

# A comprehensive foundation model for cryo-EM image processing

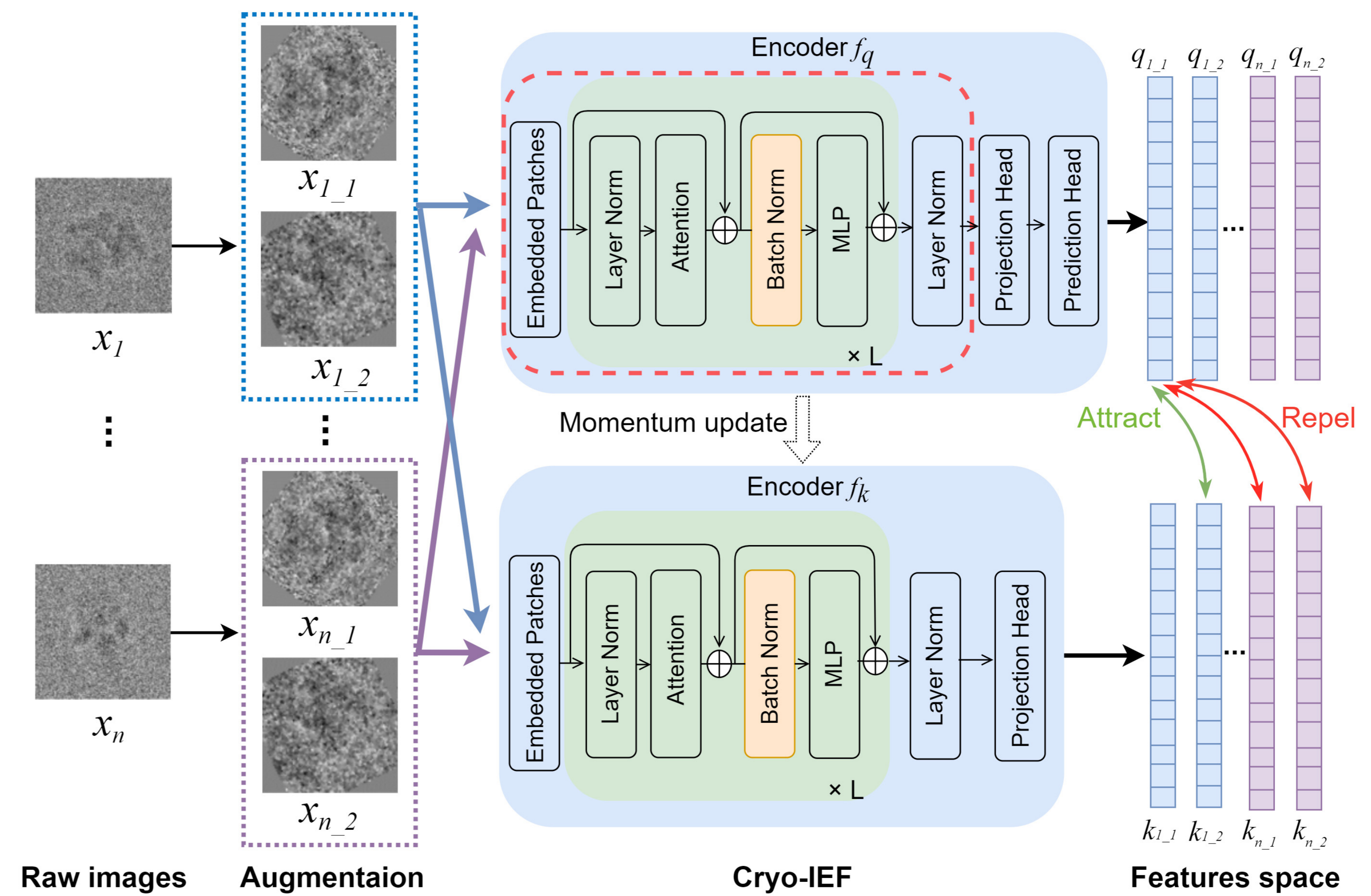
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## Abstract

Cryogenic electron microscopy (cryo-EM) has become a premier technique for determining high-resolution structures of biological macromolecules. However, its broad application is constrained by the demand for specialized expertise. To address this limitation, we introduce the **Cryo-EM Image Evaluation Foundation (Cryo-IEF)** model, a versatile tool pre-trained on **~143 million cryo-EM particle images** through unsupervised learning. Cryo-IEF performs diverse cryo-EM processing tasks, including particle classification by structure, pose-based clustering, and image quality assessment. Building on this foundation, we developed **CryoWizard**—a **fully automated single-particle cryo-EM processing pipeline** enabled by fine-tuned Cryo-IEF for efficient particle quality ranking. CryoWizard resolves high-resolution structures across samples of varied properties and effectively mitigates the prevalent challenge of preferred orientation in cryo-EM.

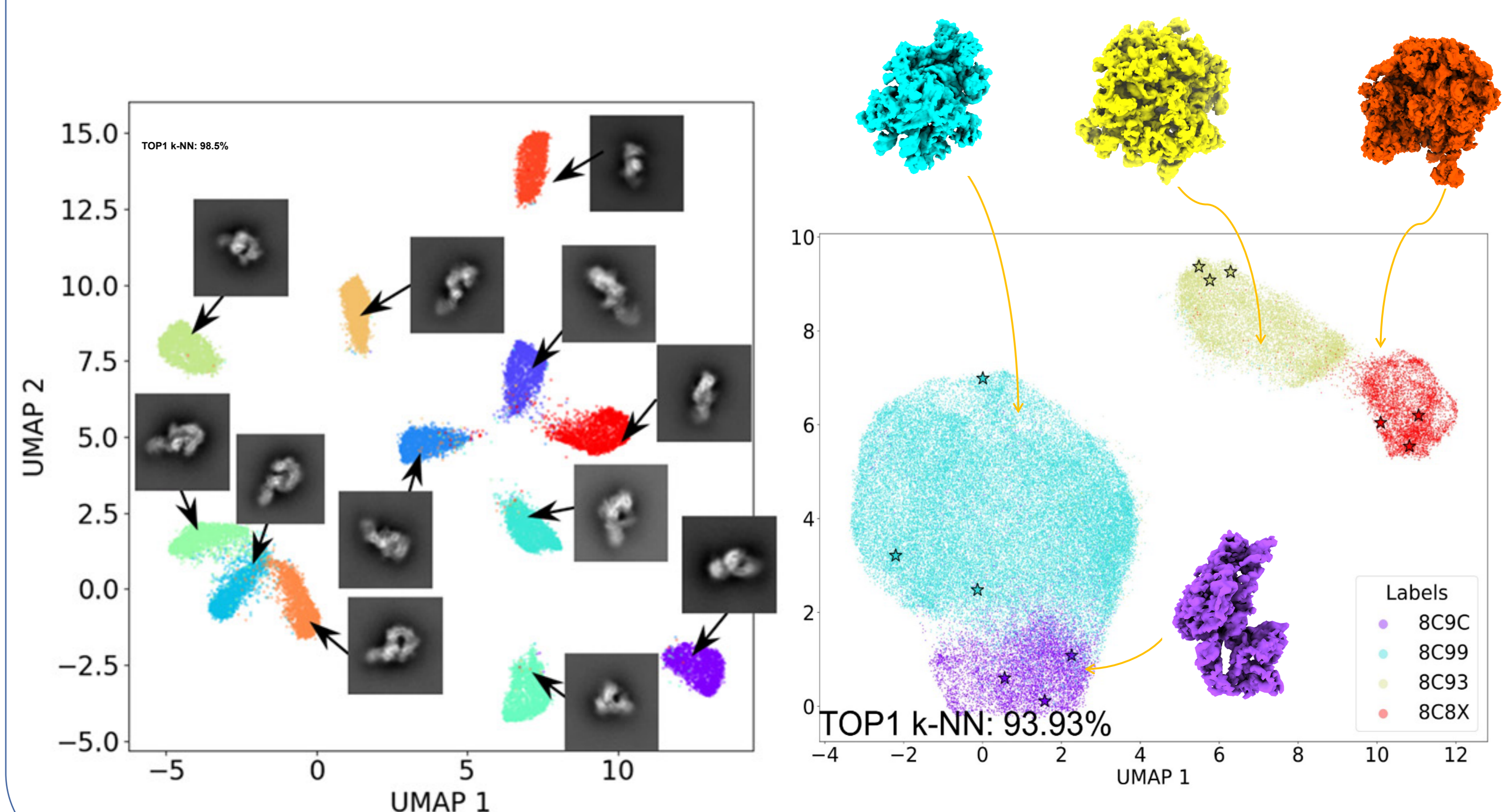
## Cryo-IEF: Cryo-EM Image Evaluation Foundation model

The first pretrained foundation model for cryo-EM particle images, tailored for a broad range of cryo-EM image processing tasks.

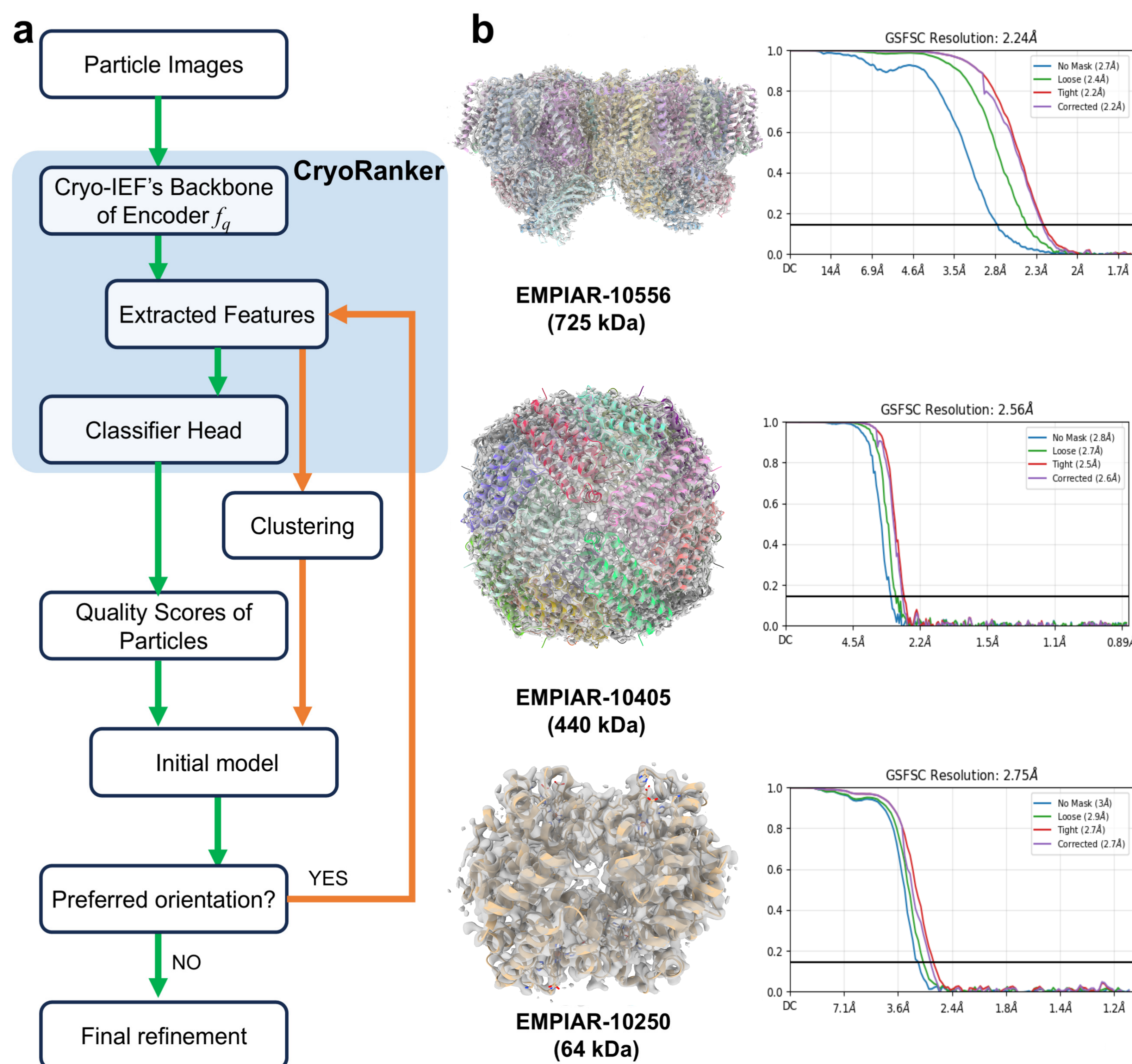


Cryo-IEF clusters particles by pose

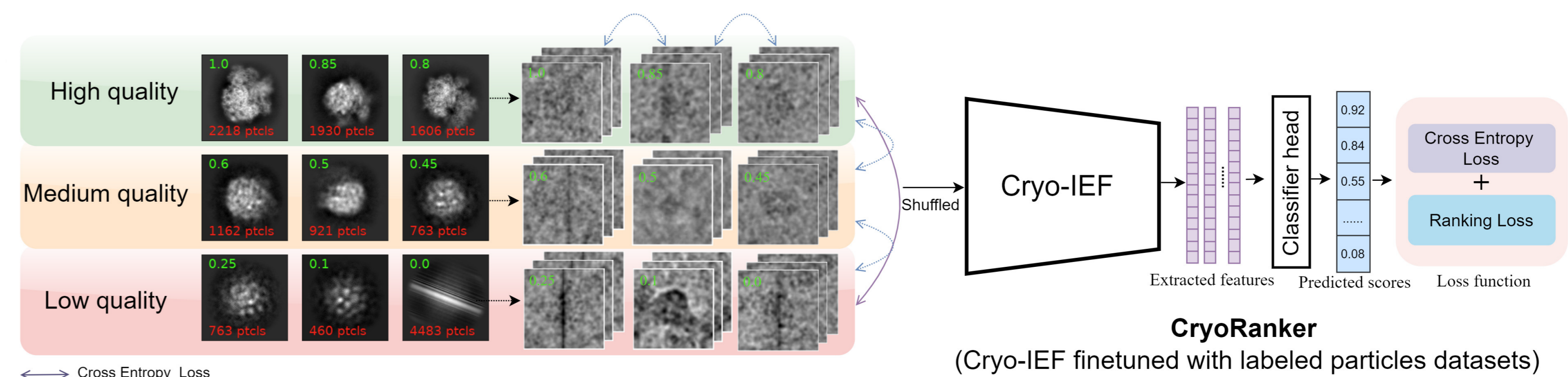
Cryo-IEF classifies particles from different structures



## CryoWizard: An automated single-particle cryo-EM data processing pipeline



## CryoRanker: Fine-tuned version of Cryo-IEF, designed for ranking particle images by quality



- Yan, Y., Fan, S., Yuan, F. et al. A comprehensive foundation model for cryo-EM image processing. *Nat Methods* 23, 88-95 (2026). <https://doi.org/10.1038/s41592-025-02916-8> (Article)
- Yan, Y., Shen, H. Artificial intelligence foundation model automates cryo-EM structure determination. *Nat Methods* 23, 26-27 (2026). <https://doi.org/10.1038/s41592-025-02917-7> (Research Briefing)

Cryo-IEF



CryoWizard

