

## Multistep method to deal with large datasets in asteroid family classification

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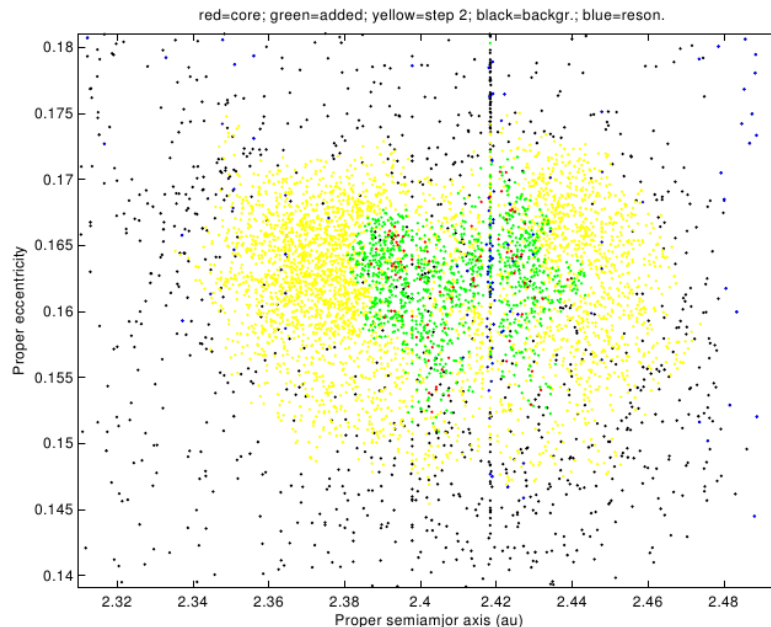
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A fast increase in the number of asteroids with accurately determined orbits and with known physical properties makes it more and more challenging to perform, maintain, and update a classification of asteroids into families. We have therefore developed a new approach to the family classification by combining the Hierarchical Clustering Method (HCM) [1] to identify the families with an automated method to add members to already known families. This procedure makes use of the maximum available information, in particular, of that contained in the proper elements catalog [2]. The catalog of proper elements and absolute magnitudes used in our study contains 336 319 numbered asteroids with an information content of 16.31 Mb. The WISE catalog of albedos [3] and SDSS catalog of color indexes [4] contain 94 632 and 59 975 entries, respectively, with a total amount of information of 0.93 Mb. Our procedure makes use of the segmentation of the proper elements catalog by semimajor axis, to deal with a manageable number of objects in each zone, and by inclination, to account for lower density of high-inclination objects. By selecting from the catalog a much smaller number of large asteroids, in the first step, we identify a number of core families; to these, in the second step, we attribute the next layer of smaller objects. In the third step, we remove all the family members from the catalog, and reapply the HCM to the rest; this gives both satellite families which extend the core families and new independent families, consisting mainly of small asteroids. These two cases are separated in the fourth step by attribution of another layer of new members and by merging intersecting families. This leads to a classification with 128 families and 87 095 members. The list of members is updated automatically with each update of the proper elements catalog, and this represents the final and repetitive step of the procedure. Changes in the list of families are not automated.



**Figure:** The family of (20) Massalia in the proper ( $a, e$ )-plane. Red dots indicate members of the family core, green dots objects added in steps 2 and 4 of the classification procedure, while yellow points refer to members of satellite families added in step 5.

**References:** [1] Zappala, V., A. Cellino, P. Farinella, and Z. Knežević: 1990, *Astronomical Journal* 100, 2030. [2] <http://hamilton.dm.unipi.it/astdys2/> [3] [http://wise2.ipac.caltech.edu/staff/bauer/NEOWISE\\_pass1](http://wise2.ipac.caltech.edu/staff/bauer/NEOWISE_pass1) [4] <http://www.astro.washington.edu/users/ivezic/sdssmoc/>