

Universität Potsdam

REMOTE SENSING OF THE ENVIRONMENT

WINTERSEMESTER 2024-2025

LAB 7

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Question 1

Adding more samples did improve the classification, yes.

Unfortunately, displaying the scatter plots did not work for me, so I checked my training data with the other test methods. In Figure 1 you can see a Spectral Signature Plot that shows several curves from each class (Water - blue, Agriculture - light green, Forest - dark green, Urban - orange). All spectra are shaped differently, so I assume good training data. The classification preview also showed good results.

In Table 1 you can see the Classification Report.

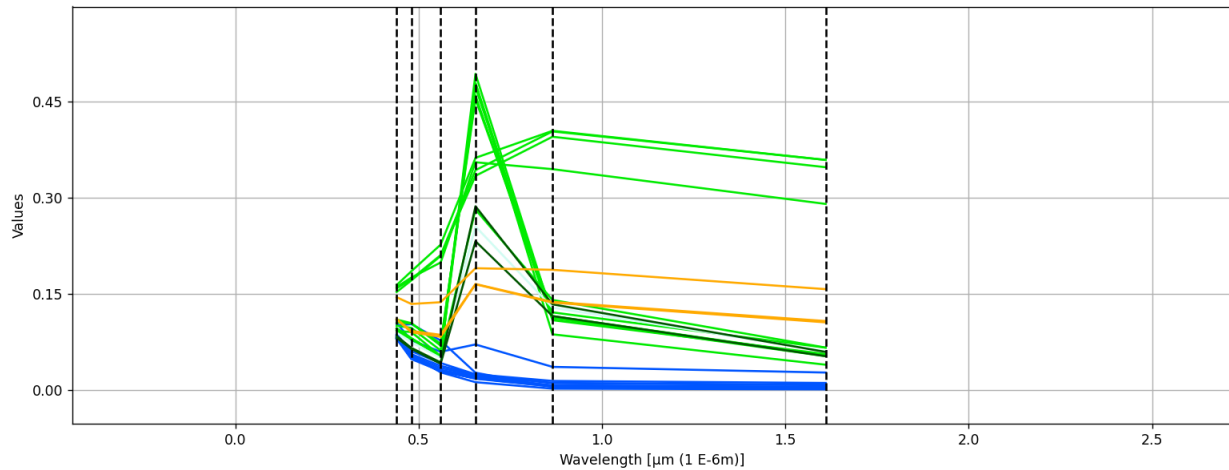


Figure 1: Spectral Signature Plot

Class	PixelSum	Percentage %	Area [<i>metre</i> ²]
1	2119403	5.090692819637662	1907462700
2	16397217	39.385239543371696	14757495300
3	21730968	52.19662459729264	19557871200
4	1385311	3.327443039698004	1246779900

Table 1: Classification Report

Question 2

The three results of the different classification algorithms can be seen in Figure 2, Figure 3 and Figure 4. Each shows a section in which Potsdam Golm is located in the centre. All around are forests, fields and water areas. Spectral Angle Mapping has classified the least area as urban, instead there are more field and forest areas according to this classification. Maximum Likelihood, on the other hand, has classified too much area as urban, but there is a lack of fields and woodland in several places. Minimum Distance lies between the other two algorithms and, in my opinion, classified the inclined area best. Each algorithm classified the water surface very similarly and correctly. In all results, the classification of forest and field

areas does not quite match reality, which is due to the training data, which could have been better at this point.

Potsdam Golm and surrounding areas classified with Spectral Angle Mapping

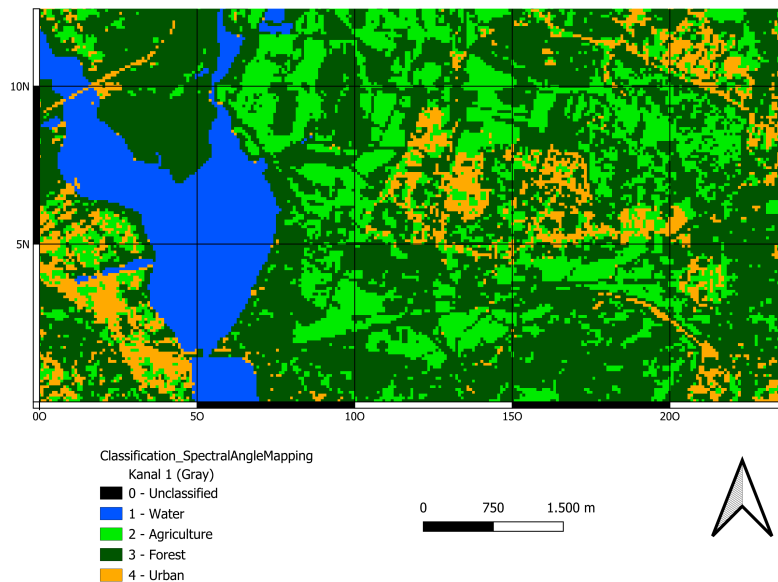


Figure 2

Question 3

Compared with the unsupervised classification, spectral angle mapping and maximum likelihood perform worse, as the urban areas were underestimated or overestimated. Minimum Distance, on the other hand, is comparable with the unsupervised classification. The advantage of the unsupervised classification is that there are initially many classes that can be combined manually. This produces a fairly accurate result in the end. With supervised classification, you can give the classes names when collecting the training data, which simplifies the process, but the result is not necessarily better.

Question 4

Unfortunately, the Random Forest Classification did not work for me. As I didn't get an error message and no result was saved after a long loading time either, there wasn't much I could do about this problem. I followed all the instructions in the explanation.

Question 5

The three results of the Accuracy Assessment of the different classification algorithms can be seen in Figure 5, Figure 6 and Figure 7. As already recognised in Question 1, Minimum Distance has the highest overall accuracy with 86%. The other two algorithms perform very poorly with < 60%.

Potsdam Golm and surrounding areas classified with Minimum Distance

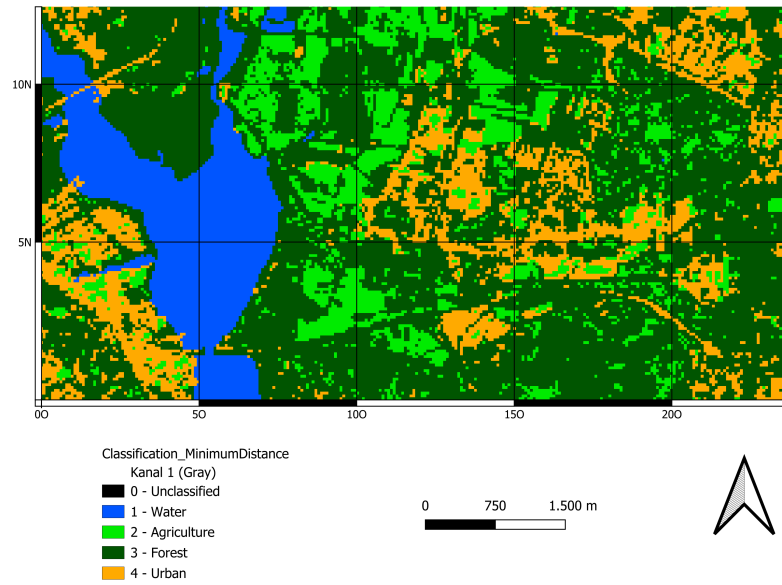


Figure 3

Potsdam Golm and surrounding areas classified with Maximum Likelihood

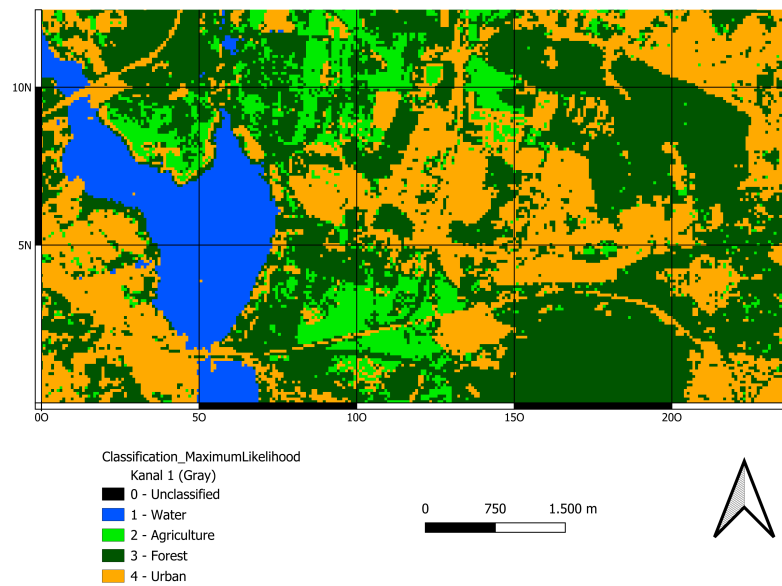


Figure 4

ErrMatrixCode	Reference	Classified	PixelSum				
3	1	1	328606				
9	2	2	9776				
13	2	3	3594				
17	2	4	2				
8	3	1	49				
12	3	2	2954				
16	3	3	37231				
19	3	4	96				
11	4	1	1				
15	4	2	134				
18	4	3	815				
20	4	4	4642				
> ERROR MATRIX (pixel count)							
> Reference							
V_Classified	0	1	2	3	4	Total	
0	0	0	0	0	0	0	
1	0	328606	0	49	1	328656	
2	0	0	9776	2954	134	12864	
3	0	0	3594	37231	815	41640	
4	0	0	2	96	4642	4740	
Total	0	328606	13372	40330	5592	387900	
> AREA BASED ERROR MATRIX							
> Reference							
V_Classified	0	1	2	3	4	Area	Wi
0	0.0000	0.0000	0.0000	0.0000	0.0000	21519262800.0000	0.3648
1	0.0000	0.0323	0.0000	0.0000	0.0000	1907462700.0000	0.0323
2	0.0000	0.0000	0.1901	0.0574	0.0026	14757495300.0000	0.2502
3	0.0000	0.0000	0.0286	0.2964	0.0065	19557871200.0000	0.3316
4	0.0000	0.0000	0.0000	0.0004	0.0207	1246779900.0000	0.0211
Total	0.0000	0.0323	0.2187	0.3543	0.0298	58988871900.0000	
Area	0	1907172509	12903552391	20901354942	1757529258	58988871900	
SE	0.0000	0.0000	0.0010	0.0011	0.0003		
SE area	0	41036	61751469	62220014	18906350		
95% CI area	0	80431	121032879	121951227	37056446		
PA [%]	nan	100.0000	86.9138	83.6645	69.4727		
UA [%]	nan	99.9848	75.9950	89.4116	97.9325		
Kappa hat	nan	0.9998	0.6927	0.8360	0.9787		

Overall accuracy [%] = 53.9596
Kappa hat classification = 0.4427

Area unit = metre^2
SE = standard error
CI = confidence interval
PA = producer's accuracy
UA = user's accuracy

Figure 5: Accuracy Spectral Angle Mapping

ErrMatrixCode	Reference	Classified	PixelSum			
1	1	1	328606			
5	2	2	9688			
9	2	3	3682			
13	2	4	2			
4	3	1	67			
8	3	2	3126			
12	3	3	36494			
15	3	4	643			
7	4	1	9			
11	4	2	24			
14	4	3	770			
16	4	4	4789			
> ERROR MATRIX (pixel count)						
> Reference						
V_Classified	1	2	3	4	Total	
1	328606	0	67	9	328682	
2	0	9688	3126	24	12838	
3	0	3682	36494	770	40946	
4	0	2	643	4789	5434	
Total	328606	13372	40330	5592	387900	
> AREA BASED ERROR MATRIX						
> Reference						
V_Classified	1	2	3	4	Area	Wi
1	0.0337	0.0000	0.0000	0.0000	1986056100.0000	0.0337
2	0.0000	0.1605	0.0518	0.0004	12547861200.0000	0.2127
3	0.0000	0.0312	0.3095	0.0065	20485088100.0000	0.3473
4	0.0000	0.0001	0.0481	0.3581	23969866500.0000	0.4063
Total	0.0337	0.1919	0.4094	0.3650	58988871900.0000	
Area	1985596871	11319960383	24149862302	21533452344	58988871900	
SE	0.0000	0.0010	0.0020	0.0018		
SE area	52671	56113183	119521554	106181845		
95% CI area	103235	109981838	234262245	208116416		
PA [%]	100.0000	83.6492	75.6020	98.1018		
UA [%]	99.9769	75.4635	89.1271	88.1303		
Kappa hat	0.9998	0.6964	0.8159	0.8131		
Overall accuracy [%] = 86.1809						
Kappa hat classification = 0.7930						
Area unit = metre^2						
SE = standard error						
CI = confidence interval						
PA = producer's accuracy						
UA = user's accuracy						

Figure 6: Accuracy Minimum Distance

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ErrMatrixCode      Reference      Classified      PixelSum
3                  1              1          328314
10                 1              3              4
14                 1              4             288
9                  2              2          10244
13                 2              3          2749
17                 2              4           379
8                  3              1              1
12                 3              2           202
16                 3              3          39912
19                 3              4           215
15                 4              2              2
18                 4              3           129
20                 4              4          5461

> ERROR MATRIX (pixel count)
> Reference
V_Classified      0              1              2              3              4              Total
0                  0              0              0              0              0              0
1                  0          328314              0              1              0          328315
2                  0              0          10244              202              2          10448
3                  0              4          2749              39912              129          42794
4                  0             288           379              215             5461          6343
Total             0          328606          13372          40330          5592          387900

> AREA BASED ERROR MATRIX
> Reference
V_Classified      0              1              2              3              4              Area              Wi
0                  0.0000          0.0000          0.0000          0.0000          0.0000          21519262800.0000          0.3648
1                  0.0000          0.0215          0.0000          0.0000          0.0000          1265421600.0000          0.0215
2                  0.0000          0.0000          0.1908          0.0038          0.0000          11481319800.0000          0.1946
3                  0.0000          0.0000          0.0179          0.2596          0.0008          16420478400.0000          0.2784
4                  0.0000          0.0064          0.0084          0.0048          0.1212          8302389300.0000          0.1407
Total             0.0000          0.0279          0.2171          0.2682          0.1221          58988871900.0000
Area              0          1643917447          12808037559          15818023313          7199630781          58988871900
SE                0.0000          0.0004          0.0006          0.0005          0.0006          36366371
SE area          0          21718002          35084586          31478782          36366371
95% CI area      0          42567284          68765788          61598412          71278088
PA [%]           nan          76.9757          87.8912          96.8176          99.2820
UA [%]           nan          99.9997          98.0475          93.2654          86.0949
Kappa hat        nan          1.0000          0.9751          0.9080          0.8416

Overall accuracy [%] = 99.3080
Kappa hat classification = 0.5297

Area unit = metre^2
SE = standard error
CI = confidence interval
PA = producer's accuracy
UA = user's accuracy

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Figure 7: Accuracy Maximum Likelihood

Question 6

The three classification reports of the different classification algorithms can be seen in Figure 8, Figure 9 and Figure 10.

With spectral angle mapping and maximum likelihood there are unclassified pixels, which make up about 36% for both. The training data was therefore not suitable for these two algorithms. For both, the majority of pixels (apart from unclassified) were assigned to forest, followed by field areas.

With Minimum Distance there are no unclassified pixels, which indicates high accuracy. Here, most pixels (40%) were classified as urban, followed by forest and field areas.

For all three algorithms, water areas take up 2 – 3%. This indicates that they were classified similarly or equally by each algorithm.

Class	PixelSum	Percentage %	Area [metre^2]
0	23910292	36.480207379588826	21519262800
1	2119403	3.233597521976005	1907462700
2	16397217	25.017422481001876	14757495300
3	21730968	33.155187699054814	19557871200
4	1385311	2.113584918378478	1246779900

Figure 8: Report Spectral Angle Mapping

Class	PixelSum	Percentage %	Area [metre^2]
1	2206729	3.3668318040847294	1986056100
2	13942068	21.271573427055145	12547861200
3	22761209	34.72703823651186	20485088100
4	26633185	40.63455653234826	23969866500

Figure 9: Report Minimum Distance

Class	PixelSum	Percentage %	Area [metre^2]
0	23910292	36.480207379588826	21519262800
1	1406024	2.1451869805972676	1265421600
2	12757022	19.46353512144381	11481319800
3	18244976	27.836569629330377	16420478400
4	9224877	14.074500889039717	8302389300

Figure 10: Report Maximum Likelihood