HIPPARCOS reductions for multiple stars, IX
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This note is an essay to describe the important 'CHF-generation' process, where a 'Case History File' is the complete summary of observations for a specific object. All the subsequent analysis-programs have the CHF as their main input, and the proper creation of these files is thus a cornerstone of NDAC's double-star reductions.

1. Introduction

The main purpose of the CHF-generation is to 'calibrate' the saved FOV-crossing data (for known and suspected non-singles), using the final attitudes, the final instrument-parameters, and the final sphere-solution results. This involves both the administration of large data-sets, and some rather involved computations.

The input to the CHF-generation has three large components. First, there are the saved FOVC-data (β-values with information matrices) from the whole mission (some 2300 Mb of data). Secondly, the final OGAR attitudes are used, including the spin-phases derived in the Great-circle reductions and the set zeropoints from the Sphere solution (some 1200 Mb). The third major input is the instrument-parameters (normally determined once per set in the Great-circle reductions), describing the large-scale field-to-grid transformations. Also needed is a photometric calibration of the IDT-data over the whole field-of-view (varying with time), a subset of the Input Catalogue, and (very important!), the goodness-of-fit histograms from the preprocessing. These latter ultimately define which objects will have their observations saved in Case History Files for further double-star analysis.

The present note describes superficially the required software-modules, but leaves aside their incorporation in some more comprehensive superstructure. All the important calculations are made in the CHFDAT-program, which exists in a preliminary version. The sorting of the data (and the actual creation of the CHF:s) is done in CHFGEN, which also exists, modelled on SORT23 of the sphere solution. The other ('preparatory') programs are still lacking, but using the present sketch of the overall procedure, no major obstacles are foreseen in writing them.

2. Preparatory programs

1. First, a special star-catalogue has to be created in a direct-access disc-file. Starting from the Input Catalogue, to each IC number a 'primary' component is associated (equal to the star itself for singles and close multiples), and its IC number becomes the 'system' identification. For each system, the IC photocentre is calculated, and this becomes the 'reference point' for all individual objects in the system. The ordering of the new catalogue is by IC-number, and it should contain for each object its primary, multiplicity-index (from the IC), CCDM-number, H-magnitude, B-V, reference point astrometric parameters, and the 'histogram statistics' accumulated during the preprocessing. In
addition, the record for each primary has to contain a list of it all the other stars in the system.

2. The FOVC-data (on high-density magnetic tapes) are available for all stars, and as a first step, the 'interesting' data have to be taken out. (This selection can not be made final at once, and some iteration of this step is foreseen). In practice, one will set a histogram discovery criterion (variable with magnitude and/or other physical aspects) and read through the above star-catalogue. An integer ('category number') is associated with each IC-number, e.g. 0 for 'skip', 1 for 'suspected non-single', 2 for 'known double' and 3 for 'known multiple'. This integer array (for all Input Catalogue entries) is small enough to be put in primary memory while the FOVC-tapes are read through sequentially. The '0'-systems are skipped, and the other three categories are labelled as they are transferred to a new sequential disk-file (which is also saved on tape).

3. The Great-circle reductions are made for (∼ 12 h) sets, and for each such interval, a number of instrument-parameters are determined, specifying the large-scale field-to-grid transformations. A sequential 'calibration-file' is set up, giving the best results for these instrument-parameters, the set zero-points (determined in the Sphere solution), and the time-varying photometric calibration of the IDT (including estimates of the background contribution). In this or another file, the satellite orbital data must also be available.

3. The CHF DAT-program

After these preliminaries, the calibrations are made in the CHF DAT-program, which works schematically as follows. Most of the FOVC-file (∼ 160 Mb per year of observation) is copied to disk, and a smaller stretch of the attitude-data (∼ 40 Mb per month). A set-interval and the requisite calibrations is read from the calibration-file, and then β-data for each FOV-passage in the set are transformed to b-data, using the known attitudes and the assumed reference point. After all the FOV-passages in a set have been calibrated, an (internal) sort is performed to system order. A new set is then treated, and when the attitude- (or FOVC-) data are exhausted, a new stretch is input. The sorted sets are output sequentially on three separate disk- and/or tape-files, according to the category-number. (This separation makes the input to the later CHFGEN-program smaller, making for somewhat simpler administration).

As to the details, it is necessary to be able to read quickly the attitude-data for a specified frame mid-time. Each new stretch is therefore put on a direct-access file ordered by an ad hoc 'frame-number' (=INT((t − t₀)/tₖ)), where t₀ is a suitable zero-point at the beginning of the time-interval, and tₖ = 32/15 sec. Another important point concerns the difference between the (IC) object number and the system identification. As described above, the primary defines the 'system no', and all the individual stars in a system must use the same astrometric parameters for the reference point. Ideally, the colour given to the reference point should be the true colour of each component separately, (giving 'colour-free' relative positions of the components). In practice, individual (estimated) values may be used when the components are observed in separate IDT-pointings, but in the majority of cases a mean ('photocentre') colour has to be adopted. (This gives slightly biased
observations when the colours are unequal, but as shown by many simulation-
results, the final effects on the astrometry are small).

The CHFDAT-calibrations are made by the well-tested subroutines used in
the ‘old’ simulations described in NDAC/LO/095, but the general layout of the
program is rather different. For several simulations I have verified however that
the results agree completely. (The old programs neglect the general-relativistic
light-deflection, but this is now included using Lindegrens ‘natdir’ routine). The
sorting of the observations from each set is done by a variant of HEAPSORT,
as described in ‘Numerical Recipes’ by Press et al.(1986). As for the computing-
times, only rough estimates can be given. On the ‘old’ HP 9000/500 of Lund
Observatory, some 0.5-1 sec is needed for each FOVC-passage. On the new HP
9000/835-machine, very preliminary runs give about 0.05 sec, translating to some
40-50 CPU-hours for the whole mission (20000 systems with 150 FOV-passages
each).

4. The CHFGEN-program

The CHFDAT-program is run until one sequential file with partly (within each set)
sorted data is available for each of the three categories of systems. The CHFGEN-
program then uses the main sort-routine of SORT23 to sort each of these files in
strict system-order. With a suitable header for each system, the output is just a
sequence of Case History Files. By separating the categories as described above,
we get one collection of CHF:s as input to STDDBL, one set for STDMUL, and
one set for SEEKDBL.

The main features of SORT23 (as described superficially in NDAC/LO/049)
are kept unchanged, in particular the use of a large direct-access file to store
LBUF (~5) observations from each set in primary memory. As presently written,
the CHFGEN program simply starts with the CHFDAT-data on a sequential disk-
file, transfers these to the direct-access file described above, and then outputs the
CHF:s sequentially on disk again. The disc-space required is about 400 Mb (for
10000 systems), but if this is too much, tape I/O may reduce it by half. From
tests on ‘dummy’ data, the full sorting will take at most some few hours, and it is
thus not a major part of the whole CHF-generation process.

5. Conclusion

The process to generate the Case History Files has been outlined rather completely.
The main programs for the task (CHFDAT and CHFGEN) are almost finished,
and have been shown to work on simulated data. The remaining ‘preparatory’
programs need a more careful specification of all input-data to be used, but they
will certainly be available when the first CHF-generation is scheduled (after the
1-year Sphere solution is completed).