# HAAG Weekly Report (Simplified) – Omar Moursy – 3D Modeling

## Time-Log

What did you do this week?

- Updated website homepage for 3D Modeling project https://sites.gatech.edu/3dmodeling/
- Uploaded the Weekly reports and meeting recordings for Week 5.
- Had a progress update meeting with Nikita and Steve.
- Read through the original Coherent Point Drift paper, Python implementation, watched online tutorials and read through textbook chapter on Gaussian Mixture Models and Expectation Maximization .

What are you going to do next week

- Add the missing sections of the 3D Modeling website and upload any missing documents.
- Research PCA and SVD.
- Meet with Nikita and Steve to plan modification of Gaussian Kernel function to include biological constraints from Dr. Porto's data.
- Create presentation for comp. advisors going over concepts such as GMM and PCA.
- Present short term and long term goals of the project and divide the remaining work into individual tasks.
- Receice feedback from comp. advisors and discuss progress.

Blockers, things you want to flag, problems, etc.

- None for this week

## Abstracts:

# Point Set Registration: Coherent Point Drift

https://arxiv.org/pdf/0905.2635

**Abstract**—Point set registration is a key component in many computer vision tasks. The goal of point set registration is to assign correspondences between two sets of points and to recover the transformation that maps one point set to the other. Multiple factors, including an unknown non-rigid spatial transformation, large dimensionality of point set, noise and outliers, make the point set registration a challenging problem. We introduce a probabilistic method, called the Coherent Point Drift (CPD) algorithm, for both rigid and non-rigid point set registration. We consider the alignment of two point sets as a probability density estimation problem. We fit the GMM centroids (representing the first point set) to the data (the second point set) by maximizing the likelihood. We force the GMM centroids to move coherently as a group to preserve the topological structure of the point sets. In the rigid case, we impose the coherence constraint by re-parametrization of GMM centroid locations with rigid parameters and derive a closed form solution of the maximization step of the EM algorithm in arbitrary dimensions. In the non-rigid case, we impose the coherence constraint by regularizing the displacement field and using the variational calculus to derive the optimal transformation. We also introduce a fast algorithm that reduces the method computation complexity to linear. We test the CPD algorithm for both rigid and non-rigid transformations in the presence of noise, outliers and missing points, where CPD shows accurate results and outperforms current state-of-the-art methods.

## What did you do and prove it

Updated website meetings and reports for 3D Modeling project

Had a researchers team meeting to discuss the GitHub fork of the PyCPD code and setup issues.

Had a team meeting with Dr. Porto to discuss progress where he answered some of our questions on the project and shared a notebook example of doing PCA on his dataset.

Links to the paper, GitHub repo and article:

https://arxiv.org/pdf/0905.2635

https://youtu.be/EWd1xRkyEog?si=5VkaR8leOLzCFc6O

https://youtu.be/UVvuwv-ne1I?si=f2wI_MqVOiTRTY4S

https://github.com/Nikitos1865/pycpd-Porto/tree/master