# CMPE 302 – Logistic Regression Assenment 5

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## Question 1 – Likelihood and Gradient

Let the training dataset be $\{(X_i, y_i)\}_{i=1}^{N}$, where $X_i \in \mathbb{R}^d$ and $y_i \in \{0, 1\}$. The logistic regression model is defined as:

$$g_W(X_i) = \sigma(W^T X_i) = \frac{1}{1 + e^{-W^T X_i}}$$

(a) Write down the log-likelihood function $\ell(W)$ for this model using the given dataset.

(b) Derive the gradient of the log-likelihood function with respect to the weight vector $W$.

(c) Explain whether gradient ascent or descent should be used to update $W$, and justify your choice.

## Question 2 – Python Logistic Regression and Interpretation

Consider the following training data where $X$ represents tumor size and $y$ indicates whether the tumor is malignant ($y = 1$) or benign ($y = 0$):

$$X = [1.2,\ 2.3,\ 3.1,\ 4.5,\ 5.7], \quad y = [0,\ 0,\ 1,\ 1,\ 1]$$

(a) Fit a logistic regression model using Python's `sklearn.linear_model.LogisticRegression`.

(b) Write the learned sigmoid function $g_W(x)$ using the learned weights.

(c) Compute the probability that a tumor of size 3.0 is malignant.

(d) If the probability threshold is 0.5, what is the predicted class for a tumor size of 3.0? Justify.