

# Homework 2

Samuel Sledzieski

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## 1 Gradient Derivation

$$LL(\mathbf{w}) = \sum_{i=1}^n y_i \mathbf{w}^T \mathbf{x}_i - \log(1 + \exp(\mathbf{w}^T \mathbf{x}_i)) \quad (1)$$

$$\frac{\delta LL}{\delta \mathbf{w}} = \frac{\delta}{\delta \mathbf{w}} \sum_{i=1}^n y_i \mathbf{w}^T \mathbf{x}_i - \log(1 + \exp(\mathbf{w}^T \mathbf{x}_i)) \quad (2)$$

$$\frac{\delta LL}{\delta \mathbf{w}} = \sum_{i=1}^n y_i \mathbf{x}_i - \frac{\delta}{\delta \mathbf{w}} \log(1 + \exp(\mathbf{w}^T \mathbf{x}_i)) \quad (3)$$

$$\frac{\delta LL}{\delta \mathbf{w}} = \sum_{i=1}^n y_i \mathbf{x}_i - \frac{\frac{\delta}{\delta \mathbf{w}} \exp(\mathbf{w}^T \mathbf{x}_i)}{(1 + \exp(\mathbf{w}^T \mathbf{x}_i))} \quad (4)$$

$$\frac{\delta LL}{\delta \mathbf{w}} = \sum_{i=1}^n y_i \mathbf{x}_i - \frac{\mathbf{x}_i \exp(\mathbf{w}^T \mathbf{x}_i)}{(1 + \exp(\mathbf{w}^T \mathbf{x}_i))} \quad (5)$$

## 2 Logistic Regression Classifier

**Files** The attached tarball contains 4 files.

- logreg\_classifier.py
- roc.py
- main.py
- Runtime.ipynb

logreg\_classifier.py contains the Logistic Regression Classifier. roc.py contains function for plotting ROC. main.py loads Wisconsin Breast Cancer dataset from sklearn and divides it into a training set and test set. It then fits the logistic regression classifier using the training set, predicts probabilities on the test set, and plots the ROC curve. Runtime.ipynb is a Jupyter notebook which performs the same functions as main.py, then fits an sklearn logistic regression classifier and plots an ROC curve on the same datasets.

**ROC Curve** Below is the ROC curve of my logistic regression classifier on the Wisconsin Breast Cancer dataset

