Assignment 2

75 marks

Remember to comment your code well, in order to get marks reserved for comments

Q1. This question builds on the gradient descent question I asked in the mid sem exam.

```
def gradient_descent(gradient,init_,learn_rate, n_iter=50, tol=1e-06):
    x = init_
    for _ in range(n_iter):
        delta = -learn_rate * gradient(x)
        if np.all(np.abs(delta) <= tol):
            break
        x += delta
    return round(x*1000)/1000
```

I have shown you above the completed version of the gradient descent algorithm. Now,

(a) Use this function to find minima for (i) $x^2 + 3x+4$ and (ii) $x^4 – 3x^2 +2x$. [5 points]

(b) Write a gradient function to calculate gradients for a linear regression y = ax + b [10 points]

(c) Generate artificial data for this regression according to the following protocol

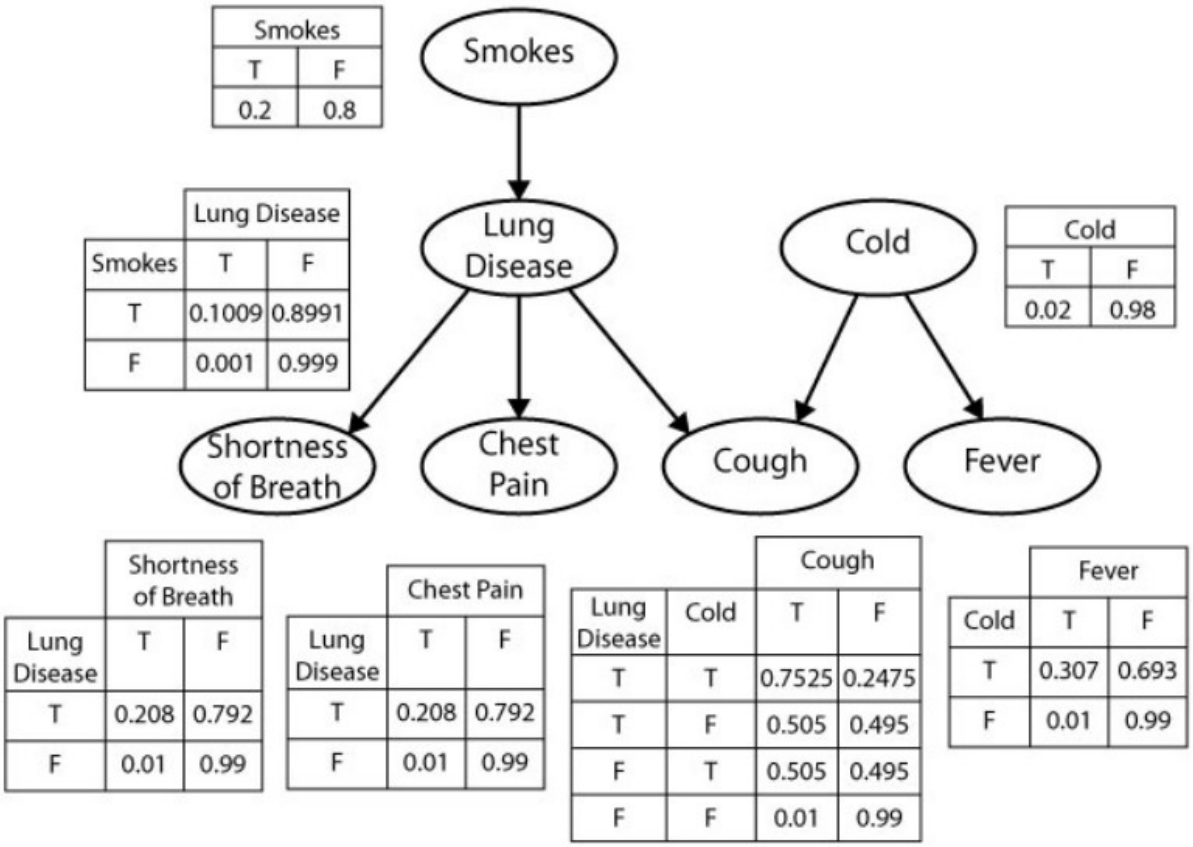
```
np.random.seed(0)
X = 2.5 * np.random.randn(10000) + 1.5   # Array of 100 values with mean = 1.5, stddev = 2.5
res = 1.5 * np.random.randn(10000)       # Generate 100 residual terms
y = 2 + 0.3 * X + res                  # Actual values of Y
```

and use gradient descent to find the optimal parameters relating X with y. If you do this correctly, you should get {a,b} ~ {0.3, 2}. [10 points]

(d) Implement minibatch stochastic gradient descent using the code base you have developed so far. [15 points]

(e) Does SGD do better or worse in terms of time performance on our data? Is there an optimal minibatch size that works best? Quantify and interpret your findings. [10 points]

Q2. Surprise! This problem too builds on a problem that I asked in the mid-sem exam. Consider again this Bayesian network



Smokes	
T	F
0.2	0.8

	Lung Disease	
Smokes	T	F
T	0.1009	0.8991
F	0.001	0.999

Cold	
T	F
0.02	0.98

	Shortness of Breath	
Lung Disease	T	F
T	0.208	0.792
F	0.01	0.99

	Chest Pain	
Lung Disease	T	F
T	0.208	0.792
F	0.01	0.99

		Cough	
Lung Disease	Cold	T	F
T	T	0.7525	0.2475
T	F	0.505	0.495
F	T	0.505	0.495
F	F	0.01	0.99

	Fever	
Cold	T	F
T	0.307	0.693
F	0.01	0.99

and calculate
(i) the probability that someone has both cold and a fever [5 points]
(i) the probability that someone who has a cough has a cold. [10 points]

Show your work, not just the final answer.

Q3. Derive the MLE for the parameters of a k-sided multinomial distribution. [10 points]