CORE SOURCES SET SELECTION

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ABSTRACT. In earlier work (Kurdubov & Skurikhina, 2009) we had suggested ranking method of sources sets in order to select the list of sources that better define the orientation parameters of rigid rotation transformation from one system to another. The transformation parameters formal errors were selected as characteristic of sources set. For all catalogues IVS WG2 was selected special order in the sources list and obtained transformation parameters accuracy as function of the number of sources. For all catalogues that function has a minimum between 300 and 400 sources, adding the sources after the minimum leads to increasing formal errors of orientation parameters. After that we selected the common sources which placed before minimum of functions and obtained the "optimal set".

The aim of this study is to select the set of sources that minimize formal errors of the orientation parameters of rigid rotation transformation model. Instead of over investigators we don't use ranking of sources. We construct ranking parameter that can characterize the list of sources. Then we can compare not individual sources but set of them. Main advantage of our method is that it take into account both geometrical distribution of the sources in the set and source positions accuracy.

Lets set some definitions. Let we have two catalogues (RA,DE) and (ra,de) then we can represent the differences $dRA = RA - ra$ and $dDE = DE - de$ between them in form

$$dRA = A1\tan(DE)\cos(RA) + A2\tan(DE)\sin(RA) - A3,$$

$$dDE = A1\sin(RA) + A2\cos(RA),$$

where A_1, A_2, A_3 are transformation parameters. If we select the set of common sources in the two catalogues then we can calculate parameters $\mathbf{A} = (A1, A2, A3)$ and formal errors σ_{A1}, σ_{A2}, σ_{A3} by the Least Square method:

$$\mathbf{A} = \mathbf{N}^{-1}\mathbf{b}, \quad \sigma_{A1} = \sigma_0\mathbf{N}^{-1}[0,0], \quad \sigma_{A2} = \sigma_0\mathbf{N}^{-1}[1,1], \quad \sigma_{A3} = \sigma_0\mathbf{N}^{-1}[2,2].$$

We form normal equation matrix $\mathbf{N} = \mathbf{C^T P C}$, where $\mathbf{C} = \partial(dRA, dDE)/\partial A$ with the $\mathbf{P} = \mathbf{E}$ unitary matrix. The diagonal elements of inverted normal matrix $\mathbf{N}^{-1}[0,0]$, $\mathbf{N}^{-1}[1,1]$, $\mathbf{N}^{-1}[2,2]$ not affected by the differences between two catalogues and depend only from the set of sources. For calculation σ_0 we use the formal errors of the selected set of sources

$$\sigma_0 = \frac{\sum(\sigma_{RA})^2 + \sum(\sigma_{DE})^2}{N-3}. \tag{1}$$

Thus we calculate σ_{A1}, σ_{A2}, σ_{A3} what not affected by the differences between two catalogues and depend only from the geometrical distribution of the sources in the set and formal errors of source coordinates. We don't use for σ_0 standard formula

$$\hat{\sigma_0} = \frac{\sum(r_{RA})^2 + \sum(r_{DE})^2}{N-3} \tag{2}$$

where r_{RA} and r_{DE} - residuals after transformation, because all CRF catalogues obtained from the same data and using σ_{RA} and σ_{DE} gives more adequate results.

For source list ranking parameter q we select maximum of the orientation parameters formal errors:

$$q = MAX(\sigma_{A1}, \sigma_{A2}, \sigma_{A3}). \tag{3}$$

If we want to define the orientation of the catalogue by the best way we need select the set of sources that minimize parameter q. The obtained set of sources can be considered as set of "defining" sources. We take into account only sources presented in the ICRF-Ext.2 catalogue and have more than 10 session in the gsf008a catalogue. We use next algorithm for the selection that set of sources:

1. Triple loop over all sources to select three sources that gives minimum of q. At this step we have optimal set for $N_{sources} = 3$.
2. Search over all remaining sources in order to minimize q for $N + 1$ sources Remove the founded source from the list of remaining sources and add it to the final set.
3. Repeat step 2 for all remaining sources.

After that we have sequence of the lists then contains optimal set of sources for given $N_{sources}$ (see the bottom line on the Fig. 1, left side). We obtained for all catalogues MAX(σ_{A1}, σ_{A2}, σ_{A3}) as a function of the number of sources. For all catalogues it has a minimum between 300 and 500 sources, adding the sources after the minimum leads to increasing formal errors of orientation parameters.

The first three sources in set after step 1 were: 0851+202, 0955+476, and 2037+511.

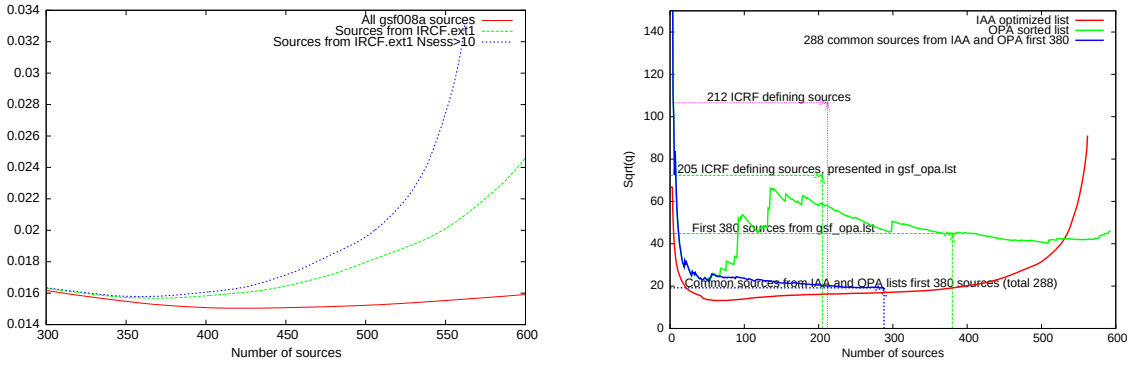

Figure 1: Normalized MAX(σ_{A1}, σ_{A2}, σ_{A3}) vs. number of sources for different catalogues (left) and MAX(σ_{A1}, σ_{A2}, σ_{A3}) vs. number of sources for different subset of gsf2008a catalogue (right).

We have compared our optimized list with the OPA ranked list. Also we calculated parameter q for ICRF 212 defining sources list and for some lists of common sources. The results are presented at the right side of Fig. 1. The $\sqrt{q}$ plotted on the graph can be considered as the maximum formal error of the orientation parameters for the given set of sources. The ICRF 212 defining list gives worse result than subset of the first sources from OPA or IAA lists. Excluding from it 7 sources not presented in OPA list gives significant improvement. First 380 sources from the OPA list (Lambert & Gontier, 2009) shows much better result than the 205 ICRF defining sources. But if we take common sources from first 380 OPA list and first 380 IAA list we obtain almost two times better result by our criteria. The common set contains 288 sources. It seems that transformation parameters for ICRF2 by the first 380 sources of OPA ranked list will be not estimated with the best accuracy. We suppose it would be better to use part of our optimized list or common part of the N sources from our list and OPA for transformation parameters calculation. The function $q(N)$ for our optimized list rapidly increases only after $N = 400$ sources. Thus if one takes the common part of any list of sources with our list for $N \leq 400$ it will increase accuracy of transformation parameters. The presented algorithm can be used for selection of core sources for new catalogues. We plan to use selected sources for actual computing transformation parameters between catalogues for ICRF3. The algorithm need to be reviewed in case of upcoming of multi wavelength reference frame.

REFERENCES

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