Abstract: Gaussian processes (GPs) are popular, flexible, and interpretable probabilistic models for functions. GPs are well suited for big data in areas such as machine learning, regression, and geospatial analysis. However, direct application of GPs is computationally infeasible for large datasets. We consider a framework for fast GP inference based on the so-called Vecchia approximation. Our framework contains many popular existing GP approximations as special cases. Representing the models by directed acyclic graphs, we determine the sparsity of the matrices necessary for inference, which leads to new insights regarding the computational properties. Based on these results, we propose novel Vecchia approaches for noisy, non-Gaussian, and massive data. We provide theoretical results, conduct numerical comparisons, and apply the methods to satellite data.

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