

Artificial Intelligence Assignment 2

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Report: Genetic Algorithms for function optimisation

1. Plots of minimum, average and standard deviation

The required statistics of the search for each of the three GA implementations in DeJong functions nr. 2, 3, 5 are presented in Figures 1, 2 and 3 respectively.

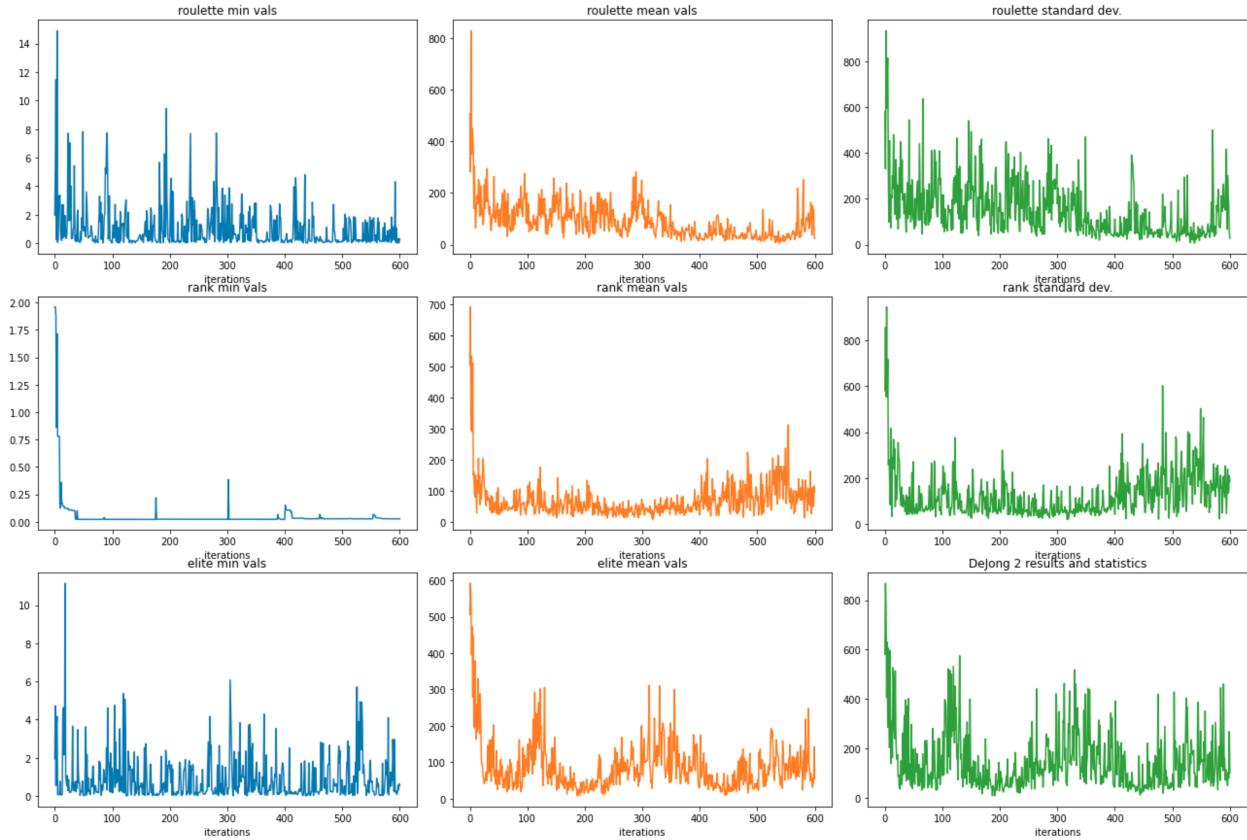


Figure 1: Plot of minimum, average and standard deviation of the population's objective value across each iteration for the search in DeJong n.2

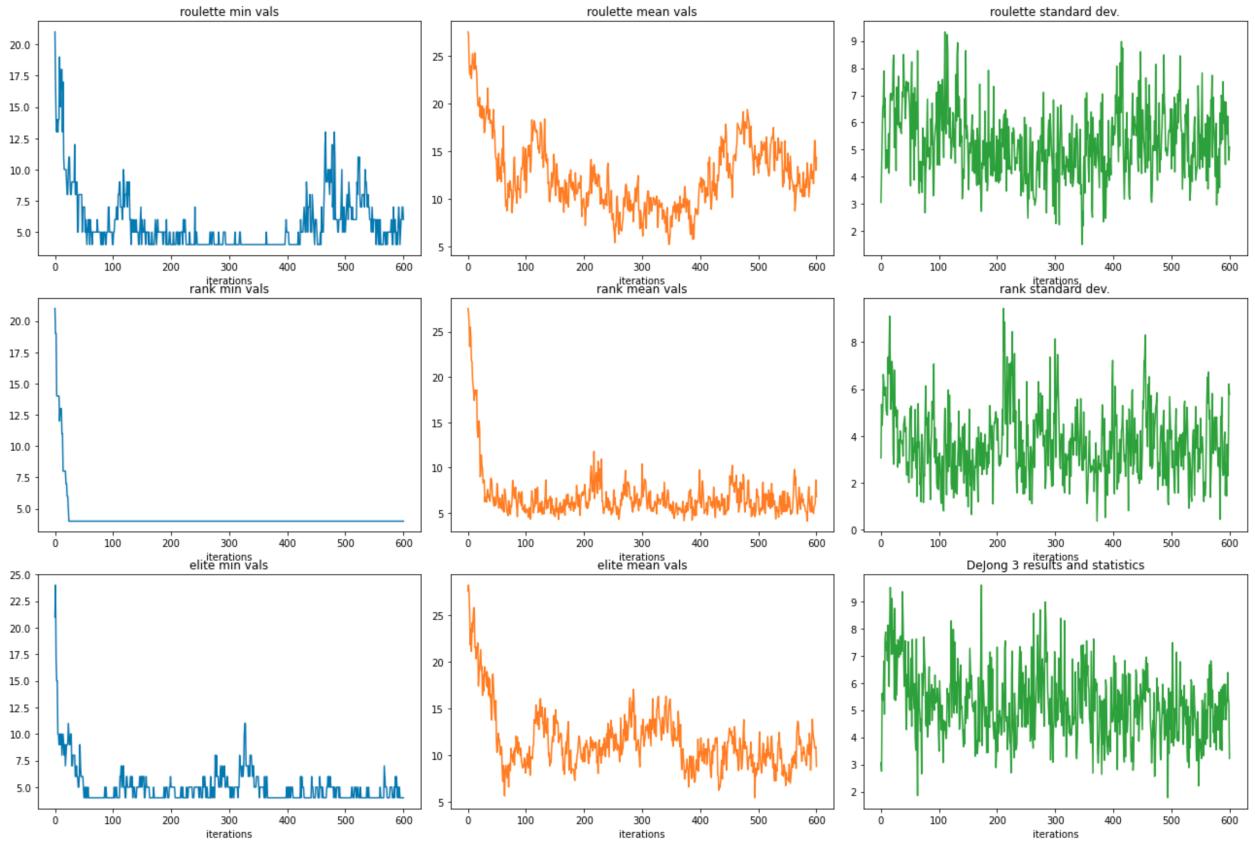


Figure 2: Plot of minimum, average and standard deviation of the population's objective value across each iteration for the search in DeJong n.3

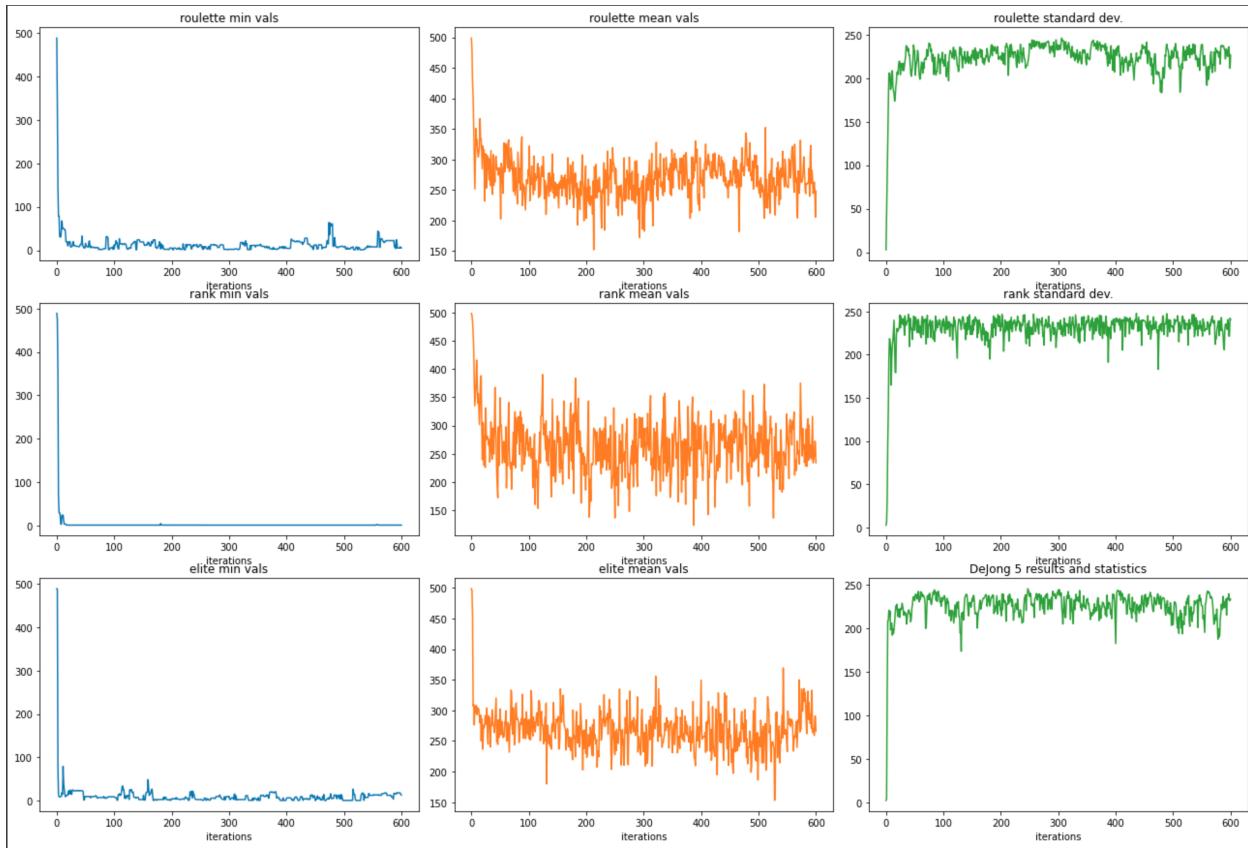


Figure 3: Plot of minimum, average and standard deviation of the population's objective value across each iteration for the search in DeJong n.5

2. Best result obtained during the search

This depended a lot on the seed of the random number generator used in the selection of parents and also in crossover. With some seeds, Rank would perform better than Roulette, and vice-versa for a different seed. Taking this into account, here are the minimum objective values across all 600 iterations obtained by each method for each DeJong function (numbers can also be found in the attached notebook), where I have taken the ceiling with respect to the resolution of each of the DeJong functions in order to avoid rounding down to a value outside the range of the function.

DJ2: Best - Roulette

- Roulette: 0.00231632809... ≈ 0.003
- Rank: 0.003700336... ≈ 0.004
- Elitism w/ Roulette: 0.004652833... ≈ 0.005

DJ3: Best - Roulette, Rank and Elitism all identical

- Roulette: 4.0
- Rank: 4.0
- Elitism w/ Roulette: 4.0

DJ5: Best - Rank

- Roulette: 0.99800834 ≈ 0.999
- Rank: 0.99800383 ≈ 0.999
- Elitism w/ Roulette: 0.99800384 ≈ 0.999

3. Comments on the results and Conclusion

The three methods (roulette, rank, elitism) performed much more similarly in terms of achieving and individual with maximum fitness on DeJong functions 3 and 5, function 2 on the other hand yielded significantly different min values across the 3 methods, and indeed Roulette didn't always perform the best, there were occasions where both Rank and Elitism performed best proving that part of the performance is seed-dependent.

Just observing the 'Best' results for each of the DeJong functions, we can see that there is no clear superior method, but rather that the efficacy of the methods is dependent on the function space being explored. For example in DJ nr. 3 the space appears to be a uniform stepwise function so the three methods compared equally well. In this situation we could go further and compare the methods in terms of their convergence speeds (as we know they eventually find the same minimum for DJ nr. 3). In this case, Rank would be the winner as we can see from the leftmost column in Figure 2, whereas for Roulette, anything beyond 300 iterations provides no lower minimum than the one found in the previous iterations.

In conclusion, it's most effective to run all three methods on your objective function if the end-goal is to find the minimum point/maximum fitness across multiple different seeds, at least for this problem where computation times are insignificant (3 seconds on average for each method). But if the goal is to get closest to the minimum without risk of premature convergence at a local minimum, in the fastest time possible, then Rank is the superior choice.