P1

Temperature Schedules:

Constant-high-temperature: 10000.0

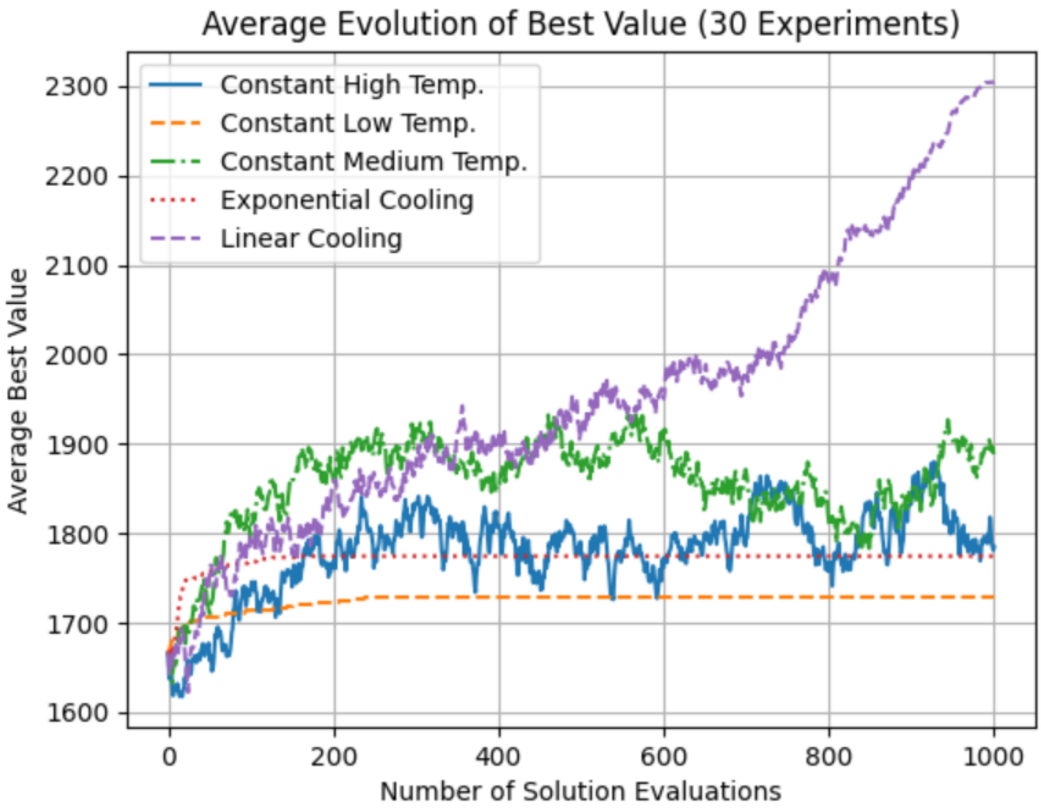
Constant-low-temperature: 1.0

Constant-medium-temperature: 300.0

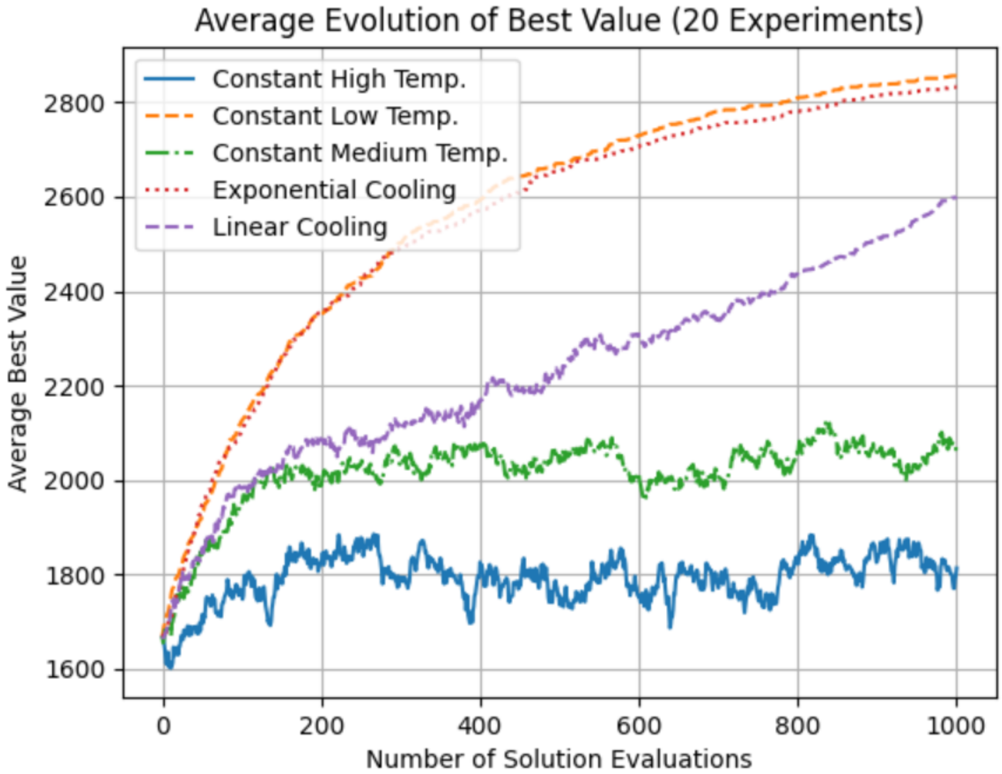
Linear-cooling: decrease linearly with initial value 300.0

Exponential-cooling: decrease exponentially with initial value 300.0

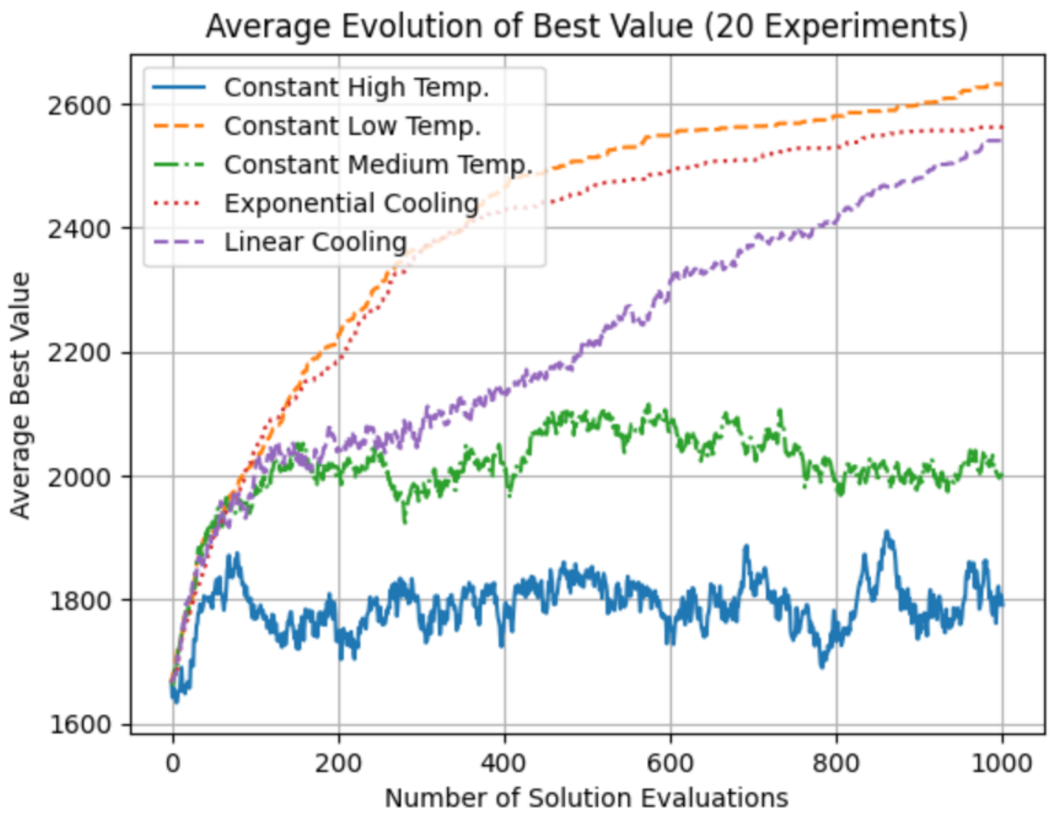
1. HD=1 30 Experiments



2. HD=2 30 Experiments


Average Evolution of Best Value (20 Experiments)
Constant High Temp.
Constant Low Temp.
Constant Medium Temp.
Exponential Cooling
Linear Cooling
Average Best Value
Number of Solution Evaluations
1600
1800
2000
2200
2400
2600
2800
0
200
400
600
800
1000

3.HD=3 30 Experiments



Code:

```
import pandas as pd
import random
import math
import matplotlib.pyplot as plt

# 从Excel文件中读取数据
values_df = pd.read_excel("~/Desktop/value for 100 items.xlsx", header=None)
weights_df = pd.read_excel("~/Desktop/weight for ten constraints.xlsx",
header=None)
capacities_df = pd.read_excel("~/Desktop/capacity for ten constraints.xlsx",
header=None)

# 将数据转换为列表
item_values = values_df.values.flatten().tolist()
item_weights = weights_df.values.tolist()
capacities = capacities_df.values.flatten().tolist()
# print(len(item_weights[1]))


num_items = len(item_values)
num_constraints = len(item_weights[0])
```

```python
# 示例目标函数：计算解的价值
def evaluate_solution(solution):
    total_value = sum(item_values[i] for i in range(num_items) if solution[i] ==
1)
    return total_value


# 示例约束函数：检查解是否满足约束条件
def is_feasible(solution):
    for j in range(num_constraints):
        total_weight = sum(item_weights[i][j] for i in range(num_items) if
solution[i] == 1)
        if total_weight > capacities[j]:
            return False
    return True


# 生成邻居解
def generate_neighbor(solution, distance):
    neighbor = solution[:].copy()  # 复制解
    # print(neighbor)
    for _ in range(distance):
        index = random.randint(0, len(solution) - 1)
        neighbor[index] = 1 - neighbor[index]  # 翻转该位置的值
    # 确保邻居解满足约束条件
    # while not is_feasible(neighbor):
    #     index = random.randint(0, len(solution) - 1)
    #     neighbor[index] = 1 - neighbor[index]  # 再次翻转该位置的值
    if is_feasible(neighbor):
        return neighbor
    return solution


# 模拟退火算法
def simulated_annealing(initial_solution, max_evaluations, initial_temperature,
cooling_schedule, distance=1):
    current_solution = initial_solution
    current_value = evaluate_solution(current_solution)
    best_solution = current_solution
    best_value = current_value
    temperature = initial_temperature
    evaluations = 0
    best_values = [best_value]

    while evaluations < max_evaluations:
        neighbor_distance = distance  # 邻居距离
        neighbor_solution = generate_neighbor(current_solution,
neighbor_distance)

        if is_feasible(neighbor_solution):
            neighbor_value = evaluate_solution(neighbor_solution)
            delta = neighbor_value - current_value
            if delta > 0 or random.random() < math.exp(delta / temperature):
                current_solution = neighbor_solution
                current_value = neighbor_value
                best_solution = current_solution
```

```python
                best_value = current_value
        best_values.append(best_value)
        temperature = cooling_schedule(temperature)
        evaluations += 1
        # print("Iteration {}: Best Value = {}".format(evaluations, best_value))

    return best_solution, best_value, best_values


# 示例冷却计划：线性降温
def linear_cooling(current_temperature):
    return current_temperature - initial_temperature / max_evaluations


# 示例冷却计划：指数降温
def exponential_cooling(current_temperature):
    alpha = 0.7  # 衰减率
    return current_temperature * alpha


# 示例冷却计划：恒定高温
def constant_high_temperature(current_temperature):
    return 10000.0


# 示例冷却计划：恒定低温
def constant_low_temperature(current_temperature):
    return 0.1


# 示例冷却计划：恒定中温
def constant_medium_temperature(current_temperature):
    return 100.0


# 初始化
initial_solution = [1 if i < 37 else 0 for i in range(num_items)]  # 初始解，所有物品都未被选中
max_evaluations = 1000
initial_temperature = 100.0

dis = 3

# 存储每次实验的结果
results_high = []
results_low = []
results_medium = []
results_exp = []
results_lin = []

# 重复实验次数
num_experiments = 20

for _ in range(num_experiments):
    # 调用模拟退火算法并保存结果
```

```
    _, _, best_values_high = simulated_annealing(initial_solution,
max_evaluations, 10000.0, constant_high_temperature,
                                                 dis)
    _, _, best_values_low = simulated_annealing(initial_solution,
max_evaluations, 1.0, constant_low_temperature, dis)
    _, _, best_values_medium = simulated_annealing(initial_solution,
max_evaluations, 100.0,
                                                   constant_medium_temperature,
dis)
    _, _, best_values_exp = simulated_annealing(initial_solution,
max_evaluations, initial_temperature,
                                                exponential_cooling, dis)
    _, _, best_values_lin = simulated_annealing(initial_solution,
max_evaluations, initial_temperature, linear_cooling,
                                                dis)

    # 存储结果
    results_high.append(best_values_high)
    results_low.append(best_values_low)
    results_medium.append(best_values_medium)
    results_exp.append(best_values_exp)
    results_lin.append(best_values_lin)

# 计算均值
avg_high = [sum(x) / num_experiments for x in zip(*results_high)]
avg_low = [sum(x) / num_experiments for x in zip(*results_low)]
avg_medium = [sum(x) / num_experiments for x in zip(*results_medium)]
avg_exp = [sum(x) / num_experiments for x in zip(*results_exp)]
avg_lin = [sum(x) / num_experiments for x in zip(*results_lin)]

# 绘制演化过程图表
plt.plot(avg_high, label='Constant High Temp.', linestyle='-')
plt.plot(avg_low, label='Constant Low Temp.', linestyle='--')
plt.plot(avg_medium, label='Constant Medium Temp.', linestyle='-.')
plt.plot(avg_exp, label='Exponential Cooling', linestyle=':')
plt.plot(avg_lin, label='Linear Cooling', linestyle='--')
plt.title('Average Evolution of Best Value ({}
Experiments)'.format(num_experiments))
plt.xlabel('Number of Solution Evaluations')
plt.ylabel('Average Best Value')
plt.legend()
plt.rcParams["figure.figsize"] = (10, 7)  # 设置图像大小
plt.grid(True)
plt.show()
```