partner of COLLECTION CARE

European Union's Horizon 2020 research and innovation programme under grant agreement No 814624

Novel approach based on machine learning techniques to predict the microclimate variables inside museums

A.Bile[1], F. Frasca[2], E.Verticchio[3], G. Favero[4], C. Chimenti[5], A. Grinde[6], A.M. Siani[2], E.Fazio[1]

[1]Department of Fundamental and Applied Science for Engineering, Sapienza Università di Roma; [2]Department of Physics, Sapienza Università di Roma; [3]Department of Earth Sciences, Sapienza Università di Roma;[4] Department of Chemistry and Pharmaceutical Technologies, Sapienza Università di Roma; [5]Department of Biology e Biotechnology Charles Darwin, Sapienza Università di Roma; [6]Royal Danish Collections, Øster Voldgad.

Prevention of art collections in Rosenborg Castle through Artificial Intelligence

The environmental parameters, such as temperature, relative humidity, light and air pollutants, are relevant in conservation of cultural artefacts because they affect the rate of physical, biological and chemical deterioration mechanisms. We have built an innovative model that processes microclimatic data and, through artificial intelligence, produces predictions. We applied the algorithm to Rosenborg Castle in Denmark, partner museum of the European CollectionCare project (Fig. 1).

Fig. 1 – Main facade of Rosenborg Castle, Copenhagen, Denmark.

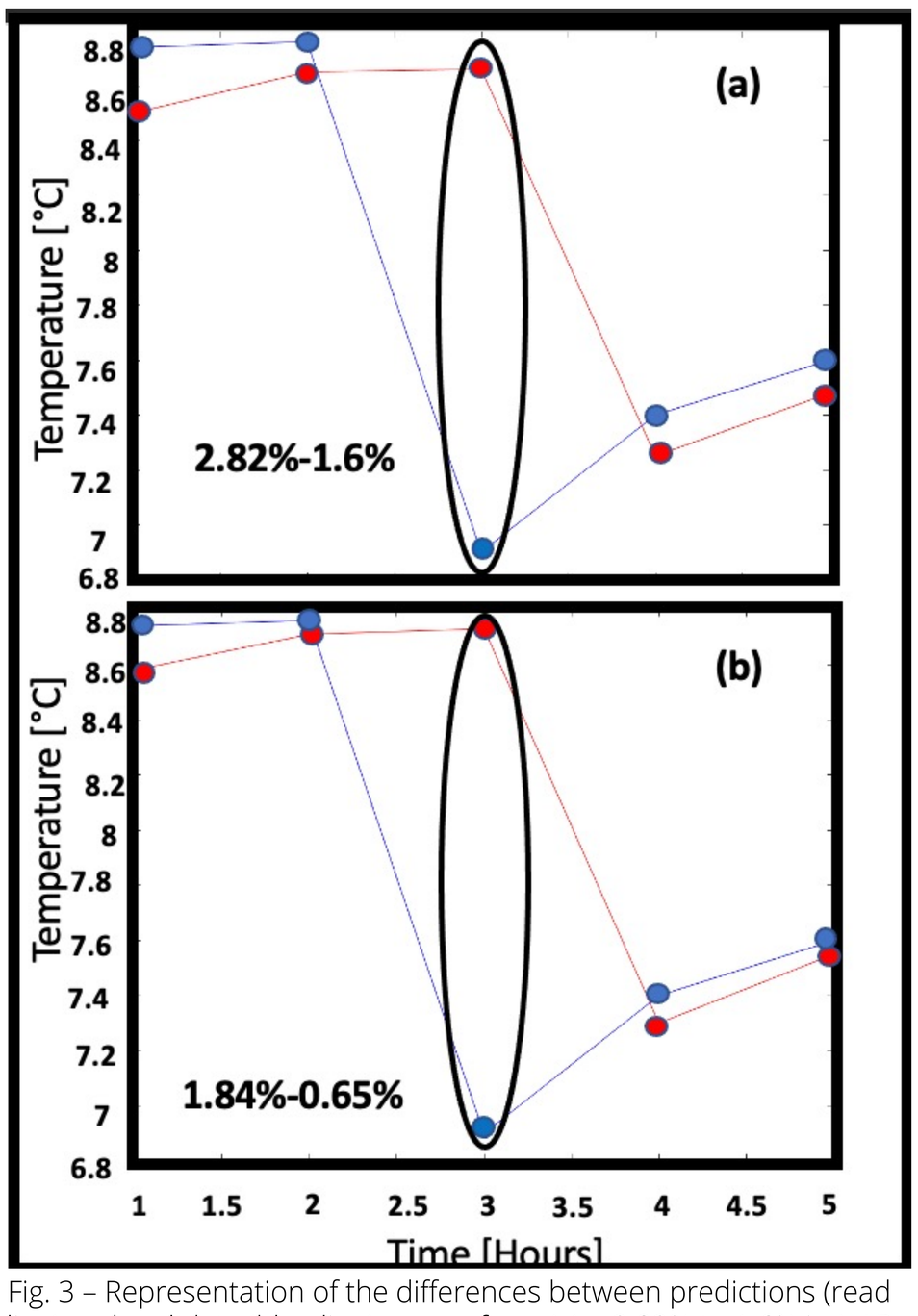

Fig. 3 – Representation of the differences between predictions (read line) and real data (blue line) ranges from (a) ~ 2.82% to 1.6% in NAR and from (b) ~1.84% to 0.65% in NARX.

The model: processing, NAR and NARX

The proposed model consists of two functional blocks. The first, in Fig. 2 (a), consists in a quality control of the available datasets and in their optimal organization. The data that passes this check are used to train two neural networks in Fig 2(b), NAR (nonlinear autoregressive) and NARX (nonlinear autoregressive with exogenous input). NAR can be trained on a single variable to predict the target; NARX predicts a target based on multiple microclimatic variables.

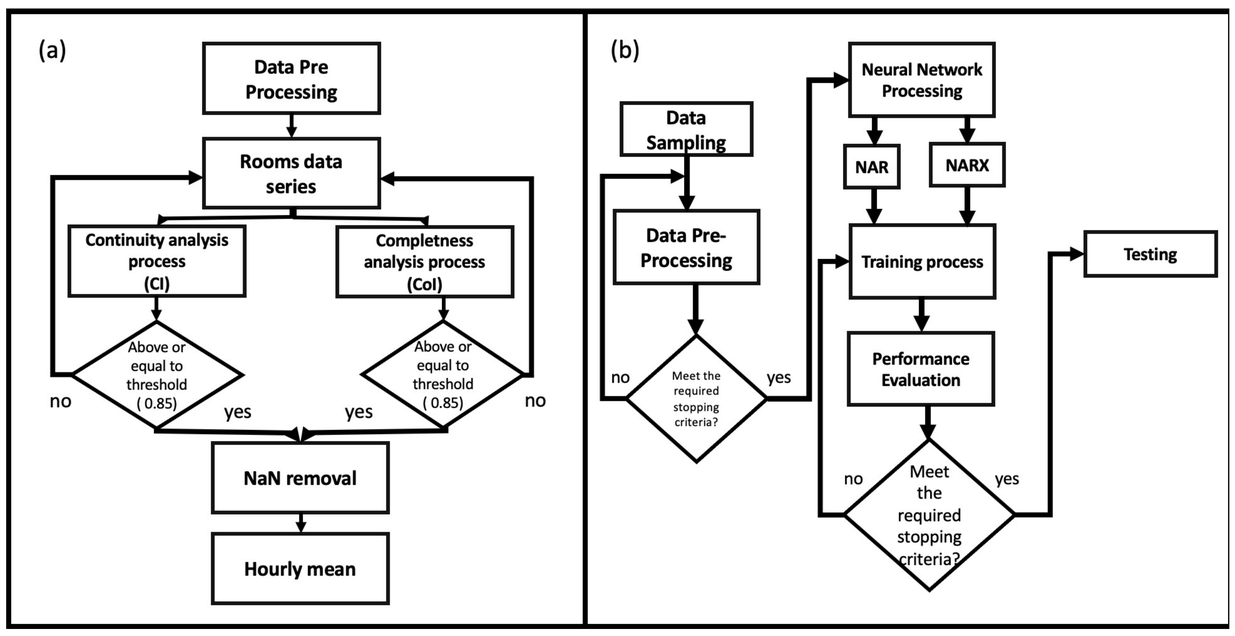

Fig. 2 – Flow-Chart of the algorithm: (a) pre-processing data steps and (b) AI functioning process.

Temperature prediction in the Rosenborg museum

Our work is applied to temperature prediction in the "The Stone Corridor" room of Rosenborg Castle. Fig 3 shows the results obtained from the two models of neural networks. The actual measurements are shown in blue while the predictions are shown in red. Both networks show an excellent degree of prediction. However with sudden changes the NAR network takes longer to reset while the NARX network takes less time. The difference between predictions and measures varies between 2.82% and 1.6% for NAR, in Fig 3 (a), while between 1.84% and 0.65% for NARX, in Fig. 3 (b).

Bile, A., Tari, H., Grinde, A., Frasca, F., Siani, A.M., Fazio, E., Novel model based on artificial neural networks to predict short-term temperature evolution in museum environment, Sensors, 2022; 22 (2): 615. https: // doi.org/10.3390/s22020615.