ABCI 3.0開発加速利用 （2025年度）成果概要（公開用）

課題名：Leveraging LLM for efficient による物理信号処理	実施時期：2025-06~2026-02 所属機関名：産業技術総合研究所 代表者氏名：叶　嘉星

成果概要：

This paper synthesizes the concept of Sim2Real generalization with Physics-Ticket lottery hypothesis to enable parameter-efficient fine-tuning and pruning of transformer models. The proposed approach efficiently leverages the pretrained models for physics signal processing in the context of ultrasonic wavefield pattern analysis for non-destructive inspection.

成果のポイント：

Deploying large-scale Vision Transformers (ViTs) on edge devices remains a significant challenge due to their high computational demands. In this work, we propose a novel two-stage framework that functions not only as a compression technique but also as a robust method for inductive-bias discovery within physics-based ultrasonic wavefield imaging. To address the dual challenges of computational efficiency and domain adaptation to physics-based signal processing, we introduce a pruning-then-finetuning framework to exploit physics knowledge on simulated data by means of Masked Autoencoder (MAE). By characterizing the physics patterns through loss gradients derived from simulation data reconstruction, compact subnetworks can be identified and retained via model pruning to encode physical causality, such as diffraction and scattering patterns, while discarding redundant structures in the large-scale ViT. The resulting physics-guided subnetworks are then well transferable via fine-tuning to limited real data, yielding substantial reductions in model size and computational cost without appreciable performance drop. Extensive experimental comparisons show that the proposed method achieves a 90% pruning ratio while maintaining a Macro-F1 score of 97.2%, comparable to the dense model baseline. This framework offers a prospective solution to deploying state-of-the-art AI models for on-site analysis of physics measurements on edge platforms.

成果についてより詳細な情報を提供しているWebページ、発表論文などの情報：

Jiaxing YE, Takumi Kobayashi, Physics-Guided Prune-then-finetune of Vision Transformers for Wavefield Pattern Analysis, 28th International Conference on Pattern Recognition (ICPR 2026), Accepted