

D-Wave Quantum Computing Ising Model: A Case Study for Forecasting of Heat Waves

Authors : Dmytro Zubov, Francesco Volponi

Abstract : In this paper, D-Wave quantum computing Ising model is used for the forecasting of positive extremes of daily mean air temperature. Forecast models are designed with two to five qubits, which represent 2-, 3-, 4-, and 5-day historical data respectively. Ising model's real-valued weights and dimensionless coefficients are calculated using daily mean air temperatures from 119 places around the world, as well as sea level (Aburatsu, Japan). In comparison with current methods, this approach is better suited to predict heat wave values because it does not require the estimation of a probability distribution from scarce observations. Proposed forecast quantum computing algorithm is simulated based on traditional computer architecture and combinatorial optimization of Ising model parameters for the Ronald Reagan Washington National Airport dataset with 1-day lead-time on learning sample (1975-2010 yr). Analysis of the forecast accuracy (ratio of successful predictions to total number of predictions) on the validation sample (2011-2014 yr) shows that Ising model with three qubits has 100 % accuracy, which is quite significant as compared to other methods. However, number of identified heat waves is small (only one out of nineteen in this case). Other models with 2, 4, and 5 qubits have 20 %, 3.8 %, and 3.8 % accuracy respectively. Presented three-qubit forecast model is applied for prediction of heat waves at other five locations: Aurel Vlaicu, Romania - accuracy is 28.6 %; Bratislava, Slovakia - accuracy is 21.7 %; Brussels, Belgium - accuracy is 33.3 %; Sofia, Bulgaria - accuracy is 50 %; Akhisar, Turkey - accuracy is 21.4 %. These predictions are not ideal, but not zeros. They can be used independently or together with other predictions generated by different method(s). The loss of human life, as well as environmental, economic, and material damage, from extreme air temperatures could be reduced if some of heat waves are predicted. Even a small success rate implies a large socio-economic benefit.

Keywords : heat wave, D-wave, forecast, Ising model, quantum computing

Conference Title : ICQOQC 2015 : International Conference on Quantum Optics and Quantum Computing

Conference Location : Paris, France

Conference Dates : November 19-20, 2015