Evolving Scalable Soft Robots

Senior Thesis Presentation

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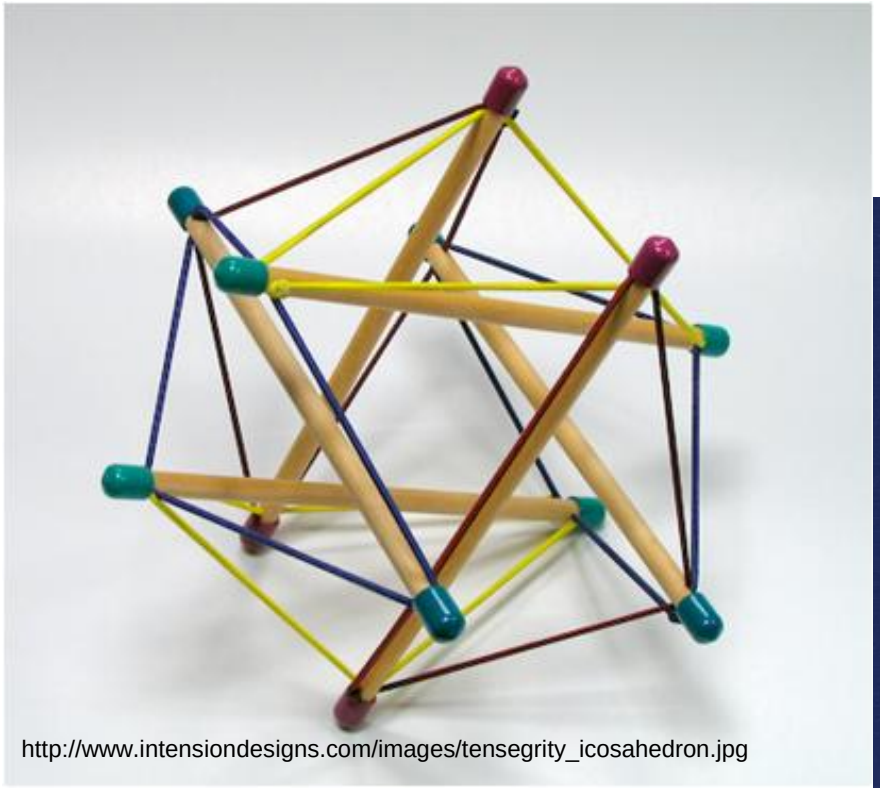
http://www.nigeriaintel.com/wp-content/uploads/2013/07/collapsed-building.jpg

Soft robot examples

http://spectrum.ieee.org/img/soft%20robot%20flexibot-1322569462509.png

http://www.chemistryviews.org/commo images/thumbnails/source/12daa023d4a.jpg



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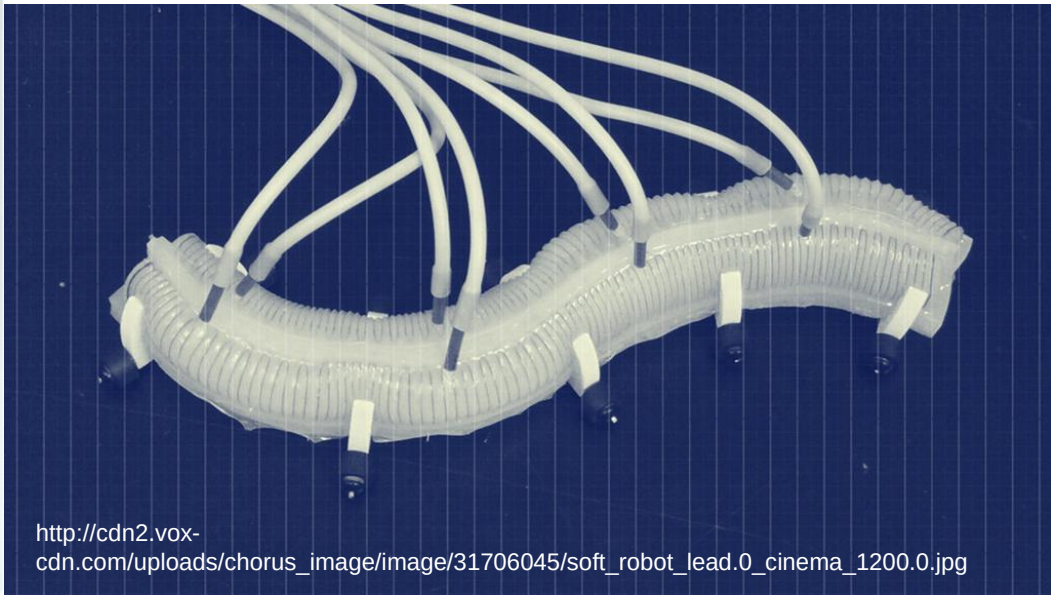

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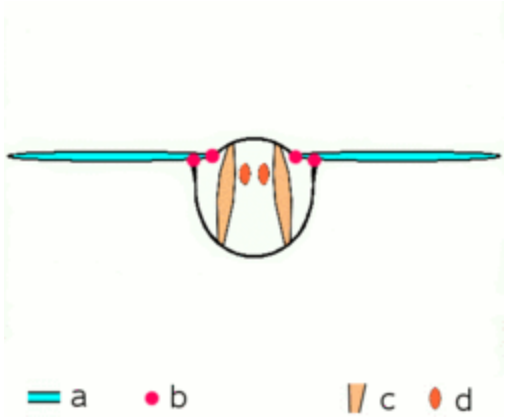
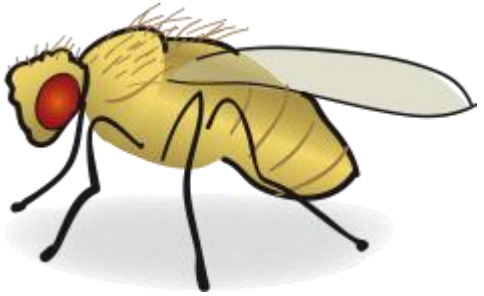
https://gs1.wac.edgecastcdn.net/8019B6/data.tumblr.com/tumblr_m678xczbji1qedb29o1_r1_500.gif

How do we make soft robots **move**?

(Hint: It’s really hard!)

We can outsource cognition to the body, analogous to how a fly's wings beat 4x faster than its nerve impulses





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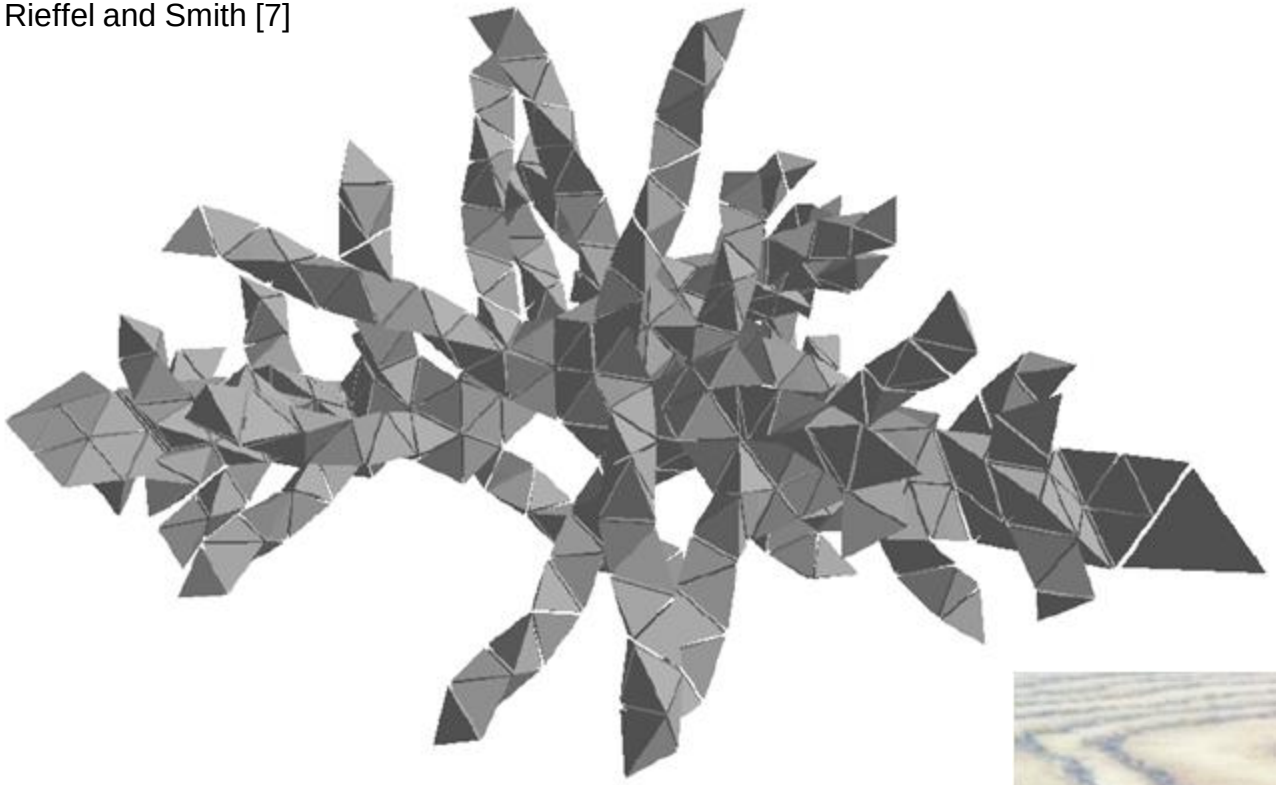
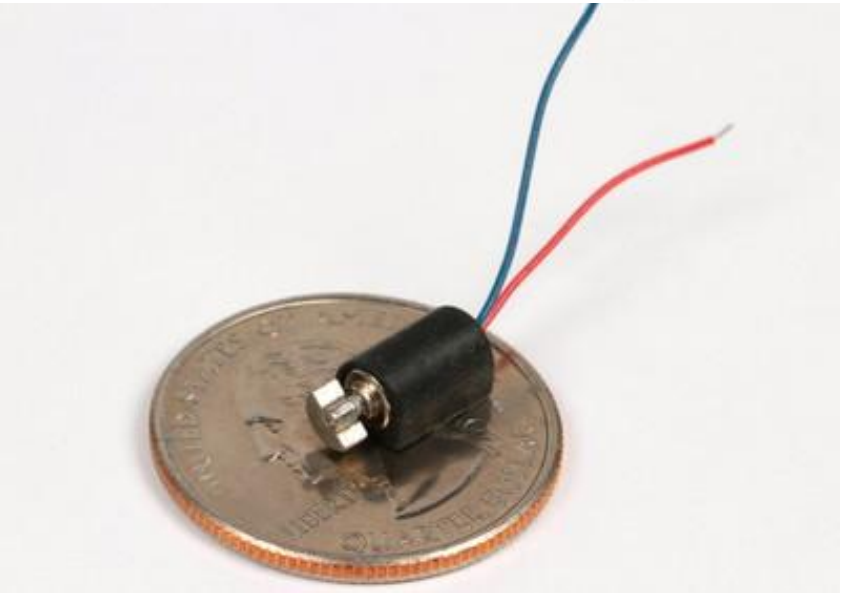
https://upload.wikimedia.org/wikipedia/commons/thumb/6/6e/Drosophila-drawing.svg/236px-Drosophila-drawing.svg.png

Rieffel and Smith [7]





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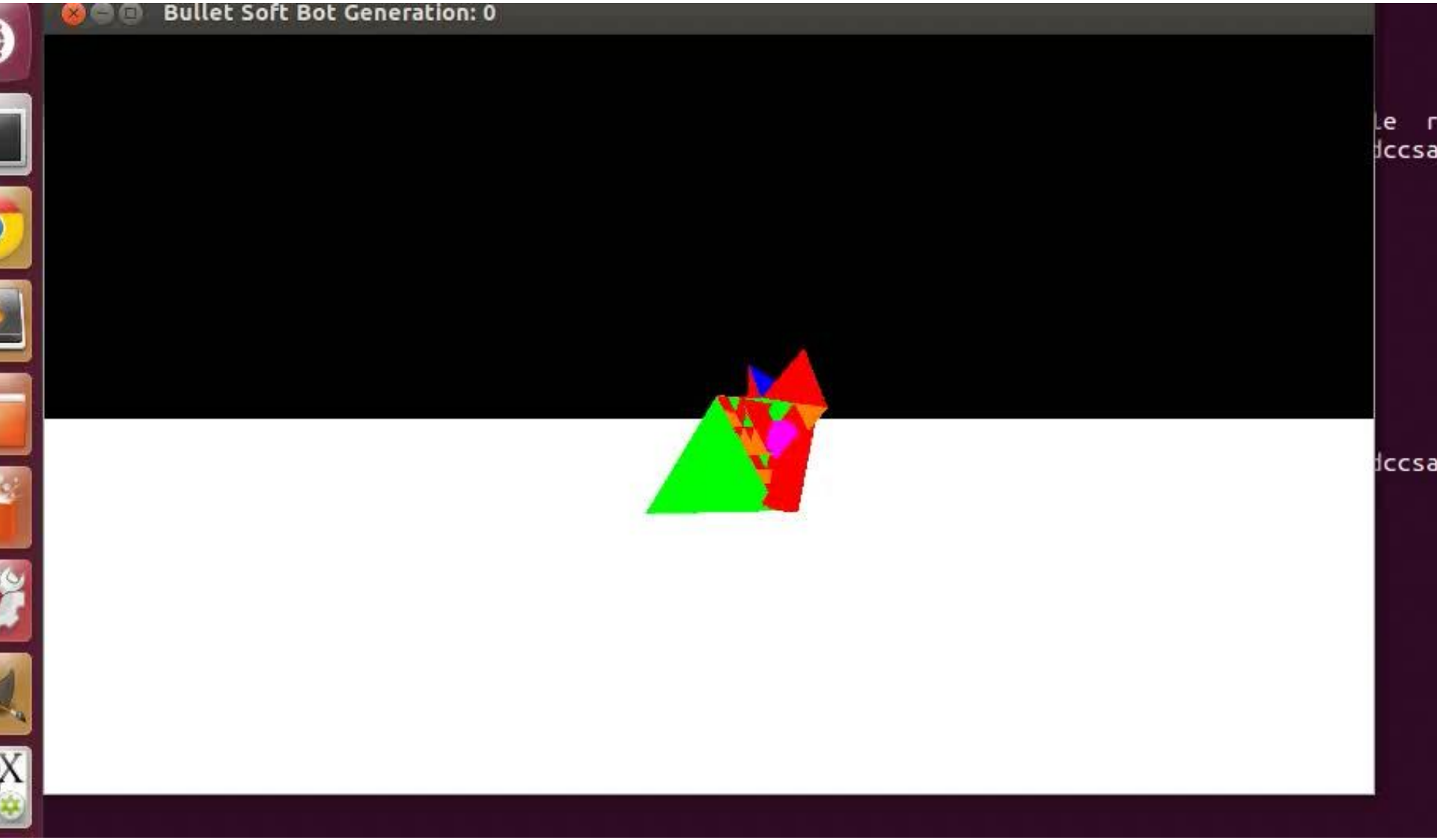
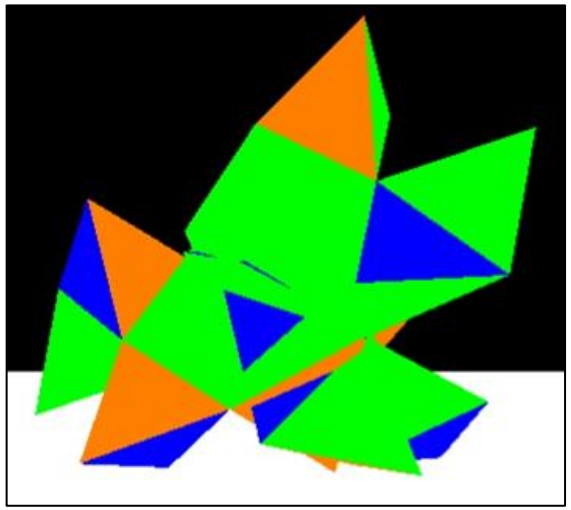
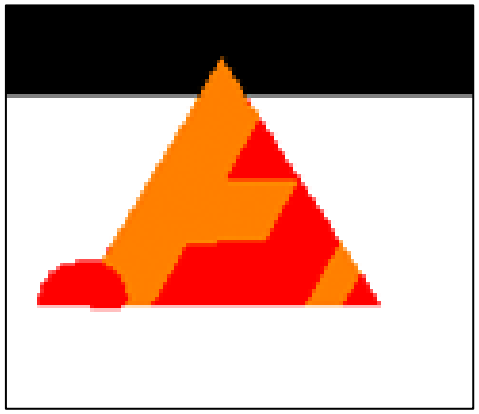
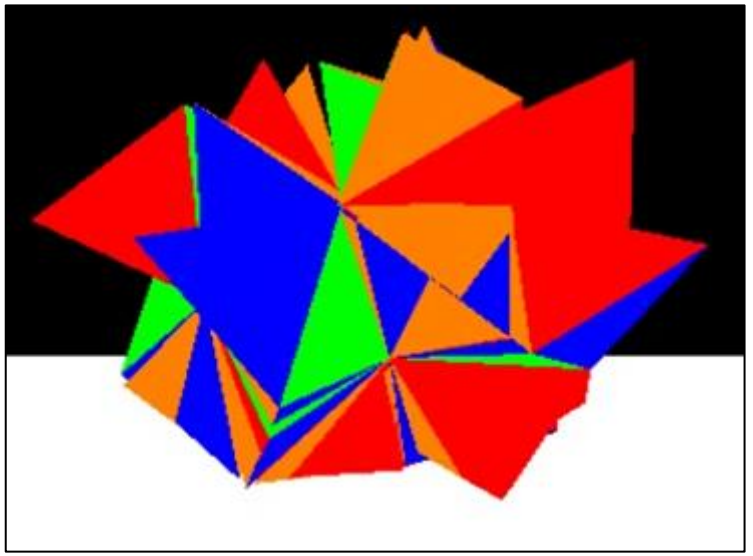
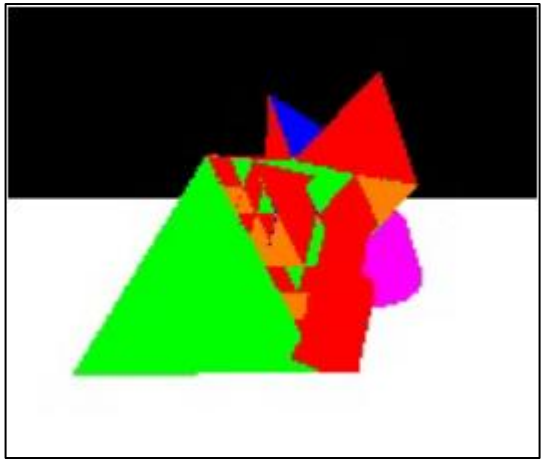


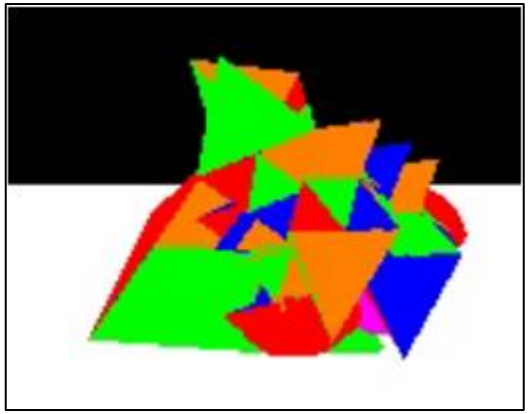
idbdb gadbc rabcb sddcc sadcd 1



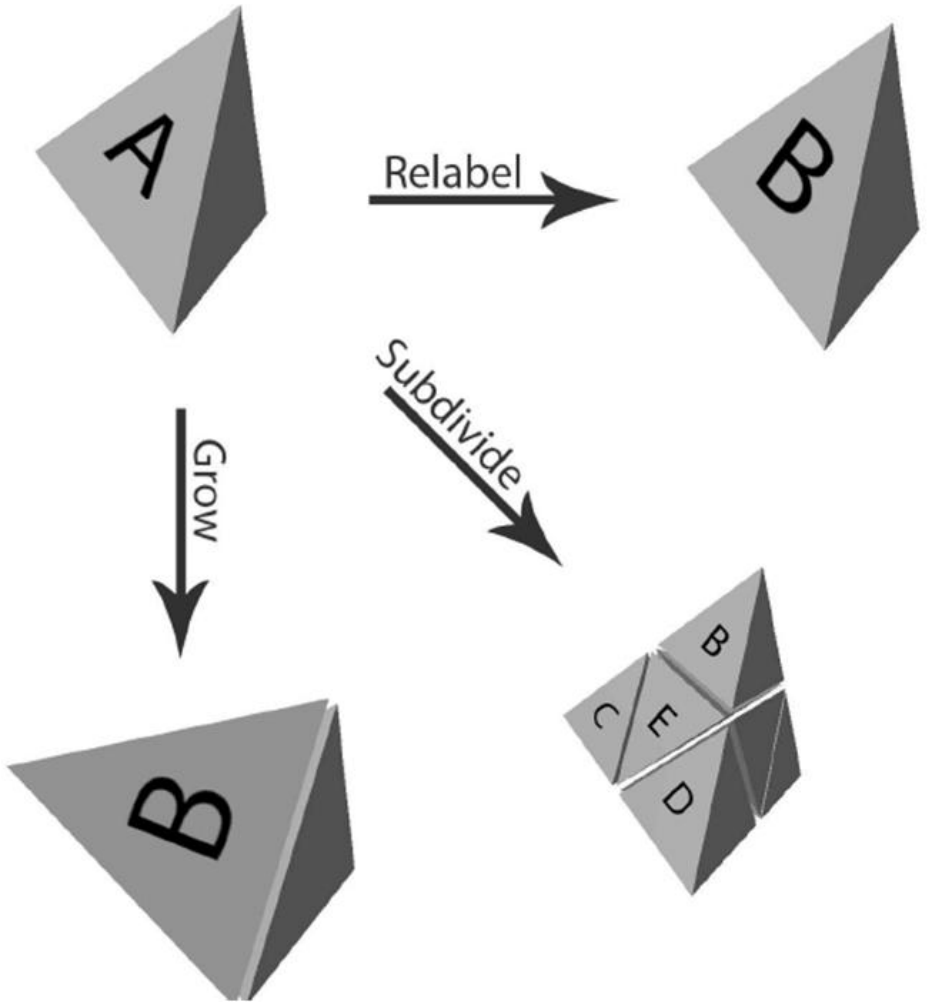




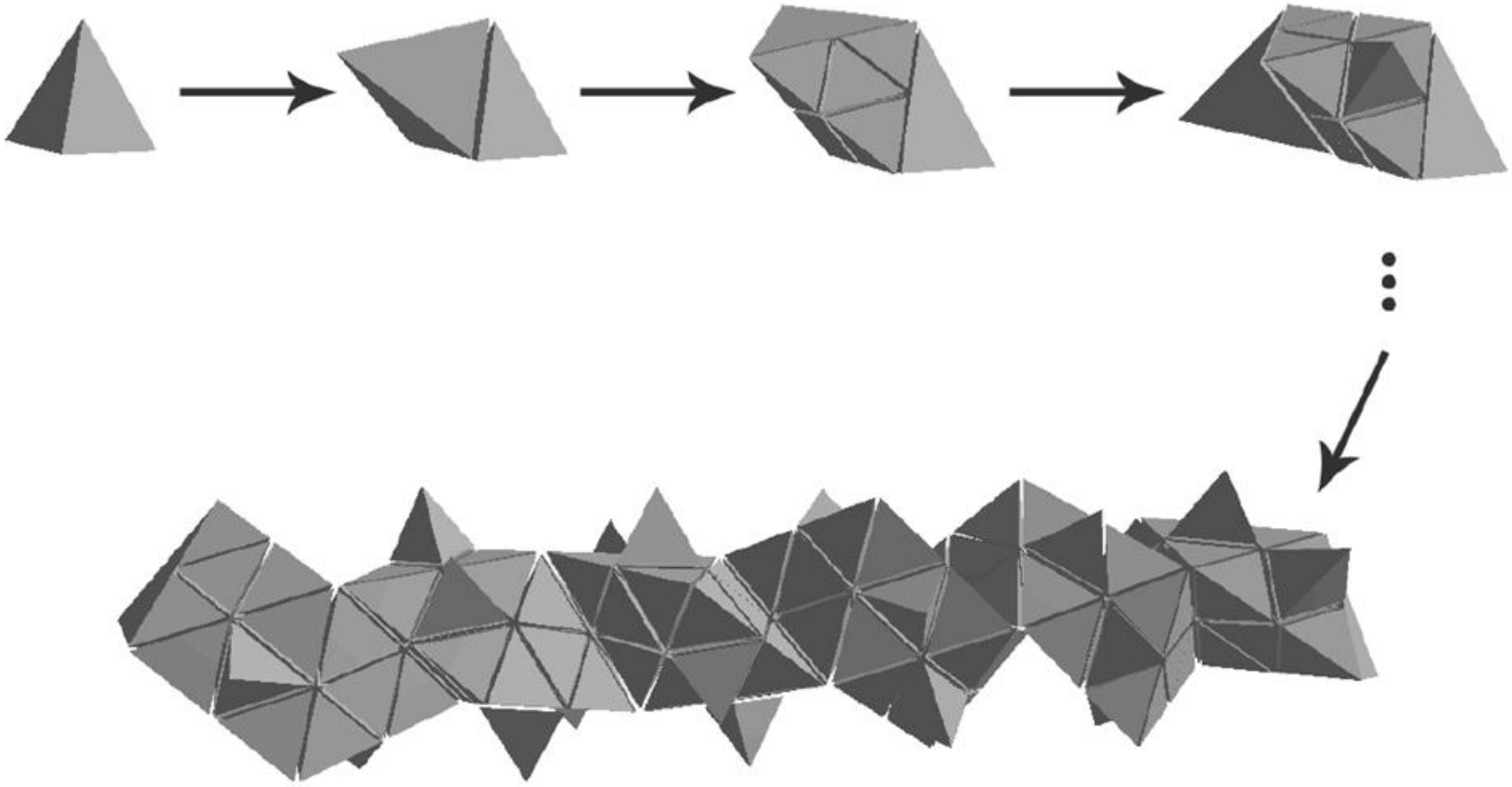




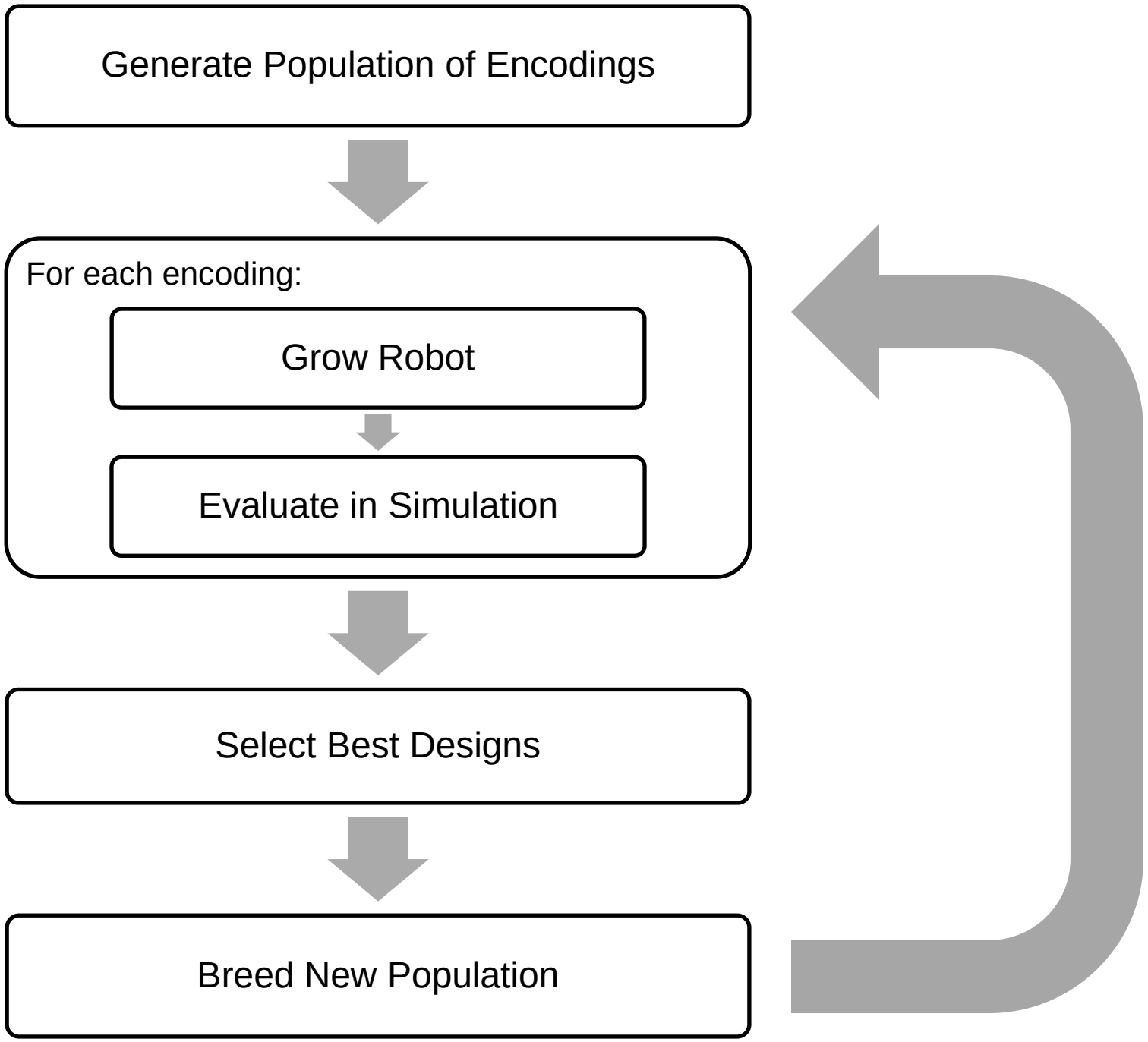
Generative Encoding

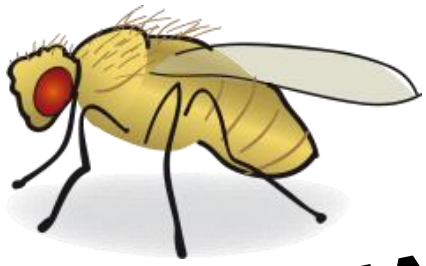


Rieffel and Smith [7]



Rieffel and Smith [7]

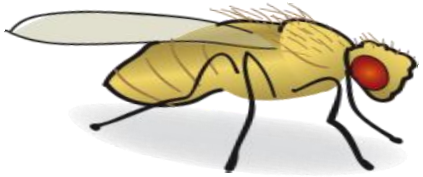

Generate Population of Encodings
For each encoding:
Grow Robot
Evaluate in Simulation
Select Best Designs
Breed New Population



SEGMENTATION FAULTS

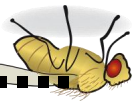
Too many graphics windows

Command line arguments

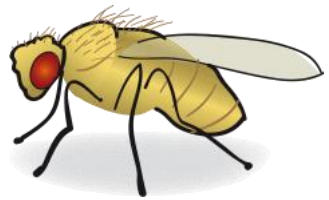


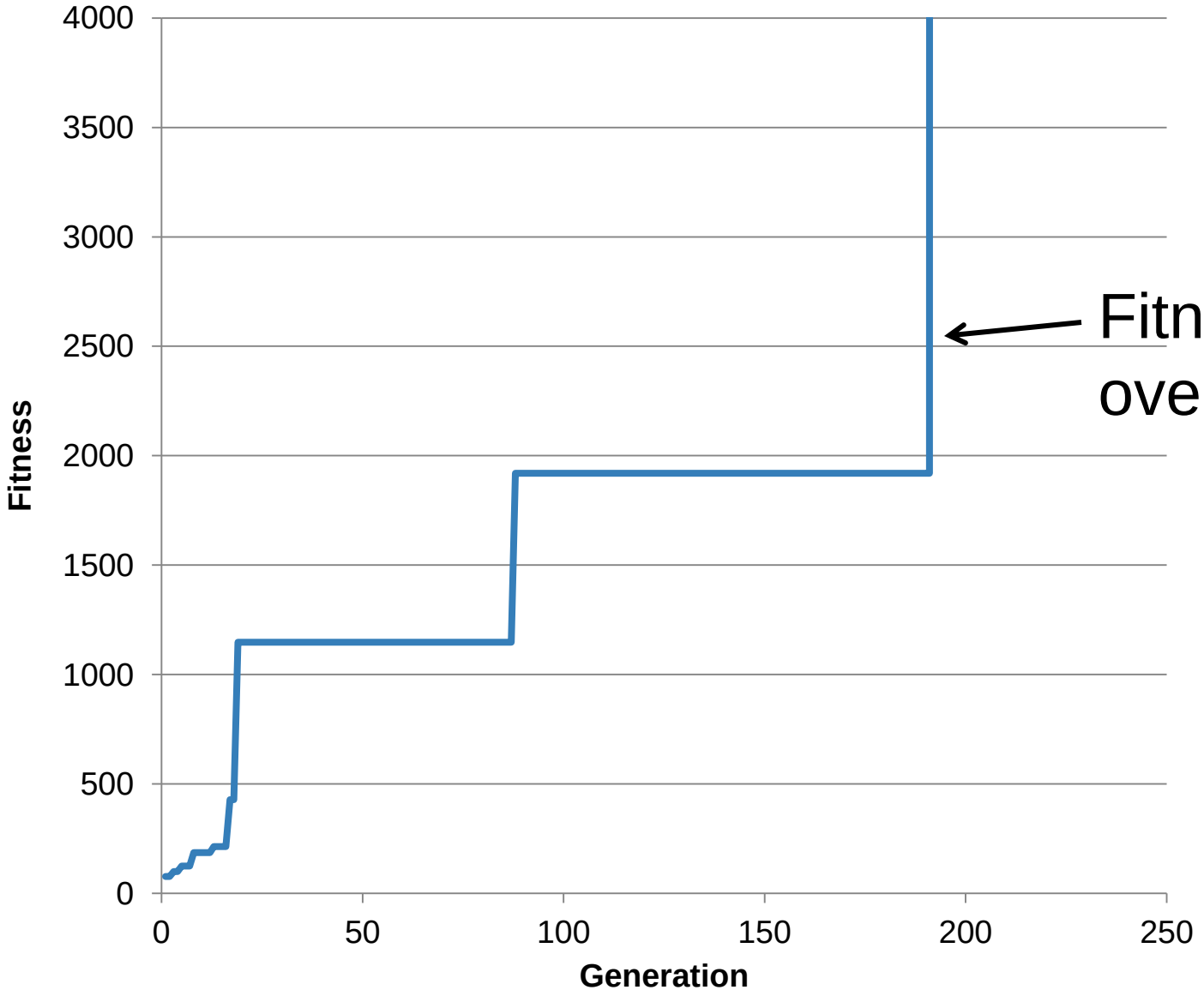
Global variables

Memory leaks....

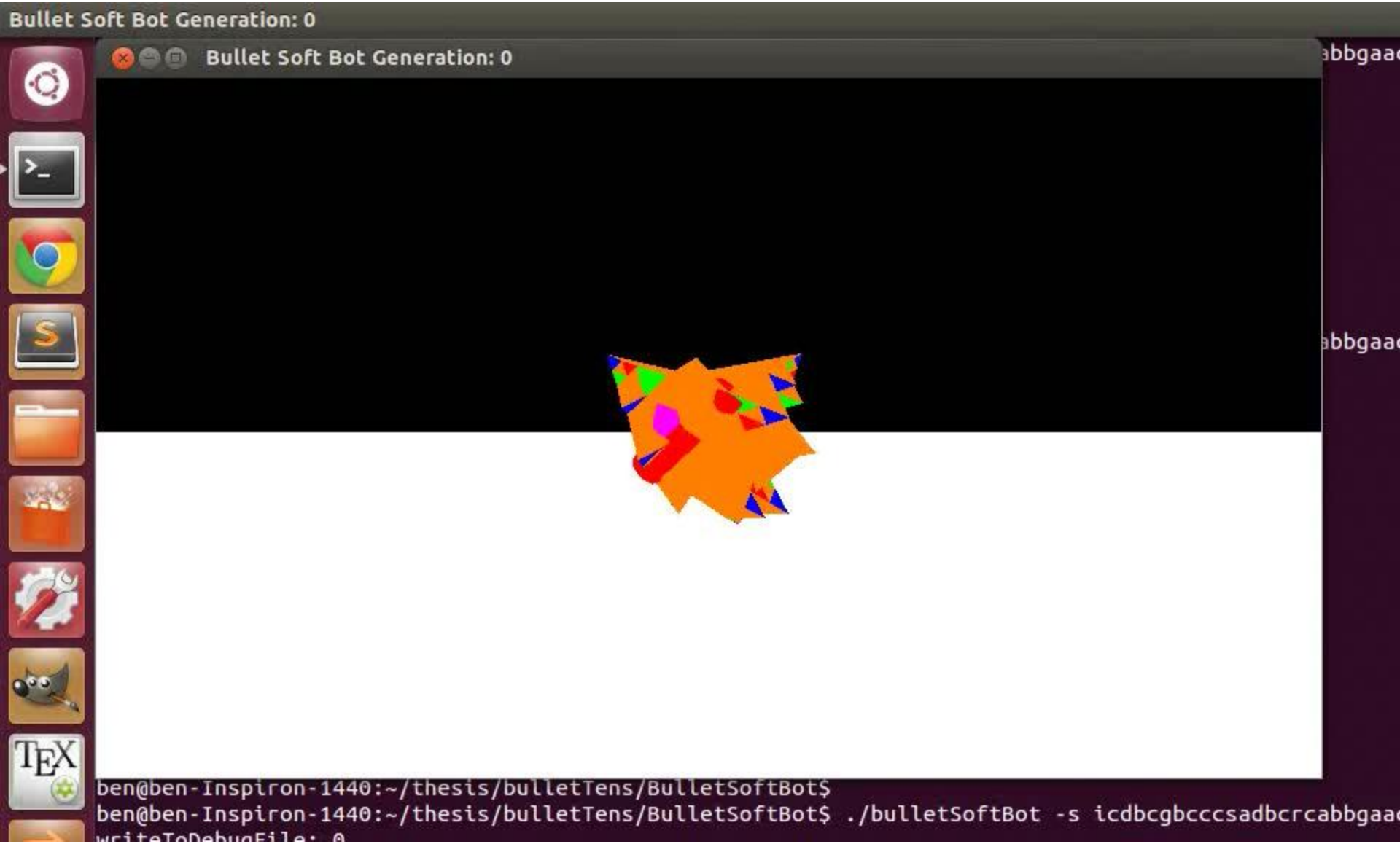


https://upload.wikimedia.org/wikipedia/commons/thumb/6/6e/Drosophila-drawing.svg/236px-Drosophila-drawing.svg.png





Fitness jumps to over **40 trillion**



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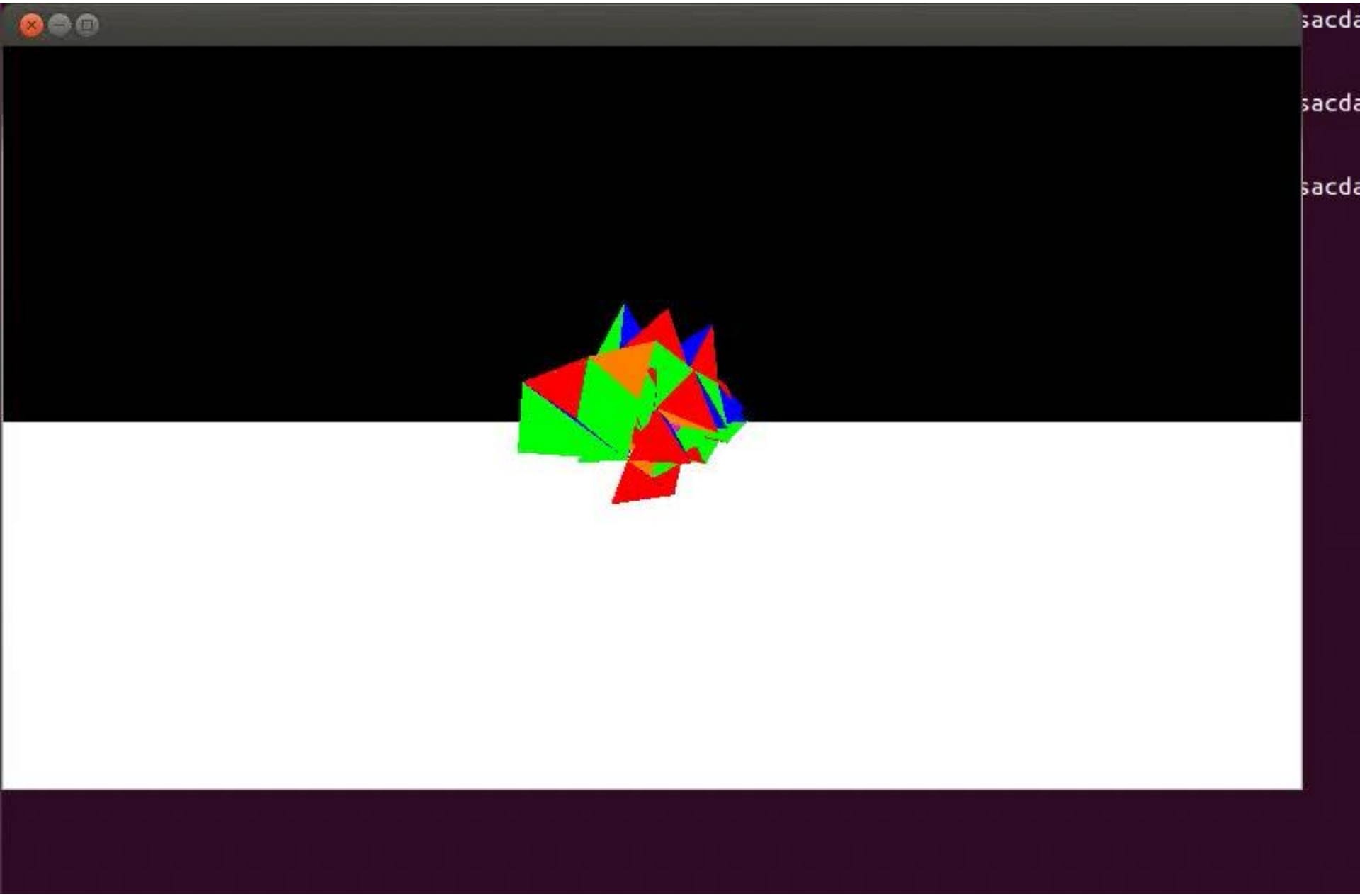
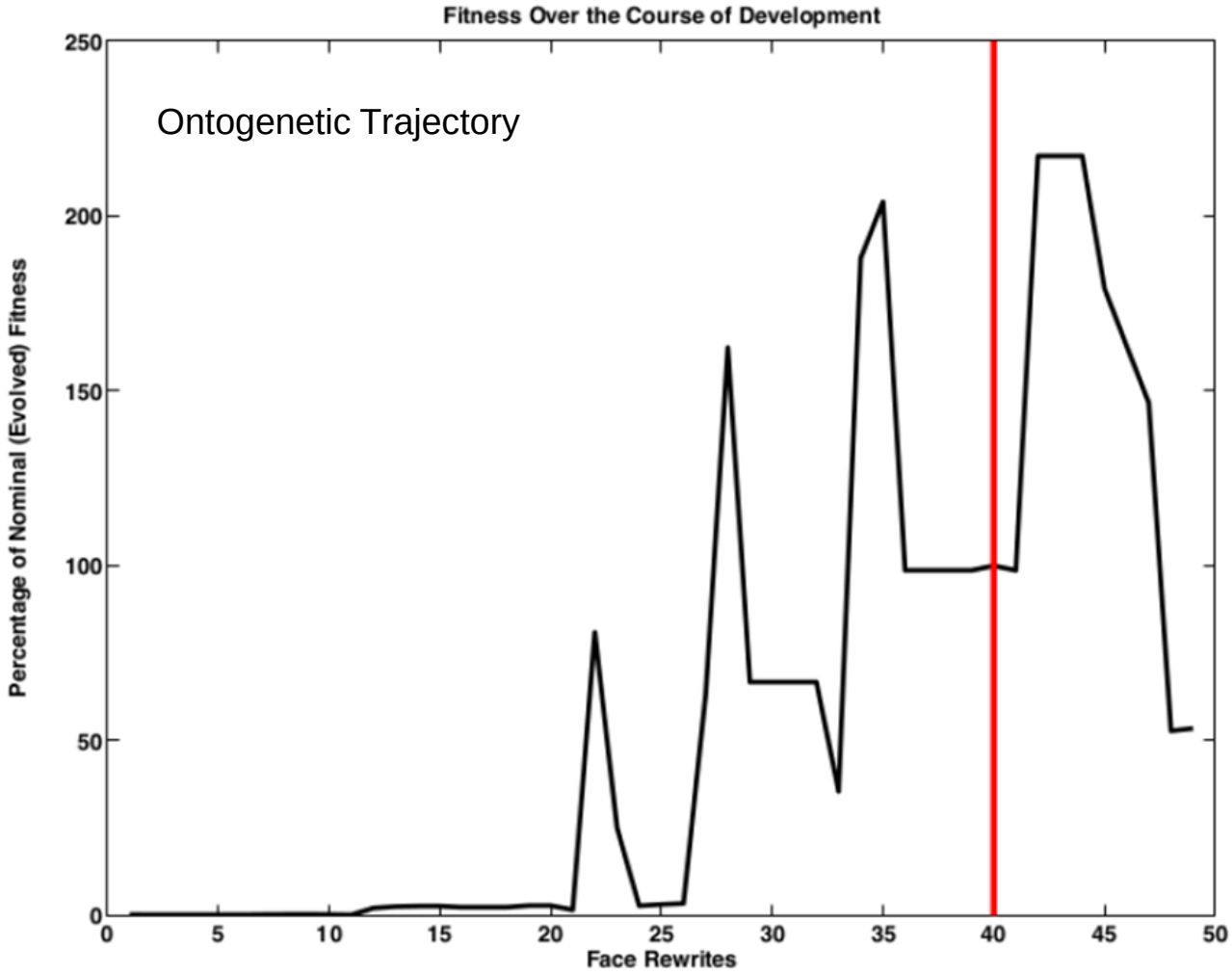
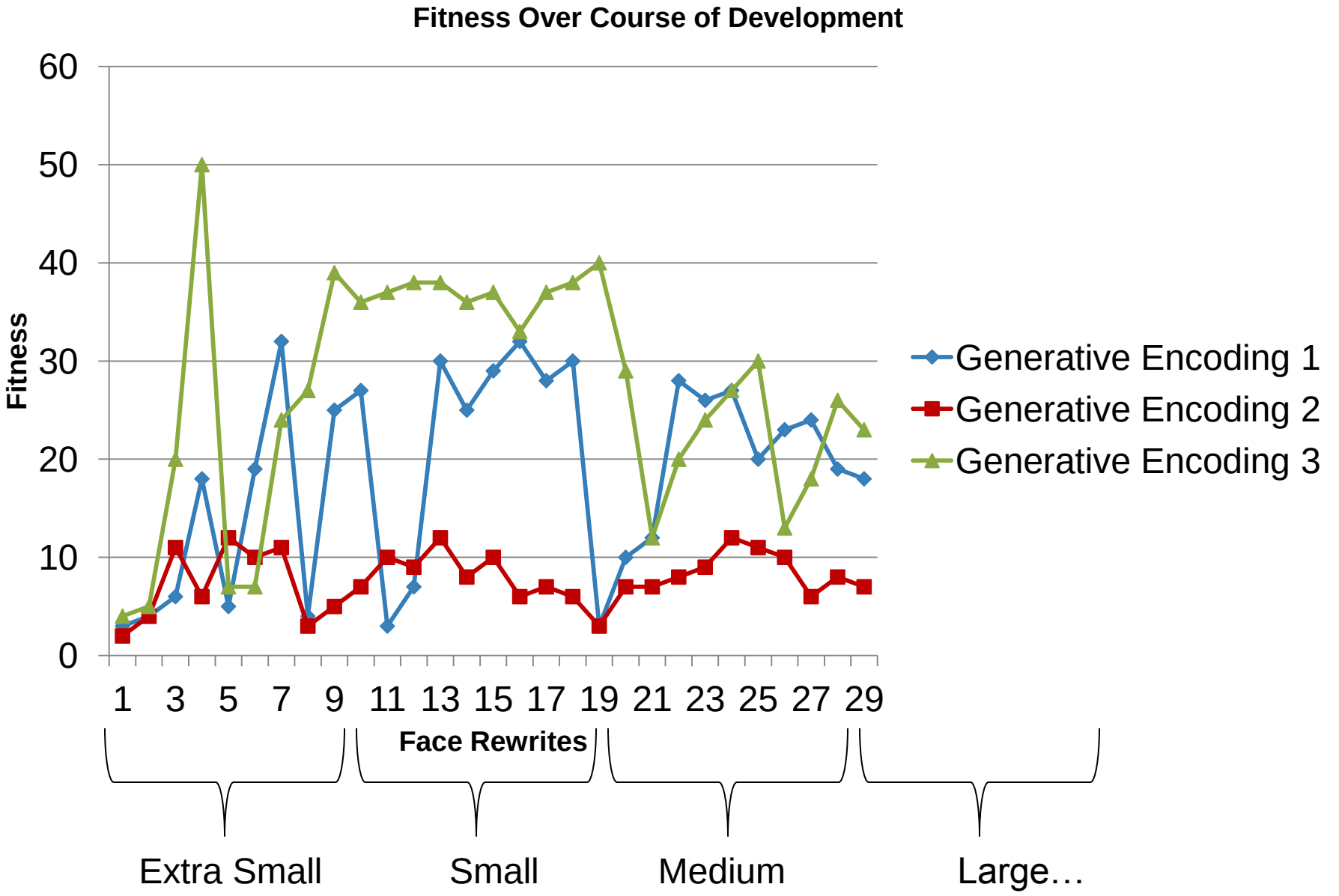


ibdcb gcbdb sacda gbabb raccc

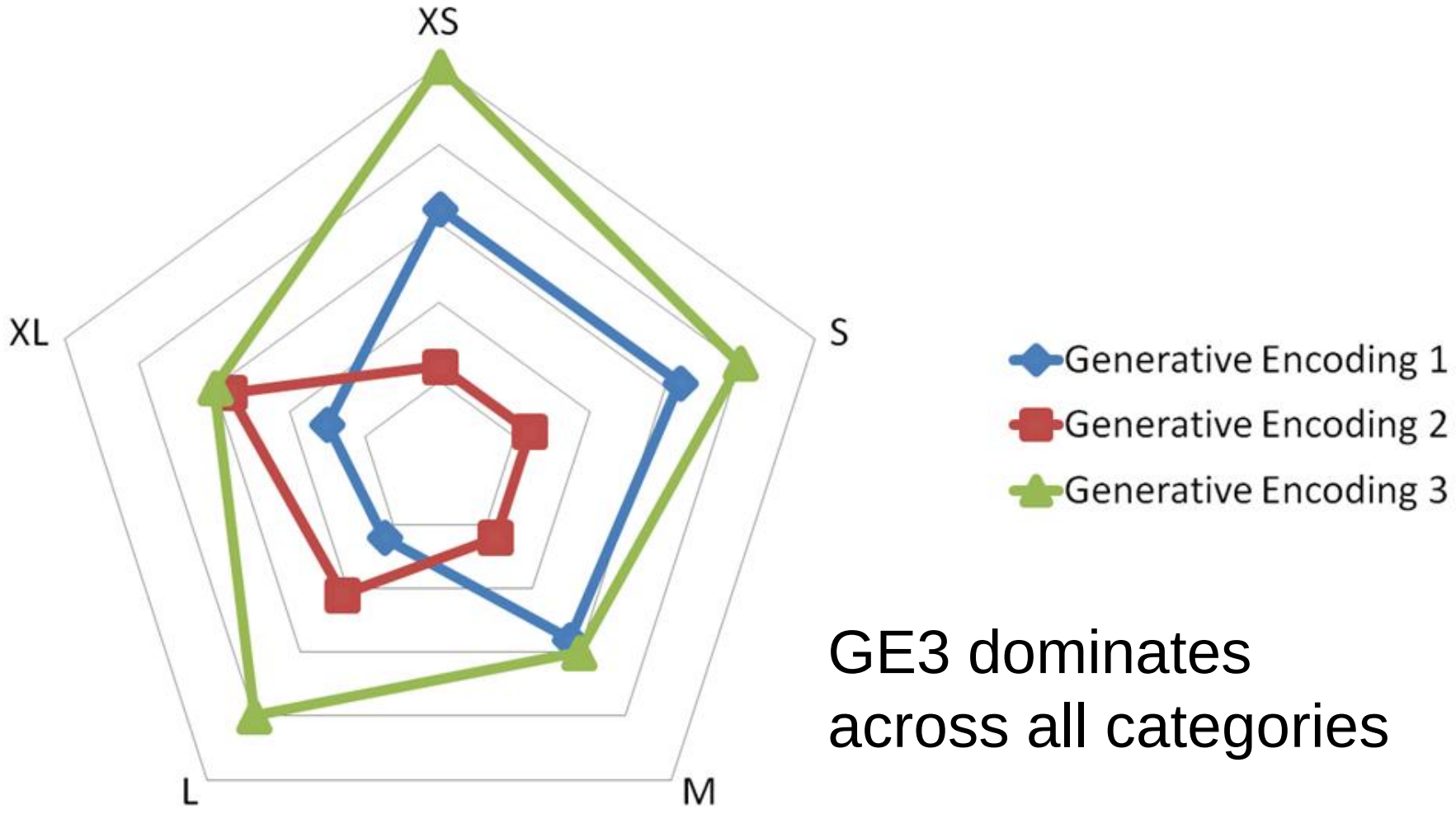
How do we create **scalable** soft robots?


Fitness Over the Course of Development
Ontogenetic Trajectory
Percentage of Nominal (Evolved) Fitness
Face Rewrites
0
50
100
150
200
250
0
5
10
15
20
25
30
35
40
45
50

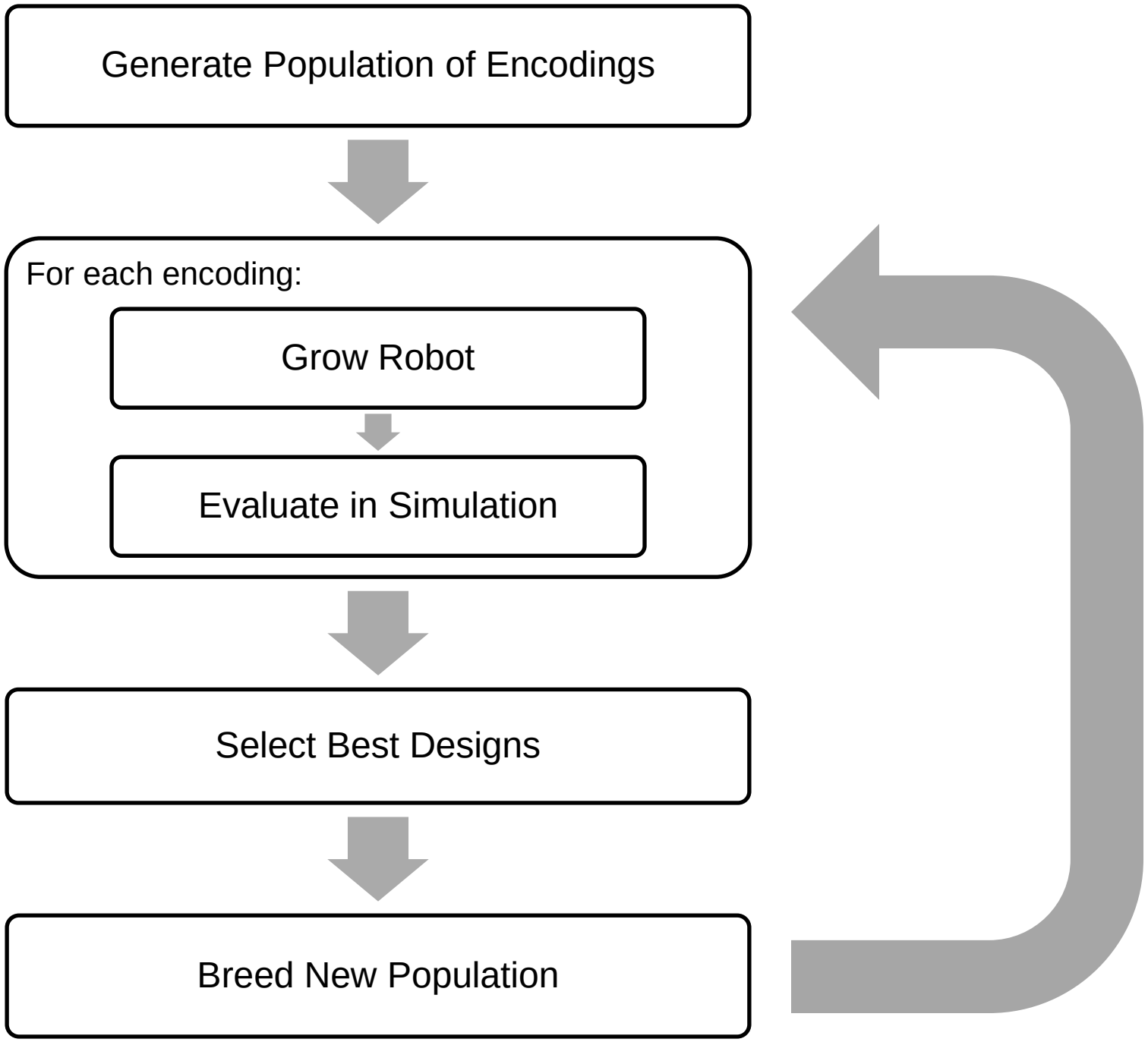
Danise [1]


Fitness Over Course of Development
Fitness
60
50
40
30
20
10
0
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29
Face Rewrites
Generative Encoding 1
Generative Encoding 2
Generative Encoding 3
Extra Small
Small
Medium
Large…

Pareto Dominance



GE3 dominates
across all categories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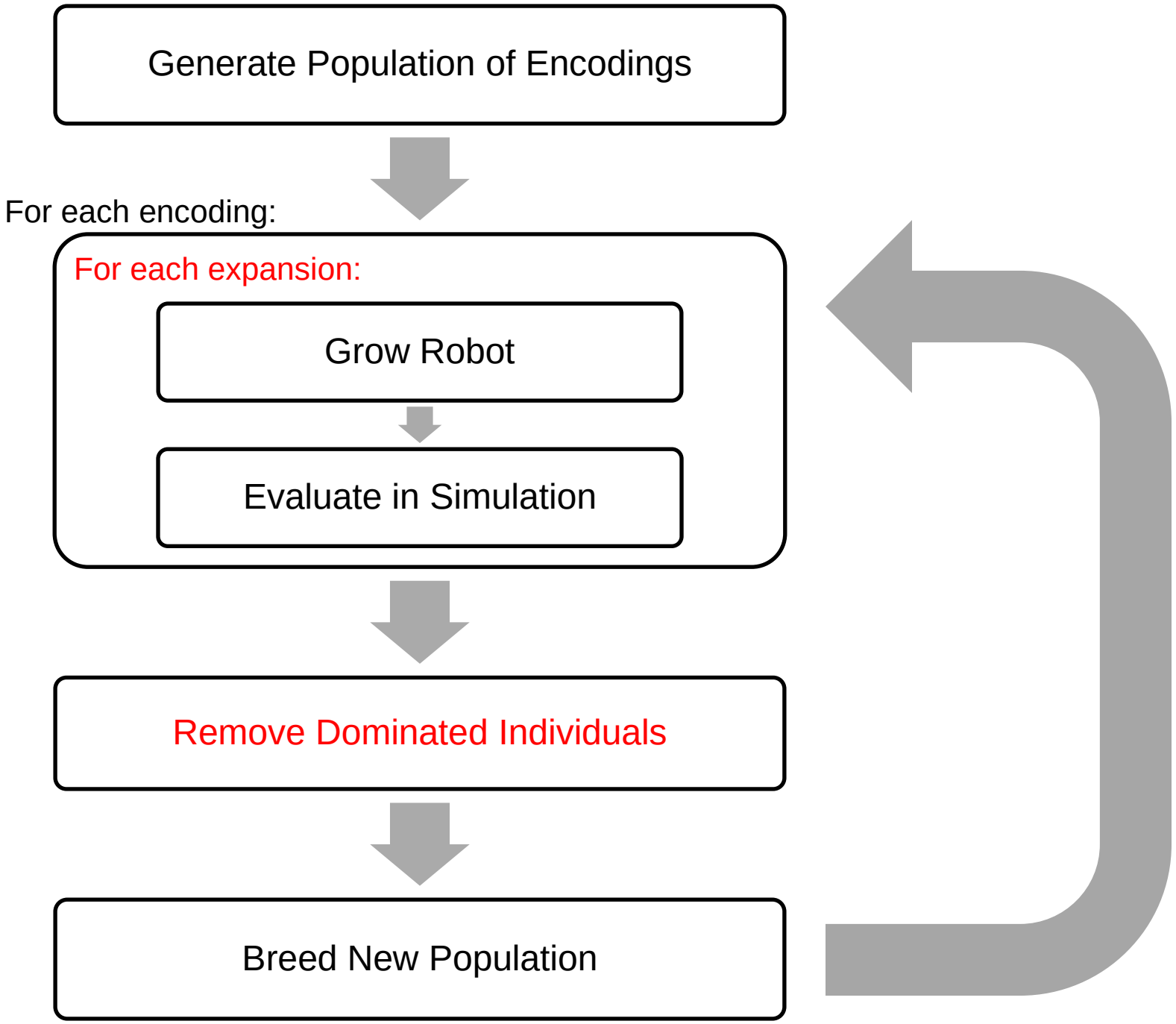
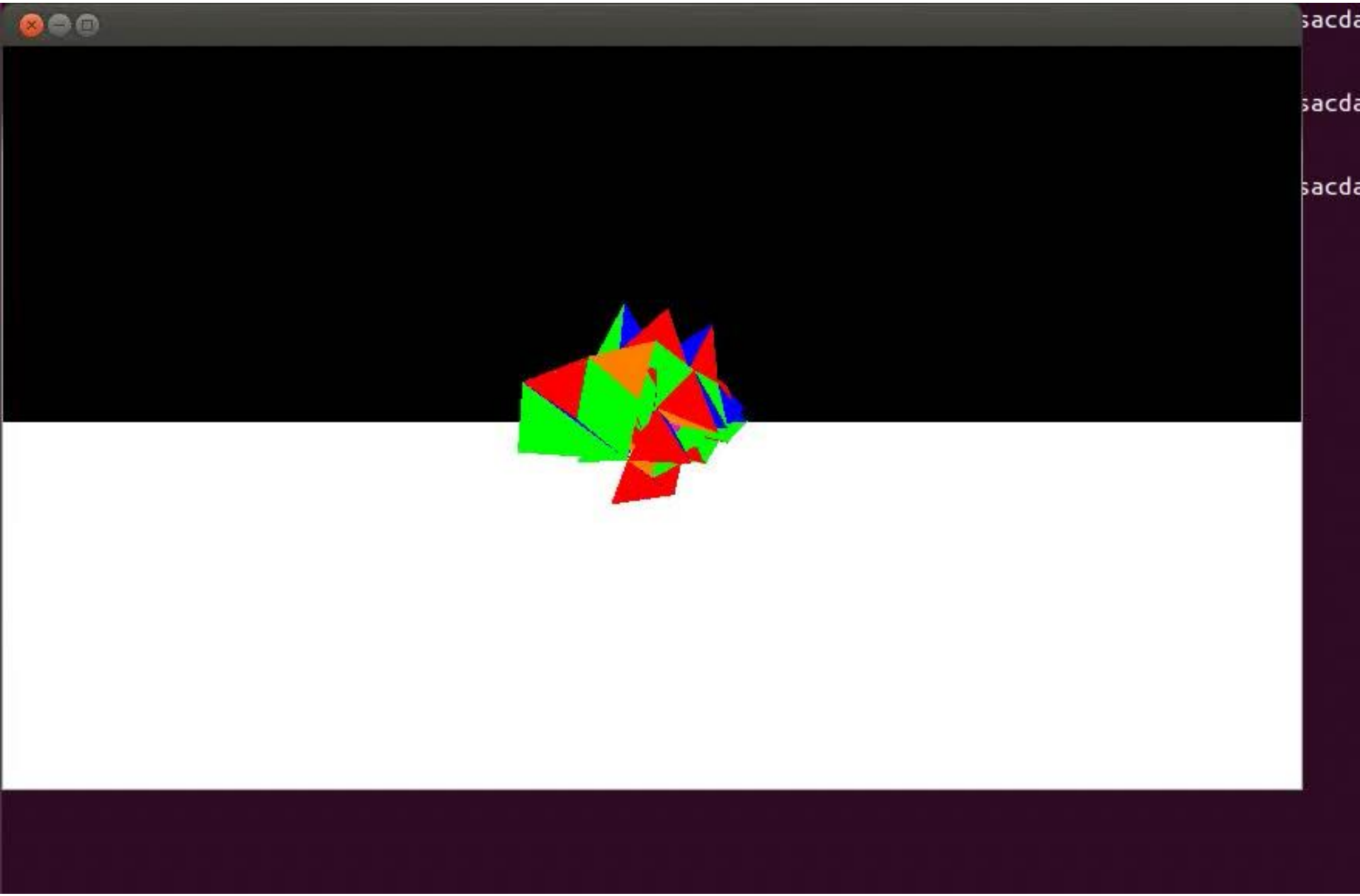

Generate Population of Encodings
For each encoding:
For each expansion:
Grow Robot
Evaluate in Simulation
Remove Dominated Individuals
Breed New Population

Future Work

Pareto front code will be done next week.

Jupiter, I’m coming for you!



ibdcb gcbdb sacda gbabb raccc

Sources

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5. John Rieffel. Heterochronic scaling of developmental durations in evolved soft robots. In Proceeding of the fifteenth annual conference on Genetic and evolutionary computation conference, pages 743–750. ACM, 2013.
6. John Rieffel, Davis Knox, Schuyler Smith, and Barry Trimmer. Growing and evolving soft robots. Artificial life, 20(1):143–162, 2014.
7. John Rieffel and Schuyler Smith. A face-encoding grammar for the generation of tetrahedral-mesh soft bodies. In ALIFE, pages 414–420, 2010.
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