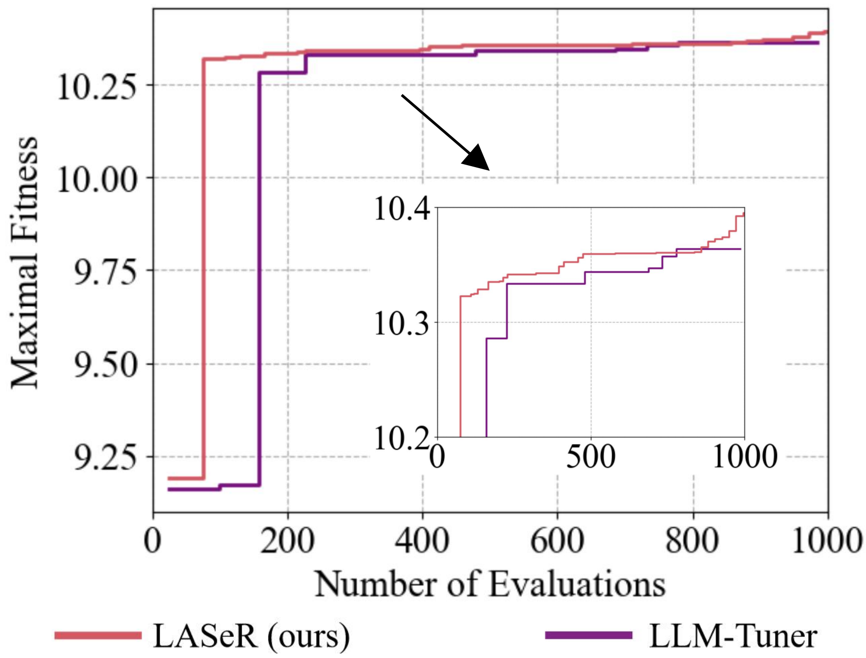
Supplementary material 6: Evaluation on 10x10 Walker-v0

In this work, we adhered to the standard setup used in previous VSR studies, specifically a 5x5 body size with five different materials, as this configuration is proven already expressive enough for complex and diverse morphological structures to emerge (Song et al., 2024; Saito and Oka, 2024; Dong et al., 2024; Wang et al., 2023). Nevertheless, to evaluate the scalability of our approach to larger design spaces, we tested both LASeR and LLM-Tuner (the best-performing baseline) on Walker-v0 with a 10x10 body size. Our findings, as presented in **Supplementary figure 6**, demonstrate that LASeR **continues to outperform the baseline** in terms of optimization efficiency, even in this larger design space. We attribute this success to the unique advantage of LLMs. Specifically, LLMs leverage their reasoning capabilities to identify favorable voxel assembly patterns within high-performing designs, instead of relying on random mutations (as seen in genetic algorithms and other heuristics), to generated offspring solutions. This is also demonstrated in **Supplementary materials 3** and **7**. It is worth noting that **the 10x10 configuration results in a design space that is 2.65×10^{52} times larger than the 5x5 case**, due to combinatorial explosion. Therefore, the promising results indicate a remarkable potential of our approach to scale to even larger and more complex robot design problems.



Supplementary figure 6. Comparison of LASeR and LLM-Tuner on 10x10 Walker-v0.

References:

[1] Dong, Heng, Junyu Zhang, and Chongjie Zhang. "Leveraging Hyperbolic Embeddings for Coarse-to-Fine Robot Design." *The Twelfth International Conference on Learning Representations*. 2024.

[2] Saito, Takumi, and Mizuki Oka. "Effective Design and Interpretation in Voxel-Based Soft Robotics: A Part Assembly Approach with Bayesian Optimization." *Artificial Life Conference Proceedings 36*. Vol. 2024. No. 1. One Rogers Street, Cambridge, MA 02142-1209, USA journals-info@ mit. edu: MIT Press, 2024.

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