CAID

Critical Assessment of Intrinsic protein Disorder

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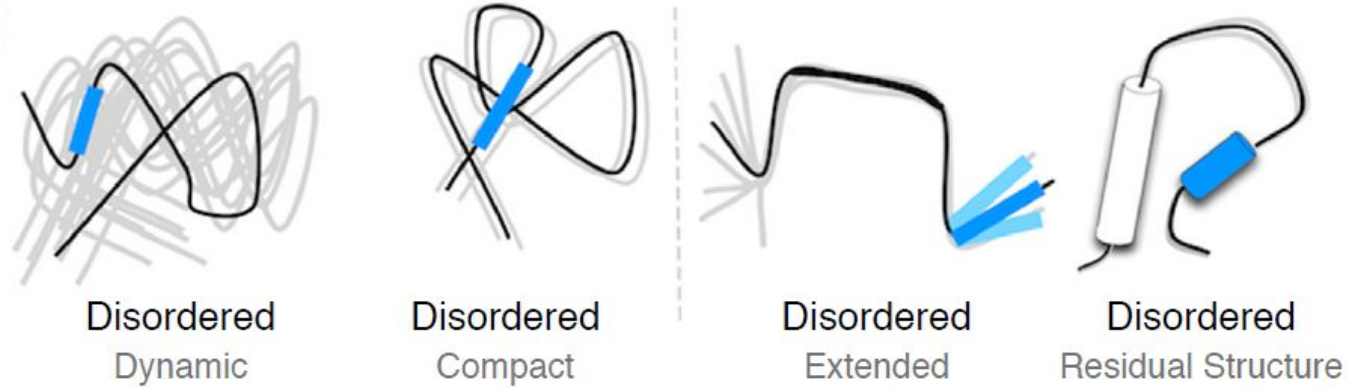
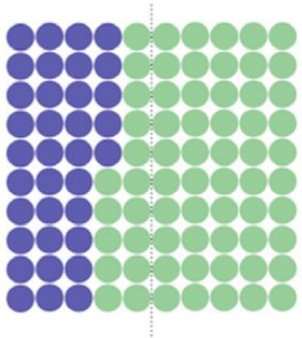
Intrinsically Disordered Proteins (IDPs) and Regions (IDRs)

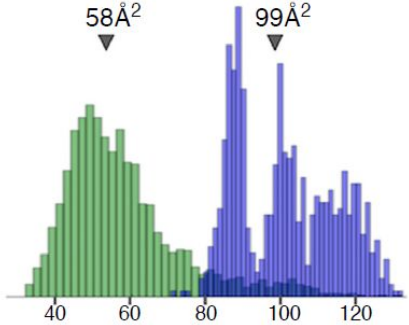


Primary isoforms of ca. 21k human proteins

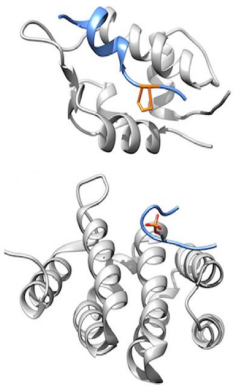
11 million residues



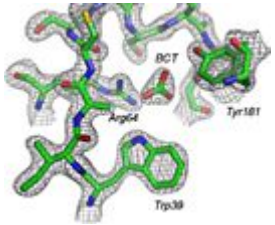
3-4 million residues in IDRs



Å2 accessible surface per residue



IDP Assessments



Missing residues
X-ray

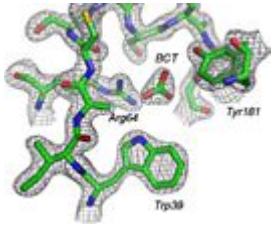
Mobile residues
NMR

Functional disorder
“Secondary methods”

CASP5 (2002) - CASP10 (2012)
(Monastyrskyy et al, Proteins, 2011)
(Monastyrskyy et al, Proteins, 2013)

- Few targets (ca. 100)
- 7:1 short / long regions
- 10% ID residues
- Regions at the C- / N-termini

IDP Assessments



Missing residues
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Mobile residues
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Functional disorder
“Secondary methods”

New DisProt 2020 (unpublished)

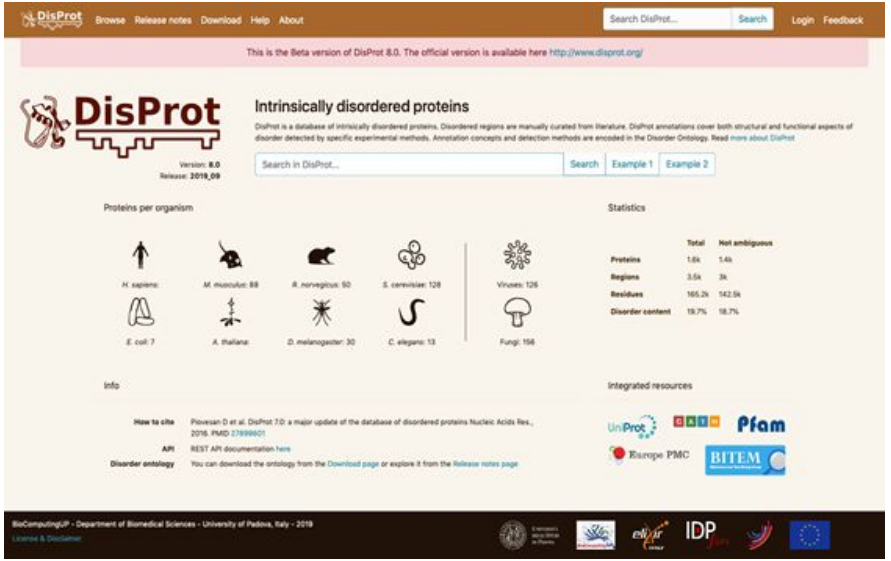
- 1,567 proteins (**764 new**)
- 646 non-redundant proteins used for CAID-1.

DisProt: intrinsic disorder evidence from the literature

Manually curated repository of disordered proteins

- first publication in 2005
- previous release in **2017**
  - completely re-annotated
  - ca. 200 new entries

- last update **(01/2020)**
  - quantitative and qualitative improvements
  - ca. 800 new entries

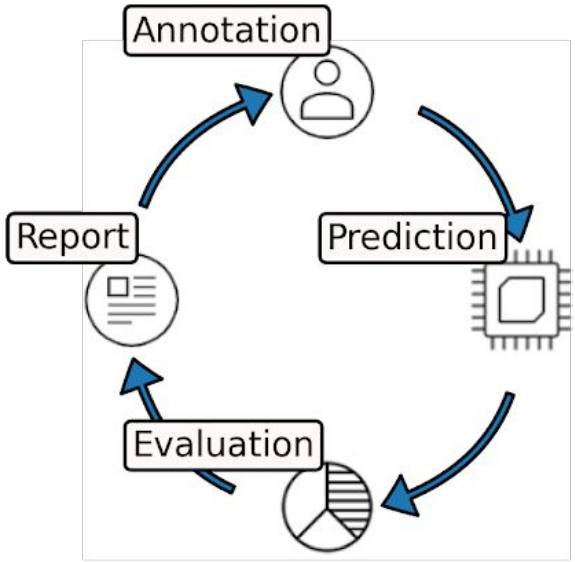


www.disprot.org

(Hatos et al., Nucleic Acids Research Database Issue 2020)

BioComputing


CAID cycle



- **Ground truth generation**
  - Literature curation (DisProt)
- **Prediction**
  - Stand-alone software (MobiDB servers)
- **Assessment**
  - Accuracy
  - Technical evaluation

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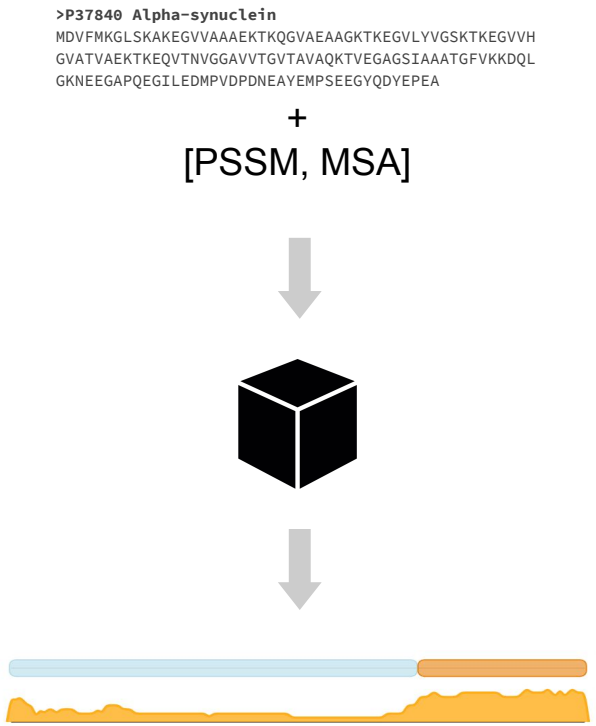
Prediction Setting



Stand-alone software (no web servers)

Installed on local machines @ University of Padua

- SGE cluster (nodes with different hardware, no GPU)
- Ubuntu (14.04/16.04), 64 bit
- 16Gb RAM, 8 cores (per node)

Predictors

27 software packages

- 8 unpublished
- 5 recently published (since 2017)

produced

gave rise to

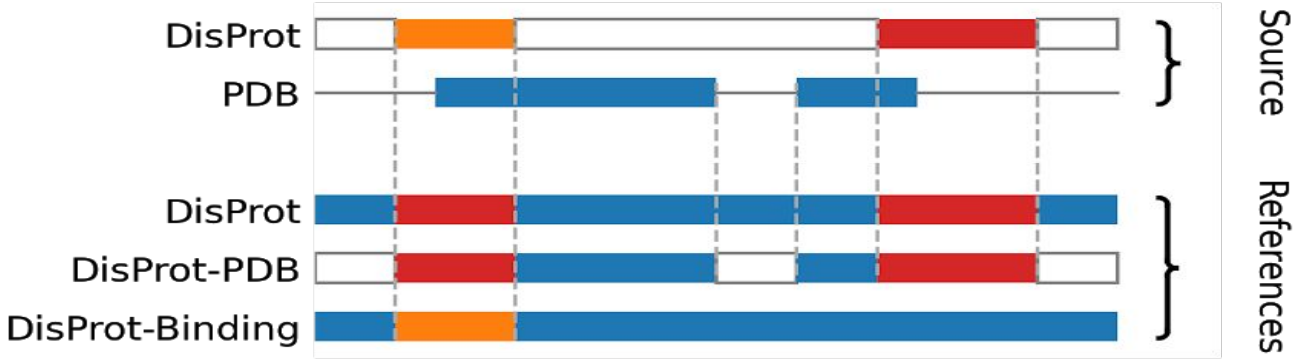
43 outputs

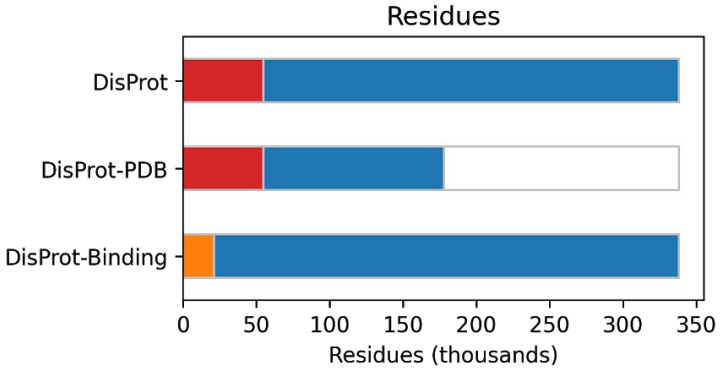
- 32 disorder
- 12 binding

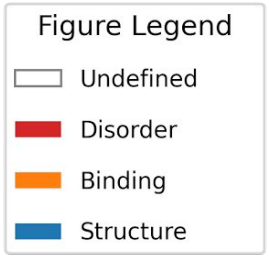
Many Issues

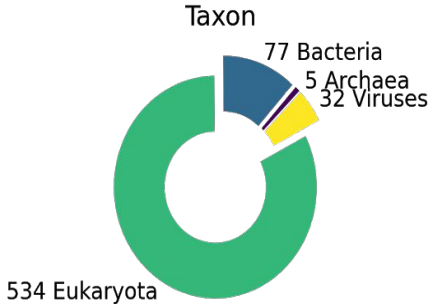
- Different output format
- Large (up to 60Gb)
- No control on output paths
- Specific version or obsolete system libraries
- Compile on new hardware (TensorFlow)
- Only one is provided as container/VM

Residue classification for *DisProt* and *DisProt-PDB*

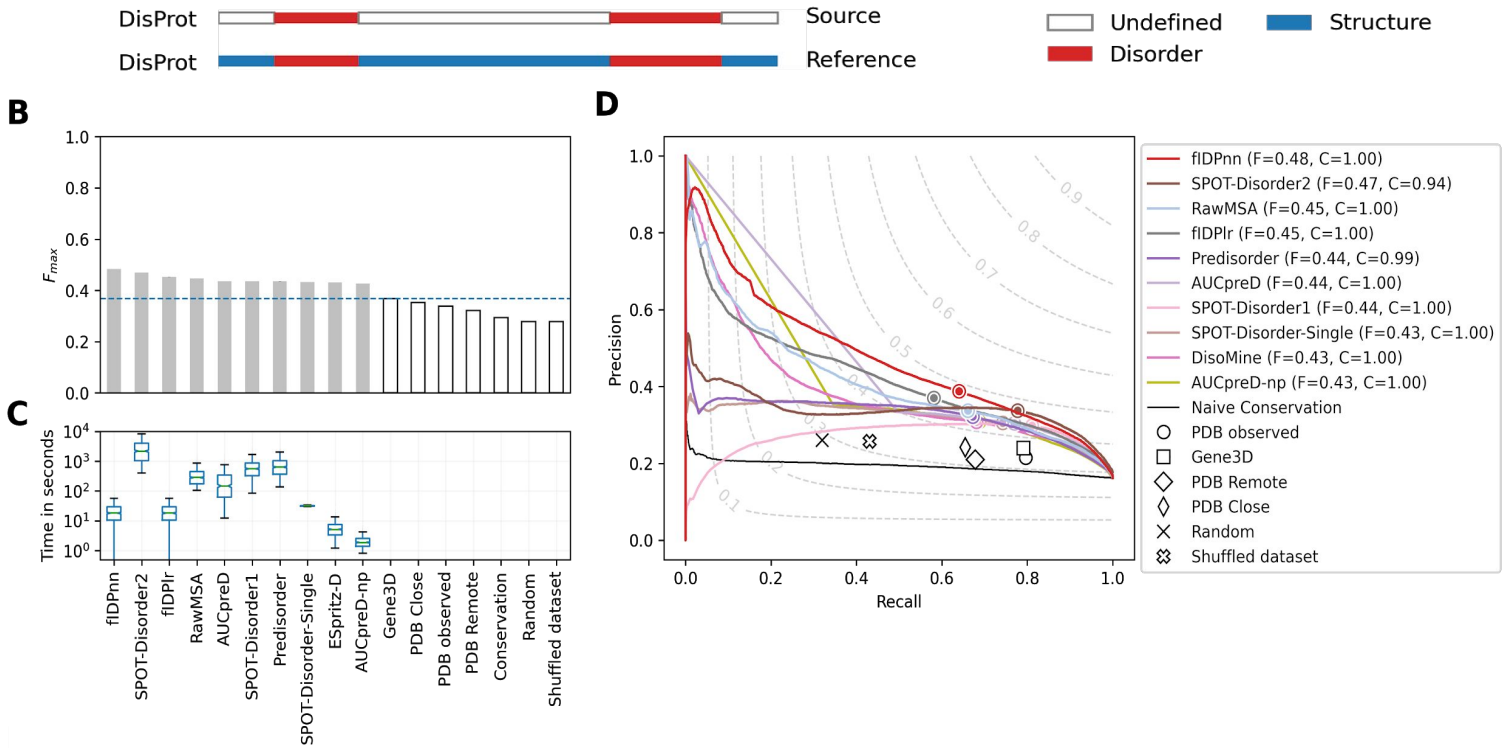








Prediction success and CPU times, top ten **disorder** predictors *DisProt* dataset



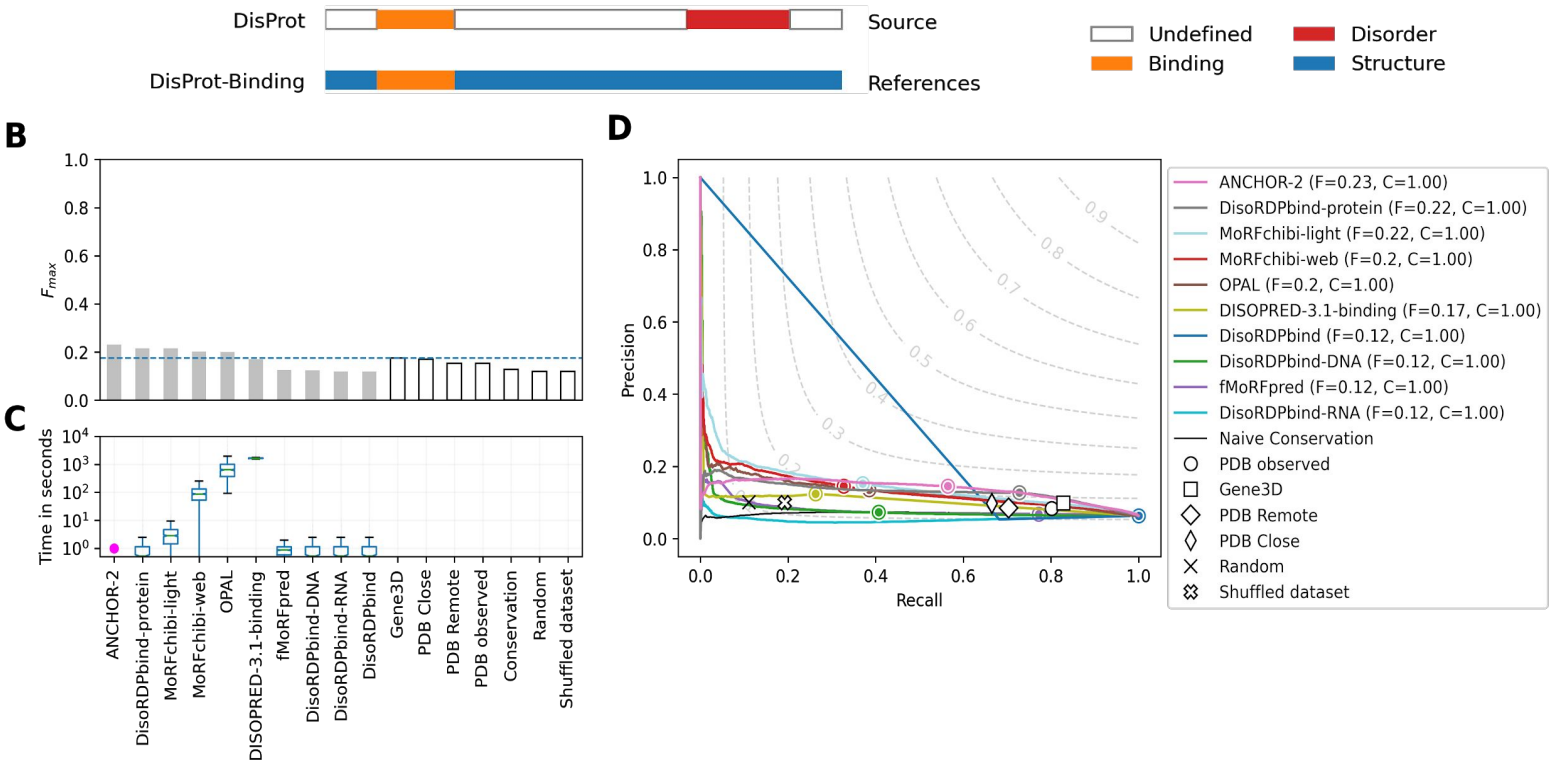
Performance of predictors expressed as maximum F1-Score across all thresholds (F_{max}) (panel B) for the top ten best ranking methods (light gray) and baselines (white) and the distribution of execution time per-target (panel C) using the *DisProt* dataset. The horizontal line in panel B indicates the F_{max} of the best baseline. Precision-Recall (panel D) of ten top-ranking methods and baselines using the *DisProt* dataset, with level curves of the F1-Score. Magenta dots on panel C indicate that the whole distribution of execution-times is lower than 1 second.

Prediction success, top 10 **disorder** predictors *fully disordered proteins* dataset

	TN	FP	FN	TP	MCC	F1-S	TNR	TPR	PPV	BAC
fIDPnn	585	16	19	26	0.569	0.598	0.973	0.578	0.619	0.776
RawMSA	582	19	19	26	0.546	0.578	0.968	0.578	0.578	0.773
VSL2B	578	23	22	23	0.468	0.505	0.962	0.511	0.500	0.736
fIDPlr	566	35	18	27	0.468	0.505	0.942	0.600	0.435	0.771
Predisorder	589	12	26	19	0.479	0.500	0.980	0.422	0.613	0.701
SPOT-Disorder1	572	29	23	22	0.416	0.458	0.952	0.489	0.431	0.720
DisoMine	551	50	17	28	0.421	0.455	0.917	0.622	0.359	0.770
AUCpreD	588	13	28	17	0.431	0.453	0.978	0.378	0.567	0.678
SPOT-Disorder2	574	27	24	21	0.409	0.452	0.955	0.467	0.438	0.711
SPOT-Disorder-Single	594	7	30	15	0.452	0.448	0.988	0.333	0.682	0.661
IsUnstruct	588	13	29	16	0.411	0.432	0.978	0.356	0.552	0.667
IUPred2A-long	595	6	32	13	0.420	0.406	0.990	0.289	0.684	0.639
Gene3D	505	96	10	35	0.391	0.398	0.840	0.778	0.267	0.809

Proteins with disorder prediction or disorder annotation covering at least 95% of the sequence are considered fully disordered.
Predictors are sorted by their F1-Score.
The Gene3D baseline is shown for comparison.

Prediction success and CPU times, top ten **binding** predictors *DisProt-Binding* dataset



Performance of predictors expressed as maximum F1-Score across all thresholds (F_{max}) (panel B) for the top ten best ranking methods (light gray) and baselines (white) and the distribution of execution time per-target (panel C) using the *DisProt-Binding* dataset. The horizontal line in panel B indicates the F_{max} of the best baseline. Precision-Recall (panel D) of ten top-ranking methods and baselines using *DisProt-Binding* dataset, with level curves of the F1-Score. Magenta dots on panel C indicate that the whole distribution of execution-times is lower than 1 second.

Conclusions

- Novel predictors outperform old ones
- Evolutionary information (MSA, PSSM) is useful
- Disorder is different from missing residues
- A number of disorder predictors are difficult to use (configuration, dependencies, different output formats)
- Disordered binding regions are more difficult to predict
- MCC and F-score are recommended to evaluate predictors. F-score is better as the MCC is undefined when some classes are not represented (e.g. for fully disordered proteins)
- Fully disordered proteins represent a significant number and cannot be evaluated using PDB missing residues

CAID bioRxiv preprint: https://doi.org/10.1101/2020.08.11.245852

BioComputing

CAID-2

- **Software submission** **30 April 2021**
- Software successfully installed 15 May 2021
- Preliminary results July 2021
- Publication of results 2022

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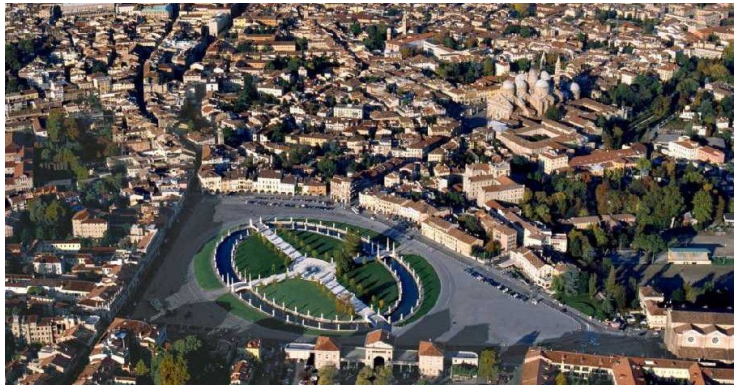
CAID meeting (online)

Thursday, **25 February 2021**, 2-6PM CET

- Methods presentations
- Town-hall discussion



...more info coming soon

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DisProt Database of protein disorder

MobiDB a database of protein disorder and mobility annotations

InterPro

Pfam

elixir ITALY

IDP f(un)

biocomputingup.it

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