Genetic Algorithm Task

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Scenario

Chromosome Structure

ch = (g0, g1, g2, g3, g4, g5, g6, g7)

0<= g <=9

Fitness

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

Maximisation Problem

Find chromosomes with the highest fitness

Part I

Finding Fitness of Chromosomes

Finding Fitness of Chromosomes

ch1 = (6, 5, 4, 1, 3, 5, 3, 2)

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

ch4 = (4, 1, 8, 5, 2, 0, 9, 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6, 5, 4, 1, 3, 5, 3, 2)

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

ch4 = (4, 1, 8, 5, 2, 0, 9, 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6 + 5) - (4 + 1) + (3 + 5) - (3 + 2)

ch2 = (8 + 7) - (1 + 2) + (6 + 6) - (0 + 1)

ch3 = (2 + 3) - (9 + 2) + (1 + 2) - (8 + 5)

ch4 = (4 + 1) - (8 + 5) + (2 + 0) - (9 + 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6 + 5) - (4 + 1) + (3 + 5) - (3 + 2) = 9

ch2 = (8 + 7) - (1 + 2) + (6 + 6) - (0 + 1)

ch3 = (2 + 3) - (9 + 2) + (1 + 2) - (8 + 5)

ch4 = (4 + 1) - (8 + 5) + (2 + 0) - (9 + 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6 + 5) - (4 + 1) + (3 + 5) - (3 + 2) = 9

ch2 = (8 + 7) - (1 + 2) + (6 + 6) - (0 + 1) = 23

ch3 = (2 + 3) - (9 + 2) + (1 + 2) - (8 + 5)

ch4 = (4 + 1) - (8 + 5) + (2 + 0) - (9 + 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6 + 5) - (4 + 1) + (3 + 5) - (3 + 2) = 9

ch2 = (8 + 7) - (1 + 2) + (6 + 6) - (0 + 1) = 23

ch3 = (2 + 3) - (9 + 2) + (1 + 2) - (8 + 5) = -16

ch4 = (4 + 1) - (8 + 5) + (2 + 0) - (9 + 4)

Finding Fitness of Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch1 = (6 + 5) - (4 + 1) + (3 + 5) - (3 + 2) = 9

ch2 = (8 + 7) - (1 + 2) + (6 + 6) - (0 + 1) = 23

ch3 = (2 + 3) - (9 + 2) + (1 + 2) - (8 + 5) = -16

ch4 = (4 + 1) - (8 + 5) + (2 + 0) - (9 + 4) = -19

Finding the Fittest Chromosomes

Chromosome	Gene	Fitness
ch1	(6, 5, 4, 1, 3, 5, 3, 2)	9
ch2	(8, 7, 1, 2, 6, 6, 0, 1)	23
ch3	(2, 3, 9, 2, 1, 2, 8, 5)	-16
ch4	(4, 1, 8, 5, 2, 0, 9, 4)	-19

Finding the Fittest Chromosomes

Chromosome	Gene	Fitness
ch2	(8, 7, 1, 2, 6, 6, 0, 1)	23
ch1	(6, 5, 4, 1, 3, 5, 3, 2)	9
ch3	(2, 3, 9, 2, 1, 2, 8, 5)	-16
ch4	(4, 1, 8, 5, 2, 0, 9, 4)	-19

Part II

Using Crossover on Chromosomes

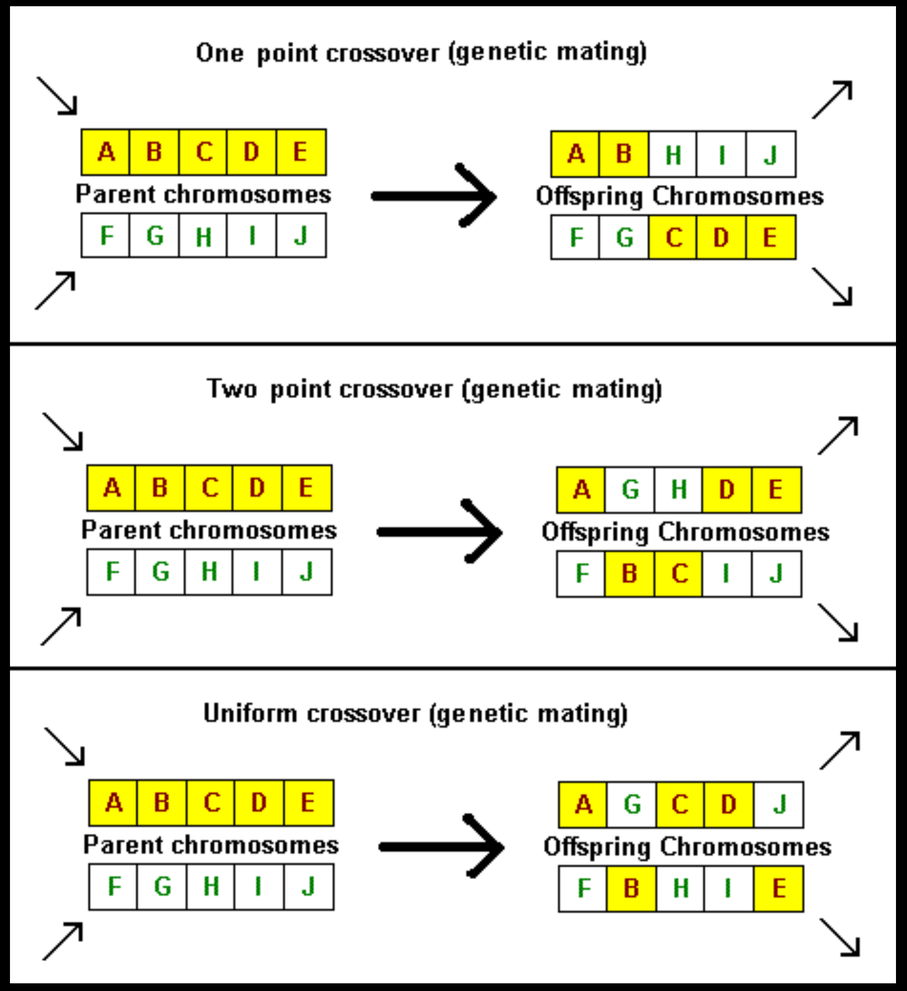
Using Crossover on Chromosomes

Crossovers that will be used:

- Single point
- Two point
- Uniform

For more information about crossover:

http://mattrclark.com/2016/11/genetic-algorithms/



Source: http://www.softtechdesign.com/GA/GA_figure1.gif

Single Point Crossover

Will be applied to the best two chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch1 = (6, 5, 4, 1, 3, 5, 3, 2)

Single Point Crossover

Will be applied to the best two chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, | 6, 6, 0, 1)

ch1 = (6, 5, 4, 1, | 3, 5, 3, 2)

Single Point Crossover

Will be applied to the best two chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, | 6, 6, 0, 1)

ch1 = (6, 5, 4, 1, | 3, 5, 3, 2)

Child Chromosomes

child1 = (8, 7, 1, 2, 3, 5, 3, 2)

child2 = (6, 5, 4, 1, 6, 6, 0, 1)

Two Point Crossover

Will be applied to the 2nd & 3rd best chromosomes

Parent Chromosomes

ch1 = (6, 5, 4, 1, 3, 5, 3, 2)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

Two Point Crossover

Will be applied to the 2nd & 3rd best chromosomes

Parent Chromosomes

ch1 = (6, 5, | 4, 1, 3, 5, | 3, 2)

ch3 = (2, 3, | 9, 2, 1, 2, | 8, 5)

Two Point Crossover

Will be applied to the 2nd & 3rd best chromosomes

Parent Chromosomes

ch1 = (6, 5, | 4, 1, 3, 5, | 3, 2)

ch3 = (2, 3, | 9, 2, 1, 2, | 8, 5)

Child Chromosomes

child3 = (6, 5, 9, 2, 1, 2, 3, 2)

child4 = (2, 3, 4, 1, 3, 5, 8, 5)

Uniform Crossover

Will be applied to the 1st & 3rd best chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

Uniform Crossover

Will be applied to the 1st & 3rd best chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

Uniform Crossover

Will be applied to the 1st & 3rd best chromosomes

Parent Chromosomes

ch2 = (8, 7, 1, 2, 6, 6, 0, 1)

ch3 = (2, 3, 9, 2, 1, 2, 8, 5)

Child Chromosomes

child5 = (8, 3, 1, 2, 1, 2, 0, 5)

child6 = (2, 7, 9, 2, 6, 6, 8, 1)

Part III

Finding Fitness of Child Chromosomes

Finding the Fittest Chromosomes

Chromosome	Gene	Fitness
child1	(8, 7, 1, 2, 3, 5, 3, 2)	
child2	(6, 5, 4, 1, 6, 6, 0, 1)	
child3	(6, 5, 9, 2, 1, 2, 3, 2)	
child4	(2, 3, 4, 1, 3, 5, 8, 5)	
child5	(8, 3, 1, 2, 1, 2, 0, 5)	
child6	(2, 7, 9, 2, 6, 6, 8, 1)	

Finding the Fittest Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

Chromosome	Gene	Fitness
child1	(8, 7, 1, 2, 3, 5, 3, 2)	
child2	(6, 5, 4, 1, 6, 6, 0, 1)	
child3	(6, 5, 9, 2, 1, 2, 3, 2)	
child4	(2, 3, 4, 1, 3, 5, 8, 5)	
child5	(8, 3, 1, 2, 1, 2, 0, 5)	
child6	(2, 7, 9, 2, 6, 6, 8, 1)	

Finding the Fittest Chromosomes

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

Chromosome	Gene	Fitness
child1	(8, 7, 1, 2, 3, 5, 3, 2)	15
child2	(6, 5, 4, 1, 6, 6, 0, 1)	17
child3	(6, 5, 9, 2, 1, 2, 3, 2)	-2
child4	(2, 3, 4, 1, 3, 5, 8, 5)	-5
child5	(8, 3, 1, 2, 1, 2, 0, 5)	6
child6	(2, 7, 9, 2, 6, 6, 8, 1)	1

Any Improvements?

Chromosome	Gene	Fitness
child1	(8, 7, 1, 2, 3, 5, 3, 2)	15
child2	(6, 5, 4, 1, 6, 6, 0, 1)	17
child3	(6, 5, 9, 2, 1, 2, 3, 2)	-2
child4	(2, 3, 4, 1, 3, 5, 8, 5)	-5
child5	(8, 3, 1, 2, 1, 2, 0, 5)	6
child6	(2, 7, 9, 2, 6, 6, 8, 1)	1
ch2	(8, 7, 1, 2, 6, 6, 0, 1)	23
ch1	(6, 5, 4, 1, 3, 5, 3, 2)	9
ch3	(2, 3, 9, 2, 1, 2, 8, 5)	-16
ch4	(4, 1, 8, 5, 2, 0, 9, 4)	-19

Any Improvements?

Chromosome	Gene	Fitness
ch2	(8, 7, 1, 2, 6, 6, 0, 1)	23
child2	(6, 5, 4, 1, 6, 6, 0, 1)	17
child1	(8, 7, 1, 2, 3, 5, 3, 2)	15
ch1	(6, 5, 4, 1, 3, 5, 3, 2)	9
child5	(8, 3, 1, 2, 1, 2, 0, 5)	6
child6	(2, 7, 9, 2, 6, 6, 8, 1)	1
child3	(6, 5, 9, 2, 1, 2, 3, 2)	-2
child4	(2, 3, 4, 1, 3, 5, 8, 5)	-5
ch3	(2, 3, 9, 2, 1, 2, 8, 5)	-16
ch4	(4, 1, 8, 5, 2, 0, 9, 4)	-19

Part IV

The Optimum Solution

The Optimum Solution

ch[optimum] = 99009900

The Optimum Solution

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch[o] = 99009900

f(ch[0]) = (9 + 9) – (0 + 0) + (9 + 9) – (0 + 0)

The Optimum Solution

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch[o] = 99009900

f(ch[0]) = (18) – (0) + (18) – (0)

The Optimum Solution

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch[o] = 99009900

f(ch[0]) = 18 + 18

The Optimum Solution

f(ch) = (g0 + g1) – (g2 + g3) + (g4 + g5) – (g6 + g7)

ch[o] = 99009900

f(ch[0]) = 36

Part V

Is mutation necessary?

Is mutation necessary?

Crossover

Mutation

Is mutation necessary?

Crossover

- Exploitation

Mutation

- Exploration

Is mutation necessary?

Crossover

- Exploitation
- Only crossover will mean more likely to be stuck in a local minimum

Mutation

- Exploration
- Only mutation will mean that the program is randomly guessing and could run indefinitely

Is mutation necessary?

Both crossover and mutation are necessary as crossover converges on an optimum solution whilst mutation tries to explore the search space.

Part VI

My Implementation

My Implementation

My implementation: http://doc.gold.ac.uk/~mclar053/downloads/session_9_GA.zip

Blog notes: http://mattrclark.com/2016/12/an-implementation-of-genetic-algorithms/