

| Epochs | train_loss | valid_loss |
|--------|------------|------------|
| 0      | 60         | 60         |
| 10     | 55         | 55         |
| 20     | 45         | 40         |
| 30     | 30         | 25         |
| 40     | 20         | 18         |
| 50     | 16         | 18         |

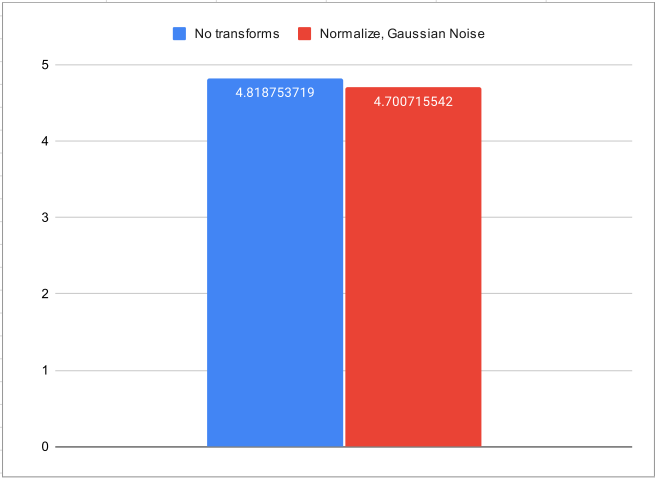
The top chart shows training and validation loss over 45 epochs for a learning rate of 1e-01. The y-axis is 'Loss (MAE Label Smoothing)' ranging from 0 to 200. The x-axis is 'Epochs' ranging from 0 to 45. The 'train\_loss' (blue line) starts at approximately 20 and stabilizes around 5. The 'valid\_loss' (orange line) starts at approximately 180 and drops sharply to around 10 by epoch 5, then fluctuates slightly before stabilizing around 5.

The middle chart shows training and validation loss over 45 epochs for a learning rate of 1e-02. The y-axis is 'Loss (MAE Label Smoothing)' ranging from 0 to 200. The x-axis is 'Epochs' ranging from 0 to 45. The 'train\_loss' (blue line) starts at approximately 180 and drops sharply to around 10 by epoch 5, then fluctuates slightly before stabilizing around 5. The 'valid\_loss' (orange line) starts at approximately 180 and drops sharply to around 10 by epoch 5, then fluctuates slightly before stabilizing around 5.

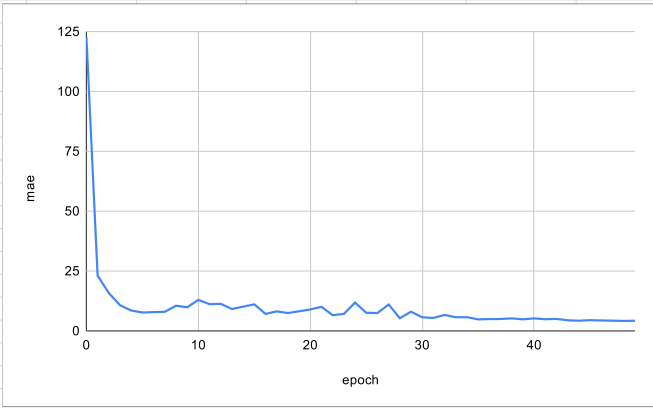
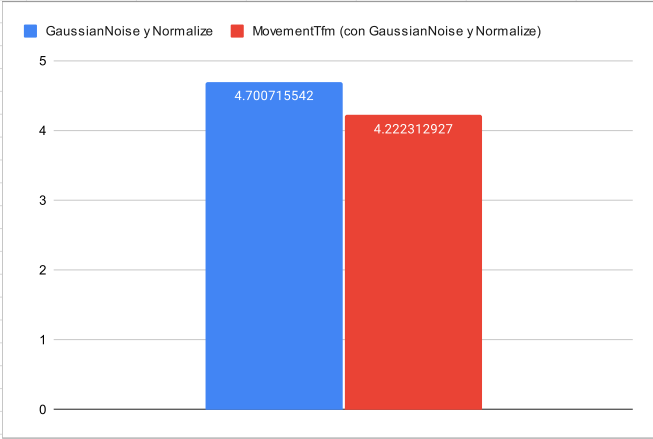
The bottom chart is a bar chart comparing the final MAE for two learning rates. The y-axis is 'Metric (MAE)' ranging from 0 to 20. The x-axis has two categories: 'Default learning rate' (blue bar) and '1e-01 learning rate' (red bar). The 'Default learning rate' bar has a value of 17.11759186. The '1e-01 learning rate' bar has a value of 4.818753719.

| Metric (MAE) | Default learning rate | 1e-01 learning rate |
|--------------|-----------------------|---------------------|
| 17.11759186  | 17.11759186           | 4.818753719         |

| epoch | train_loss  | valid_loss  | mae         | time |  |  |  |  |  |  |
|-------|-------------|-------------|-------------|------|--|--|--|--|--|--|
| 0     | 52.23398972 | 22.90345573 | 22.90345573 | 0:05 |  |  |  |  |  |  |
| epoch | train_loss  | valid_loss  | mae         | time |  |  |  |  |  |  |
| 0     | 15.64302063 | 242.0689697 | 242.0689697 | 0:06 |  |  |  |  |  |  |
| 1     | 13.35676098 | 22.49403191 | 22.49403191 | 0:06 |  |  |  |  |  |  |
| 2     | 12.12638569 | 16.20879173 | 16.20879173 | 0:06 |  |  |  |  |  |  |
| 3     | 11.19224453 | 15.66699696 | 15.66699696 | 0:06 |  |  |  |  |  |  |
| 4     | 10.45260143 | 8.378947258 | 8.378947258 | 0:06 |  |  |  |  |  |  |
| 5     | 9.955103874 | 8.682997704 | 8.682997704 | 0:06 |  |  |  |  |  |  |
| 6     | 9.538402557 | 11.98884392 | 11.98884392 | 0:06 |  |  |  |  |  |  |
| 7     | 9.331453323 | 12.16456795 | 12.16456795 | 0:06 |  |  |  |  |  |  |
| 8     | 9.04106617  | 9.388827324 | 9.388827324 | 0:06 |  |  |  |  |  |  |
| 9     | 8.912714005 | 12.79879093 | 12.79879093 | 0:06 |  |  |  |  |  |  |
| 10    | 8.685866356 | 10.79220963 | 10.79220963 | 0:06 |  |  |  |  |  |  |
| 11    | 8.493879318 | 9.941980362 | 9.941980362 | 0:06 |  |  |  |  |  |  |
| 12    | 8.199374199 | 9.403951645 | 9.403951645 | 0:06 |  |  |  |  |  |  |
| 13    | 8.05796051  | 9.622600555 | 9.622600555 | 0:06 |  |  |  |  |  |  |
| 14    | 7.974678516 | 11.97872925 | 11.97872925 | 0:06 |  |  |  |  |  |  |
| 15    | 7.831742287 | 10.93729496 | 10.93729496 | 0:06 |  |  |  |  |  |  |
| 16    | 7.677259922 | 8.312571526 | 8.312571526 | 0:06 |  |  |  |  |  |  |
| 17    | 7.486081123 | 6.467100143 | 6.467100143 | 0:07 |  |  |  |  |  |  |
| 18    | 7.216100693 | 7.535621643 | 7.535621643 | 0:06 |  |  |  |  |  |  |
| 19    | 7.097898483 | 7.1971035   | 7.1971035   | 0:06 |  |  |  |  |  |  |
| 20    | 6.971338272 | 9.789575577 | 9.789575577 | 0:06 |  |  |  |  |  |  |
| 21    | 6.915234089 | 7.502090454 | 7.502090454 | 0:06 |  |  |  |  |  |  |
| 22    | 6.811673164 | 7.118709087 | 7.118709087 | 0:06 |  |  |  |  |  |  |
| 23    | 6.707813263 | 7.169671535 | 7.169671535 | 0:06 |  |  |  |  |  |  |
| 24    | 6.597995758 | 7.018040657 | 7.018040657 | 0:06 |  |  |  |  |  |  |
| 25    | 6.539188862 | 6.913377285 | 6.913377285 | 0:06 |  |  |  |  |  |  |
| 26    | 6.473728657 | 8.082018852 | 8.082018852 | 0:06 |  |  |  |  |  |  |
| 27    | 6.521291733 | 7.949656487 | 7.949656487 | 0:06 |  |  |  |  |  |  |
| 28    | 6.50356245  | 6.802912235 | 6.802912235 | 0:06 |  |  |  |  |  |  |
| 29    | 6.362267971 | 7.403543472 | 7.403543472 | 0:06 |  |  |  |  |  |  |
| 30    | 6.281558514 | 6.511723995 | 6.511723995 | 0:06 |  |  |  |  |  |  |
| 31    | 6.161056995 | 5.731553555 | 5.731553555 | 0:06 |  |  |  |  |  |  |
| 32    | 6.061950684 | 5.545393467 | 5.545393467 | 0:06 |  |  |  |  |  |  |
| 33    | 5.973070145 | 6.531844616 | 6.531844616 | 0:06 |  |  |  |  |  |  |
| 34    | 5.872395992 | 5.595588684 | 5.595588684 | 0:06 |  |  |  |  |  |  |
| 35    | 5.693408966 | 6.031140804 | 6.031140804 | 0:06 |  |  |  |  |  |  |
| 36    | 5.617545128 | 5.286297321 | 5.286297321 | 0:06 |  |  |  |  |  |  |
| 37    | 5.480725765 | 5.096310139 | 5.096310139 | 0:06 |  |  |  |  |  |  |
| 38    | 5.425454617 | 5.139780998 | 5.139780998 | 0:06 |  |  |  |  |  |  |
| 39    | 5.343470573 | 5.053991795 | 5.053991795 | 0:06 |  |  |  |  |  |  |
| 40    | 5.247589111 | 4.935120106 | 4.935120106 | 0:06 |  |  |  |  |  |  |
| 41    | 5.155478001 | 4.923383236 | 4.923383236 | 0:06 |  |  |  |  |  |  |
| 42    | 5.126234531 | 4.883264542 | 4.883264542 | 0:06 |  |  |  |  |  |  |
| 43    | 5.028892994 | 4.598216057 | 4.598216057 | 0:06 |  |  |  |  |  |  |
| 44    | 5.028365135 | 4.693628311 | 4.693628311 | 0:06 |  |  |  |  |  |  |
| 45    | 4.927525043 | 4.737321377 | 4.737321377 | 0:06 |  |  |  |  |  |  |
| 46    | 4.886593342 | 4.661301613 | 4.661301613 | 0:06 |  |  |  |  |  |  |
| 47    | 4.850450993 | 4.710813046 | 4.710813046 | 0:06 |  |  |  |  |  |  |
| 48    | 4.81725502  | 4.684630871 | 4.684630871 | 0:06 |  |  |  |  |  |  |
| 49    | 4.769656181 | 4.700715542 | 4.700715542 | 0:06 |  |  |  |  |  |  |



| epoch | train_loss  | valid_loss  | mae         | time |
|-------|-------------|-------------|-------------|------|
| 0     | 52.04727173 | 28.03587723 | 28.03587723 | 0:06 |
| epoch | train_loss  | valid_loss  | mae         | time |
| 0     | 16.20768356 | 122.8257599 | 122.8257599 | 0:07 |
| 1     | 14.02889633 | 23.07849503 | 23.07849503 | 0:07 |
| 2     | 12.69958782 | 15.82986164 | 15.82986164 | 0:07 |
| 3     | 11.86321068 | 10.73067665 | 10.73067665 | 0:08 |
| 4     | 11.06181431 | 8.512529373 | 8.512529373 | 0:08 |
| 5     | 10.59011364 | 7.662456036 | 7.662456036 | 0:08 |
| 6     | 10.08053589 | 7.83613205  | 7.83613205  | 0:08 |
| 7     | 9.804548264 | 7.962843895 | 7.962843895 | 0:08 |
| 8     | 9.566657066 | 10.49464321 | 10.49464321 | 0:08 |
| 9     | 9.377542496 | 9.846886635 | 9.846886635 | 0:08 |
| 10    | 9.27030468  | 12.93295288 | 12.93295288 | 0:08 |
| 11    | 9.208685875 | 11.17153931 | 11.17153931 | 0:08 |
| 12    | 8.975809097 | 11.28958416 | 11.28958416 | 0:08 |
| 13    | 8.915672302 | 9.136039734 | 9.136039734 | 0:08 |
| 14    | 8.994821548 | 10.11786175 | 10.11786175 | 0:08 |
| 15    | 8.861361504 | 11.07320595 | 11.07320595 | 0:08 |
| 16    | 8.727535248 | 7.095398426 | 7.095398426 | 0:08 |
| 17    | 8.487668037 | 8.143832207 | 8.143832207 | 0:08 |
| 18    | 8.471387863 | 7.455142021 | 7.455142021 | 0:08 |
| 19    | 8.373667717 | 8.170403481 | 8.170403481 | 0:08 |
| 20    | 8.222648621 | 8.965211868 | 8.965211868 | 0:08 |
| 21    | 8.156078339 | 10.05960751 | 10.05960751 | 0:08 |
| 22    | 8.090497971 | 6.543748379 | 6.543748379 | 0:08 |
| 23    | 7.990794182 | 7.083890915 | 7.083890915 | 0:08 |
| 24    | 7.768881321 | 11.83225441 | 11.83225441 | 0:08 |
| 25    | 7.649441242 | 7.555634499 | 7.555634499 | 0:08 |
| 26    | 7.595966339 | 7.45977211  | 7.45977211  | 0:08 |
| 27    | 7.50899744  | 10.98481941 | 10.98481941 | 0:08 |
| 28    | 7.425238609 | 5.285026073 | 5.285026073 | 0:08 |
| 29    | 7.322659969 | 8.005800247 | 8.005800247 | 0:08 |
| 30    | 7.25973177  | 5.674442768 | 5.674442768 | 0:08 |
| 31    | 7.108019352 | 5.407767296 | 5.407767296 | 0:08 |
| 32    | 6.936644554 | 6.653773308 | 6.653773308 | 0:08 |
| 33    | 6.796116352 | 5.679975033 | 5.679975033 | 0:08 |
| 34    | 6.672667027 | 5.710474014 | 5.710474014 | 0:08 |
| 35    | 6.496857166 | 4.801344395 | 4.801344395 | 0:08 |
| 36    | 6.377504826 | 4.922531128 | 4.922531128 | 0:08 |
| 37    | 6.214481831 | 4.957373619 | 4.957373619 | 0:08 |
| 38    | 6.110846996 | 5.234139442 | 5.234139442 | 0:08 |
| 39    | 6.006389618 | 4.808365822 | 4.808365822 | 0:08 |
| 40    | 5.894705772 | 5.215469837 | 5.215469837 | 0:08 |
| 41    | 5.814524174 | 4.861517906 | 4.861517906 | 0:08 |
| 42    | 5.741152287 | 4.988432884 | 4.988432884 | 0:08 |
| 43    | 5.606197357 | 4.417826653 | 4.417826653 | 0:08 |
| 44    | 5.587378502 | 4.239909172 | 4.239909172 | 0:08 |
| 45    | 5.50177145  | 4.465577602 | 4.465577602 | 0:08 |
| 46    | 5.481752396 | 4.346788406 | 4.346788406 | 0:08 |
| 47    | 5.439116955 | 4.253921509 | 4.253921509 | 0:08 |
| 48    | 5.377739429 | 4.159992218 | 4.159992218 | 0:08 |
| 49    | 5.323379517 | 4.222312927 | 4.222312927 | 0:08 |

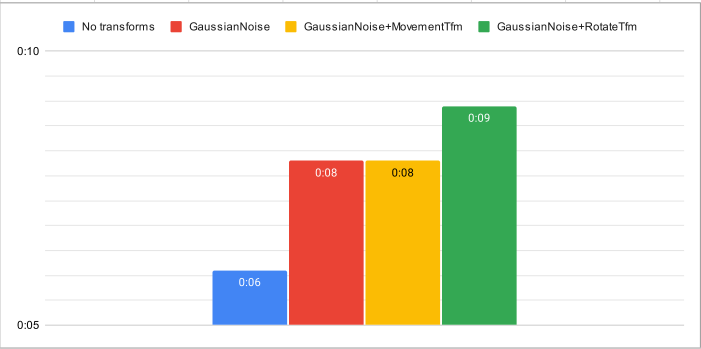
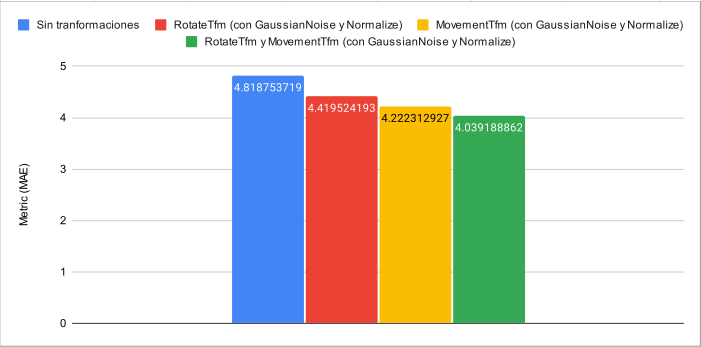


Métrica final obtenida según las transformaciones aplicadas

■ GaussianNoise y Normalize ■ RotateTfm (con GaussianNoise y Normalize)

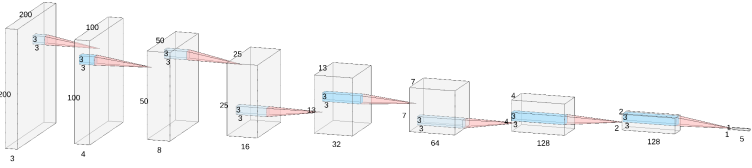
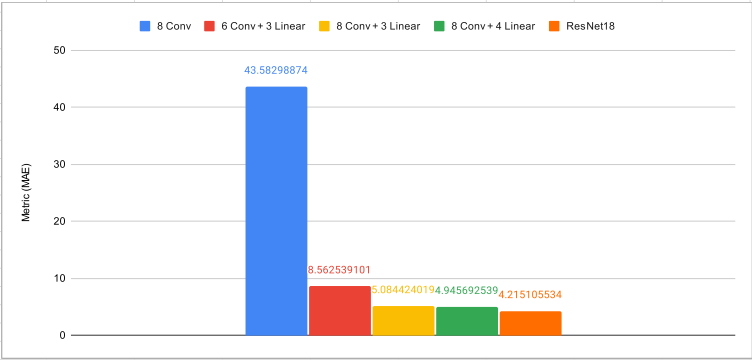
| Transformación                            | Métrica (MAE) |
|---|---------------|
| GaussianNoise y Normalize                 | 4.700715542   |
| RotateTfm (con GaussianNoise y Normalize) | 4.419524193   |

| epoch | train_loss  | valid_loss  | mae         | time |
|-------|-------------|-------------|-------------|------|
| 0     | 52.29184341 | 29.21567345 | 29.21567345 | 0:07 |
| epoch | train_loss  | valid_loss  | mae         | time |
| 0     | 16.69838142 | 62.8373642  | 62.8373642  | 0:08 |
| 1     | 14.04134369 | 24.45101547 | 24.45101547 | 0:08 |
| 2     | 12.69673347 | 12.7228241  | 12.7228241  | 0:08 |
| 3     | 11.94009495 | 8.591676712 | 8.591676712 | 0:08 |
| 4     | 11.43335724 | 11.269207   | 11.269207   | 0:08 |
| 5     | 11.05273533 | 8.930670738 | 8.930670738 | 0:08 |
| 6     | 10.66037369 | 11.12750721 | 11.12750721 | 0:08 |
| 7     | 10.36841106 | 9.707837105 | 9.707837105 | 0:08 |
| 8     | 10.09142685 | 9.965669632 | 9.965669632 | 0:08 |
| 9     | 10.11120987 | 9.590073586 | 9.590073586 | 0:08 |
| 10    | 10.11300564 | 8.40629673  | 8.40629673  | 0:08 |
| 11    | 9.97367382  | 12.95999146 | 12.95999146 | 0:08 |
| 12    | 9.658127785 | 7.87444067  | 7.87444067  | 0:08 |
| 13    | 9.491709709 | 10.64125443 | 10.64125443 | 0:08 |
| 14    | 9.180420876 | 9.753568649 | 9.753568649 | 0:08 |
| 15    | 9.100538254 | 9.127080917 | 9.127080917 | 0:09 |
| 16    | 8.97867775  | 6.528069973 | 6.528069973 | 0:09 |
| 17    | 8.80321045  | 9.380734444 | 9.380734444 | 0:08 |
| 18    | 8.778180122 | 8.006649017 | 8.006649017 | 0:08 |
| 19    | 8.678424835 | 7.487980366 | 7.487980366 | 0:08 |
| 20    | 8.641148567 | 8.412527084 | 8.412527084 | 0:08 |
| 21    | 8.50465892  | 7.444210529 | 7.444210529 | 0:08 |
| 22    | 8.546194077 | 8.3183918   | 8.3183918   | 0:08 |
| 23    | 8.554186821 | 6.379916668 | 6.379916668 | 0:08 |
| 24    | 8.404702187 | 10.54880714 | 10.54880714 | 0:08 |
| 25    | 8.409450531 | 6.704873085 | 6.704873085 | 0:08 |
| 26    | 8.398709297 | 6.961904049 | 6.961904049 | 0:08 |
| 27    | 8.255598068 | 6.97318697  | 6.97318697  | 0:08 |
| 28    | 8.256527901 | 5.705773354 | 5.705773354 | 0:08 |
| 29    | 8.068374634 | 8.254722595 | 8.254722595 | 0:09 |
| 30    | 8.014647484 | 5.750543594 | 5.750543594 | 0:09 |
| 31    | 7.920248985 | 6.526049614 | 6.526049614 | 0:08 |
| 32    | 7.887644482 | 7.26300621  | 7.26300621  | 0:09 |
| 33    | 7.671931267 | 7.164931297 | 7.164931297 | 0:08 |
| 34    | 7.623235226 | 5.544976711 | 5.544976711 | 0:08 |
| 35    | 7.490169048 | 5.409333706 | 5.409333706 | 0:08 |
| 36    | 7.349642277 | 5.149328709 | 5.149328709 | 0:08 |
| 37    | 7.160364151 | 5.317180634 | 5.317180634 | 0:08 |
| 38    | 7.040596485 | 4.448809147 | 4.448809147 | 0:08 |
| 39    | 6.947624207 | 5.052920341 | 5.052920341 | 0:08 |
| 40    | 6.840912342 | 4.918730736 | 4.918730736 | 0:08 |
| 41    | 6.806815147 | 4.731729507 | 4.731729507 | 0:08 |
| 42    | 6.783137798 | 4.570641518 | 4.570641518 | 0:08 |
| 43    | 6.654021263 | 3.987673759 | 3.987673759 | 0:08 |
| 44    | 6.590134144 | 4.032967091 | 4.032967091 | 0:08 |
| 45    | 6.529037952 | 4.203742981 | 4.203742981 | 0:08 |
| 46    | 6.451602936 | 3.973523617 | 3.973523617 | 0:08 |
| 47    | 6.490466118 | 4.029663563 | 4.029663563 | 0:08 |
| 48    | 6.402285099 | 4.010158062 | 4.010158062 | 0:09 |
| 49    | 6.369795799 | 4.039188862 | 4.039188862 | 0:08 |





| epoch | train_loss  | valid_loss  | mae_angle   | time |
|-------|-------------|-------------|-------------|------|
| 0     | 59.72793579 | 58.4662056  | 58.4662056  | 0:04 |
| epoch | train_loss  | valid_loss  | mae_angle   | time |
| 0     | 59.44062424 | 59.01514435 | 59.01514435 | 0:04 |
| 1     | 59.28918076 | 58.59498978 | 58.59498978 | 0:04 |
| 2     | 59.19007111 | 59.26094818 | 59.26094818 | 0:04 |
| 3     | 59.1456422  | 59.11948776 | 59.11948776 | 0:04 |
| 4     | 59.05139923 | 58.55131149 | 58.55131149 | 0:04 |
| 5     | 58.77574539 | 58.83501053 | 58.83501053 | 0:04 |
| 6     | 58.58174515 | 57.85995102 | 57.85995102 | 0:04 |
| 7     | 58.44350815 | 57.88043976 | 57.88043976 | 0:04 |
| 8     | 58.17225647 | 56.51634216 | 56.51634216 | 0:04 |
| 9     | 57.85528946 | 57.0509491  | 57.0509491  | 0:04 |
| 10    | 57.49597549 | 56.72806168 | 56.72806168 | 0:04 |
| 11    | 57.25395584 | 55.13620758 | 55.13620758 | 0:04 |
| 12    | 56.82542038 | 55.34337234 | 55.34337234 | 0:04 |
| 13    | 56.33610153 | 54.52725983 | 54.52725983 | 0:04 |
| 14    | 55.89431763 | 52.20823669 | 52.20823669 | 0:04 |
| 15    | 55.37417984 | 53.12958145 | 53.12958145 | 0:04 |
| 16    | 54.79021835 | 52.42190933 | 52.42190933 | 0:04 |
| 17    | 54.20536041 | 53.88725662 | 53.88725662 | 0:04 |
| 18    | 53.69509125 | 50.73859787 | 50.73859787 | 0:04 |
| 19    | 53.07619858 | 51.08130264 | 51.08130264 | 0:04 |
| 20    | 52.48683929 | 50.694561   | 50.694561   | 0:04 |
| 21    | 51.98460388 | 49.61082458 | 49.61082458 | 0:04 |
| 22    | 51.34820557 | 48.9957962  | 48.9957962  | 0:04 |
| 23    | 50.81088257 | 48.89363861 | 48.89363861 | 0:04 |
| 24    | 50.25935364 | 48.19297028 | 48.19297028 | 0:04 |
| 25    | 49.72683334 | 47.42770004 | 47.42770004 | 0:04 |
| 26    | 49.24481201 | 47.70923615 | 47.70923615 | 0:04 |
| 27    | 48.76948929 | 47.30128479 | 47.30128479 | 0:04 |
| 28    | 48.38739014 | 47.81565475 | 47.81565475 | 0:04 |
| 29    | 47.90553665 | 46.2314949  | 46.2314949  | 0:04 |
| 30    | 47.42543411 | 46.03703308 | 46.03703308 | 0:04 |
| 31    | 47.05360413 | 45.91680908 | 45.91680908 | 0:04 |
| 32    | 46.70838928 | 45.72539902 | 45.72539902 | 0:04 |
| 33    | 46.28620148 | 45.56218338 | 45.56218338 | 0:04 |
| 34    | 45.84220505 | 357.9127197 | 357.9127197 | 0:04 |
| 35    | 45.43801498 | 824.1922607 | 824.1922607 | 0:04 |
| 36    | 45.23125839 | 45.32436752 | 45.32436752 | 0:04 |
| 37    | 45.00936508 | 45.07541275 | 45.07541275 | 0:04 |
| 38    | 44.84223175 | 44.49590683 | 44.49590683 | 0:04 |
| 39    | 44.70759201 | 44.70875168 | 44.70875168 | 0:04 |
| 40    | 44.5648553  | 44.30334854 | 44.30334854 | 0:04 |
| 41    | 44.38856888 | 43.64928818 | 43.64928818 | 0:04 |
| 42    | 44.25804901 | 43.61221313 | 43.61221313 | 0:04 |
| 43    | 44.07471085 | 43.74190521 | 43.74190521 | 0:04 |
| 44    | 43.9426918  | 43.85195923 | 43.85195923 | 0:04 |
| 45    | 43.84564972 | 43.81521606 | 43.81521606 | 0:04 |
| 46    | 43.75601959 | 43.66691589 | 43.66691589 | 0:04 |
| 47    | 43.6662178  | 43.61265945 | 43.61265945 | 0:04 |
| 48    | 43.63705444 | 43.58837891 | 43.58837891 | 0:04 |
| 49    | 43.56836319 | 43.58298874 | 43.58298874 | 0:04 |









| epoch | train_loss  | valid_loss  | mae_angle   | time |  |  |  |  |  |  |  |  |  |
|-------|-------------|-------------|-------------|------|--|--|--|--|--|--|--|--|--|
| 0     | 88.30802917 | 3658996     | 3658996     | 0:04 |  |  |  |  |  |  |  |  |  |
| epoch | train_loss  | valid_loss  | mae_angle   | time |  |  |  |  |  |  |  |  |  |
| 0     | 64.19870758 | 349.8434143 | 349.8434143 | 0:04 |  |  |  |  |  |  |  |  |  |
| 1     | 43.43523026 | 22.90886307 | 22.90886307 | 0:04 |  |  |  |  |  |  |  |  |  |
| 2     | 34.11413574 | 21.9437561  | 21.9437561  | 0:04 |  |  |  |  |  |  |  |  |  |
| 3     | 28.01916885 | 17.03746414 | 17.03746414 | 0:04 |  |  |  |  |  |  |  |  |  |
| 4     | 24.11285973 | 13.42706013 | 13.42706013 | 0:04 |  |  |  |  |  |  |  |  |  |
| 5     | 21.02969551 | 11.61648655 | 11.61648655 | 0:04 |  |  |  |  |  |  |  |  |  |
| 6     | 18.8588047  | 11.47070503 | 11.47070503 | 0:04 |  |  |  |  |  |  |  |  |  |
| 7     | 17.39383125 | 15.61144447 | 15.61144447 | 0:04 |  |  |  |  |  |  |  |  |  |
| 8     | 16.18762589 | 25.41969109 | 25.41969109 | 0:04 |  |  |  |  |  |  |  |  |  |
| 9     | 15.71536922 | 17.73514175 | 17.73514175 | 0:04 |  |  |  |  |  |  |  |  |  |
| 10    | 15.84703541 | 14.42396641 | 14.42396641 | 0:04 |  |  |  |  |  |  |  |  |  |
| 11    | 16.80662918 | 28.39225197 | 28.39225197 | 0:04 |  |  |  |  |  |  |  |  |  |
| 12    | 17.37120247 | 32.86845398 | 32.86845398 | 0:04 |  |  |  |  |  |  |  |  |  |
| 13    | 17.25267982 | 11.15034294 | 11.15034294 | 0:04 |  |  |  |  |  |  |  |  |  |
| 14    | 17.03529549 | 20.80851746 | 20.80851746 | 0:04 |  |  |  |  |  |  |  |  |  |
| 15    | 16.98388481 | 14.44054794 | 14.44054794 | 0:04 |  |  |  |  |  |  |  |  |  |
| 16    | 16.2514019  | 16.55176926 | 16.55176926 | 0:04 |  |  |  |  |  |  |  |  |  |
| 17    | 15.25784683 | 10.19077396 | 10.19077396 | 0:04 |  |  |  |  |  |  |  |  |  |
| 18    | 14.32132626 | 18.67009544 | 18.67009544 | 0:04 |  |  |  |  |  |  |  |  |  |
| 19    | 13.52899742 | 8.347789764 | 8.347789764 | 0:04 |  |  |  |  |  |  |  |  |  |
| 20    | 12.62997437 | 13.27958965 | 13.27958965 | 0:04 |  |  |  |  |  |  |  |  |  |
| 21    | 12.17777729 | 11.88927364 | 11.88927364 | 0:04 |  |  |  |  |  |  |  |  |  |
| 22    | 11.78227901 | 10.57011127 | 10.57011127 | 0:04 |  |  |  |  |  |  |  |  |  |
| 23    | 11.24253464 | 8.453212738 | 8.453212738 | 0:04 |  |  |  |  |  |  |  |  |  |
| 24    | 10.81764889 | 21.31358147 | 21.31358147 | 0:04 |  |  |  |  |  |  |  |  |  |
| 25    | 10.40986538 | 13.16202259 | 13.16202259 | 0:04 |  |  |  |  |  |  |  |  |  |
| 26    | 10.00684738 | 13.87852573 | 13.87852573 | 0:04 |  |  |  |  |  |  |  |  |  |
| 27    | 9.868828773 | 13.58460331 | 13.58460331 | 0:04 |  |  |  |  |  |  |  |  |  |
| 28    | 9.59603405  | 15.47540188 | 15.47540188 | 0:04 |  |  |  |  |  |  |  |  |  |
| 29    | 9.310399055 | 10.00194645 | 10.00194645 | 0:04 |  |  |  |  |  |  |  |  |  |
| 30    | 9.03422451  | 9.353685379 | 9.353685379 | 0:04 |  |  |  |  |  |  |  |  |  |
| 31    | 8.803283691 | 8.07272625  | 8.07272625  | 0:04 |  |  |  |  |  |  |  |  |  |
| 32    | 8.502196312 | 6.664409637 | 6.664409637 | 0:04 |  |  |  |  |  |  |  |  |  |
| 33    | 8.221853256 | 16.97943306 | 16.97943306 | 0:04 |  |  |  |  |  |  |  |  |  |
| 34    | 8.07235527  | 7.806980133 | 7.806980133 | 0:04 |  |  |  |  |  |  |  |  |  |
| 35    | 7.870940685 | 6.005363941 | 6.005363941 | 0:04 |  |  |  |  |  |  |  |  |  |
| 36    | 7.663242817 | 7.768704891 | 7.768704891 | 0:04 |  |  |  |  |  |  |  |  |  |
| 37    | 7.453757763 | 6.537957668 | 6.537957668 | 0:04 |  |  |  |  |  |  |  |  |  |
| 38    | 7.260745049 | 5.970533848 | 5.970533848 | 0:04 |  |  |  |  |  |  |  |  |  |
| 39    | 7.121899605 | 6.366733551 | 6.366733551 | 0:04 |  |  |  |  |  |  |  |  |  |
| 40    | 7.00103569  | 5.943131447 | 5.943131447 | 0:04 |  |  |  |  |  |  |  |  |  |
| 41    | 6.831925869 | 5.480800629 | 5.480800629 | 0:04 |  |  |  |  |  |  |  |  |  |
| 42    | 6.661894321 | 5.282142162 | 5.282142162 | 0:04 |  |  |  |  |  |  |  |  |  |
| 43    | 6.493031979 | 5.394862652 | 5.394862652 | 0:04 |  |  |  |  |  |  |  |  |  |
| 44    | 6.293295383 | 5.06404686  | 5.06404686  | 0:04 |  |  |  |  |  |  |  |  |  |
| 45    | 6.123876572 | 4.974314213 | 4.974314213 | 0:04 |  |  |  |  |  |  |  |  |  |
| 46    | 5.975683689 | 4.874971867 | 4.874971867 | 0:04 |  |  |  |  |  |  |  |  |  |
| 47    | 5.827127457 | 5.007303238 | 5.007303238 | 0:04 |  |  |  |  |  |  |  |  |  |
| 48    | 5.679265499 | 4.931193829 | 4.931193829 | 0:04 |  |  |  |  |  |  |  |  |  |
| 49    | 5.548295498 | 4.945692539 | 4.945692539 | 0:04 |  |  |  |  |  |  |  |  |  |

```
def simple_cnn():
    return sequential(
        conv(3,4),
        conv(4,8),
        conv(8,16),
        conv(16,32),
        conv(32,64),
        conv(64,128),
        conv(128,128),
        conv(128,128),
        Flatten(),
        nn.Linear(128,128),
        nn.Linear(128,128),
        nn.Linear(128,128),
        nn.Linear(128,5)
    )
```

| epoch | train_loss  | valid_loss  | mae_angle   | time |  |  |  |  |  |
|-------|-------------|-------------|-------------|------|--|--|--|--|--|
| 0     | 52.45162582 | 40.58101273 | 40.58101273 | 1:52 |  |  |  |  |  |
| epoch | train_loss  | valid_loss  | mae_angle   | time |  |  |  |  |  |
| 0     | 14.54671383 | 25.86151695 | 25.86151695 | 0:06 | <pre>learn = cnn_learner(     dls, resnet18,     metrics = mae_angle,     loss_func=mae_label_smoothing_angle,     cbs = [         ShowGraphCallback(),         CSVLogger(fname=csv_path, append=true)     ] )</pre> |  |  |  |  |
| 1     | 12.61101246 | 10.98160458 | 10.98160458 | 0:06 |  |  |  |  |  |
| 2     | 11.41543579 | 9.642669678 | 9.642669678 | 0:06 |  |  |  |  |  |
| 3     | 10.84736347 | 8.862018585 | 8.862018585 | 0:05 |  |  |  |  |  |
| 4     | 10.58529854 | 9.764378548 | 9.764378548 | 0:06 |  |  |  |  |  |
| 5     | 10.25718498 | 11.17044163 | 11.17044163 | 0:05 |  |  |  |  |  |
| 6     | 9.887062073 | 8.710762978 | 8.710762978 | 0:06 |  |  |  |  |  |
| 7     | 9.600913048 | 11.67406082 | 11.67406082 | 0:06 |  |  |  |  |  |
| 8     | 9.615699768 | 10.03939819 | 10.03939819 | 0:06 |  |  |  |  |  |
| 9     | 9.629380226 | 12.86807537 | 12.86807537 | 0:06 |  |  |  |  |  |
| 10    | 9.71000576  | 11.31438065 | 11.31438065 | 0:06 |  |  |  |  |  |
| 11    | 9.593191147 | 10.78139782 | 10.78139782 | 0:06 |  |  |  |  |  |
| 12    | 9.594537735 | 9.257903099 | 9.257903099 | 0:06 |  |  |  |  |  |
| 13    | 9.447477341 | 10.08505535 | 10.08505535 | 0:06 |  |  |  |  |  |
| 14    | 9.257442474 | 8.67951107  | 8.67951107  | 0:06 |  |  |  |  |  |
| 15    | 9.009102821 | 9.489330292 | 9.489330292 | 0:06 |  |  |  |  |  |
| 16    | 8.824462891 | 8.830742836 | 8.830742836 | 0:06 |  |  |  |  |  |
| 17    | 8.729857445 | 9.20661068  | 9.20661068  | 0:06 |  |  |  |  |  |
| 18    | 8.977952957 | 21.07271576 | 21.07271576 | 0:06 |  |  |  |  |  |
| 19    | 9.042396545 | 7.461384296 | 7.461384296 | 0:06 |  |  |  |  |  |
| 20    | 8.840611458 | 6.577373505 | 6.577373505 | 0:06 |  |  |  |  |  |
| 21    | 8.664148331 | 6.788990974 | 6.788990974 | 0:06 |  |  |  |  |  |
| 22    | 8.540624619 | 7.330665112 | 7.330665112 | 0:06 |  |  |  |  |  |
| 23    | 8.384679794 | 7.018182278 | 7.018182278 | 0:06 |  |  |  |  |  |
| 24    | 8.301711082 | 7.531926632 | 7.531926632 | 0:06 |  |  |  |  |  |
| 25    | 8.32258606  | 8.830720901 | 8.830720901 | 0:06 |  |  |  |  |  |
| 26    | 8.317789078 | 6.456150532 | 6.456150532 | 0:06 |  |  |  |  |  |
| 27    | 8.161967278 | 6.545367718 | 6.545367718 | 0:05 |  |  |  |  |  |
| 28    | 8.052829742 | 6.694919109 | 6.694919109 | 0:06 |  |  |  |  |  |
| 29    | 8.105623245 | 9.24079895  | 9.24079895  | 0:06 |  |  |  |  |  |
| 30    | 8.236409187 | 6.849930286 | 6.849930286 | 0:06 |  |  |  |  |  |
| 31    | 8.207005501 | 6.143426418 | 6.143426418 | 0:06 |  |  |  |  |  |
| 32    | 8.038319588 | 6.550918579 | 6.550918579 | 0:06 |  |  |  |  |  |
| 33    | 7.901584625 | 6.18900156  | 6.18900156  | 0:06 |  |  |  |  |  |
| 34    | 7.784224033 | 6.175678253 | 6.175678253 | 0:06 |  |  |  |  |  |
| 35    | 7.71340847  | 6.465015888 | 6.465015888 | 0:06 |  |  |  |  |  |
| 36    | 7.581870556 | 5.632621765 | 5.632621765 | 0:06 |  |  |  |  |  |
| 37    | 7.496272564 | 5.479718208 | 5.479718208 | 0:06 |  |  |  |  |  |
| 38    | 7.413432598 | 5.01666069  | 5.01666069  | 0:06 |  |  |  |  |  |
| 39    | 7.334882736 | 4.933948994 | 4.933948994 | 0:05 |  |  |  |  |  |
| 40    | 7.206153393 | 4.687387466 | 4.687387466 | 0:06 |  |  |  |  |  |
| 41    | 7.092870235 | 4.578873634 | 4.578873634 | 0:06 |  |  |  |  |  |
| 42    | 7.005785465 | 4.545853615 | 4.545853615 | 0:06 |  |  |  |  |  |
| 43    | 6.886572838 | 4.23263216  | 4.23263216  | 0:06 |  |  |  |  |  |
| 44    | 6.812350273 | 4.214941025 | 4.214941025 | 0:06 |  |  |  |  |  |
| 45    | 6.758116722 | 4.625423908 | 4.625423908 | 0:06 |  |  |  |  |  |
| 46    | 6.6813941   | 4.385443687 | 4.385443687 | 0:06 |  |  |  |  |  |
| 47    | 6.604685307 | 4.190562248 | 4.190562248 | 0:06 |  |  |  |  |  |
| 48    | 6.60178566  | 4.22110033  | 4.22110033  | 0:06 |  |  |  |  |  |
| 49    | 6.55737257  | 4.215105534 | 4.215105534 | 0:06 |  |  |  |  |  |