1. [*18 points*] Explain the following concepts:

   1) supervised learning,
   2) unsupervised learning,
   3) online learning,
   4) batch learning,
   5) model-based learning,
   6) instance-based learning.

2. [42 *points*] Write a program to estimate the parameters for an unknown polynomial using the *polyfit()* function of the *numpy* package.

   1) Plot the noisy data and the polynomial you found in the same figure. You can use any value of *m* from 2, 3, 4, 5, 6, where *m* is the degree of the polynomial.
   2) Plot *MSE* versus *m*, for *m* = 1, 2, 3, 4, 5, 6, 7, 8 respectively. Identify the best choice of *m* and explain why.
   3) Change variable *noise_scale* to 150, 200, 400, 600, 1000 respectively, re-run the algorithm and plot the polynomials with the *m* found in 2). Discuss the impact of the noise scale on the accuracy of the returned parameters. [You need to plot a figure as in 1) for each choice of noise_scale.]
   4) Change variable *number_of_samples* to 40, 30, 20, 10 respectively, re-ran the algorithm and plot the polynomials with the *m* found in 2). Discuss the impact of the number of samples on the accuracy of the returned parameters. [You need to plot a figure as in 1) for each choice of number_of_samples.]

   A simulated dataset will be generated as below.

   Simulated data is given as follows in Python:

```
import matplotlib.pyplot as plt
plt.style.use('seaborn-whitegrid')
import numpy as np

noise_scale = 100
number_of_samples = 50
x =  25*(np.random.rand(number_of_samples, 1) - 0.8)
y = 5 * x + 20 * x**2 + 1 * x**3 + noise_scale*np.random.randn(number_of_samples, 1)
plt.plot(x,y,'ro')
```