

Optimization

Given a function $f(x_1, \dots, x_n)$, find x_1, \dots, x_n that yield $\max f(x_1, \dots, x_n)$
measure of strength of agent
constants in heuristic

- 6
 - 4
 - 5
 - 3
 - 1
- green
 rook
 bishop/knight
 pawn

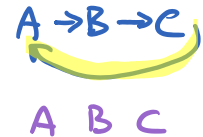
find x, y to maximize $4x + 5y - 2xy - x^2 - y^2$

TSP NP-complete find ordering of Seattle, Denver, Allentown, Baltimore, New Haven, Washington to minimize distance of corresponding tour

find assignment of classrooms to minimize student conflicts

NP-complete feedback arc set find ordering of teams to minimize upsets during previous season


		A	B	C	H	W
	A		w	w	L	w
	B			w	L	w
	C				w	w
	H					w
X		W	A	C	B	H



Solitaire Yahtzee: Estimate start-of-turn position value by counting

-2 4 3 for 1's open
 6 for 2's
 ⋮
 -6 12 18 for 6's open
 +6/open upper if on pace for bonus
 20 for open 3 of a kind
 -10 0 10 for FH
 15 for FH
 ⋮
 10 for Yahtzee

6 + 18 = 10 = 34



Play each turn to maximize turn score + next position value using heuristic

Find parameters to maximize avg. score

Fitness for 2-player games:

Elo :

numeric measure of strength based on strength of opps and results

2000 beats 1000
 2001 ↓ 999
 small change

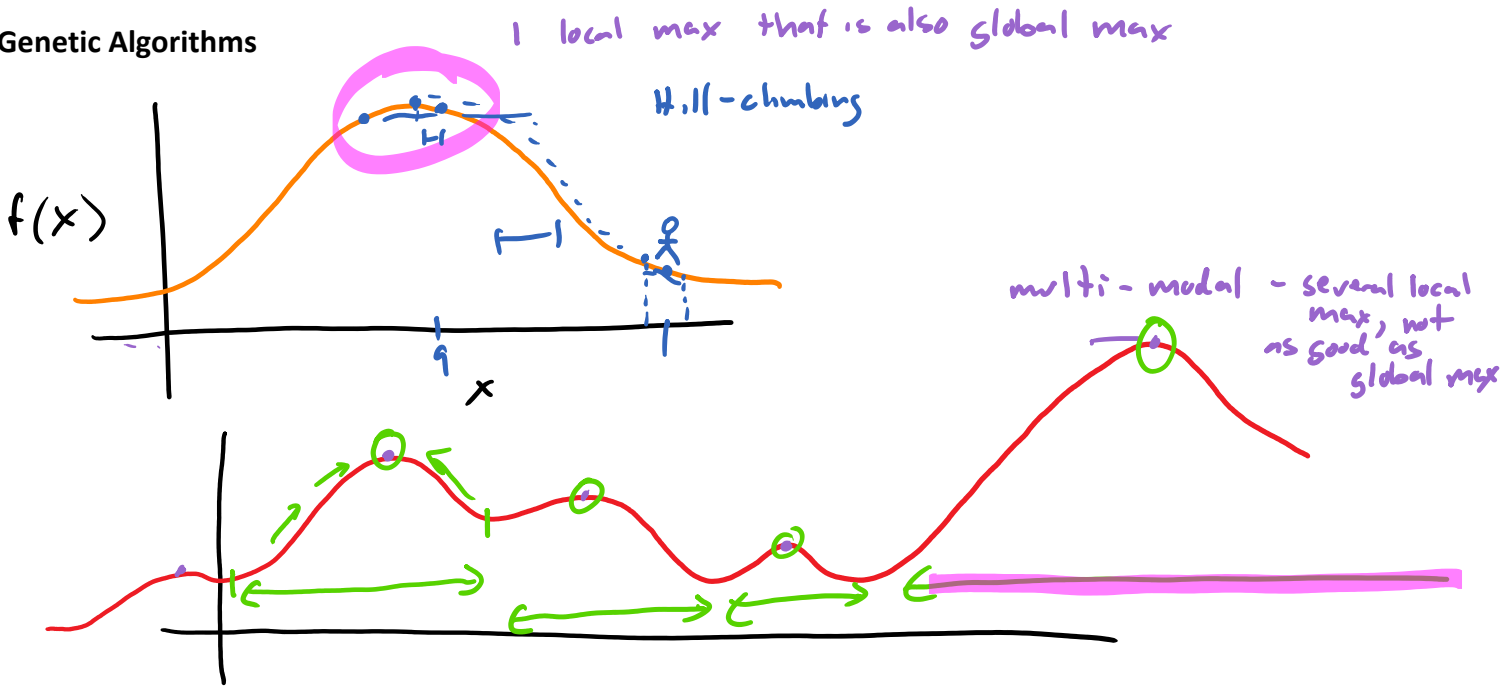
1000 beats 2000
 1032 ↓ 1968
 large change

diff of 200 → higher rated wins 75%

expected wins for A = $\frac{1}{1 + 10^{\frac{R_B - R_A}{400}}}$ ← ratings of player

update for $R_A = K \cdot (\text{observed wins for A} - \text{expected wins for A})$
 32

Genetic Algorithms



Evolutionary Computation

mimic natural selection

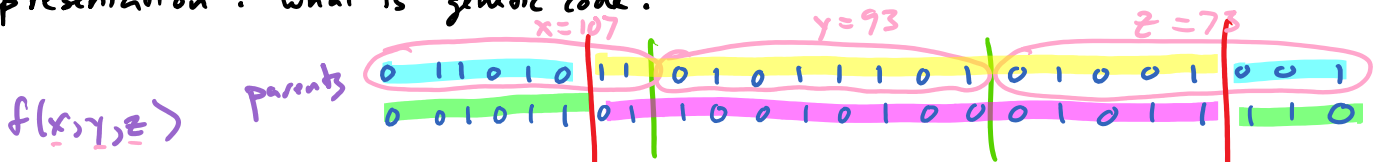
- Individuals have genes
- genes determine phenotype
- phenotype contributes to fitness
- fitness contributes to propagation

Genetic Algorithms

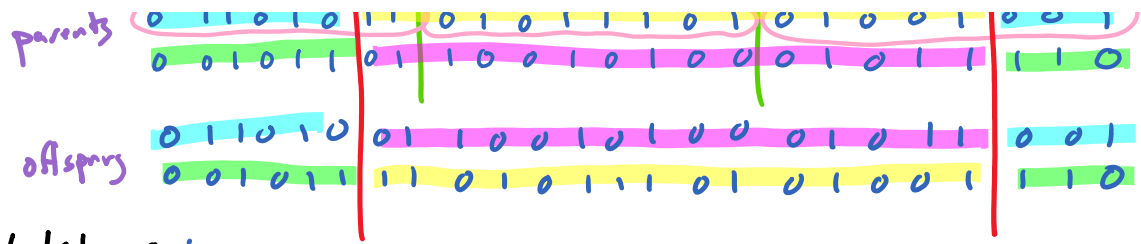
- start with random population candidate solutions randomly initialized
- while not done (out of time, no improvement, good enough)
- evaluate each individual inputs to $f \rightarrow$ evaluate $f \rightarrow$ fitness
- select for crossover select pairs of individuals, biased towards more fit individuals
- crossover combine genes from selected pairs exploitation
- select for survival replacement, or fitness-based
- mutate randomly change genes in survivors exploration

9 4 4 3 1
5

Representation : what is genetic code?

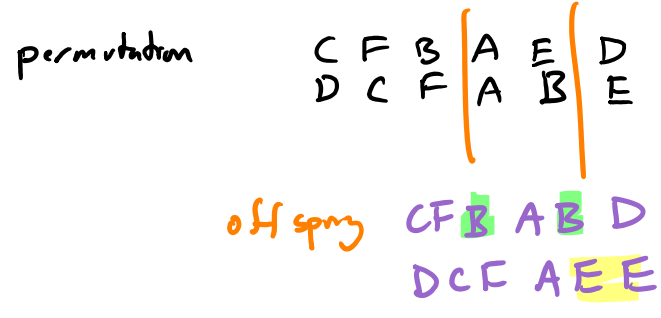


$f(x, y, z)$



Crossover: Bitstrings

two-point crossover



A B C D E F

Genetic Programming:

```

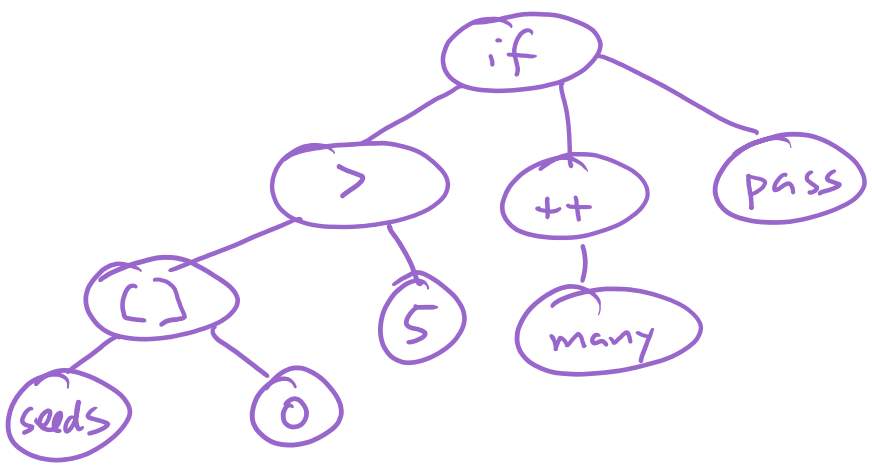
if seeds[0] > 5
{
  many++
}

```

```

if seeds[i] == 0 and seeds[i - 1] == 1
{
  return i-1
}

```



if seeds[0] > 5

```
{  
  return i - 1;  
}
```