

Name: - Hrishikesh Bodkhe

Enrolment No.- 2022CSM1006

Subject: - Digital Image Processing (CS-517) Lab Assignment 3 Report

Observations: -

1. Analysis by varying number of DC components:

The input image taken is kodim01.png as shown below, which is tested for a block size of 8 and the number of DC components as 21.



Figure 1. Input image kodak1.png



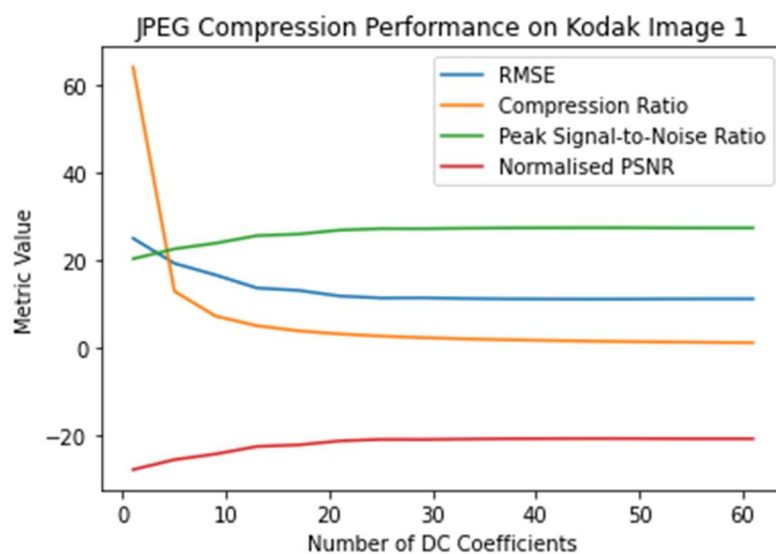
Figure 2. Reconstructed image

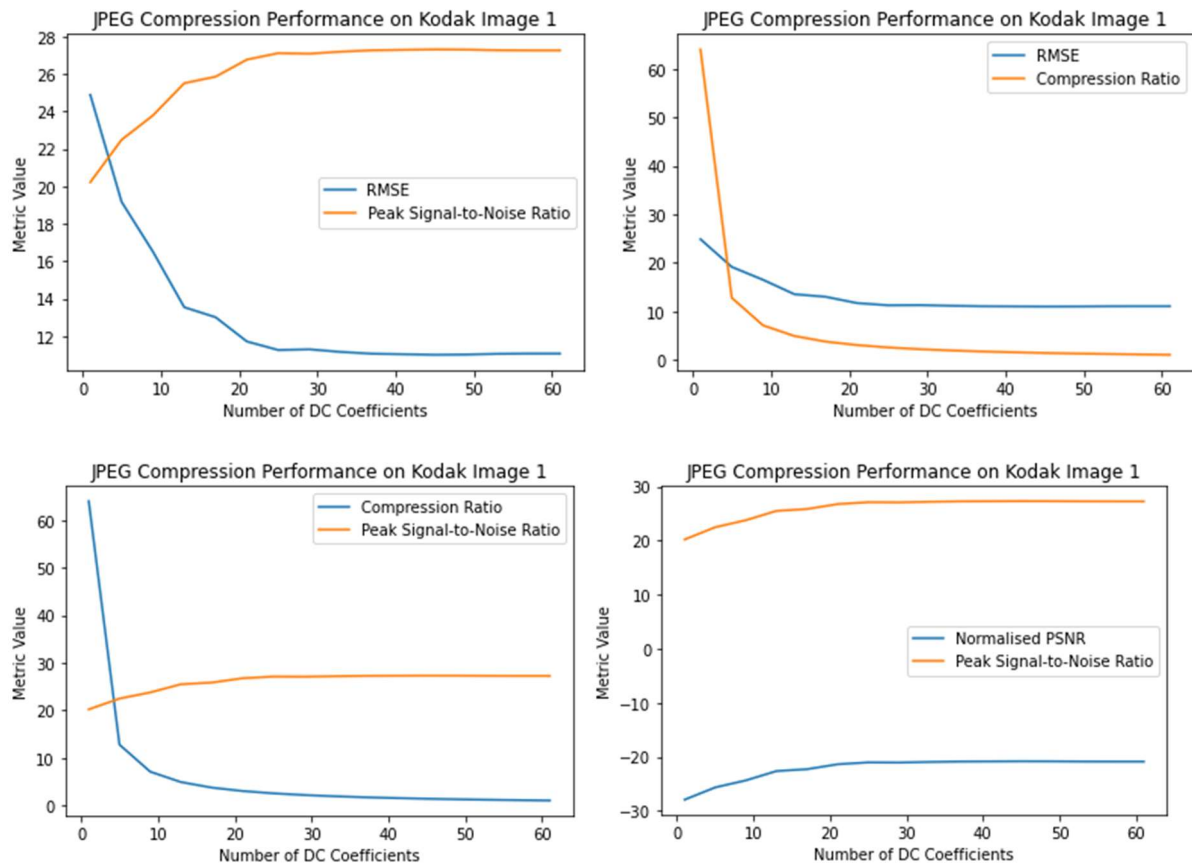
The same image is then tested by varying the number of DC components. After applying the JPEG encoding and decoding, Root Mean Square Error (RMSE), Peak Signal-to-Noise Ratio (PSNR) and compression ratio are calculated concerning the output image and the input image. The statistics are shown in the below table.

	Number of DC Components	RMSE	Compression Ratio	PSNR	NPSNR
0	1	24.877153	64.000000	20.214790	-27.916014
1	5	19.163273	12.800000	22.481410	-25.649394
2	9	16.505568	7.111111	23.778195	-24.352609
3	13	13.537753	4.923077	25.499872	-22.630932
4	17	13.005828	3.764706	25.848043	-22.282760
5	21	11.709546	3.047619	26.760003	-21.370801
6	25	11.254207	2.560000	27.104506	-21.026298
7	29	11.290426	2.206897	27.076597	-21.054207
8	33	11.151530	1.939394	27.184114	-20.946690
9	37	11.056974	1.729730	27.258078	-20.872726
10	41	11.027234	1.560976	27.281472	-20.849332
11	45	10.999417	1.422222	27.303410	-20.827394
12	49	11.011180	1.306122	27.294127	-20.836677
13	53	11.049920	1.207547	27.263621	-20.867183
14	57	11.063449	1.122807	27.252993	-20.877811
15	61	11.063449	1.049180	27.252993	-20.877811

Table 1

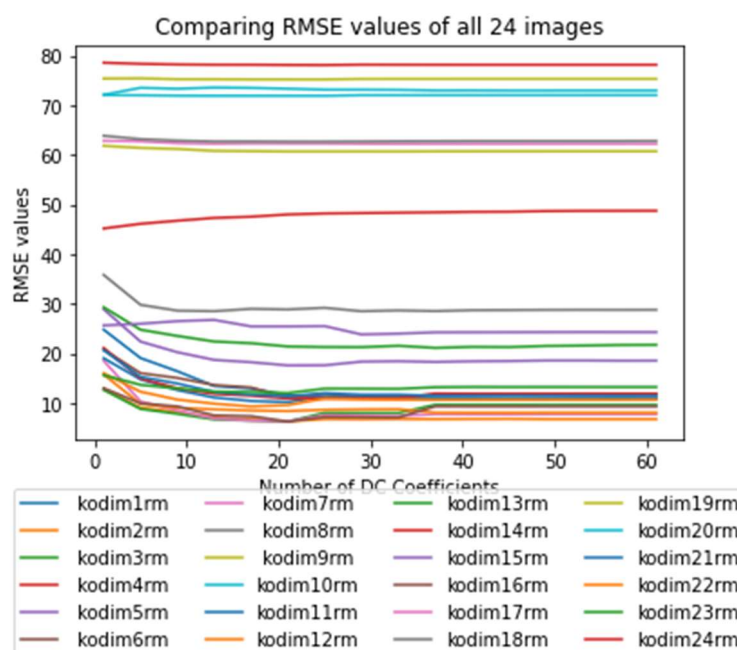
As we can see from the above table, the RMSE and compression ratio are decreasing as the number of DC components are increased. This is because now we have more values for decoding, thus the decoded image is closer to the original image. Also, as there are more values to send, so the compression ratio decreases. Also noting the PSNR increases for the same case. PSNR (Peak Signal-to-Noise Ratio) is a measure of the quality of the reconstructed image compared to the original image. As the number of DC components increases, the reconstructed image's quality increases, ultimately increasing the PSNR. The below graph represents the statistics of Table 1 graphically.





Further, when the normalized PSNR (NPSNR) is compared with several DC coefficients, as the number of DC coefficients is increased we see that the NPSNR increases because it varies linearly with PSNR.

The RMSE values are calculated for all 24 images and their graph is shown below.

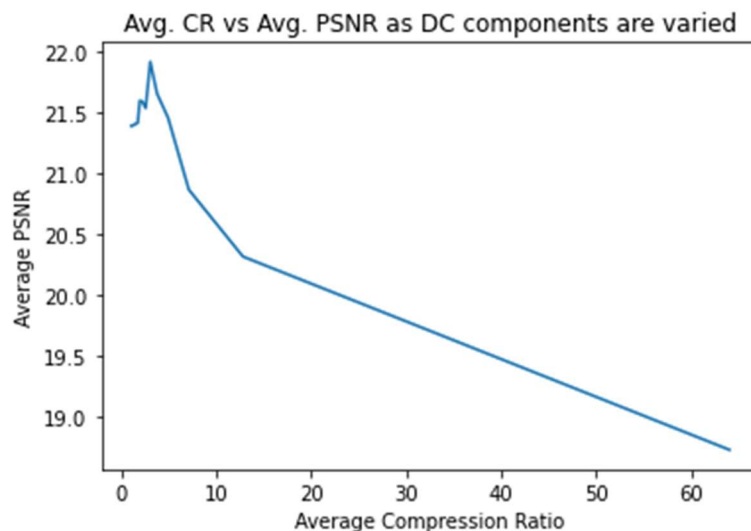


The PSNR table for all 24 images for different DC components is shown below: -

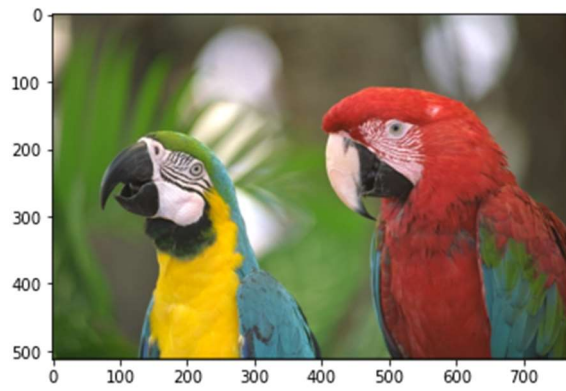
Image	DC 1	DC 5	DC 9	DC 13	DC 17	DC 21	DC 25	DC 29	DC 33	DC 37	DC 41	DC 45	DC 49	DC 53	DC 57	DC 61
kodim1.png	20.21479	22.48141	23.77819	25.49987	25.84804	26.76	27.10451	27.0766	27.18411	27.25808	27.28147	27.30341	27.29413	27.26362	27.25299	27.25299
kodim2.png	25.91043	28.88231	29.72277	30.92409	31.39756	31.98601	31.3877	31.41845	31.3637	31.37478	31.34913	31.32645	31.38025	31.38104	31.38121	31.38123
kodim3.png	26.01334	29.1217	30.1372	31.46305	31.75417	32.05501	29.9015	29.93607	29.96151	28.33185	28.34303	28.34434	28.3529	28.35385	28.35398	28.35398
kodim4.png	10.22204	10.24752	10.26071	10.26701	10.2674	10.2721	10.27463	10.26574	10.26673	10.2674	10.26814	10.26814	10.26814	10.26814	10.26814	10.26814
kodim5.png	18.89102	21.09638	21.96522	22.65092	22.86806	23.17864	23.16599	22.8149	22.77551	22.84321	22.78257	22.75813	22.70611	22.70345	22.72465	22.71718
kodim6.png	21.74219	23.98239	24.51831	25.37543	25.68727	27.14155	26.58774	26.96848	26.99149	26.72049	26.6767	26.64904	26.59915	26.61774	26.64073	26.64145
kodim7.png	22.73381	27.75798	29.42368	31.22076	31.76079	31.99309	30.44981	30.53481	30.63118	30.22452	30.25112	30.24378	30.23831	30.23868	30.23868	30.23868
kodim8.png	17.03079	18.62393	18.97176	19.00512	18.86356	18.89929	18.80153	19.00746	18.95735	18.99949	18.9435	18.93672	18.92409	18.92013	18.92244	18.92074
kodim9.png	10.5826	10.57774	10.59785	10.59826	10.60178	10.60209	10.60206	10.59148	10.59098	10.59089	10.59051	10.59034	10.59043	10.59043	10.59049	10.59049
kodim10.png	10.97433	10.97883	10.98797	10.99132	10.99067	10.99113	10.9917	10.97663	10.9775	10.97748	10.97693	10.97644	10.97632	10.97607	10.97583	10.97583
kodim11.png	22.49744	24.68617	26.0416	27.13561	27.67736	27.8791	26.92941	27.05498	27.18581	27.19294	27.22188	27.27347	27.26606	27.19623	27.20628	27.2116
kodim12.png	24.12859	28.19506	28.89413	29.21104	29.44227	29.55018	29.28498	29.20719	29.17086	29.88337	29.88977	29.89284	29.87629	29.87649	29.87012	29.87012
kodim13.png	18.76635	20.2191	20.66751	21.0903	21.22338	21.48489	21.53005	21.53836	21.42738	21.59936	21.51728	21.53443	21.44242	21.41213	21.36589	21.35172
kodim14.png	21.60766	24.58118	25.79741	26.57985	26.85582	27.29225	27.29524	27.243	27.27158	26.52799	26.55891	26.55877	26.5613	26.53954	26.54347	26.54347
kodim15.png	19.92265	19.81	19.63609	19.55644	19.98606	19.9896	19.96981	20.55785	20.4984	20.40658	20.39956	20.39583	20.3912	20.38604	20.38821	20.39278
kodim16.png	25.78335	28.08796	28.63739	30.48533	30.6549	32.03036	30.8671	30.90645	30.96154	28.6443	28.64847	28.65277	28.65375	28.65375	28.65404	28.65404
kodim17.png	12.1601	12.17367	12.22608	12.2409	12.23259	12.23428	12.23584	12.24164	12.24468	12.2436	12.24315	12.24314	12.24217	12.2421	12.24227	12.2421
kodim18.png	12.02196	12.1133	12.15407	12.17874	12.17734	12.1831	12.18353	12.17896	12.17278	12.16954	12.16666	12.16619	12.16625	12.16655	12.16571	12.16261
kodim19.png	12.30107	12.35925	12.38906	12.44436	12.45275	12.46148	12.46181	12.46046	12.46184	12.45721	12.45636	12.45576	12.45553	12.45543	12.45541	12.45541
kodim20.png	10.96599	10.79972	10.82199	10.79319	10.80122	10.82135	10.84301	10.84335	10.84753	10.86254	10.86157	10.86502	10.86483	10.86411	10.86442	10.86442
kodim21.png	21.79273	24.40053	25.18124	26.30517	26.68615	26.92879	26.45724	26.68823	26.68206	26.8555	26.86481	26.85502	26.87181	26.85923	26.87631	26.87667
kodim22.png	23.98839	26.27166	27.46161	28.14985	28.65017	28.40406	27.29163	27.44374	27.472	27.5049	27.49986	27.48474	27.49382	27.48765	27.49364	27.48176
kodim23.png	24.2162	25.34607	25.8293	26.24268	26.33006	26.4593	25.84352	25.85538	25.87305	25.65483	25.62254	25.63077	25.62648	25.62978	25.62978	25.63031
kodim24.png	15.01919	14.84117	14.72527	14.62132	14.57738	14.49531	14.45933	14.44559	14.43135	14.41726	14.40097	14.39597	14.37386	14.36594	14.36308	14.36091

It can be seen from the table that as the number of DC coefficients is increased, the PSNR values for each image increase, as the quality of the reconstructed image is increased.

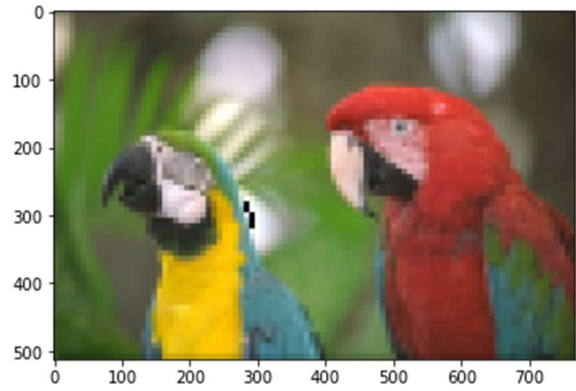
By comparing the Average Compression Ratio and Average PSNR, it is observed that the Avg. CR increases, the Avg. PSNR decreases. This is because as the compression increases, the quality of the reconstructed image decreases and thus the average PSNR decreases. This relation can be observed in the below graph.



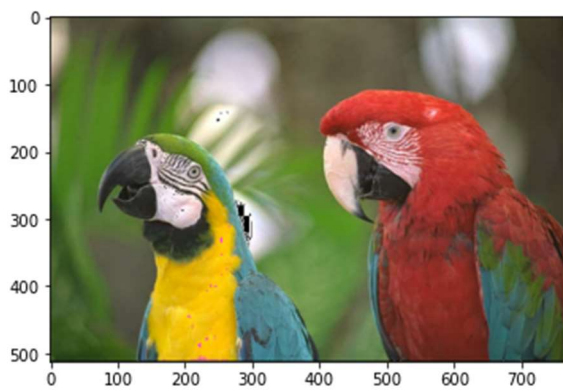
Considering an example on the image *kodim23.png*. Observing the quality of the reconstructed image by varying the number of DC coefficients.



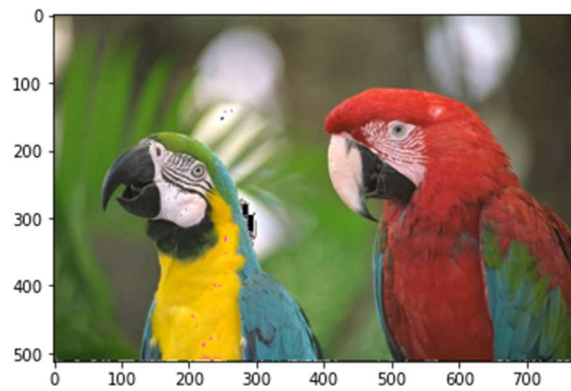
Original Image



Output for Block Size 8 and DC coefficient 1



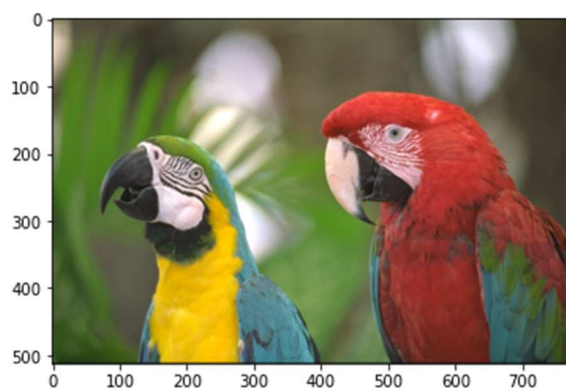
Output for Block Size 8 and DC coefficient 20



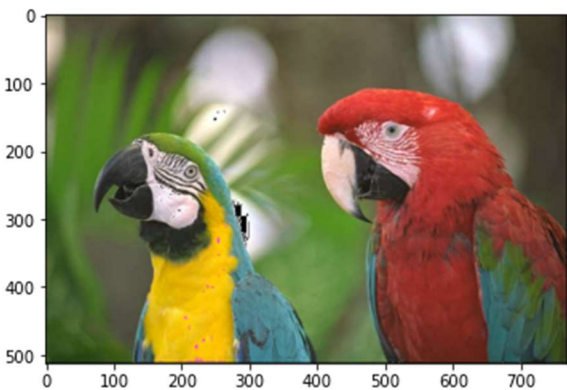
Output for Block Size 8 and DC coefficient 50

2. Analysis by varying block size:

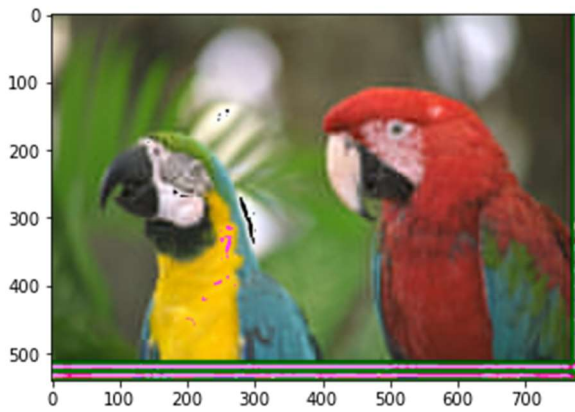
For this observation, I have considered the image *kodim23.png*.



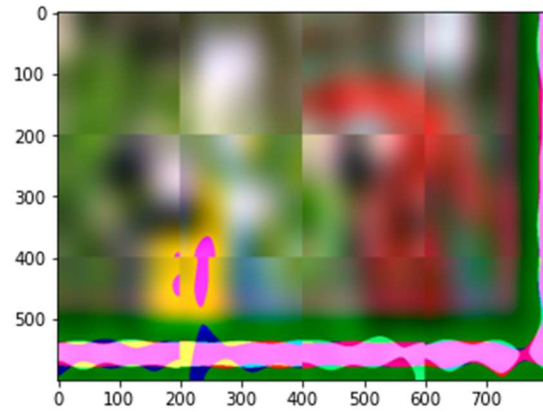
Original Image



Output for Block Size 8 and DC coefficient 20



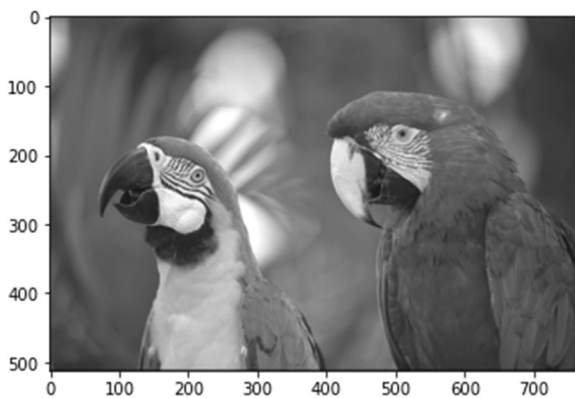
Output for Block Size 30 and DC coefficient 20



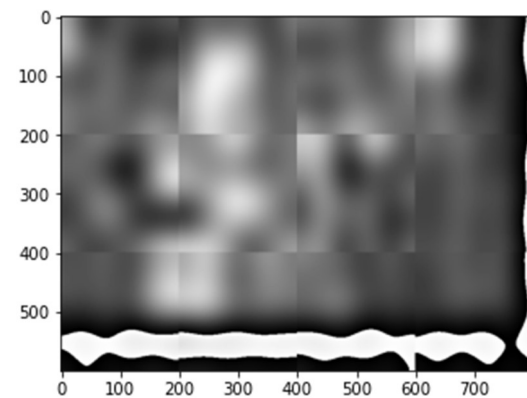
Output for Block Size 200 and DC coefficient 20

As we can observe, if we increase the block size by keeping the DC coefficient constant, the quality of the image decreases.

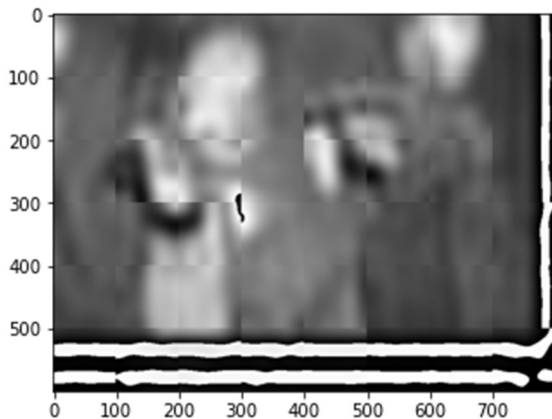
3. Analysis of Gray Scale image by varying block size:



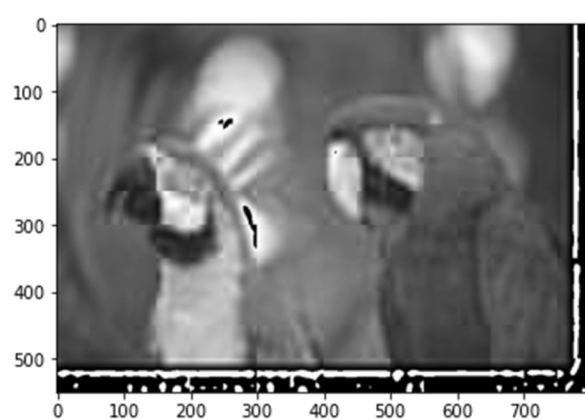
Original Image



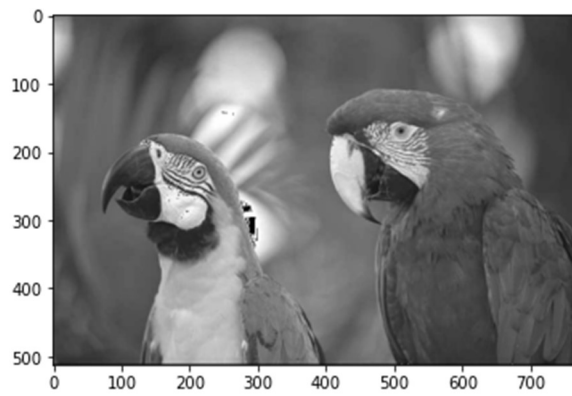
Output for Block Size 200 and DC coefficient 20



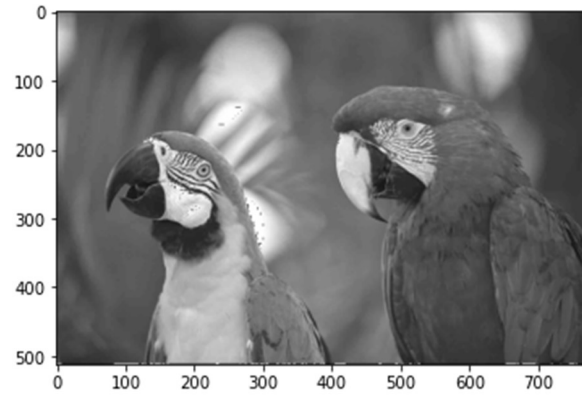
Output for Block Size 100 and DC coefficient 20



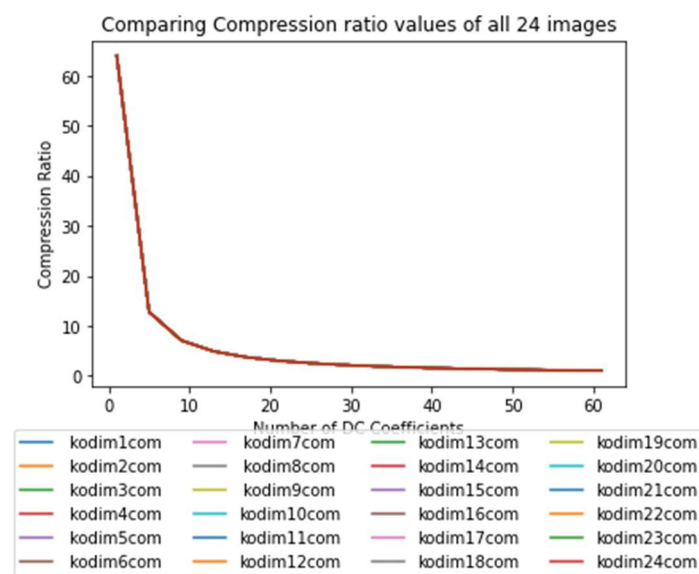
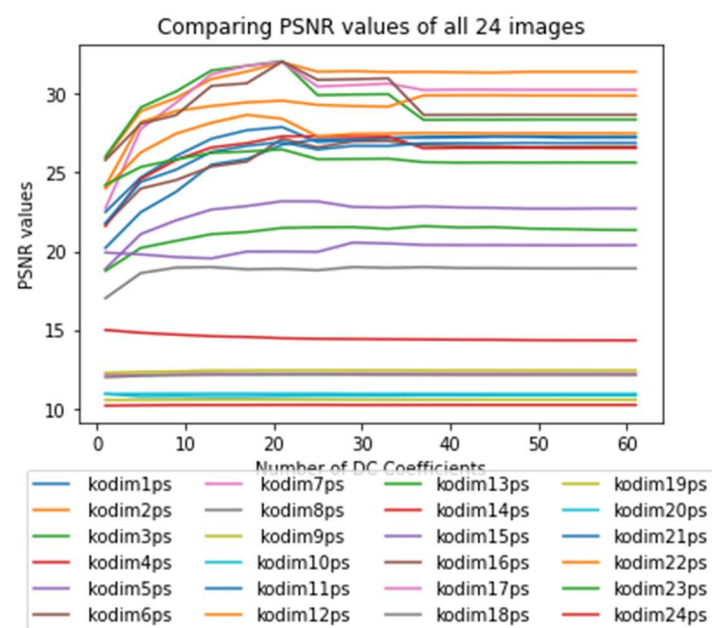
Output for Block Size 50 and DC coefficient 20



Output for Block Size 8 and DC coefficient 20



Output for Block Size 4 and DC coefficient 20



Conclusion: - Thus we got an understanding of JPEG compression for images.