Advanced Machine Learning

2020-2021

AUTOMATIC CLASSIFICATION OF 102 SPECIES OF FLOWERS

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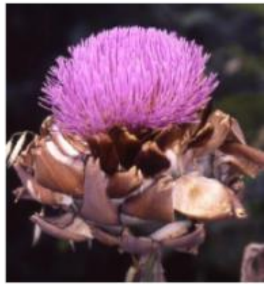
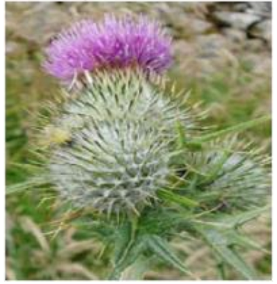
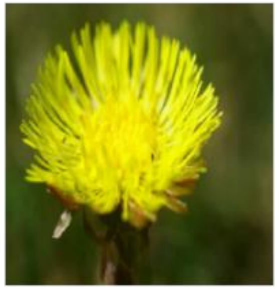
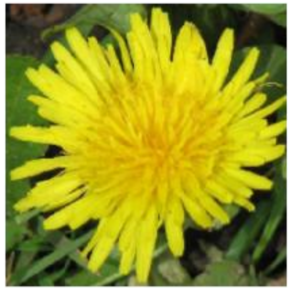
OBJECTIVE

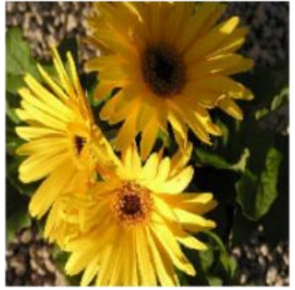
- Identify a combination of features and an effective and efficient model that is able to disinguish between very similar flowers.

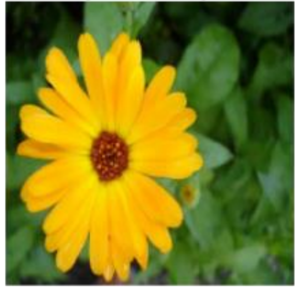

artichoke


spear thistle


colt's foot


common dandelion


barbeton daisy


english marigold

DATA

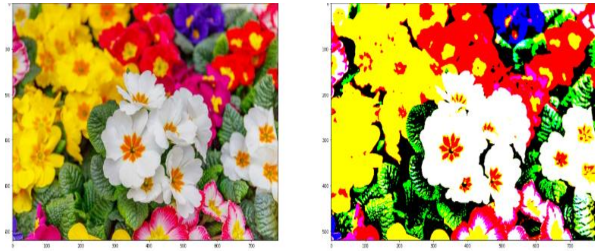
- 8189 images of 102 species of flowers
    - 6149 train
    - 1020 test
    - 1020 validation

- Segmented images

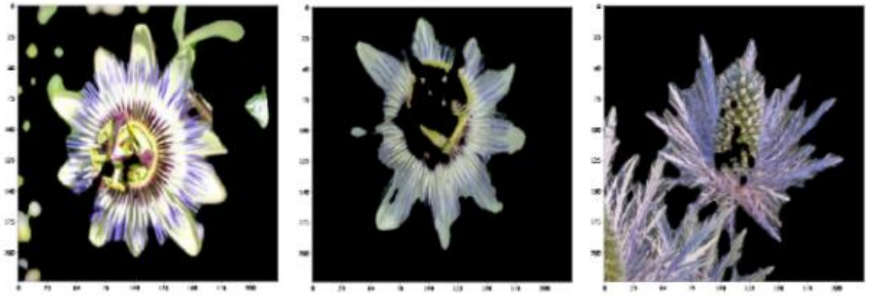
IMAGE SEGMENTATION

GREEN-REMOVAL METHOD

- Every color is approximated to the closest ‘*pure*’ RGB color. (i.e. (0,0,255), (0, 255,255), (255,0,0) …)
- Remove green (0,255,0)



Approximation to approximated to the closest ‘pure’ RGB color



Green-removal method applied on 3 images

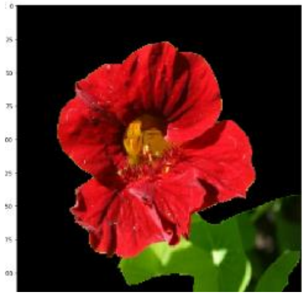
✓ PRO: Flower is well-identified

✗ CONTRO: - noisy background
- what if background is not green?

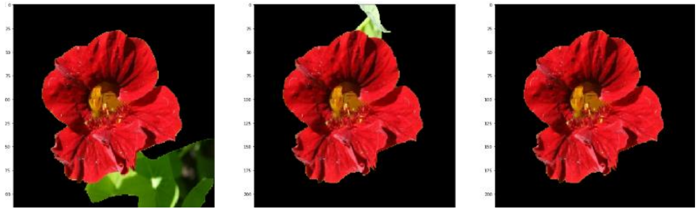
IMAGE SEGMENTATION

GRABCUT METHOD

GrabCut : Iterative method that determines if a pixel belongs to background or foreground



⚠ PROBLEM: not good behavoiur with bottom parts of some images



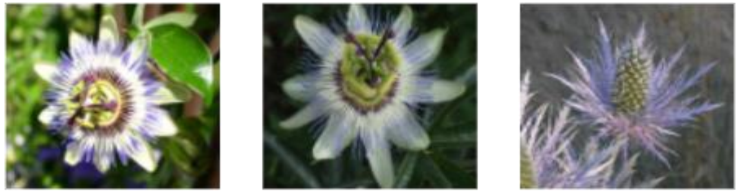
GrabCut on original image; GrabCut on rotated image brought back to the original orientation; Overlap

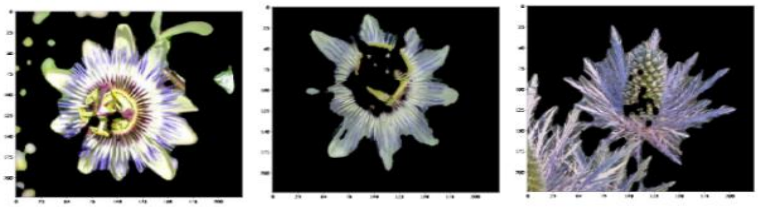
💡 SOLUTION: apply grabCut on the original image and on the same one with a 180° rotation

IMAGE SEGMENTATION

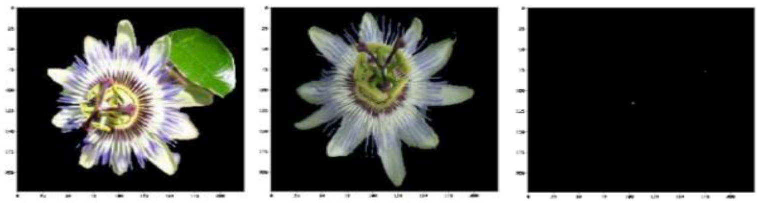
COMPARE METHODS

Original images





Green-removal method



GrabCut method

IMAGE SEGMENTATION

COMPARE METHODS

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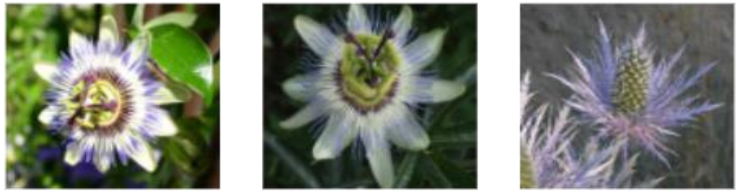

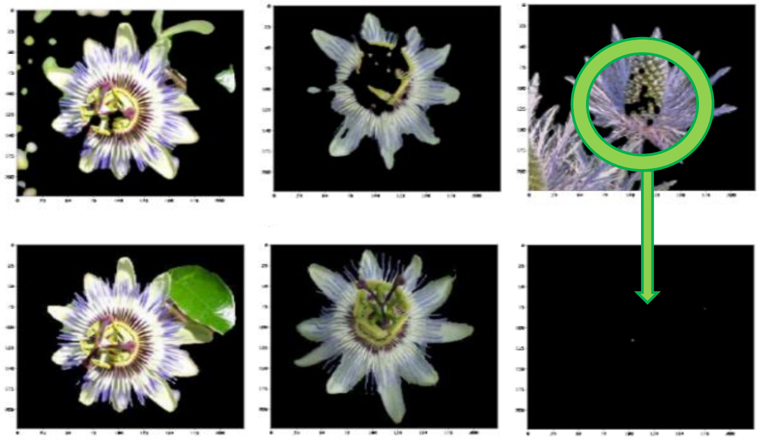

Green-removal method

GrabCut method

CLASSIFICATION

- Hand Crafted Features approach

- Transfer Learning approach
  - Fine-tuning
  - CNN as features extractor

HAND CRAFTED FEATURES APPROACH

- **Color**: After every color has been approximated to the closest '*pure*' RGB color, red, green and blue percentages have been extracted

- **LBP**: extraction of Local Binary Patterns

- **SURF/SIFT**: extraction of keypoints e their descriptors

⚠ PROBLEM: variable dimensionality

HAND CRAFTED FEATURES APPROACH

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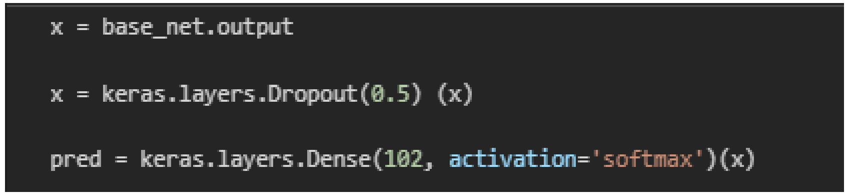
- **HoG**: estrazione Histograms of Gradients

→ **SVM**

TRANSFER LEARNING APPROACH

FINE-TUNING

- MobileNetV2
- EfficientNetB0
- EfficientNetB2

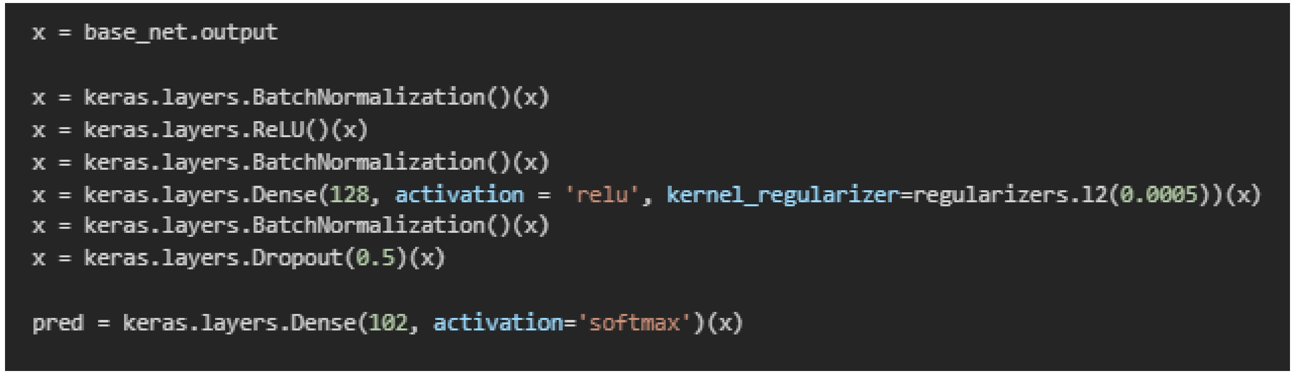


```
x = base_net.output

x = keras.layers.Dropout(0.5) (x)

pred = keras.layers.Dense(102, activation='softmax')(x)
```

Starting Net



```
x = base_net.output

x = keras.layers.BatchNormalization()(x)
x = keras.layers.ReLU()(x)
x = keras.layers.BatchNormalization()(x)
x = keras.layers.Dense(128, activation = 'relu', kernel_regularizer=regularizers.l2(0.0005))(x)
x = keras.layers.BatchNormalization()(x)
x = keras.layers.Dropout(0.5)(x)

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```
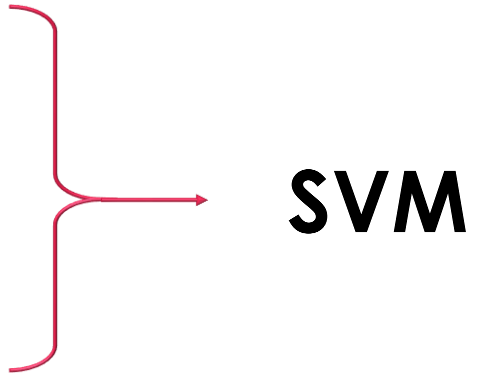

Complete Net

TRANSFER LEARNING APPROACH

CNN AS FEATURES EXTRACTOR

- Features extracted from pre-trained CNN
- Combination between CNN-features and hand crafted features



SVM

RESULTS

Relevant results for every approach

Approach	Features	Train Accuracy	Test Accuracy
SVM with hand-crafted features	colors+HoG	0.30	0.28
	colors+HoG+LBP	0.15	0.12
Fine-tuning	EfficientNetB2 - Complete Net	0.87	0.85
	MobileNetV2 – Complete Net	0.85	0.79
	EfficientNetB0 - Complete Net	0.89	0.90
	EfficientNetB0 – Starting Net	0.93	0.91
SVM with CNN features + hand-crafted features	EfficientNetB0	0.95	0.89
	EfficientNetB0+colors+HoG	0.95	0.84
	EfficientNetB0+colors+HoG+LBP	0.20	0.17

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RISULTATI

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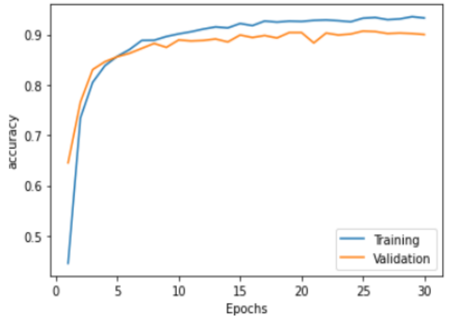

Starting Net

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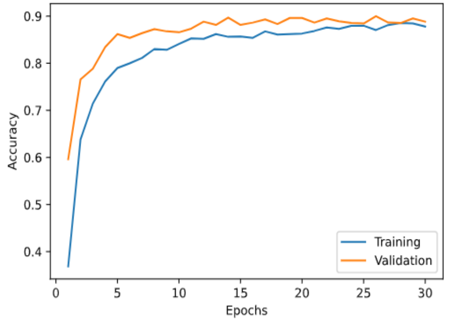

Complete net

'EfficientNetB0 – Starting Net' *shows an overfitting* phenomenon.
Therefore it's been preferred to use *'EfficientNetB0 – Complete Net'*

RESULTS

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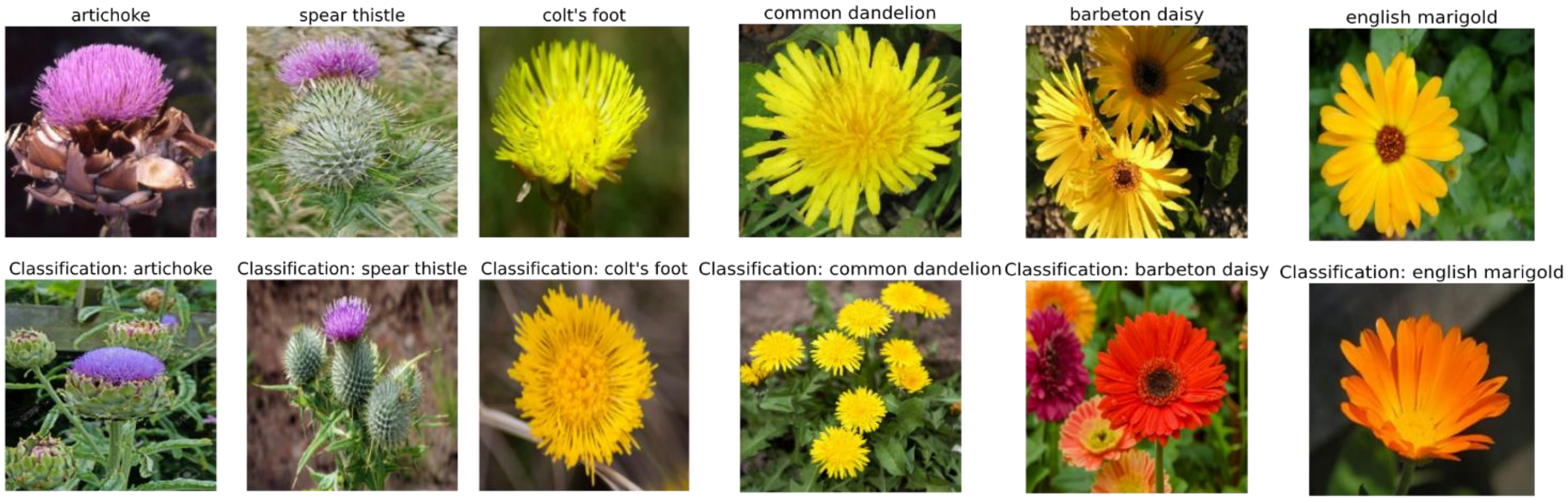
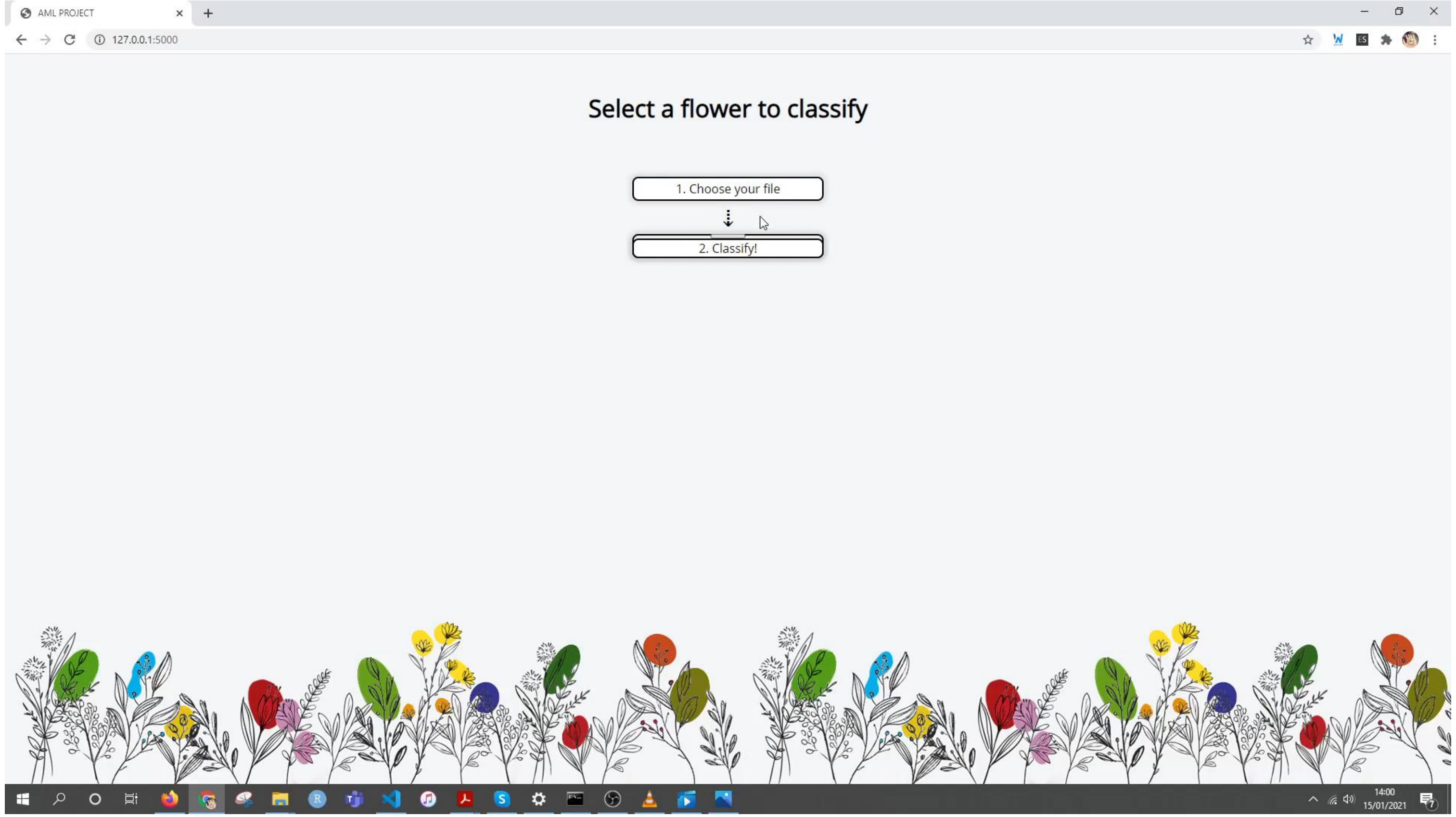

artichoke
spear thistle
colt's foot
common dandelion
barbeton daisy
english marigold
Classification: artichoke
Classification: spear thistle
Classification: colt's foot
Classification: common dandelion
Classification: barbeton daisy
Classification: english marigold

Top: Original images to be classified. Bottom: classification results obtained from the 2 best models. (Bottom images are examples images of the predicted species of flowers)

CONCLUSIONS AND FUTURE DEVELOPMENTS

- A good segmentation system it's crucial for this purpose
- The use of the features related to color and Histogram of Gradients alone is not useful for classification
- LBP seems to be not useful to any model. A future development could concern the search for optimal parameters
- Transfer learning is effective and EfficientNetB0 turns out to be the best pre-trained CNN

DEMO



Select a flower to classify

https://drive.google.com/file/d/1F_LhDM5KcPDUODutrK5HOdYhoKZIwAlm/view?usp=sharing

THANK YOU