1. (4 pts)Given a target string, the goal is to produce it starting from a random string of the same length. Use **Genetic Algorithm** to solve this problem. The algorithm terminates when the number of iterations is larger than **5000**, or the target string is generated. The details of implementation are as follows.

   - Characters A-Z, a-z, 0-9 and other special symbols are considered as genes. The target string is "Hello, World! 19/11/09".
   - A string generated by these characters is considered as chromosome.
   - Fitness score is the number of characters which are equal to characters in target string at a particular index. For example, the fitness score of "ke:lF,)5X#iM# &$n11g0A" is 6.

H	e	l	l	o	,		W	o	r	l	d	!		-	9	/	1	1	/	1	0
	|		|									|				|	|			
k	e	:	l	f	,	)	5	X	#	i	M	#		&	$	n	1	1	g	0	a

   Requirement: Print the individual of the highest fitness score in each generation. For example,

   Generation: 1 String: H6f7Vu1Fol1eZB#g73SK#z
   ⋮
   Generation: 54 String: ke:lF,)5X#iM# &$n11g0A
   ⋮
   Generation: 396 String: Hello, Noeld! g9/11/09
   ⋮

```
// Valid Genes
const string GENES = "ABCDEFGHIJKLMNOPQRSTUVWXYZ"\
"abcdefghijklmnopqrstuvwxyz 1234567890 , .-;:_!\"#%&/()=?@${[]}";

// Target string
const string TARGET = "Hello,World! 19/11/09";
```

2. (4 pts)Find x^* to minimize $x \cdot sin(x), x \in [-1, 15]$ $(sin(\pi) = 0)$. Use **Genetic Algorithm**. Chromosome is a 16-bit binary code. The algorithm terminates when the number of iterations is larger than **5000**, or the average fitness score $\approx$ the best fitness score.

   Requirements:

   - Design the implementation details by yourself.

- $x^* = \arg\min_x x \cdot \sin x \approx 11.0857$. It will be accepted as long as your final result falls into $(11.08, 11.10)$.
- Print the individual of the best fitness score in each generation.

3. (2 pts) Describe your implementation of Question 2, including the end criterion, crossover operator, selection methods and so on.

Important Notes:

- **Reference**: The class note of Lecture 15.
- Remember to submit your **makefile**!
- Submit question 3 in a *pdf* file.
- Due: **2019/11/17 11:59pm**