Structure of a Well-Known Modularity-Inducing Problem Domain*

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ABSTRACT

This is where the abstract goes.[1]

CCS CONCEPTS

• **Computer systems organization → Embedded systems**; *Redundancy*; Robotics; • **Networks** → Network reliability;

KEYWORDS

ACM proceedings, LaTeX, text tagging

ACM Reference Format:
Author One, Author Two, and Author Three. 2018. Structure of a Well-Known Modularity-Inducing Problem Domain. In *Proceedings of the Genetic and Evolutionary Computation Conference 2018 (GECCO '18).* ACM, New York, NY, USA, 2 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Why modularity is important

Why the Wagner-Espinosa Soto model is important, and why we are also considering Larson's variant. We will almost certainly want to cite [2].

Why we need to understand the fitness landscapes

Sensitivity to algorithm variants

2 BACKGROUND

This is where we give more detail of the background in modularity.

We might also put in a brief description of our initial experiments with tournament selection, explaining that we were puzzled why we didn't see any modular solutions this way.

In the inception phase of this project, we utilised the Louvain heuristics to compute the partition of the network vertices in order to maximize the modularity of the given graph [1]. We applied the tournament selection scheme with the tournament size being three and the elitism mechanism with ten elites in every generation. As a result of this setting, the partition of the gene regulatory networks by the Louvain heuristics demonstrated a very low modularity score. As Figure X indicates, by simulating the work in [2], we had expected there would be a spike after 500 generations on modularity. In contrast, we observed a modularity decrease as a result.

Figure X. An example of evolutions that did not evolve out high modularity

In order to understand this puzzling phenomenon, we removed the elitism mechanism and changed the tournament to proportional selection scheme. In consequence, we eliminated the deviant phenomenon as Figure X indicates. Therefore, we hypothesized that the elitism mechanism or the tournament selection scheme hamper the evolutionary process on evolving out modular structures.

3 METHODS

This is where we describe what we're going to do. As discussed previously, we don't mention symmetry or noisy evaluation in this paper, nor do we cover hotspots, diploidy or dominance.

What we do work with is a basic GA with mutation as per previous work, and cross over. The variations are:

Espinosa Soto vs Larson fitness function Fitness proportionate (roulette) selection vs tournament (maybe a couple of different tournament sizes)

We may end up merging this with the experiments section

4 EXPERIMENTS

This may end up merged with the methods section. Detailed settings for the experiments, including full evolutionary tableaux.

5 RESULTS

This is where we present the detailed results. We need fitness and modularity results. We also need the comparison between the optimum and the fittests high-modularity solutions. Then we need the results of deleting non-modular links from optimal solutions, and comparing resulting fitnesses, and showing the fitnesses of intervening paths. Finally, it may be desirable to check the result of evaluating the fitness of a good solution under one sampling method from one generation with the fitness of that solution under some other fitness function (i.e. how much do the fitnesses of an individual vary from generation to generation under Espinosa-Soto evaluation? How different are the Larson fitnesses? Are the differences larger or smaller for modular or non-modular solutions?

6 DISCUSSION

This is where we discuss the results, and their implications. Basically, we express this as puzzlement: we need to understand the fitness landscape better, and this probably requires better tools. We also discuss the sensitivity of the fitness landscape and the

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[1]This is an abstract footnote

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GECCO '18, July 15–19, 2018, Kyoto, Japan
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ACM ISBN 978-x-xxxx-xxxx-x/YY/MM.
https://doi.org/10.1145/nnnnnnn.nnnnnnn

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emergence of modularity, and compare it with biological evolution, where the emergence of modularity is robust and almost universal.

7 CONCLUSIONS

Summarise the results

Why these results are important.

Where we go from here.

ACKNOWLEDGEMENTS

?Do we need to acknowledge grants here? Assistance from Bongard? etc.

REFERENCES

[1] Vincent Blondel, Jean-Loup Guillaume, Renaud Lambiotte, and Etienne Lefebvre. 2008. Fast unfolding of communities in large networks. *Journal of Statistical Mechanics: Theory and Experiment* 10 (2008), P10008.

[2] Carlos Espinosa-Soto and Andreas Wagner. 2010. Specialization can drive the evolution of modularity. *PLoS computational biology* 6, 3 (2010), e1000719.

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