# Statement of Work

## Tony Liu (RA) Hypernets Project OCT 5 2020

Hypernets is a research project advancing the theory and application of hypergraphs as models for complex multiway data. The primary DEC 2020 deliverable is an updated release of PNNL’s open sourced Python library, HyperNetX (HNX), a collection of methods and classes for the analysis of data modeled as a hypergraph. The new version will include optimized methods written in C++ and bound to a Python namespace for seamless integration into the existing framework. The optimized framework will support the practical use of HNX on very large datasets, increasing its usefulness to our sponsor.

RA will report to Tech Lead Brenda Praggastis as supervisor, backed up by Task Lead Cliff Joslyn and Project Manager Brian Kritzstein. RA’s academic advisors Prof. Gebremedhin (WSU) and Prof. Lumsdaine (UW) will be fully informed and consulted. RA will coordinate with project practices for software management and development (e.g. stash) and attend (virtually) project meetings.

The following task list and deliverables are an initial consideration, to be negotiated flexibly with the RA, Praggastis, Joslyn, and academic advisors, to be revisited as conditions warrant.

**TASKS**

1. Work with project staff to consult on:
   1. Efficient data structures for static (immutable) hypergraphs with core functions supported by the C++ backend.
   2. PyBind module linking the C++ backend to a Python namespace.
2. Write core hypergraph algorithms in C++ for static hypergraphs. These could include but may not be limited to:
   1. Collapsing nodes and/or edges
   2. Computation of k-cells and/or the associated Abstract Simplicial Complex
   3. Computation of toplexes
   4. Restriction to nodes and/or edges
   5. s-connected components
   6. s-diameter
   7. s-distance
   8. s-neighbors
   9. s-shortest paths
3. Replace the current Python implementation for computing mod2 homology groups and Betti numbers with optimized C++ methods.
4. Replace current NetworkX dependencies in HNX hypernetwork science algorithms for static hypergraphs with above optimized C++ methods. This could include but not be limited to:
   1. s-betweenness centrality
   2. s-harmonic closeness centrality
   3. s-eccentricity

**DELIVERABLES**

1. C++ code for hypergraph algorithms and data strcutures.
2. C++ code for mode2 homology groups.
3. Revised HNX python code for C++ back end.

**LEVEL OF EFFORT**

20 hrs/wk

**PERIOD OF PERFORMANCE**

OCT 5 2020 – DEC 31 2020