Intro

- Sometimes state space is SO large, search can't do much
- n-queens problem (set up queens in such a way that they can't attack each other)

Traveling Salesman Problem

- Have to visit n cities and then return to the starting point. Have to visit all nodes
- NP hard (nondeterministic polynomial), exponentially difficult
  - connect all the cities randomly, and then uncross all the paths that cross
  - can get really close to the optimal solution

4-Queens

- Iterative improvement problem, no queen can be on the same verticle, horizontal, or diagonal
- probably want to start with the queen with the most "attacks"
- the example was solved with 2 moves, search would have taken forever here

5-Queens

-

n-Queens Heuristic Function

- reduce the number of atacks per move
-

n-Queens Local Minima

- when the position has the least amount of attacks, any move will make more attacks than before.

Hill Climbing

- Queens is multidementional, point of this is to maximize the value of a line
- Can move left or right on the X axis
- shoulder - on the hill up but flat
- global maximum - the highest point
- local maximum - a high point on the graph
- "flat" local maximum, multiple points that are part of the local max

Local Maximum

- look to the left, goes down. Look to the right, goes down this is a local maximum
- tallest peak is the global maximum

Random Restart

- climb and restart until you find a bunch of local peaks, and then return the highest one
- taboo search: keep track of where you've been already and not repeat that search

Step Size Too Small

- if at a shoulder, and the step size is too small, it might only see the shoulder
- how many times should a flat line be okay

Step size too big

- if the step size is too big, it might be that the hill gets passed
- you could end up with a infinite loop (skipping the max and then oscilate)
  - start with a big step size and then make it smaller as you go

Annealing

- lowest enegry positons, like mudcracks, honeycombs
- mimization done by design, iron molecule low energy states
- Idea of heating and cooling to get out of oscilation
- increase and decrease randomness

Simulated Annealing

- Formula:
- for t=1 to infinity do:
  - T <– schedule(t)
  - if T=0 then return current
  - next <– a randomly selected successor of current
  - if delta(E) > 0 then current <– next
  - else current <– next only with probablity e^(delta(E)/T)
- English:
  - itrate looking for points to current points that have better value
  - however, select points randomly in the region near us, if positon is better than curren postion, then take it.
  - if new position is not better, than take it with a crazy weird probabilty
  - in the beginning the temprature is high (moves randomly) then cools down when it gets to the peak and does a hill search
- guaranteed to find global max if start T big enough and cool it slow enough

Simulated Simulaed Annealing

-

Local Beam Search

- instead of one particle, we have K particles
  - unline random restart, the particles share info between iterations

- stociastic beem search, has some randomness

Representing n-queens

- encode by column, number represents how high up (row) the single queen is at

Genetic Algorithms

- there are 28 posibile pairs of attacking queens
  - 8!/(8-2)!*2! = 28
- good to know, because thats part of the fitness function (28 means we won!)
- Example
  - get four random boards, evaluate each boards based on fitness function
  - porportional probability of how likely it is to breed (normalize to percentage)
  - then based on that probability, choose which boards can be parents
  - n parents make m babies by crossover (select random point to split parents. The children get a slice based on the split from each parent)
  -

GA Crossover

-

GA Mutation

- small chance that the digit will mutate into another digit, this adds some randomness and ensures that good features aren't lost forever
- randomness stociastic beam search
-

Method Similarities

- reducing the randomness in mutation, but the method could do better
- tuning crossover, number of parents etc.
- this is a version of stociastic beam search (but has an anaology with biology)
-

Outro

- could get stuck in local max, so we used randomness to fix this
- random restart, restart randomly
- simulated annealing to cool of the randomness to get better
- genetic algoritm, select position based on fitness
- stociastic beam search, children get better ## READINGS

- AIMA: Chapter 4.1
- Further information 4.2 -4.5 ## Lab (optional)
-