Assignment 1: Evolutionary Process Discovery

Course: 1BM120 – Decision Making with Artificial Intelligence
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Group 3

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Repository: GitHub – Group 3 Repo

Description

This assignment focuses on discovering a **Petri Net (PN) matrix** from logged activity traces recorded by a company. The data is provided in `dataset_a1.txt`, and the objective is to extract a meaningful process model using **evolutionary algorithms** and evaluate its performance based on alignment and fitness.

Exercise 1

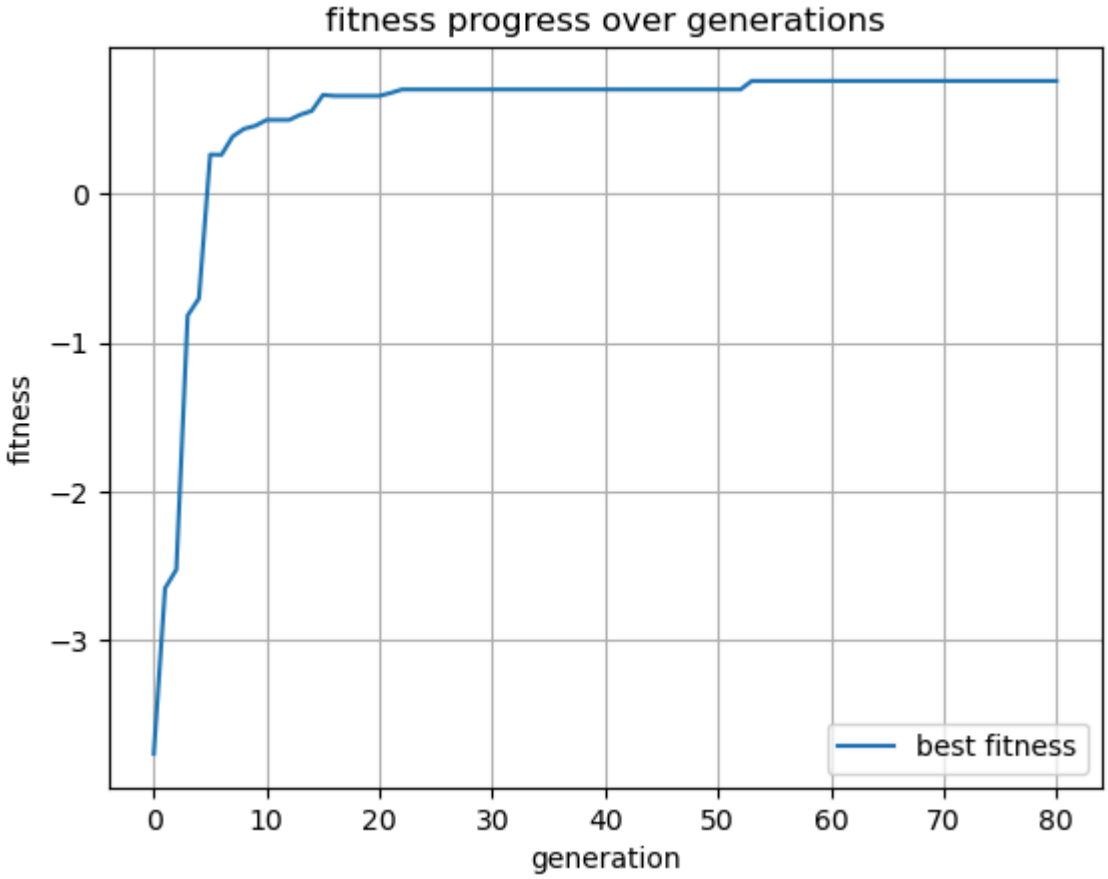
We perform exercise 1 using ['cxTwoPoint', 'mutFlipBit', 'selTournament'] as the [Crossover, Mutation, Selection] and the eaSimple algorithm as the following:

- *POP_SIZE* = 100
- *N_GEN* = 80

Best solution: [7, 5, 7, 8, 0, 2, 2, 3, 3, 7, 0, 4, 5, 7, 3, 6, 1, 3, 7, 8, 5, 8, 7, 8]

Best fitness: 0.7604725552225553

And the plot shows the convergence to the optimum solution:



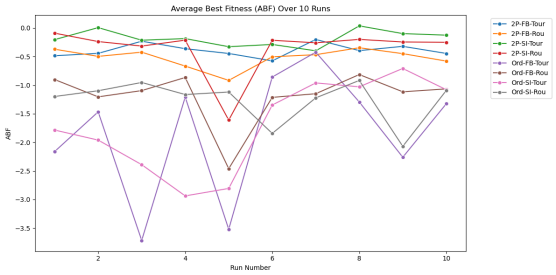
Exercise 2

In part 2 we've extended the previous exercise by changing the setting and run the algorithm with each setting 10 times which gives the following table:

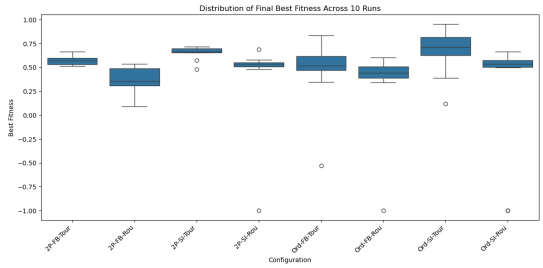
config results over 10 runs

Crossover	Mutation	Selection	ABF	Time (Seconds)
cxTwoPoint	mutFlipBit	selTournament	0.569	125.84
cxTwoPoint	mutFlipBit	selRoulette	0.380	105.22
cxTwoPoint	mutShuffleIndexes	selTournament	0.653	112.88
cxTwoPoint	mutShuffleIndexes	selRoulette	0.395	97.27
cxOrdered	mutFlipBit	selTournament	0.451	93.66
cxOrdered	mutFlipBit	selRoulette	0.314	122.25
cxOrdered	mutShuffleIndexes	selTournament	0.670	475.11
cxOrdered	mutShuffleIndexes	selRoulette	0.255	71.29

plots



Average Best Fitness over generations for each run



Average Best Fitness over each run

Exercise 3

In part 3 we explore different probabilities for mutation and crossover which the results can be shown below

Mutation Prob \ Crossover Prob	0.2	0.4	0.6	0.8
0.2	0.4267	0.5100	0.5640	0.5460
0.4	0.4890	0.4930	0.5460	0.5648
0.6	0.4470	0.4700	0.5040	0.4780
0.8	0.2160	0.3590	0.4190	0.3830

In order to find the best combo, we also measure the time it takes for getting the fitness and sorted the results based on fitness value AND time which gave us the following: ✅
Best combo: CX=0.8, MUT=0.4 with mean Best Fitness = 0.5648

Exercise 4

Here we made this

```
def repair_candidate(matrix):
    repaired = matrix.copy()

    # using step size of 2 to iterate over [src, tgt] pairs
    for i in range(0, len(repaired), 2):
        src = repaired[i]
        tgt = repaired[i + 1]

        # Fix self-loops
        while src == tgt:
            tgt = np.random.randint(0, MAX_VAL + 1) # using
MAX_VAL + 1 to include MAX_VAL

        # Fix backwards visible transitions (only for visible
transitions: i >= 4)
        # i = 0 → t0, i = 2 → t1, i = 4 → t2 (visible starts
at transition index 2)
        if i >= 4 and src > tgt:
            tgt = np.random.randint(src, MAX_VAL + 1)

        # Write back into flat array
```

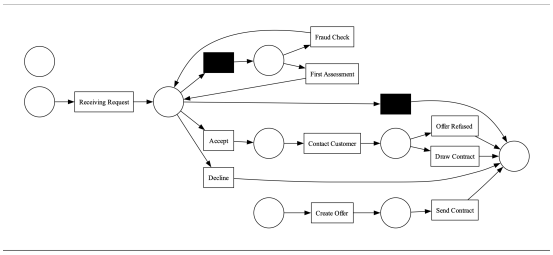
```
            repaired[i] = src
            repaired[i + 1] = tgt

    return repaired
```

Which basically fix the self loops by generating a new target and also fix the backward for visibile transitions by generating a new target larger than source. Note that i is stepping 2 times not 1, this is to jump to the next pair for each iteration of for loop

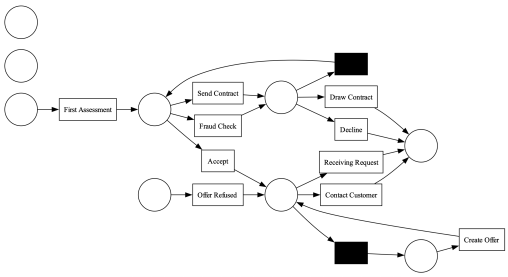
Exercise 5

Here we used and best params (cxTwoPoint, mutShuffleIndexes and selTournament) and best probs (CX=0.8, MUT=0.4) one before and one after using the decorator and this was the result.

graphviz



Before Repair



After Repair