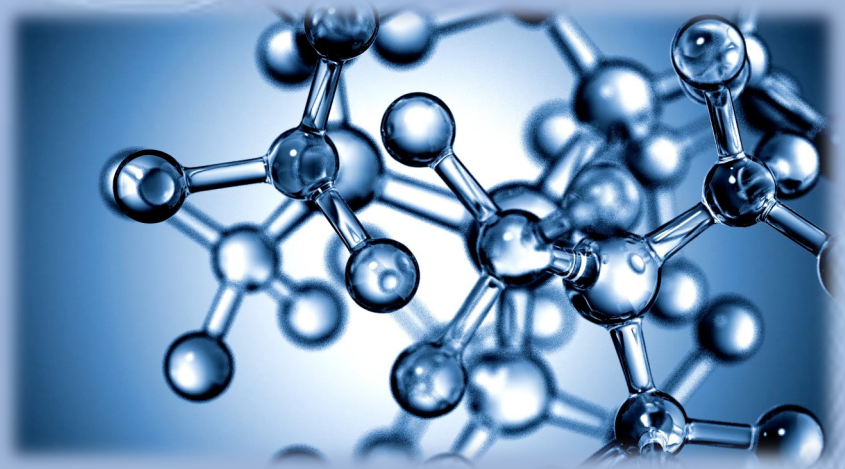
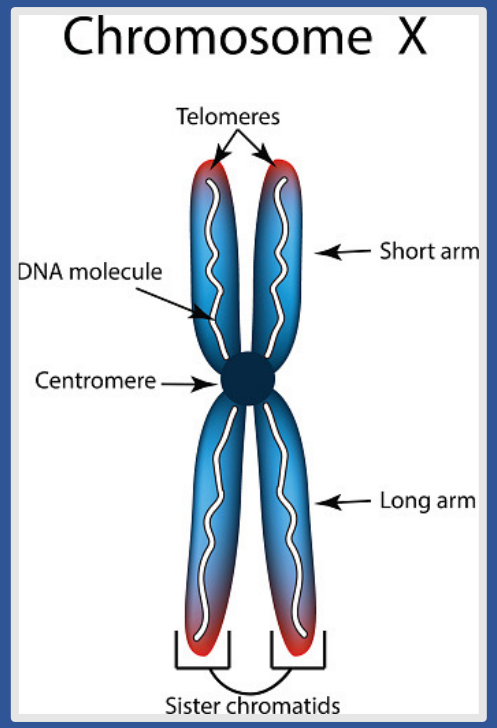
Genetic Algorithm Research Project



- Yueqiao Wang & Rebecca Testa

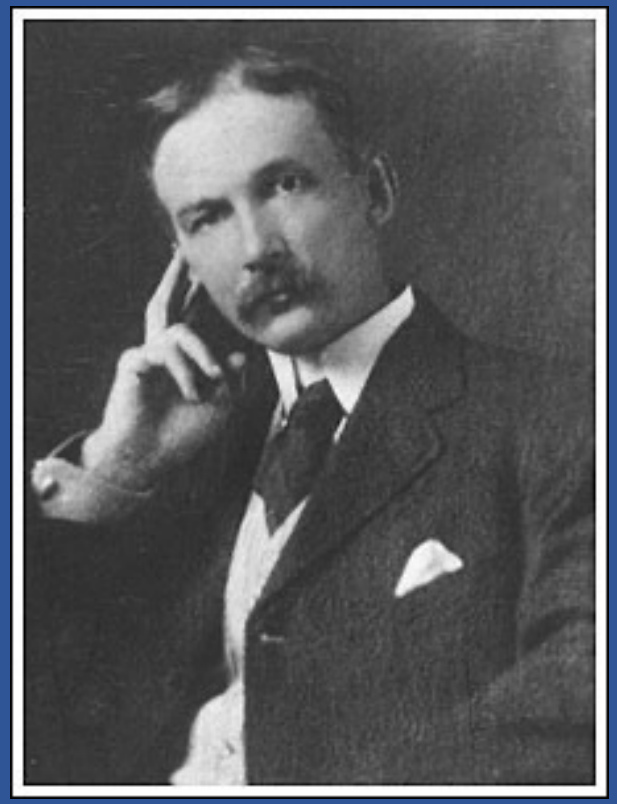
- CSSE220 – 03
- Winter 2022



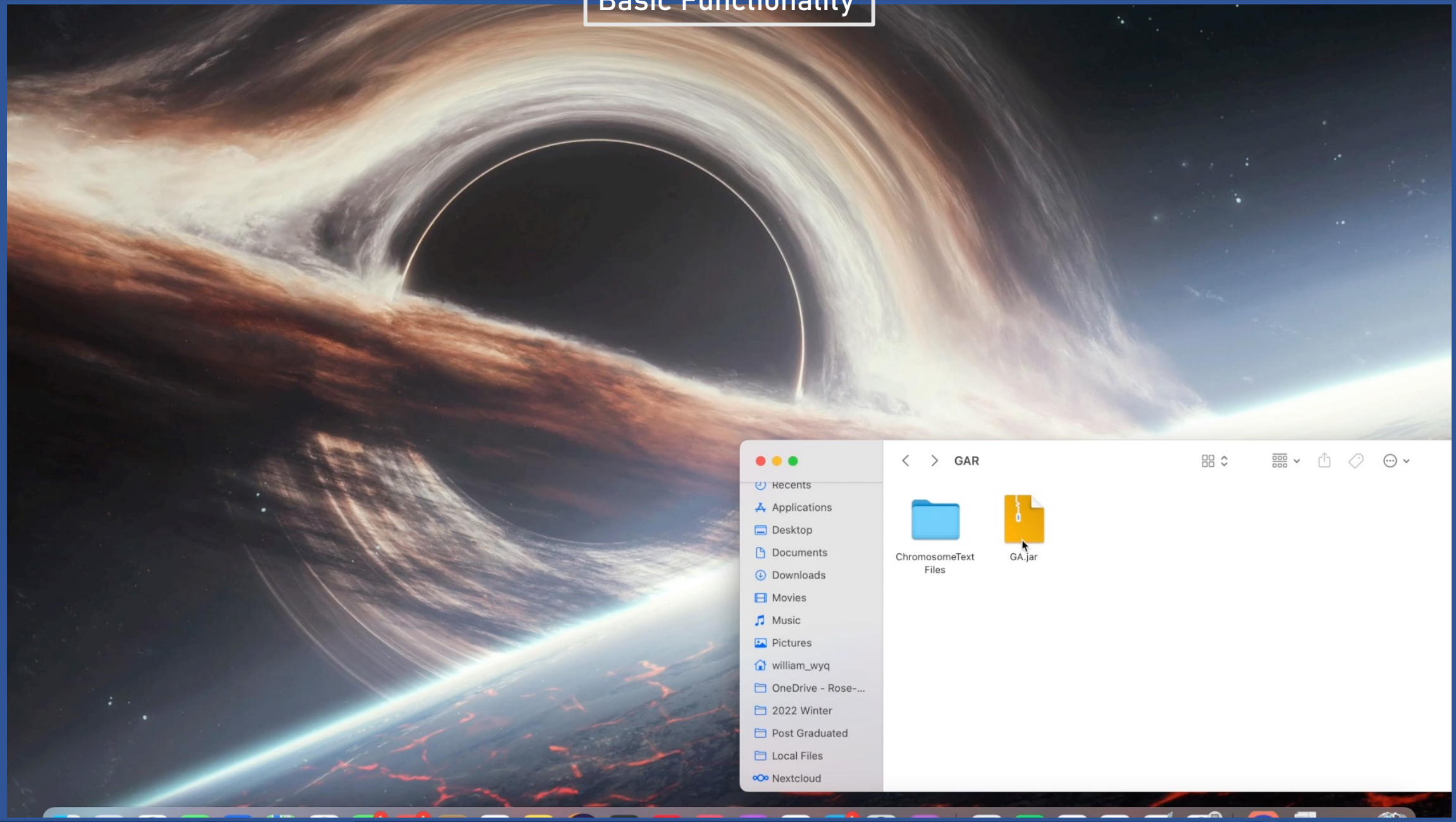
1	1	0	1	0	1	0	0	0	1

Example: a real-world chromosome and its genes are represented by an array of integers

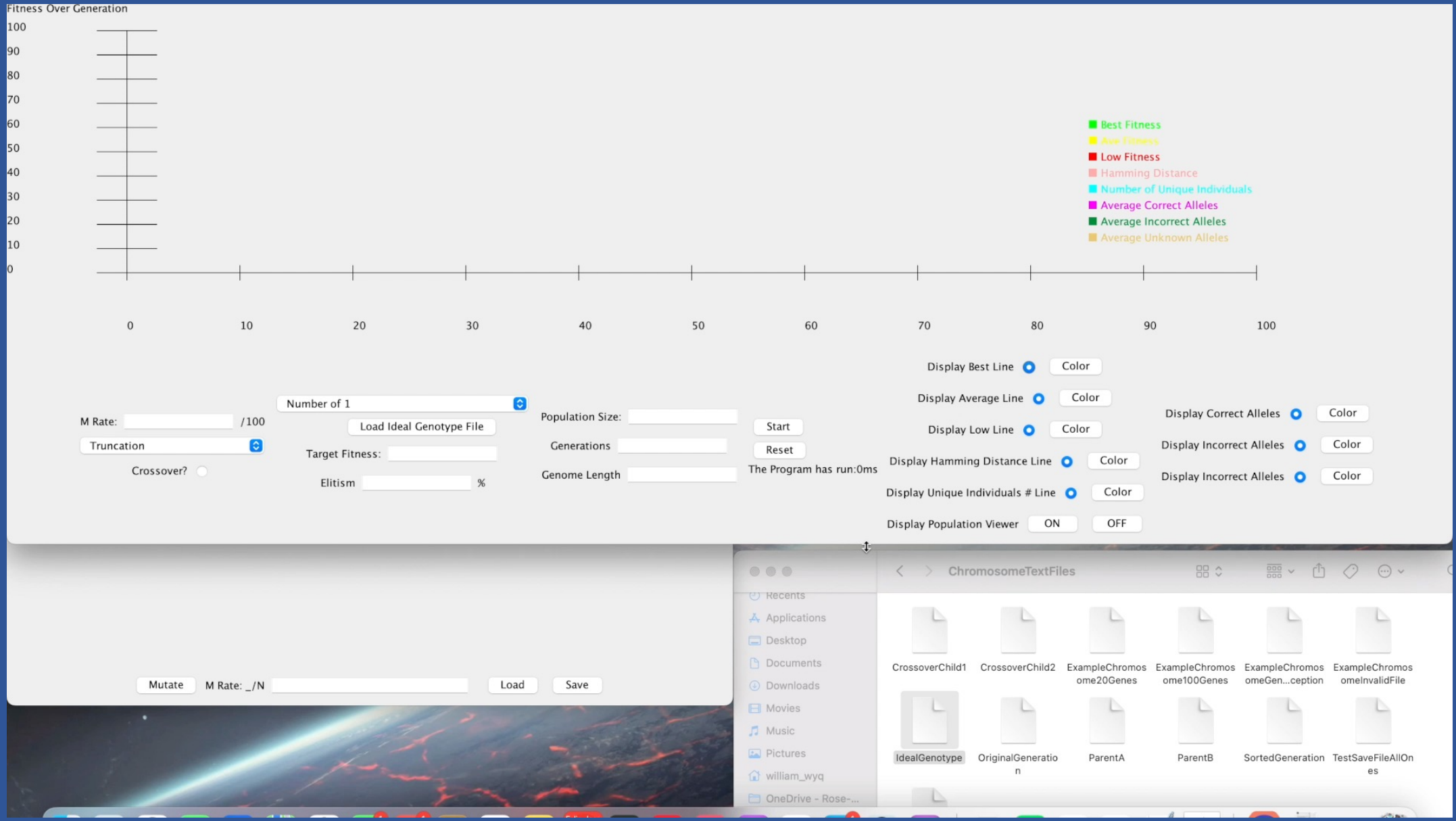
James Mark Baldwin asserted that learning during an organism's lifetime may influence the evolution of a population.



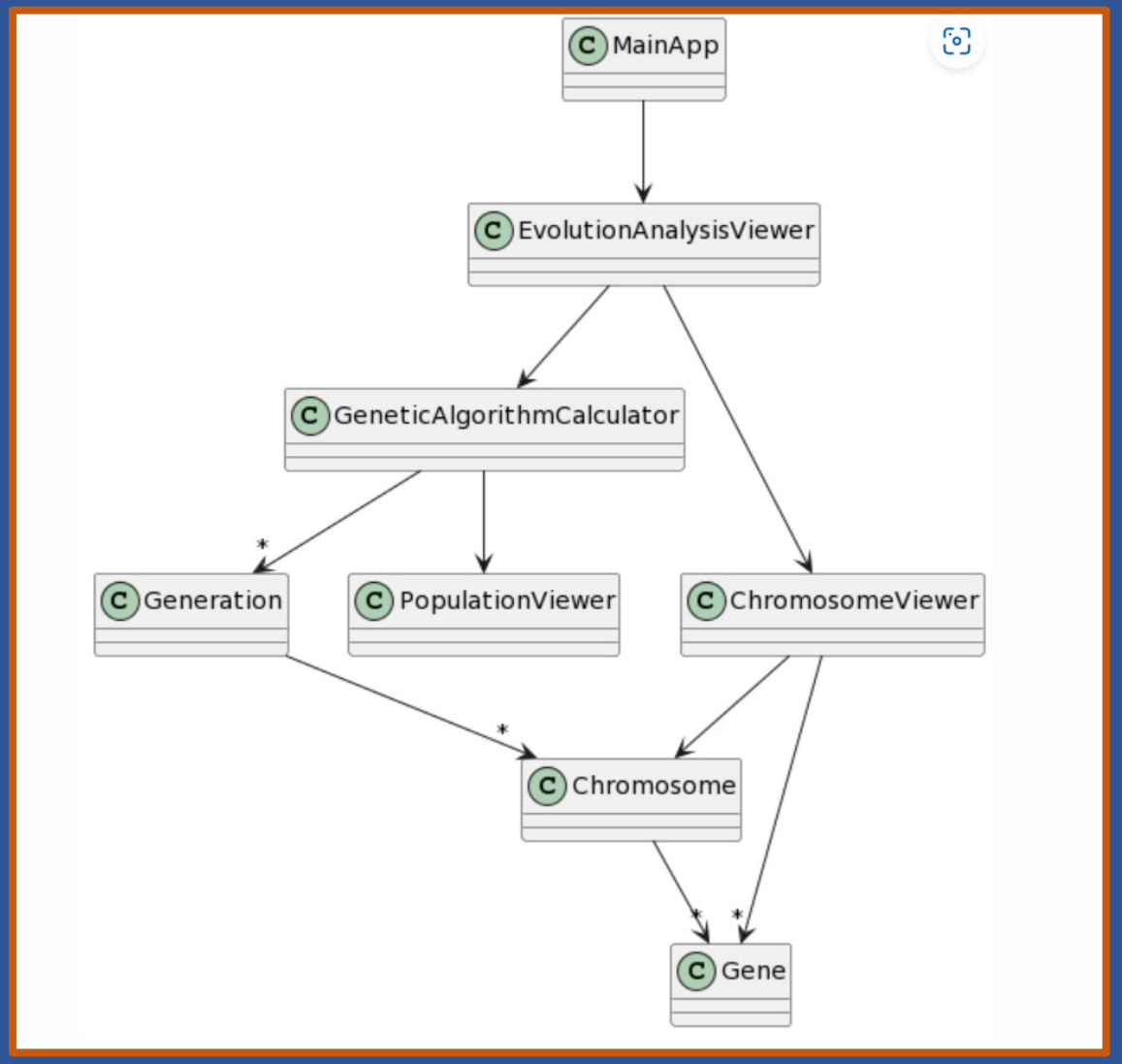
Basic Functionality



Additional Functionality



System Design



A Basic UML Representation

System Design and OO Design Principles

- DP2: Nouns should become classes.
- DP3: No class should be too large.
- DP3: Functionality should be distributed efficiently.
- DP4: Don't have message chains (more on this later).

```
public Gene() {
    double randomValue = Math.random();
    if(randomValue < 0.5) {
        this.currentValue = CORRECT_ALLELE;
    }
    else {
        this.currentValue = INCORRECT_ALLELE;
    }
}
```

```
public void changeValue() {
    if(this.currentValue == INCORRECT_ALLELE) {
        this.currentValue = CORRECT_ALLELE;
    }
    else {
        this.currentValue = INCORRECT_ALLELE;
    }
}
```

```
public Gene(boolean baldwinianEvolution) {
    if(baldwinianEvolution == true) {
        double randomValue = Math.random();
        if(randomValue < 0.5) {
            this.currentValue = UNKNOWN_ALLELE;
        }
        else if(randomValue >= 0.5 && randomValue < 0.75) {
            this.currentValue = CORRECT_ALLELE;
        }
        else {
            this.currentValue = INCORRECT_ALLELE;
        }
    }
}
```

Notice: Rather than putting all this functionality in the Chromosome class, the Gene class is forced to choose and manipulate its own value.

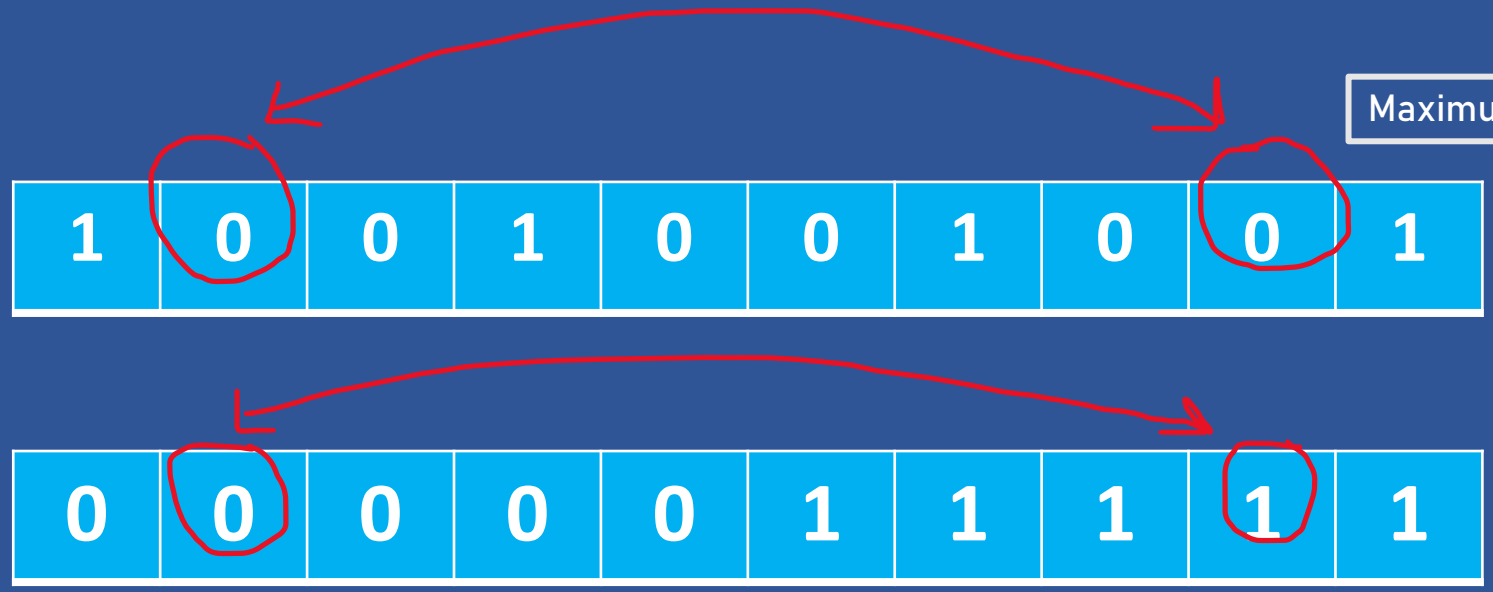
Our Original Fitness Function: Symmetry

Life's Preference for Symmetry Is Like 'A New Law of Nature'

Techniques from computer science may help explain the tendency in biology for structures to repeat themselves.

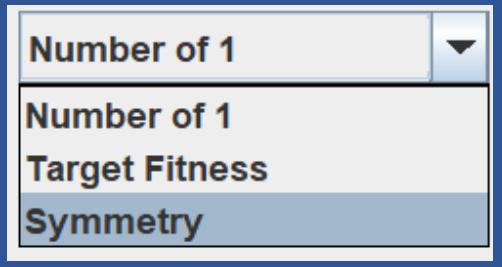
molecules that control how genes switch on and off. They found that evolution tends toward symmetry because the instructions to produce symmetry are easier to embed in genetic code and follow.

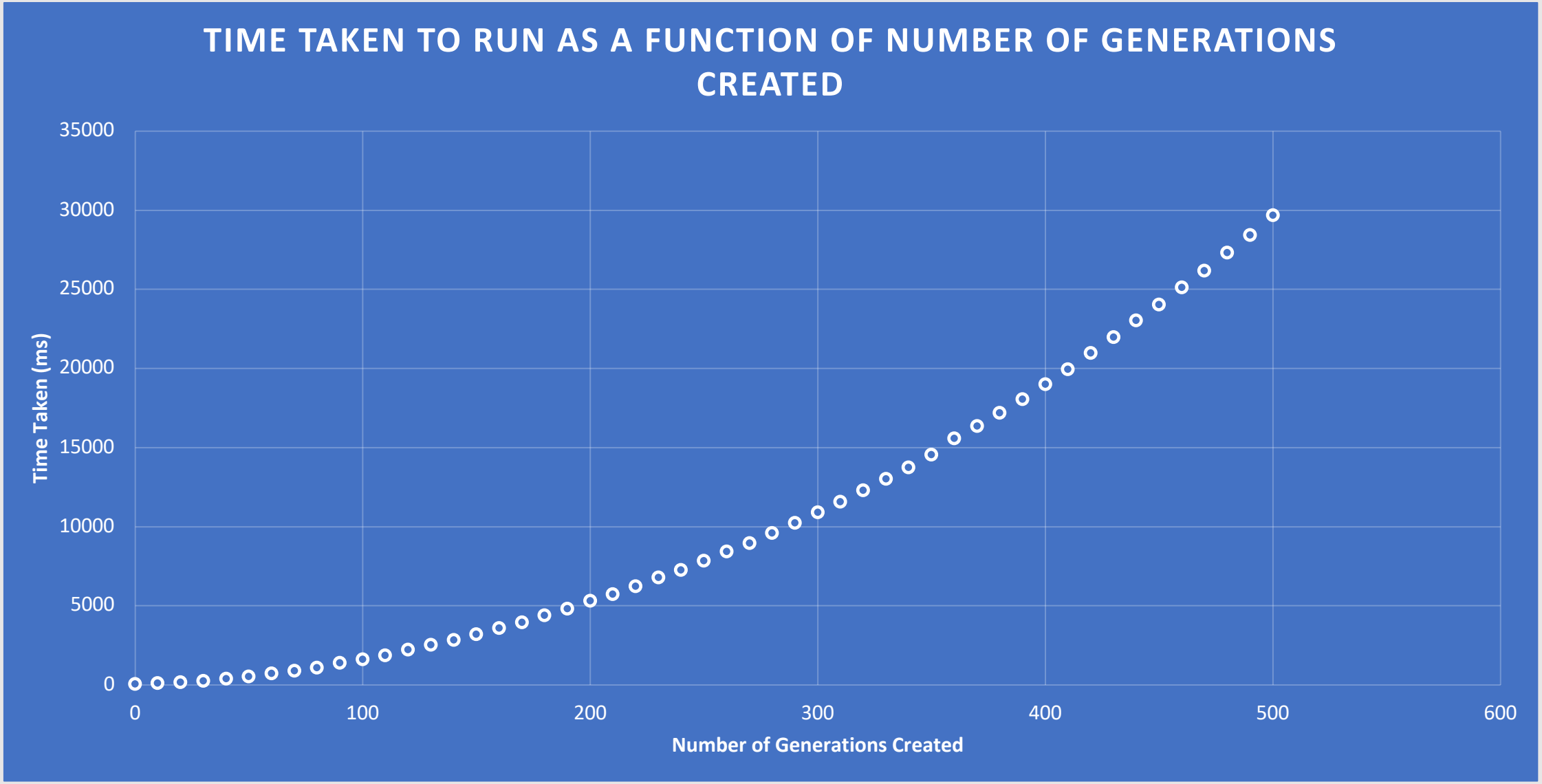
Symmetry runs rampant in nature.



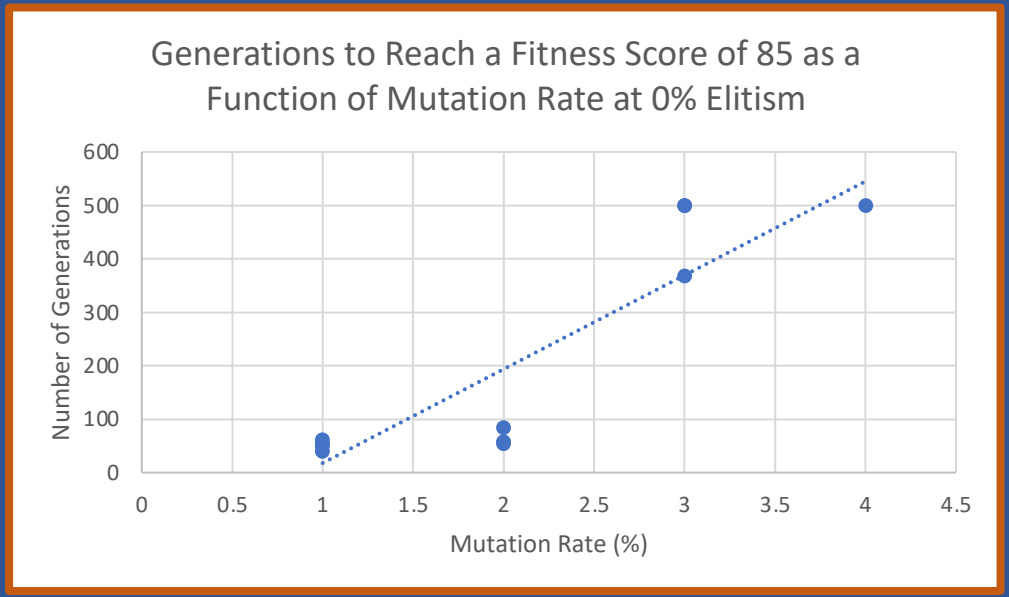
Maximum fitness score

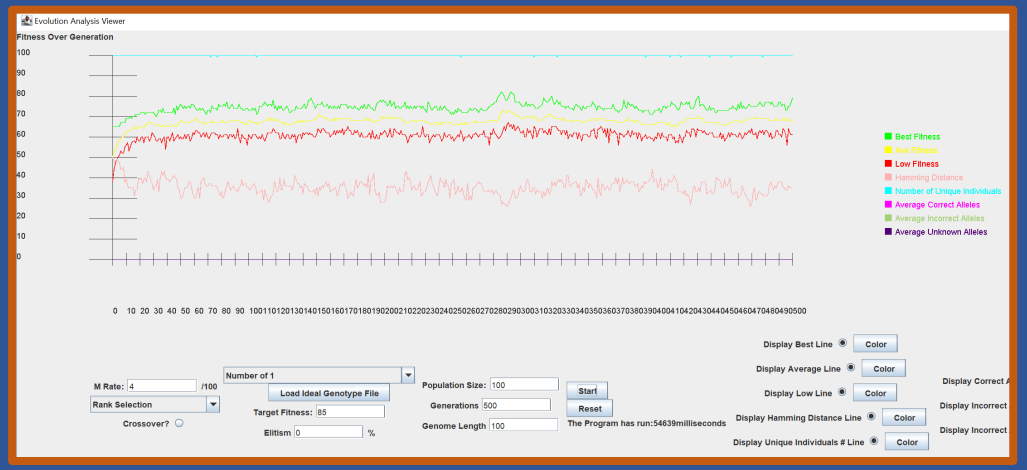
Minimum fitness score



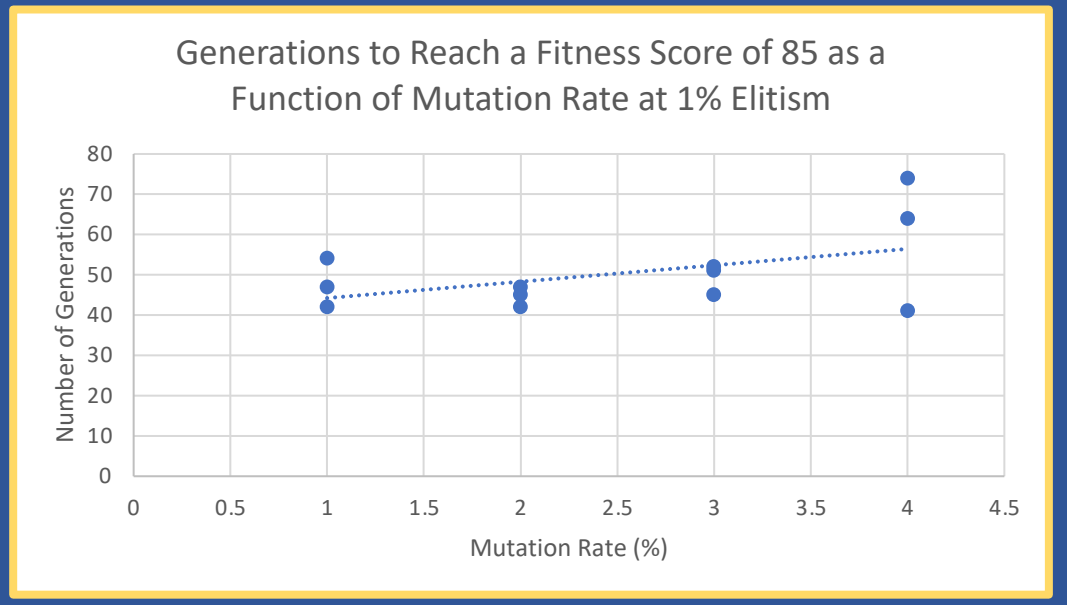

TIME TAKEN TO RUN AS A FUNCTION OF NUMBER OF GENERATIONS CREATED
35000
30000
25000
20000
15000
10000
5000
0
Time Taken (ms)
0
100
200
300
400
500
600
Number of Generations Created

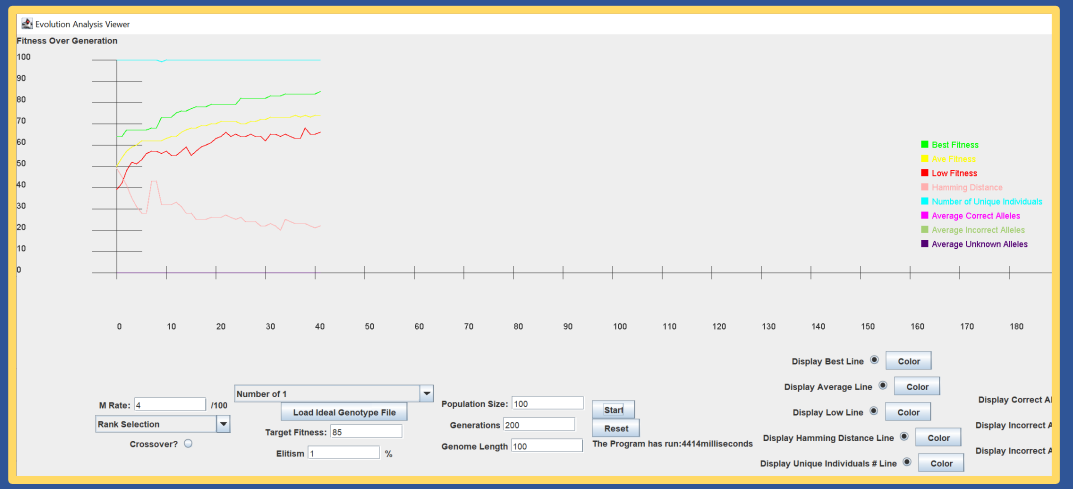
Original Experiment: When are high mutation rates a hindrance?





In 500 generations, the target fitness was never reached with a mutation rate of 4% and 0% elitism.





With a mutation rate of 4% and 1% elitism, the target fitness was reached in an average of just 60 generations.

Reproducing Results of a Scientific Paper on Baldwinian Adaptation

1	1	1	1	1	1	1	1	1	1

Once a chromosome "learns" the ideal phenotype, its fitness score is greatly increased.

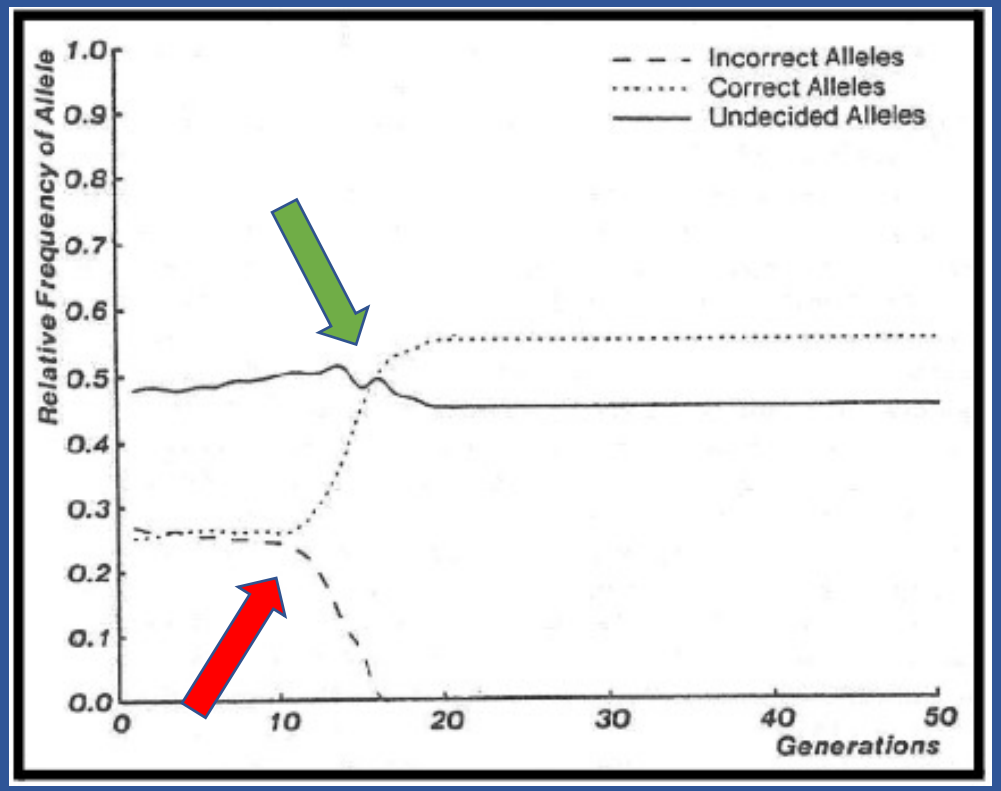
Ultimately, genotypes that support learning the ideal phenotype are favored.

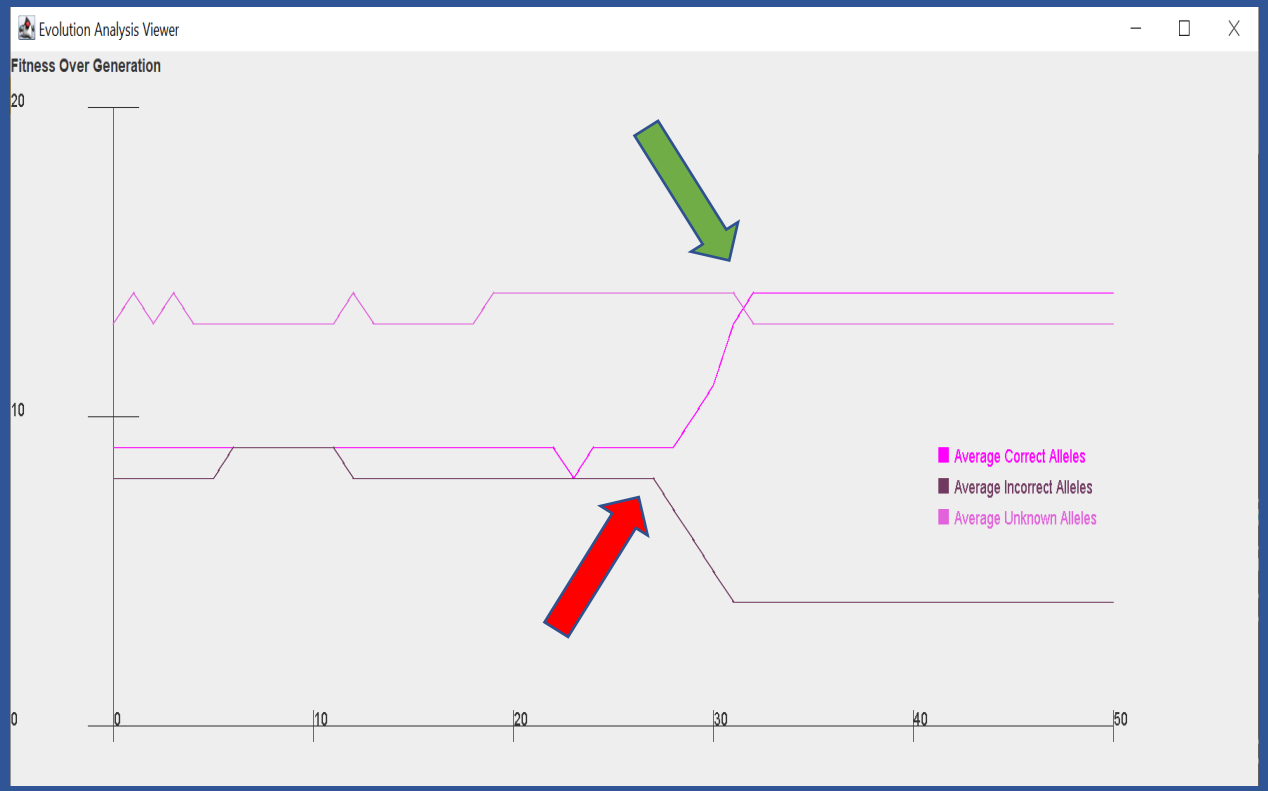
1	0	0	?	0	?	?	?	1	0

1	1	1	?	1	?	?	1	1	?

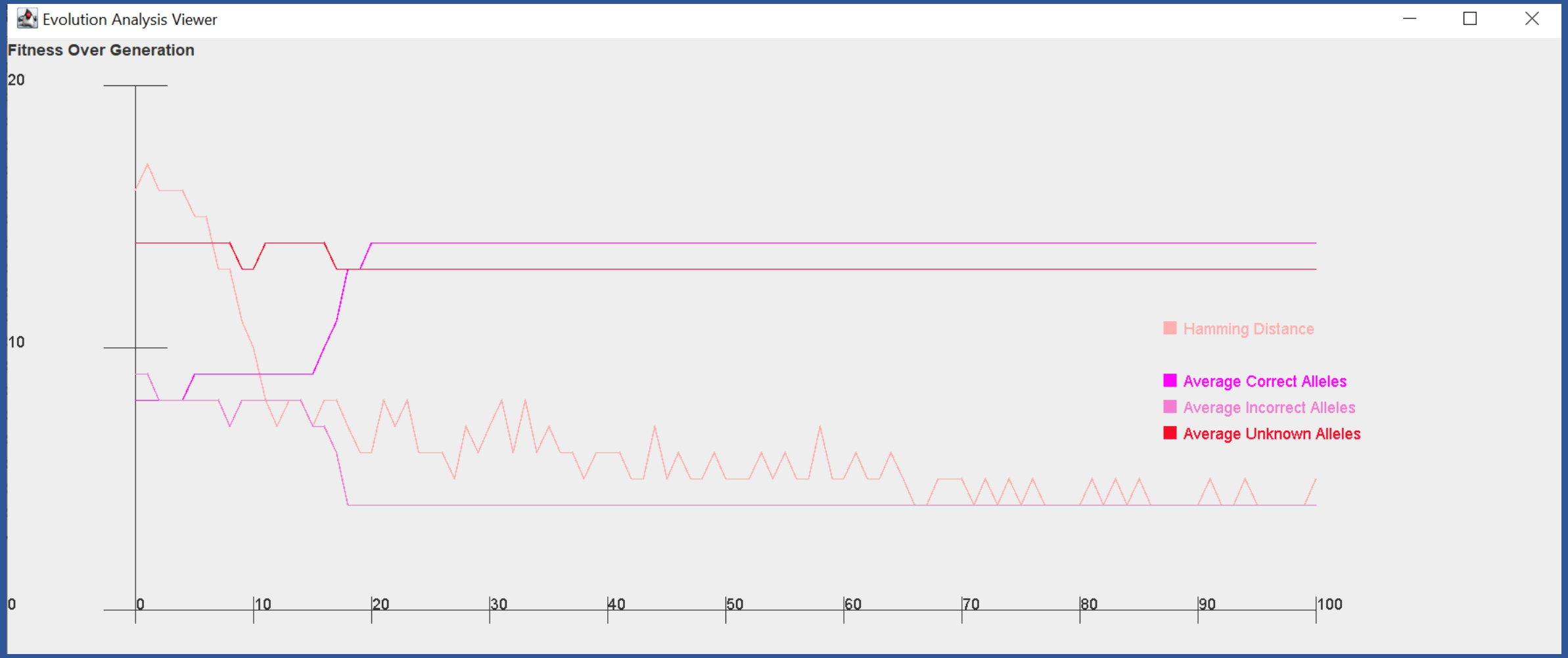
Recall: Baldwin asserted that learning accelerates evolution

Reproducing Results of a Scientific Paper on Baldwinian Adaptation

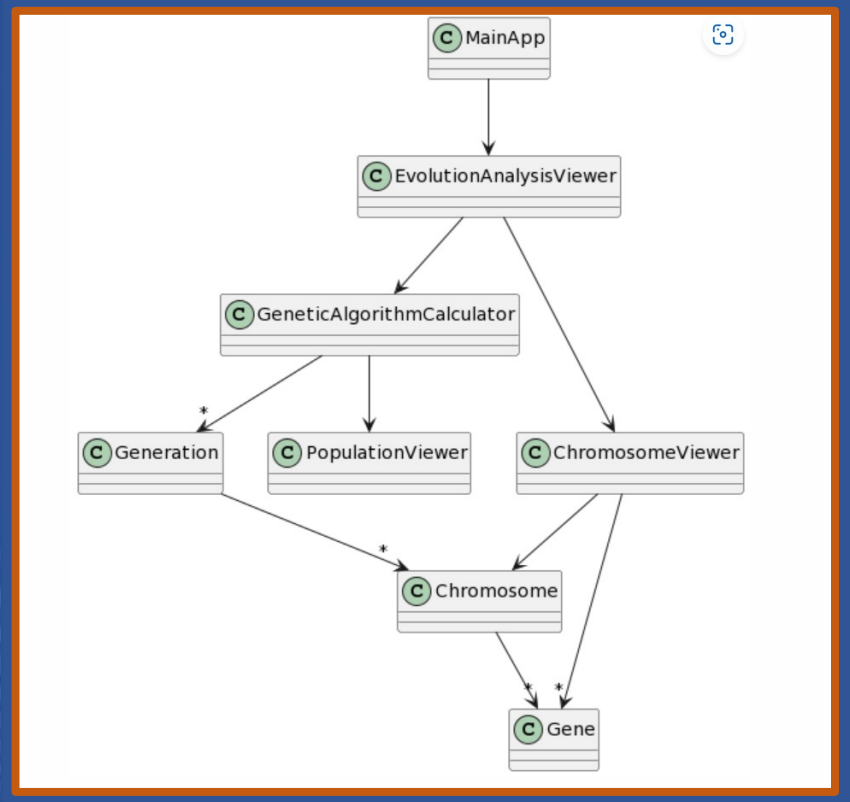




Reproducing Results of a Scientific Paper on Baldwinian Adaptation



Code Extensibility and an Interesting Bug

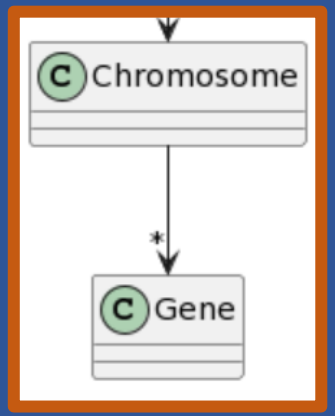



```
public ArrayList<Chromosome> chooseNextParents(int parentSelectionType,
```

```
private ArrayList<Chromosome> chooseNextParentsWithTruncation(
private ArrayList<Chromosome> chooseNextParentsWithRouletteWheel
private ArrayList<Chromosome> chooseParentsWithRanked(
private ArrayList<Chromosome> chooseParentsWithBaldwinian(
```

Calling a single function based on the settings in the viewer and allowing the Generation class to choose the correct implementation of that function made adding an entirely new type of reproduction much easier.

DP4: Don't have message chains and reduce dependencies.



Questions?

Thanks