An Artificial Ecosystem Algorithm Applied to the Travelling Salesman Problem

Manal T. Adham and Peter J. Bentley
University College London

Introduction

We present an Artificial Ecosystem inspired algorithm designed to take advantage of highly distributed computer architectures.

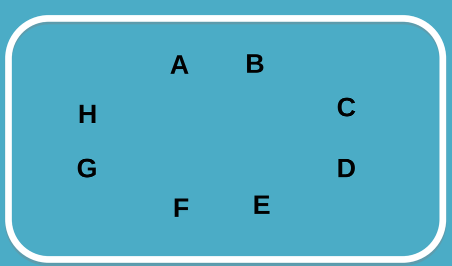
An ecosystem is comprised of many separate components that adapt to form a single synergistic whole. Our aim is to take advantage of this phenomenal property.

AEA works by splitting the problem into smaller sub-problems, solving the sub-problems and then combining the sub-solutions to form a complete solution.

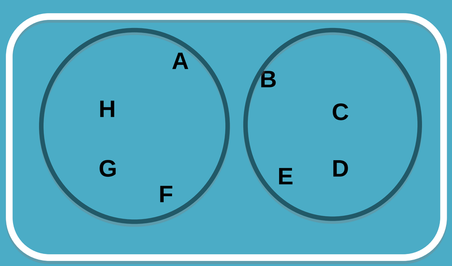
Three versions of this algorithm are illustrated; the basic AEA algorithm and two AEA with Species. They are then evaluated through experiments using TSP.

Artificial Ecosystem Algorithm

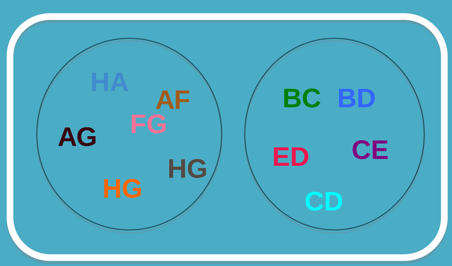
We focused on using AEA to solve the TSP:



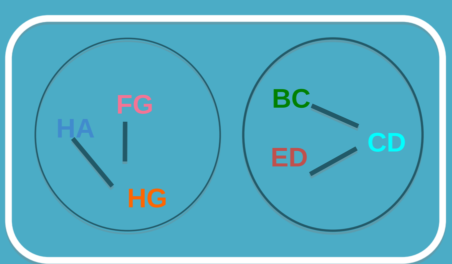
1) Environment - holds all the cities from TSP.



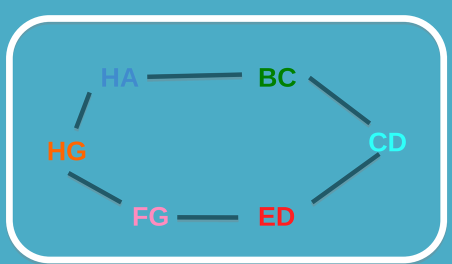
2) Split into species (sub-problems)



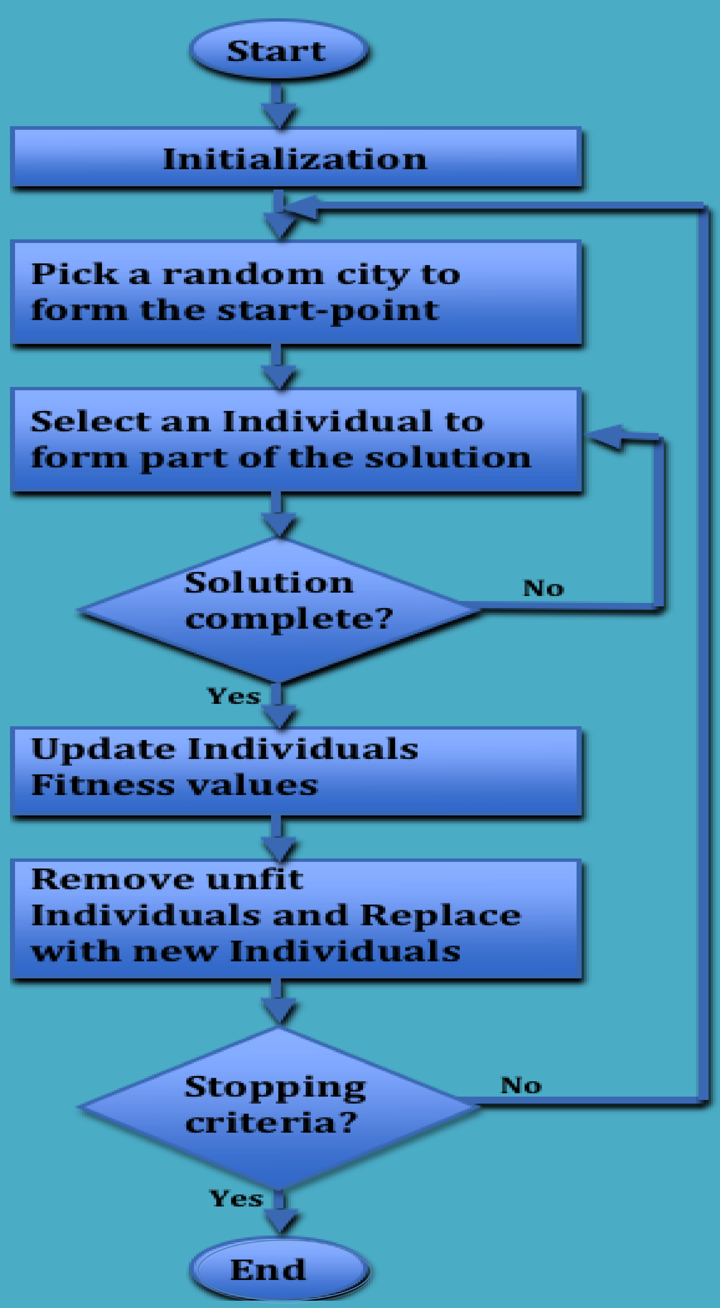
3) Species create populations of individuals that evolve to form building blocks for the sub-solution



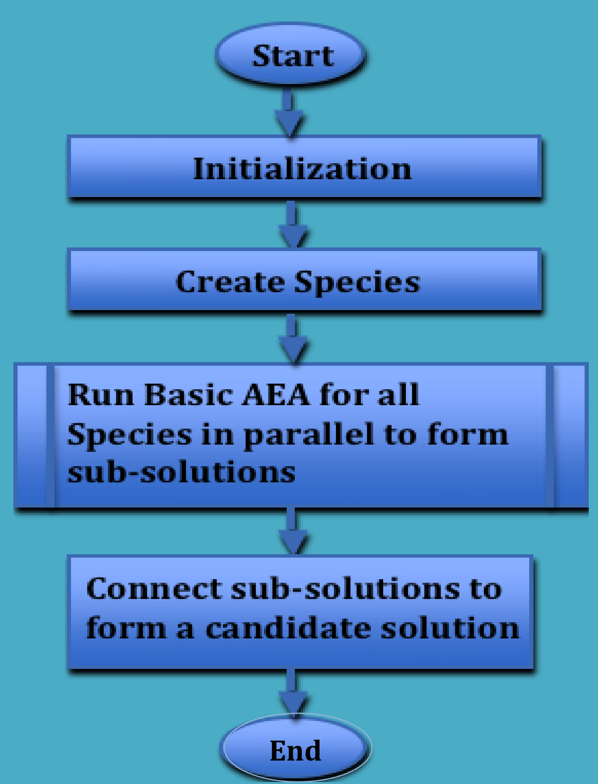
4) Species evolve and build sub-solutions by connecting Individuals.



5) Sub-solutions are then linked to form a complete solution.



Overview of Basic AEA

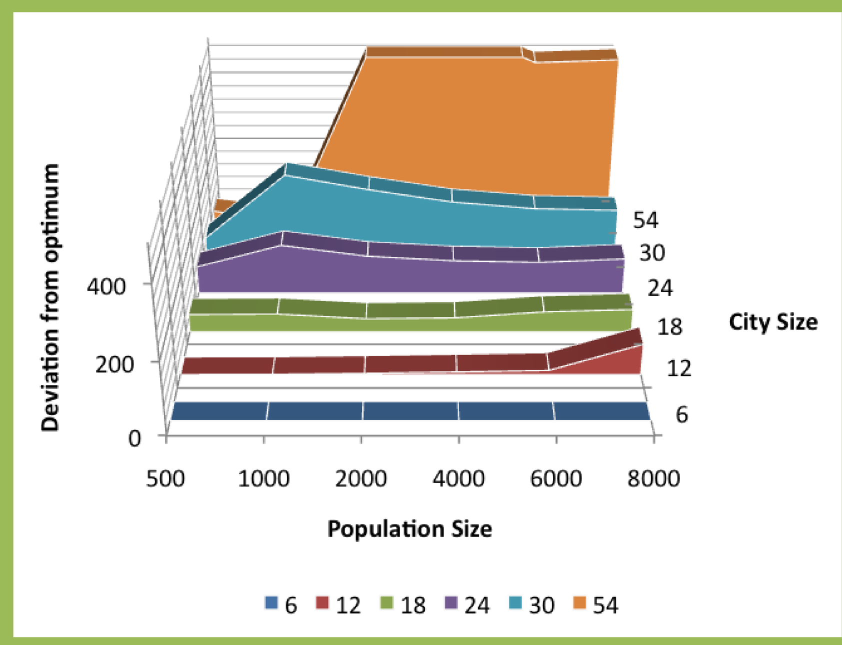


Overview of AEA with species

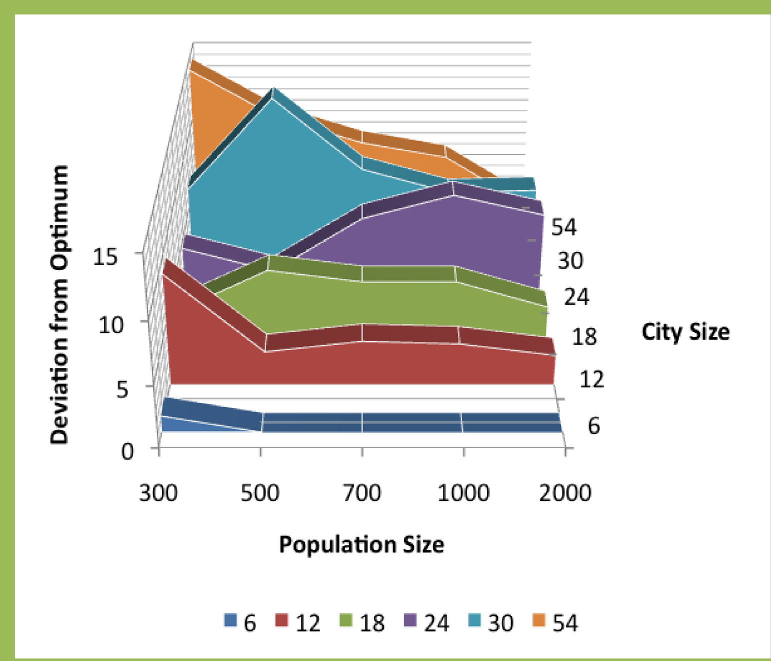
Experiments

Investigate the ability of AEA and AEAS to solve the TSP for different numbers of cities. A combination of artificially created 2D circle data and benchmark TSP data is used.

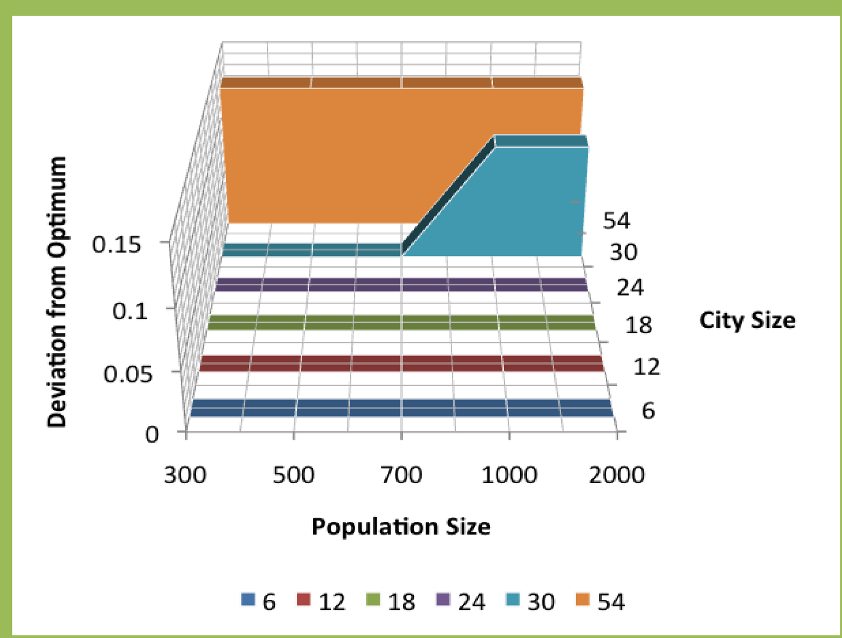
Experiment 1: Analyses the effects of population size on a given problem size.



AEAS (SOM) deviation from optimal for different TSP sizes against population sizes.

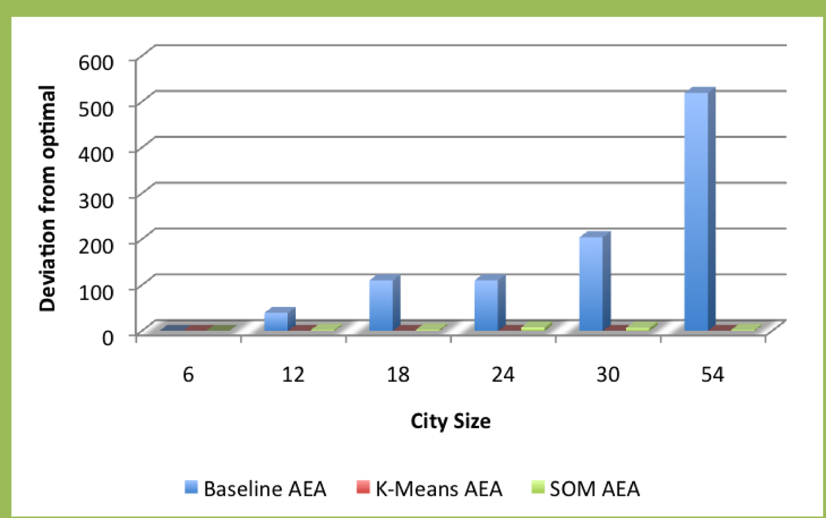


Baseline AEA deviation from optimal for different TSP sizes against population sizes.

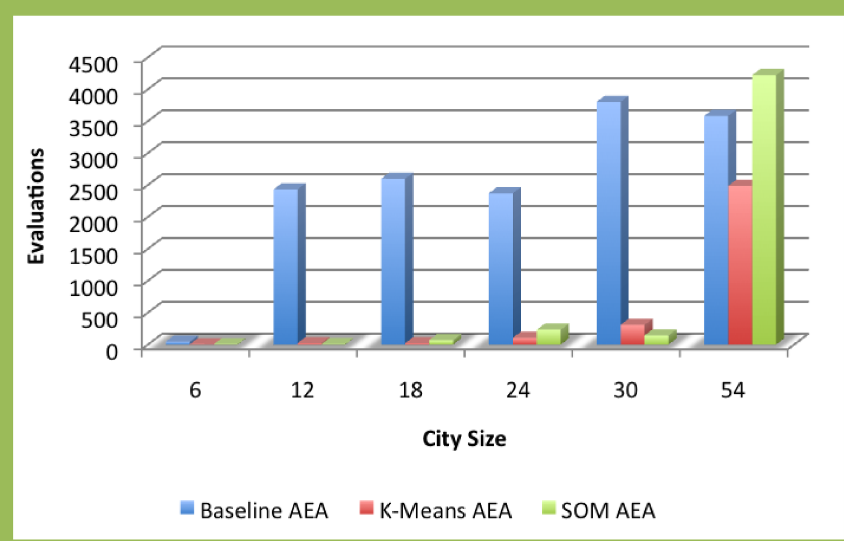


AEAS (K-Means) deviation from optimal for different TSP sizes against population sizes.

Experiment 2: Distinguishes between the different AEA algorithm variants, focusing on the number of evaluations used to find the solution and how percentage deviation from the optimal.



Views deviation from the optimal solution.



Compares the number of evaluations needed to reach a solution.

Experiment 3: Compare AEA's performance against bio-inspired methods reported in the literature. The result in the table below clearly demonstrate the potential of this approach.

Comparative Analysis, results were taken from [1] [2].

File	Cities	Opt	AEAS (K-means)	AEAS(SOM)	GA	BCO	IWD
Eil51	51	426	**445.5**	452	445.8	447.8	471
Eil76	76	538	**555**	569		559	
Eil101	101	629	670.3	**631.6**			

Conclusion

Presented an ecosystem-inspired algorithm designed to take advantage of highly distributed computer architectures.

AEAS has also been used to successfully solve the TSP. Furthermore, Comparisons of AEAS's performance against more established biology inspired methods provides us with very encouraging results.

In future we plan to; extend AEAS to allow outlier individuals to migrate between species. Apply AEAS to different, more dynamic and distributed, versions of TSP. As well as, continuing our exploitation of other potentially useful features of natural ecosystems.