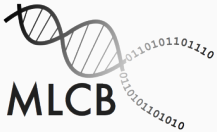
Progress update

Philip Hartout

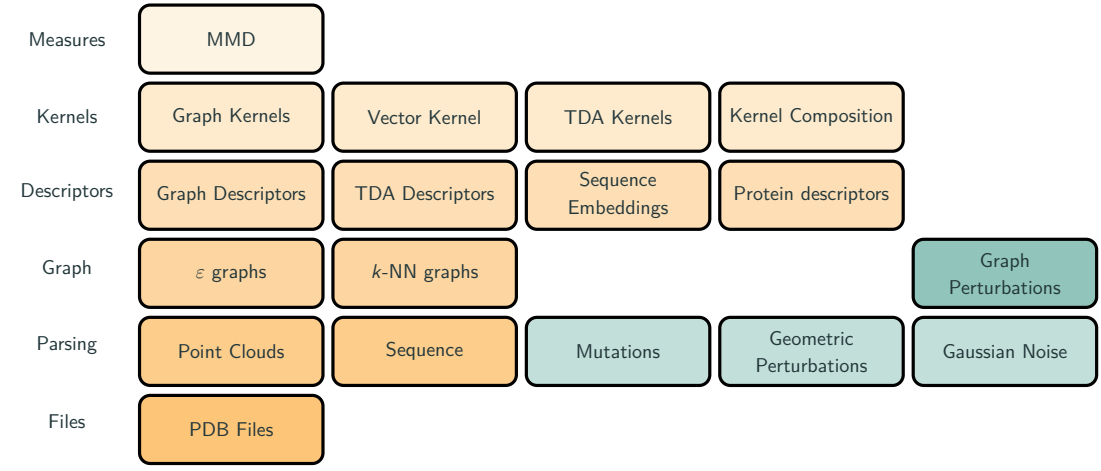
April 13, 2022



D BSSE

ETH zürich

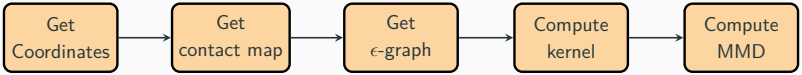
Overview



Green: perturbations

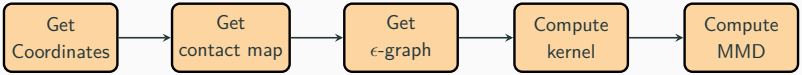
Orange: sequence embeddings

Composable transformations & using `sklearn` API standards sensibly




```
base_feature_pipeline = pipeline.Pipeline(
    [
        ("coordinates", Coordinates(granularity="CA", n_jobs=12),),
        ("contact map", ContactMap(metric="euclidean", n_jobs=12,),),
        ("epsilon graph", EpsilonGraph(epsilon=epsilon, n_jobs=12),),
    ]
)

proteins = base_feature_pipeline.fit_transform(paths_to_pdb_files)

mmd = MaximumMeanDiscrepancy(
    biased=True,
    squared=True,
    kernel=WeisfeilerLehmanKernel(
        n_jobs=12, n_iter=5, normalize=True, biased=True,
    ),
).compute(graphs, graphs_perturbed)
```

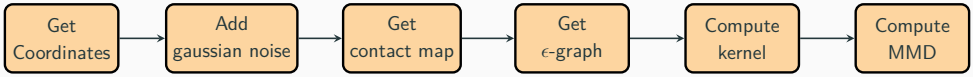
Composable transformations & using `sklearn` API standards sensibly




```
base_feature_pipeline = pipeline.Pipeline(
    [
        ("coordinates", Coordinates(granularity="CA", n_jobs=12),),
        ("contact map", ContactMap(metric="euclidean", n_jobs=12,),),
        ("epsilon graph", EpsilonGraph(epsilon=epsilon, n_jobs=12),),
    ]
)

proteins = base_feature_pipeline.fit_transform(paths_to_pdb_files)

mmd = MaximumMeanDiscrepancy(
    biased=True,
    squared=True,
    kernel=WeisfeilerLehmanKernel(
        n_jobs=12, n_iter=5, normalize=True, biased=True,
    ),
).compute(graphs, graphs_perturbed)
```

What if we now want to add noise?

Composable transformations & using `sklearn` API standards sensibly



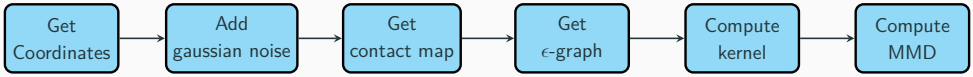

```
base_feature_pipeline = pipeline.Pipeline(
    [
        ("coordinates", Coordinates(granularity="CA", n_jobs=12),),
        ("contact map", ContactMap(metric="euclidean", n_jobs=12,),),
        ("epsilon graph", EpsilonGraph(epsilon=epsilon, n_jobs=12),),
    ]
)

proteins = base_feature_pipeline.fit_transform(paths_to_pdb_files)

mmd = MaximumMeanDiscrepancy(
    biased=True,
    squared=True,
    kernel=WeisfeilerLehmanKernel(
        n_jobs=12, n_iter=5, normalize=True, biased=True,
    ),
).compute(graphs, graphs_perturbed)
```

```
base_feature_pipeline = pipeline.Pipeline(
    [
        ("coordinates", Coordinates(granularity="CA", n_jobs=12),),
        (
            "add gaussian noise",
            GaussianNoise(
                random_seed=42, noise_mean=0, noise_variance=10, n_jobs=12,
            ),
        ),
        ("contact map", ContactMap(metric="euclidean", n_jobs=12,),),
        ("epsilon graph", EpsilonGraph(epsilon=epsilon, n_jobs=12),),
    ]
)

proteins_perturbed = base_feature_pipeline.fit_transform(paths_to_pdb_files)

graphs = load_graphs(proteins, graph_type="eps_graph")
graphs_perturbed = load_graphs(proteins_perturbed, graph_type="eps_graph")

mmd = MaximumMeanDiscrepancy(
    biased=True,
    squared=True,
    kernel=WeisfeilerLehmanKernel(
        n_jobs=12, n_iter=5, normalize=True, biased=True,
    ),
).compute(graphs, graphs_perturbed)
```

Reusable Components

But I want results!

Multiple experiments with error bars



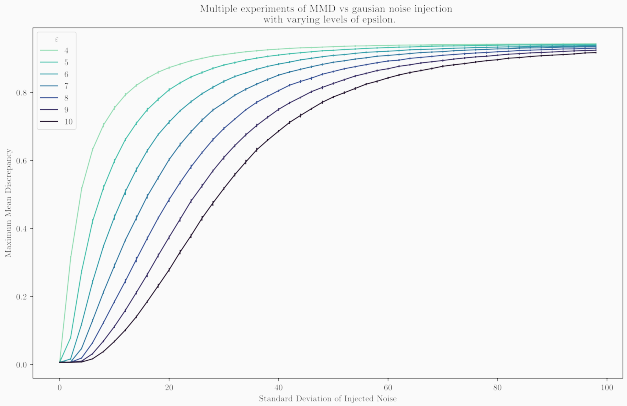


Figure 1: Multiple runs of last week's plot – 100% confidence interval over 10 runs.

One-sentence takeway

Use MMD to evaluate your generative protein model

Backup slides

Detailed breakdown of modules

Point clouds:

- Granularity can be set to α-Carbon, β-Carbon, entire backbone or all-atom setting.

Graph Descriptors:

- Degree Histogram
- Clustering Histogram
- Laplacian spectrum

Topological Descriptors

- Persistence diagrams
- Persistence landscape
- Persistence image
- Betti Curves

Sequence Embeddings (ESM, different sizes)

Protein Descriptors

- Ramachandran angles
- Interactomic clashes

Graph Kernels (Weisfeiler-Lehman Kernel)
Vector kernels (Linear, Gaussian)
TDA Kernel (Persistence Fisher Kernel)
Kernel composition ($\times$, $+$)
MMD (Squared, biased)

Perturbations
Graph level (rewire, add/remove edge)
Point cloud perturbations (twist, taper, shear)
Protein perturbations (mutate)
All modules work on multiple proteins simultaneously

The admin stuff

Message through slack for follow-up Qs

Extensive GitHub documentation & up-to-date codebase at

https://github.com/pjhartout/msc_thesis

Private repo a.t.m., message me to request access.