

Caroline Umila
Homework 2
23 September 2021

N-queens:

Code:

```
# This function is the evaluation function, we want
# to give high score to chromosomes that have higher collisions
# want to minimize
def eval_func(chromosome):
    score = 0.0

    # check diagonals
    for value, i in enumerate(chromosome):
        for value2, j in enumerate(chromosome):
            #print(i, j, value, value2, score)
            if value != value2:
                if abs(value - value2) == abs(i-j):
                    score += 1

    #print("check row-----")

    # check row
    for value, i in enumerate(chromosome):
        for value2, j in enumerate(chromosome):
            #print(i, j, value, value2, score)
            if value != value2:
                if i == j:
                    score += 1

    return score

def G1DListTSPInitializer(genome, **args):
    n = 10

    genome.clearList()
    lst = [i+1 for i in xrange(n)]

    for i in xrange(n):
        choice = random.choice(lst)
        lst.remove(choice)
        genome.append(choice)

def run_main():
    # number of queens
    n = 10
```

```

setOfAlleles = GAllele.GAlleles(homogeneous=True)
lst = [ i+1 for i in xrange(n) ]
a = GAllele.GAlleleList(lst)
setOfAlleles.add(a)

# Genome instance
genome = G1DList.G1DList(n)
genome.setParams(rangemin=1, rangemax=n, bestRawScore=0.00, roundDecimal=2)
genome.crossover.set(Crossovers.G1DListCrossoverCutCrossfill)
genome.setParams(allele=setOfAlleles)
genome.initializer.set(G1DListTSPInitializer)

# the evaluator function
genome.evaluator.set(eval_func)

# genetic algorithm instance
ga = GSsimpleGA.GSimpleGA(genome)
ga.setPopulationSize(100)
ga.setGenerations(10000)
#ga.terminationCriteria.set(GSimpleGA.ConvergenceCriteria)
ga.setMinimax(Consts.minimaxType["minimize"])
ga.setMutationRate(0.03)

# run the evolution
ga.evolve(freq_stats=100)

# print best individual
print(ga.bestIndividual())

if __name__ == "__main__":
    run_main()

```

Runs:

N = 10, Generations = 10,000, population size = 100 (runs 1-5)

N = 20, Generations = 10,000, population size = 100 (runs 6-8)

N = 100, Generations = 10,000, population size = 100 (runs 9-10)

Run	Results
1	<pre>- GenomeBase Score: 0.000000 Fitness: 1.376780 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 10, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 10 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializator - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note::: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 10 List: [10, 7, 4, 1, 3, 6, 9, 2, 8, 5]</pre>
2	<pre>- GenomeBase Score: 0.000000 Fitness: 0.962570 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 10, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 10 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializator - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note::: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 10 List: [6, 1, 7, 10, 8, 2, 4, 9, 3, 5]</pre>

3	<pre>Total time elapsed: 30.353 seconds. - GenomeBase Score: 0.000000 Fitness: 0.877183 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 10, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 10 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 10 List: [6, 4, 1, 7, 9, 2, 8, 5, 3, 10]</pre>
4	<pre>- GenomeBase Score: 0.000000 Fitness: 1.330734 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 10, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 10 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 10 List: [3, 10, 4, 7, 9, 2, 6, 8, 1, 5]</pre>

5	<pre> - GenomeBase Score: 0.000000 Fitness: 1.643883 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 10, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 10 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 10 List: [2, 8, 3, 9, 7, 5, 10, 1, 6, 4] </pre>
6	<pre> - GenomeBase Score: 0.000000 Fitness: 2.690239 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 20, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 20 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 20 List: [15, 11, 7, 2, 4, 14, 19, 10, 16, 20, 6, 3, 1, 17, 9, 13, 18, 5, 8, 12] </pre>

7	<pre> - GenomeBase Score: 0.000000 Fitness: 3.109580 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 20, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 20 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note::: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 20 List: [9, 7, 5, 19, 15, 12, 6, 17, 20, 2, 8, 3, 1, 14, 18, 11, 4, 16, 13, 10] </pre>
8	<pre> - GenomeBase Score: 0.000000 Fitness: 2.642239 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 20, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 20 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note::: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 20 List: [19, 10, 15, 4, 12, 9, 2, 13, 18, 20, 5, 1, 6, 11, 14, 17, 7, 16, 3, 8] </pre>

9	<pre> - GenomeBase Score: 4.000000 Fitness: 11.295656 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 100, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 100 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 5 9, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90 , 91, 92, 93, 94, 95, 96, 97, 98, 99, 100] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 100 List: [59, 71, 35, 39, 30, 87, 19, 38, 88, 67, 21, 43, 91, 60, 41, 50, 66, 82, 48, 27, 15, 42, 36, 95, 53, 70, 90, 81, 12, 73, 22, 94, 54, 8, 75, 3, 93, 98, 32, 49, 58, 79, 11, 46, 6, 100, 97, 84, 37, 89, 51, 33, 4, 18, 20, 25, 23, 80, 2, 9, 1, 55, 7, 63, 92, 28, 57, 24, 56, 65, 13, 78, 45, 77, 83, 47, 34, 64, 16, 85, 99, 86, 62, 29, 31, 61, 14, 68, 52, 44, 17, 69, 40, 76, 96, 26, 10, 74, 72, 5] </pre>
10	<pre> - GenomeBase Score: 0.000000 Fitness: 8.422452 Params: {'roundDecimal': 2, 'bestRawScore': 0.0, 'rangemax': 100, 'rangemin': 1, 'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 100 Allele Options: [1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 5 9, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90 , 91, 92, 93, 94, 95, 96, 97, 98, 99, 100] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverCutCrossfill - Weight: 0.50 Doc: The crossover of G1DList, Cut and crossfill, for permutations - G1DList List size: 100 List: [59, 38, 21, 93, 65, 57, 47, 35, 48, 69, 63, 56, 7, 39, 43, 89, 8, 72, 29, 96, 23, 84, 94, 6, 82, 19 , 64, 92, 13, 37, 46, 18, 16, 42, 88, 2, 78, 14, 26, 71, 90, 5, 40, 50, 17, 58, 4, 52, 60, 95, 98, 73, 79, 97, 11, 54, 77, 10 0, 44, 9, 99, 81, 32, 22, 27, 80, 34, 67, 33, 15, 76, 1, 51, 53, 75, 12, 36, 3, 10, 68, 55, 91, 86, 24, 74, 66, 25, 30, 49, 8 5, 62, 45, 83, 20, 87, 61, 70, 41, 31, 28] </pre>

Problem Formulation:

Representation: Permutation

Parenthood Selection: Rank-based selection

Mutation: Swap mutator with mutation rate 3%

Crossover: Cut and cross-fill

Survival Selection: Rank-based selection

TSP:

Code: I used the Pyevolve TSP example. This is the only part of code I slightly altered to fit the problem. I also removed the part of the code that created a random seed file and used the provided coordinates for a seed file.

```
def G1DListTSPInitializer(genome, **args):
    """ The initializer for the TSP """
    genome.clearList()
    lst = [i for i in xrange(127)]

    for i in xrange(127):
        choice = random.choice(lst)
        lst.remove(choice)
        genome.append(choice)
```

Runs:

Generation = 10,000, Population Size = 100

Run	Results
1	<pre>- GenomeBase Score: 234675.360243 Fitness: 226189.435626 Params: {'allele': - GAlleles Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2 7, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Doc: The initializer for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [60, 89, 63, 123, 6, 13, 42, 41, 97, 96, 94, 92, 126, 122, 121, 26, 79, 83, 81, 116, 77, 75, 72, 18, 16, 29, 14, 11, 10, 12, 61, 59, 115, 23, 105, 8, 0, 102, 44, 93, 47, 45, 117, 46, 4, 120, 34, 35, 17, 70, 69, 108, 109, 84, 58, 90, 57, 9, 5, 78, 76, 73, 62, 118, 68, 67, 66, 71, 22, 7, 19, 43, 53, 106, 110, 111, 51, 119, 2, 104, 113, 125, 100, 101, 82, 21, 107, 15, 49, 114, 99, 91, 103, 86, 85, 87, 95, 74, 80, 31, 27, 36, 112, 124, 98, 88, 64, 65, 54, 52, 48, 55, 50, 56, 1, 40, 39, 33, 37, 28, 24, 32, 25, 38, 30, 20, 3]</pre>

2	<pre> - GenomeBase Score: 232633.176383 Fitness: 217461.899551 Params: {'allele': - GAlleles Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2 7, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89 , 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116 , 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Doc: The initializer for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [61, 115, 104, 1, 43, 53, 56, 90, 124, 98, 64, 57, 63, 99, 9, 55, 47, 117, 54, 120, 4, 42, 33, 32, 2 7, 122, 96, 28, 116, 125, 81, 82, 83, 74, 77, 78, 68, 108, 85, 87, 84, 86, 109, 72, 18, 21, 3, 23, 119, 91, 88, 103, 22, 7, 4 0, 29, 26, 101, 100, 97, 94, 48, 52, 46, 51, 123, 49, 35, 11, 25, 24, 121, 31, 80, 79, 17, 20, 73, 76, 75, 5, 19, 36, 38, 41 , 37, 30, 13, 16, 15, 2, 8, 6, 39, 44, 102, 92, 126, 106, 110, 111, 45, 93, 50, 34, 6, 113, 60, 65, 112, 114, 12, 10, 58, 59 , 67, 14, 71, 107, 105, 69, 70, 95, 62, 118, 66, 89] </pre>
3	<pre> - GenomeBase Score: 233374.852452 Fitness: 220963.067959 Params: {'allele': - GAlleles Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2 7, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89 , 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116 , 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Doc: The initializer for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [5, 107, 113, 2, 114, 9, 91, 98, 88, 124, 61, 89, 102, 92, 93, 117, 45, 52, 48, 53, 39, 11, 3, 22, 1 3, 35, 34, 4, 63, 57, 112, 64, 51, 49, 56, 7, 71, 21, 33, 42, 29, 40, 36, 6, 23, 10, 99, 65, 54, 123, 50, 0, 15, 30, 18, 17 , 73, 72, 66, 58, 60, 90, 59, 119, 105, 104, 16, 26, 78, 41, 43, 44, 12, 1, 38, 37, 32, 79, 75, 69, 118, 62, 81, 101, 100, 125 , 77, 120, 46, 47, 55, 94, 122, 97, 96, 27, 28, 24, 121, 31, 116, 80, 83, 82, 74, 68, 95, 87, 86, 84, 108, 25, 126, 106, 111 , 110, 8, 70, 109, 85, 103, 115, 20, 67, 76, 19, 14] </pre>

4

```

- GenomeBase
  Score: 235383.365673
  Fitness: 214395.495706

  Params: {'allele': - GAlleles}
  Homogeneous: True
  List size: 1
  Alleles:

Allele for 0 position:
- GAlleleList
  List size: 127
  Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2
, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58
, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89
, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116
, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126]

}

Slot [Evaluator] (Count: 1)
  Name: eval_func - Weight: 0.50
  Doc: The evaluation function
Slot [Initializer] (Count: 1)
  Name: G1DListTSPInitializer - Weight: 0.50
  Doc: The initializer for the TSP
Slot [Mutator] (Count: 1)
  Name: G1DListMutatorSwap - Weight: 0.50
  Doc: The mutator of G1DList, Swap Mutator

.. note:: this mutator is :term:`Data Type Independent` 

Slot [Crossover] (Count: 1)
  Name: G1DListCrossoverOX - Weight: 0.50
  Doc: The OX Crossover for G1DList (order crossover)

- G1DList
  List size: 127
  List: [90, 103, 98, 64, 112, 115, 7, 17, 76, 66, 8, 61, 109, 84, 87, 86, 85, 95, 70, 72, 67, 60, 99, 6, 33
, 121, 96, 97, 126, 122, 13, 1, 120, 56, 51, 12, 5, 20, 18, 23, 3, 21, 105, 77, 125, 82, 101, 100, 81, 83, 74, 68, 14, 94, 92
, 106, 110, 93, 102, 40, 50, 34, 26, 25, 30, 42, 15, 2, 9, 10, 107, 22, 19, 24, 27, 32, 38, 48, 45, 111, 47, 117, 49, 113, 57
, 91, 88, 124, 65, 123, 4, 63, 89, 59, 58, 108, 118, 62, 69, 73, 71, 16, 79, 29, 37, 31, 28, 80, 116, 75, 78, 39, 41, 11, 35
, 36, 55, 52, 46, 54, 53, 43, 44, 0, 114, 104, 119]

```

5

```

- GenomeBase
  Score: 249825.755388
  Fitness: 230987.152503

  Params: {'allele': - GAlleles}
  Homogeneous: True
  List size: 1
  Alleles:

Allele for 0 position:
- GAlleleList
  List size: 127
  Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2
, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58
, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89
, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116
, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126]

}

Slot [Evaluator] (Count: 1)
  Name: eval_func - Weight: 0.50
  Doc: The evaluation function
Slot [Initializer] (Count: 1)
  Name: G1DListTSPInitializer - Weight: 0.50
  Doc: The initializer for the TSP
Slot [Mutator] (Count: 1)
  Name: G1DListMutatorSwap - Weight: 0.50
  Doc: The mutator of G1DList, Swap Mutator

.. note:: this mutator is :term:`Data Type Independent` 

Slot [Crossover] (Count: 1)
  Name: G1DListCrossoverOX - Weight: 0.50
  Doc: The OX Crossover for G1DList (order crossover)

- G1DList
  List size: 127
  List: [43, 44, 52, 54, 65, 2, 90, 63, 104, 73, 17, 11, 121, 24, 32, 122, 96, 25, 37, 78, 19, 5, 119, 6, 3
, 109, 86, 108, 66, 7, 125, 81, 97, 126, 106, 110, 111, 93, 46, 45, 48, 123, 120, 23, 14, 79, 30, 26, 49, 51, 112, 57, 64, 91
, 88, 124, 99, 9, 1, 33, 92, 94, 31, 28, 42, 36, 8, 98, 103, 84, 85, 87, 58, 4, 47, 117, 102, 41, 29, 105, 0, 50, 12, 114, 13
, 38, 27, 80, 83, 77, 61, 60, 59, 115, 89, 18, 72, 20, 16, 39, 34, 40, 56, 53, 55, 35, 15, 107, 22, 113, 10, 21, 71, 75, 116
, 76, 69, 67, 70, 68, 74, 82, 101, 100, 62, 118, 95]

```

6	<pre> - GenomeBase Score: 241469.631731 Fitness: 216969.563380 Params: {'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Doc: The initializer for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [76, 22, 14, 104, 0, 123, 111, 110, 106, 126, 92, 1, 89, 60, 61, 58, 88, 124, 115, 114, 119, 9, 12, 49, 15, 53, 122, 121, 8, 23, 99, 112, 4, 47, 45, 43, 38, 41, 34, 56, 44, 93, 52, 46, 54, 65, 94, 96, 97, 27, 42, 3, 7, 66, 78, 77, 83, 125, 80, 75, 74, 67, 70, 69, 72, 71, 5, 107, 11, 35, 36, 39, 50, 55, 51, 117, 48, 102, 24, 82, 100, 101, 62, 118, 1, 08, 68, 73, 13, 33, 25, 116, 81, 84, 86, 87, 85, 103, 91, 98, 64, 120, 6, 21, 40, 29, 37, 79, 26, 32, 31, 28, 105, 18, 10, 30, 17, 16, 20, 19, 113, 2, 57, 63, 90, 59, 109, 95] </pre>
7	<pre> - GenomeBase Score: 229822.619298 Fitness: 235895.598522 Params: {'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89, 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116, 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializer] (Count: 1) Name: G1DListTSPInitializer - Weight: 0.50 Doc: The initializer for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [62, 68, 67, 72, 115, 63, 124, 91, 103, 88, 98, 64, 99, 23, 18, 22, 92, 126, 106, 110, 111, 45, 48, 13, 14, 19, 36, 29, 26, 101, 100, 97, 96, 122, 94, 39, 40, 11, 75, 125, 83, 80, 28, 25, 76, 17, 70, 69, 73, 66, 21, 16, 35, 4, 2, 116, 84, 86, 95, 74, 77, 24, 31, 32, 41, 37, 38, 33, 34, 55, 56, 112, 54, 123, 51, 49, 6, 114, 65, 57, 61, 58, 89, 60, 90, 7, 8, 10, 105, 20, 30, 78, 79, 82, 81, 121, 27, 53, 120, 4, 12, 1, 50, 93, 47, 52, 59, 3, 5, 107, 71, 113, 104, 15, 0, 43, 1, 02, 44, 117, 46, 119, 9, 2, 109, 87, 85, 108, 118] </pre>

8	<pre> - GenomeBase Score: 227497.108255 Fitness: 202248.746155 Params: {'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2 , 7, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89 , 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116 , 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializator] (Count: 1) Name: G1DListTSPInitializator - Weight: 0.50 Doc: The initializator for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [114, 0, 39, 35, 122, 94, 42, 33, 34, 50, 1, 14, 57, 63, 112, 64, 91, 88, 103, 58, 99, 9, 55, 117, 4 , 7, 46, 120, 49, 115, 10, 8, 3, 107, 21, 104, 6, 15, 36, 13, 41, 75, 77, 25, 38, 22, 5, 23, 7, 71, 18, 2, 60, 65, 48, 45, 111 , 110, 106, 44, 102, 11, 26, 16, 69, 85, 86, 59, 54, 52, 53, 37, 31, 121, 24, 32, 27, 79, 78, 29, 40, 30, 67, 125, 81, 82, 101 , 100, 62, 118, 108, 109, 95, 84, 87, 66, 76, 72, 17, 19, 105, 113, 123, 51, 90, 124, 98, 61, 89, 119, 4, 56, 43, 93, 92, 126 , 97, 96, 28, 116, 80, 83, 74, 68, 70, 73, 20, 12] </pre>
9	<pre> - GenomeBase Score: 231481.178999 Fitness: 216056.890069 Params: {'allele': - GAlleles} Homogeneous: True List size: 1 Alleles: Allele for 0 position: - GAlleleList List size: 127 Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2 , 7, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58 , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89 , 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116 , 117, 118, 119, 120, 121, 122, 123, 124, 125, 126] } Slot [Evaluator] (Count: 1) Name: eval_func - Weight: 0.50 Doc: The evaluation function Slot [Initializator] (Count: 1) Name: G1DListTSPInitializator - Weight: 0.50 Doc: The initializator for the TSP Slot [Mutator] (Count: 1) Name: G1DListMutatorSwap - Weight: 0.50 Doc: The mutator of G1DList, Swap Mutator .. note:: this mutator is :term:`Data Type Independent` Slot [Crossover] (Count: 1) Name: G1DListCrossoverOX - Weight: 0.50 Doc: The OX Crossover for G1DList (order crossover) - G1DList List size: 127 List: [44, 102, 56, 120, 50, 0, 75, 109, 84, 85, 87, 101, 100, 28, 121, 26, 11, 20, 30, 36, 37, 96, 97, 10 , 110, 111, 93, 45, 48, 123, 64, 98, 88, 124, 60, 10, 113, 6, 99, 119, 49, 114, 71, 72, 17, 7, 18, 21, 12, 51, 55, 4, 9, 1 , 117, 47, 46, 52, 54, 115, 57, 2, 8, 22, 76, 116, 83, 62, 118, 69, 70, 73, 19, 16, 107, 14, 5, 78, 77, 67, 86, 95, 108, 68, 66 , 23, 104, 3, 105, 34, 39, 53, 43, 122, 126, 92, 94, 41, 40, 15, 13, 35, 79, 31, 82, 125, 81, 80, 74, 103, 91, 90, 59, 61, 65 , 112, 63, 89, 58, 29, 42, 38, 33, 25, 24, 32, 27] </pre>

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```

- GenomeBase
  Score: 230455.967316
  Fitness: 196377.834664

  Params: {'allele': - GAlleles}
  Homogeneous: True
  List size: 1
  Alleles:

  Allele for 0 position:
  - GAlleleList
    List size: 127
    Allele Options: [0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 2
    , 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58
    , 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76, 77, 78, 79, 80, 81, 82, 83, 84, 85, 86, 87, 88, 89
    , 90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103, 104, 105, 106, 107, 108, 109, 110, 111, 112, 113, 114, 115, 116
    , 117, 118, 119, 120, 121, 122, 123, 124, 125, 126]

  }

  Slot [Evaluator] (Count: 1)
    Name: eval_func - Weight: 0.50
    Doc: The evaluation function
  Slot [Initializer] (Count: 1)
    Name: G1DListTSPInitializer - Weight: 0.50
    Doc: The initializer for the TSP
  Slot [Mutator] (Count: 1)
    Name: G1DListMutatorSwap - Weight: 0.50
    Doc: The mutator of G1DList, Swap Mutator

  .. note:: this mutator is :term:`Data Type Independent`

  Slot [Crossover] (Count: 1)
    Name: G1DListCrossoverOX - Weight: 0.50
    Doc: The OX Crossover for G1DList (order crossover)

- G1DList
  List size: 127
  List: [98, 91, 88, 64, 65, 54, 120, 43, 102, 55, 45, 48, 52, 46, 117, 94, 122, 116, 80, 68, 95, 87, 86, 10
    , 8, 118, 74, 83, 2, 119, 50, 21, 5, 10, 3, 25, 24, 26, 37, 14, 1, 53, 47, 93, 123, 51, 4, 42, 33, 96, 97, 126, 92, 56, 114, 8
    , 6, 19, 107, 17, 22, 12, 9, 59, 60, 99, 57, 98, 58, 61, 20, 76, 71, 73, 7, 66, 72, 67, 77, 75, 79, 15, 35, 39, 38, 40, 11, 11
    , 3, 104, 49, 109, 84, 85, 103, 70, 69, 78, 30, 29, 13, 125, 81, 82, 62, 101, 100, 28, 31, 121, 27, 32, 41, 36, 34, 63, 89, 115
    , 23, 16, 18, 105, 0, 44, 106, 110, 111, 112, 124]

```

Problem Formulation:

Representation: Permutation

Parenthood Selection: Rank-based selection

Mutation: Swap mutator with mutation rate 3%

Crossover: Order crossover

Survival Selection: Rank-based selection