Fastradiomics: Accelerating High-Throughput Texture Feature Extraction Via Just-in-time Compilation and Vectorization

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Introduction

Radiomics turns medical images into high-dimensional data, but slow computation limits its use in real-time clinical practice and large population studies. Existing gold-standard libraries are reliable but often depend on repeated Python loops resulting in longer processing times and decreased efficiency. As a result, expanding radiomic analysis to larger or time-sensitive applications is challenging.

Hypothesis

As a result, expanding radiomic analysis to larger or time-sensitive applications is challenging. We hypothesis FastRadiomics, a high-performance feature extraction engine leveraging Just-In-Time (JIT) compilation (via Numba) and vectorized memory management.

Methods

Unlike traditional implementations, FastRadiomics compiles Python code into optimized machine code at runtime and utilizes parallel threading to bypass the Global Interpreter Lock (GIL). We benchmarked the engine against the standard PyRadiomics library using volumetric chest CT data, evaluating both numerical accuracy (feature concordance) and execution speed across multiple segmented Regions of Interest (ROIs).

Results

Validation confirmed that FastRadiomics maintains strict mathematical equivalence with standard implementations, with texture feature deviations (GLCM Energy, Contrast) remaining below 1%. Performance benchmarking demonstrated drastic efficiency gains. While the baseline extraction required an average of 7.0s per ROI, the serial FastRadiomics implementation reduced this 1.92 s (≈3.6× speedup). Enabling parallel execution further reduced processing time to ~0.082 s per ROI, achieving an ≈85× speedup on standard hardware.

Conclusion

FastRadiomics effectively eliminates the computational latency of radiomic feature extraction. By reducing processing time from seconds to sub-seconds, this open-source framework enables on-the-fly radiomic phenotyping at the point of care and significantly accelerates data pipelines for large-scale machine learning research in imaging informatics.

Keywords

Imaging Research; Machine Learning