Introduction to Evolutionary Computation
(22753) and
Evolutionary Computation (02411)
— Exercise Questions (not assessed) —

1. In the lecture it was explained that an EA is useful in optimisation, learning and design. Nevertheless, if you want to build it you need to be clear with the basic concepts. Could you explain the following terms with your own words?
   (a) It is well known that an EA works over a population. So, what is a population?
   (b) From the point of view of programming language, how can you create/represent individuals and the population to manipulate them? i.e. an individual is a bit, byte, int, char, ..., and the population is a vector, matrix, structure, etc.
   (c) If we want to solve a problem (real or artificial) we need to translate it in a way that it could be 'understood' by the EA, then, can you explain the difference between phenotype and genotype and give some examples?
   (d) Explain why the population needs to be initialised in a random way? And what could happen in the algorithm/solution if we do not perform that?
   (e) Why is it important to evaluate the fitness of each individual?
   (f) What is the role of selection, crossover and mutation in an EA? Could you imagine another way to look for a solution if these two operators are not used (crossover and mutation)?
   (g) At the beginning, you were asked to explain what is a population. Now, could you explain what is a Generation? And what are the different steps involve into it? (e.g. selection, ...)

2. Could you find out and explain what is the difference between GA, EP, ES and GP? Can you choose one of them and explain how could be the phenotype and genotype? e.g. for a EP the phenotype could be represent as 'X' and the genotype as 'Y'.

3. Implement an EA that minimises the function $f(x_1, x_2) = x_1^2 + x_2^2$, given the following:
   (a) Use a binary representation of integers.
(b) Use one-point crossover, bit-mutation and roulette-wheel selection (the student need to choose the crossover and mutation rates)
(c) Minimise $f(x)$ in the range of $-1024 \leq x_i \leq 1023$
(d) Before you start to solve it, do you know what is the minimum of this particular function?