Searching Algorithms

CSCI 4352 ML

Searching Algorithms

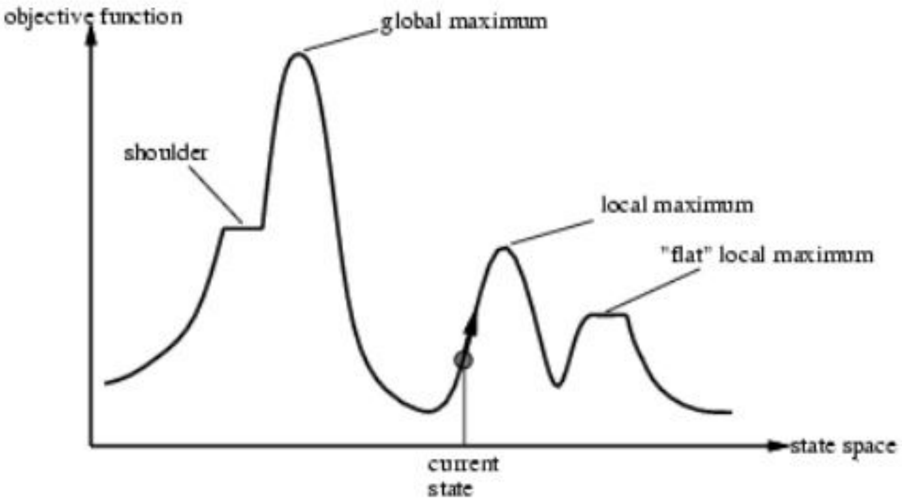
- Hill-climbing
- Randomized Hill-climbing
- Simulated Annealing
- Genetic Algorithm

Hill-climbing

Hill-climbing: Attempt to maximize Eval(X) by moving to the highest configuration in our moveset. If they're all lower, we are stuck at a "local optimum."

1. Let X = initial config
2. Let E = Eval(X)
3. Let N = moveset_size(X)
4. For (i = 0 ; i<N ; i = i+1)
5.   Let E_i = Eval(move(X,i))
6. If all E_i's are ≤ E, terminate, return X
7. Else let i* = $\text{argmax}_i\ E_i$
8. X := move(X,i*)
9. E := E_i*
10. Goto 3

Hill-climbing search

- Problem: depending on initial state, can get stuck in local maxima
- 

Randomized Hill-climbing

What stopping criterion should we use?

Any obvious pros or cons compared with our previous hill climber?

1. Let X = initial config
2. Let E = Eval(X)
3. Let i = random move from the moveset
4. Let E_i = Eval(move(X,i))
5. If E < E_i then
   X = move(X,i)   E = E_i
6. Goto 3 unless bored.

Simulated Annealing

This may make the search fall out of mediocre local minima and into better local maxima.

How should we choose the probability of accepting a worsening move?

Idea One. Probability = 0.1

Idea Two. Probability decreases with time

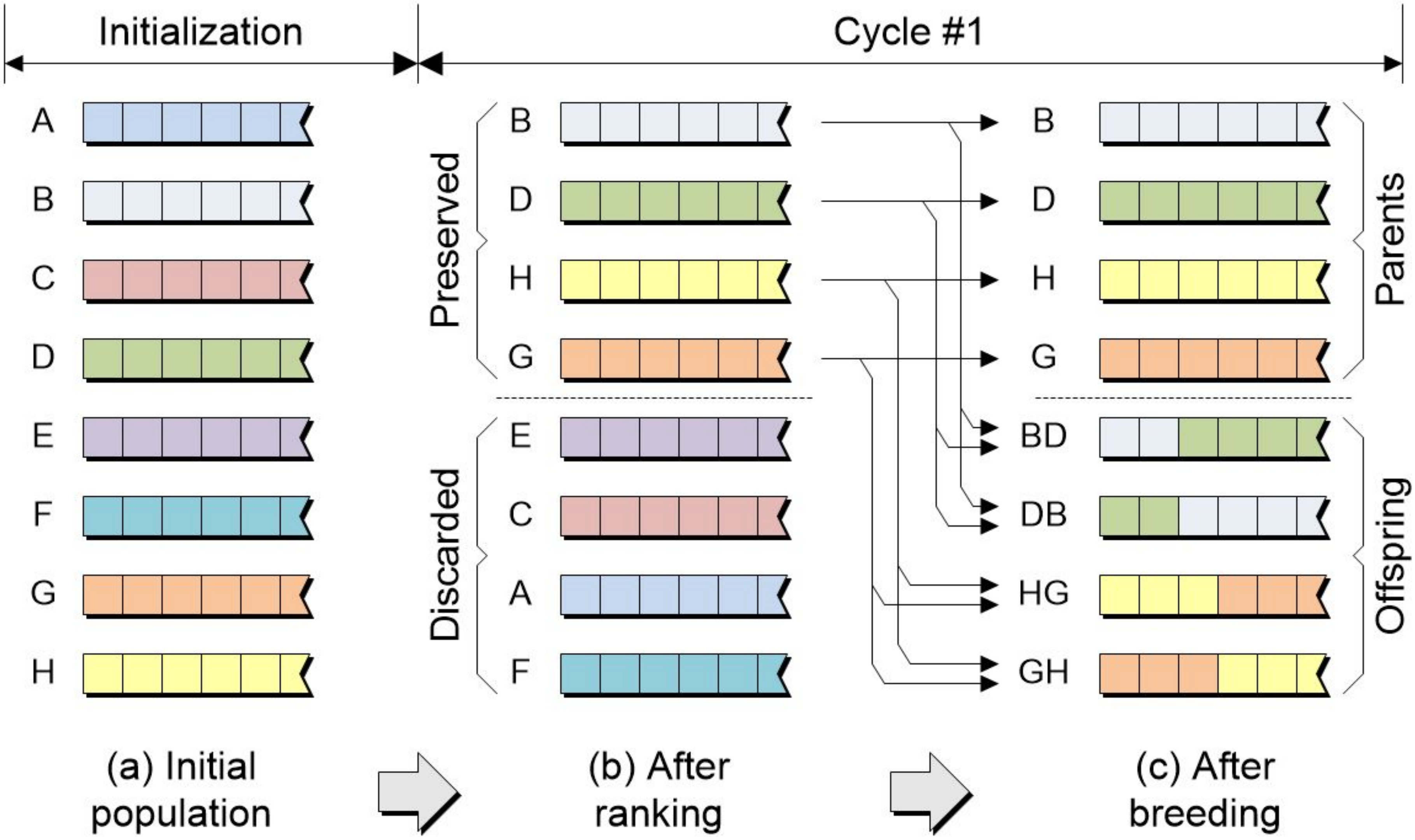
Idea Three. Probability decreases with time, and also as $E – E_i$ increases.

```
1.  Let X = initial config
2.  Let E = Eval(X)
3.  Let i = random move from  the moveset
4.  Let E_i = Eval(move(X,i))
5.  If E < E_i then
6.        X = move(X,i)
7.        E = E_i
8.  Else
9.        with some probability, accept the
    move even though     things get worse:

10.       X := move(X,i)
11.       E := E_i
12. Goto 3 unless bored.
```

Genetic Algorithm

A genetic algorithm is a search heuristic that is inspired by the theory of natural evolution. This algorithm reflects the process of natural selection where the fittest individuals are selected for reproduction in order to produce offspring of the next generation.



Initialization
Cycle #1
A
B
C
D
E
F
G
H
Preserved
Discarded
B
D
H
G
E
C
A
F
B
D
H
G
BD
DB
HG
GH
Parents
Offspring
(a) Initial population
(b) After ranking
(c) After breeding