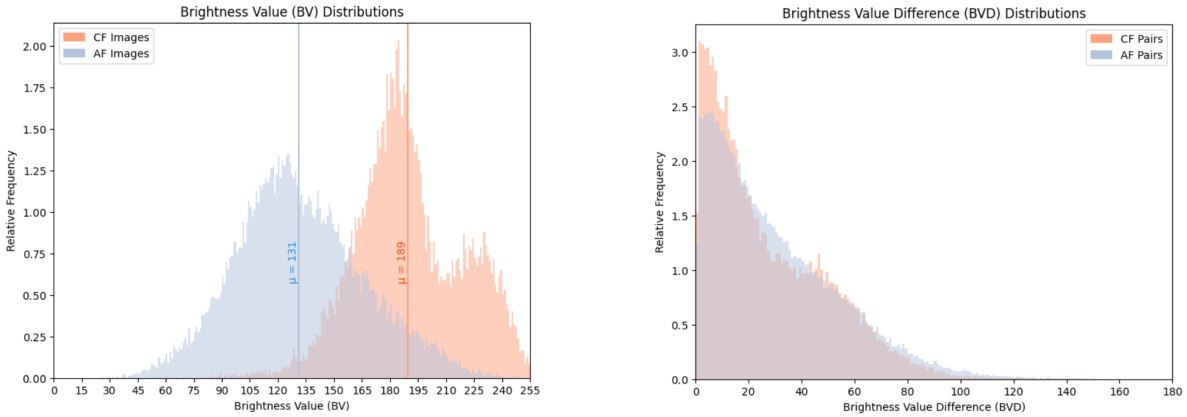
Lights, Camera, Matching:
The Role of Image Illumination in Fair Face Recognition
Supplementary Material

Gabriella Pangelinan[1], Grace Bezold[2], Haiyu Wu[2], Michael C. King[1], Kevin W. Bowyer[2]
[1]Florida Institute of Technology
Melbourne, FL, USA
gpangelinan@my.fit.edu
michaelking@fit.edu
[2]University of Notre Dame
Notre Dame, IN
{gbezold,hwu6}@nd.edu
kwb@nd.edu

1. Brightness Value Difference (BVD)

Each image is assigned a brightness value (BV) based on the median pixel value of the face skin region. Fig. 1a shows the distributions of BV values for CF / AF images. We use the BV values to calculate BVD for each pair. The distributions of BVD values for CF / AF pairs are shown in Fig. 1b.



(a) BVs for CF / AF Images.

(b) BVDs for CF / AF Pairs.

Figure 1. BV and BVD distributions.

The full results of the BVD experiment are shown in Tab. 1. For each balanced N Top Pairs subset, we report the mean similarity score ("Score $\bar{x}_b$"), shift in $\bar{x}_b$ vs. the baseline mean score ("Score $\bar{x}_b$" Shift), d' between CF-AF, d' shift vs. the baseline d', as well as mean / std. dev / min. / max. BVD value for each subset.

Table 1. Full results for BVD Experiment.

Balancing Factor: Brightness Value Difference (BVD)									
N Top Pairs	**Dem**	**Score** $\bar{x}_b$	**Score** $\bar{x}_b$ **Shift**	**d'**	**d' Shift**	**BVD** $\bar{x}_b$	**BVD STD**	**BVD Min**	**BVD Max**
10k	CF	0.7468	3.66%	0.3925	-24.23%	4.965	2.977	0	10
	AF	0.7758	2.03%						
9k	CF	0.7473	3.73%	0.3885	-25.00%	4.434	2.645	0	9
	AF	0.776	2.05%						
8k	CF	0.7474	3.75%	0.3881	-25.08%	3.914	2.327	0	8
	AF	0.7761	2.06%						
7k	CF	0.7482	3.86%	0.3801	-26.62%	3.411	2.031	0	7
	AF	0.7763	2.09%						
6k	CF	0.7484	3.89%	0.3728	-28.03%	2.913	1.743	0	6
	AF	0.776	2.05%						
5k	CF	0.7494	4.03%	0.3605	-30.41%	2.417	1.457	0	5
	AF	0.7761	2.06%						
4k	CF	0.7495	4.04%	0.3583	-30.83%	1.931	1.189	0	4
	AF	0.7761	2.06%						
3k	CF	0.7497	4.07%	0.3368	-34.98%	1.445	0.928	0	3
	AF	0.7751	1.93%						
2k	CF	0.749	3.97%	0.3351	-35.31%	0.964	0.69	0	2
	AF	0.7742	1.81%						
1k	CF	0.7506	4.19%	0.2756	-46.80%	0.486	0.5	0	1
	AF	0.7712	1.42%						

2. Brightness Distribution Modality (BDM)

In order to provide modality labels to each image, we analyzed its distribution using parameters for smoothing window (SW) and relative threshold (RT).

First, we overlaid a smooth curve on top of the binned histogram of pixel values (representing the face region). The SW parameter determines the number of adjacent bins to average over when smoothing. A smaller SW value (e.g. 1-2) is more reflective of the original histogram shape, allowing for detection of more subtle features. A larger SW value (e.g. 9-10) yields a smoother curve that may reduce noise, but may also obscure smaller peaks in the data.

The RT parameter determines the minimum height a peak occurring in the smooth curve must be to be considered "significant". Its value is given as a fraction of the maximum count in the smoothed histogram. A lower RT value (e.g. 0.05) is useful for data with many minor (but important) fluctuations, but may detect noise as peaks. A higher RT value (e.g. 0.5) focuses on the distribution's major features. We use the RT value to label peaks on the smoothed curve.

We tested multiple combinations of SW / RT value and manually checked the results. We ultimately selected SW = 4 and RT = 0.5.

The plots in Fig. 2 overlay the pixel distributions of Uni / Bi / Multi images. All plots have the same scaling for the y-axis (relative frequency).

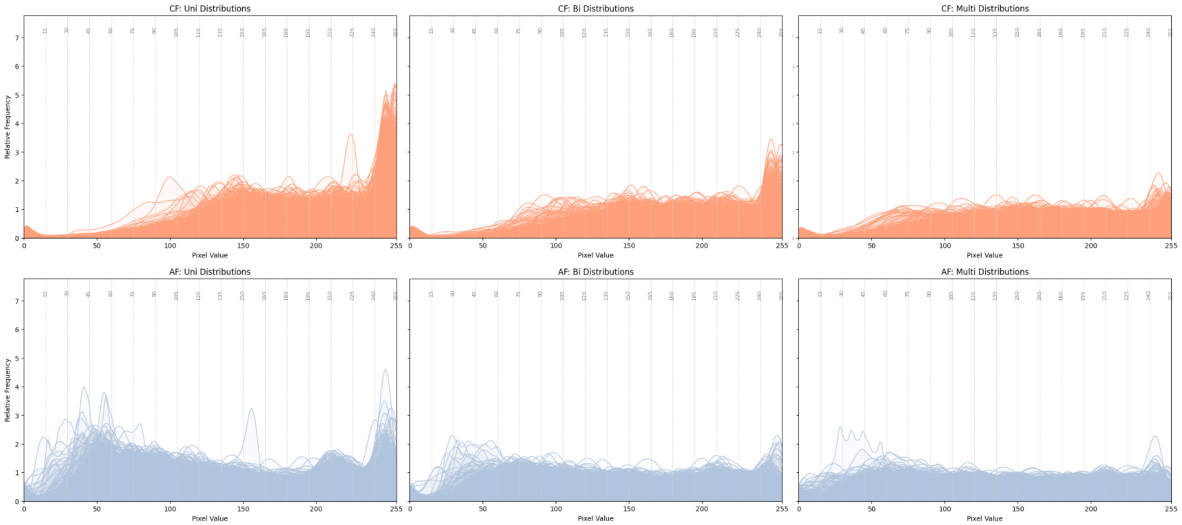
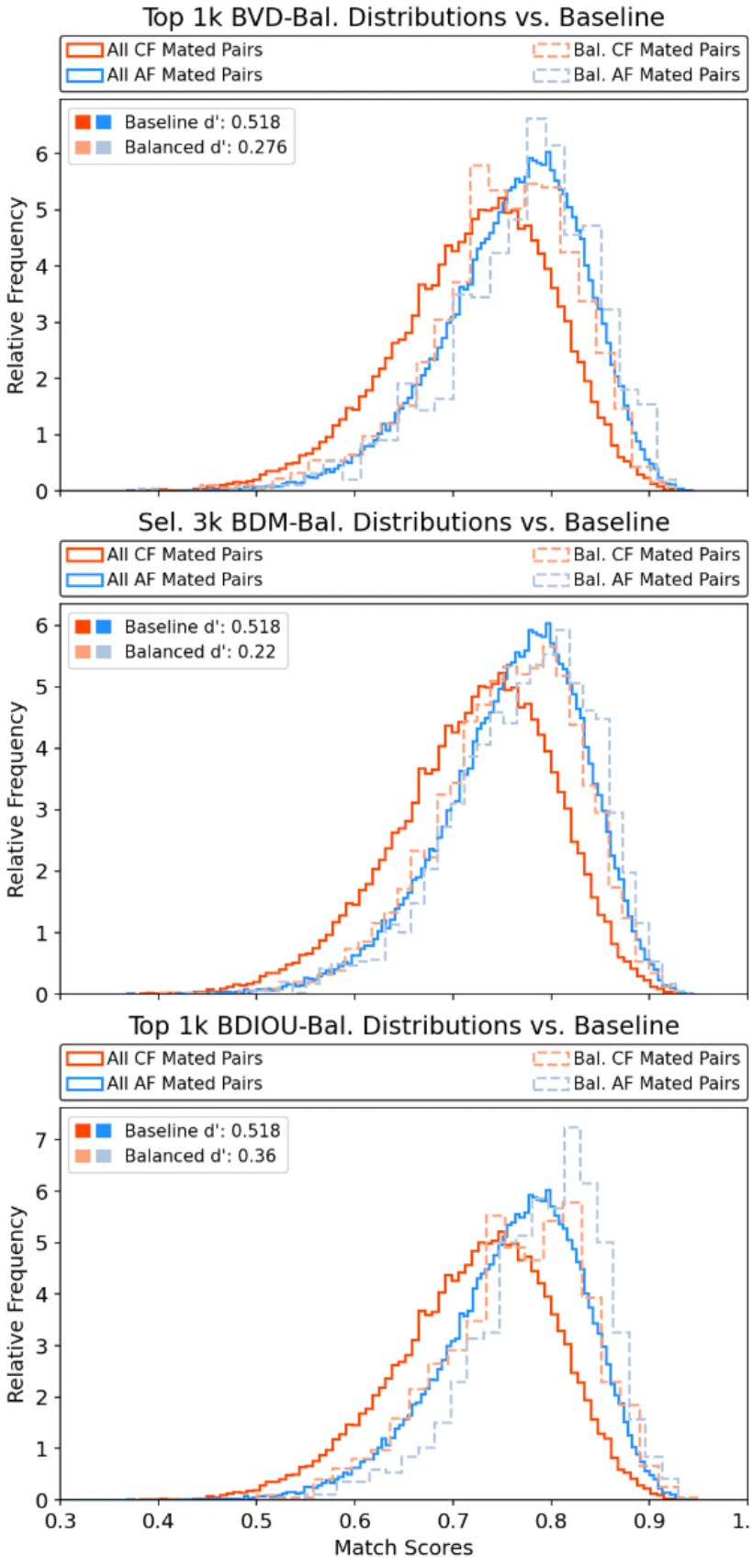


Figure 2. Relative frequency distributions of pixel values for Uni, Bi, and Multi images.

3. Comparison of Best Results

The plots on the next page show the baseline and balanced distributions corresponding to Table 6 in the paper.


Top 1k BVD-Bal. Distributions vs. Baseline
All CF Mated Pairs
All AF Mated Pairs
Bal. CF Mated Pairs
Bal. AF Mated Pairs
Baseline d': 0.518
Balanced d': 0.276
Relative Frequency
Sel. 3k BDM-Bal. Distributions vs. Baseline
All CF Mated Pairs
All AF Mated Pairs
Bal. CF Mated Pairs
Bal. AF Mated Pairs
Baseline d': 0.518
Balanced d': 0.22
Relative Frequency
Top 1k BDIOU-Bal. Distributions vs. Baseline
All CF Mated Pairs
All AF Mated Pairs
Bal. CF Mated Pairs
Bal. AF Mated Pairs
Baseline d': 0.518
Balanced d': 0.36
Relative Frequency
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Match Scores