Contribution ID: **90** Type: **Standard 15 min talk**

[Remote] Randomized Point Serialization-Based Efficient Point Transformer in High-Energy Physics Applications

Tuesday 15 October 2024 14:00 (15 minutes)

This study introduces a novel transformer model optimized for large-scale point cloud processing in scientific domains such as high-energy physics (HEP) and astrophysics. Addressing the limitations of graph neural networks and standard transformers, our model integrates local inductive bias and achieves near-linear complexity with hardware-friendly regular operations. One contribution of this work is the quantitative analysis of the error-complexity tradeoff of various sparsification techniques for building efficient transformers. Our findings highlight the superiority of using locality-sensitive hashing (LSH), especially OR & AND-construction LSH, in kernel approximation for large-scale point cloud data with local inductive bias. Based on this finding, we propose LSH-based Efficient Point Transformer (HEPT), which is based on randomized point serialization via E^2LSH with OR & AND constructions and is built upon regular computations. HEPT demonstrates remarkable performance on two critical yet time-consuming HEP tasks (tracking & pileup mitigation), significantly outperforming existing GNNs and transformers in accuracy and computational speed, marking a significant advancement in geometric deep learning and large-scale scientific data processing. Our code is available at https://github.com/Graph-COM/HEPT.

Focus areas

HEP

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Session Classification: Contributed talks