raport

November 28, 2023

1 Lab 2 - Algorytmy ewolucyjne

[13]:

```
from wsilib.algorithms.evo.evo import  EvoSolver, StopConditions
from wsilib.algorithms.evo.individual import TSPIndividualType,␣
 ↪DomainIndividualType
from wsilib.algorithms.evo.genetic_operations import GeneticOperations
from wsilib.algorithms.evo.selection_methods import SelectionMethods
from wsilib.algorithms.evo.succession_metods import SuccessionMethods
from wsilib.utils.function import Function

from src.experiments import generate_cost_function, experiment,␣
 ↪params_to_label, avg_f_value, test_sets_generator
from src.plotting import plot_results, plot_cities
```

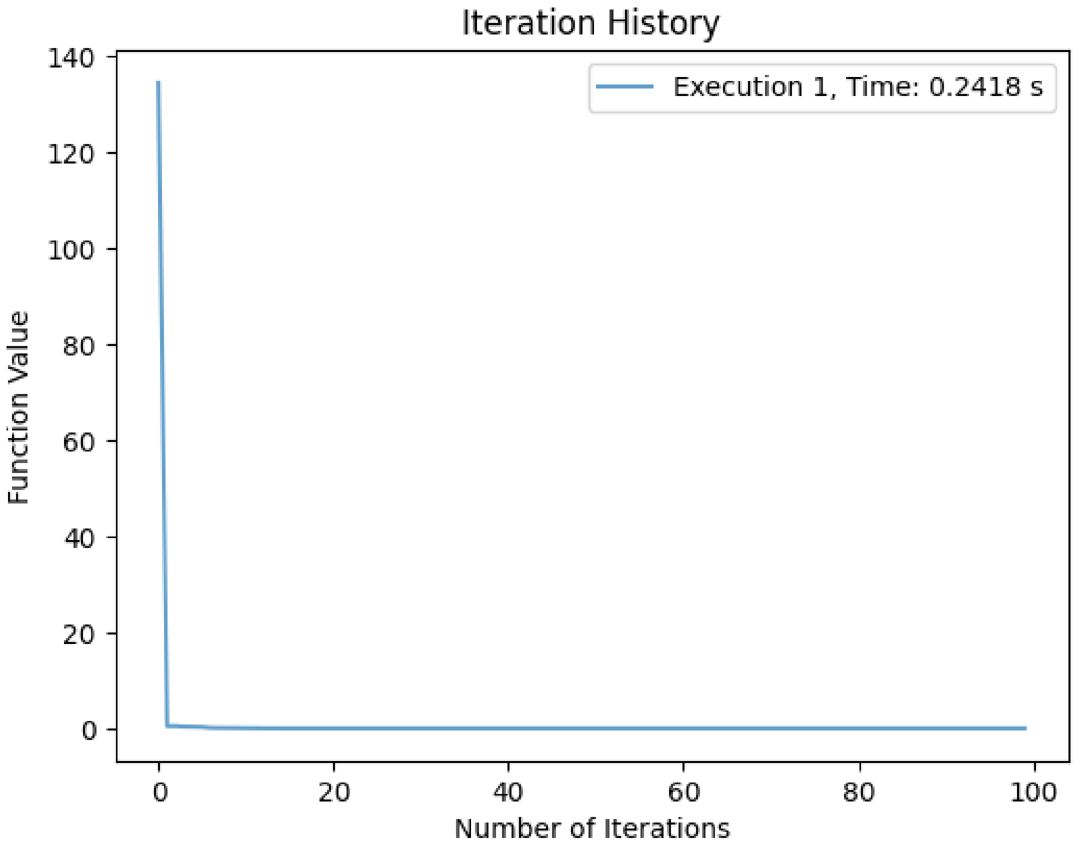
1.1 Optymalizacja funkcji kwadratowej

[14]:

```
f = Function(
    lambda x: x[0]**2 + x[1]**2,
    dim=2,
)

solver = EvoSolver(
    individual_type=DomainIndividualType(20, (-10, 10)),
    population_size=100,
    selection_method=SelectionMethods.tournament_selection(2),
    genetic_operations=[
        GeneticOperations.mutation(0.1),
        GeneticOperations.single_point_crossover(),
    ],
    succession_method=SuccessionMethods.elitism_succession(1),
    stop_conditions=[
        StopConditions.max_iterations(100),
    ]
)

res = solver.solve(f)
plot_results([res], mean=False)
```

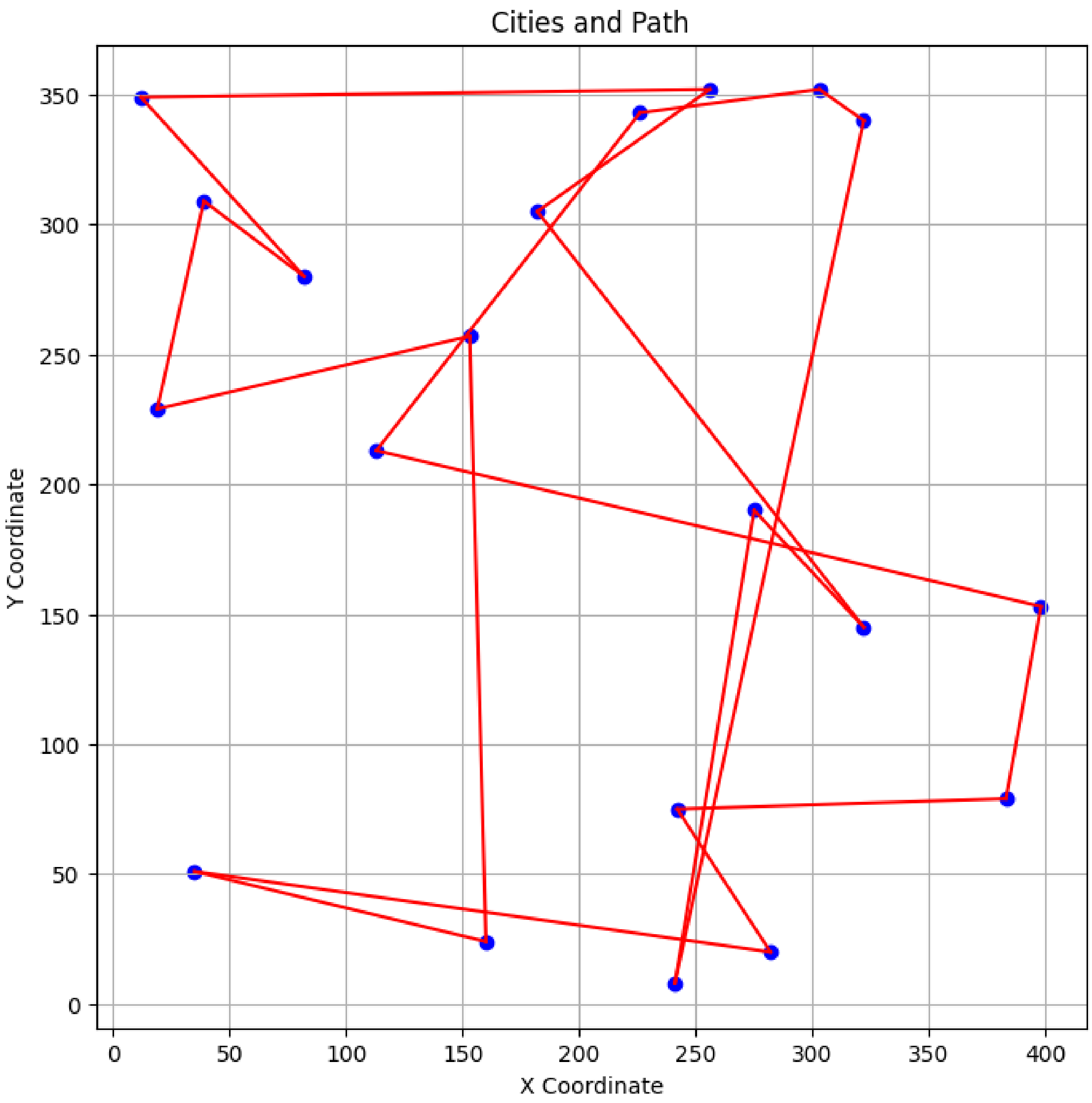


1.2 Problem komwojażera

[15]:
```
cities = [
    [35, 51],
    [113, 213],
    [82, 280],
    [322, 340],
    [256, 352],
    [160, 24],
    [322, 145],
    [12, 349],
    [282, 20],
    [241, 8],
    [398, 153],
    [182, 305],
    [153, 257],
    [275, 190],
    [242, 75],
    [19, 229],
    [303, 352],
    [39, 309],
    [383, 79],
    [226, 343],
]


solver = EvoSolver(
    individual_type=TSPIndividualType(n_genes=len(cities)),
    population_size=100,
    selection_method=SelectionMethods.tournament_selection(2),
    genetic_operations=[
        GeneticOperations.mutation(0.1),
        GeneticOperations.tsp_crossover(0.5),
    ],
    succession_method=SuccessionMethods.generational_succession(),
    stop_conditions=[
        StopConditions.max_iterations(100),
    ],
)

result = solver.solve(generate_cost_function(cities))
plot_cities(cities, result.x)
```



1.3 Eksperyment: szukanie optymalnych hiperparametrów dla problemu komwojażera

[16]:
```
exp = experiment(params={
    'population_size': [10, 100],
    'selection_method': [SelectionMethods.tournament_selection(2),␣
 ↪SelectionMethods.tournament_selection(5)],
    'genetic_operations': [
        [
            GeneticOperations.mutation()
        ],
        [
```

```python
            GeneticOperations.mutation(),
            GeneticOperations.tsp_crossover(0.5),
        ],
        [
            GeneticOperations.mutation(),
            GeneticOperations.tsp_crossover(0.7),
        ]
    ],
    'succession_method': [SuccessionMethods.generational_succession(), SuccessionMethods.elitism_succession(1)],
    'stop_conditions': [
        StopConditions.max_iterations(1000),
    ],
}, n_sets=10)

best = (None, None, None, None)
for params, results, progress in exp:
    label = params_to_label(params)
    print(progress)
    print(label)
    plot_results(results)
    if(best == (None, None, None, None)):
        best = (avg_f_value(results), label, results, params)
    else:
        if(avg_f_value(results) < best[0]):
            best = (avg_f_value(results), label, results, params)

print("Best config:")
print(best[1])
plot_results(best[2])
print("Średnia wartość funkcji kosztu: " + str(best[0]))
best_params = best[3]
```

```
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Params:
    population_size: 10
    selection_method: tournament_selection(2)
    genetic_operations:
        mutation
    succession_method: generational_succession
    stop_conditions:
        max_iterations(1000)
```
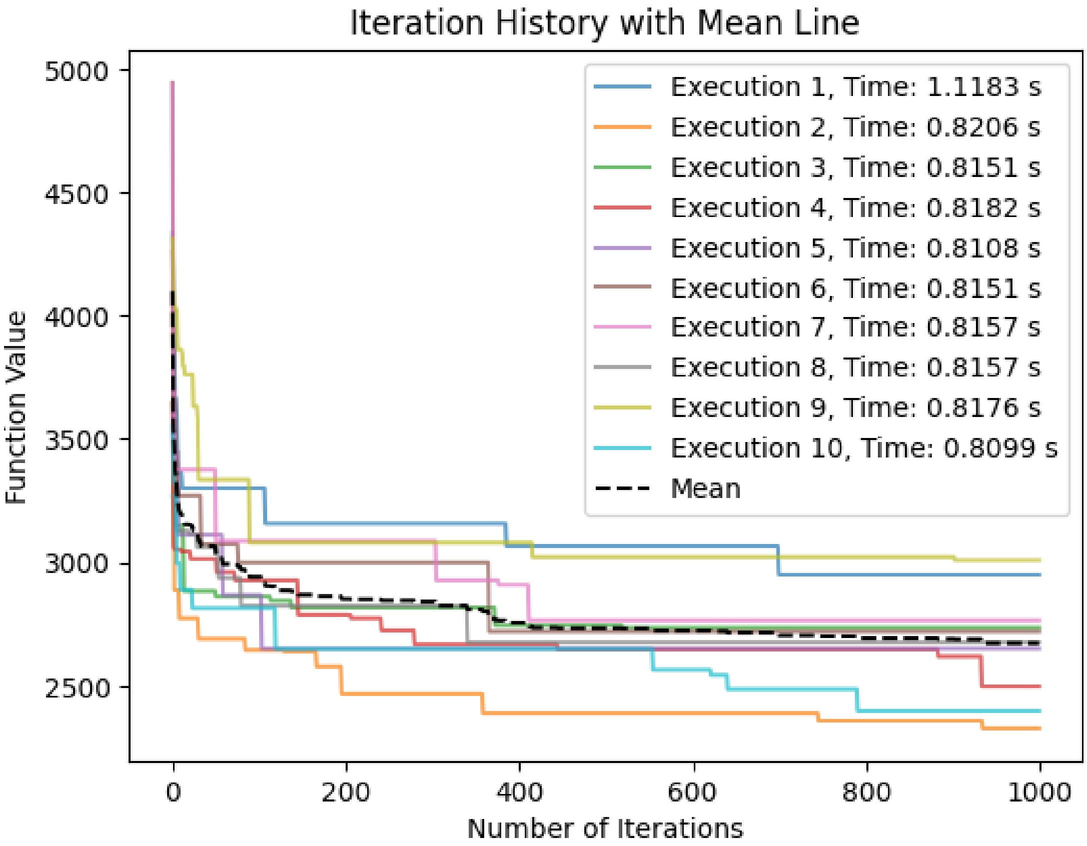



```
---------------------------------------------------------------------------
KeyboardInterrupt                         Traceback (most recent call last)
/Users/aszokalski/Developer/studia/Sem 3/WSI/notebooks/lab2/lab2.ipynb Cell 8␣
 ↪line 2
      <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=0'>1</a> exp =␣
 ↪experiment(params={
      <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=1'>2</a>     ␣
 ↪'population_size': [10, 100],
      <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=2'>3</a>     ␣
 ↪'selection_method': [SelectionMethods.tournament_selection(2),␣
 ↪SelectionMethods.tournament_selection(5)],
   (…)
     <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=19'>20</a>     ],
     <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=20'>21</a> }, n_sets=10)
     <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=22'>23</a> best = (None,␣
 ↪None, None, None)
```

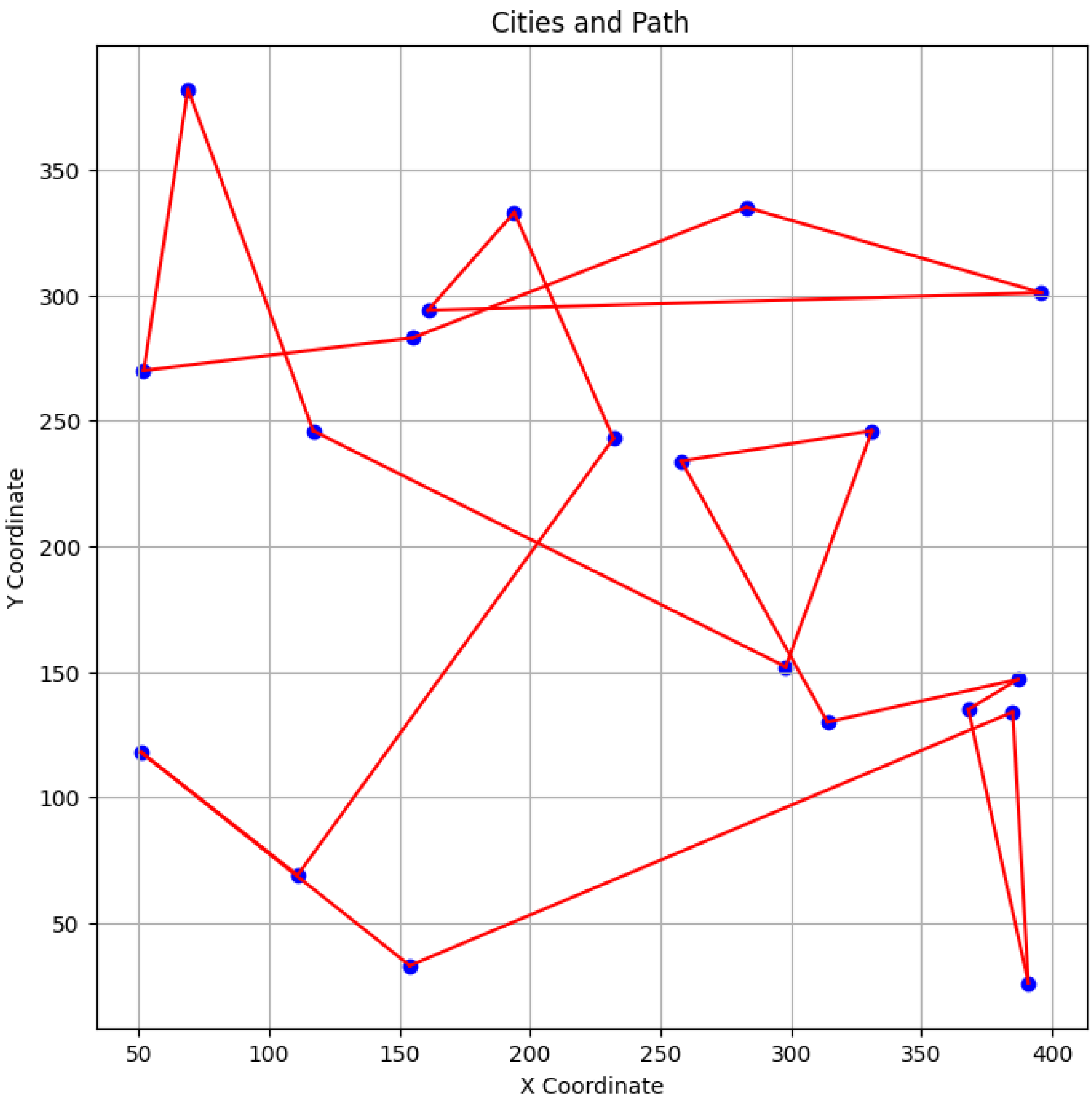
```
---> <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=23'>24</a> for params,␣
 ↪results, progress in exp:
     <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=24'>25</a>     label =␣
 ↪params_to_label(params)
     <a href='vscode-notebook-cell:/Users/aszokalski/Developer/studia/Sem%203/
 ↪WSI/notebooks/lab2/lab2.ipynb#X10sZmlsZQ%3D%3D?line=25'>26</a>     ␣
 ↪print(progress)

File ~/Developer/studia/Sem 3/WSI/notebooks/lab2/experiments.py:125, in␣
 ↪experiment(params, n_sets, log)
    123 for cities in test_sets:
    124     loss_function = generate_cost_function(cities)
--> 125     result = solver.solve(loss_function, log=log)
    126     results.append(result)
    128 yield params, results, f"{i + 1}/{total}"

File ~/Developer/studia/Sem 3/WSI/.venv/lib/python3.10/site-packages/wsilib/
 ↪algorithms/evo/evo.py:122, in EvoSolver.solve(self, problem, x0, log,␣
 ↪log_interval_time)
    109     return EvoResult(
    110         x0=x0,
    111         x=iteration.x,
   (…)
    117         history=history,
    118     )
    120 history.append(iteration)
--> 122 new_population = self.selection_method.function(population, problem)
    124 mutated_population = new_population
    125 for operation in self.genetic_operations:

File ~/Developer/studia/Sem 3/WSI/.venv/lib/python3.10/site-packages/wsilib/
 ↪algorithms/evo/selection_methods.py:25, in SelectionMethods.
 ↪tournament_selection.<locals>.selection_method(population, cost_function)
     19 def selection_method(
     20     population: Population, cost_function: Function
     21 ) -> Population:
     22     """Select k individuals from population using tournament selection.
 ↪"""
     24     return np.array(
---> 25         [
     26             min(
     27                 [
     28                     population[i]
     29                     for i in np.random.choice(
     30                         len(population), size=k, replace=False
     31                     )
     32                 ],
     33                 key=cost_function.f,
     34             )
     35             for _ in range(len(population))
     36         ]
     37     )

File ~/Developer/studia/Sem 3/WSI/.venv/lib/python3.10/site-packages/wsilib/
 ↪algorithms/evo/selection_methods.py:29, in <listcomp>(.0)
     19 def selection_method(
     20     population: Population, cost_function: Function
     21 ) -> Population:
     22     """Select k individuals from population using tournament selection.
 ↪"""
     24     return np.array(
     25         [
     26             min(
     27                 [
     28                     population[i]
---> 29                     for i in np.random.choice(
     30                         len(population), size=k, replace=False
     31                     )
     32                 ],
     33                 key=cost_function.f,
     34             )
     35             for _ in range(len(population))
     36         ]
     37     )

File numpy/random/mtrand.pyx:981, in numpy.random.mtrand.RandomState.choice()

File ~/Developer/studia/Sem 3/WSI/.venv/lib/python3.10/site-packages/numpy/core
 ↪fromnumeric.py:3100, in prod(a, axis, dtype, out, keepdims, initial, where)
   2979 @array_function_dispatch(_prod_dispatcher)
   2980 def prod(a, axis=None, dtype=None, out=None, keepdims=np._NoValue,
   2981          initial=np._NoValue, where=np._NoValue):
   2982     """
   2983     Return the product of array elements over a given axis.
   2984
   (…)
   3098     10
   3099     """
-> 3100     return _wrapreduction(a, np.multiply, 'prod', axis, dtype, out,
   3101                           keepdims=keepdims, initial=initial,␣
 ↪where=where)

File ~/Developer/studia/Sem 3/WSI/.venv/lib/python3.10/site-packages/numpy/core
 ↪fromnumeric.py:88, in _wrapreduction(obj, ufunc, method, axis, dtype, out,␣
 ↪**kwargs)
```

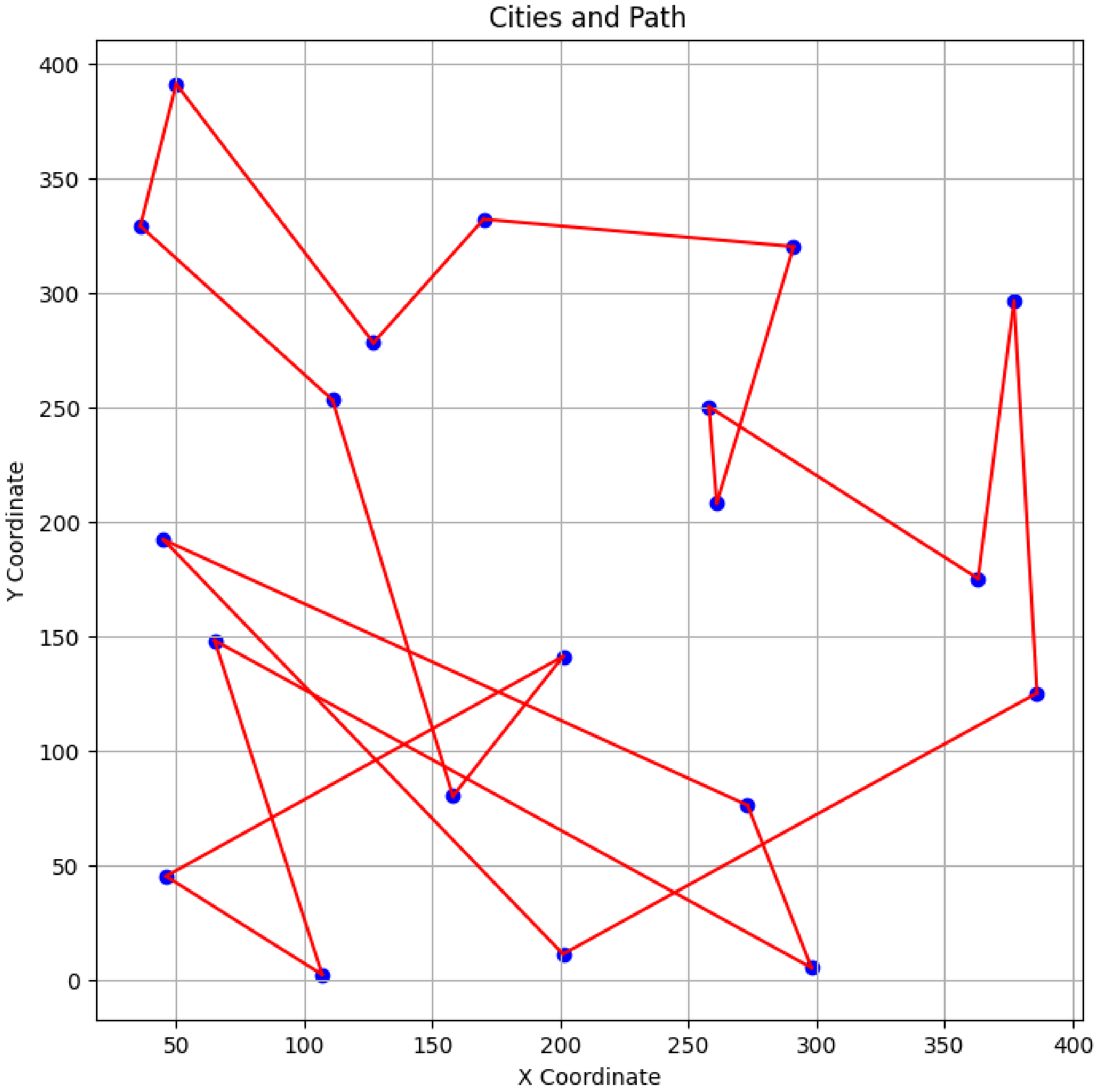
```
     85         else:
     86             return reduction(axis=axis, out=out, **passkwargs)
---> 88 return ufunc.reduce(obj, axis, dtype, out, **passkwargs)

KeyboardInterrupt:
```

1.4 Problem komwojażera na zoptimizowanym algorytmie ewolucyjnym

[ ]:

```
solver_opt = EvoSolver(
    individual_type=TSPIndividualType(n_genes=len(cities)),
    population_size=best_params['population_size'],
    selection_method=best_params['selection_method'],
    genetic_operations=best_params['genetic_operations'],
    succession_method=best_params['succession_method'],
    stop_conditions=best_params['stop_conditions'],
)

for cities2 in test_sets_generator(4):
    result = solver_opt.solve(generate_cost_function(cities2))
    plot_cities(cities2, result.x)
```


Cities and Path
Y Coordinate
X Coordinate
350
300
250
200
150
100
50
50
100
150
200
250
300
350
400


Cities and Path
Y Coordinate
X Coordinate
0
50
100
150
200
250
300
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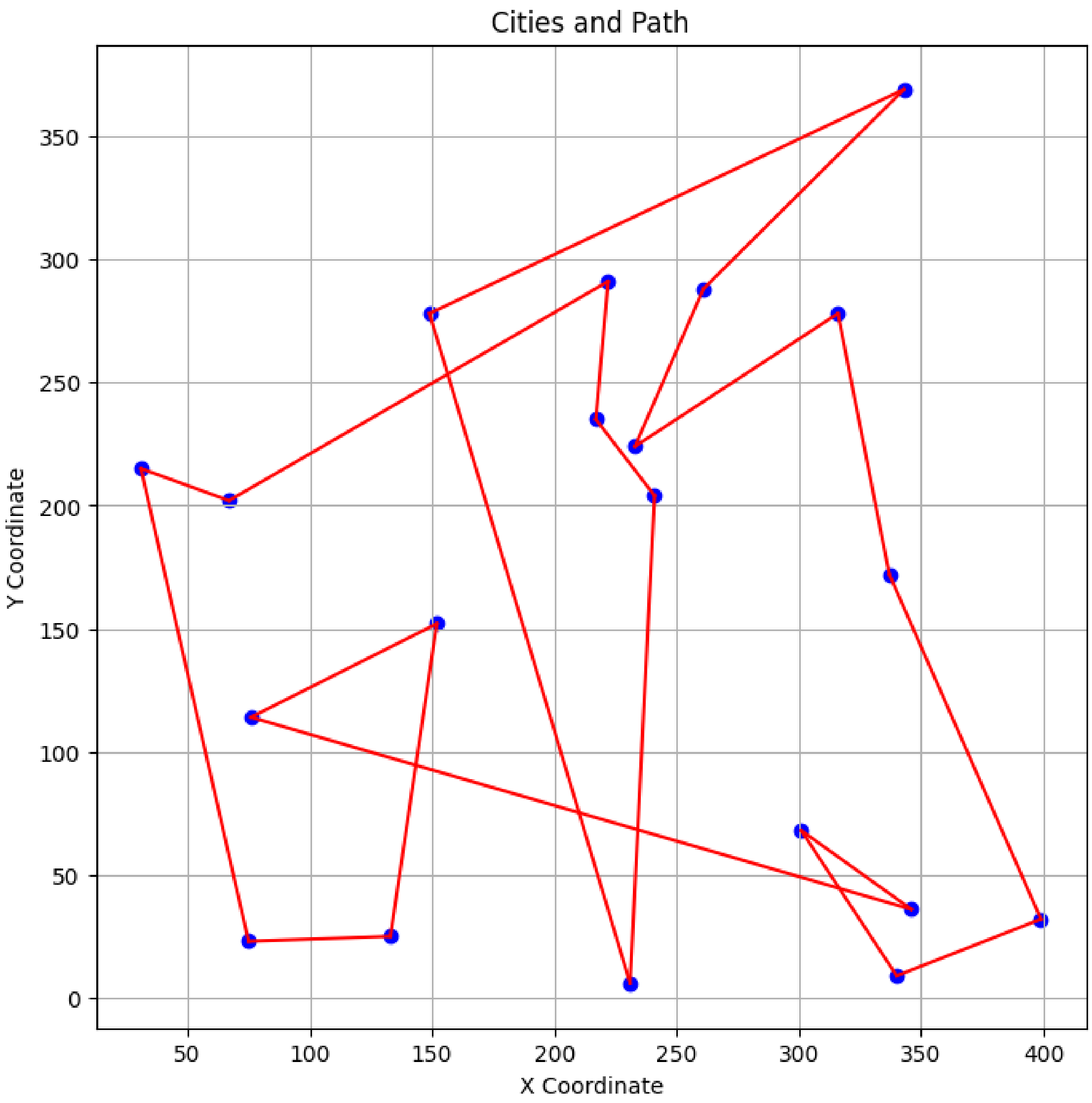
Cities and Path
Y Coordinate
X Coordinate
0
50
100
150
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250
300
350
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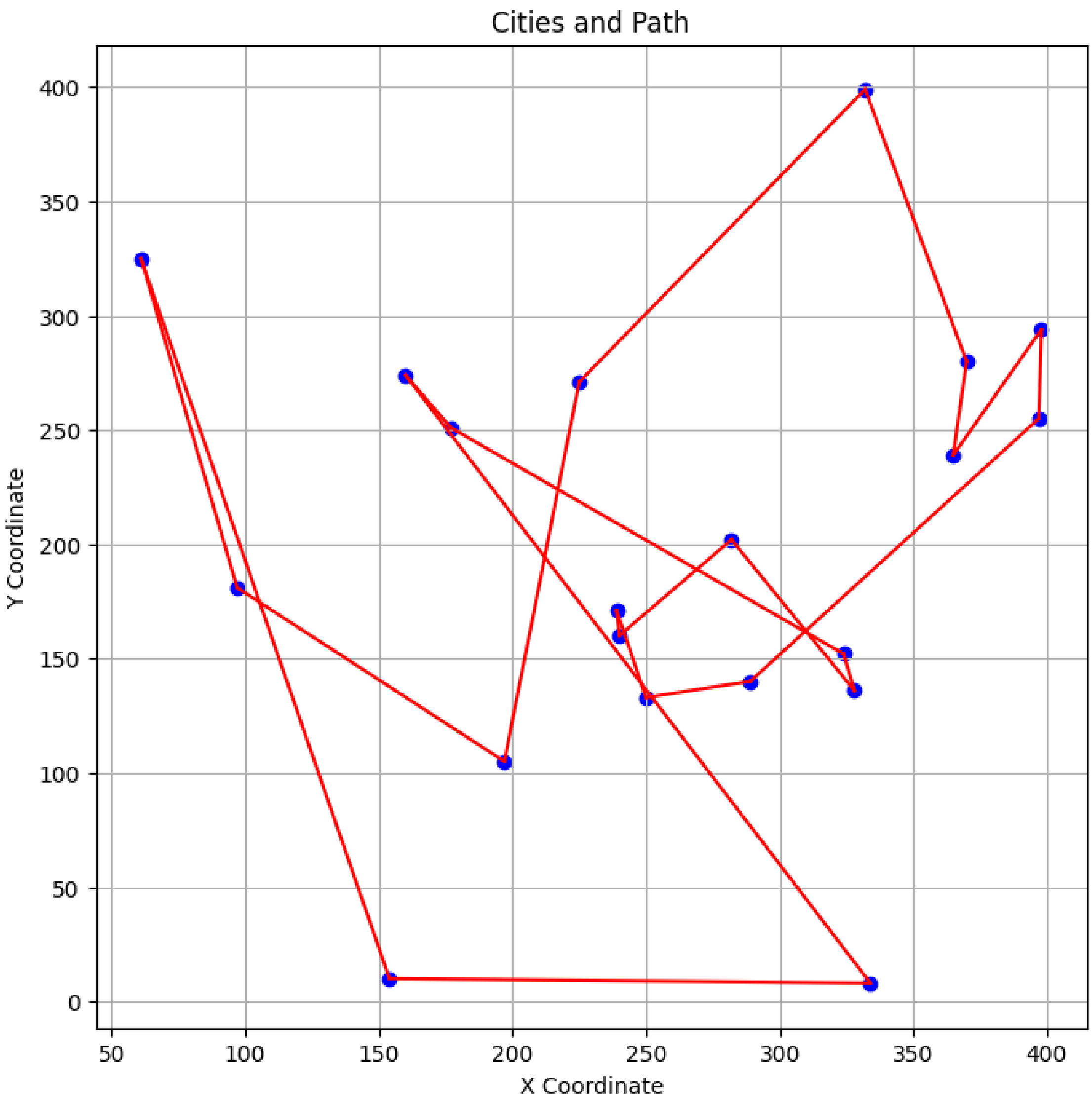
350
400



1.5 Wnioski

- Większy rozmiar populacji daje lepsze wyniki - lepsza zdolność eksploracyjna algorytmu
- Selekcja turniejowa dla par daje podobne wyniki co dla grup 5 elementowych.
- Zastosowanie mutacji oraz krzyżowania daje najlepsze wyniki.
- Krzyżowanie najlepiej wykonywać z parametrem `alpha=0.5` czyli dzielić osobnika na dwie równe części
- Lepszą metoda sukcesji okazała się być sukcesja generacyjna - prawdopodobnie zwiększa to zdolność eksploracyjną algorytmu