Homework8
Advanced algorithm

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Exercise 25:
Design your own good neighborhood structure for the knapsack problem.

$$\frac{\text{if we choose a greedy solution as initial solution}}{\text{How much this initial solution can improve}}$$

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Situation1
Item num = 10
ratio para= 5
Weight para = 5
Capacity = 15

Opt weight = 15.00
Opt value = 45.47
Greedy weight = 12.11
Greedy value = 39.84

Situation2
Item num = 20
ratio para= 5
Weight para = 5
Capacity = 35

Opt weight = 35.00
Opt value = 114.03
Greedy weight = 32.57
Greedy value = 111.59

Situation1
Item num = 50
ratio para= 10
Weight para = 5
Capacity = 100

Opt weight = 100.00
Opt value = 662.97
Greedy weight = 99.79
Greedy value = 662.32

When the number of item is large, the algorithm behave really, so we only talk about the less item situation using local search

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x	0	1	1	0	0	1
y	1	1	1	0	0	1
y	0	0	1	0	0	1

method1	weight	value
opt	30	103
greedy	29	102
neighbor	25	99
neighbor	28	99
neighbor	25	91
neighbor	29	102
neighbor	25	83
neighbor	28	99
neighbor	26	91
neighbor	27	95
neighbor	27	98
neighbor	24	84
neighbor	26	95
neighbor	29	101
neighbor	27	91

Conclusion: it behave well to exchange 2 choice

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if we choose a greedy solution as initial solution

How much this initial solution can improve

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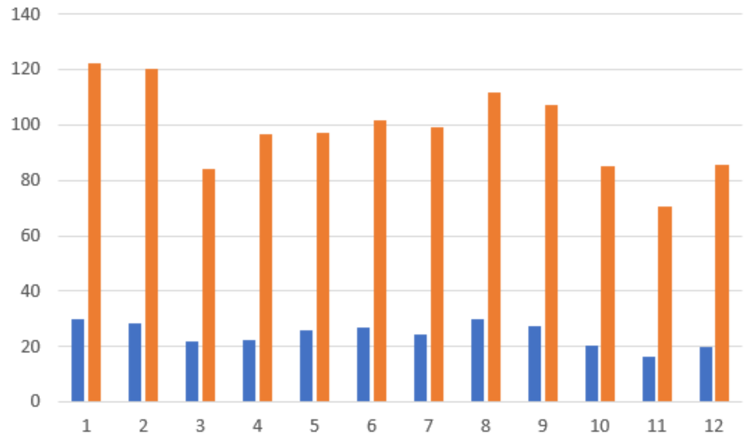
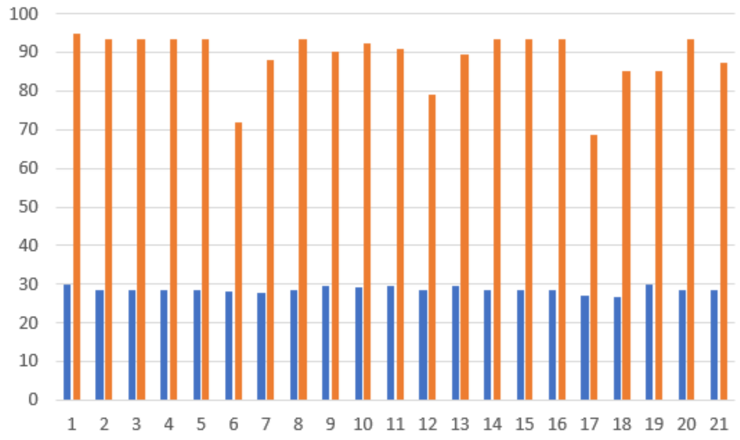
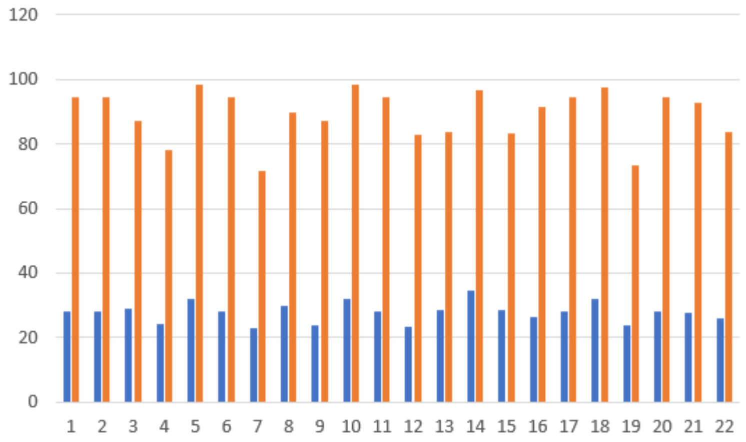
The first term is optimal by linear programming
The second term is greedy local optimal
It's hard to find better neighbor



Method 1



Method 2



Method 3

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- The name stems from annealing in metallurgy: A process to heat and cool down (in a controlled manner) a metal
- Having an iterate x^k and a temperature T^k, choose randomly y^k “close” to x^k. If there is an improvement, i.e., $f\left(y^k\right) < f(x^k)$, set $x^{k+1} = y^k$
- If $f\left(y^k\right) \geq f(x^k)$, set $x^{k+1} = y^k$ with probability $P(x^k, y^k, T^k)$ and $x^{k+1} = x^k$ with probability $1 - P(x^k, y^k, T^k)$
- Decrease temperature $T^{k+1} < T^k$ and repeat until a stopping criterion is satisfied

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- Always accepts better points but worst points may be accepted as well
- This prevents the algorithm to get stuck in local optima
- How to decrease the temperature?
  - Linear decrease $T^k = \frac{T^0}{k+1}$
  - Exponential decrease $T^k = \beta T^{k-1} = \beta^k T^0$ for some $\beta < 1$
- How to choose the acceptance probability?
  - In general $P(x, y, T) \to 0$ as $T \to 0$. The willingness to jump to worse points reduces as the algorithm progresses
  - For example $P(x, y, T) = \exp(\frac{f(x)-f(y)}{T})$. Since it is used only for $f(x) < f(y)$, we have $P(x, y, T) \in (0,1)$

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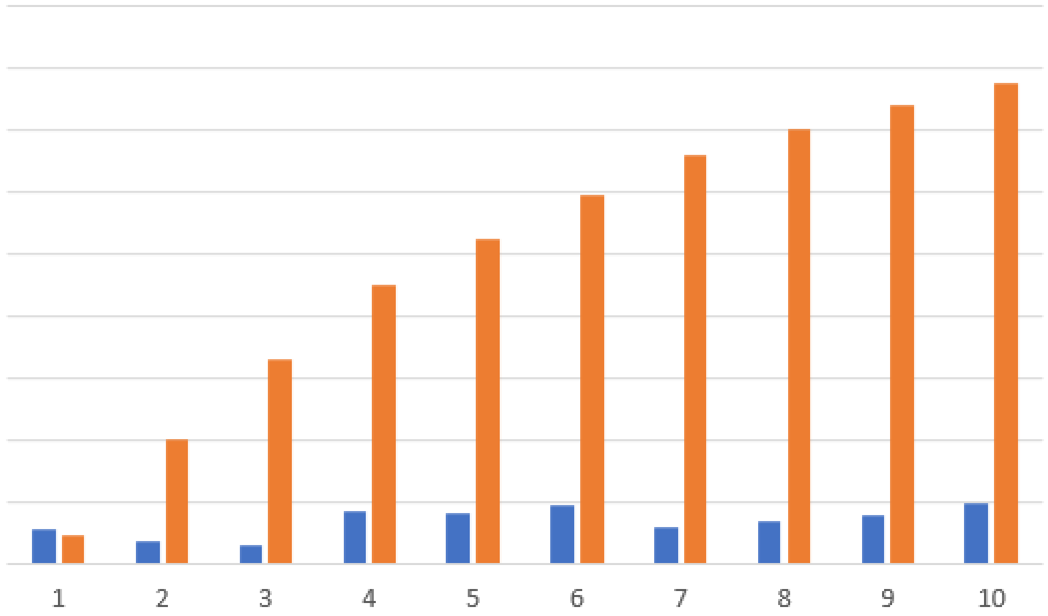

Relative improvent = (local seach value – greedy value) / (optimal value – greedy value)

move strategy: exchange 2 item selection

Relative improvement 0.1618

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Item number

ratio para

Weight para

Capacity

Concerning about the data
If the ratio parameters is very low, near to 1, the problem will be more difficult,and simulated anneal still work

Concerning about the algorithm
It would be better using Particle swarm optimization or add Mutation idea in evolution algorithm

Thanks

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