#Iterations for Gradient Descent - num\_iterations = 1000

Step size - learning\_rate = 0.01

**Chart 1: The loss as a function of time/iteration**

A graph with a line and a red line

Description automatically generated

Known Minimum Loss Value: 1956525.8508438326

Known Probabilities:

[0.0600961 0.01179456 0.01848825 0.03316831 0.09897002 0.01816731

0.0141927 0.047939 0.05426866 0.00140857 0.00413062 0.03064982

0.02171846 0.05712146 0.06242738 0.01180645 0.00089744 0.04939809

0.0486938 0.06685517 0.02186704 0.00869065 0.01880325 0.0012481

0.01735159 0.00010252 0.16153558 0.05820909]

Gradient Descent Output Probabilities:

[0.060044 0.011733 0.01845325 0.03316603 0.09872618 0.01813125

0.01414192 0.04792133 0.05423482 0.00169563 0.00401792 0.03064405

0.02169324 0.05707906 0.06236716 0.01174495 0.0013843 0.04937708

0.04867443 0.06677827 0.02184223 0.00861092 0.01876927 0.00159273

0.01731275 0.00099377 0.16070712 0.05816324]

**Chart 2: Comparison of True vs Gradient Descent Assigned Probabilities**

A graph of probabilities

Description automatically generated

**Chart 3: Scatterplot Comparison of True vs Gradient Descent Assigned Probabilities**

A graph with blue dots

Description automatically generated

Table 1: Comparison of Actual and Assigned Probabilities

|  |  |  |  |
| --- | --- | --- | --- |
| **Character** | **Actual Probabilities** | **Assigned Probabilities** | **Difference** |
| a | 0.060096104 | 0.060044002 | 0.0000521 |
| b | 0.011794562 | 0.011732998 | 0.0000616 |
| c | 0.018488251 | 0.018453252 | 0.0000350 |
| d | 0.033168307 | 0.033166032 | 0.0000023 |
| e | 0.098970019 | 0.098726183 | 0.0002438 |
| f | 0.018167311 | 0.018131249 | 0.0000361 |
| g | 0.014192701 | 0.014141921 | 0.0000508 |
| h | 0.047938998 | 0.047921326 | 0.0000177 |
| i | 0.054268657 | 0.054234821 | 0.0000338 |
| j | 0.001408572 | 0.001695634 | -0.0002871 |
| k | 0.004130623 | 0.004017924 | 0.0001127 |
| l | 0.030649815 | 0.03064405 | 0.0000058 |
| m | 0.021718458 | 0.021693239 | 0.0000252 |
| n | 0.057121461 | 0.057079062 | 0.0000424 |
| o | 0.06242738 | 0.062367156 | 0.0000602 |
| p | 0.011806449 | 0.011744945 | 0.0000615 |
| q | 0.000897445 | 0.0013843 | -0.0004869 |
| r | 0.049398088 | 0.04937708 | 0.0000210 |
| s | 0.048693802 | 0.048674431 | 0.0000194 |
| t | 0.06685517 | 0.066778272 | 0.0000769 |
| u | 0.021867041 | 0.021842234 | 0.0000248 |
| v | 0.008690652 | 0.008610919 | 0.0000797 |
| w | 0.018803249 | 0.01876927 | 0.0000340 |
| x | 0.001248102 | 0.001592731 | -0.0003446 |
| y | 0.017351587 | 0.017312754 | 0.0000388 |
| z | 0.000102523 | 0.000993769 | -0.0008912 |
| <*space*> | 0.161535581 | 0.160707116 | 0.0008285 |
| None | 0.058209093 | 0.058163244 | 0.0000458 |