Neural Networks with Backpropagation:

Additional Libraries Used:

from sklearn.model\_selection import train\_test\_split

Pre-Processing strategy:

* Any null values in the data set are removed.
* Normalization is performed on numerical data attributes.
* Encoding is performed on categorical columns and on top of that normalization is performed.

Error Function is:

error = sum(error)/length (of dataset).

Implemented the sigmoid, Relu and Tanh function and tested them with different values of learning rate and maximum number of iterations.

Implemented the Predict function to validate the test for trained model.

Below are some of the Observations:

Iris data:

1)Best o/p predictions of three functions among varied parameters of learning rate and iterations(shown below).

2)Among three we observed Tanh activation is optimal.

|  |  |  |
| --- | --- | --- |
| Function | Training Error | Test Error |
| Sigmoid | 0.394445159 | 0.274074676 |
| Tanh | 0.068358921 | 0.049077566 |
| Relu | 0.394444444 | 0.274074074 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Activation\_Function** | **Learning\_Rate** | **Maximum\_Iterations** | **Training\_Error** | **Testing\_Error** |
| sigmoid | 0.0001 | 100 | 0.803148299 | 0.618833814 |
| sigmoid | 0.0001 | 250 | 0.756839024 | 0.578672731 |
| sigmoid | 0.0001 | 500 | 0.682456343 | 0.514344588 |
| sigmoid | 0.0001 | 750 | 0.61485825 | 0.45630776 |
| sigmoid | 0.0001 | 1000 | 0.559528582 | 0.409333788 |
| sigmoid | 0.0001 | 1500 | 0.489440712 | 0.350879168 |
| sigmoid | 0.0001 | 2000 | 0.45486379 | 0.322612722 |
| sigmoid | 0.0001 | 2500 | 0.43670546 | 0.307942046 |
| sigmoid | 0.0001 | 5000 | 0.409220758 | 0.285938251 |
| sigmoid | 0.0005 | 100 | 0.683639324 | 0.514373396 |
| sigmoid | 0.0005 | 250 | 0.518938711 | 0.374849454 |
| sigmoid | 0.0005 | 500 | 0.436765851 | 0.307903376 |
| sigmoid | 0.0005 | 750 | 0.416981287 | 0.292104034 |
| sigmoid | 0.0005 | 1000 | 0.409222863 | 0.285926205 |
| sigmoid | 0.0005 | 1500 | 0.402890383 | 0.28087896 |
| sigmoid | 0.0005 | 2000 | 0.400248952 | 0.278767759 |
| sigmoid | 0.0005 | 2500 | 0.398830346 | 0.27763088 |
| sigmoid | 0.0005 | 5000 | 0.396370128 | 0.275649669 |
| sigmoid | 0.001 | 100 | 0.561255028 | 0.409319636 |
| sigmoid | 0.001 | 250 | 0.436841766 | 0.307855074 |
| sigmoid | 0.001 | 500 | 0.409225498 | 0.285911161 |
| sigmoid | 0.001 | 750 | 0.402889378 | 0.280871969 |
| sigmoid | 0.001 | 1000 | 0.400247746 | 0.278763689 |
| sigmoid | 0.001 | 1500 | 0.397953131 | 0.276925012 |
| sigmoid | 0.001 | 2000 | 0.396936775 | 0.276106918 |
| sigmoid | 0.001 | 2500 | 0.396369659 | 0.275648885 |
| sigmoid | 0.001 | 5000 | 0.395334912 | 0.274808594 |
| sigmoid | 0.005 | 100 | 0.409246709 | 0.285791346 |
| sigmoid | 0.005 | 250 | 0.39882086 | 0.277606703 |
| sigmoid | 0.005 | 500 | 0.396365883 | 0.275642608 |
| sigmoid | 0.005 | 750 | 0.395662516 | 0.275074076 |
| sigmoid | 0.005 | 1000 | 0.395333446 | 0.274806606 |
| sigmoid | 0.005 | 1500 | 0.395020136 | 0.274550689 |
| sigmoid | 0.005 | 2000 | 0.39486964 | 0.274427171 |
| sigmoid | 0.005 | 2500 | 0.394781392 | 0.274354504 |
| sigmoid | 0.005 | 5000 | 0.394609692 | 0.274212428 |
| sigmoid | 0.01 | 100 | 0.40022578 | 0.278690898 |
| sigmoid | 0.01 | 250 | 0.396361113 | 0.275634752 |
| sigmoid | 0.01 | 500 | 0.395331587 | 0.274804102 |
| sigmoid | 0.01 | 750 | 0.395019075 | 0.274549364 |
| sigmoid | 0.01 | 1000 | 0.394868928 | 0.274426316 |
| sigmoid | 0.01 | 1500 | 0.394723031 | 0.274306198 |
| sigmoid | 0.01 | 2000 | 0.39465173 | 0.274247238 |
| sigmoid | 0.01 | 2500 | 0.394609491 | 0.274212206 |
| sigmoid | 0.01 | 5000 | 0.394526241 | 0.274142868 |
| sigmoid | 0.05 | 100 | 0.395315429 | 0.274783106 |
| sigmoid | 0.05 | 250 | 0.394776152 | 0.274348535 |
| sigmoid | 0.05 | 500 | 0.394607628 | 0.274210208 |
| sigmoid | 0.05 | 750 | 0.394552727 | 0.274164746 |
| sigmoid | 0.05 | 1000 | 0.394525505 | 0.274142106 |
| sigmoid | 0.05 | 1500 | 0.394498422 | 0.274119502 |
| sigmoid | 0.05 | 2000 | 0.394484925 | 0.2741082 |
| sigmoid | 0.05 | 2500 | 0.394476838 | 0.274101414 |
| sigmoid | 0.05 | 5000 | 0.394460673 | 0.274087811 |
| sigmoid | 0.1 | 100 | 0.394852053 | 0.274407342 |
| sigmoid | 0.1 | 250 | 0.394604326 | 0.274206806 |
| sigmoid | 0.1 | 500 | 0.394524149 | 0.274140747 |
| sigmoid | 0.1 | 750 | 0.394497621 | 0.274118707 |
| sigmoid | 0.1 | 1000 | 0.394484375 | 0.274107658 |
| sigmoid | 0.1 | 1500 | 0.394471126 | 0.27409657 |
| sigmoid | 0.1 | 2000 | 0.394464494 | 0.274091003 |
| sigmoid | 0.1 | 2500 | 0.394460509 | 0.274087652 |
| sigmoid | 0.1 | 5000 | 0.394452516 | 0.274080913 |
| sigmoid | 0.5 | 100 | 0.394483344 | 0.274106011 |
| sigmoid | 0.5 | 250 | 0.394458473 | 0.274085708 |
| sigmoid | 0.5 | 500 | 0.394450988 | 0.274079501 |
| sigmoid | 0.5 | 750 | 0.394448716 | 0.274077617 |
| sigmoid | 0.5 | 1000 | 0.394447633 | 0.274076721 |
| sigmoid | 0.5 | 1500 | 0.394446587 | 0.274075857 |
| sigmoid | 0.5 | 2000 | 0.394446076 | 0.274075435 |
| sigmoid | 0.5 | 2500 | 0.394445772 | 0.274075183 |
| sigmoid | 0.5 | 5000 | 0.394445159 | 0.274074676 |
| tanh | 0.0001 | 100 | 0.378375024 | 0.25849322 |
| tanh | 0.0001 | 250 | 0.34343369 | 0.240248153 |
| tanh | 0.0001 | 500 | 0.310887665 | 0.217207127 |
| tanh | 0.0001 | 750 | 0.280861296 | 0.20169522 |
| tanh | 0.0001 | 1000 | 0.251858144 | 0.189467646 |
| tanh | 0.0001 | 1500 | 0.202160878 | 0.168014081 |
| tanh | 0.0001 | 2000 | 0.177702283 | 0.158622019 |
| tanh | 0.0001 | 2500 | 0.169105317 | 0.152910427 |
| tanh | 0.0001 | 5000 | 0.159086791 | 0.141473178 |
| tanh | 0.0005 | 100 | 0.311584485 | 0.217464953 |
| tanh | 0.0005 | 250 | 0.226431613 | 0.177724434 |
| tanh | 0.0005 | 500 | 0.169242135 | 0.153095572 |
| tanh | 0.0005 | 750 | 0.16190668 | 0.144871088 |
| tanh | 0.0005 | 1000 | 0.159119338 | 0.141489294 |
| tanh | 0.0005 | 1500 | 0.156539912 | 0.138881668 |
| tanh | 0.0005 | 2000 | 0.155366282 | 0.137583122 |
| tanh | 0.0005 | 2500 | 0.154750472 | 0.136643665 |
| tanh | 0.0005 | 5000 | 0.153796236 | 0.133853144 |
| tanh | 0.001 | 100 | 0.254418294 | 0.190658981 |
| tanh | 0.001 | 250 | 0.169417061 | 0.153328966 |
| tanh | 0.001 | 500 | 0.159161571 | 0.141513404 |
| tanh | 0.001 | 750 | 0.156566451 | 0.138830776 |
| tanh | 0.001 | 1000 | 0.155380722 | 0.137502877 |
| tanh | 0.001 | 1500 | 0.154393374 | 0.135805734 |
| tanh | 0.001 | 2000 | 0.154000592 | 0.13465481 |
| tanh | 0.001 | 2500 | 0.153795695 | 0.133809023 |
| tanh | 0.001 | 5000 | 0.153442159 | 0.131748713 |
| tanh | 0.005 | 100 | 0.159549389 | 0.141873395 |
| tanh | 0.005 | 250 | 0.154875069 | 0.135864945 |
| tanh | 0.005 | 500 | 0.15378335 | 0.133332834 |
| tanh | 0.005 | 750 | 0.153527 | 0.132307999 |
| tanh | 0.005 | 1000 | 0.153406149 | 0.131754966 |
| tanh | 0.005 | 1500 | 0.153252235 | 0.131305403 |
| tanh | 0.005 | 2000 | 0.152928768 | 0.131677485 |
| tanh | 0.005 | 2500 | 0.117137256 | 0.086174057 |
| tanh | 0.005 | 5000 | 0.068358921 | 0.049077566 |
| tanh | 0.01 | 100 | 0.155986009 | 0.137056607 |
| tanh | 0.01 | 250 | 0.153412916 | 0.134111129 |
| tanh | 0.01 | 500 | 0.119978309 | 0.070200969 |
| tanh | 0.01 | 750 | 0.087682369 | 0.068263864 |
| tanh | 0.01 | 1000 | 0.082040328 | 0.060235156 |
| tanh | 0.01 | 1500 | 0.078731372 | 0.055227976 |
| tanh | 0.01 | 2000 | 0.077004887 | 0.053145688 |
| tanh | 0.01 | 2500 | 0.076082962 | 0.052384031 |
| tanh | 0.01 | 5000 | 0.072964277 | 0.049982608 |
| tanh | 0.05 | 100 | 0.158431762 | 0.184555051 |
| tanh | 0.05 | 250 | 0.158528334 | 0.144716156 |
| tanh | 0.05 | 500 | 0.153878133 | 0.140566951 |
| tanh | 0.05 | 750 | 0.172275884 | 0.136712417 |
| tanh | 0.05 | 1000 | 0.154911072 | 0.129475997 |
| tanh | 0.05 | 1500 | 0.146689095 | 0.123993185 |
| tanh | 0.05 | 2000 | 0.147611207 | 0.149255295 |
| tanh | 0.05 | 2500 | 0.184829719 | 0.18487754 |
| tanh | 0.05 | 5000 | 0.19258905 | 0.20391769 |
| tanh | 0.1 | 100 | 0.18444985 | 0.157042504 |
| tanh | 0.1 | 250 | 0.199999965 | 0.21847989 |
| tanh | 0.1 | 500 | 0.199999965 | 0.218479037 |
| tanh | 0.1 | 750 | 0.199999965 | 0.218478153 |
| tanh | 0.1 | 1000 | 0.199999965 | 0.218477237 |
| tanh | 0.1 | 1500 | 0.199999965 | 0.218475305 |
| tanh | 0.1 | 2000 | 0.199999964 | 0.218473228 |
| tanh | 0.1 | 2500 | 0.199999964 | 0.21847099 |
| tanh | 0.1 | 5000 | 0.199999962 | 0.218456717 |
| tanh | 0.5 | 100 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 250 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 500 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 750 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 1000 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 1500 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 2000 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 2500 | 0.288888876 | 0.262962963 |
| tanh | 0.5 | 5000 | 0.288888876 | 0.262962963 |
| relu | 0.0001 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.0001 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.0005 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.001 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.005 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.01 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.05 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.1 | 5000 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 100 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 250 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 500 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 750 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 1000 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 1500 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 2000 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 2500 | 0.394444444 | 0.274074074 |
| relu | 0.5 | 5000 | 0.394444444 | 0.274074074 |

CAR data:

1)Best o/p predictions of three functions among varied parameters of learning rate and iterations (shown below).

2)Among three we observed Tanh activation is optimal.

|  |  |  |
| --- | --- | --- |
| Function | Training Error | Test Error |
| Sigmoid | 0. 20920767 | 0.192648121 |
| Tanh | 0.055402993 | 0.05440669 |
| Relu | 0.20920767 | 0.192648121 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Activation\_Function** | **Learning\_Rate** | **Maximum\_Iterations** | **Training\_Error** | **Testing\_Error** |
| sigmoid | 0.0001 | 100 | 0.317213913 | 0.288084107 |
| sigmoid | 0.0001 | 250 | 0.245066102 | 0.223715392 |
| sigmoid | 0.0001 | 500 | 0.224740425 | 0.205985978 |
| sigmoid | 0.0001 | 750 | 0.219053815 | 0.201076755 |
| sigmoid | 0.0001 | 1000 | 0.21640979 | 0.198803909 |
| sigmoid | 0.0001 | 1500 | 0.213888792 | 0.196643168 |
| sigmoid | 0.0001 | 2000 | 0.212670869 | 0.195601616 |
| sigmoid | 0.0001 | 2500 | 0.21195268 | 0.194988155 |
| sigmoid | 0.0001 | 5000 | 0.210542611 | 0.193785238 |
| sigmoid | 0.0005 | 100 | 0.224753601 | 0.205873523 |
| sigmoid | 0.0005 | 250 | 0.214875048 | 0.197471229 |
| sigmoid | 0.0005 | 500 | 0.211949216 | 0.194981292 |
| sigmoid | 0.0005 | 750 | 0.211006994 | 0.194179472 |
| sigmoid | 0.0005 | 1000 | 0.210541485 | 0.193783325 |
| sigmoid | 0.0005 | 1500 | 0.210079877 | 0.193390481 |
| sigmoid | 0.0005 | 2000 | 0.209850879 | 0.193195583 |
| sigmoid | 0.0005 | 2500 | 0.209714328 | 0.193079359 |
| sigmoid | 0.0005 | 5000 | 0.209445077 | 0.192850167 |
| sigmoid | 0.001 | 100 | 0.216388787 | 0.198726504 |
| sigmoid | 0.001 | 250 | 0.211944889 | 0.194972755 |
| sigmoid | 0.001 | 500 | 0.210540104 | 0.193780962 |
| sigmoid | 0.001 | 750 | 0.210079255 | 0.193389428 |
| sigmoid | 0.001 | 1000 | 0.209850559 | 0.193195017 |
| sigmoid | 0.001 | 1500 | 0.209623729 | 0.193002114 |
| sigmoid | 0.001 | 2000 | 0.209511598 | 0.192906722 |
| sigmoid | 0.001 | 2500 | 0.209445098 | 0.192850139 |
| sigmoid | 0.001 | 5000 | 0.209315985 | 0.192740264 |
| sigmoid | 0.005 | 100 | 0.210529985 | 0.193763089 |
| sigmoid | 0.005 | 250 | 0.209713752 | 0.193077209 |
| sigmoid | 0.005 | 500 | 0.209445999 | 0.192850547 |
| sigmoid | 0.005 | 750 | 0.209359029 | 0.192776741 |
| sigmoid | 0.005 | 1000 | 0.209316741 | 0.192740823 |
| sigmoid | 0.005 | 1500 | 0.209276033 | 0.192706229 |
| sigmoid | 0.005 | 2000 | 0.209256671 | 0.192689771 |
| sigmoid | 0.005 | 2500 | 0.209245534 | 0.192680303 |
| sigmoid | 0.005 | 5000 | 0.209224848 | 0.19266272 |
| sigmoid | 0.01 | 100 | 0.209849521 | 0.193189037 |
| sigmoid | 0.01 | 250 | 0.209449083 | 0.192852732 |
| sigmoid | 0.01 | 500 | 0.209318949 | 0.192742599 |
| sigmoid | 0.01 | 750 | 0.209277545 | 0.192707473 |
| sigmoid | 0.01 | 1000 | 0.209257749 | 0.192690665 |
| sigmoid | 0.01 | 1500 | 0.209238983 | 0.192674724 |
| sigmoid | 0.01 | 2000 | 0.209230164 | 0.192667232 |
| sigmoid | 0.01 | 2500 | 0.209225115 | 0.192662943 |
| sigmoid | 0.01 | 5000 | 0.209215728 | 0.192654967 |
| sigmoid | 0.05 | 100 | 0.209292733 | 0.192719985 |
| sigmoid | 0.05 | 250 | 0.209250769 | 0.192684697 |
| sigmoid | 0.05 | 500 | 0.209231674 | 0.192668533 |
| sigmoid | 0.05 | 750 | 0.209224363 | 0.192662327 |
| sigmoid | 0.05 | 1000 | 0.209220477 | 0.192659025 |
| sigmoid | 0.05 | 1500 | 0.209216412 | 0.192655567 |
| sigmoid | 0.05 | 2000 | 0.209214304 | 0.192653773 |
| sigmoid | 0.05 | 2500 | 0.209213012 | 0.192652673 |
| sigmoid | 0.05 | 5000 | 0.209210363 | 0.192650416 |
| sigmoid | 0.1 | 100 | 0.209207821 | 0.19264825 |
| sigmoid | 0.1 | 250 | 0.20920782 | 0.19264825 |
| sigmoid | 0.1 | 500 | 0.20920782 | 0.192648249 |
| sigmoid | 0.1 | 750 | 0.209207819 | 0.192648248 |
| sigmoid | 0.1 | 1000 | 0.209207818 | 0.192648248 |
| sigmoid | 0.1 | 1500 | 0.209207817 | 0.192648246 |
| sigmoid | 0.1 | 2000 | 0.209207815 | 0.192648245 |
| sigmoid | 0.1 | 2500 | 0.209207814 | 0.192648244 |
| sigmoid | 0.1 | 5000 | 0.209207807 | 0.192648238 |
| sigmoid | 0.5 | 100 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 250 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 500 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 750 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 1000 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 1500 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 2000 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 2500 | 0.20920767 | 0.192648121 |
| sigmoid | 0.5 | 5000 | 0.20920767 | 0.192648121 |
| tanh | 0.0001 | 100 | 0.122548082 | 0.12446705 |
| tanh | 0.0001 | 250 | 0.112301221 | 0.11625135 |
| tanh | 0.0001 | 500 | 0.097247127 | 0.103138766 |
| tanh | 0.0001 | 750 | 0.075890299 | 0.076967617 |
| tanh | 0.0001 | 1000 | 0.068624345 | 0.070854663 |
| tanh | 0.0001 | 1500 | 0.064536313 | 0.067359762 |
| tanh | 0.0001 | 2000 | 0.061549073 | 0.06428356 |
| tanh | 0.0001 | 2500 | 0.06104932 | 0.063965518 |
| tanh | 0.0001 | 5000 | 0.05626961 | 0.060098739 |
| tanh | 0.0005 | 100 | 0.097812705 | 0.103475619 |
| tanh | 0.0005 | 250 | 0.071954045 | 0.071191637 |
| tanh | 0.0005 | 500 | 0.064832812 | 0.06470948 |
| tanh | 0.0005 | 750 | 0.063310064 | 0.063798493 |
| tanh | 0.0005 | 1000 | 0.06212317 | 0.062731722 |
| tanh | 0.0005 | 1500 | 0.06014801 | 0.059478586 |
| tanh | 0.0005 | 2000 | 0.058907945 | 0.057676769 |
| tanh | 0.0005 | 2500 | 0.057977328 | 0.056633642 |
| tanh | 0.0005 | 5000 | 0.055402993 | 0.05440669 |
| tanh | 0.001 | 100 | 0.091404635 | 0.087025404 |
| tanh | 0.001 | 250 | 0.070194819 | 0.067761369 |
| tanh | 0.001 | 500 | 0.068772314 | 0.066891171 |
| tanh | 0.001 | 750 | 0.070896533 | 0.068119686 |
| tanh | 0.001 | 1000 | 0.072372329 | 0.068819573 |
| tanh | 0.001 | 1500 | 0.074011849 | 0.069348438 |
| tanh | 0.001 | 2000 | 0.074516156 | 0.0692396 |
| tanh | 0.001 | 2500 | 0.074529728 | 0.068813471 |
| tanh | 0.001 | 5000 | 0.07244345 | 0.065908767 |
| tanh | 0.005 | 100 | 0.384653812 | 0.41147982 |
| tanh | 0.005 | 250 | 0.38615526 | 0.412928413 |
| tanh | 0.005 | 500 | 0.386805682 | 0.415866999 |
| tanh | 0.005 | 750 | 0.386747285 | 0.415802634 |
| tanh | 0.005 | 1000 | 0.386848549 | 0.415913771 |
| tanh | 0.005 | 1500 | 0.386848547 | 0.41591377 |
| tanh | 0.005 | 2000 | 0.386848546 | 0.415913768 |
| tanh | 0.005 | 2500 | 0.386848545 | 0.415913767 |
| tanh | 0.005 | 5000 | 0.386848538 | 0.415913759 |
| tanh | 0.01 | 100 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 250 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 500 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 750 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 1000 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 1500 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 2000 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 2500 | 0.38684877 | 0.415914017 |
| tanh | 0.01 | 5000 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 100 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 250 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 500 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 750 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 1000 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 1500 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 2000 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 2500 | 0.38684877 | 0.415914017 |
| tanh | 0.05 | 5000 | 0.38684877 | 0.415914017 |
| tanh | 0.1 | 100 | 0.386848753 | 0.415913999 |
| tanh | 0.1 | 250 | 0.386848753 | 0.415913999 |
| tanh | 0.1 | 500 | 0.386848752 | 0.415913999 |
| tanh | 0.1 | 750 | 0.386848752 | 0.415913999 |
| tanh | 0.1 | 1000 | 0.386848752 | 0.415913999 |
| tanh | 0.1 | 1500 | 0.386848752 | 0.415913998 |
| tanh | 0.1 | 2000 | 0.386848752 | 0.415913998 |
| tanh | 0.1 | 2500 | 0.386848752 | 0.415913998 |
| tanh | 0.1 | 5000 | 0.386848751 | 0.415913997 |
| tanh | 0.5 | 100 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 250 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 500 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 750 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 1000 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 1500 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 2000 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 2500 | 0.38684877 | 0.415914017 |
| tanh | 0.5 | 5000 | 0.38684877 | 0.415914017 |
| relu | 0.0001 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.0001 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.0005 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.001 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.005 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.01 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.05 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.1 | 5000 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 100 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 250 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 500 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 750 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 1000 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 1500 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 2000 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 2500 | 0.20920767 | 0.192648121 |
| relu | 0.5 | 5000 | 0.20920767 | 0.192648121 |

The Tanh function has a derivate that goes upto 1.0 which helps to make weight updates larger so it converges easily.