Solving the Catalogue Cross-Match Problem in the Era of LSST: The Effect of Unresolved Contaminant Objects on Photometric Catalogues

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Traditionally, matching sources between photometric catalogues involves a nearest neighbour search. However, for Rubin Obs. LSST this will fail, as typical 2” error circles will contain up to 10 random objects. As such, it might be tempting to use probabilistic cross-matching techniques which include the astrometric uncertainty of the observations to reduce the length scale over which to consider matches. Unfortunately, these Bayesian matching methods ultimately assume that the Astrometric Uncertainty Function of the sources is Gaussian, which does not apply in all cases, and will not apply to LSST. The extreme source densities and significant number of objects with no known proper motion mean that systematic effects, not noise-based scatter, dominant the separations of objects between LSST and other surveys. It is vitally important that these effects are understood and modelled correctly before any composite datasets can be trusted. As part of the LSST:UK consortium we have developed and are implementing methods to handle these effects, and will be producing robust cross-matches between LSST and a wide range of other catalogues.

Wilson & Naylor (2017, MNRAS, 468, 2517); Wilson & Naylor (2018a, MNRAS, 473, 5570); Wilson & Naylor (2018b, MNRAS, 481, 2148)
Wilson (2022, RNAAS, 6, 60); Wilson (2022, RASTI, in review)

The “busy” astronomer: uses a 2 arcsecond nearest neighbour match

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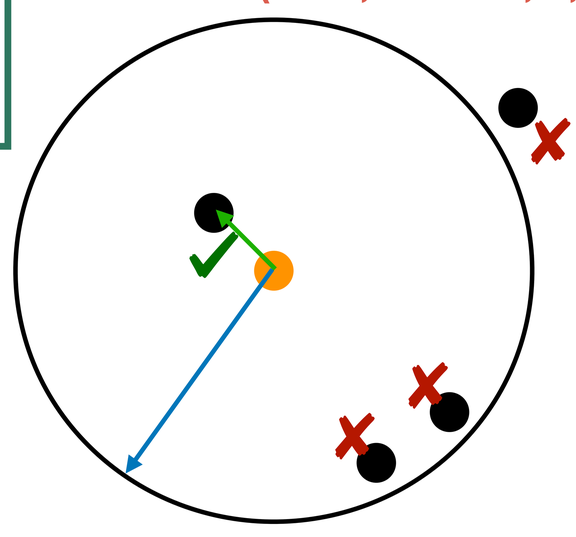
Rubin Obs. LSST will have too *many* matches, high false *positive* rate — ~1 random Galactic plane source/ circle at 20th mag, ~10 by 26th



The “Bayesian” astronomer: uses astrometric uncertainty to reduce match radius

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Too *few* matches, high false *negative* rate

The “careful” astronomer: includes important systematic effects in the Astrometric Uncertainty Function, and colour information to reject false matches

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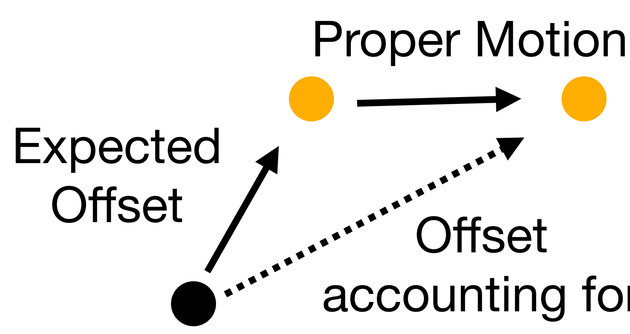
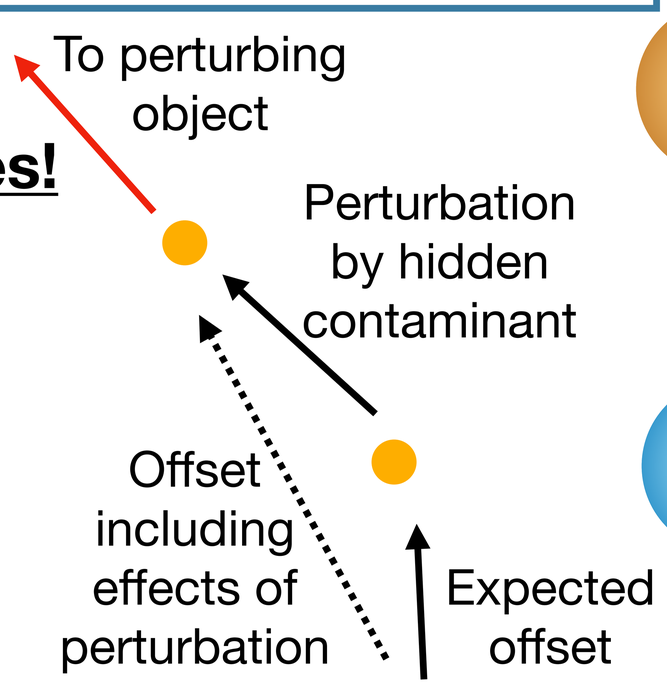
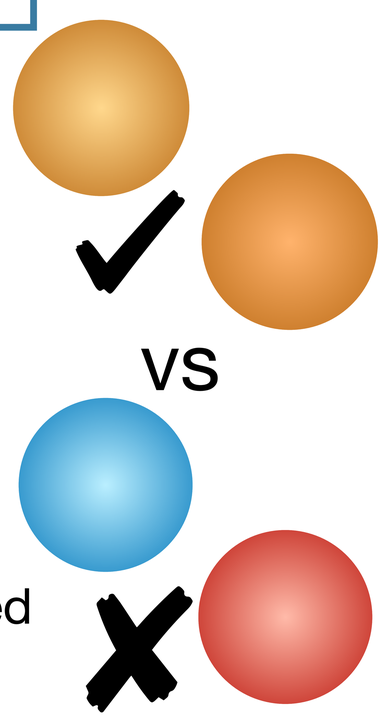
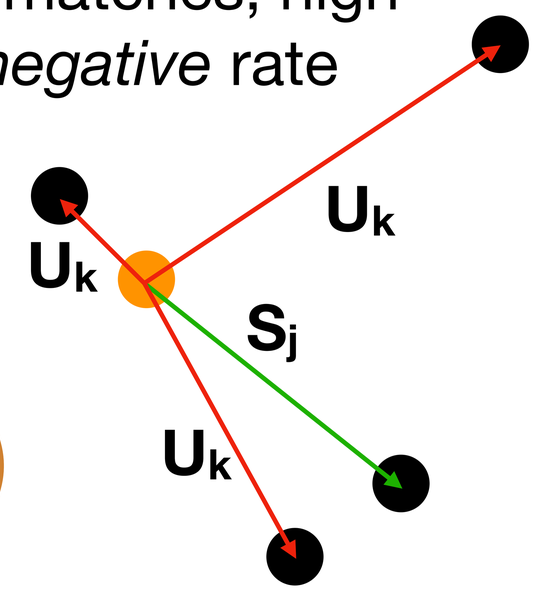
The correct number of matches!









Sutherland & Saunders (1992)

Coming Soon!

The “**smart**” astronomer: uses our cross-matches to get the correct matches *and* information on how much contamination is brightening their object!

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https://github.com/Onoddil/macauff/
https://onoddil.github.io/macauff/