

## Machine learning-based performance prediction framework for real-time 3D asset optimization in 3D modeling

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This study presents a machine learning-based performance prediction framework that enables 3D artists and game developers to estimate rendering cost. such as frame rate, CPU/GPU usage, memory consumption, and draw calls during the asset creation process. With the rapid growth of the gaming and real-time graphics industry, the demand for performance optimized 3D assets has increased significantly. However, existing tools such as Unity Profiler and Unreal Insights are inherently reactive, providing feedback only after assets are imported into an engine, which leads to iterative, time-consuming optimization cycles and production delays. To address this gap, the proposed system introduces a proactive, real-time prediction approach that operates at the modeling stage. A structured dataset of 3D asset features including polygon count, vertex density, texture resolution, and shader complexity is combined with runtime performance metrics collected from Unity. Using Random Forest, XGBoost, Multi-Layer Perceptron, and Graph Convolutional Network models, the framework predicts key performance indicators with high accuracy. Preliminary experiments show best  $R^2$  values for frame-rate prediction, while maintaining millisecond-level inference latency suitable for interactive use. The trained model is integrated into Blender through a plug-in and REST based service, providing instant feedback to artists as they modify meshes, materials, and textures. A user survey indicates that 90% of participating artists perceive the tool as practically valuable for reducing optimization effort. Overall, this work introduces a proactive surrogate model for 3D asset performance prediction, with strong potential to reduce iteration cycles and streamline real-time content production pipelines.

**Keywords:** 3D Assets, Machine Learning, Rendering Performance, Optimization, Game Engine