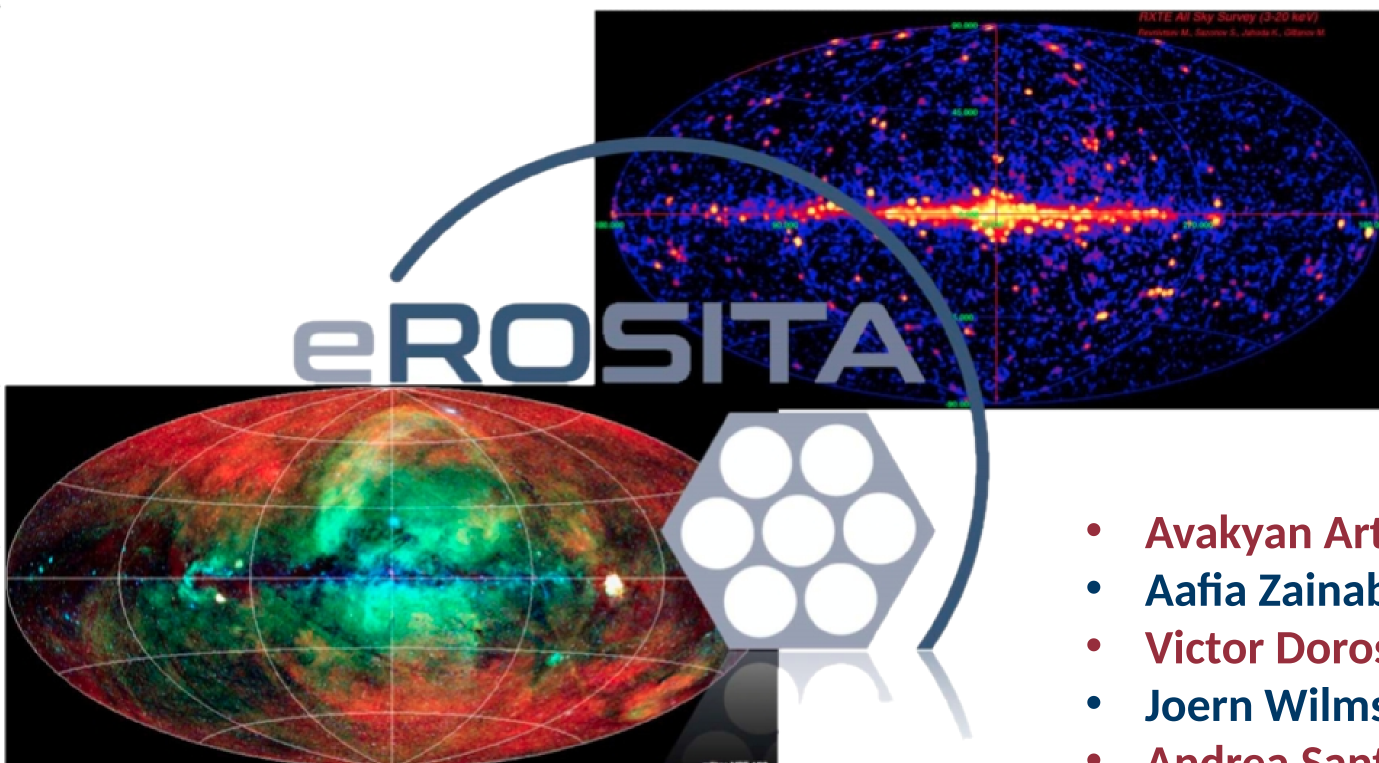
eROSITA

eRO-STEP FOR2990

Catalogue of new Galactic XRBs found in eRASS DR1



- Avakyan Artur
- Aafia Zainab (FAU)
- Victor Doroshenko
- Joern Wilms (FAU)
- Andrea Santagelo

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

eROSITA. View of XRBs

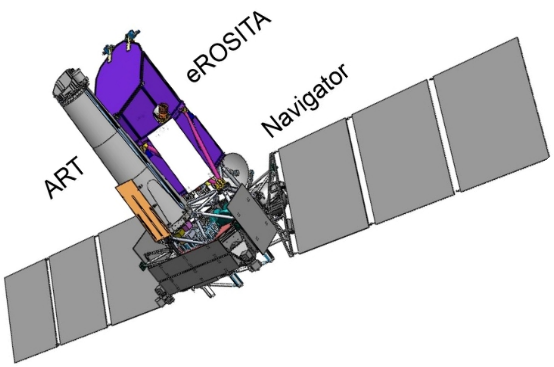
EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Table 1. Estimated XLF parameters for high- and low- mass X-ray binaries from INTEGRAL 9-year survey, and expected number and fraction of sources to be detected by INTEGRAL and eRosita.

	LMXB	*HMXB*
L_{br}, 10^{36} erg s^{-1}	$8^{+7}_{-6.5}$	$0.55^{+4.6}_{-0.28}$
α_1	$0.9^{+0.2}_{-0.4}$	$0.3^{+0.8}_{-0.2}$
α_2	$2.6^{+3}_{-0.9}$	$2.1^{+3}_{-0.6}$
$N_{total,MW}$	200^{+175}_{-75}	110^{+180}_{-10}
$N_{INTEGRAL}$	108 (29-86%)	82 (27–82%)
$N_{eRosita}$	130–270 (75–95%)	105-220 (78–96%)
$N_{eRosita,new}$	22–162	23–138

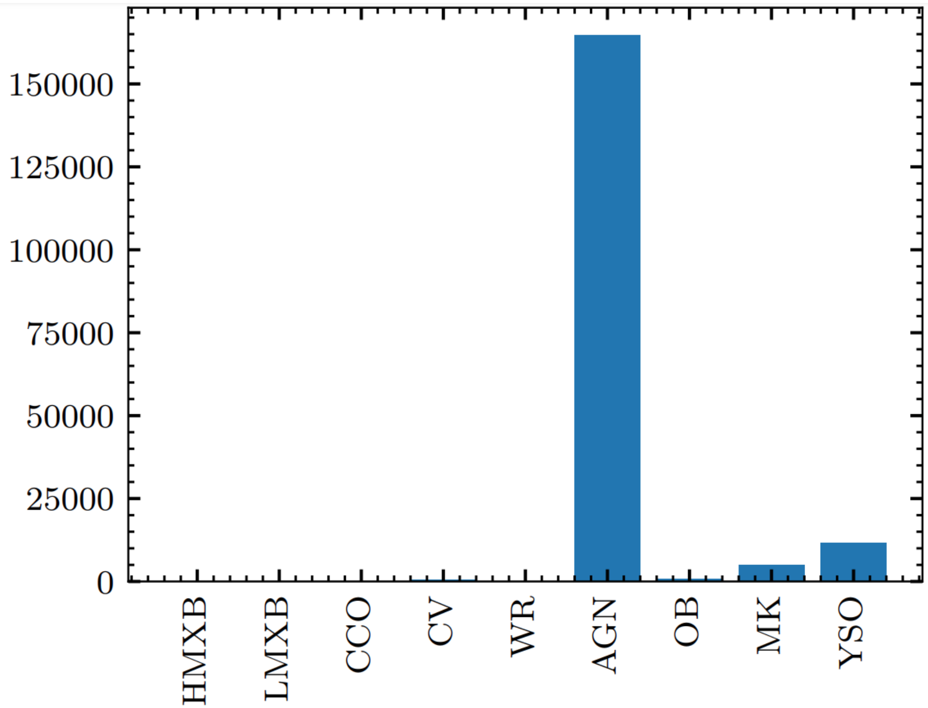
~22-150
of new XRBs
on eROSITA_DE side

Doroshenko et al (2014)



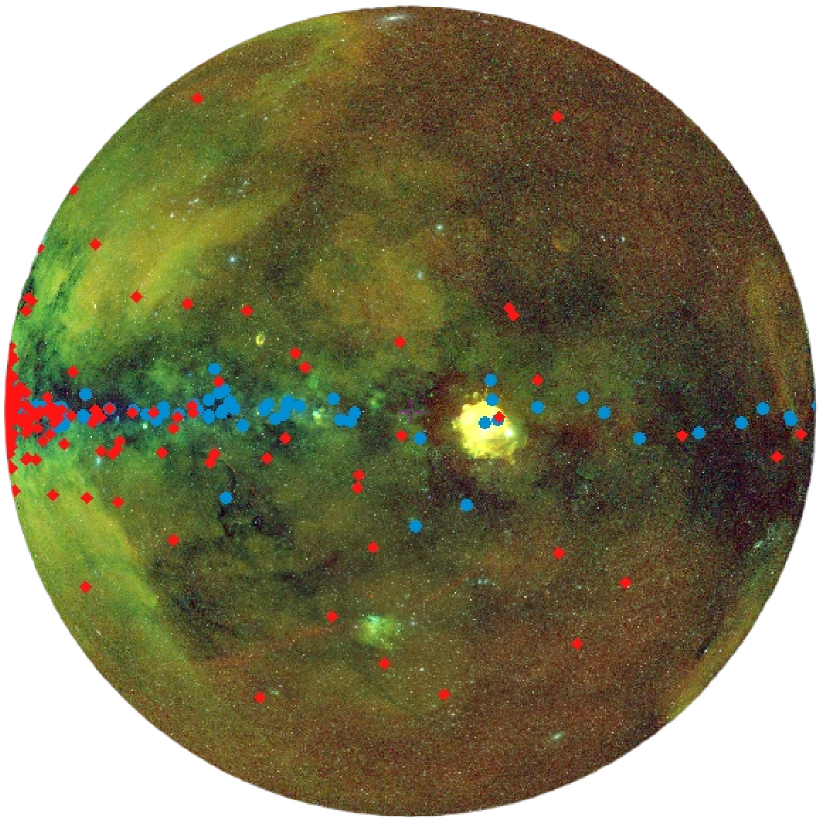
A needle in haystack problem for XRBs

EBERHARD KARLS UNIVERSITÄT TÜBINGEN



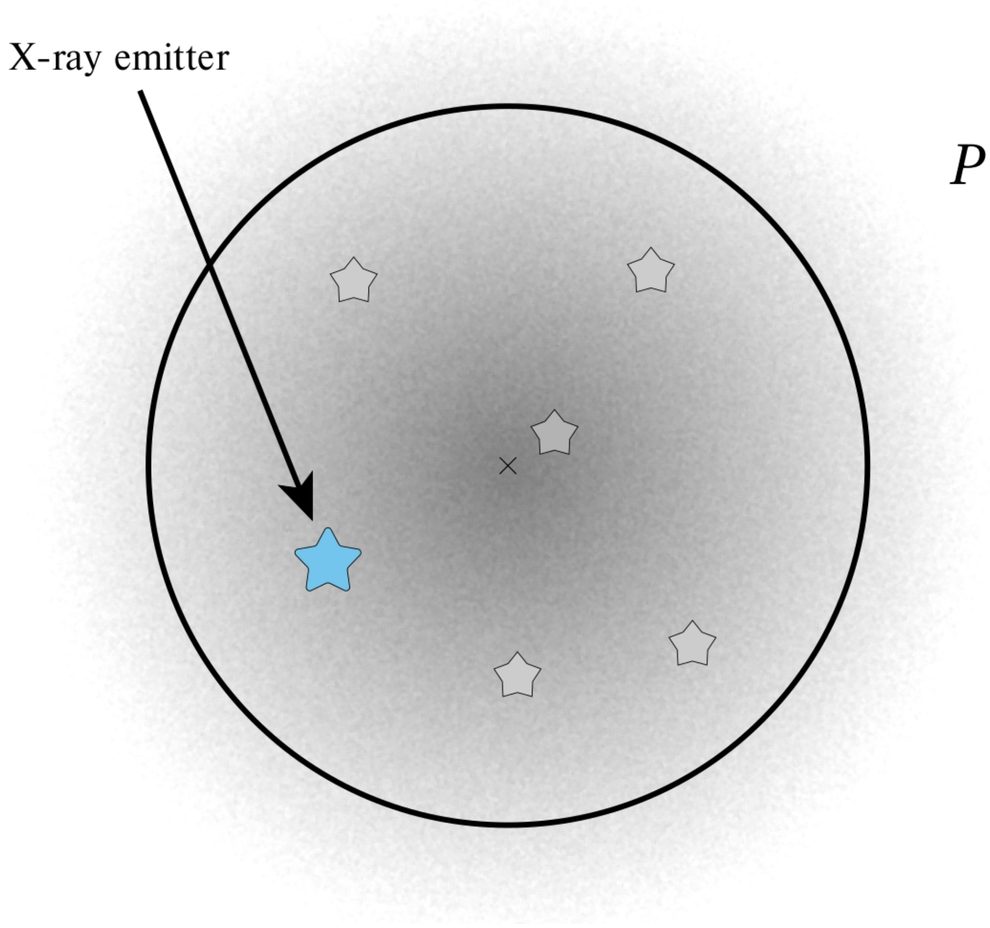
Problem:
AGNs outnumber other X-ray emitting class sources

Solution:
Usage of Multiwavelength (MWL) data for classification



Kwown HMXBs (blue) and LMXBs (red) eRASS DR1 map view

Identification of the optical/IR counterpart



Bayesian framework **(NWAY)**:

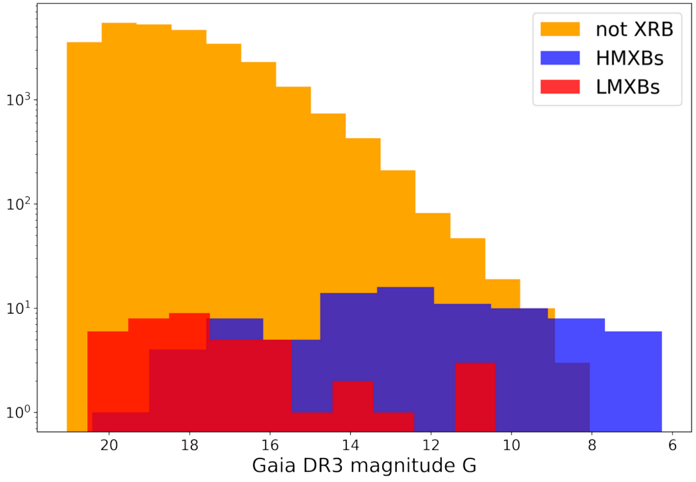
$$P(D|H) = P(D_\phi|H) \times P(D_m|H)$$

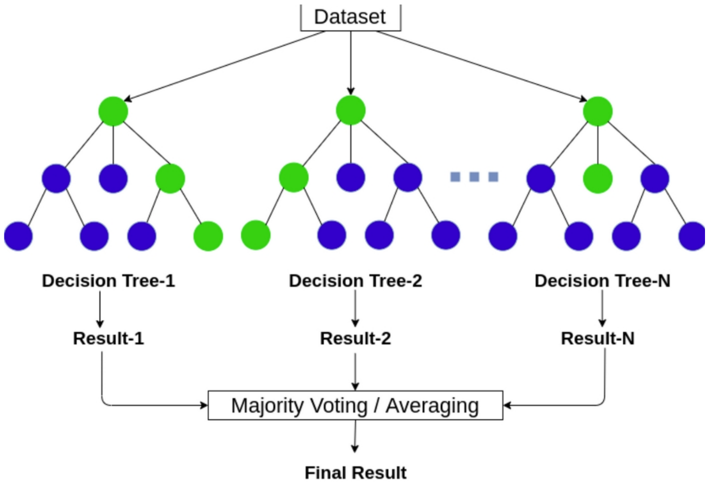
$P(D_\phi|H)$ - Likelihood based on geometrical positions

$P(D_m|H)$ - Likelihood based on photometric data

Salvato et. al. (2018)
Budavári&Szalay (2008)

Identification of the optical counterpart
Machine learning approach



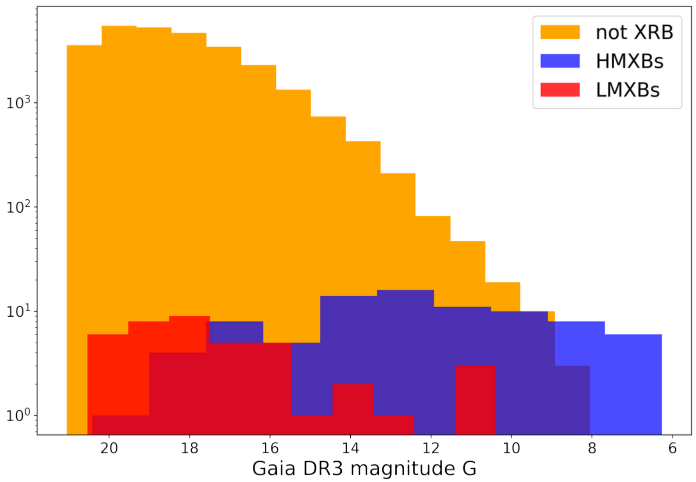


+

distances, magnitudes, colours, etc

P_XRAY_CTPT

Identification of the optical counterpart
Machine learning approach

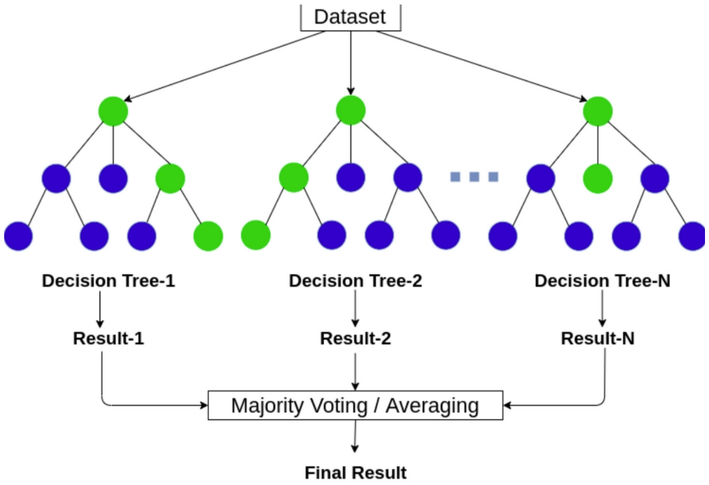


+

distances, magnitudes, colours, etc

+

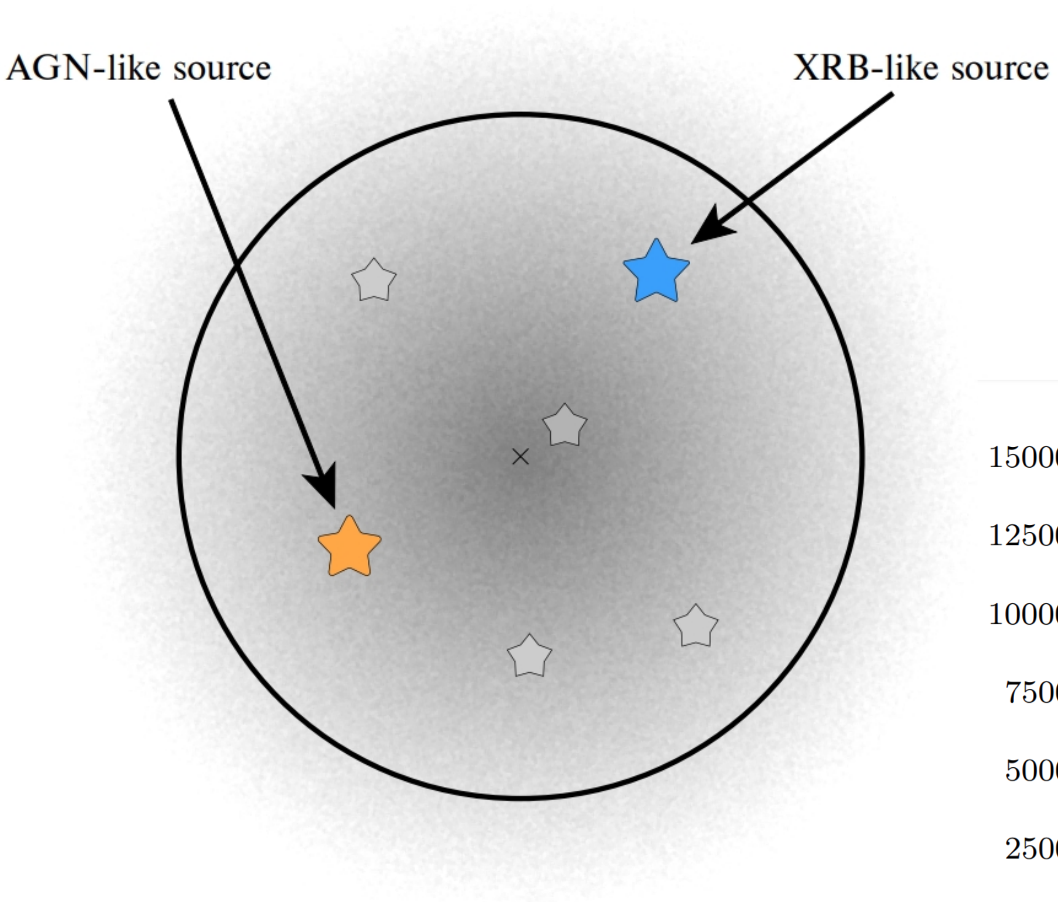
Xray features



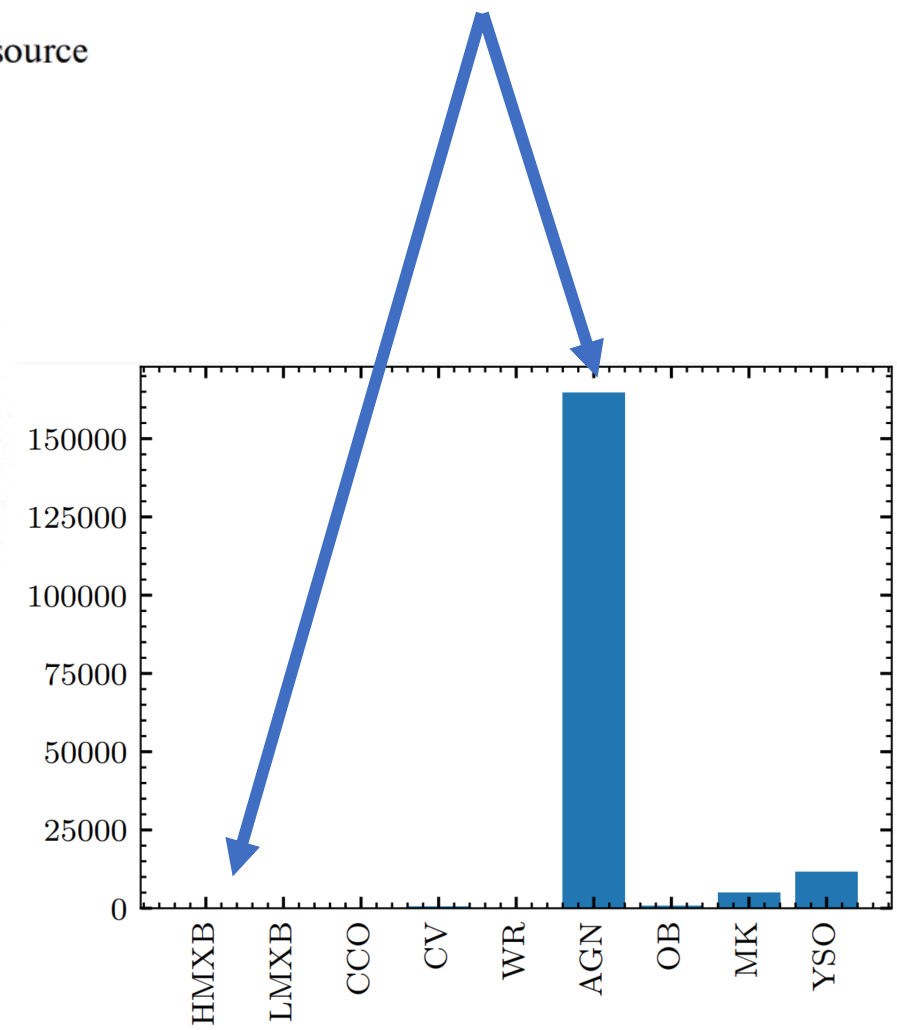
P_XRAY_CTPT

(repeat classification) → P_XRAY_SOURCE

Identification of the optical/IR counterpart
Discrimination from AGNs

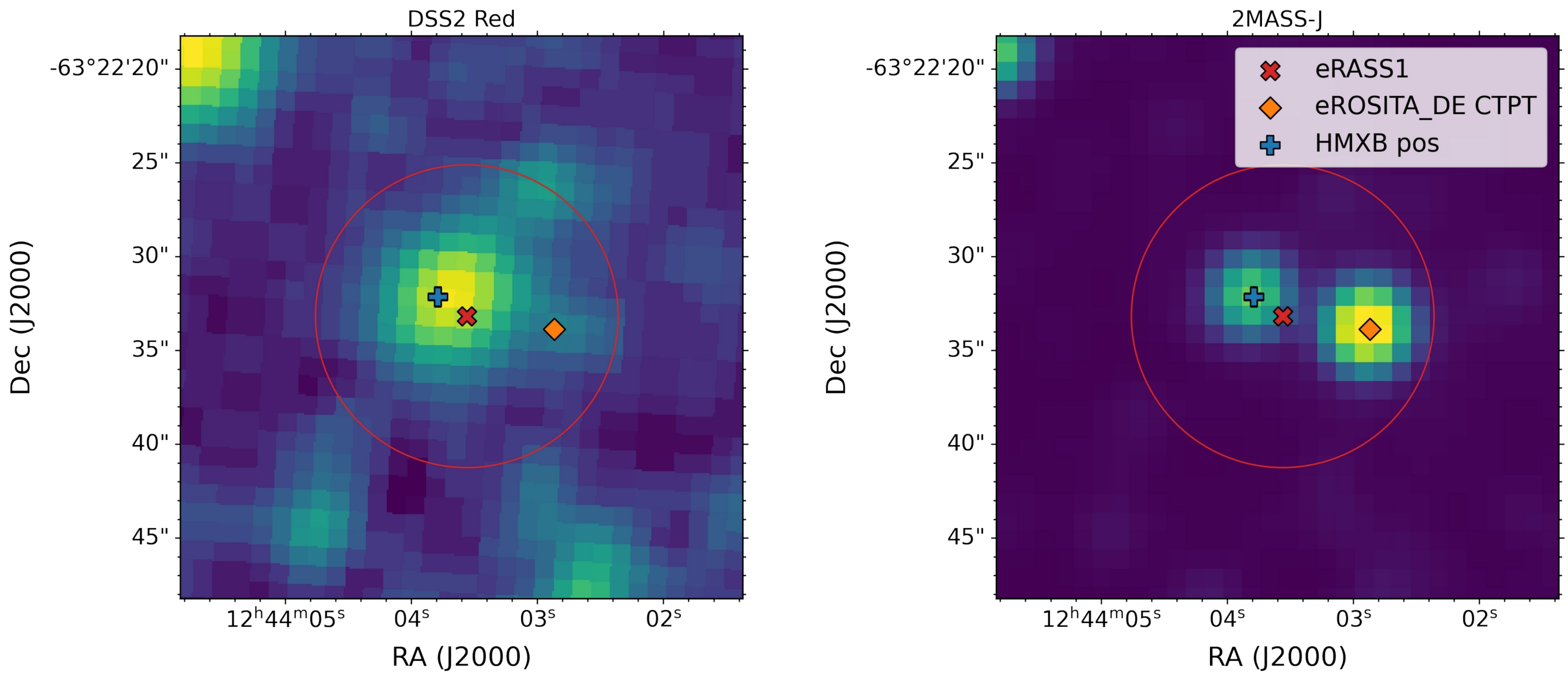


Huge imbalance!



Problem:
AGN-like optical/IR sources are preferred as counterparts

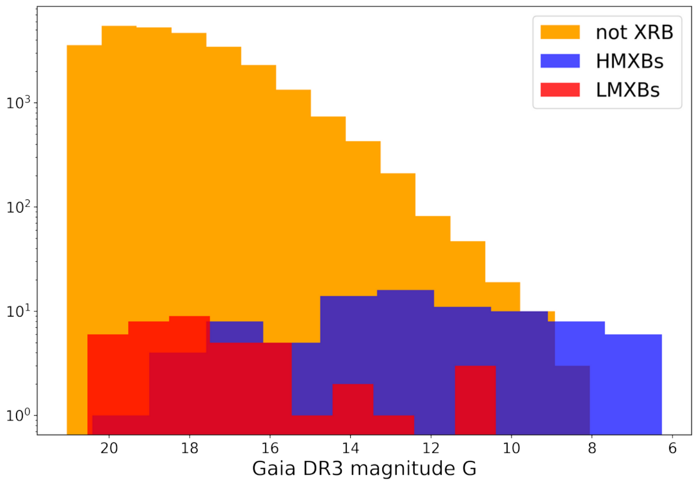
Identification of the optical/IR counterpart
Discrimination from AGNs

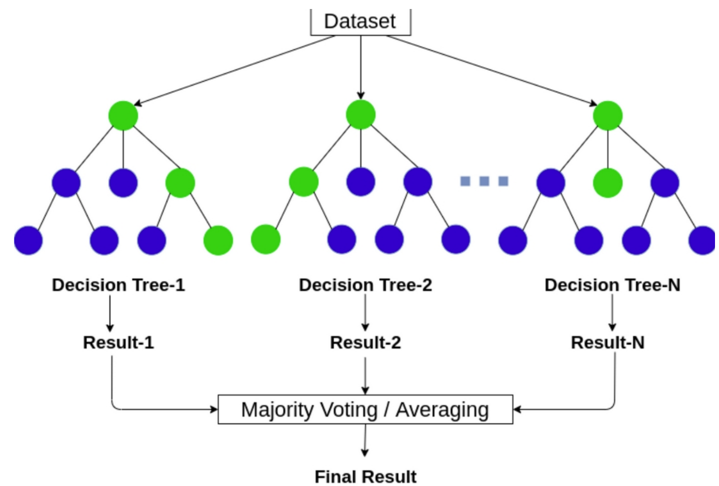


An optical/IR view of view HMXB SRGA J124404.1-632232

Optical counterparts are incorrectly identified for ~30% of XRBs

Identification of the optical counterpart
Machine learning approach





+

distances, magnitudes, colours, etc

+

Xray features

P_HMXB_CTPT (repeat classification) → P_HMXB, …

P_LMXB_CTPT (repeat classification) → P_LMXB, …

Classification X-ray sources

EBERHARD KARLS UNIVERSITÄT TÜBINGEN

Features:

1. G band magnitude
2. BP band magnitude
3. RP band magnitude
4. Variability
5. Excess noise
6. Significance of excess noise

5. J band magnitude
6. H band magnitude
7. K band magnitude

8. W1 magnitude (3.35um)
9. W2 magnitude (4.6um)

10. Nh column

11. X-ray flux (0.2-2.3 keV)
12. X-ray flux (2.0-8.0 keV)
13. Fluxes significance

14. Distance
15. Distance significance

Gaia DR3

2MASS/VVV

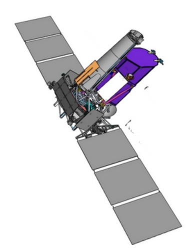
CatWISE2020

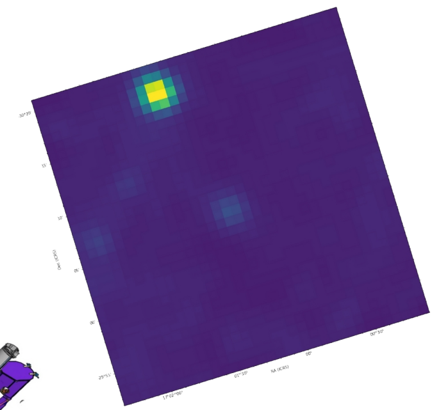
Doroshenko et al (2024)

eRASS1M

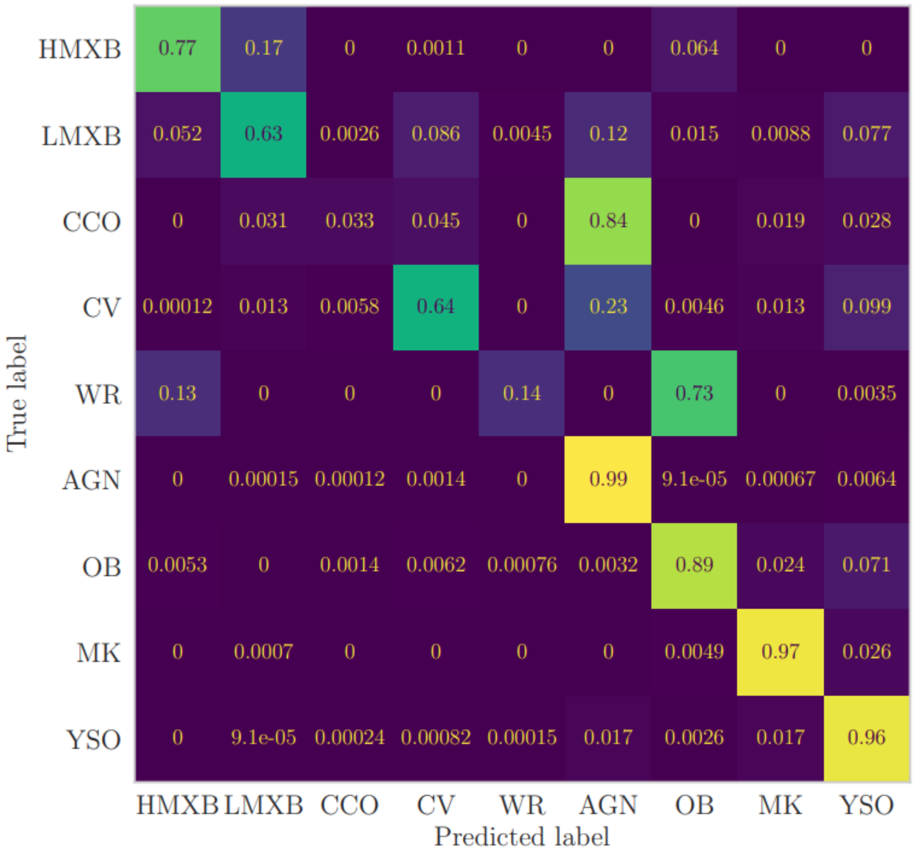
Classes/labels:

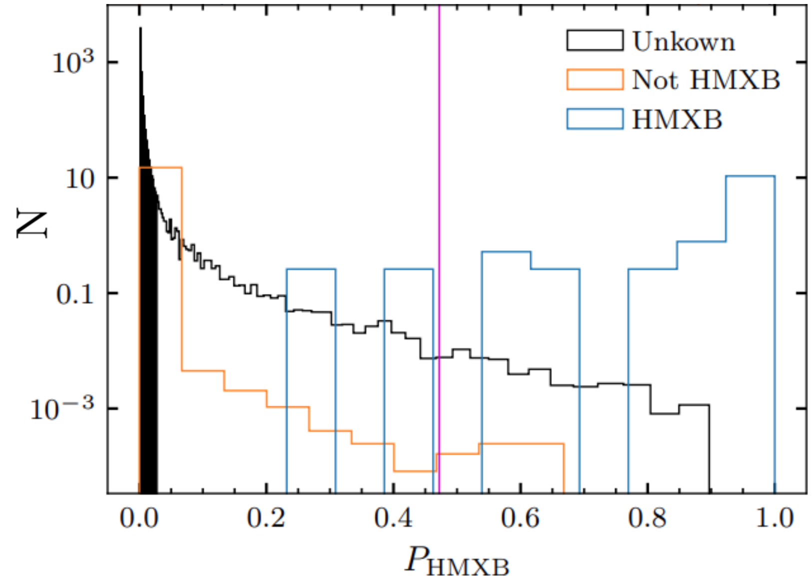
1. HMXBs
2. LMXBs
3. X-ray emitting INSs (magnetars, pulsars, CCOs)
4. CVs
5. WR
6. AGN
7. Early type stars (O-B, Be, Gamma Cas),
8. Evolved stars (Chromo-active mostly)
9. YSOs

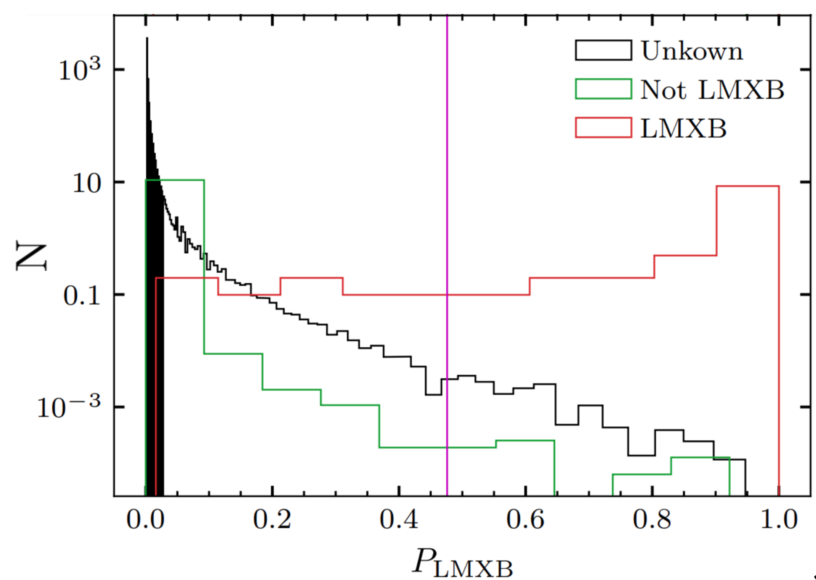




ML classification results
Selecting plausible candidates



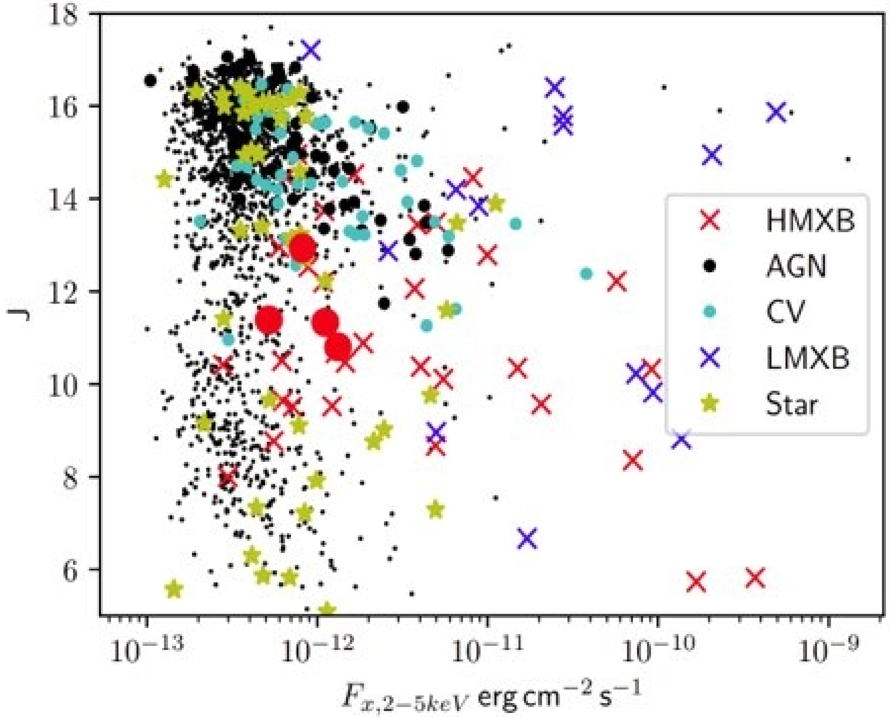


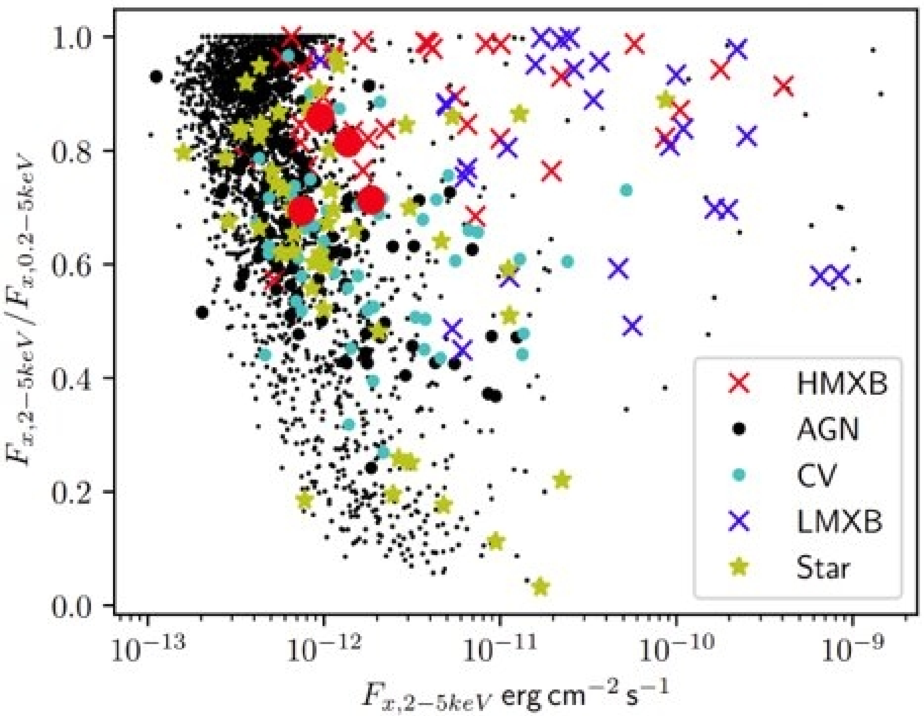


Completness = 0.7
Purity = 0.83
Prob_cut = 0.472
HMXB Candidates: 185

Thank you for your attention!

Classification of X-ray sources. MWL data

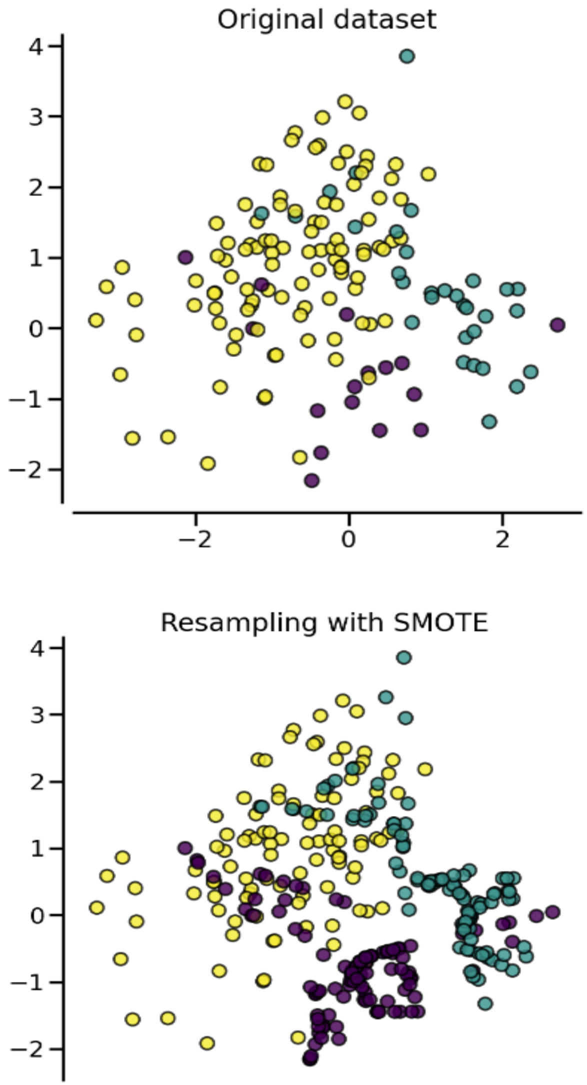


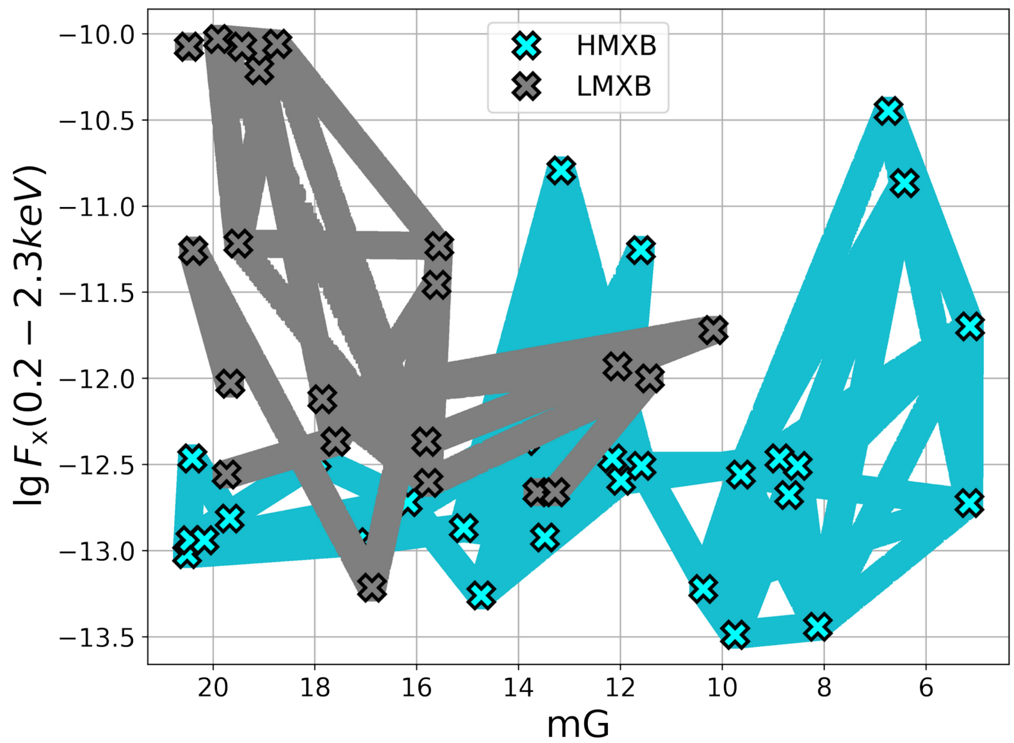


Classification problem:

Properties of different class sources strongly overlap

Imbalanced sample problem
Data augmentation





Synthetic Minority Oversampling Technique (SMOTE) generate new samples in by interpolation between known class label sources.