0456024

Evolutionary Computation Homework #1

1. The eight-queens problem.

(a) How big is the phenotype space for the eight-queens problem?

one can set restrictions on board configurations depending on his problem domain knowledge:

(1) if no restrictions ⟶ 64^8

(2) if each queen should be put on a different square ⟶ $\binom{64}{8}$

(3) if queens cannot check each other ⟶ $8!$

(b) Give a genotype to encode the 8×8 chessboard configuration.

a permutation of $\{1,2,3,4,5,6,7,8\}$

value of elements ⟶ row numbers; order of elements ⟶ column numbers

(c) How big is the genotype space you give in 1b?

$8!$

(d) Briefly describe why the proposed genotype is able to cover the phenotype space.

the restriction mentioned in 1.(a)(3) means there is exactly one queen per row and per column

value/order of elements in a permutation can guarantee distinct row/column position of queens

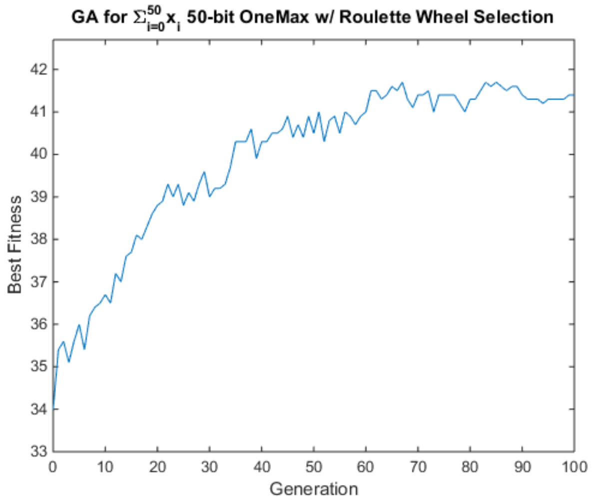
2. Given a function $f(x)$: $[0,1] \to \mathbb{R}$. We want to find an optimal x value with a required precision of 0.001 of the solution. That is, we want to be sure that the distance between the found optimum and the real optimum is at most 0.001. How many bits are needed at least to achieve this precision for a bit-string genetic algorithm?

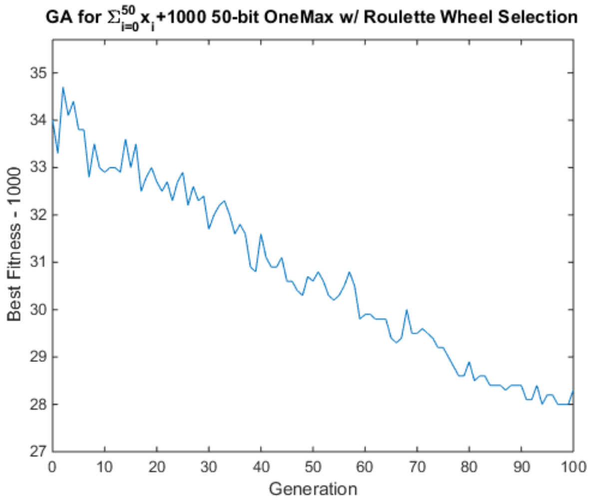
for $\vec{x} \in \mathbb{R}^n$, $x_i \in [a_i, b_i]$, $i = 1, \ldots, n$

required precision = 0.001 ≥ $|b_{max} - a_{min}|/2^L = 1/2^L$

required bits = $L \geq 10$

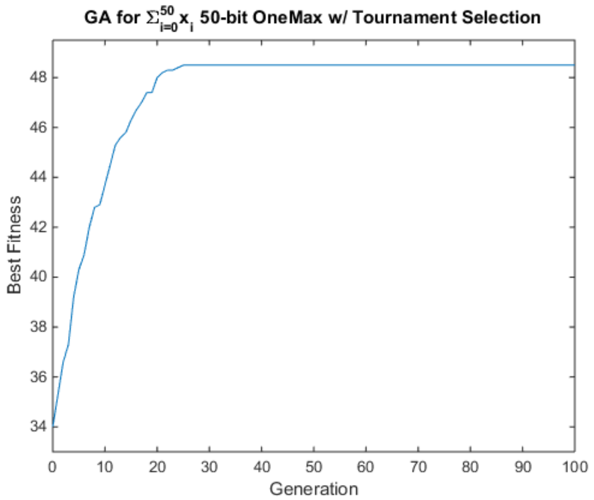
3. Genetic algorithm with roulette wheel selection for 50-bit OneMax.
4. Genetic algorithm with roulette wheel selection for modified 50-bit OneMax .
5. Compare the results of 3 and 4.

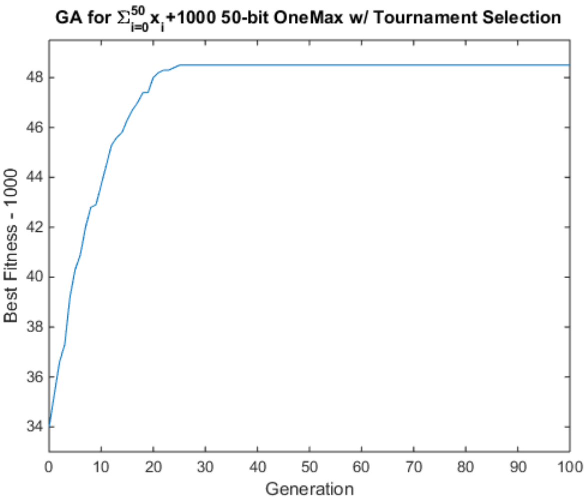




the same genetic algorithm with roulette wheel selection and the same random seeds are applied to both problems. the results show that 3. gets closer to real optimum but 4. does not.
in this case, +1000 has a great effect on roulette wheel selection, which selects individuals according to their fitness proportion. because 1000 is much larger than $\sum_{i=0}^{50} x_i$, the real fitness values becomes insignificant and the selection mechanism can not work well.

6. Genetic algorithm with tournament selection for 50-bit OneMax.
7. Genetic algorithm with tournament selection for modified 50-bit OneMax.
8. Compare the results of 6 and 7.





the same genetic algorithm with tournament selection and the same random seeds are applied to both problems. the results show that there is no difference between 6. and 7.

9. Compare the results of 3, 4, 6, 7.
tournament selection is independent of shift of fitness functions but roulette wheel selection is not.