



OpenComplex-2: A Pure Data-Driven System for Biomolecular Conformation Prediction

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2024.12

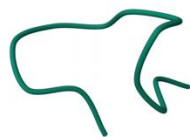




OpenComplex -2 : From Structure to Ensemble



(a) OpenComplex Sampling



(pdbid: 9bvs)



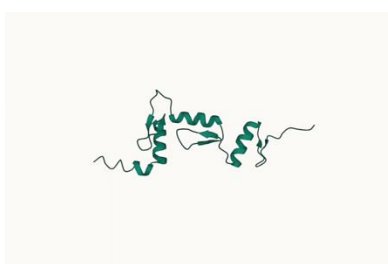
(c) AlphaFold3 Sampling



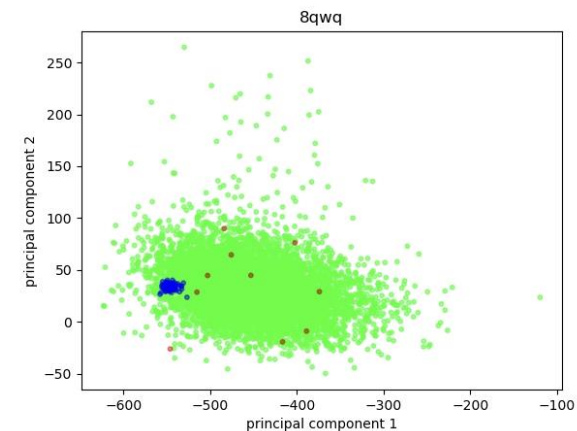
(a) OpenComplex Sampling



(pdbid: 8tho)



(c) AlphaFold3 Sampling



PCA Visualization of multiple samples ;

AlphaFold3 tends to predict a stable conformation that cannot cover **NMR** results, while **OpenComplex** sampling can provide stable coverage

AlphaFold3 (100 samples)	OpenComplex2 (100 samples)	OpenComplex2 (1000 samples)
1.9%	31.3%	98.4%

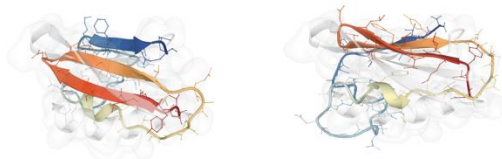
The Successful Coverage Rate over different sampling



OpenComplex -2 : Pathway Prediction



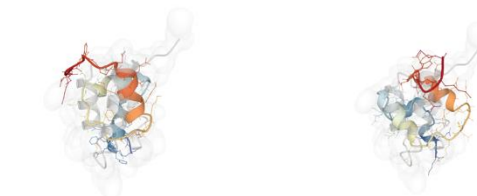
Protein Villin
(Left) OpenComplex2 (Right) Anton



Protein G
(Left) OpenComplex2 (Right) Anton



Protein B
(Left) OpenComplex2 (Right) Anton



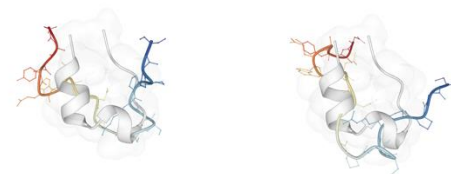
Homeodomain
(Left) OpenComplex2 (Right) Anton



WW
(Left) OpenComplex2 (Right) Anton



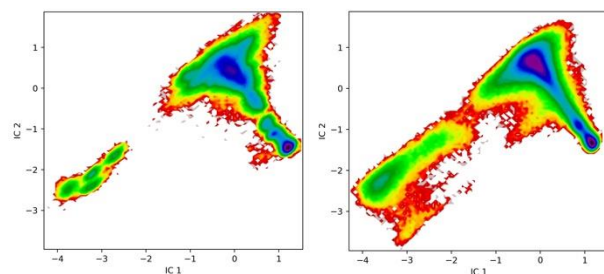
a3D
(Left) OpenComplex2 (Right) Anton



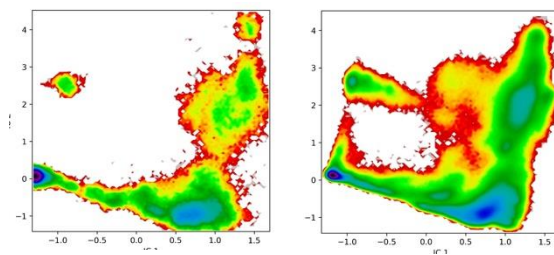
Trp-Cage
(Left) OpenComplex2 (Right) Anton



NTL9
(Left) OpenComplex2 (Right) Anton



TICA Map of Protein Villin under 1M samples
(Left) OpenComplex2 (Right) Anton

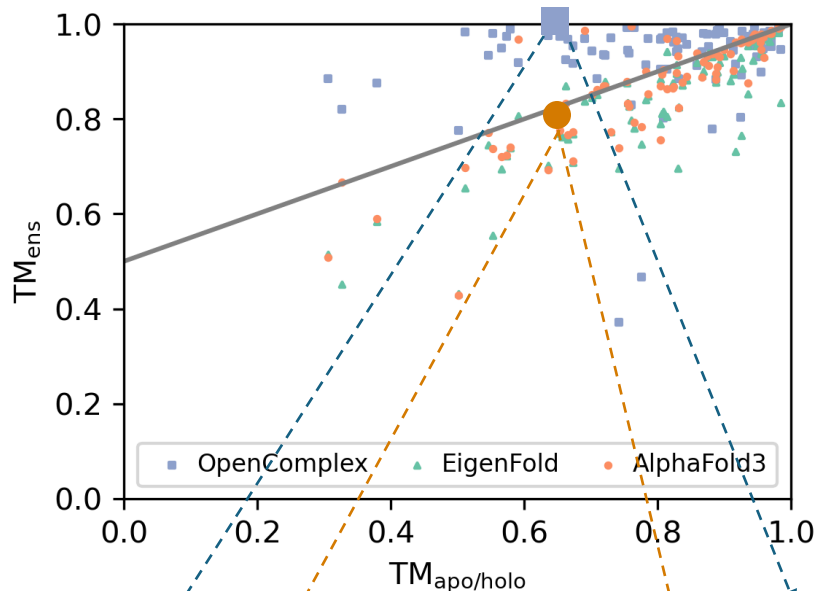


TICA Map of Protein G under 1M samples
(Left) OpenComplex2 (Right) Anton

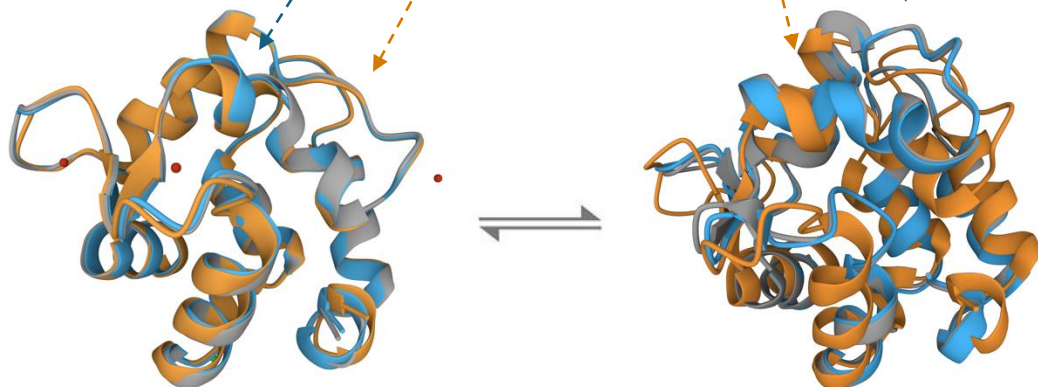


OpenComplex-2 : Multi-Conformation prediction

➤ OpenComplex captures ligand-bound states



- Induced-fit docking phenomenon: the interaction between a protein and a rigid binding partner induces a **conformational change** in the protein
- These conformational changes promote key regulatory mechanisms, including signal transduction, cooperativity, etc
- AlphaFold3 does not reproduce conformational diversity



1RRO (Holo)

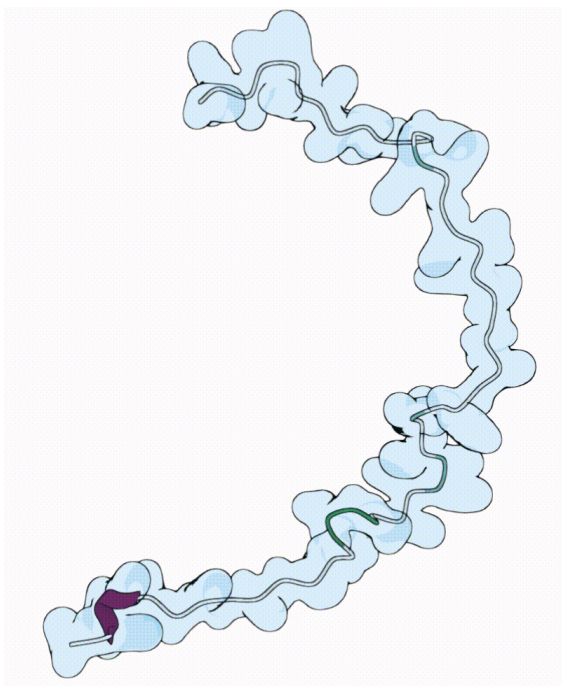
TM score: 0.99 vs 0.98

2NLN (Apo)

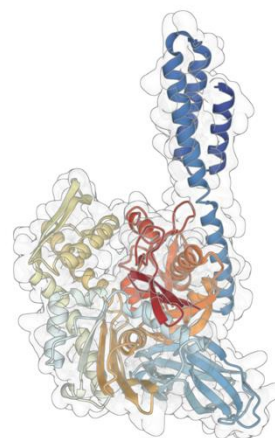
TM score: 0.98 vs 0.66



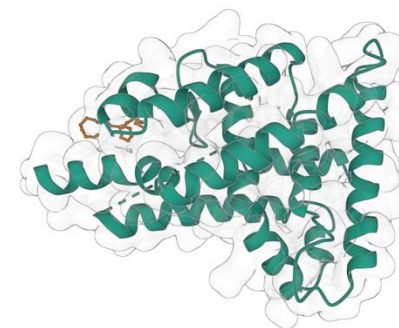
OpenComplex-2: Dynamic Simulation (In-house)



Crambin protein folding simulation:
Simulated the process of protein
gradually folding from an unfolded state
into a stable conformation



AMP-activated protein kinase
conformational change simulation: In
the absence of ADP, AMPK switches
between open and closed states



Retinoid X Receptor (RXR) ligand
binding simulation: After ligand binding,
the RXR protein undergoes a
conformational change.



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Key takeaway:

- A **homology-aware complete-graph representation**
 - encodes comprehensive structural and chemical information between all atom pairs
- **Graphfusion:**
 - FloydAttention for efficient information propagation
 - Pure Diffusion without auxiliary losses

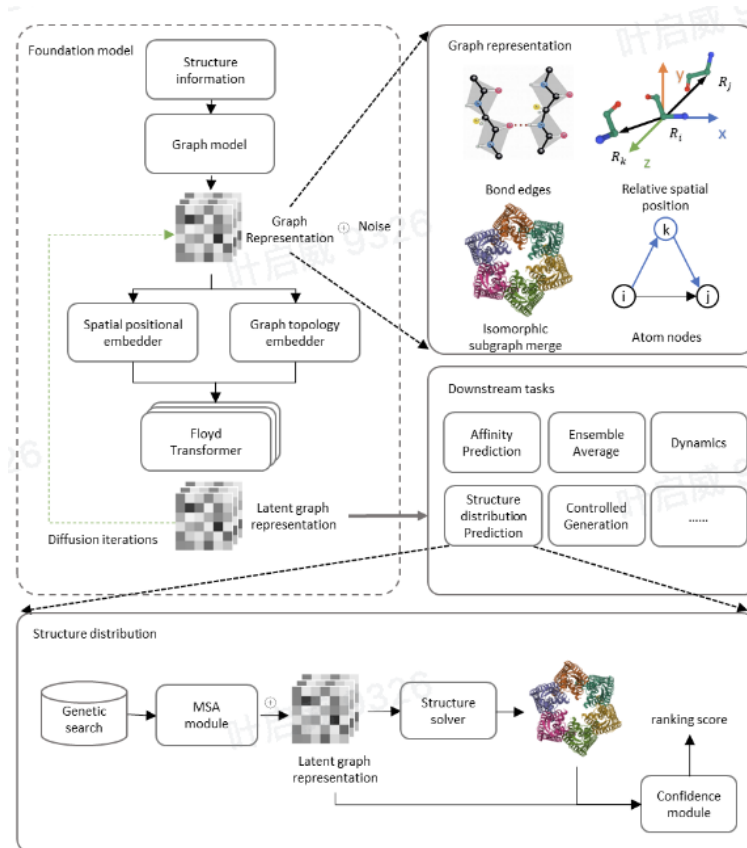


Figure1. Overview of OpenComplex2 architecture and training flow. OpenComplex2 consists of two training stages: in the pre-training stage, the model focuses on structural relationships between atoms; in the fine-tuning stage, it incorporates additional information for specific tasks.

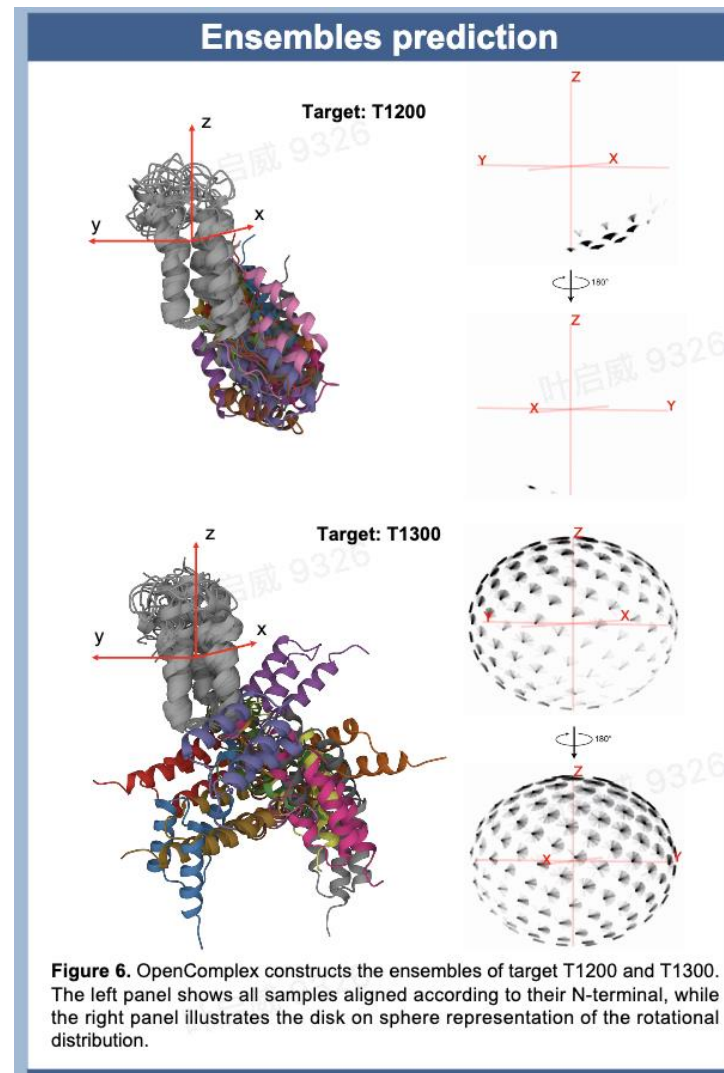


Figure 6. OpenComplex constructs the ensembles of target T1200 and T1300. The left panel shows all samples aligned according to their N-terminal, while the right panel illustrates the disk on sphere representation of the rotational distribution.

Thanks



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