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Madter Thesis

Simultaneous Evolution of Morphology and Locomotion of Soft Robots by Novelty Search

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Abstract

Faculty Name
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Master of Science

Simultaneous Evolution of Morphology and Locomotion of Soft Robots by Novelty Search

by Georgios Methenitis

Soft robotics is a vivid research field on the science and engineering aspects of soft materials in mobile machines. Recent development in soft robotics and evolutionary optimization have shown the possibility to simultaneously evolve the morphology and locomotion of soft robots. Generative encoding coupled with neural evolution of augmented topologies (NEAT) shows promising results. It is of interest to study the development of different types of locomotion in low gravity environments while rewarding diversity at the behavioral level. Unlike most evolutionary algorithms, novelty search seeks novel behaviors and has no defined objective (e.g. distance traveled or speed). This research could result in a taxonomy of possible locomotion strategies at a given (low) gravity level that inspire new concepts for future robotic missions.

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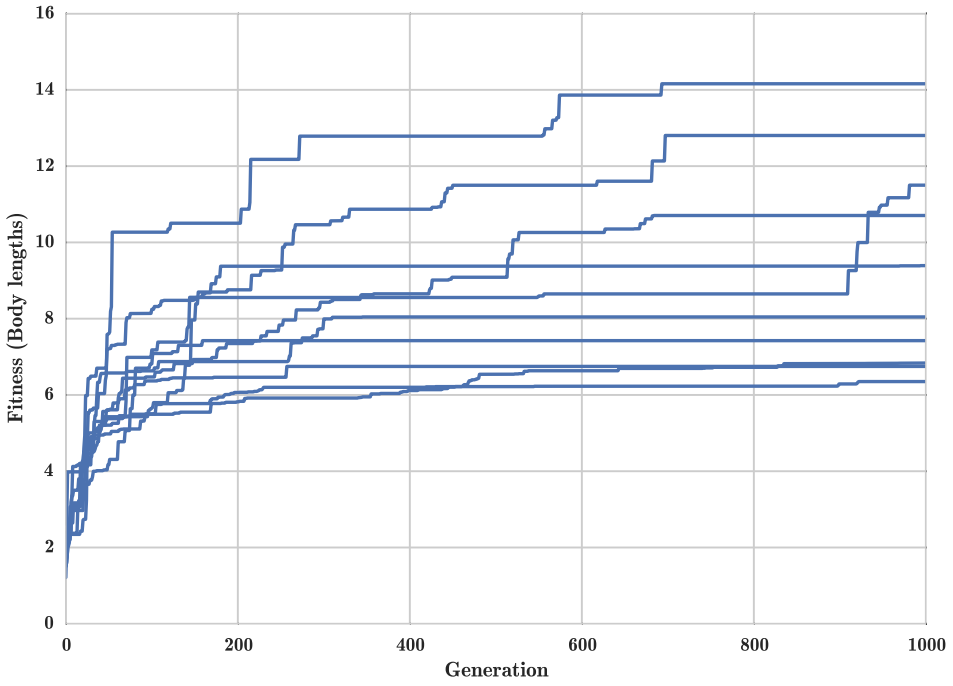

FIGURE 3.1: Caption

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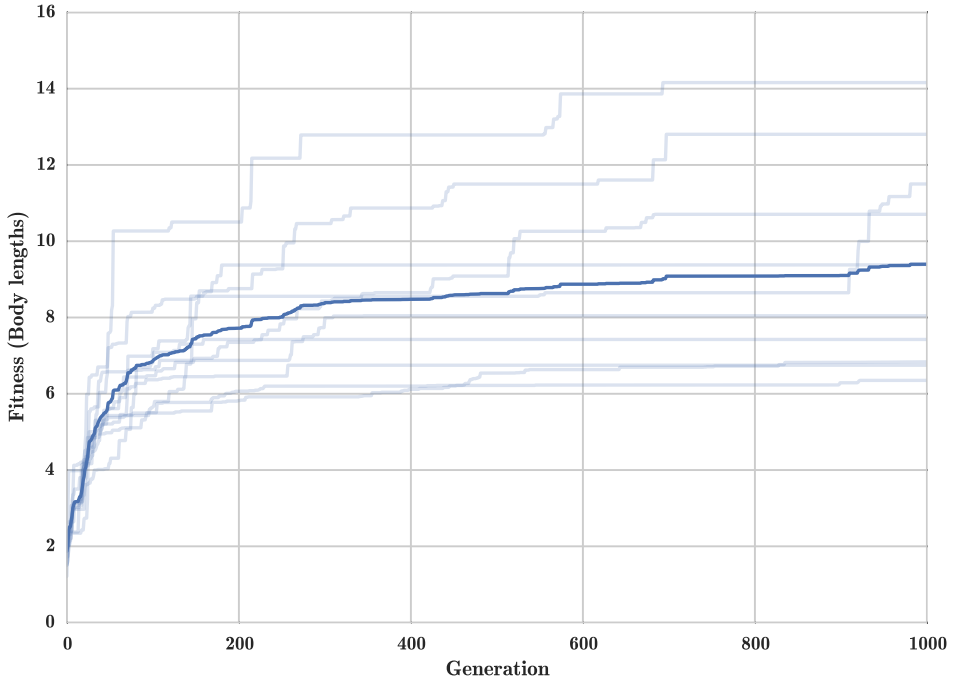

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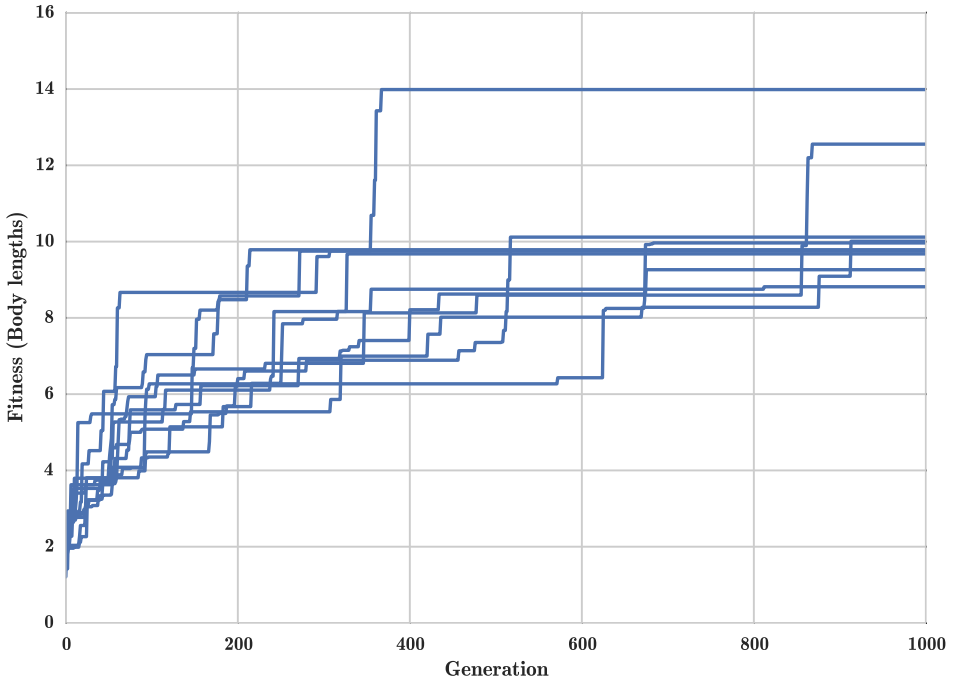

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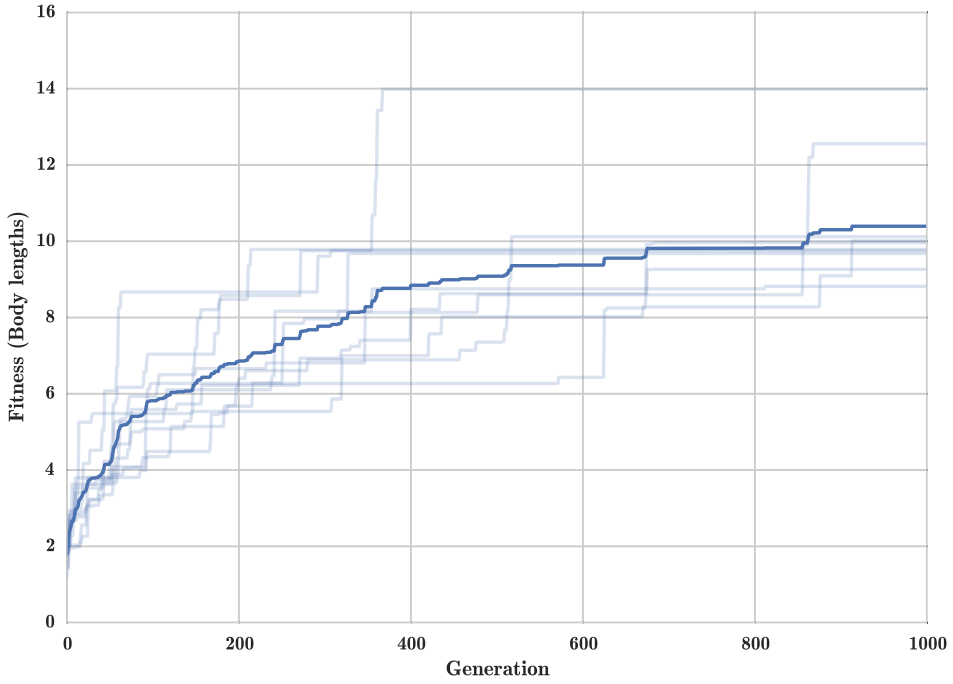

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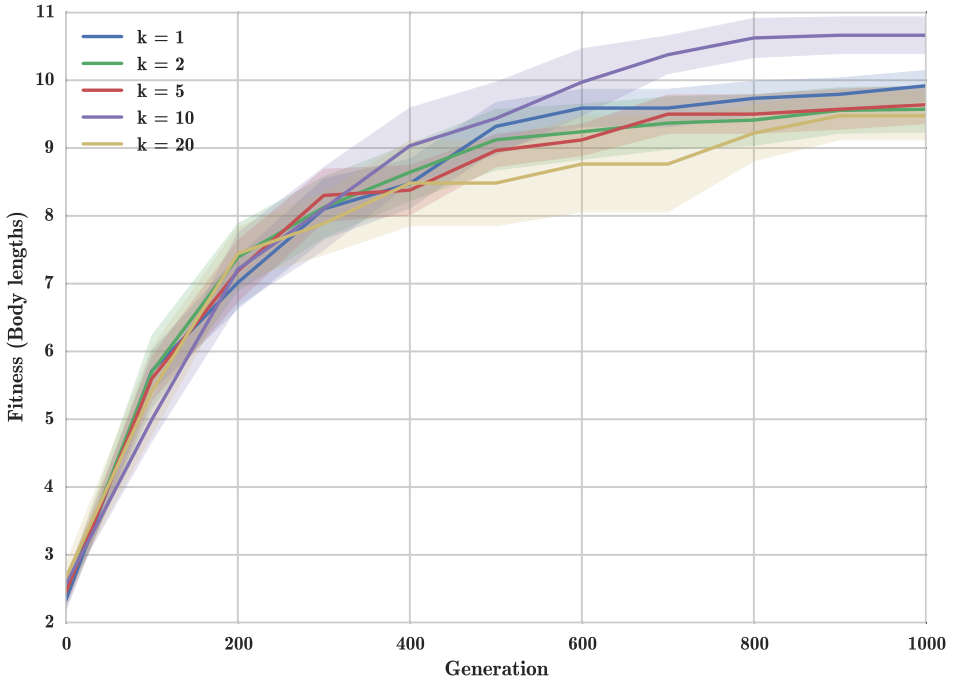

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3.1.3 Novelty-Fitness Based Search Comparison

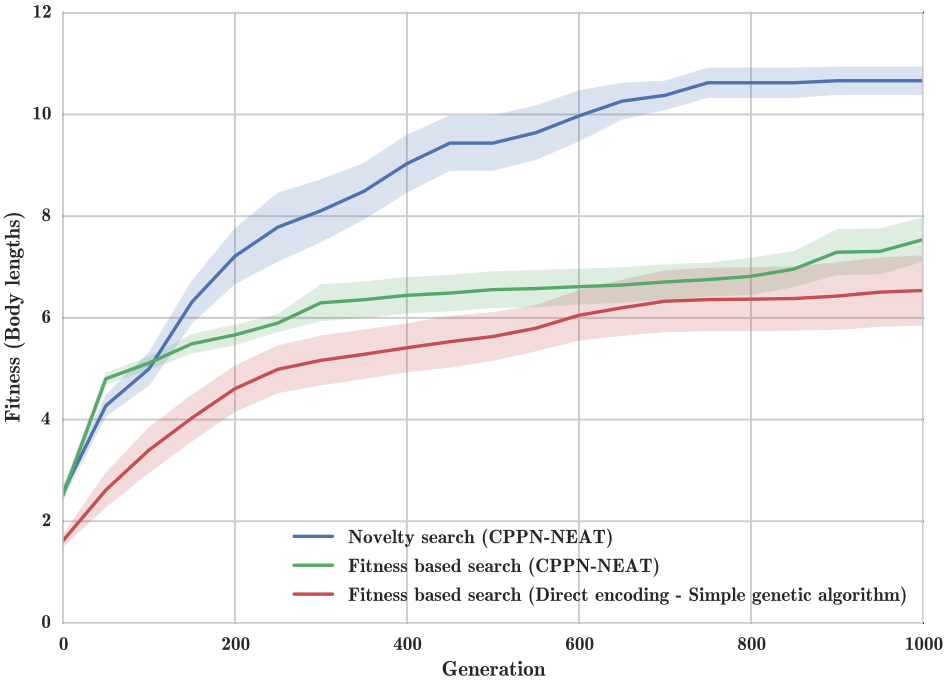
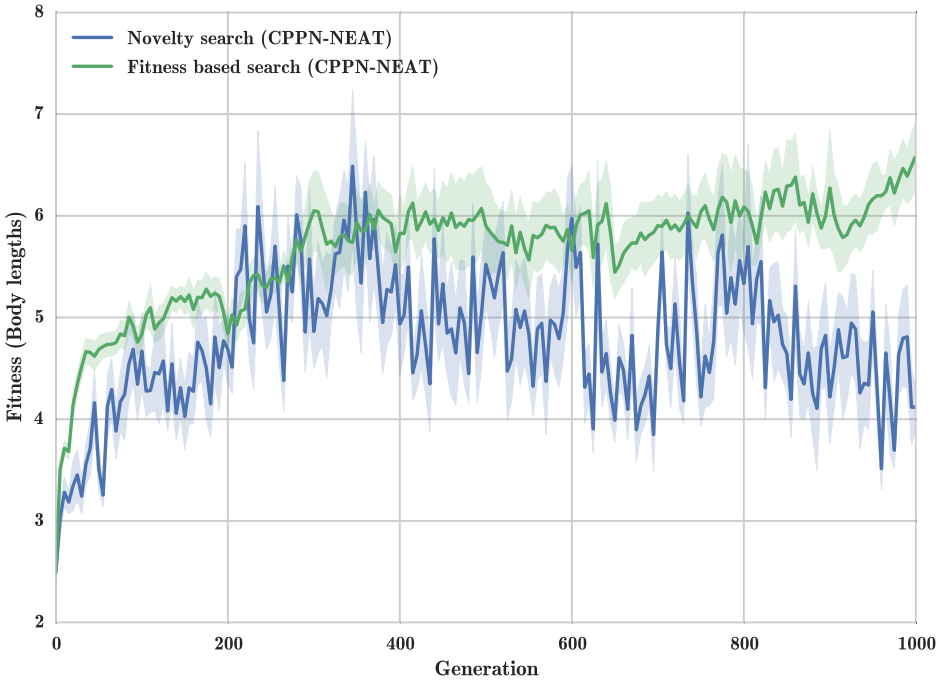


FIGURE 3.7: Best so far fitness in body lengths displacement of softbot's center of mass averaged over 10 runs together with the standard deviation error. The gravity acceleration for this experiment used was $-27.468\ m/s^2$, the size of the lattice $5 \times 5 \times 5$ and 4 available materials (2-actuated).

[1]Actuated materials penalize fitness:

$$f = (1 - (n_{actuated}/n_{total})^{1.5}) \times disp$$

, where $n_{actuated}$, is the number of actuated voxels, n_{total} total number of voxels and $disp$ the displacement of the softbot's center of mass.



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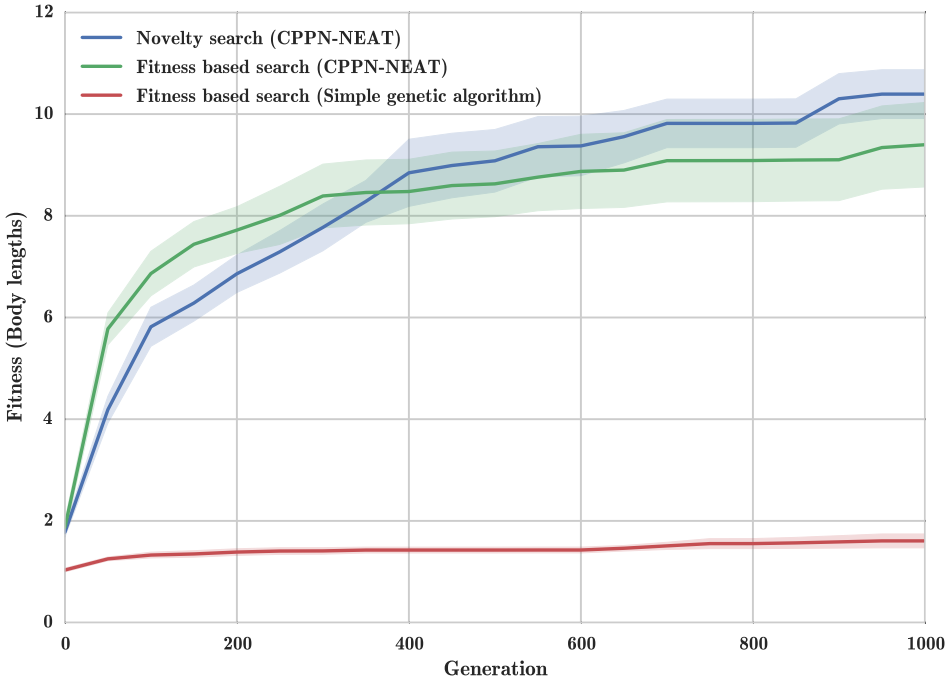

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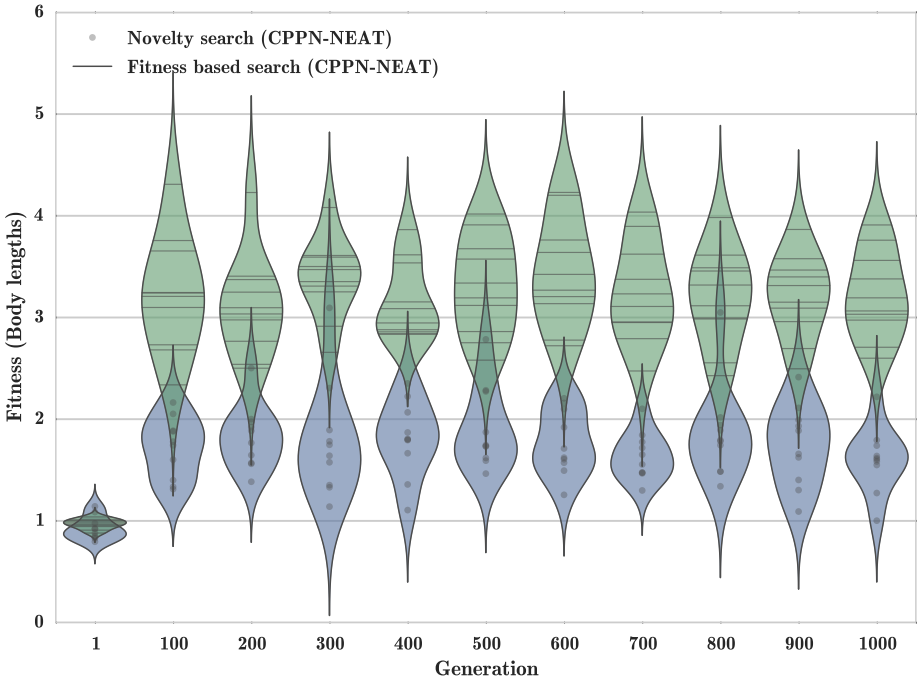

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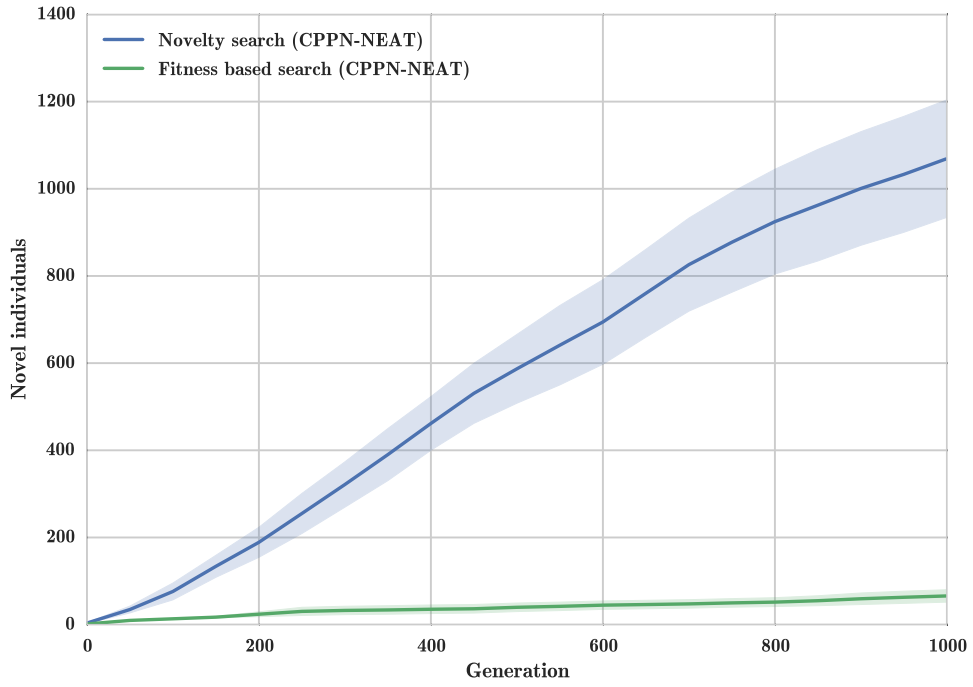

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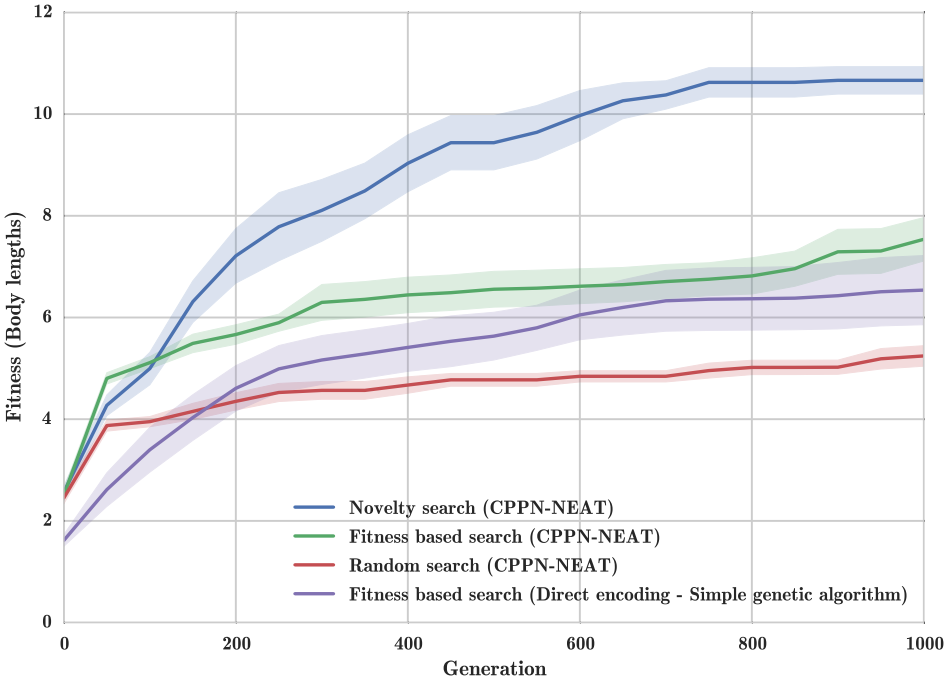

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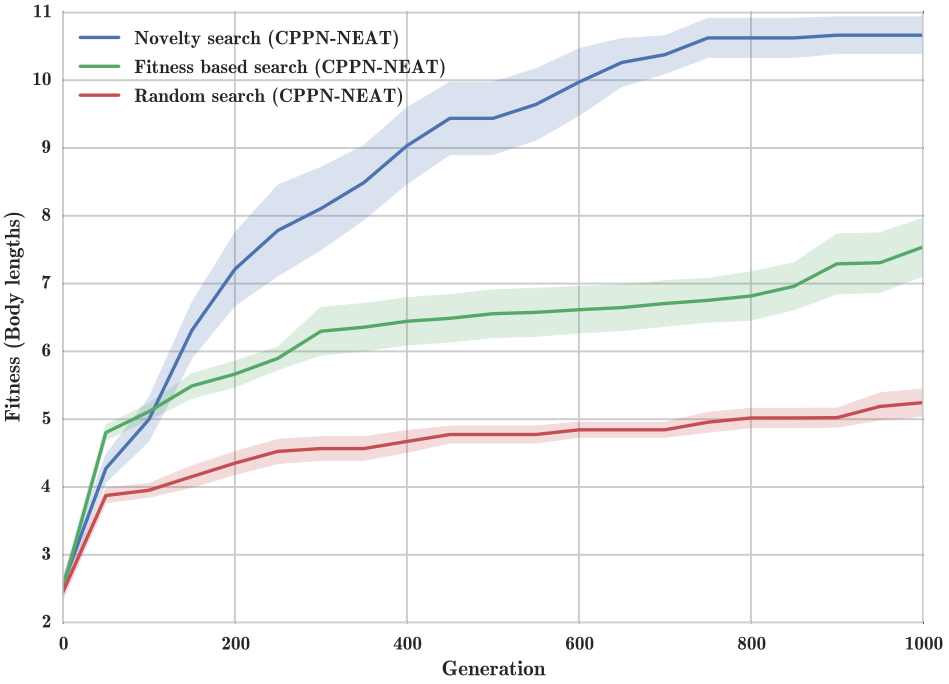

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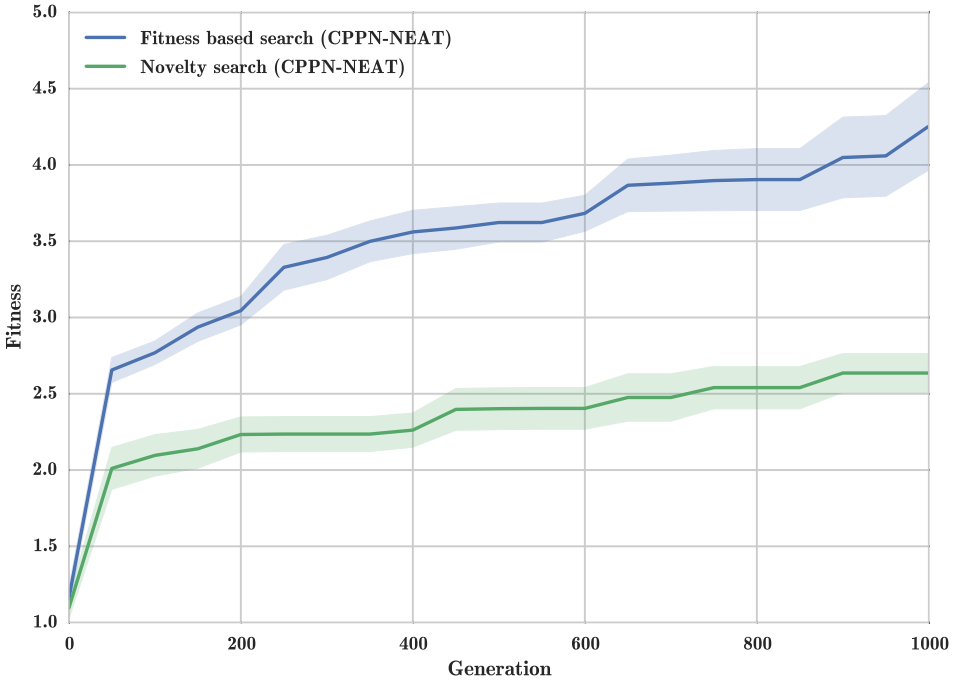

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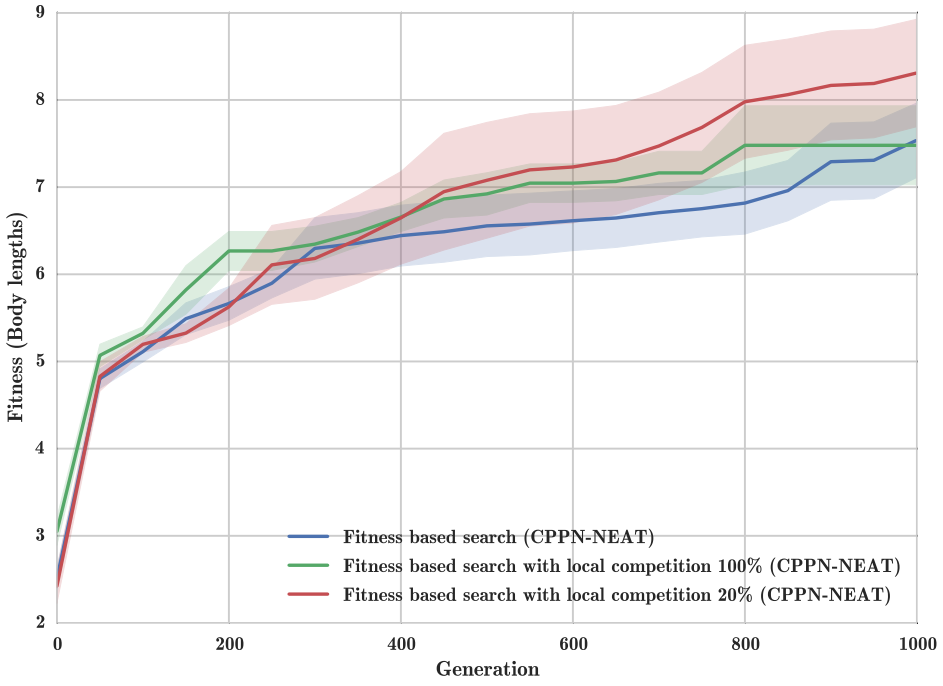
3.1.4 Local competition in fitness based evolution



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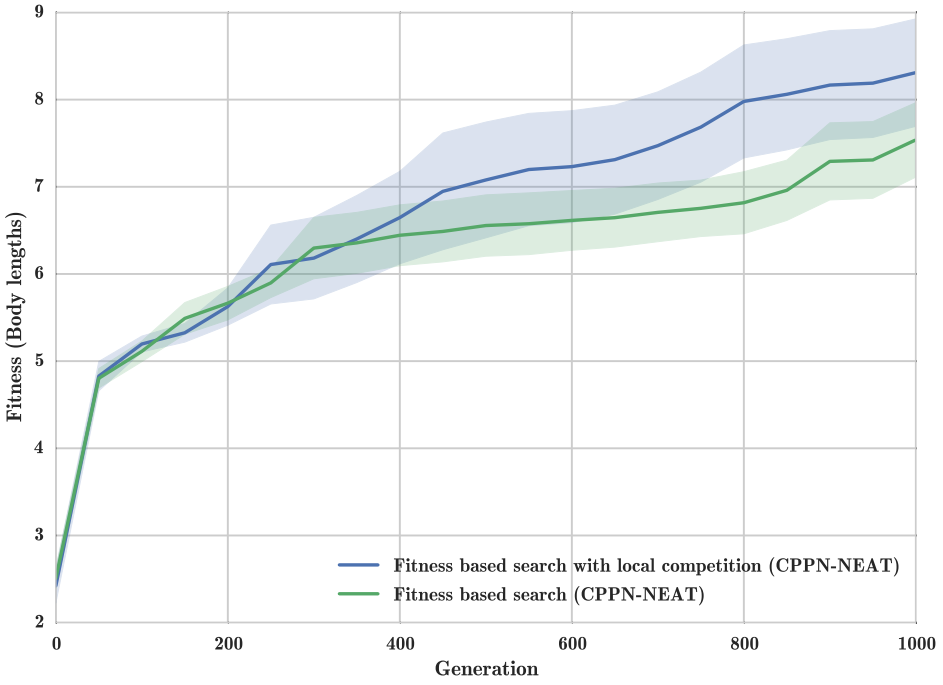

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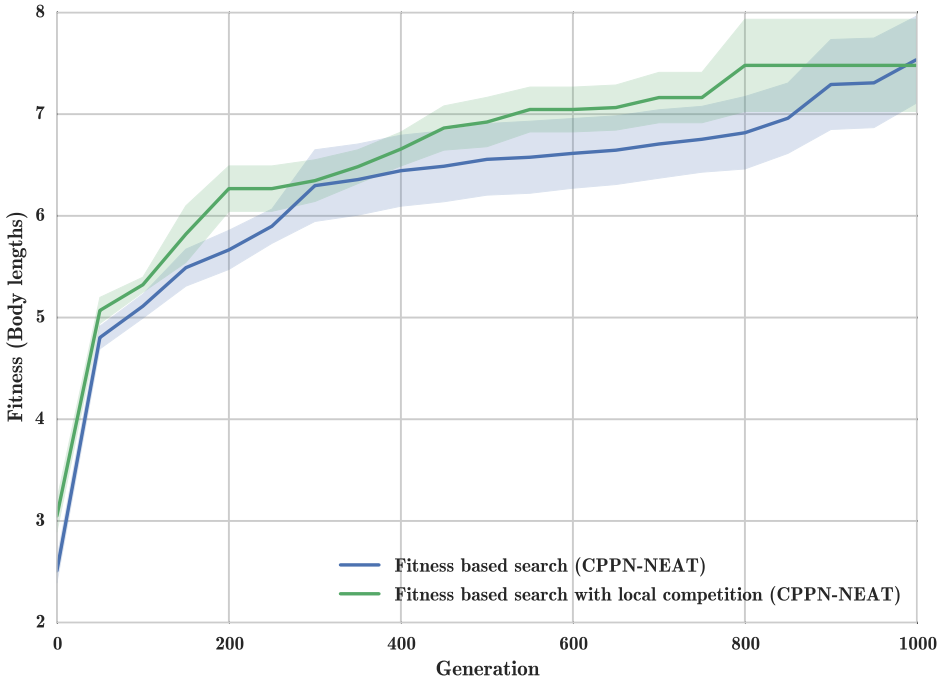

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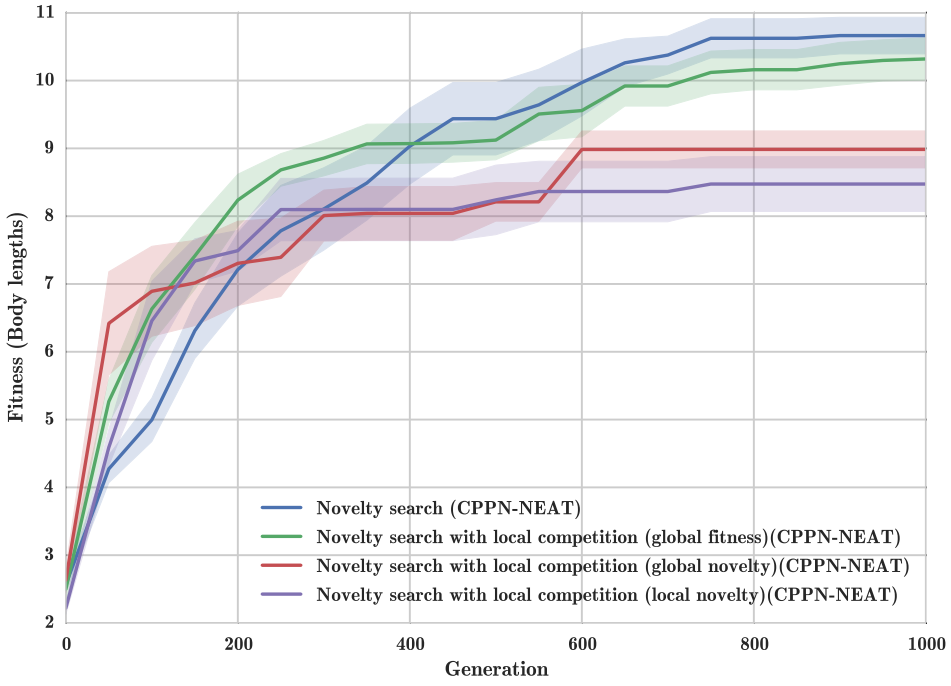
3.1.5 Local competition in novelty search evolution



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Appendix A

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