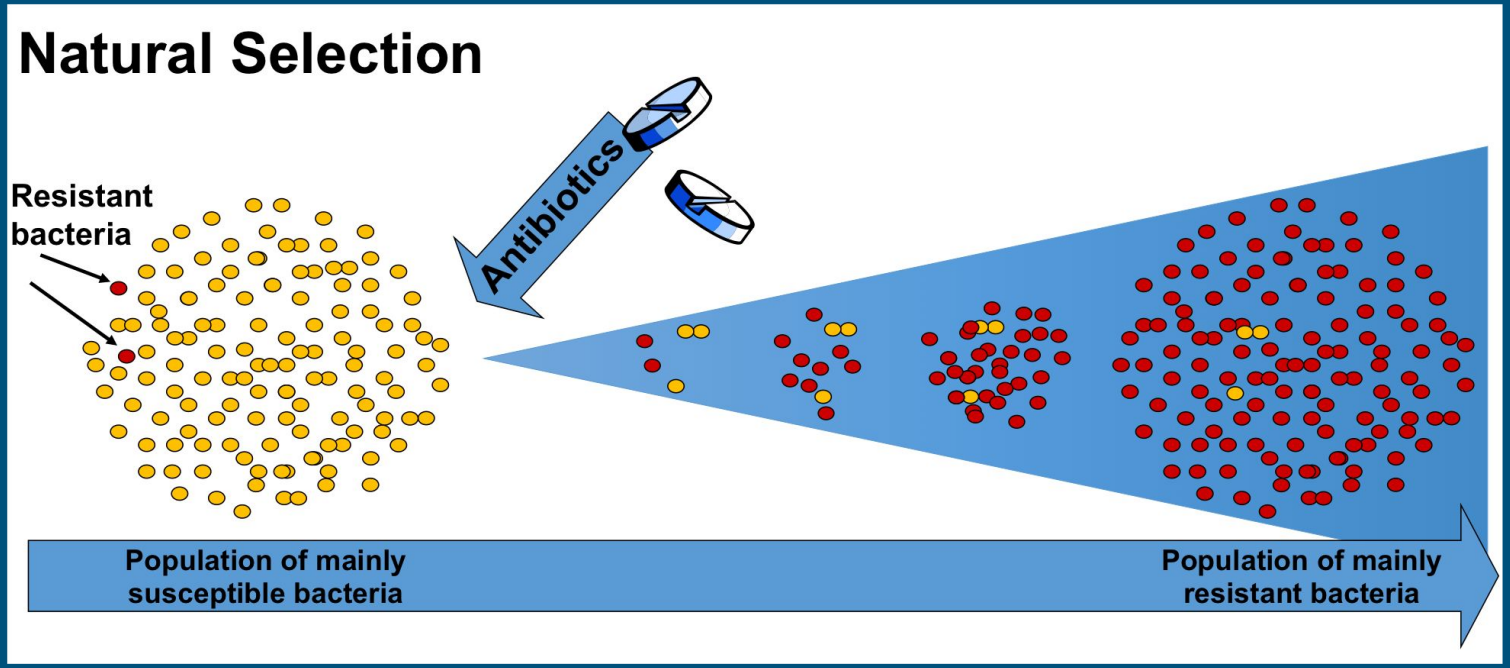
# THE LIFE OF A BACTERIUM

## A probabilistic evolutionary simulator of the microbiome

Kwanho Kim, Saideep Gona, Xinling Li, Zhenyu Yang

# Inspiration



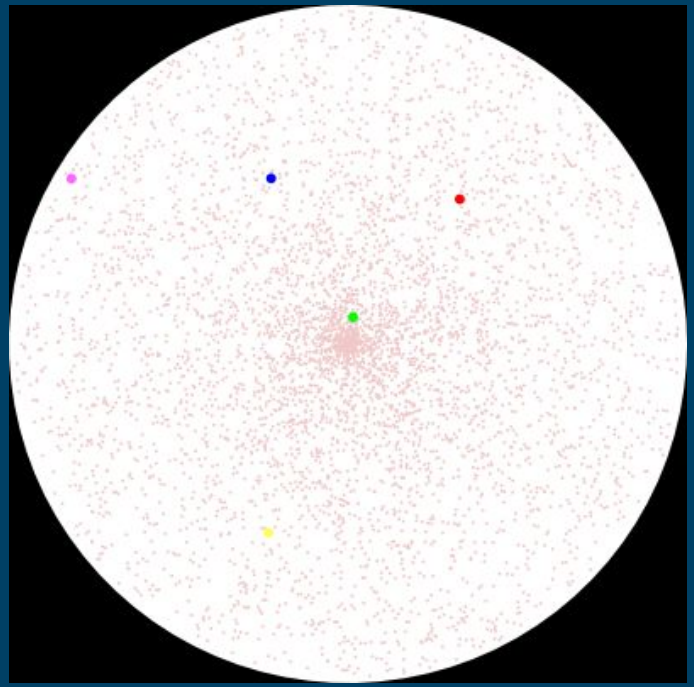

https://www.sciencedaily.com/terms/antibiotic_resistance.htm

# Contents

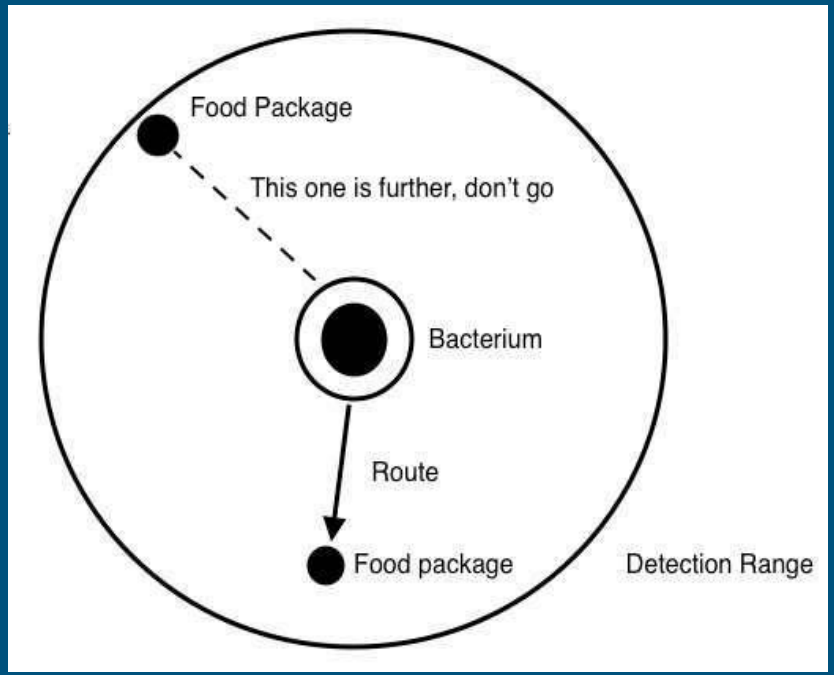
# 1. Environment

## Initialization

```
type Petri struct {
  radius float64
  allBacteria []Bacteria
  allFoodpack []Foodpackage
  allPredator []Predator
  allDrugpack []Drugpackage
  allPredKill []PredatorKiller
}
```



# Bacteria Properties - Movement



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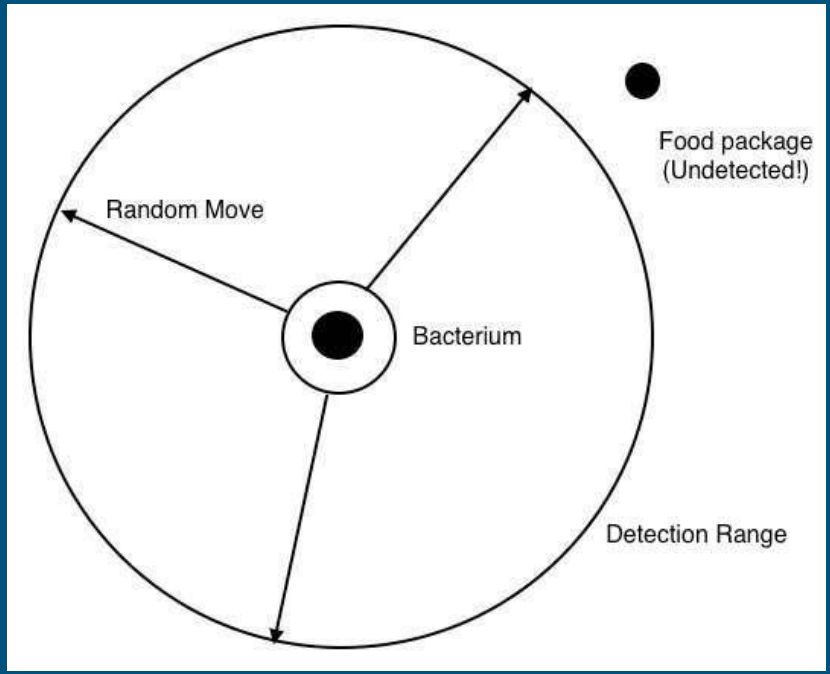
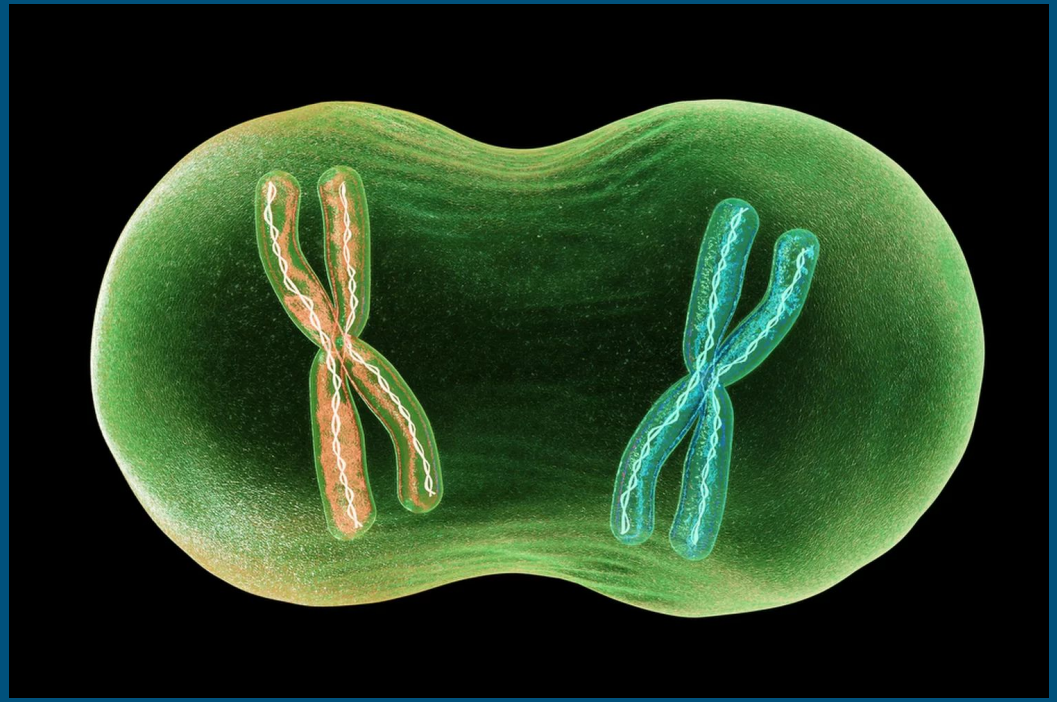
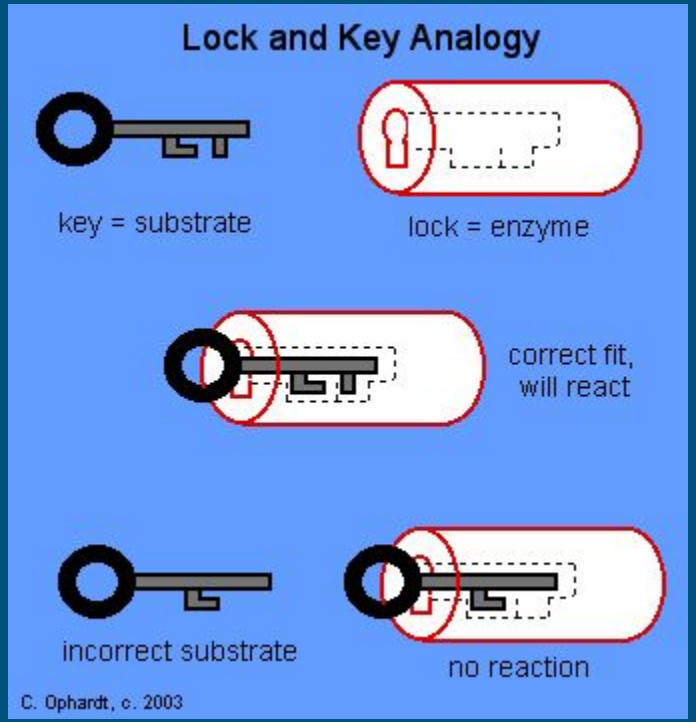


# Bacteria Properties - Replication

- Requirements
  - Energy content
  - Space



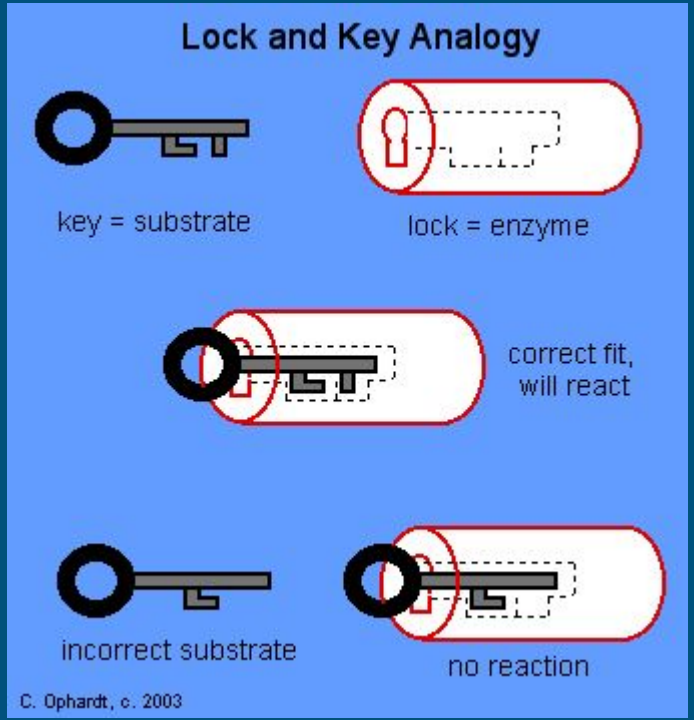
# Bacteria Properties - Combat




Based on the type VI secretion system :
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4887148/

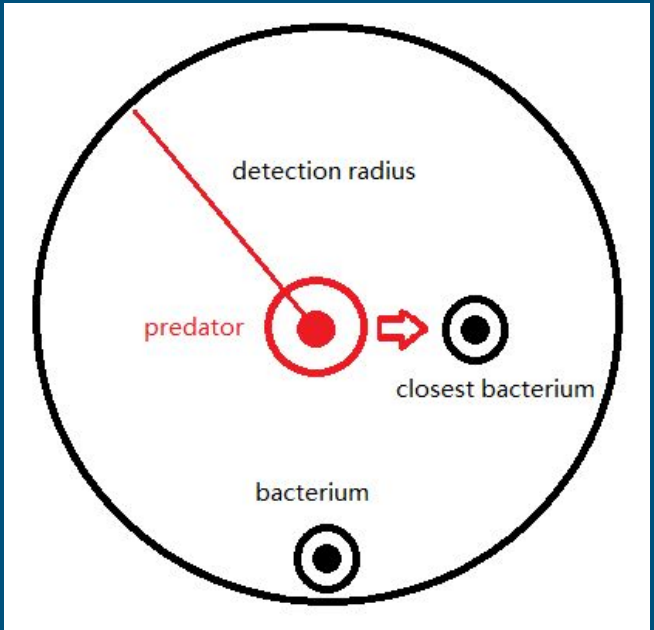
# Hazards - Drug Package

- Use lock and key model to kill bacteria




https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4887148/

# Hazards - Predator



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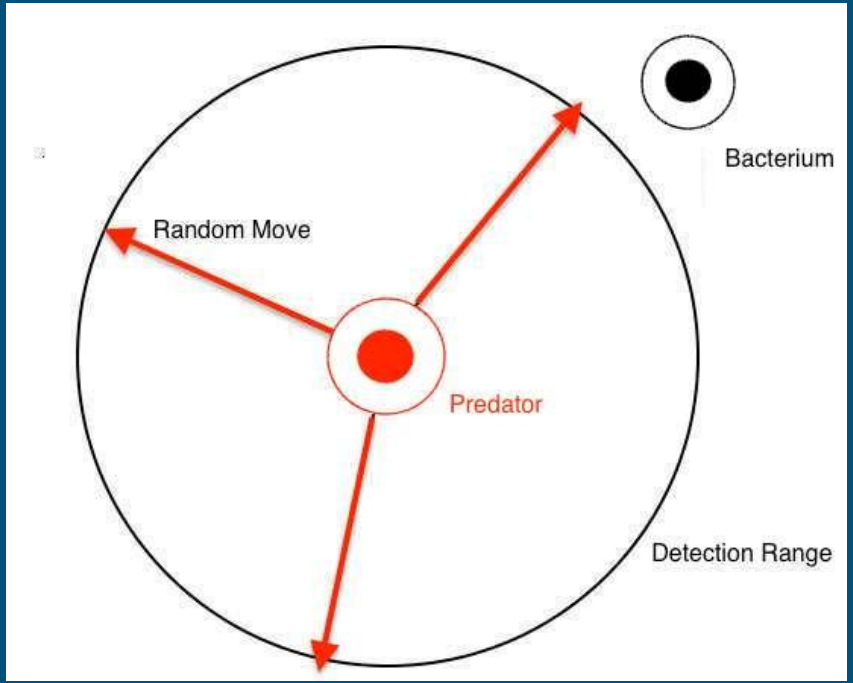
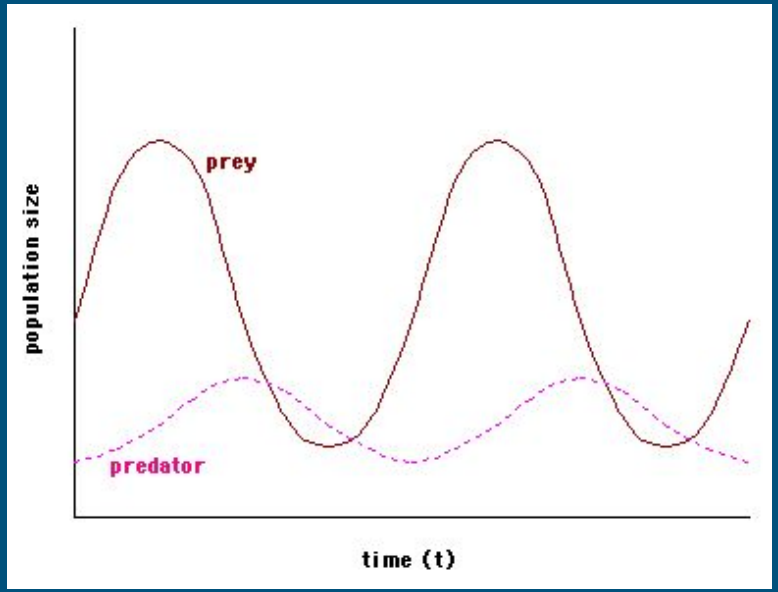


# Hazards - Predator Killer

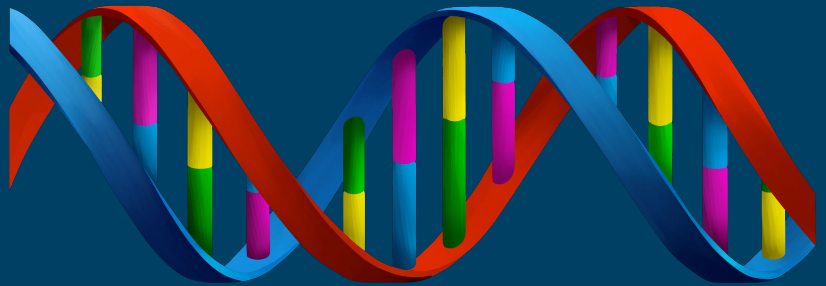
- Mechanism for limiting predator overgrowth




http://www.tiem.utk.edu/~gross/bioed/bealsmodules/predator-prey.html

# 3. DNA

```
type DNA struct {
  phenotypes map[string]Phenotype
  edges map[string]Edge          // Co
  genome map[string]Gene
  mutRate float64                //
  mutMagnitude float64
  boundsLow float64              //
  boundsHigh float64
  geneSize int                   // Re
  sampleSize int
  lksize int                     // Repr
}
```



# DNA

“Genes encode proteins and proteins dictate cell functions” [1]

“**Genes** encode **Values** and **Values** dictate **Phenotypes**

[1]https://www.nature.com/scitable/topicpage/gene-expression-14121669

# DNA - Genes

- For this simulation, a gene is simply a slice of float64:

**[3.5, -2.0, 1.0, 0.0, ..., 4.5]**

- We can take the mean of a random sample to generate a **value**

$$[3.5, -2.0, 1.0, 0.0, \ldots, 4.5] \Rightarrow [-2.0, 4.5]; \bar{x} = 1.25$$

# DNA - Genes

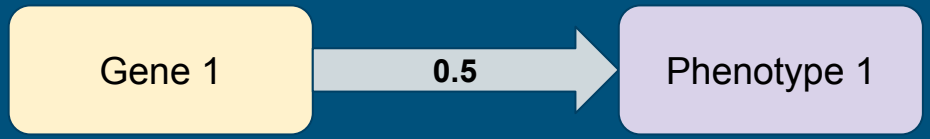
We can also **MUTATE** genes!

**[3.5, -2.0, 1.0, 0.0, ..., 4.5]**

**[3.5, -1.5, 1.0, 0.5, ..., 4.0]**

# DNA - Edges

- Each gene can have one or more “edges” radiating from it
- Each edge has a **weight** and a target **phenotype**



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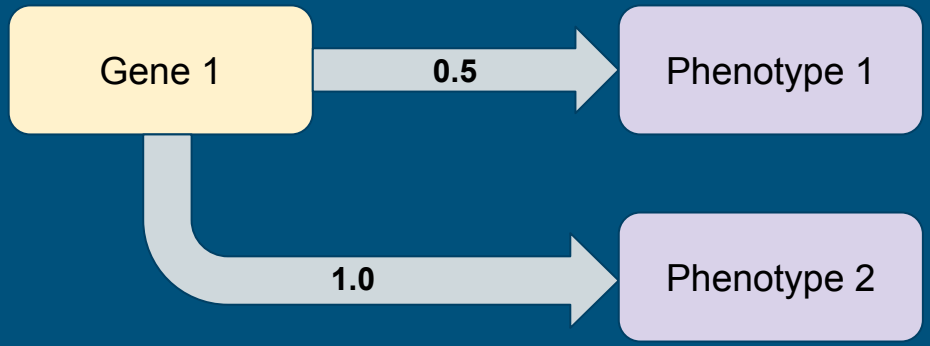
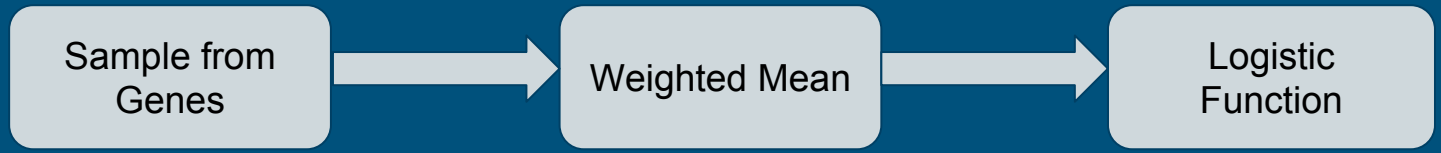


# DNA - Edges

Edges represent the contribution of a **single gene** to a **single phenotype.**

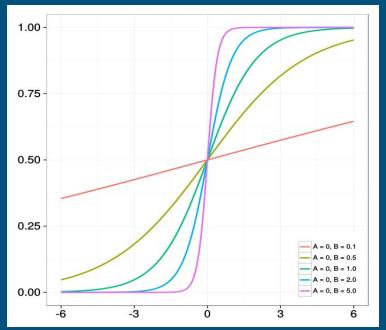
# DNA - Phenotypes

- Any **variable** property of a bacteria
- At each timepoint, phenotypes pull from genes to establish behavior

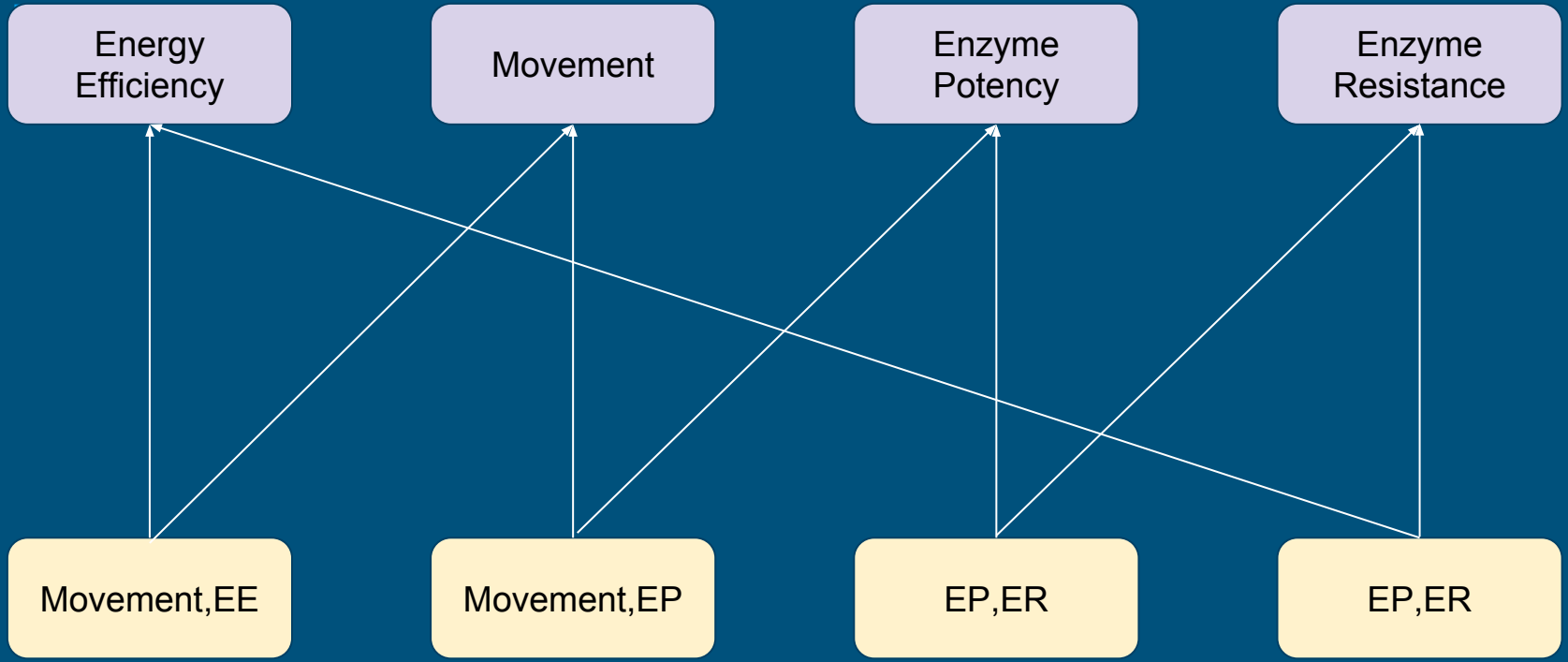



$$\bar{x_1}, \bar{x_2}, \ldots, \bar{x_n}$$

$$\frac{1}{n}\sum_{1}^{n} w_{n,p} * \bar{x_n}$$



# DNA - Full Graph



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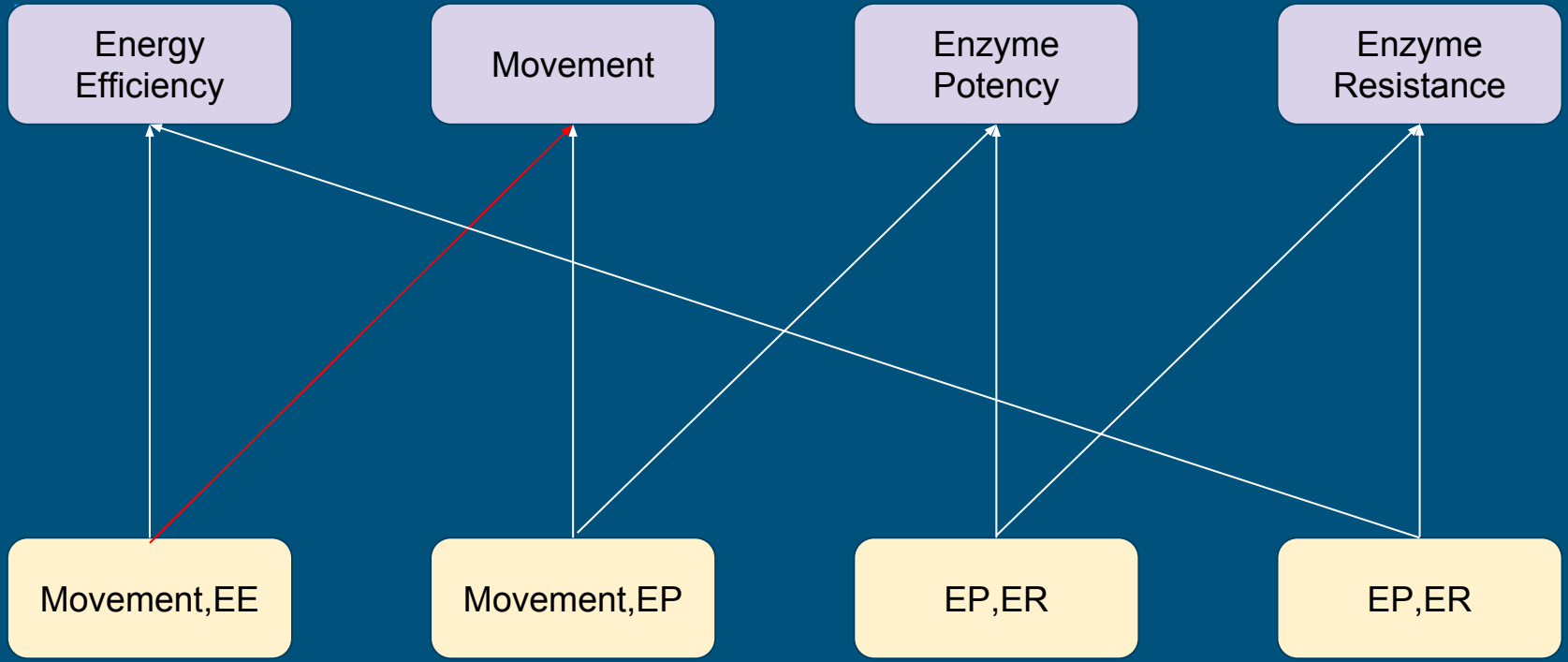

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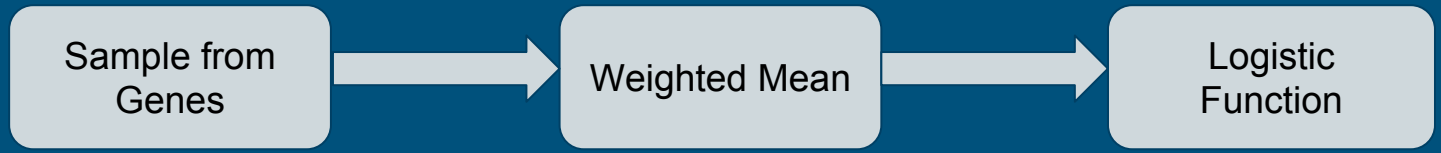


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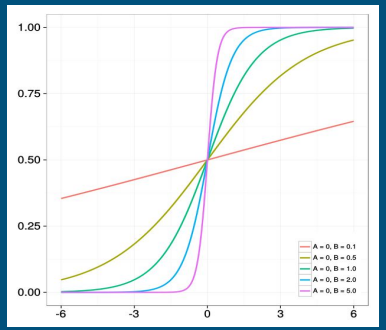

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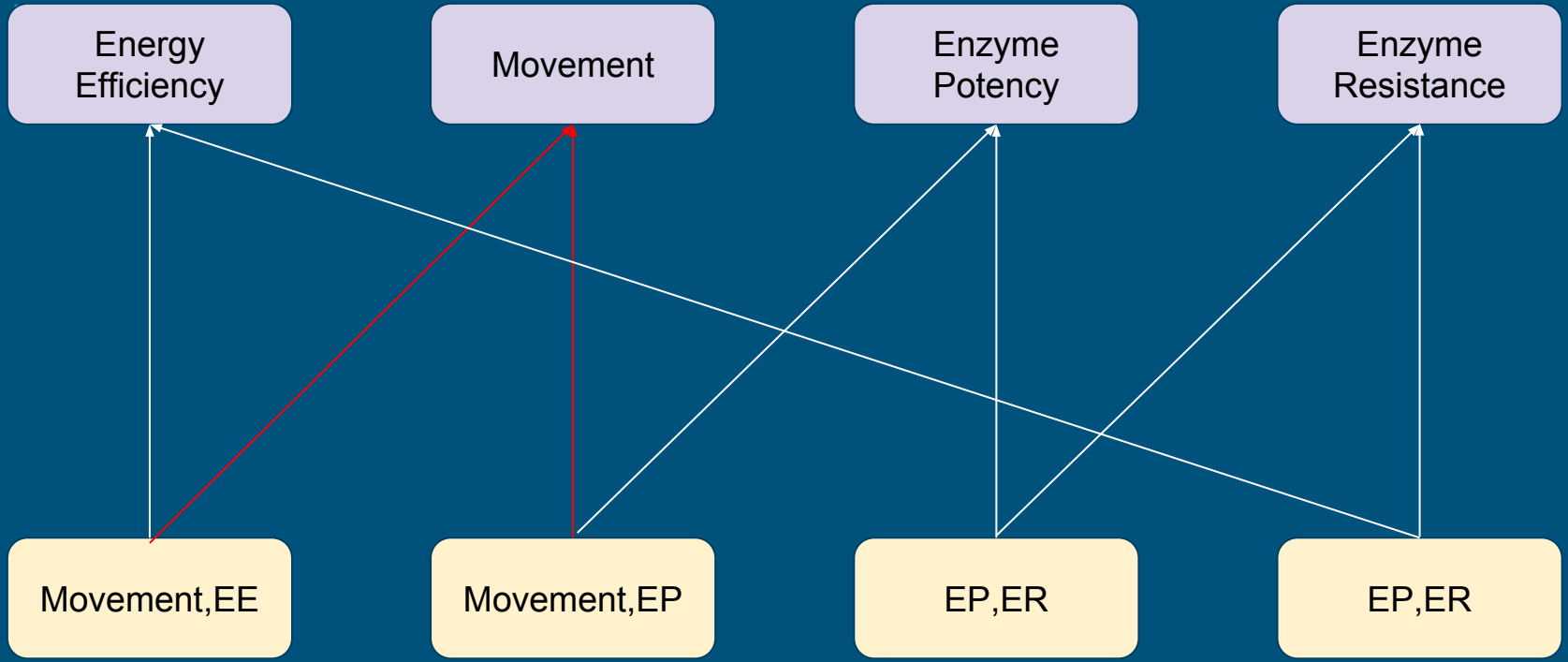

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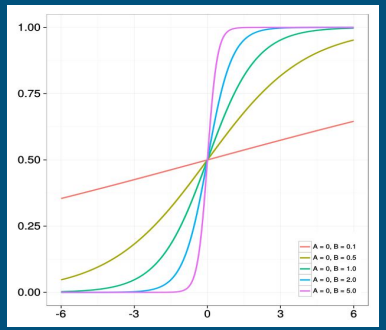

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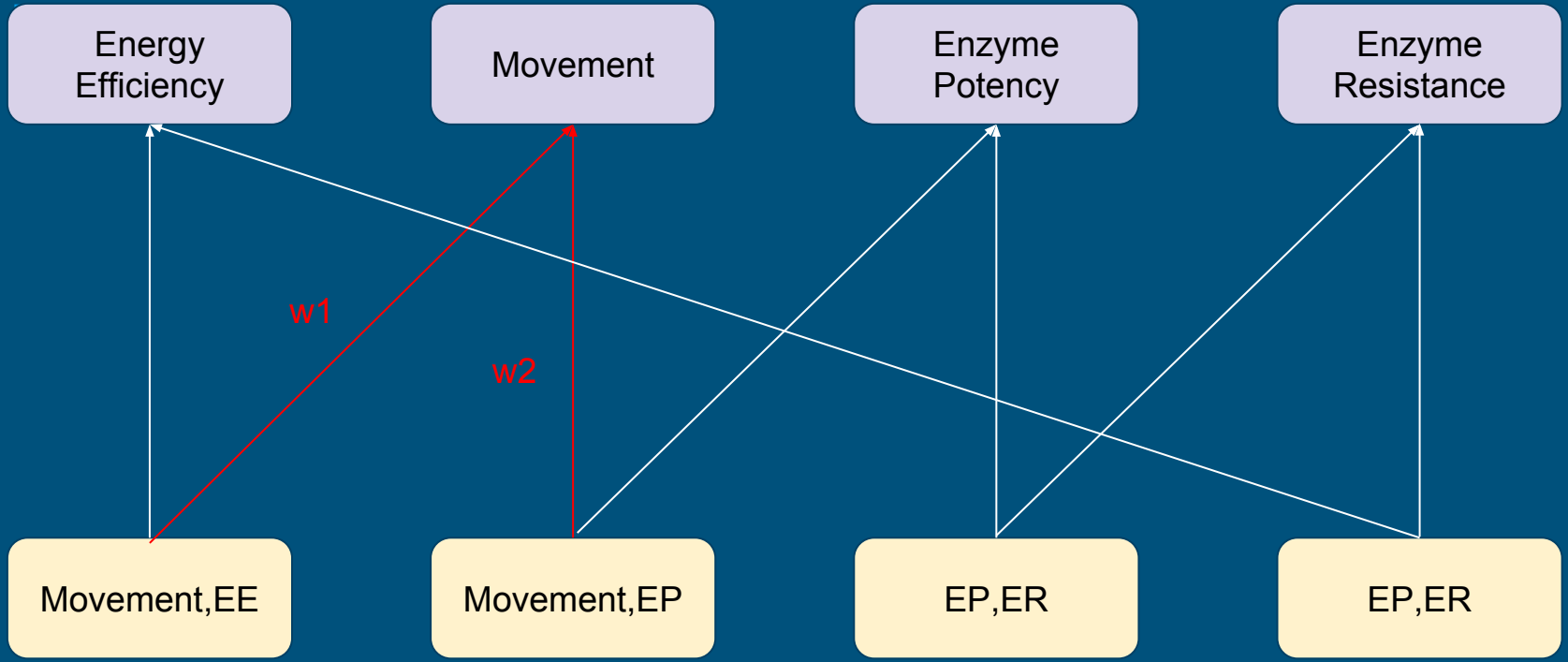

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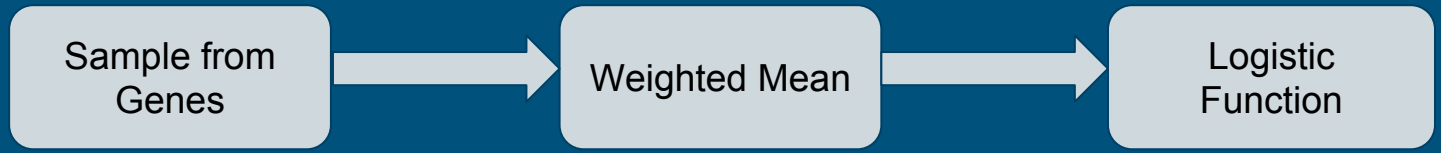


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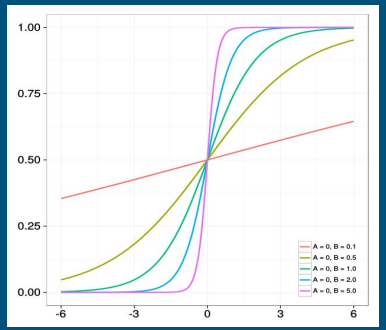

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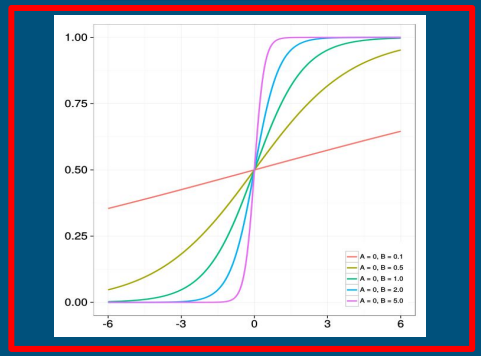
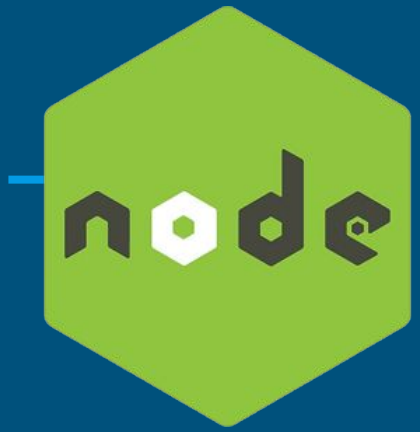
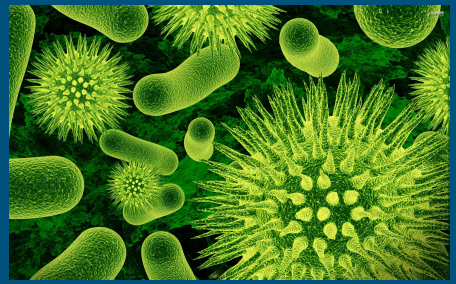


# 4. The App

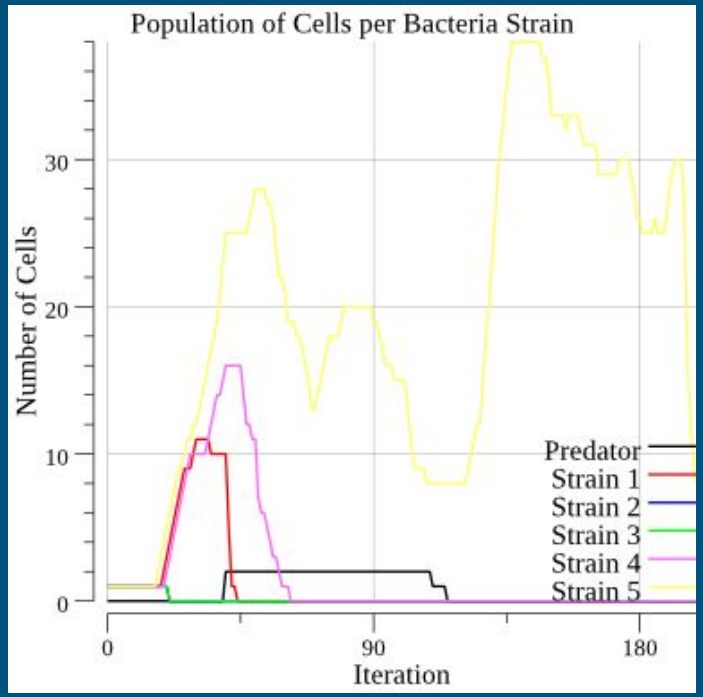

node

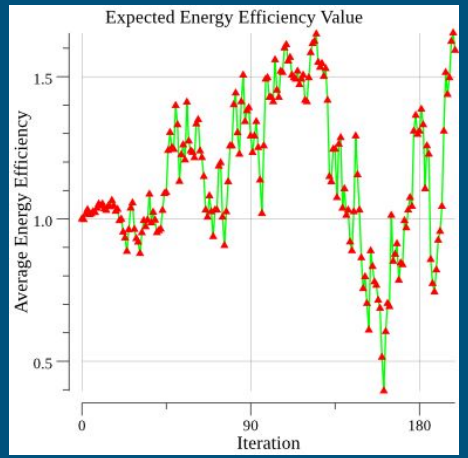


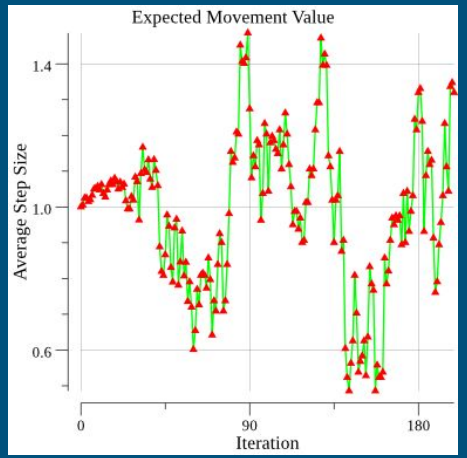



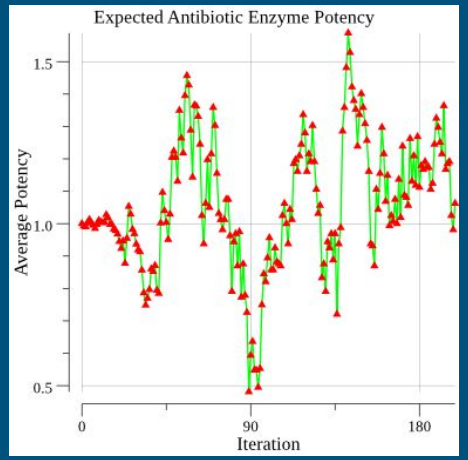
# 5. Research and Results

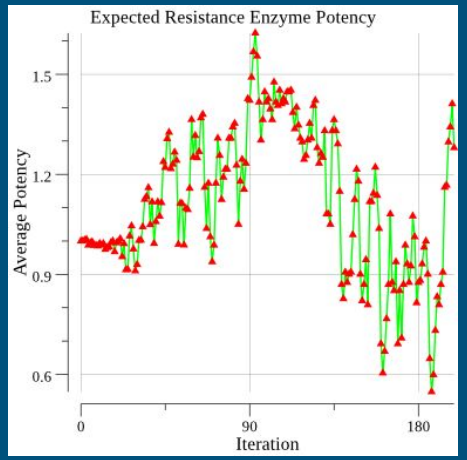
# Data Collection



# Thanks for watching!