URSI GASS 2023, Sapporo, Japan, 19 – 26 August 2023

Towards application of machine learning methods to improve performance of the UTC(CNM) timescale

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The Centro Nacional de Metrología, CENAM, the Mexican national metrology institute, has the responsibility about the establishment of the national time and frequency standards as well as the dissemination of their accuracy. Among the national time and frequency standards is the realization of the UTC, named UTC(CNM). The official time in Mexico is defined in terms of the UTC(CNM). The UTC(CNM) time differences respect to UTC were reported for first time on the Circular T 100 (May 14th, 1996) of the BIPM. Since then, the UTC(CNM) has been improved in several ways, the most important one is related to the use of a timescale algorithm that combine the measurements of a set of cesium atomic clocks and hydrogen masers in a single time scale. Values of UTC(CNM) are within 5 ns from the UTC most of the time. According with the Circular T 420 (January 13th, 2023), combined uncertainty of UTC – UTC(CNM) values is around 4 ns.

In this paper we present an evaluation of UTC(CNM) performance as result of the implementation of deep learning algorithm on the production of the timescale. We utilize a deep learning technique called Gated Recurrent Unit (GRU) due to its success on sequence-based tasks and incorporate the dropout algorithm in order to improve the generalization ability of the model. The Circular T data is considered as a time series and restructured for multi-step-ahead prediction. Additionally, the GRU is trained using the Adam Optimization Algorithm. Results of GRU predictions are used to anticipate both, the frequency and time deviations of the UTC(CNM). A new stirring on UTC(CNM), based on GRU predictions, is applied with the aim to improve the approximation of the UTC(CNM) to the UTC as well as the UTC(CNM) frequency stability. In this paper, we present an evaluation of the UTC(CNM) performance and the impact of the use of deep learning algorithm to predict [UTC-UTC(CNM)] time differences and their use to improve both, the approximation of the UTC(CNM) to UTC and the UTC(CNM) stability.