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Towards Camera Identification From Cropped Query Images

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Source Camera Attribution

Social Media

Anonymous Image

- Verification: Was this picture taken with this camera?
- Identification: Was this picture taken from one a large collection of cameras?
- PRNU helps answer these questions.

PRNU[1]

- Uniform light → Different pixel values
- Physical property of sensor → resilient
- Similar noise pattern is in all images of a camera
- Signal = $I_0 + I_0 * PRNU + Other\ noise$

[1]:Jan Lukas, Jessica Fridrich, and Miroslav Goljan, “Digital camera identification from sensor pattern noise, ”IEEE Transactions on Information Forensics and Security, vol. 1, no. 2, pp. 205–214, 2006.

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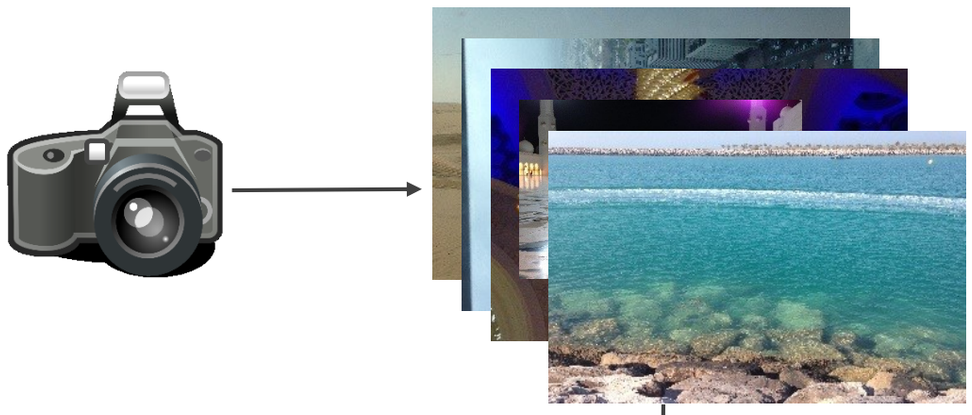
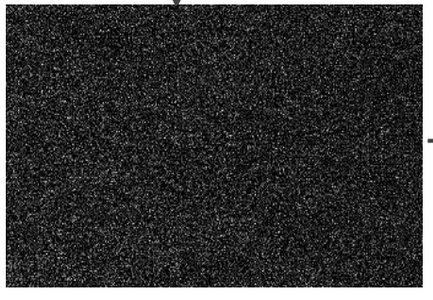
Source Camera Verification

Images from Alice's Camera



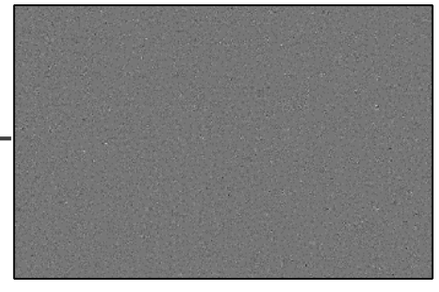
Anonymous Image



Fingerprint (FP)

Correlation

Decision?



PRNU noise

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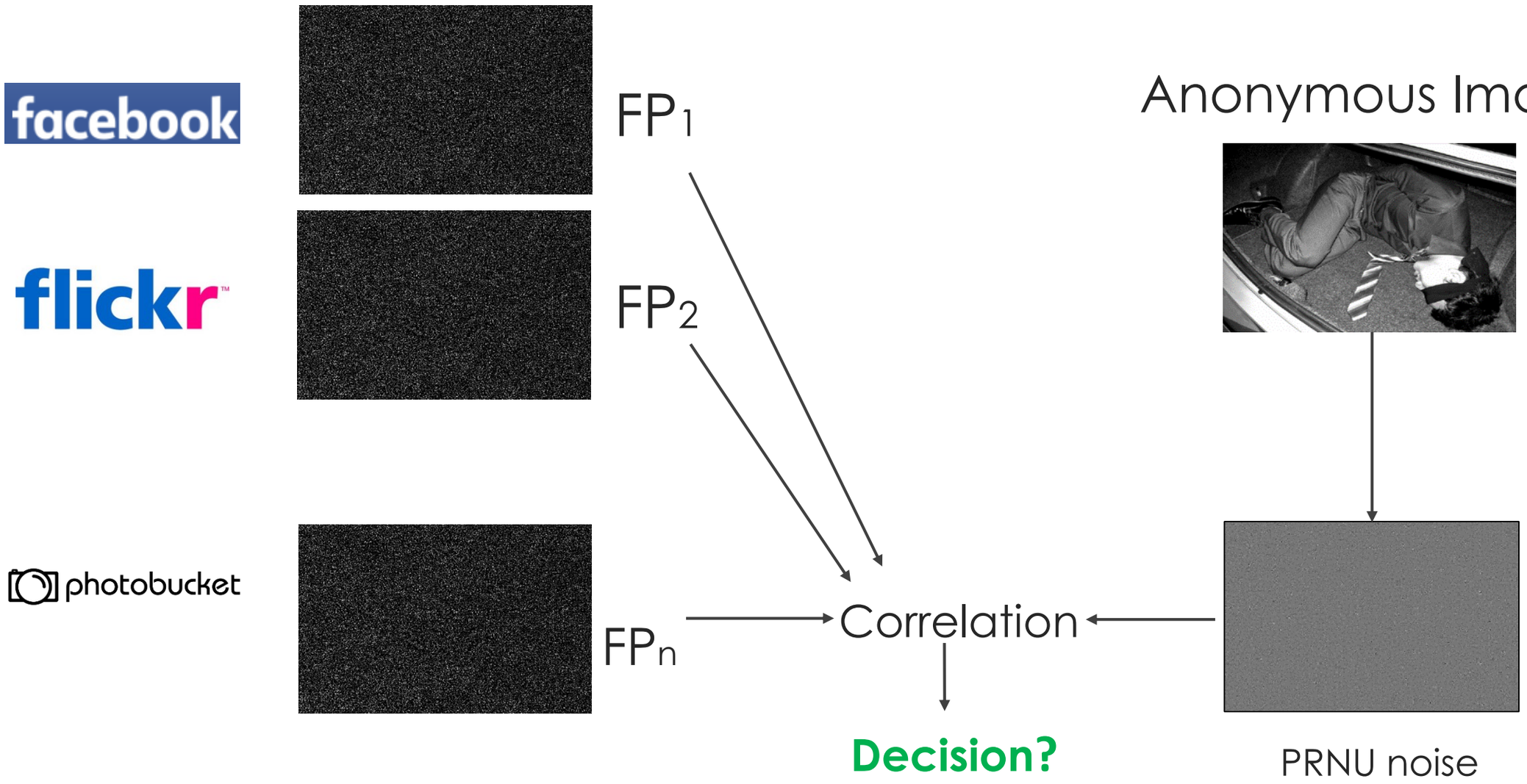
Source Camera Identification



FP = Fingerprint

PRNU Based Source Camera Identification has Computational Overheads

- Correlation with billions of FP
- Existing speedups don't work with crop

FP = Fingerprint

Existing Methods of Speedup

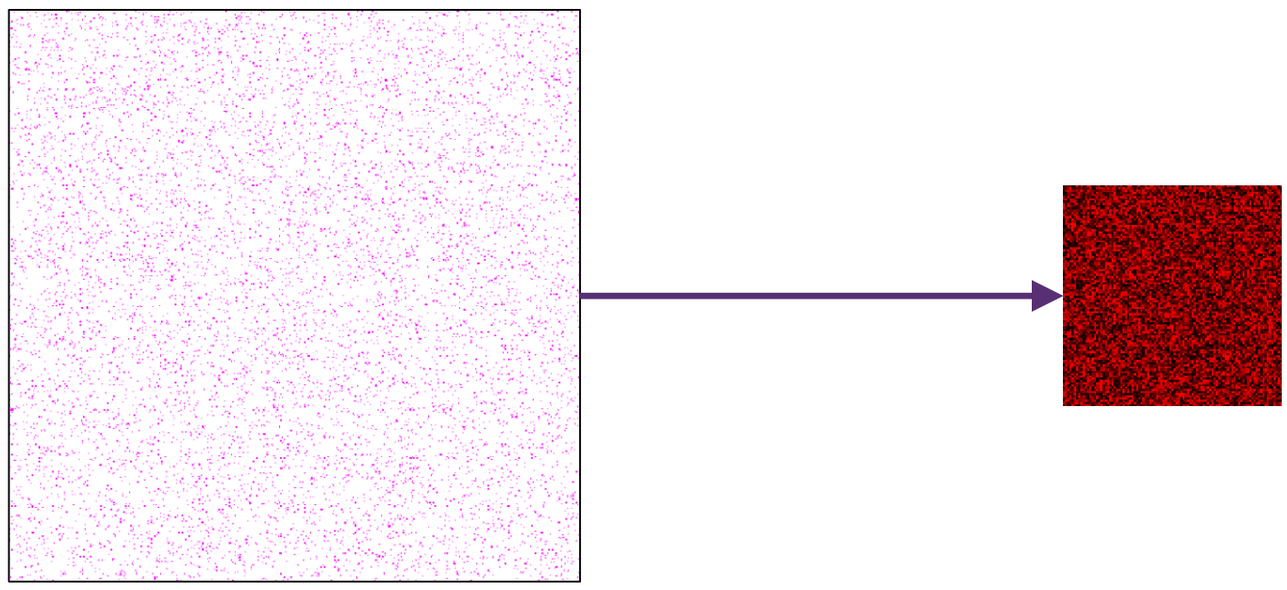
- Binarization: each fingerprint pixel by a single bit instead of 32bits
- ShortDigest: Only hottest & coldest pixel values
- Composite: fingerprint which is a mixture of many fingerprints

Existing Methods of Speedup (Binarization)

- 01010010111110101011110100010101010 → 1
- 10000001010101010010111010100111 → 0
- Hamming distance instead of correlation
- Computation & Storage (32 times better)
- Performance (3-5% drop)

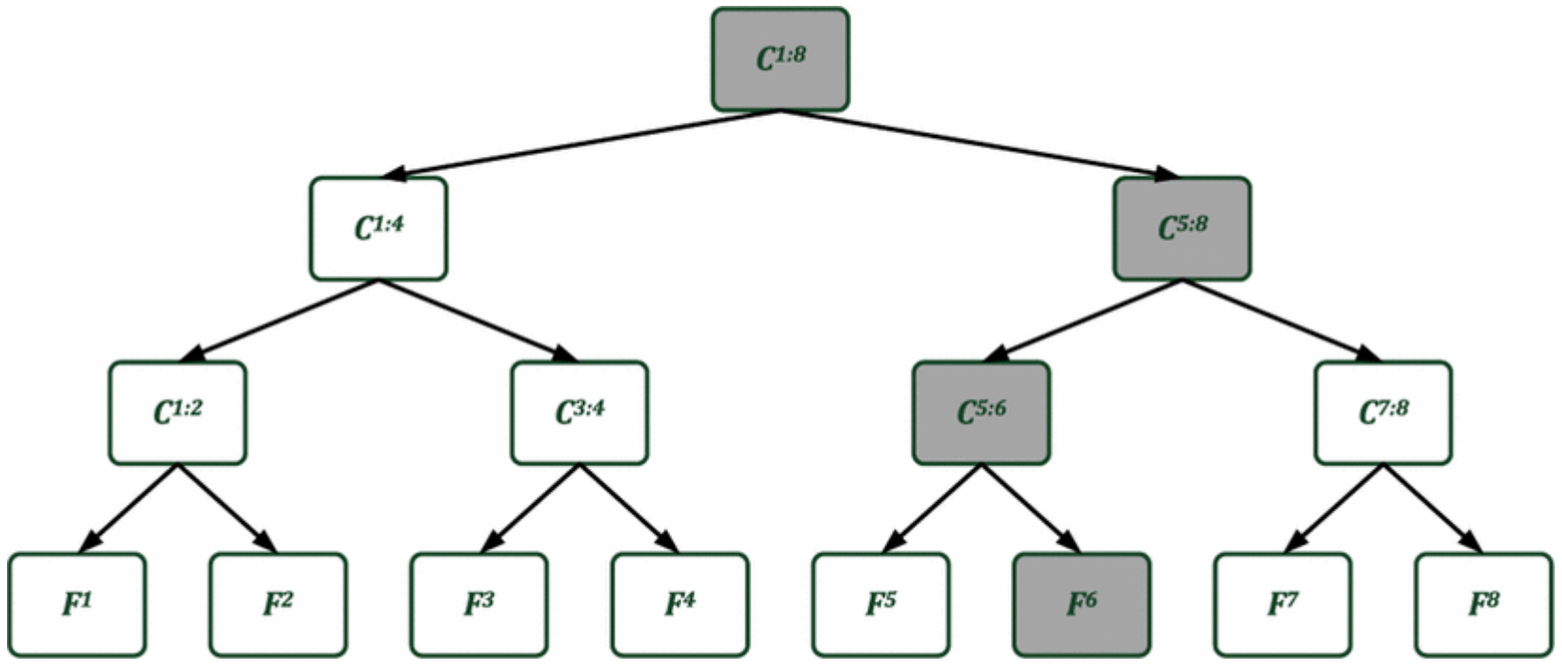
Existing Methods of Speedup (ShortDigest)

- Only hottest & coldest pixel values
- Storage, Speed (70-80 times)
- Performance (1-2% drop)



Existing Methods of Speedup (Composite)

- Speed (up to 90-100 times)
- Performance (1-2% drop)
- Storage (double storage)
- IO load(60-80 time improvement)



Our Contribution

- Speedup attribution can still be done when cropped images (speedup factor 13)
- Non-cropped images speeds up by factor of 55.
- Test with variety of scaling techniques
- Storage requirements increased by 33%

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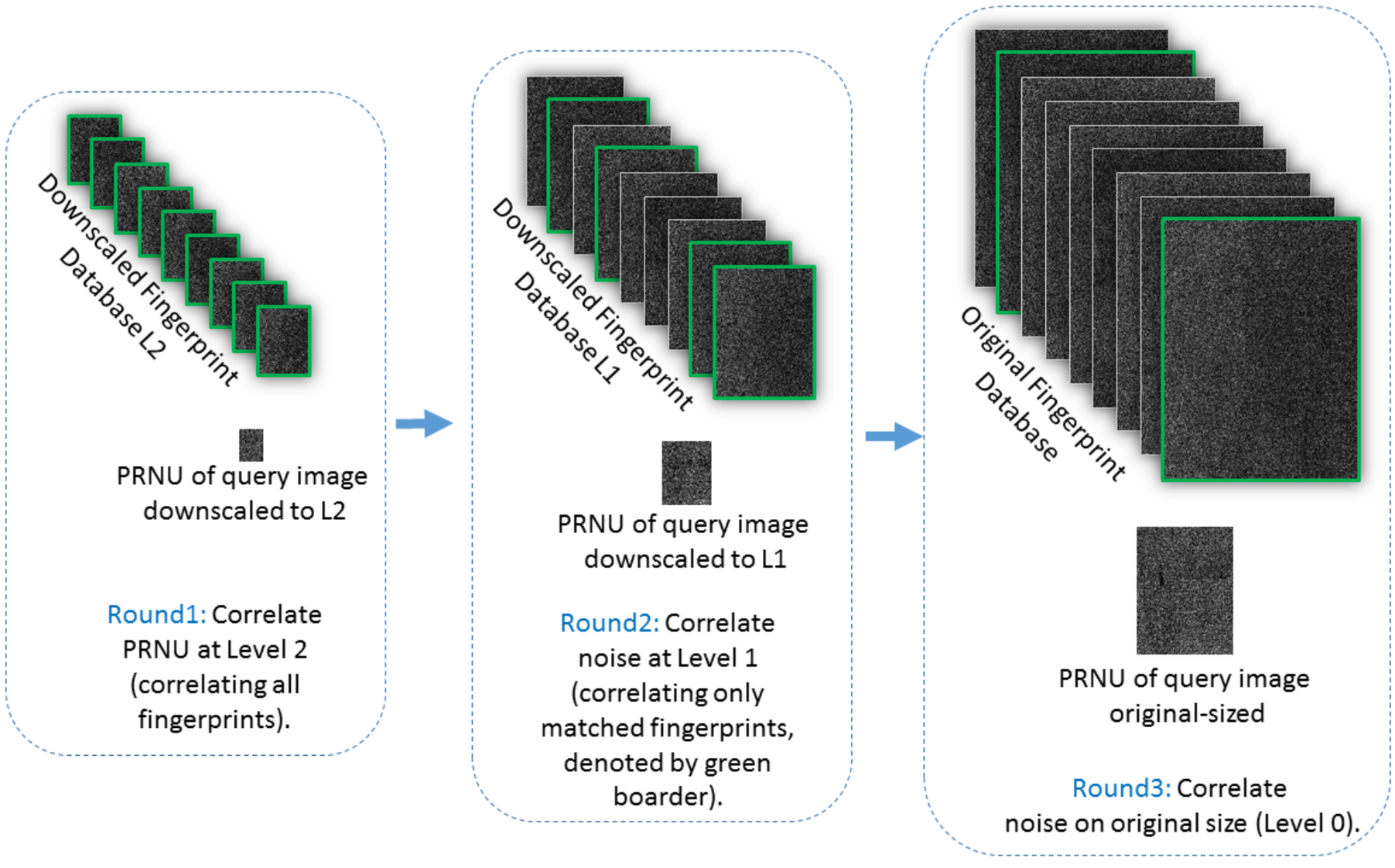
Our Proposed Scheme



Proposed Scheme (cropped)

Fingerprint downscaled to L2

PRNU of query image downscaled to L2

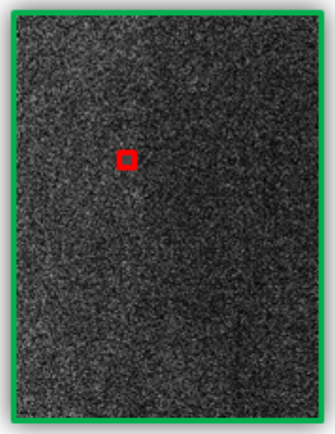
Round1: Correlation with NCC

Fingerprint downscaled to L1

PRNU of query image downscaled to L1

Round2: PCE correlation for potential cropped locations

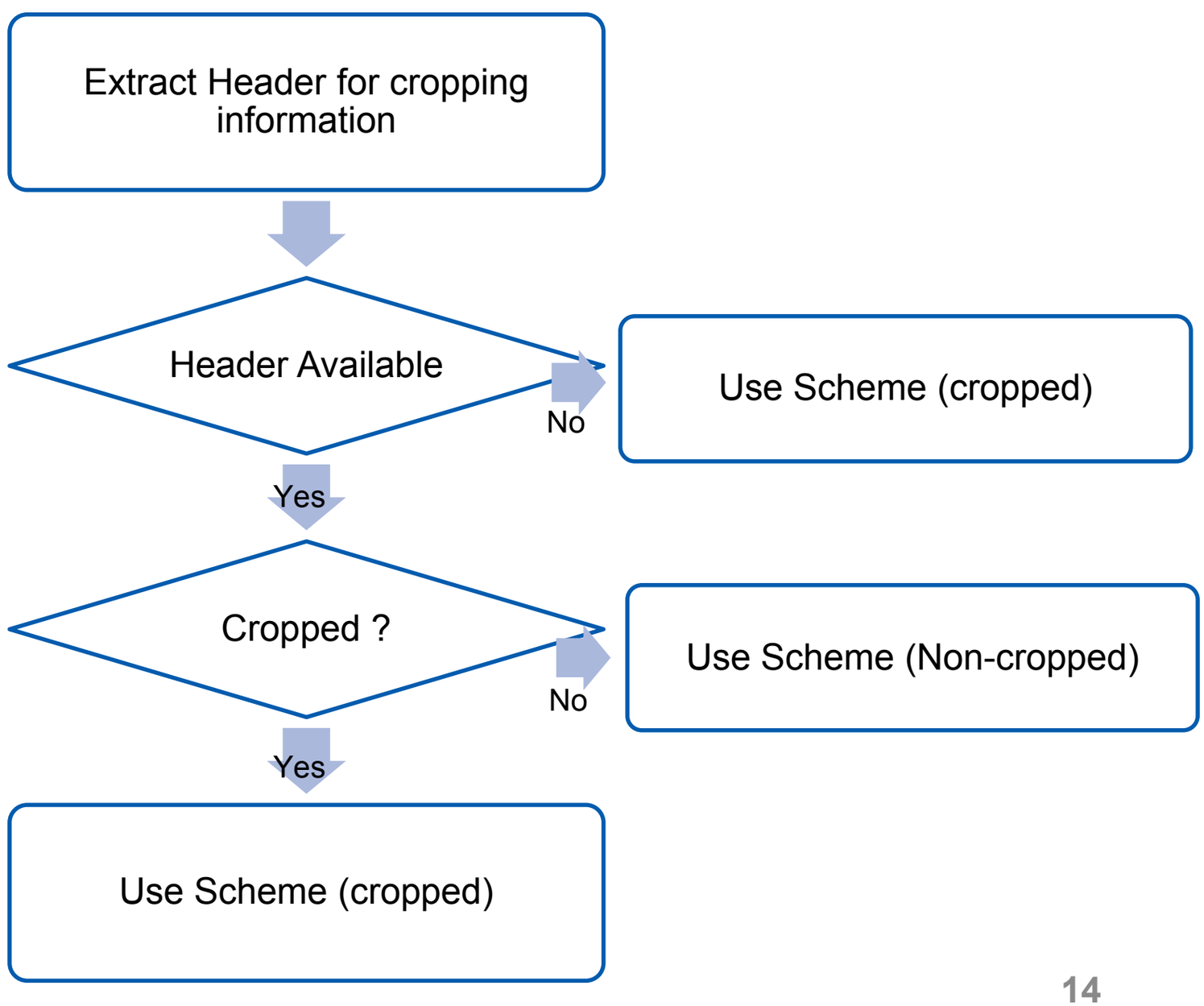
Original Fingerprint



PRNU of originally-sized query image

Round3:. PCE correlation for potential cropped locations

Our Proposed Scheme (flowchart)



Simple Example of Scaling PRNU

- F1 ≈ mean(f1+f2+f5+f6) ; Each pixel contribution is considered when scaling
- Bilinear interpolation Instance for one level

Fingerprint

f_1	f_2	f_3	f_4
f_5	f_6	f_7	f_8
f_9	f_{10}	f_{11}	f_{12}
f_{13}	f_{14}	f_{15}	f_{16}

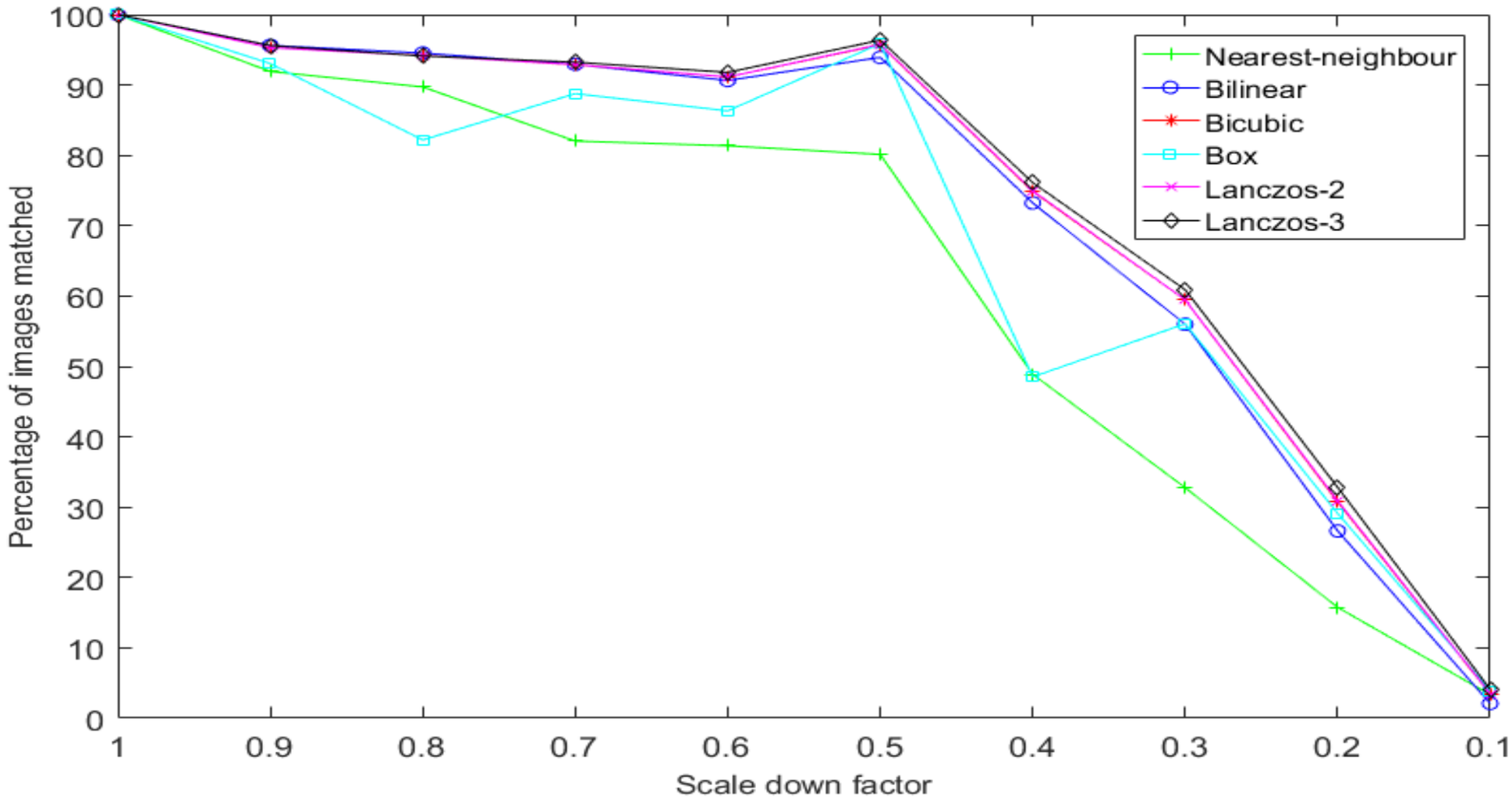
Group for Scaling

f_1	f_2	f_3	f_4
f_5	f_6	f_7	f_8
f_9	f_{10}	f_{11}	f_{12}
f_{13}	f_{14}	f_{15}	f_{16}

Scaled

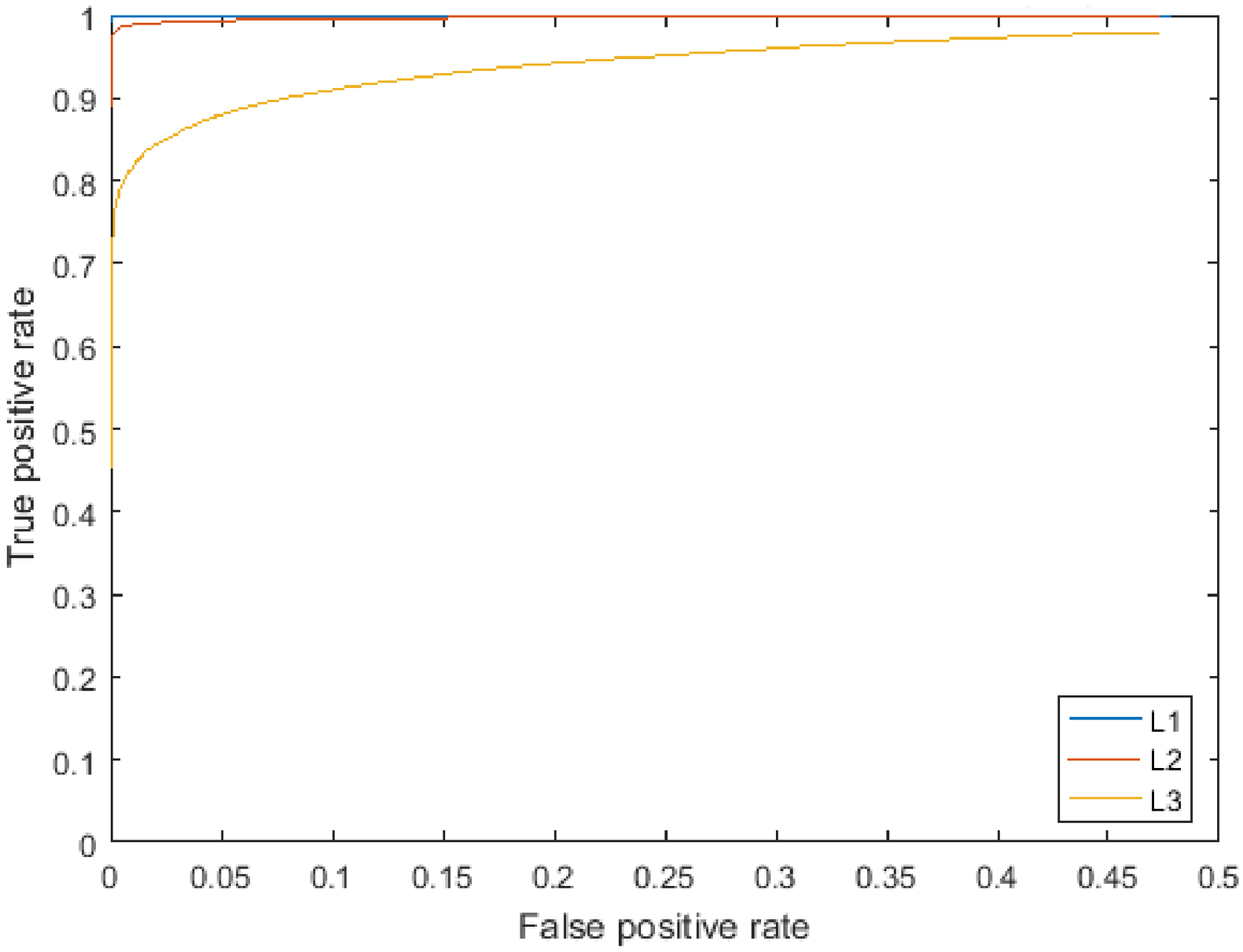
F_1	F_2
F_3	F_4

Various Scaling Methods

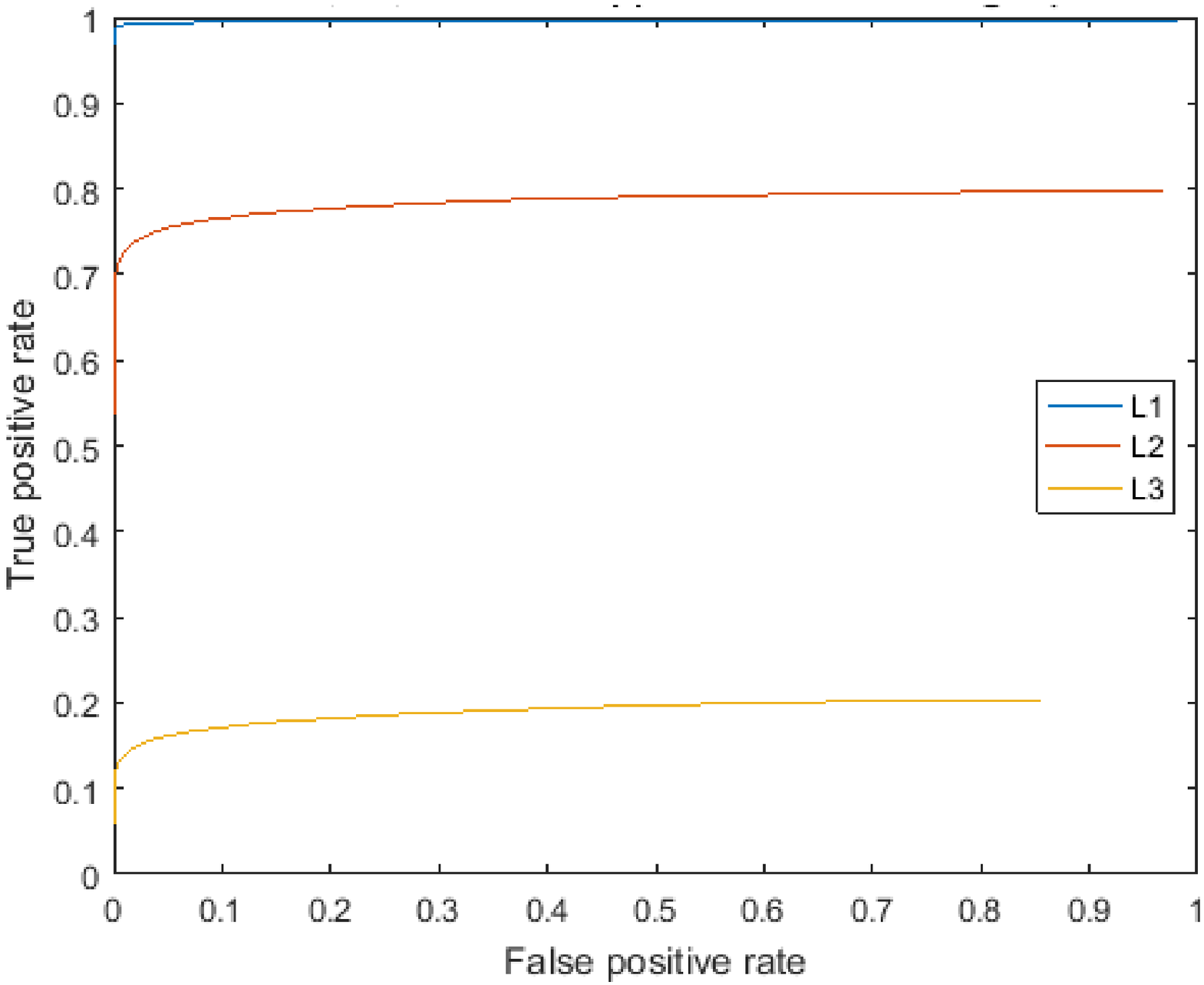


Lanczos scaling methods has the highest true positive rate compared to other scaling methods

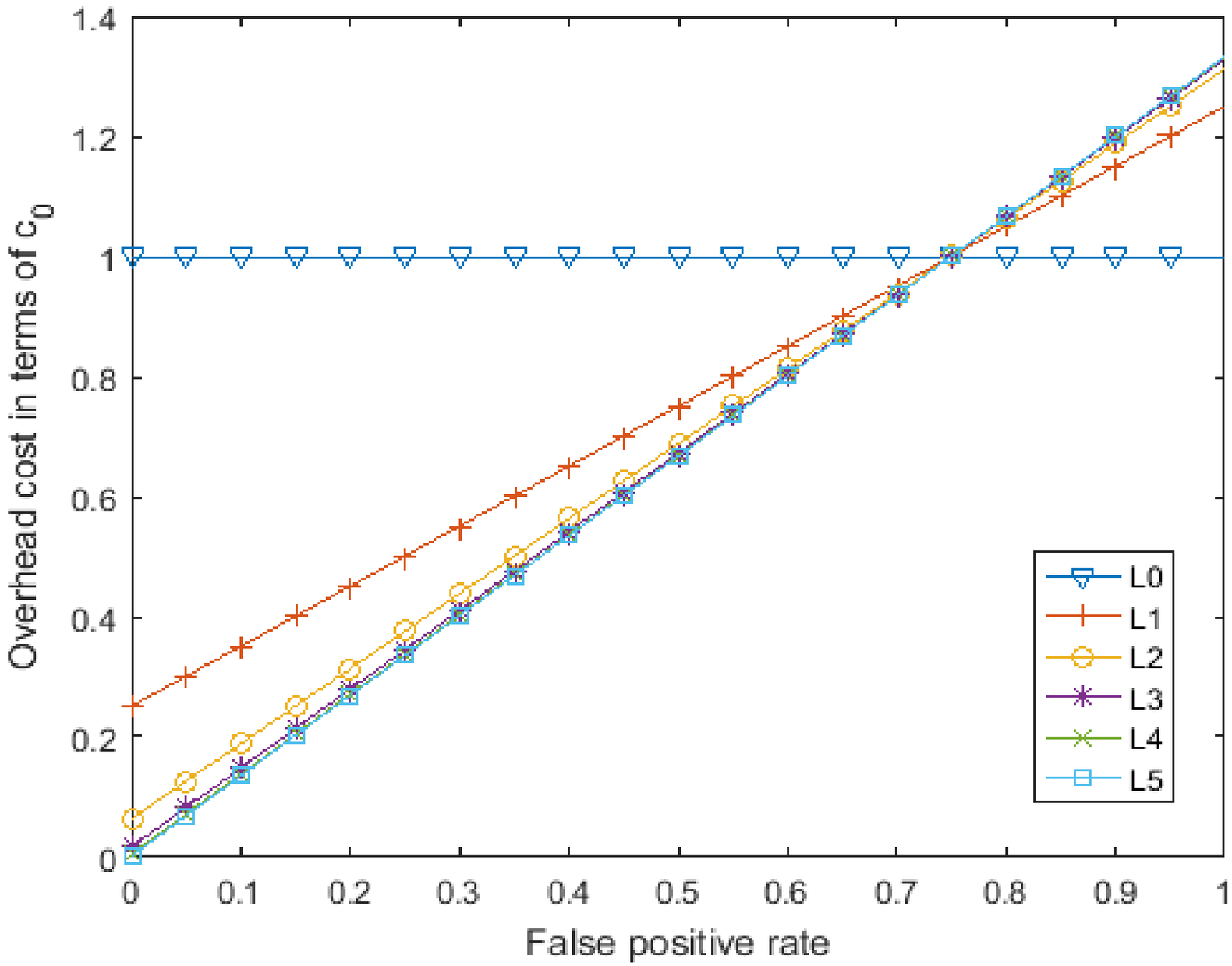
ROC for Different Scaling Levels



ROC for Different Scaling Levels- Cropped



Overhead Cost for Scaling



Conclusion

- In practice, images in social media are cropped and scaled and camera identification is difficult; conventional speed optimization techniques are either ineffective or do not apply
- Iteratively scaling the FP noise can be used to correlate cropped images

Questions
email :
memon@nyu.edu

W. Yaqub, M. Mohanty and N. Memon, "Towards Camera Identification from Cropped Query Images," *2018 25th IEEE International Conference on Image Processing (ICIP)*, Athens, Greece, 2018, pp. 3798-3802.