Morfometryka and the search for constraints on galaxy morphometry

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How can we **measure** galaxy **structure** and **morphology**?

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Via Parametric Morphology (Photometry)

- Sérsic Profiles (n, R_n, I_n) (Sérsic 1967)

Via Non-Parametric Morphology (Morphometry)

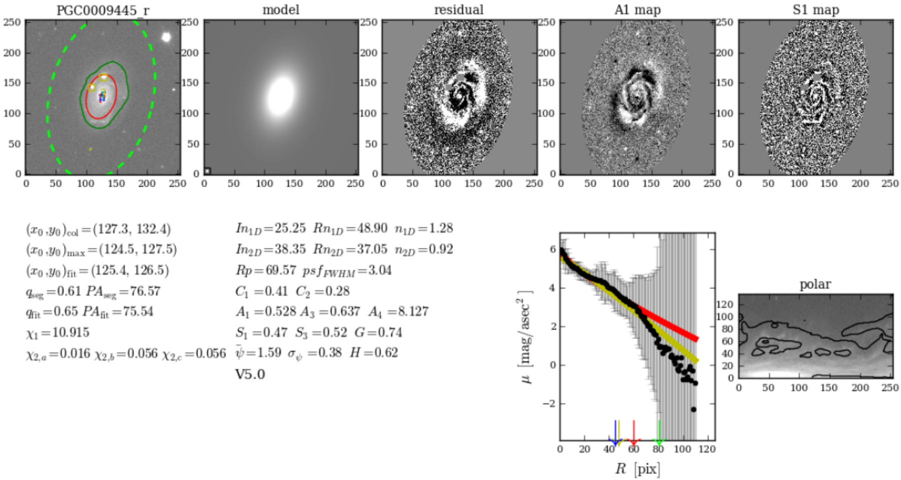
- **C**oncentrations (Kent, 1985) (Abraham et al. 1994)
- **A**symmetries (Abraham et al. 1996) (Conselice et al. 2000)
- **S**moothness (Conselice et al. 2000)
- **G**ini (Lotz et al. 2004)
- $\mathbf{M}_{20}$ (Lotz et al. 2004)

...with **Morfometryka**!

Morfometryka (Ferrari et al, 2015)

- Python!
- Standalone application
- Designed to be used in **data** from **large surveys**
- **Automated** photometry and morphometry
- **Easy** to run in parallel
- Publicly available in the near future

For more information visit `http://morfometryka.ferrari.pro.br` usage: morfometryka.py galaxy_image.fits psf.fits



Visual output from a Morfometryka run on the r-band image of the PGC 40032 galaxy

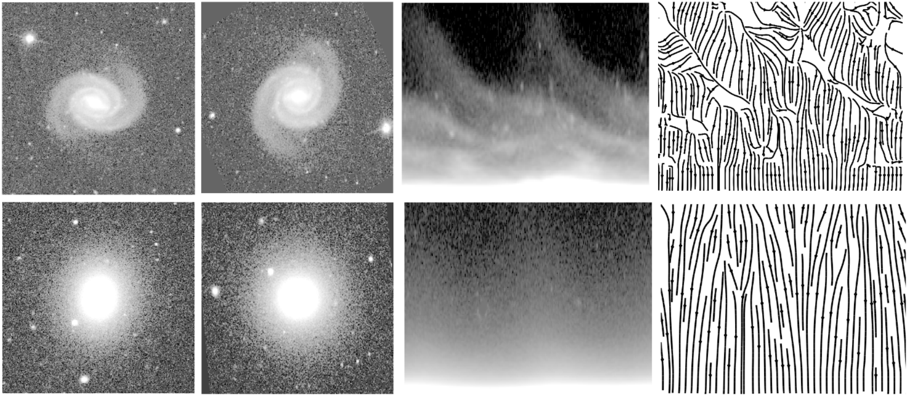
What's **new**?

New approach for non-parametric morphology:

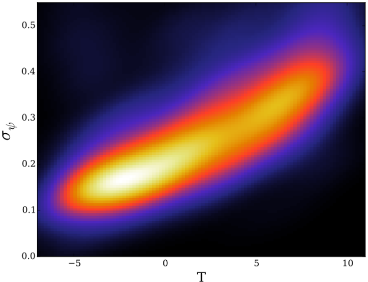
Usual		**Morfometryka**
$\mathbf{A}_1 = \frac{\sum_i abs(I_i - I_{i\pi})}{\sum_i I_i}$	$\rightarrow$	$\mathbf{A}_3 = 1 - s(I, I_\pi)$
$\mathbf{S}_1 = \frac{\sum_i abs(I_i - I_{iF})}{\sum_i I_i}$		$\mathbf{S}_3 = 1 - s(I, I_F)$
Gini		Information Entropy **H**

Plus a **new way** to measure **structure**: The Spirality σ_ψ

$$s(x, y) \equiv \text{Spearman's Rank Correlation Coefficient between x and y}$$



How do we measure σ_ψ?



But **how** do we know which approach is **better**?

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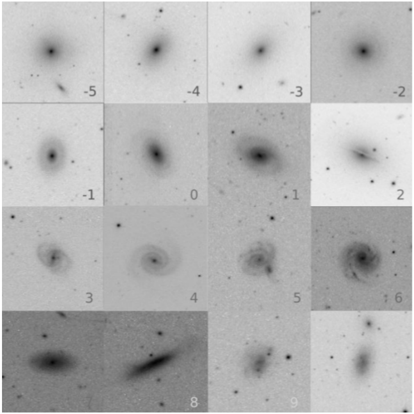
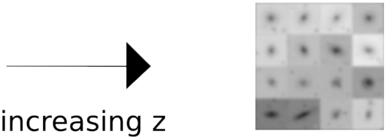
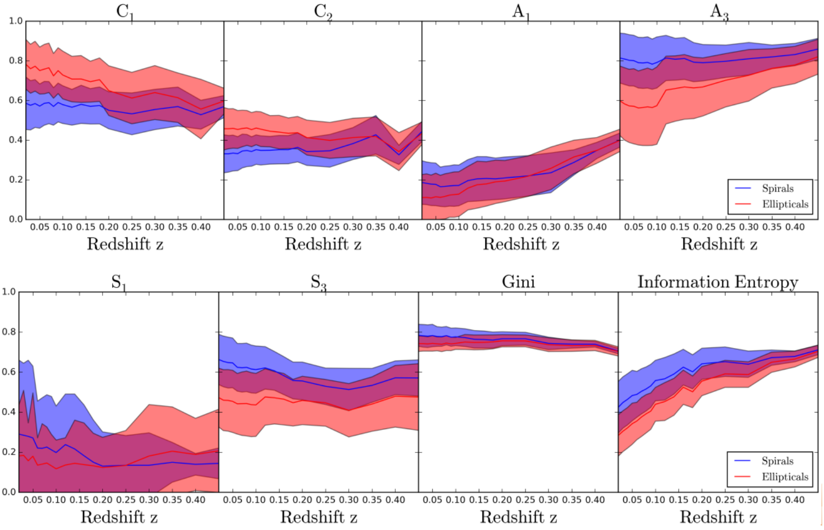
(Ferreira & Ferrari, in prep)

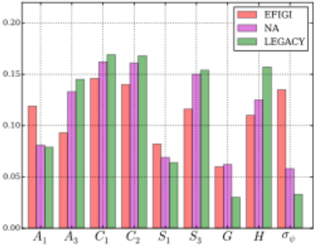
Morphometry vs. redshift simulations with **FERENGI** (Barden et al, 2008)





$0 \geq z \geq 0.5$ in 20 steps
for $\sim$ 4500 galaxies in the EFIGI catalog (Baillard et al. 2011)
SDSS DR8





$$\mathbf{x} = \{C_1, A_3, S_3, H, \sigma_\psi\},$$

MFMTK + GALAXY ZOO + scikit learn

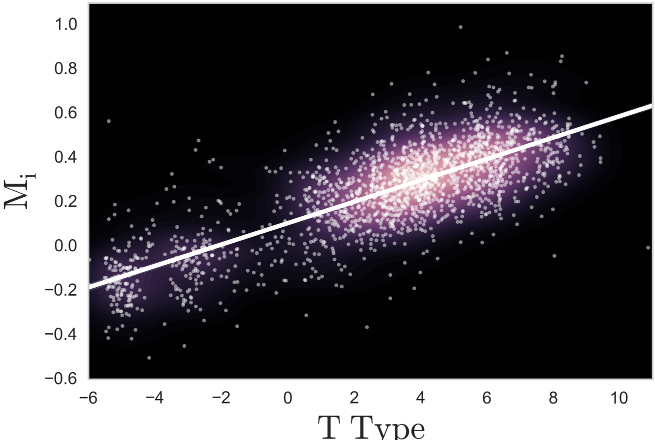
$$f(\mathbf{x}) = \mathbf{w}^T \mathbf{x} + w_0$$

	EFIGI	NA	LEGACY	LEGACY-zr
A	0.938	0.902	0.877	0.938
P	0.962	0.931	0.905	0.956
R	0.964	0.899	0.935	0.968
F_1	0.963	0.914	0.920	0.963

(Ferrari et al, 2015)

These features have **physical meaning**!

Distance from the class separation hyperplane M_i can be used as a **morphology** estimator



Where do we want to **go** from here?

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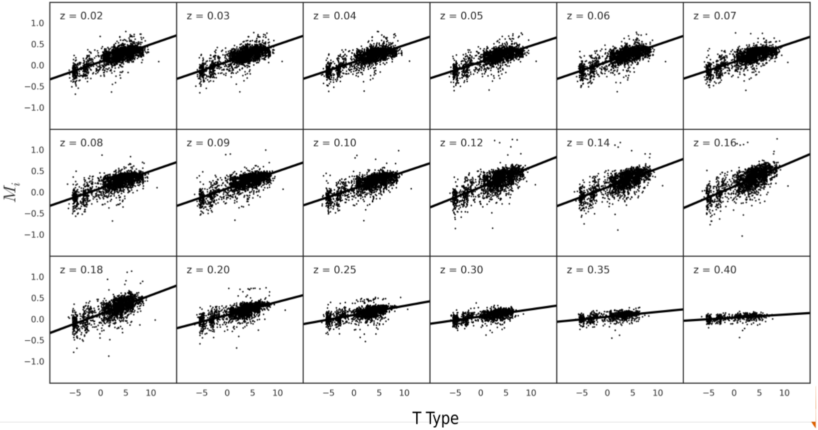
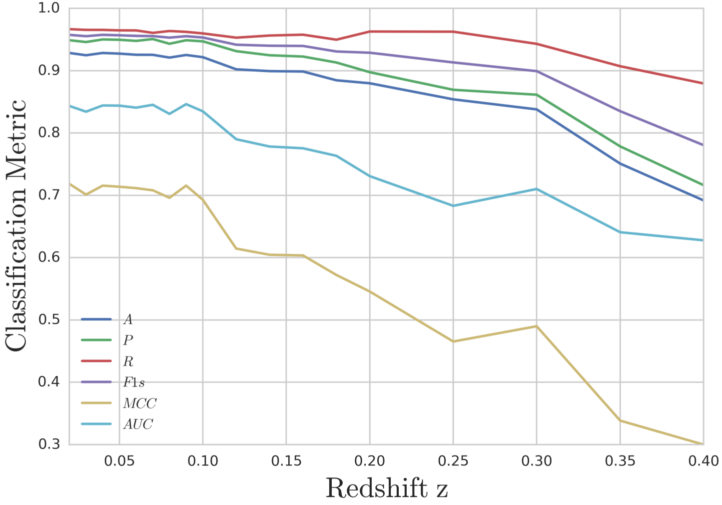
Can we find the **limiting redshift** for **reliable** morphological classification?

$$f(PSF_{FWHM}, \text{pixel scale}, \cdots) = \mathrm{z}_{\text{limit}}$$

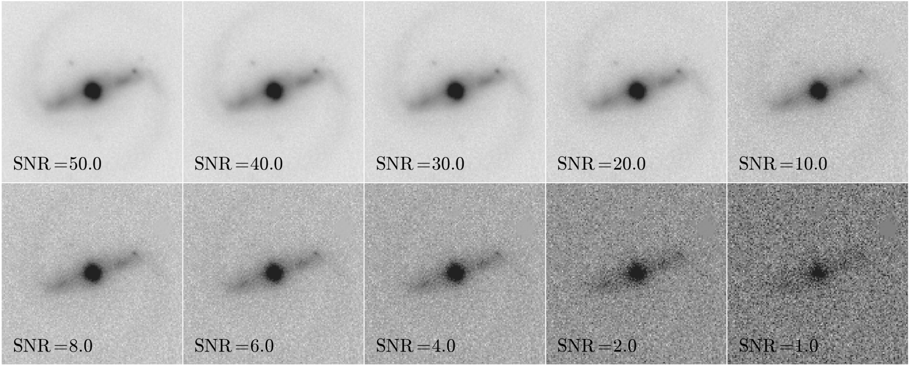


Where do we want to **go** from here?

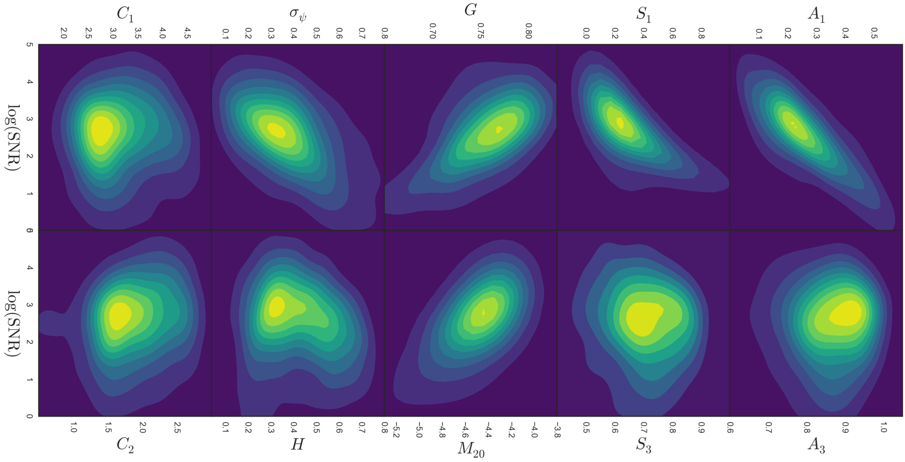


Obrigado
GitHub, Twitter: @astroferreira

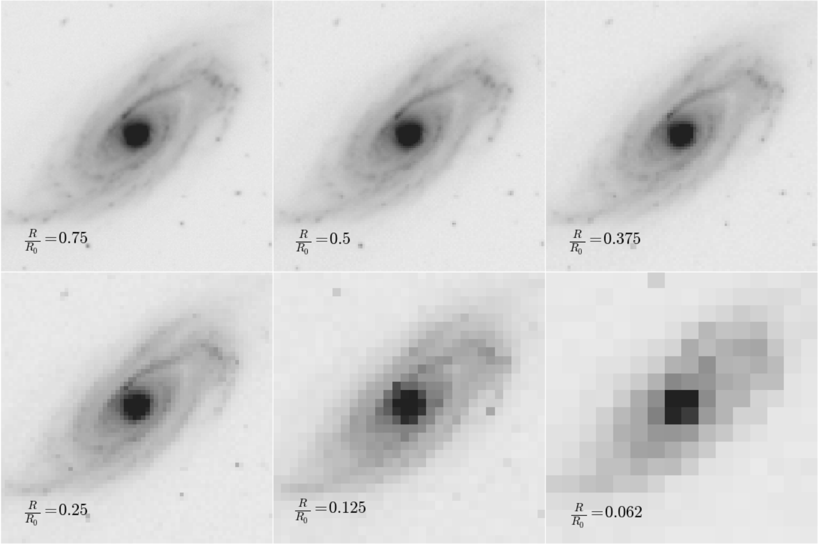
vs. SNR


SNR = 50.0
SNR = 40.0
SNR = 30.0
SNR = 20.0
SNR = 10.0
SNR = 8.0
SNR = 6.0
SNR = 4.0
SNR = 2.0
SNR = 1.0

vs. **SNR**



vs. **pixel resolution**



vs. **pixel resolutions**