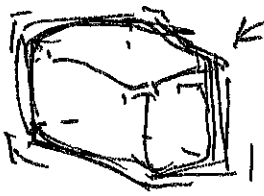
MIDTERMS: TIFFANY - set covering
STEPHEN - traveling sales ✓ ← TODAY
JAMES - dynamic prog.
JEREMY - longest substr.

QUESTIONS?

Simulated Annealing: heat a metal/glass & cool slowly to remove internal stresses & strengthen it.

analog: ice cubes aren't clear (or obviously symmetric.)



OUTSIDE FREEZES FIRST FORMS CRYSTAL STRUCTURES.. BREAKS SYM
... BUT INSIDE HAS TO "RECONCILE" THIS BROKEN SYM FROM BOUNDARY! → "BREAKS"

→ this, by the way, is similar to the isotropy problem of the early universe.

This boils down to finding a global min of E.
↳ will be similar to machine learning! ↑

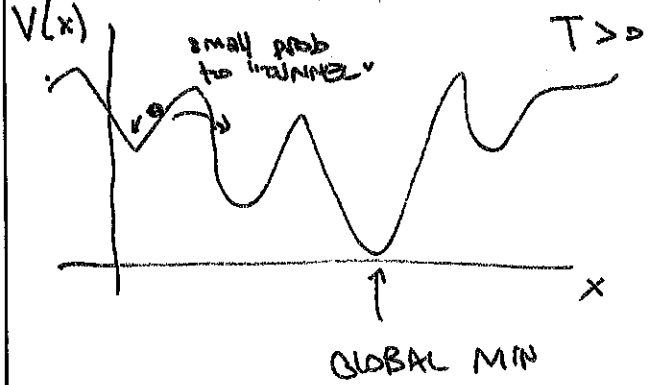
IMPORTANT: technique to find global min of a func. HARD.
→ not nec. having to do w/ phys!

clever solution: Scott Kirkpatrick (1985) using STATMECH
↳ can be seen as limit/application of MCMC

sample many k states randomly

Metropolis: even allows sampling energetically disfavored states (@ cost of low prob.)

this is key to getting out of local minima.



IDEA: WANT TO FREEZE IN GLOBAL MIN of $V(x)$ ← $E(x)$

special "μ state"

start @ hi T (sample the space {x})

↓ SLOW

cool to low T (freeze into global min)

What if you get stuck in local min?

↳ brittle glass is in a local min.

nb: in real glass annealing: cooling is SUPER slow (days)

.. in simulated annealing: to GUARANTEE ground state, thy ⇒ also very slow & comp. intensive.

.. in practice, this is an efficient method for "PROBABLY good enough"

RULES: • start hot, equilibrate quickly

↑ wrt WHAT? ↳ $p \sim e^{-\beta E_i}/Z$

HOT → UNIFORM

roll dice, pick step $i \to j$ → accept? $\begin{cases} 1 & \text{if } E_j \le E_i \\ e^{-\beta(E_j - E_i)} & \text{otherwise} \end{cases}$ ← ≤ important now

($T \to \infty$, $\beta \to 0$

$e^{-\beta\Delta E} \to 1$ ← $e^{-\beta\Delta E}$

↑ accept if you land here

↳ reject prob is low.

- WHAT RATE OF COOLING? (cooling schedule)

typical choice:

$$T(t) = T_0 e^{-t/\tau}$$

T_0: hot w/rt typical energies

τ: what time constant? (basically units)

↑ PRACTICALLY, TIME SCALE SET BY YOUR WILLINGNESS TO WAIT.

↳ BIG τ vs. SMALL τ

BIG τ: slower. BETTER ANNEALING

SMALL τ: faster. REACH T ~ 0 SOONER.

TRAVELING SALESMAN

significance: NP hard

↳ non polynomial time (this is why cs loves O notation)

given N coordinates, find shortest series of connections that minimize total travel time.

↳ feels like a path integral problem (euler-L)

↳ led me to "PIMC" eg 1709.05496

METRIC: $\Delta D_i = \sqrt{(\vec{r}_{i+1} - \vec{r}_i)^2}$

$$D = \sum_i^{N-1} \Delta D_i$$

↳ minimize this