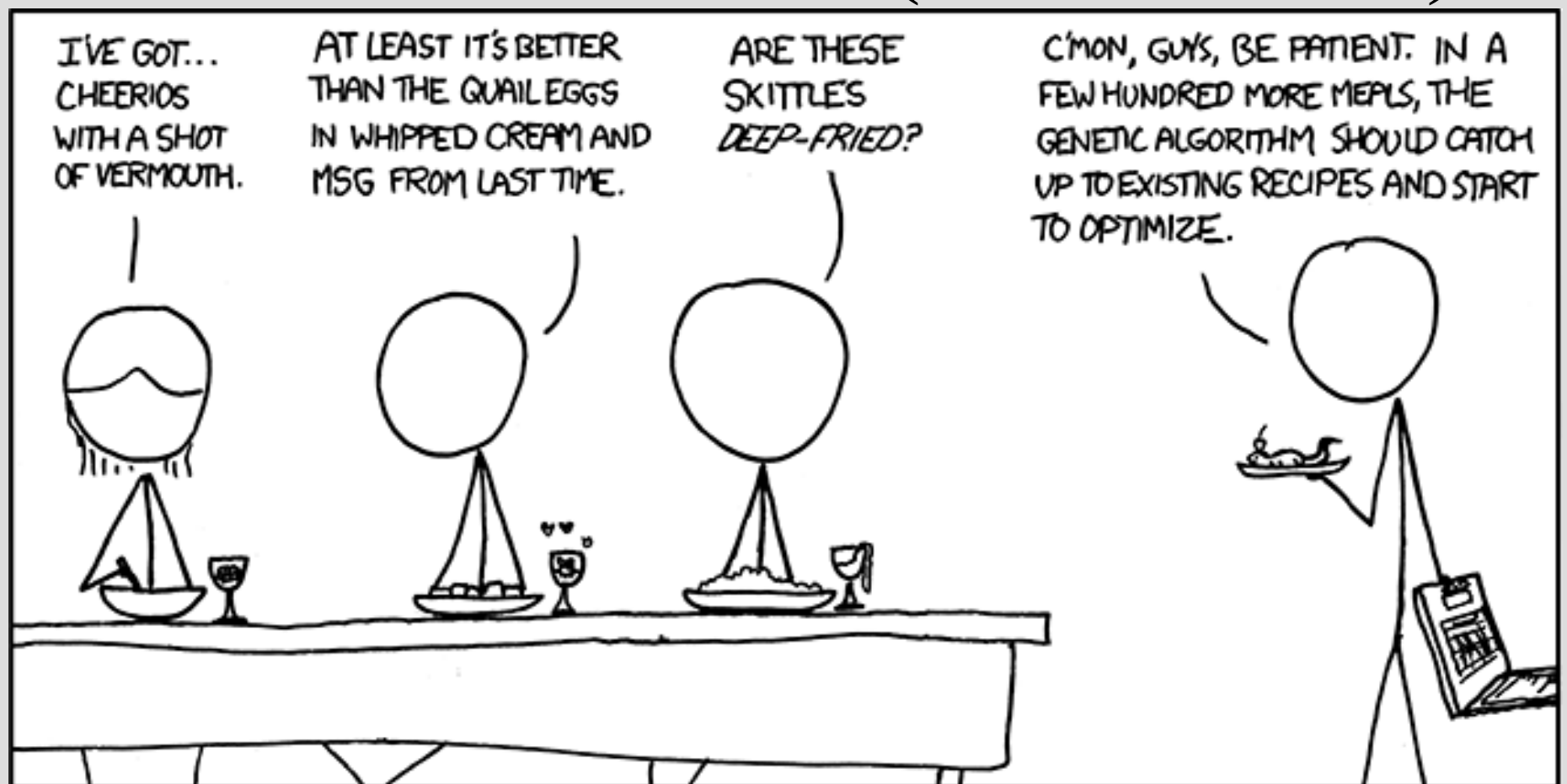


Local Search (Ch. 4-4.1)



WE'VE DECIDED TO DROP THE CS DEPARTMENT FROM OUR WEEKLY DINNER PARTY HOSTING ROTATION.

Local search

We will discuss four optimization algorithms:

1. Hill climbing ✓
2. Simulated annealing ✓
3. Beam search
4. Genetic algorithms

All of these will only consider neighbors while looking for a goal

Local beam search

Beam search is similar to hill climbing, except we track multiple states simultaneously

Initialize: start with K random nodes

1. Find all children of the K nodes
2. Add children and K nodes to pool, pick best
3. Repeat...

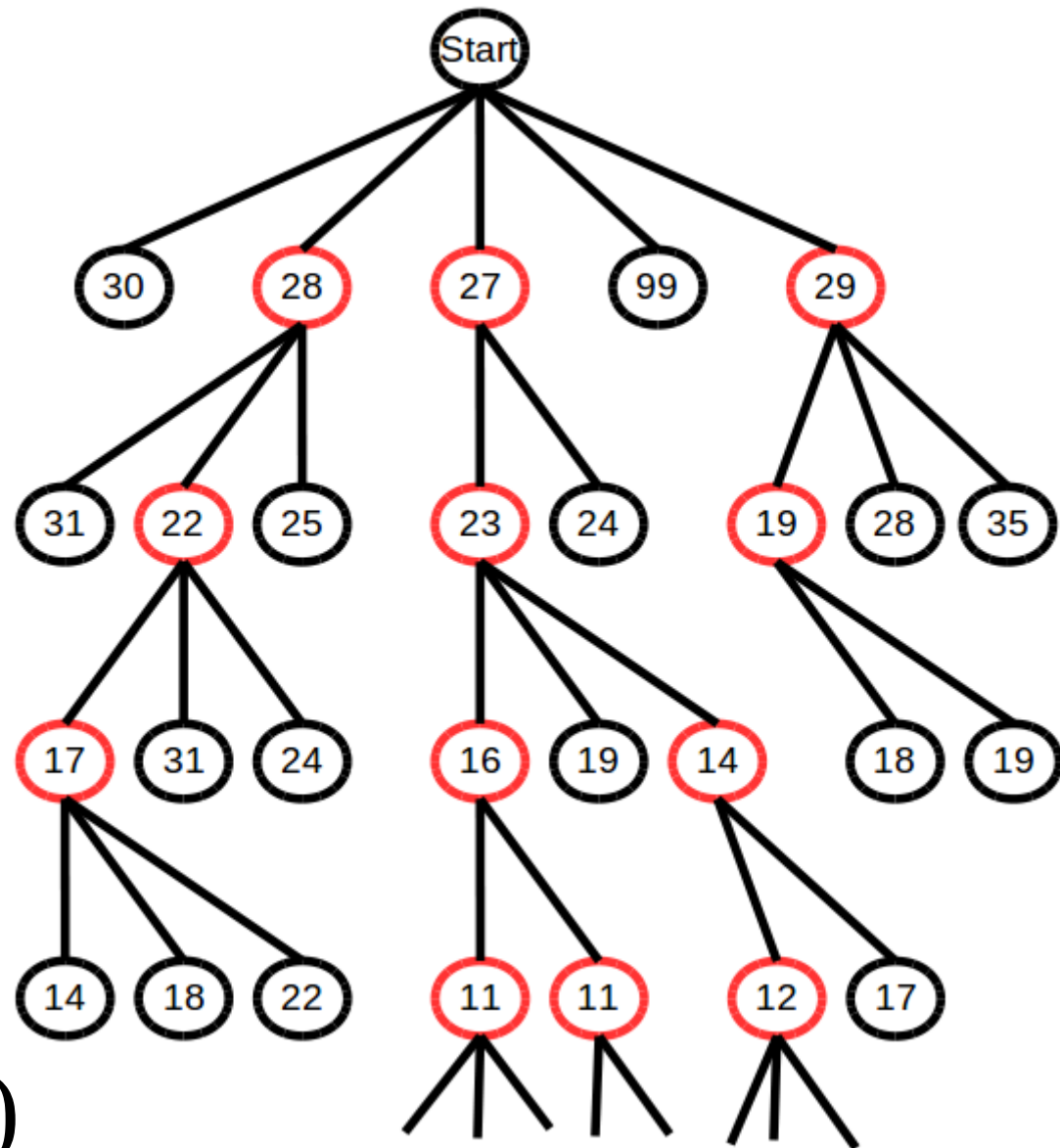
Unlike previous approaches, this uses more memory to better search “hopeful” options

Local beam search

Beam search with
3 beams

Pick best 3 options
at each stage to
expand

Stop like hill-climb
(next pick is same
or worse as last pick)



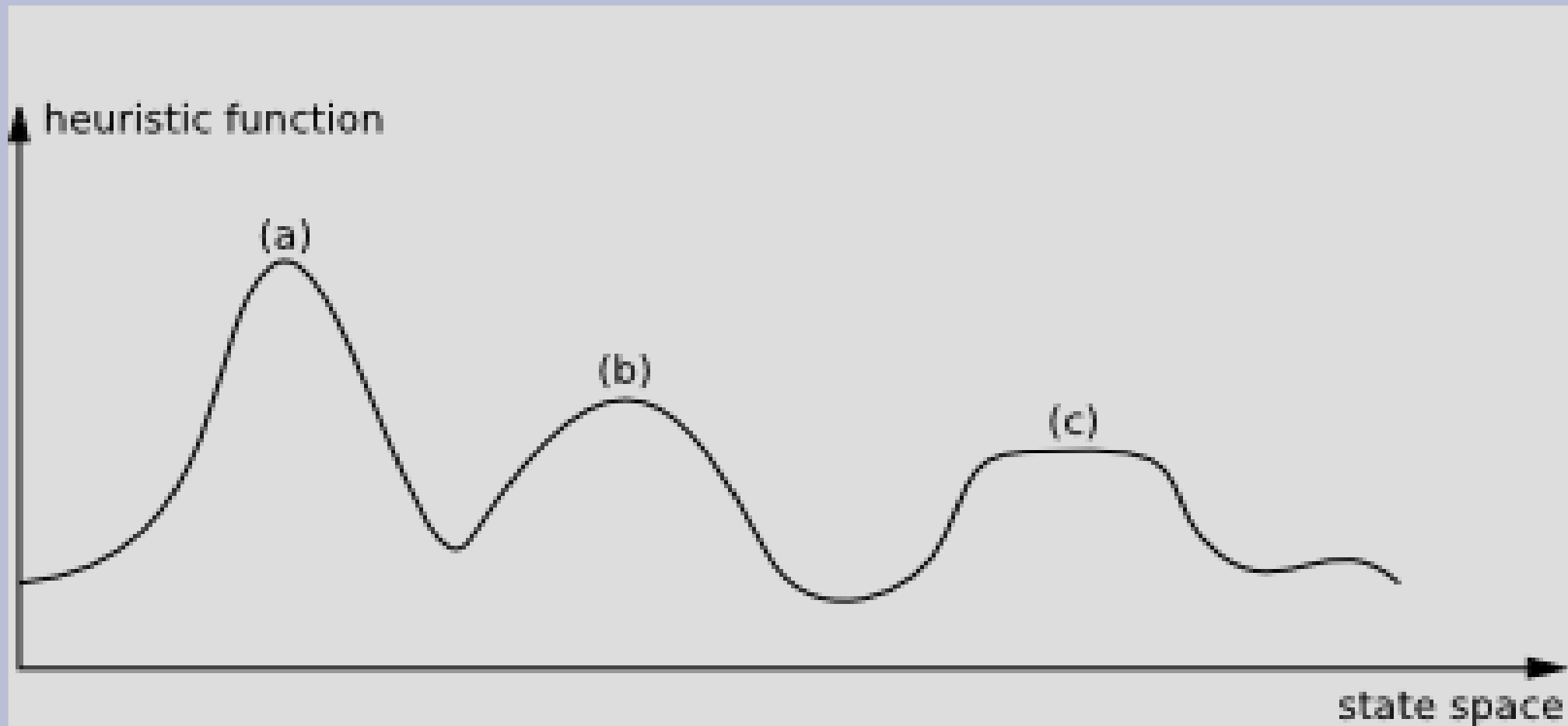
Local beam search

However, the basic version of beam search can get stuck in local maximum as well

To help avoid this, stochastic beam search picks children with probability relative to their values

This is different that hill climbing with K restarts as better options get more consideration than worse ones

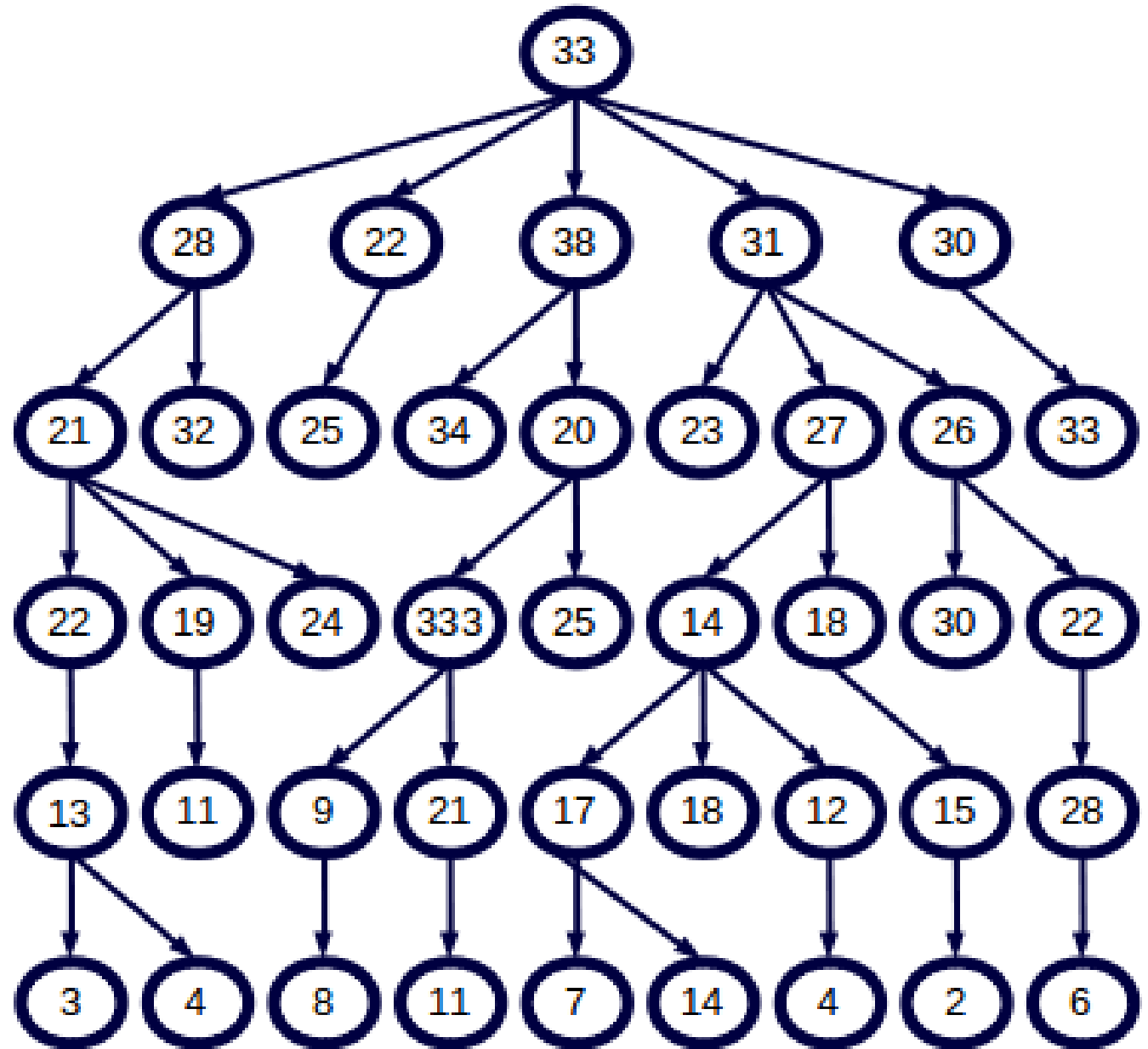
Local beam search



Local beam search

You try it!

Run local-
beam search
with $k=4$
on this tree



Genetic algorithms

Genetic algorithms are based on how life has evolved over time

They (in general) have 3 (or 5) parts:

1. Select/generate children
 - 1a. Select 2 random parents
 - 1b. Mutate/crossover
2. Test fitness of children to see if they survive
3. Repeat until convergence

Genetic algorithms

Nice examples of GAs:

http://rednuht.org/genetic_cars_2/

<http://boxcar2d.com/>

Donate

Save Population
Restore Saved Population Surprise!
New Population

Create new world with seed:
Enter any string Go!

Mutation rate: 5%
Mutation size: 100%
Floor: fixed
Gravity: Earth (9.81)
Elite clones: 1
generation 94
cars alive: 13
distance: 36.79 meters
height: 2.67 meters

Watch Leader

Rank	Score	Time
0	139.5	0:24
1	84.4	0:10
2	3.8	0:01
3	0.3	0:02
4	3.4	0:02
5	1.8	0:00
6	10	0:05
7	3.2	0:02
8	22.2	0:10
9	11.6	0:03

View top replay

Top Scores:

- #1: 212.25 d:206.16 h:-11.8/10.66m (gen 66)
- #2: 211.61 d:206.83 h:-12.05/10.46m (gen 43)
- #3: 203.18 d:197.94 h:-9.09/10.37m (gen 7)
- #4: 182.57 d:176.11 h:0/10.83m (gen 84)
- #5: 180.08 d:174.49 h:0/10.95m (gen 39)
- #6: 176.99 d:172.86 h:0/11.14m (gen 26)
- #7: 169.33 d:162.43 h:0/10.83m (gen 85)
- #8: 168.81 d:162.43 h:0/10.56m (gen 79)
- #9: 168.6 d:163.12 h:0/11.19m (gen 32)
- #10: 168.49 d:164.13 h:0/11.59m (gen 17)

BoxCar 2D

Home | [Designer](#) | [Best Cars](#) | [Forum](#) | [News](#) | [FAQ](#) | [The Algorithm](#) | [Versions](#) | [Contact](#)

Computation Intelligence Car Evolution Using Box2D Physics (v3.2)

60 fps average
Physics step: 1 ms (833 fps)
18 MB used

Hide 139

Generation: 4 Max Score: 139.5

Copy All Copy Selectec

Car	Score	Time
0	139.5	0:24
1	84.4	0:10
2	3.8	0:01
3	0.3	0:02
4	3.4	0:02
5	1.8	0:00
6	10	0:05
7	3.2	0:02
8	22.2	0:10
9	11.6	0:03

Up
Next
Down
Copy Current
Copy Best

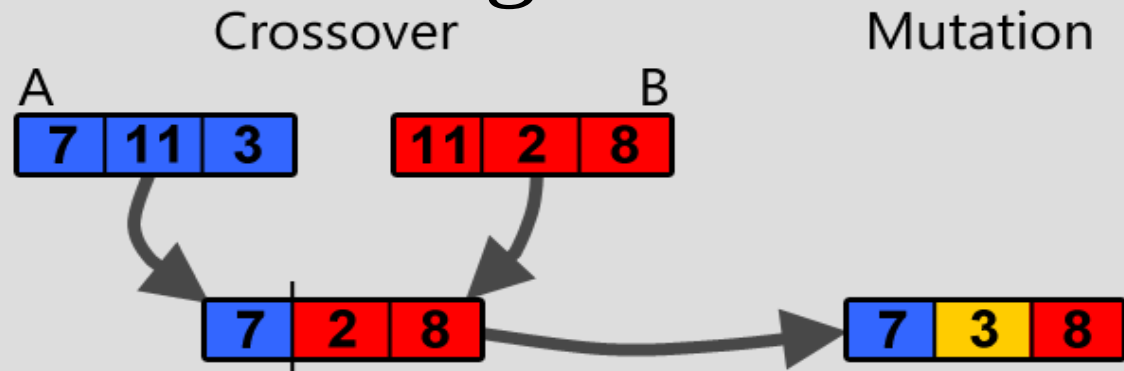
Time: 3:52 Score: 71.1 Torque: 152

Score Cache max wheels wheel speed Tournament Elite Selector mutation rate

Genetic algorithms

Selection/survival:

Typically children have a probabilistic survival rate (randomness ensures genetic diversity)



Crossover:

Split the parent's information into two parts, then take part 1 from parent A and 2 from B

Mutation:

Change a random part to a random value

Genetic algorithms

Genetic algorithms are very good at optimizing the fitness evaluation function (assuming fitness fairly continuous)

While you have to choose parameters (i.e. mutation frequency, how often to take a gene, etc.), GAs tend to head to optimal

The downside is that often it takes many generations to converge to the optimal

Genetic algorithms

There are a wide range of options for selecting who to bring to the next generation:

- always the top (similar to hill-climbing... gets stuck a lot)
- choose purely by weighted random (i.e. 4 fitness chosen twice as much as 2 fitness)
- choose the best and others weighted random

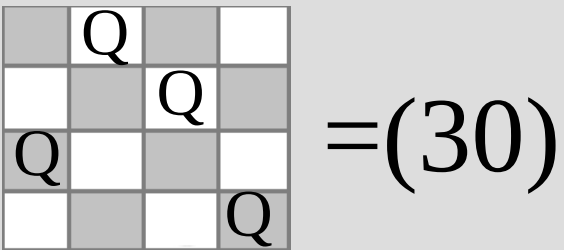
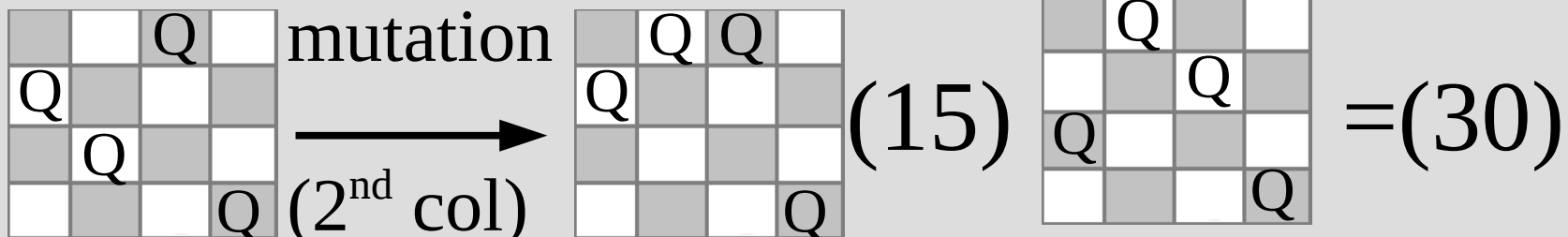
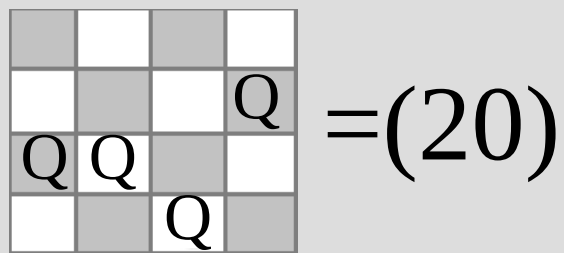
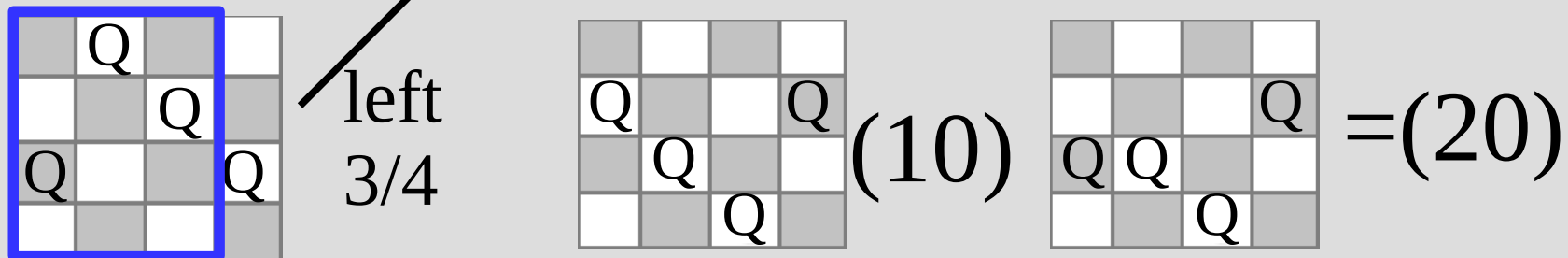
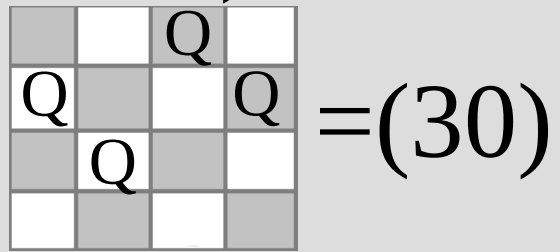
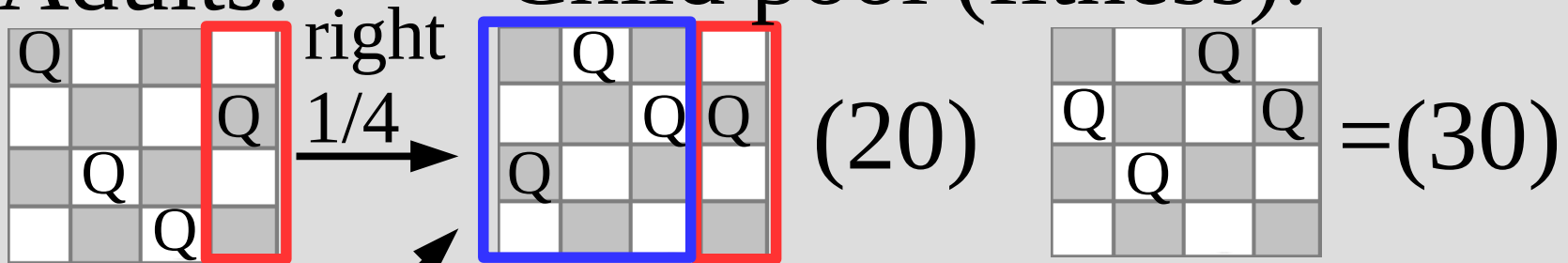
Can get stuck if pool's diversity becomes too little (hope for many random mutations)

Genetic algorithms

Let's make a small (fake) example with the 4-queens problem

Adults:

Child pool (fitness):



Genetic algorithms

Let's make a small (fake) example with the 4-queens problem

Child pool (fitness):

	Q		
		Q	Q
Q			

 (20)

		Q	
Q			Q
	Q		

 = (30)

Q			Q
	Q		
		Q	

 (10)

			Q
Q	Q		
		Q	

 = (20)

	Q	Q	
Q			
			Q

 (15)

	Q		
		Q	
Q			
			Q

 = (30)

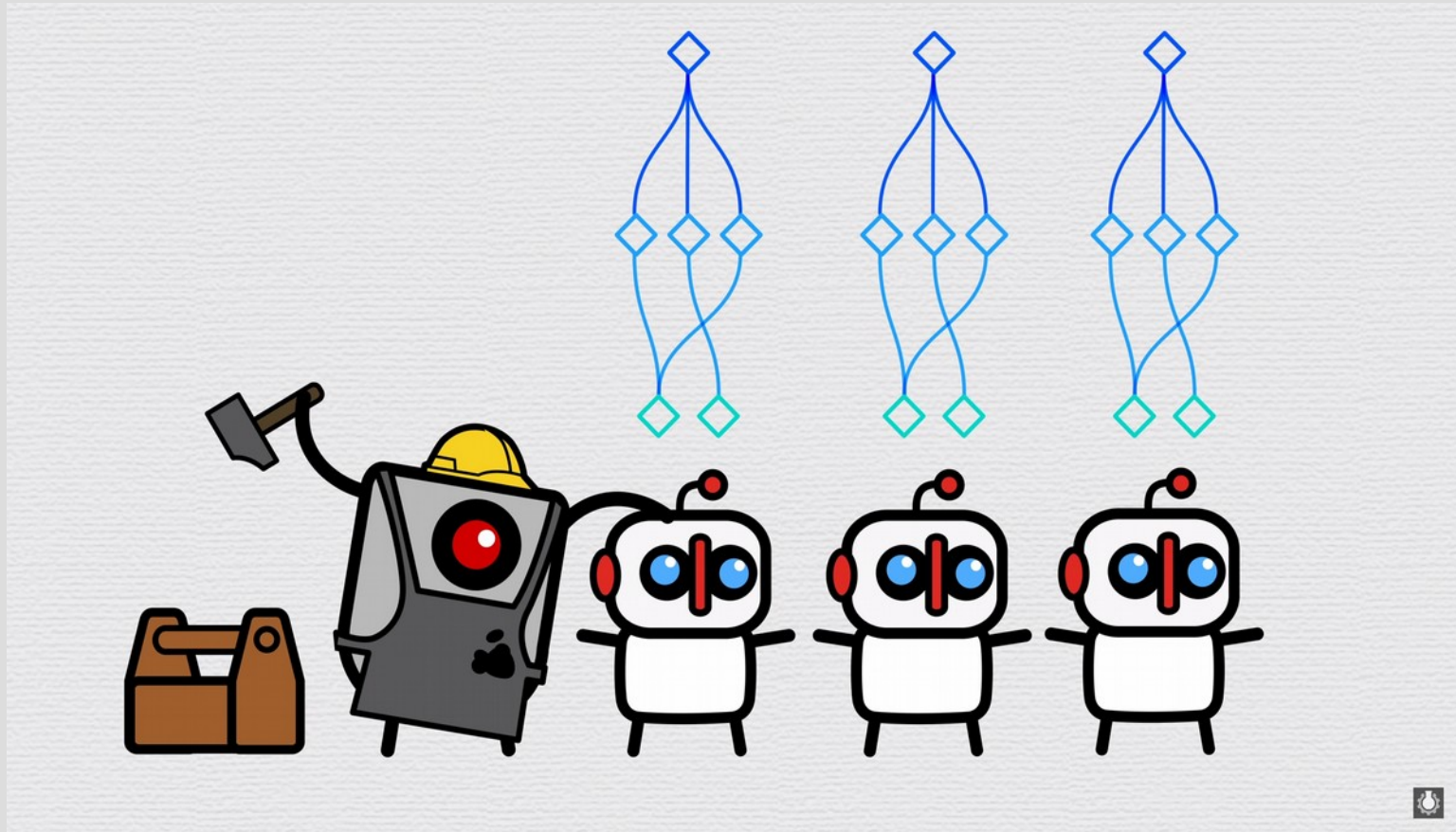
Weighted random selection:

		Q	
Q			Q
	Q		

	Q		
		Q	Q
Q			

	Q	Q	
Q			
			Q

Genetic algorithms



<https://www.youtube.com/watch?v=R9OHn5ZF4Uo>