Simulated Annealing Algorithm

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Introduction

- Simulated annealing is a probabilistic technique for finding global optimum.
- This algorithm is a proposed alternative to generic greedy search, hill climbing algorithms.
- Hill climbing algorithms are good at finding local optimal solutions but don't perform well with global solutions.
- Simulated annealing is inspired by the process of annealing in metallurgy where a material is heated and slowly cooled under controlled conditions to increase the size of the crystals in the material and reduce their defects.

Simulated Annealing Algorithm

1. Generate an initial candidate solution x.
2. Get an initial Temperature $T > 0$.
3. for i in 1:N(N = number of iterations)
   - Sample ζ $g(\zeta)$ where g is a symmetrical distribution.
   - The new candidate solution is $x' = x\zeta$
   - Calculate probability $p = exp(\Delta h / T_i)$
   - Accept the candidate solution with probability p; $uU(0, 1)$, accept $x = x'$ if $u \leq p$.
   - Update the temperature (cooling), e.g. $T = aT$ where $0 < a < 1$

Simulated Annealing Algorithm Contd.

- The main difference in strategy between greedy search and simulated annealing is that greedy search will always choose the best proposal, whereas simulated annealing has a probability (using a Boltzmann distribution) of choosing a worse proposal than strictly only accepting improvements.
- This helps the algorithm find a global optimum by jumping out of local optimum.

Notes on Parameters

- The greater the value of T (temperature), the greater the likelihood of moving around the search space. As T gets closer to zero, the algorithm will function like greedy hill climbing.
- Good starting values for T will vary problem by problem. We usually start with 1, 10, 100, and adjust after a few experiments.
- For a, we normally choose 0.95. However, you can change T by any amount, Robert and Casella suggest a temperature decrease in $1/\log(1+i)$ for i in $1:N$.
- For a review of cooling schedules, we recommend reading "A comparison of simulated annealing cooling strategies."

References

- Introduction to Monte Carlo Methods with R by Robert and Casella.
- Optimization by Simulated Annealing: An Experimental Evaluation; Part I, Graph Partitioning.