|  |  |
| --- | --- |
| parameter | value |
| bit string length | 100 |
| population size | 100 |
| selection | Truncation Selection |
| elitism | 1%  (i.e. best chromosome cloned) |
| mutation rate | 1% ( i.e. 1.0/N) |
| crossover | true |
| generations | 500 (terminate at max fitness) |

1. Try evolving a solution using just mutation (no crossover) 10 (or more) times. How many generations does it appear to take to evolve a solution? How much variation is there in the number of generations taken from run to run? Is this more or less than you expected (both how many generations and the variation in required generations between runs)?

Graphical user interface

Description automatically generated with medium confidence

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| More than 500 | More than 500 | More than 500 | More than 500 | More than 500 | 564 | More than 500 | More than 500 | More than 500 | More than 500 |

They take a very long time to evolve to a fitness of 100, though there is some variation – some get it relatively soon after 500 generations, while others take more than 1000. They get up to 98 or 99 within 500, but it takes a long time to then get to 100 without crossover. The variation is about what I’d expect, but the number of generations is more than I would have expected.

2. Repeat experiment #1, but use crossover (single crossover point) and mutation. What do you think will happen? How many generations does it appear to take to evolve a solution? What can you conclude from this?

Probably it will evolve to 100 more quickly, because crossover typically makes it evolve more quickly by allowing higher fitness individuals to spread.

Graphical user interface

Description automatically generated with medium confidence

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 42 | 50 | 47 | 48 | 51 | 51 | 60 | 48 | 51 | 55 |

It appears to take around 50 generations to evolve to perfect fitness with both crossover and mutation. We can conclude that crossover makes populations evolve much faster than populations that do not use crossover.

3. Repeat experiment #1, but with ONLY crossover (single crossover point) meaning you should set the mutation rate to 0. What do you think will happen? Run the experiment and report on your findings. Write down your best explanation of the results.

Probably it will be slower than either – it may never reach a fitness of 100, because just getting part of each parent with no mutation will take a long time to reach a perfect fitness.

Graphical user interface

Description automatically generated with medium confidence

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Never | Never | Never | Never | Never | Never | Never | Never | Never | Never |

The fitness quickly flatlines, because without mutation all the chromosomes converge to the same thing, so crossover doesn’t do anything anymore.

4. Try different variations of parameters and turn mutation and crossover on and off in conjunction with different selection methods. (In particular, you might try experiments 1/2/3 with rank selection and Roulette Wheel) Do you find anything surprising? (You do not have to provide plots of all the experiment you run here, but select the most interesting ones to report on)

Graphical user interface, chart

Description automatically generated

This is 2 with roulette wheel selection – roulette wheel selection tends to evolve more slowly than truncation, especially when the fitnesses become fairly similar. Thus, it increases quickly at the beginning when they’re more different, but quickly slows as the fitnesses become more similar.

Our experiment: we created a fitness function where either high numbers of ones or high numbers of zeroes resulted in a high fitness. With crossover it evolves similarly to the all ones fitness function, but it’s interesting because when there’s no crossover, sometimes the population will start evolving towards one then switch and evolve towards the other, or sometimes different individuals will evolve towards each extreme for a while before one takes over. This sort of simulates what might happen if a population started to split into two different species because there were two biological niches available, or if two different results of evolution competed for the same space.

Chart, histogram

Description automatically generated