



Figure 17: The structure of the simulated annealing algorithm.



Simulated Annealing

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References

- ▶ C. Blum and A. Roli. **Metaheuristics in Combinatorial Optimization: Overview and Conceptual Comparison.** *ACM Computing Surveys*, Vol.35, No.3, Sept. 2003, pp. 268-308.
- ▶ Sean Luke, 2009, ***Essentials of Metaheuristics***, available at: <http://cs.gmu.edu/~sean/book/metaheuristics/>

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Simulated Annealing

- ▶ Inspired by the Metropolis Hastings Algorithm.
- ▶ Developed in the mid 1980s.
- ▶ Inspired by how atoms within a metal change their structure through the application of heating and cooling (metal annealing).
- ▶ Single-state algorithm (no population)

Simulated Annealing Algorithm details

- 1: t = temperature (initially this is large)
- 2: S = a random (or otherwise) starting solution
- 3: $BestS = S$
- 4: **repeat** (until convergence) **or** (time is expired)
- 5: $R = \text{Neighbour}(S)$
- 6: **if** ($\text{Quality}(R) > \text{Quality}(S)$) **or** (random number from 0 to 1 $< e^{(\text{Quality}(R) - \text{Quality}(S))/t}$) **then**
- 7: $S = R$
- 8: Decrease t
- 9: **if** $\text{Quality}(S) > \text{Quality}(BestS)$ **then**
- 10: $BestS = S$

Intensification versus diversification

- ▶ How does the SA algorithm control intensification and diversification?
- ▶ Temperature
 - ▶ High - - - - Low

Software Demo

- ▶ <http://www.heatonresearch.com/articles/64/page1.html>

Stochastic Local Search

- ▶ Simulated Annealing without a temperature component.
- ▶ Good at improving the quality of already good solutions.
- ▶ Often run as hybrid with other global search techniques.
- ▶ Good example of a SLS algorithm is 2-opt for the TSP.