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Time Series Simulation by Conditional Generative Adversarial Net

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Abstract : Generative Adversarial Net (GAN) has proved to be a powerful machine learning tool in image data analysis and generation. In this paper, we propose to use Conditional Generative Adversarial Net (CGAN) to learn and simulate time series data. The conditions include both categorical and continuous variables with different auxiliary information. Our simulation studies show that CGAN has the capability to learn different types of normal and heavy-tailed distributions, as well as dependent structures of different time series. It also has the capability to generate conditional predictive distributions consistent with training data distributions. We also provide an in-depth discussion on the rationale behind GAN and the neural networks as hierarchical splines to establish a clear connection with existing statistical methods of distribution generation. In practice, CGAN has a wide range of applications in market risk and counterparty risk analysis: it can be applied to learn historical data and generate scenarios for the calculation of Value-at-Risk (VaR) and Expected Shortfall (ES), and it can also predict the movement of the market risk factors. We present a real data analysis including a backtesting to demonstrate that CGAN can outperform Historical Simulation (HS), a popular method in market risk analysis to calculate VaR. CGAN can also be applied in economic time series modeling and forecasting. In this regard, we have included an example of hypothetical shock analysis for economic models and the generation of potential CCAR scenarios by CGAN at the end of the paper.

Keywords : conditional generative adversarial net, market and credit risk management, neural network, time series
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