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6:  */
7:
8:
9:
10: #pragma once
11: #include <stdint.h>
12: #include <cstdlib>
13:
14: using namespace std;
15:
16: // Data from beans.ppm
17:
18: const uint32_t actualHistBean[256] = {0,0,58,365,639,876,1196,1270,1373,1754,1665,1630,1802,1717,1921,1754
,1699,1844,1721,1668,1639,1587,1611,1520,1508,1483,1497,1473,1395,1367,1398,1310,1282,1223,1258,1306,1289,1293,127
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48,1463,1566,1491,1470,1517,1537,1484,1487,1492,1485,1507,1504,1516,1490,1470,1486,1504,1490,1482,1478,1498,1423,1
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1371,1442,1373,1390,1363,1412,1382,1358,1371,1383,1294,1423,1381,1417,1345,1308,1386,1315,1378,1352,1377,1315,1323
,1379,1409,1306,1324,1331,1360,1320,1318,1282,1269,1317,1285,1307,1311,1347,1354,1339,1320,1341,1304,1280,1341,128
1,1237,1294,1259,1312,1228,1239,1283,1202,1200,1270,1247,1177,1247,1165,1213,1177,1145,1115,1144,1137,1089,1075,10
91,1147,1065,1140,1103,1027,1131,1080,1107,1064,1029,1026,1038,988,992,1043,979,988,972,1012,919,959,966,909,872,9
02,852,822,846,827,799,761,722,725,665,692,659,635,596,593,602,572,570,506,552,499,479,487,434,410,419,321,328,334
,291,207,208,187,151,147,121,106,74,75,60,63,36,26,27,19,18,15,23,15,13,10,9,3,0,0,0};
19: const float actualMeanBean = 104.263387784091;
20: const uchar actualminBean = 2;
21: const uchar actualMaxBean = 252;
22: const float actualStdBean = 61.106823;
23: const uint32_t actualSumBean = 29360570;
24:
25: const uint32_t actualHistBeanMask[256] = {0,0,30,156,238,363,484,509,534,695,651,653,745,708,741,676,611,64
4,648,600,596,590,588,526,559,528,531,556,486,494,524,476,454,475,469,491,455,467,454,457,495,444,463,486,490,521,
490,500,522,554,514,531,528,555,571,533,535,550,522,608,582,596,537,616,577,577,611,599,544,570,592,560,560,565,58
9,575,522,562,591,575,587,561,578,547,539,587,569,582,569,523,541,626,538,597,521,542,557,516,523,505,525,531,528,
560,531,539,539,522,537,510,508,525,530,523,511,504,527,495,503,507,539,511,495,507,502,505,506,545,482,553,525,55
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8,394,408,391,394,376,365,354,354,366,381,347,352,344,312,308,329,312,291,288,299,262,292,255,267,229,276,268,240,
261,230,253,216,223,201,175,171,171,127,122,137,102,86,94,65,63,57,59,41,37,34,24,25,14,12,12,11,8,5,15,8,10,8,5,0
,0,0,0};
26: const float acutalMeanBeanMask = 105.113610746688;
27: const uint32_t actualSumBeanMask = 11377287;
28: const uchar actualminBeanMask = 2;
29: const uchar actualMaxBeanMask = 251;
30: const float actualStdBeanMask = 61.4932556;
31:
32:
```

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6:  */
7:
8:
9:
10: #include <stdint.h>
11: #include <cstdlib>
12:
13: using namespace std;
14:
15: const double meanTestResult = 127.445198;
16: const uint8_t mediaanTestResult = 128;
17: const double stdTestResult = 73.5821;
18: const uint32_t nTestResult = 40000;
19: const uint8_t modeTestResult = 173;
20: const uint8_t rangeTestResult = 255;
21: const uint32_t sumTestResult = 5097808;
22: const uint8_t minTestResult = 0;
23: const uint8_t maxTestResult = 255;
24:
25: const uint8_t histTestResult[256] =
26: { 89, 139, 157, 150, 165, 149, 146, 166, 147, 164, 144, 128, 153, 162, 182, 164, 160, 167, 142, 171, 148, 1
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56, 174, 143, 156, 176, 150, 158, 165, 164, 135, 166, 158, 151, 132, 169, 162, 147, 169, 154, 159, 172, 159, 169,
151, 155, 172, 166, 147, 155, 154, 149, 167, 160, 161, 170, 175, 168, 160, 185, 167, 166, 134, 165, 140, 166, 141,
160, 134, 168, 150, 151, 168, 172, 135, 136, 153, 161, 170, 167, 138, 167, 160, 151, 176, 181, 164, 148, 152, 150
, 167, 151, 152, 163, 151, 133, 138, 147, 174, 151, 150, 155, 149, 158, 159, 171, 163, 164, 144, 145, 164, 149, 17
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43, 134, 156, 155, 148, 148, 86 };
27:
28: const uint8_t testMatrix[200][200] =
29: { { 208, 164, 108, 217, 174, 161, 128, 128, 171, 51, 190, 14, 208, 13, 124, 97, 63, 183, 234, 161, 109, 32,
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106, 215, 168, 39, 163, 152, 211, 208, 105, 34, 213, 242, 205, 148, 31, 71, 110, 161, 60, 161, 24, 163, 56, 87, 24
8, 227, 190, 168, 73, 140, 158, 217, 230, 248, 89, 166, 47, 21, 10, 230, 29, 60, 222, 189, 186, 33, 53, 122, 154,
87, 81, 254, 83, 111, 106, 178, 243, 177, 94, 48, 85, 42, 33, 26, 144, 2, 37, 80, 98, 102, 193, 215, 62, 166, 234,
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30: { 231, 97, 24, 143, 34, 91, 125, 156, 110, 50, 228, 208, 48, 139, 127, 81, 99, 34, 154, 251, 244, 93, 214,
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32: { 233, 136, 120, 178, 28, 57, 90, 136, 65, 224, 33, 177, 209, 82, 99, 183, 212, 130, 190, 153, 148, 96, 131
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33: { 161, 89, 177, 149, 30, 166, 115, 52, 2, 120, 57, 54, 163, 206, 30, 105, 210, 135, 98, 232, 138, 220, 114,
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36: { 139, 140, 9, 252, 167, 36, 248, 246, 241, 247, 237, 244, 131, 204, 214, 163, 236, 205, 120, 244, 200, 172
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27, 89, 60, 64, 109, 224, 21, 186, 237, 87, 175, 159, 185, 37, 221, 24, 134, 187, 243, 244, 243, 239, 45, 40, 22,
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228, 172, 217, 98, 231, 101, 30, 85, 47, 111, 166, 149, 162, 23, 48, 16, 10, 101, 122, 227, 134, 153, 41, 170, 15
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37: { 244, 159, 18, 0, 191, 6, 48, 158, 231, 104, 13, 113, 139, 13, 247, 19, 189, 135, 164, 112, 236, 52, 160,
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133, 65, 48, 175, 70, 239, 104, 21, 101, 39, 189, 90, 113, 168, 157, 181, 62, 118, 85, 12, 188, 42, 19, 116, 89, 3
7, 149, 7, 247, 3, 129, 104, 165, 158, 90, 1, 106, 146, 35, 33, 150, 224, 204, 17, 72, 184, 200, 188, 141, 203, 46
, 115, 243, 18, 241, 142, 109, 237, 222, 238, 139, 104, 186, 197, 95, 186, 149, 32, 232, 253, 119, 62, 60, 59, 160
, 168, 79, 90, 202, 42, 130, 125, 170, 63, 140, 202, 97, 173, 1, 198, 67, 180, 163, 162, 146, 144, 51, 45, 75, 5,
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38: { 246, 150, 81, 221, 149, 107, 170, 177, 100, 215, 151, 22, 155, 72, 55, 31, 188, 244, 71, 153, 2, 221, 46,
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40: { 3.03492346633185, 0.0325574641649735, -0.839588747336614, -0.847926243637934, 1.68210359466318, -1.664164 47498706, -0.131937867924581, -0.124889947723107, 0.126947068043646, 1.80886262051925, -1.09334345623960, -0.43827 0518204902, 0.291570288770806, -2.35952351095849, 0.0595705885660458, 0.400737998146962, -1.85300807141960, 0.3061 57818568223, 1.26652847557265, -0.698654270705207, 0.269540707973063, -0.187120544841388, 0.0173443460436582, -0.1 06671817056153, -1.45904186908361, 0.221273067715513, -0.482810840319050, -2.25984035153099, 0.0668692106170284, -0.594353281657676, -0.386394169497248, -0.229292809268995, 1.09453846090965, -0.908705616318882, 0.246449516399111 , -0.249413421524592, 0.616300507674839, 1.10769457603403, 1.14360315451890, -0.260139430391064, 1.39185483504681, 1.40631490892524, 1.38321391556811, 0.685252427932931, -0.799395126005953, -0.557410875209181, 1.79975278578809, 0.680584962724148, -1.56662624914657, -1.37120417016298 },

41: { 0.725404224946106, 0.552527021112224, 1.35459432800464, -1.12012830124373, -0.875729346160017, -0.5900345 64205222, -0.147201456151267, 1.47895849150403, -0.656815928948083, -1.07986625073883, -0.433609296474824, 2.00339 061086226, -0.77698538311603, -0.509972045799939, -0.411250925532220, 0.0951421578641687, -0.207303159647625, -1. 17233486755329, -0.251169287438378, 0.832770575778025, -2.56444935612109, 0.291727455002394, 0.828387265991093, -0 .687829135427859, -0.581709725467177, 2.73037758486803, -0.231497194486117, -0.564376691130426, -1.63938739369786, -0.443766910105021, -0.505078413652473, 0.262250813294937, 0.321180732968874, 0.240575037229452, 1.56103723018519 , 1.29401900835506, 0.863919369587695, 0.820471461466290, -0.914714245055425, -0.228795364308812, -1.3455020101611 0, 0.496833731924583, 1.30368137352944, 1.03767321527948, 0.566975092899232, 0.677017656847446, -0.878374305578532 , 0.437823622565729, 1.05705962894953, 0.0103074544255457 },

42: { -0.0630548731896562, 1.10061021788087, -1.07215528838425, 2.52599969211831, -0.483815050110121, -0.278064 163765309, 1.00777340530544, -0.860815690006961, -1.48139907157878, 0.199189444075264, -0.168469878275448, 0.95099 3499549085, 0.566696097539305, -1.32162559081010, -0.368010733040955, 0.496684391636530, 0.270378202689916, -0.960 966563537669, -0.204570050663136, -0.694605254228204, 0.465864128078826, 0.987694691911684, 0.217738348381478, 0.3 31880876981422, -1.83014932210345, -0.296165383347162, 0.613385212333465, 0.901491435092922, -2.42474991337221, -1 .32252964774282, 0.408073894625228, -0.897979544722800, 0.0151128385440506, -0.654046335191623, -1.19662171456272, 0.361980137920309, -1.41691416697625, -0.817611832254945, 0.179801671924433, -0.524812993989912, 0.00074740619173 4232, 0.0828305622755246, -0.125812180556037, 1.82221152843106, -0.00144289886256035, 0.849297440422057, 0.6477327 26433212, -0.143267546672041, -0.587577796579298, 0.204132045747979 },

43: { 0.714742903826096, 1.54421189550395, 0.960953869740567, 1.65549759288735, -0.712004549027423, 0.422715691 220478, -2.12365546241575, 0.784668467287822, 0.15548895903894, -1.52102656176895, -0.218533560026581, -0.4320038 43727780, -1.38262115948035, -0.636128249660041, -1.36096312939369, 1.08224059616070, -0.652771012058928, -0.65373 5016358028, -2.20152190603627, -0.461882993134125, 1.85356094249385, 0.392934569877554, -1.90924490126273, 2.36522 474259891, -0.449103079849422, 0.564295551934993, 1.68285053633205, 0.394675531568292, -0.283829926302804, -0.8595

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44: { -0.204966058299775, 0.0859311331754255, 0.124049800003193, 0.307535159238252, -1.17421233145682, -1.6702069785047, -0.504586405514010, 0.308623139948530, 0.818551368521001, -0.723631125289073, 0.541334435719376, 0.648940737363587, 0.244474675589888, 0.317851419059697, 0.779567428734972, 0.970447788354572, 0.477227285007673, -1.22939364899916, -0.774513104760749, 0.883617136720828, 1.03928933984721, 0.194551374026050, -0.536821821287498, -0.482230718469758, 0.949274703601312, 1.58262066304722, 0.568393573839513, 0.00485442371891243, 1.14580629896864, -1.41300117247607, 0.967982891147789, 0.0939167564889651, 0.494840747422341, -0.551190610935942, 1.00482816344250, 1.08214445191656, 0.195826852819803, 0.264142905788656, 0.384828570751979, 0.550139249522149, -2.34190519391168, 1.86315963313024, -1.52064632561286, -1.62796673299559, 0.126440831034675, -0.239781704489258, 1.32309337684571, 2.05781063406419, 0.219462388420982, 0.663561179344313 },

45: { -0.124144348216312, -1.49159031063761, 1.43669662271894, -1.25711835935205, -0.192239517539275, 0.471634326416303, -1.27059444980866, -0.233860042129153, -0.292588130834394, -0.593250315010804, 0.389266203843264, -0.360076301153972, 0.808438803176791, 0.138047974449526, 0.439411111553712, -0.568569570389605, -0.0713196500274540, -0.270965129963311, -1.39327258405515, 0.435944182163725, 0.910896579458498, 0.279784956482345, -0.302032298446366, 0.647448206700766, 0.717441409444788, 2.72923012321038, -1.20602925424890, 0.436918628028167, 0.181169289545898, -0.515985900361916, 0.270145532752676, -0.951181464851560, -1.21584898482425, -0.0874088682817872, -1.92012580512738, 0.982434080192891, -0.151132402938184, 3.15852807293036, 0.325697632239670, 1.85514736069923, 1.24809514455416, 0.134026621818908, 0.671841600663500, 1.61730243170781, 0.680867794187540, 0.920985453809901, -0.517358965637976, -0.374535035425795, -0.878201101512337, 0.225782139434436 },

46: { 1.48969760778547, -0.742301837259857, -1.96089999936503, -0.865468030554804, -0.274070229932602, -1.21284719967446, -0.382584802707648, -1.05697274596013, -0.540786416488526, 0.401336339818801, 0.751228984688333, 0.705885019349416, 0.213041698417000, -0.710735074811226, -0.0896224837412097, 0.809972073318538, -0.938301288268817, -0.89950067342813, -0.386234650983645, 0.896747363054464, -0.239731286601329, 0.0512203118444502, 1.81358213090433, -1.03442471723417, 2.28782860567075, 0.303564280841044, 0.433060388963240, 1.13007271999667, 0.0542502285446183, -1.08509809672172, -0.634406535588807, 1.17258993043935, 1.59078797675859, -0.347820318259741, 0.625445779460800, -0.111443964288855, 0.892784163034418, 1.22661722851171, 1.29631036855968, -0.277298794530625, 2.80923185356508, -1.54600257382621, 0.0228442900561173, 0.264136741915250, -1.28741591386074, -0.906881378407088, 0.0243149497110560, -0.190203197452842, -2.86139975927085, -0.212843113131577 },

47: { 1.40903448980048, -1.06158173331999, -0.197698225974150, -0.176534114231451, 1.53007251442410, 0.0661900484246114, 0.64867922048621, -0.284140954626164, -0.308641815280113, 0.942133319236942, 1.7782558929100, 1.41584906843659, 0.879677164233489, 0.777003526719788, 1.02118011801418, 0.173247371832088, 0.161363534650636, -0.285686137601834, 0.525586350117865, 0.504732027944892, 0.180998079792441, -0.774466243939416, 0.914851752841074, 1.33955459790412, 0.166727663349700, -0.790258478597882, -0.0921207484997504, 0.153770741090754, 0.687753654274765, -0.707158590760918, 0.629763180328370, 1.73509586636980, 0.526475048595550, 0.993962534155598, 0.752960417782594, 1.2959705848944, -0.364190188083625, 2.32063532135348, 1.09922948349201, 1.06663077087253, -0.232184861775627, 0.433282396191631, -1.17778858625395, -1.12714618565917, 0.218084852524728, 0.144440606275470, -0.162366873553542, -0.938732410611696, 0.535555296585250, -0.0440345710123355 },

48: { 1.41719241342961, 2.35045722400204, -1.20784548525980, 0.791416061628634, -0.249024742513714, 0.652355888661374, 0.825727149241758, -0.0866902824593051, -1.09659330152547, 0.300485967595730, 1.22306255173381, -1.60451566859706, 2.03887625141404, 0.622393924172013, -0.873979465028903, -0.505542568515379, -0.268182881913388, -0.462421544353747, 1.52326927539060, -0.400897135515841, 0.244249546813347, 0.786781710402895, -0.0570807159144771, -0.969140355828830, -2.15649445075169974, 0.803380232506624, -0.244054937965400, -0.758627156743334, -1.39340730198454, -0.301654545754811, -0.0792337539515894, -0.371696045350843, 0.264818591763603, 0.428436173023810, 0.213483683522705, 1.78129502150358, -0.826188688560360, 0.414497860639019, 0.653223048749175, -2.09923885099037, 0.287032146893391, 0.102954219987465, -0.334578164099747, -0.559175859035221, -1.56656707369580, 1.39640902818180, -0.605661086067383, -0.813462364383170, -0.342037309902017, 0.458181822856723 },

49: { 0.671497133608081, -0.615601881466894, 2.90800803072936, -1.33200442131525, -1.06421341288933, 0.327059967177088, -1.01494364268014, -1.46939507448636, -0.493009815316451, -0.373070658631004, -1.28325610460477, 1.02885306900203, 0.923932448688937, 0.647380884516047, 0.414700293047627, -1.19330579089020, -0.409872647756742, -0.409785214740165, 1.79849445190826, -0.513848012099214, 0.0963928845397177, 1.40890695099350, 1.30936207782942, 0.208715601272198, 1.68939930742667, -1.31990270235869, -0.219188663046641, -0.180163097123277, 1.42536573618701, -1.20044050380044, 1.37694916561229, 1.19286412868397, -0.393597890579411, -1.00418528016197, -0.770234072868573, -0.0656148757390404, 0.276011305268776, 0.211831566780286, -0.505073387271410, 0.638483769418353, -0.464604489893360, -0.570346099876642, -1.82945520860790, -0.8088845156537362, 0.783281930836874, -0.189698759604886, 0.271709764009016, -0.583618751528597, -0.597858854736041, -0.441417378808432 },

50: { -1.20748692268504, 0.748076783703985, 0.825218894228491, -2.32986715580508, 1.60345729812004, 1.08263350423676, -0.471069912683167, 0.192182244870785, -0.180739356415037, 0.815488508092498, -2.32895451628334, 1.457936778066199, 0.2669174465958128, -0.425631681660351, 0.3484441199952281, 0.646970938881150, -0.711322710526139, -0.5035358984131873, -0.116884266969787, 0.796367596233901, -0.830468497619261, -0.534098583791872, -1.04473584840963, -0.618593355360547, 1.28228074709257, -0.273845759626558, -0.879766716388638, -0.207789586107980, -0.893851157858867, -0.0193622662427422, -1.40821248993324, 0.953648026213912, -2.17631003833625, -0.632687876663078, -0.00713465252874278, -0.255680865369883, 0.459797300972681, 0.613166891702506, -0.475993806983387, 0.371465456657102, 0.384317776712264, 0.493062156693751, 0.429989596952203, 1.16100428559655, -0.310569908721570, -0.843835890826002, 0.358643412179061, 1.70952537052387, 0.418912708410303, -1.05494672227734 },

51: { 0.717238651328839, -0.192418510588264, 1.37897197791661, -1.44909729283874, 1.23467914689078, 1.00607711081905, 0.137024874130050, -0.822293276290175, 0.0458411057137050, 0.798886992156716, 0.901931466951714, 0.0474713232748285, 0.641661506421779, 1.04858076053644, 0.349254416663714, -0.353622599299341, 0.0614454835840975, 1.23329711264414, -0.320196186885630, -0.671190164007305, -0.352252185662263, 1.92775842981169, -0.348266810335265, 0.512015643736454, -0.582630964347252, 0.271866921602583, -0.320804325089082, 0.896745287933842, 0.0377646999541895, 0.340370564189367, 0.141231683307765, -1.41504453500076, -1.19565443202559, -1.04570999122494, 0.093186527774352, 0.404638157039467, -0.217506670385249, -0.527776960816186, -2.05156142183125, -0.374179299914121, -0.379827523353313, -0.707513213507977, -0.173993462313665, 0.592105269146540, 0.655324411572857, 1.94343804984731, -0.352315122780687, -0.390419817771038, -0.689680720773709, -0.155584259505827 },

52: { 1.63023528916473, 0.888610425420721, -1.05818025798736, 0.333510833065806, -0.229626450963181, -0.650907736597753, -0.291863375753573, -0.0942405879597235, -0.0637831200223327, 0.120205281956355, -1.83563868373519, 1.74625671011842, 0.425485355625296, 0.660707086367175, -0.729247267629503, 0.0464345266878230, -1.84612923609859, 0.610305217573950, 0.817516283237215, 1.18665904286638, -0.174775039544099, -0.176247547257615, 1.41256116072929, 0.0113541711008201, 0.226614480633598, 1.48955304778608, -0.784415293755632, 0.412307702040531, -0.363569288189157, -0.963230982199040, 1.28971939494037, -0.0333563180476360, 0.365328392431846, 0.505707009458752, 0.935251207390719, 0.351756753327098, 0.796122967431404, 1.24160125135253, -0.448304537939442, 0.695348326151247, -0.101778227545497

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53: { 0.488893770311789, -0.764849236567874, -0.468615581100624, 0.391353604432901, -1.50615970397972, 0.257056
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54: { 0.103469300991786, -1.40226896933876, -0.272469409250188, 0.451679418928238, -0.444627816446985, -0.944377
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```

79:

80:

```

1:  /* Copyright (C) Jelle Spijker - All Rights Reserved
2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:  #define QCLOSE_COMPARE(actual, expected, A) \
9:      QCOMPARE((int64)((actual) / A), (int64)((expected) / A))
10: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, type) \
11:     count = 0; \
12:     for_each(actual, actual + endcount, \
13:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++]); })
14: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, A, type) \
15:     count = 0; \
16:     for_each(actual, actual + endcount, \
17:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++], A); })
18:
19: #include <QString>
20: #include <QtTest>
21:
22: #include <stdint.h>
23:
24: #include <opencv2/core.hpp>
25: #include <opencv2/highgui.hpp>
26:
27: #include "SoilMath.h"
28:
29: #include "StatisticalComparisonDefinition.h"
30: #include "FloatTestMatrix.h"
31: #include "TestMatrix.h"
32: #include "beanhisttest.h"
33:
34: class SoilMath_Test : public QObject {
35:     Q_OBJECT
36:
37: public:
38:     SoilMath_Test();
39:
40: private:
41:     uint32_t count = 0;
42:
43: private Q_SLOTS:
44:     void testCase_Sort();
45:     void testCase_Sort_withKey();
46:
47:     void testCase_Stats_BigNoDiscrete();
48:     void testCase_Stats_Shifted();
49:
50:     void testCase_Mat_Stats();
51:     void testCase_Mat_Stats_Mask();
52:
53:     void testCase_benchmark_roundcast();
54:     void testCase_benchmark_float2intround();
55:
56:     void testCase_quickPow();
57:     void testCase_fastPow();
58:
59:     void testCase_benchmark_quickPow();
60:     void testCase_benchmark_fastPow();
61:     void testCase_benchmark_normalPow();
62: };
63:
64: SoilMath_Test::SoilMath_Test() {}
65:
66: void SoilMath_Test::testCase_Sort() {
67:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
68:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
69:     SoilMath::Sort::QuickSort<uint16_t>(startArr, 10);
70:
71:     QCLOSE_COMPARE_RANGE(startArr, compArr, 10, uint16_t);
72:
73:     QBENCHMARK {
74:         uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
75:         SoilMath::Sort::QuickSort<uint16_t>(sArr, 10);
76:     }
77: }
78:
79: void SoilMath_Test::testCase_Sort_withKey() {
80:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
81:     uint16_t compKeyArr[10] = {3, 1, 6, 8, 2, 9, 4, 7, 5, 0};
82:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
83:     uint16_t startKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};

```

```

84:
85:     SoilMath::Sort::QuickSort<uint16_t>(startArr, startKeyarr, 10);
86:     QCOMPARE_RANGE(startArr, compArr, 10, uint16_t);
87:     QCOMPARE_RANGE(startKeyarr, compKeyArr, 10, uint16_t);
88:
89:     QBENCHMARK {
90:         uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
91:         uint16_t sKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
92:         SoilMath::Sort::QuickSort<uint16_t>(sArr, sKeyarr, 10);
93:     }
94: }
95:
96: void SoilMath_Test::testCase_Stats_BigNoDiscrete() {
97:     uint16_t *BigNoTestMatrix = new uint16_t[40000];
98:     uint32_t count = 0;
99:     for (uint32_t i = 0; i < 200; i++) {
100:         for (uint32_t j = 0; j < 200; j++) {
101:             BigNoTestMatrix[count++] = testMatrix[i][j] * 10;
102:         }
103:     }
104:
105:     uint16Stat_t Test(BigNoTestMatrix, 200, 200);
106:
107:     QCOMPARE_RANGE(Test.bins, histTestResult, 255, uint32_t);
108:     QCLOSE_COMPARE(Test.Mean, meanTestResult * 10, 0.01);
109:     QCOMPARE(Test.n, nTestResult);
110:     QCOMPARE((uint64_t)Test.Sum, (uint64_t)(sumTestResult * 10));
111:     QCOMPARE((uint32_t)Test.min, (uint32_t)(minTestResult * 10));
112:     QCOMPARE((uint32_t)Test.max, (uint32_t)(maxTestResult * 10));
113:     QCOMPARE((uint32_t)Test.Range, (uint32_t)(rangeTestResult * 10));
114:     QCLOSE_COMPARE(Test.Std, stdTestResult * 10, 0.025);
115:
116:     delete[] BigNoTestMatrix;
117: }
118:
119: void SoilMath_Test::testCase_Stats_Shifted() {
120:     uint16_t *BigNoTestMatrix = new uint16_t[40000];
121:     uint32_t count = 0;
122:     for (uint32_t i = 0; i < 200; i++) {
123:         for (uint32_t j = 0; j < 200; j++) {
124:             BigNoTestMatrix[count++] = testMatrix[i][j] + 10;
125:         }
126:     }
127:
128:     uint32_t *histTestResultShifted = new uint32_t[266]{};
129:     for (uint32_t i = 10; i < 266; i++) {
130:         histTestResultShifted[i] = histTestResult[i - 10];
131:     }
132:
133:     uint16Stat_t Test(BigNoTestMatrix, 200, 200, 266, 0, 265);
134:
135:     QCOMPARE_RANGE(Test.bins, histTestResultShifted, 266, uint32_t);
136:     QCLOSE_COMPARE(Test.Mean, meanTestResult + 10, 0.01);
137:     QCOMPARE(Test.n, nTestResult);
138:     QCLOSE_COMPARE(Test.Std, stdTestResult, 0.025);
139:
140:     delete[] BigNoTestMatrix;
141: }
142:
143: void SoilMath_Test::testCase_Mat_Stats() {
144:     cv::Mat beans = cv::imread("Images/beans.ppm", 0);
145:     ucharStat_t Test((uchar *)beans.data, beans.cols, beans.rows);
146:     QCLOSE_COMPARE(Test.Mean, actualMeanBean, 0.001);
147:     QCOMPARE_RANGE(Test.bins, actualHistBean, 256, uint32_t);
148:     QCOMPARE(Test.min, actualminBean);
149:     QCOMPARE(Test.max, actualMaxBean);
150:     QCLOSE_COMPARE(Test.Std, actualStdBean, 0.01);
151:     QCOMPARE((uint64_t)Test.Sum, (uint64_t)actualSumBean);
152:
153:     QBENCHMARK {
154:         ucharStat_t TestBench((uchar *)beans.data, beans.cols, beans.rows);
155:     }
156: }
157:
158: void SoilMath_Test::testCase_Mat_Stats_Mask() {
159:     cv::Mat beans = cv::imread("Images/beans.ppm", 0);
160:     cv::Mat mask = cv::imread("Images/beansmask.ppm", 0);
161:     ucharStat_t Test((uchar *)beans.data, beans.cols, beans.rows,
162:                     (uchar *)mask.data);
163:     QCLOSE_COMPARE(Test.Mean, actualMeanBeanMask, 0.001);
164:     QCOMPARE_RANGE(Test.bins, actualHistBeanMask, 256, uint32_t);
165:     QCOMPARE(Test.min, actualminBeanMask);
166:     QCOMPARE(Test.max, actualMaxBeanMask);

```



```
167: QCOMPARE((uint64_t)Test.Sum, (uint64_t)actualSumBeanMask);
168: QCLOSE_COMPARE(Test.Std, actualStdBeanMask, 0.01);
169: QBENCHMARK {
170:     ucharStat_t TestBench((uchar *)beans.data, beans.cols, beans.rows,
171:                           (uchar *)mask.data);
172: }
173: }
174:
175: void SoilMath_Test::testCase_benchmark_roundcast() {
176:     float testf = 254.5;
177:
178:     QBENCHMARK { static_cast<int>(std::round(testf)); }
179: }
180:
181: void SoilMath_Test::testCase_benchmark_float2intround() {
182:     float testf = 254.5;
183:
184:     QBENCHMARK { SoilMath::float2intRound(testf); }
185: }
186:
187: void SoilMath_Test::testCase_quickPow() {
188:     for (int i = -255; i < 256; i++) {
189:         QCLOSE_COMPARE(SoilMath::quick_pow2(i), std::pow(i, 2), 0.0001);
190:     }
191:
192:     QBENCHMARK { SoilMath::quick_pow2(127); }
193: }
194:
195: void SoilMath_Test::testCase_fastPow() {
196:     for (int i = 1; i < 256; i++) {
197:         QCLOSE_COMPARE(SoilMath::fastPow(i, 2), std::pow(i, 2), 1.2);
198:     }
199:
200:     QBENCHMARK { SoilMath::fastPow(127, 2); }
201: }
202:
203: void SoilMath_Test::testCase_benchmark_quickPow() {
204:     QBENCHMARK { SoilMath::quick_pow2(127); }
205: }
206:
207: void SoilMath_Test::testCase_benchmark_fastPow() {
208:     QBENCHMARK { SoilMath::fastPow(127, 2); }
209: }
210:
211: void SoilMath_Test::testCase_benchmark_normalPow() {
212:     QBENCHMARK { std::pow(127, 2); }
213: }
214:
215: QTEST_APPLESS_MAIN(SoilMath_Test)
216:
217: #include "tst_soilmath_test.moc"
```

```
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5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:
10: // Comparison values
11: #define N_MAT 3145728
12:
13: #define L_STD 5.028381605997681
14: #define L_MEAN 80.890745699097508
15: #define L_RANGE 79.936077729332197
16: #define L_MIN 16.742040567344091
17: #define L_MAX 96.678118296676288
18: #define L_SUM 2.544602836865306e8
19:
20: #define A_STD 0.866299119209983
21: #define A_MEAN -3.380512963778564
22: #define A_RANGE 28.974365656143501
23: #define A_MIN -21.293453236190196
24: #define A_MAX 7.680912419953306
25: #define A_SUM -0.106341742845212e8
26:
27: #define B_STD 1.582722966505156
28: #define B_MEAN -14.069966616731605
29: #define B_RANGE 52.152618100375619
30: #define B_MIN -49.577771326645184
31: #define B_MAX 2.574846773730433
32: #define B_SUM -0.442602879453179e8
33:
34: #define X_STD 0.063845026292892
35: #define X_MEAN 0.544538411135235
36: #define X_RANGE 0.783231866666667
37: #define X_MIN 0.019708690196078
38: #define X_MAX 0.802940556862745
39: #define X_SUM 1.712969726983621e6
40:
41: #define Y_STD 0.068325856701040
42: #define Y_MEAN 0.586997317935942
43: #define Y_RANGE 0.894038392156863
44: #define Y_MIN 0.022487607843137
45: #define Y_MAX 0.916526000000000
46: #define Y_SUM 1.846533898955995e6
47:
48: #define Z_STD 0.097003939083143
49: #define Z_MEAN 0.814970278082424
50: #define Z_RANGE 1.032072011764706
51: #define Z_MIN 0.048455952941176
52: #define Z_MAX 1.080527964705882
53: #define Z_SUM 2.563674822931669e6
54:
55: #define RI_STD 0.215470901001717
56: #define RI_MEAN -0.061338583528514
57: #define RI_RANGE 1.861278665280243e2
58: #define RI_MIN -1.210658478499890e2
59: #define RI_MAX 65.062018678035301
60: #define RI_SUM -1.929544996859839e5
```

```

1: #include <opencv2/core.hpp>
2: #include <opencv2/highgui.hpp>
3: #include <QDebug>
4:
5: #include "Vision.h"
6: #include "VisionFunctions.h"
7:
8: void VisionFunctions::CLAHE(Mat &src, Mat &newImage, int GridSize = 3){
9:     // apply the CLAHE algorithm to the L channel
10:    std::vector<cv::Mat> lab_planes(3);
11:    cv::split(src, lab_planes);
12:
13:    // create the CLAHE algorithm and apply it
14:    cv::Ptr<cv::CLAHE> clahe = cv::createCLAHE();
15:    //clahe->setClipLimit(GetThresholdLevel(src, Vision::Segment::Dark, 0, 2));
16:    clahe->setTilesGridSize(cv::Size(GridSize,GridSize));
17:    clahe->apply(lab_planes[0], newImage);
18:
19: };
20:
21: void VisionFunctions::Laplace(Mat &src, Mat &newImage,int kernelSize){
22:    cv::Laplacian(src, newImage, -1, kernelSize); // CV_16S
23: };
24:
25: void VisionFunctions::AdaptiveThreshold(Mat &src, Mat &newImage, uchar kernelSize, Vision::Segment::TypeOfO
bjects Object){
26:
27:     // reset the values in the newImage
28:     newImage = Scalar(0);
29:
30:     // determine the length of an arm of the window
31:     int length = (kernelSize - 1)/2;
32:
33:     for(int i = length; i < (src.cols - length); i++)
34:     {
35:         for(int j = length; j < (src.rows - length) ; j++)
36:         {
37:             /*
38:             // determine the threshold level for a local pixel
39:             //cv::Mat subImage = src.colRange(i-length,i+length).rowRange(j-length,j+length);
40:             //Mat subImage(src, cv::Rect(i - length, j - length, kernelSize, kernelSize));
41:
42:             if (j == length && i == length){
43:                 //imshow("one",subImage);
44:             }
45:
46:             // determine if the local pixel is 0 or 1
47:             if (src.at<uchar>(j,i) < T){
48:                 newImage.at<uchar>(j,i) = 255;
49:             }
50:             else{
51:                 newImage.at<uchar>(j,i) = 0;
52:             }
53:             */
54:         }
55:     }
56: };
57:
58: uint8_t VisionFunctions::GetThresholdLevel(Mat &src, Vision::Segment::TypeOfObjects TypeObject,int threshol
dOffset = 0, int sigma = 2) {
59:     // Calculate the statistics of the whole picture
60:     ucharStat_t OriginalImgStats(src.data, src.rows, src.cols);
61:
62:     // Sets the initial threshold with the mean of the total picture
63:     pair<uchar, uchar> T;
64:     T.first = (uchar)(OriginalImgStats.Mean + 0.5);
65:     T.second = 0;
66:
67:     uchar Rstd = 0;
68:     uchar Lstd = 0;
69:     uchar Rmean = 0;
70:     uchar Lmean = 0;
71:
72:     // Iterate till optimum Threshold is found between back- & foreground
73:     while (T.first != T.second) {
74:         // Gets an array of the left part of the histogram
75:         uint32_t i = T.first;
76:         uint32_t *Left = new uint32_t[i]{};
77:         while (i-- > 0) {
78:             Left[i] = OriginalImgStats.bins[i];
79:         }
80:
81:         // Gets an array of the right part of the histogram

```

```

82:     uint32_t rightEnd = 256 - T.first;
83:     uint32_t *Right = new uint32_t[rightEnd]{};
84:     i = rightEnd;
85:     while (i-- > 0) {
86:         Right[i] = OriginalImgStats.bins[i + T.first];
87:     }
88:
89:     // Calculate the statistics of both histograms,
90:     // taking into account the current threshold
91:     ucharStat_t sLeft(Left, 0, T.first);
92:     ucharStat_t sRight(Right, T.first, 256);
93:
94:     // Calculate the new threshold the mean of the means
95:     T.second = T.first;
96:     T.first = (uchar)(((sLeft.Mean + sRight.Mean) / 2) + 0.5);
97:
98:     Rmean = (uchar)(sRight.Mean + 0.5);
99:     Lmean = (uchar)(sLeft.Mean + 0.5);
100:    Rstd = (uchar)(sRight.Std + 0.5);
101:    Lstd = (uchar)(sLeft.Std + 0.5);
102:    delete[] Left;
103:    delete[] Right;
104: }
105:
106: // Assumes the pixel value of the sought object lies between 2 sigma
107: int val = 0;
108: switch (TypeObject) {
109: case Vision::Segment::Bright: // bright
110:     val = Rmean - (sigma * Rstd) - thresholdOffset;
111:     if (val < 0) {
112:         val = 0;
113:     } else if (val > 255) {
114:         val = 255;
115:     }
116:     T.first = (uchar)val;
117:     break;
118: case Vision::Segment::Dark: // dark
119:     val = Lmean + (sigma * Lstd) + thresholdOffset;
120:     if (val < 0) {
121:         val = 0;
122:     } else if (val > 255) {
123:         val = 255;
124:     }
125:     T.first = (uchar)val;
126:     break;
127: }
128:
129: return T.first;
130: }
131:

```

```

1: #define NO_OF_BLOBS 379
2: #define SMALL_NO_OF_BLOBS 4
3:
4: #include <QString>
5: #include <QtTest>
6: #include <opencv2/core.hpp>
7: #include <opencv2/highgui.hpp>
8:
9: #include "Vision.h"
10:
11: class Vision_Test : public QObject
12: {
13:     Q_OBJECT
14:
15: public:
16:     Vision_Test();
17:
18: private Q_SLOTS:
19:     void TestCase_SimpleLabelBlob();
20:     void TestCase_SingleComplexLabelBlob();
21:     void TestCase_LabelBlobs();
22: };
23:
24: Vision_Test::Vision_Test()
25: {
26: }
27:
28: void Vision_Test::TestCase_SimpleLabelBlob() {
29:     uchar testImgData[100] = { 0, 0, 1, 1, 0, 0, 1, 1, 1, 1,
30:                                0, 0, 0, 1, 0, 0, 0, 1, 1, 1,
31:                                1, 0, 0, 1, 0, 1, 0, 0, 1, 1,
32:                                1, 1, 1, 1, 0, 1, 1, 0, 1, 1,
33:                                1, 1, 0, 0, 0, 0, 1, 0, 1, 1,
34:                                0, 0, 0, 1, 1, 0, 0, 0, 0, 1,
35:                                1, 1, 0, 0, 1, 1, 0, 0, 1, 1,
36:                                1, 1, 1, 0, 0, 1, 1, 0, 1, 1,
37:                                0, 0, 1, 1, 0, 1, 1, 0, 1, 1,
38:                                0, 0, 0, 1, 0, 0, 1, 1, 1, 1};
39:
40:     cv::Mat testImg(10, 10, CV_8UC1, testImgData);
41:     testImg *= 255;
42:     Vision::Segment Segmenter(testImg);
43:     Segmenter.ConvertToBW(Vision::Segment::Bright);
44:     Segmenter.GetBlobList(true);
45:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
46:     QCOMPARE(totalNoOfBlobs, uint16_t(SMALL_NO_OF_BLOBS));
47: }
48:
49: void Vision_Test::TestCase_SingleComplexLabelBlob() {
50:     uchar testImgData[100] = { 0, 0, 0, 0, 0, 0, 0, 1, 1, 0,
51:                                0, 0, 0, 0, 0, 1, 1, 1, 1, 1,
52:                                0, 0, 0, 1, 1, 1, 1, 1, 1, 1,
53:                                0, 1, 1, 1, 1, 1, 1, 1, 1, 1,
54:                                1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
55:                                0, 0, 0, 1, 0, 0, 0, 1, 1, 1,
56:                                0, 0, 0, 0, 0, 1, 1, 1, 1, 1,
57:                                0, 0, 0, 1, 1, 1, 1, 1, 0, 0,
58:                                0, 1, 1, 1, 1, 1, 1, 0, 0, 0,
59:                                1, 1, 1, 1, 1, 1, 1, 0, 0, 0};
60:
61:     cv::Mat testImg(10, 10, CV_8UC1, testImgData);
62:     testImg *= 255;
63:     Vision::Segment Segmenter(testImg);
64:     Segmenter.ConvertToBW(Vision::Segment::Bright);
65:     Segmenter.GetBlobList(true);
66:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
67:     QCOMPARE(totalNoOfBlobs, uint16_t(1));
68: }
69: }
70:
71: void Vision_Test::TestCase_LabelBlobs()
72: {
73:     cv::Mat testImg = cv::imread("379_blobs.ppm", 0);
74:
75:     Vision::Segment Segmenter(testImg);
76:     Segmenter.ConvertToBW(Vision::Segment::Dark);
77:     Segmenter.GetBlobList(true);
78:     uint16_t totalNoOfBlobs = Segmenter.MaxLabel;
79:     QCOMPARE(totalNoOfBlobs, uint16_t(NO_OF_BLOBS));
80: }
81:
82: QTEST_APPLESS_MAIN(Vision_Test)
83:

```

```
84: #include "tst_vision_test.moc"
```

```

1: #ifndef VISIONFUNCTIONS_H
2: #define VISIONFUNCTIONS_H
3:
4: #include <opencv2/core.hpp>
5: #include <opencv2/highgui.hpp>
6:
7: #include "Vision.h"
8:
9: class VisionFunctions{
10:
11:     public:
12:         void Laplace(Mat &src, Mat &newImage,int kernelSize);
13:         void CLAHE(Mat &src, Mat &newImage, int GridSize);
14:         void AdaptiveThreshold(Mat &src, Mat &newImage, uchar kernelSize, Vision::Segment::TypeOfObjects Ob
ject);
15:
16:     private:
17:         uint8_t GetThresholdLevel(Mat &src, Vision::Segment::TypeOfObjects TypeObject,int thresholdOffset,
int sigma);
18:
19: };
20:
21: #endif // VISIONFUNCTIONS_H

```

```

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5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:  #define QCLOSE_COMPARE(actual, expected, A) \
9:      QCOMPARE((int64)((actual) / A), (int64)((expected) / A))
10: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, type) \
11:     count = 0; \
12:     for_each(actual, actual + endcount, \
13:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++]); })
14: #define QCLOSE_COMPARE_RANGE(actual, expected, endcount, A, type) \
15:     count = 0; \
16:     for_each(actual, actual + endcount, \
17:         [&](type & AC) { QCLOSE_COMPARE(AC, (type)expected[count++], A); })
18: #include <QString>
19: #include <QtTest>
20: #include "SoilMath.h"
21:
22: class Math_TestTest : public QObject
23: {
24:     Q_OBJECT
25:
26: public:
27:     Math_TestTest();
28:
29: private Q_SLOTS:
30:     void testCase1();
31:     void testCase_Sort();
32:     void testCase_Sort_withKey();
33: };
34:
35: Math_TestTest::Math_TestTest()
36: {
37: }
38:
39: void Math_TestTest::testCase1()
40: {
41:     QVERIFY2(true, "Failure");
42: }
43:
44: void Math_TestTest::testCase_Sort() {
45:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
46:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
47:     SoilMath::Sort::QuickSort<uint16_t>(startArr, 10);
48:
49:     uint32_t count = 0;
50:     for_each(compArr, compArr + 10, [&](uint16_t & AC) { QCLOSE_COMPARE(AC, (uint16_t)compArr[count++]); });
51:
52:     QBENCHMARK {
53:         uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
54:         SoilMath::Sort::QuickSort<uint16_t>(sArr, 10);
55:     }
56: }
57:
58: void Math_TestTest::testCase_Sort_withKey() {
59:     uint16_t compArr[10] = {1, 2, 4, 4, 5, 6, 7, 10, 10, 10};
60:     uint16_t compKeyArr[10] = {3, 1, 6, 8, 2, 9, 4, 7, 5, 0};
61:     uint16_t startArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
62:     uint16_t startKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
63:
64:     SoilMath::Sort::QuickSort<uint16_t>(startArr, startKeyarr, 10);
65:     uint32_t count = 0;
66:     for_each(startArr, startArr + 10, [&](uint16_t & AC) { QCLOSE_COMPARE(AC, (uint16_t)compArr[count++]); });
67:
68:     count = 0;
69:     for_each(startKeyarr, startKeyarr + 10, [&](uint16_t & AC) { QCLOSE_COMPARE(AC, (uint16_t)compKeyArr[count++]); });
70: }
71: // QBENCHMARK {
72: //     uint16_t sArr[10] = {10, 2, 5, 1, 7, 10, 4, 10, 4, 6};
73: //     uint16_t sKeyarr[10] = {0, 1, 2, 3, 4, 5, 6, 7, 8, 9};
74: //     SoilMath::Sort::QuickSort<uint16_t>(sArr, sKeyarr, 10);
75: // }
76: }
77:
78: QTEST_APPLESS_MAIN(Math_TestTest)
79:
80: #include "tst_math_testtest.moc"

```



```

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6:  */
7:
8:
9:  #include <QString>
10: #include <QtTest>
11:
12: class Soil_TestTest : public QObject
13: {
14:     Q_OBJECT
15:
16: public:
17:     Soil_TestTest();
18:
19: private Q_SLOTS:
20:     void testCase1();
21: };
22:
23: Soil_TestTest::Soil_TestTest()
24: {
25: }
26:
27: void Soil_TestTest::testCase1()
28: {
29:     QVERIFY2(true, "Failure");
30: }
31:
32: QTEST_APPLESS_MAIN(Soil_TestTest)
33:
34: #include "tst_soil_testtest.moc"

```

```
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6:  */
7:
8:
9: #define BOOST_TEST_MODULE VSA_UNIT_TESTS
10:
11: // Custom libraries
12: #include "../src/VisionSoilAnalyzer/Vision/Vision.h"
13: #include "../src/VisionSoilAnalyzer/Soil/VisionSoil.h"
14: #include "../src/VisionSoilAnalyzer/SoilMath/SoilMath.h"
15: #include "../src/VisionSoilAnalyzer/SoilPlot/SoilPlot.h"
16:
17: // Test Libraries
18: #include "FloatTestMatrix.h"
19: #include "TestMatrix.h"
20: #include "StatisticalComparisonDefinition.h"
21:
22: #include <boost/test/unit_test.hpp>
23: #include <boost/test/results_reporter.hpp>
24: #include <iostream>
25: #include <fstream>
26: #include <sstream>
27: #include <opencv2/core/core.hpp>
28: #include <opencv2/highgui/highgui.hpp>
29: #include <string>
30: #include <boost/archive/xml_oarchive.hpp>
31: #include <boost/archive/xml_iarchive.hpp>
32: #include <boost/archive/binary_iarchive.hpp>
33: #include <boost/archive/binary_oarchive.hpp>
34: #include <boost/serialization/vector.hpp>
35:
36: // Statistical analysis
37:
38: #include <math.h>
39: #include <cmath>
40: #include <random>
41: #include <sys/time.h>
42:
43: using namespace cv;
44: using namespace std;
45:
46: // Create the Report Redirector
47: struct LogToFile
48: {
49:     LogToFile()
50:     {
51:         std::string logFileName(boost::unit_test::framework::master_test_suite().p_name);
52:         logFileName.append(".log");
53:         logFile.open(logFileName.c_str());
54:         boost::unit_test::unit_test_log.set_stream(logFile);
55:     }
56:     ~LogToFile()
57:     {
58:         boost::unit_test::unit_test_log.test_finish();
59:         logFile.close();
60:         boost::unit_test::unit_test_log.set_stream(std::cout);
61:     }
62:     std::ofstream logFile;
63: };
64: BOOST_GLOBAL_FIXTURE(LogToFile);
65:
66: struct M {
67:     M()
68:     {
69:         BOOST_TEST_MESSAGE("setup fixture");
70:         src = imread("../ComparisionPictures/SoilSampleRGB.ppm");
71:     }
72:     ~M() { BOOST_TEST_MESSAGE("teardown fixture"); }
73:
74:     friend class SoilAnalyzer::Sample;
75:     Mat src;
76:     Mat dst;
77:     Mat comp;
78: };
79:
80: struct B {
81:     B()
82:     {
83:         BOOST_TEST_MESSAGE("Setup fixture");
```

```

84:         src = imread("../ComparisionPictures/BlobTest.ppm", 0);
85:     }
86:     ~B()
87:     {
88:         src.release();
89:         BOOST_TEST_MESSAGE("teardown fixture");
90:     }
91:
92:     Mat src;
93:     Mat dst;
94:     Mat comp;
95: };
96:
97: struct BM {
98:     BM()
99:     {
100:         BOOST_TEST_MESSAGE("Setup fixture");
101:         src = imread("../ComparisionPictures/BlobTestMany.ppm", 0);
102:     }
103:     ~BM() { BOOST_TEST_MESSAGE("teardown fixture"); }
104:
105:     Mat src;
106:     Mat dst;
107:     Mat comp;
108: };
109:
110: struct PM {
111:     PM()
112:     {
113:         BOOST_TEST_MESSAGE("Setup fixture");
114:         checker = imread("../ComparisionPictures/checker.ppm", 0);
115:         std::vector<cv::Mat> RGB;
116:         for (uint32_t i = 0; i < 3; i++)
117:         {
118:             RGB.push_back(checker);
119:         }
120:         cv::Mat alpha(checker.rows, checker.cols, CV_8UC1);
121:         alpha.setTo(255);
122:         RGB.push_back(alpha);
123:         merge(RGB, RGBchecker);
124:     }
125:     ~PM() { BOOST_TEST_MESSAGE("teardown fixture"); }
126:
127:     std::string TestWindow = "SoilPlot Image window";
128:     Mat checker;
129:     Mat RGBchecker;
130:     Mat comp;
131: };
132:
133: //SoilPlot Test
134: BOOST_FIXTURE_TEST_CASE(SoilPlot_Label, PM)
135: {
136:     SoilPlot::Label TestR("RED", "times", 30, cv::Scalar(255, 0, 0, 255), cv::Scalar(0,0,0,0), false, true)
;
137:     SoilPlot::Label TestG("GREEN", "times", 30, cv::Scalar(0, 255, 0, 255), cv::Scalar(0, 0, 0, 0), false,
true);
138:     SoilPlot::Label TestB("BLUE", "times", 30, cv::Scalar(0, 0, 255, 255), cv::Scalar(0, 0, 0, 0), false, t
rue);
139:     SoilPlot::Label TestA("ALPHA", "times", 30, cv::Scalar(255, 125, 0, 10), cv::Scalar(0, 0, 0, 0), false,
true);
140:     namedWindow(TestWindow, cv::WINDOW_NORMAL);
141:
142:     TestR.TopLeftCorner = cv::Point(50, 10);
143:     TestR.Draw();
144:     imshow(TestWindow, TestR.Figure);
145:     cv::waitKey(0);
146:     TestR.DrawOnTop(RGBchecker);
147:     TestG.TopLeftCorner = cv::Point(50, TestR.Figure.rows + 30);
148:     TestG.Draw();
149:     imshow(TestWindow, TestG.Figure);
150:     cv::waitKey(0);
151:     TestG.DrawOnTop(RGBchecker);
152:     TestB.TopLeftCorner = cv::Point(50, TestG.TopLeftCorner.y + TestG.Figure.rows + 20);
153:     TestB.Draw();
154:     imshow(TestWindow, TestB.Figure);
155:     cv::waitKey(0);
156:     TestB.DrawOnTop(RGBchecker);
157:     TestA.TopLeftCorner = cv::Point(50, TestB.TopLeftCorner.y + TestB.Figure.rows + 20);
158:     TestA.Draw();
159:     imshow(TestWindow, TestA.Figure);
160:     cv::waitKey(0);
161:     TestA.DrawOnTop(RGBchecker);
162:

```

```

163:
164:         imshow(TestWindow, RGBchecker);
165:         cv::waitKey(0);
166:     }
167:
168: BOOST_FIXTURE_TEST_CASE(SoilPlot_Lines, PM)
169: {
170:     std::vector<SoilPlot::Line> Lines;
171:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(150, 150), 1, cv::Scalar(255, 0, 0, 255
)))
172:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(10, 150), 2, cv::Scalar(0, 255, 0, 255)
)))
173:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(10, 10), 3, cv::Scalar(0, 0,255, 255)))
;
174:     Lines.push_back(SoilPlot::Line(cv::Point(80, 80), cv::Point(150, 10), 4, cv::Scalar(255, 0, 0, 255)
)))
175:     Lines.push_back(SoilPlot::Line(cv::Point(80, 10), cv::Point(80, 150), 5, cv::Scalar(255, 0, 255, 25
5)))
176:     Lines.push_back(SoilPlot::Line(cv::Point(10, 80), cv::Point(150, 80), 10, cv::Scalar(255, 255, 0, 2
00)))
177:     for_each(Lines.begin(), Lines.end(), [&](SoilPlot::Line &L)
178:     {
179:         L.Draw();
180:         L.DrawOnTop(RGBchecker);
181:     });
182:
183:     namedWindow(TestWindow, cv::WINDOW_NORMAL);
184:     imshow(TestWindow, RGBchecker);
185:     cv::waitKey(0);
186: }
187:
188: BOOST_FIXTURE_TEST_CASE(SoilPlot_Axis, PM)
189: {
190:     std::vector<SoilPlot::Axis> axes;
191:     SoilPlot::Label axisLabel("Horizontal", "times", 30, cv::Scalar(200, 80, 80, 255), cv::Scalar(0, 0,
0, 0), true, true);
192:
193:     std::vector<SoilPlot::Label> Values;
194:     Values.push_back(SoilPlot::Label("1", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
195:     Values.push_back(SoilPlot::Label("2", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
196:     Values.push_back(SoilPlot::Label("3", "times", 16, cv::Scalar(200,80,3,255), cv::Scalar(0,0,0,0), f
alse, true));
197:
198:     axes.push_back(SoilPlot::Axis(cv::Point(20,140), 120, SoilPlot::Axis::Orientation_enum::Horizontal,
Values, axisLabel, SoilPlot::Axis::ValuePosition::UnderTick, false));
199:     for_each(axes.begin(), axes.end(), [&](SoilPlot::Axis &A)
200:     {
201:         A.Draw();
202:         A.DrawOnTop(RGBchecker);
203:     });
204: }
205:
206:
207: BOOST_AUTO_TEST_CASE(SoilPlot_Bar_Graph)
208: {
209:
210: }
211:
212: // SoilMath Test
213: BOOST_AUTO_TEST_CASE(Vision_Create_Blobs)
214: {
215:     cv::Mat src = imread("../ComparisionPictures/BlobTest.ppm", 0);
216:
217:     Vision::Segment Test(src);
218:     Test.ConvertToBW(Vision::Segment::Bright);
219:     Test.GetBlobList(true);
220:     imwrite("LabeledBlobs.ppm", Test.LabelledImg);
221:     BOOST_CHECK_EQUAL(42, Test.BlobList.size());
222:     for_each(Test.BlobList.begin(), Test.BlobList.end(), [](Vision::Segment::Blob_t &b)
223:     {
224:         stringstream ss;
225:         ss << b.Label << "_few_1nd.ppm";
226:         imwrite(ss.str(), b.Img);
227:     });
228: }
229:
230: BOOST_FIXTURE_TEST_CASE(Vision_Create_Many_Blobs, BM)
231: {
232:     Vision::Segment Test(src);
233:     Test.ConvertToBW(Vision::Segment::Bright);
234:     Test.GetBlobList(true);

```

```

235:         imwrite("LabeledBlobsMany.ppm", Test.LabelledImg);
236:         BOOST_CHECK_EQUAL(370, Test.BlobList.size());
237:         for_each(Test.BlobList.begin(), Test.BlobList.end(), [](Vision::Segment::Blob_t &b)
238:         {
239:             stringstream ss;
240:             ss << b.Label << "_many_.ppm";
241:             imwrite(ss.str(), b.Img);
242:         });
243:     }
244:
245:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_BigNoDiscrete)
246:     {
247:         uint16_t *BigNoTestMatrix = new uint16_t[40000];
248:         uint32_t count = 0;
249:         for (uint32_t i = 0; i < 200; i++)
250:         {
251:             for (uint32_t j = 0; j < 200; j++)
252:             {
253:                 BigNoTestMatrix[count++] = testMatrix[i][j] * 10;
254:             }
255:         }
256:
257:         uint16Stat_t Test(BigNoTestMatrix, 200, 200);
258:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, histTestResult, histTestResult + 255);
259:         BOOST_CHECK_CLOSE(Test.Mean, meanTestResult * 10, 0.0001);
260:         BOOST_CHECK_EQUAL(Test.n, nTestResult);
261:         BOOST_CHECK_EQUAL(Test.Sum, sumTestResult * 10);
262:         BOOST_CHECK_EQUAL(Test.min, minTestResult * 10);
263:         BOOST_CHECK_EQUAL(Test.max, maxTestResult * 10);
264:         BOOST_CHECK_EQUAL(Test.Range, rangeTestResult * 10);
265:         BOOST_CHECK_CLOSE(Test.Std, stdTestResult * 10, 0.01);
266:         delete[] BigNoTestMatrix;
267:     }
268:
269:     BOOST_AUTO_TEST_CASE(SoilMath_Sort)
270:     {
271:         int testDiscrete[] = { 2, 8, 1, 3, 0, 7, 4, 5, 9, 6, 6 };
272:         int ucomp[] = { 0, 1, 2, 3, 4, 5, 6, 6, 7, 8, 9 };
273:         SoilMath::Sort::QuickSort<int>(testDiscrete, 11);
274:         BOOST_CHECK_EQUAL_COLLECTIONS(testDiscrete, testDiscrete + 10, ucomp, ucomp + 10);
275:     }
276:
277:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_ucharStat_t)
278:     {
279:         ucharStat_t Test((uint8_t *)testMatrix, 200, 200);
280:
281:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, histTestResult, histTestResult + 255);
282:         BOOST_CHECK_CLOSE(Test.Mean, meanTestResult, 0.0001);
283:         BOOST_CHECK_EQUAL(Test.n, nTestResult);
284:         BOOST_CHECK_EQUAL(Test.Sum, sumTestResult);
285:         BOOST_CHECK_EQUAL(Test.min, minTestResult);
286:         BOOST_CHECK_EQUAL(Test.max, maxTestResult);
287:         BOOST_CHECK_EQUAL(Test.Range, rangeTestResult);
288:         BOOST_CHECK_CLOSE(Test.Std, stdTestResult, 0.01);
289:     }
290:
291:     BOOST_AUTO_TEST_CASE(SoilMath_Stats_floatStat_t)
292:     {
293:         floatStat_t Test((float *)fTestMatrix, 50, 50);
294:
295:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.bins, Test.bins + 255, fhistTestResult, fhistTestResult + 255);
296:         BOOST_CHECK_CLOSE(Test.Mean, fmeanTestResult, 0.01);
297:         BOOST_CHECK_EQUAL(Test.n, fnTestResult);
298:         BOOST_CHECK_CLOSE(Test.Sum, fsumTestResult, 0.01);
299:         BOOST_CHECK_CLOSE(Test.min, fminTestResult, 0.01);
300:         BOOST_CHECK_CLOSE(Test.max, fmaxTestResult, 0.01);
301:         BOOST_CHECK_CLOSE(Test.Range, frangeTestResult, 0.01);
302:         BOOST_CHECK_CLOSE(Test.Std, fstdTestResult, 0.025);
303:     }
304:
305:     BOOST_AUTO_TEST_CASE(SoilMath_FFT_GetDescriptors)
306:     {
307:         uchar data[] =
308:         { 0, 0, 1, 1, 0, 0,
309:         0, 1, 0, 0, 1, 0,
310:         0, 1, 0, 0, 1, 0,
311:         1, 0, 0, 0, 0, 1,
312:         1, 0, 0, 0, 0, 1,
313:         0, 1, 0, 0, 1, 0,
314:         0, 1, 0, 0, 1, 0,
315:         0, 0, 1, 1, 0, 0 };
316:         cv::Mat src(8, 6, CV_8UC1, &data, 1);
317:         SoilMath::FFT Test;

```

```

318:     ComplexVect_t desc = Test.GetDescriptors(src);
319:     Complex_t desc_exp[] = {
320:         Complex_t(-1.6666667, -6),
321:         Complex_t(2.02375780, -0.16742019),
322:         Complex_t(-3.1094758, -6.13316500),
323:         Complex_t(-1.8036530, 1.023864110),
324:         Complex_t(-0.6666667, -1),
325:         Complex_t(0.04350554, -2.55884126),
326:         Complex_t(-3.0522848, -0.63807119),
327:         Complex_t(-0.7780360, -0.31809187),
328:         Complex_t(-0.3333333, 0),
329:         Complex_t(-1.3856866, -1.43021101),
330:         Complex_t(-1.2238576, 0.466498316),
331:         Complex_t(-0.3295119, 1.459385072),
332:         Complex_t(1.33333331, -1),
333:         Complex_t(-0.3482434, 0.489805636),
334:         Complex_t(0.71895134, 0.304737878),
335:         Complex_t(5.24453433, -0.49849056)
336:     };
337:
338:     BOOST_CHECK_EQUAL(desc.size(), 16);
339:
340:     for (uint32_t i = 0; i < 16; i++)
341:     {
342:         BOOST_CHECK_CLOSE(desc[i].real(), desc_exp[i].real(), 0.0001);
343:         BOOST_CHECK_CLOSE(desc[i].imag(), desc_exp[i].imag(), 0.0001);
344:     }
345: }
346:
347: BOOST_AUTO_TEST_CASE(SoilMath_FFT_GetDescriptors_Non_Continues_Contour)
348: {
349:     uchar data[] =
350:     { 0, 0, 0, 1, 0, 0,
351:       0, 1, 0, 0, 1, 0,
352:       0, 1, 0, 0, 1, 0,
353:       1, 0, 0, 0, 0, 1,
354:       1, 0, 0, 0, 0, 1,
355:       0, 1, 0, 0, 1, 0,
356:       0, 1, 0, 0, 1, 0,
357:       0, 0, 1, 1, 0, 0 };
358:     cv::Mat src(8, 6, CV_8UC1, &data, 1);
359:     SoilMath::FFT Test;
360:     BOOST_CHECK_THROW(Test.GetDescriptors(src), SoilMath::Exception::MathException);
361: }
362:
363: BOOST_AUTO_TEST_CASE(SoilMath_NN_Save_And_Load)
364: {
365:     SoilMath::NN Test(3, 5, 2);
366:
367:     InputLearnVector_t inputVect;
368:     OutputLearnVector_t outputVect;
369:
370:     //Population_t pop;
371:     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
372:     std::default_random_engine gen(seed);
373:     std::uniform_real_distribution<float> dis(0.0, 1.0);
374:
375:     float i1 = 0.0, i2 = 0.0, i3 = 0.0;
376:     float o1 = 0.0, o2 = 0.0;
377:
378:     for (uint32_t i = 0; i < 200; i++)
379:     {
380:         if (dis(gen) > 0.5f) { i1 = 1.0; }
381:         else { i1 = 0.0; }
382:         if (dis(gen) > 0.5f) { i2 = 1.0; }
383:         else { i2 = 0.0; }
384:         if (dis(gen) > 0.5f) { i3 = 1.0; }
385:         else { i3 = 0.0; }
386:
387:         if (i1 == 1.0 && i2 == 1.0 && i3 == 0.0)
388:         {
389:             o1 = 1.0;
390:             o2 = -1.0;
391:         }
392:         else if (i1 == 0.0 && i2 == 0.0 && i3 == 1.0)
393:         {
394:             o1 = 1.0;
395:             o2 = -1.0;
396:         }
397:         else
398:         {
399:             o1 = -1.0;
400:             o2 = 1.0;

```

```

401:         }
402:
403:         ComplexVect_t inputTemp;
404:         inputTemp.push_back(Complex_t(i1, 0));
405:         inputTemp.push_back(Complex_t(i2, 0));
406:         inputTemp.push_back(Complex_t(i3, 0));
407:         inputVect.push_back(inputTemp);
408:
409:         Predict_t outputTemp;
410:         outputTemp.OutputNeurons.push_back(o1);
411:         outputTemp.OutputNeurons.push_back(o2);
412:         outputVect.push_back(outputTemp);
413:     }
414:
415:     Test.Learn(inputVect, outputVect, 0);
416:     Test.SaveState("NN.xml");
417:
418:     SoilMath::NN loadTest;
419:     loadTest.LoadState("NN.xml");
420:
421:     std::vector<float> test_out = Test.Predict(inputVect[0]).OutputNeurons;
422:     std::vector<float> loadtest_out = loadTest.Predict(inputVect[0]).OutputNeurons;
423:
424:     BOOST_REQUIRE_EQUAL_COLLECTIONS(Test.hWeights.begin(), Test.hWeights.end(), loadTest.hWeights.begin(), loadTest.hWeights.end());
425:     BOOST_REQUIRE_EQUAL_COLLECTIONS(Test.iWeights.begin(), Test.iWeights.end(), loadTest.iWeights.begin(), loadTest.iWeights.end());
426: }
427:
428: BOOST_AUTO_TEST_CASE(SoilMath_NN_Prediction_Accuracy)
429: {
430:     SoilMath::NN Test;
431:     Test.LoadState("../ComparisionPictures/NN_Test.xml");
432:
433:     InputLearnVector_t inputVect;
434:     OutputLearnVector_t outputVect;
435:     OutputLearnVector_t outputPredictVect;
436:
437:     unsigned seed = std::chrono::system_clock::now().time_since_epoch().count();
438:     std::default_random_engine gen(seed);
439:     std::uniform_real_distribution<float> dis(0.0, 1.0);
440:
441:     float i1 = 0.0, i2 = 0.0, i3 = 0.0;
442:     float o1 = 0.0, o2 = 0.0;
443:
444:     for (uint32_t i = 0; i < 10; i++)
445:     {
446:         if (dis(gen) > 0.5f) { i1 = 1.0; }
447:         else { i1 = 0.0; }
448:         if (dis(gen) > 0.5f) { i2 = 1.0; }
449:         else { i2 = 0.0; }
450:         if (dis(gen) > 0.5f) { i3 = 1.0; }
451:         else { i3 = 0.0; }
452:
453:         if (i1 == 1.0 && i2 == 1.0 && i3 == 0.0)
454:         {
455:             o1 = 1.0;
456:             o2 = -1.0;
457:         }
458:         else if (i1 == 0.0 && i2 == 0.0 && i3 == 1.0)
459:         {
460:             o1 = 1.0;
461:             o2 = -1.0;
462:         }
463:         else
464:         {
465:             o1 = -1.0;
466:             o2 = 1.0;
467:         }
468:
469:         ComplexVect_t inputTemp;
470:         inputTemp.push_back(Complex_t(i1, 0));
471:         inputTemp.push_back(Complex_t(i2, 0));
472:         inputTemp.push_back(Complex_t(i3, 0));
473:         inputVect.push_back(inputTemp);
474:
475:         Predict_t outputTemp;
476:         outputTemp.OutputNeurons.push_back(o1);
477:         outputTemp.OutputNeurons.push_back(o2);
478:         outputVect.push_back(outputTemp);
479:
480:         Predict_t outputPredictTemp;
481:         outputPredictTemp.OutputNeurons = Test.Predict(inputTemp).OutputNeurons;

```

```
482:
483:         for (uint32_t j = 0; j < outputTemp.OutputNeurons.size(); j++)
484:         {
485:             BOOST_CHECK_CLOSE(outputPredictTemp.OutputNeurons[j], outputTemp.OutputNeurons[j],
5);
486:         }
487:     }
488: }
489:
490: // Vision Test
491:
492: BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_Intensity, M)
493: {
494:     // Convert the RGB picture to an intensity picture
495:     Vision::Conversion Test;
496:     Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::Intensity);
497:
498:     // Read in the Matlab converted intensity picture converted with the Matlab command:
499:     // Matlab_int=0.2126*RGB(:,:,1)+0.7152*RGB(:,:,2)+0.0722*RGB(:,:,3);
500:     comp = imread("../ComparisionPictures/Matlab_int.ppm", 0);
501:
502:     // Calculate the statistics of the two images
503:     ucharStat_t statDst(dst.data, dst.rows, dst.cols);
504:     ucharStat_t statComp(comp.data, comp.rows, comp.cols);
505:
506:     // Simple comparison
507:     BOOST_CHECK_CLOSE(statDst.Mean, statComp.Mean, 0.5);
508:     BOOST_CHECK_CLOSE(statDst.Std, statComp.Std, 0.5);
509:     BOOST_CHECK_CLOSE((double)statDst.Range, (double)statComp.Range, 0.5);
510:     BOOST_CHECK_CLOSE((double)statDst.min, (double)statComp.min, 0.5);
511:     BOOST_CHECK_CLOSE((double)statDst.max, (double)statComp.max, 0.5);
512:     BOOST_CHECK_CLOSE((double)statDst.Sum, (double)statComp.Sum, 0.5);
513: }
514:
515: BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_CIEXYZ, M)
516: {
517:     // Convert the RGB to an CIElab
518:     Vision::Conversion Test;
519:     Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::CIE_XYZ);
520:     vector<Mat> LAB = Test.extractChannel(dst);
521:
522:     floatStat_t statDstX((float *)LAB[0].data, src.rows, src.cols);
523:     floatStat_t statCompX;
524:     statCompX.Std = X_STD;
525:     statCompX.n = N_MAT;
526:     statCompX.Mean = X_MEAN;
527:     statCompX.Range = X_RANGE;
528:     statCompX.min = X_MIN;
529:     statCompX.max = X_MAX;
530:     statCompX.Sum = X_SUM;
531:
532:     // Simple comparison
533:     BOOST_CHECK_CLOSE(statDstX.Mean, statCompX.Mean, 0.5);
534:     BOOST_CHECK_CLOSE(statDstX.Std, statCompX.Std, 0.5);
535:     BOOST_CHECK_CLOSE((double)statDstX.Range, (double)statCompX.Range, 0.5);
536:     BOOST_CHECK_CLOSE((double)statDstX.min, (double)statCompX.min, 0.5);
537:     BOOST_CHECK_CLOSE((double)statDstX.max, (double)statCompX.max, 0.5);
538:     BOOST_CHECK_CLOSE((double)statDstX.Sum, (double)statCompX.Sum, 0.5);
539:
540:     floatStat_t statDstY((float *)LAB[1].data, src.rows, src.cols);
541:     floatStat_t statCompY;
542:     statCompY.Std = Y_STD;
543:     statCompY.n = N_MAT;
544:     statCompY.Mean = Y_MEAN;
545:     statCompY.Range = Y_RANGE;
546:     statCompY.min = Y_MIN;
547:     statCompY.max = Y_MAX;
548:     statCompY.Sum = Y_SUM;
549:
550:     // Simple comparison
551:     BOOST_CHECK_CLOSE(statDstY.Mean, statCompY.Mean, 0.5);
552:     BOOST_CHECK_CLOSE(statDstY.Std, statCompY.Std, 0.5);
553:     BOOST_CHECK_CLOSE((double)statDstY.Range, (double)statCompY.Range, 0.5);
554:     BOOST_CHECK_CLOSE((double)statDstY.min, (double)statCompY.min, 0.5);
555:     BOOST_CHECK_CLOSE((double)statDstY.max, (double)statCompY.max, 0.5);
556:     BOOST_CHECK_CLOSE((double)statDstY.Sum, (double)statCompY.Sum, 0.5);
557:
558:     floatStat_t statDstZ((float *)LAB[2].data, src.rows, src.cols);
559:     floatStat_t statCompZ;
560:     statCompZ.Std = Z_STD;
561:     statCompZ.n = N_MAT;
562:     statCompZ.Mean = Z_MEAN;
563:     statCompZ.Range = Z_RANGE;
```



```
564:         statCompZ.min = Z_MIN;
565:         statCompZ.max = Z_MAX;
566:         statCompZ.Sum = Z_SUM;
567:
568:         // Simple comparison
569:         BOOST_CHECK_CLOSE(statDstZ.Mean, statCompZ.Mean, 0.5);
570:         BOOST_CHECK_CLOSE(statDstZ.Std, statCompZ.Std, 0.5);
571:         BOOST_CHECK_CLOSE((double)statDstZ.Range, (double)statCompZ.Range, 0.5);
572:         BOOST_CHECK_CLOSE((double)statDstZ.min, (double)statCompZ.min, 0.5);
573:         BOOST_CHECK_CLOSE((double)statDstZ.max, (double)statCompZ.max, 0.5);
574:         BOOST_CHECK_CLOSE((double)statDstZ.Sum, (double)statCompZ.Sum, 0.5);
575:     }
576:
577: BOOST_FIXTURE_TEST_CASE(Vision_Convert_RGB_To_CIElab, M)
578: {
579:     // Convert the RGB to an CIElab
580:     Vision::Conversion Test;
581:     Test.Convert(src, dst, Vision::Conversion::RGB, Vision::Conversion::CIE_lab);
582:     vector<Mat> LAB = Test.extractChannel(dst);
583:
584:     floatStat_t statDstL((float *)LAB[0].data, src.rows, src.cols);
585:     floatStat_t statCompL;
586:     statCompL.Std = L_STD;
587:     statCompL.n = N_MAT;
588:     statCompL.Mean = L_MEAN;
589:     statCompL.Range = L_RANGE;
590:     statCompL.min = L_MIN;
591:     statCompL.max = L_MAX;
592:     statCompL.Sum = L_SUM;
593:
594:     // Simple comparison
595:     BOOST_CHECK_CLOSE(statDstL.Mean, statCompL.Mean, 0.5);
596:     BOOST_CHECK_CLOSE(statDstL.Std, statCompL.Std, 0.5);
597:     BOOST_CHECK_CLOSE((double)statDstL.Range, (double)statCompL.Range, 0.5);
598:     BOOST_CHECK_CLOSE((double)statDstL.min, (double)statCompL.min, 0.5);
599:     BOOST_CHECK_CLOSE((double)statDstL.max, (double)statCompL.max, 0.5);
600:     BOOST_CHECK_CLOSE((double)statDstL.Sum, (double)statCompL.Sum, 0.5);
601:
602:     floatStat_t statDstA((float *)LAB[1].data, src.rows, src.cols);
603:     floatStat_t statCompA;
604:     statCompA.Std = A_STD;
605:     statCompA.n = N_MAT;
606:     statCompA.Mean = A_MEAN;
607:     statCompA.Range = A_RANGE;
608:     statCompA.min = A_MIN;
609:     statCompA.max = A_MAX;
610:     statCompA.Sum = A_SUM;
611:
612:     // Simple comparison
613:     BOOST_CHECK_CLOSE(statDstA.Mean, statCompA.Mean, 0.5);
614:     BOOST_CHECK_CLOSE(statDstA.Std, statCompA.Std, 0.5);
615:     BOOST_CHECK_CLOSE((double)statDstA.Range, (double)statCompA.Range, 0.5);
616:     BOOST_CHECK_CLOSE((double)statDstA.min, (double)statCompA.min, 0.5);
617:     BOOST_CHECK_CLOSE((double)statDstA.max, (double)statCompA.max, 0.5);
618:     BOOST_CHECK_CLOSE((double)statDstA.Sum, (double)statCompA.Sum, 0.5);
619:
620:     floatStat_t statDstB((float *)LAB[2].data, src.rows, src.cols);
621:     floatStat_t statCompB;
622:     statCompB.Std = B_STD;
623:     statCompB.n = N_MAT;
624:     statCompB.Mean = B_MEAN;
625:     statCompB.Range = B_RANGE;
626:     statCompB.min = B_MIN;
627:     statCompB.max = B_MAX;
628:     statCompB.Sum = B_SUM;
629:
630:     // Simple comparison
631:     BOOST_CHECK_CLOSE(statDstB.Mean, statCompB.Mean, 0.5);
632:     BOOST_CHECK_CLOSE(statDstB.Std, statCompB.Std, 0.5);
633:     BOOST_CHECK_CLOSE((double)statDstB.Range, (double)statCompB.Range, 0.5);
634:     BOOST_CHECK_CLOSE((double)statDstB.min, (double)statCompB.min, 0.5);
635:     BOOST_CHECK_CLOSE((double)statDstB.max, (double)statCompB.max, 0.5);
636:     BOOST_CHECK_CLOSE((double)statDstB.Sum, (double)statCompB.Sum, 0.5);
637: }
638:
639: BOOST_FIXTURE_TEST_CASE(Vision_Convert_LAB_To_RI, M)
640: {
641:     // Convert the RGB to an CIElab
642:     Vision::Conversion Test;
643:     Test.Convert(src, src, Vision::Conversion::RGB, Vision::Conversion::CIE_lab);
644:
645:     Test.Convert(src, dst, Vision::Conversion::CIE_lab, Vision::Conversion::RI);
646: }
```

```

647:         floatStat_t statDstRI((float *)dst.data, src.rows, src.cols);
648:         floatStat_t statCompRI;
649:         statCompRI.Std = RI_STD;
650:         statCompRI.n = N_MAT;
651:         statCompRI.Mean = RI_MEAN;
652:         statCompRI.Range = RI_RANGE;
653:         statCompRI.min = RI_MIN;
654:         statCompRI.max = RI_MAX;
655:         statCompRI.Sum = RI_SUM;
656:
657:         // Simple comparison
658:         BOOST_CHECK_CLOSE(statDstRI.Mean, statCompRI.Mean, 1.25);
659:         BOOST_CHECK_CLOSE(statDstRI.Std, statCompRI.Std, 1.25);
660:         BOOST_CHECK_CLOSE((double)statDstRI.Range, (double)statCompRI.Range, 1.25);
661:         BOOST_CHECK_CLOSE((double)statDstRI.min, (double)statCompRI.min, 1.25);
662:         BOOST_CHECK_CLOSE((double)statDstRI.max, (double)statCompRI.max, 1.25);
663:         BOOST_CHECK_CLOSE((double)statDstRI.Sum, (double)statCompRI.Sum, 1.25);
664:     }
665:
666:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_3_Uchar_Channel_With_Mask)
667:     {
668:         Mat RGB_crop = imread("../ComparisionPictures/RGB_crop.ppm", 1);
669:         Mat mask = imread("../ComparisionPictures/mask.ppm", 0);
670:         Mat RGB_res = imread("../ComparisionPictures/RGB_res.ppm", 1);
671:
672:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uchar>(RGB_crop, mask, CV_8UC1);
673:
674:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<cv::Vec3b>(), copiedMat.end<cv::Vec3b>(), RGB_res.begin<cv::Vec3b>(), RGB_res.end<cv::Vec3b>());
675:         cv::imwrite("Copy_with_Mask.ppm", copiedMat);
676:     }
677:
678:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_1_Uchar_Channel_With_Mask)
679:     {
680:         Mat Int = imread("../ComparisionPictures/RGB_crop.ppm", 0);
681:         Mat mask = imread("../ComparisionPictures/mask.ppm", 0);
682:         Mat Int_res = imread("../ComparisionPictures/RGB_res.ppm", 0);
683:
684:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uchar>(Int, mask, CV_8UC1);
685:
686:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<uchar>(), copiedMat.end<uchar>(), Int_res.begin<uchar>(), Int_res.end<uchar>());
687:         cv::imwrite("Copy_with_Mask.ppm", copiedMat);
688:     }
689:
690:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_1_Float_Channel_With_Mask)
691:     {
692:         Mat floatTest = (Mat_<float>(5, 5) <<
1.5,
1.5,
2.5,
3.5,
4.5,
5.5);
693:
694:
695:
696:
697:
698:
699:         Mat mask = (Mat_<float>(5, 5) <<
700:
701:
702:
703:
704:
705:
706:         Mat floatres = (Mat_<float>(5, 5) <<
707:
708:
709:
710:
711:
712:         Mat copiedMat = Vision::ImageProcessing::CopyMat<float>(floatTest, mask, CV_32F);
713:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.begin<float>(), copiedMat.end<float>(), floatres.begin<float>(), floatres.end<float>());
714:     }
715:
716:     BOOST_AUTO_TEST_CASE(Vision_CopyMat_With_LUT)
717:     {
718:         Mat BW_res = imread("../ComparisionPictures/mask.ppm", 0);
719:         Mat Label = imread("../ComparisionPictures/label.ppm", 0);
720:         uint8_t *LUT = new uint8_t[300]{};

```

```

721:         LUT[255] = 1;
722:
723:         Mat copiedMat = Vision::ImageProcessing::CopyMat<uint8_t, uint8_t>(Label, LUT, CV_8UC1);
724:         imwrite("copiedMat.ppm", copiedMat);
725:         BOOST_CHECK_EQUAL_COLLECTIONS(copiedMat.data, copiedMat.data + (copiedMat.rows * copiedMat.cols), B
W_res.data, BW_res.data + (BW_res.rows * BW_res.cols));
726:         delete[] LUT;
727:     }
728:
729:     BOOST_AUTO_TEST_CASE(Vision_RemoveBorder)
730:     {
731:         cv::Mat Border = imread("../ComparisionPictures/Border.ppm", 0);
732:         cv::Mat noBorderComp = imread("../ComparisionPictures/noBorder.ppm", 0);
733:
734:         Vision::Segment Test(Border);
735:         Test.RemoveBorderBlobs(1);
736:         imwrite("noBorder.ppm", Test.ProcessedImg);
737:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.data, Test.ProcessedImg.data + (Test.ProcessedImg.r
ows * Test.ProcessedImg.cols), noBorderComp.data, noBorderComp.data + (noBorderComp.rows * noBorderComp.cols));
738:     }
739:
740:     BOOST_AUTO_TEST_CASE(Vision_RemoveBorder_Chain_Event)
741:     {
742:         cv::Mat Border = imread("../ComparisionPictures/Border.ppm", 0);
743:         cv::Mat noBorderComp = imread("../ComparisionPictures/noBorder.ppm", 0);
744:         Border *= 255;
745:
746:         Vision::Segment Test(Border);
747:         Test.ConvertToBW(Vision::Segment::Bright);
748:         Test.FillHoles(true);
749:         Test.RemoveBorderBlobs(1, true);
750:         imwrite("noBorder.ppm", Test.ProcessedImg);
751:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.data, Test.ProcessedImg.data + (Test.ProcessedImg.r
ows * Test.ProcessedImg.cols), noBorderComp.data, noBorderComp.data + (noBorderComp.rows * noBorderComp.cols));
752:     }
753:
754:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Erode)
755:     {
756:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
757:         cv::Mat ErosionComp = imread("../ComparisionPictures/erodedResult.ppm", 0);
758:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
759:         Vision::MorphologicalFilter Test(FilterImg);
760:         Test.Erosion(mask);
761:
762:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Ero
sionComp.begin<uchar>(), ErosionComp.end<uchar>());
763:     }
764:
765:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Dilate)
766:     {
767:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
768:         cv::Mat DilateComp = imread("../ComparisionPictures/DilatedResult.ppm", 0);
769:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
770:         Vision::MorphologicalFilter Test(FilterImg);
771:         Test.Dilation(mask);
772:
773:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Dil
ateComp.begin<uchar>(), DilateComp.end<uchar>());
774:     }
775:
776:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Open)
777:     {
778:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
779:         cv::Mat OpenComp = imread("../ComparisionPictures/openResult.ppm", 0);
780:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
781:         Vision::MorphologicalFilter Test(FilterImg);
782:         Test.Open(mask);
783:
784:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Ope
nComp.begin<uchar>(), OpenComp.end<uchar>());
785:     }
786:
787:     BOOST_AUTO_TEST_CASE(Vision_MorphologicalFilter_Close)
788:     {
789:         cv::Mat FilterImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
790:         cv::Mat CloseComp = imread("../ComparisionPictures/closeResult.ppm", 0);
791:         Mat mask = imread("../ComparisionPictures/MorphMask.ppm", 0);
792:         Vision::MorphologicalFilter Test(FilterImg);
793:         Test.Close(mask);
794:         BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Clo
seComp.begin<uchar>(), CloseComp.end<uchar>());
795:     }
796:

```

```
797: BOOST_AUTO_TEST_CASE(Vision_Segment_GetEdgesByErosion)
798: {
799:     cv::Mat BlobImg = imread("../ComparisionPictures/FilterImg.ppm", 0);
800:     cv::Mat EdgeComp = imread("../ComparisionPictures/BlobTestEdgeResult.ppm", 0);
801:
802:     Vision::Segment Test(BlobImg);
803:     Test.GetEdgesEroding();
804:     BOOST_CHECK_EQUAL_COLLECTIONS(Test.ProcessedImg.begin<uchar>(), Test.ProcessedImg.end<uchar>(), Edg
eComp.begin<uchar>(), EdgeComp.end<uchar>());
805: }
806:
807: // Soil Test
808:
809: BOOST_FIXTURE_TEST_CASE(Soil_Particle_Analyze, M)
810: {
811:     SoilMath::NN nn;
812:     nn.LoadState("../ComparisionPictures/NN_Test.xml");
813:
814:     SoilAnalyzer::Sample Test(src);
815:     Test.Analyse(nn);
816:
817:     std::string filename = "SoilSample.vsa";
818:     Test.Save(filename);
819:
820:     imwrite("BW.ppm", Test.BW);
821:     // imwrite("Edge.ppm", Test.Edge);
822:
823:     //uint32_t i = 0;
824:     //for_each(Test.Population.begin(), Test.Population.end(), [&](SoilAnalyzer::Particle &p)
825:     //{
826:     //    stringstream ss_edge;
827:     //    stringstream ss_RGB;
828:     //    ss_edge << i << "_edge.ppm";
829:     //    ss_RGB << i << "_RGB.ppm";
830:     //    imwrite(ss_edge.str(), p.Edge);
831:     //    imwrite(ss_RGB.str(), p.RGB);
832:     //});
833: }
834:
835: BOOST_FIXTURE_TEST_CASE(Soil_Sample_Save_And_Load, M)
836: {
837:     SoilAnalyzer::Sample Test(src);
838:     std::string filename = "SoilSample.vsa";
839:     Test.Save(filename);
840:
841:     SoilAnalyzer::Sample TestLoad;
842:     TestLoad.Load(filename);
843:
844:     BOOST_CHECK_EQUAL_COLLECTIONS(Test.OriginalImage.data, Test.OriginalImage.data + 1000, TestLoad.Ori
ginalImage.data, TestLoad.OriginalImage.data + 1000);
845: }
846:
847: BOOST_FIXTURE_TEST_CASE(Soil_Sample_Analyze, M)
848: {
849:     //SoilAnalyzer::Sample Test(src);
850:     //Test.Analyse();
851:
852:     //imwrite("A_BW.ppm", Test.BW);
853:     //imwrite("A_Edge.ppm", Test.Edge);
854:     //imwrite("A_Int.ppm", Test.Intensity);
855:     //
856:     //for (uint32_t i = 0; i < Test.Population.size(); i++)
857:     //{
858:     //    std::stringstream ss;
859:     //    ss << i << "_BW.ppm";
860:     //    imwrite(ss.str(), Test.Population[i].BW);
861:     //    std::stringstream sss;
862:     //    sss << i << "_Edge.ppm";
863:     //    imwrite(sss.str(), Test.Population[i].Edge);
864:     //    std::stringstream ssss;
865:     //    ssss << i << "_RGB.ppm";
866:     //    imwrite(ssss.str(), Test.Population[i].RGB);
867:     //}
868: }
869:
```

```
1: /* Copyright (C) Jelle Spijker - All Rights Reserved
2:  * Unauthorized copying of this file, via any medium is strictly prohibited
3:  * and only allowed with the written consent of the author (Jelle Spijker)
4:  * This software is proprietary and confidential
5:  * Written by Jelle Spijker <spijker.jelle@gmail.com>, 2015
6:  */
7:
8:
9:
10: #include <stdint.h>
11: #include <cstdlib>
12:
13: using namespace std;
14:
15: const double meanTestResult = 127.445198;
16: const uint8_t mediaanTestResult = 128;
17: const double stdTestResult = 73.5821;
18: const uint32_t nTestResult = 40000;
19: const uint8_t modeTestResult = 173;
20: const uint8_t rangeTestResult = 255;
21: const uint32_t sumTestResult = 5097808;
22: const uint8_t minTestResult = 0;
23: const uint8_t maxTestResult = 255;
24:
25: const uint8_t histTestResult[256] =
26: { 89, 139, 157, 150, 165, 149, 146, 166, 147, 164, 144, 128, 153, 162, 182, 164, 160, 167, 142, 171, 148, 1
58, 173, 181, 170, 154, 156, 161, 167, 138, 154, 148, 162, 167, 172, 148, 146, 169, 149, 183, 150, 166, 179, 143,
148, 141, 148, 140, 171, 153, 155, 150, 152, 162, 140, 167, 167, 131, 163, 163, 153, 161, 157, 163, 149, 149, 174,
144, 155, 162, 164, 141, 168, 159, 146, 162, 165, 168, 151, 151, 159, 148, 151, 184, 166, 161, 162, 144, 148, 154
, 149, 150, 161, 154, 156, 156, 178, 178, 179, 167, 143, 150, 168, 145, 154, 154, 165, 148, 155, 136, 163, 156, 17
6, 164, 155, 141, 154, 153, 149, 153, 156, 135, 139, 129, 152, 172, 130, 171, 165, 157, 148, 152, 152, 173, 135, 1
56, 174, 143, 156, 176, 150, 158, 165, 164, 135, 166, 158, 151, 132, 169, 162, 147, 169, 154, 159, 172, 159, 169,
151, 155, 172, 166, 147, 155, 154, 149, 167, 160, 161, 170, 175, 168, 160, 185, 167, 166, 134, 165, 140, 166, 141,
160, 134, 168, 150, 151, 168, 172, 135, 136, 153, 161, 170, 167, 138, 167, 160, 151, 176, 181, 164, 148, 152, 150
, 167, 151, 152, 163, 151, 133, 138, 147, 174, 151, 150, 155, 149, 158, 159, 171, 163, 164, 144, 145, 164, 149, 17
5, 157, 169, 163, 155, 164, 169, 177, 142, 158, 145, 160, 163, 162, 151, 162, 172, 148, 172, 162, 140, 135, 168, 1
43, 134, 156, 155, 148, 148, 86 };
27:
28: const uint8_t testMatrix[200][200] =
29: { { 208, 164, 108, 217, 174, 161, 128, 128, 171, 51, 190, 14, 208, 13, 124, 97, 63, 183, 234, 161, 109, 32,
190, 75, 114, 43, 112, 77, 191, 155, 59, 139, 126, 85, 166, 197, 230, 85, 5, 86, 173, 4, 171, 159, 240, 225, 24,
106, 215, 168, 39, 163, 152, 211, 208, 105, 34, 213, 242, 205, 148, 31, 71, 110, 161, 60, 161, 24, 163, 56, 87, 24
8, 227, 190, 168, 73, 140, 158, 217, 230, 248, 89, 166, 47, 21, 10, 230, 29, 60, 222, 189, 186, 33, 53, 122, 154,
87, 81, 254, 83, 111, 106, 178, 243, 177, 94, 48, 85, 42, 33, 26, 144, 2, 37, 80, 98, 102, 193, 215, 62, 166, 234,
212, 41, 41, 167, 64, 178, 80, 146, 107, 194, 143, 187, 135, 172, 187, 37, 2, 105, 249, 206, 67, 53, 39, 48, 17,
200, 54, 183, 210, 51, 72, 144, 212, 74, 107, 238, 95, 56, 172, 248, 136, 143, 59, 87, 91, 128, 5, 56, 19, 177, 22
0, 6, 136, 127, 119, 177, 187, 138, 29, 96, 75, 151, 214, 248, 78, 224, 96, 43, 179, 122, 178, 184, 214, 66, 48, 2
41, 86, 13 },
30: { 231, 97, 24, 143, 34, 91, 125, 156, 110, 50, 228, 208, 48, 139, 127, 81, 99, 34, 154, 251, 244, 93, 214,
7, 166, 190, 82, 155, 124, 197, 189, 140, 155, 52, 37, 175, 101, 252, 186, 110, 124, 174, 15, 232, 217, 131, 51, 7
0, 58, 30, 245, 179, 136, 154, 180, 4, 194, 98, 3, 205, 18, 251, 92, 86, 131, 250, 37, 112, 78, 200, 228, 36, 80,
75, 45, 237, 199, 111, 180, 133, 148, 69, 156, 126, 214, 211, 18, 187, 70, 225, 68, 138, 125, 20, 236, 55, 214, 20
7, 46, 191, 0, 69, 58, 120, 75, 216, 27, 150, 203, 139, 82, 139, 118, 112, 147, 40, 13, 21, 173, 43, 228, 90, 236,
59, 235, 170, 153, 134, 105, 134, 168, 23, 222, 192, 68, 75, 172, 214, 93, 138, 21, 203, 94, 98, 59, 173, 130, 18
2, 110, 161, 23, 0, 187, 162, 80, 121, 169, 6, 254, 124, 98, 165, 101, 121, 238, 168, 177, 194, 111, 208, 195, 127
, 25, 191, 10, 98, 234, 220, 194, 158, 175, 252, 12, 173, 204, 80, 83, 245, 85, 169, 201, 188, 91, 152, 99, 240, 1
4, 171, 118, 79 },
31: { 32, 207, 153, 237, 184, 254, 224, 209, 177, 83, 62, 135, 32, 241, 239, 251, 110, 114, 179, 162, 185, 172,
67, 24, 43, 122, 34, 71, 98, 14, 227, 177, 1, 126, 177, 221, 177, 121, 208, 202, 9, 224, 98, 155, 35, 96, 155, 80
, 109, 33, 223, 220, 85, 209, 147, 191, 157, 2, 43, 224, 95, 151, 199, 116, 142, 240, 144, 80, 30, 74, 129, 219, 7
2, 47, 160, 204, 143, 106, 109, 41, 247, 190, 223, 86, 89, 7, 251, 227, 35, 87, 62, 161, 214, 149, 138, 172, 161,
26, 117, 57, 56, 186, 204, 180, 49, 70, 240, 205, 16, 84, 186, 248, 30, 116, 31, 164, 81, 131, 235, 164, 115, 17,
210, 42, 27, 128, 62, 160, 131, 65, 107, 174, 56, 16, 49, 36, 253, 33, 176, 247, 109, 29, 43, 202, 213, 91, 141, 1
70, 110, 146, 53, 207, 145, 175, 138, 156, 50, 200, 163, 72, 222, 245, 152, 50, 114, 95, 237, 144, 13, 145, 123, 5
0, 188, 170, 118, 77, 117, 140, 16, 75, 115, 110, 204, 136, 27, 147, 241, 114, 89, 85, 2, 149, 142, 38, 159, 101,
237, 118, 82, 113 },
32: { 233, 136, 120, 178, 28, 57, 90, 136, 65, 224, 33, 177, 209, 82, 99, 183, 212, 130, 190, 153, 148, 96, 131
, 203, 136, 167, 34, 204, 16, 218, 219, 237, 150, 8, 160, 148, 52, 190, 30, 36, 29, 110, 125, 124, 168, 225, 181,
148, 94, 20, 125, 97, 218, 244, 253, 16, 101, 79, 193, 22, 9, 69, 114, 196, 252, 250, 103, 97, 244, 15, 143, 194,
17, 42, 223, 84, 77, 73, 158, 37, 11, 184, 202, 53, 231, 94, 231, 113, 45, 243, 42, 69, 148, 67, 135, 83, 63, 54,
143, 244, 99, 136, 194, 125, 82, 112, 33, 41, 24, 16, 93, 30, 183, 81, 170, 10, 222, 221, 249, 3, 221, 50, 30, 145
, 37, 8, 86, 158, 72, 206, 239, 232, 206, 199, 44, 246, 112, 175, 103, 19, 21, 128, 187, 197, 200, 46, 80, 94, 222
, 208, 202, 230, 159, 18, 17, 194, 44, 39, 115, 122, 45, 197, 88, 215, 193, 191, 110, 197, 218, 150, 43, 170, 72,
2, 176, 198, 56, 235, 203, 84, 215, 208, 51, 24, 182, 41, 221, 168, 156, 131, 64, 185, 135, 146, 208, 98, 154, 39,
94, 107 },
33: { 161, 89, 177, 149, 30, 166, 115, 52, 2, 120, 57, 54, 163, 206, 30, 105, 210, 135, 98, 232, 138, 220, 114,
181, 162, 246, 206, 203, 54, 98, 152, 241, 198, 211, 11, 160, 16, 171, 125, 155, 20, 161, 197, 147, 10, 63, 227,
176, 177, 187, 104, 182, 68, 166, 118, 110, 215, 213, 213, 170, 104, 110, 15, 193, 160, 17, 14, 254, 210, 178, 201
, 194, 15, 19, 45, 188, 117, 231, 164, 16, 48, 218, 185, 27, 147, 45, 239, 104, 95, 79, 155, 151, 70, 149, 215, 16
2, 122, 114, 167, 4, 185, 96, 87, 93, 238, 81, 85, 152, 111, 22, 130, 162, 170, 236, 46, 17, 238, 168, 15, 3, 191,
128, 43, 39, 163, 195, 169, 184, 121, 193, 182, 39, 37, 4, 47, 145, 180, 240, 60, 12, 217, 18, 80, 199, 178, 105,
92, 46, 190, 37, 174, 112, 65, 250, 68, 89, 244, 19, 190, 174, 27, 231, 49, 146, 105, 188, 156, 160, 210, 170, 75
, 42, 31, 166, 204, 32, 69, 17, 24, 0, 49, 16, 112, 100, 249, 183, 161, 45, 129, 118, 24, 100, 98, 102, 244, 195,
```

242, 20, 106, 116 },

34: { 25, 239, 178, 208, 163, 154, 246, 116, 136, 103, 89, 139, 4, 153, 61, 25, 116, 219, 64, 146, 180, 74, 87, 200, 4, 80, 134, 243, 139, 102, 167, 230, 168, 67, 203, 28, 159, 203, 89, 237, 155, 149, 38, 250, 38, 42, 154, 220, 241, 142, 32, 133, 238, 160, 126, 138, 10, 72, 154, 128, 168, 237, 12, 253, 217, 50, 35, 222, 39, 163, 89, 117, 148, 111, 165, 145, 235, 174, 226, 218, 133, 234, 104, 39, 13, 129, 171, 106, 252, 238, 157, 221, 92, 9, 46, 91, 253, 99, 207, 207, 196, 98, 59, 157, 170, 32, 205, 242, 3, 104, 66, 38, 143, 184, 45, 137, 109, 18, 7, 105, 114, 100, 203, 171, 68, 201, 14, 12, 7, 181, 243, 240, 147, 89, 75, 52, 222, 116, 244, 70, 225, 221, 167, 130, 216, 204, 191, 113, 101, 68, 120, 93, 43, 16, 91, 239, 251, 218, 63, 50, 37, 6, 1, 96, 181, 85, 175, 205, 122, 43, 70, 99, 213, 37, 118, 137, 2, 246, 8, 22, 171, 109, 98, 114, 23, 6, 142, 145, 65, 169, 200, 226, 192, 87, 126, 41, 138, 117, 245, 49 },

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49: { 0.671497133608081, -0.615601881466894, 2.90800803072936, -1.33200442131525, -1.06421341288933, 0.327059967177088, -1.01494364268014, -1.46939507448636, -0.493009815316451, -0.373070658631004, -1.28325610460477, 1.02885306900203, 0.923932448688937, 0.647380884516047, 0.414700293047627, -1.19330579089020, -0.409872647756742, -0.409785214740165, 1.79849445190826, -0.513848012099214, 0.0963928845397177, 1.40890695099350, 1.30936207782942, 0.208715601272198, 1.68939930742667, -1.31990270235869, -0.219188663046641, -0.180163097123277, 1.42536573618701, -1.20044050380044, 1.37694916561229, 1.19286412868397, -0.393597890579411, -1.00418528016197, -0.770234072868573, -0.0656148757390404, 0.276011305268776, 0.211831566780286, -0.505073387271410, 0.638483769418353, -0.464604489893360, -0.570346099876642, -1.82945520860790, -0.808845156537362, 0.783281930836874, -0.189698759604886, 0.271709764009016, -0.583618751528597, -0.597858854736041, -0.441417378808432 },

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51: { 0.717238651328839, -0.192418510588264, 1.37897197791661, -1.44909729283874, 1.23467914689078, 1.00607711081905, 0.137024874130050, -0.822293276290175, 0.0458411057137050, 0.798886992156716, 0.901931466951714, 0.0474713232748285, 0.641661506421779, 1.04858076053644, 0.349254416663714, -0.353622599299341, 0.0614454835840975, 1.23329711264414, -0.320196186885630, -0.671190164007305, -0.352252185662263, 1.92775842981169, -0.348266810335265, 0.512015643736454, -0.582630964347252, 0.271866921602583, -0.320804325089082, 0.896745287933842, 0.0377646999541895, 0.340370564189367, 0.141231683307765, -1.41504453500076, -1.19565443202559, -1.04570999122494, 0.093186527774352, 0.404638157039467, -0.217506670385249, -0.527776960816186, -2.05156142183125, -0.374179299914121, -0.379827523353313, -0.707513213507977, -0.173993462313665, 0.592105269146540, 0.655324411572857, 1.94343804984731, -0.352315122780687, -0.390419817771038, -0.689680720773709, -0.155584259505827 },

52: { 1.63023528916473, 0.888610425420721, -1.05818025798736, 0.333510833065806, -0.229626450963181, -0.650907736597753, -0.291863375753573, -0.0942405879597235, -0.0637831200223327, 0.120205281956355, -1.83563868373519, 1.74625671011842, 0.425485355625296, 0.660707086367175, -0.729247267629503, 0.0464345266878230, -1.84612923609859, 0.610305217573950, 0.817516283237215, 1.18665904286638, -0.174775039544099, -0.176247547257615, 1.41256116072929, 0.0113541711008201, 0.222614480633598, 1.48955304778608, -0.784415293755632, 0.412307702040531, -0.363569288189157, -0.963230982199040, 1.28971939494037, -0.0333563180476360, 0.365328392431846, 0.505707009458752, 0.935251207390719, 0.351756753327098, 0.796122967431404, 1.24160125135253, -0.448304537939442, 0.695348326151247, -0.101778227545497

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62: { -0.809498694424876, 1.58769908997406, 0.507974650905946, -0.334886938964048, -0.741106093940412, 1.25025122830500, -1.42864686463210, 0.428622679859396, 0.593930795648753, 0.595357673884102, -1.22259338018663, -1.63866572993389, 0.347592631960065, -0.556778063950366, -3.23203779594001, -1.26908677286849, 0.639517303110873, 0.547639504480465, -0.809737610765752, -0.647911623091645, 1.94368447839214, -2.49953344192971, -0.425867845571710, 0.327529812476210, 0.686480847833935, 0.716471380571449, -0.286673862460466, 1.57239787877300, 0.0169709715690618, -2.06486003648070, -0.368728264159064, 1.20196562169025, -0.376237143988673, -0.145372990423397, 0.0692218210392502, -1.24428798710640, -0.848469411304335, -0.488901765718944, 0.168411320921666, -0.790518736896563, 0.520475669516038, 1.22620898517007, -1.07411490177333, 1.39220787088793, 0.137794865730364, -1.99119578942207, 0.0532160174531869, -0.687549755080742, 0.828116552303536, -0.921238282183121 },

63: { -2.94428416199490, -0.804465956349547, 0.281984063670556, 0.552783345944550, -0.507817550278174, 0.929789458557716, -0.0208576177016003, -1.03598477851339, -2.18602161274824, 1.04683278430523, 0.316500360797716, -0.760089998635267, -0.181843218459334, -0.895113135482436, -1.08695922946133, 0.497980623046732, -0.0809780150606096, 1.56508398508243, -1.23681835282285, 2.61733491205073, -1.08469845223762, -0.167559322169704, 0.636139891402968, 0.652124811269931, -0.854933633648374, 1.33728872704226, 0.598015714251220, 0.560490613996136, 0.219159093583546, 0.565059812252813, -0.838170422573186, -0.660738591146436, 0.0524291487772232, -0.386241663817012, 2.48682132029734, -0.155099375334764, -0.240370839253825, -0.222782007935513, -1.12049669501273, -0.489477981932457, -0.380699996153992, 0.494943144464081, -0.672560081842942, 2.47390028937627, -1.58682139990345, 0.0284089339182698, -0.436415217054889, 0.317575756440424, 0.00650927822731750, -0.926951533232400 },

64: { 1.43838029281510, 0.696624415849607, 0.0334798822444514, 1.03909065350496, -0.320575506600239, 0.239763257058580, -0.560664996528185, 1.87786546049586, -1.32704314952029, -0.197958632611842, -1.34286923662193, -0.818793096250257, -0.939534765941492, -0.409327721634070, -1.42643615947972, 2.78908112764392, 0.540870143763936, -1.6933436132081, 0.214686448131779, 0.550950420745412, 0.226818975021420, 0.353015314527152, 0.793178081389574, -0.27886116387822, -1.07523531747808, 2.12567994685694, -0.245532675353110, -0.420344605627487, 1.04582061013608, 2.00014236659301, -0.282475041408237, 0.327559040044413, -1.95393370060853, 1.31620411236280, -1.66564311788150, -1.61491381350160, 0.602929436161534, 0.272066496438054, 0.400730907563090, 2.97447387060198, 1.99285194124338, 0.908594854357714, 0.736462181575454, 0.503919242690866, -1.01914551483764, 1.93051540875233, 0.280007472266163, 0.162842340124270, -0.235892197136722, -0.961220672752141 },

65: { 0.325190539456198, 0.835088165072682, -1.33367794342811, -1.11763868326521, 0.0124690413616180, -0.690361103111226, 2.17777870918415, 0.940704403352132, -1.44101359763891, 0.327678163907201, -1.03218434407217, 0.51972888133619, -0.0375331888191716, -0.160886766738443, -1.01445076770532, 0.727572036915723, -1.26256484462796, -0.449397359860250, 2.01077176753361, 0.294203684446698, 1.09892920248474, 0.717253725490156, -0.898377114100747, 0.245191593724021, -0.0909672511936310, 0.0540457844376036, -1.78073717512705, -0.153945389665798, -0.950982653969911, 2.2332772023387, 3.56986777687433, 1.50812707914556, 0.565420571160198, -0.796464226593885, -0.415927944852021, 2.24606514978483, -1.51625365102634, -1.16853089383044, 0.739062644702988, -0.622585356871510, 1.63587024814945, -1.15421883476858, -1.06996069280028, -0.822480553830570, -1.38523374102593, 0.941136788326655, 0.0846058871809478, 1.15911590583064, 0.652821094952842, 1.78482983886684 },

66: { -0.754928319169703, -0.243715140377952, 1.12749227834159, 1.26065870912090, -3.02917734140415, -0.651553641750281, 1.13846538732960, 0.787345779935246, 0.401844497039815, -0.238301504589733, 1.33121588506497, -0.0141600590972047, -1.89630449362245, 0.409334430455455, -0.213267188307358, -0.773064102152237, 1.11042384067016, -0.0842920727534208, 0.0255544334123088, -0.777843798253388, 0.147188752472257, -1.30485163873161, 0.156244844277549, 1.47251347882158, -0.252771832938988, 0.163035918032164, -2.34723922894497, -0.275198593421559, 0.794797422861683, -0.492177585883521, 3.40753236638644, -0.888908957861214, 0.7779944624002781, 0.135441371885595, -0.0842246064708947, 0.739281132309719, -0.0683485022814264, -1.22423430692922, 0.900044704629629, 1.92030299011263, 0.559018891329504, 1.25755551743134, 0.334715119526138, 0.200981870646343, 0.954886430307147, -0.00692445130187208, 0.729119059568140, 0.128388058663602, 1.96453251156114, -0.200188986216284 },

67: { 1.37029854009523, 0.215670086403744, 0.350179410603312, 0.660143141046978, -0.457014640871583, 1.19210187053127, -2.49688650318450, -0.875874261956672, 1.47020128084852, 0.229596893220314, -0.418903195029849, -1.15552936828724, -2.12797676818267, -0.952635997119978, -0.325347780360491, 0.836633754476153, -0.989562679068364, -1.9919717760327, 0.308299436246859, -1.06493009609004, 2.29566581301284, -1.00586895174408, 1.59725391127757, -2.27510154234740, 1.19482381863413, -0.632706740469993, -1.71359529882238, 0.241120454779083, 0.0714298098874079, -0.0460029344953983, 1.14691785982515, -0.959284630503597, 0.0807011876263225, 0.417806430208596, 0.0892519475074891, -2.06764536263329, 0.782392865209733, -2.09947869962566, -1.53121827215908, 0.961148926751320, 0.563637584407024, 1.45253241673925, 0.411882595255150, -1.00705252750908, -0.601120319370960, -0.338241647272311, 0.900753095645828, 1.03945813330173, 0.884584173475766, 0.940411654286259 },

68: { -1.71151641885370, -1.16584393148205, -0.299066030332982, -0.0678655535426873, 1.24244840639074, -1.61183038867781, 0.441326931727609, 0.319949134382331, -0.326814228785906, 0.439997904822629, -0.140321722056366, -0.00952491609816556, -1.17692333071496, 0.317317472324612, 1.94439779196628, -1.12833031008360, -1.82883593420384, 0.841245666352581, -0.938247210627779, -1.76841403231106, 2.75255787759549, 0.790683469747323, 0.112439710593741, -1.63329072492124, 0.606063709364258, 1.61199149271534, -0.237127260967104, 0.754686393744638, -0.773686902272389, -0.465747005835051, 0.787257533014092, -0.492719304254721, 0.794707809437465, 0.819879645963700, 1.45614720047535, -1.15455058140430, -1.42072592307485, -0.390242630059538, 0.504620786866477, -0.557803164624111, -0.338396621324276, -2.07681148516310, 0.154120187534393, -0.613171560234073, -1.17189080414528, 0.528265783681366, -1.32563829453186, -0.116771141304530, 0.0845369570761526, 0.349156337155410 },

69: { -0.102242446085491, -1.14795277889859, 0.0228897927516298, -0.195221197898754, -1.06670139898475, -0.0244619366359185, -1.39813787581107, -0.55829428484850904, 0.812323004640796, -0.616865928889227, 0.899822328897224, -0.689810537631710, -0.990532220484176, 0.0780200809780775, -0.571773218349456, -1.42447009141638, 1.38449851135426, -0.414658917455486, 1.67421595177913, -0.422919535898430, 0.138317724815553, -0.116571328658856, -0.308624934547028, 0.415468936978757, 0.540514429162091, -0.0754487241870864, -0.619625814831921, -0.291909899784922, 0.774161843596113, 0.0759474321256630, -1.27813736919090, 0.441056579174584, 1.04368893647872, -0.85433739120009, 0.219453518638082, -0.107191878127395, 0.669365130823024, 0.664281757759034, -0.864214645938950, -0.106555151565640, 0.763647371585355, -0.176488004066557, 0.554570697670329, -0.658963390849518, -0.577110307096737, 1.05689959434016, -1.52457882484501, -0.648296910104249, -0.574514061258489, 1.85928030068645 },

70: { -0.241447041607358, 0.104874716016494, -0.261995434966092, -0.217606350143192, 0.933728162671239, -1.94884717689890, -0.255055179880806, -0.311429418546895, 0.545540103526116, 0.274836786911666, -0.300111005615676, -0.66699153601164, -1.17303232726741, 1.32438544916022, -0.250032278035044, 0.717442315507358, -0.0627267940412559, 1.91218083836386, 0.124988173845023, -1.05310242919018, -1.90706620837312, 0.553089887878288, 0.456659609115151, -0.654768851858015, -1.44493941921490, -0.473237143331362, -0.720160379657291, 0.458445379977201, 0.265654717978835, -0.918769644159625, -0.584593101281239, -0.204764248303628, 0.802184648027535, 0.357318588185117, -0.114877251919321, -1.71287908652886, 0.683236637724418, -0.702264007180178, -0.376554951987101, -0.215161246502892, 1.12744234603729, -0.652082191475747, -1.17284568845615, -0.833229327511956, -0.836430524453065, 0.0147406166024418, 0.50243333062860, -0.0379812048876393, 0.499750630743405, 0.92701973161696 },

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9379550766, 1.18859467046427, 1.37793427720460, -0.0478903304637657 },
77: { 1.09326566903948, -0.438966153934773, -2.00263573588306, -0.209713338388737, 0.0983477746401080, -2.19243
491996591, 0.664734120627595, -0.117798289267962, -0.425058490610031, 0.910482579647112, -1.04310830133763, 0.6829
64276111937, 0.0931087600588035, 0.503744055737328, -0.700620213418206, 0.661536244123409, -0.197342906850919, 1.3
0183950434961, -0.450598603707587, 1.15216580794839, -0.715847393133824, -1.33685240472023, 0.451874567380709, -0.
421846780441972, 0.875135601991687, -1.09224451734164, 0.302407416537707, -0.100647949072058, 0.173593051437428, 0
.403880739292361, 0.00532168979485395, -1.09541491865986, 0.0776686794320303, 0.497899500583305, -0.94179196906103
5, -1.35155634252200, -1.18212703394540, 0.0483900176597465, -1.35010016594322, -0.126011360116434, -0.39816310715
5080, -1.28940788194516, 1.01414104094213, 0.618953085869227, 0.541608366255458, -0.847371160164792, 0.75416580828
2410, -0.414907279235850, 1.85120493279698, -1.55186406853224 },
78: { 1.10927329761440, -1.79467884145512, 0.964229422631628, 0.625190357087626, 0.0413736134896147, -2.3192803
0664330, 0.0851885927211602, 0.699160333644167, 0.589433366718221, 0.867082552947325, -0.270068812648099, 1.170608
66003560, -0.378157056589758, -0.892661403477038, -1.63054289274725, 2.13850225382851, 0.405605372640549, -0.59364
1761840396, 0.109247941665665, -1.14650763211670, -0.280515661741481, -1.47384649800853, 1.64838365704617, -0.9426
66324280616, 1.39544988693277, -0.225794451802544, 0.0583198538886379, -1.62504844947823, 0.453591153371088, 1.192
46859933815, 1.13914949095078, 0.549233489827528, 1.79093025896060, 2.31562610334450, -0.652861505816215, 0.364211
322734809, 0.583847690104213, -0.664853402867584, -1.16224097904506, 0.299580407299929, -0.0854625512885032, 0.057
5636417288340, -0.0843484107867966, 1.80306351071647, -0.821128258718891, 1.33723804312817, 1.52449750573379, -0.6
58616762511396, -1.89766476744468, 0.444083312031626 }};

79:

80:

```
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6:  */
7:
8:
9:
10: // Comparison values
11: #define N_MAT 3145728
12:
13: #define L_STD 5.028381605997681
14: #define L_MEAN 80.890745699097508
15: #define L_RANGE 79.936077729332197
16: #define L_MIN 16.742040567344091
17: #define L_MAX 96.678118296676288
18: #define L_SUM 2.544602836865306e8
19:
20: #define A_STD 0.866299119209983
21: #define A_MEAN -3.380512963778564
22: #define A_RANGE 28.974365656143501
23: #define A_MIN -21.293453236190196
24: #define A_MAX 7.680912419953306
25: #define A_SUM -0.106341742845212e8
26:
27: #define B_STD 1.582722966505156
28: #define B_MEAN -14.069966616731605
29: #define B_RANGE 52.152618100375619
30: #define B_MIN -49.577771326645184
31: #define B_MAX 2.574846773730433
32: #define B_SUM -0.442602879453179e8
33:
34: #define X_STD 0.063845026292892
35: #define X_MEAN 0.544538411135235
36: #define X_RANGE 0.783231866666667
37: #define X_MIN 0.019708690196078
38: #define X_MAX 0.802940556862745
39: #define X_SUM 1.712969726983621e6
40:
41: #define Y_STD 0.068325856701040
42: #define Y_MEAN 0.586997317935942
43: #define Y_RANGE 0.894038392156863
44: #define Y_MIN 0.022487607843137
45: #define Y_MAX 0.916526000000000
46: #define Y_SUM 1.846533898955995e6
47:
48: #define Z_STD 0.097003939083143
49: #define Z_MEAN 0.814970278082424
50: #define Z_RANGE 1.032072011764706
51: #define Z_MIN 0.048455952941176
52: #define Z_MAX 1.080527964705882
53: #define Z_SUM 2.563674822931669e6
54:
55: #define RI_STD 0.215470901001717
56: #define RI_MEAN -0.061338583528514
57: #define RI_RANGE 1.861278665280243e2
58: #define RI_MIN -1.210658478499890e2
59: #define RI_MAX 65.062018678035301
60: #define RI_SUM -1.929544996859839e5
```

```

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6:  */
7:
8:
9:  #include "testparticlegenerator.h"
10:
11:
12:  TestParticleGenerator::TestParticleGenerator()
13:  {
14:  }
15:
16:  cv::Mat TestParticleGenerator::GenParticle(uint32_t size, float ellipseratio, cv::Vec3b meanColor, cv::Vec3
f stdColor, float roughness, float angle)
17:  {
18:      uint32_t height, width;
19:      height =
20:          cv::Mat img(x ? x : y, );
21:          cv::ellipse(img, cv::Point(img.cols/2, img.rows/2), cv::Size(size, size * ellipseratio), angle, 0 360,
cv::Scalar(1,1,1), -1);
22:
23:  }

```

```
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6:  */
7:
8:
9:
10: #ifndef TESTPARTICLEGENERATOR_GLOBAL_H
11: #define TESTPARTICLEGENERATOR_GLOBAL_H
12:
13: #include <QtCore/qglobal.h>
14:
15: #if defined(TESTPARTICLEGENERATOR_LIBRARY)
16: #   define TESTPARTICLEGENERATORSHARED_EXPORT Q_DECL_EXPORT
17: #else
18: #   define TESTPARTICLEGENERATORSHARED_EXPORT Q_DECL_IMPORT
19: #endif
20:
21: #endif // TESTPARTICLEGENERATOR_GLOBAL_H
```

```

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6:  */
7:
8:
9:
10: #ifndef TESTPARTICLEGENERATOR_H
11: #define TESTPARTICLEGENERATOR_H
12:
13: #include "testparticlegenerator_global.h"
14: #include <opencv2/core.hpp>
15: #include <vector>
16: #include <stdint.h>
17:
18: class TESTPARTICLEGENERATORSHARED_EXPORT TestParticleGenerator
19: {
20:
21:
22: public:
23:     std::vector<cv::Mat> particles;
24:     TestParticleGenerator();
25:     cv::Mat GenParticle(uint32_t size, float ellipseratio, cv::Vec3b meanColor, cv::Vec3f stdColor, float roughness, float angle);
26: };
27:
28: #endif // TESTPARTICLEGENERATOR_H

```