***Artificial Life - Exercise 6***

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**Assignment 35**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Sheet** | 1 | PA-A | 2 | 3 | PA-B | 4 | 5 | **Total** |
| **Points** | 15 | 14 | 15 | 11 | 10 | 14 | 13 | **92** |

So we need 8 points (200 are possible) to be admitted to the written exam.

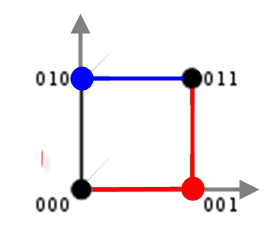
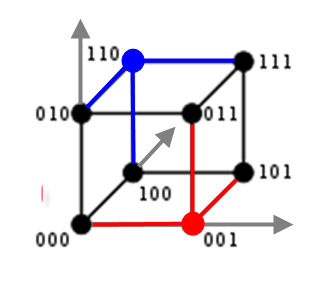
**Assignment 36**

We can view the binary genome of length *n* as a vector in *Rn* by treating each bit in the genome as a real coordinate. Two vertices are adjacent whenever their labels differ in a single bit and we can visualise this as a hypercube. In the scope of the Evolutionary Algorithm this hypercube model is often used in the inheritance stage for determining what are the possible offsprings of the parents. Ie. most evolutionary algorithms are designed so that the offspring is more likely to be an individual that is genetically close to its parents (ie. from the immediate neighbourhood of the parents). The area enclosed by the hypercube is considered to be the exploitation zone of possible offsprings - in the case of binary values, the possible offsprings lie in the vertices. The final selection of the offspring depends on the distinct algorithm itself (eg. how much weighting it gives each parent or what the crossover positions are). The hypercube model is also applicable for more than 2 parents.

Eg.

a) Two parent binary genomes labelled 110 and 001 form a hypercube in 3-dimensional space with possible offsprings at its vertices: 111, 011, 010, 100, 101, 000

b) Two parent binary genomes 010 and 001 form a hypercube in 2-dimensional space with 2 possible offsprings at its vertices: 011 and 000.



**Assignment 37**

Some drawbacks of the gradient descent method:

* one can get stuck in local minima in the case of deep descents and one is hence unlikely to find the global optimum.
* can only be applied to continuously differentiable functions, ie unusable in cases with 0 gradient.
* cannot be used in cases of limited knowledge where function not completely given which is often the case of real-world applications - ie. discontinuities in the function.

**Assignment 38**

If one makes the assumption that minimising costs is equivalent to maximising performance, we can reduce the task of optimisation to only finding the global minima, rather than the maxima. Since we often already know the minimum possible value of costs, it makes the task of finding the global maximum easier. However, the latter also presents a problem in this case - if costs are zero and we assume then performance is infinity which is rarely the real-world case. Hence, our opinion is that the minimisation and maximisation problems are not always completely equivalent.

**Assignment 39**

For the genome, we propose to use a 25x12 table where each cell can either have no value or a value between 1 and 25. The value reflects the number of the lecture (in case of an exercise it's the number of the lecture the exercise is for). The first four rows reflect the four lecture halls while the last 8 rows reflect the exercise rooms. Furthermore, we assume that all 25 lectures take place as well as the 50 exercises while there's no collision. I.e. There are 75 cells set where each value occurs exactly three times.

To enable students to attend as many lectures and exercises as possible, it's good if the schedule is pretty much fragmented and as little events happen in the same slot as possible. The first table shows an example where such a fragmentation is pretty well while the second table shows an example of the pretty much worst case.

The fitness function should be designed in a way that schedules like the first one get a much better than schedules that tend to be like the latter one.

We propose to count the lectures on each of the 25 timeslots and take the inverse. We also take the exercises per timeslot and take the inverse. The first slot on Monday and the two last slots on Friday are furthermore multiplied with a malus factor of 0.5.

To calculate the final fitness value we take the average of the two sums. We see that the first table has a fitness value of and the second table has much lower fitness value of

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| **Room** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |  |
| L1 |  | 1 |  | 5 | 2 |  |  | 3 |  | 10 |  | 25 |  |  |  |  | 14 |  | 23 |  |  | 21 |  |  |  |  |
| L2 |  |  |  |  | 15 |  |  |  | 17 |  |  |  |  | 19 |  |  |  | 24 |  |  | 13 |  |  |  |  |  |
| L3 |  |  | 9 | 11 |  |  | 18 |  |  |  |  |  | 7 |  |  |  | 20 |  |  |  |  |  | 22 |  |  |  |
| L4 |  |  | 16 |  |  |  |  |  |  | 4 |  |  |  |  | 12 |  |  |  | 6 |  | 8 |  |  |  |  |  |
| E1 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  |  |  |  |  |  |
| E2 |  |  |  |  | 8 |  | 1 |  |  | 6 |  | 9 |  | 25 | 18 |  |  |  |  |  |  | 22 |  | 5 |  |  |
| E3 |  |  | 1 | 24 |  |  |  | 17 | 22 |  | 16 |  |  |  |  | 12 |  | 7 |  | 13 |  |  | 14 |  |  |  |
| E4 |  |  | 19 |  |  | 15 |  |  | 8 |  |  |  |  | 2 |  |  | 21 |  |  |  |  |  |  |  |  |  |
| E5 |  |  |  | 2 |  |  |  |  |  |  |  | 14 |  |  | 24 |  |  |  | 25 |  | 9 |  | 11 |  |  |  |
| E6 |  | 13 |  |  |  |  | 11 |  | 21 | 3 |  |  |  |  |  |  | 5 |  |  | 17 |  |  |  |  |  |  |
| E7 |  |  |  |  | 10 | 20 |  |  |  | 19 |  |  | 6 |  |  | 16 |  | 23 |  |  |  | 4 |  | 18 |  |  |
| E8 |  | 7 |  | 15 |  |  |  | 4 |  |  | 12 |  |  | 20 |  |  |  |  | 10 |  | 23 |  |  |  |  |  |
|  | 0,0 | 1,0 | 0,5 | 0,5 | 0,5 | 0,0 | 1,0 | 1,0 | 1,0 | 0,5 | 0,0 | 1,0 | 1,0 | 1,0 | 1,0 | 0,0 | 0,5 | 1,0 | 0,5 | 0,0 | 0,5 | 1,0 | 1,0 | 0,0 | 0,0 | **14,5** |
|  | 0,0 | 0,5 | 0,5 | 0,3 | 0,5 | 0,5 | 0,5 | 0,5 | 0,3 | 0,3 | 0,5 | 0,5 | 1,0 | 0,3 | 0,5 | 0,5 | 0,5 | 0,5 | 0,3 | 0,5 | 0,5 | 0,5 | 0,5 | 0,5 | 0,0 | **11,2** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **12,8** |

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| **Room** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** | **1** | **2** | **3** | **4** | **5** |  |
| L1 | 1 | 5 | 9 | 13 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 18 | 22 |  |
| L2 | 2 | 6 | 10 | 14 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 19 | 23 |  |
| L3 | 3 | 7 | 11 | 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 20 | 24 |  |
| L4 | 4 | 8 | 12 | 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 17 | 21 | 25 |  |
| E1 | 5 | 1 | 5 | 17 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 16 | 22 | 1 |  |
| E2 | 6 | 2 | 6 | 23 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 22 | 23 | 2 |  |
| E3 | 7 | 3 | 7 | 24 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 24 | 3 |  |
| E4 | 8 | 4 | 8 | 25 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 25 | 4 |  |
| E5 | 9 | 13 | 9 | 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 13 | 18 |  |
| E6 | 10 | 14 | 10 | 19 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 14 | 19 |  |
| E7 | 11 | 15 | 11 | 20 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 15 | 20 |  |
| E8 | 12 | 16 | 12 | 21 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 17 | 21 |  |
|  | 0,125 | 0,25 | 0,25 | 0,25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0,125 | 0,125 | **2,1** |
|  | 0,125 | 0,125 | 0,125 | 0,125 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0,5 | 0,125 | 0,125 | **1,3** |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **1,7** |

**Assignment 40**

No single flip operation must happen. The Probability that the flip operation does *not* happen is . Since there are flip operations, it follows from simple laws of probability: