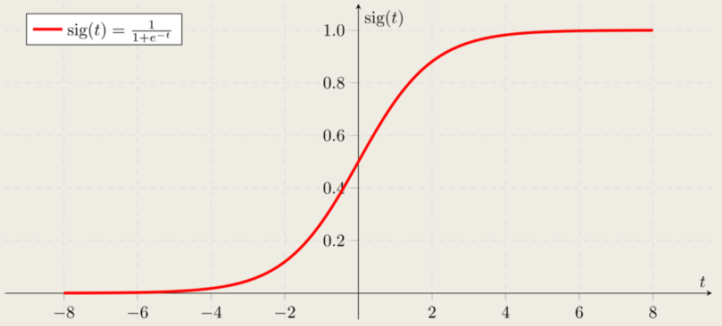
- **Multilayer Perceptron**: also known as **Artificial Neural Network**, is a simple neural network model that can also be trained to learn how to classify new samples into classes

Source: Machine Learning Mastery

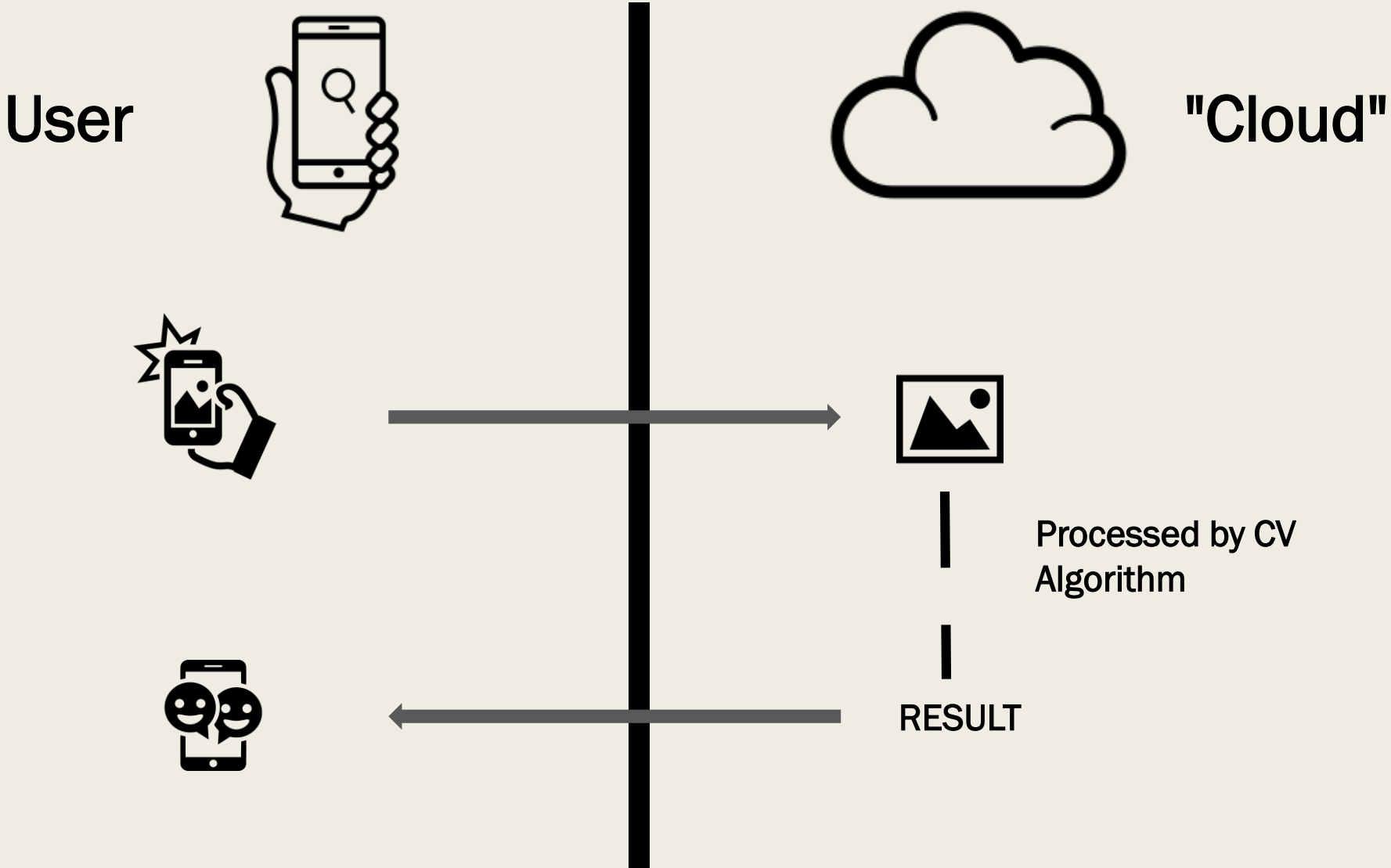


- **Logistic Regression**: which is a model that passes a linear function through a logistic (also know as sigmoid) function that will output a probability

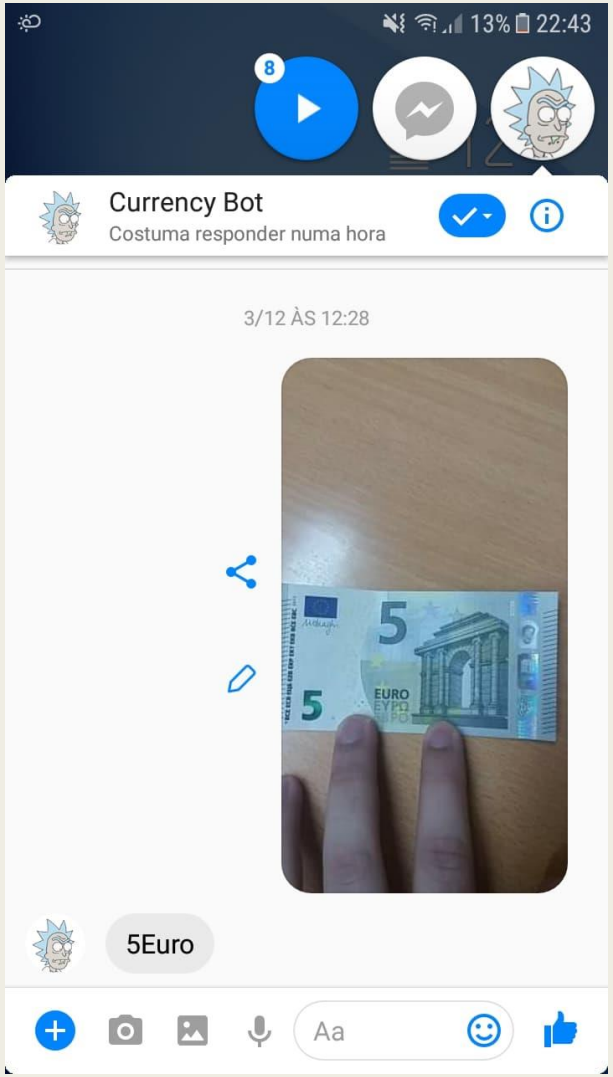
Source: Towards Data Science



The Web Application



The Web Application



Final Remarks

Discussion of the Results & Conclusions

- **The *Computer Vision* approach performed better**
- No need to do pre-processing (**SIFT are robust descriptors**)
- Not high time and computational costs
- **Lack of training data lead to bad performances on the *Machine Learning* approach**

Future Improvements

- Acquire more training data to improve performances on the *Machine Learning* approach
- **Evaluate more currency classes and extend the system to coins**

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