HEIF

High Efficiency Image File Format

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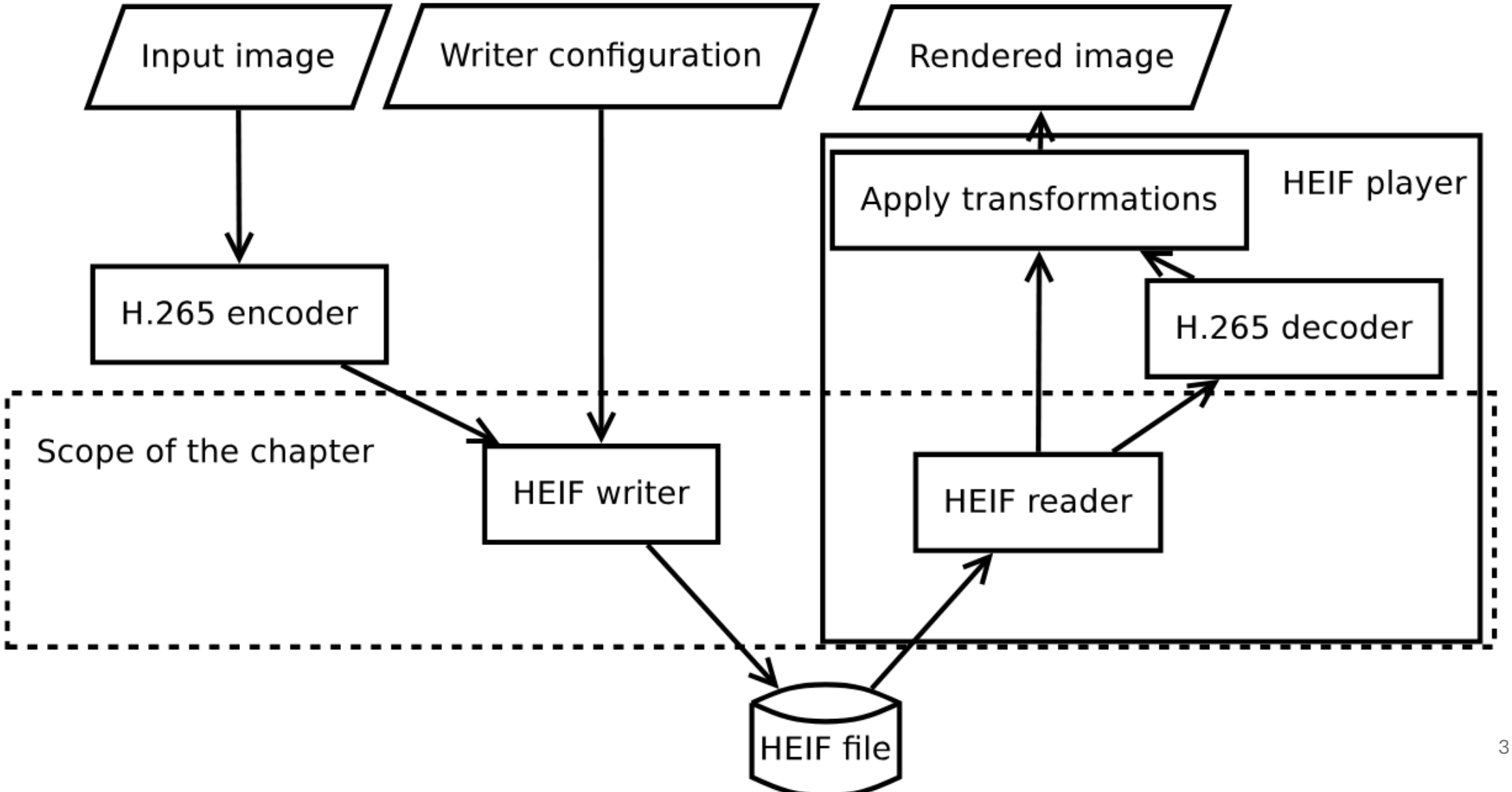
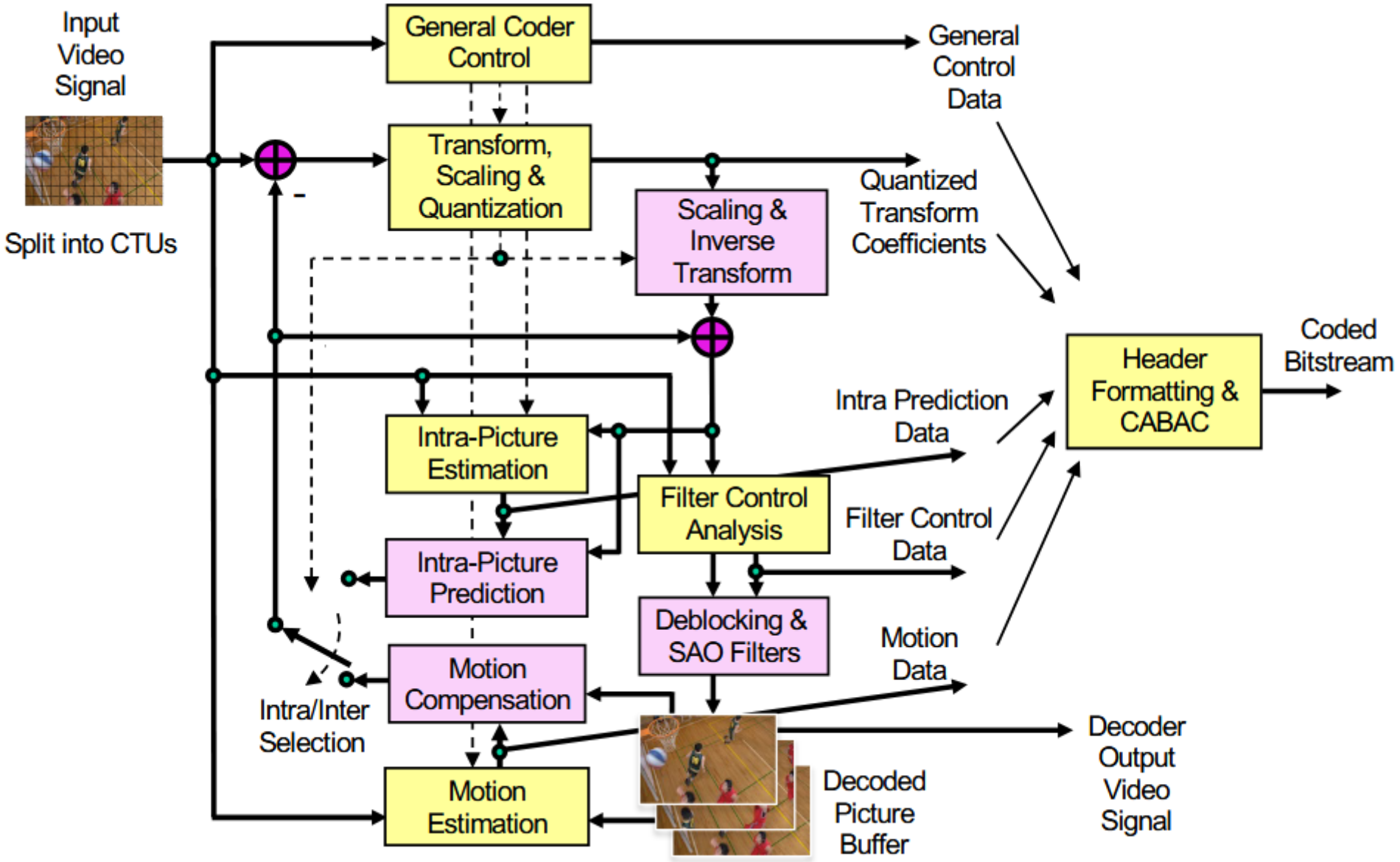
MPEG-H

- Part-2: HEVC (H.265) published in 2013
- Part-12: Image file format (HEIF) published in 2015
- Both developed by ITU-T Video Coding Experts Group and ISO/IEC Moving Picture Experts Group (MPEG)

Block Diagram




Input Video Signal
Split into CTUs
General Coder Control
General Control Data
Transform, Scaling & Quantization
Quantized Transform Coefficients
Scaling & Inverse Transform
Header Formatting & CABAC
Coded Bitstream
Intra Prediction Data
Intra-Picture Estimation
Filter Control Analysis
Filter Control Data
Intra-Picture Prediction
Deblocking & SAO Filters
Motion Data
Motion Compensation
Intra/Inter Selection
Decoder Output Video Signal
Motion Estimation
Decoded Picture Buffer

"ftyp": Declares the Brands Included in the File

"meta": A Container for Boxes that Provide Information About Items

hdlr = "pict"

iref		
type	from	to
"init"	00	01
"init"	03	01
"cdsc"	02	00, 03

dinf

iloc		
id	loc	len
00	x_1	l_1
01	x_2	l_2
02	x_3	l_3
03	x_4	l_4

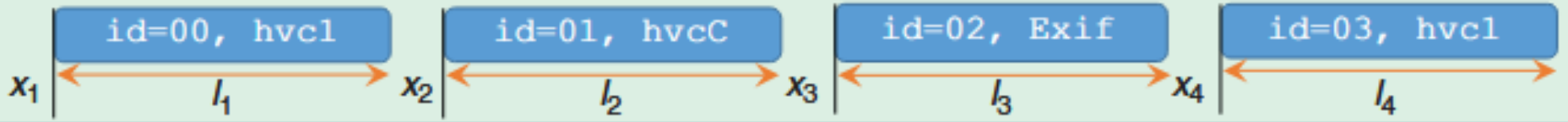
iinf

...

Other Boxes

hdlr: Declare the Format of the Contents of the "meta" Box
iref: Typed References that Link Items Stored in the File
dinf: Declares the Location of Items (in the File or External to the File)
iloc: Locating Items, Their Offsets and Length
iinf: Provide Additional Information About Stored Items

"mdat"/"idat": A Container for Coded Data Bytes



[TABLE 3] A MAPPING OF BRANDS SPECIFIED IN THE HEIF STANDARD TO THE CODING FORMAT, THE TYPE OF THE BRAND (A STILL IMAGE BRAND OR AN IMAGE SEQUENCE BRAND), THE RESPECTIVE MIME SUBTYPE, AND THE RECOMMENDED FILE NAME EXTENSION.

BRAND	CODING FORMAT	TYPE	MIME SUBTYPE	FILE EXTENSION
mif1	ANY	IMAGE	heif	.heif
msf1	ANY	SEQUENCE	heif-sequence	.heif
heic	HEVC (MAIN OR MAIN STILL PICTURE PROFILE)	IMAGE	heic	.heic
heix	HEVC (MAIN 10 OR FORMAT RANGE EXTENSIONS PROFILE)	IMAGE	heic	.heic
hevc	HEVC (MAIN OR MAIN STILL PICTURE PROFILE)	SEQUENCE	heic-sequence	.heic
hevx	HEVC (MAIN 10 OR FORMAT RANGE EXTENSIONS PROFILE)	SEQUENCE	heic-sequence	.heic

Libheif

- Version 1.20.2
- Only support 23008-12:2017 and partially 23008-12:2022
- Developed by Struktur AG and Dirk Farin
- Use libde265 1.0.16 for decoding
- Use x256 for encoding 4.1+1 by MulticoreWare

- Can generate lossless and lossy images

PSNR

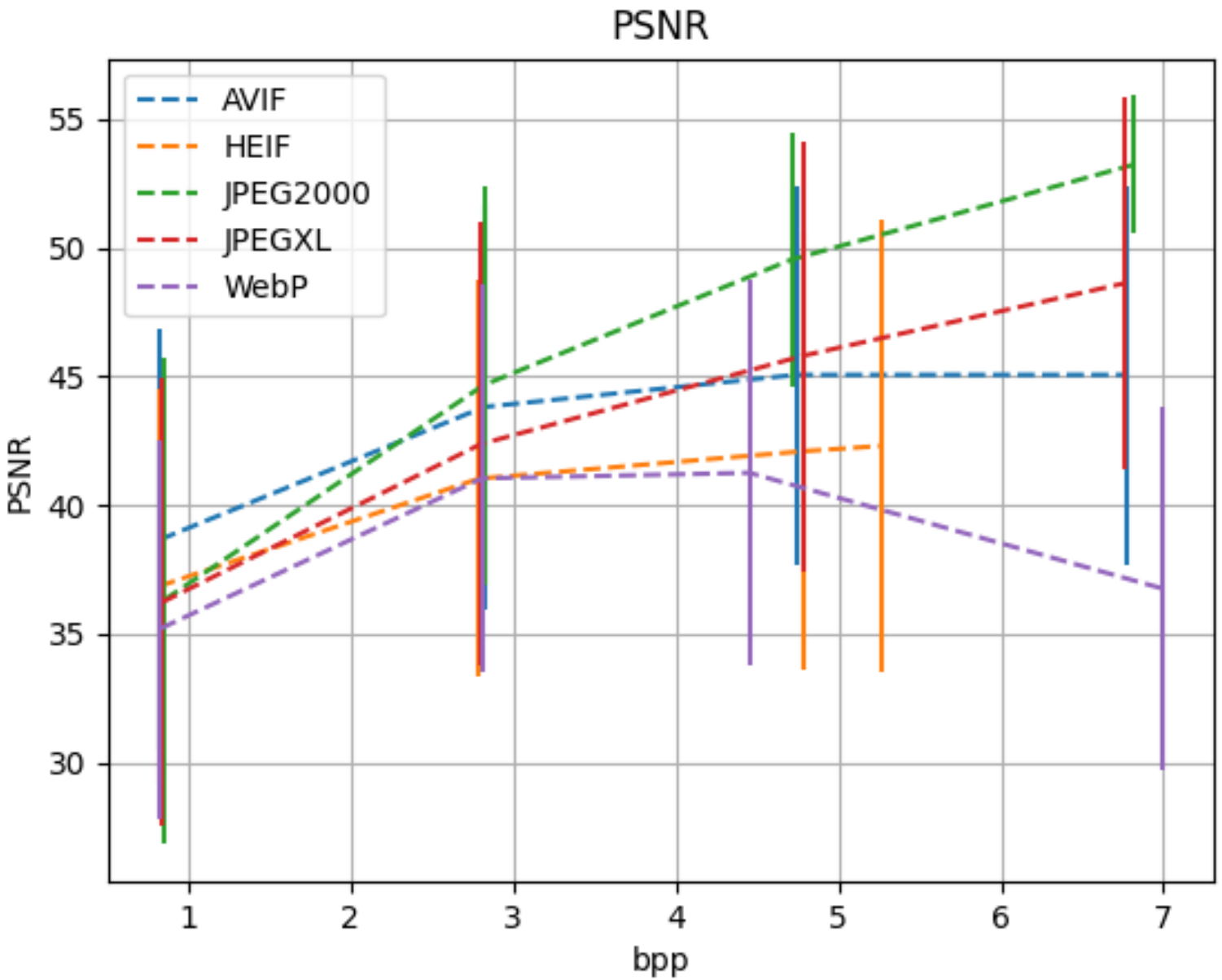
Peak signal-to-noise ratio

$$MSE = \frac{1}{mn}\sum_{i=0}^{m-1}\sum_{j=0}^{n-1}[I(i,j) - K(i,j)]^2$$

```
# Constant for numerical stability
EPS = 1e-8

x = x / float(data_range)
y = y / float(data_range)

if (x.size(1) == 3) and convert_to_greyscale:
    # Convert RGB image to YIQ and take luminance: Y = 0.299 R + 0.587 G + 0.114 B
    rgb_to_grey = torch.tensor([0.299, 0.587, 0.114], device=x.device, dtype=x.dtype).
    view(1, -1, 1, 1)
    x = torch.sum(x * rgb_to_grey, dim=1, keepdim=True)
    y = torch.sum(y * rgb_to_grey, dim=1, keepdim=True)

mse = torch.mean((x - y) ** 2, dim=[1, 2, 3])
score: torch.Tensor = - 10 * torch.log10(mse + EPS)

return _reduce(score, reduction)
```

$$PSNR = 10\ log_{10}\left(\frac{MAX_I^2}{MSE}\right) = 20log_{10}(MAX_I) - 10\ log_{10}(MSE)$$

```
mse1 = np.mean((conv/255-lossless/255)**2)
psnr1 = -10*np.log10(mse1)

mse2 = np.mean((conv-lossless)**2)
psnr2 = 20*np.log10(255)-10*np.log10(mse2)
```


PSNR
AVIF
HEIF
JPEG2000
JPEGXL
WebP
PSNR
55
50
45
40
35
30
1
2
3
4
5
6
7
bpp


00002_853x945.png


00003_945x840.png


00007_1600x1200.png


00009_2048x1536.png


00010_2592x1946.png


apple_tree_1365_2048.png


bridge_1848_1224.png


celebration_2048_1365.png


crosswalk_backlight_2048_1360.png


neon_2048_1365.png

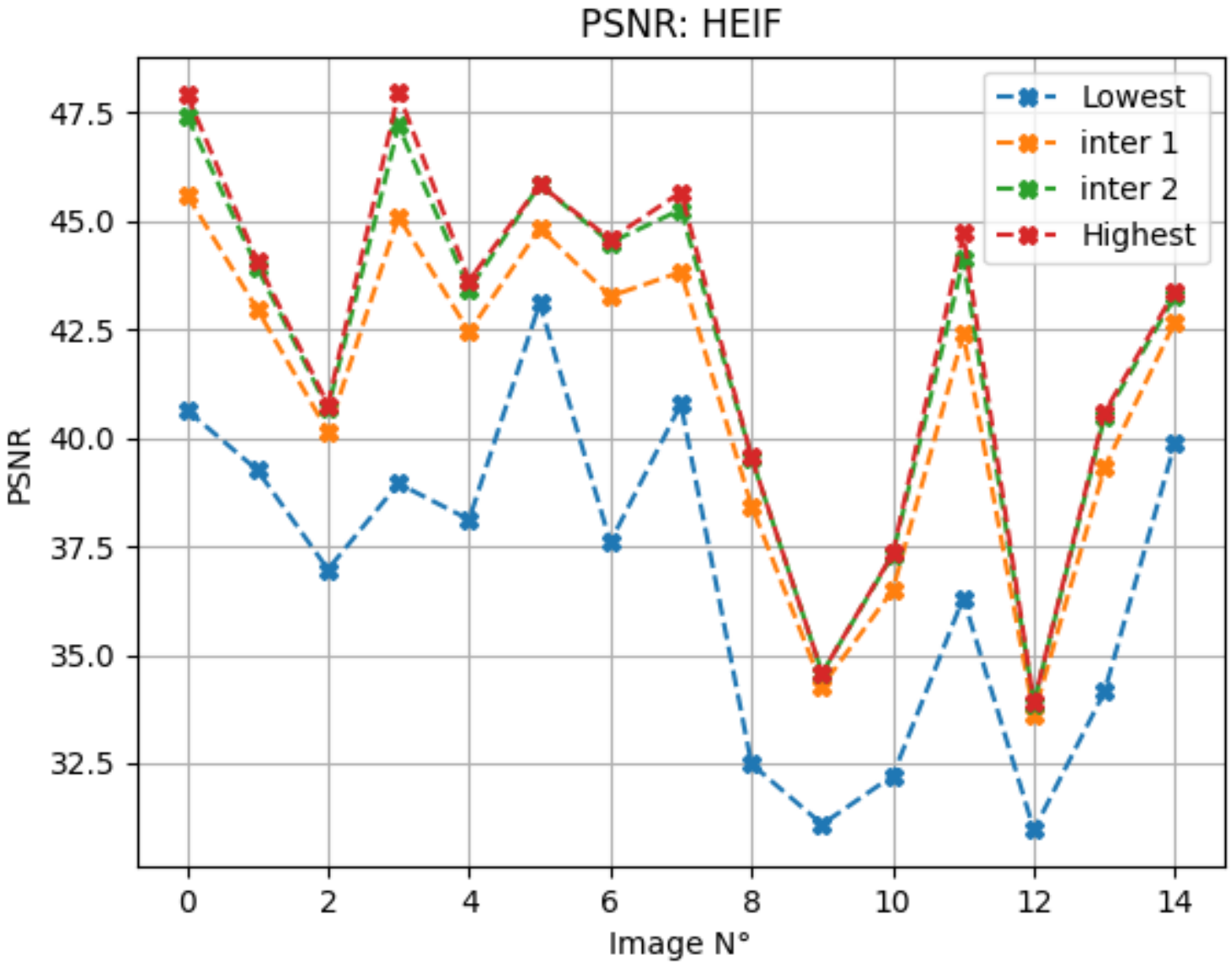

night_event_1463_2048.png

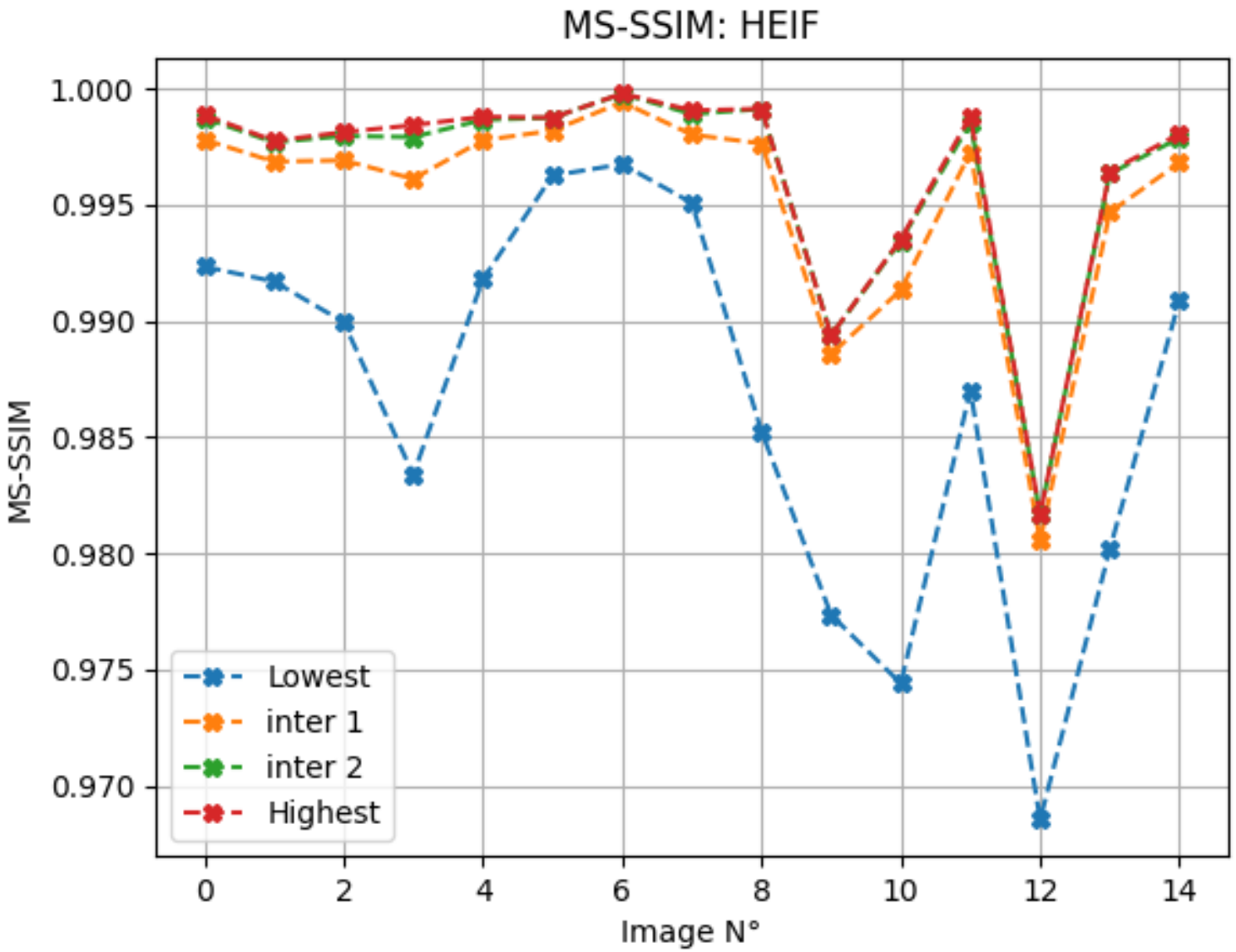

portrait_veil_1391_2048.png

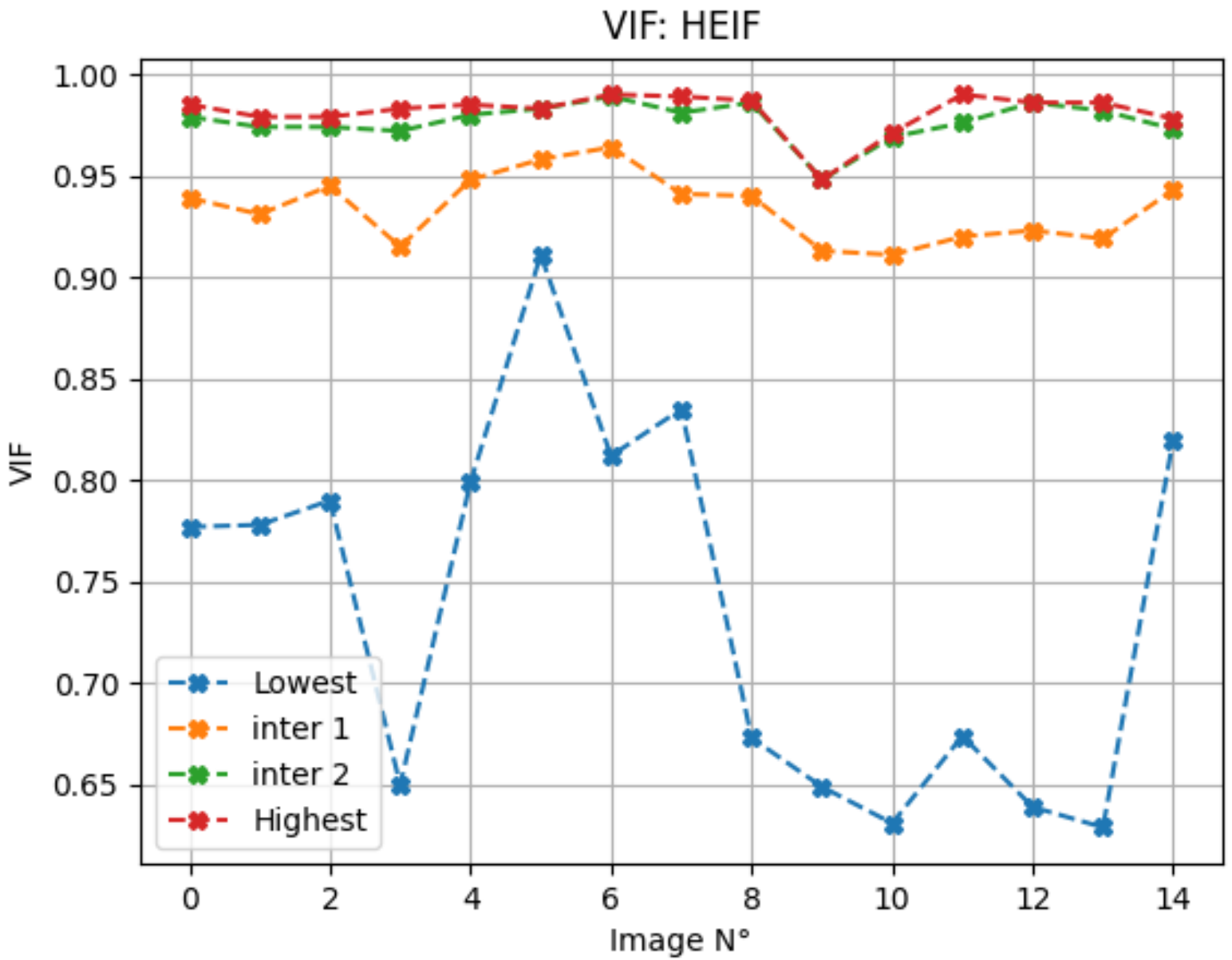

rapeseed_field_2048_1365.png

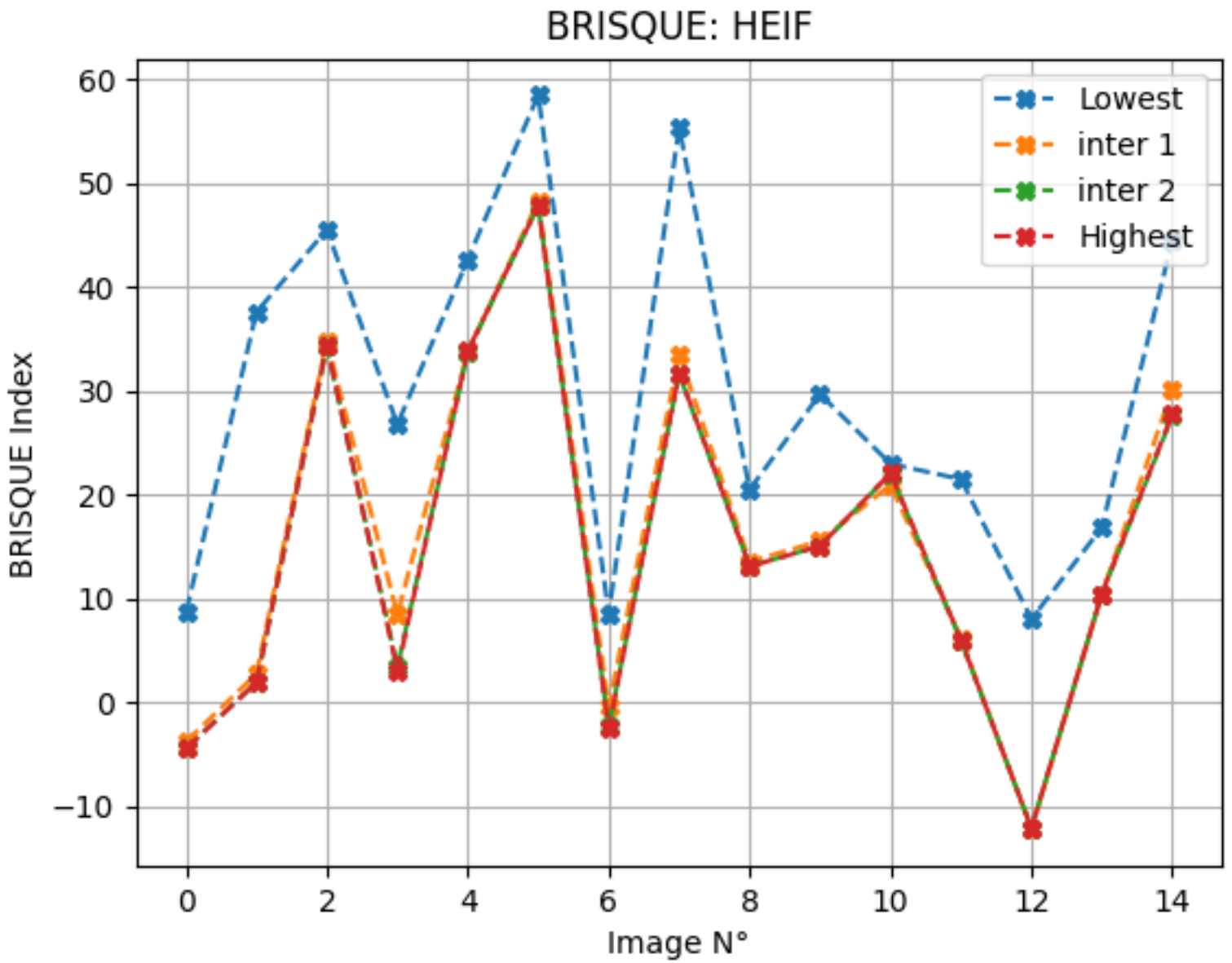

street_dusk_2048_1135.png

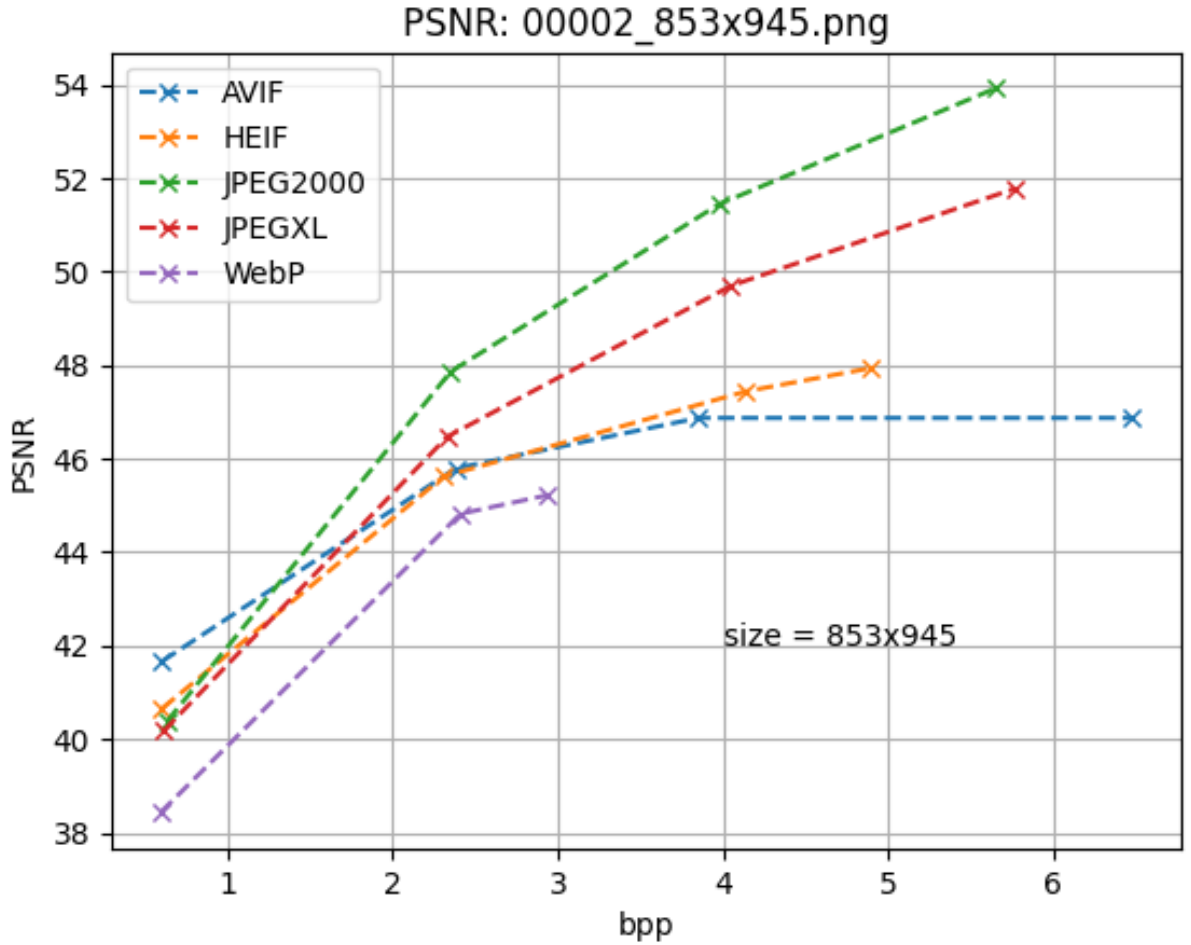

video_game_2048_1152.png

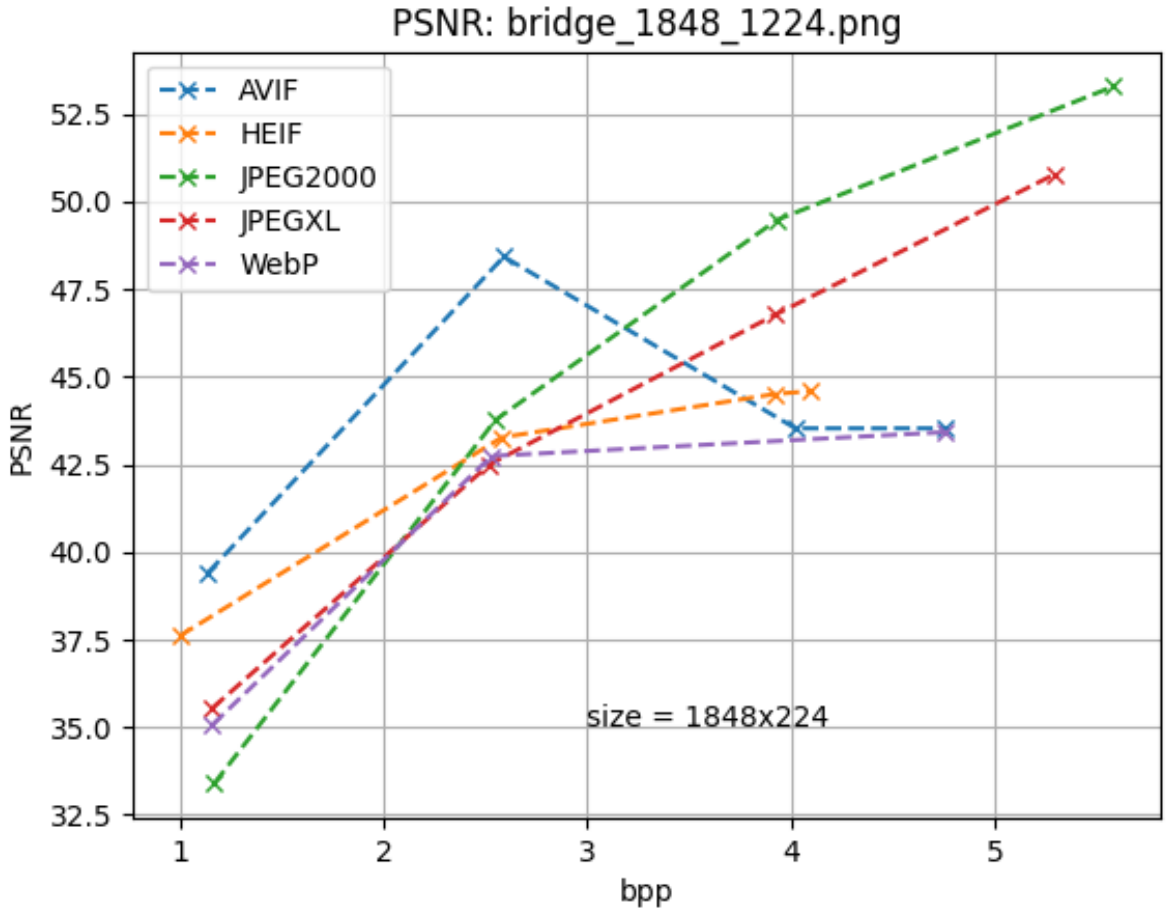

PSNR: HEIF
Lowest
inter 1
inter 2
Highest
PSNR
47.5
45.0
42.5
40.0
37.5
35.0
32.5
0
2
4
6
8
10
12
14
Image N°

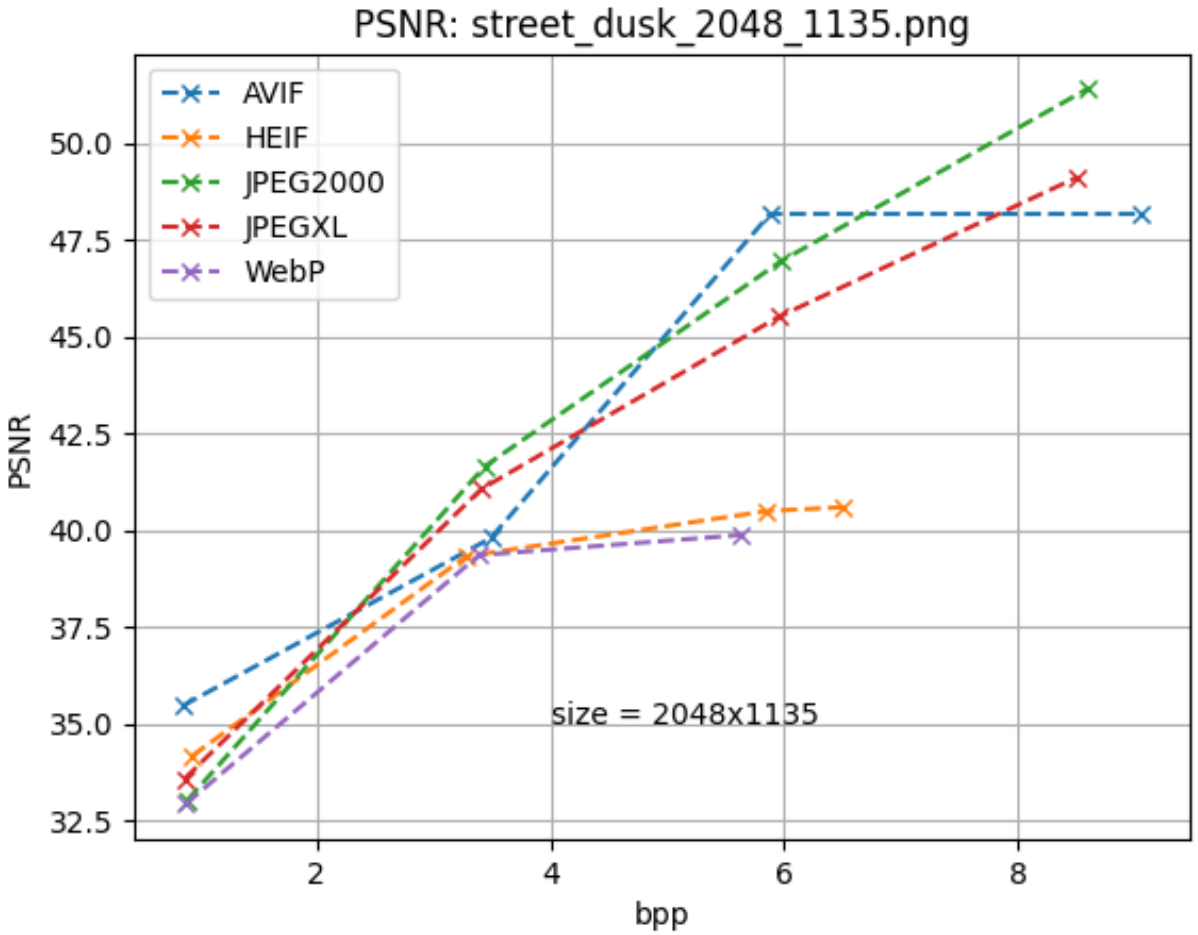

MS-SSIM: HEIF
MS-SSIM
Image N°
1.000
0.995
0.990
0.985
0.980
0.975
0.970
0
2
4
6
8
10
12
14
Lowest
inter 1
inter 2
Highest

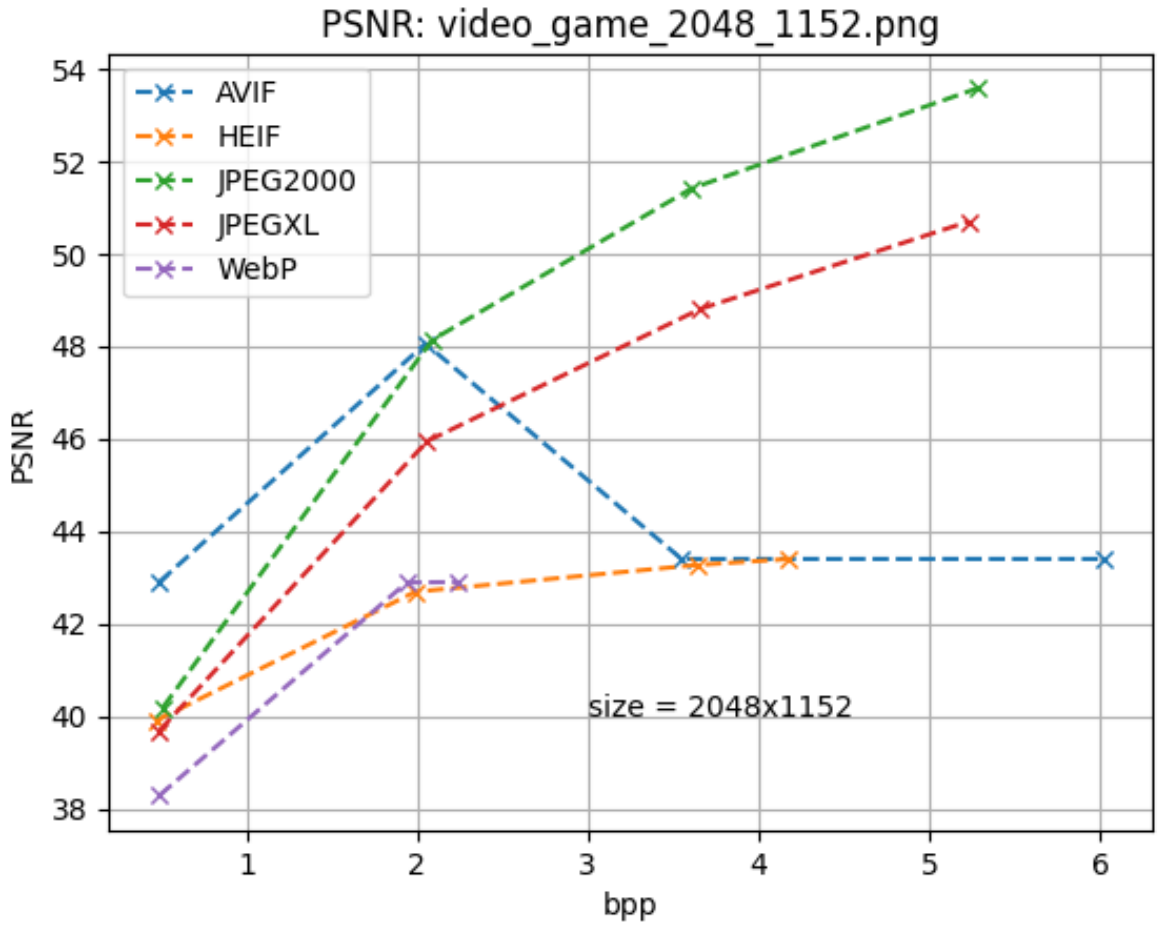

VIF: HEIF
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
VIF
0
2
4
6
8
10
12
14
Image N°
Lowest
inter 1
inter 2
Highest


BRISQUE: HEIF
BRISQUE Index
Image N°
Lowest
inter 1
inter 2
Highest
60
50
40
30
20
10
0
−10
0
2
4
6
8
10
12
14


PSNR: 00002_853x945.png
AVIF
HEIF
JPEG2000
JPEGXL
WebP
size = 853x945
PSNR
bpp
54
52
50
48
46
44
42
40
38
1
2
3
4
5
6


PSNR: bridge_1848_1224.png
AVIF
HEIF
JPEG2000
JPEGXL
WebP
52.5
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
PSNR
1
2
3
4
5
bpp
size = 1848x224


PSNR: street_dusk_2048_1135.png
AVIF
HEIF
JPEG2000
JPEGXL
WebP
50.0
47.5
45.0
42.5
40.0
37.5
35.0
32.5
PSNR
2
4
6
8
bpp
size = 2048x1135


PSNR: video_game_2048_1152.png
AVIF
HEIF
JPEG2000
JPEGXL
WebP
size = 2048x1152
PSNR
bpp
54
52
50
48
46
44
42
40
38
1
2
3
4
5
6

Conclusion

- Smaller than JPEG
- Worse than JPEG2000 and JPEG XL
- 1s for encoding
- 0.75s for decoding in png