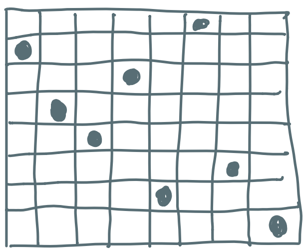
Hill Climbing / Genetic Algorithm

Ex. 8-queens, place 8 queens such that they do not attack each other
- Hard to know the goal state
- Hard to know successor state
- Cannot enumerate

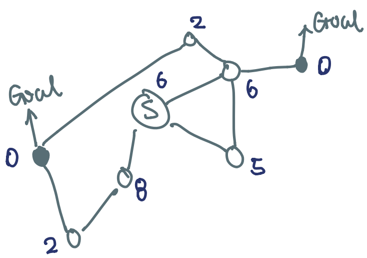


$S = \{2\ 4\ 5\ 3\ 7\ 1\ 6\ 8\}$

$succ(S) = \{t,\ t$ differs from S by one column$\}$

$$= \left\{ \begin{array}{ll} (1\ 4\ 5\ 3\ 7\ 1\ 6\ 8), & (2\ 1\ 5\ 3\ 7\ 1\ 6\ 8) \cdots \\ (3\ \cdots\cdots), & (2\ 2\ 5\ 5\ \cdots) \\ (4\ \cdots\cdots) & \vdots \\ (\vdots\ ) & \vdots \\ (8\ \cdots\cdots) & (2\ 8\ \cdots\cdots) \end{array} \right\}$$

This will form a graph with direction, and connected.



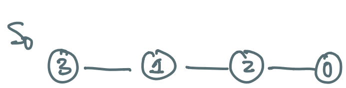
It's possible that there are more than 1 goal.

Create a quality on each state, such that the quality on Goal state is very good.

The quality is the number of queens attacking each other.
Hence, a score function
score $f(S) :=$ # of queens being attacked in S

Imagine the graph is a 3-D graph, where the z-axis represents the score
Optimization: $\min_{s \in \mathcal{S}} f(s)$ ← state space

Hill-Climbing
-greedy!



global minimum
if $\forall t \in \mathcal{S},\ f(s) < f(t)$

local minimum
S is a local minimum if $\forall t \in succ(S),\ f(s) < f(t)$

Hill Climbing with random restart

population = set of (init) states

$S_0 = (2, 8, 1, 7, 6, 4, 5, 3)$
$S_1 = (\qquad)$
$S_2 = (\cdots \qquad)$

fitness $f(s)$

$$\frac{[9 - f(s_i)]}{\sum_{j=0}^{n} [9 - f(s_j)]} = P_i \quad \text{probability of state } S_i \qquad i = 0 \ldots n$$

draw $i \sim (P_0, \ldots, P_n)$ $\qquad i \in \{0, 1, \ldots, n\}$
$j \sim (P_0, \ldots, P_n)$

$S_i = (\boxed{1\ 3\ 2}\ 5\ 4\ 6\ 8\ 7)$
$S_j = (5\ 2\ 3\ \boxed{4\ 8\ 7\ 1\ 6})$

pos1 pos2 pos3

pos $\sim$ unif(1 ... 8)
e.g. pos = 3

$t_1 = (1\ 3\ 2\ 4\ 8\ \boxed{7}^{2}\ 1\ 6)$
$t_0 = (5\ 2\ \boxed{3}_{4}\ 5\ 4\ 6\ 8\ \boxed{7}_{5})$

randomly choose $\boxed{n}$, and change value arbitrary (mutation)