

CleanAI Analysis Report

Model Informations

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

	Model name	Total params	Number of layers
Informations	ResNet	60192808	423

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	302586	802816	37.69%	0.22
Layer 13	ReLU	319545	802816	39.80%	0.12
Layer 24	ReLU	322665	802816	40.19%	0.14
Layer 32	ReLU	333167	802816	41.50%	0.16
Layer 41	ReLU	142553	401408	35.51%	0.13
Layer 52	ReLU	146514	401408	36.50%	0.14
Layer 60	ReLU	152610	401408	38.02%	0.15
Layer 68	ReLU	154508	401408	38.49%	0.16
Layer 76	ReLU	153098	401408	38.14%	0.16
Layer 84	ReLU	153364	401408	38.21%	0.16
Layer 92	ReLU	154170	401408	38.41%	0.17
Layer 100	ReLU	153847	401408	38.33%	0.17
Layer 109	ReLU	64488	200704	32.13%	0.11
Layer 120	ReLU	65604	200704	32.69%	0.12
Layer 128	ReLU	65600	200704	32.68%	0.12
Layer 136	ReLU	66485	200704	33.13%	0.13
Layer 144	ReLU	66062	200704	32.92%	0.13
Layer 152	ReLU	65518	200704	32.64%	0.13
Layer 160	ReLU	65488	200704	32.63%	0.14
Layer 168	ReLU	65615	200704	32.69%	0.14
Layer 176	ReLU	65262	200704	32.52%	0.13

Layer 184	ReLU	64402	200704	32.09%	0.13
Layer 192	ReLU	65003	200704	32.39%	0.13
Layer 200	ReLU	65456	200704	32.61%	0.13
Layer 208	ReLU	64939	200704	32.36%	0.13
Layer 216	ReLU	64040	200704	31.91%	0.13
Layer 224	ReLU	63288	200704	31.53%	0.13
Layer 232	ReLU	63463	200704	31.62%	0.13
Layer 240	ReLU	63237	200704	31.51%	0.13
Layer 248	ReLU	63373	200704	31.58%	0.13
Layer 256	ReLU	63339	200704	31.56%	0.13
Layer 264	ReLU	63227	200704	31.50%	0.13
Layer 272	ReLU	62778	200704	31.28%	0.13
Layer 280	ReLU	62767	200704	31.27%	0.13
Layer 288	ReLU	62575	200704	31.18%	0.13
Layer 296	ReLU	62139	200704	30.96%	0.13
Layer 304	ReLU	61586	200704	30.68%	0.13
Layer 312	ReLU	61498	200704	30.64%	0.13
Layer 320	ReLU	60552	200704	30.17%	0.13
Layer 328	ReLU	59558	200704	29.67%	0.12
Layer 336	ReLU	58878	200704	29.34%	0.12
Layer 344	ReLU	57929	200704	28.86%	0.11
Layer 352	ReLU	56523	200704	28.16%	0.11
Layer 360	ReLU	54563	200704	27.19%	0.10
Layer 368	ReLU	53713	200704	26.76%	0.10
Layer 376	ReLU	51755	200704	25.79%	0.09
Layer 384	ReLU	52389	200704	26.10%	0.09
Layer 392	ReLU	51268	200704	25.54%	0.09
Layer 401	ReLU	32092	100352	31.98%	0.22
Layer 412	ReLU	33126	100352	33.01%	0.32
Layer 420	ReLU	32260	100352	32.15%	0.51
All model	-	4810465	13948928	34.49%	

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	240223749	697446400	34.44%

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	49301	802816	6.14%
Layer 13	ReLU	3368	802816	0.42%
Layer 24	ReLU	4504	802816	0.56%
Layer 32	ReLU	5440	802816	0.68%
Layer 41	ReLU	3823	401408	0.95%
Layer 52	ReLU	3748	401408	0.93%
Layer 60	ReLU	4170	401408	1.04%
Layer 68	ReLU	4854	401408	1.21%
Layer 76	ReLU	5526	401408	1.38%
Layer 84	ReLU	6108	401408	1.52%
Layer 92	ReLU	6613	401408	1.65%
Layer 100	ReLU	6587	401408	1.64%
Layer 109	ReLU	2520	200704	1.26%
Layer 120	ReLU	2739	200704	1.36%
Layer 128	ReLU	3050	200704	1.52%
Layer 136	ReLU	3170	200704	1.58%
Layer 144	ReLU	3388	200704	1.69%
Layer 152	ReLU	3564	200704	1.78%
Layer 160	ReLU	3655	200704	1.82%
Layer 168	ReLU	3568	200704	1.78%
Layer 176	ReLU	3500	200704	1.74%
Layer 184	ReLU	3447	200704	1.72%
Layer 192	ReLU	3414	200704	1.70%
Layer 200	ReLU	3554	200704	1.77%

Layer 208	ReLU	3673	200704	1.83%
Layer 216	ReLU	3642	200704	1.81%
Layer 224	ReLU	3636	200704	1.81%
Layer 232	ReLU	3740	200704	1.86%
Layer 240	ReLU	3845	200704	1.92%
Layer 248	ReLU	3990	200704	1.99%
Layer 256	ReLU	3987	200704	1.99%
Layer 264	ReLU	4111	200704	2.05%
Layer 272	ReLU	3962	200704	1.97%
Layer 280	ReLU	4000	200704	1.99%
Layer 288	ReLU	4016	200704	2.00%
Layer 296	ReLU	3969	200704	1.98%
Layer 304	ReLU	3936	200704	1.96%
Layer 312	ReLU	4056	200704	2.02%
Layer 320	ReLU	4121	200704	2.05%
Layer 328	ReLU	4017	200704	2.00%
Layer 336	ReLU	3872	200704	1.93%
Layer 344	ReLU	3890	200704	1.94%
Layer 352	ReLU	3696	200704	1.84%
Layer 360	ReLU	3529	200704	1.76%
Layer 368	ReLU	3360	200704	1.67%
Layer 376	ReLU	3099	200704	1.54%
Layer 384	ReLU	3002	200704	1.50%
Layer 392	ReLU	2673	200704	1.33%
Layer 401	ReLU	8406	100352	8.38%
Layer 412	ReLU	14329	100352	14.28%
Layer 420	ReLU	24035	100352	23.95%
All model	-	280203	13948928	2.01%

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	6823384	13948928	48.92%
Value Coverage	281901	13948928	2.02%

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	467.94	153	3.06

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	13948928	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	8243615	13948928	59.10%
0.1 - 0.2	1910427	13948928	13.70%
0.2 - 0.3	1409205	13948928	10.10%
0.3 - 0.4	912240	13948928	6.54%
0.4 - 0.5	554407	13948928	3.97%