



Calhoun: The NPS Institutional Archive

DSpace Repository

Faculty and Researchers

Faculty and Researchers' Publications

2022

Bipartite Graph Learning for Autonomous Task-to-Sensor Optimization

Karpenko, Mark; Ross, Isaac M.; Proulx, Ronald J.; Magallanes, Lara C.

Monterey, California: Naval Postgraduate School

https://hdl.handle.net/10945/71882

This publication is a work of the U.S. Government as defined in Title 17, United States Code, Section 101. Copyright protection is not available for this work in the United States.

Downloaded from NPS Archive: Calhoun

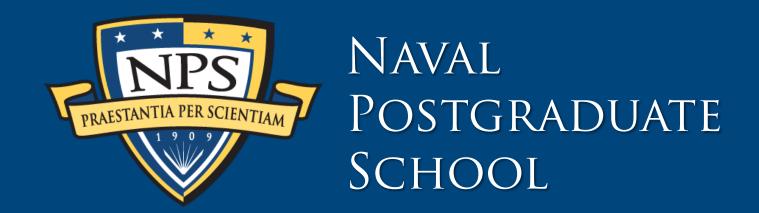


Calhoun is the Naval Postgraduate School's public access digital repository for research materials and institutional publications created by the NPS community. Calhoun is named for Professor of Mathematics Guy K. Calhoun, NPS's first appointed -- and published -- scholarly author.

> Dudley Knox Library / Naval Postgraduate School 411 Dyer Road / 1 University Circle Monterey, California USA 93943

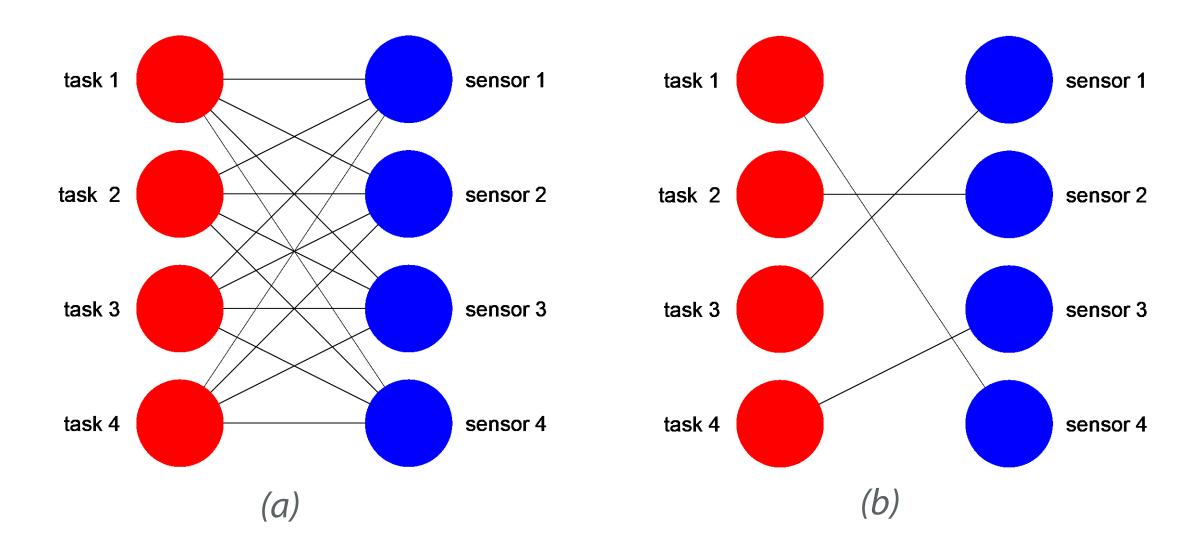
http://www.nps.edu/library

Bipartite Graph Learning for Task-to-Sensor Optimization



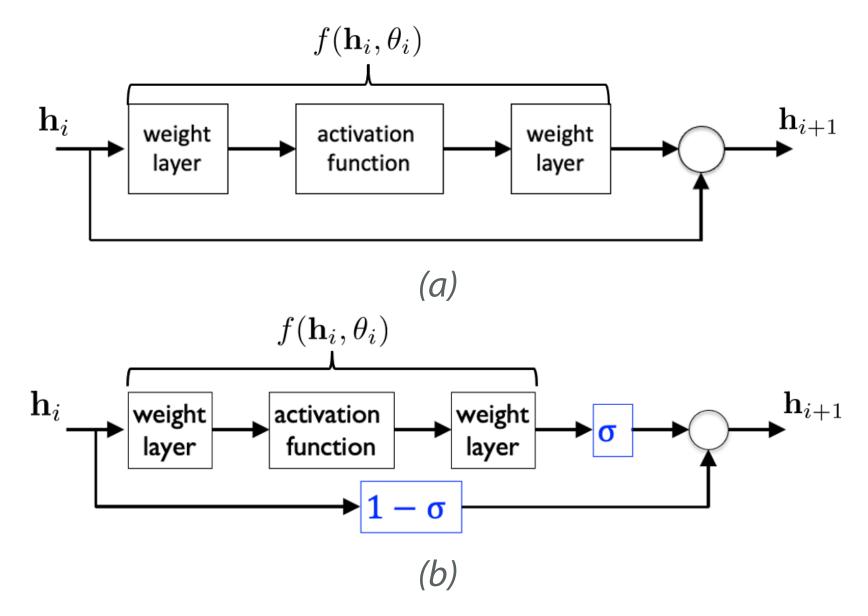
Background/Objective

- •The concept of a bipartite graph provides a mathematical framework for task-to-sensor mapping by establishing connectivity between various highlevel tasks and the specific sensors and/or processes that must be invoked to fulfil the task requirements.
- •This project studies how machine learning can be used to perform autonomous bipartite matching for task-to-sensor optimization.
- •The results can be applied for various DoD applications including joint targeting and fires.



Task-to-sensor allocation can be posed as a bipartite graph matching problem (a) where the goal is to match each task to a sensor in a way that minimizes cost or maximizes value (b).

Network Architecture

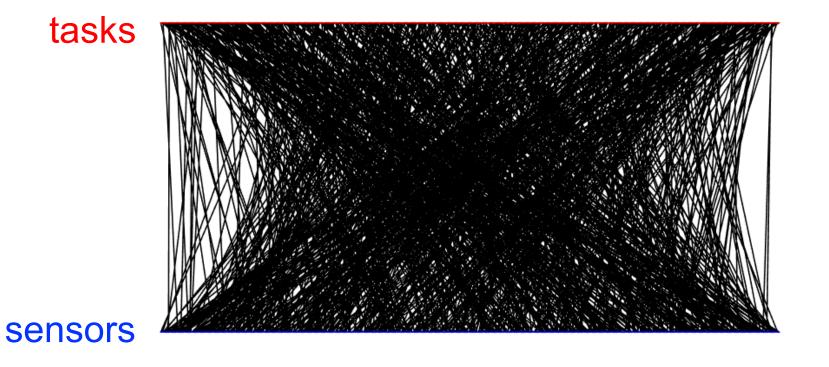


Conventional residual network layer (a) and the 'weighted residual' network layer (b) used for solving bipartite matching problems •A deep network of *weighted residual* layers was studied for solving the bipartite graph problem.

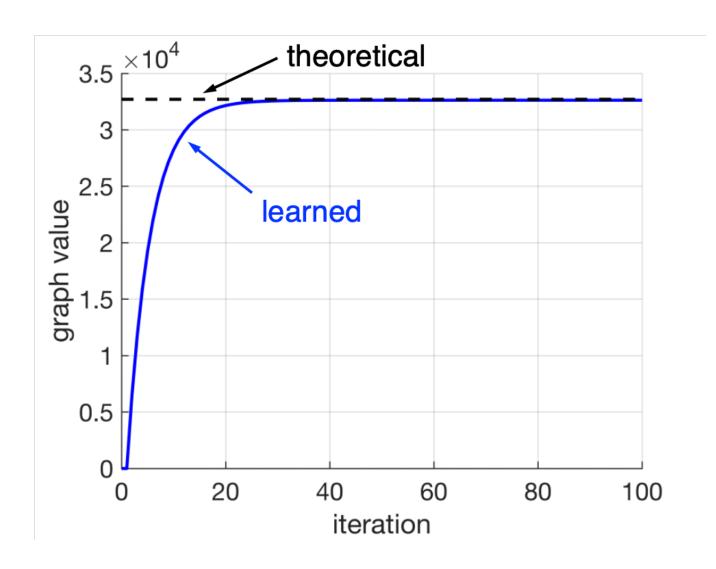
- •A conventional residual network, uses 'skip' connections to add the input of a layer together with its output. By weighting the skip connection, the feedforward term can be modulated to influence the signal evolution within the network equations to solve the matching problem
- •The proposed architecture can be used for finding minimum cost or maximum value mappings (depending on the objective of the user)

Example Results

• The machine learning-based approach is scalable to large problem sets



Example bipartite matching solution for n=m=800 (left) and the evolution of the 'learned' graph value (right)



NRP Project ID:

NPS-22-N192-B

Conclusion

- This study shows that machine learning concepts can be used to autonomously perform bipartite matching for task-to-sensor planning/optimization problems.
- As the state of knowledge evolves, the approach can be used to periodically and rapidly re-solve allocation problems to reflect changes in resource availability and/or task completion.



Researchers: Dr. M. Karpenko, Mechanical and Aerospace Engineering;
Dr. R. J. Proulx, Space Systems Academic Group; LT Michael Zepeda USN, Mechanical and Aerospace Engineering.
Topic Sponsor: Naval Special Warfare Command (NAVSPECWARCOM).

This research is supported by funding from the Naval Postgraduate School, Naval Research Program (PE 0605853N/2098). Approved for public release; distribution is unlimited.