

Guided-restart Hill-climbing

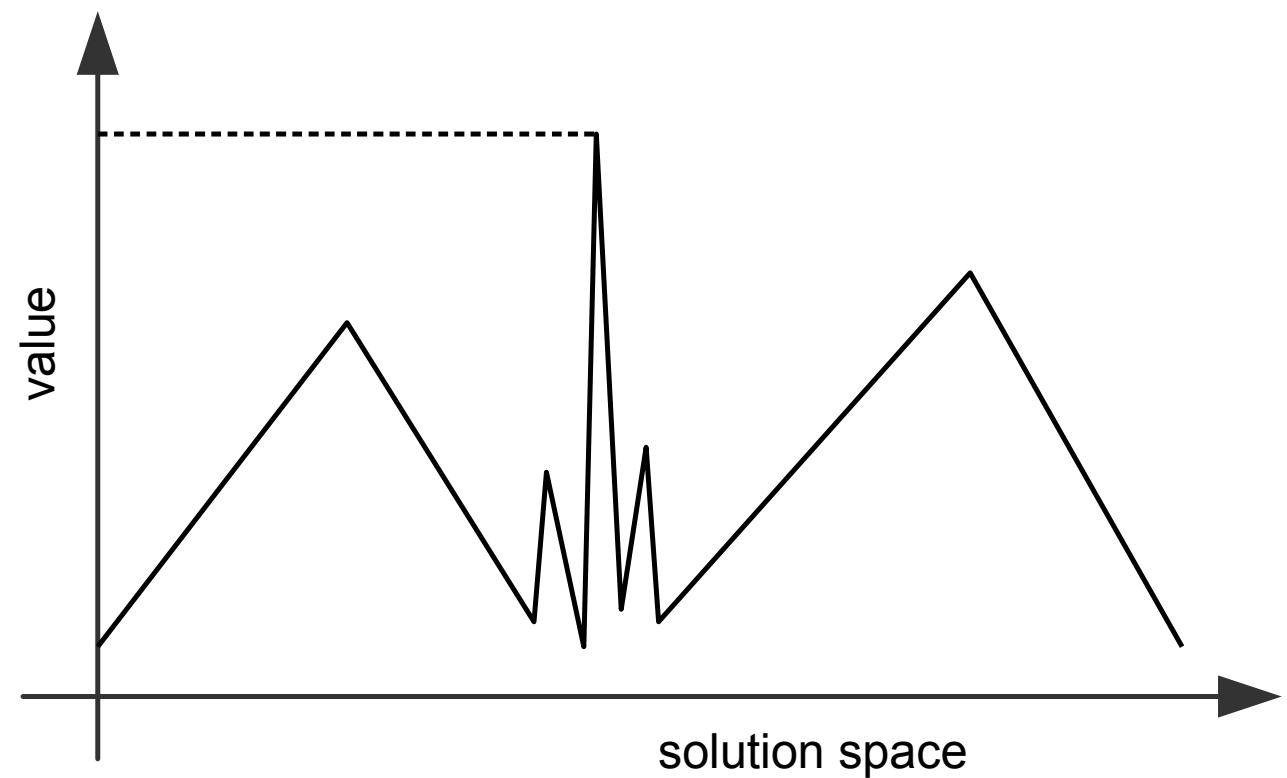
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Guided-restart Hill-climbing

- Random-restart hill-climbing wastes time
- Choose restart using multi-armed bandit learner
- Quadratic assignment problem

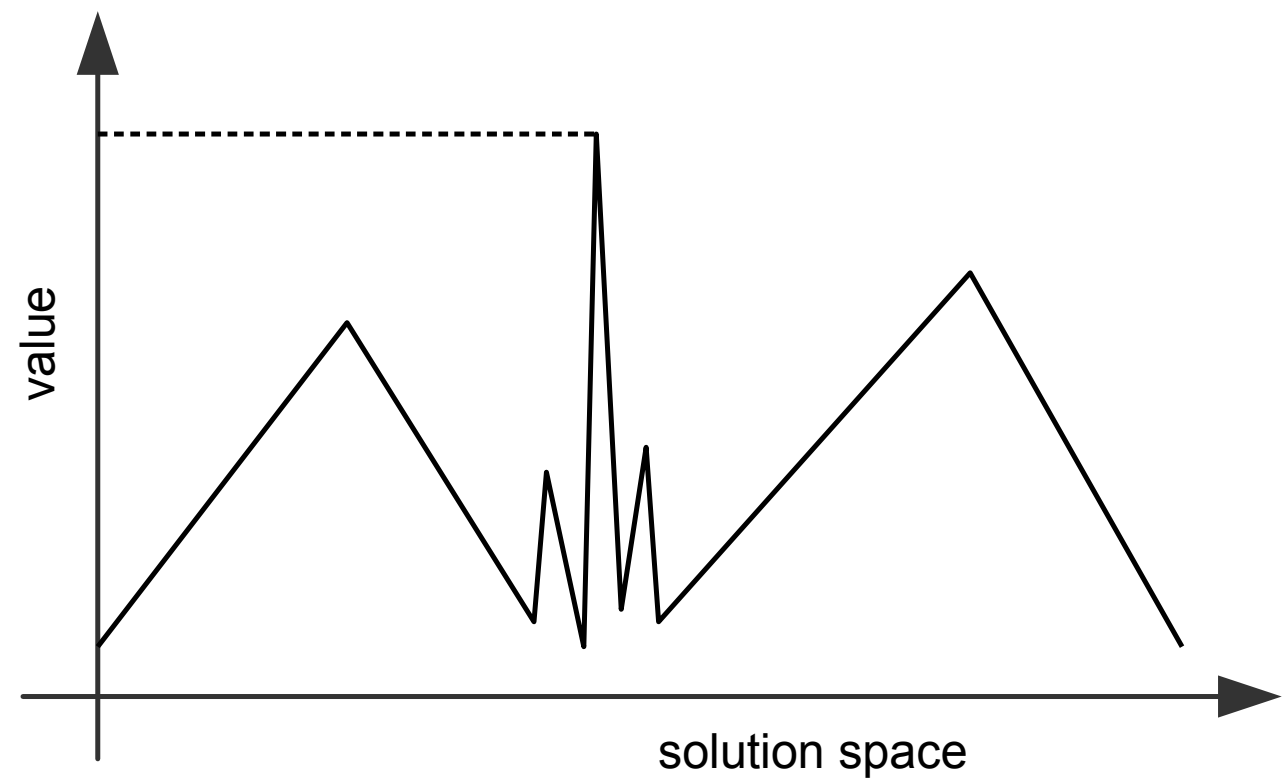
Hill-climbing

- Take random solution
- Repeatedly, replace it by its best neighbor
- Until no neighbor is better



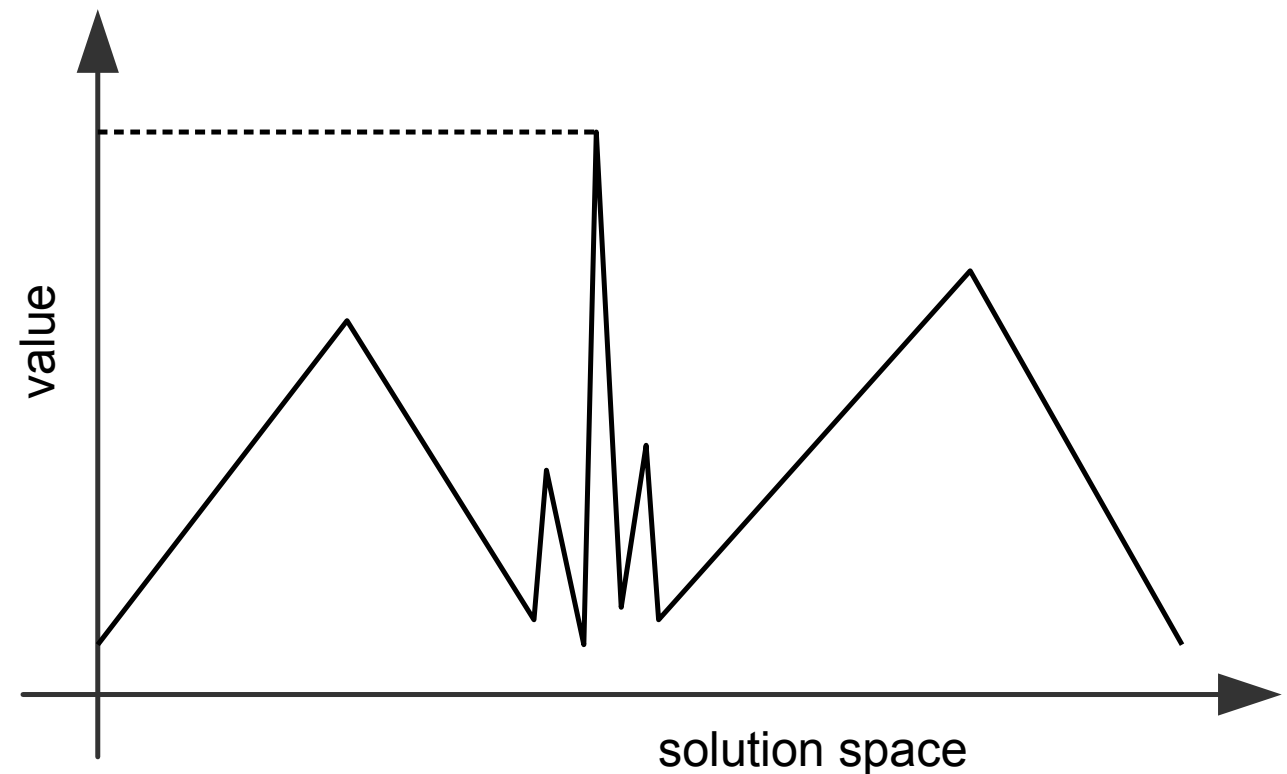
Random-restart

- Repeat hill-climbing n times
- Return the best solution



Guided-restart

- Random-restart explores solution space uniformly
- repeatedly reaches the same local optima
- Guided-restart avoids regions that lead often to the same local optima.
- Random-restart with multiarmed bandit exploration

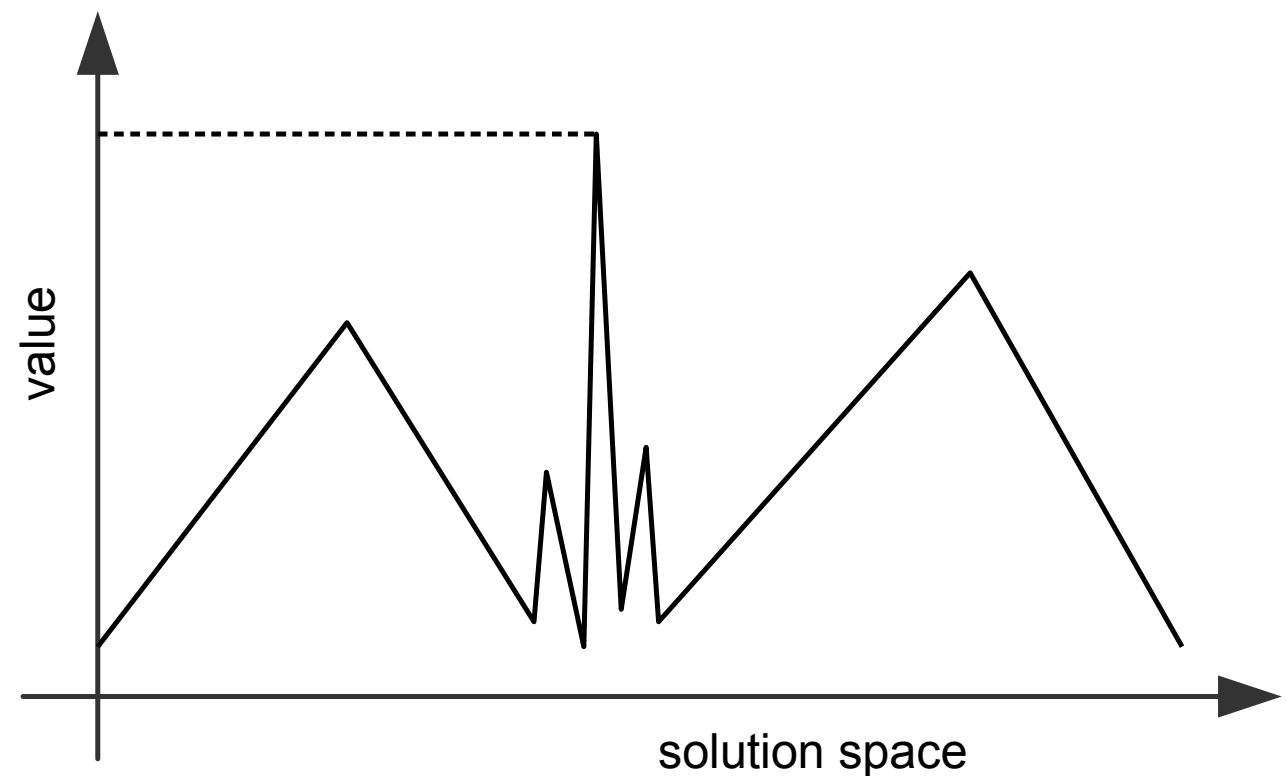


Multiarmed Bandit

- n actions with unknown stochastic reward
- repeatedly choose action and observe reward
- optimize total reward

Guided-restart

- Divide solution space in several regions and assign probability to each.
- Repeat n times:
 - Choose region r
 - Choose solution from r
 - Apply hill-climbing
 - If local optimum already reached, decrease r 's probability; else increase it

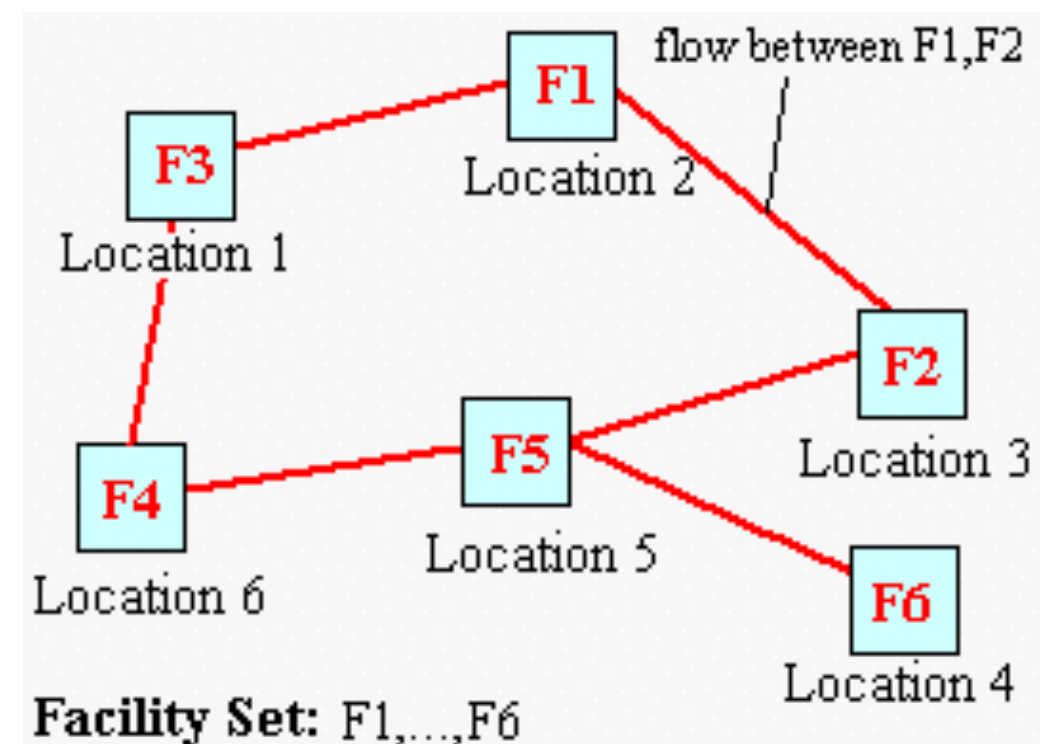


ϵ -greedy Q-learning

- Each action has Q-value, initially Q_0 .
- With prob. ϵ : choose a random action
- With prob. $1-\epsilon$: choose action with highest Q-value
- Update Q-value of action chosen with observed reward: $q \leftarrow q + \alpha (r - q)$

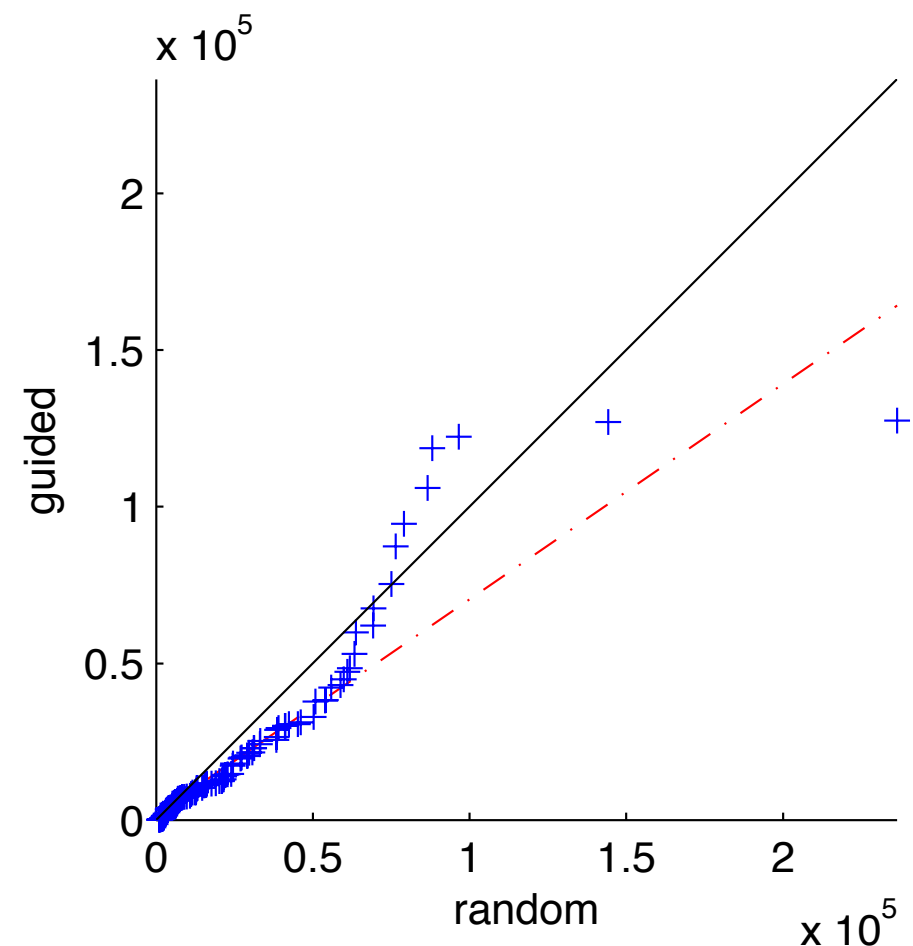
Quadratic Assignment Problem

- Example: location of electronic components on circuit board
- Given: locations with distances and objects with flow
- Assign all objects to a location: permutation p
- Minimize sum of all pair-wise costs: $\sum_i \sum_j \text{flow}(i, j) \times \text{distance}(p_i, p_j)$



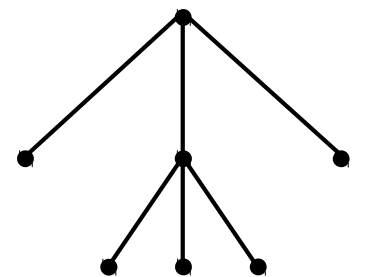
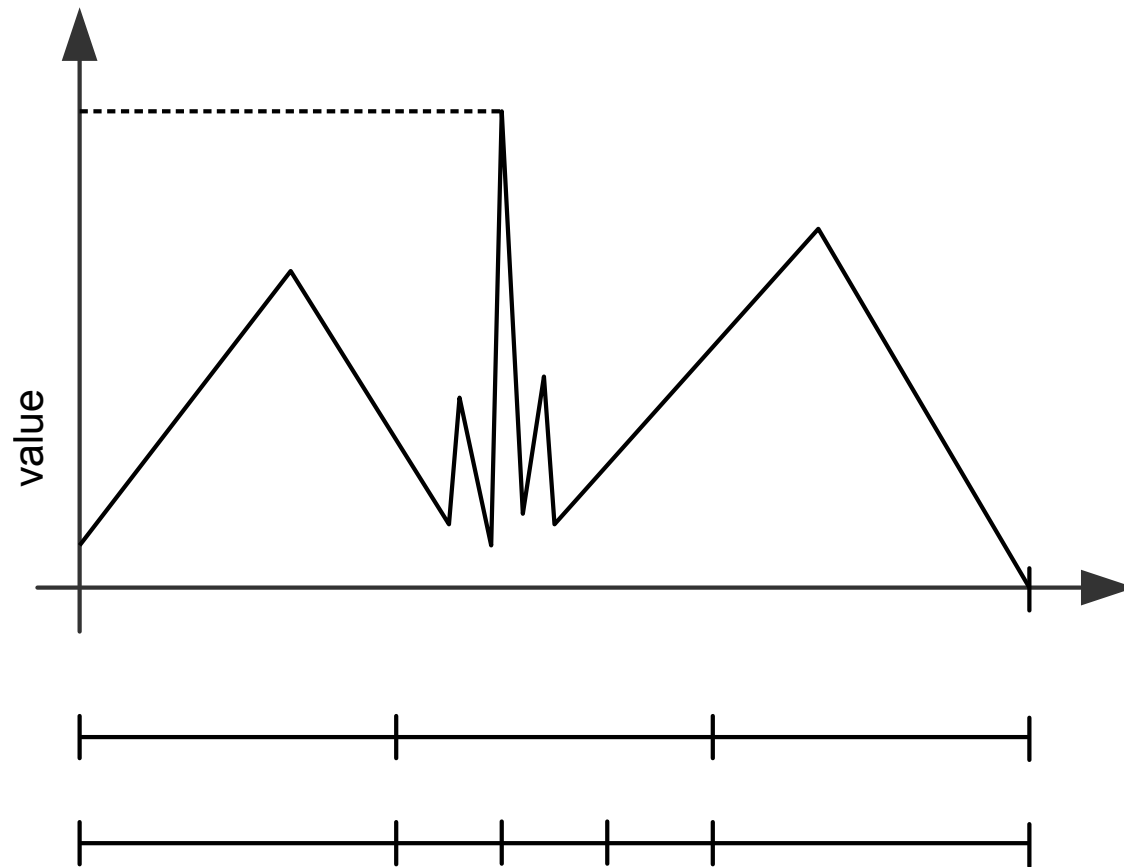
Quadratic Assignment Problem

- Choose an object at random, each assignment to a location is a region of the solution space
- Neighborhood: swap location of any 2 objects
- Many local optima with same value
- reward = $1 - h/t$, t is current restart, h is # local optima found with same value as current one
- Example: Random20 from Taillard1991.



Extension

- Split up regions with many local optima
- Grow tree incrementally



Thanks!

- Random-restart hill-climbing waists time
- Choose restart using multi-armed bandit learner
- Quadratic assignment problem

References

- QAP figure copied from <http://tracer.lcc.uma.es/problems/qap/qap.htm>.
- E. Taillard, “Robust taboo search for the quadratic assignment problem,” *Parallel Computing*, vol. 17, pp. 443–455, July 1991.