Math 343, Lecture 22

① Simulated annealing

How can we get out of local maxima?
One approach is

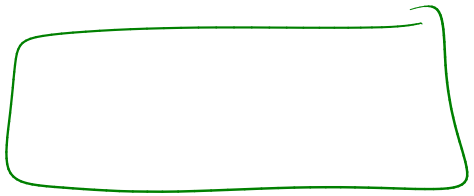
If

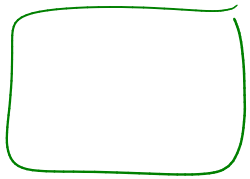
If

What we do is

This approach is called simulated annealing in analogy with annealing of metal

Back to simulated annealing,





Generally

Meta Algorithm Generic Simulated Annealing

$c = 0$

$T = T_0$

Select a feasible $X \in \mathcal{X}$

$bestX = X$

while $c \leq maxc$

return $bestX$

Lets use simulated annealing with the knapsack problem

Make the following choices

- $N(X) =$
- given X, generate a random $Y \in N(X)$ by

Then $w(Y) =$

and $P(Y) - P(X) =$

- begin with

Good choices of c_{max}, α and T_0 will depend on the problem instance

Algorithm Simulated Annealing Knapsack

input: c_{max}, T_0, α

eg Take the following profits and weights

profits	135	139	149	150	156	163	173	184	192	201	210	214	221	229	240
weights	70	73	77	80	82	87	90	94	98	106	110	113	115	118	120

capacity 750

backtracking will give the optimal solution

$$X = [1010101111000011]$$

with profit 1458

Choose T_0 so we have a high probability of accepting a downwards move initially. Kreher and Stinson choose $T_0 = 1000$ as then $e^{-240/T_0} = .787\ldots$

$e^{-135/T_0} = .874\ldots$ which are the extreme profits

This algorithm needs slow cooling. lets use $\alpha = 0.999$

lets do a few iterations by hand

Kreher and Stinson tried different values of α and c_{max} running 10 instances of each

The table is from p178

TABLE 5.3
Summary data for the knapsack simulated annealing algorithm.

α	c_{max}	profits found		
		minimum	maximum	average
0.999	1000	1441	1454	1446.8
0.999	5000	1448	1456	1452.1
0.999	20000	1448	1456	1450.9
0.9995	1000	1445	1455	1448.4
0.9995	5000	1450	1458	1454.6
0.9995	20000	1452	1458	1453.9
0.9999	1000	1445	1455	1449.6
0.9999	5000	1450	1458	1454.3
0.9999	20000	1453	1458	1456.1

(2) Next time

Review questions. I will post some.

Please come with any questions you have.