EUCLID MORPHOLOGY CHALLENGE
Morfometryka Results

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1 Morfometryka

Morfometryka is a python 3.8 algorithm designed to perform several photometric and morphometric measurements on a galaxy image in an automated way with no user interaction [Ferrari et al., 2015]. The inputs are the galaxy image stamp and respective point spread function (PSF) image. It then measures the background in an iterative way, segmentates the image – separating galaxy, other objects and background – and measure basic geometric parameters of the segmented region, like the centre, the position angle, major and minor axis (see Fig. 3 for an example of an output result from Morfometryka). Based on this information, it performs aperture photometry on similar ellipses from the centre up to 2Rp (the Petrosian radius). The brightness profile I(R) is the azimuthally averaged value of the ellipses aforementioned; To the I(R) it adjusts a 1D Sersic profile. Then, the 1D profile parameters are used as initial guesses to the fit of a 2D profile onto the image itself.

Originally, Morfometryka did not feature component decomposition for multiple components. However, we are in the process of developing an automated process based on the idea of the curvature of the brightness profile [Lucatelli and Ferrari, 2019]. We had the goal to have it ready for the challenge, but unfortunately, our new feature is not production ready yet and still needs more work. However, we still aim to provide decomposition results for the next deadline. At this moment we provide Morfometryka outputs for the measurements required **only** for the Single Sersic case.

2 Pipeline and Computer Resources

For each field, we run SExtractor using the input positions for sources with $\sigma > 5$ as an ASSOC catalog to get a size estimate for the cutouts. Then, we created square cutouts with 3 Petrosian Radius length for each detection, both for the science image and the RMS map. Then, our Morfometryka runs were done using an Intel(R) Xeon(R) CPU E5-2640 v3 @ 2.60GHz shared 32-core workstation running 16 jobs in parallel at any given time. The wall time was roughly 920 min per field.

3 Single-Sersic

For the reference field, FIELD4, we provide the following visualizations for the Sérsic Index (n, Fig.1). Half-light semi-major axis (R_n, Fig.2). Mag measured by total flux within the Petrosian region (MAG, Fig.3). Axis ratio (q, Fig.4) and Position Angle (PA, Fig.5). These plots were made filtering all Quality Flags in the fits tables, removing non-detections, convergence problems and low SNR objects (57197 out of 75717).

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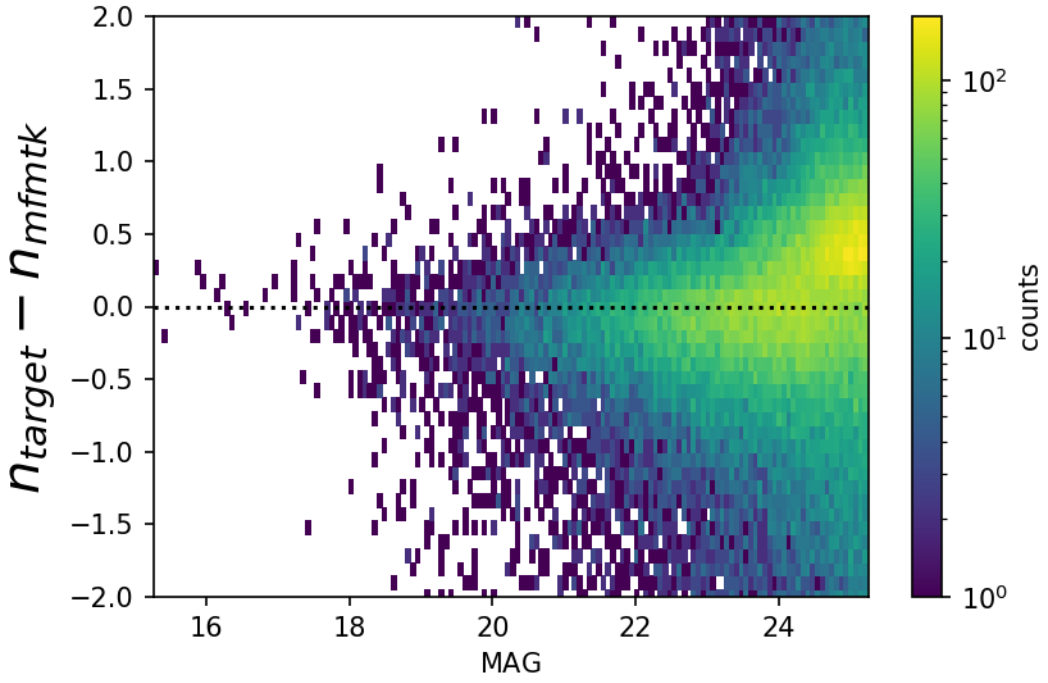

Figure 1: 2D Histogram of $\Delta(n)$ with respect to the MAG for the sources in FIELD4

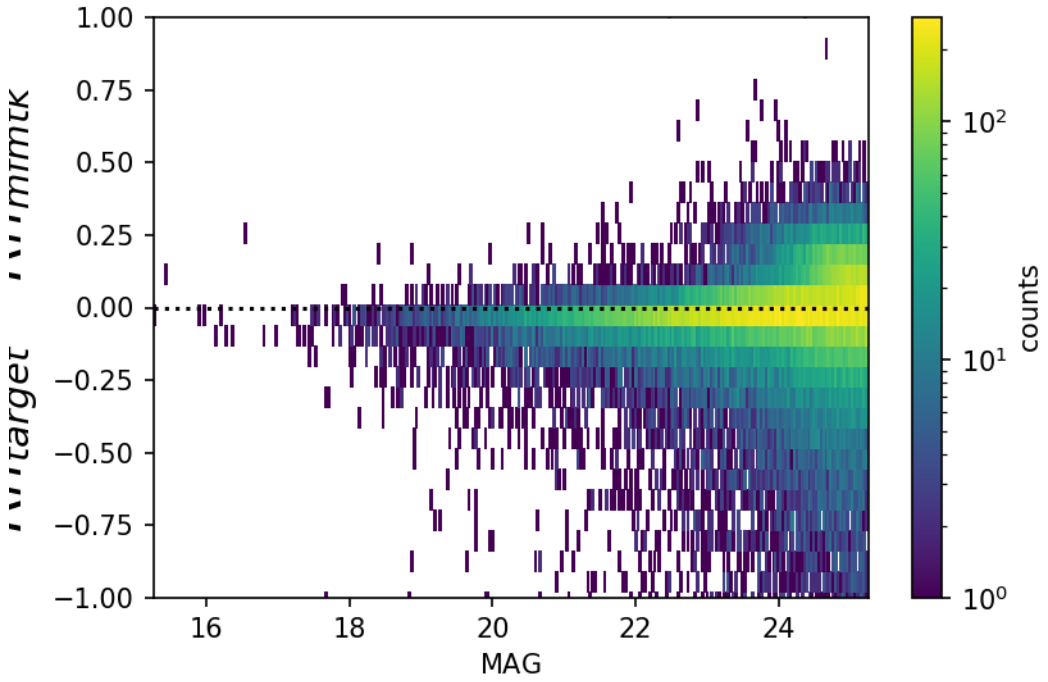

Figure 2: 2D Histogram of $\Delta(R_n)$ with respect to the MAG for the sources in FIELD4

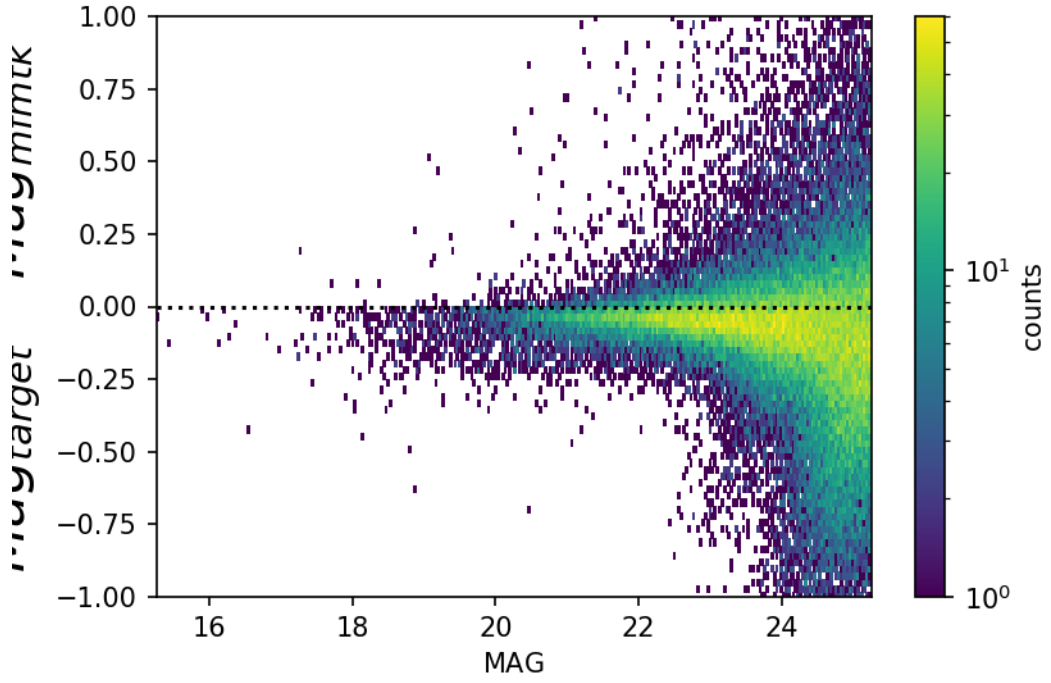

Figure 3: 2D Histogram of $\Delta(MAG)$ with respect to the MAG for the sources in FIELD4

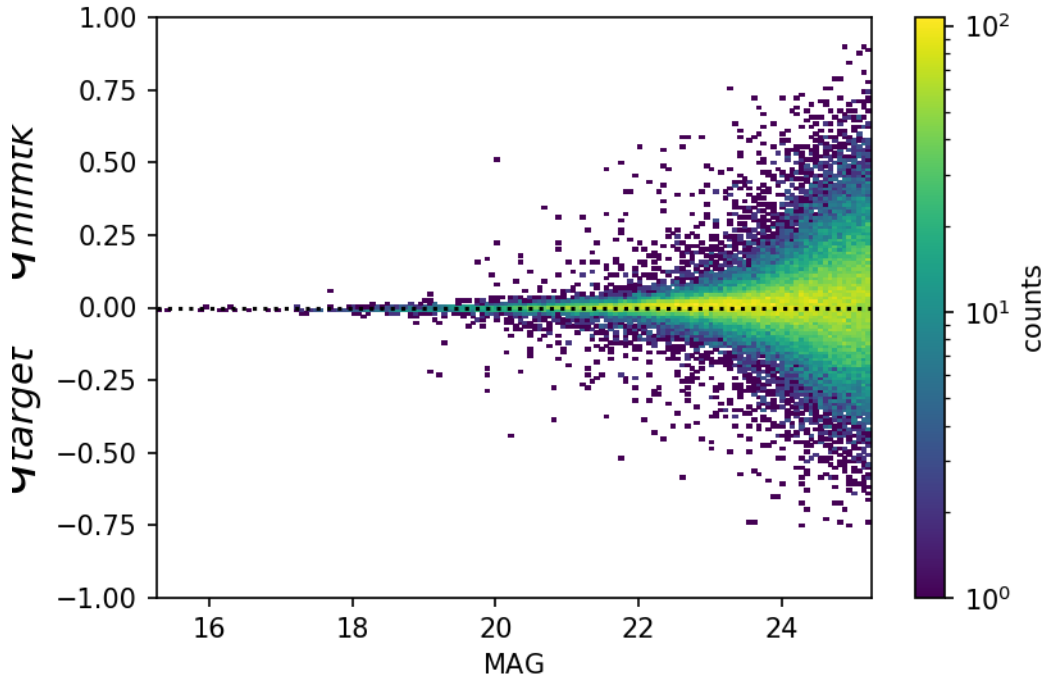

Figure 4: 2D Histogram of $\Delta(q)$ with respect to the MAG for the sources in FIELD4

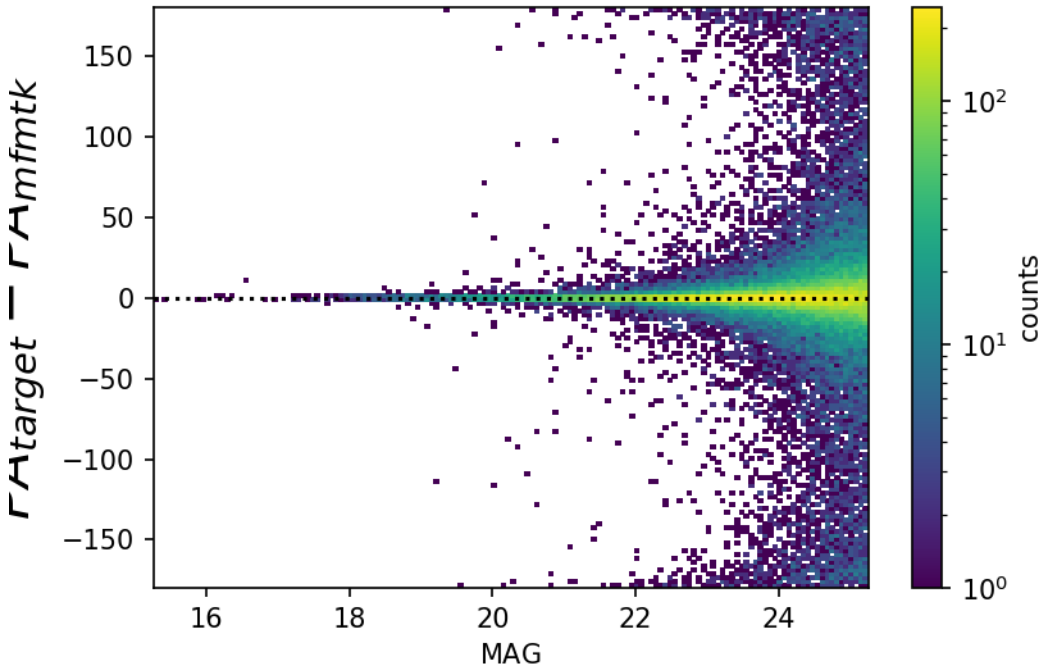

Figure 5: 2D Histogram of $\Delta(PA)$ with respect to the MAG for the sources in FIELD4

4 Outputs

We provide fits tables for each Single-Sersic FIELD. Each field contains:

- 'ID'
- 'X' and 'Y' as per inputs
- 'nFit2D' and 'nerr' – Sersic index and its uncertainty
- 'RnFit2D' and 'Rnerr' – Half-light radius and its uncertainty
- 'Rp' – Petrosian Radius
- 'LT' and 'LTerr' – Total flux within the Petrosian Region and its uncertainty
- 'InFit2D' and 'Inerr' – Flux at RnFit2D and its uncertainty
- 'qFit2D' and 'qerr' – Axis ratio and its uncertainty
- 'PAFit2D' and 'PAerr' – Position Angle and its uncertainty

The tables contain also four quality flags:

- QF_CONVERGENCE – True when Morfometryka failed to converge for a profile fit.
- QF_FAULTY$_{\mathrm{R}}$UN – True when Unexpected error found during the run. Possible: No segmentation region, no detectable source.
- QF_NOT_SEXTRACTED – True when SExtractor did not find the source in the ASSOC catalog.
- QF_INCOMPLETE_BADCUTOUT – True when source size bigger than image. Faulty profile or bad cutout.

5 Issues

We had a small issue with the PSF where it displayed null edges. When it was used by Morfometryka, the edges caused the PSF to assume a non-symmetric position relative to the image sampling (85, 86). To avoid this problem we re-centered it and re-normalized it to (83, 83).

References

F. Ferrari, R. R. de Carvalho, and M. Trevisan. Morfometryka—A New Way of Establishing Morphological Classification of Galaxies. , 814(1):55, November 2015. doi: 10.1088/0004-637X/814/1/55.

Geferson Lucatelli and Fabricio Ferrari. Galaxy structural analysis with the curvature of the brightness profile. , 489(1):1161–1180, October 2019. doi: 10.1093/mnras/stz2154.