CASP14 : InterDomain Performance

R. Dustin Schaeffer, Lisa Kinch, Nick Grishin
Full-length results suggest the future contains fewer EVUs

- Prediction of domain position in multidomain targets was challenging
- EVUs can belong to multiple assessment categories
- Performance in individual assessment categories suggested full-length predictions worthy of independent assessment
Selection of Domain Interaction Targets

<table>
<thead>
<tr>
<th>Split Target Domains</th>
<th>D0</th>
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<tbody>
<tr>
<td>T1024</td>
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<td>T1094</td>
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<tr>
<td>T1101</td>
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<tr>
<td>T1038</td>
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<td>T1052</td>
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<td>T1061</td>
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<tr>
<td>T1085</td>
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</tbody>
</table>

1. Conformation change

Template conformations

T1091

2. Little Interaction dictated by complex

3. Mainly Oligomeric
CASP 14 InterDomain targets
What about T1044?

Very few submitted models / calculated scores

Interdomain scores for submitted models are mostly poor:

- e.g. F1 score

T1044 – 9 EVUs + one previously published region excluded from individual consideration

T1044 was excluded from the PCA+heatmap interdomain analysis due to lack of data
BAKER-Experimental outperforms on T1044

1281 contacts, F1 56.0
T1044 Morph Movie
CASP14 interdomain scores repurposed from assembly analysis

**Iface-check**
- Precision - % of correct interdomain contacts over total model interdomain contacts
- Recall - % of correct interdomain contacts over total native interdomain contacts
- **Jacc. Coefficient** – Shows the similarity of model and target interfaces given the residues participating in interdomain interfaces in the model
- **F1** – Harmonic mean of the precision and recall

**QS**
- QS (Contact Agreement Score) – Fraction of correctly modeled interface contacts over the maximum of either correct (target) or predicted (model) interface contacts
- Global.RMSD – RMSD over all domains based on the lowest RMSD domain matching
- Iface.RMSD – RMSD of the superposition based on the alignment of interface residues

**Chose 3 prediction Center contact scores for overall interdomain ranking**

PMID: 28874689

PMID: 29071742
Interdomain Top Performance Similar to Domain Category

- Analysis on model 1
- Top Group: 427
- Top Server: 209
- Top5: 427, 403, 420, 473, 339

<table>
<thead>
<tr>
<th>Gr. #</th>
<th>Group</th>
<th>SumZ(&gt;0)</th>
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<tbody>
<tr>
<td>427</td>
<td>AlphaFold2</td>
<td>35.30</td>
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<tr>
<td>403</td>
<td>BAKER-experimental</td>
<td>15.71</td>
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<td>420</td>
<td>MultiCom</td>
<td>8.98</td>
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<td>473</td>
<td>BAKER</td>
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<td>339</td>
<td>ProQ3D</td>
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<tr>
<td>334</td>
<td>FEIG-R3</td>
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<tr>
<td>209</td>
<td>BAKER-ROSETTASERVER</td>
<td>7.84</td>
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</table>

What is the sensitivity of these rankings to different parameters?
Comparison of ranking schemes show ranks of top groups insensitive to chosen scores/weights/sum, some sensitivity to model selection...

![Comparison of ranking schemes](image)
What methods did you use?

• PCA
  • pcaMethods implementation of NIPALS PCA

• Heatmap clustering
  • pheatmap() R implementation

• Repurposed interchain assembly scores for interdomain analysis
  • QS
  • Iface-check
Interdomain Scores – Filter Missing Values

- Selected model: 1st
- Scores: Jacc.Coeff., F1, Qsb100
- Manually scaled to 0-100
- 99/135 groups were considered

Number of non-NA scores per Group for InterDomain Targets
10 targets * 3 scores

9-10 targets submitted

Selected groups compared by heatmap
Contact Z-scores for Interdomain Targets for Selected Groups

Branches weighted by performance

Score converted to Z-scores over selected groups/scores/models. 1.3% missing data imputed
Contact Z-scores for Interdomain Targets for Selected Groups

Scaled data over selected groups/scores/models
Contact Z-scores for Interdomain Targets for Selected Groups

Sum over contact Z-scores for each target, then cluster by target.
SumZ of selected contact scores cluster groups by well-predicted domain interfaces
SumZ of selected contact scores shows clustering by target domain count.
SumZ of selected contacts scores

Targets in which AlphaFold2, Baker groups outperformed on InterDomain targets
T1094: Two domains that look like 3

AlphaFold (427), F1 = 68.3
SumZ(contact) = 10.5

BAKER-Experimental (403), F1 = 50
SumZ(contact) = 5.36

1127.3 Å²
interface area

PISA PMID: 17681537
Comparison of 2-domain/EVU contact score annotated by interface buried ASA quartile
T1038: Interdomain interactions in the presence of multimeric interaction

AlphaFold2 (427_1), SumZ(contact) = 7.77, GDT_TS = 86.7

BAKER-Experimental (403_1), SumZ(contact) = -3.29, GDT_TS = 26.4

Inter-domain interface area

733.5 Å²

Inter-chain interface area

943.9 Å²

T1038 w/ dimer partner
PCA – InterDomain target / scores (w427)

- Scaling = prescaled raw contact scores
- Centered
- NIPALS imputation (1.3 % missing data)
- 30 variables (scores*models)
- 99 samples (groups)

AlphaFold2 distinct from manual and server clusters
PCA – Interdomain targets / contact scores (no427)

Baker also distinct from manual cluster removed from PCA

MultiCom and ProQ3D distinct from server cluster removed from PCA

JCF1/Qsb InterDomain targets

PC1 (46.8%)  PC2 (10.5%)

BaseS  manual  server  server  Top5  TopS

427  AlphaFold2
403  BAKER-experimental
420  MultiCom
473  BAKER
339  ProQ3D
209  BAKER-ROSETTASERVER
Sum of General Z-scores (GDT/IDDT) on Interdomain targets

Can InterDomain targets by assessed by structural Scores?

Rank SumZ(>0) for top20 InterDomain groups (general scores)
Weights: GDT_TS/IDDT = 1
Performance between Interdomain and general targets correlates

<table>
<thead>
<tr>
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<th>#</th>
<th>Ri</th>
<th>Rg</th>
</tr>
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</table>
Conclusions

• Groups which perform well on Interdomain targets perform well on general targets
  • AlphaFold clearly top performer, scores well even by GDT
  • Baker clear second, top T1044 prediction

• 2-domain targets are being predicted well and above baseline by many groups
  • Targets with multiple domain interfaces are still not being predicted well
Thank You!

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Ezgi Karaca (Assembly)
Chaok Seok (Model Accuracy)
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