IAPR: Image Analysis and Pattern Recognition

Project presentation

Varroas detector

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Outline

1. Problem statement
2. Method
    - Detection by image segmentation
    - Advance object detection method
        - Simple SVM detection
        - SVM-HOG object detection
        - Convolutional Neural Network
3. Discussion and conclusion

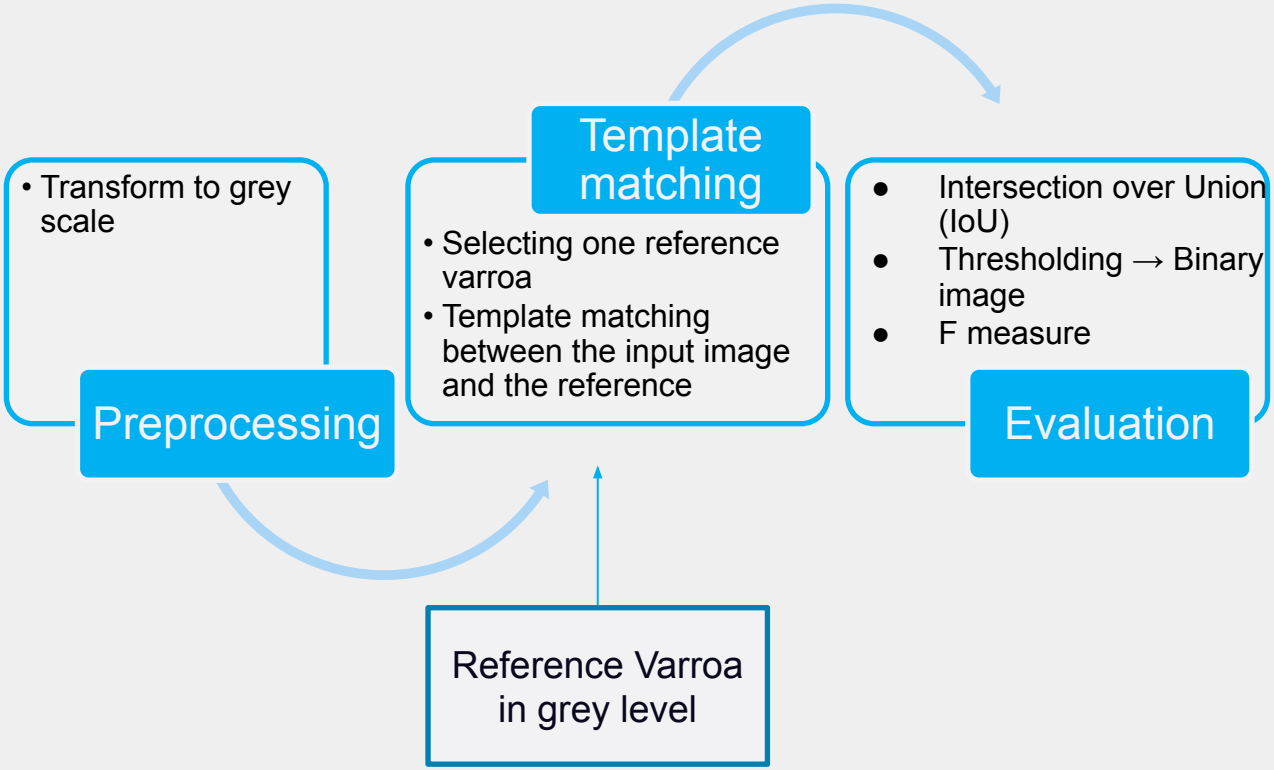
Problem statement

Provided Dataset

- Training data : 800 RGB images
- Validation data : 150 RGB images
- Testing data : 50 RGB images
- Competition data : 259 RGB images

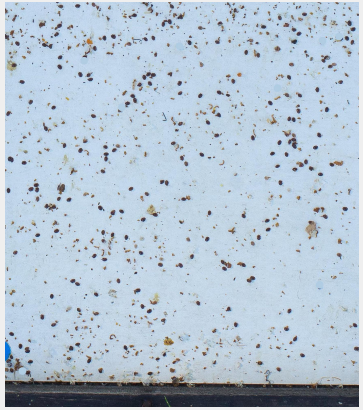
Varroa detection with simple image segmentation : Template Matching

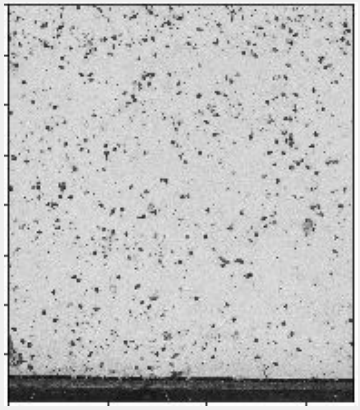
+ Very simple
+ No need to train
  → Very fast

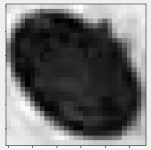


Template Matching

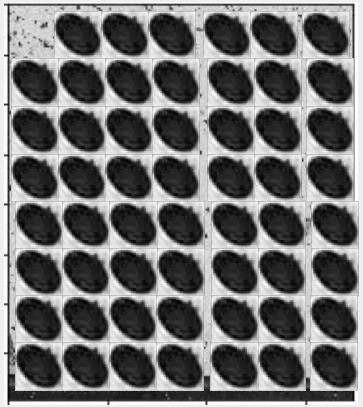
Transform to grayscale the input image and the reference image [40*40]



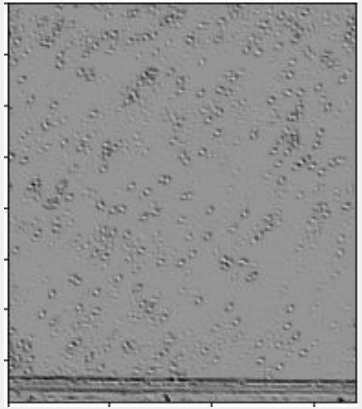




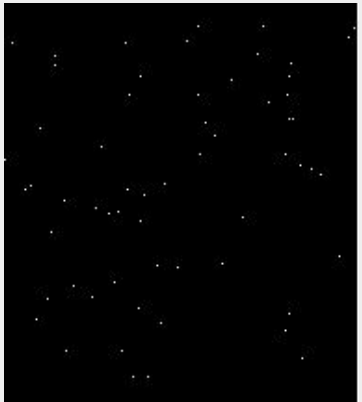
Template Matching



Correlation result



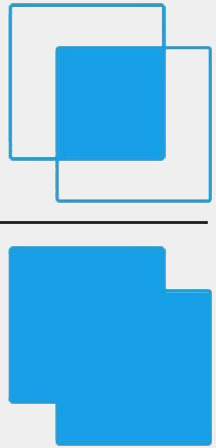
Threshold the correlation result □



Performance metric

- Intersection over union

$$\text{IoU} = \frac{\text{Area of Overlap}}{\text{Area of Union}}$$



- F-measure

- True positive (TP) IoU(A,B) ≥T={0.1,0.2,0.3,0.4,0.5}
- $Precision = \frac{TP}{TP+FP}$
- $Recall = \frac{TP}{TP+FN}$
- $F_{measure} = \frac{2 \times Recall \times Precsion}{Precision+Recall}$

2 approaches for testing performance:

- Calculating F measure for each image (on each Iou threshold) and taking the mean
- Calculating all TP , FP , FN and one F measure

Advanced object detection: Dataset preparation

- **Splitting original dataset images to small windows : 48*48:**
  - Ground truth boxes of varroas
  - Generating non varroas randomly
  - Starting with 50% varroas and 50% non varroas

→

- Feature extraction
- Preprocessing : scale features between 0 and 1
- Training SVM model
- Tuning hyperparameters (gridsearch)

Injecting False positives to the training

 We repeat the process 3 times to end up with
- 7493 varroas (38%)
- 12213 non varroas (62 %)

1st method : SVM Detector
Feature extraction

After thresholding the windows and getting a binary image we compute 10 features :

01 Area

02 Perimeter

03 Circularity

04 Rectangularity

05 Template matching

06 Mean of red color

07 Mean of green color

08 Mean of blue color

09 Circular hough transform: Mean

10 Circular hough transform: Standard deviation

X_train [19706][10]

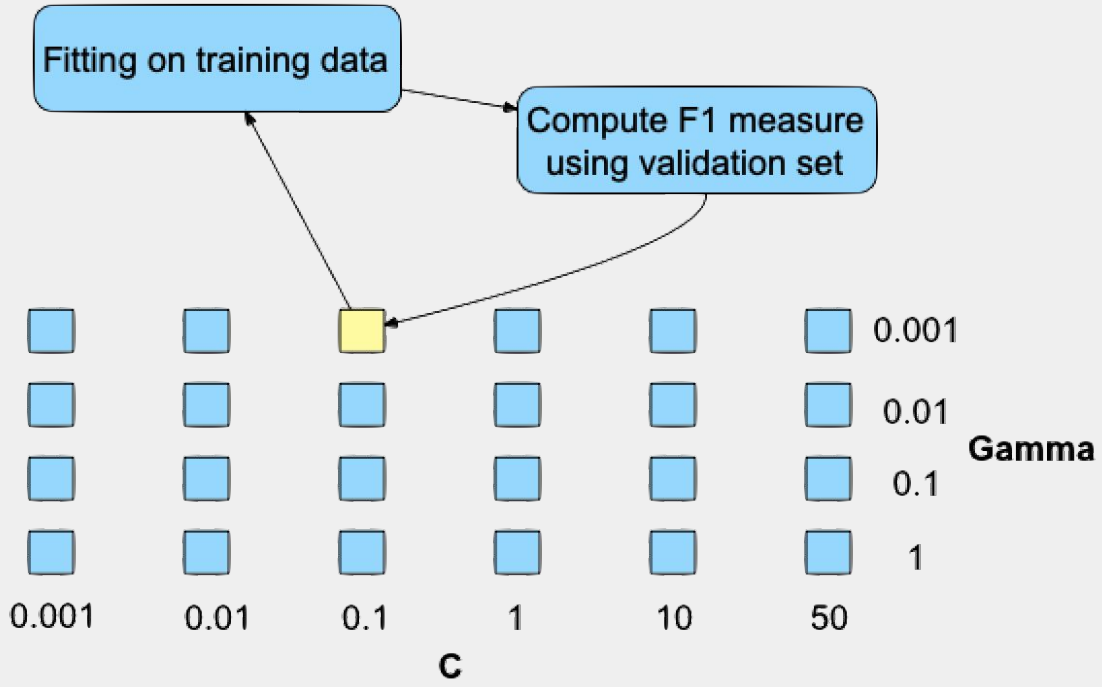
Preprocessing : Scaling feature values between 0 and 1

1st method : SVM detection Hyperparameter Tuning

- Gridsearch on validation dataset:

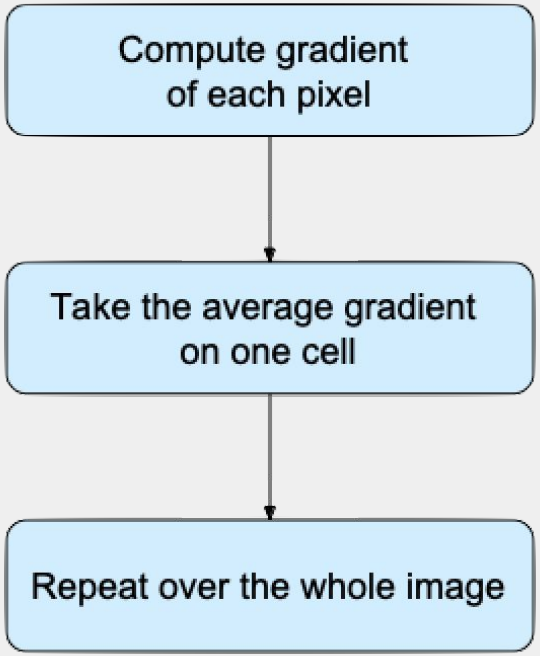
  Regularization parameter C
  Parameter Gamma

- Performance metric : f1 score
- Train the svm classifier with the best hyperparameters
- Evaluation on testing dataset

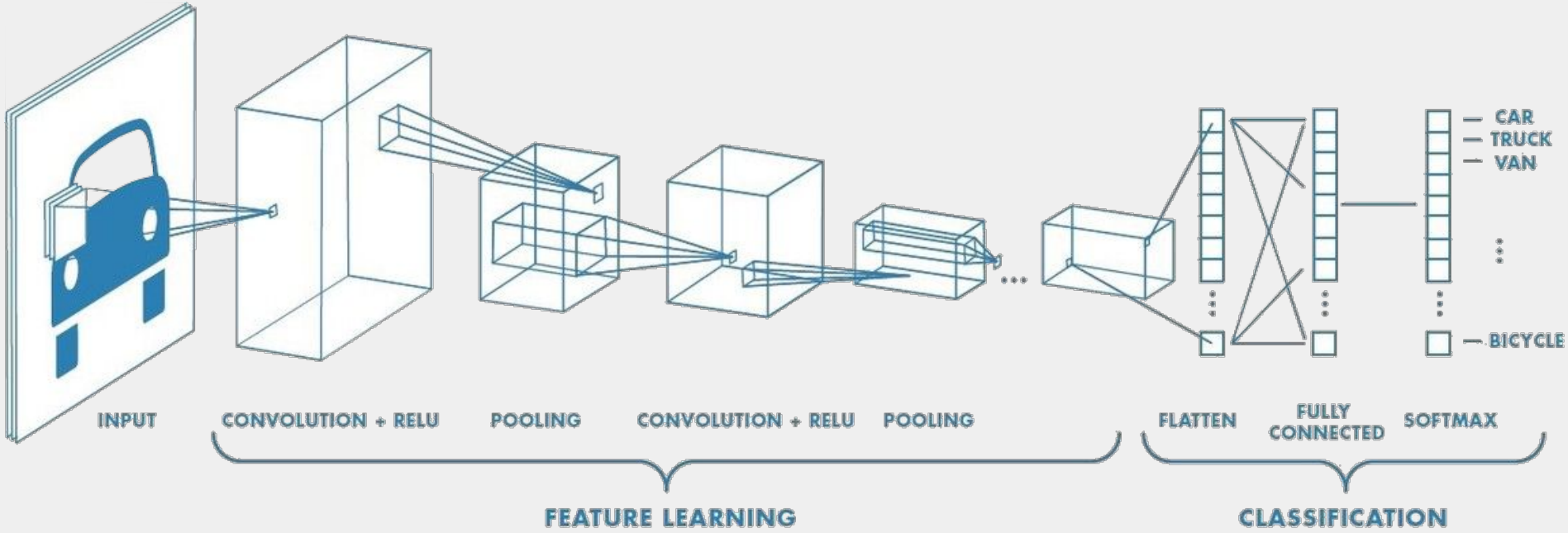


2nd method
SVM based on histogram of gradient (HOG) as features

The idea of HOG is that, instead of using each individual pixel, the gradient of each pixel of the image is used as follow :



3rd method
Convolution Neural Network (CNN)



CNN Architecture : 3 Convolution layers
Input channel : Subimage of depth = 3 (RGB colors)
Output : probability of being a varroa
Sigmoid function as output

3rd method
Convolution Neural Network (CNN)

- Hyperparameters:
  - epoch = 10
  - Batch site = 100
  - learning rate = 0.001

- Tuning : Trial and error and random search

- Computing performance on testing small boxes (known ground truth)

- Computing performance on testing with sliding windows (unseen)

Result : Template matching

- Mean of F-measure calculated for each image separately: 0.48
- Total F-measure calculated at the end after summing all the FP FN and TP together for all images : 0.275

\+ Very simple technique : Good way to start
\+ Very fast : no train
\- Huge number of FP (cumulative FP for all images give low F-measure)
\- Difficult to do better

Results of SVM and CNN subimages datasets

	Recall	Precesion	F measure	Best hyper-param
SVM detector	Train : 0.9 Test: 0.91	Train : 0.86 Test : 0.96	Train : 0.88 Test : 0.93	C=50, γ=0.01
SVM-Hog based method	Test : 0.82	Test :0.97	Test : 0.9	C=50, γ=1
Neural Network	-	-	Train :0.85 Test : 0.95	epoch = 10 Batch site = 100 learning rate = 0.001

Results of SVM and CNN on testing set using sliding window

- SVM Detector : F measure = 0.22
- SVM based on HOG = 0.2

→ We tested Two appraches of SVM that gives almost the same result

CNN : F measure = 0.53

→ Better result : We detect less False postives compared to the SVM

Discussion and conclusion

- CNN has higher F-measure compared to other methods, but need training and a well designed and big dataset.
- On the other hand a CNN do not required feature extraction by humans
- The CNN can be improved by changing the non-varroa images at each epoch, this approach was briefly tested, with little improvement

Questions?