

CleanAI Analysis Report

Model Informations

The table below shows general information about the 'ResNet' model.

	Model name	Total params	Number of layers
Informations	ResNet	44549160	287

Coverage Values of Layers (For Only One Input)

The table below shows coverage values about the 'ResNet' model's all layers. The 'mean of layer' value shows the average of neurons in that layer. When calculating the number of covered neurons, this value is accepted as the threshold value for that layer. NOTE: The coverage value of a layer is the ratio of the number of covered neurons to the total number of neurons in that layer. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' input in the data set to the model.

Layer Index	Activation Function	Number of Covered Neurons	Number of Total Neurons	Coverage Value	Mean of Layer
Layer 3	ReLU	289134	802816	36.01%	0.22
Layer 13	ReLU	310685	802816	38.70%	0.11
Layer 24	ReLU	315243	802816	39.27%	0.13
Layer 32	ReLU	324946	802816	40.48%	0.14
Layer 41	ReLU	139232	401408	34.69%	0.10
Layer 52	ReLU	146722	401408	36.55%	0.11
Layer 60	ReLU	149143	401408	37.15%	0.12
Layer 68	ReLU	148418	401408	36.97%	0.12
Layer 77	ReLU	64815	200704	32.29%	0.10
Layer 88	ReLU	65455	200704	32.61%	0.11
Layer 96	ReLU	66689	200704	33.23%	0.12
Layer 104	ReLU	66893	200704	33.33%	0.12
Layer 112	ReLU	66441	200704	33.10%	0.12
Layer 120	ReLU	65624	200704	32.70%	0.12
Layer 128	ReLU	64704	200704	32.24%	0.12
Layer 136	ReLU	63754	200704	31.77%	0.11
Layer 144	ReLU	62087	200704	30.93%	0.11
Layer 152	ReLU	63253	200704	31.52%	0.11
Layer 160	ReLU	63370	200704	31.57%	0.11
Layer 168	ReLU	62439	200704	31.11%	0.11
Layer 176	ReLU	62969	200704	31.37%	0.11

Layer 184	ReLU	62378	200704	31.08%	0.11
Layer 192	ReLU	62023	200704	30.90%	0.11
Layer 200	ReLU	61368	200704	30.58%	0.11
Layer 208	ReLU	60096	200704	29.94%	0.11
Layer 216	ReLU	58786	200704	29.29%	0.10
Layer 224	ReLU	55924	200704	27.86%	0.09
Layer 232	ReLU	53090	200704	26.45%	0.09
Layer 240	ReLU	51876	200704	25.85%	0.08
Layer 248	ReLU	50046	200704	24.94%	0.07
Layer 256	ReLU	51414	200704	25.62%	0.07
Layer 265	ReLU	31038	100352	30.93%	0.22
Layer 276	ReLU	32768	100352	32.65%	0.33
Layer 284	ReLU	33734	100352	33.62%	0.55
All model	-	3326557	9734144	34.17%	

Coverage Values of Layers (For Multiple Inputs) 50 Inputs

The table below shows coverage values for multiple inputs about the 'ResNet' model. The values in the table below, it was formed as a result of giving the '50' inputs in the data set to the model.

Layer index	Number of covered neurons	Number of total neurons	Coverage value
All model	164429818	486707200	33.78%

Threshold Coverage Values of Layers (TH = 0.75)

The table below shows threshold coverage values about the 'ResNet' model's all layers. NOTE: The threshold coverage value of a layer is the ratio of the number of covered neurons (number of neurons greater than the threshold value) to the total number of neurons in that layer. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' input in the data set to the model.

Layer index	Activation function	Number of covered neurons	Number of total neurons	Coverage value
Layer 3	ReLU	51831	802816	6.46%
Layer 13	ReLU	3545	802816	0.44%
Layer 24	ReLU	3604	802816	0.45%
Layer 32	ReLU	4481	802816	0.56%
Layer 41	ReLU	1617	401408	0.40%
Layer 52	ReLU	1758	401408	0.44%

Layer 60	ReLU	2218	401408	0.55%
Layer 68	ReLU	2820	401408	0.70%
Layer 77	ReLU	1600	200704	0.80%
Layer 88	ReLU	1744	200704	0.87%
Layer 96	ReLU	1828	200704	0.91%
Layer 104	ReLU	1970	200704	0.98%
Layer 112	ReLU	2059	200704	1.03%
Layer 120	ReLU	2169	200704	1.08%
Layer 128	ReLU	2230	200704	1.11%
Layer 136	ReLU	2265	200704	1.13%
Layer 144	ReLU	2236	200704	1.11%
Layer 152	ReLU	2249	200704	1.12%
Layer 160	ReLU	2413	200704	1.20%
Layer 168	ReLU	2385	200704	1.19%
Layer 176	ReLU	2361	200704	1.18%
Layer 184	ReLU	2303	200704	1.15%
Layer 192	ReLU	2350	200704	1.17%
Layer 200	ReLU	2391	200704	1.19%
Layer 208	ReLU	2363	200704	1.18%
Layer 216	ReLU	2390	200704	1.19%
Layer 224	ReLU	2262	200704	1.13%
Layer 232	ReLU	2136	200704	1.06%
Layer 240	ReLU	2066	200704	1.03%
Layer 248	ReLU	1820	200704	0.91%
Layer 256	ReLU	1565	200704	0.78%
Layer 265	ReLU	8891	100352	8.86%
Layer 276	ReLU	15248	100352	15.19%
Layer 284	ReLU	26526	100352	26.43%
All model	-	171694	9734144	1.76%

Sign Coverage and Value Coverage (TH = 0.75) Values of Model

The table below shows Sign Coverage and Value Coverage values of the 'ResNet' model. Sign Coverage: When given two different test inputs, it checks whether the signs of a specific neuron's value after the activation function are the same. If the signs are not the same, the counter is incremented.

Value Coverage: When given two different test inputs, it checks whether the difference between the values of a specific neuron after the activation function is greater than the given threshold value. If the difference is greater than the threshold value, the counter is incremented. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' and 'n01443537_ILSVRC2012_val_00000994.JPEG' input in the data set to the model.

Coverage Metric	Number of covered neurons	Number of total neurons	Coverage value
Sign Coverage	4948698	9734144	50.84%
Value Coverage	177566	9734144	1.82%

Top-K Neuron Coverage (K = 3) Value of Model

The table below shows Top-K Neuron Coverage value of the 'ResNet' model. Top-K Neuron Coverage (TKNC) is a metric used to evaluate the activation patterns and coverage of neurons in a deep neural network (DNN). It measures the percentage of neurons that are activated for a given set of input samples. The idea behind TKNC is to assess how well a set of input samples can activate different neurons in the network. How is it calculated? TKNC travels through all layers on a model one by one and ranks the neuron values of each layer in order from largest to smallest. Then it takes k neurons in each layer and adds it to a list. It then creates a value called 'TKNC Sum', which represents the sum of neurons in this list. The 'Number of Selected Neurons' value shows how many neurons were selected on the whole model as a result of k neurons from each layer. The 'Mean of Top-K Neurons' value shows the ratio of the 'TKNC Sum' value to the 'Number of Selected Neurons' value. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' input in the data set to the model.

Coverage Metric	TKNC Sum	Number of Selected Neurons	Mean of Top-K Neurons
Top-K Neuron Coverage	309.14	102	3.03

Neuron Boundary Coverage Value of Model (For 50 Inputs)

The table below shows Neuron Boundary Coverage value of the 'ResNet' model. Neuron Boundary Coverage (NBC) is a metric used to evaluate the coverage of decision boundaries in a deep neural network (DNN). It measures the percentage of decision boundaries in the network that have been activated or crossed by the input samples. How is it calculated? NBC receives a random set of inputs from the user, and as a result of these inputs, it determines the maximum and minimum interval value for each layer. Then, for the input data to be checked, it is checked whether each neuron belonging to each layer is within the maximum and minimum range of this layer. If it is within this range, the 'NBC Counter' value is increased by one. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' input in the data set to the model.

Coverage Metric	NBC Counter	Number of Total Neurons	Neuron Boundary Coverage
Neuron Boundary Coverage	0	9734144	0.00%

Multisection Neuron Coverage Value of Model

The table below shows Multisection Neuron Coverage value of the 'ResNet' model. Multisection Neuron Coverage (MNC) specifically focuses on assessing the coverage of individual neurons within the model. The goal of MNC is to evaluate the degree to which the decisions made by individual neurons have been exercised by the test cases. It helps identify potential shortcomings in the model's behavior and reveal areas that may require further testing. It provides the user with the information of how many neurons are found according to the threshold value ranges given by the user. How is it calculated? The MNC receives threshold ranges from the user. Then, it evaluates all the neurons on the model and checks whether each neuron is within these threshold ranges. If the corresponding neuron is within this threshold value, it increases the 'MNC Counter' value found for the relevant range by one. The 'Multisection Neuron Coverage' value is the ratio of the 'MNC Counter' value to the number of all neurons on the model. The values in the table below, it was formed as a result of giving the 'n01440764_ILSVRC2012_val_00009111.JPEG' input in the data set to the model.

Threshold Intervals	MNC Counter	Number of Total Neurons	Multisection Neuron Coverage
0 - 0.1	6031889	9734144	61.97%
0.1 - 0.2	1347685	9734144	13.84%
0.2 - 0.3	969030	9734144	9.95%
0.3 - 0.4	563331	9734144	5.79%
0.4 - 0.5	310601	9734144	3.19%