**Assignment 01 - Linear Regression Assignment: Part 2**

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**Alpha (Learning Rate):** Controls the step size during weight updates.

**Epochs:** The number of times the model sees the entire training dataset.

**Experiments and Results:**

Observations:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Alphas | Epochs | Training Loss | Testing Loss | Weights |
| 0.0001 | 93089 | 0.00582130 | 0.00757410 | [21.07772523, 46.98908338, 75.06583492, 76.19575298] |
| 0.001 | 12000 | 0.00015584 | 0.00020950 | [21.07734465, 46.95684358, 75.15428547, 76.25243578] |
| 0.002 | 7500 | 0.0000029 | 0.0000040 | [21.07663541, 46.94931326, 75.16861454, 76.26178203] |
| 0.002 | 5000 | 0.00226574 | 0. 00297734 | [21.07804265, 46.97620148, 75.10598923, 76.2213652 ] |
| 0.01 | 900 | 0.0084959 | 0.0110142 | [21.07742366, 46.99577947, 75.04355955, 76.18157478] |
| 0.01 | 1000 | 0.0021839 | 0.0028722 | [21.078077, 46.97589201, 75.10722798, 76.22214929] |
| 0.1 | 90 | 0.00572476 | 0.00749398 | [21.07848821, 46.99129109, 75.06735467, 76.19654316] |
| 0.13 | 90 | 0.00011398 | 0.00015454 | [21.07736656, 46.95602032, 75.15686077, 76.25407703] |
| 0.195 | 50 | 0.00124329 | 0.00166167 | [21.0786281, 46.97207085, 75.12380404, 76.23261308] |

Analysis:

**Impact of Alpha:**

* Smaller alpha values (e.g., 0.0001) required more epochs to converge but achieved stable results.
* Larger alpha values (e.g., 0.13) allowed faster convergence with fewer epochs.

**Impacts of Epochs:**

* Increasing the number of epochs improved the model’s performance up to a certain point.
* Beyond a certain number of epochs, the model started to overfit, as seen by the increasing gap between training and testing loss.

The best performance was achieved with alpha = 0.13 and epochs = 90, resulting in a testing loss of 0. 00015454.

**Relationship between Alpha and Epochs**

There is an inverse relationship between alpha and epochs:

* A larger alpha allows the model to converge faster, requiring fewer epochs.
* A smaller alpha required more epochs to achieve similar performance.

Like, with alpha = 0.0001, the model required 93089 epochs to achieve a testing loss of 0.00757410.

And with alpha = 0.13, the model achieved a much lower testing loss of 0. 00015454 in just 90 epochs.

**Conclusion:**

The observations demonstrated the importance of tuning hyperparameters in linear regression. The best performance was achieved with alpha = 0.13 and epochs = 90, resulting in a testing loss of 0.00015454. This highlights the trad-off between alpha and epochs, where a larger alpha allows for faster convergence with fewer epochs.