Minor Planets recovery

Analysis and verify of data obtained by OrbFit and Edipo Sw

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Minor planets recovery at the second opposition has always been a matter that involves different aspects both instrumental (instrument limit as magnitude , field of view) and computational. Ephemeris calculations are also connected to the error in the sky, in relation to the nominal position predicted.

Free software " ***OrbFit*** " realized by ***OrbFit Consortium*** (*A. Milani, S.R. Chesley, M. Carpino, Z. Knezevic, G.B. Valsecchi*) can be used to calculate the position error in the sky, starting from an observation set available for the object to be recovered. Output data obtained by OrbFit, needed to quantify the error, are contained in the file named **< *Object_file_name.cbd* >** . File **.cbd* includes several points to plot elipse error where, inside which, the recovery will be expected. Sometimes the estimated area is very big, 10 degrees or more (RA or DEC or both); in this case the plot area could be an open curve. During several tests we have realized that the graphic and numerical prediction led to misinterpretation mistakes, among which:

uncertainty calculation, Right Ascension previsions, over-estimated at first, were correct in reality because located at high declination.

very often the position angle of the object appeared perpendicular with respect to its elipse error and was sometimes made worse by fast motion, creating many troubles to its recovery.

Thanks to the help provided by *Mario Carpino*[1] in teaching us all different aspects of *OrbFit*, the software " ***EDIPO***" has been developed by *Augusto Testa* [2] .
The main peculiarity of this program is to use file ***<filename.cbd>*** provided by *OrbFit*. This *<filename.cbd>*, must be then edited to create a specific format (nominal ephemeris are also added just to plot the motion of the object) and saved in a new file named ***<filename.erd>*** . The user must put in some parameters (saved in an option file):

- Telescope's focal length in mm
- CCD parameters (number and dimension of pixel)

Running *EDIPO* it is possible to plot on the PC screen the uncertainty elipse in the sky (cos*decl. was taken into account) with all CCD fields needed to cover it. In the output file created by the program the ephemeris are available (RA and DEC) to point the telescope without any further computation.

This procedure, already tested to recover both Main Belt Asteroids (MBA), discovered by us at 587 and Near Earth Asteroids (NEA), was performed at *Sormano Observatory* , and will be

fundamental to automate an effective recovery program with the new telescope under construction for *Sormano Observatory* (or in other Observatories).

EDIPO's author has used a software named ***Mappa2*** created by himself which realizes a sky map (stereoscopy projection) plotting all minor planets and comets for a specific epoch and monthly updated from MPC data.

Uncertainty elipse using the free Sw *OrbFit* was computed by *Francesco Manca*[2] . He has checked and completed all files for *EDIPO*, selecting minor planets (MBA discovered at Sormano and NEA) both to recover and to submit as test starting from a list of numbered and multiopposition objects.

After some success and failures we decided to investigate about the previsional goodness estimate provided by OrbFit. This test was carried out on various samples of listed minor planets both MBA and NEA. Using the observations set available BEFORE their recovery, for all objects, the elipse error at ***3 sigma*** was obtained and pointed for the epoch and Observatory code that performed it.

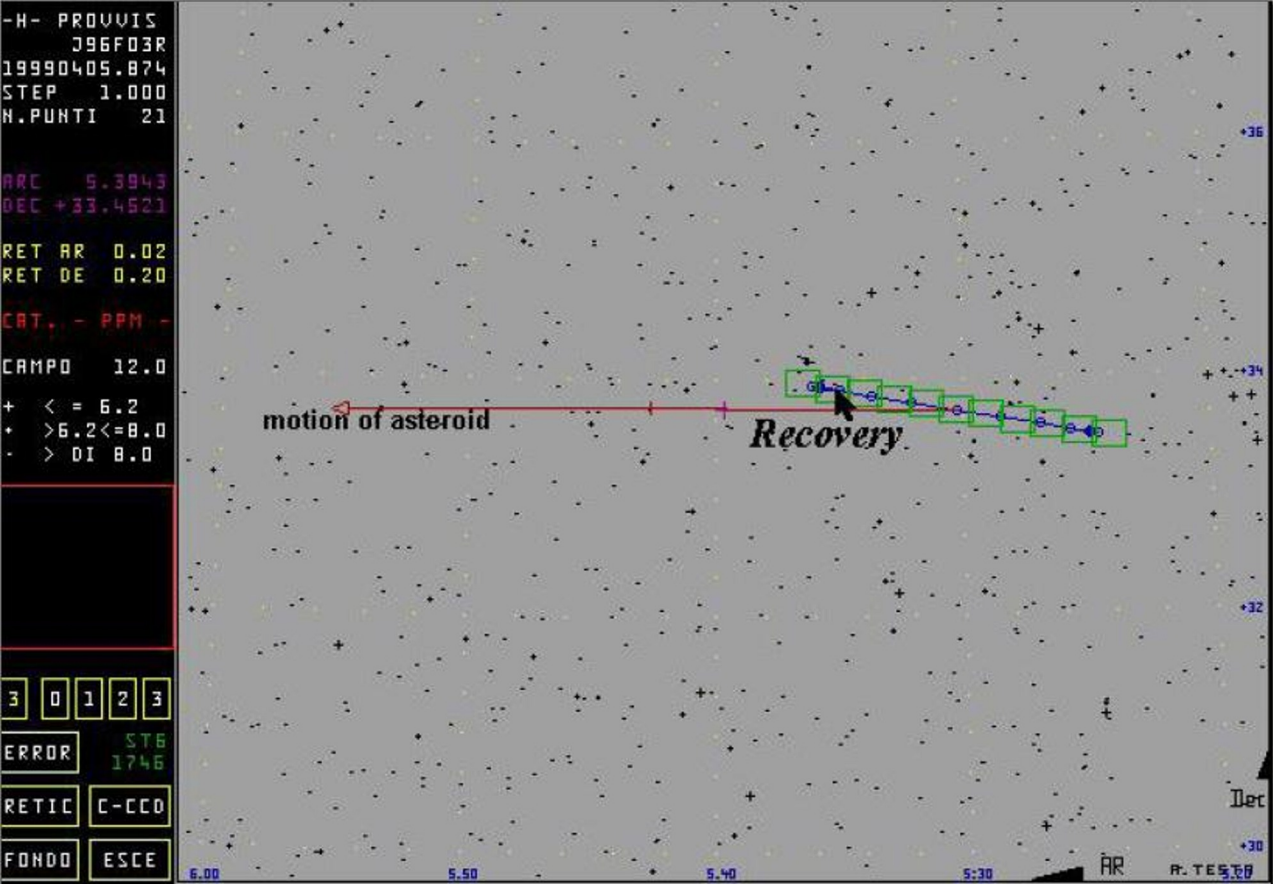
This method was used for real minor planets like numbered or multioppositions asteroids just to have the possibility to check the goodness of the previsional data. We have also checked, for the same cases, strange errors for uncertainty estimate of about 5 arcmin. In these cases the object was recovered outside or on the elipse external border.

Next some samples obtained with *OrbFit* and *EDIPO*:

- Near Earth Asteroid 04660
- Unusual minor planet 1996 RF3 (recovered at Sormano)
- Aten 2000 ED14 (also recovered at Sormano)

Available for the above samples:

- filenames.cbd by OrbFit
- filenames.erd input for EDIPO-
- map graphics and ephemeris fields to cover entire elipse error.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CAMPO 12.0
+ < = 6.2
• >6.2<=8.0
· > DI 8.0
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ERROR
ST6
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FONDO
ESCE
motion of asteroid
Recovery
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+32
+30
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AR
Dec