IDENTIFICATION OF KNOWN OBJECTS IN SOLAR SYSTEM SURVEYS.

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Introduction: The discovery of new objects in modern wide-field asteroid and comet surveys can be enhanced by first identifying observations belonging to known solar system objects. It is desirable to separately treat the identification of the known moving objects for four reasons: to avoid claiming as a new discovery some well known object, to reduce the dataset while searching for new discoveries, to improve the orbits of the known objects while ensuring they are not contaminated by false associations, and finally, for statistical quality control of the astrometric data using the residuals with the well known orbits.

The assignation of new observations to a known object is an attribution problem that occurs when a least squares orbit already exists for the object but a separate fit is not possible to just the set of new observations [1]. Here we explore the strongly asymmetric attribution problem in which the existing least squares orbit is very well constrained and the new data are sparse. There is typically just one tracklet, a very short arc of astrometric observations, assembled by the observer using just a linear or a quadratic fit to the astrometry as a function of time.

The main difficulty of the asymmetric attribution problem is that both the existing and new data are biased by the astrometric catalogs and a reliable astrometric error model is usually not available. Our two-step solution is to (i) devise a statistical quality control procedure which is applied asymmetrically to the old and new data and (ii) apply a debiasing procedure to the MPC-archived historical observations to remove the known position-dependent bias due to regional systematic errors in the astrometric star catalogs [2].

We test the attribution algorithm using data from the Pan-STARRS PS1 survey [3] that uses the 2MASS star catalog [4] for the astrometric reduction. The source orbits are both numbered and multi-apparition asteroids.

Results: The attribution algorithm is accurate and efficient. For multi-apparition asteroids the false attribution fraction is less than 1/1000 and even those can be eliminated by following the MPC's good practice of requiring two nights of data for a recovery at a new apparition. The algorithm's attribution efficiency is high and consistent with 100% but cannot really be measured because it is entangled with other efficiency losses such as the fill factor.

The PS1 data have significantly lower astrometric error than other asteroid surveys. This error can be identified only after removing the biases due to systematic errors in the star catalogs. Indeed, the conclusion is that even the 2MASS star catalog contains enough biases to affect the PS1 error model.

We consider that the PS1 data can be included in the fit for asteroid orbits with weights corresponding to 1/0.3 arcsec^{-1} that implicitly account for the effects of correlations. A model with debiasing of the 2MASS astrometry and explicitly taking into account the correlations could allow a further improvement in the diagonal elements of the weighting matrix by another factor 2~3.

References: [1] Milani A. and Gronchi G. F. (2010) *Theory of Orbit Determination*. [2] Chesley S. R. et al. (2010) *Icarus, 210,* 158–181. [3] Hodapp K. W. et al. (2004) *Astronomische Nachrichten, 325,* 636–642. [4] Skrutskie, M. F. et al. (2006) *Lthe Astronomical Journal, 131,* 1163–1183.