Embedding

```
# DWT
block = image[block_location]
coeffs = wavedec2(block, wavelet="haar", level=1)
LLb = coeffs[0]

# SVD
Ub, Sb, Vb = np.linalg.svd(LLb)
Sb[0] += Swm[idx] * ALPHA

# iSVD
LLnew = Ub.dot(np.diag(Sb)).dot(Vb)
# iDWT
coeffs[0] = LLnew
block_watermarked = waverec2(coeffs, wavelet="haar")
```

Detection

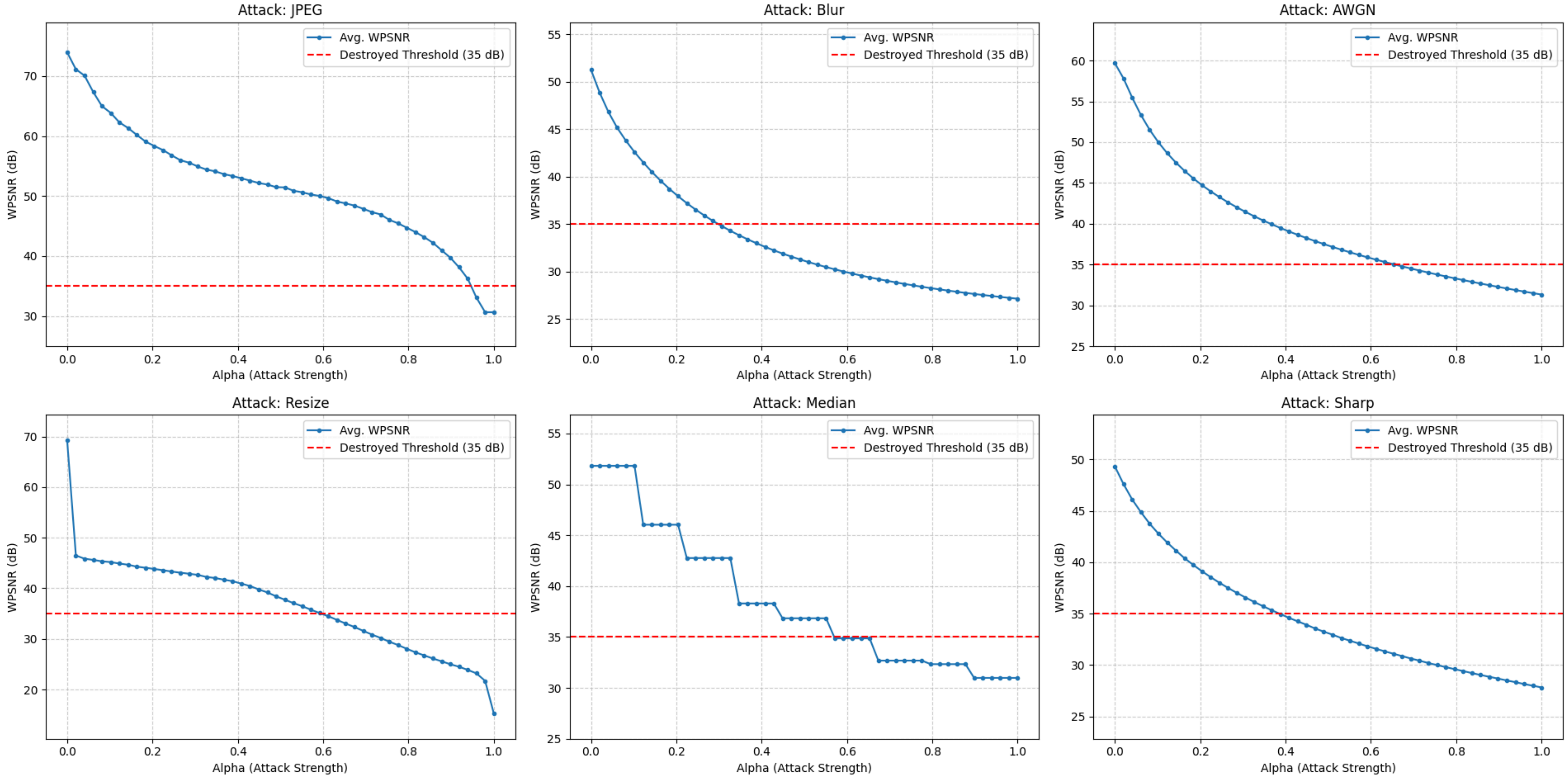
Attack Strategy

- binary search to find optimal attack strength
- attack functions tweaked to accept parameter $0 \leq \alpha \leq 1$
- use of masks to attack different areas of the image
- parallelization to improve execution speed

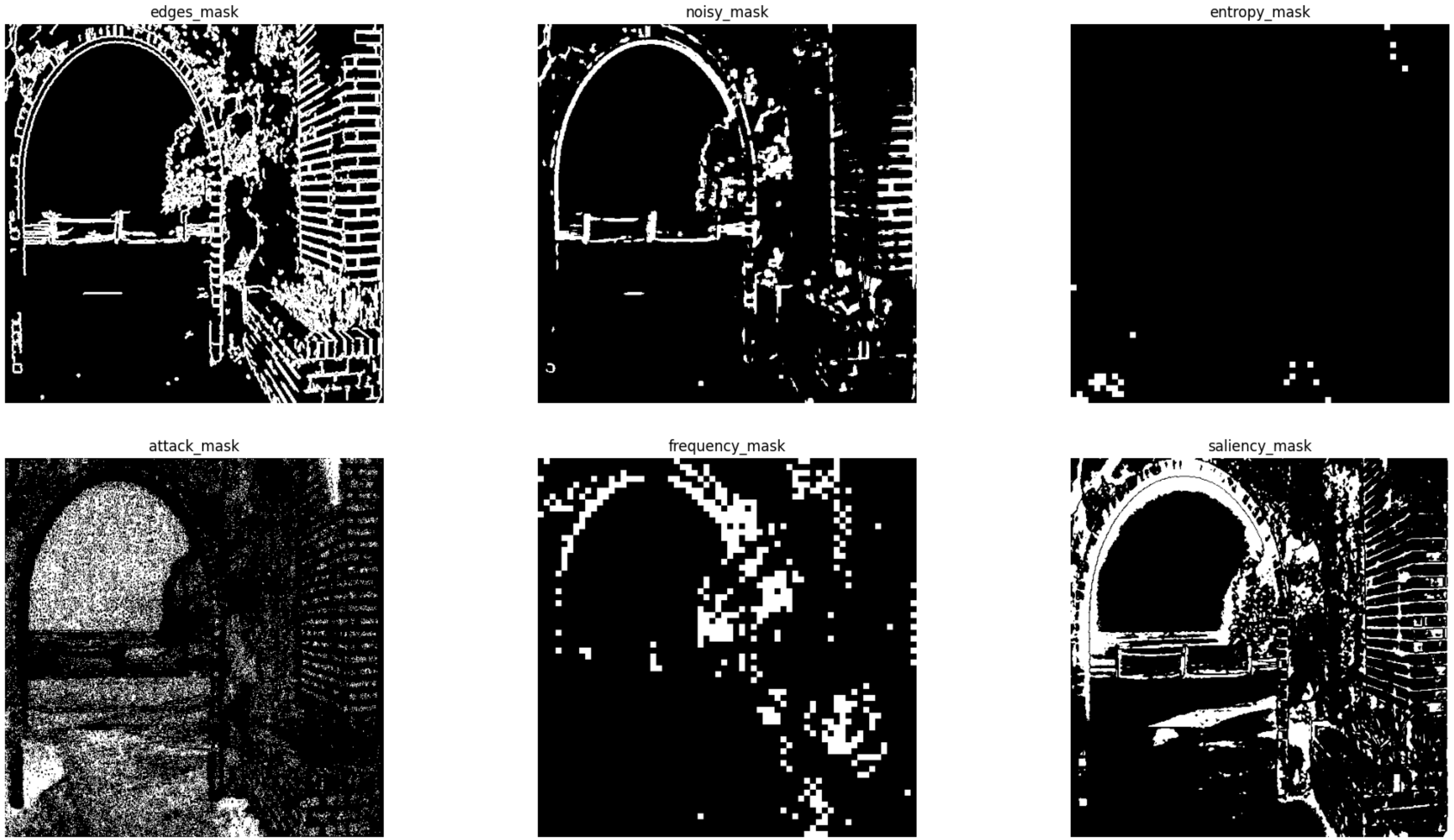
Attack Strategy - binary search

```
# JPEG
return int(round((1 - x) * 100))

# Blur
return (x + 0.15) * 3

# AWGN
return (x+ 0.01) * 40

# Median
return max(1,np.round((1 - x) * 512)) / 512

# Resize
return [[1,3], [3,1], [3,3], [3,5], [5,3], [5,5], [5,7], [7,5], [7,7]][(int(np.floor(x * 8.999)))]

# Sharp
return (x+0.1) * 0.2
```

Attack Strategy - binary search



Attack Strategy - masks



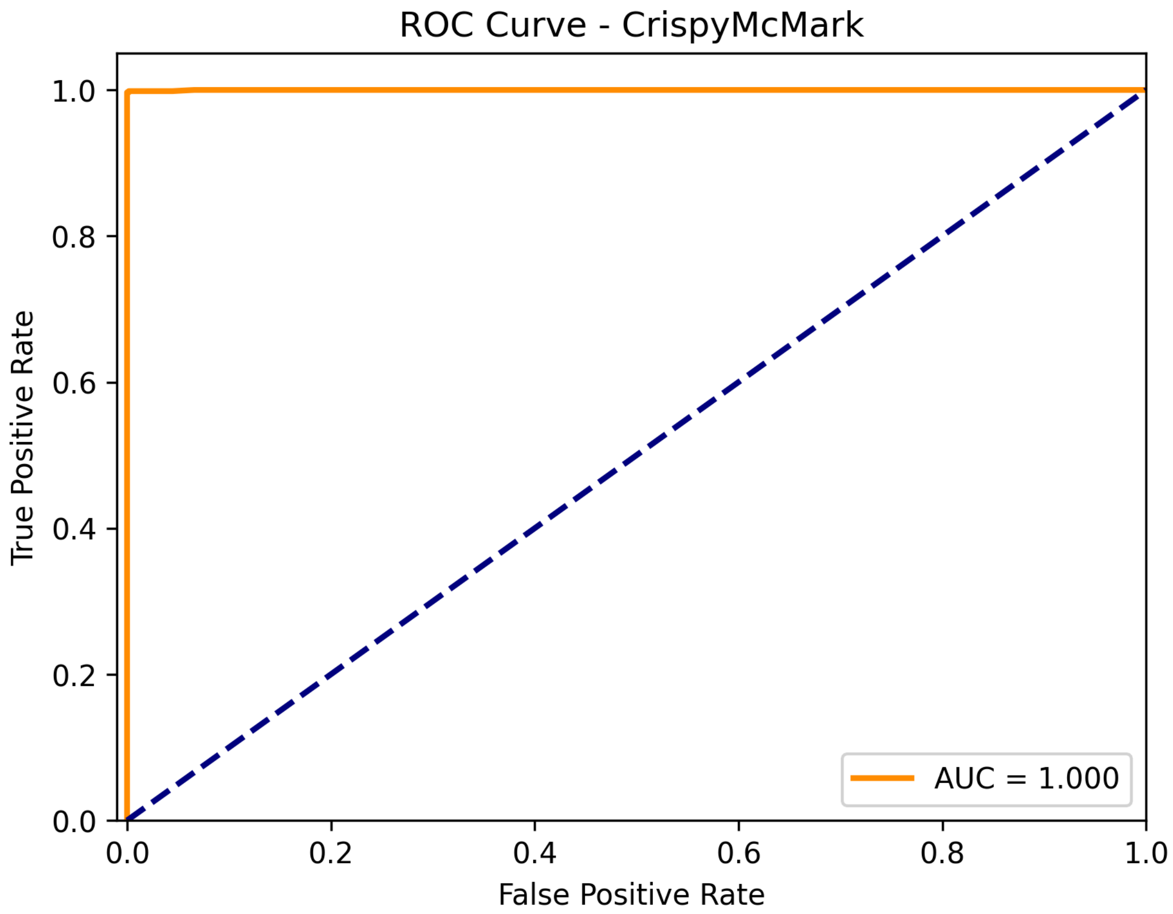
Possible Improvements

- Add redundancy based on singular value importance
- Improve the invisibility of attack squares, either by block choice or embedding strength

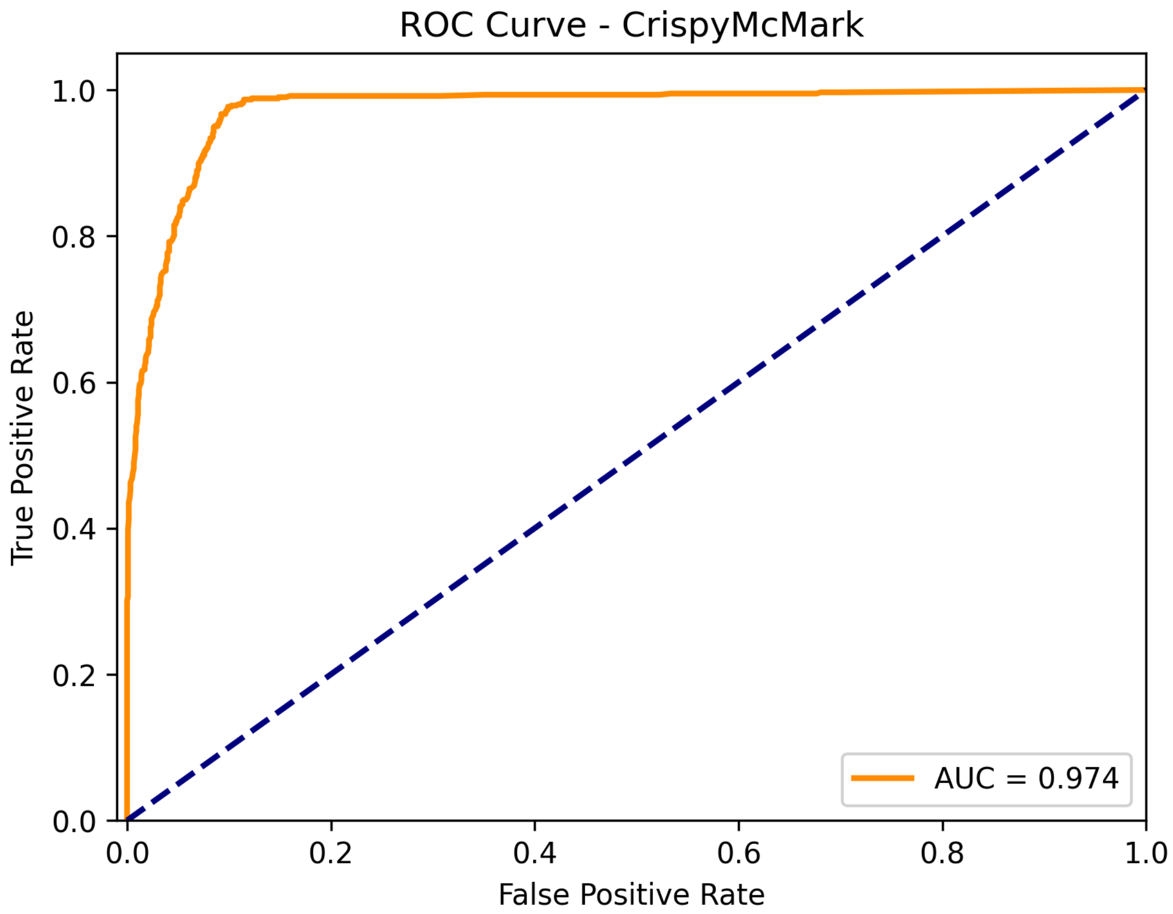
Implementation challenges

- Attack resistance is very image-dependent, so harder to immediately measure
- Invisibility is also quite image-dependent
- Hard to understand how the algorithm performed/ find bugs based on the provided ROC function: we added some additional checks in the ROC to better understand the performance of our extraction in different scenarios.
- Not enough time to refine the design and try different techniques(better block choice algorithm, add redundancy etc...)

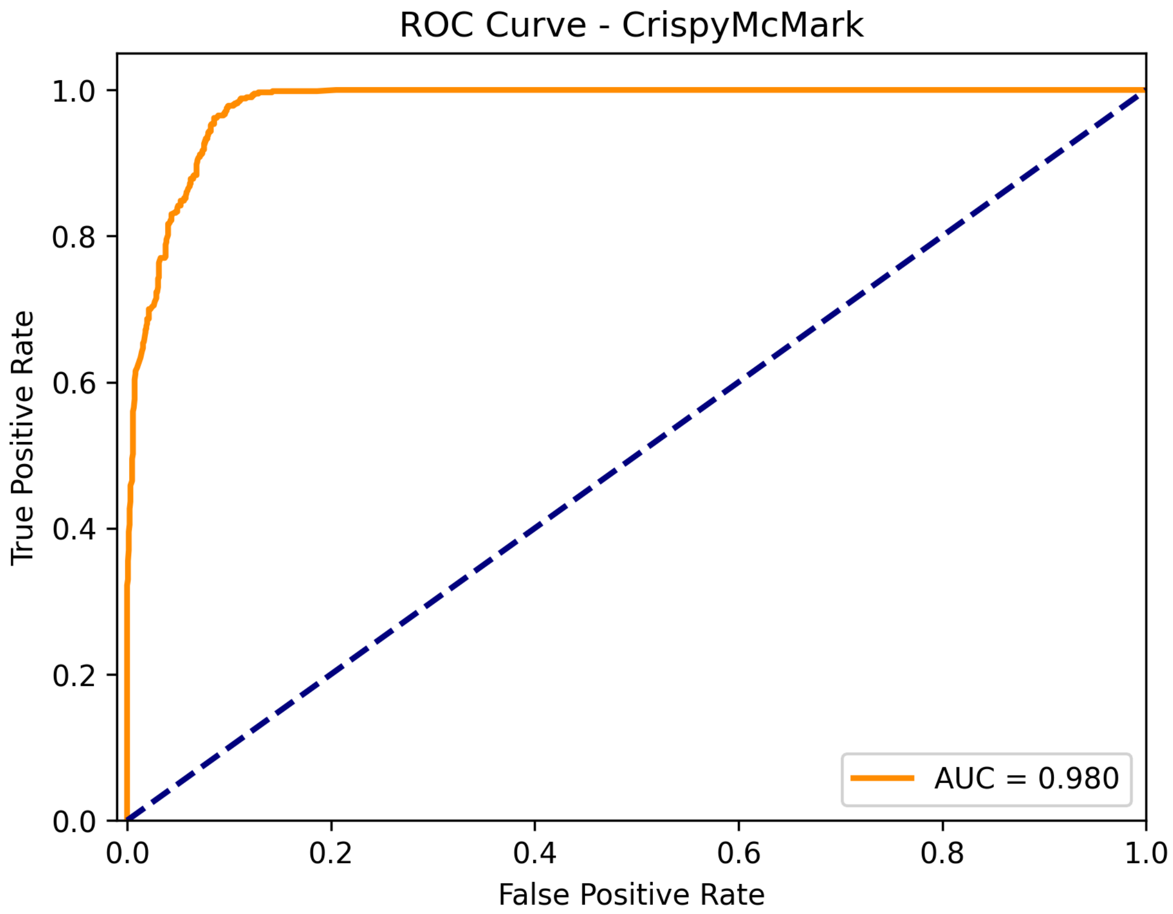
ROC1: Original



ROC2: ROC1 + check original(attacked) images



ROC3: ROC2 + label 0 for destroyed



Effects of hardcoding some of the watermark