

Activity 7: Feature Extraction from Labeled Blobs

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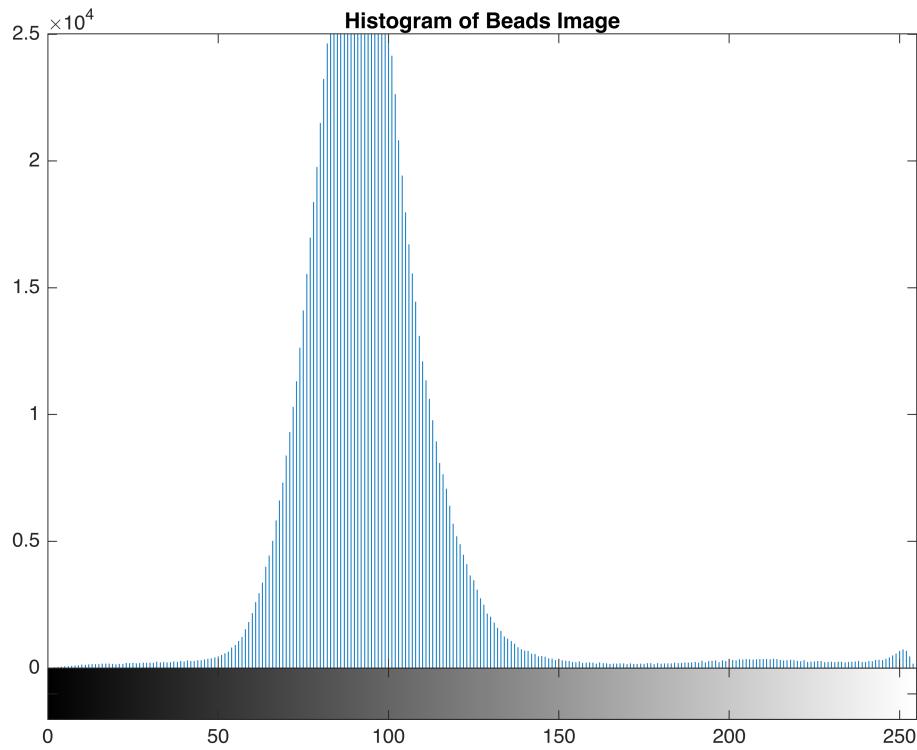
App Physics 157 WFY FX 2

```
%opening the images and converting them to grayscale
beads_orig = imread('beads_7.png');
coins_orig = imread("coins_7.png");
dice_orig = imread('dice_7.png');
rice_orig = imread('rice_7.png');
beads = rgb2gray(beads_orig);
coins = rgb2gray(coins_orig);
dice = rgb2gray(dice_orig);
rice =rgb2gray(rice_orig);

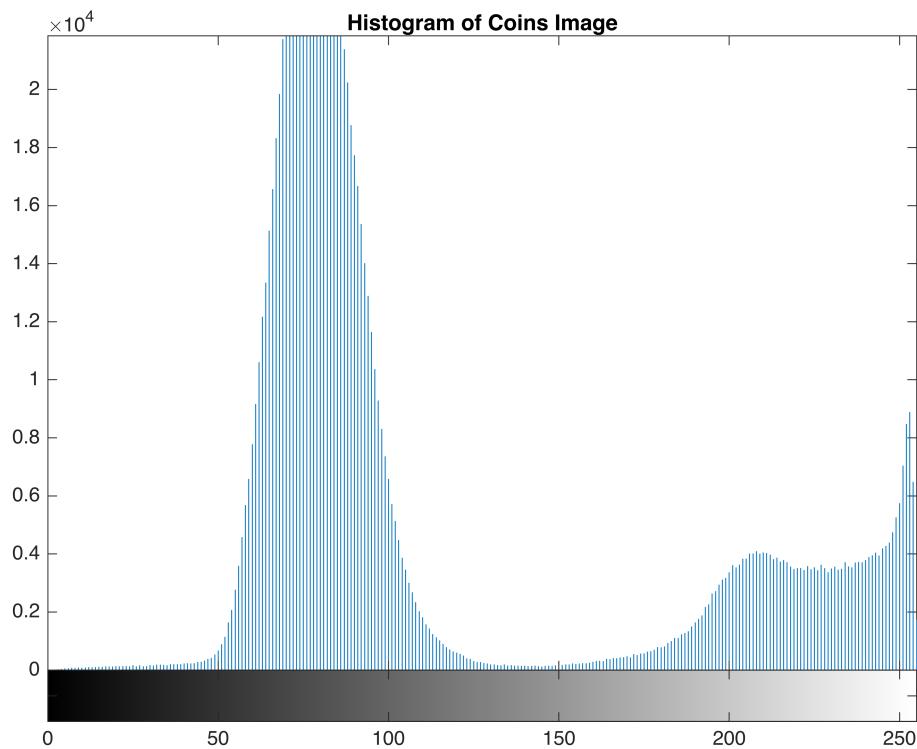
montage([beads, coins, dice, rice], 'Size', [1 NaN]);
```



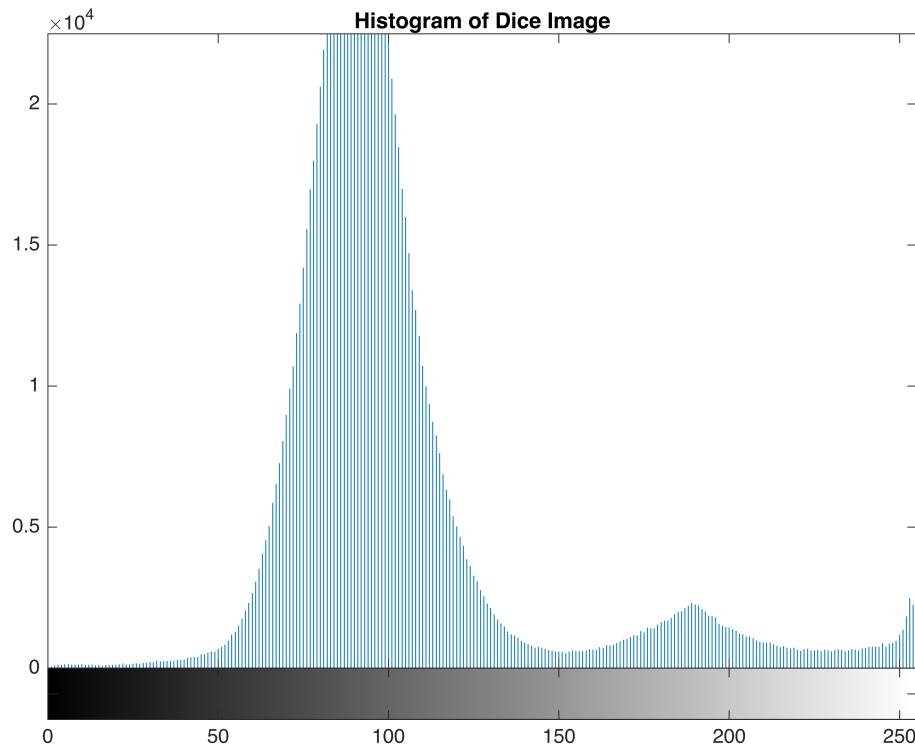
```
%getting the histograms
figure; imhist(beads); title('Histogram of Beads Image');
```



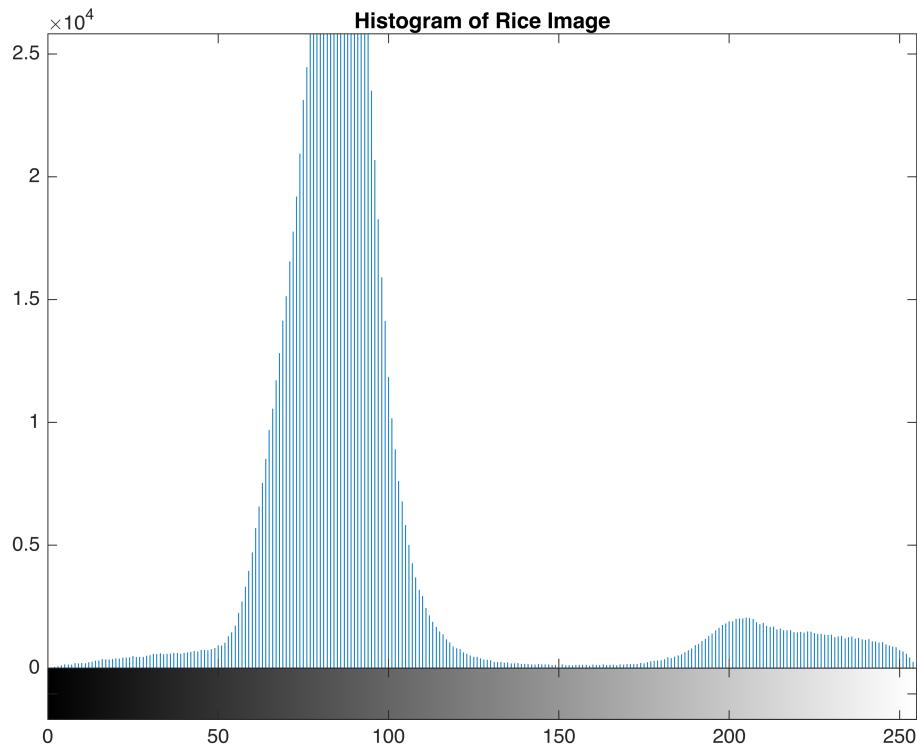
```
figure; imhist(coins); title('Histogram of Coins Image');
```



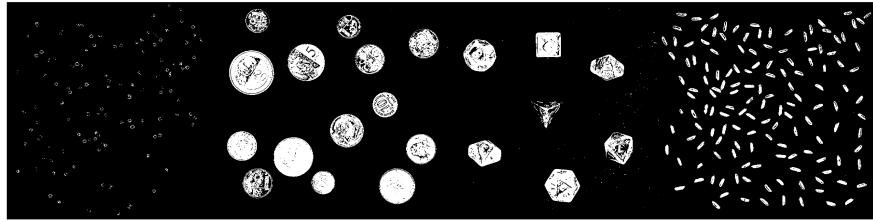
```
figure; imhist(dice); title('Histogram of Dice Image');
```



```
figure; imhist(rice); title('Histogram of Rice Image');
```



```
%thresholding
beads_thrsh = and(beads < 250, beads > 225);
%imshow(beads_thrsh)
coins_thrsh = and(coins < 250, coins > 181);
%imshow(coins_thrsh)
dice_thrsh = and(dice < 250, dice > 170);
%imshow(dice_thrsh)
rice_thrsh = and(rice < 250, rice > 190);
%imshow(rice_thrsh)
montage([beads_thrsh, coins_thrsh, dice_thrsh, rice_thrsh], 'Size', [1
NaN]);
```



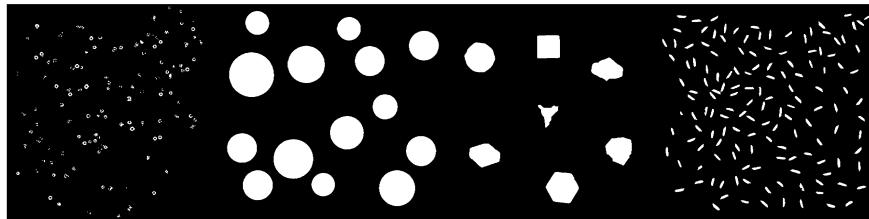
```
%cleaning
%beads
bw_beads = bwmorph(beads_thrsh, 'close');
bw_beads = bwmorph(bw_beads, 'thick');
%imshow(bw_beads)

%coins
bw_coins = imclose(coins_thrsh, strel('disk',12));
bw_coins = imfill(bw_coins, 'holes');
bw_coins = bwmorph(bw_coins, 'open');
%imshow(bw_coins)

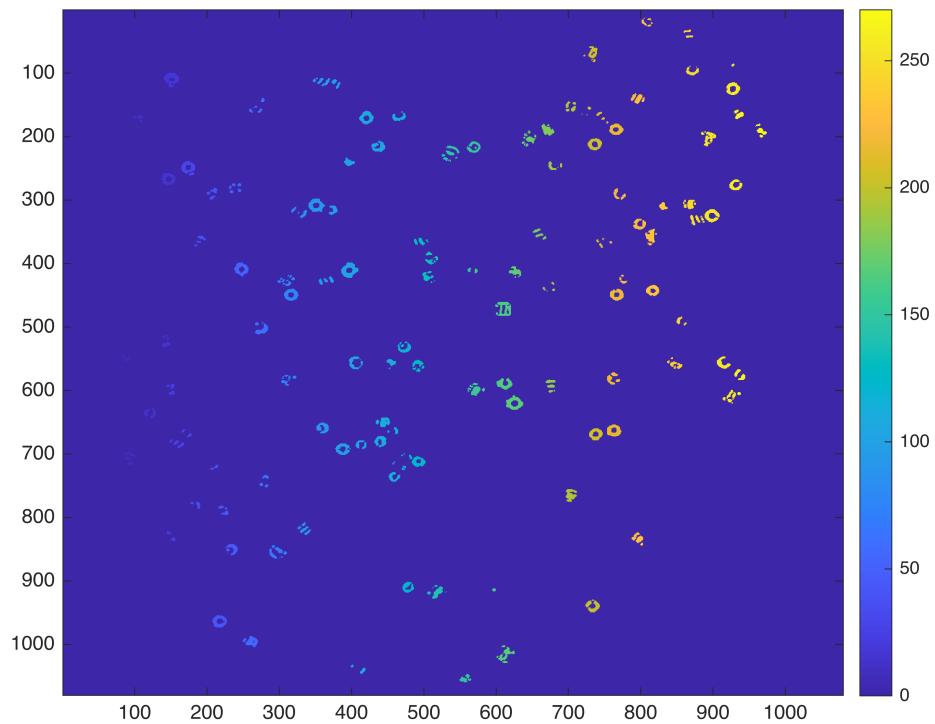
%dice
bw_dice = bwmorph(dice_thrsh, 'open');
bw_dice = bwmorph(bw_dice, 'thin');
bw_dice = bwmorph(bw_dice, 'majority');
bw_dice = imfill(bw_dice, 'holes');
bw_dice = imclose(bw_dice, strel('disk', 35));
bw_dice = bwmorph(bw_dice, 'clean');
bw_dice = imeroode(bw_dice, strel('disk', 5));
%imshow(bw_dice);

%rice
bw_rice = bwmorph(rice_thrsh, 'close');
bw_rice = bwmorph(bw_rice, 'thin');
```

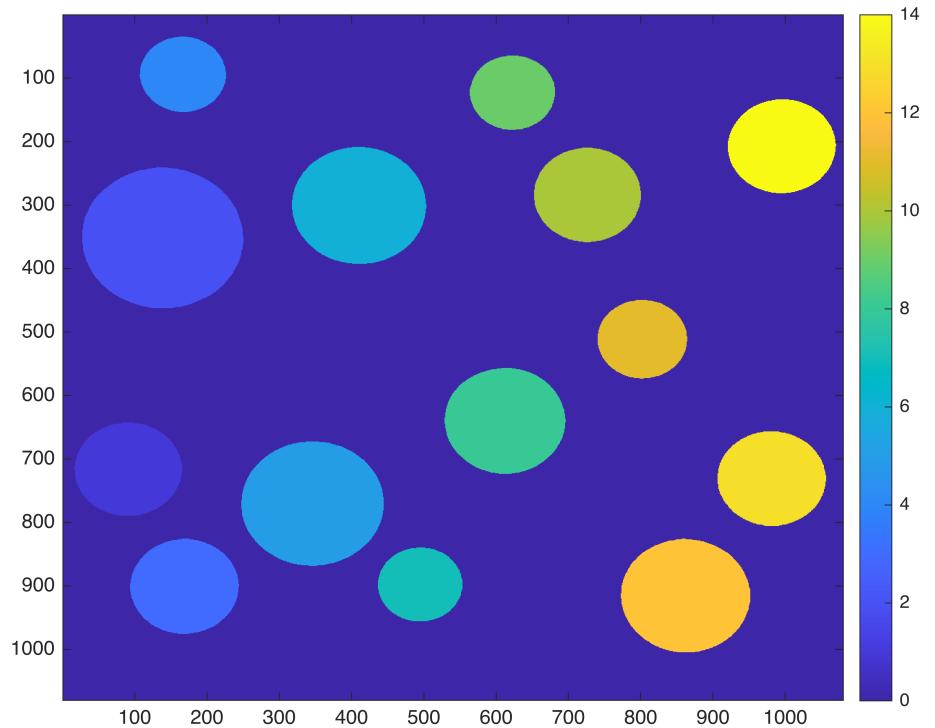
```
bw_rice = imfill(bw_rice, 'holes');
bw_rice = imerode(bw_rice, strel('disk', 1));
% imshow(bw_rice);
montage([bw_beads, bw_coins, bw_dice, bw_rice], 'Size', [1 NaN]);
```



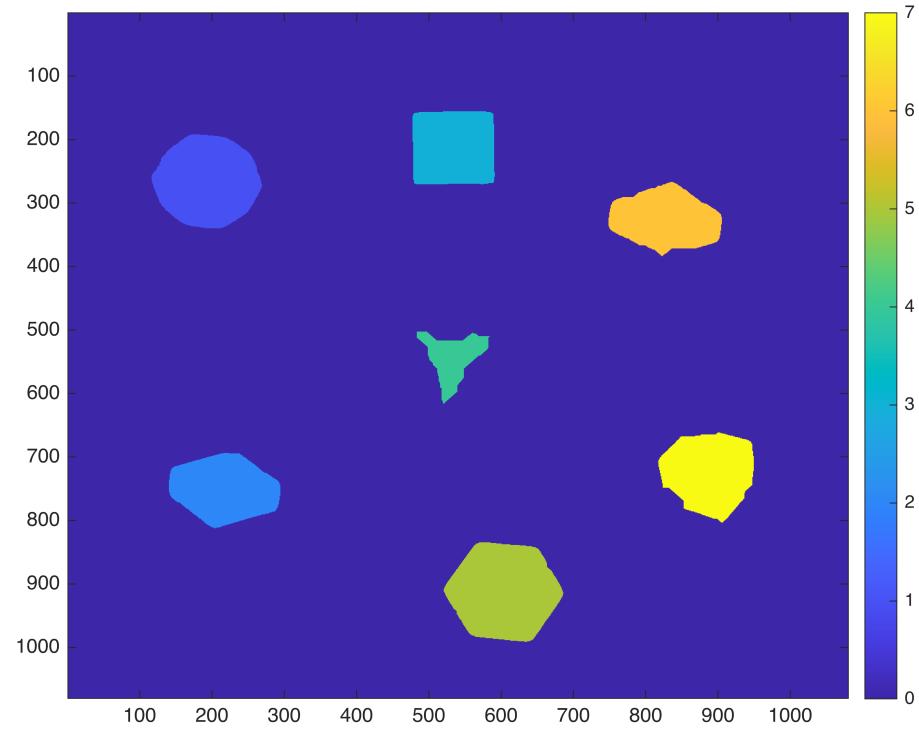
```
%putting labels
bw_beads_label = bwlabel(bw_beads); imagesc(bw_beads_label); colorbar;
```



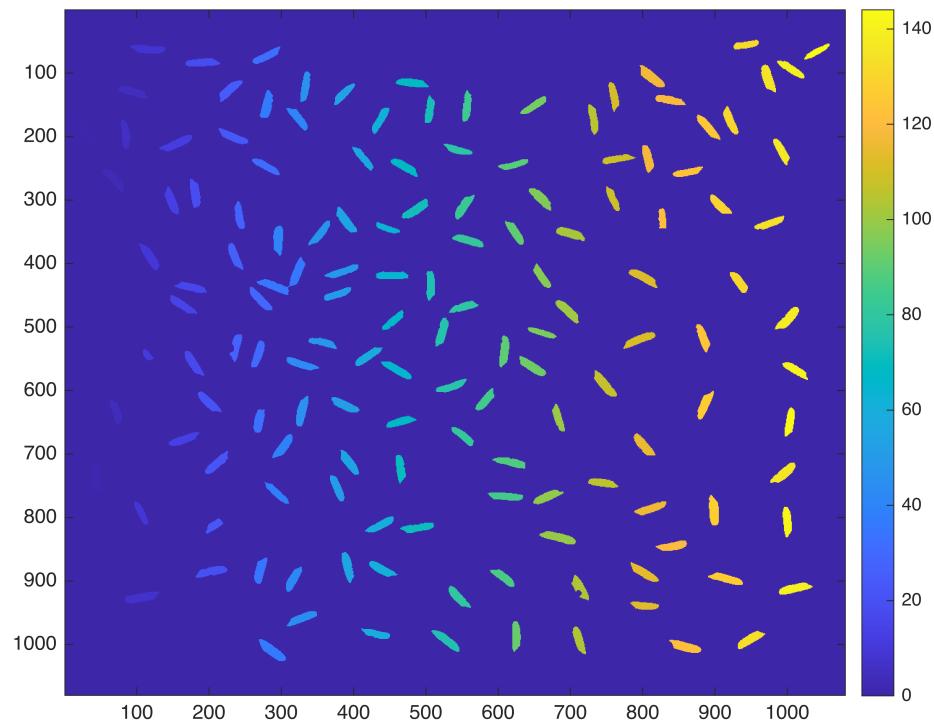
```
bw_coins_label = bwlabel(bw_coins); imagesc(bw_coins_label); colorbar;
```



```
bw_dice_label = bwlabel(bw_dice); imagesc(bw_dice_label); colorbar;
```



```
bw_rice_label = bwlabel(bw_rice); imagesc(bw_rice_label); colorbar;
```



```
% regionprops
ftr_beads = regionprops(bw_beads_label);
ftr_beads_table = struct2table(struct(ftr_beads))
```

ftr_beads_table = 270×3 table

...

	Area	Centroid	
1	175	57.1486	841.4457
2	21	54.4762	338.2857
3	14	54.1429	353.0714
4	12	77.3333	542.6667
5	29	85	545.5172
6	47	90.2553	550.4468
7	65	93.5077	700.4154
8	36	91.0278	707.1667
9	30	93.9333	714.8333
10	16	99.8125	169.1875
11	43	107.1860	169.2558
12	13	108.3846	175.6154

	Area	Centroid	
13	67	116.4179	634.4030
14	66	126.0303	636.4848
15	243	146.5679	266.7202
16	60	143.6667	527.6000
17	7	140.5714	515.7143
18	286	151.0734	109.3322
19	7	144.2857	514
20	21	146.6190	592.5714
21	7	146	518.2857
22	25	147.0800	824.2400
23	44	151.5682	603.9545
24	16	150.3125	679.6250
25	32	153.4375	834.5000
26	32	152.4688	593.3125
27	33	157.5152	681.9697
28	40	164.2750	686.1250
29	231	173.6623	248.2641
30	17	166.8824	663.6471
31	26	175.8077	670.4231
32	29	178.6207	258.9310
33	16	179.1875	777.5000
34	12	184.5000	371.5000
35	47	187.9787	780.7234
36	18	188.5556	365.8333
37	48	192.6458	359.4583
38	21	202	289
39	35	207.4286	296
40	53	210.3396	284.9811
41	35	210.6286	721.1714
42	245	217.1918	963.8980
43	29	219.4483	783.7931
44	45	225.4889	793.3333
45	11	226.4545	785.8182

	Area	Centroid	
46	140	236	849.1071
47	19	229.0526	851.2105
48	2	228.5000	856.5000
49	16	232.2500	279.8750
50	21	234	287
51	20	237.1000	275.9500
52	247	247.6316	408.5749
53	21	245	276
54	21	245.0476	284.7143
55	24	251.9583	993.3333
56	188	262.4947	995.7553
57	22	260.8182	159.3182
58	12	267.2500	153.2500
59	21	269	495
60	151	276.9205	504.3576
61	26	273.4615	159.1538
62	21	275	748
63	26	277.0769	142.5385
64	36	281.0833	736.1111
65	19	282.2632	750.1579
66	75	290.3867	858.0667
67	18	291.7222	845.8333
68	65	299.6000	851.6923
69	29	300.8966	426.7586
70	2	300.5000	863.5000
71	94	309.1702	583.9894
72	5	303.6000	862.2000
73	14	305.6429	427.1429
74	53	311.4717	431.4717
75	20	308.1000	856.0500
76	237	316.4641	449.2068
77	4	312.5000	419
78	12	315.5000	420.1667

	Area	Centroid	
79	33	319.8788	315.1515
80	19	319.1579	424.1579
81	21	321	579
82	5	326.6000	320.2000
83	17	327.7647	816.1765
84	60	334.1000	322.3000
85	56	334.3214	819.1429
86	23	333.8696	810.9130
87	38	339.2632	823.4211
88	293	351.2014	308.4437
89	26	349.6154	110.7692
90	187	360.4385	658.8503
91	44	357.0455	112.2727
92	37	357.5676	428.8378
93	59	365.2373	114.8136
94	26	364.4615	426.5385
95	104	374.9808	315.6538
96	44	372.2045	425.2727
97	39	376.0513	113.3333
98	223	387.7937	692.3004
99	35	381.4286	119.1429
100	337	396.9199	410.5668

:

```
ftr_coins = regionprops(bw_coins_label);
ftr_coins_table = struct2table(struct(ftr_coins))
```

ftr_coins_table = 14x3 table

...

	Area	Centroid	
1	17151	91.0457	716.2047
2	38832	138.5847	351.9339
3	17578	168.8718	900.7984
4	11059	166.7646	94.0199
5	30332	345.9953	770.2590

	Area	Centroid	
6	26865	410.3280	300.7135
7	10701	494.9831	897.7025
8	21857	612.3477	639.8447
9	10823	622.7763	122.8148
10	17274	726.3596	283.9344
11	12045	802.2771	511.2585
12	25022	862.0335	915.4658
13	17516	981.1424	730.8846
14	17314	995.2172	207.3548

```
ftr_dice = regionprops(bw_dice_label);
ftr_dice_table = struct2table(struct(ftr_dice))
```

ftr_dice_table = 7x3 table

...

	Area	Centroid	
1	16969	193.1782	265.9649
2	13002	216.9487	750.9502
3	12758	534.2554	212.9570
4	4997	533.2045	545.2594
5	18991	603.7937	912.3840
6	12264	827.6353	325.8425
7	13574	887.5958	725.0038

```
ftr_rice = regionprops(bw_rice_label);
ftr_rice_table = struct2table(struct(ftr_rice))
```

ftr_rice_table = 144x3 table

...

	Area	Centroid	
1	443	31.0293	194.4221
2	516	43.8740	735.1124
3	453	68.7837	267.2141
4	383	71.2898	633.2428
5	456	94.9079	129.8333
6	438	84.5274	196.8014
7	569	106.6415	926.0475
8	521	116.4741	62.3474

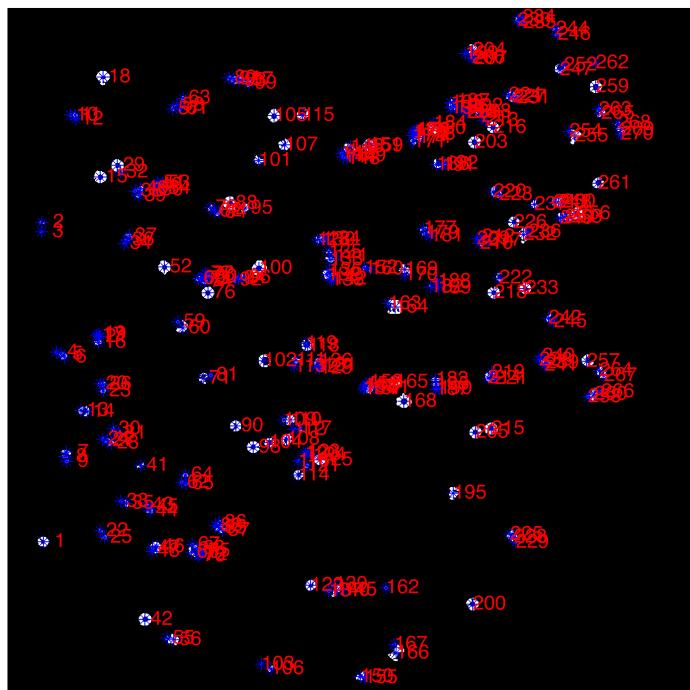
	Area	Centroid	
9	336	106.3065	793.2649
10	503	118.4553	389.7694
11	160	114.9750	544.4250
12	514	155.6187	210.7977
13	470	148.5128	301.7106
14	458	165.2074	677.0218
15	454	163.2048	465.5286
16	444	175.5766	437.7477
17	459	178.2941	557.3573
18	492	190.7073	83.5183
19	490	180.7429	289.9612
20	498	203.7550	885.2169
21	455	199.6462	618.6352
22	475	211.1495	714.7474
23	285	207.1789	812.9579
24	467	233.6360	200.6702
25	474	228.7595	126.5612
26	440	236.0341	388.6705
27	411	237.8345	531.0560
28	415	242.1904	325.0964
29	469	270.9851	456.6546
30	444	268.0788	542.8041
31	414	278.9179	246.9928
32	432	279.7060	72.9838
33	418	269.3086	647.9474
34	455	271.0681	883.7429
35	1028	306.0973	425.0321
36	572	287.3776	1.0101e+03
37	511	280.0235	150.5499
38	404	293.9381	761.8317
39	479	302.9040	688.1315
40	514	295.9436	362.5214
41	435	323.2828	171.3356

	Area	Centroid	
42	444	316.8311	897.1847
43	463	327.8445	558.5248
44	477	329.1426	958.6541
45	521	328.6392	633.0365
46	453	333.3201	121.4967
47	442	354.0204	352.3665
48	389	357.6761	524.6735
49	461	384.7570	412.6334
50	397	377.9068	448.2091
51	420	377.4857	753.8214
52	472	388.1737	623.3665
53	389	386.4653	132.6504
54	504	389.3036	332.6865
55	468	394.0791	713.7607
56	510	391.7314	877.7098
57	404	413.4233	234.1782
58	465	419.9892	546.1032
59	392	431.6097	983.4694
60	448	437.4821	811.8549
61	459	439.1416	881.7081
62	444	437.0383	173.7230
63	291	446.7835	344.5704
64	469	453.2324	418.9574
65	493	460.4158	567.6755
66	382	455.2199	490.0340
67	425	465.1765	649.2235
68	466	470.6888	247.5794
69	465	480.8624	115.5742
70	442	464.9570	722.8235
71	470	488.7723	816.1915
72	514	486.1693	314.9728
73	418	505.1699	158.3373
74	457	506.4880	434.2144

	Area	Centroid	
75	510	528.5078	993.7510
76	484	522.3988	507.9360
77	443	535.4334	593.5937
78	372	544.5376	221
79	413	552.6416	468.2203
80	454	545.1233	925.8767
81	396	551.5960	671.8687
82	481	559.1538	363.9605
83	474	552.4937	310.4325
84	459	556.8257	152.9564
85	416	582.6178	615.3702
86	489	610.9407	766.8160
87	422	607.2891	894.5972
88	476	617.4412	713.2521
89	369	621.5420	244.3767
90	504	608.3552	538.1984
91	445	623.4157	351.3663
92	467	624.7816	986.7452
93	518	647.2297	562.5521
94	411	649.9976	151.1946
95	333	660.9009	509.2132
96	499	659.1503	297.3988
97	414	660.4686	420.7633
98	470	668.2277	767.4553
99	577	683.6898	831.7192
100	403	683.5112	643.5484

:

```
beads_properties = properties(bw_beads_label,ftr_beads);
```



Area Statistics:

Mean: 63.3185

Standard Deviation: 73.629

Perimeter Statistics:

Mean: 27.9395

Standard Deviation: 22.3761

Eccentricity Statistics:

Mean: 0.70272

Standard Deviation: 0.23476

stats_beads = 270x1 struct

Fields	Area	Eccentricity	Perimeter
1	175	0.4063	49.522
2	21	0.9132	19.84
3	14	0.7988	10.751
4	12	0.5714	12.083
5	29	0.8249	17.326
6	47	0.9227	28.003
7	65	0.9467	32.758
8	36	0.8599	19.931
9	30	0.7186	16.747
10	16	0.6487	11.512
11	43	0.44	20.32
12	13	0.5058	9.461
13	67	0.8413	30.054
14	66	0.9185	37.547
15	243	0.352	64.896
16	60	0.8339	29.872
17	7	0.8562	6.922
18	286	0.3802	75.772
19	7	0.3531	6.368
20	21	0.735	13.381
21	7	0.3531	6.368
22	25	0.7213	17.301
23	44	0.729	22.95
24	16	0.8452	12.273
25	32	0.5648	20.8
26	32	0.8553	19.195
27	33	0.8834	19.493
28	40	0.9301	23.901

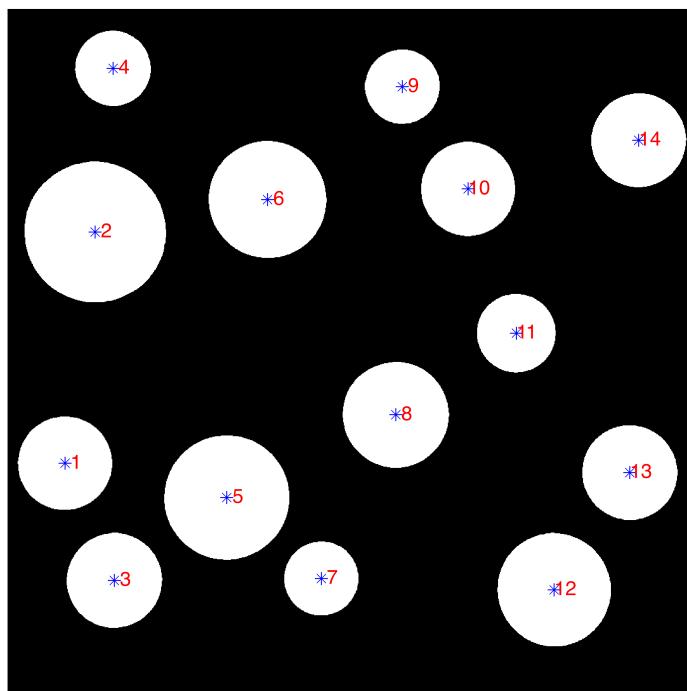
Fields	Area	Eccentricity	Perimeter
29	231	0.333	57.784
30	17	0.8873	13.307
31	26	0.841	16.863
32	29	0.873	17.789
33	16	0.6842	11.33
34	12	0	8.816
35	47	0.9008	25.075
36	18	0.8388	13.472
37	48	0.9173	26.787
38	21	0	12.736
39	35	0.8506	20.047
40	53	0.5009	26.878
41	35	0.9577	28.094
42	245	0.2222	59.926
43	29	0.8376	17.326
44	45	0.8059	24.893
45	11	0.7243	9.089
46	140	0.7347	60.298
47	19	0.505	12.827
48	2	0.9258	2.812
49	16	0.8217	12.918
50	21	0	12.736
51	20	0.3837	12.645
52	247	0.394	61.828
53	21	0	12.736
54	21	0.6709	14.051
55	24	0.833	15.639
56	188	0.2611	51.97
57	22	0.8502	15.457
58	12	0.8748	13.952
59	21	0	12.736
60	151	0.8361	64.442
61	26	0.8744	16.681

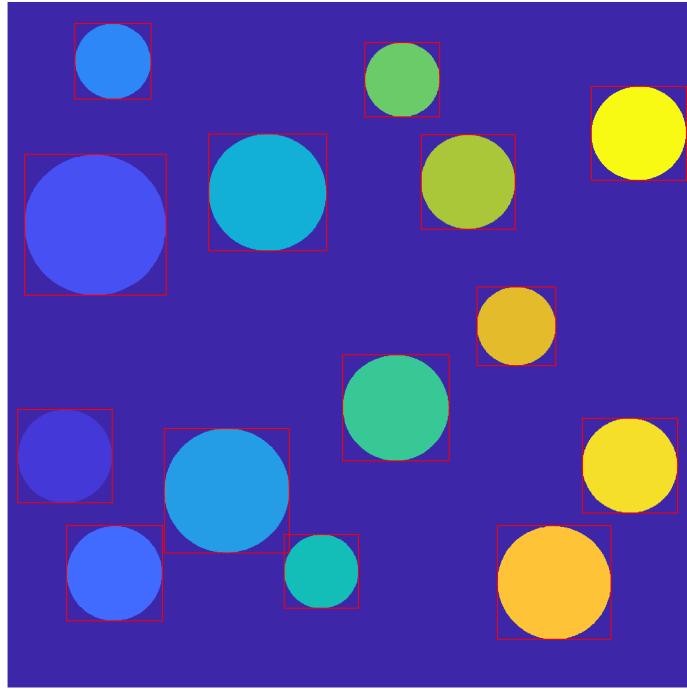
Fields	Area	Eccentricity	Perimeter
62	21	0	12.736
63	26	0.7185	16.193
64	36	0.8434	21.246
65	19	0.6631	12.645
66	75	0.9467	40.367
67	18	0.5732	12.182
68	65	0.8842	30.079
69	29	0.8888	24.364
70	2	0.9258	2.812
71	94	0.728	82.057
72	5	0.7651	4.962
73	14	0.8584	11.239
74	53	0.6342	41.872
75	20	0.3837	12.645
76	237	0.3179	57.966
77	4	0.8704	4.408
78	12	0.8498	10.313
79	33	0.9364	21.635
80	19	0.5086	12.182
81	21	0	12.736
82	5	0.7651	4.962
83	17	0.7283	12.364
84	60	0.939	31.576
85	56	0.9518	30.286
86	23	0.8799	18.079
87	38	0.9404	26.06
88	293	0.3867	68.436
89	26	0.8994	22.305
90	187	0.3952	79.005
91	44	0.9279	25.026
92	37	0.8726	21.18
93	59	0.9518	34.487
94	26	0.8482	17.045

Fields	Area	Eccentricity	Perimeter
95	104	0.7558	47.479
96	44	0.8991	23.992
97	39	0.7129	19.584
98	223	0.3122	66.691
99	35	0.9491	23.231
100	337	0.5021	73.307

⋮

```
coins_properties = properties(bw_coins_label,ftr_coins);
```





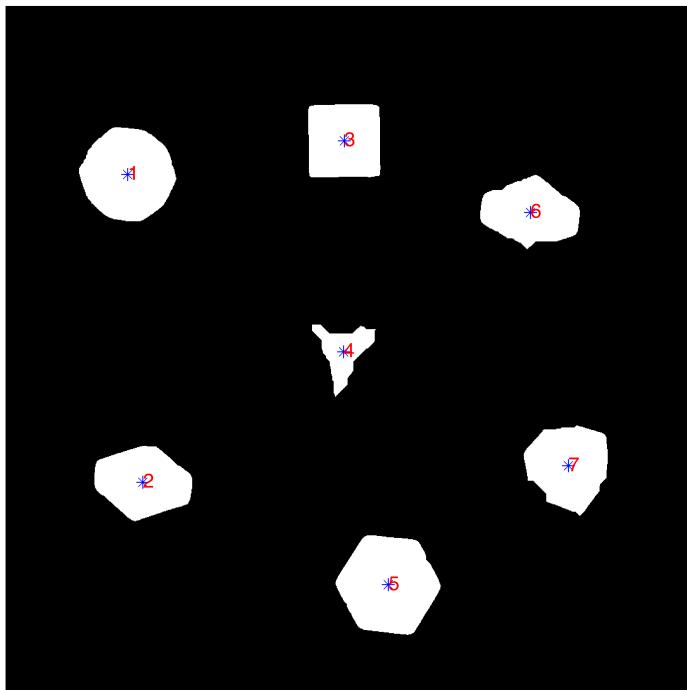
```
stats_coins = statistical_properties(bw_coins_label)
```

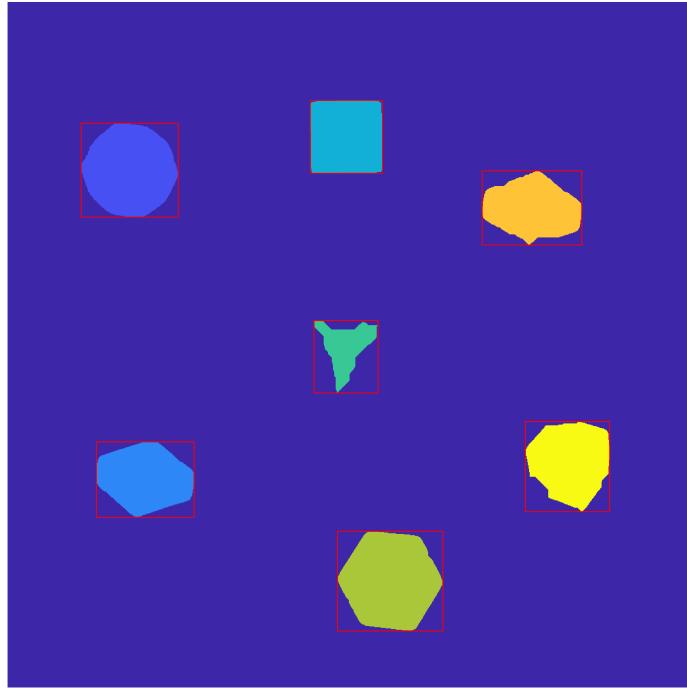
Area Statistics:
 Mean: 19597.7857
 Standard Deviation: 8244.5217
 Perimeter Statistics:
 Mean: 484.6009
 Standard Deviation: 100.3123
 Eccentricity Statistics:
 Mean: 0.12118
 Standard Deviation: 0.027241
 stats_coins = 14x1 struct

Fields	Area	Eccentricity	Perimeter
1	17151	0.1322	461.85
2	38832	0.1322	696.592
3	17578	0.1337	468.243
4	11059	0.1502	370.944
5	30332	0.1249	614.932
6	26865	0.1321	578.882
7	10701	0.1108	363.972
8	21857	0.0852	521.884
9	10823	0.11	366.056
10	17274	0.0609	464.083

Fields	Area	Eccentricity	Perimeter
11	12045	0.0945	386.74
12	25022	0.1357	559.224
13	17516	0.1265	467.085
14	17314	0.1677	463.926

```
dice_properties = properties(bw_dice_label,ftr_dice);
```





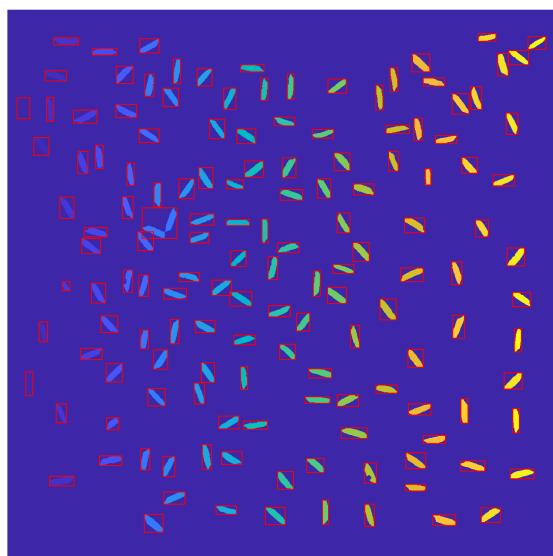
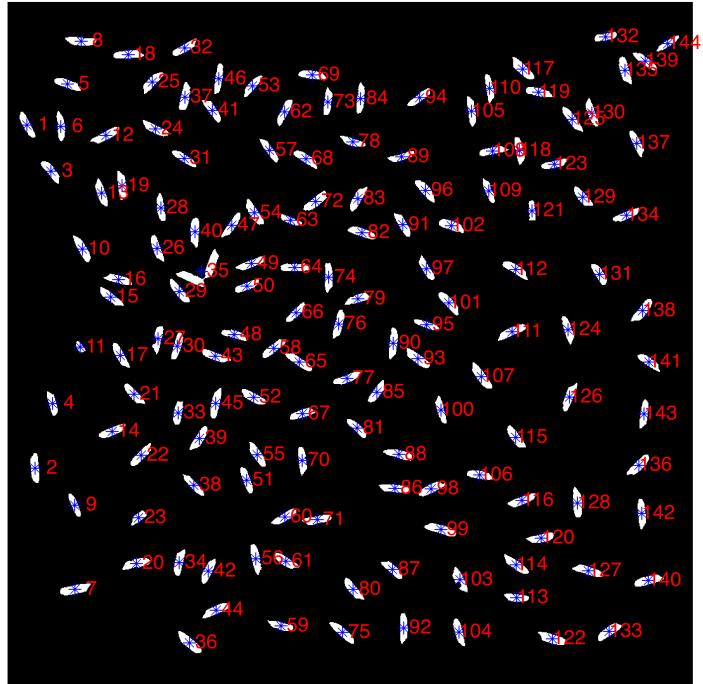
```
stats_dice = statistical_properties(bw_dice_label)
```

Area Statistics:
 Mean: 13222.1429
 Standard Deviation: 4402.2221
 Perimeter Statistics:
 Mean: 437.1339
 Standard Deviation: 41.825
 Eccentricity Statistics:
 Mean: 0.4129
 Standard Deviation: 0.26573

`stats_dice = 7x1 struct`

Fields	Area	Eccentricity	Perimeter
1	16969	0.1608	465.425
2	13002	0.7091	426.132
3	12758	0.1738	431.697
4	4997	0.5856	364.529
5	18991	0.2383	502.001
6	12264	0.7717	429.722
7	13574	0.251	440.431

```
rice_properties = properties(bw_rice_label,ftr_rice);
```



```
stats_rice = statistical_properties(bw_rice_label)
```

Area Statistics:

Mean: 455.0625

Standard Deviation: 76.1278

Perimeter Statistics:

Mean: 98.3675

Standard Deviation: 12.6493

Eccentricity Statistics:

Mean: 0.95751

Standard Deviation: 0.012901

stats_rice = 144x1 struct

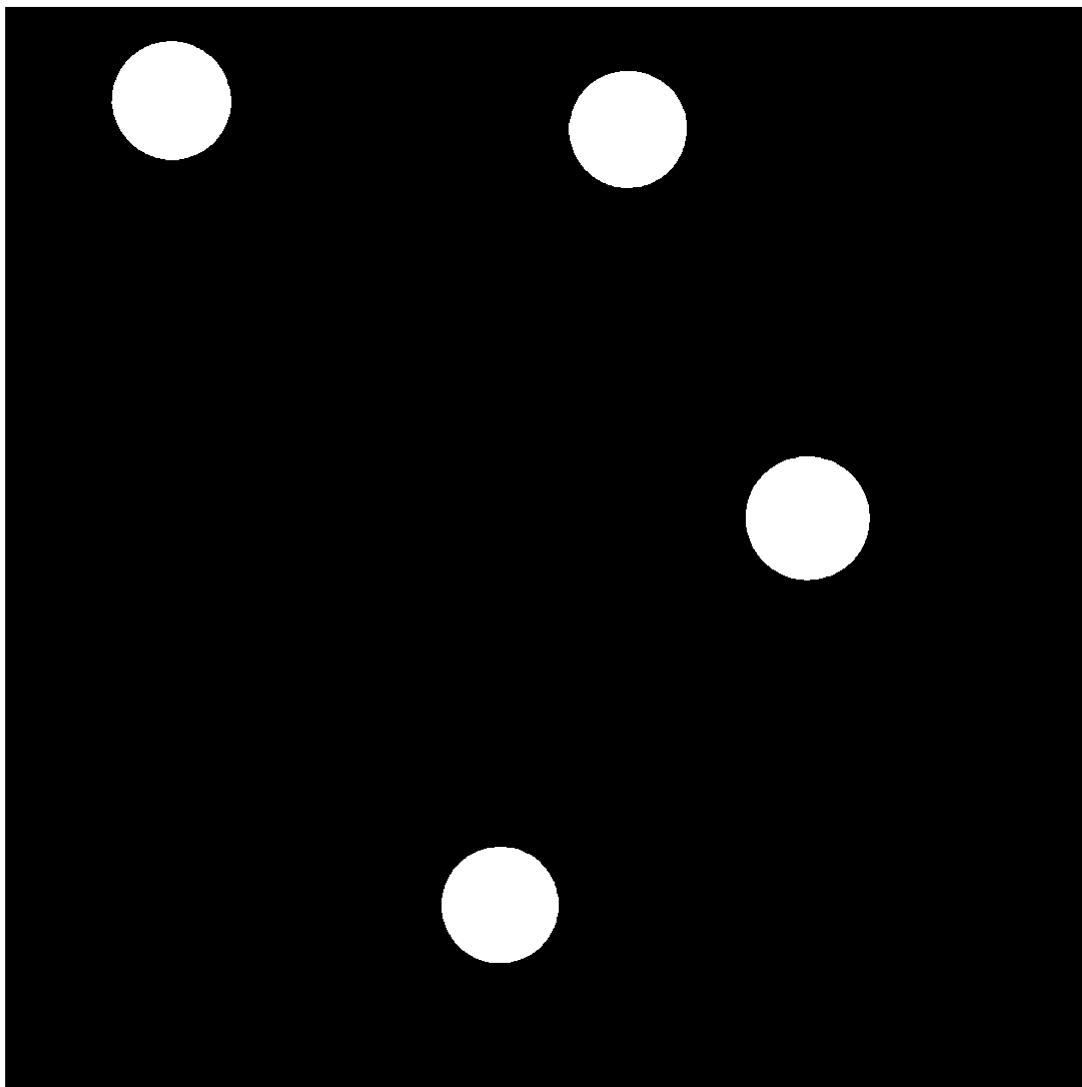
Fields	Area	Eccentricity	Perimeter
1	443	0.9661	97.638
2	516	0.9609	102.938
3	453	0.9514	94.811
4	383	0.9534	88.54
5	456	0.9556	96.62
6	438	0.9678	99.812
7	569	0.9583	109.364
8	521	0.9619	105.287
9	336	0.9683	85.34
10	503	0.9595	102.435
11	160	0.8662	48.058
12	514	0.9633	107.281
13	470	0.9549	97.687
14	458	0.9595	98.051
15	454	0.9613	99.02
16	444	0.9583	99.341
17	459	0.9597	98.68
18	492	0.9649	102.384
19	490	0.9573	102.227
20	498	0.9541	101.202
21	455	0.951	95.754
22	475	0.9592	100.328
23	285	0.9043	68.875
24	467	0.9603	99.424
25	474	0.9471	97.706
26	440	0.9609	98.514
27	411	0.9653	102.31
28	415	0.9664	95.71
29	469	0.9633	99.674
30	444	0.9641	96.504
31	414	0.9671	95.505
32	432	0.9629	96.72

Fields	Area	Eccentricity	Perimeter
33	418	0.9411	87.87
34	455	0.9504	95.826
35	1028	0.8988	217.605
36	572	0.9511	105.314
37	511	0.9513	101.921
38	404	0.971	98.384
39	479	0.9515	97.349
40	514	0.9558	102.012
41	435	0.957	96.415
42	444	0.9533	93.693
43	463	0.9656	102.07
44	477	0.9602	100.044
45	521	0.964	106.544
46	453	0.9746	104.195
47	442	0.9674	101.468
48	389	0.9563	92.328
49	461	0.9727	105.461
50	397	0.9601	89.326
51	420	0.9665	94.296
52	472	0.9476	93.875
53	389	0.9597	91.073
54	504	0.956	102.204
55	468	0.9535	97.705
56	510	0.9648	109.34
57	404	0.9705	98.218
58	465	0.9617	99.128
59	392	0.9578	90.864
60	448	0.9609	96.679
61	459	0.946	95.571
62	444	0.9673	99.11
63	291	0.9616	77.938
64	469	0.9666	103.716
65	493	0.9674	104.189

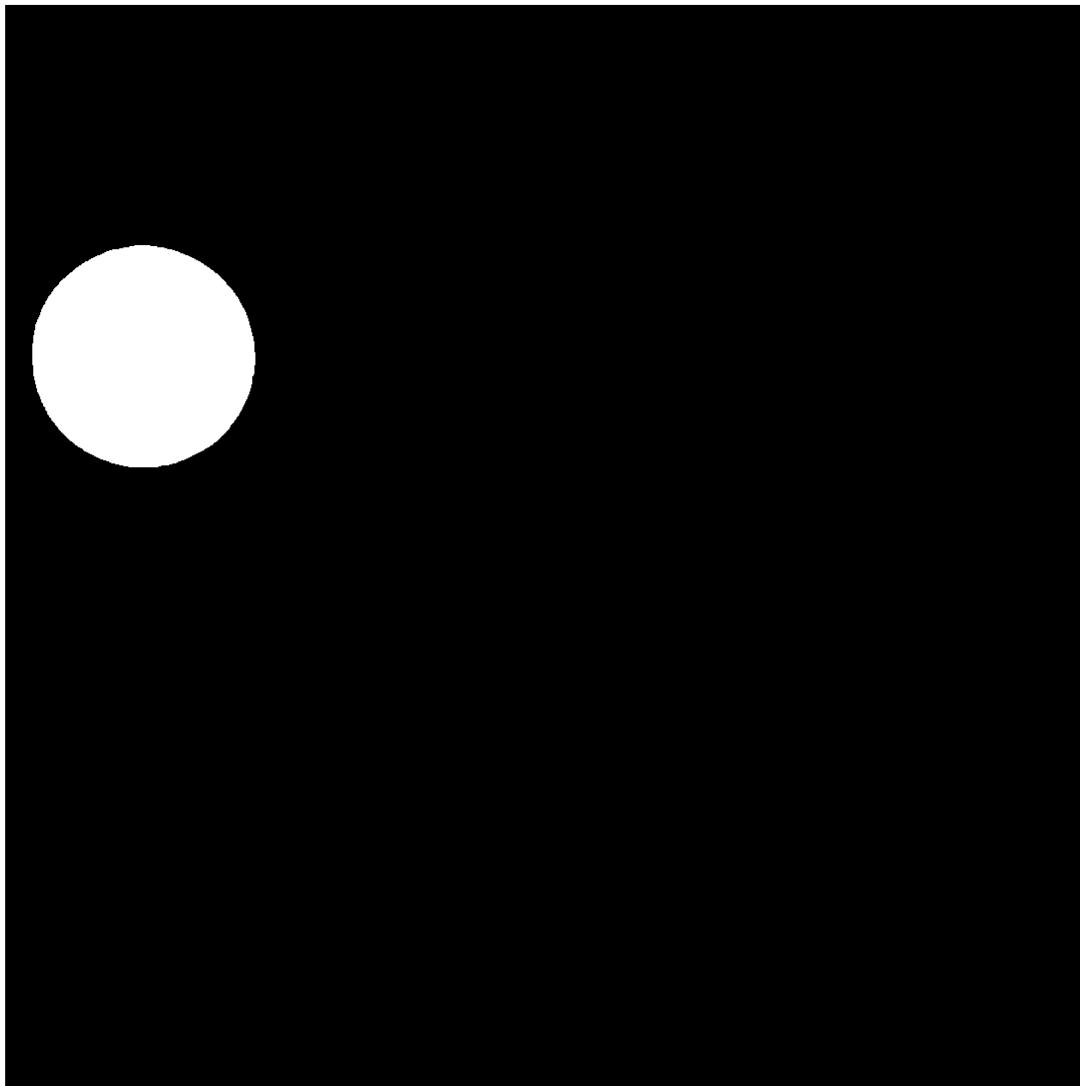
Fields	Area	Eccentricity	Perimeter
66	382	0.9599	89.841
67	425	0.9549	93.56
68	466	0.954	97.258
69	465	0.9578	98.853
70	442	0.9606	98.034
71	470	0.9642	103.41
72	514	0.9497	100.468
73	418	0.9625	96.347
74	457	0.967	101.83
75	510	0.9666	105.695
76	484	0.9618	104.088
77	443	0.9633	99.647
78	372	0.958	89.574
79	413	0.9508	94.123
80	454	0.9525	96.316
81	396	0.957	88.344
82	481	0.9592	99.647
83	474	0.951	98.002
84	459	0.9721	107.396
85	416	0.9458	89.187
86	489	0.9689	105.262
87	422	0.9468	90.122
88	476	0.9623	102.93
89	369	0.9696	92.675
90	504	0.9685	107.826
91	445	0.9557	95.463
92	467	0.9675	101.987
93	518	0.9528	100.641
94	411	0.9658	93.132
95	333	0.9747	89.442
96	499	0.9456	98.541
97	414	0.9579	92.238
98	470	0.9506	97.729

Fields	Area	Eccentricity	Perimeter
99	577	0.9643	112.077
100	403	0.9679	96.893
:			

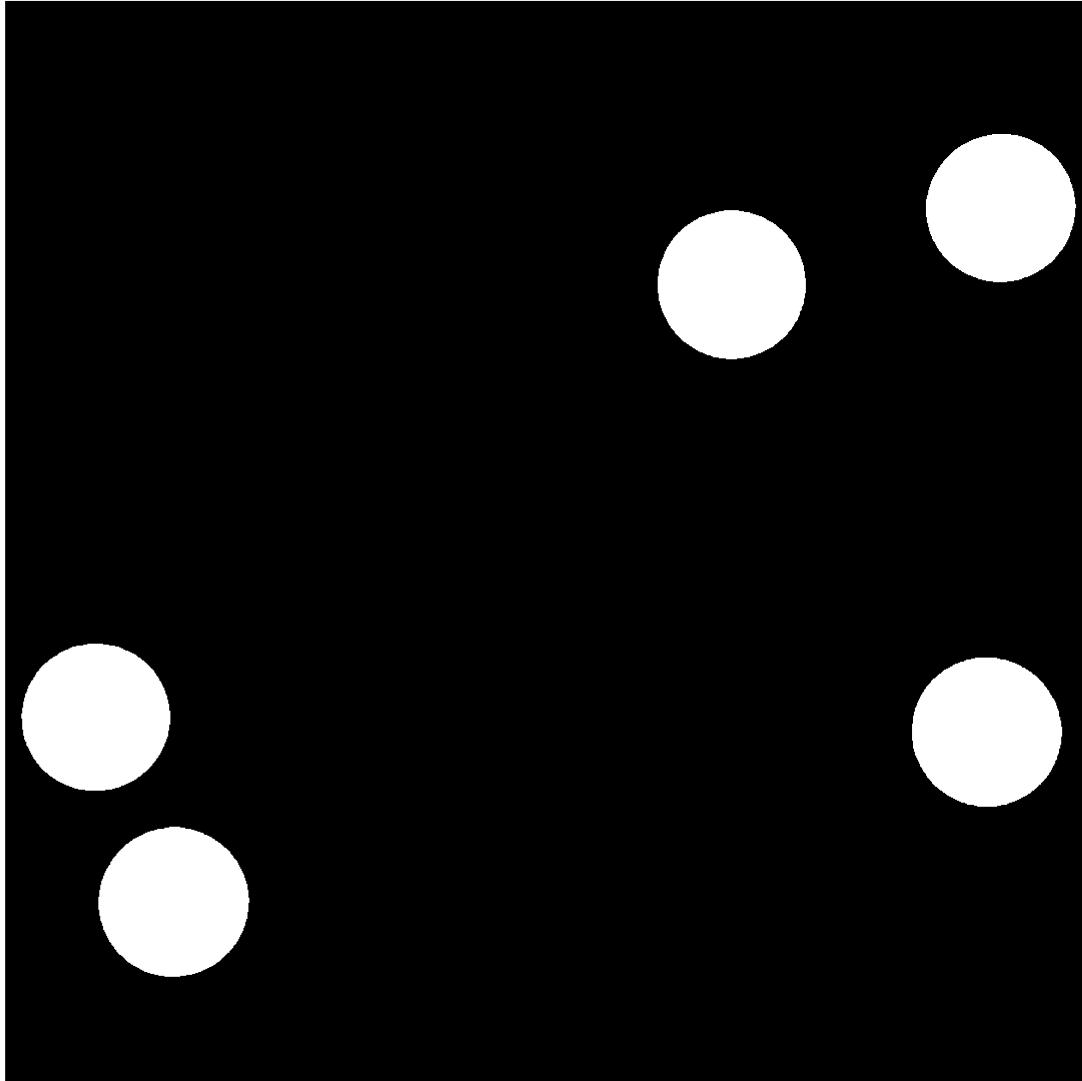
```
%regionprops but limited
stats_coins_5cents = regionprops(bw_coins_label, 'Area');
idx = find([stats_coins_5cents.Area] > 10000 & [stats_coins_5cents.Area] <
13000);
coins_cents = ismember(bw_coins_label,idx);
figure; imshow(coins_cents); axis image;
saveas(gcf,'coins_cents.jpeg')
```



```
stats_coins_20 = regionprops(bw_coins_label, 'Area');
idx = find([stats_coins_20.Area] > 35000 & [stats_coins_20.Area] < 40000);
coins_20 = ismember(bw_coins_label, idx);
figure; imshow(coins_20); axis image;
saveas(gcf, 'coins_20.jpeg')
```



```
stats_coins_25 = regionprops(bw_coins_label, 'Area');
idx = find([stats_coins_25.Area] > 16000 & [stats_coins_25.Area] < 18000);
coins_25 = ismember(bw_coins_label, idx);
figure; imshow(coins_25); axis image;
saveas(gcf, 'coins_25.jpeg')
```



```
%properties
function centroid = properties(image, x)
    centroid = cat(1, x.Centroid);
    imshow(image);
    hold on;
    plot(centroid(:,1), centroid(:,2), 'b*');

    % Add label numbers to centroids
    labels = 1:size(centroid, 1);
    text(centroid(:, 1), centroid(:, 2), num2str(labels'), 'Color', 'red');

    hold off;

    figure(); imagesc(image); hold on; axis off; axis image;
    bounding_box = cat(1,x.BoundingBox);
    for i= 1:size(x,1);
```

```

        rectangle('Position', bounding_box(i,:), 'EdgeColor', 'r');
    end
end

function stats = statistical_properties(bwlabel);
    stats = regionprops(bwlabel, 'Area', 'Perimeter', 'Eccentricity');

    %area statistics
    areas = [stats.Area];
    mean_area = mean(areas);
    std_area = std(areas);

    %calculate perimeter stats
    perimeters= [stats.Perimeter];
    mean_perimeter = mean(perimeters);
    std_perimeter = std(perimeters);

    %eccentricity stats
    eccentricities = [stats.Eccentricity];
    mean_eccentricity = mean(eccentricities);
    std_eccentricity = std(eccentricities);

    % Display the statistics
    disp('Area Statistics:');
    disp(['Mean: ' num2str(mean_area)]);
    disp(['Standard Deviation: ' num2str(std_area)]);
    disp('Perimeter Statistics:');
    disp(['Mean: ' num2str(mean_perimeter)]);
    disp(['Standard Deviation: ' num2str(std_perimeter)]);
    disp('Eccentricity Statistics:');
    disp(['Mean: ' num2str(mean_eccentricity)]);
    disp(['Standard Deviation: ' num2str(std_eccentricity)]);

end

```