Tentamen 25 Oktober 2018, vragen en antwoorden

Evolutionary Computing (Vrije Universiteit Amsterdam)

Evolutionary Computing

Question ***With Answers***

October 15, 2018

Answers in bold italics. The exam is *closed* book, but you may bring and use:

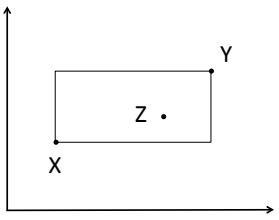
- One cheat sheet (i.e., 2 pages) of *handwritten* notes;
- A (graphical) calculator as long as it doesn't provide (internet) connectivity.

The exam grade determines 75% of your final grade for the course, the other 25% is determined by your project grade. Your exam grade must at least be 5.5 to pass the course.
This exam consists of 40 multiple choice questions on 8 pages.
Good luck!

Questions

1. Which of the following statements is true?
   A Evolution Strategies do not use genotypes, they work directly on the phenotypes
   B Evolution Strategies do not use phenotypes, they work directly on the genotypes
   C In Evolution Strategies the genotype space and the phenotype space are identical
   D In Evolution Strategies the phenotype space and the fitness space are identical
   C

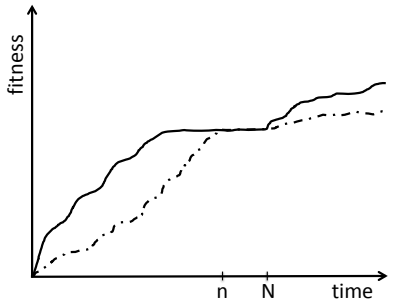
2. Consider the following illustration of two parents and a child in a 2-dimensional real valued search space. Point Z is the child of X and Y obtained through



   A Single arithmetic crossover
   B Whole arithmetic crossover
   C Blend crossover
   D Simple arithmetic crossover
   B

3. When defining problem complexity ("difficulty"), the definition of class P relies on the characteristics of
   A The problem at hand
   B The algorithms that can solve the problem at hand
   C Both
   D None; it concerns the search space.
   B

4. The following picture shows the maximum and average fitness curves of an evolving population. What can we infer regarding the population diversity at generation n?



   A Nothing
   B The first derivative of the diversity curve is zero
   C Diversity must be at its maximum
   D Diversity must be at its minimum
   A

5. The above picture shows that the maximum and average fitness curves touch each other at generation n, stay equal for a few generations and split again after generation N. What is the most likely cause of this split at generation N?
   A Cannot tell, could be anything
   B A stronger selection scheme was activated
   C A softer selection scheme was activated
   D A successful mutation took place
   D

6. We are to solve a graph 3-coloring problem with evolutionary computing. That is, we have a graph $G = (N, E)$ with $n = |N|$ nodes and $m = |E|$ edges and three colors $\{r, w, b\}$. We define a coloring as an assignment of colors to all nodes. Then the task is to find a coloring such that no neighboring nodes have the same color. What kind of problem is this?
   A FOP
   B COP
   C CSP
   D A combination of B and C
   C

7. Which of the following characterisations describes Evolutionary Algorithms best? An Evolutionary Algorithm is ...
   A stochastic and explorative.
   B stochastic and population-based.
   C deterministic and population-based.
   D deterministic and explorative.
   B

8. Which operators have a direct influence on the novelty of solutions in a population?
   A Mutation and parent selection
   B Parent selection and survivor selection
   C Mutation and recombination
   D Survivor selection and recombination
   C

9. Which statement is false when considering the representation of a problem?
   A The variation operators must fit the representation
   B The selection operators must fit the representation
   C The search space depends on the choice of representation
   D Problem constraints can be incorporated in the representation
   B

10. We tackle the n-queens problem with a GA using a bitstring representation where 1 (0) denotes the presence (absence) of a queen on a square. What is the dimensionality of the search space?
    A $2n$
    B $n!$
    C n^2
    D n
    C

11. We tackle the n-queens problem with a GA using a bitstring representation where 1 (0) denotes the presence (absence) of a queen on a square. What is the size of the search space?
    A $n!$
    B $2n$
    C 2^{n*n}
    D n^2
    C

12. Which of the following statements is false?
    A A penalty function makes it possible to search through the infeasible part of the searh space.
    B A penalty function is an alternative to prohibiting certain individuals
    C A penalty function reduces the fitness value when an individual is infeasible
    D A penalty function removes the infeasible individuals from the population
    D

13. Which of the following methods is not likely to help increase diversity?
    A Divide population into islands
    B Increase selection pressure
    C Decrease selection pressure
    D Increase mutation probability
    B

14. Which of the following statements is false?
    A An EA without crossover, using only mutation, is possible and could very well work
    B Crossover is explorative and mutation exploitative
    C Crossover is applied to two or more individuals and mutation to one individual
    D Crossover is exploitative and mutation explorative
    D

15. Which of the following items is not part of the representation in an EA?
    A Genotype
    B Phenotype
    C Initialisation
    D Mapping from genotype to phenotype
    C

16. What is the correct order to update x and σ when using self-adaptive mutation?
    A First σ then x
    B Does not matter
    C First x then σ
    D Only x, σ is not mutated
    A

17. Consider a population of 100 individuals where 10 of them are replaced by offspring. How big is the generational gap?
    A 10
    B 0.1
    C 90
    D 0.9
    B

18. Which of the following selection mechanisms is deterministic?
    A Rank-based
    B Elitism
    C Uniform
    D Tournament
    B

19. We want to maxime $f(x, y) = x + y$ with an evolutionary algorithm. Our current population consists of 5 individuals exhibited below. What is the chance individual 2 is selected if we apply fitness proportionate selection? (Answer may be rounded up.)

i	1	2	3	4	5
x_i	0	3	4	1	1
y_i	3	2	1	2	3

    A 10%
    B 15%
    C 20%
    D 25%
    D

20. Let $g(x, y) = f(x, y) + 1000$. What is the chance individual 2 is selected if we apply fitness proportionate selection with the function g? (Answer may be rounded up.)
    A 10%
    B 15%
    C 20%
    D 25%
    C

21. Assume we have a simple unimodal problem and therefore we want the highest possible selection pressure in our EA. Which parent selection mechanism should we choose?
    A Tournament selection with size 1
    B Uniform
    C Rank-based: exponential
    D Rank-based: linear
    C

22. What is the relation between tournament size and selection pressure?
    A Decreasing tournament size decreases selection pressure
    B Decreasing tournament size increases selection pressure
    C Increasing tournament size decreases selection pressure
    D No relation
    A

23. What EA variant should we use to evolve a formula to fit a certain data set?
    A Evolution Strategy
    B Genetic Programming
    C Differential Evolution
    D Genetic Algorithm
    B

24. What survivor selection is used for Differential Evolution?
    A Child always replaces parent
    B Uniform selection
    C Deterministic tournament between parent and child
    D Differential mutation
    C

25. How many parents are needed to create one offspring when using Differential Evolution?
    A 1
    B 2
    C 3
    D 4
    D

26. What recombination method is used in Particle Swarm Optimisation?
    A Uniform crossover
    B 1-point crossover
    C None
    D Cycle crossover
    C

27. Technically speaking and individual in Particle Swarm Optimisation is
    A $\overline{x}$, a candidate solution vector
    B $\langle \overline{x}, \overline{v} \rangle$, a candidate solution vector and a velocity vector
    C $\langle \overline{x}, \overline{v}, \overline{b} \rangle$, a candidate solution vector, a velocity vector, and a personal best
    D $\langle \overline{x}, \overline{v}, \overline{b}, \overline{c} \rangle$, a candidate solution vector, a velocity vector, a personal best, and an overall best
    C

28. We want to optimise the function $f(x, y) = x + y$ with Differential Evolution. Consider the following population of 6 individuals:

i	1	2	3	4	5	6
x_i	0.2	0.1	0.4	0.9	0.3	0.7
y_i	0.3	0.1	0.5	0.2	0.8	0.3

The first step in creating the next generation is the creation of a mutant vector population. What is mutant vector $\overline{v}_4$ if the base vector $\overline{a}_4$ is individual 5, the difference vector is defined by $\overline{b}_4$ = individual 1 and $\overline{c}_4$ = individual 2, and the scaling factor is $F = 0.5$?

A $\overline{v}_4 = \langle 0.2, 0.5 \rangle$
B $\overline{v}_4 = \langle 0.25, 0.9 \rangle$
C $\overline{v}_4 = \langle 0.35, 0.9 \rangle$
D $\overline{v}_4 = \langle 0.4, 1.0 \rangle$

C

29. What is parameter tuning?

A Parameter tuning is adjusting parameters of the evolutionary algorithm before a run
B Parameter tuning is adjusting parameters of the evolutionary algorithm during a run
C Parameter tuning is adjusting parameters of the evolutionary algorithm during a run based on time
D Parameter tuning is adjusting parameters of the evolutionary algorithm by coding them in the genome

A

30. Which of the following methods falls in the category of deterministic parameter control?

A Mutate individuals by a Gaussian mutation operator with standard deviation $\sigma > 0.5$
B Double the standard deviation σ of the Gaussian mutation operator after every 10 generations
C Include the standard deviation σ of the Gaussian mutation operator in the genome
D The 1/5 Rechenberg rule

B

31. Let us compare GAs and GP by their usage of crossover and mutation. Which of the following statements is true?

A In one GP cycle offspring are created by crossover followed by mutation
B In one GA cycle offspring are created by mutation followed by crossover
C In one GP cycle offspring are created by either crossover or mutation
D They use crossover and mutation in the same way, only the inner mechanics differ because of the different representations

C

32. We can compare different EAs by their efficiency and effectiveness that can be defined through various measures. Which of the following statements is true?

A AES measures effectivity, SR measures efficiency
B AES measures effectivity, MBF measures efficiency
C SR and AES both measure efficiency
D MBF measures effectivity, AES measures efficiency

D

33. What is the Pareto-optimal set?

A The optimal solutions of the Pareto function
B The set of non-dominated points in the solution space
C Those points in the solution space that dominate the largest possible number of other points
D Those points in the solution space that are optimal in at least one objective

34. We want a neural network controller for a legged robot for walking as fast as possible. It is possible that the robot trips and falls on the ground, but it is advanced enough to stand up and continue walking. We decide to evolve such a neural network through pursuing two objectives: x, the time needed to cover 5 metres (in minutes) and y, the number of times the robot tripped during the evaluation period of 5 minutes.

Consider the following population of individuals.

i	1	2	3	4	5
x_i	10	12	8	9	11
y_i	2	1	3	1	0

What individual(s) make up the Pareto-optimal set? (Hint: make an illustration)

A Individuals 3 and 4
B Individuals 3, 4, and 5
C Individual 5
D Individuals 4 and 5
B

35. We decide to merge the above two objectives into one through a preference based weighting scheme and determine that tripping is 5 times more important than speed. What would be the best solution(s)?

A Individuals 4 and 5
B Individuals 3, 4, and 5
C Individual 5
D Individual 4
C

36. We use a simple generational bit-string GA with population size M and chromosome length L, fitness proportional selection, one-point crossover with crossover rate p_c, and bit-flip mutation with mutation rate $p_m = 1/L$. Given two parent individuals $\overline{x} \in \{0,1\}^L$ and $\overline{y} \in \{0,1\}^L$ ($\overline{x} \neq \overline{y}$), what is the chance that their first child is identical to $\overline{x}$ and $\overline{y}$?

A $1 - p_c$
B Greater than $1 - p_c$ because of the possible effects of mutation
C p_c
D Smaller than p_c because of the possible effects of mutation
B

37. Take the above GA and an individual $\overline{x} \in \{0,1\}^L$ to be mutated. What is the chance that the mutant is identical to $\overline{x}$?

A $1/L$
B $(1/L)^L$
C $M \cdot (1/L)^L$
D $1 - (1/L)^L$
D

38. We design a GA and an ES to minimise an objective function of n variables: $f(x_1, \ldots, x_n)$. Which statement is true regarding their genotypes?

A A GA always uses bitstrings, hence its genotypes are longer than those of the ES
B An ES always uses σs and αs, hence its genotypes are longer than those of the GA
C On the same function the genotypes will have the same length
D We cannot say anything about the genotypes without further information
D

39. We are to solve the n-queens problem with an EA and decide to mutate those locations where the error is the greatest. Which statement is false?

A This implies that we have to increase selection pressure
B This implies "hidden labour" and thus unfair speed comparisons with other EAs
C This turns the Evolutionary Algorithm into a Memetic Algorithm
D This is likely to increase the performance of the EA
A

40. The following table describes a population in a GA, showing the population members and their fitness, e.g., $f(a) = 1$. What is the probability that individual c gets selected when using 2-tournament selection? (Drawings are made with replacement.)

individual x	a	b	c	d	e
fitness $f(x)$	1	1.5	2	2.5	3

A 2/10
B 10/25
C 9/25
D 11/25
C