Banding Annoyance vs. Overall Quality

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We developed CAMBI to estimate the annoyance of banding.

Remaining question is how banding compares to the standard compression artifacts with respect to the overall perceived quality?

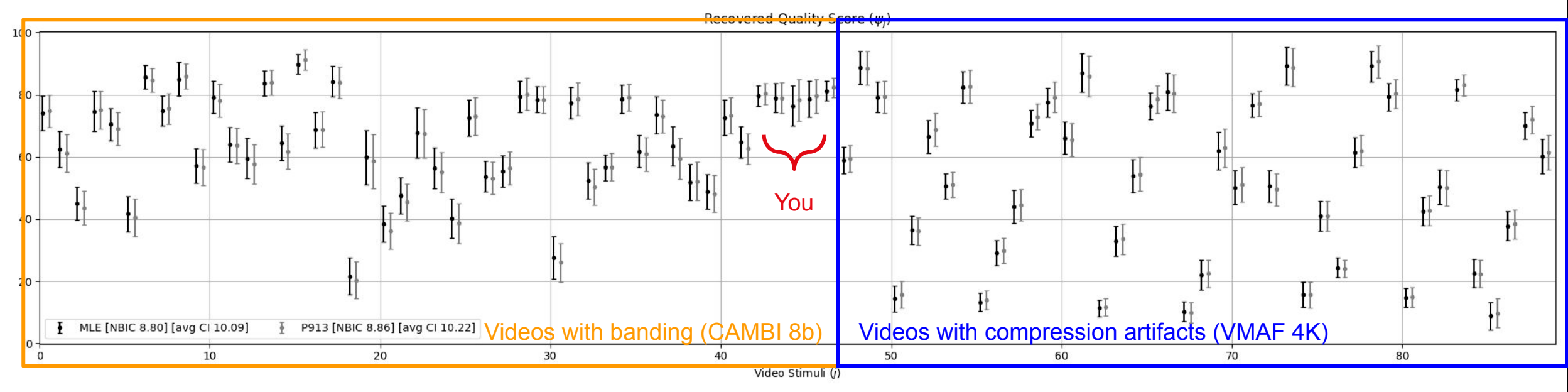
The answer will help us find a reasonable combination of CAMBI and VMAF into a banding-aware quality estimator.

Study on 8-bit videos with banding and with compression artifacts

- 14 source contents (7 from CAMBI 8-bit dataset, 7 from VMAF 4K dataset)
- 84 videos (6 per content)
- 42 observers
- Continuous quality scale
  - Quality is:

100	Excellent
75	Good
50	Fair
25	Poor
0	Bad

Recovered Quality Scores

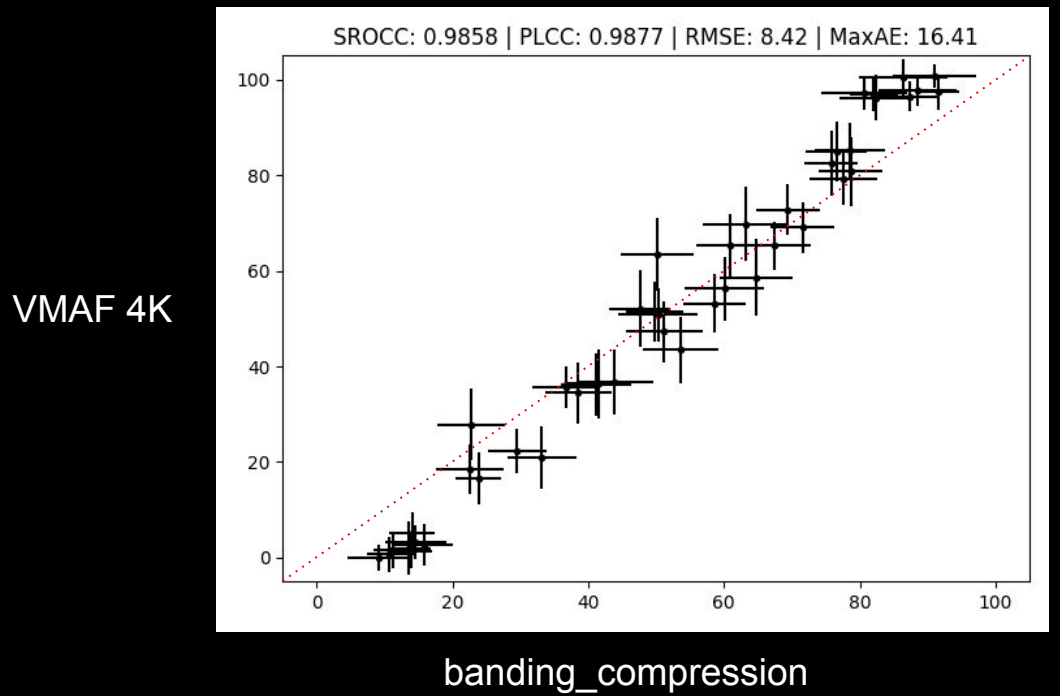


- Banding covers big portion of the quality scale
- Localized banding outside of region of interest (You), does not seem to bother observers as much as global artifacts

Sanity check

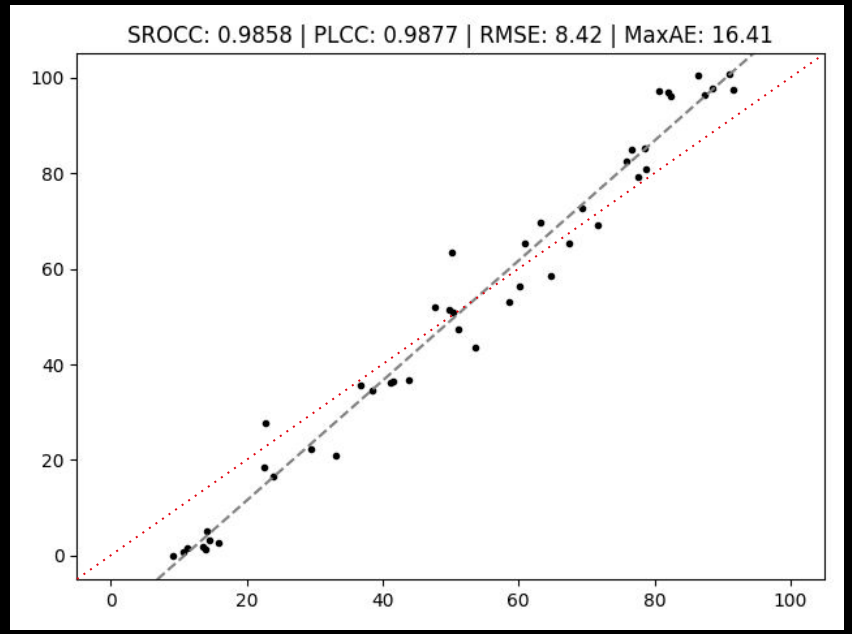
Results for the videos from Nantes 4k dataset

Sanity check: Results for the videos from VMAF 4K dataset



- No two videos with inverted order and non-overlapping CIs
- Videos distributed fairly well along the 45° line
- RMSE (8.42) < Average CI length (~11)

Sanity check: Results for the videos from VMAF 4K dataset



- The linear fit reveals slight compression of the scale
  - Scores in the cambi_vmaf study don't go as high and as low
  - Possible explanations:
    - Continuous vs. discrete scale
    - Monitor vs. 4K display
    - Different training

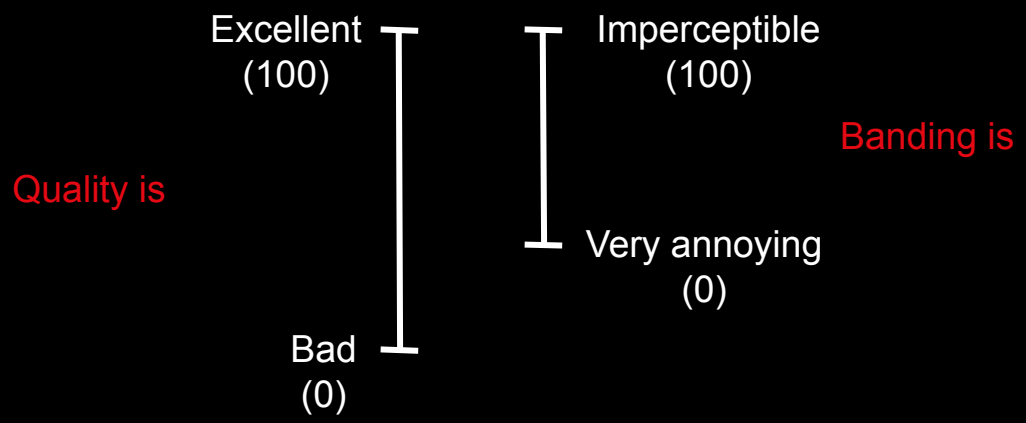
…overall, the results are VERY well aligned.

Scores for banding videos

Subset of videos from CAMBI 8bit dataset

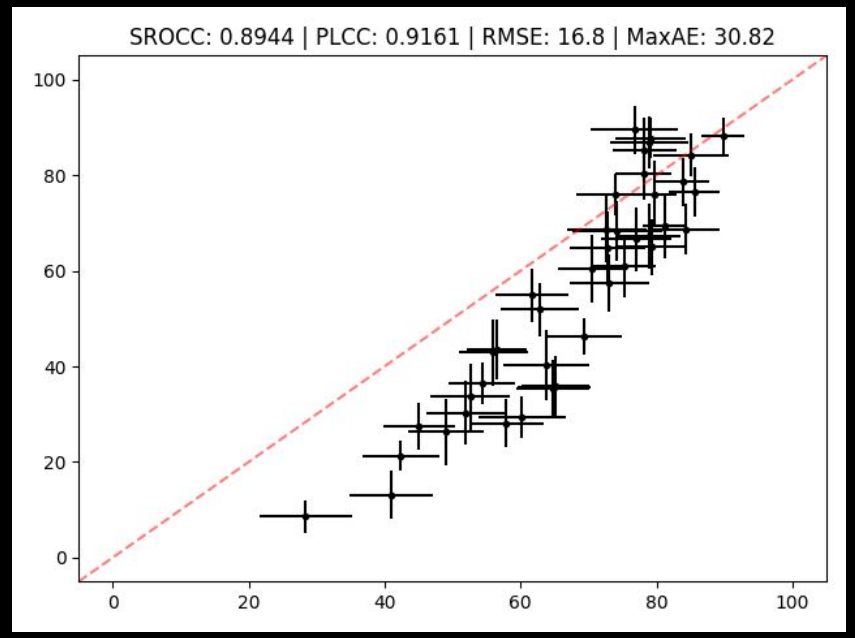
Our expectation is that the overall quality scores will be generally higher than banding annoyance scores.

Reason being that even the most severe banding will not be as annoying as the lowest bitrate videos from VMAF 4K dataset.



Results for the subset of videos from CAMBI 8b dataset show fairly linear relationship between banding annoyance and overall quality.

CAMBI 8b



--- linear fit of the data

- Most scores below 45° line seem to confirm our assumption
- Relationship between banding annoyance and overall quality seems fairly linear

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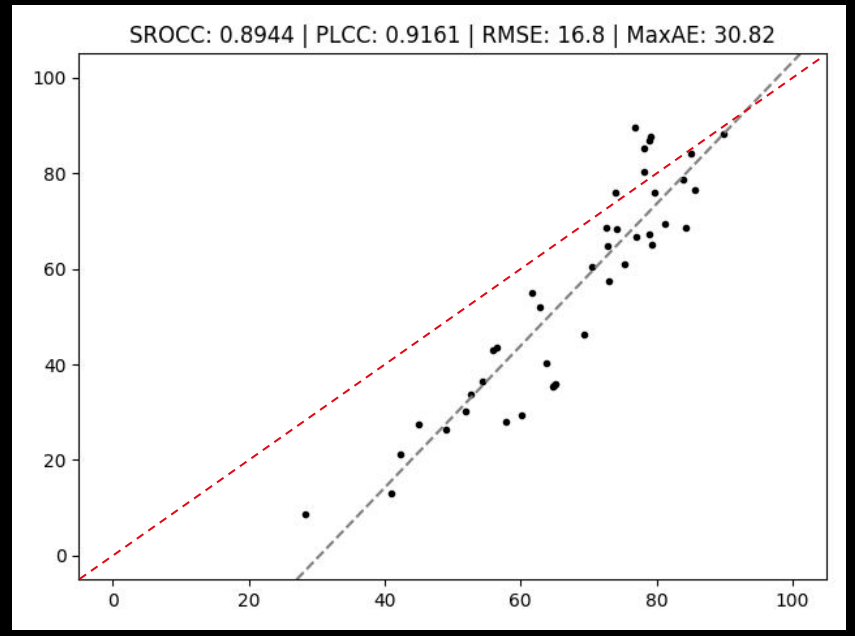
CAMBI 8b



--- linear fit of the data

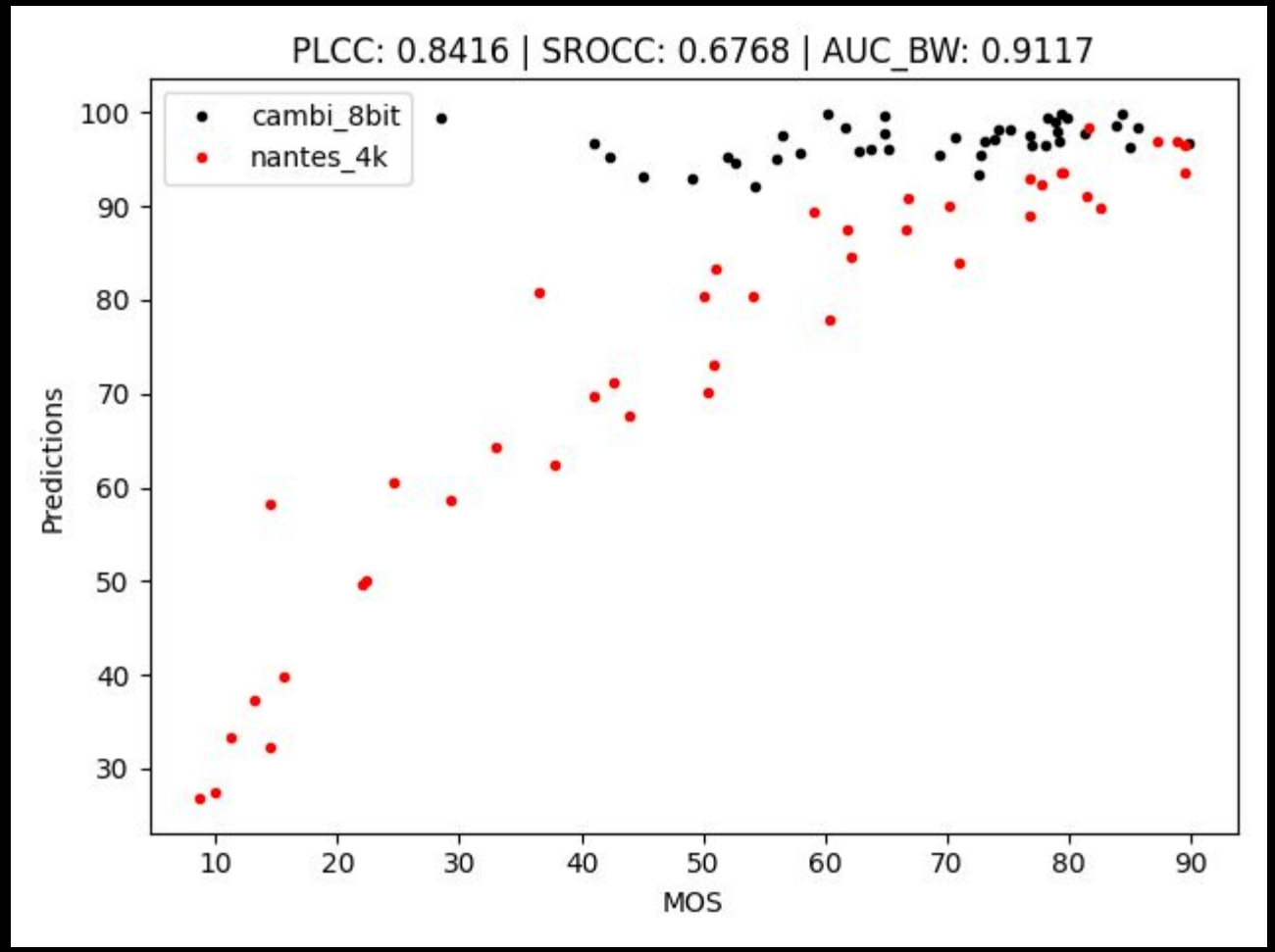
- Most scores below 45° line seem to confirm our assumption
- Relationship between banding annoyance and overall quality seems fairly linear

$VMAF_{BA}$

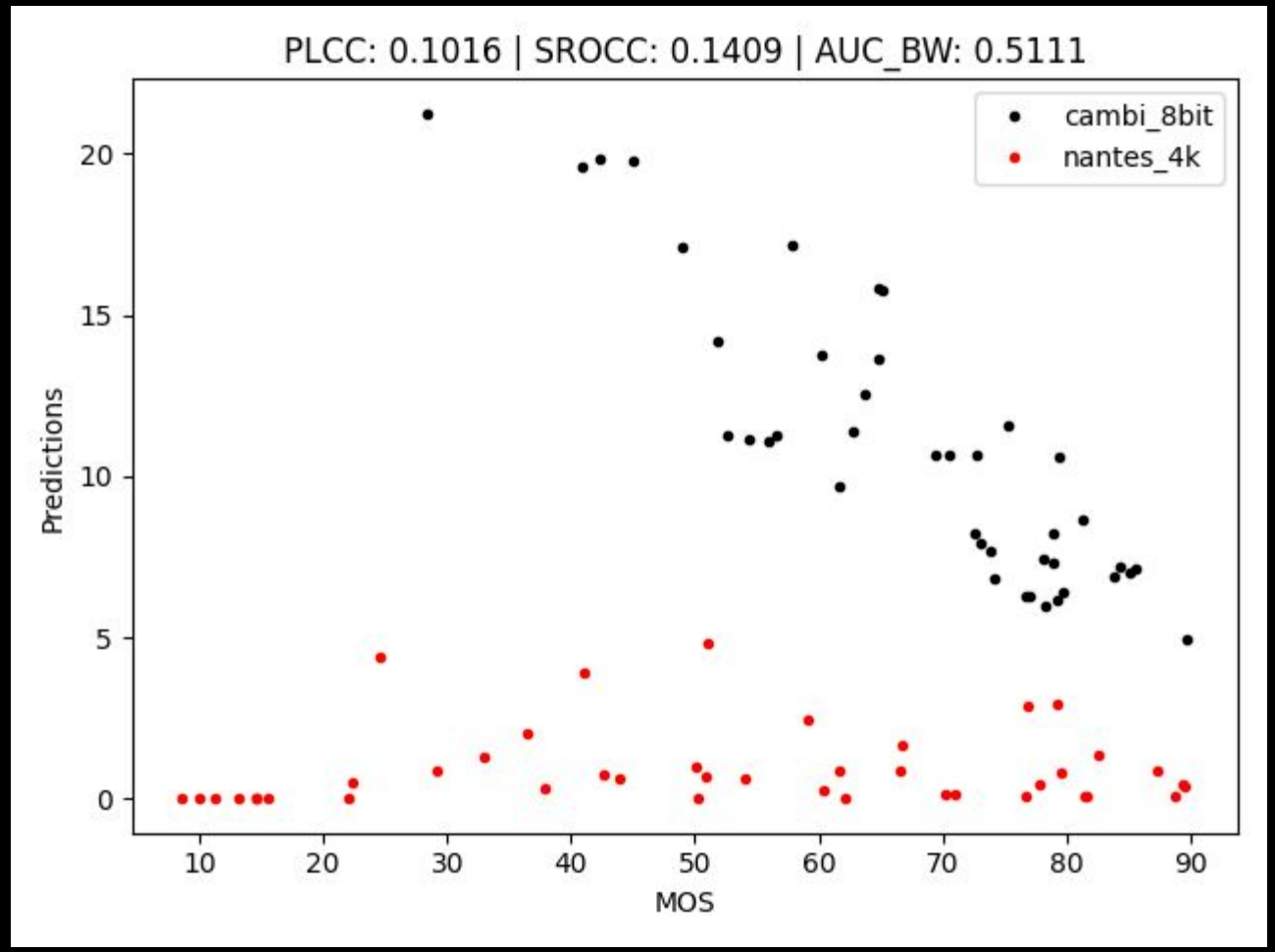
A Banding Aware Quality Metric

Given the aforementioned linear relationship between banding annoyance and overall quality, it may be possible to estimate the quality by a linear combination of VMAF and CAMBI.

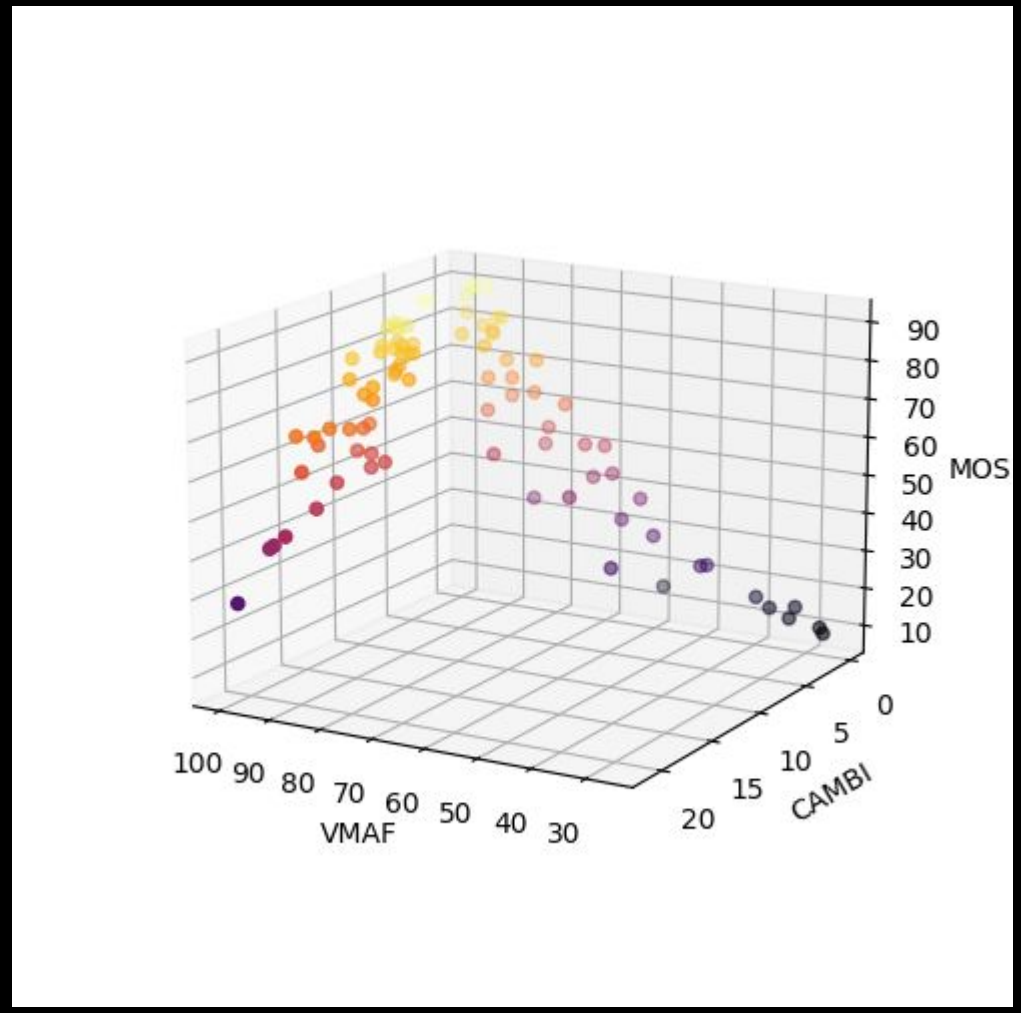
Results for VMAF

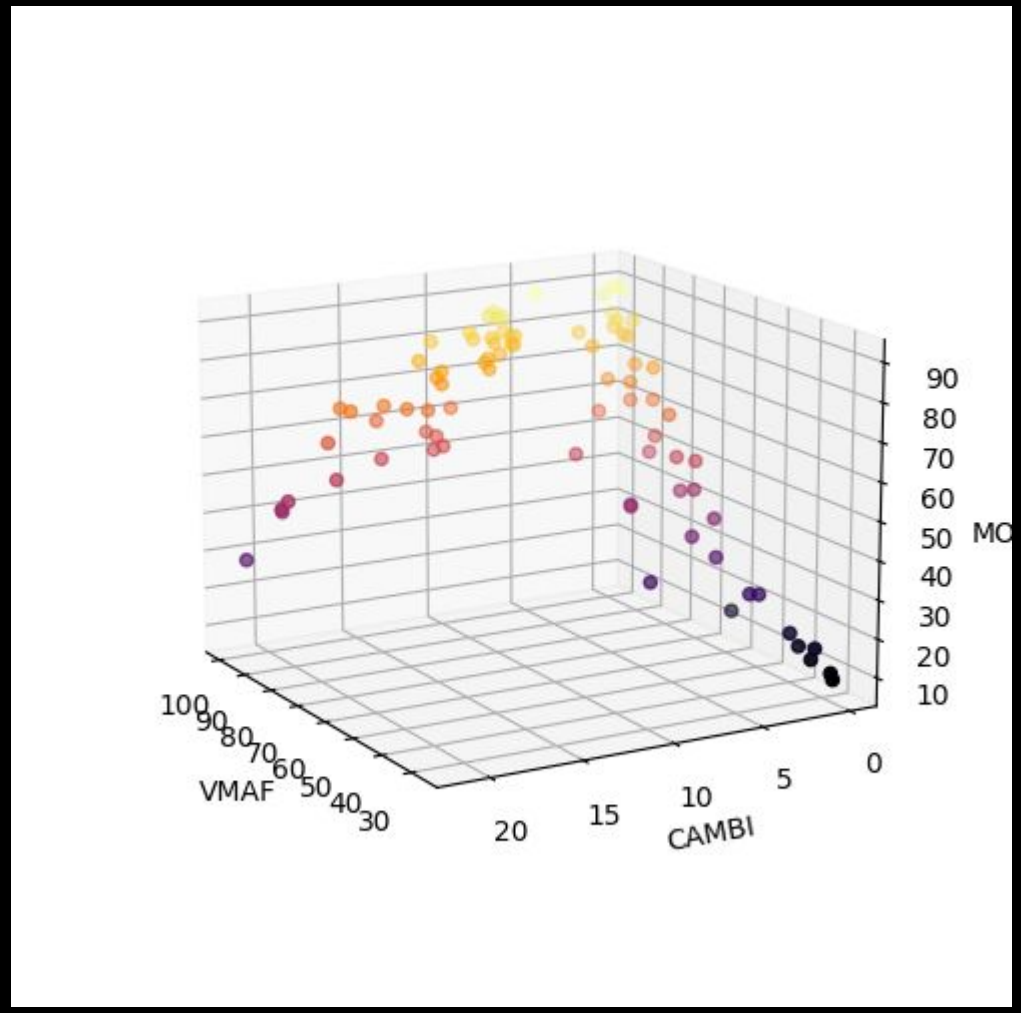


Results for CAMBI



3D plots


90
80
70
60
50
40
30
20
10
MOS
100 90 80 70 60 50 40 30
VMAF
0
5
10
15
20
CAMBI


90
80
70
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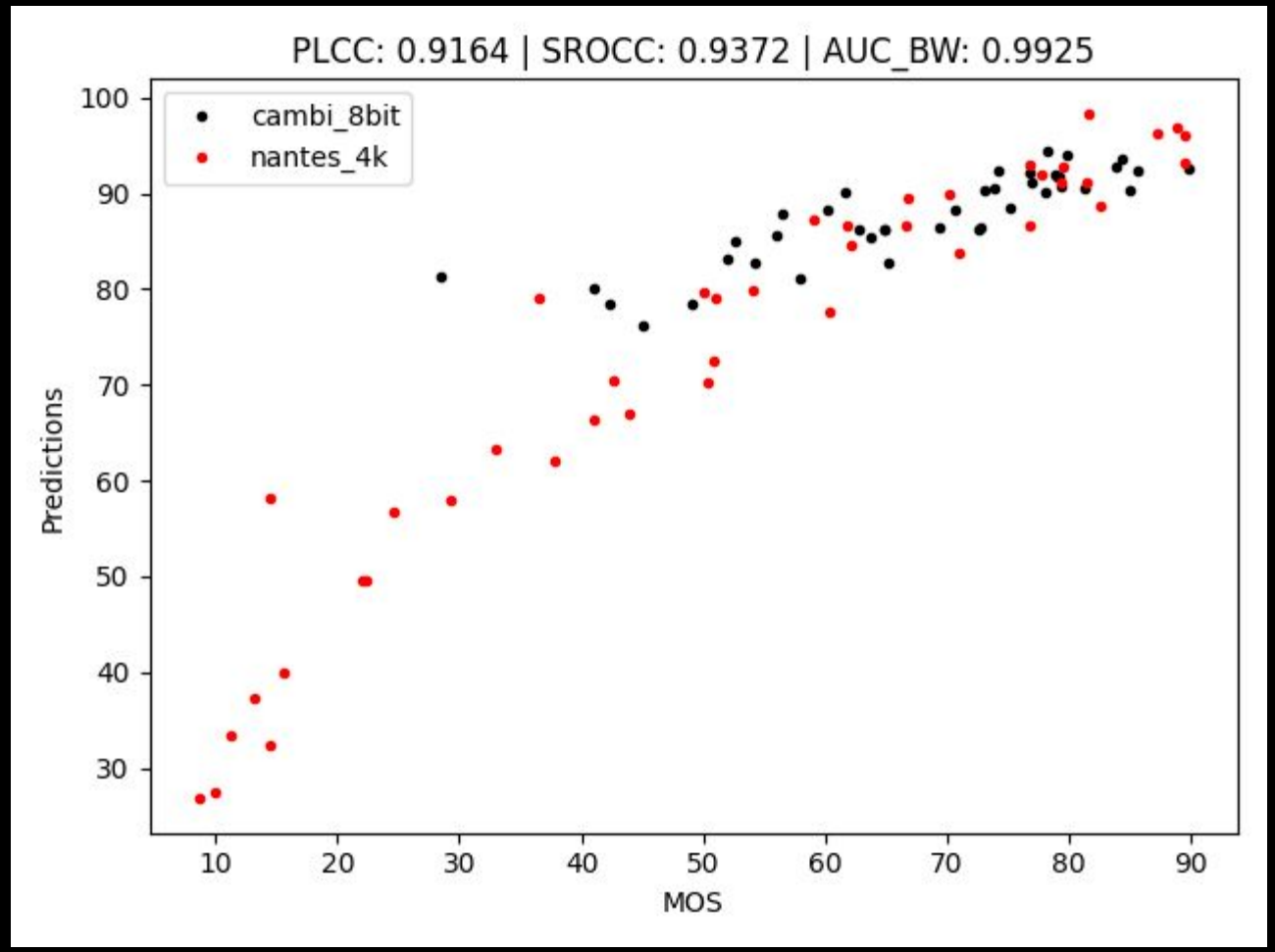
40
30
20
10
MO
100 90 80 70 60 50 40 30
VMAF
0
5
10
15
20
CAMBI

Linear combination (maximizing SROCC)



$$VMAF_{BA} = VMAF - 0.85 * CAMBI$$

$VMAF_{BA}$ can improve VMAF even on datasets not targeting banding directly.

PLCC	VMAF4K [12]	NFLX [2]	VMAF+ [18]	VQEGHD3 [19]	LIVEvideo [20]	LIVEmobile [21]	CSIQVQA [22]
$VMAF_{BA}$	**0.899**	**0.944**	**0.906**	**0.946**	0.700	0.889	0.612
VMAF	0.890	0.937	0.902	0.936	**0.709**	**0.893**	0.608
SSIM	0.708	0.750	0.734	0.879	0.630	0.717	0.712
MS-SSIM	0.605	0.729	0.693	0.871	0.626	0.711	**0.738**
SROCC	VMAF4K [12]	NFLX [2]	VMAF+ [18]	VQEGHD3 [19]	LIVEvideo [20]	LIVEmobile [21]	CSIQVQA [22]
$VMAF_{BA}$	**0.899**	**0.926**	**0.904**	**0.939**	0.719	0.861	0.622
VMAF	0.893	0.922	0.901	0.924	**0.726**	**0.863**	0.615
SSIM	0.751	0.806	0.722	0.904	0.685	0.709	0.698
MS-SSIM	0.625	0.765	0.679	0.895	0.692	0.699	**0.749**

For more information check out:

L. Krasula et al., “Banding vs. Quality: Perceptual Impact and Objective Assessment”, submitted to ICIP 2022, arXiv link

Future work

- Investigation of interaction between heavy compression and heavy banding
- Integration of CAMBI into VMAF as an elementary feature

Thank you!

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