C1 PROJECT

Content-Based Image Retrieval (CBIR)

Team 2:

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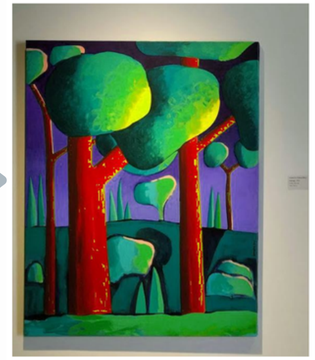
OUR PIPELINE

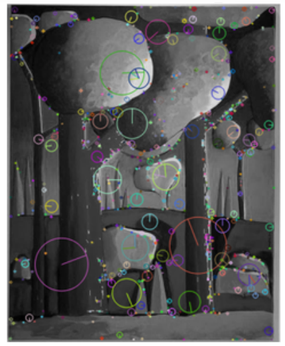
Noise removal

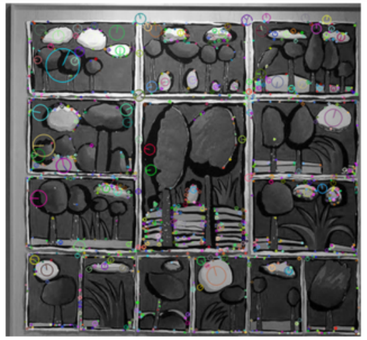
Split



Background removal

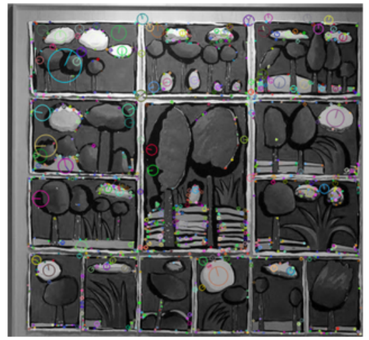
Descriptors





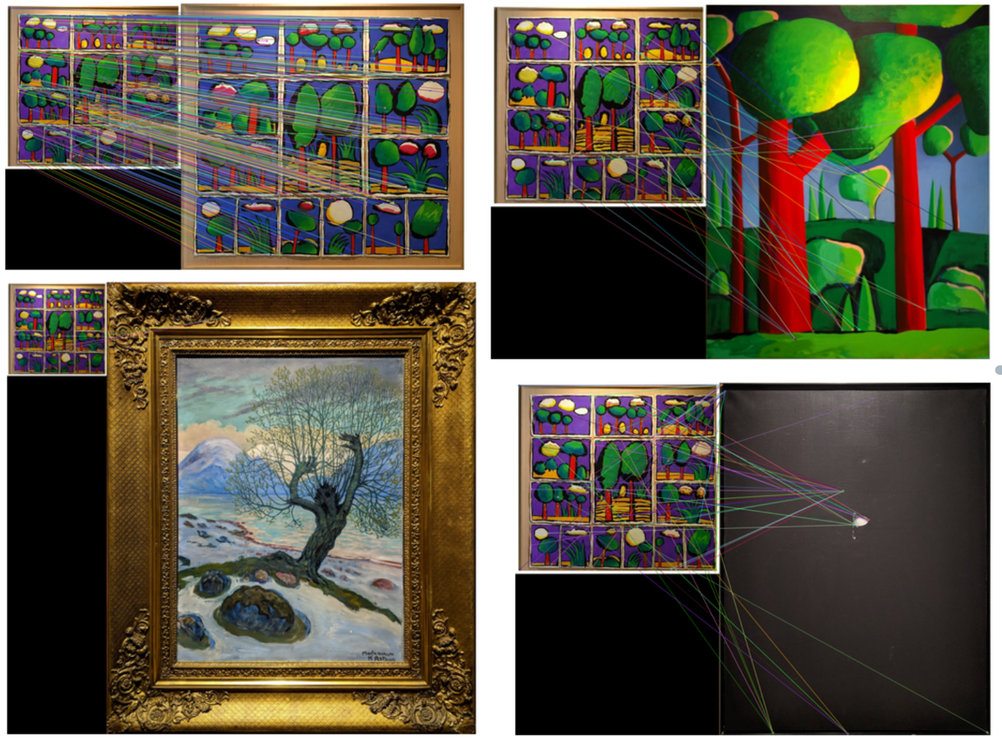
OUR PIPELINE

Query descriptors



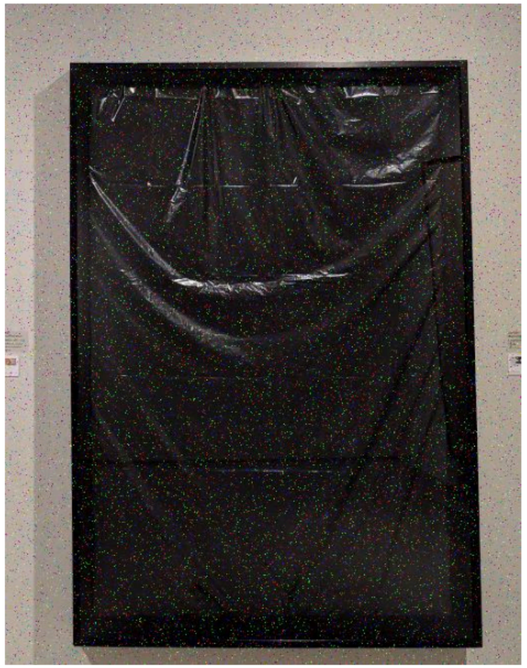
Database descriptors

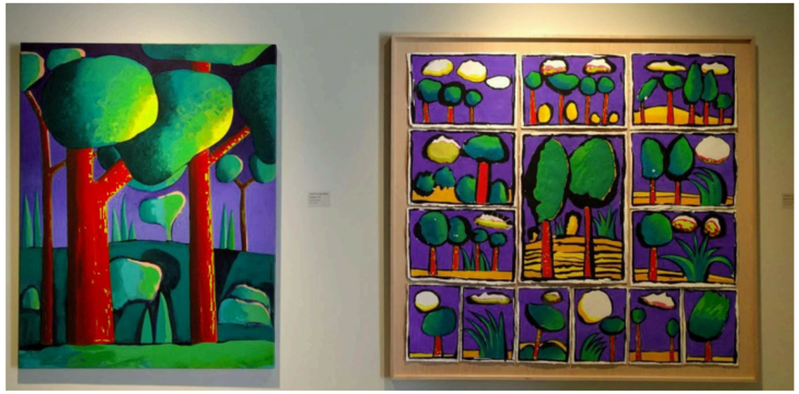
Compute matches & rank



Unknown detection filter

Noise Removal

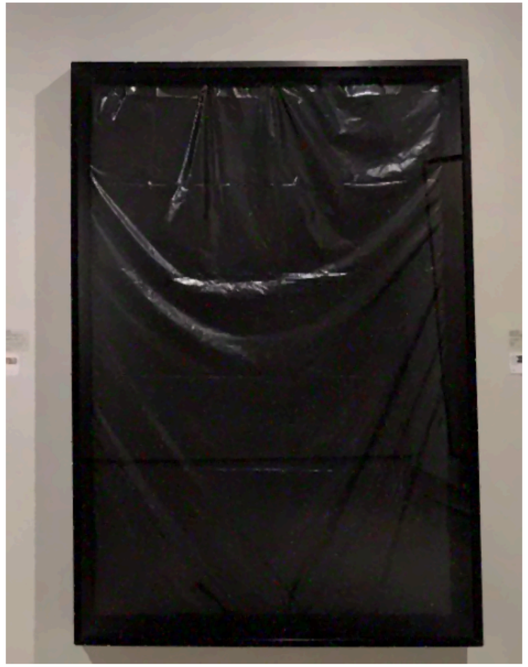


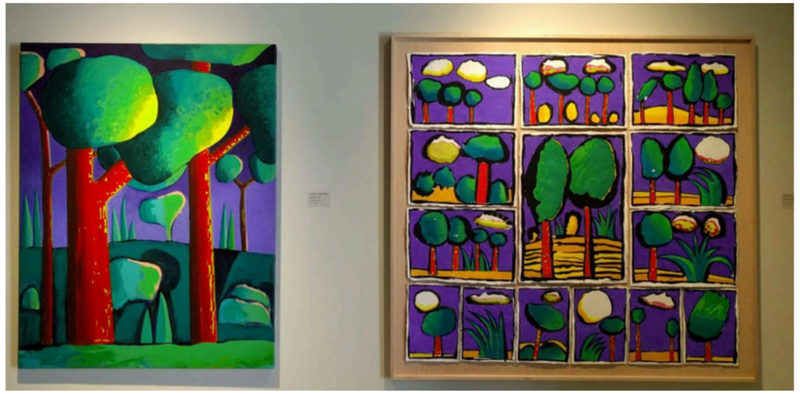


Same method as Week 3

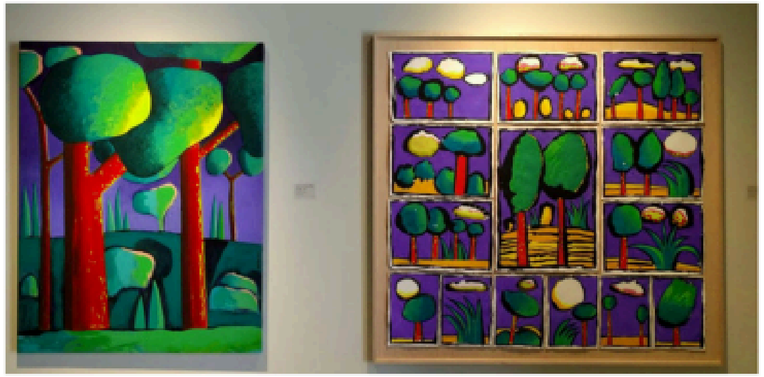
- **Detects noise using high-frequency energy in the Fourier spectrum.**
- **If noise_score > 40 → apply median + bilinear filter.**
- **Otherwise → image is kept unchanged.**

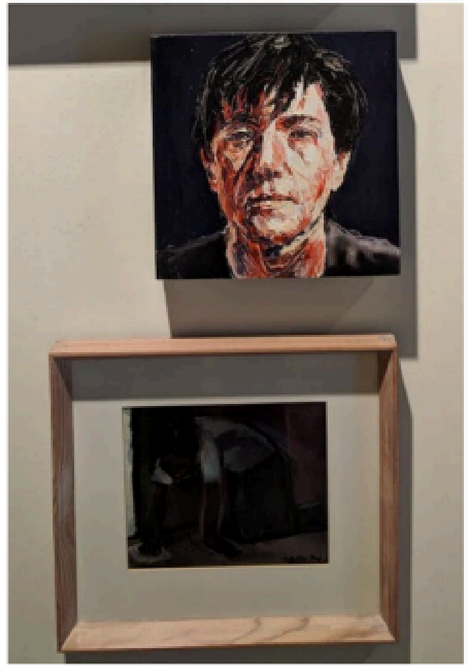
→ **Noise removal** →





Split Detection

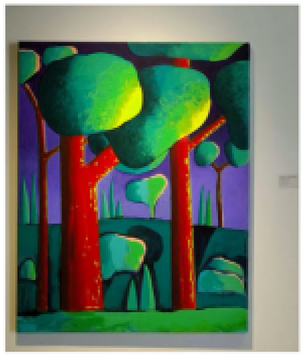




Team 5 Week 3 method:

- **It can handle both horizontal and vertical splits**
- **Based on analyzing 1D signal projections of the segmentation mask to find large gaps between paintings**

→ **Split** →



Split *Check 1*

Filter to discard overly unbalanced splits using the MIN_SIZE_RATIO = 0.20 rule.

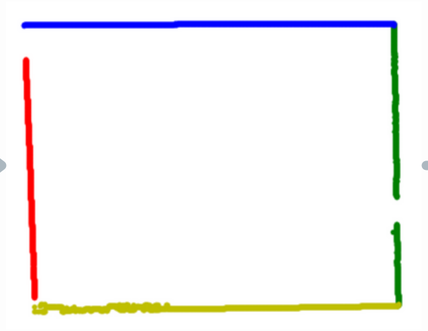
Split

Are both splits bigger than **20%** of the original?

Yes
Valid split
Keep both paintings

No
Invalid split
Return original image

Background Removal



Same method as Week 2

- **Use morphological gradient**
- **Detects outermost points and filters by median**
- **Approximate a quadrilateral among those points**

→ **Struggles with shadow removal**

The Week 3 implementation included a watershed-based shadow removal algorithm, which solved the issue and worked almost perfectly, but it was too complex and slow. Since background removal is not a critical aspect for feature extraction, we decided to keep it simple.

Split *Check 2*

Split

Over **20%** of the original → "correct" split

Background removal

Are both splits bigger than **20%** of the original?

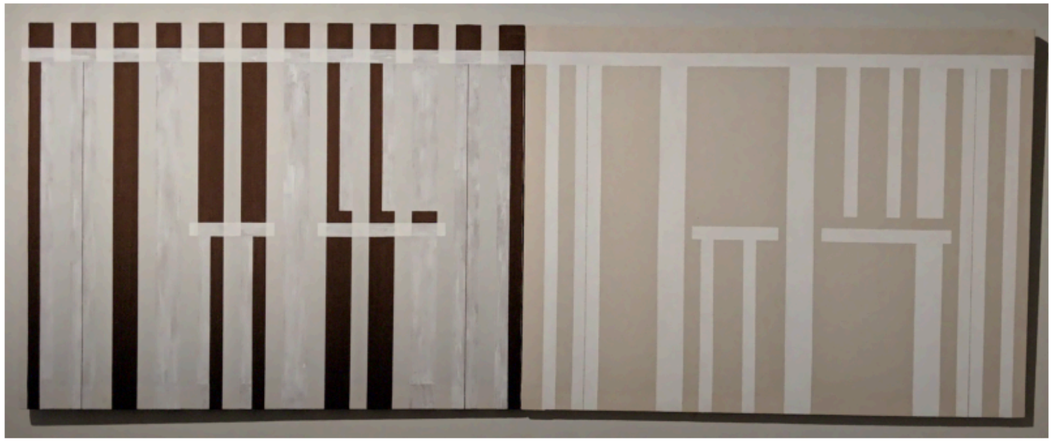
Yes
Valid split
Keep both paintings

No
Invalid split
Do background removal on original image

Second filter to discard overly unbalanced splits using the CROP_MIN_RATIO = 0.20 rule.

Background Removal *Check*

Filter to discard excessive background removal using the BG_CROP_MIN_RATIO = 0.10 rule.



Background removal

4.21%

Is the cropped area larger than **10%** of the original?

No
Invalid
Use original image (no background removal)

Yes
Valid
Keep background-removed image

Descriptors

	SIFT	COLOR-SIFT	ORB
Type	float	float	binary
Invariance	Scale, rotation, illumination	Scale, rotation, color	Rotation, noise
Speed	Moderate	Slow	Fast
Key Feature	Stable and accurate	Color awareness	Lightweight

Descriptors

00005

Comparison of three local descriptors used in our pipeline.

SIFT

NFEATURES = 1200
ROOTSIFT = True

ORB

NFEATURES = 2000
FAST_THRESHOLD = 20
SCORE_TYPE = "HARRIS"

COLOR-SIFT

NFEATURES = 1500
COLOR_SPACE = “OPPONENT”
ROOTSIFT = True

Matching & Scoring

Score = number of good matches after Lowe ratio filtering.

SIFT / COLOR-SIFT

FlannBasedMatcher
LOWE_RATIO = 0.76

Score: SIFT = 336
COLOR-SIFT=221

ORB

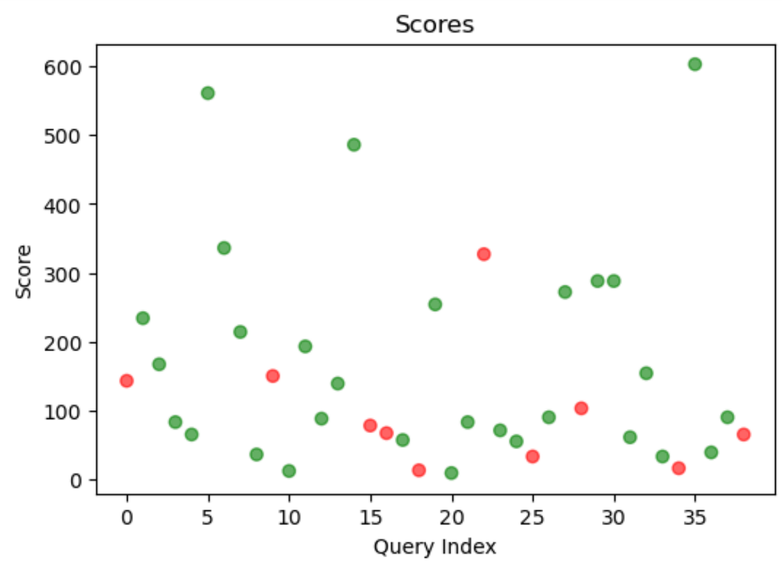
BFMatcher
LOWE_RATIO = 0.76

Score: ORB = 434

Matching & Scoring

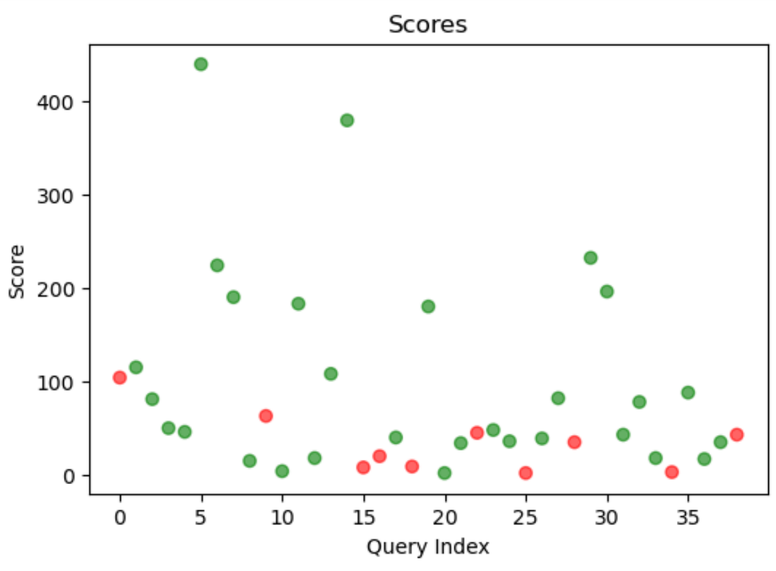
Score = number of good matches after Lowe ratio filtering.

SIFT



ORB

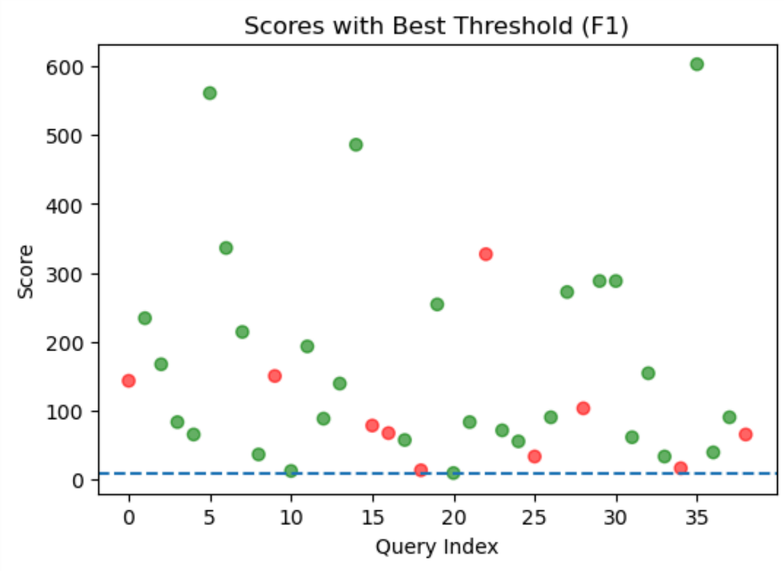
COLOR-SIFT



Unknown Detection

Score = number of good matches after Lowe ratio filtering.

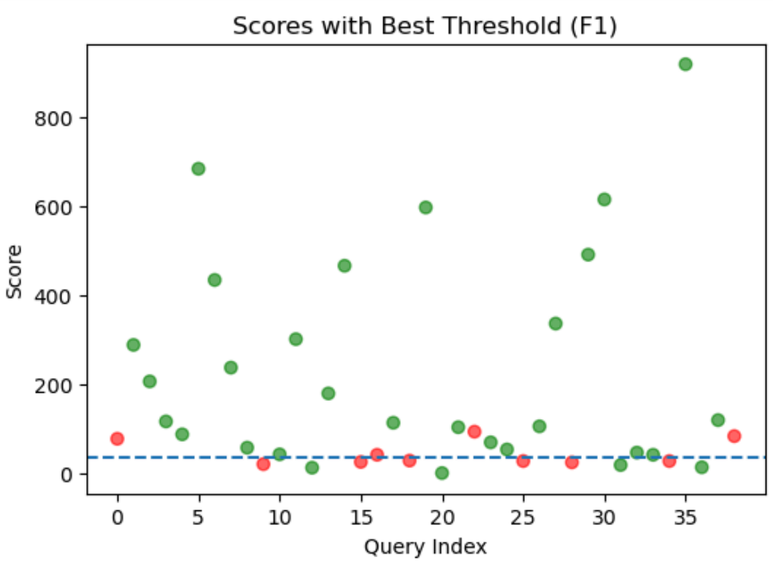
SIFT



Best threshold: 9

F1=0.853
Precision=0.744 Recall=1.000

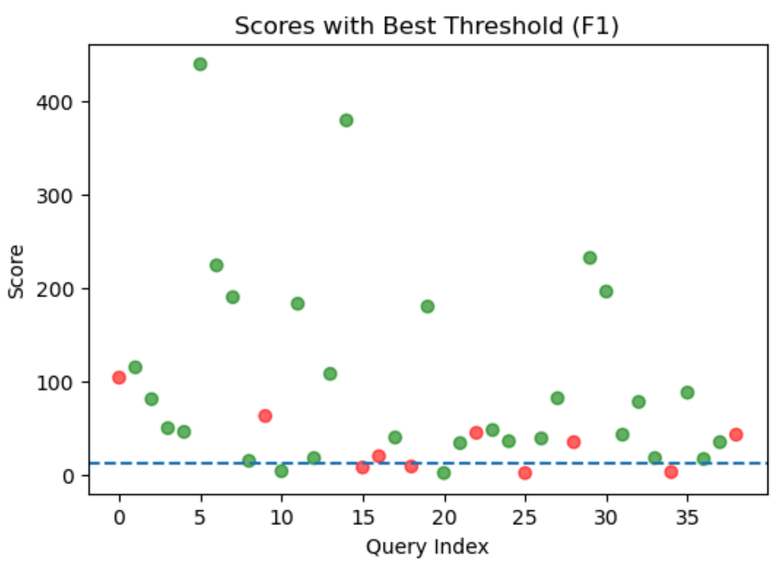
ORB



Best threshold: 34.5

F1=0.862
Precision=0.862 Recall=0.862

COLOR-SIFT



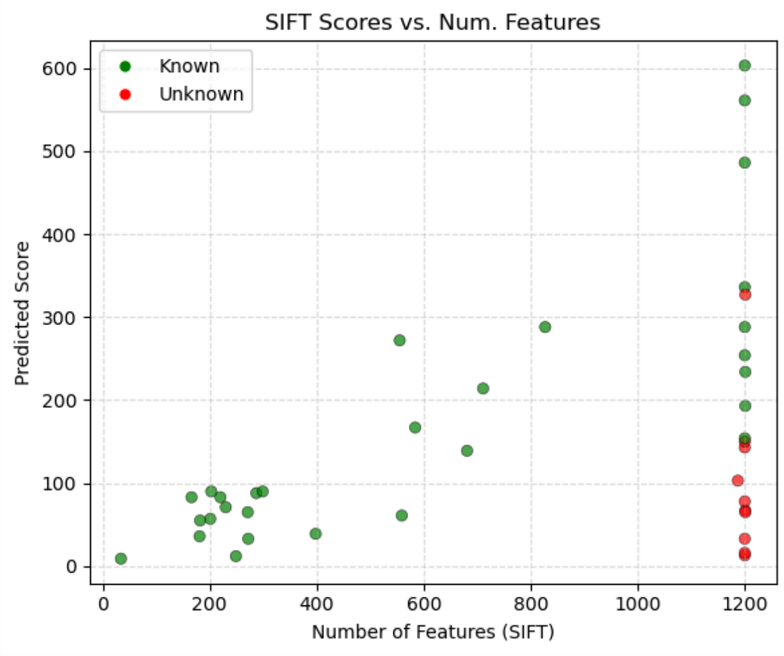
Best threshold: 12

F1=0.871
Precision=0.818 Recall=0.931

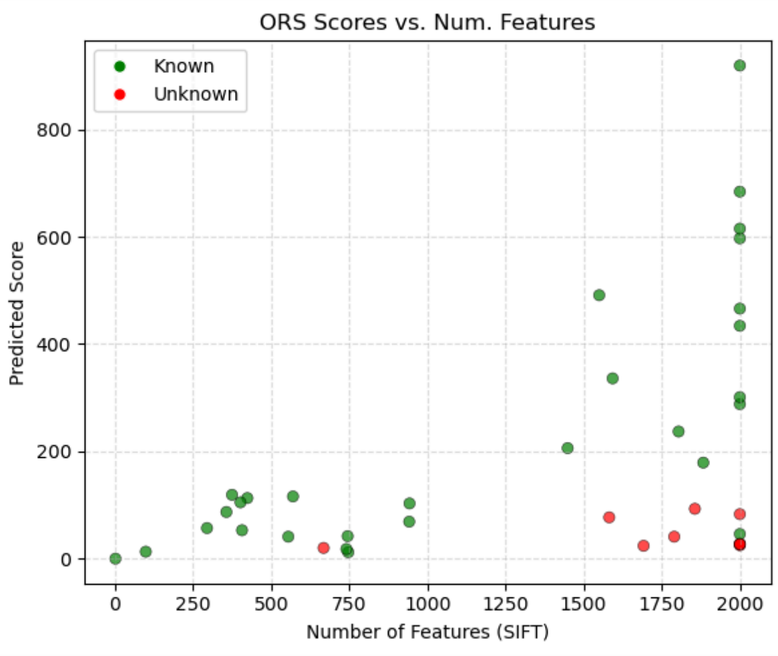
Unknown Detection

Normalized Score = Score / number of key points of the image

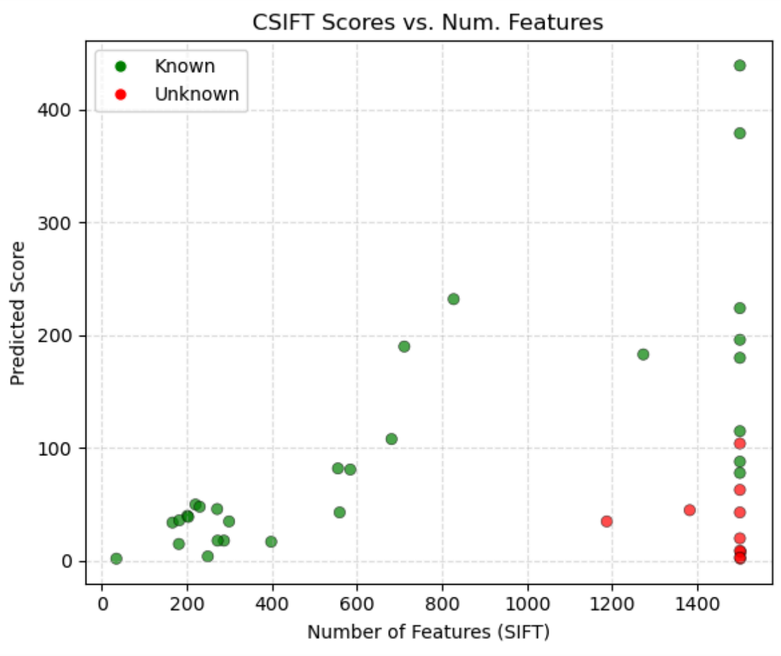
SIFT



ORB



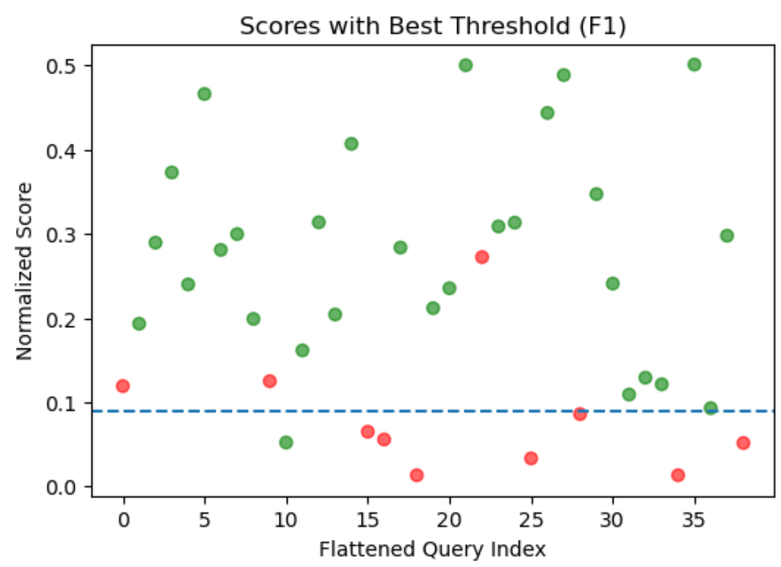
COLOR-SIFT



Unknown Detection

Normalized Score = Score / number of key points of the image

SIFT

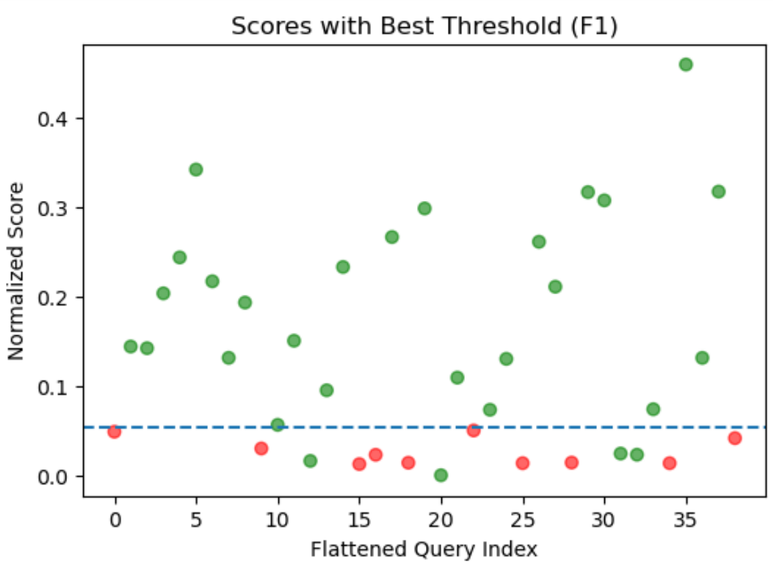


Best threshold: 0.090147

F1=0.933
Precision=0.903 Recall=0.966

mAP@1 = 0.8462
mAP@5 = 0.8526

ORB

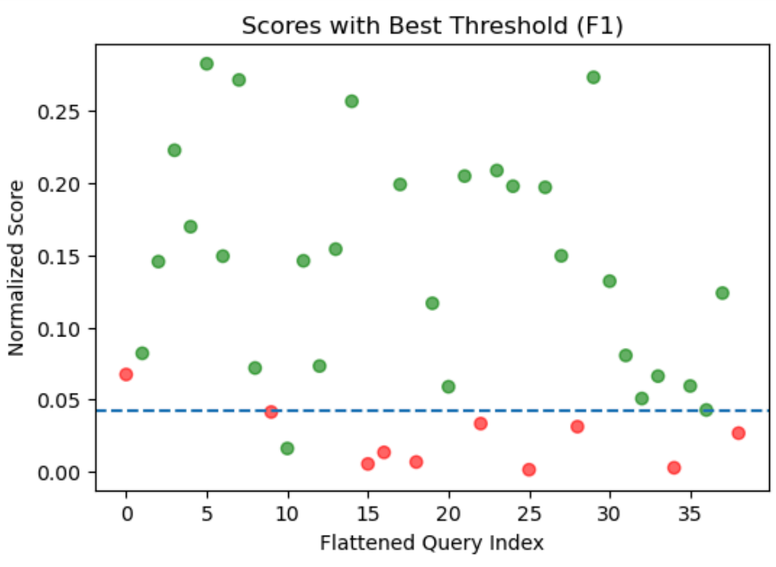


Best threshold: 0.053242

F1=0.926
Precision=1.00 Recall=0.862

mAP@1 = 0.8718
mAP@5 = 0.8718

COLOR-SIFT



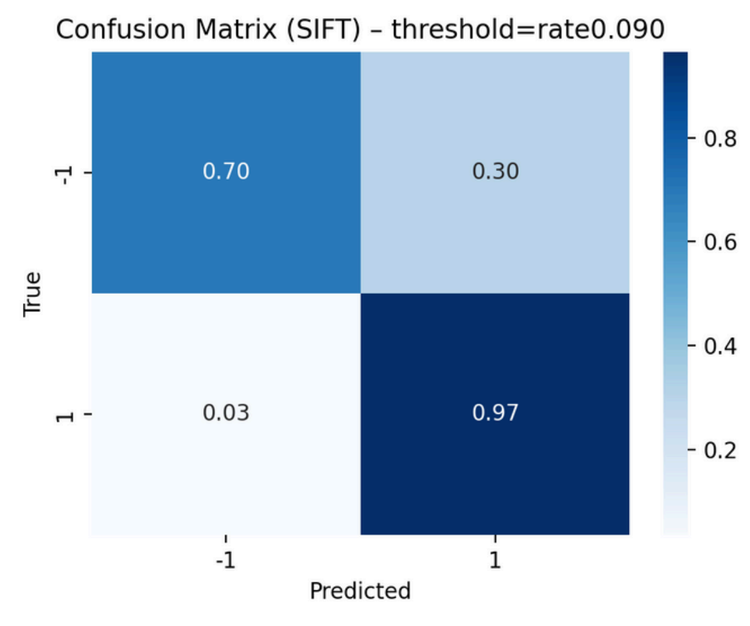
Best threshold: 0.042357

F1=0.966
Precision=0.966 Recall=0.966

mAP@1 = 0.8974
mAP@5 = 0.8974

Unknown Detection

SIFT

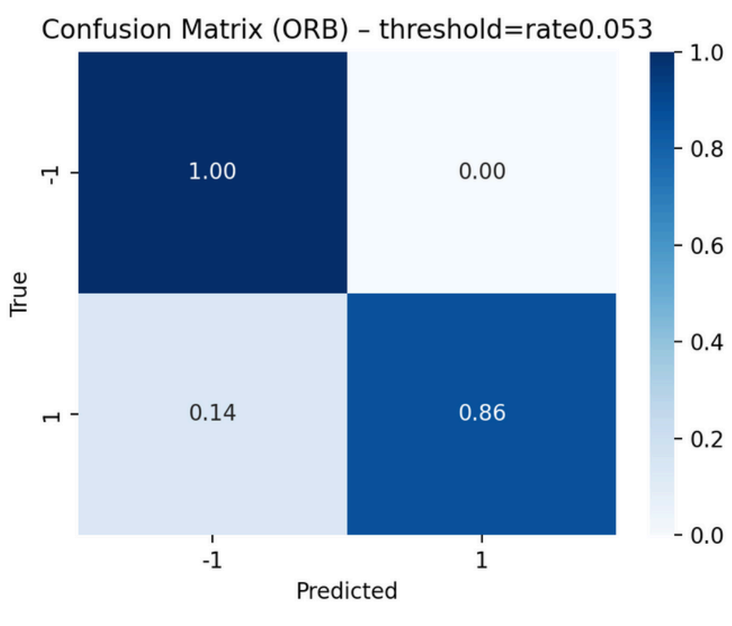


Best threshold: 0.090147

F1=0.933
Precision=0.903 Recall=0.966

mAP@1 = 0.8462
mAP@5 = 0.8526

ORB

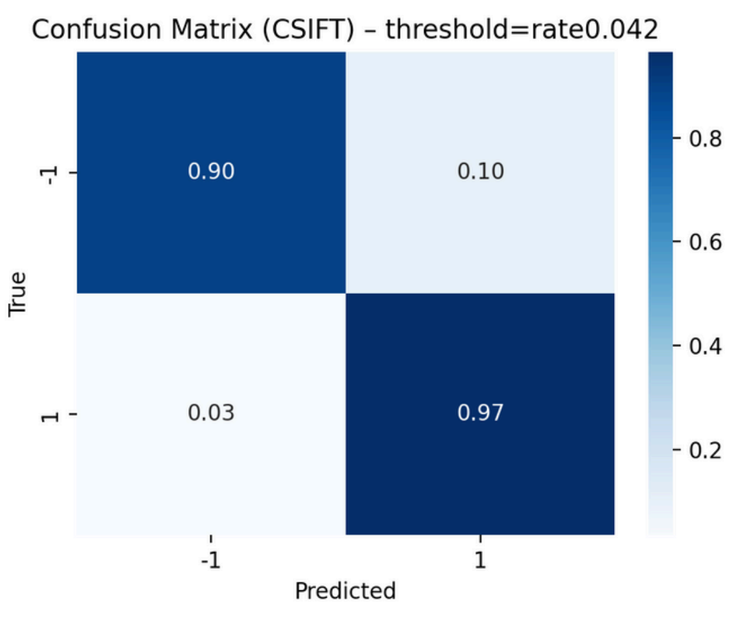


Best threshold: 0.053242

F1=0.926
Precision=1.00 Recall=0.862

mAP@1 = 0.8718
mAP@5 = 0.8718

COLOR-SIFT



Best threshold: 0.042357

F1=0.966
Precision=0.966 Recall=0.966

mAP@1 = 0.8974
mAP@5 = 0.8974

Results COLOR-SIFT

Norm Score: 0.1387
Num Features: 584

Norm Score: 0.2273
Num Features: 220

:

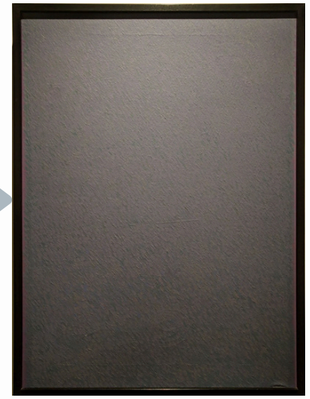
Results COLOR-SIFT

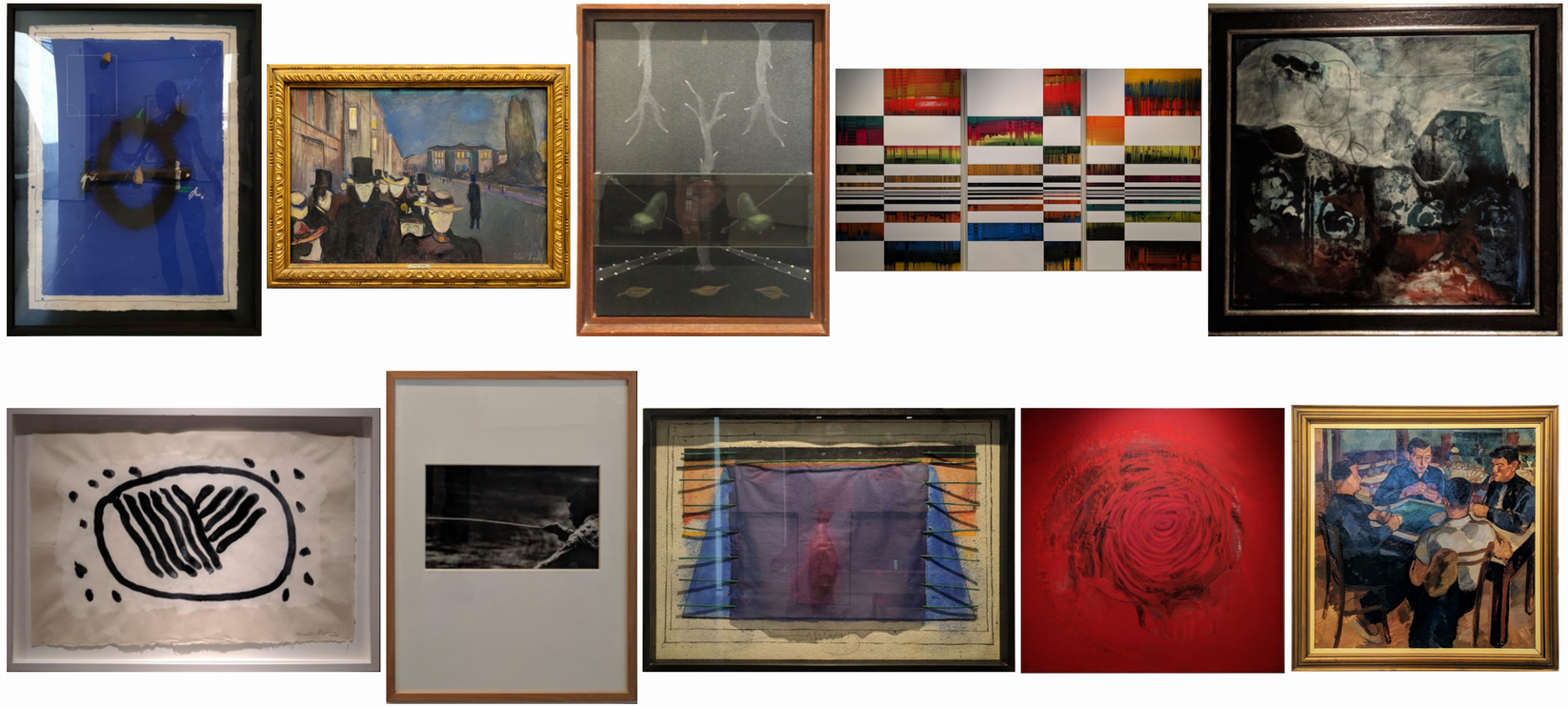
GT

Norm Score: 0.0588
Num Features: 34

Norm Score: 0.2048
Num Features: 166

:



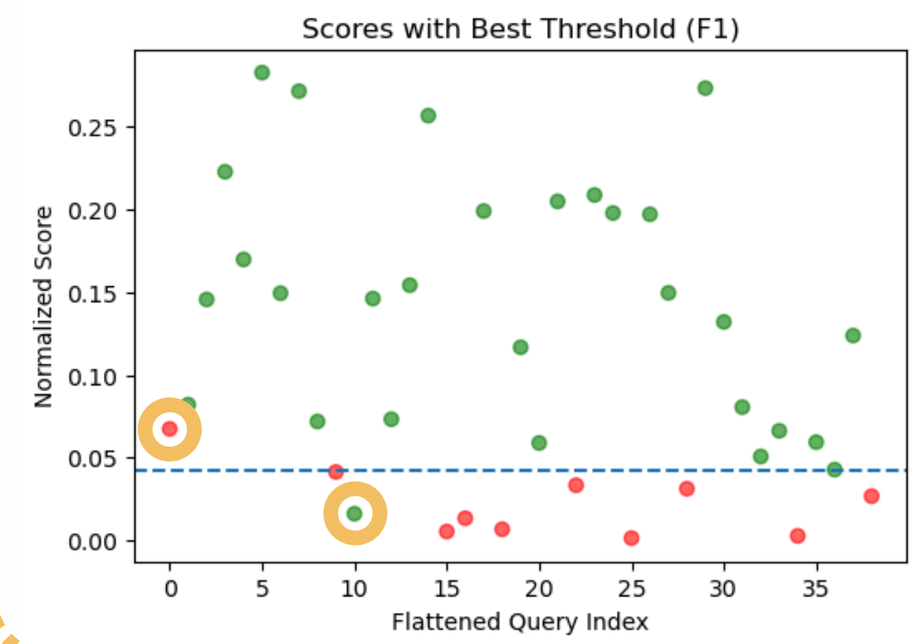


Results COLOR-SIFT

Norm Score: 0.0161
Num Features: 249

: **[-1]** GT →

Threshold: 0.042357



Norm Score: 0.0693
Num Features: 1500

:

... GT → **[-1]**

Conclusions

- **Designed a complete CBIR pipeline integrating preprocessing, descriptor extraction, matching, and unknown-detection.**
- **Color-SIFT achieved the best trade-off between accuracy and robustness.**
- **Normalizing the score by the number of keypoints improved unknown-detection consistency (F1 up to ≈ 0.97).**

Limitations

- **Image-splitting thresholds were fitted on a small subset (≈ 30 queries), so they may overfit and fail on unseen data.**
- **Descriptor extraction was computationally demanding, limiting broader parameter tuning.**
- **Background removal still struggles with shadows and bright regions.**

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