

Pattern Recognition

Assignment 2

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Results of the first 50 images from the test set

image #	f-measure	entropy
105027	0.43907387116539454	0.8607935539309157
8068	0.8220811390283173	0.6592469757382446
51084	0.40854921487069085	3.0521078639467074
225022	0.5709891567746822	1.4566242073057878
100039	0.505100601203366	2.082300194059344
2018	0.5222877638685437	1.8403582149389535
87015	0.4656070924886316	1.3519583303958915
130066	0.5210675921686277	1.7637565439228666
246009	0.4594384149130357	2.182111284216797
157087	0.4138020885935673	3.0160861743082656
230098	0.4028606690955911	2.745543223317699
3063	0.7458425892147614	0.4179994694996389
226060	0.3847929741609246	3.0767537082299263
145079	0.5562616708839776	1.9582619943919368
48025	0.7654930636753845	1.3767510473052464
220003	0.5985955575227697	1.778639325812692
344010	0.6678897284322524	1.5204003135612856
196027	0.6735520418446763	1.0391086198484747
77062	0.47569602568368863	1.7560536513573872
267036	0.5064035852708121	2.3083264707307913

163096	0.4558179915396658	2.0843940729122403
384022	0.7406617720486122	1.3355518003095725
334025	0.6956029763101038	1.843087573532804
97010	0.6125478887718975	1.8784684256178696
198087	0.5031801628012046	2.4248149117259437
306052	0.6350764772933319	0.9954726006096551
120003	0.5723362324464477	2.549159009017071
335094	0.6116697649529294	1.949204588564358
228076	0.6516243957832539	1.2164277182601815
15062	0.5780998260558698	1.9820433616112298
206062	0.5620169349988109	2.140172633731112
159002	0.7470934937397363	1.351213358543528
372019	0.5574626807464605	1.6120362211584418
29030	0.4280753528088049	1.645276968634205
141012	0.43659316214798505	0.8606336474350037
36046	0.7084446850329723	1.0244359385102644
187058	0.3775189193685453	2.04609478723613
104055	0.5475620152138947	1.63236592339675
41029	0.545021963431278	1.5478153992071972
33044	0.6789602339410742	1.5814721168819867
176051	0.5996338352874881	1.41606487451179
146074	0.4316068901095499	3.044168454920887

41096	0.6136723356857688	1.090059863198028
160067	0.601451283858996	1.1967183147288973
147080	0.48461217925514954	2.59727380094816
302022	0.44461595947812854	1.8429208019040442
128035	0.4529770178860348	2.987503107699419
388018	0.43881435762264465	3.265073757950552

Overall average f-measure : 0.5526721081256682

Overall average entropy : 1.8470447988764425

Segmentation using K-means

Notes & Assumptions

- Entropy is calculated using log to the base 2

Good Results

Image #29030: good F-measure at K = 5

F-measure = 0.5227783051999882

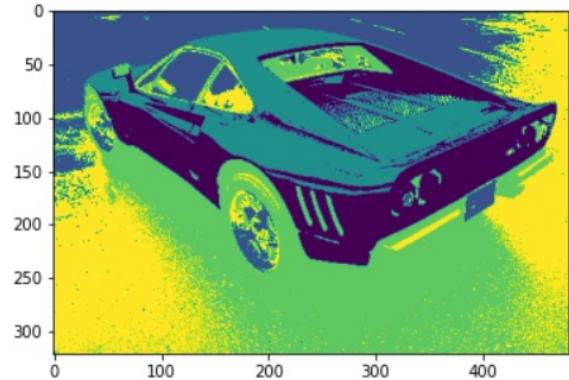


Image #8068: good F-measure at K = 3

F-measure = 0.8220811390283173

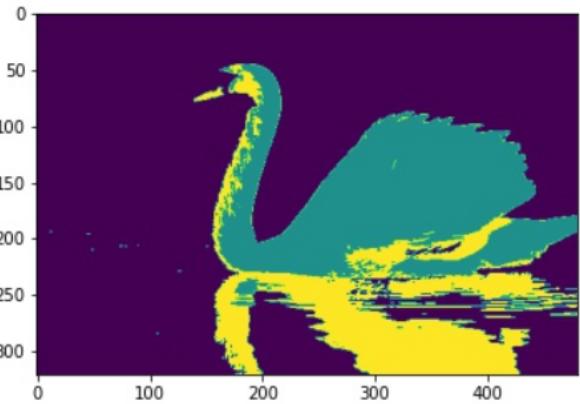


Image #246009: good Entropy at K = 11
Entropy = 1.6155529934111155

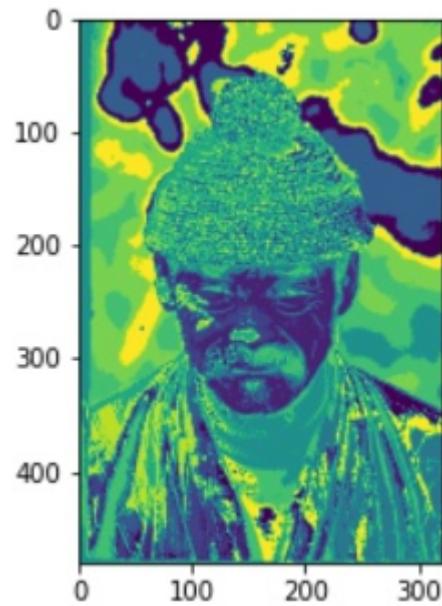
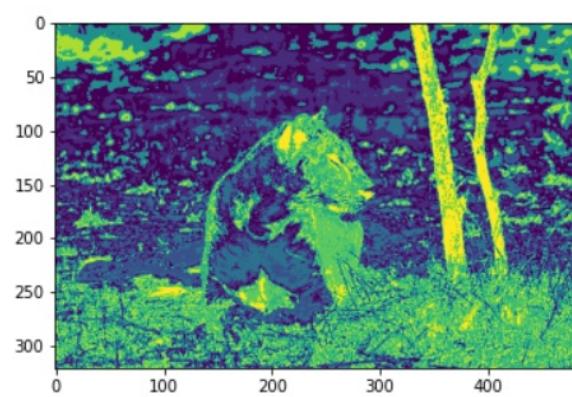


Image #105027: good Entropy at K = 9
Entropy = 0.7746398230451256

- although it has a bad result in F-measure at K = 11
F-measure = 0.22816723134977943



Bad Results

Image #77062 : bad F-measure at k = 7
F-measure = 0.2982

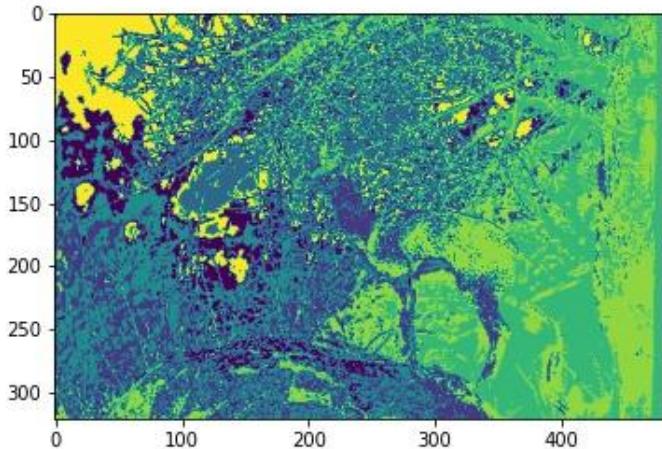


Image #196088 : bad F-measure and entropy at k = 5
F-measure = 0.2917 Entropy = 2.2458

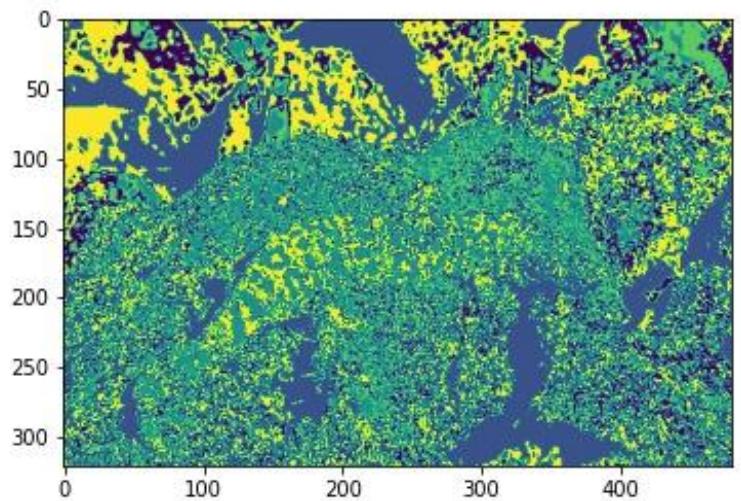
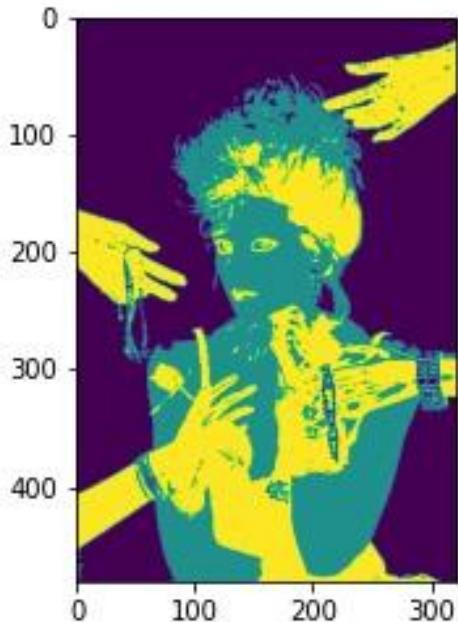


Image #198087 : bad entropy at k = 3

Entropy = 2.4248



Bonus : considering spatial layout

- x and y coordinates of each pixel are added as features beside the rgb values and then K-means algorithms are applied.
- The x and y coordinates features are multiplied by a 0.2 factor to increase their importance (distances values for these features becomes smaller)
- Adding these features gives higher chances for pixels with similar colors to become in the same cluster.

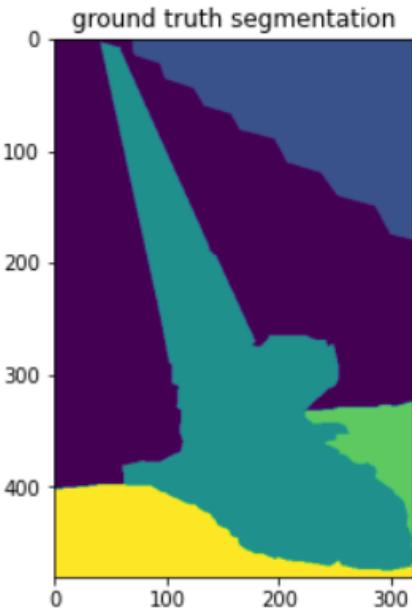
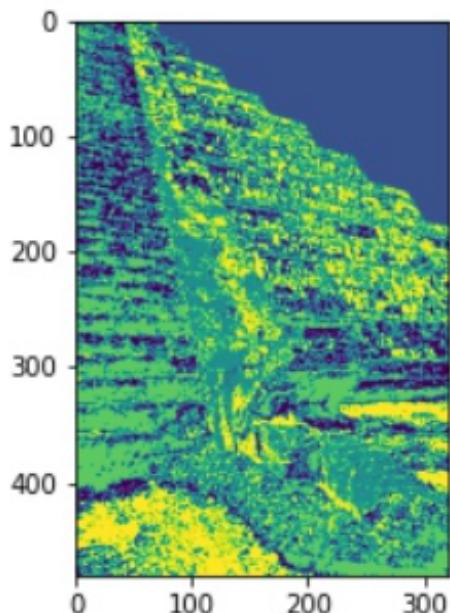
Big Picture: (K = 5)

- **Image #33044 (one large item)**

K-means

F-measure = 0.5174353601881198

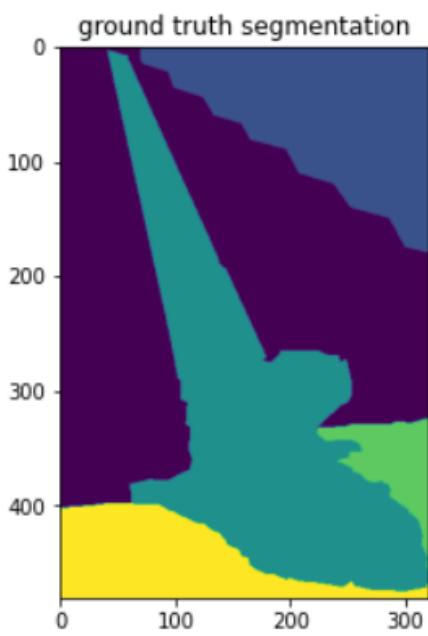
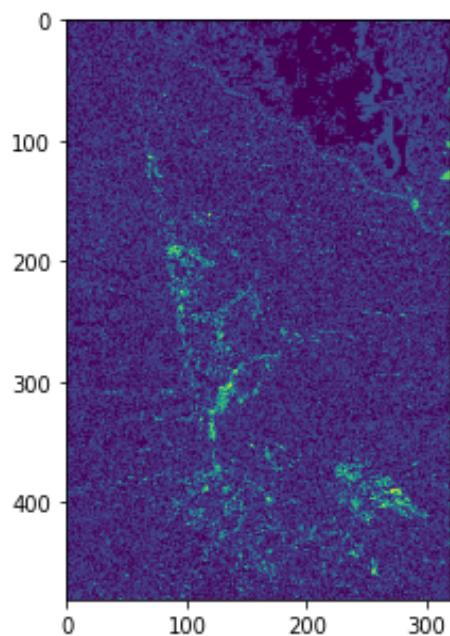
Entropy = 1.4948450049006539



Normalized-cut

F-measure=0.2264520499552173

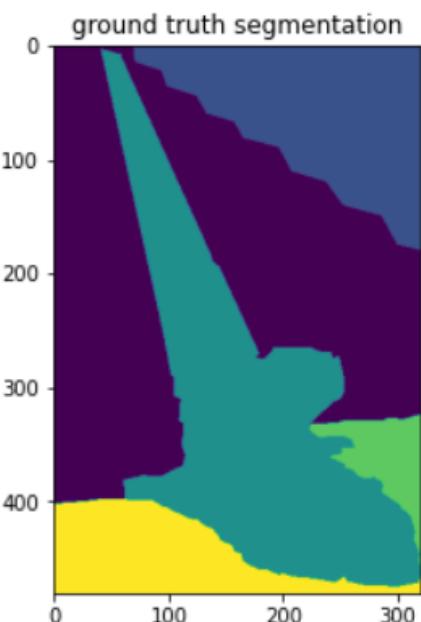
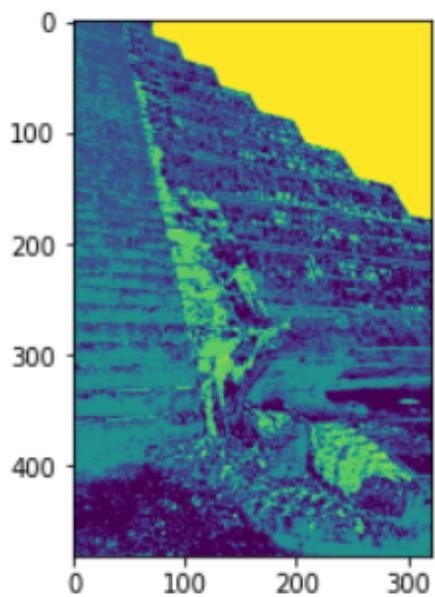
Entropy=1.56005714401715



spatial layout

F-measure= 0.515892937694942

Entropy= 1.472149200964691

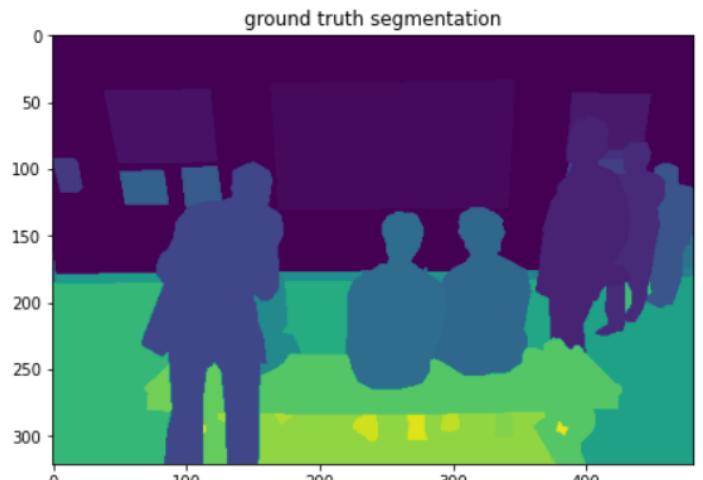
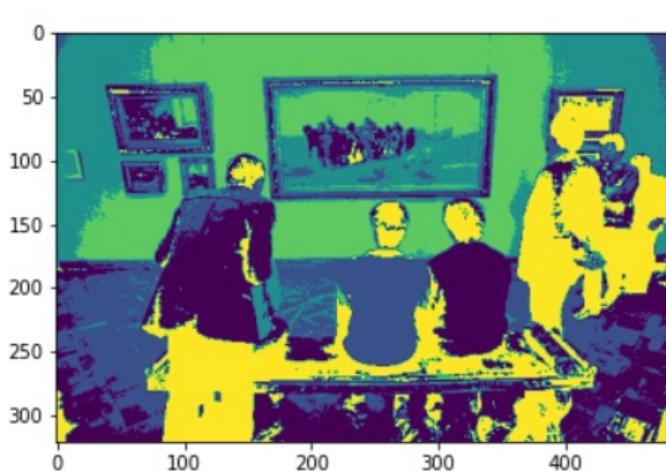


- **Image #128035 (many smaller items)**

K-means

F-measure = 0.42198081969838963

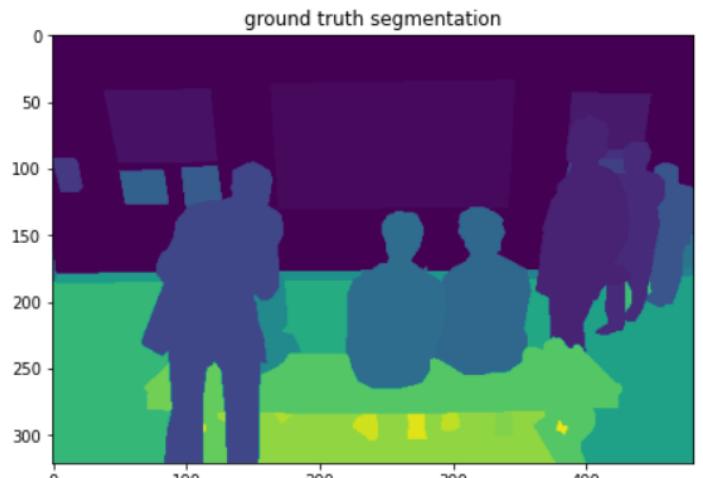
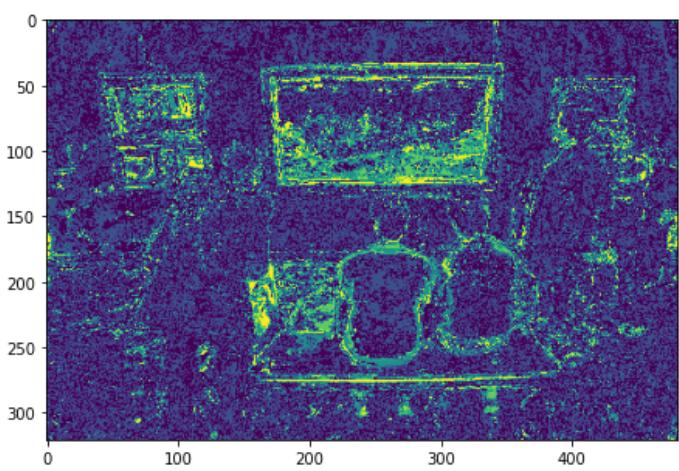
Entropy = 2.729556519235195



Normalized-cut

F-measure=0.20219876110702484

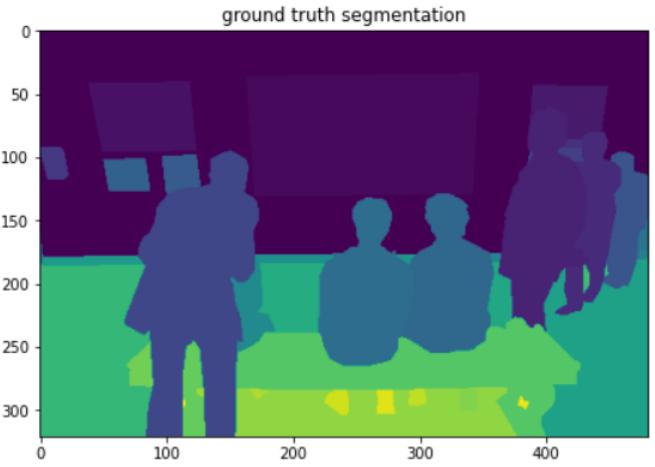
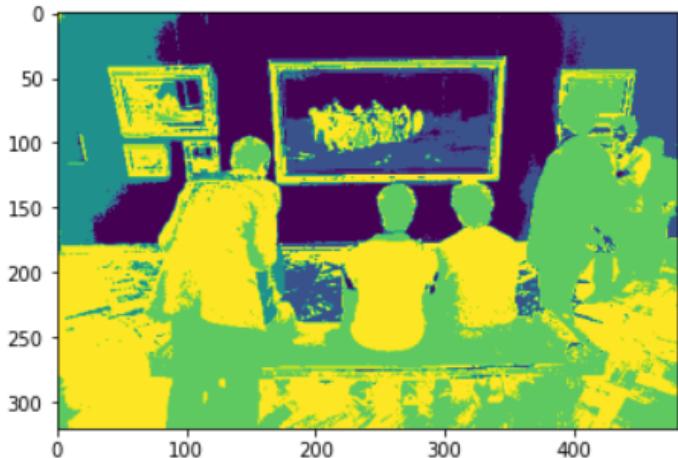
Entropy=2.213116785829561



spatial layout

F-measure= 0.3794532337482902

Entropy= 2.770881025282102

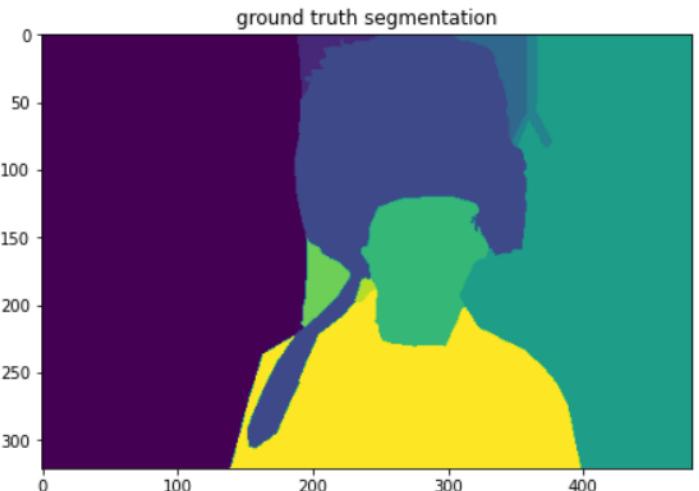
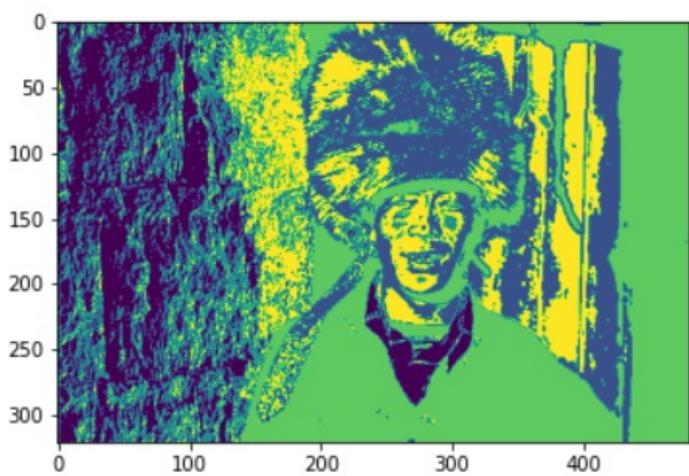


- **Image #15062 (face)**

K-means

F-measure = 0.484576219450729

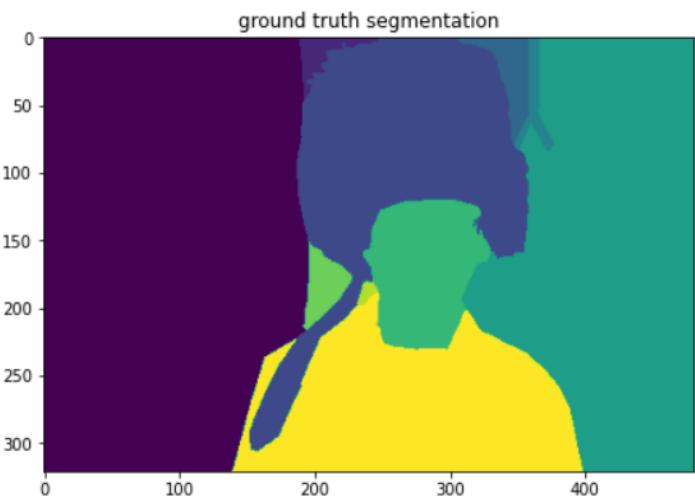
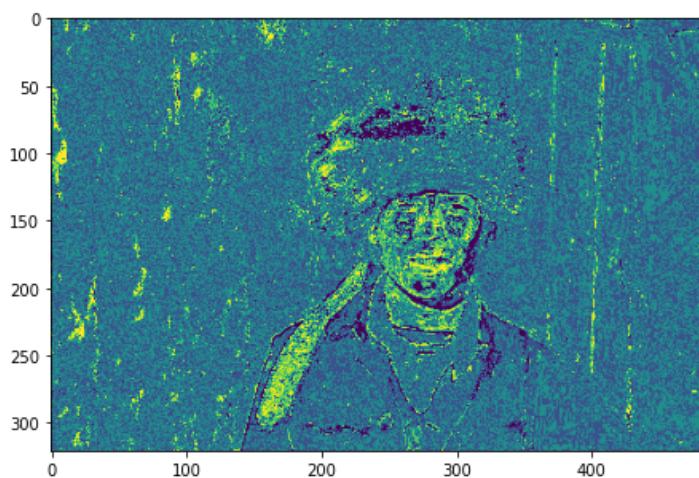
Entropy = 1.8397073031548041



Normalized-cut

F-measure=0.24537957019332146

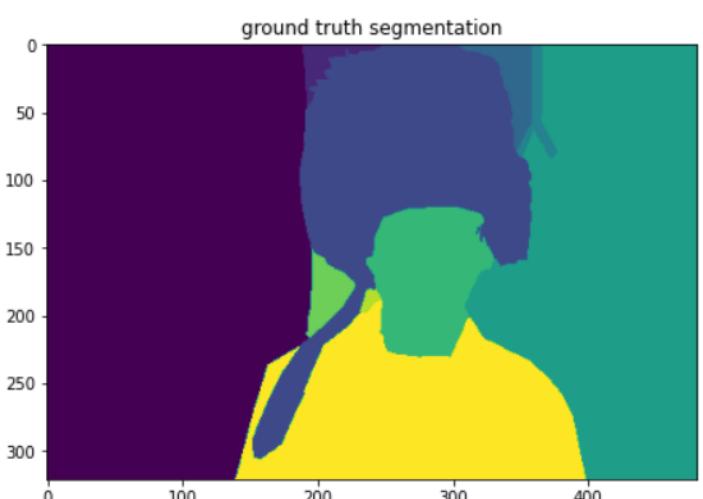
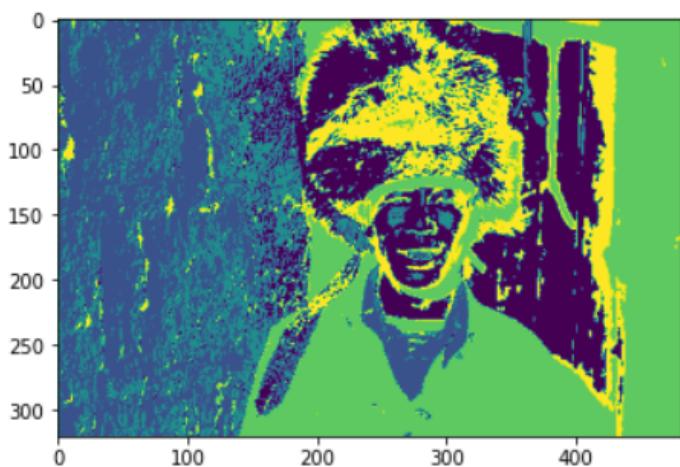
Entropy=3.6339210845487697



spatial layout

F-measure=0.5122559402451479

Entropy=1.7721132065703575

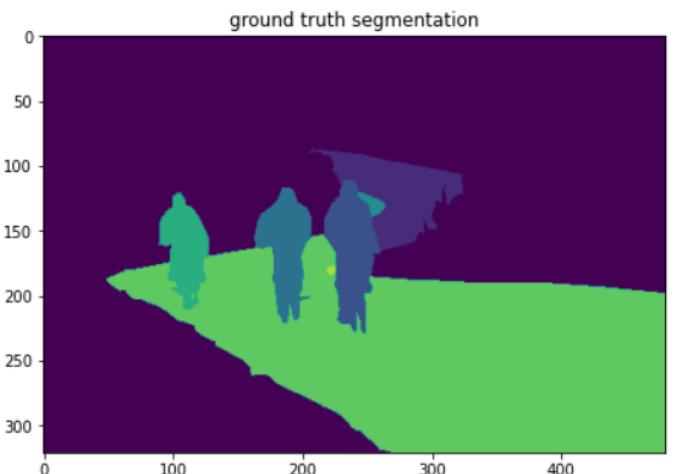
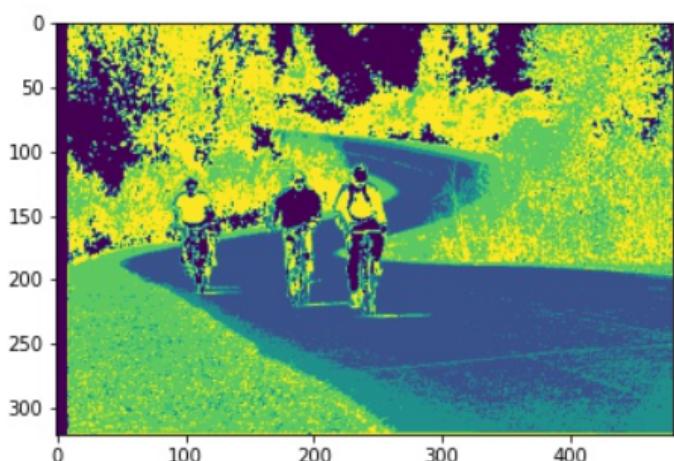


- **Image #344010 (big and small items)**

K-means

F-measure = 0.5146479349101487

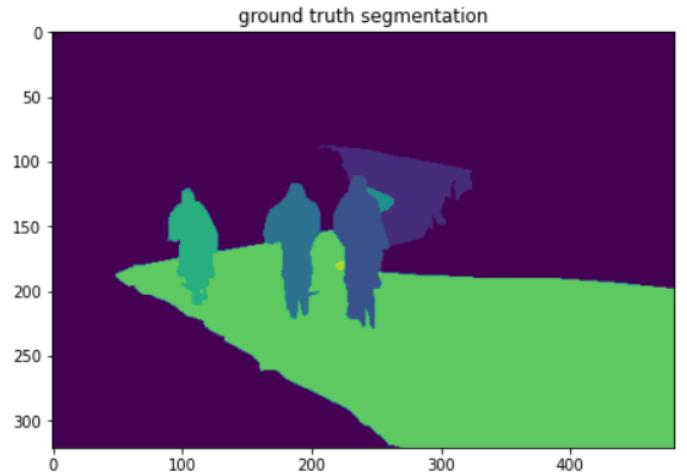
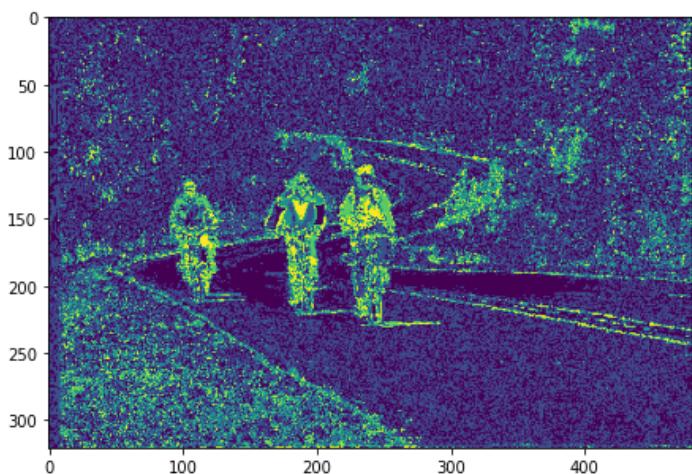
Entropy = 1.4525753383505706



Normalized-cut

F-measure=0.23034990957043658

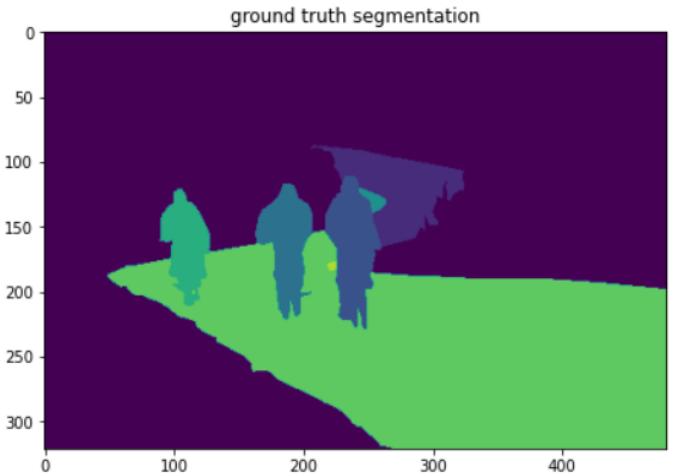
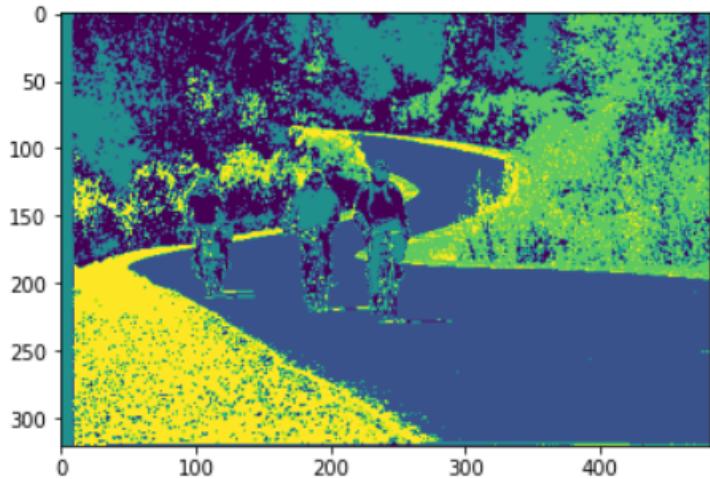
Entropy=2.699271235822294



spatial layout

F-measure=0.6079019433466643

Entropy=1.2930713386660604

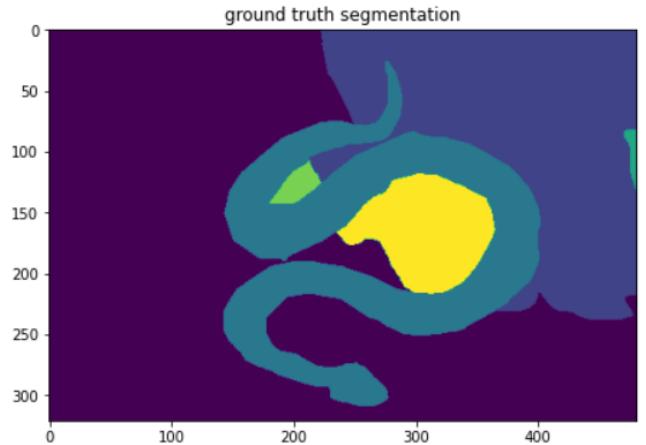
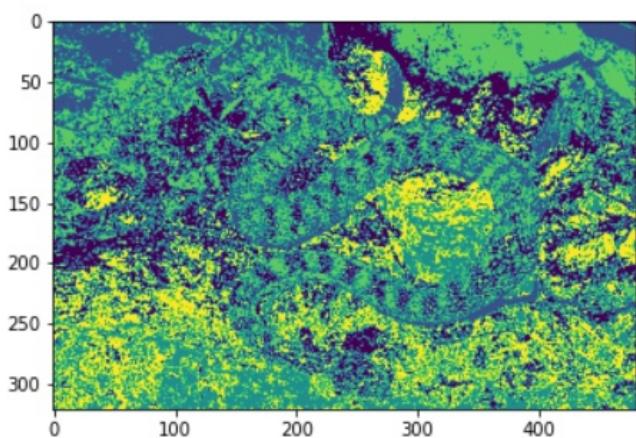


- **Image #87015 (complex item)**

K-means

F-measure = 0.33641430120405796

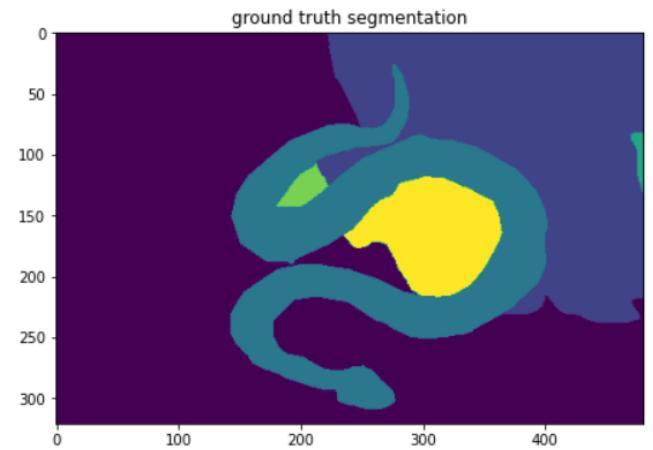
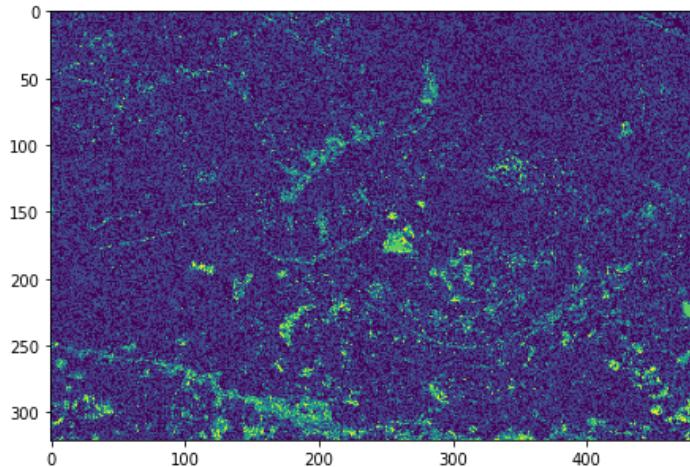
Entropy = 1.3250092343862445



Normalized-cut

F-measure=0.2498520665108547

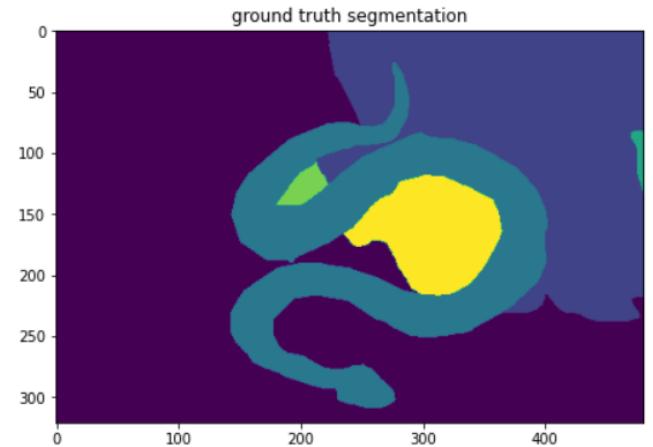
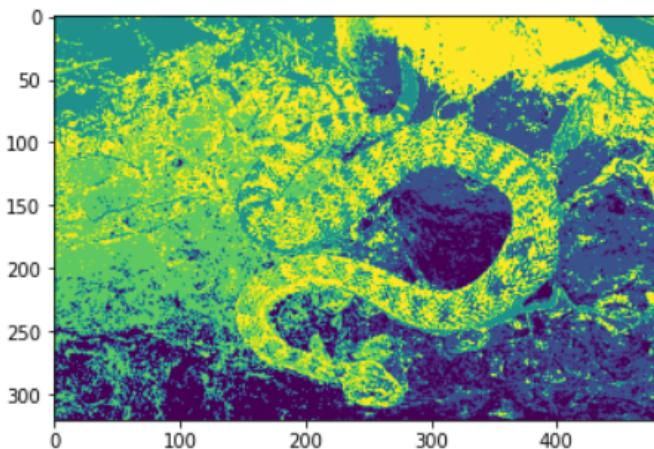
Entropy=2.312871142746998



spatial layout

F-measure=0.3737305506369474

Entropy=1.235594381955373



Comments on results

- Results are generally not good at $k = 5$.
- K-means and K-ways algorithms only consider color features and they don't identify pixels of the same object.
- Normalized cut algorithm using 5-NN graph resulted in significantly worse results, especially in pictures with similar colors (works better in high contrast situations)
- Adding the new spatial features didn't add much improvement to evaluation results because it still uses the original K-means algorithm.

Colab: [link](#)