1, average compression ratio outputs of 5 times for each k

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | k=2 | k=5 | k=10 | k=15 | k=20 |
| Penguins.jpg  Average Comp Ratio | 11.04% | 14.1% | 14.7% | 15.2% | 15.2% |
| Penguins.jpg Variance | 0.36 | 16.2 | 7.57 | 1.91 | 1.76 |
| Koala.jpg Average Comp Ratio | 16.3% | 22.1% | 21.1% | 20.5% | 20.2% |
| Koala.jpg Variance | 10.1 | 2.8 | 1.2 | 0.7 | 0.8 |

2, according to outputs and compression ratio above, there seems to be a tradeoff between quality and degree of compression ratio. it seems like k=20 is a good value for penguins.jpg, k=15 is a good value for koala.jpg. however, since the samples are quite few, we still need more experiments to figure out the real relation.

Command line output:

1, java -jar MLAssign3.jar penguins.jpg 2 penguins

the 1th output is: penguins\_2.jpg

the 1th compression ratio is: 10.916068317830902%

the 2th output is: penguins\_2.jpg

the 2th compression ratio is: 10.956179652496994%

the 3th output is: penguins\_2.jpg

the 3th compression ratio is: 11.241330102142486%

the 4th output is: penguins\_2.jpg

the 4th compression ratio is: 10.916068317830902%

the 5th output is: penguins\_2.jpg

the 5th compression ratio is: 11.048615708987125%

the 6th output is: penguins\_2.jpg

the 6th compression ratio is: 11.103125984302583%

the 7th output is: penguins\_2.jpg

the 7th compression ratio is: 11.103125984302583%

the 8th output is: penguins\_2.jpg

the 8th compression ratio is: 11.103125984302583%

the 9th output is: penguins\_2.jpg

the 9th compression ratio is: 10.915039822070232%

the 10th output is: penguins\_2.jpg

the 10th compression ratio is: 11.244415589424491%

the 11th output is: penguins\_2.jpg

the 11th compression ratio is: 11.103125984302583%

the 12th output is: penguins\_2.jpg

the 12th compression ratio is: 10.956308214467079%

the 13th output is: penguins\_2.jpg

the 13th compression ratio is: 11.244415589424491%

the 14th output is: penguins\_2.jpg

the 14th compression ratio is: 10.904883426433628%

the 15th output is: penguins\_2.jpg

the 15th compression ratio is: 10.915039822070232%

the 16th output is: penguins\_2.jpg

the 16th compression ratio is: 10.916068317830902%

the 17th output is: penguins\_2.jpg

the 17th compression ratio is: 10.916068317830902%

the 18th output is: penguins\_2.jpg

the 18th compression ratio is: 11.241330102142486%

the 19th output is: penguins\_2.jpg

the 19th compression ratio is: 11.241330102142486%

the 20th output is: penguins\_2.jpg

the 20th compression ratio is: 10.916068317830902%

the average compression ratio is: 11.04508668290833%

the variance is: 0.3609812550797889

2, java -jar MLAssign3.jar penguins.jpg 5 penguins

the 1th output is: penguins\_5.jpg

the 1th compression ratio is: 13.939203044347451%

the 2th output is: penguins\_5.jpg

the 2th compression ratio is: 14.326431698239345%

the 3th output is: penguins\_5.jpg

the 3th compression ratio is: 15.44312097038575%

the 4th output is: penguins\_5.jpg

the 4th compression ratio is: 13.584500568886718%

the 5th output is: penguins\_5.jpg

the 5th compression ratio is: 13.41389883458574%

the 6th output is: penguins\_5.jpg

the 6th compression ratio is: 14.405111623930525%

the 7th output is: penguins\_5.jpg

the 7th compression ratio is: 15.429750525497052%

the 8th output is: penguins\_5.jpg

the 8th compression ratio is: 14.035238835999921%

the 9th output is: penguins\_5.jpg

the 9th compression ratio is: 13.533590028733599%

the 10th output is: penguins\_5.jpg

the 10th compression ratio is: 15.543399307050981%

the 11th output is: penguins\_5.jpg

the 11th compression ratio is: 13.533590028733599%

the 12th output is: penguins\_5.jpg

the 12th compression ratio is: 13.512762989580052%

the 13th output is: penguins\_5.jpg

the 13th compression ratio is: 13.042097617103884%

the 14th output is: penguins\_5.jpg

the 14th compression ratio is: 12.844240745145177%

the 15th output is: penguins\_5.jpg

the 15th compression ratio is: 15.552398644956837%

the 16th output is: penguins\_5.jpg

the 16th compression ratio is: 12.915206952631342%

the 17th output is: penguins\_5.jpg

the 17th compression ratio is: 15.143957266001143%

the 18th output is: penguins\_5.jpg

the 18th compression ratio is: 15.035579525220644%

the 19th output is: penguins\_5.jpg

the 19th compression ratio is: 14.343787564200634%

the 20th output is: penguins\_5.jpg

the 20th compression ratio is: 13.41955556126942%

the average compression ratio is: 14.149871116624988%

the variance is: 16.200123750542478

3, java -jar MLAssign3.jar penguins.jpg 10 penguins

the 1th output is: penguins\_10.jpg

the 1th compression ratio is: 15.661547757557837%

the 2th output is: penguins\_10.jpg

the 2th compression ratio is: 14.564399904864143%

the 3th output is: penguins\_10.jpg

the 3th compression ratio is: 15.694202497959079%

the 4th output is: penguins\_10.jpg

the 4th compression ratio is: 15.43039333534747%

the 5th output is: penguins\_10.jpg

the 5th compression ratio is: 14.148501931643601%

the 6th output is: penguins\_10.jpg

the 6th compression ratio is: 15.009995693174002%

the 7th output is: penguins\_10.jpg

the 7th compression ratio is: 15.192039442812423%

the 8th output is: penguins\_10.jpg

the 8th compression ratio is: 14.060436982136315%

the 9th output is: penguins\_10.jpg

the 9th compression ratio is: 14.966156061375486%

the 10th output is: penguins\_10.jpg

the 10th compression ratio is: 14.65400759801243%

the 11th output is: penguins\_10.jpg

the 11th compression ratio is: 15.458291282855619%

the 12th output is: penguins\_10.jpg

the 12th compression ratio is: 14.130503255831892%

the 13th output is: penguins\_10.jpg

the 13th compression ratio is: 15.102174625723967%

the 14th output is: penguins\_10.jpg

the 14th compression ratio is: 14.583555638406603%

the 15th output is: penguins\_10.jpg

the 15th compression ratio is: 14.991611331452043%

the 16th output is: penguins\_10.jpg

the 16th compression ratio is: 14.872177261244351%

the 17th output is: penguins\_10.jpg

the 17th compression ratio is: 13.812826627755243%

the 18th output is: penguins\_10.jpg

the 18th compression ratio is: 14.348415795123644%

the 19th output is: penguins\_10.jpg

the 19th compression ratio is: 15.198853227226856%

the 20th output is: penguins\_10.jpg

the 20th compression ratio is: 13.388057878598932%

the average compression ratio is: 14.763407406455096%

the variance is: 7.578862815479527

4, java -jar MLAssign3.jar penguins.jpg 15 penguins

the 1th output is: penguins\_15.jpg

the 1th compression ratio is: 15.236393322491274%

the 2th output is: penguins\_15.jpg

the 2th compression ratio is: 15.007681577712498%

the 3th output is: penguins\_15.jpg

the 3th compression ratio is: 14.899432398902082%

the 4th output is: penguins\_15.jpg

the 4th compression ratio is: 15.322658404417389%

the 5th output is: penguins\_15.jpg

the 5th compression ratio is: 15.155913529218923%

the 6th output is: penguins\_15.jpg

the 6th compression ratio is: 15.19486780615426%

the 7th output is: penguins\_15.jpg

the 7th compression ratio is: 15.310573579229528%

the 8th output is: penguins\_15.jpg

the 8th compression ratio is: 15.372540448809838%

the 9th output is: penguins\_15.jpg

the 9th compression ratio is: 15.290389349926398%

the 10th output is: penguins\_15.jpg

the 10th compression ratio is: 15.603823432990287%

the 11th output is: penguins\_15.jpg

the 11th compression ratio is: 15.735599452326007%

the 12th output is: penguins\_15.jpg

the 12th compression ratio is: 14.318332294124076%

the 13th output is: penguins\_15.jpg

the 13th compression ratio is: 15.173012271240044%

the 14th output is: penguins\_15.jpg

the 14th compression ratio is: 14.938129551897253%

the 15th output is: penguins\_15.jpg

the 15th compression ratio is: 15.39388173584372%

the 16th output is: penguins\_15.jpg

the 16th compression ratio is: 15.402623949809408%

the 17th output is: penguins\_15.jpg

the 17th compression ratio is: 14.791954591912166%

the 18th output is: penguins\_15.jpg

the 18th compression ratio is: 15.352870467387042%

the 19th output is: penguins\_15.jpg

the 19th compression ratio is: 15.09420378357878%

the 20th output is: penguins\_15.jpg

the 20th compression ratio is: 15.576953981242808%

the average compression ratio is: 15.20859179646069%

the variance is: 1.9127440727638299

5, java -jar MLAssign3.jar penguins.jpg 20 penguins

the 1th output is: penguins\_20.jpg

the 1th compression ratio is: 15.675561012296951%

the 2th output is: penguins\_20.jpg

the 2th compression ratio is: 14.732301837793363%

the 3th output is: penguins\_20.jpg

the 3th compression ratio is: 15.781238951705696%

the 4th output is: penguins\_20.jpg

the 4th compression ratio is: 15.506502021636981%

the 5th output is: penguins\_20.jpg

the 5th compression ratio is: 15.088547056895099%

the 6th output is: penguins\_20.jpg

the 6th compression ratio is: 15.568340329247205%

the 7th output is: penguins\_20.jpg

the 7th compression ratio is: 15.269819434713018%

the 8th output is: penguins\_20.jpg

the 8th compression ratio is: 15.23665044643144%

the 9th output is: penguins\_20.jpg

the 9th compression ratio is: 14.988911530080287%

the 10th output is: penguins\_20.jpg

the 10th compression ratio is: 15.150256802535242%

the 11th output is: penguins\_20.jpg

the 11th compression ratio is: 15.355441706788714%

the 12th output is: penguins\_20.jpg

the 12th compression ratio is: 14.832708736428676%

the 13th output is: penguins\_20.jpg

the 13th compression ratio is: 15.61809381166957%

the 14th output is: penguins\_20.jpg

the 14th compression ratio is: 15.056020878463942%

the 15th output is: penguins\_20.jpg

the 15th compression ratio is: 15.043807491305996%

the 16th output is: penguins\_20.jpg

the 16th compression ratio is: 14.980683563994933%

the 17th output is: penguins\_20.jpg

the 17th compression ratio is: 15.358012946190389%

the 18th output is: penguins\_20.jpg

the 18th compression ratio is: 15.030308484447216%

the 19th output is: penguins\_20.jpg

the 19th compression ratio is: 15.305173976486017%

the 20th output is: penguins\_20.jpg

the 20th compression ratio is: 14.750557637545239%

the average compression ratio is: 15.2164469328328%

the variance is: 1.7665356390818934

6, java -jar MLAssign3.jar Koala.jpg 2 Koala

the 1th output is: Koala\_2.jpg

the 1th compression ratio is: 16.218234163346487%

the 2th output is: Koala\_2.jpg

the 2th compression ratio is: 17.02762825758711%

the 3th output is: Koala\_2.jpg

the 3th compression ratio is: 17.206924417703704%

the 4th output is: Koala\_2.jpg

the 4th compression ratio is: 16.36948328127341%

the 5th output is: Koala\_2.jpg

the 5th compression ratio is: 17.478430031594545%

the 6th output is: Koala\_2.jpg

the 6th compression ratio is: 16.779303075825627%

the 7th output is: Koala\_2.jpg

the 7th compression ratio is: 14.741730284786335%

the 8th output is: Koala\_2.jpg

the 8th compression ratio is: 16.09080582097791%

the 9th output is: Koala\_2.jpg

the 9th compression ratio is: 16.25588635697097%

the 10th output is: Koala\_2.jpg

the 10th compression ratio is: 16.38549186699811%

the 11th output is: Koala\_2.jpg

the 11th compression ratio is: 16.377295471107065%

the 12th output is: Koala\_2.jpg

the 12th compression ratio is: 16.38549186699811%

the 13th output is: Koala\_2.jpg

the 13th compression ratio is: 17.032751005019012%

the 14th output is: Koala\_2.jpg

the 14th compression ratio is: 16.142929776097517%

the 15th output is: Koala\_2.jpg

the 15th compression ratio is: 17.155184668641486%

the 16th output is: Koala\_2.jpg

the 16th compression ratio is: 15.416011915510527%

the 17th output is: Koala\_2.jpg

the 17th compression ratio is: 17.01494945769315%

the 18th output is: Koala\_2.jpg

the 18th compression ratio is: 15.157825444942633%

the 19th output is: Koala\_2.jpg

the 19th compression ratio is: 16.09080582097791%

the 20th output is: Koala\_2.jpg

the 20th compression ratio is: 15.416011915510527%

the average compression ratio is: 16.337158744978105%

the variance is: 10.164070143193172

7, java -jar MLAssign3.jar Koala.jpg 5 Koala

the 1th output is: Koala\_5.jpg

the 1th compression ratio is: 22.4706754726695%

the 2th output is: Koala\_5.jpg

the 2th compression ratio is: 21.569456130712023%

the 3th output is: Koala\_5.jpg

the 3th compression ratio is: 22.476310494844594%

the 4th output is: Koala\_5.jpg

the 4th compression ratio is: 22.342094512128746%

the 5th output is: Koala\_5.jpg

the 5th compression ratio is: 22.06751524977876%

the 6th output is: Koala\_5.jpg

the 6th compression ratio is: 22.168433374187245%

the 7th output is: Koala\_5.jpg

the 7th compression ratio is: 21.991954725158198%

the 8th output is: Koala\_5.jpg

the 8th compression ratio is: 22.653173349931034%

the 9th output is: Koala\_5.jpg

the 9th compression ratio is: 22.131165386620154%

the 10th output is: Koala\_5.jpg

the 10th compression ratio is: 22.464784313122816%

the 11th output is: Koala\_5.jpg

the 11th compression ratio is: 21.72544379001346%

the 12th output is: Koala\_5.jpg

the 12th compression ratio is: 22.33556300915307%

the 13th output is: Koala\_5.jpg

the 13th compression ratio is: 22.18226479225338%

the 14th output is: Koala\_5.jpg

the 14th compression ratio is: 21.599296134502858%

the 15th output is: Koala\_5.jpg

the 15th compression ratio is: 21.943544761926717%

the 16th output is: Koala\_5.jpg

the 16th compression ratio is: 22.596823128180105%

the 17th output is: Koala\_5.jpg

the 17th compression ratio is: 21.165271358334902%

the 18th output is: Koala\_5.jpg

the 18th compression ratio is: 22.368476661403044%

the 19th output is: Koala\_5.jpg

the 19th compression ratio is: 21.938934289238006%

the 20th output is: Koala\_5.jpg

the 20th compression ratio is: 21.812530496355805%

the average compression ratio is: 22.10018557152572%

the variance is: 2.855491389367996

8, java -jar MLAssign3.jar Koala.jpg 10 Koala

the 1th output is: Koala\_10.jpg

the 1th compression ratio is: 20.985719060846712%

the 2th output is: Koala\_10.jpg

the 2th compression ratio is: 21.404119457347363%

the 3th output is: Koala\_10.jpg

the 3th compression ratio is: 21.31216614094471%

the 4th output is: Koala\_10.jpg

the 4th compression ratio is: 20.841897926696046%

the 5th output is: Koala\_10.jpg

the 5th compression ratio is: 21.021578292870032%

the 6th output is: Koala\_10.jpg

the 6th compression ratio is: 21.049625335059698%

the 7th output is: Koala\_10.jpg

the 7th compression ratio is: 20.941919570303945%

the 8th output is: Koala\_10.jpg

the 8th compression ratio is: 21.142090926205544%

the 9th output is: Koala\_10.jpg

the 9th compression ratio is: 20.845099643840985%

the 10th output is: Koala\_10.jpg

the 10th compression ratio is: 20.93064952595376%

the 11th output is: Koala\_10.jpg

the 11th compression ratio is: 21.340725457877568%

the 12th output is: Koala\_10.jpg

the 12th compression ratio is: 21.388751215051656%

the 13th output is: Koala\_10.jpg

the 13th compression ratio is: 21.160276679588797%

the 14th output is: Koala\_10.jpg

the 14th compression ratio is: 21.762071434151565%

the 15th output is: Koala\_10.jpg

the 15th compression ratio is: 20.9338512430987%

the 16th output is: Koala\_10.jpg

the 16th compression ratio is: 21.338676358904806%

the 17th output is: Koala\_10.jpg

the 17th compression ratio is: 21.203435826702577%

the 18th output is: Koala\_10.jpg

the 18th compression ratio is: 20.758909418299222%

the 19th output is: Koala\_10.jpg

the 19th compression ratio is: 21.104694869952652%

the 20th output is: Koala\_10.jpg

the 20th compression ratio is: 20.835110286348772%

the average compression ratio is: 21.115068433502252%

the variance is: 1.206841232580938

9, java -jar MLAssign3.jar Koala.jpg 15 Koala

the 1th output is: Koala\_15.jpg

the 1th compression ratio is: 20.947682661164833%

the 2th output is: Koala\_15.jpg

the 2th compression ratio is: 20.593444676248765%

the 3th output is: Koala\_15.jpg

the 3th compression ratio is: 20.675408635159208%

the 4th output is: Koala\_15.jpg

the 4th compression ratio is: 20.75109722846557%

the 5th output is: Koala\_15.jpg

the 5th compression ratio is: 20.564501153258515%

the 6th output is: Koala\_15.jpg

the 6th compression ratio is: 20.81538770873595%

the 7th output is: Koala\_15.jpg

the 7th compression ratio is: 20.561043298741982%

the 8th output is: Koala\_15.jpg

the 8th compression ratio is: 20.71639061461443%

the 9th output is: Koala\_15.jpg

the 9th compression ratio is: 20.58844999750266%

the 10th output is: Koala\_15.jpg

the 10th compression ratio is: 20.567190595660264%

the 11th output is: Koala\_15.jpg

the 11th compression ratio is: 20.866102908311788%

the 12th output is: Koala\_15.jpg

the 12th compression ratio is: 20.689752327968534%

the 13th output is: Koala\_15.jpg

the 13th compression ratio is: 20.410818730301436%

the 14th output is: Koala\_15.jpg

the 14th compression ratio is: 20.438609635119505%

the 15th output is: Koala\_15.jpg

the 15th compression ratio is: 20.541192652443357%

the 16th output is: Koala\_15.jpg

the 16th compression ratio is: 20.375599841707103%

the 17th output is: Koala\_15.jpg

the 17th compression ratio is: 20.101660922786106%

the 18th output is: Koala\_15.jpg

the 18th compression ratio is: 20.704736364206852%

the 19th output is: Koala\_15.jpg

the 19th compression ratio is: 20.57282561783536%

the 20th output is: Koala\_15.jpg

the 20th compression ratio is: 20.414404653503766%

the average compression ratio is: 20.594815011186803%

the variance is: 0.7018436477694424

10, java -jar MLAssign3.jar Koala.jpg 20 Koala

the 1th output is: Koala\_20.jpg

the 1th compression ratio is: 20.29004995959433%

the 2th output is: Koala\_20.jpg

the 2th compression ratio is: 20.481896850919085%

the 3th output is: Koala\_20.jpg

the 3th compression ratio is: 20.13162899526274%

the 4th output is: Koala\_20.jpg

the 4th compression ratio is: 20.34601597528787%

the 5th output is: Koala\_20.jpg

the 5th compression ratio is: 20.478182859030955%

the 6th output is: Koala\_20.jpg

the 6th compression ratio is: 20.377136665936675%

the 7th output is: Koala\_20.jpg

the 7th compression ratio is: 20.084371650203437%

the 8th output is: Koala\_20.jpg

the 8th compression ratio is: 20.05363516561202%

the 9th output is: Koala\_20.jpg

the 9th compression ratio is: 20.213849091544777%

the 10th output is: Koala\_20.jpg

the 10th compression ratio is: 20.572313343092166%

the 11th output is: Koala\_20.jpg

the 11th compression ratio is: 20.36381752261373%

the 12th output is: Koala\_20.jpg

the 12th compression ratio is: 20.34230198339974%

the 13th output is: Koala\_20.jpg

the 13th compression ratio is: 19.806206464651122%

the 14th output is: Koala\_20.jpg

the 14th compression ratio is: 19.982428976308576%

the 15th output is: Koala\_20.jpg

the 15th compression ratio is: 20.339740609683783%

the 16th output is: Koala\_20.jpg

the 16th compression ratio is: 20.13431843766449%

the 17th output is: Koala\_20.jpg

the 17th compression ratio is: 20.294916569654635%

the 18th output is: Koala\_20.jpg

the 18th compression ratio is: 20.140337665896972%

the 19th output is: Koala\_20.jpg

the 19th compression ratio is: 20.65312468383043%

the 20th output is: Koala\_20.jpg

the 20th compression ratio is: 20.03647396171515%

the average compression ratio is: 20.256137371595134%

the variance is: 0.8508762368501795