

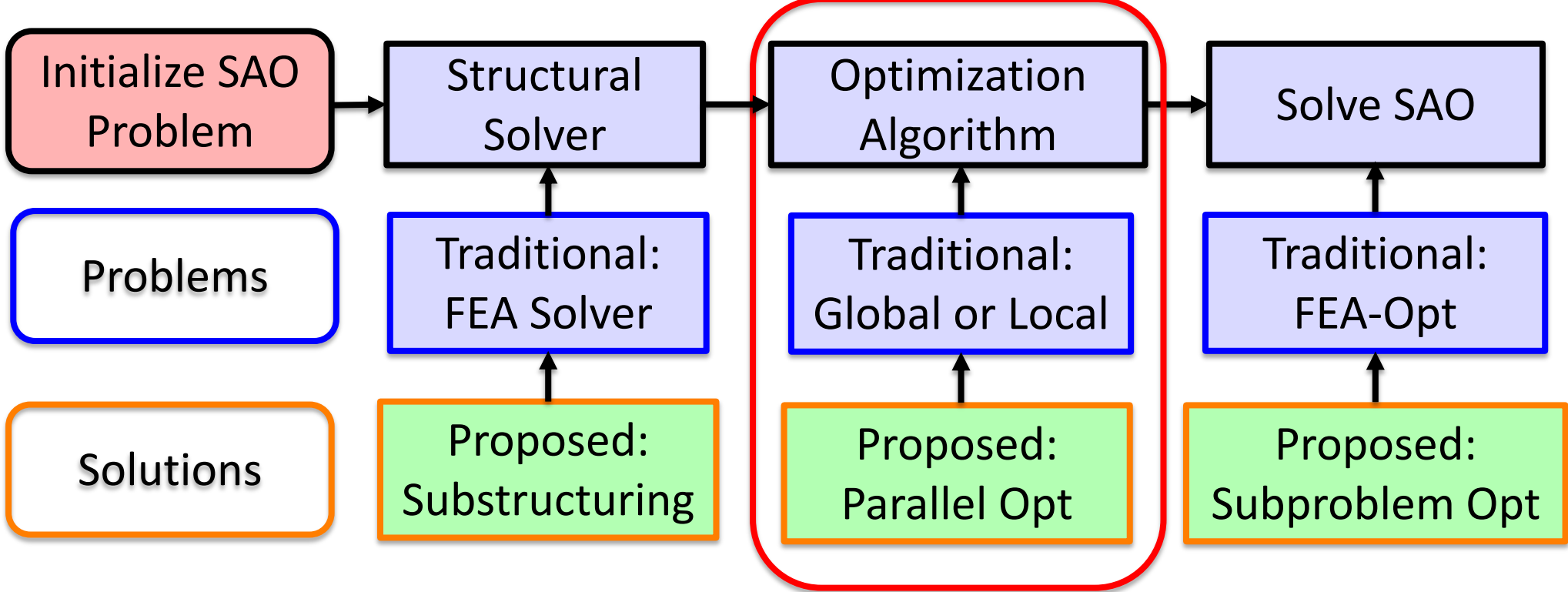
# MASO: Multi-Algorithm Substructuring Optimization

Matthew Luu, Acoustics, PhD (2025)

Advisor: Dr. Andrew Wixom

## Introduction

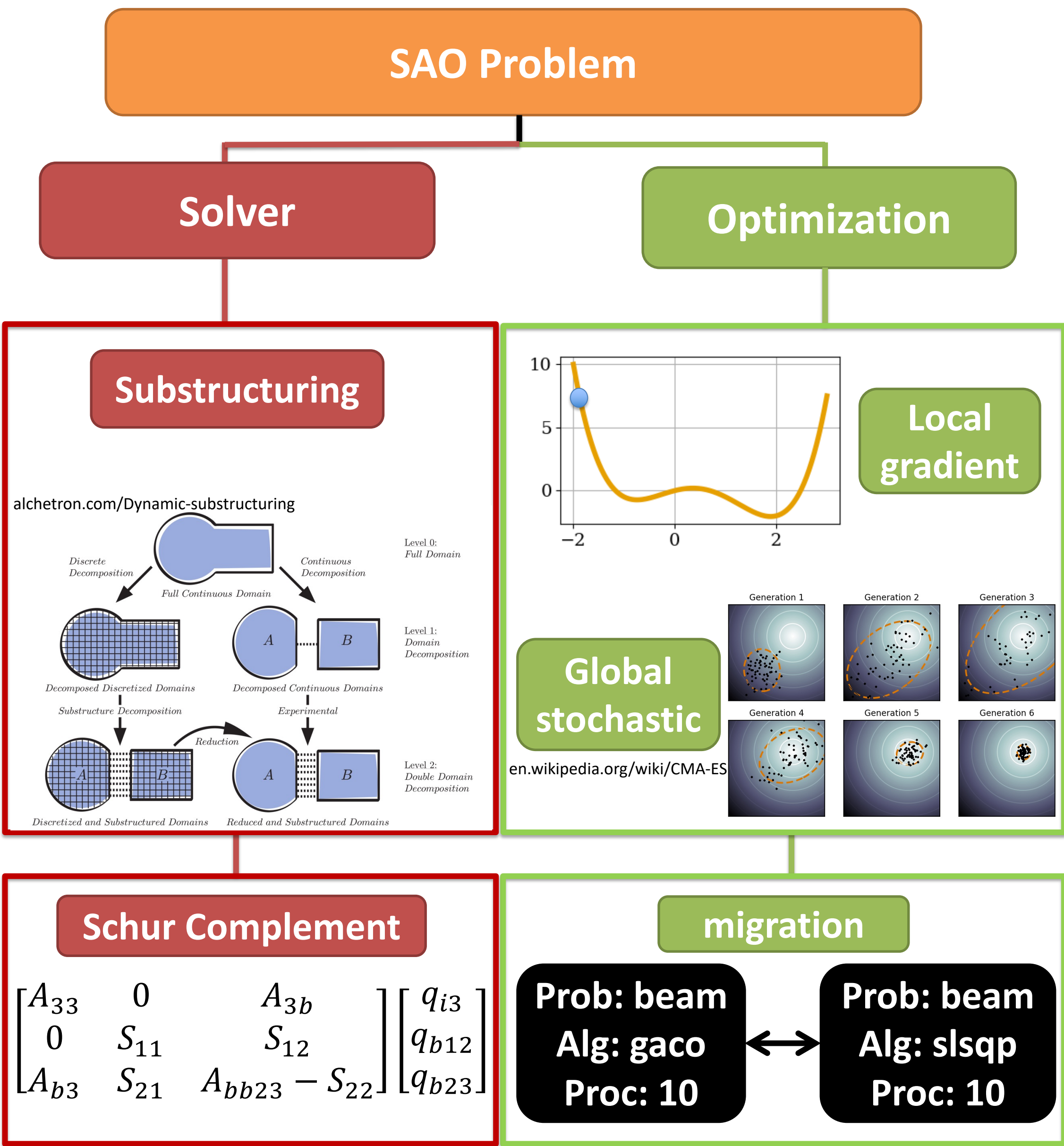
Current structural acoustics optimization (SAO) techniques can be accurate, but time consuming and **inefficient**. The goal of this project is to develop and deploy a **python package** combining the research efforts of **substructuring** and **multi-algorithm** optimization to improve upon current SAO techniques.



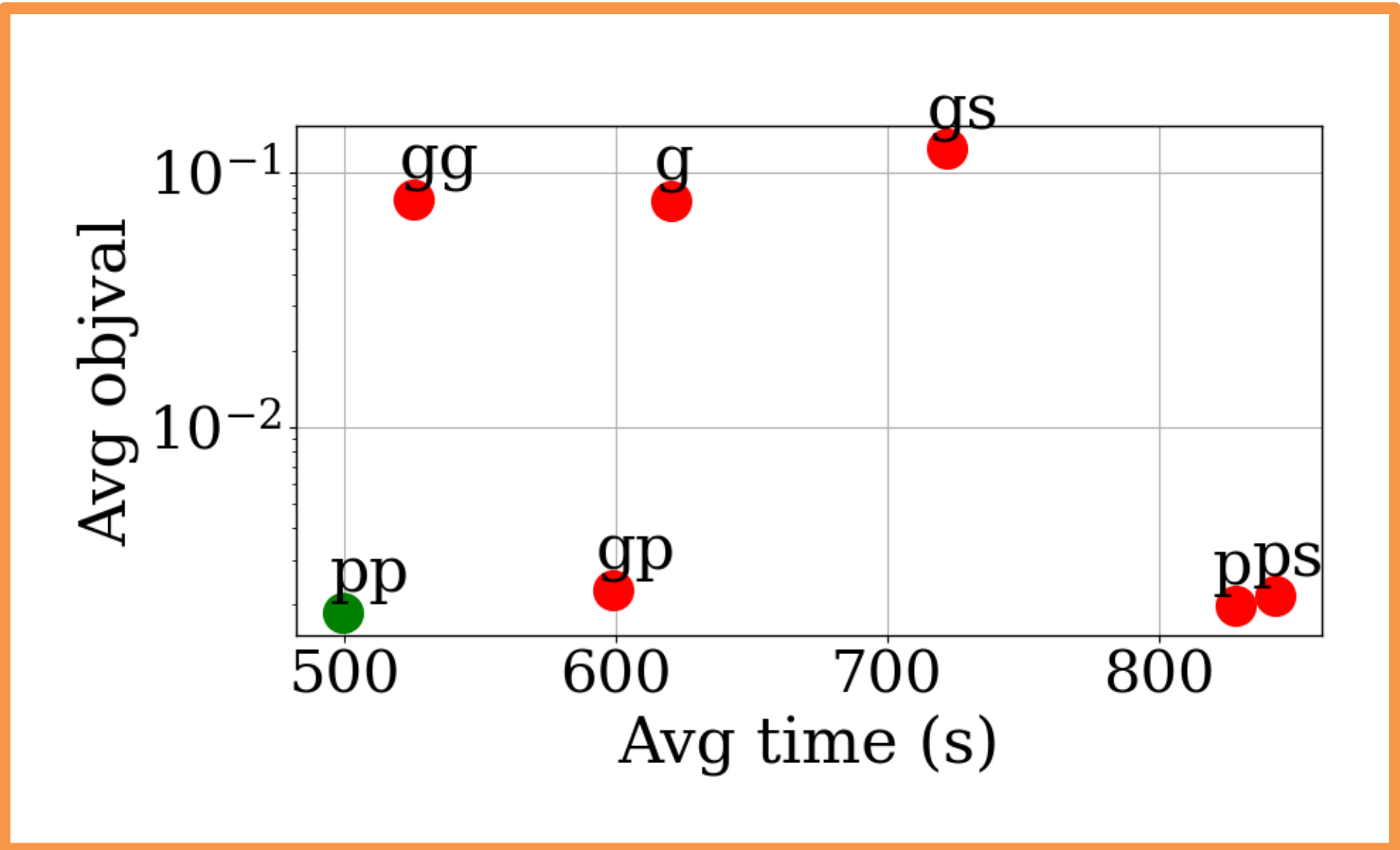
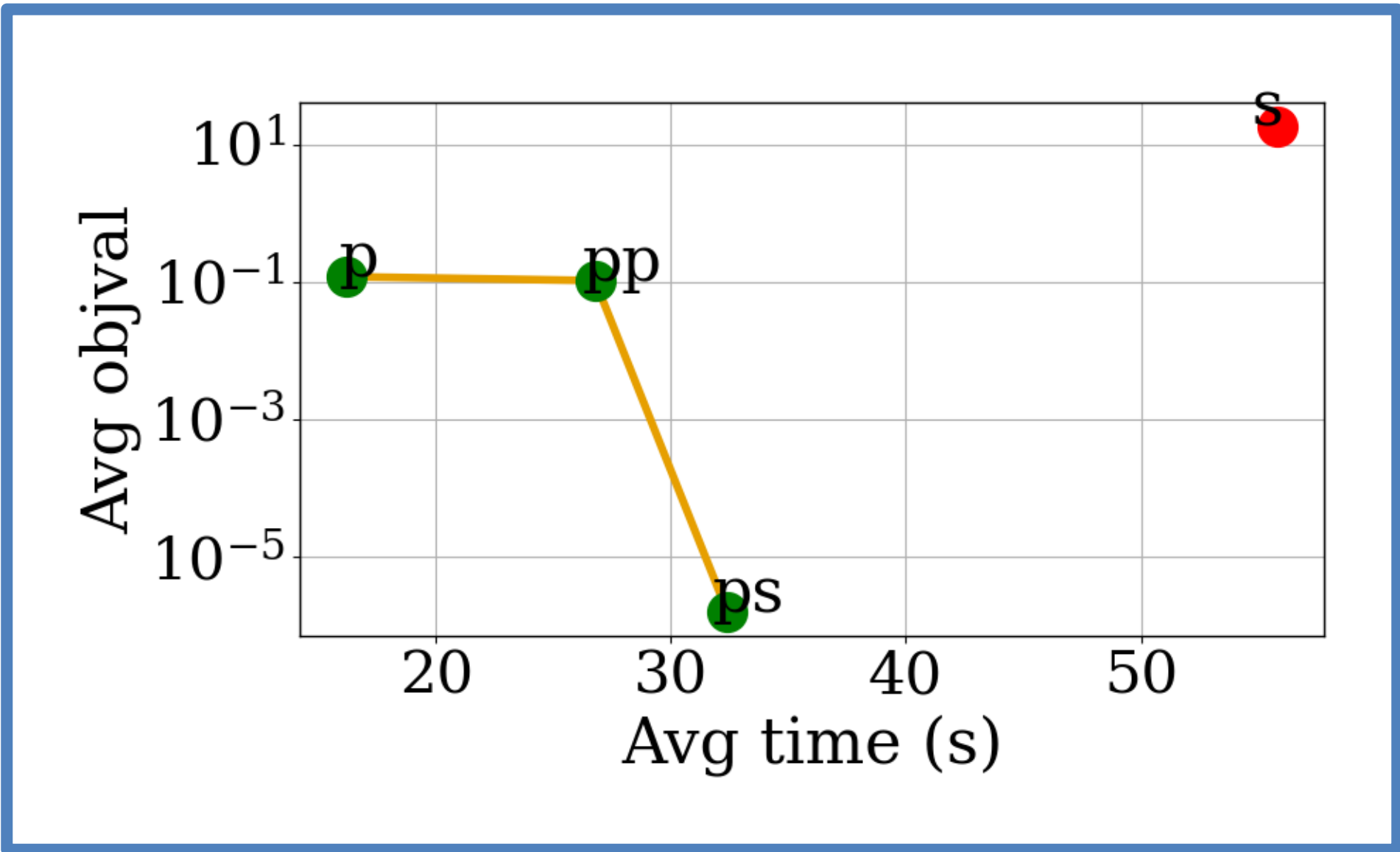
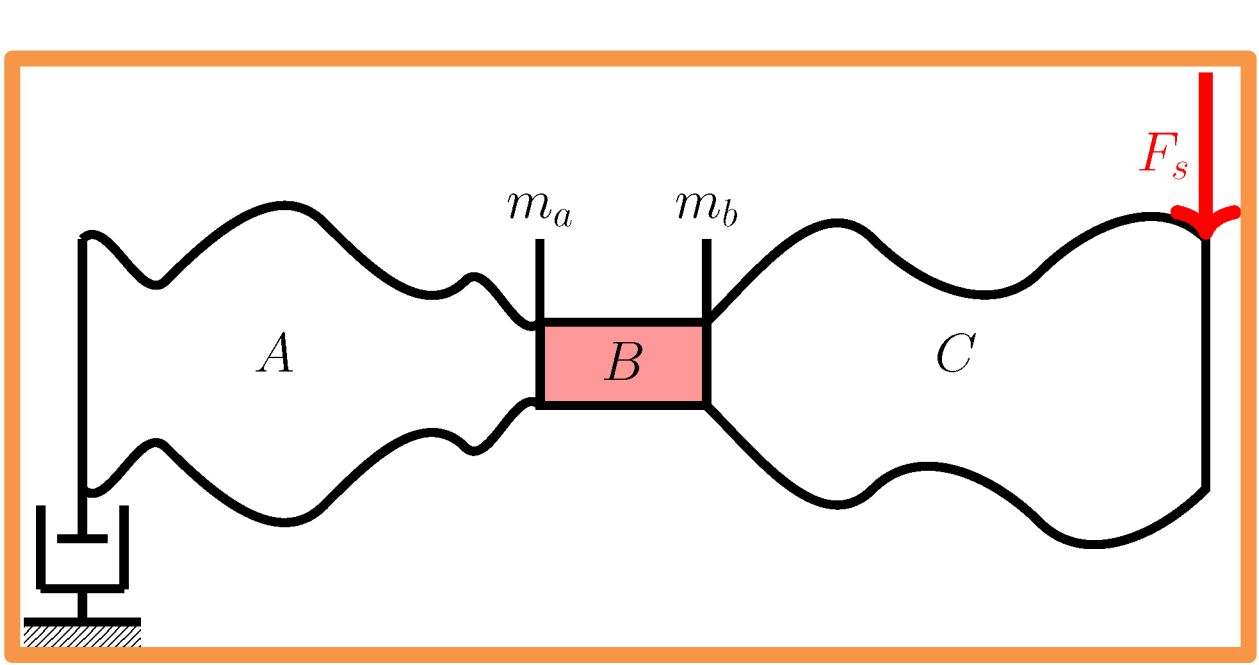
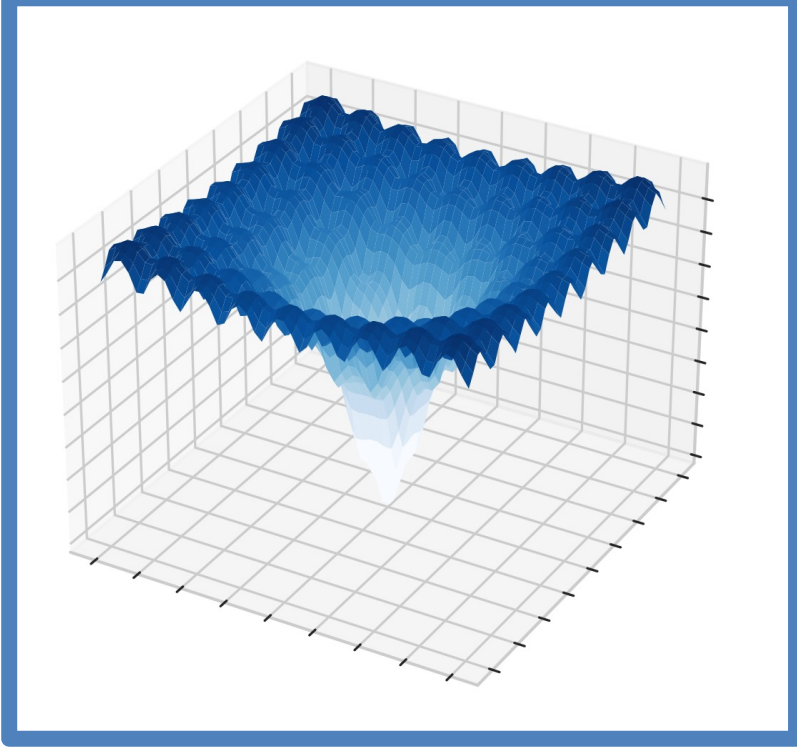
## Objectives / Deliverables

- Implement **substructuring** techniques [1]
- Implement **Multi-Algorithm** techniques [2]
- Implement distributed and shared memory
- Test MASO on two test problems

## Methodology



## Results / Analysis



- **PSO + PSO = Consistent**
- **PSO + SLSQP = Good if gradient smooth**
- **PSO Alone = consistent algorithm**
- Two global = benefits if complicated decision space
- Global + local = benefits if decision space is smooth

## Summary

Problems with **calculable gradients** and **smooth decision spaces** benefit from gradient based and global based algorithms. While performing a wide search with **two global algorithms** is beneficial when decision spaces become complicated. **Substructuring** is implemented for the **beam** problem to ensure techniques work. Results are done on an HPC server with **distributed memory**.

## Future Work

- Test more algorithms in different configurations
- Analyze more test problems and implement more substructuring techniques
- Format library for easy user access

## References

[1] R. Craig, C. Mervyn, and C. Bampton, Coupling of substructures for dynamic analyses, AIAA Journal, 6 378 (1968), pp. 1313–1319, <https://doi.org/10.2514/3.4741>.  
[2] F. Biscani and D. Izzo, A parallel global multiobjective framework for optimization: pagmo, Journal of 373 Open Source Software, 5 (2020), p. 2338, <https://doi.org/10.21105/joss.02338>,

## Acknowledgements

This work was partially supported by the **PIPELINE: Penn State Intern Pipeline** **LI**ns to **N**avy **E**ngineering program, ONR grant #N000142312656. The Penn State PIPELINE Program motivates and connects students and faculty to careers and research opportunities with the Navy technical workforce.

