

Modeling of Protein Complexes in CASP13 and CAPRI Round 46

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PPI3D and VoroMQA

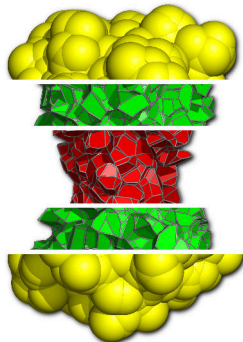
PPI3D:

Search for templates of
protein-protein interactions



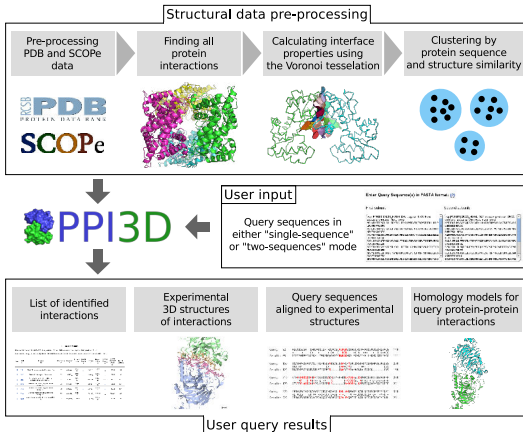
VoroMQA:

Quality assessment of protein
structural models



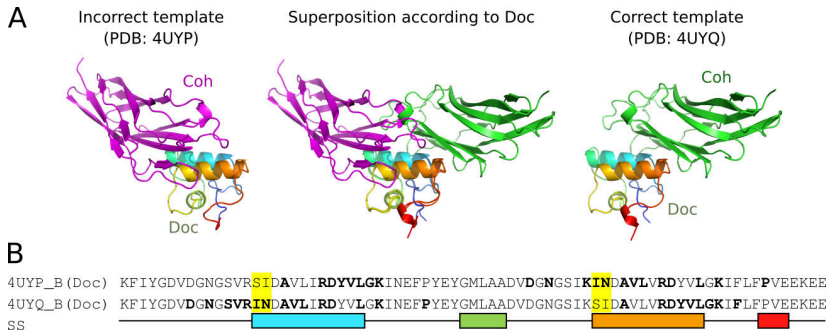
PPI3D: search, analyze and model protein interactions

<http://bioinformatics.ibt.lt/ppi3d/>



PPI3D finds alternative protein interaction modes

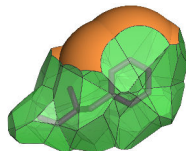
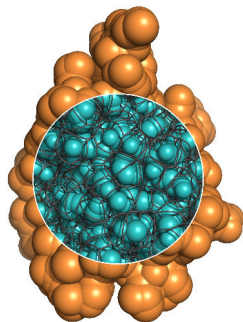
Templates for CASP T0921-T0922, CAPRI T120



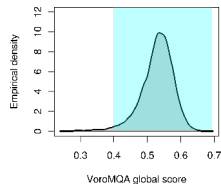
Dapkūnas et al., *Proteins*, 2018, 86:292

VoroMQA: Voronoi tessellation-based model quality assessment

$$E(a_i, a_j, c_k) = \log \frac{P_{\text{exp}}(a_i, a_j, c_k)}{P_{\text{obs}}(a_i, a_j, c_k)} = \log \frac{F_{\text{exp}}(\text{area}(a_i), \text{area}(a_j), \text{area}(c_k))}{F_{\text{obs}}(\text{area}(a_i, a_j, c_k))}$$

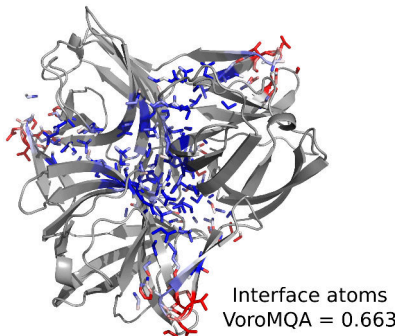
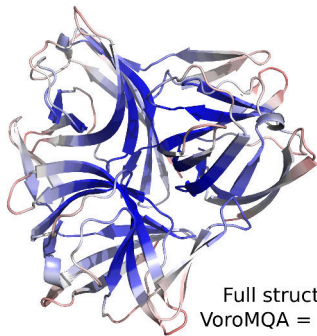


PDB X-ray structures



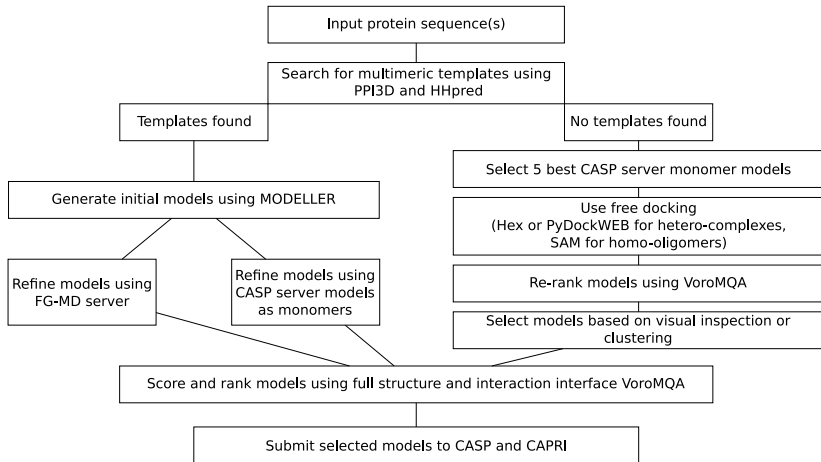
Evaluation of protein interaction interface using VoromQA

PDB ID 5FJL, CASP T0860, CAPRI T110

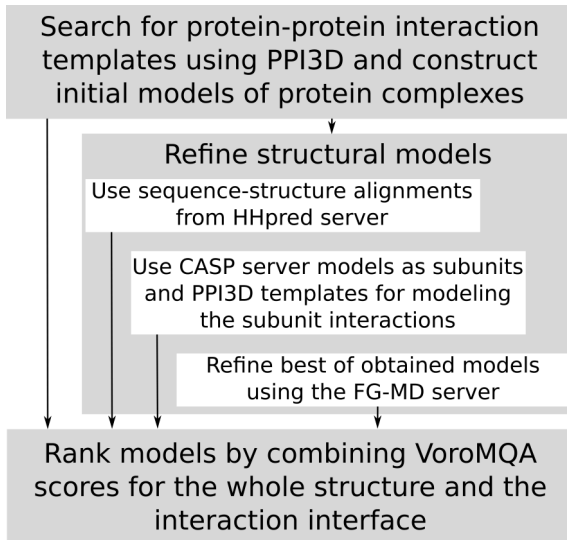


Dapkūnas et al., *Proteins*, **2018**, 86:292

Modeling workflow



Template-based modeling workflow



Free docking workflow

- ▶ Select 5 best CASP server models according to VoroMQA
- ▶ Heteromers: rigid body docking using Hex or PyDockWEB
- ▶ Homomers: symmetry docking using Sam
- ▶ Re-scoring docking poses using VoroMQA
- ▶ Visual inspection of models based on possible templates
- ▶ Clustering of docking models

Results

	Templates found	Partial templates found	Free docking	
Possible to model, we generated a model	17	10	2	29
Possible to model, we failed	2	5	2	9
Impossible to model	0	3	1	4
Total	19	18	5	42

Cases of successful template-based modeling

T0998 (A2)

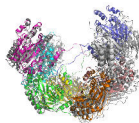
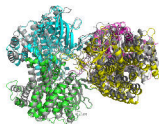
T0979 (A3)

T0961/CAPRI T139 (A4)

T0995/CAPRI T147 (A8)

H0974/CAPRI T142 (A1B1)

CASP:
Image
redacted



CASP:
Image
redacted

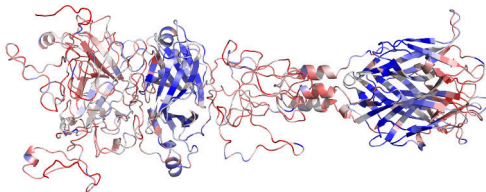
Accurate models are generated, if templates are found using PPI3D

CASP:

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Modeling domain interactions: problems with linkers

T0960 trimer model
(QS_glob=0.289, CAD_interface=0.166)



T1004 trimer model
(QS_glob=0.639, CAD_interface=0.476)

90

CASP:
Image redacted

0 (bad)  1 (good)

Interface vs. whole structure quality: T0999

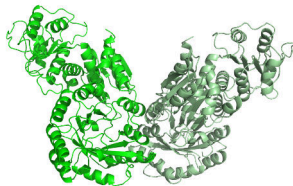


D1: homodimer D2: probably monomer D3: ? D4-D5: homodimer

D1 homodimer model



D4D5 homodimer model



Free docking: successful only rarely

H1015	H1017	H1019
QS_glob=0.088	QS_glob=0.359	QS_glob=0.147

90

CASP:
Images redacted

- ▶ Monomer quality may be important
- ▶ More reliable scoring methods are necessary
- ▶ Despite incorrect subunit orientation, interface patches can be predicted correctly

Conclusions

- ▶ PPI3D web server is useful in finding templates for modeling protein complexes
- ▶ Modeling a multimer may improve quality of subunits
- ▶ Linking domains of the same subunit may be problematic
- ▶ Even incomplete models can be highly accurate at the interaction interface
- ▶ Free docking is rarely successful

Acknowledgements

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