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Genetically Modified Networks: A Genetic Algorithm contribution to Space Geodesy. Application to the transformation of SLR and DORIS EOP time series into ITRF2005.

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In this study, we apply Genetic Algorithms (GAs) in order to optimize the referencing (and consequently the precision – stability – and the accuracy) of the EOPs with respect to ITRF2005. These EOPs are derived from SLR or DORIS data at a daily sampling, simultaneously with weekly station positions.

GAs are evolutionary algorithms, i.e. stochastic algorithms based on the evolution theory and using some genetic operators such as chromosome crossover and gene mutations. They are currently used for a broad spectrum of activities, from medicine to defence to finance. They have also been used in Earth and Space sciences (remote sensing, geophysics, meteorology, astrophysics, astronomy, etc.) since the early nineties. But, as far as we know, the present work is the first application of GAs in the framework of Space Geodesy.

In this work, we use an algorithm based on GAs to find weekly optimal sub-networks over which applying minimum constraints in order to reference EOPs. Each week, the three rotations of the involved terrestrial frames are forced to be zero with respect to ITRF2005 through minimum constraints applied over these sub-networks, which are called Genetically Modified Networks (GMNs). The reference system effects are used as objectives to optimize with GAs.

Regarding SLR, our approach provides an improvement of 10 % in accuracy for polar motion in comparison to the results obtained with the network specially designed for EOP referencing by the Analysis Working Group of the International Laser Ranging Service. This improvement of nearly 25 μas represents 50 % of the current precision of the IERS 05 C04 reference series. We also show preliminary results regarding such GMNs for the DORIS technique using two different solutions (IGN and CNES/CLS solutions).

Finally, for practical applications, we also test, for the SLR and the DORIS techniques, the possible emergence of global core networks to be used for EOP referencing on the basis of GAs.