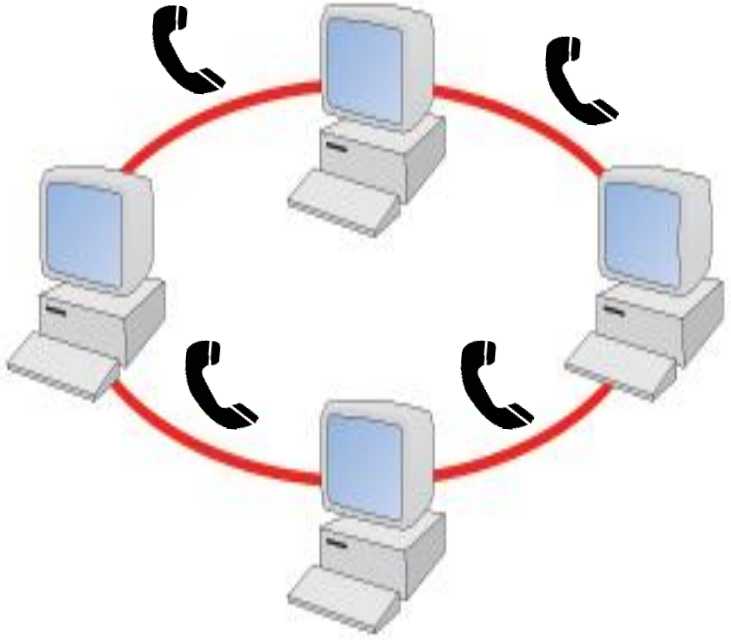
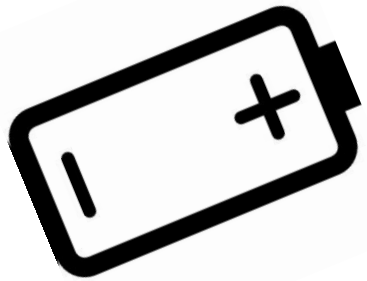
Evolutionary Computation for Energy Conservation Within a Distributed System

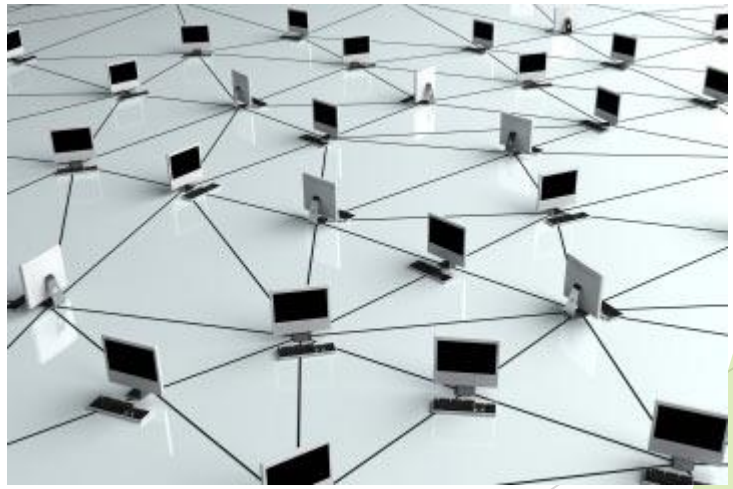




Jose Guadalupe Hernandez, Alexander Lalejini, Dr. Charles Ofria
Department of Computer Science and Engineering
Digital Evolution Lab
Michigan State University

Introduction

- Evolutionary Computation
  - Abstraction from the theory of biological evolution
  - Organisms carry information on how to execute
  - Create optimization procedures or methodologies



- Distributed System
  - Independent computers that function in a single system.
  - Can pass information via landline or wireless.
  - Often rely on finite energy reserves.
  - Coordination may be difficult to implement.

Introduction

- Example
  - NASA needed an antenna for radio communications
  - Start with simple antenna shapes
  - Evolved overtime towards objective

Research Question

- Can digital organisms evolve a distributed algorithm to contend with energy conservation and coordination within a distributed system that is in a resource varying environment?

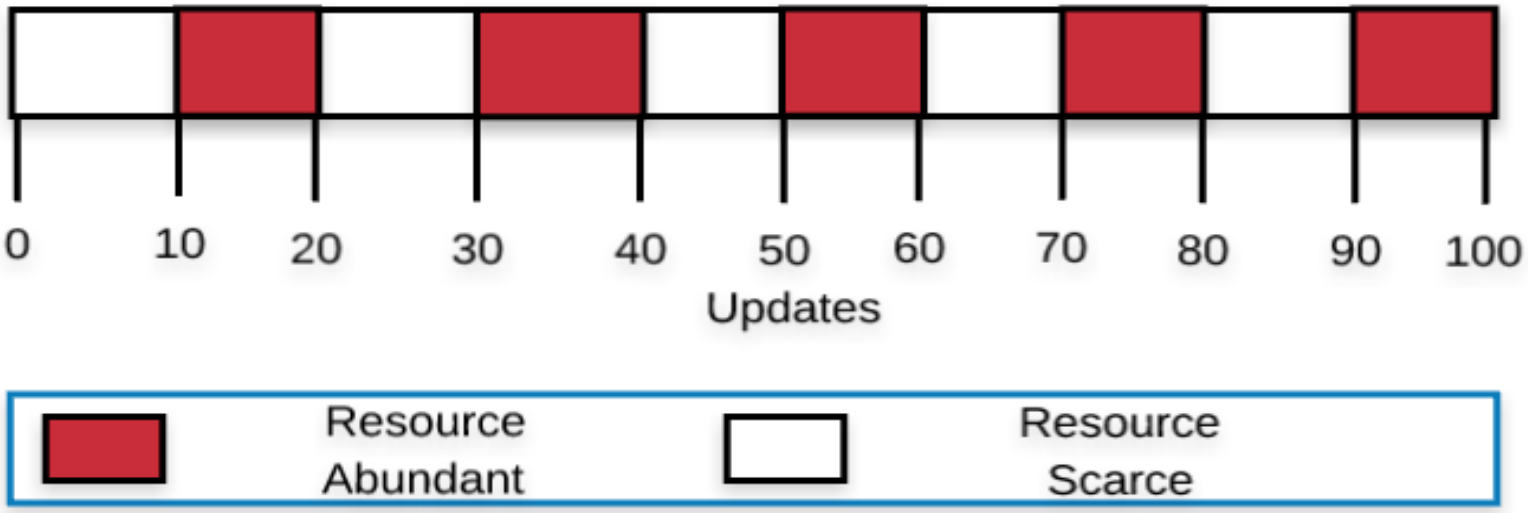
Research Design

- Environment will have depleting resources that come in abundant or scarce amounts.
- Evolve digital organisms to collect as many resources, survive as long as possible, and coordinate within the distributed system
- Allow organism to reproduce 10,000 times
- Analyze distributed algorithms that have the best resources and survived the longest
- Organisms will have battery life relative to 50% of allotted time in environment

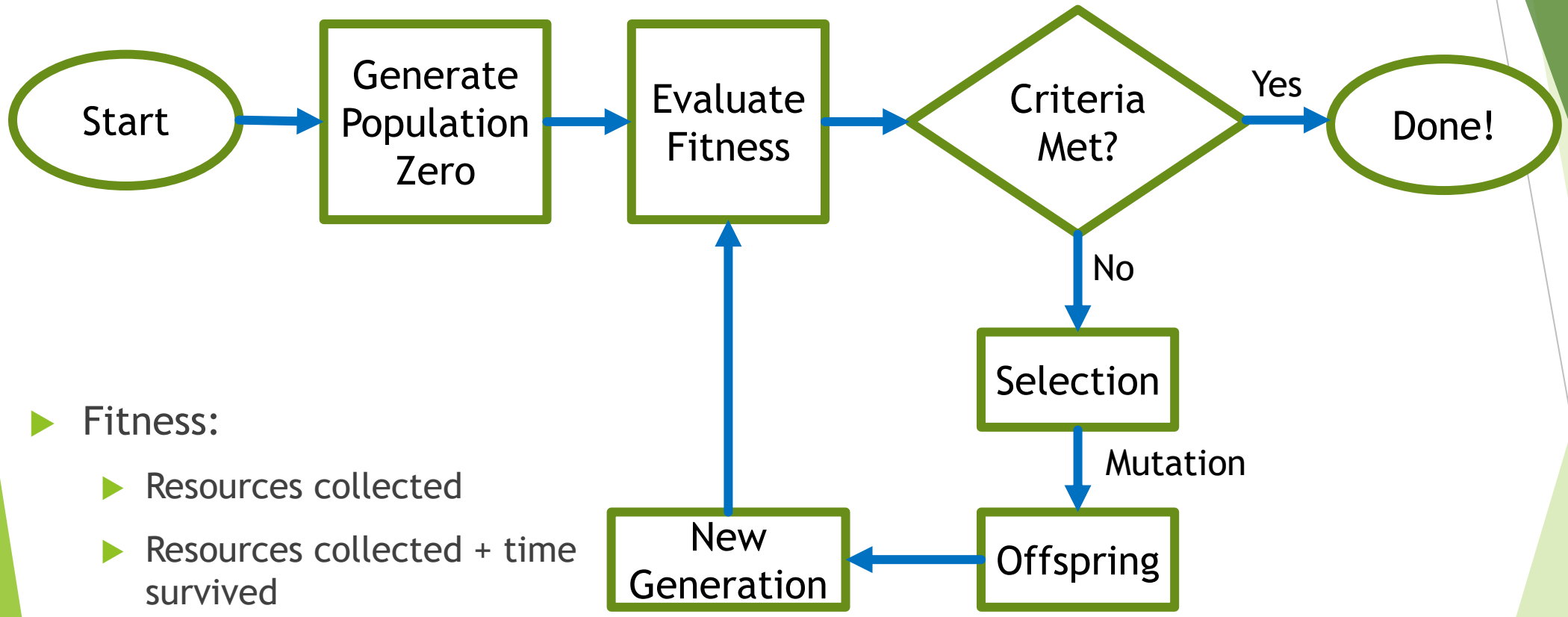
Environment

- Predetermined battery levels force cooperation for higher fitness

Example of possible environment

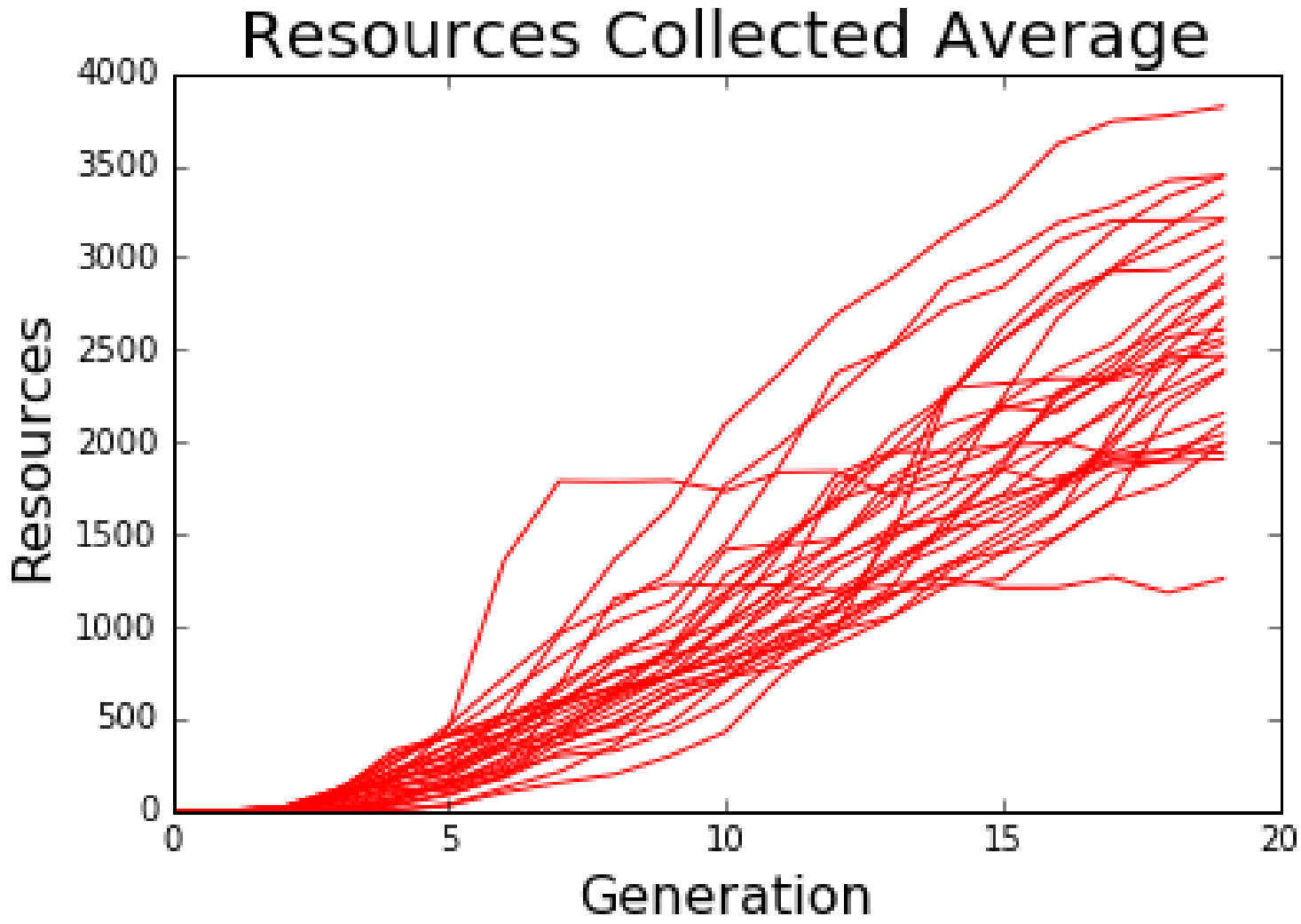


Methodology

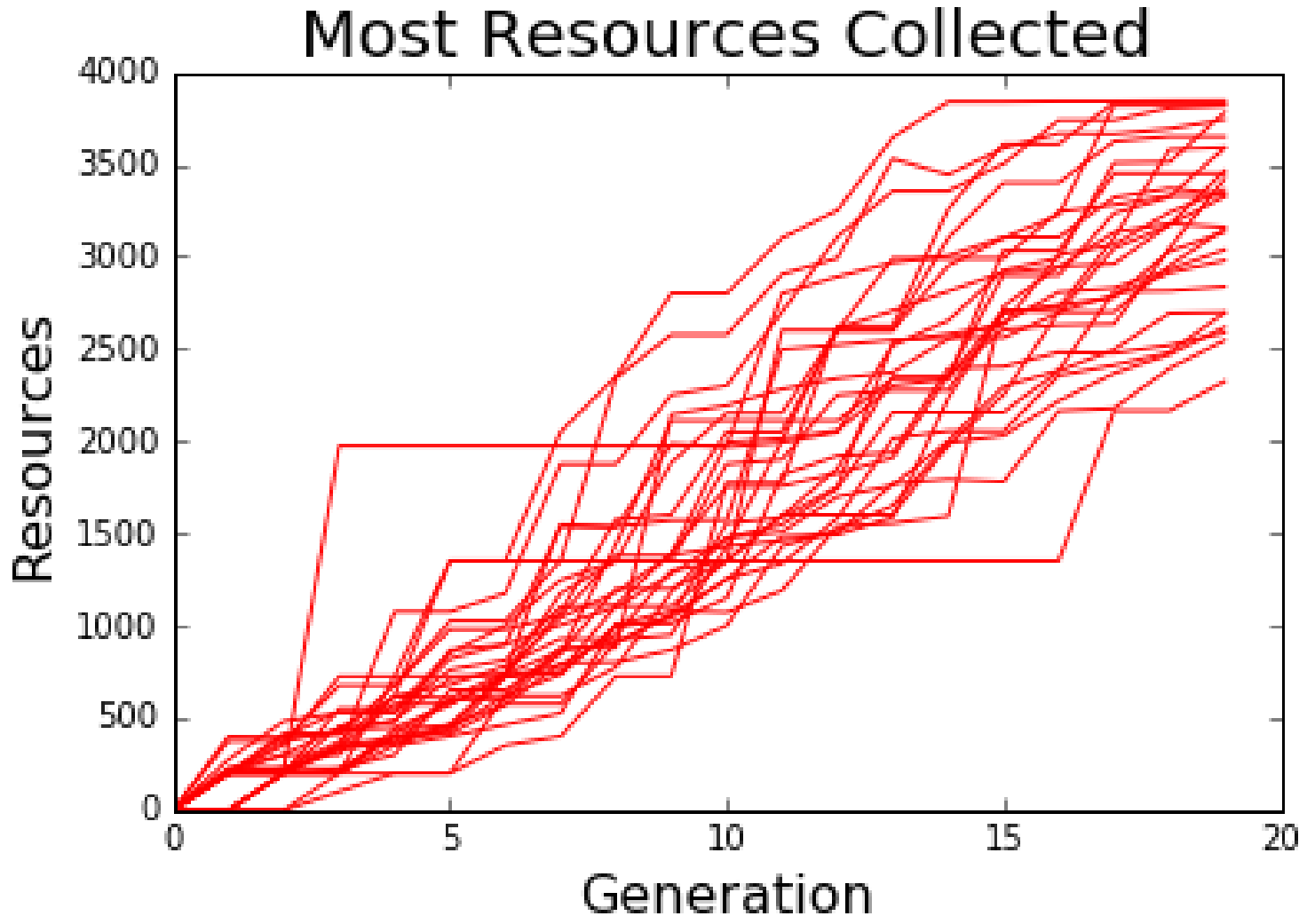


- Fitness:
  - Resources collected
  - Resources collected + time survived
- Reproduction:
  - Allow 10,000 generations to reproduce
- Population:
  - Size of 500

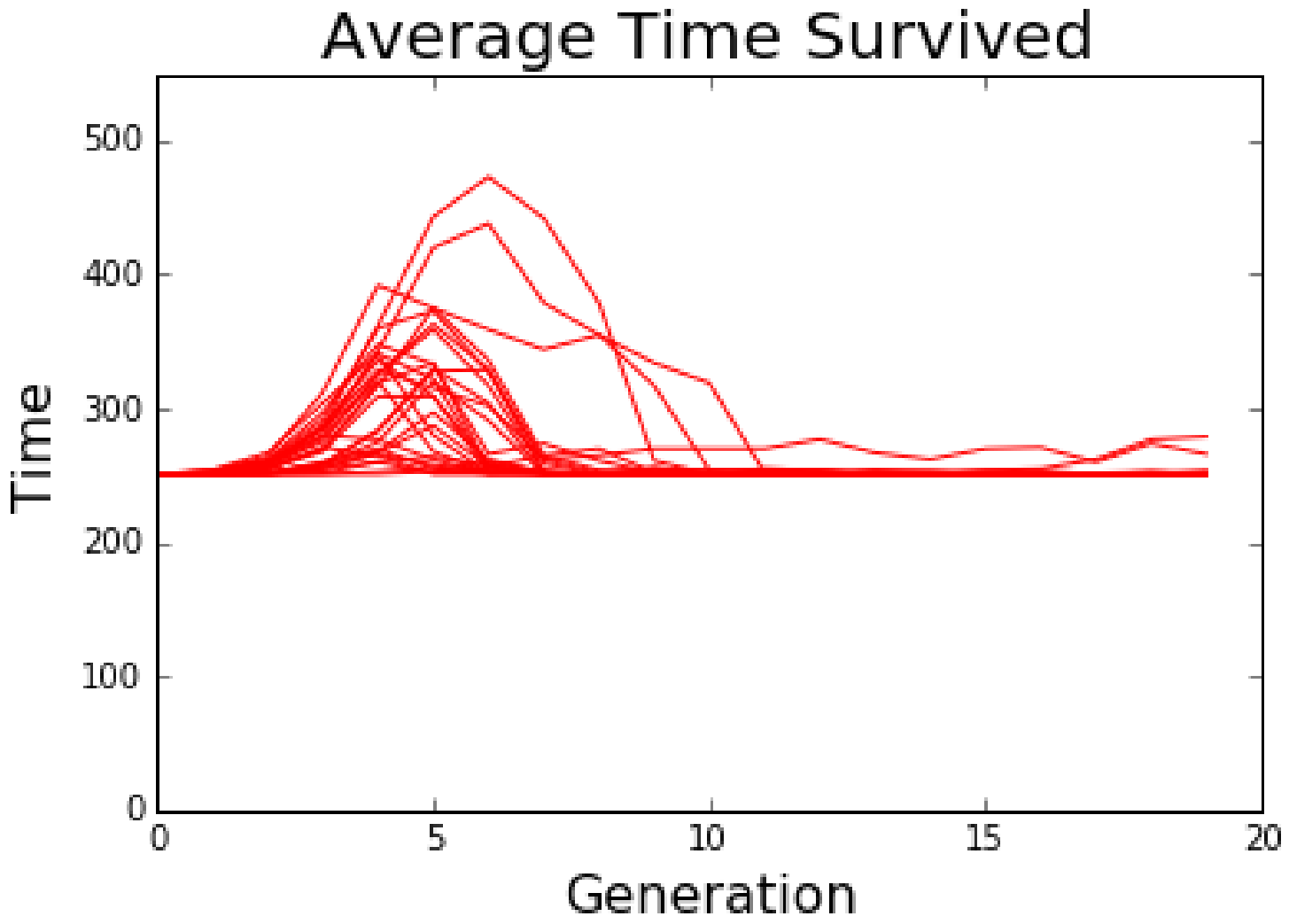
Preliminary Results



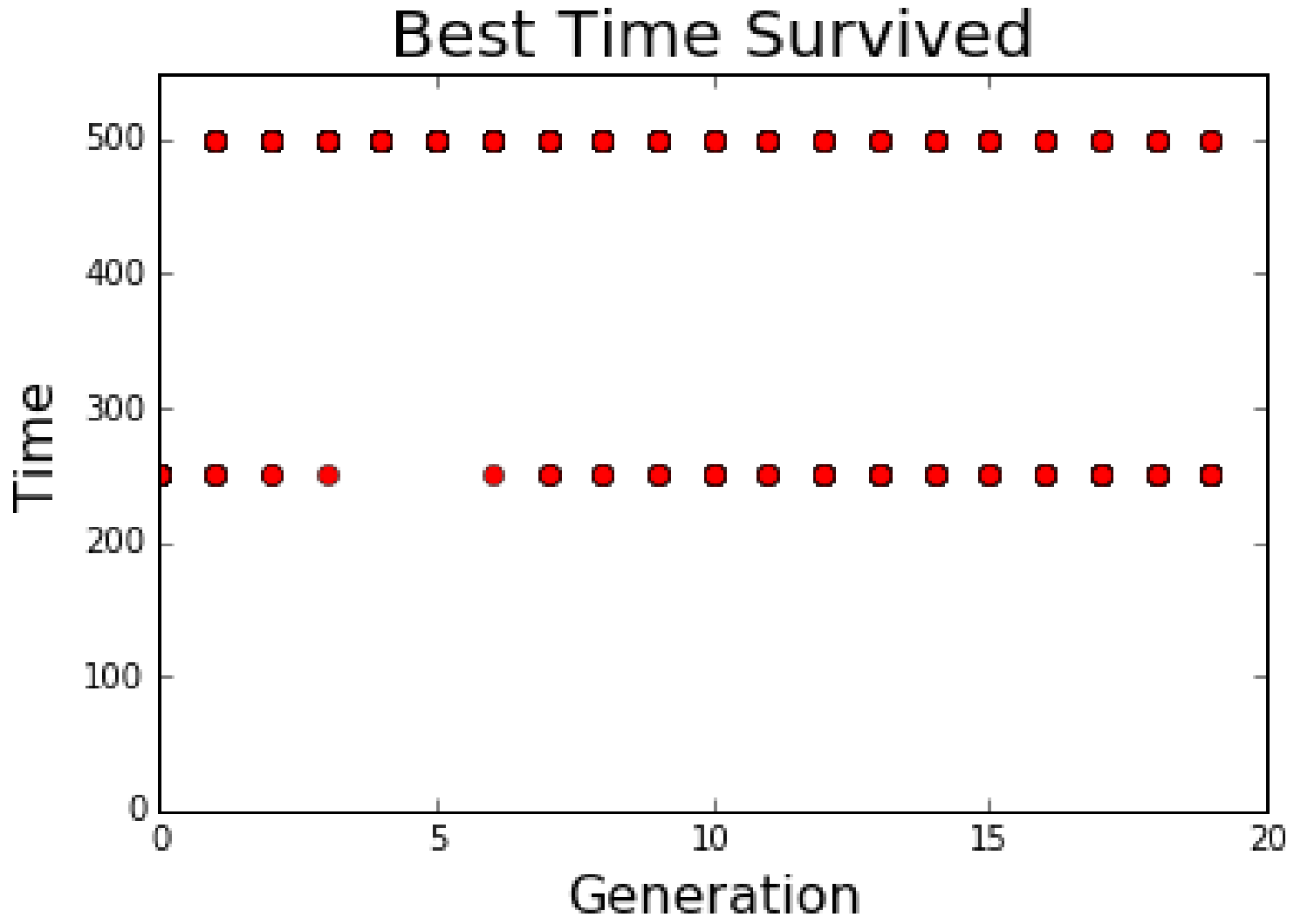
Preliminary Results



Preliminary Results



Preliminary Results



Discussion

- Resources being collected increasing
- Some form of communication arising
- Algorithm:
  - Ability to process resource
  - Ability to communicate
- Incorporate these algorithms in real world systems

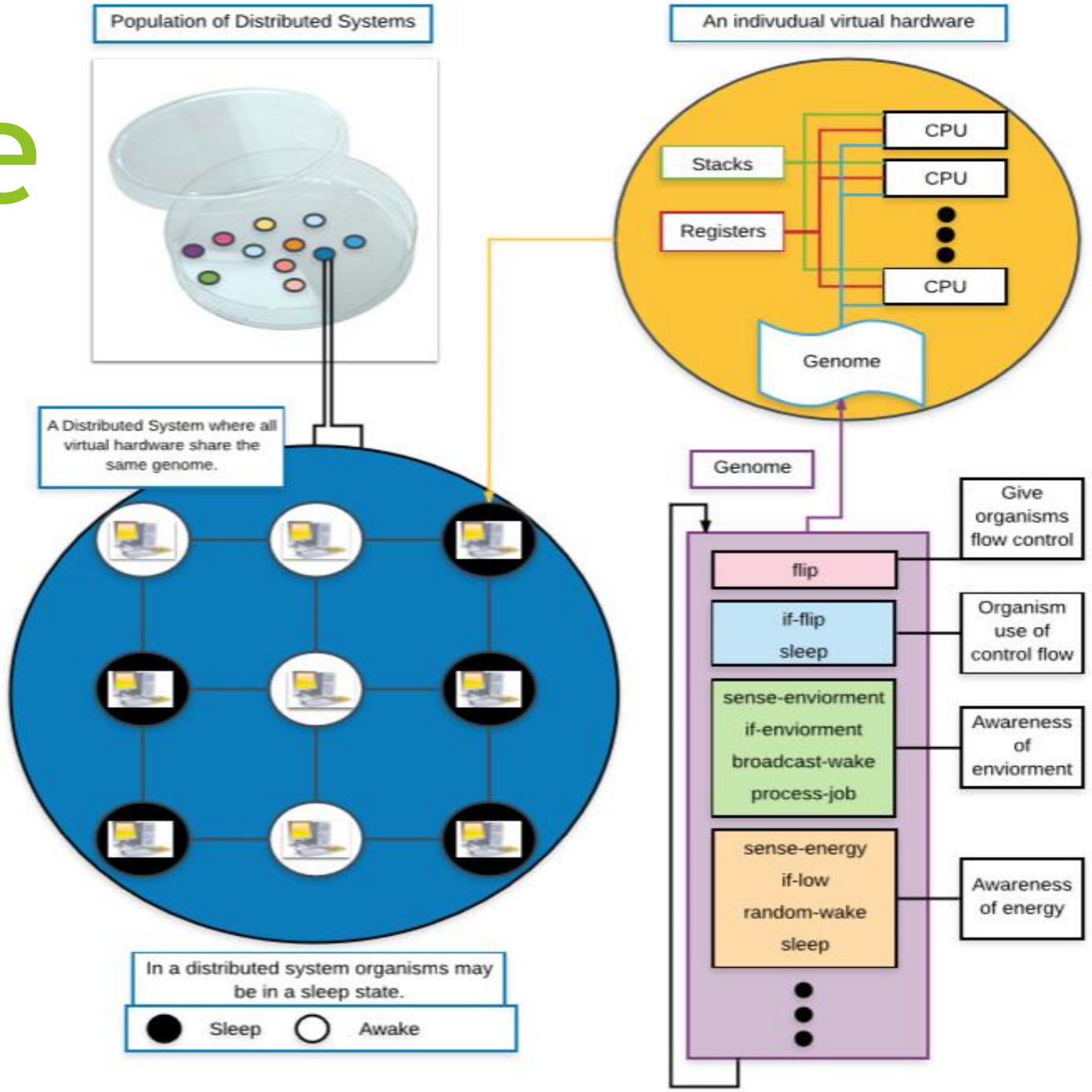
Acknowledgements

The presenter would like to thank:

Dr. Charles Ofria • Alex Lalejini • Dr. Eric Torng • Summer Research Opportunities Program (SROP) • College Assistant Migrant Program (CAMP) • TRIO • BEACON • for their assistance during this journey

QUESTIONS?

Hardware


Population of Distributed Systems
An indivudual virtual hardware
CPU
CPU
CPU
Stacks
Registers
Genome
A Distributed System where all virtual hardware share the same genome.
Genome
Give organisms flow control
flip
if-flip
sleep
Organism use of control flow
sense-enviorment
if-enviorment
broadcast-wake
process-job
Awareness of enviorment
sense-energy
if-low
random-wake
sleep
Awareness of energy
In a distributed system organisms may be in a sleep state.
Sleep
Awake