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CS434 - HW 2

Written Exercise

Linear Model with Laplace Error:

$$logL(w) = \sum_{i=1}^{N} log(\frac{1}{2b}^{-\frac{|y_i - w^T x_i|}{b}})$$

$$logL(w) = \sum_{i=1}^{N} (-\ log(2b)\ - \frac{|y_i - w^T x_i|}{b})$$

$$= -\ Nlog(2b)\ - \frac{1}{b}\sum_{i=1}^{N} |y_i - w^T x_i|$$

$-\ Nlog(2b)$ is a constant.

Computing Recall and Precision:

t	Recall	Precision
0	$0 = \frac{0}{0+0}$	$0 = \frac{0}{0+8}$
0.2	$0 = \frac{0}{0+2}$	$0 = \frac{0}{0+8}$
0.4	$0.2857 = \frac{2}{2+5}$	$0.25 = \frac{2}{2+6}$
0.6	$0.2222 = \frac{2}{2+7}$	$0.25 = \frac{2}{2+6}$
0.8	$0.3636 = \frac{4}{4+7}$	$0.5 = \frac{4}{4+4}$
1	$0.5 = \frac{8}{8+8}$	$1 = \frac{8}{8+0}$

Implementing Logistic Regression for Tumor Diagnosis

Negative Likelihood:
See code.

Gradient Descent for Logistic Regression:
Weight Vector: [-0.5918, 1.8634, 0.4107, 0.5977, -1.4359, -0.7158, 0.8494, -0.647]
Accuracy: 86.7%

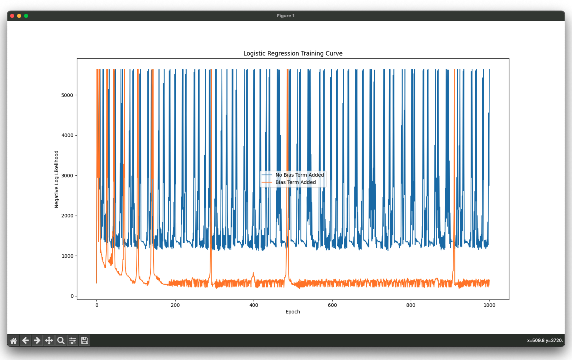
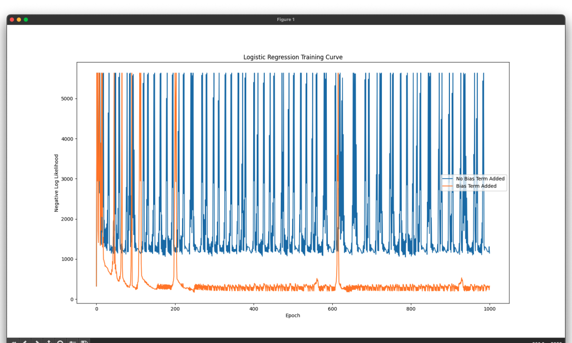
Adding a Dummy Variable:

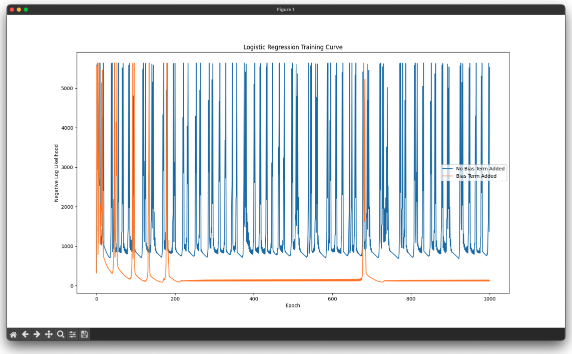
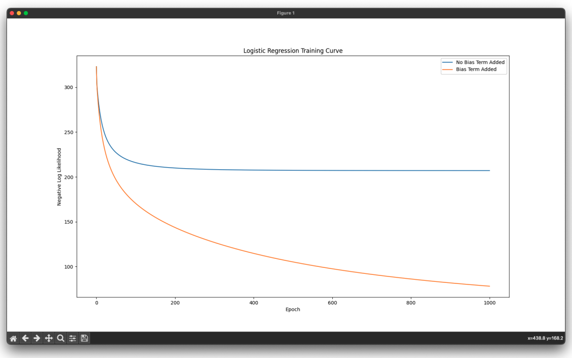
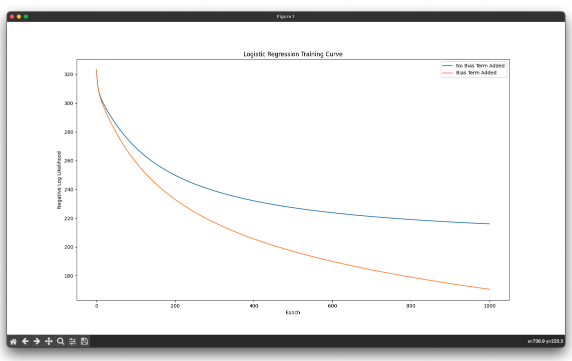
New weight vector: [-10.3341, 0.619, -0.0981, 0.5501, 0.6539, 0.0438, 0.4901, 0.2643, 0.6473]
New accuracy: 96.78%

I would say that this did make a significant difference. Adding about 10% accuracy is a large improvement compared to the previous accuracy.

Learning Rates/Step Sizes:
Looking at what happens when you further increase the max_iters global parameter, the two lines seem to more quickly deviate from each other. Rather than a slow curve away, the change is much more drastic.

Looking below at what happens when you change the step size… decreasing the step size appears to make the two lines converge on each other, while increasing the step size does the opposite.

<table>
<tr><th colspan="2">step_size = 1</th></tr>
<tr><td rowspan="2">
</td><td>No Bias Training:
34.33%</td></tr>
<tr><td>Added Bias Training:
95.06%</td></tr>
<tr><th colspan="2">step_size = 0.1</th></tr>
<tr><td rowspan="2">
</td><td>No Bias Training:
85.41%</td></tr>
<tr><td>Added Bias Training:
95.49%</td></tr>
<tr><th colspan="2">step_size = 0.01</th></tr>
</table>

<table>
<tr><td rowspan="2">
</td><td>No Bias Training:
34.55%</td></tr>
<tr><td>Added Bias Training:
95.46%</td></tr>
<tr><td colspan="2">step_size = 0.0001 (base)</td></tr>
<tr><td rowspan="2">
</td><td>No Bias Training:
86.27%</td></tr>
<tr><td>Added Bias Training:
96.35%</td></tr>
<tr><td colspan="2">step_size = 0.00001</td></tr>
<tr><td rowspan="2">
</td><td>No Bias Training:
85.92%</td></tr>
<tr><td>Added Bias Training:
90.77%</td></tr>
</table>

Evaluating Cross Validation:

```
2024-10-29 14:02:59 INFO     Running cross-fold validation for bias case:
2024-10-29 14:02:59 INFO     2-fold Cross Val Accuracy -- Mean (stdev): 96.14% (1.288%)
2024-10-29 14:02:59 INFO     3-fold Cross Val Accuracy -- Mean (stdev): 96.56% (1.717%)
2024-10-29 14:03:00 INFO     4-fold Cross Val Accuracy -- Mean (stdev): 95.5% (1.936%)
2024-10-29 14:03:00 INFO     5-fold Cross Val Accuracy -- Mean (stdev): 96.11% (1.544%)
2024-10-29 14:03:01 INFO     10-fold Cross Val Accuracy -- Mean (stdev): 96.34% (2.354%)
2024-10-29 14:03:04 INFO     20-fold Cross Val Accuracy -- Mean (stdev): 96.25% (4.146%)
2024-10-29 14:03:09 INFO     50-fold Cross Val Accuracy -- Mean (stdev): 96.17% (5.281%)
```

Looking at the stats for the cross-fold validation, we can see that the accuracies were fairly accurate, given the standard deviations. I scored a 0.93 on the Kaggle submission. For the larger cross validations, which all seem to have larger standard deviations, this score is captured within one standard deviation of the mean, while the rest are between 3-4 standard deviations. The cross validation accuracy was a fairly good representation of my final score.

Kaggle Submission:

For my kaggle submission, I changed the step_size global parameter to 0.001 and the max_iters parameter to 5000. For me, this proved to provide the best results.

Debriefing

1. **Approximately how many hours did you spend on this assignment?**
   About 4 hours.
2. **Would you rate it as easy, moderate, or difficult?**
   Moderate.
3. **Did you work mostly alone or did you discuss the problems with others?**
   Completely alone.
4. **How deeply do you feel you understand the material it covers?**
   I feel that I understand the material very well.
5. **Any other comments?**
   Nope.