

AI 프로그래밍 059분반

# HW11 보고서

2020년 12월 2일

정보컴퓨터공학과

201824481 박지우

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코드가 점점 많아짐에 따라 모든 코드를 싣지 않고 저번 과제와 대비해 추가되거나 수정된 부분만 설명하였다. 또한 Problem.py의 추가된 코드와 GA의 skeleton 코드는 수정 없이 추가하였기 때문에 따로 설명하지 않았다.

## 1. Setup.py

```
class Setup:
    def __init__(self):
        self.delta = 0.01
        self.updateRate = 0
        self.dx = 0
        self.aType = 0
        self._resolution = 0

    def setVariables(self, parameters):
        if parameters['pType'] == 1:
            self._resolution = int(1 / parameters['mrF'])
        if parameters['pType'] == 2:
            self._resolution = int(1 / parameters['mR'])
        self.delta = parameters['delta']
        self.updateRate = parameters['alpha']
        self.dx = parameters['dx']
        self.aType = parameters['aType']
```

GA에서 사용하는 bit의 길이를 정의하는 변수 resolution은 Problem과 Optimizer에서 모두 사용하므로 Setup Class에 정의하였다. setVariables 함수를 통해 pType에 따라 mrF의 역수이거나 mR의 역수로 하였다.

## 2. Optimizer.py

```

def run(self, p):
    pop = p.initializePop(self._popSize)
    best = self.findBest(pop, p)
    whenBest = i = 1
    while i < self.limitEval:
        newPop = []
        j = 0
        while j < self._popSize:
            parent1, parent2 = self.selectParent(pop)
            child1, child2 = p.crossover(parent1, parent2, self._pC)
            child1_ = p.mutation(child1, self._pM)
            child2_ = p.mutation(child2, self._pM)
            p.evalInd(child1_)
            p.evalInd(child2_)
            newPop.extend([child1_])
            newPop.extend([child2_])
            j += 2
        pop = newPop
        newBest = self.findBest(pop, p)
        if newBest[0] < best[0]:
            best = newBest
            whenBest = p.getNumEval()
        i += 1
    self.whenBestFound = whenBest
    bestSolution = p.indToSol(best)
    bestMinimum = best[0]
    p.saveResult(bestSolution, bestMinimum)

```

Run은 다른 알고리즘과 동등하게 GA를 실행하는 함수이다. 강의자료의 알고리즘을 참고하였다. 먼저 initializePop 함수를 통해 popSize만큼의 랜덤한 값들을 pop에 저장한다. 이때 pop의 구조는 리스트로, 하나의 값은 또 evaluate된 value와 solution으로 이루어진 리스트이다. Best는 findBest 함수를 통해 pop 중 value가 가장 작은 것을 뽑아 저장하였다. whenBest는 초기로 1로 설정하였다. limitEval만큼 루프를 돌면서 parent의 child가 저장될 newPop 변수를 선언한다. popSize만큼 루프를 돌면서 selectParent 함수를 통해 pop에 저장된 값들 중 parent 2개를 저장한다. Parent 2개와 crossover되는 확률인 pC값으로 crossover 함수를 통해 child1과 child2를 생성한다. pM의 확률로 mutation한 뒤, evalInd 함수를 통해 생성된 child를 evaluate하여 값을 저장한다. newPop에 child를 저장하고 한 루프에 2개의 child가 생성되므로 iteration도 2씩 증가된다. 모든 child를 생성하고 나면 newPop에 저장된 child를 pop으로 저장하며 child들 중 findBest 함수를 통해

best를 찾는다. 그 값이 기존 best보다 더 작다면 best를 newBest로 바꾸고 whenBest를 그때의 numEval 값으로 한다. 모든 탐색을 마치면 값을 저장한다.

```
def findBest(self, pop, p):
    best = pop[0]
    p.evalInd(best)
    bestValue = best[0]
    for i in range(len(pop)):
        p.evalInd(pop[i])
        newValue = pop[i][0]
        if newValue < bestValue:
            best = pop[i]
    return best
```

Pop에 저장된 값 중 제일 작은 값을 찾아 반환하는 함수이다. evalInd를 통해 pop의 인자들을 evaluate하고 그 값을 비교하여 가장 작은 인자를 반환한다.

```
def selectParent(self, pop):
    ind1, ind2 = self.selectTwo(pop)
    parent1 = self.tournament(ind1, ind2)
    ind1, ind2 = self.selectTwo(pop)
    parent2 = self.tournament(ind1, ind2)
    return parent1, parent2

def selectTwo(self, pop):
    pop_ = pop[:]
    random.shuffle(pop_)
    return pop_[0], pop_[1]
```

```
def tournament(self, ind1, ind2):
    if ind1[0] < ind2[0]:
        return ind1
    else:
        return ind2
```

Parent 2개를 고르는데 사용된 함수이다. selectParent 함수는 selectTwo 함수를 통해 2개의 값을 받아 tournament 함수로 더 좋은 값을 parent로 삼는다. selectTwo 함수는 pop

에 저장된 인자들 중 랜덤하게 두 인자를 뽑아 반환한다. Tournament 함수는 두 값을 비교하여 더 작은(Solution에 가까운 값) 인자를 반환한다.

### 3. Main.py

```
def readPlan():
    fileName = input("Enter the file name of experimental setting: ")
    infile = open(fileName, 'r')
    parameters = {'pType':0, 'pFileName':'', 'aType':0, 'delta':0,
                  'limitStuck':0, 'alpha':0, 'dx':0, 'numRestart':0,
                  'limitEval':0, 'numExp':0, 'popSize':0, 'uXp':0,
                  'mrF':0, 'XR':0, 'mR':0, }
```

readPlan 함수에 exp.txt로부터 받아온 값인 popSize, uXp, mrF, XR, mR을 parameters의 인자로 추가하였다.

```
def createOptimizer(parameters):#####
    # Create an optimizer instance (a class object) 'alg' of the type
    # as specified by 'aType', set the class variables, and return 'alg'.
    optimizers = {1: 'SteepestAscent()',
                  2: 'FirstChoice()',
                  3: 'Stochastic()',
                  4: 'GradientDescent()',
                  5: 'SimulatedAnnealing()',
                  6: 'GA()'}
    aType = parameters['aType']
    alg = eval(optimizers[aType])
    alg.setVariables(parameters)
    return alg
```

Optimizers에 6번으로 알고리즘 GA를 추가하였다.

### 4. 출력 결과 및 비교

Numeric의 Ackley.txt를 SteepestAscent로 출력한 결과이다.

Average objective value: 17.825	Average objective value: 17.866
Average number of evaluations: 41,141	Average number of evaluations: 44,356
Best solution found: (-9.987, 0.999, -0.004, 13.991, -5.99)	Best solution found: (18.989, 5.002, 3.0, -4.998, -6.0)
Best value: 16.088	Best value: 17.037
Average objective value: 17.718	Average objective value: 17.832
Average number of evaluations: 40,316	Average number of evaluations: 41,562
Best solution found: (-10.996, 4.992, -10.989, -9.996, 2.993)	Best solution found: (-4.998, -5.001, -12.986, 12.991, -2.0)
Best value: 16.468	Best value: 16.595
Average objective value: 17.371	Average objective value: 18.089
Average number of evaluations: 40,948	Average number of evaluations: 41,610
Best solution found: (-9.997, -2.995, 6.998, 6.997, 12.992)	Best solution found: (-8.997, -10.0, 3.993, 16.99, 8.992)
Best value: 16.468	Best value: 17.622
Average objective value: 17.788	Average objective value: 17.722
Average number of evaluations: 43,986	Average number of evaluations: 42,717
Best solution found: (2.997, -8.991, -1.997, 17.985, 5.0)	Best solution found: (1.996, -0.996, 5.996, -12.988, 15.99)
Best value: 16.955	Best value: 17.098
Average objective value: 17.452	Average objective value: 17.279
Average number of evaluations: 44,138	Average number of evaluations: 41,346
Best solution found: (-3.998, 6.997, -2.996, -13.985, -8.989)	Best solution found: (-2.993, 1.003, 10.987, 9.984, 1.001)
Best value: 16.254	Best value: 14.874

Numeric의 Ackley.txt를 FirstChoice로 출력한 결과이다.

Average objective value: 17.41	Average objective value: 18.113
Average number of evaluations: 72,697	Average number of evaluations: 72,287
Best solution found: (7.998, -9.994, -14.991, -2.997, -3.993)	Best solution found: (13.991, 11.992, 8.0, -4.0, 5.994)
Best value: 16.757	Best value: 17.037
Average objective value: 18.218	Average objective value: 17.793
Average number of evaluations: 73,560	Average number of evaluations: 73,043
Best solution found: (-0.996, -7.997, 1.003, -6.997, -18.992)	Best solution found: (0.004, -4.002, -5.997, 2.003, -19.993)
Best value: 17.157	Best value: 17.037

Average objective value: 17.634	Average objective value: 16.72
Average number of evaluations: 73,591	Average number of evaluations: 72,209
Best solution found: (-3.002, -2.995, -5.996, 16.988, -0.999)	Best solution found: (7.994, -2.997, -2.995, -11.984, 5.993)
Best value: 16.191	Best value: 15.294
Average objective value: 17.475	Average objective value: 18.292
Average number of evaluations: 73,369	Average number of evaluations: 72,848
Best solution found: (-1.004, -10.99, 4.001, 4.995, -12.989)	Best solution found: (6.99, 9.991, -8.997, 11.988, 1.004)
Best value: 16.078	Best value: 16.460
Average objective value: 16.76	Average objective value: 18.125
Average number of evaluations: 72,837	Average number of evaluations: 72,530
Best solution found: (3.988, -6.988, -1.997, -1.0, -9.978)	Best solution found: (0.004, -11.985, 9.993, -7.988, 4.998)
Best value: 13.762	Best value: 16.088

Numeric의 Ackley.txt를 Stochastic으로 출력한 결과이다.

Average objective value: 17.75	Average objective value: 17.826
Average number of evaluations: 162,736	Average number of evaluations: 157,820
Best solution found: (6.997, -6.0, -4.999, 5.999, -16.993)	Best solution found: (10.988, 4.993, -12.993, -1.001, 8.993)
Best value: 16.902	Best value: 16.633
Average objective value: 16.959	Average objective value: 17.276
Average number of evaluations: 153,118	Average number of evaluations: 153,074
Best solution found: (-1.995, 7.99, -4.988, 10.986, 3.999)	Best solution found: (0.001, 0.998, -6.987, 6.989, 12.98)
Best value: 14.844	Best value: 15.371
Average objective value: 17.179	Average objective value: 16.441
Average number of evaluations: 150,856	Average number of evaluations: 159,746
Best solution found: (-14.978, 5.991, -2.994, -0.001, 2.994)	Best solution found: (-0.997, -0.996, 7.975, 4.982, 4.985)
Best value: 15.507	Best value: 12.357
Average objective value: 18.191	Average objective value: 17.284
Average number of evaluations: 158,912	Average number of evaluations: 154,906
Best solution found: (12.99, -16.996, 4.999, -1.999, 9.993)	Best solution found: (-10.989, -4.995, 0.997, 9.988, -5.992)
Best value: 17.709	Best value: 15.555

Average objective value: 16.74	Average objective value: 17.658
Average number of evaluations: 148,038	Average number of evaluations: 157,562
Best solution found: (5.993, 5.995, -9.983, -0.998, 5.989)	Best solution found: (-12.988, 3.997, -1.995, 8.99, -8.994)
Best value: 14.506	Best value: 16.254

Numeric의 Ackley.txt를 GradientDescent로 출력한 결과이다.

Average objective value: 14.601	Average objective value: 16.667
Average number of evaluations: 54,310	Average number of evaluations: 50,435
Best solution found: (0.995, -1.99, -4.976, -5.971, -1.991)	Best solution found: (-5.993, -2.996, -2.996, -11.985, -7.99)
Best value: 10.520	Best value: 15.294
Average objective value: 18.242	Average objective value: 17.849
Average number of evaluations: 54,649	Average number of evaluations: 54,728
Best solution found: (10.993, 2.998, 1.999, -9.994, 13.991)	Best solution found: (4.994, 6.992, -0.0, 12.985, -4.994)
Best value: 16.868	Best value: 15.371
Average objective value: 18.003	Average objective value: 17.622
Average number of evaluations: 60,818	Average number of evaluations: 53,383
Best solution found: (-12.989, -4.996, -2.997, -10.99, -3.997)	Best solution found: (-3.996, 2.997, 6.994, -1.998, -15.986)
Best value: 16.153	Best value: 16.097
Average objective value: 17.582	Average objective value: 16.045
Average number of evaluations: 53,706	Average number of evaluations: 52,615
Best solution found: (-0.999, -6.995, 12.99, -2.998, -11.991)	Best solution found: (1.995, 3.99, -9.975, -3.99, 1.995)
Best value: 16.435	Best value: 13.050
Average objective value: 17.526	Average objective value: 16.821
Average number of evaluations: 51,952	Average number of evaluations: 50,675
Best solution found: (8.99, -5.994, -10.988, 0.999, -6.992)	Best solution found: (-4.99, -7.984, 2.994, -7.984, -1.996)
Best value: 15.613	Best value: 13.675

Numeric의 Ackley.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 19.175	Average objective value: 18.967
Average iteration of finding the best: 19,999	Average iteration of finding the best: 19,998
Best solution found: (17.991, -3.985, -7.993, -15.999, -7.004)	Best solution found: (-9.001, -10.995, 12.004, -3.995, -15.993)
Best value: 18.154	Best value: 17.836
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 18.833	Average objective value: 19.455
Average iteration of finding the best: 19,999	Average iteration of finding the best: 19,997
Best solution found: (11.99, 10.006, -12.005, 1.005, -13.993)	Best solution found: (7.001, 23.996, -6.003, 3.994, 19.994)
Best value: 17.703	Best value: 18.938
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 18.898	Average objective value: 19.377
Average iteration of finding the best: 19,999	Average iteration of finding the best: 19,998
Best solution found: (5.993, -7.993, -16.995, -2.978, -16.996)	Best solution found: (-10.995, -8.982, -22.997, -7.003, 6.996)
Best value: 18.086	Best value: 18.480
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 19.627	Average objective value: 19.123
Average iteration of finding the best: 19,998	Average iteration of finding the best: 19,997
Best solution found: (5.012, -0.001, -26.989, 29.0, -2.005)	Best solution found: (2.001, 22.995, 1.995, 1.002, -19.996)
Best value: 19.444	Best value: 18.708
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 19.333	Average objective value: 19.484
Average iteration of finding the best: 19,999	Average iteration of finding the best: 19,998
Best solution found: (27.998, 4.996, -6.999, 14.993, -2.004)	Best solution found: (0.002, 6.003, 18.003, -29.991, -7.999)
Best value: 18.952	Best value: 19.229
Average number of evaluations: 60,600	Average number of evaluations: 60,600

Numeric의 Ackley.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 14.146	Average objective value: 16.577
Average iteration of finding the best: 61,727	Average iteration of finding the best: 49,078
Best solution found: (1.067, -3.883, 3.28, -1.611, -2.085)	Best solution found: (-12.026, 0.008, -8.985, 3.002, -4.976)
Best value: 9.474	Best value: 15.277
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 15.501	Average objective value: 15.022
Average iteration of finding the best: 60,416	Average iteration of finding the best: 53,449
Best solution found: (2.253, 3.816, 2.175, -0.918, 4.922)	Best solution found: (0.152, 0.749, 6.044, 2.795, -3.988)
Best value: 10.374	Best value: 11.008
Average number of evaluations: 62,970	Average number of evaluations: 62,970

Average objective value: 15.668	Average objective value: 15.005
Average iteration of finding the best: 59,119	Average iteration of finding the best: 58,115
Best solution found: (-2.424, 3.986, -1.018, -6.201, -0.342)	Best solution found: (0.875, -3.963, 2.021, 4.248, -1.254)
Best value: 11.606	Best value: 9.670
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 16.456	Average objective value: 15.481
Average iteration of finding the best: 55,725	Average iteration of finding the best: 57,884
Best solution found: (-3.862, -0.039, -2.244, 4.04, 3.905)	Best solution found: (-9.051, -0.44, 1.176, 1.181, -4.905)
Best value: 10.200	Best value: 13.448
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 15.424	Average objective value: 15.214
Average iteration of finding the best: 56,993	Average iteration of finding the best: 60,358
Best solution found: (-4.972, -2.927, 2.346, -1.77, 7.018)	Best solution found: (-2.165, 8.149, 4.394, -4.017, -3.121)
Best value: 12.577	Best value: 13.594
Average number of evaluations: 62,970	Average number of evaluations: 62,970

Numeric의 Griewank.txt를 SteepestAscent로 출력한 결과이다.

Average objective value: 0.179	Average objective value: 0.123
Average number of evaluations: 228,667	Average number of evaluations: 228,878
Best solution found: (12.558, -4.435, 0.004, 12.546, -7.006)	Best solution found: (3.143, 4.44, 0.003, 6.268, -7.01)
Best value: 0.096	Best value: 0.030
Average objective value: 0.178	Average objective value: 0.157
Average number of evaluations: 217,067	Average number of evaluations: 237,709
Best solution found: (-12.565, 4.44, 0.003, -12.538, -7.008)	Best solution found: (15.699, 0.001, -5.432, -0.0, 0.002)
Best value: 0.096	Best value: 0.069
Average objective value: 0.153	Average objective value: 0.209
Average number of evaluations: 220,043	Average number of evaluations: 245,238
Best solution found: (6.282, 13.32, 5.428, 6.266, 7.011)	Best solution found: (15.699, 4.435, -16.304, 6.273, 0.004)
Best value: 0.084	Best value: 0.143
Average objective value: 0.15	Average objective value: 0.113
Average number of evaluations: 236,761	Average number of evaluations: 234,363
Best solution found: (9.425, 8.878, 0.001, -6.268, -0.001)	Best solution found: (-6.276, -4.438, 5.433, 0.003, -0.001)
Best value: 0.052	Best value: 0.022

Average objective value: 0.152	Average objective value: 0.123
Average number of evaluations: 214,567	Average number of evaluations: 223,493
Best solution found:	Best solution found:
(3.142, 13.32, 5.434, -6.275, 14.015)	(-3.142, -0.004, 0.001, 6.267, 0.005)
Best value: 0.113	Best value: 0.012

Numeric의 Griewank.txt를 FirstChoice로 출력한 결과이다.

Average objective value: 0.158	Average objective value: 0.184
Average number of evaluations: 88,284	Average number of evaluations: 88,863
Best solution found:	Best solution found:
(-6.278, 13.318, -5.43, -6.266, 7.004)	(-9.417, 4.437, -10.866, 6.271, -7.008)
Best value: 0.084	Best value: 0.079
Average objective value: 0.102	Average objective value: 0.153
Average number of evaluations: 88,690	Average number of evaluations: 91,298
Best solution found:	Best solution found:
(-0.003, 0.004, 5.429, -0.004, 7.012)	(-3.137, -0.004, 0.003, -6.269, -14.017)
Best value: 0.020	Best value: 0.062
Average objective value: 0.126	Average objective value: 0.139
Average number of evaluations: 86,218	Average number of evaluations: 88,374
Best solution found:	Best solution found:
(-0.001, -13.315, -5.435, 6.268, -7.006)	(6.278, -8.878, 10.864, -0.001, -0.003)
Best value: 0.074	Best value: 0.059
Average objective value: 0.146	Average objective value: 0.153
Average number of evaluations: 86,875	Average number of evaluations: 82,952
Best solution found:	Best solution found:
(-3.138, 4.443, 16.299, 0.003, -7.004)	(6.283, -4.434, 5.433, -0.001, -14.01)
Best value: 0.086	Best value: 0.071
Average objective value: 0.162	Average objective value: 0.124
Average number of evaluations: 86,325	Average number of evaluations: 82,325
Best solution found:	Best solution found:
(-0.005, -4.435, 10.867, -6.272, 0.001)	(6.28, 4.436, 5.43, 0.001, 0.001)
Best value: 0.044	Best value: 0.022

Numeric의 Griewank.txt를 Stochastic으로 출력한 결과이다.

Average objective value: 0.172 Average number of evaluations: 911,620  Best solution found: (-9.416, 8.874, -0.005, 12.543, -7.008) Best value: 0.094	Average objective value: 0.16 Average number of evaluations: 914,926  Best solution found: (-6.276, -8.873, -0.004, 0.003, 14.014) Best value: 0.079
Average objective value: 0.196 Average number of evaluations: 893,242  Best solution found: (-9.422, 4.436, -10.865, 18.812, 7.003) Best value: 0.158	Average objective value: 0.195 Average number of evaluations: 850,330  Best solution found: (-15.702, 8.874, -0.001, 0.003, -7.006) Best value: 0.094
Average objective value: 0.116 Average number of evaluations: 814,434  Best solution found: (-6.28, -4.443, 10.864, -0.004, -7.011) Best value: 0.057	Average objective value: 0.126 Average number of evaluations: 793,178  Best solution found: (9.424, -0.001, -5.428, -12.537, -0.002) Best value: 0.069
Average objective value: 0.081 Average number of evaluations: 846,190  Best solution found: (-0.005, 0.004, 5.434, 6.272, 14.015) Best value: 0.066	Average objective value: 0.12 Average number of evaluations: 840,252  Best solution found: (0.004, 8.878, -0.004, -12.536, 0.004) Best value: 0.059
Average objective value: 0.173 Average number of evaluations: 887,522  Best solution found: (-0.005, -8.875, -10.869, 12.54, -0.0) Best value: 0.089	Average objective value: 0.164 Average number of evaluations: 854,724  Best solution found: (-9.416, -8.881, -5.436, 6.269, 7.007) Best value: 0.071

Numeric의 Griewank.txt를 GradientDescent로 출력한 결과이다.

Average objective value: 0.191 Average number of evaluations: 69,816  Best solution found: (12.56, 8.877, 10.866, 6.271, -7.007) Best value: 0.111	Average objective value: 0.25 Average number of evaluations: 79,163  Best solution found: (-15.7, 4.438, -5.433, 6.271, -14.015) Best value: 0.133
Total number of evaluations: 349,080 Average number of evaluations: 69,816	Total number of evaluations: 395,814 Average number of evaluations: 79,163

Average objective value: 0.172	Average objective value: 0.188
Average number of evaluations: 71,665	Average number of evaluations: 67,709
Best solution found: (3.14, -0.0, -0.0, -12.541, -7.007)	Best solution found: (-6.28, -0.0, -10.867, -18.812, 7.007)
Best value: 0.054	Best value: 0.140
Total number of evaluations: 358,326	Total number of evaluations: 338,544
Average number of evaluations: 71,665	Average number of evaluations: 67,709
Average objective value: 0.113	Average objective value: 0.109
Average number of evaluations: 71,850	Average number of evaluations: 70,806
Best solution found: (-6.28, 13.315, -0.0, 6.271, 0.0)	Best solution found: (-15.7, -8.877, -0.0, -0.0, 7.007)
Best value: 0.064	Best value: 0.094
Total number of evaluations: 359,250	Total number of evaluations: 354,030
Average number of evaluations: 71,850	Average number of evaluations: 70,806
Average objective value: 0.135	Average objective value: 0.088
Average number of evaluations: 73,578	Average number of evaluations: 76,286
Best solution found: (9.42, -13.315, -5.433, -6.271, -0.0)	Best solution found: (-3.14, -0.0, 5.433, -0.0, 0.0)
Best value: 0.084	Best value: 0.010
Total number of evaluations: 367,890	Total number of evaluations: 381,432
Average number of evaluations: 73,578	Average number of evaluations: 76,286
Average objective value: 0.181	Average objective value: 0.188
Average number of evaluations: 75,323	Average number of evaluations: 79,028
Best solution found: (3.14, -0.0, -5.433, 12.541, 0.0)	Best solution found: (3.14, 4.438, 16.3, 12.541, -7.007)
Best value: 0.049	Best value: 0.126
Total number of evaluations: 376,614	Total number of evaluations: 395,142
Average number of evaluations: 75,323	Average number of evaluations: 79,028

Numeric의 Griewank.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 0.447	Average objective value: 0.362
Average iteration of finding the best: 19,999	Average iteration of finding the best: 19,998
Best solution found: (15.679, -17.767, 0.015, 18.856, 14.024)	Best solution found: (9.429, 8.873, 21.733, -18.775, -14.018)
Best value: 0.279	Best value: 0.298
Average number of evaluations: 60,600	Average number of evaluations: 60,600

Average objective value: 0.381	Average objective value: 0.447
Average iteration of finding the best: 19,997	Average iteration of finding the best: 19,998
Best solution found: (0.004, 22.194, -16.322, -18.835, 6.969)	Best solution found: (6.285, -22.192, -21.738, -0.004, -6.97)
Best value: 0.291	Best value: 0.264
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 0.385	Average objective value: 0.333
Average iteration of finding the best: 19,998	Average iteration of finding the best: 19,999
Best solution found: (-9.42, -17.772, 5.456, -0.004, -28.012)	Best solution found: (15.708, 0.005, -0.009, -6.279, -28.053)
Best value: 0.306	Best value: 0.269
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 0.36	Average objective value: 0.331
Average iteration of finding the best: 19,998	Average iteration of finding the best: 19,999
Best solution found: (-9.429, 17.775, 16.303, 0.036, -14.003)	Best solution found: (-28.258, 8.876, 5.438, -6.256, 6.994)
Best value: 0.217	Best value: 0.249
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 0.412	Average objective value: 0.265
Average iteration of finding the best: 20,000	Average iteration of finding the best: 19,999
Best solution found: (-9.425, -17.761, 10.911, 0.005, 21.013)	Best solution found: (3.118, 4.42, -16.31, -6.216, 0.002)
Best value: 0.242	Best value: 0.084
Average number of evaluations: 60,600	Average number of evaluations: 60,600

Numeric의 Griewank.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 0.677	Average objective value: 0.864
Average iteration of finding the best: 49,984	Average iteration of finding the best: 53,369
Best solution found: (-13.166, -0.039, 0.029, 5.692, -6.596)	Best solution found: (-9.184, -0.859, -11.456, -5.53, -1.949)
Best value: 0.287	Best value: 0.611
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 0.782	Average objective value: 0.686
Average iteration of finding the best: 54,238	Average iteration of finding the best: 41,970
Best solution found: (-10.065, 3.673, -10.893, -12.263, 14.263)	Best solution found: (24.929, -8.349, 10.441, 6.572, 7.082)
Best value: 0.471	Best value: 0.353
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 0.779	Average objective value: 0.756
Average iteration of finding the best: 50,269	Average iteration of finding the best: 52,976
Best solution found: (-3.902, 17.814, -5.516, -0.177, 28.12)	Best solution found: (7.096, 13.122, 10.972, 18.896, 0.235)
Best value: 0.567	Best value: 0.499
Average number of evaluations: 62,970	Average number of evaluations: 62,970

Average objective value: 0.7	Average objective value: 0.706
Average iteration of finding the best: 59,980	Average iteration of finding the best: 61,651
Best solution found: (19.252, 0.421, 0.162, -0.293, -13.981)	Best solution found: (-12.671, 8.319, 16.361, 0.368, -7.611)
Best value: 0.276	Best value: 0.269
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 0.67	Average objective value: 0.609
Average iteration of finding the best: 53,512	Average iteration of finding the best: 56,792
Best solution found: (-28.312, 3.986, 5.168, 11.759, 7.691)	Best solution found: (0.281, -14.076, -0.003, -13.153, 7.118)
Best value: 0.438	Best value: 0.312
Average number of evaluations: 62,970	Average number of evaluations: 62,970

Numeric의 Convex.txt를 SteepestAscent로 출력한 결과이다.

Numeric의 Convex.txt를 FirstChoice로 출력한 결과이다.

Average objective value: 0.0 Average number of evaluations: 335,528  Best solution found: (2.007, 4.998, -7.998, -0.998, 7.002) Best value: 0.000	Average objective value: 0.0 Average number of evaluations: 347,153  Best solution found: (1.995, 5.005, -8.002, -1.0, 6.999) Best value: 0.000
Average objective value: 0.0 Average number of evaluations: 346,129  Best solution found: (1.998, 4.999, -8.001, -1.004, 7.007) Best value: 0.000	Average objective value: 0.0 Average number of evaluations: 326,528  Best solution found: (1.991, 4.996, -8.003, -0.999, 6.999) Best value: 0.000
Average objective value: 0.0 Average number of evaluations: 338,533  Best solution found: (2.002, 4.997, -8.0, -1.0, 6.999) Best value: 0.000	Average objective value: 0.0 Average number of evaluations: 355,563  Best solution found: (2.003, 5.002, -7.998, -1.0, 7.002) Best value: 0.000
Average objective value: 0.001 Average number of evaluations: 329,933  Best solution found: (2.0, 4.997, -8.001, -0.997, 6.997) Best value: 0.000	Average objective value: 0.001 Average number of evaluations: 337,447  Best solution found: (1.995, 5.005, -8.0, -1.0, 6.996) Best value: 0.000

Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 351,419	Average number of evaluations: 318,267
Best solution found: (2.0, 4.998, -7.999, -1.002, 7.005)	Best solution found: (1.998, 5.003, -8.001, -0.998, 7.001)
Best value: 0.000	Best value: 0.000

Numeric의 Convex.txt를 Stochastic으로 출력한 결과이다.

Numeric의 Convex.txt를 GradientDescent로 출력한 결과이다.

Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 462,154	Average number of evaluations: 457,121
Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)	Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)
Best value: 0.000	Best value: 0.000
Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 448,741	Average number of evaluations: 419,996
Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)	Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)
Best value: 0.000	Best value: 0.000
Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 478,864	Average number of evaluations: 461,508
Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)	Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)
Best value: 0.000	Best value: 0.000
Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 481,619	Average number of evaluations: 415,908
Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)	Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)
Best value: 0.000	Best value: 0.000
Average objective value: 0.0	Average objective value: 0.0
Average number of evaluations: 355,679	Average number of evaluations: 472,664
Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)	Best solution found: (2.0, 5.0, -8.0, -1.0, 7.0)
Best value: 0.000	Best value: 0.000

Numeric의 Convex.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 0.0	Average objective value: 0.0
Average iteration of finding the best: 99,994	Average iteration of finding the best: 99,985
Best solution found: (1.998, 4.999, -8.003, -1.002, 6.997)	Best solution found: (1.997, 4.999, -8.002, -1.0, 7.003)
Best value: 0.000	Best value: 0.000
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 0.0	Average objective value: 0.0
Average iteration of finding the best: 99,986	Average iteration of finding the best: 99,993
Best solution found: (2.002, 5.002, -8.0, -1.0, 6.999)	Best solution found: (1.998, 5.002, -8.0, -0.999, 7.002)
Best value: 0.000	Best value: 0.000
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 0.0	Average objective value: 0.0
Average iteration of finding the best: 99,996	Average iteration of finding the best: 99,993
Best solution found: (1.999, 5.001, -7.998, -0.996, 7.002)	Best solution found: (2.003, 5.002, -8.002, -1.001, 6.997)
Best value: 0.000	Best value: 0.000
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 0.0	Average objective value: 0.0
Average iteration of finding the best: 99,994	Average iteration of finding the best: 99,991
Best solution found: (2.001, 4.995, -8.0, -0.999, 7.004)	Best solution found: (2.003, 4.999, -8.001, -1.004, 7.0)
Best value: 0.000	Best value: 0.000
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 0.0	Average objective value: 0.0
Average iteration of finding the best: 99,989	Average iteration of finding the best: 99,995
Best solution found: (1.999, 5.0, -8.001, -0.997, 6.997)	Best solution found: (1.997, 5.002, -8.0, -1.004, 7.0)
Best value: 0.000	Best value: 0.000
Average number of evaluations: 300,600	Average number of evaluations: 300,600

Numeric의 Convex.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 602.427	Average objective value: 386.742
Average iteration of finding the best: 295,730	Average iteration of finding the best: 306,688
Best solution found: (1.521, 5.389, -9.956, -0.82, 7.624)	Best solution found: (-0.967, 3.735, -7.507, -1.876, 9.404)
Best value: 34.028	Best value: 55.738
Average number of evaluations: 314,970	Average number of evaluations: 314,970

Average objective value: 427.881	Average objective value: 491.846
Average iteration of finding the best: 304,907	Average iteration of finding the best: 310,888
Best solution found: (-1.7, 3.77, -7.603, -0.78, 7.003)	Best solution found: (2.023, 7.632, -8.013, 0.27, 5.017)
Best value: 22.657	Best value: 63.073
Average number of evaluations: 314,970	Average number of evaluations: 314,970
Average objective value: 885.154	Average objective value: 382.129
Average iteration of finding the best: 304,646	Average iteration of finding the best: 309,350
Best solution found: (17.153, 5.617, -7.031, -2.93, 9.377)	Best solution found: (1.244, 5.356, -8.54, -1.407, 7.504)
Best value: 284.110	Best value: 5.561
Average number of evaluations: 314,970	Average number of evaluations: 314,970
Average objective value: 530.841	Average objective value: 416.622
Average iteration of finding the best: 304,462	Average iteration of finding the best: 313,076
Best solution found: (-5.83, 5.801, -7.725, -3.753, 6.986)	Best solution found: (1.728, 1.838, -5.39, -4.864, 7.869)
Best value: 87.873	Best value: 153.889
Average number of evaluations: 314,970	Average number of evaluations: 314,970
Average objective value: 271.016	Average objective value: 885.136
Average iteration of finding the best: 313,374	Average iteration of finding the best: 312,047
Best solution found: (1.23, 7.531, -7.488, -0.901, 6.555)	Best solution found: (-0.002, 5.772, -10.854, 1.875, -0.535)
Best value: 35.939	Best value: 437.640
Average number of evaluations: 314,970	Average number of evaluations: 314,970

TSP의 tsp30.txt를 SteepestAscent로 출력한 결과이다.

Average objective value: 539.934	Average objective value: 538.624
Best solution found: 5 21 14 15 8 0 10 27 12 24 16 25 1 6 9 7 23 28 11 29 4 2 26 20 3 13 19 18 22 17	Best solution found: 28 23 7 9 1 5 15 14 21 25 6 26 2 16 24 12 0 8 10 27 22 18 17 20 13 19 3 4 29 11
Average number of evaluations: 20,824	Average number of evaluations: 21,566
Best value: 480.255	Best value: 503.426
Average objective value: 526.324	Average objective value: 553.892
Best solution found: 28 23 6 25 14 15 21 5 1 7 9 4 26 2 16 24 27 0 8 10 12 17 18 22 19 13 29 20 3 11	Best solution found: 11 29 4 28 23 7 9 6 14 25 1 5 21 15 10 12 16 17 19 18 22 13 3 20 2 26 24 27 0 8
Average number of evaluations: 22,020	Average number of evaluations: 19,505
Best value: 509.948	Best value: 523.968
Average objective value: 529.690	Average objective value: 539.446
Best solution found: 11 29 3 20 13 19 18 22 17 24 12 27 15 14 21 5 1 25 6 9 7 28 23 4 26 2 16 0 10 8	Best solution found: 7 9 23 28 29 11 20 3 19 13 17 12 16 2 26 4 6 25 1 5 21 14 15 8 0 10 24 27 22 18
Average number of evaluations: 21,297	Average number of evaluations: 21,310
Best value: 479.745	Best value: 506.758

Average objective value: 545.421	Average objective value: 528.683
Best solution found:	Best solution found:
22 18 19 13 3 11 20 16 24 17	15 2 26 4 29 11 28 23 7 9
27 12 0 10 8 15 14 21 5 1	6 1 25 5 21 14 16 17 24 12
25 6 2 29 4 26 9 7 28 23	27 8 10 0 22 18 19 13 20 3
Average number of evaluations: 21,784	Average number of evaluations: 19,339
Best value: 529.850	Best value: 497.538
Average objective value: 537.423	Average objective value: 522.411
Best solution found:	Best solution found:
17 3 20 13 19 18 22 0 27 8	13 20 3 19 18 22 0 10 8 12
10 12 24 16 26 2 15 14 21 5	27 17 24 16 26 2 6 4 29 11
1 25 6 9 23 7 28 4 29 11	28 23 9 7 1 25 14 21 5 15
Average number of evaluations: 20,824	Average number of evaluations: 21,387
Best value: 487.581	Best value: 507.934

TSP의 tsp30.txt를 FirstChoice로 출력한 결과이다.

#### 4

Average objective value: 440.417	Average objective value: 425.042
Best solution found:	Best solution found:
28 23 7 9 6 1 25 14 5 21	7 28 23 9 6 25 1 5 21 14
15 8 10 0 27 22 18 19 13 20	15 8 10 0 27 12 24 16 17 22
3 11 29 4 26 2 16 17 24 12	18 19 13 3 20 2 26 4 29 11
Average number of evaluations: 31,729	Average number of evaluations: 34,296
Best value: 434.497	Best value: 418.596
Average objective value: 432.502	Average objective value: 433.458
Best solution found:	Best solution found:
22 18 19 13 20 3 11 29 4 26	22 18 19 13 20 3 11 29 4 26
2 16 17 24 12 27 0 10 8 15	2 16 17 24 12 27 0 10 8 15
14 21 5 25 1 6 9 7 23 28	14 21 5 1 25 6 9 7 23 28
Average number of evaluations: 35,520	Average number of evaluations: 34,868
Best value: 416.505	Best value: 407.979
Total number of evaluations: 177,599	Total number of evaluations: 174,342
Average objective value: 429.596	Average objective value: 429.183
Best solution found:	Best solution found:
3 20 13 19 18 22 17 16 24 12	28 23 7 9 6 25 1 5 21 14
27 0 10 8 15 14 21 5 1 25	15 8 10 0 27 12 24 16 17 22
6 9 7 23 28 11 29 4 26 2	18 19 13 3 20 2 26 4 29 11
Average number of evaluations: 34,312	Average number of evaluations: 36,895
Best value: 419.905	Best value: 409.972
Total number of evaluations: 171,562	
Average objective value: 433.375	Average objective value: 426.813
Best solution found:	Best solution found:
3 20 13 19 18 22 17 16 24 12	28 23 7 9 6 25 1 5 21 14
27 0 10 8 15 21 5 14 25 1	15 8 10 0 27 12 24 17 16 2
7 28 23 9 6 2 26 4 29 11	26 4 29 11 3 20 13 19 18 22
Average number of evaluations: 35,791	Average number of evaluations: 35,760
Best value: 425.980	Best value: 407.979

Average objective value: 429.116	Average objective value: 424.986
Best solution found:	
11 29 4 26 2 16 24 12 17 13	22 18 19 13 20 3 11 29 4 26
20 3 19 18 22 27 0 10 8 15	2 16 17 24 12 27 0 10 8 15
14 21 5 25 1 6 9 7 23 28	14 21 5 1 25 6 9 23 28 7
Average number of evaluations: 34,861	
Best value: 420.600	
Best value: 416.603	

TSP의 tsp30.txt를 Stochastic으로 출력한 결과이다.

Average objective value: 431.576	Average objective value: 432.478
Best solution found:	
22 18 19 13 20 3 29 4 26 2	22 18 19 13 20 3 11 29 4 26
16 17 24 12 27 0 10 8 15 14	2 16 17 12 24 27 0 10 8 15
21 5 1 25 6 9 7 23 28 11	14 21 5 1 25 6 9 7 23 28
Average number of evaluations: 559,543	
Best value: 421.447	
Average objective value: 427.013	Average objective value: 432.636
Best solution found:	
28 23 7 9 6 25 1 5 21 14	22 18 19 13 20 3 11 29 4 26
15 8 10 0 27 12 24 17 16 2	2 16 17 24 12 27 0 10 8 15
26 4 29 11 3 20 13 19 18 22	14 21 5 1 25 6 9 7 23 28
Average number of evaluations: 598,590	
Best value: 407.979	
Average objective value: 429.103	Average objective value: 427.716
Best solution found:	
28 23 7 9 6 25 1 5 21 14	11 29 4 26 2 16 17 20 3 13
15 8 10 0 27 12 24 17 16 2	19 18 22 27 24 12 0 10 8 15
26 4 29 11 3 20 13 19 18 22	14 21 5 1 25 6 9 7 23 28
Average number of evaluations: 532,325	
Best value: 407.979	
Average objective value: 429.440	Average objective value: 422.050
Best solution found:	
22 18 19 13 20 3 11 29 4 26	28 23 7 9 6 25 1 5 21 14
2 16 17 24 12 27 0 10 8 15	15 8 10 0 27 12 17 24 16 2
14 21 5 1 25 6 9 23 7 28	26 4 29 11 3 20 13 19 22 18
Average number of evaluations: 549,703	
Best value: 412.941	
Average objective value: 429.319	Average objective value: 433.437
Best solution found:	
28 23 7 9 6 25 1 5 21 14	22 18 19 13 20 3 11 29 4 26
15 8 10 0 27 22 18 19 13 3	2 17 16 24 12 27 0 10 8 15
20 17 16 12 24 2 26 4 29 11	14 21 5 1 25 6 9 7 23 28
Average number of evaluations: 523,050	
Best value: 416.710	
Best value: 413.900	

TSP의 tsp30.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 506.013	Average objective value: 506.844
Best solution found:	Best solution found:
13 20 3 19 18 22 0 27 8 10	1 7 9 23 28 6 25 5 21 14
12 17 16 24 2 26 4 29 11 28	15 8 0 10 27 17 20 3 13 19
23 7 9 6 25 1 5 21 14 15	18 22 12 24 16 2 26 4 29 11
Average iteration of finding the best: 19,953	Average iteration of finding the best: 19,984
Best value: 462.176	Best value: 457.507
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 475.587	Average objective value: 516.419
Best solution found:	Best solution found:
11 7 28 23 9 6 25 1 5 21	11 29 4 26 2 24 16 17 10 0
14 15 8 10 0 27 22 18 19 13	27 22 18 19 13 20 3 12 8 15
20 3 29 4 26 2 16 17 24 12	14 21 5 1 25 6 9 7 23 28
Average iteration of finding the best: 19,957	Average iteration of finding the best: 19,977
Best value: 456.963	Best value: 460.544
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 493.203	Average objective value: 466.248
Best solution found:	Best solution found:
5 21 14 15 25 6 1 9 7 23	13 20 3 19 18 22 17 16 24 12
28 11 29 4 26 2 20 3 13 19	27 10 0 8 15 14 21 5 1 25
18 22 17 16 24 12 27 8 10 0	6 9 7 23 28 11 29 4 26 2
Average iteration of finding the best: 19,976	Average iteration of finding the best: 19,956
Best value: 454.023	Best value: 435.552
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 504.096	Average objective value: 499.043
Best solution found:	Best solution found:
11 29 4 26 2 12 24 16 13 17	11 29 28 23 7 9 6 25 1 5
3 20 19 22 18 27 0 10 8 15	21 14 15 8 10 0 27 12 24 2
14 21 5 1 25 6 9 23 7 28	17 16 4 26 3 20 13 19 18 22
Average iteration of finding the best: 19,956	Average iteration of finding the best: 19,925
Best value: 463.550	Best value: 475.382
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 479.337	Average objective value: 491.822
Best solution found:	Best solution found:
28 23 7 9 1 5 21 15 14 25	6 25 15 14 21 5 1 9 23 7
6 2 26 29 11 4 20 3 13 19	28 11 29 4 26 2 16 24 12 17
18 22 17 16 24 12 27 0 10 8	20 13 3 19 22 18 27 10 0 8
Average iteration of finding the best: 19,935	Average iteration of finding the best: 19,973
Best value: 452.261	Best value: 475.608
Average number of evaluations: 60,600	Average number of evaluations: 60,600

TSP의 tsp30.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 491.545	Average objective value: 493.717
Best solution found:	Best solution found:
22 18 19 3 20 13 4 23 28 7	17 16 24 12 10 8 0 27 22 18
9 6 1 25 14 5 21 15 8 10	19 13 20 3 11 29 4 26 2 6
0 27 24 12 17 16 2 26 29 11	9 23 28 7 1 25 5 21 15 14
Average iteration of finding the best: 60,572	Average iteration of finding the best: 62,042
Best value: 474.485	Best value: 446.812
Average number of evaluations: 62,970	Average number of evaluations: 62,970

Average objective value: 496.982	Average objective value: 491.781
Best solution found:	Best solution found:
16 2 26 23 28 7 9 6 25 1 5 21 14 15 8 27 0 10 12 24 17 18 22 19 13 3 20 4 29 11	28 23 7 9 1 6 2 26 4 29 11 20 3 13 19 18 22 17 16 27 0 12 24 10 8 15 14 25 5 21
Average iteration of finding the best: 61,655	Average iteration of finding the best: 60,013
Best value: 463.945	Best value: 470.796
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 497.247	Average objective value: 479.144
Best solution found:	Best solution found:
29 11 4 26 6 2 16 24 12 17 13 20 3 19 18 22 27 0 10 8 15 21 5 14 25 1 9 23 7 28	22 18 19 13 3 20 17 16 12 24 27 10 0 8 15 14 21 5 25 1 6 9 7 23 28 11 29 4 26 2
Average iteration of finding the best: 62,054	Average iteration of finding the best: 60,815
Best value: 480.852	Best value: 447.155
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 485.706	Average objective value: 484.818
Best solution found:	Best solution found:
28 23 7 9 25 1 6 2 26 4 29 11 3 20 13 19 18 22 17 12 24 16 27 0 10 8 15 14 5 21	22 18 13 19 20 3 11 29 4 2 26 16 17 24 12 27 0 10 8 15 14 5 21 1 25 6 9 23 7 28
Average iteration of finding the best: 61,655	Average iteration of finding the best: 62,126
Best value: 453.274	Best value: 457.185
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 506.423	Average objective value: 518.265
Best solution found:	Best solution found:
5 21 8 0 10 27 12 24 17 16 2 6 9 23 28 7 1 25 14 15 26 4 29 11 3 20 13 19 18 22	8 10 0 27 22 18 19 13 3 20 11 29 4 26 12 24 16 17 2 9 1 5 21 14 15 25 6 23 7 28
Average iteration of finding the best: 61,559	Average iteration of finding the best: 59,812
Best value: 491.213	Best value: 502.706
Average number of evaluations: 62,970	Average number of evaluations: 62,970

TSP의 tsp50.txt를 SteepestAscent로 출력한 결과이다.

Average objective value: 768.434	Average objective value: 772.546
Best solution found:	Best solution found:
49 13 24 18 34 32 4 33 3 6 21 10 41 1 28 45 35 38 19 16 17 5 20 0 31 11 42 40 23 9 48 36 15 46 30 29 43 7 22 12 27 47 8 44 2 26 37 14 39 25	36 46 30 15 29 18 23 9 48 31 35 38 16 17 0 19 11 42 40 34 24 13 39 7 43 25 49 14 27 22 12 47 8 44 2 1 28 41 21 26 37 10 6 5 33 4 20 3 32 45
Average number of evaluations: 62,804	Average number of evaluations: 60,506
Best value: 738.572	Best value: 755.008

Average objective value: 786.978	Average objective value: 785.817
Best solution found:	Best solution found:
12 27 47 22 7 43 29 30 46 15	21 6 3 45 32 37 28 1 41 10
36 9 40 42 48 23 18 34 24 39	26 2 49 14 7 22 12 27 44 8
13 49 44 8 14 25 26 10 21 1	47 43 25 39 29 30 15 46 36 23
28 37 2 41 33 3 6 32 45 4	18 24 13 34 40 42 9 48 11 19
35 17 16 0 11 19 31 20 5 38	31 4 33 5 35 20 38 17 0 16
Average number of evaluations: 60,724	Average number of evaluations: 59,664
Best value: 758.211	Best value: 748.450
Average objective value: 746.248	Average objective value: 761.033
Best solution found:	Best solution found:
2 37 10 41 28 1 6 3 21 26	44 8 27 12 47 22 7 49 2 28
32 45 33 4 20 31 35 38 5 16	41 1 10 21 6 45 3 33 4 20
0 17 19 11 42 9 23 18 34 13	5 38 16 17 35 31 19 0 11 42
24 39 49 14 44 8 27 47 12 22	40 23 48 9 36 46 15 30 18 34
43 7 25 29 30 15 46 36 48 40	32 37 26 24 13 14 25 39 29 43
Average number of evaluations: 62,804	Average number of evaluations: 62,877
Best value: 696.311	Best value: 679.143
Average objective value: 764.986	Average objective value: 753.634
Best solution found:	Best solution found:
3 6 21 10 41 1 28 37 26 24	22 7 29 18 43 30 15 46 36 48
25 49 2 8 44 27 12 22 47 7	9 23 40 42 31 35 16 0 11 19
43 30 14 13 39 29 18 34 4 32	17 38 5 4 33 20 32 45 3 6
33 45 20 5 38 35 17 0 16 31	21 1 28 41 10 26 37 2 49 44
19 11 42 48 40 23 9 36 46 15	8 12 27 47 14 25 39 24 34 13
Average number of evaluations: 59,996	Average number of evaluations: 61,317
Best value: 717.371	Best value: 716.626
Average objective value: 772.071	Average objective value: 771.871
Best solution found:	Best solution found:
37 49 14 25 29 30 46 15 36 48	8 27 47 12 22 29 43 7 14 39
42 9 23 40 18 34 24 13 39 43	24 18 13 25 49 44 2 28 1 6
7 22 47 12 27 8 44 2 1 28	21 3 26 37 41 10 32 34 23 48
41 10 26 21 3 20 5 35 17 38	42 11 19 17 16 0 35 38 33 45
16 0 11 19 31 32 33 4 45 6	20 5 4 31 40 9 36 15 46 30
Average number of evaluations: 62,524	Average number of evaluations: 61,484
Best value: 723.964	Best value: 743.374

TSP의 tsp50.txt를 FirstChoice로 출력한 결과이다.

Average objective value: 631.759	Average objective value: 639.812
Best solution found:	Best solution found:
32 34 24 13 26 37 10 41 1 28	3 6 21 10 41 1 28 37 26 32
21 6 3 45 33 4 20 5 38 35	45 33 4 20 5 17 35 38 16 0
31 17 16 0 19 11 42 40 18 23	19 11 31 42 23 18 29 43 7 22
9 48 36 15 46 30 29 43 25 14	47 12 27 8 44 2 49 14 25 39
49 39 7 22 47 12 27 8 44 2	13 24 34 40 48 9 36 15 30 46
Average number of evaluations: 60,011	Average number of evaluations: 57,000
Best value: 614.627	Best value: 628.279

Average objective value: 631.498	Average objective value: 629.757
Best solution found:	Best solution found:
34 18 29 39 13 24 14 25 49 2 44 8 47 27 12 22 7 43 30 46 15 36 9 48 23 40 42 11 19 0 16 17 31 35 5 38 20 4 33 45 32 26 37 10 3 6 21 41 28 1	31 42 40 23 18 29 30 46 15 36 9 48 11 19 0 16 17 35 38 5 20 33 4 45 32 34 24 39 13 49 14 25 7 43 47 22 12 27 8 44 2 26 37 10 3 21 6 41 28 1
Average number of evaluations: 61,566	Average number of evaluations: 59,247
Best value: 611.523	Best value: 604.162
Average objective value: 616.801	Average objective value: 642.027
Best solution found:	Best solution found:
1 28 41 37 26 32 10 6 21 3 45 33 4 20 5 38 35 31 17 16 0 19 11 42 40 23 18 34 24 13 39 25 14 49 2 44 8 27 47 12 22 43 7 29 30 46 15 36 9 48	44 8 27 12 47 22 7 43 29 30 46 15 36 9 23 18 40 48 42 31 11 19 0 16 17 35 38 20 5 33 4 45 32 34 24 39 25 49 14 13 2 26 37 10 21 3 6 41 28 1
Average number of evaluations: 59,061	Average number of evaluations: 60,948
Best value: 589.467	Best value: 627.558
Average objective value: 628.269	Average objective value: 619.159
Best solution found:	Best solution found:
46 15 36 9 23 40 48 42 11 19 0 16 17 35 5 38 20 31 4 33 32 45 3 6 21 37 26 10 41 1 28 2 44 8 27 47 12 22 43 7 25 49 14 39 13 24 34 18 29 30	2 49 14 44 8 27 47 12 22 7 25 39 13 24 34 32 26 37 10 41 28 1 6 21 3 45 4 33 20 5 38 35 16 17 0 19 11 31 42 40 48 9 23 18 29 43 30 15 46 36
Average number of evaluations: 58,392	Average number of evaluations: 60,368
Best value: 612.076	Best value: 593.255
Average objective value: 622.230	Average objective value: 635.744
Best solution found:	Best solution found:
0 16 17 19 11 42 31 35 38 5 20 4 33 45 3 21 6 1 28 41 10 37 26 32 34 24 13 39 25 14 49 2 44 8 27 47 12 22 7 43 29 30 46 15 36 48 9 23 40 18	36 15 46 30 43 7 22 12 47 27 8 44 2 49 25 14 39 24 13 34 32 26 37 10 41 1 28 21 6 3 45 4 33 20 5 35 31 16 17 38 0 19 11 42 40 48 9 23 18 29
Average number of evaluations: 55,872	Average number of evaluations: 60,169
Best value: 583.914	Best value: 594.254

TSP의 tsp50.txt를 Stochastic으로 출력한 결과이다.

Average objective value: 628.117	Average objective value: 636.290
Best solution found:	Best solution found:
30 46 15 36 9 48 23 40 31 42 11 19 17 35 16 0 38 5 20 4 33 45 3 6 21 10 28 1 41 37 26 32 34 18 29 43 7 22 12 47 27 8 44 2 49 14 25 39 13 24	33 4 20 5 38 35 16 17 19 0 31 11 42 48 9 23 40 18 34 32 45 3 6 21 10 41 1 28 37 26 13 24 29 39 25 14 49 2 44 8 27 12 47 7 22 43 30 46 15 36
Average number of evaluations: 1,575,349	Average number of evaluations: 1,531,152
Best value: 604.027	Best value: 610.117

Average objective value: 641.728	Average objective value: 646.561
Best solution found:	Best solution found:
46 15 36 9 48 23 40 42 31 11	44 8 27 47 12 22 7 14 25 49
19 0 16 17 35 38 5 20 4 33	2 26 37 10 41 21 28 1 6 3
34 18 29 30 43 7 22 12 47 27	45 33 4 20 5 38 35 17 16 0
8 44 49 14 25 39 24 13 2 1	19 11 31 32 34 18 24 13 39 29
28 41 6 21 10 37 26 32 45 3	43 30 46 15 36 9 23 40 42 48
Average number of evaluations: 1,685,815	Average number of evaluations: 1,458,936
Best value: 605.373	Best value: 621.158
Average objective value: 637.801	Average objective value: 629.990
Best solution found:	Best solution found:
0 17 16 35 38 5 20 4 33 31	39 14 25 47 7 43 22 12 27 8
19 11 42 40 23 18 29 7 14 25	44 2 49 13 24 34 32 37 26 10
39 13 24 34 32 45 3 26 37 10	41 28 1 6 21 3 45 4 33 31
21 6 41 1 28 2 49 44 8 27	20 5 38 35 17 16 0 19 11 42
47 12 22 43 30 46 15 36 9 48	40 23 18 29 30 46 15 36 9 48
Average number of evaluations: 1,515,097	Average number of evaluations: 1,617,281
Best value: 601.208	Best value: 604.606
Average objective value: 633.465	Average objective value: 635.302
Best solution found:	Best solution found:
1 28 41 10 21 6 3 45 33 4	27 47 12 22 7 25 8 44 2 49
20 5 38 35 17 16 0 19 31 11	14 24 13 39 43 30 29 18 34 32
42 40 34 32 26 37 2 44 8 27	26 37 10 41 28 1 6 21 3 45
12 47 22 7 39 25 14 49 13 24	33 4 31 20 5 38 35 17 16 0
18 23 9 48 36 15 46 30 29 43	19 11 48 42 40 23 9 36 15 46
Average number of evaluations: 1,663,803	Average number of evaluations: 1,616,842
Best value: 592.838	Best value: 616.971
Average objective value: 643.905	Average objective value: 623.737
Best solution found:	Best solution found:
31 11 42 48 40 23 9 36 15 46	43 22 7 47 12 27 8 44 2 37
30 18 29 43 22 12 27 47 8 44	10 41 28 1 6 21 3 45 33 4
49 14 25 7 39 13 24 34 32 26	20 5 38 35 17 16 0 11 19 31
10 41 37 2 28 1 6 21 3 45	42 40 48 9 23 18 34 32 26 49
33 4 20 5 38 35 16 17 19 0	14 25 13 24 39 29 30 46 15 36
Average number of evaluations: 1,436,394	Average number of evaluations: 1,585,895
Best value: 626.861	Best value: 595.373

TSP의 tsp50.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 772.736	Average objective value: 798.367
Best solution found:	Best solution found:
46 15 36 48 42 40 34 32 3 21	1 28 41 10 6 21 3 4 38 35
6 2 44 8 47 27 12 22 7 43	31 0 16 17 42 11 19 5 20 45
30 23 18 29 24 39 25 14 13 49	33 34 32 24 25 7 43 47 49 14
26 41 28 1 37 10 45 4 33 20	22 12 27 8 44 2 37 26 13 39
5 38 35 31 0 16 17 19 11 9	29 18 23 48 40 9 36 15 46 30
Average iteration of finding the best: 19,974	Average iteration of finding the best: 19,986
Best value: 708.046	Best value: 759.419
Average number of evaluations: 60,600	Average number of evaluations: 60,600

Average objective value: 832.344	Average objective value: 794.183
Best solution found:	Best solution found:
0 19 35 17 16 5 38 20 45 10 28 41 21 37 26 32 34 24 39 25 14 7 29 43 22 27 12 47 44 8 13 49 2 1 6 3 4 33 31 42 11 48 9 23 40 18 30 46 15 36	2 25 49 44 8 27 12 47 22 7 14 24 13 39 18 43 29 46 15 30 36 9 48 23 40 42 34 32 45 33 5 38 35 17 0 19 11 31 16 20 4 3 26 37 6 21 10 41 28 1
Average iteration of finding the best: 19,959	Average iteration of finding the best: 19,932
Best value: 745.410	Best value: 743.804
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 760.765	Average objective value: 778.441
Best solution found:	Best solution found:
42 48 9 23 40 11 19 0 31 35 38 16 17 20 5 3 10 21 6 41 1 28 37 26 45 33 4 18 43 7 39 24 34 32 13 25 14 49 2 44 8 12 27 22 47 29 30 36 15 46	38 5 35 19 0 16 17 31 11 42 48 40 23 9 36 15 46 30 29 43 39 24 13 14 25 49 44 7 22 12 47 27 8 2 26 10 21 6 41 1 28 37 32 4 33 20 3 45 34 18
Average iteration of finding the best: 19,971	Average iteration of finding the best: 19,980
Best value: 739.223	Best value: 702.423
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 795.215	Average objective value: 800.481
Best solution found:	Best solution found:
35 16 38 17 0 19 11 40 23 9 42 48 36 15 46 30 29 18 5 20 31 4 33 26 37 10 41 1 28 6 21 3 45 32 34 24 39 13 25 14 43 27 22 7 12 47 8 44 2 49	27 8 44 2 49 14 29 26 37 10 41 28 1 6 21 3 45 33 4 20 31 40 23 18 34 32 24 13 39 25 43 22 12 47 7 30 15 46 36 9 48 42 11 19 16 35 38 5 17 0
Average iteration of finding the best: 19,976	Average iteration of finding the best: 19,984
Best value: 740.121	Best value: 690.257
Average number of evaluations: 60,600	Average number of evaluations: 60,600
Average objective value: 786.970	Average objective value: 778.973
Best solution found:	Best solution found:
2 44 49 47 12 27 8 22 7 43 25 14 39 13 34 18 23 36 15 46 30 29 24 26 37 41 1 28 21 10 6 3 35 38 0 17 31 32 45 33 4 20 5 16 19 11 42 48 40 9	8 44 2 37 41 1 28 10 21 6 3 45 20 33 4 5 31 35 38 16 0 17 19 11 42 40 48 9 23 18 43 39 14 13 26 25 7 47 12 27 22 49 24 32 34 29 30 46 15 36
Average iteration of finding the best: 19,969	Average iteration of finding the best: 19,974
Best value: 740.634	Best value: 742.763
Average number of evaluations: 60,600	Average number of evaluations: 60,600

TSP의 tsp50.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 887.812	Average objective value: 891.344
Best solution found:	Best solution found:
2 8 27 47 12 22 43 7 24 26	0 35 38 5 20 16 31 17 48 9
13 39 25 14 49 44 28 1 6 10	42 11 19 23 36 46 15 30 39 14
37 41 21 3 45 20 33 32 46 30	25 7 22 12 27 47 44 49 8 2
15 36 23 9 40 42 48 31 11 19	28 1 41 6 21 4 33 3 45 10
0 16 35 17 38 5 4 34 18 29	37 26 34 32 13 24 40 18 29 43
Average iteration of finding the best: 61,777	Average iteration of finding the best: 61,168
Best value: 827.102	Best value: 841.294
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 900.039	Average objective value: 823.121
Best solution found:	Best solution found:
12 47 27 8 44 49 37 26 28 1	28 1 41 21 10 26 24 39 13 14
41 10 6 21 24 18 43 39 14 25	25 49 44 8 27 12 22 47 7 2
7 22 2 13 34 29 23 48 36 15	37 6 3 45 4 33 20 31 40 23
46 30 40 9 42 31 0 11 19 35	36 15 46 43 29 30 18 34 32 42
38 16 17 5 20 4 33 32 45 3	9 48 11 0 35 5 38 17 16 19
Average iteration of finding the best: 62,353	Average iteration of finding the best: 62,092
Best value: 855.136	Best value: 765.746
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 936.417	Average objective value: 895.873
Best solution found:	Best solution found:
32 39 25 44 8 27 12 47 22 43	11 42 40 9 48 30 36 15 46 29
29 23 9 40 45 26 41 6 21 28	24 13 14 25 39 43 7 47 22 12
1 10 2 49 13 14 24 18 7 30	27 8 44 49 2 1 28 41 10 37
46 15 36 48 42 34 37 3 20 5	26 34 4 21 32 45 3 6 20 33
16 38 33 4 31 17 35 11 19 0	5 38 35 31 23 18 17 16 19 0
Average iteration of finding the best: 62,214	Average iteration of finding the best: 62,302
Best value: 877.846	Best value: 830.695
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 863.929	Average objective value: 885.443
Best solution found:	Best solution found:
20 5 38 0 16 35 17 31 45 34	28 41 1 2 44 8 27 12 47 22
24 30 46 15 36 9 23 48 40 42	29 43 7 25 39 9 48 42 40 34
11 19 4 33 32 13 39 18 37 1	45 14 49 13 24 18 30 23 15 46
6 21 3 28 41 10 26 2 44 8	36 11 19 0 35 16 31 17 20 38
27 12 47 29 7 22 43 25 14 49	5 33 4 32 26 37 10 21 6 3
Average iteration of finding the best: 62,327	Average iteration of finding the best: 62,235
Best value: 809.571	Best value: 830.801
Average number of evaluations: 62,970	Average number of evaluations: 62,970
Average objective value: 881.116	Average objective value: 882.440
Best solution found:	Best solution found:
0 38 16 35 17 11 19 5 20 31	44 49 13 24 39 14 25 7 26 37
42 40 9 48 23 36 15 46 30 18	2 41 6 1 28 21 10 3 45 33
29 24 14 25 7 49 8 44 27 47	23 15 30 43 12 8 27 47 22 29
12 22 43 39 13 2 26 37 34 32	18 46 36 9 48 42 40 34 32 4
33 4 45 10 41 28 1 6 3 21	31 5 20 35 16 17 38 19 11 0
Average iteration of finding the best: 62,584	Average iteration of finding the best: 62,542
Best value: 768.879	Best value: 833.392
Average number of evaluations: 62,970	Average number of evaluations: 62,970

TSP의 tsp100.txt를 SteepestAscent로 출력한 결과이다.

Average objective value: 1,229.951	Average objective value: 1,201.830
Best solution found:	Best solution found:
29 39 8 15 67 99 40 6 88 62	96 73 29 52 89 16 90 93 83 95
85 1 23 96 73 4 52 89 27 18	77 9 50 72 17 38 51 65 59 58
41 48 84 66 10 94 30 56 82 2	75 81 70 37 49 3 91 25 80 13
11 79 13 5 69 28 45 36 7 34	2 19 79 11 92 35 55 60 43 33
98 24 47 22 46 78 63 42 20 0	71 31 53 76 57 26 54 64 8 15
44 86 14 21 74 32 61 87 33 71	23 97 67 1 39 68 4 85 88 40
60 26 43 31 76 53 57 12 25 80	6 62 66 84 94 10 28 27 48 18
92 19 35 64 91 55 49 54 3 97	99 41 5 82 36 69 56 30 45 7
68 16 90 9 77 50 72 75 81 70	98 34 22 47 24 46 63 78 20 44
37 59 58 65 17 51 38 95 83 93	0 42 14 74 21 32 87 61 12 86
Average number of evaluations: 268,841	Average number of evaluations: 269,290
Best value: 1,208.574	Best value: 1,125.390
Average objective value: 1,182.364	Average objective value: 1,191.241
Best solution found:	Best solution found:
61 87 32 74 21 14 57 86 12 53	61 87 14 74 32 21 86 71 26 76
31 43 33 71 26 76 42 49 3 60	20 78 7 22 34 98 47 24 46 63
54 58 59 65 38 17 51 95 83 93	44 0 12 57 53 42 33 60 70 64
16 90 77 9 81 70 64 37 75 72	35 37 77 9 50 72 90 16 38 95
50 8 97 23 15 67 99 1 48 10	83 93 68 89 52 4 85 88 6 62
94 30 36 45 7 34 98 22 78 47	40 84 69 28 56 13 2 79 5 82
24 0 44 46 63 20 25 80 55 91	45 36 94 10 30 66 48 18 27 99
35 2 5 11 13 56 69 28 82 79	67 39 8 97 96 73 29 1 41 23
19 92 41 18 27 66 84 40 6 88	15 11 19 92 25 80 55 43 49 31
62 73 39 96 29 52 85 4 68 89	91 3 54 81 75 59 58 65 17 51
Average number of evaluations: 267,698	Average number of evaluations: 266,821
Best value: 1,081.016	Best value: 1,121.175
Average objective value: 1,162.603	Average objective value: 1,209.859
Best solution found:	Best solution found:
5 79 13 2 47 46 63 44 0 57	0 63 46 2 13 82 41 18 69 30
86 12 74 21 32 61 87 14 71 33	36 7 34 98 22 47 24 44 12 74
55 49 3 43 26 31 76 53 42 20	21 32 14 86 61 87 33 26 57 53
80 25 78 24 98 34 22 7 36 82	76 49 91 3 54 60 55 71 43 31
41 28 69 56 45 10 30 48 67 1	42 20 78 80 25 79 19 5 56 45
99 94 66 84 40 6 62 88 85 4	28 94 10 84 66 48 40 62 88 6
89 52 29 73 18 27 96 39 8 97	29 96 73 99 1 27 67 23 39 89
23 15 37 91 35 19 11 92 64 50	4 85 52 68 93 83 95 38 17 51
72 90 9 68 93 83 95 38 17 51	16 9 90 50 72 77 8 97 15 11
16 77 75 70 81 58 54 60 59 65	92 35 64 37 70 81 75 58 59 65
Average number of evaluations: 273,084	Average number of evaluations: 262,843
Best value: 1,105.513	Best value: 1,075.547

Average objective value: 1,176.700	Average objective value: 1,237.525
Best solution found:	Best solution found:
61 21 32 74 14 87 12 76 53 26	86 12 42 76 57 53 25 49 55 70
42 43 49 31 55 60 54 37 91 3	37 64 35 92 97 15 8 41 23 89
25 20 63 78 19 35 92 11 5 13	85 4 68 16 93 83 95 38 17 65
79 2 80 44 46 0 86 57 71 33	51 59 58 75 50 72 77 9 90 96
65 51 17 59 70 64 8 15 39 96	39 6 62 88 40 84 10 18 67 29
23 97 99 1 67 27 18 41 82 56	52 73 1 27 94 66 99 48 69 82
69 28 45 36 22 34 98 24 47 7	36 5 28 30 56 45 34 98 22 7
30 10 94 48 66 84 6 88 62 40	47 63 46 20 0 44 24 78 13 2
73 29 85 4 52 89 68 16 90 77	79 11 19 80 91 3 54 81 33 60
72 58 75 81 50 9 93 83 95 38	43 31 26 71 21 32 74 14 87 61
Average number of evaluations: 265,720	Average number of evaluations: 262,170
Best value: 1,120.189	Best value: 1,210.713
Average objective value: 1,183.461	Average objective value: 1,224.881
Best solution found:	Best solution found:
0 44 46 63 24 98 34 7 22 36	35 92 11 13 79 19 41 82 36 56
30 48 84 66 94 10 69 45 56 82	5 2 25 80 49 43 26 71 57 76
47 78 20 49 54 75 81 58 50 68	31 55 60 91 15 96 23 50 72 58
52 85 4 89 73 39 29 88 62 6	81 75 64 37 70 3 54 59 65 51
40 28 18 99 27 67 1 96 23 97	17 95 38 83 93 16 90 77 9 8
8 41 79 2 5 13 19 11 92 25	97 39 52 89 68 40 6 73 29 4
80 31 71 26 57 42 53 76 86 87	85 62 88 94 10 18 99 1 67 27
32 21 74 12 14 61 33 60 43 55	48 66 84 28 69 30 45 34 98 22
3 91 64 15 35 37 70 72 77 9	7 47 78 24 63 46 44 20 42 53
90 16 93 83 95 38 51 17 65 59	33 61 87 74 21 32 12 0 86 14
Average number of evaluations: 266,944	Average number of evaluations: 259,069
Best value: 1,109.692	Best value: 1,182.273

TSP의 tsp100.txt를 FirstChoice로 출력한 결과이다.

Average objective value: 863.702	Average objective value: 872.573
Best solution found:	Best solution found:
61 87 14 21 32 74 12 86 57 31	54 91 3 55 49 43 60 33 71 26
42 76 53 26 71 33 60 43 49 55	57 86 14 87 61 21 32 74 12 76
3 91 54 70 81 75 72 50 90 77	53 31 42 20 80 25 19 79 2 78
9 58 59 65 17 51 38 95 83 93	46 63 0 44 24 47 22 98 34 7
16 68 4 85 29 73 52 89 39 97	36 45 30 28 69 56 41 82 5 13
15 8 64 37 35 92 11 13 2 79	11 92 35 37 64 8 15 97 39 96
19 25 80 20 78 46 63 0 44 24	23 67 1 99 27 18 48 10 94 66
47 98 34 22 7 36 45 56 82 5	84 40 6 62 88 85 4 73 29 52
41 23 96 67 1 99 27 18 48 28	89 68 16 90 77 9 50 72 81 70
69 30 10 94 66 84 40 6 62 88	75 58 59 65 17 51 38 95 83 93
Average number of evaluations: 388,902	Average number of evaluations: 409,834
Best value: 833.527	Best value: 852.848

Average objective value: 864.750	Average objective value: 857.661
Best solution found:	Best solution found:
93 83 95 38 51 17 65 59 58 75	61 87 14 12 74 32 21 86 57 76
81 72 50 9 77 90 16 68 89 52	53 26 71 33 43 60 54 3 91 55
4 85 88 62 40 6 29 73 39 96	49 31 42 20 0 44 46 78 63 24
1 67 27 99 18 48 66 84 94 10	47 98 34 22 7 45 36 56 82 5
28 69 30 45 36 7 22 34 98 47	13 2 79 80 25 19 11 92 35 37
24 78 46 63 44 0 20 2 79 19	70 64 8 15 97 96 1 67 27 99
25 80 31 42 76 53 57 86 12 74	18 23 41 69 28 30 10 94 48 66
32 21 14 87 61 33 71 26 60 43	84 40 88 62 6 29 73 39 89 52
49 55 3 91 54 70 37 35 92 11	85 4 68 16 93 83 95 38 51 17
13 5 82 56 41 23 97 15 8 64	65 59 58 75 81 72 50 77 9 90
Average number of evaluations: 390,266	Average number of evaluations: 406,764
Best value: 859.934	Best value: 841.129
Average objective value: 860.899	Average objective value: 870.810
Best solution found:	Best solution found:
16 93 83 95 38 51 17 65 59 58	98 34 22 7 36 82 56 45 30 69
75 81 72 50 9 77 90 68 4 85	28 48 94 10 66 84 40 88 62 6
88 62 6 40 84 66 94 10 30 69	99 18 27 67 1 96 39 89 52 73
28 48 18 99 27 1 67 96 73 29	29 85 4 68 16 93 83 95 38 51
52 89 39 23 97 15 8 35 64 70	17 65 59 58 75 81 9 77 90 50
37 54 60 55 43 26 71 33 61 87	72 70 37 35 64 8 97 23 15 92
14 21 32 74 12 86 57 53 76 42	11 41 5 13 2 79 19 25 80 31
31 49 3 91 19 25 80 20 0 44	49 43 55 3 91 54 60 33 71 26
24 46 63 78 47 22 98 34 7 36	57 53 76 42 20 63 78 47 24 46
45 56 41 82 5 13 2 79 11 92	44 0 12 86 74 32 21 14 87 61
Average number of evaluations: 415,874	Average number of evaluations: 391,264
Best value: 843.888	Best value: 862.433
Average objective value: 867.662	Average objective value: 870.300
Best solution found:	Best solution found:
40 6 62 88 85 4 29 73 39 89	88 62 6 40 1 73 29 85 4 68
52 68 16 93 95 83 38 17 65 59	52 89 39 96 67 27 99 18 48 66
58 75 81 72 50 77 90 9 51 54	84 94 10 30 28 69 56 82 41 23
91 3 55 60 43 49 31 26 71 33	97 15 8 64 70 81 72 50 9 77
61 87 14 21 74 32 12 86 57 53	90 16 93 83 95 38 17 51 65 59
76 42 20 0 44 63 46 78 24 47	58 75 54 60 43 71 33 61 87 14
22 98 34 7 36 56 45 30 69 28	21 32 74 12 86 57 26 49 55 3
10 94 66 84 48 18 27 99 1 67	91 37 35 92 11 5 13 2 79 19
96 97 23 15 8 64 70 37 35 92	25 80 31 53 76 42 20 78 46 63
11 79 2 80 25 19 13 5 82 41	0 44 24 47 22 98 34 7 45 36
Average number of evaluations: 398,004	Average number of evaluations: 373,527
Best value: 852.830	Best value: 851.381
Average objective value: 879.951	Average objective value: 869.823
Best solution found:	Best solution found:
59 65 17 51 38 95 83 93 16 90	40 6 62 88 85 4 68 89 52 29
77 9 50 72 70 64 37 81 75 58	73 39 97 15 23 96 67 1 99 27
60 54 91 3 55 43 49 31 26 33	18 48 84 66 94 10 30 28 69 41
71 61 87 14 21 32 74 12 86 57	56 45 36 7 22 34 98 47 24 46
53 76 42 80 25 19 11 92 35 8	63 44 0 20 78 80 25 19 79 2
15 23 97 39 89 52 68 4 85 29	13 82 5 11 92 8 64 35 37 70
73 96 67 1 99 27 18 41 56 82	75 81 72 50 9 77 90 16 93 83
5 13 79 2 78 46 63 20 0 44	95 38 51 17 65 58 59 61 87 32
24 47 22 98 34 7 36 45 30 69	21 74 14 86 57 26 71 33 43 55
28 48 94 10 66 84 40 6 88 62	60 54 91 3 49 31 42 76 53 12
Average number of evaluations: 386,174	Average number of evaluations: 415,690
Best value: 854.980	Best value: 856.240

TSP의 tsp100.txt를 Stochastic으로 출력한 결과이다.

Average objective value: 1,164.720	Average objective value: 1,116.298
Best solution found:	Best solution found:
66 48 18 99 27 23 67 1 96 39 57 71 26 31 3 91 54 70 37 64 97 8 15 35 37 92 11 19 20 42 81 58 75 72 50 9 77 90 16 93 31 71 87 61 32 21 74 12 14 86 83 95 38 17 59 65 51 33 61 87 57 53 76 25 80 91 3 60 43 55 14 21 32 74 86 12 76 53 42 63 49 26 33 65 17 51 38 83 95 93 46 44 0 20 80 79 11 78 47 24 16 9 72 50 64 70 54 59 58 75 98 34 22 7 45 69 48 30 10 28 81 77 90 68 29 85 4 52 89 73 99 18 27 41 82 56 36 5 2 13 6 88 62 40 84 94 10 30 28 69 19 25 55 43 60 49 35 92 8 15 56 41 82 5 13 79 2 78 47 24 23 67 1 96 97 89 39 52 68 85 22 7 45 36 34 98 46 63 0 44 4 73 29 6 62 88 40 66 84 94	Best solution found:
Average number of evaluations: 6,214,661	Average number of evaluations: 6,343,254
Best value: 1,063.096	Best value: 1,077.724
Average objective value: 1,147.824	Average objective value: 1,124.970
Best solution found:	Best solution found:
23 39 97 15 8 64 81 51 16 68 30 45 36 56 69 28 10 84 40 6 4 85 29 73 89 52 96 1 67 99 62 88 85 4 52 89 90 9 77 95 48 27 62 88 6 40 84 66 10 30 83 16 93 38 17 51 72 81 50 68 56 36 45 69 28 94 18 41 82 2 29 73 39 96 99 27 8 15 23 97 13 79 25 20 0 44 63 46 24 98 67 1 18 48 66 94 41 82 5 11 34 7 22 47 78 80 42 76 53 57 13 92 35 37 64 70 75 58 65 59 86 12 21 74 32 87 61 14 26 71 33 60 54 55 43 49 91 3 25 2 33 60 43 55 31 49 3 91 19 35 19 79 80 20 42 31 26 14 87 61 92 5 11 37 70 54 9 90 77 50 71 76 57 53 86 21 32 74 12 0 72 58 75 59 65 17 38 83 95 93 44 24 63 46 78 47 22 7 34 98	Best solution found:
Average number of evaluations: 6,150,930	Average number of evaluations: 6,449,648
Best value: 1,062.672	Best value: 1,071.396
Average objective value: 1,102.162	Average objective value: 1,098.615
Best solution found:	Best solution found:
38 17 51 9 77 93 83 95 16 90 22 47 24 98 34 7 36 45 30 94 68 52 89 4 85 29 73 99 1 23 66 10 84 40 6 62 88 73 29 96 96 67 40 88 62 6 39 97 15 8 1 39 97 15 35 92 23 67 27 99 50 72 54 58 75 81 70 64 37 19 18 48 69 28 56 41 82 2 13 5 25 80 47 46 63 20 12 86 71 33 11 19 80 25 79 78 46 44 0 76 26 31 57 76 53 42 0 44 24 98 42 12 21 74 32 87 71 33 60 54 34 22 7 36 45 56 28 69 30 94 70 50 72 81 75 58 3 91 37 64 84 10 66 48 27 18 41 82 5 13 8 89 52 85 4 68 16 90 77 9 2 78 79 11 92 35 91 3 49 55 51 95 83 93 38 17 65 59 61 14 43 60 59 65 61 87 14 74 21 32 86 57 26 55 43 49 31 53 20 63	Best solution found:
Average number of evaluations: 6,533,478	Average number of evaluations: 6,358,586
Best value: 1,068.047	Best value: 1,068.857

Average objective value: 1,129.301	Average objective value: 1,129.726
Best solution found:	Best solution found:
32 74 21 87 61 65 59 58 60 55	98 34 7 30 94 84 66 10 28 69
91 3 54 75 81 15 97 23 96 39	48 18 27 67 96 52 89 93 68 4
67 41 82 5 18 48 69 56 36 45	29 85 88 62 6 40 73 99 1 23
7 22 34 98 47 24 63 46 78 20	39 97 15 8 50 72 77 90 16 9
44 0 53 31 26 71 43 33 57 86	51 38 83 95 17 65 59 58 75 81
14 12 42 76 49 25 80 79 2 13	70 64 37 49 55 3 91 54 60 43
19 11 92 35 37 70 64 8 50 72	33 26 71 31 76 53 86 57 61 87
17 38 95 83 93 51 90 77 9 16	14 74 32 21 12 42 20 78 47 22
68 89 52 85 4 29 73 1 99 27	36 45 56 41 5 82 13 11 92 35
66 94 10 28 30 84 40 62 88 6	19 25 80 2 79 24 46 63 44 0
Average number of evaluations: 6,228,114	Average number of evaluations: 5,955,980
Best value: 1,077.037	Best value: 1,042.648
Average objective value: 1,106.797	Average objective value: 1,113.794
Best solution found:	Best solution found:
41 82 5 13 2 79 19 80 25 20	19 11 5 82 56 28 69 99 30 45
0 12 21 32 74 86 14 87 61 33	36 7 22 34 98 47 24 44 0 12
71 57 53 76 42 49 55 3 60 43	57 31 53 76 86 74 21 14 32 87
26 31 91 54 37 64 72 50 9 77	61 26 71 33 60 43 55 91 70 64
90 93 16 83 95 38 17 65 59 51	37 75 81 72 50 51 17 65 59 58
58 81 75 70 35 92 11 78 47 98	54 3 49 42 20 63 46 25 80 79
34 22 44 63 46 24 36 7 45 56	78 2 13 35 92 8 77 9 90 38
30 10 94 66 84 48 99 73 85 4	95 83 93 16 68 4 85 88 62 6
68 89 52 29 39 96 23 15 8 97	29 52 89 73 1 40 84 66 94 10
67 27 18 69 28 1 40 88 62 6	48 18 27 67 23 97 39 96 15 41
Average number of evaluations: 6,355,899	Average number of evaluations: 6,590,482
Best value: 1,040.334	Best value: 1,082.843

TSP의 tsp100.txt를 SimulatedAnnealing으로 출력한 결과이다.

Average objective value: 826.005	Average objective value: 830.577
Best solution found:	Best solution found:
72 50 9 77 90 16 93 83 95 38	40 6 62 88 85 4 68 89 52 29
51 17 65 59 58 75 81 70 37 91	73 39 96 1 99 48 18 27 67 23
3 54 60 43 55 49 31 26 33 71	97 15 8 50 72 9 77 90 16 93
57 53 76 42 20 80 25 19 79 2	83 95 38 51 17 65 59 58 75 81
13 11 92 35 64 8 15 97 23 96	70 64 37 91 35 92 11 19 25 80
39 73 29 52 89 68 4 85 88 62	79 2 13 5 82 41 56 69 28 94
6 40 84 66 10 94 48 18 27 99	66 84 10 30 45 36 7 34 98 22
1 67 41 5 82 56 69 28 30 45	47 24 44 0 63 46 78 20 42 76
36 7 34 98 22 47 24 78 46 63	53 31 49 55 3 54 60 43 33 71
44 0 12 86 14 21 74 32 87 61	26 57 86 12 74 32 21 14 87 61
Average iteration of finding the best: 90,865	Average iteration of finding the best: 81,973
Best value: 810.890	Best value: 819.319
Average number of evaluations: 300,600	Average number of evaluations: 300,600

Average objective value: 831.122	Average objective value: 843.823
Best solution found:	Best solution found:
65 17 51 38 95 83 93 16 90 77 9 50 72 81 75 58 59 54 91 3 55 60 43 49 31 26 71 33 61 87 14 21 32 74 12 86 57 53 76 42 20 78 46 63 0 44 24 47 98 34 22 7 36 45 30 28 69 56 41 82 5 13 2 79 80 25 19 11 92 35 37 70 64 8 15 97 23 96 1 67 27 99 18 48 94 10 66 84 40 6 62 88 85 4 68 89 52 29 73 39	72 50 9 77 90 16 93 83 95 38 51 17 65 59 58 75 81 70 37 64 8 35 92 11 19 25 80 79 2 13 5 82 41 69 28 48 18 27 99 1 67 96 23 15 97 39 73 29 52 89 68 4 85 88 62 6 40 84 66 94 10 30 45 56 36 7 22 34 98 47 24 78 46 63 44 0 20 42 76 53 31 26 43 49 55 3 91 54 60 33 71 57 86 12 74 32 21 14 87 61
Average iteration of finding the best: 91,124	Average iteration of finding the best: 94,997
Best value: 812.141	Best value: 807.348
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 842.245	Average objective value: 830.211
Best solution found:	Best solution found:
61 87 14 21 32 74 12 86 57 26 71 33 43 31 53 76 42 20 49 55 60 54 3 91 37 70 81 75 58 59 65 17 51 38 95 83 93 16 90 77 9 72 50 68 4 85 29 73 52 89 39 96 23 97 15 8 64 35 92 11 5 13 2 79 19 25 80 78 46 63 0 44 24 47 22 98 34 7 36 45 56 82 41 27 67 1 99 18 48 28 69 30 10 94 66 84 40 6 62 88	91 3 55 43 49 31 26 71 33 60 54 75 81 58 59 65 17 51 38 95 83 93 16 9 72 50 77 90 68 89 52 4 85 29 73 39 96 23 97 15 8 64 70 37 35 92 11 19 25 80 79 2 13 5 82 41 18 99 27 67 1 6 62 88 40 84 66 48 94 10 30 28 69 56 45 36 7 22 34 98 47 24 78 46 63 44 0 20 42 76 53 57 86 12 74 32 21 14 87 61
Average iteration of finding the best: 94,853	Average iteration of finding the best: 88,251
Best value: 827.146	Best value: 824.041
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 840.695	Average objective value: 838.694
Best solution found:	Best solution found:
61 87 14 21 32 74 12 86 57 26 71 33 43 60 54 58 59 65 17 51 38 95 83 93 16 90 77 9 50 72 81 75 70 37 64 8 39 73 29 52 89 68 4 85 88 62 6 40 84 66 94 10 30 69 28 48 18 27 99 1 67 96 23 97 15 92 35 91 3 55 49 31 53 76 42 20 0 44 63 46 78 24 47 22 98 34 7 36 45 56 41 82 5 11 13 2 79 19 25 80	61 87 14 21 32 74 12 86 57 53 76 42 31 26 71 33 58 59 65 17 51 38 95 83 93 16 90 77 9 50 72 81 75 54 91 3 60 43 55 49 25 80 20 0 44 63 46 78 24 47 22 98 34 7 36 45 56 69 28 30 10 94 84 66 48 18 99 27 41 82 5 13 2 79 19 11 92 35 37 70 64 8 15 97 23 96 67 1 73 29 39 89 52 68 4 85 88 62 6 40
Average iteration of finding the best: 97,518	Average iteration of finding the best: 81,404
Best value: 811.058	Best value: 814.814
Average number of evaluations: 300,600	Average number of evaluations: 300,600
Average objective value: 830.475	Average objective value: 835.825
Best solution found:	Best solution found:
32 21 74 12 86 14 87 61 71 33 60 54 58 59 65 17 51 38 95 83 93 16 90 77 9 50 72 81 75 70 37 35 64 8 15 97 23 96 39 89 52 68 4 85 29 73 1 67 27 99 18 48 28 69 56 41 82 5 13 2 79 11 92 19 80 25 49 91 3 55 43 26 57 53 76 31 42 20 0 44 63 46 78 24 47 98 34 22 7 36 45 30 10 94 66 84 40 6 62 88	93 83 95 38 51 17 65 59 58 75 81 72 50 9 77 90 16 68 52 89 39 96 23 97 15 8 64 70 37 54 60 33 71 26 31 49 43 55 3 91 35 92 11 19 25 80 79 2 13 5 82 41 18 99 27 67 1 73 29 4 85 88 62 6 40 84 66 48 94 10 30 28 69 56 45 36 7 34 98 22 47 24 78 46 63 44 0 20 42 76 53 57 86 12 74 32 21 14 87 61
Average iteration of finding the best: 92,273	Average iteration of finding the best: 98,393
Best value: 823.981	Best value: 804.185
Average number of evaluations: 300,600	Average number of evaluations: 300,600

TSP의 tsp100.txt를 Genetic Algorithm으로 출력한 결과이다.

Average objective value: 1,228.114	Average objective value: 1,236.038
Best solution found:	Best solution found:
51 17 65 59 61 87 71 33 60 55	61 87 74 32 12 57 58 75 81 39
70 54 43 31 26 53 76 57 14 32	52 89 90 95 83 38 17 16 51 65
21 74 12 86 42 20 80 49 25 79	59 60 54 70 37 91 55 3 35 64
19 3 91 37 92 5 82 45 30 69	15 96 73 29 84 94 10 66 48 99
56 36 10 84 66 94 88 62 6 40	1 27 67 23 97 8 92 11 5 69
73 29 85 52 89 68 4 16 38 83	28 56 82 79 2 13 19 25 80 53
95 93 90 72 77 9 58 81 75 50	31 26 71 33 43 49 14 21 86 76
39 23 97 96 1 67 27 99 48 28	42 20 0 44 24 63 46 78 47 22
18 15 8 35 64 41 13 2 11 0	98 34 7 36 45 30 41 18 40 88
44 78 46 63 24 47 7 22 34 98	62 6 85 4 68 93 9 77 50 72
Average iteration of finding the best: 311,933	Average iteration of finding the best: 312,337
Best value: 1,197.076	Best value: 1,185.112
Average number of evaluations: 314,970	Average number of evaluations: 314,970
Average objective value: 1,269.563	Average objective value: 1,238.417
Best solution found:	Best solution found:
34 98 24 63 46 44 47 78 2 80	62 6 40 88 29 73 85 4 52 89
35 92 37 64 8 15 19 11 79 5	39 96 23 67 99 1 18 48 84 66
13 82 56 41 45 30 48 6 88 62	94 10 28 69 15 97 8 27 56 41
84 40 66 94 10 28 69 36 7 22	45 34 98 22 7 30 36 82 5 79
18 27 99 1 67 97 96 23 39 52	80 25 35 11 92 13 19 2 78 47
85 4 29 73 89 90 72 9 77 16	24 63 44 46 0 20 76 53 42 12
68 93 83 95 38 17 51 58 59 65	86 57 31 26 43 49 91 54 50 75
75 70 50 81 60 55 43 3 54 91	81 58 59 51 17 65 61 87 14 21
49 25 20 0 12 74 32 21 14 86	32 74 71 33 60 55 3 37 64 70
57 76 53 42 31 26 71 87 61 33	72 77 9 16 95 38 83 68 90 93
Average iteration of finding the best: 314,122	Average iteration of finding the best: 311,450
Best value: 1,192.381	Best value: 1,171.127
Average number of evaluations: 314,970	Average number of evaluations: 314,970
Average objective value: 1,286.625	Average objective value: 1,259.920
Best solution found:	Best solution found:
61 87 57 12 21 32 74 14 86 26	98 7 36 56 45 30 28 69 41 99
53 76 42 0 44 46 47 22 98 34	27 18 48 1 82 5 25 13 2 79
7 36 56 27 67 64 37 35 92 11	78 34 22 47 24 44 46 63 0 20
5 82 13 80 63 24 78 2 19 79	55 49 53 76 86 12 74 21 61 33
25 20 31 71 33 55 72 90 9 16	87 32 14 57 71 26 42 31 43 60
68 89 4 52 8 97 39 73 85 29	54 3 19 92 11 80 35 91 37 70
96 1 99 40 6 88 62 48 10 30	64 15 8 23 96 67 94 10 66 84
45 28 69 66 84 94 18 41 23 15	40 88 62 6 29 73 85 4 52 68
70 54 75 81 91 49 3 43 60 58	89 39 97 16 90 9 77 93 83 95
59 65 83 95 93 38 17 51 77 50	38 51 17 75 65 59 81 58 50 72
Average iteration of finding the best: 312,395	Average iteration of finding the best: 313,597
Best value: 1,242.012	Best value: 1,202.139
Average number of evaluations: 314,970	Average number of evaluations: 314,970

Average objective value: 1,233.568	Average objective value: 1,257.296																												
Best solution found:															Best solution found:														
83 93 16 90 9 77 68 89 52 85 20 46 63 42 80 25 19 79 2 41	4 29 62 88 6 40 73 23 67 1 56 13 5 11 92 15 8 64 70 37																												
27 10 94 30 28 69 84 66 99 48 50 77 9 90 68 93 95 83 38 17	18 5 13 19 25 80 2 79 11 92 65 59 51 16 89 52 99 6 88 62																												
41 82 56 36 45 7 34 98 22 78 40 85 4 29 73 39 97 23 96 1	47 24 44 20 46 63 0 76 14 61 67 27 94 66 84 48 18 10 45 30																												
87 32 74 12 21 86 57 53 42 49 28 69 82 36 7 34 98 22 47 24	31 43 55 35 8 39 15 96 97 64 78 44 0 12 32 87 71 53 57 86																												
37 91 3 81 70 72 50 75 58 59 76 74 21 14 61 33 26 43 31 49	51 38 95 17 65 54 60 71 26 33 35 55 60 54 91 3 58 75 81 72																												
Average iteration of finding the best: 314,130															Average iteration of finding the best: 313,374														
Best value: 1,135.673															Best value: 1,182.077														
Average number of evaluations: 314,970															Average number of evaluations: 314,970														
Average objective value: 1,273.435															Average objective value: 1,271.756														
Best solution found:															Best solution found:														
11 15 8 97 1 27 94 10 84 66 61 87 21 86 12 57 14 32 74 26	48 18 99 62 6 73 96 23 67 39 71 33 55 49 3 91 35 37 25 80																												
29 88 40 85 4 52 89 64 35 37 79 19 92 11 36 45 56 5 41 99	70 75 81 58 59 38 17 65 72 50 27 18 94 10 28 69 98 34 22 7																												
90 9 77 68 93 83 95 16 51 33 30 84 66 48 40 62 6 88 4 52	71 26 60 3 80 25 19 92 91 54 89 85 16 90 77 93 68 29 73 67																												
43 55 49 53 31 76 57 61 87 86 96 1 23 82 13 2 47 78 63 24	14 74 32 21 12 0 42 20 63 46 46 44 0 20 42 76 53 31 43 60																												
44 24 98 34 7 45 30 28 69 56 54 58 59 65 17 38 83 95 51 72	41 82 36 5 13 22 47 78 79 2 70 75 81 64 15 8 97 39 50 9																												
Average iteration of finding the best: 312,555															Average iteration of finding the best: 312,761														
Best value: 1,219.114															Best value: 1,201.613														
Average number of evaluations: 314,970															Average number of evaluations: 314,970														

평균을 내어 표로 정리하였다.

### Ackley.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest	17.6942	16.5459	42212	-
First Choice	17.654	16.1861	72897.1	-
Stochastic	17.3304	15.5638	155676.8	-
Gradient	17.0998	14.9076	53727.1	-
Simulated	19.2272	18.553	60600	19998.2
GA	15.4494	11.7178	62970	57286.4

### Griewank.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest	0.1537	0.0717	228678.6	-

First Choice	0.1447	0.0601	87020.4	-
Stochastic	0.1503	0.0836	860641.8	-
Gradient	0.1615	0.0865	73522.4	-
Simulated	0.3723	0.2499	60600	19998.5
GA	0.7229	0.4083	62970	53474.1

Convex.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest				-
First Choice	0.0002	0	338650	-
Stochastic				-
Gradient	0	0	445425.4	-
Simulated	0	0	300600	99991.6
GA	527.9794	118.0508	314970	307516.8

Tsp30.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest	536.1848	502.7003	20985.6	-
First Choice	430.4488	424.3580	32188.5	-
Stochastic	429.4768	414.4965	556281	-
Simulated	493.8612	459.3616	60600	19959.2
GA	494.5708	468.8423	62970	61231.3

Tsp50.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest	768.3618	727.703	61470	-
First Choice	629.7056	605.9115	59263.4	-
Stochastic	635.6896	607.8532	1568656.4	-
Simulated	789.8475	731.21	60600	19970.5
GA	884.7534	824.0362	62970	62239.4

## Tsp100.txt

	avgValue	bestValue	avgNumEval	avgWhenBest
Steepest	1200.0415	1134.0082	266248	-
First Choice	867.8131	850.919	397629.9	-
Stochastic	1123.4207	1065.4654	6318103.2	-
Simulated	834.9672	815.4923	300600	91173.1
GA	1255.4832	1192.8324	314970	312865.4

Steepest Ascent는 Random한 시작점과 greedy한 성향을 띄기 때문에 확실히 Solution간의 편차가 다른 알고리즘보다 컸다. First Choice는 Steepest보다 Greedy한 정도를 줄였기 때문에 확실히 출력 값이 더 안정적이었다. Stochastic은 다른 알고리즘 테스트와 유사하게 avgNumEval을 조정하려 하였지만, 그렇게 되면 limitStuck이 너무 작아져 Value가 좋지 못하게 나왔다. 결국 다른 알고리즘과 비교하였을 때 같은 성능을 내려면 훨씬 많은 evaluation이 필요하기 때문에 오랜 시간이 걸렸다. Simulated Annealing은 지수 함수의 그래프 개형을 따라가므로 GA에 비해 When Best Found가 마지막이 아닌 중간 값으로 일정한 형태를 보였다. GA는 Stochastic만큼은 아니지만 유사한 성능을 내기 위해서는 Simulated Annealing보다 많은 Evaluation을 해야 할 것 같다. 특히 Convex.txt의 경우, 다른 알고리즘은 거의 0.002 수준의 낮은 값이 나왔지만, GA는 높은 값이 나왔다. When Best Found 값으로 보면, 좋은 Solution을 찾기 위한 탐색 횟수가 충분하지 않았던 것으로 보였다.