Genetic Algorithms

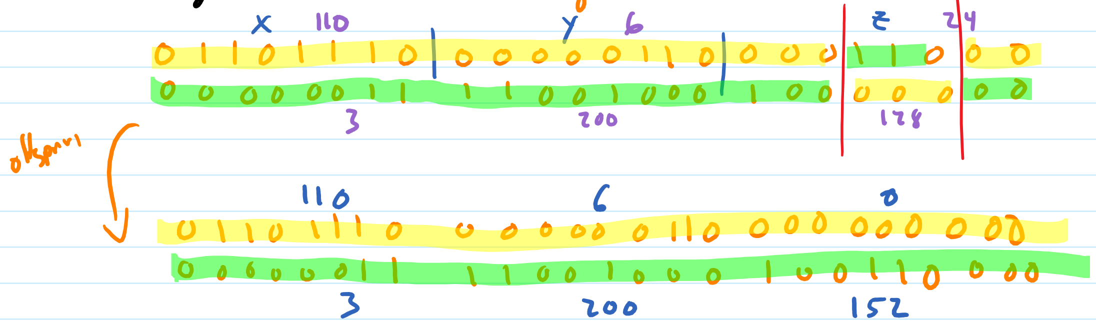
mimic natural selection — nature-inspired — ant colony opt / particle swarm opt

max f(x,y,z) ← individuals have genes
genes determine phenotype (physical characteristics)
phenotype contributes to fitness
fitness contributes to propagation

start with random population — random collection of individuals (random genes)
while not done (out of time, no recent improvement)
generation:
    evaluate individuals — genes → inputs to f → evaluate f → fitness
    select for crossover
    crossover — randomly select genes from each parent for offspring
    select for survival
    mutate — randomly change genes for some individuals

exploitation
exploration

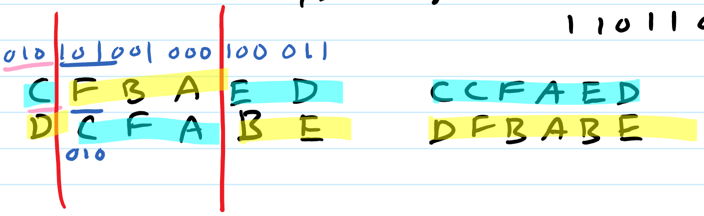
Representation : what is genetic code? some sequence of bits



Crossover : bitstrings - choose start/end randomly, exchange

0 1 1 1 0 1 0
1 1 0 1 1 0 0

permutation



offspring not permutations any more!

ABCDEF 24101
012345 32300

24300	CFEABD
32101	DCBAFE

Genetic Programming :

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

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

```
if seeds[i] == 0
{
      many++
}
```

O. David et al

Chess heuristic : for each player, count

9 for queen
5 for rook
3 for bishop
3 for knight
1 for pawn

+4 breakout pawn
+1 king protection
+1 rook mobility
⋮

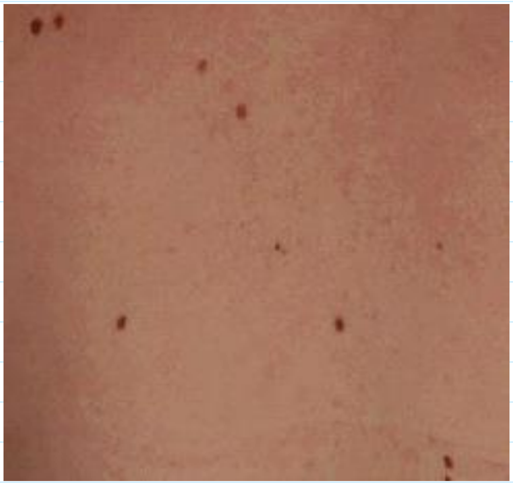
Problems for GA :

coevolution : fitness based on results of competing with other individuals

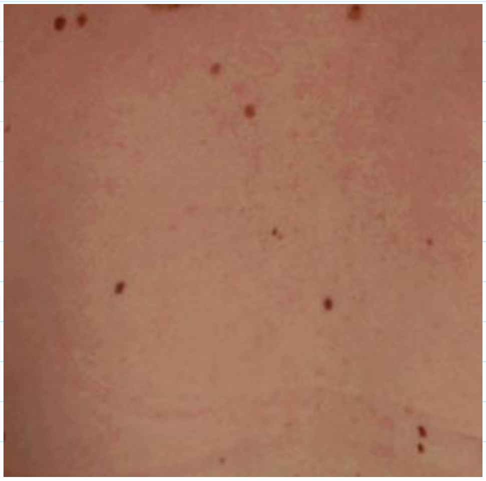
mentor : compare output to experts choices

GAs in Noisy Environments

Medical Image Registration



scale
translation
rotation
color shift



Optimization: Find parameters to

Fitness function: sum of difference of all pixels

of sum of difference of randomly selected pixels
(now a noisy fitness function)

Evolving a die with a high average

Parameter: num of sides

Fitness: mean value when rolling

Die 1	6 sided: 5 1 4
2	20-sided: 15 18 20
3	4 sided: 3 2 2
4	100-sided: 11 15 16
5	10-sided: 3 6 3

Evaluation Scheduling: Given budget T of fitness estimations, allocate across
individuals

generations
phases

to optimize evolution

Game Playtesting : Input

Fitness