

Optimizing Gaits for Coverage on Lie Groups

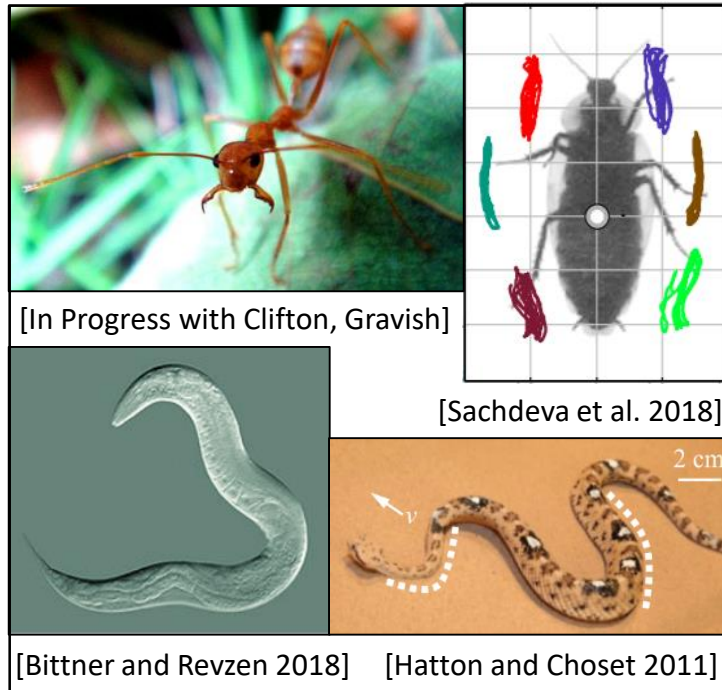
Brian Bittner and Shai Revzen

University of Michigan

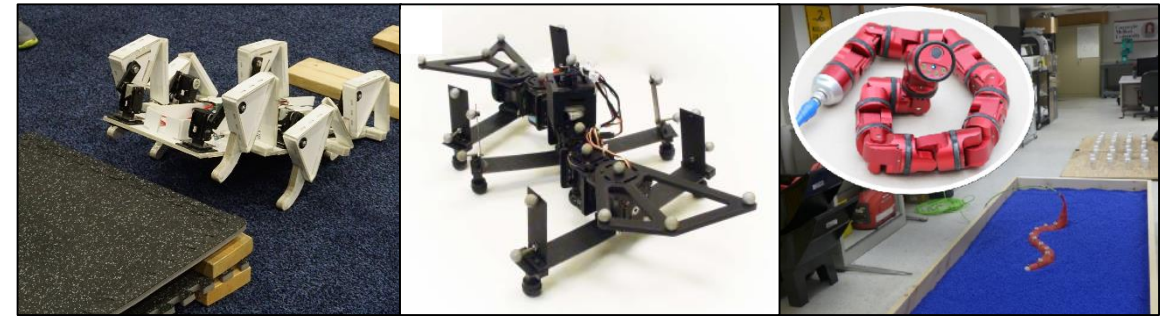


First Order Motion Models and Gait Optimization

Biological Locomotors



Bio-inspired Counterparts



[Zhao et al. 2018]

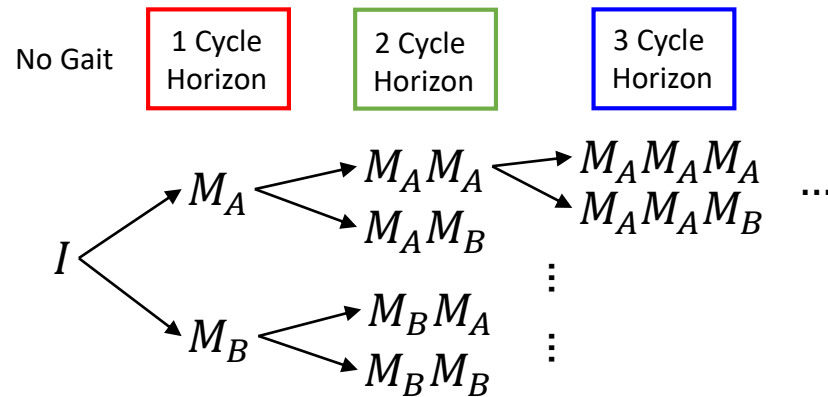
[Dai et al. 2016]



[Bittner, Hatton, and Revzen 2018]

Defining Coverage

Cyclic changes in shape (gaits) can generate group actions (M):



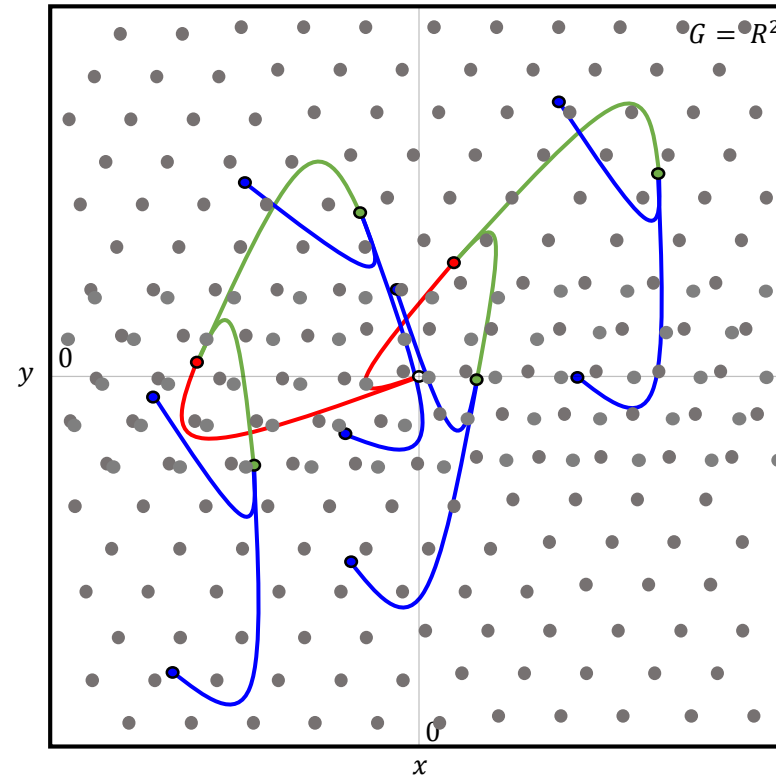
Computing Coverage:

Let $M := \{M_j\}_{j=1}^m$ be achievable motions.

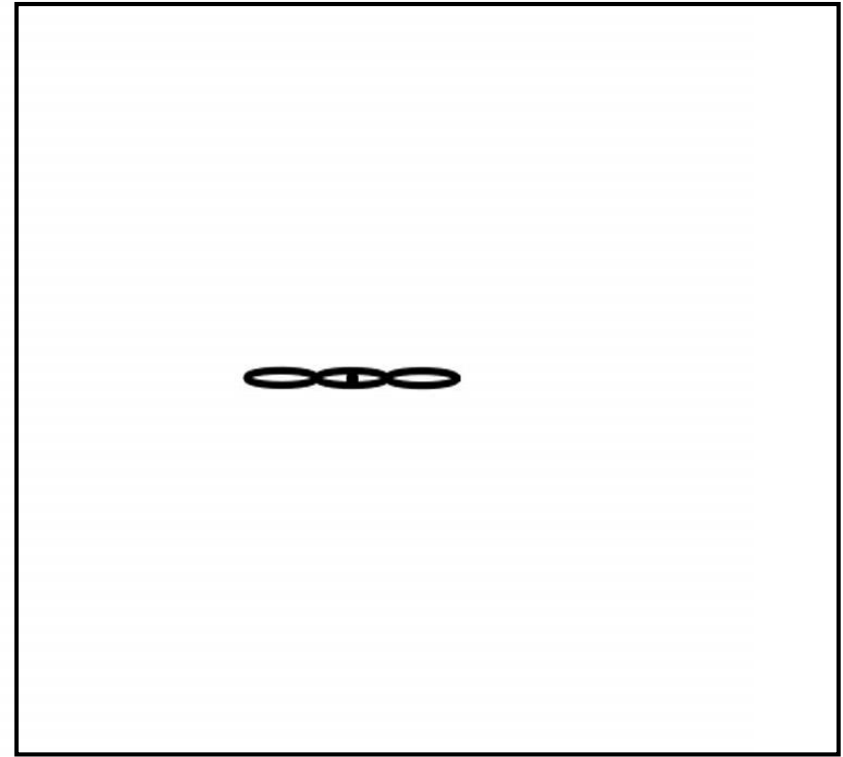
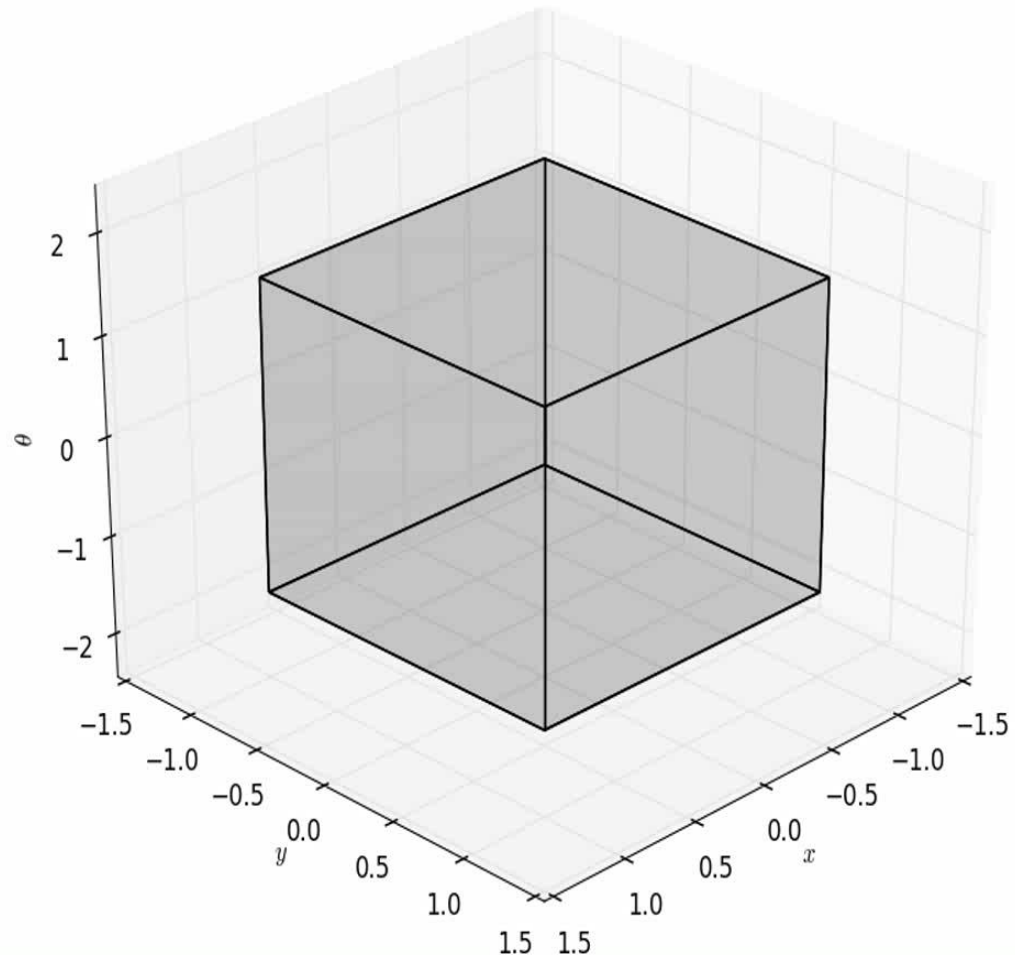
Let $G := \{G_i\}_{i=1}^n$ be the goal motions.

Let $W := \{w_i\}_{i=1}^n$ be associated scalar weights.

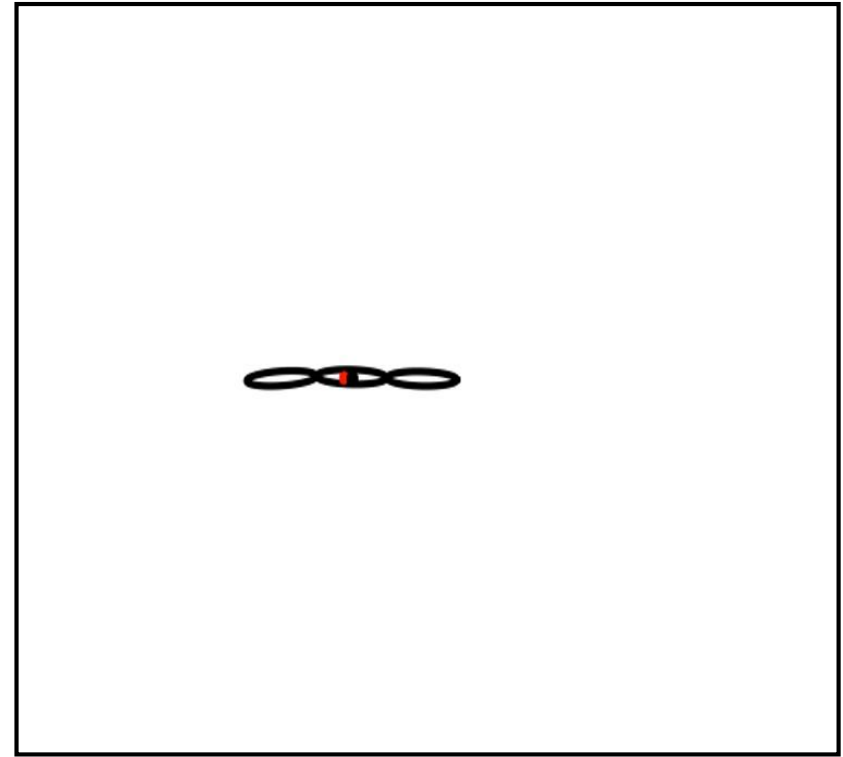
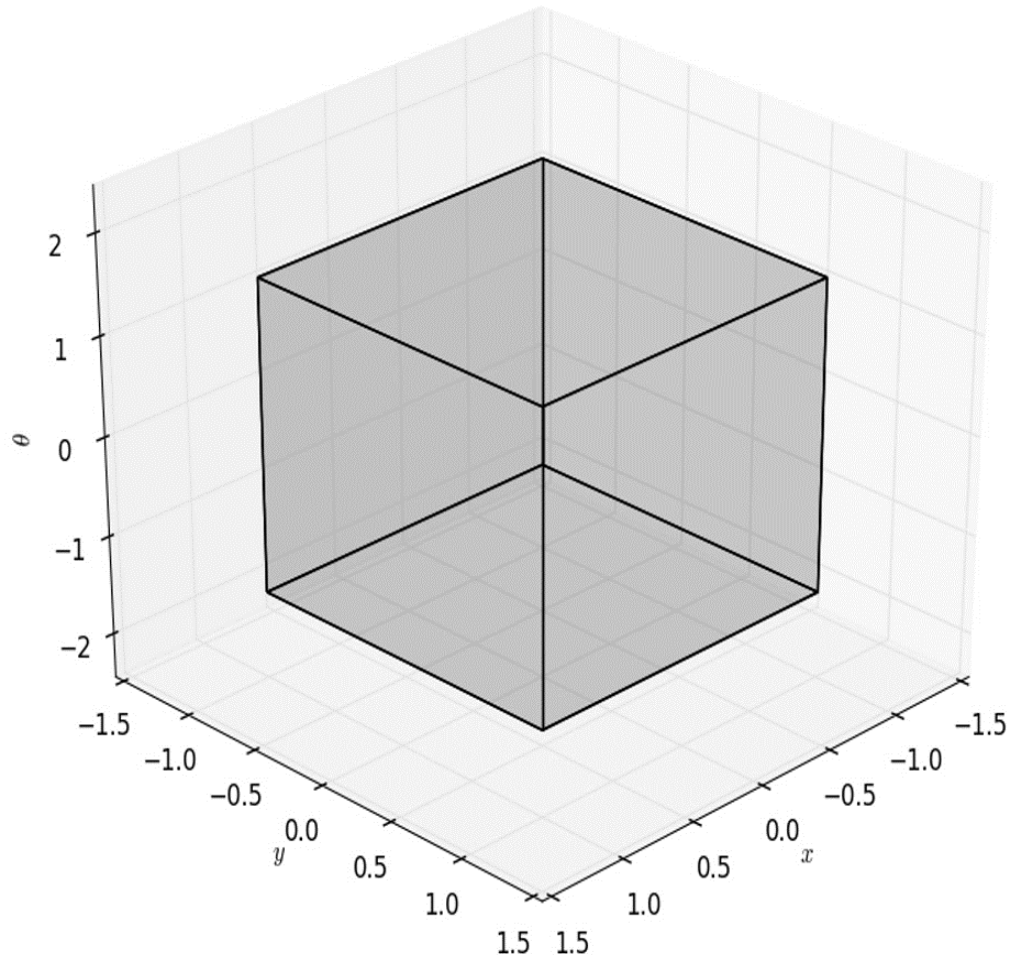
We define "coverage" as $h(M) := \sum_i w_i \min_j | \log(M_j G_i^{-1}) |$



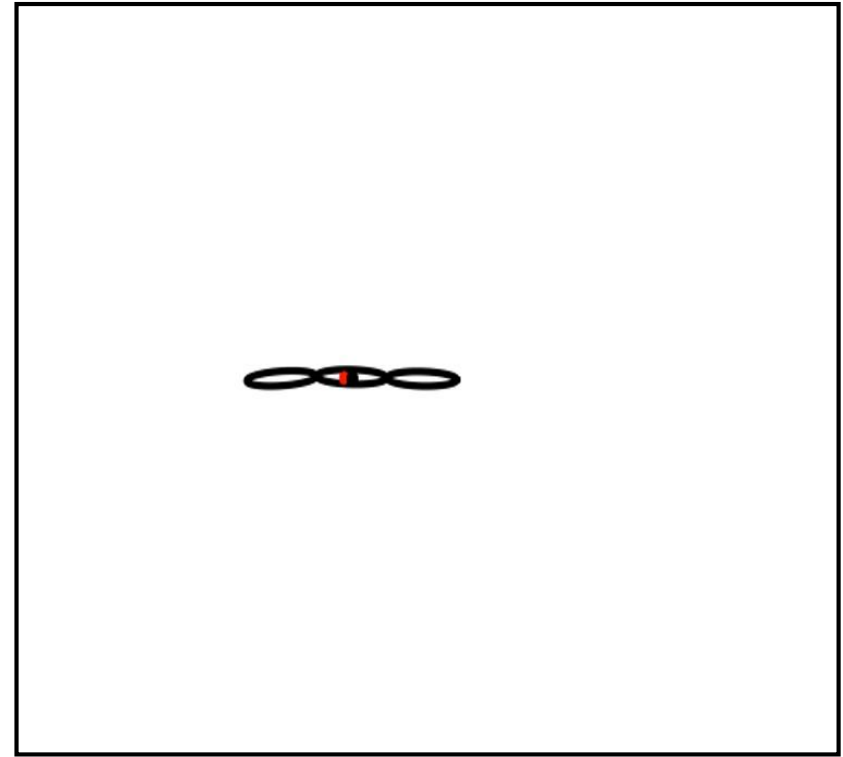
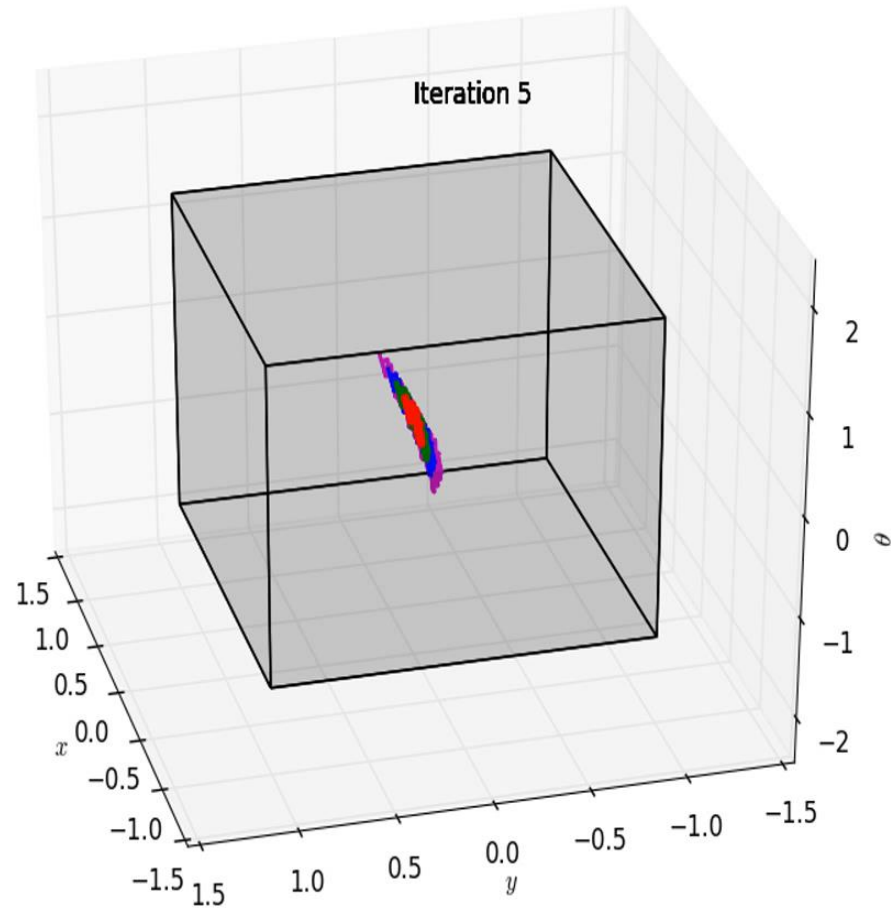
Selecting 3 Gaits for Maximal Coverage



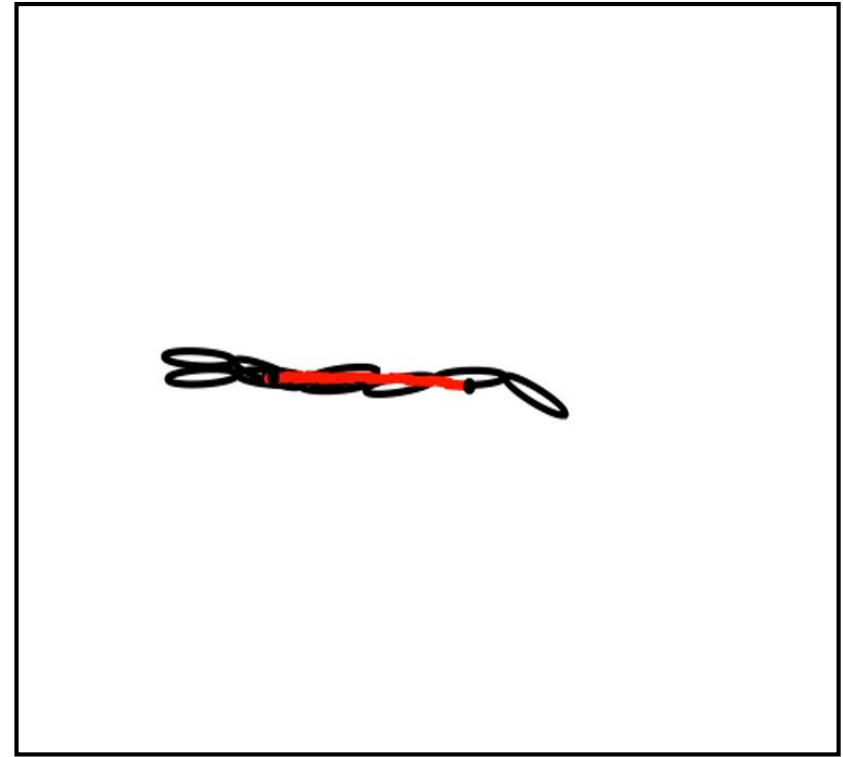
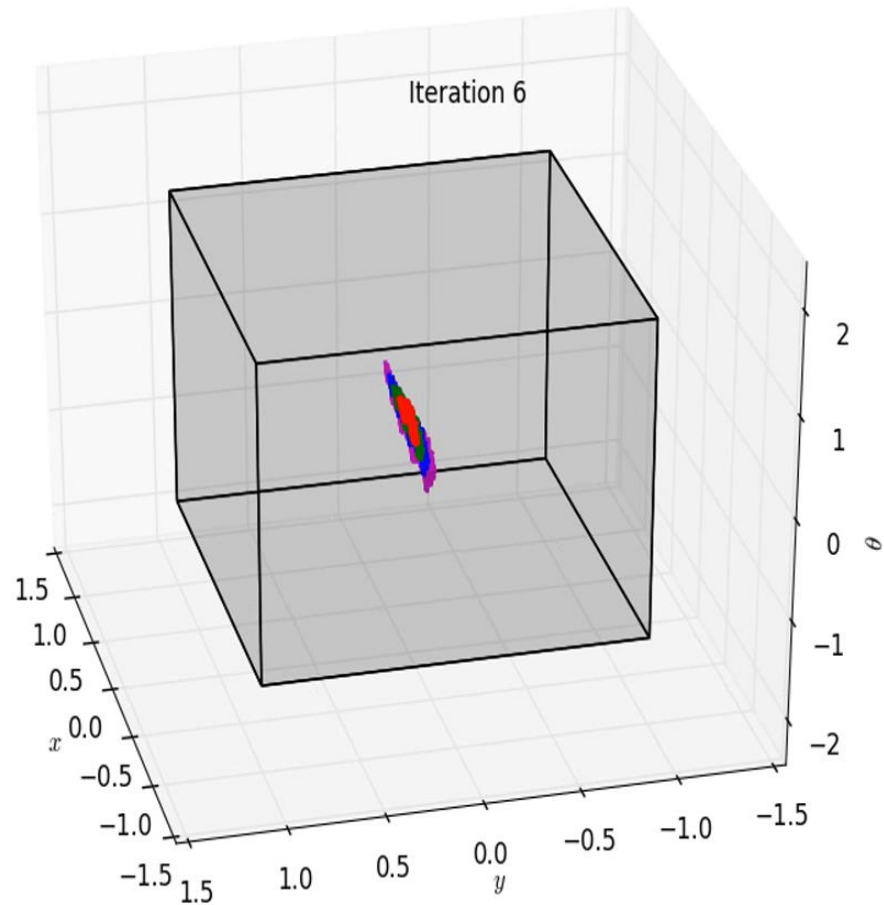
Selecting 3 Gaits for Maximal Coverage



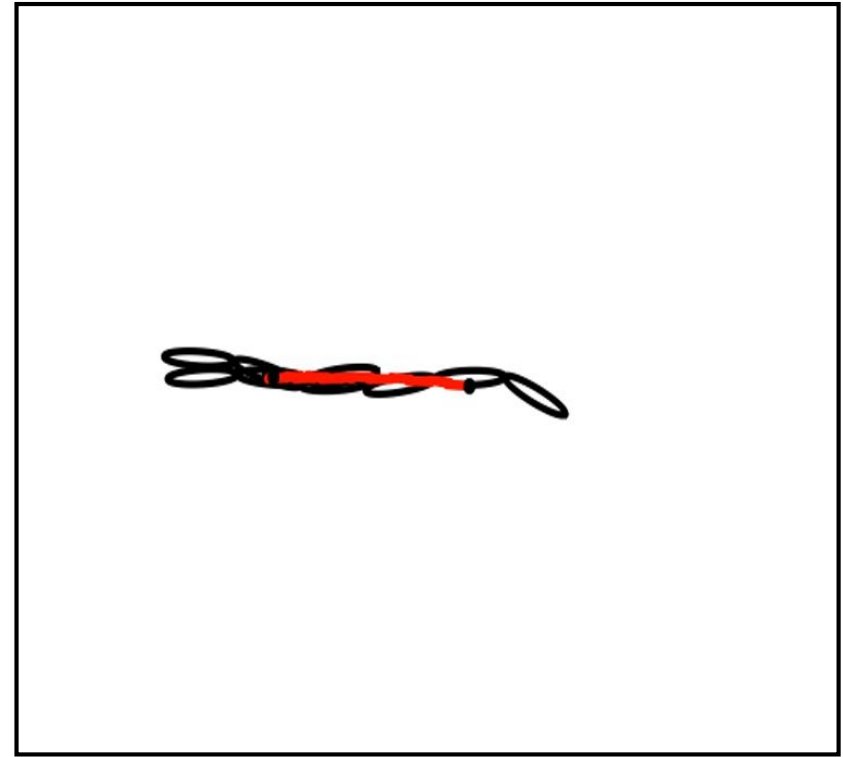
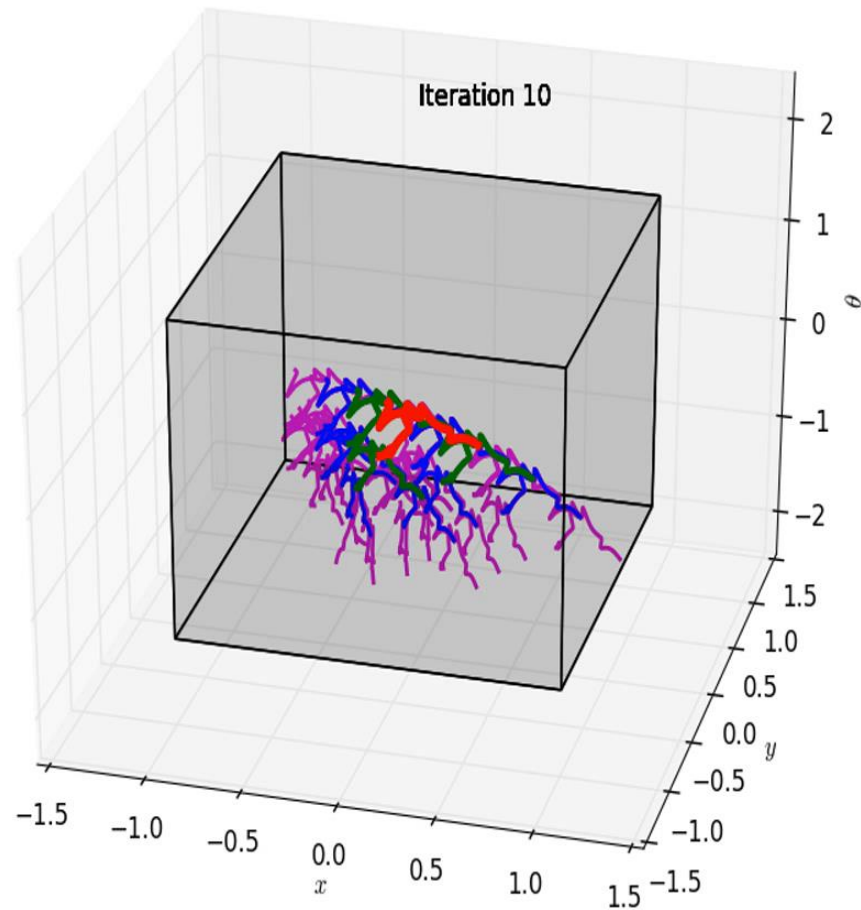
Selecting 3 Gaits for Maximal Coverage



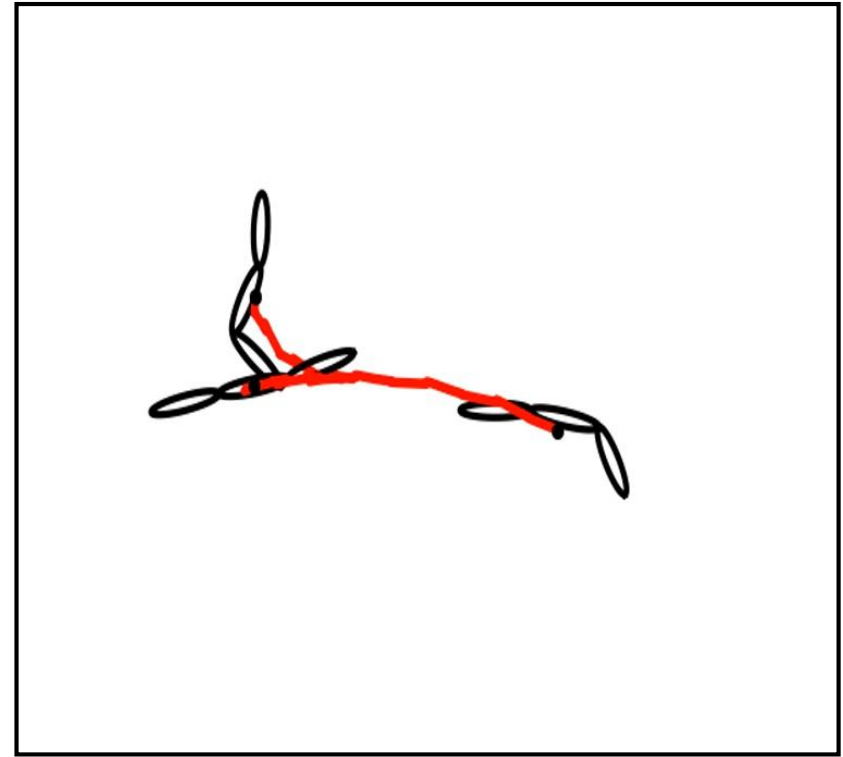
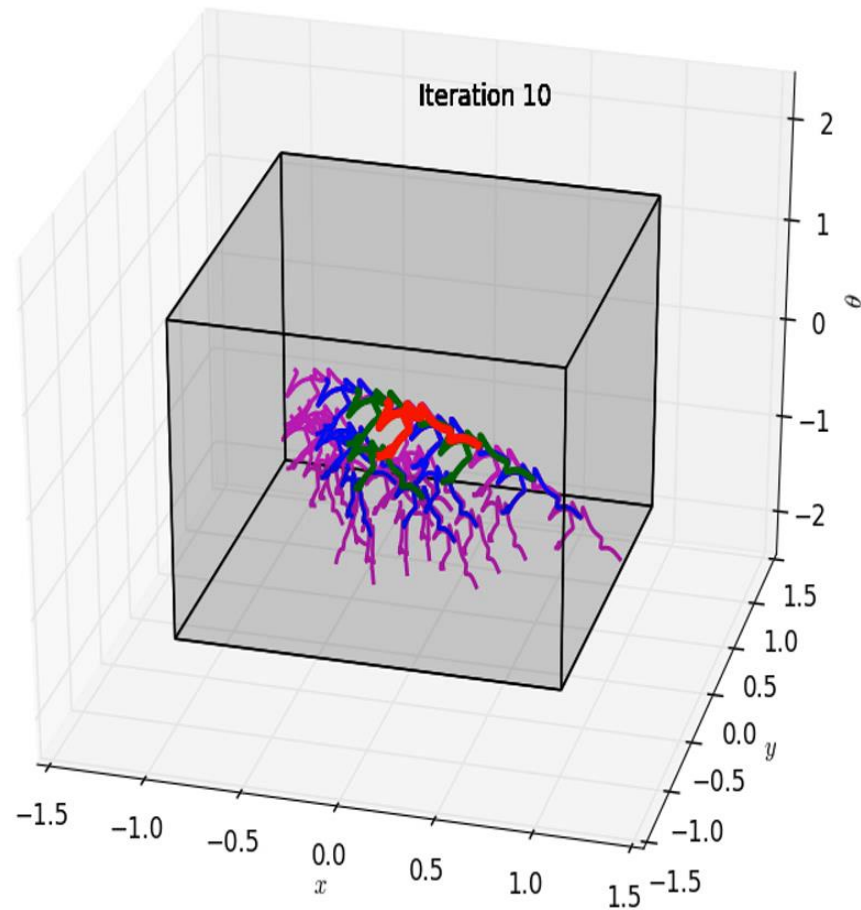
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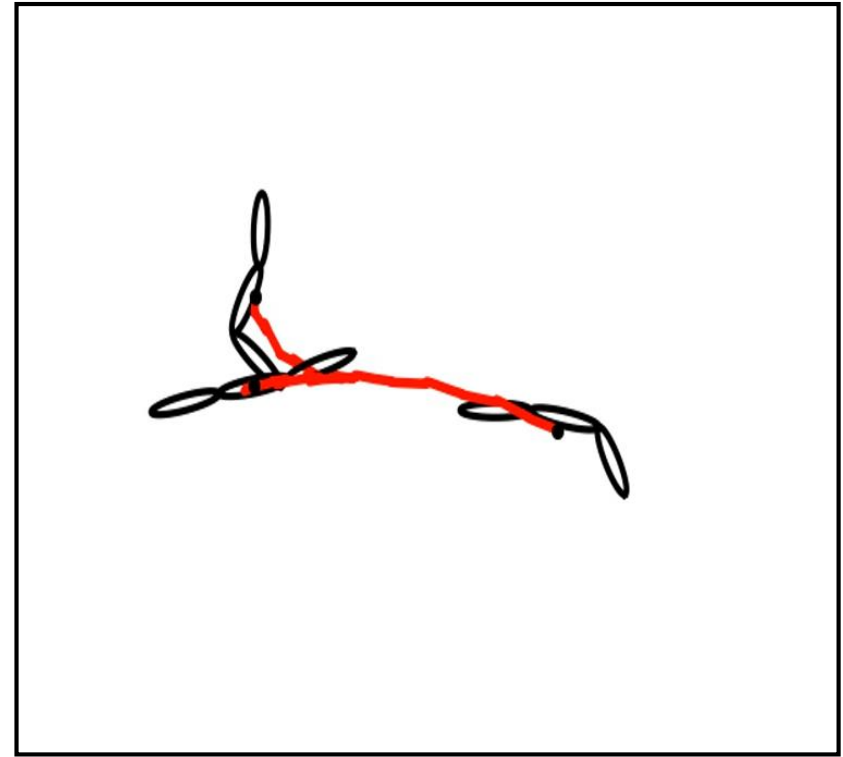
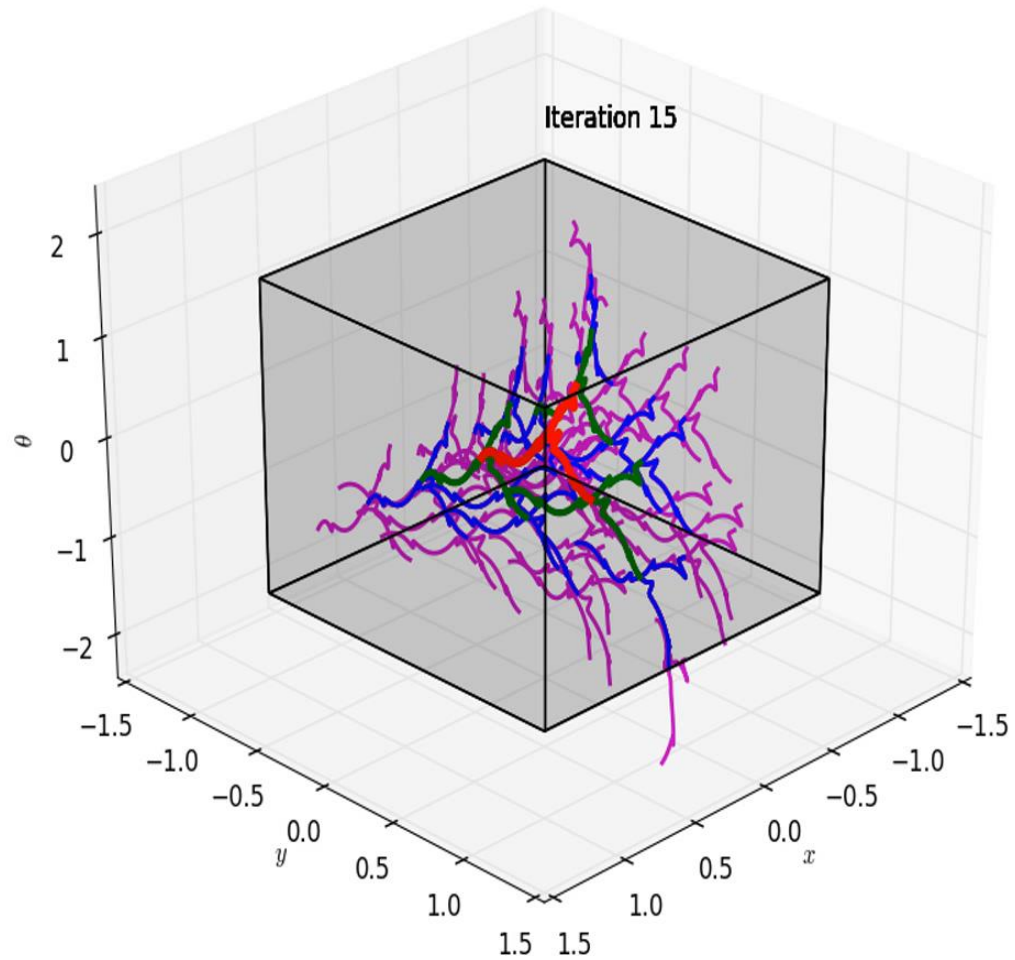
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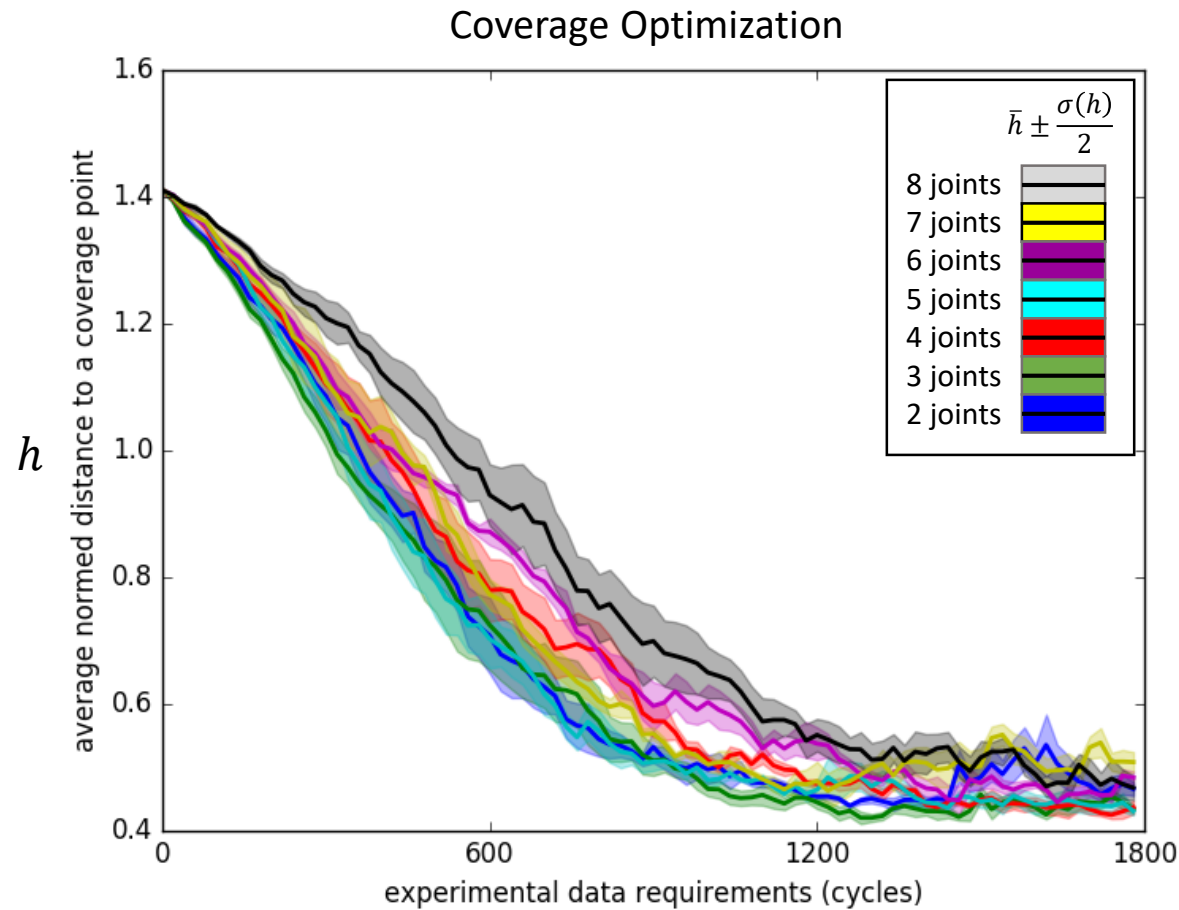
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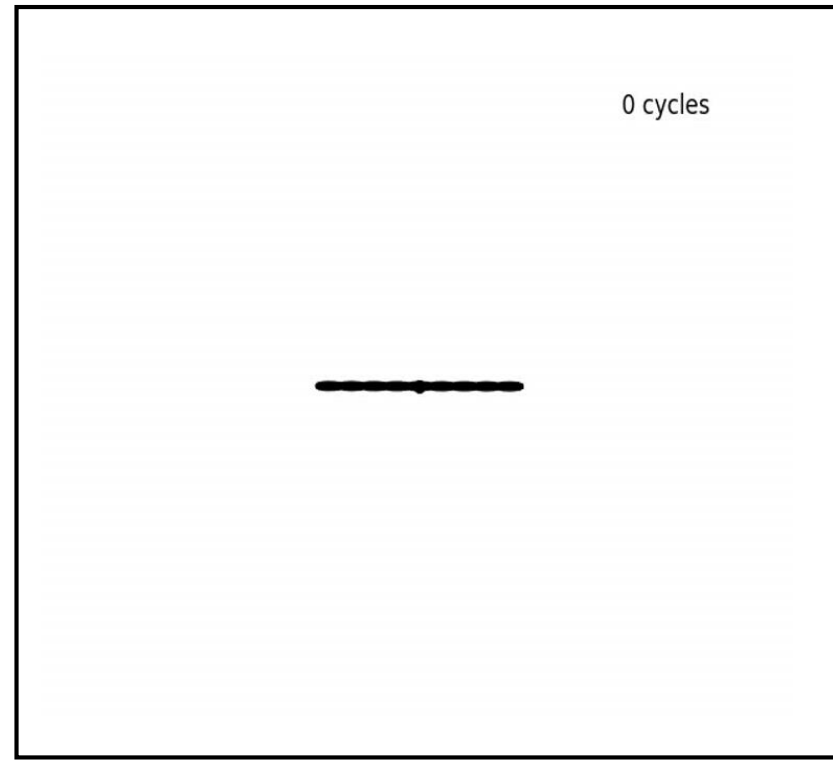
Selecting 3 Gaits for Maximal Coverage of SE(2)



Coverage for Higher Complexity Swimmers



8 Joint Viscous Swimmer



Future Work

Hardware examples.

Random CAD model generated -> robot built -> learns gaits quickly -> moves through maze.

Investigation: Mechanical redundancy is an asset, or a liability?



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