Hill-Climbing
start in a random place
[do a tweak
[if it's better, we go there

So far, we never allow moving to a worse score — always uphill.

We need MHs that allow downhill moves.

Two ideas: exploration   vs.   exploitation
              diversification   vs.   intensification

looking in new areas   searching the
of the search space   area you've
                                  already in for
                                  better and better
                                  solutions

Maximally explorative: Random Search
Maximally exploitative: Hill Climbing

MHs: "how to go downhill smartly"

Two ways right now:
  (1) Hill Climbing with Random Restarts
MH #5

```
best = random solution
while True:
    x = random solution
    for some amount of time:
        s = tweak(x)
        if score(s) > score(x):
            x = s
    if score(x) > score(best):
        best = x
```

(2) Probabilistic Hill-Climbing
  You look at a bunch of tweaks,
  pick one at random, weighted
  according to score.

Topic #13 – Simulated <u>Annealing</u>

SA: worsening moves are allowed with some probability

↓

change over time

At the start, the system has a high temperature → worsening moves are accepted with high probability

The system cools over time, that probability decreases

Very high temp: basically random search (explorative)

Very low temp: basically hill climbing

Idea: As the system is cooling, you hope to wander onto a good hill and then stay there.

Technical Details: (max)

Acceptance Conditions:

Suppose the current temp is T.

Let $s = \text{tweak}(x)$ and $\Delta = \text{score}(s) - \text{score}(x)$

If $\Delta > 0$, improvement, always accept.

If $\Delta \leq 0$, accept with some prob.

$$p = e^{\Delta / T}$$

(Boltzmann distr.)

High T $\Rightarrow$ Small Δ / T $\Rightarrow$ p close to 1
          +negative $\Rightarrow$ high prob of accepting

* If minimizing: $p = e^{-\Delta / T}$.