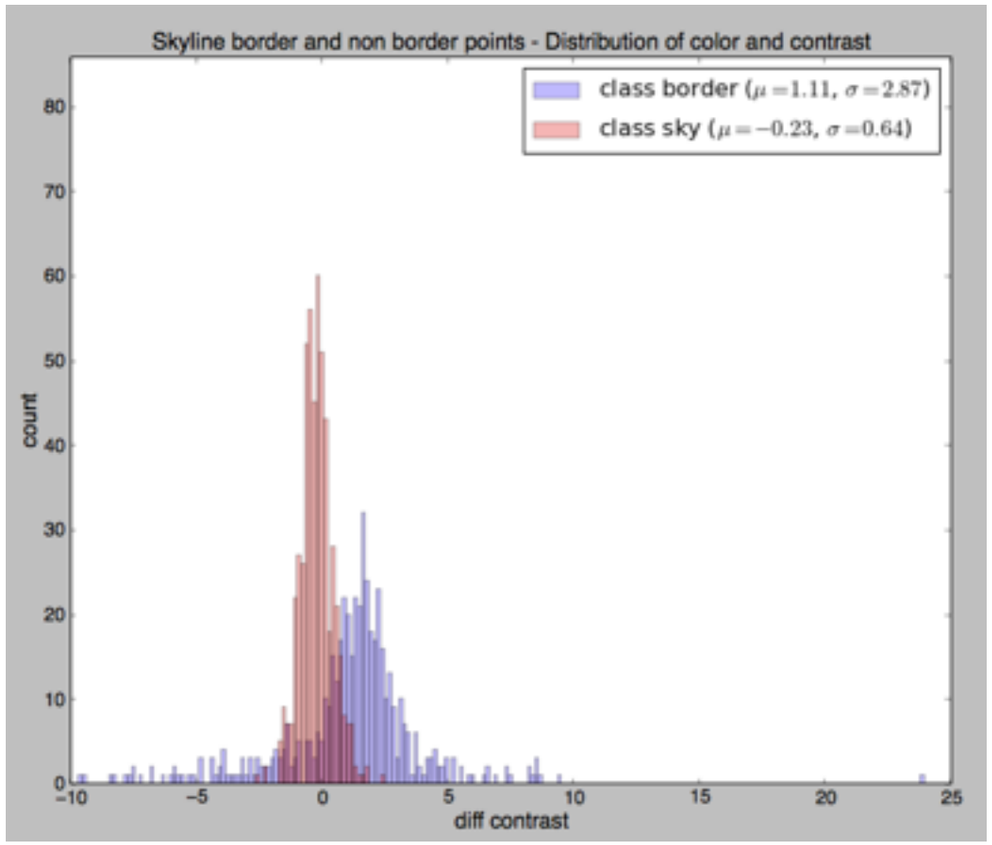
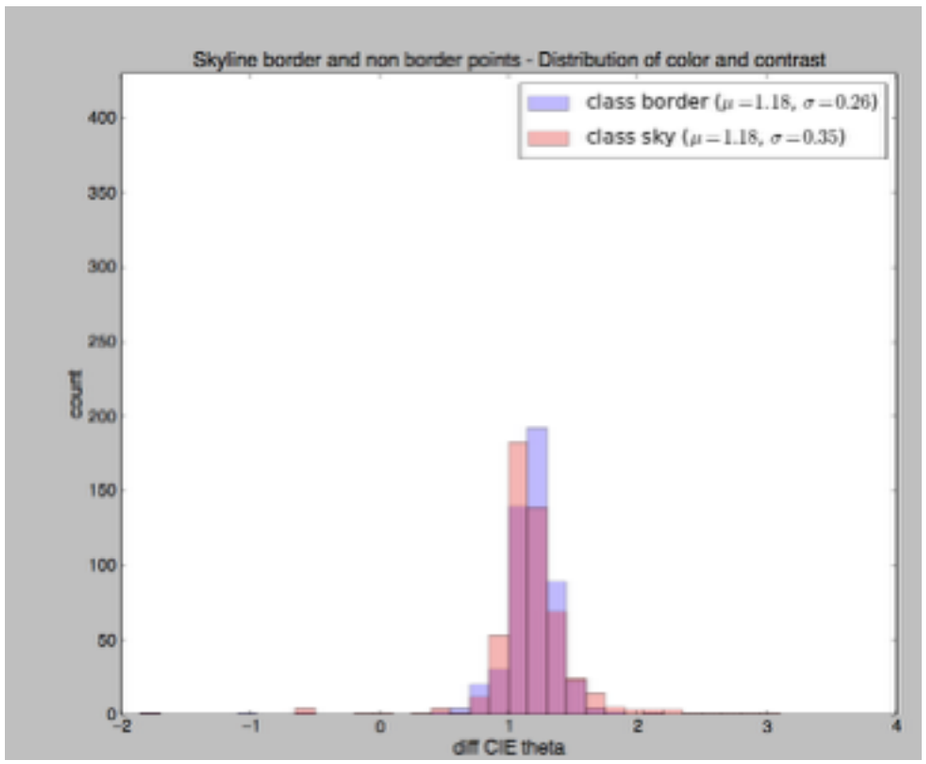
LDA look at difference in contrast, hue, blue or red, and CIE theta, all divided by their respective standard deviations.

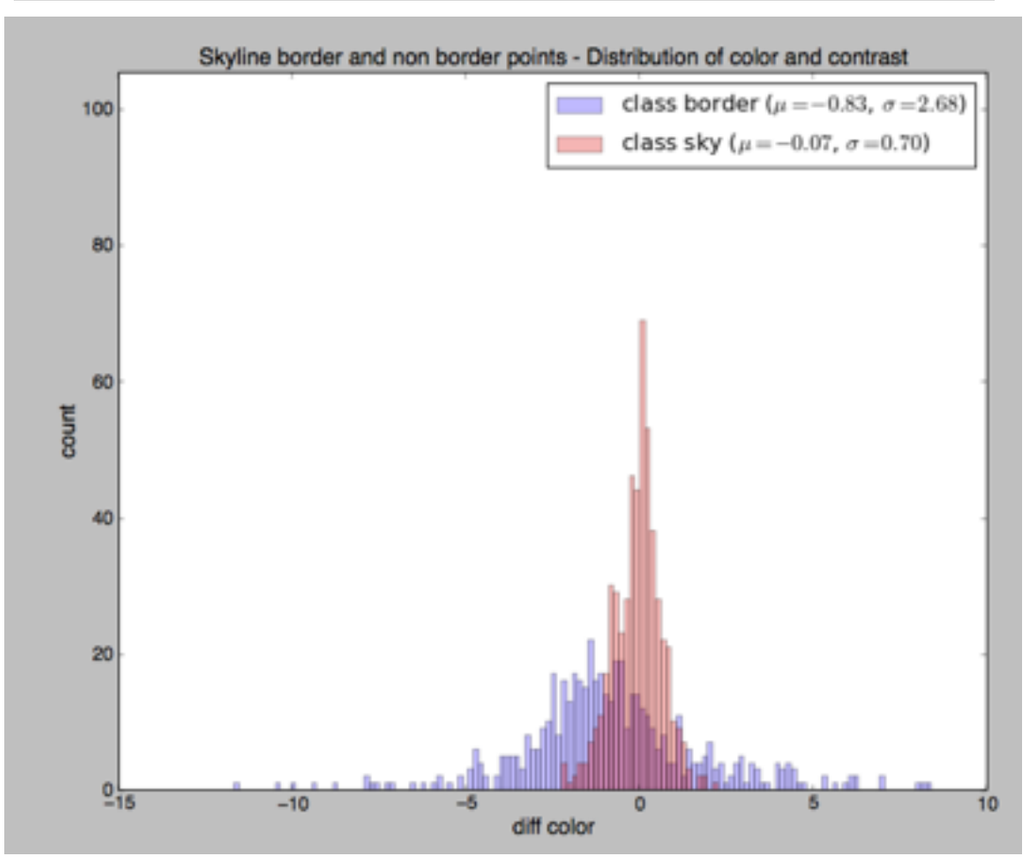
Brown & Lowe 2003, image 1

Brown & Lowe 2003, image 1

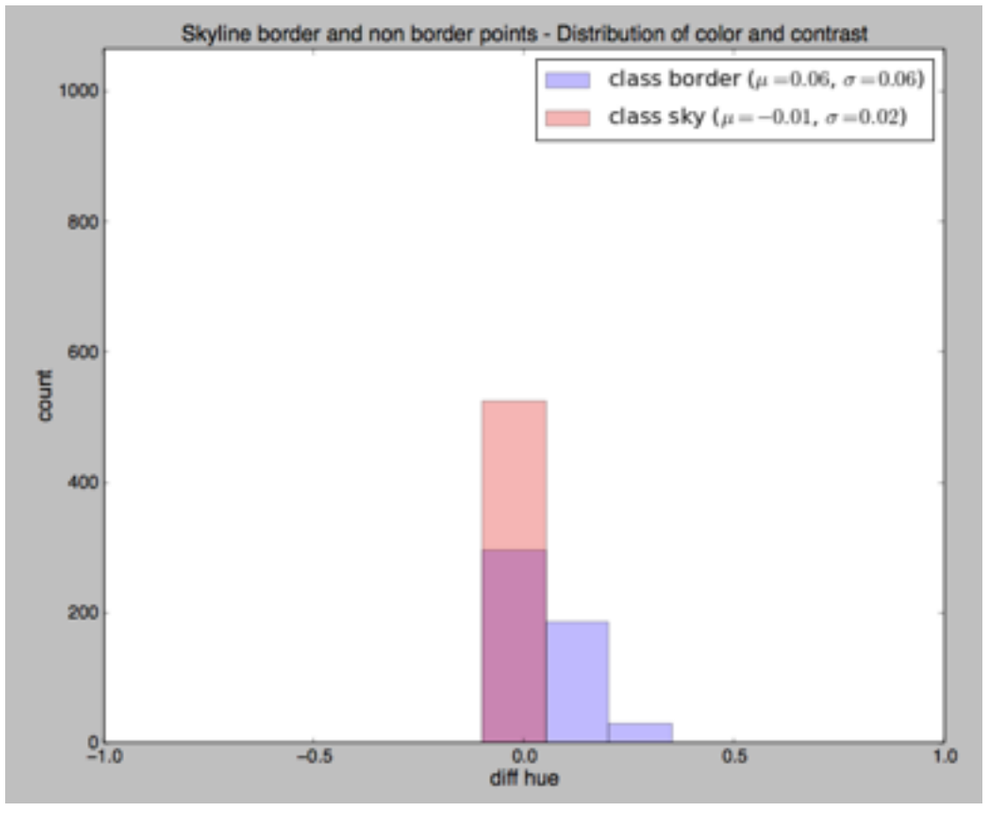


*note: the largest contrasts were removed from analysis for plot visibility

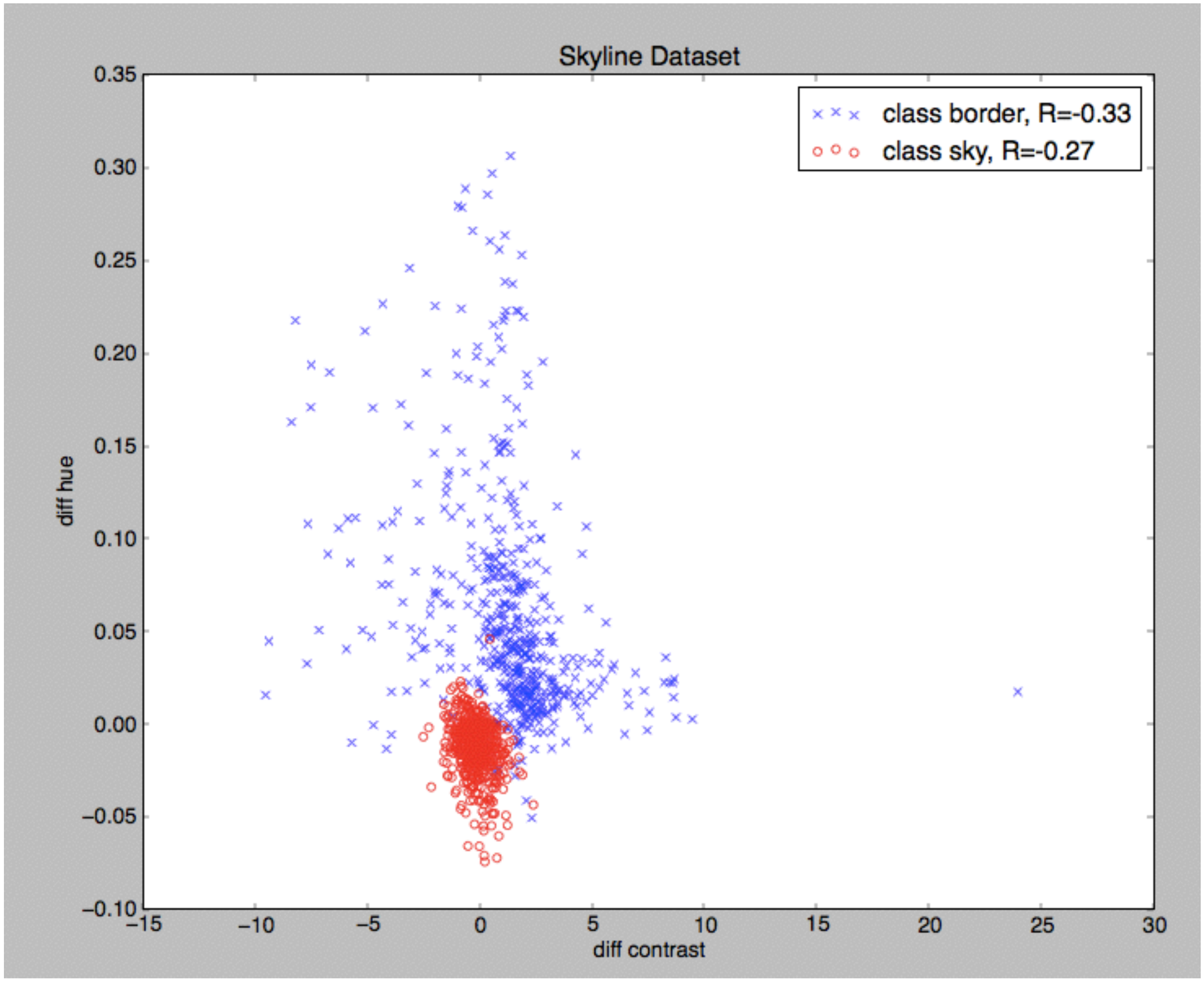




stats using 24 neighbors

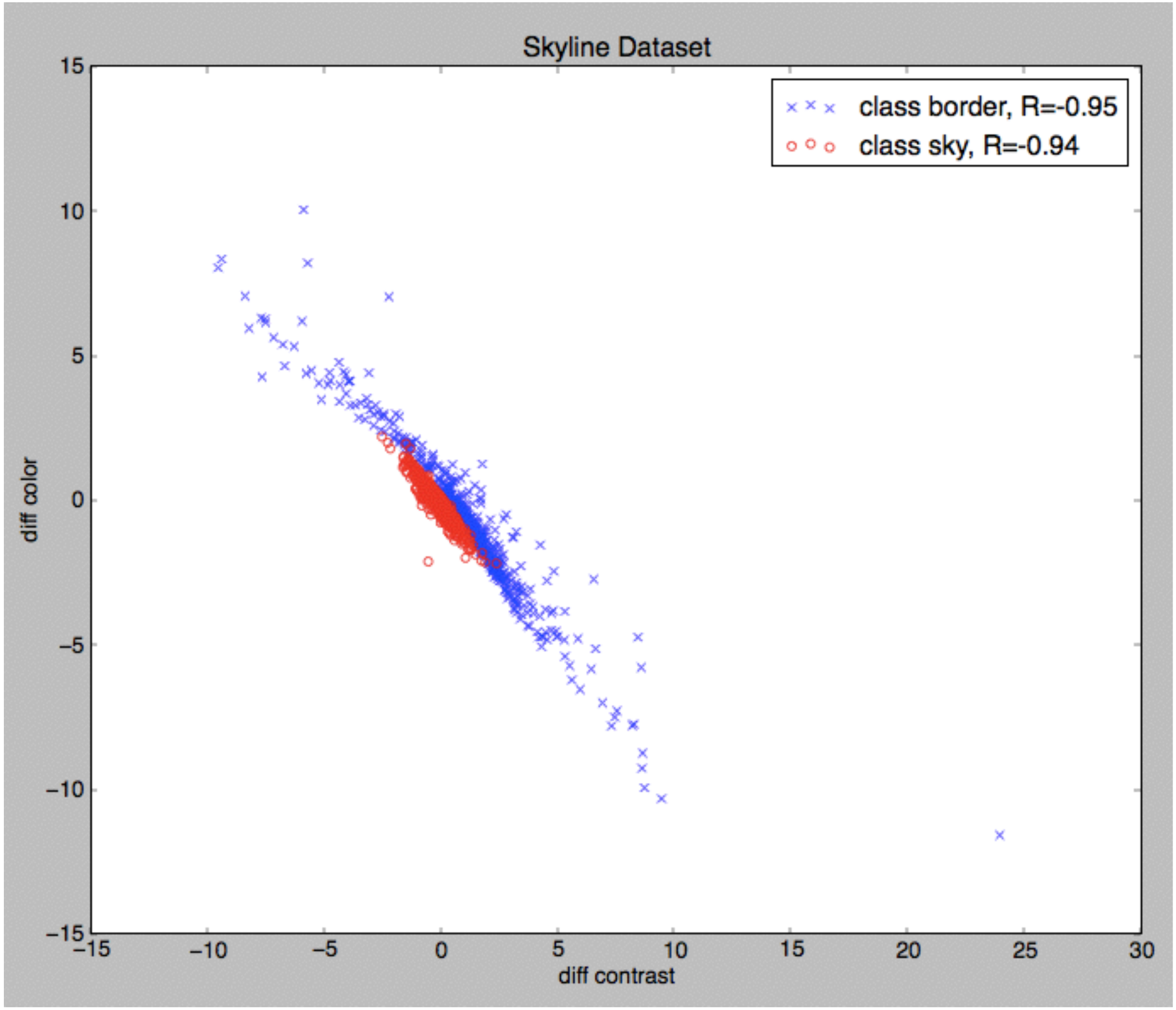


Brown & Lowe 2003, image 1



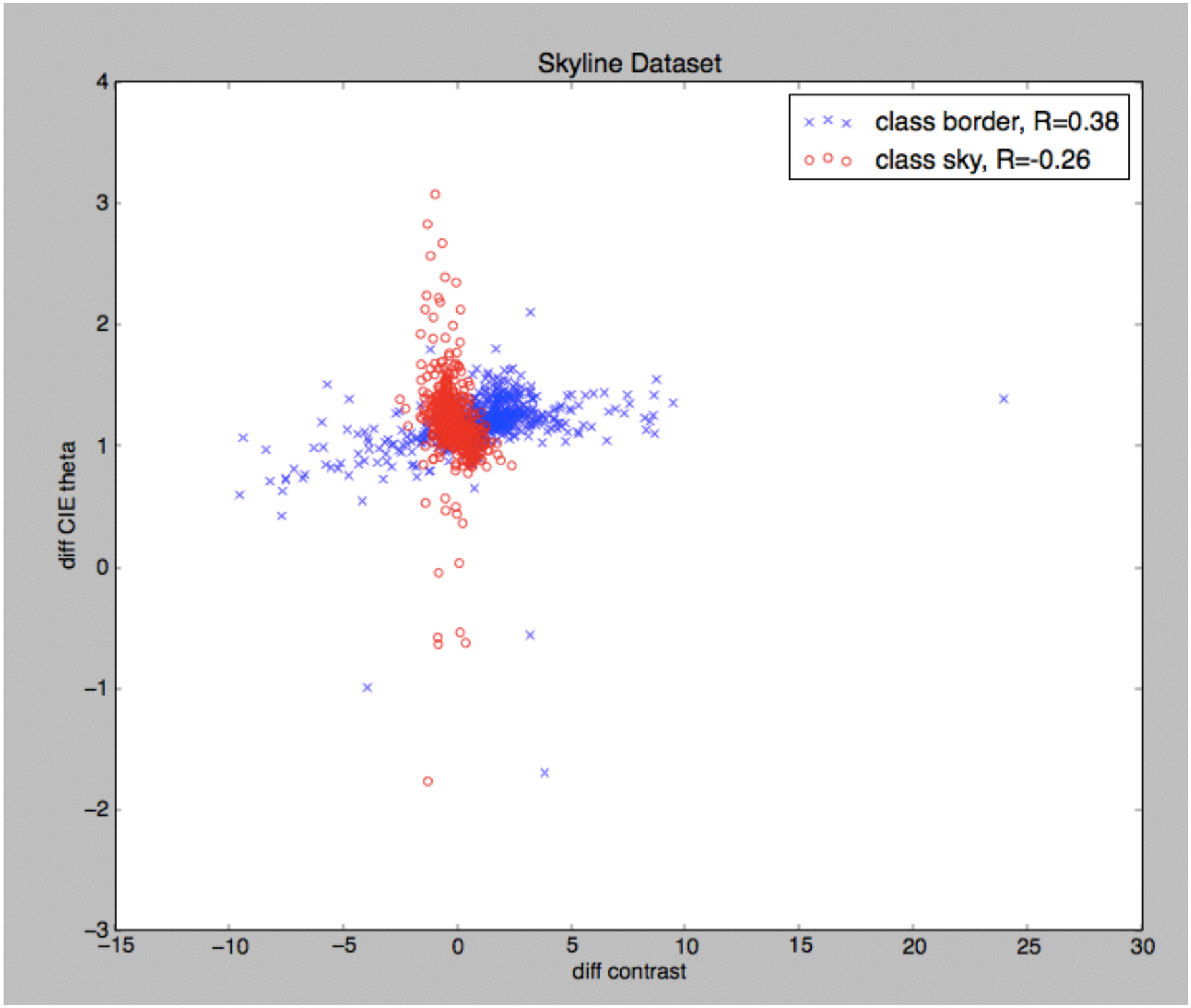
stats using 24 neighbors

Brown & Lowe 2003, image 1



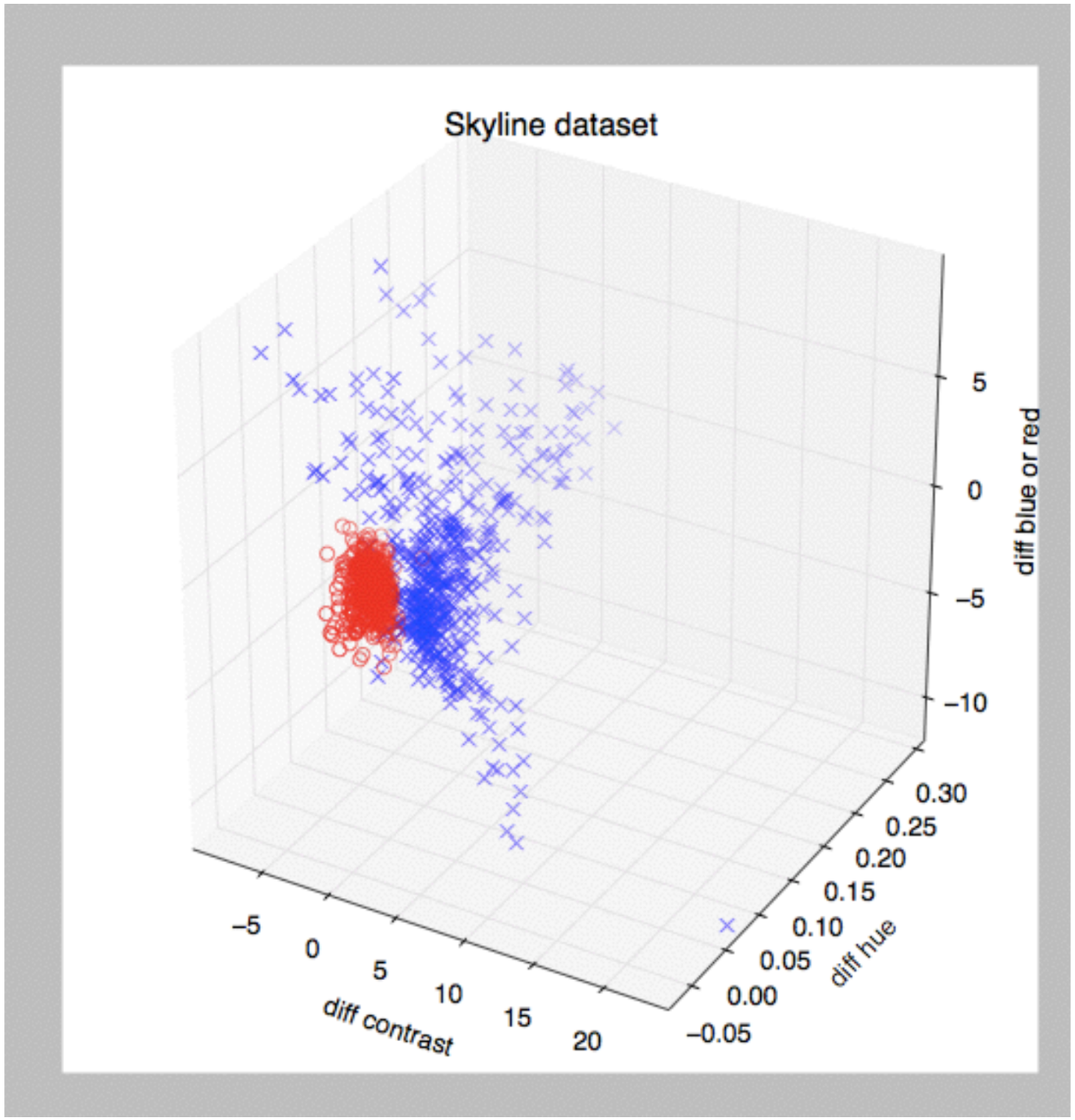
stats using 24 neighbors

Brown & Lowe 2003, image 1



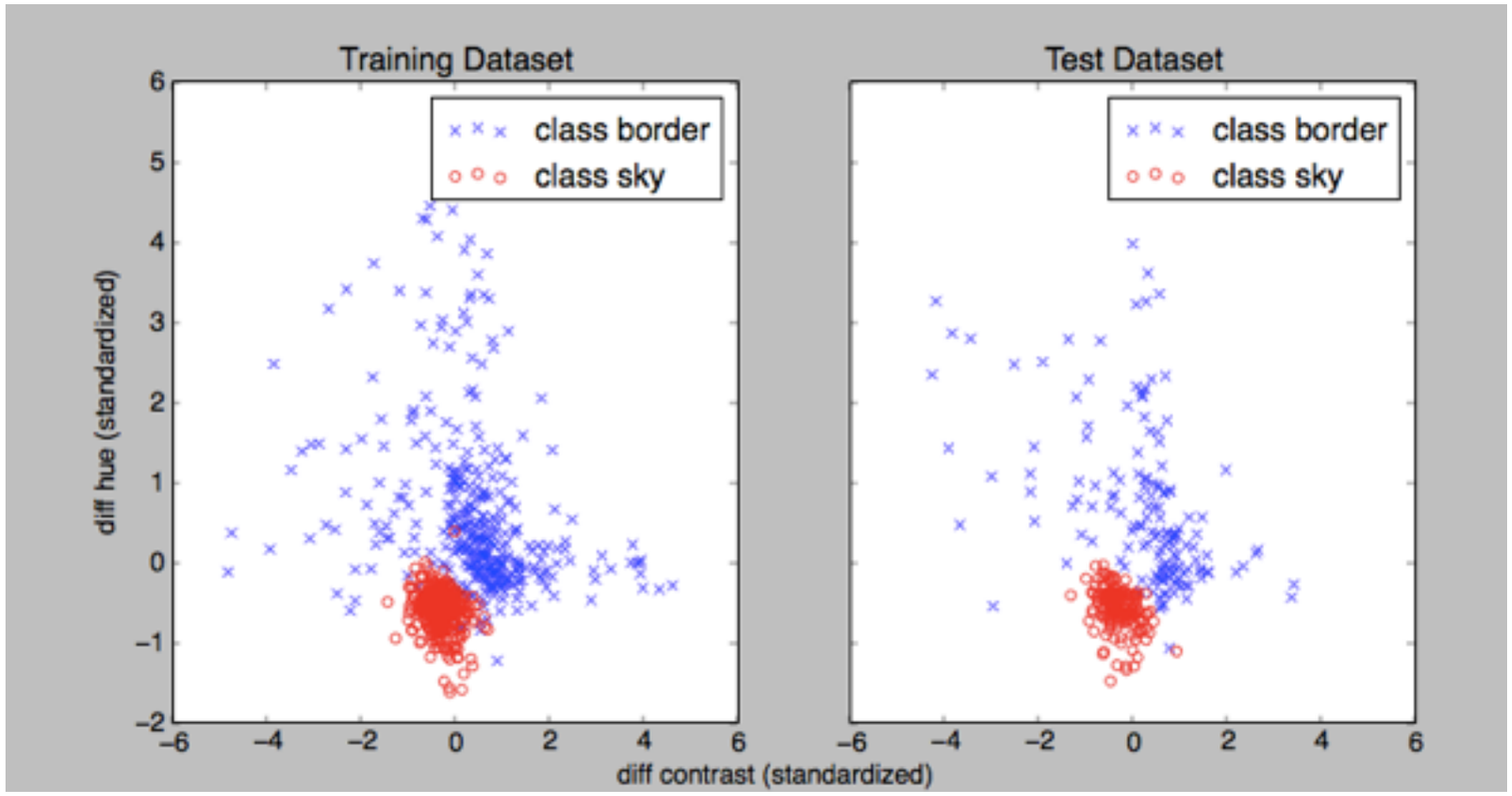
stats using 24 neighbors

Brown & Lowe 2003, image 1

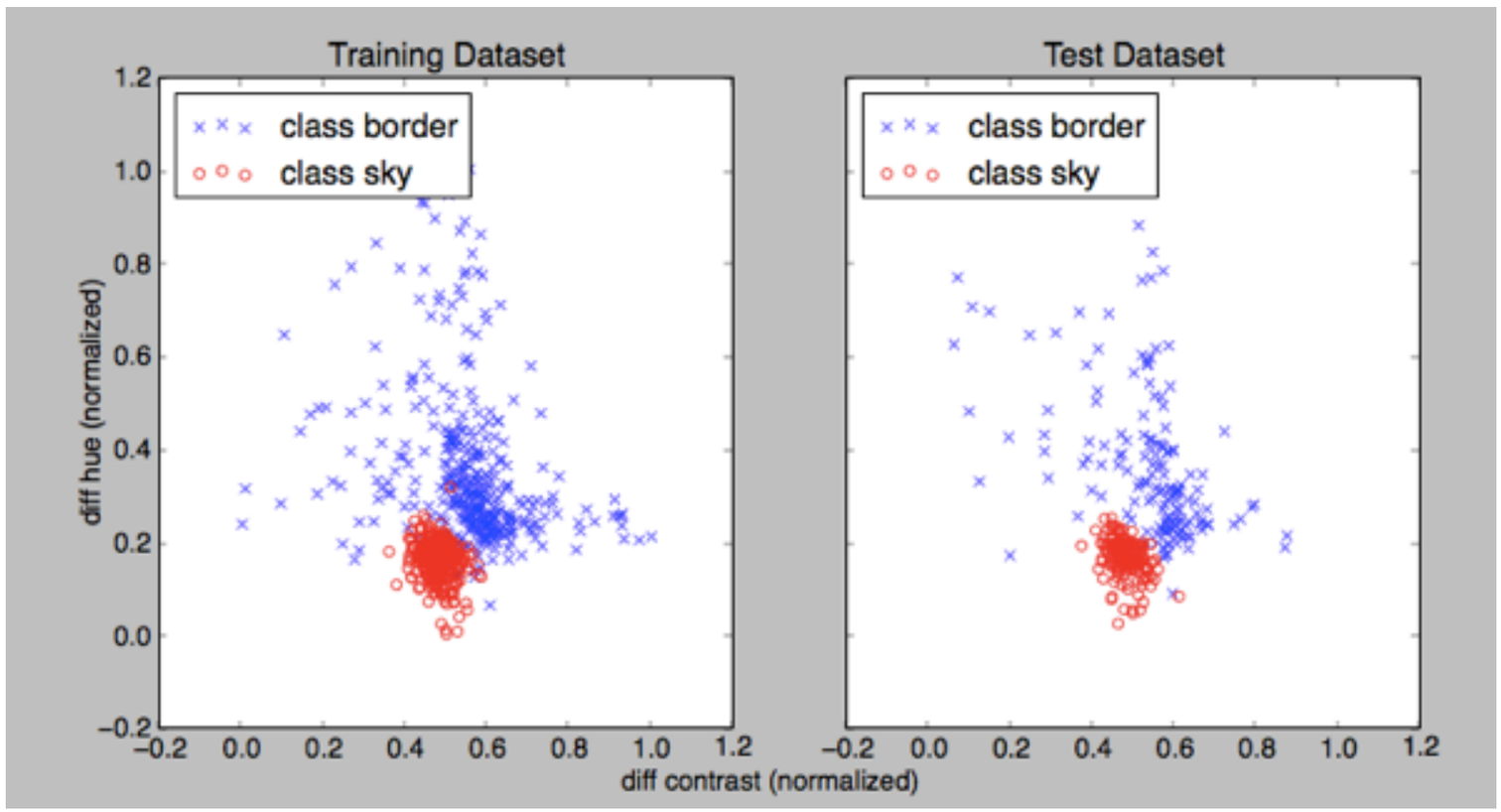


stats using 24 neighbors

Brown & Lowe 2003, image 1



Z-score normalization:
rescaled to mean μ = 0
and standard deviation
σ = 1

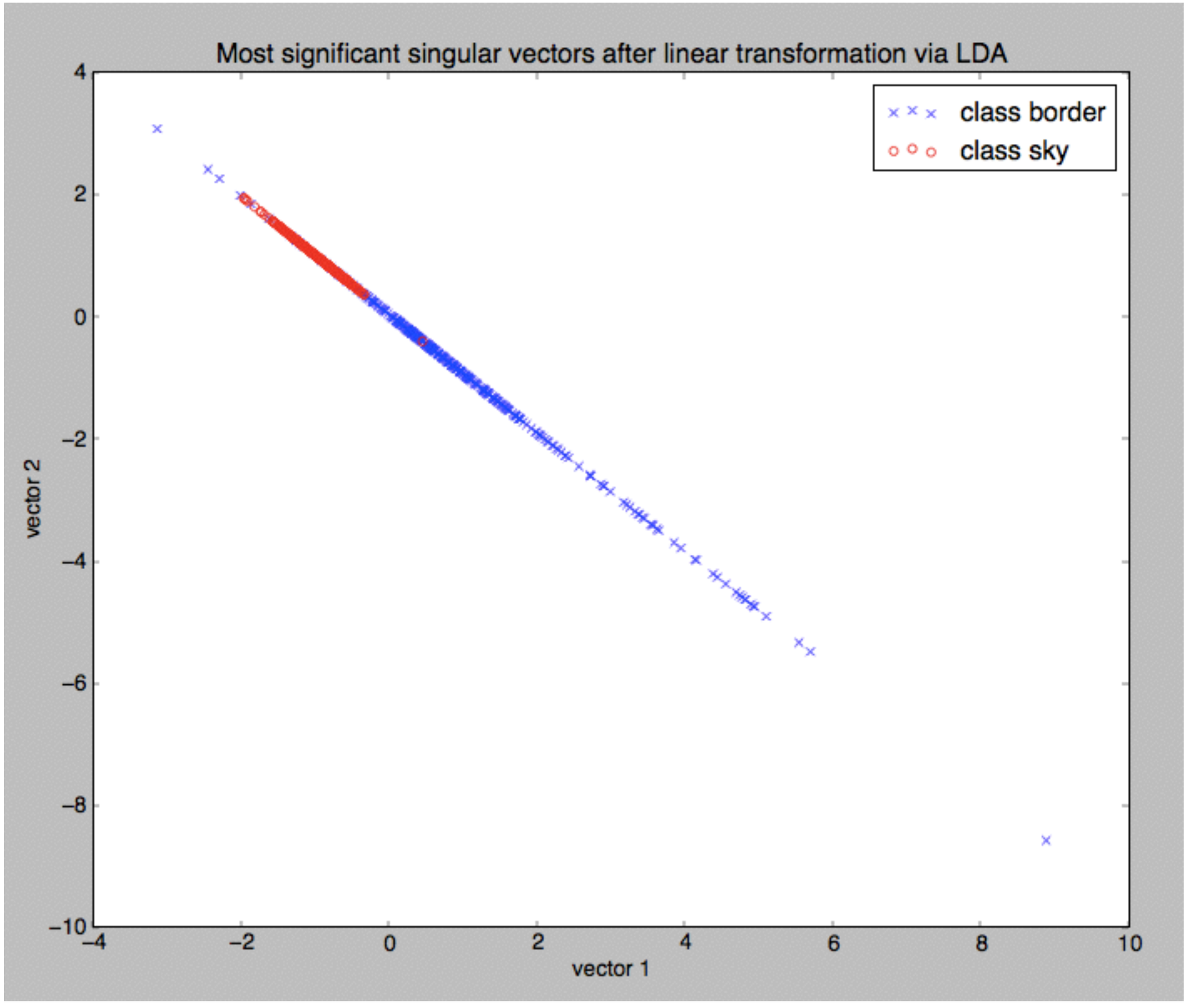


Min-max normalization:
rescaled to a fixed
range of 0 to 1 using:

```
X' = (X-X_min)
     /(X_max-X_min)
```

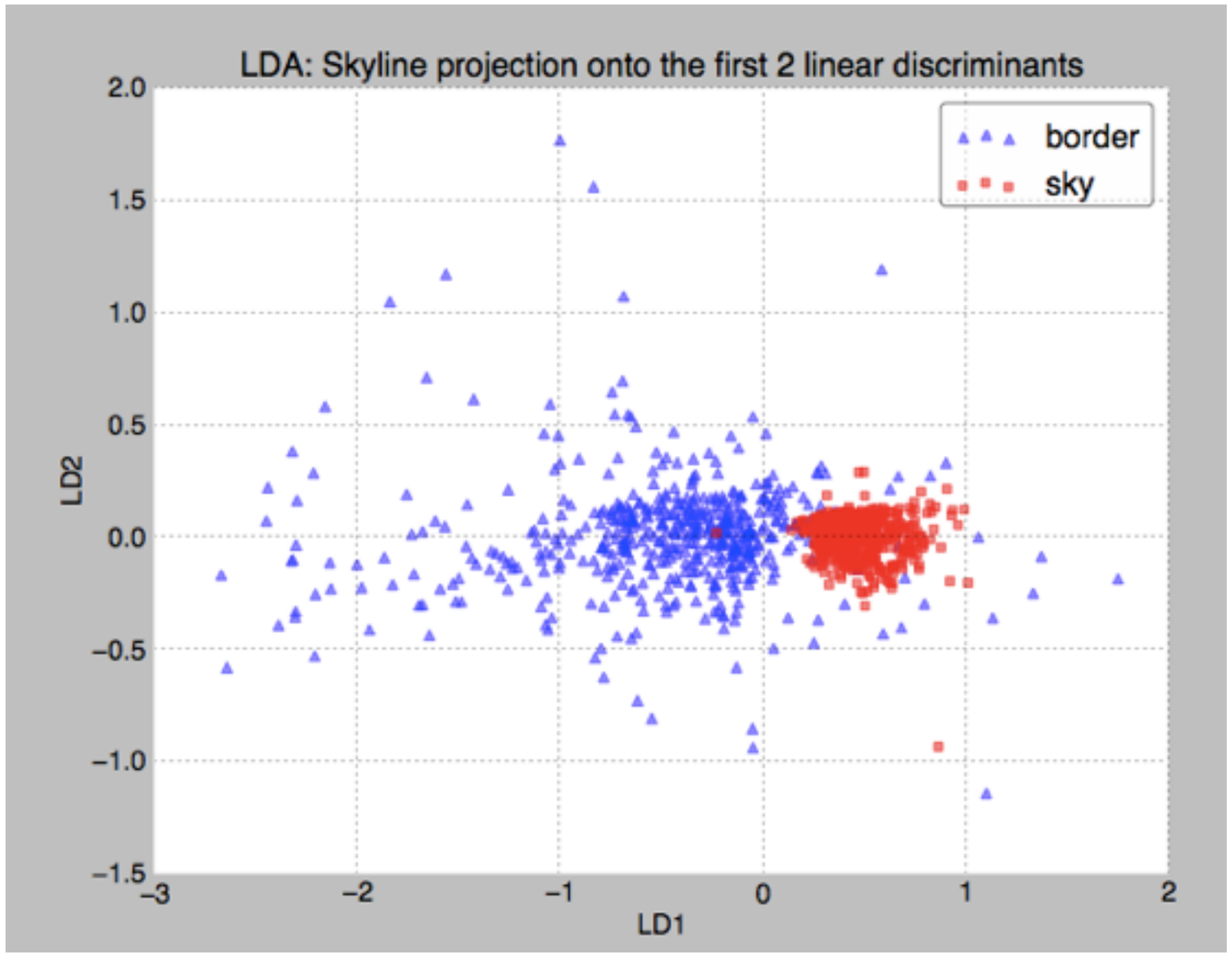
stats using 24 neighbors

Brown & Lowe 2003, image 1



stats using 24 neighbors

Brown & Lowe 2003, image 1




```
                        contrast  hue     BorR
Mean Vector class 1: [ 0.3219  0.6334 -0.1949]
Mean Vector class 2: [-0.3127 -0.6153  0.1894]

('within-class Scatter Matrix:\n',
array([[ 929.0412, -256.3866, -924.4859],
       [-256.3866,  630.4283,  296.2583],
       [-924.4859,  296.2583,  994.8667]]))
('between-class Scatter Matrix:\n',
array([[  311.9914,   613.8395,  -188.773 ],
       [  613.8395,  1207.8298,  -371.5872],
       [ -188.773 ,  -371.5872,   114.5147]]))

Eigenvector 1:
[[-0.7296]
 [-0.5264]
 [-0.4365]]
Eigenvalue 1: 3.36e+00

Eigenvector 2:
[[-0.8083]
 [ 0.5043]
 [ 0.304 ]]
Eigenvalue 2: -1.78e-17

Eigenvector 3:
[[ 0.6804]
 [-0.1237]
 [ 0.7224]]
Eigenvalue 3: 4.66e-03
ok
Eigenvalues in decreasing order:

3.36159544502
0.00466279798653
1.7822517108e-17
Variance explained:

eigenvalue 1: 99.86%
eigenvalue 2: 0.14%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.7296, -0.5264, -0.4365],
       [ 0.6804, -0.1237,  0.7224]]))
```

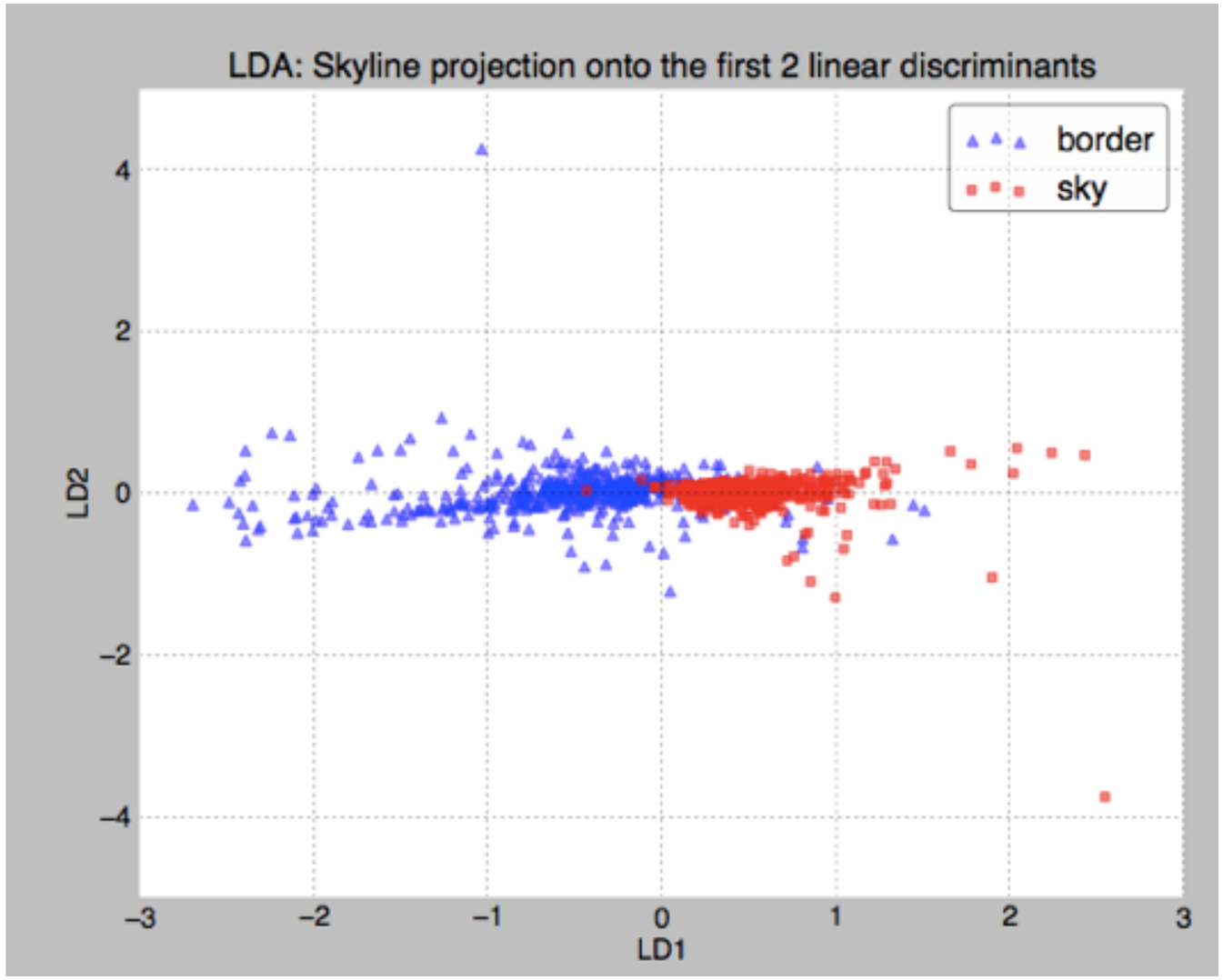
http://sebastianraschka.com/Articles/2014_python_lda.html

"*within-class scattering matrix*": for each class i: S_i = summation_x in data((x-m_i)*(x-m_i)^T)
where m_i = (1/n_i) * summation_d in data(x_k)
==> S_w = summation_i in classes (S_i)

"*between-class scattering matrix*":
==> S_B = summation_i in classes (N * (m_i - m) * (m_i - m)^T)
where m is the overall mean, and m_i and N_i are the sample mean and sizes

Solving for A*nu = lambda * nu where A = *S_w^-1 dot S_B, nu is eigenvector ,and lambda is eigenvalue*
==> LD1 and LD2 are diff contrast and diff hue transformed by y = W^T * X (== W.T.dot(X.T).T)

Brown & Lowe 2003, image 1 same analysis, except the neighborhood for stats is 8 pixels instead of 24.

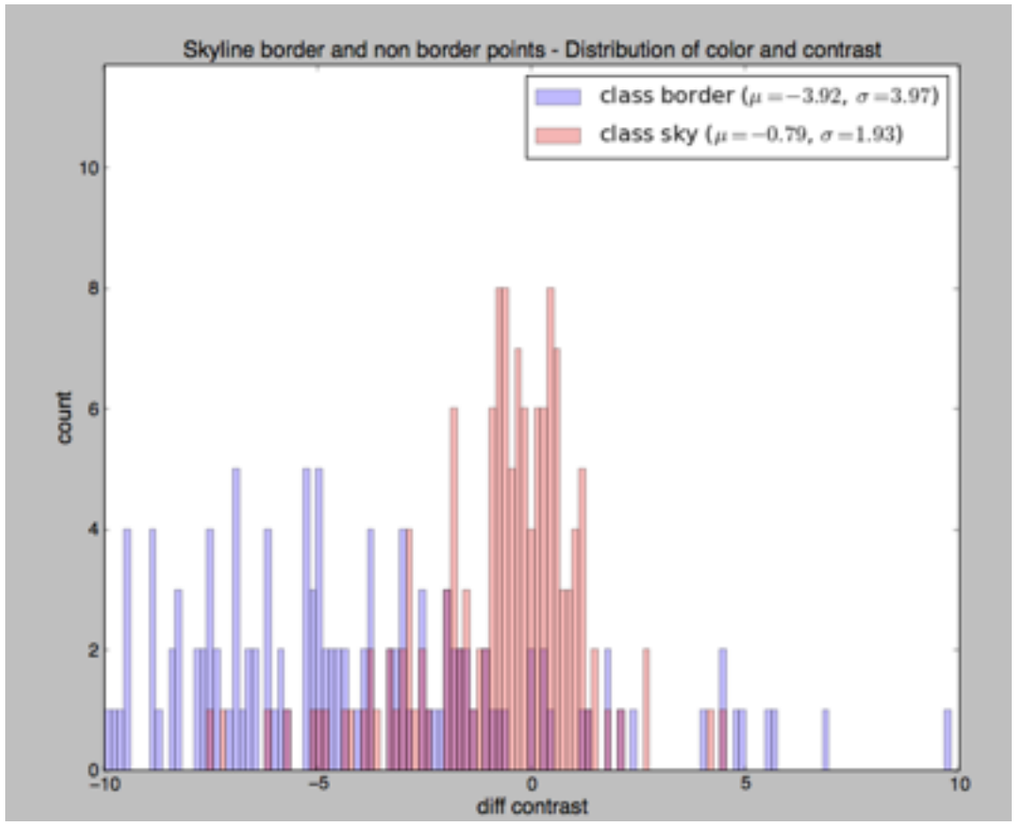



```
Mean Vector class 1: [ 0.332   0.6717 -0.158 ]

Mean Vector class 2: [-0.3124 -0.6319  0.1486]

('within-class Scatter Matrix:\n',
array([[ 911.5281, -190.6089, -889.5255],
       [-190.6089,  585.3437,  218.0827],
       [-889.5255,  218.0827,  993.1179]]))
('between-class Scatter Matrix:\n',
array([[  316.9373,   640.6376,  -150.044 ],
       [  640.6376,  1295.4907,  -304.0761],
       [ -150.044 ,  -304.0761,    72.1681]]))

Eigenvector 1:
[[-0.7012]
 [-0.5647]
 [-0.4353]]
Eigenvalue 1: 3.59e+00

Eigenvector 2:
[[-0.8121]
 [ 0.4796]
 [ 0.3325]]
Eigenvalue 2: 3.52e-16

Eigenvector 3:
[[ 0.6703]
 [-0.162 ]
 [ 0.7242]]
Eigenvalue 3: 1.10e-02
ok
Eigenvalues in decreasing order:

3.59292475827
0.0109669690478
3.5237701844e-16
Variance explained:

eigenvalue 1: 99.70%
eigenvalue 2: 0.30%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.7012, -0.5647, -0.4353],
       [ 0.6703, -0.162 ,  0.7242]]))
```

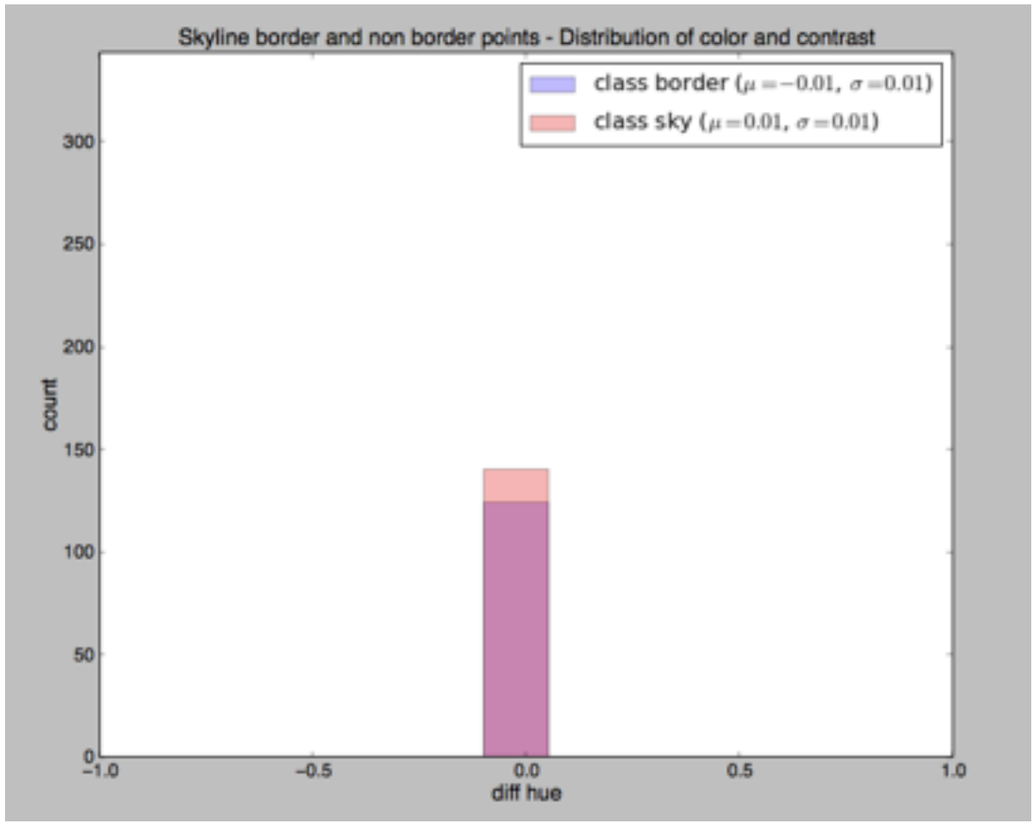
LDA look at difference in contrast, hue, blue or red, and CIE theta, all divided by their respective standard deviations.

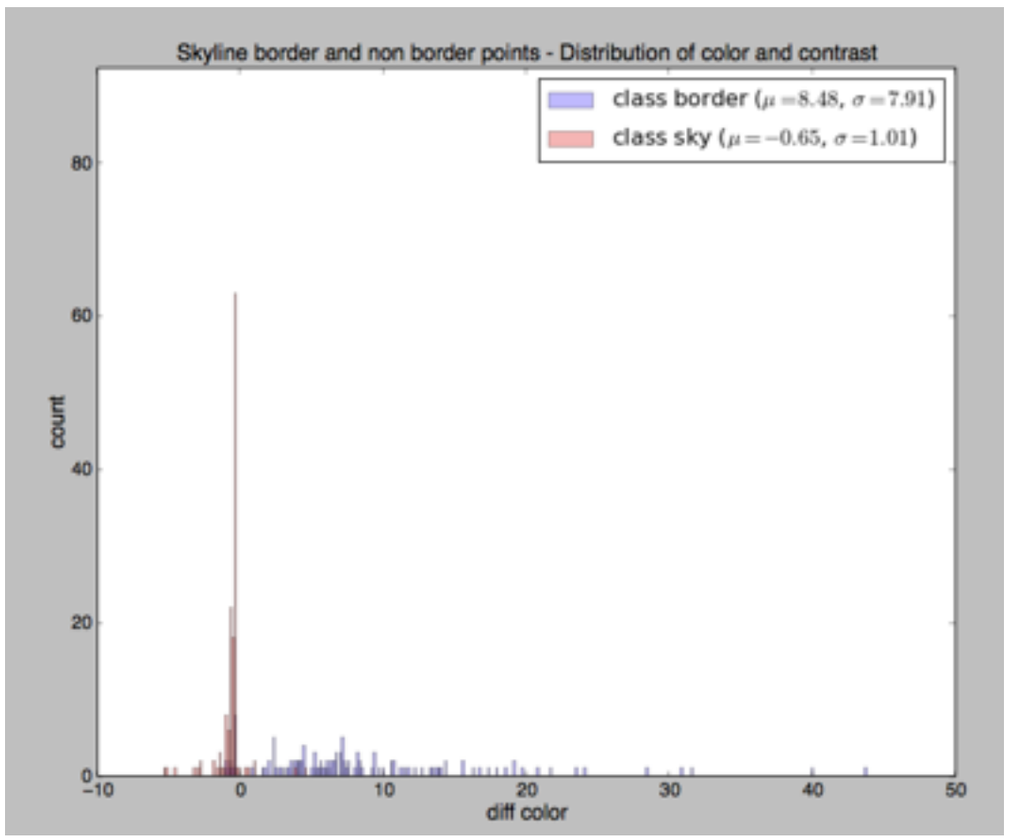
Venturi mtn range, image 1

Venturi mtn range, image 1



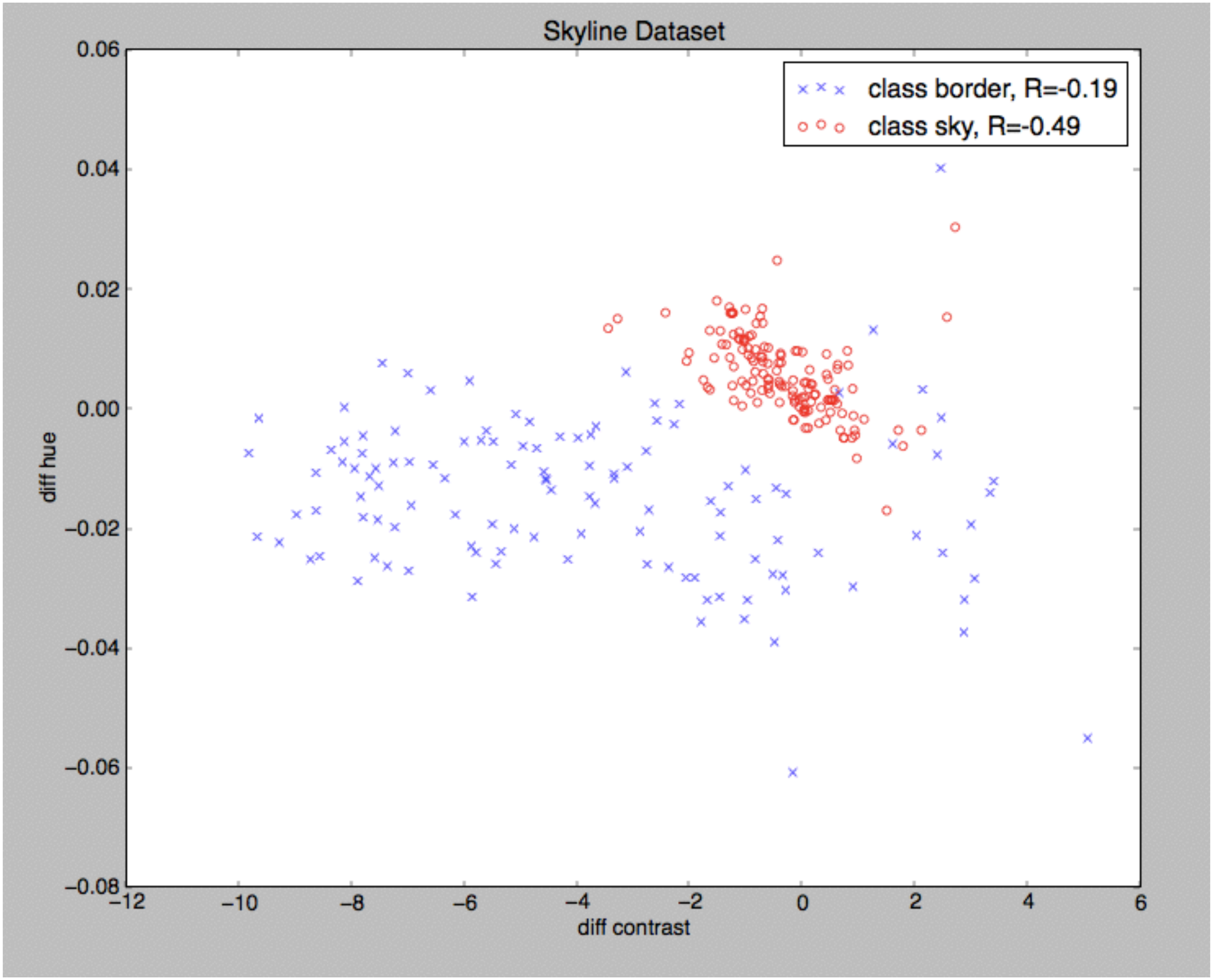
*note: the largest contrasts were removed from analysis for plot visibility





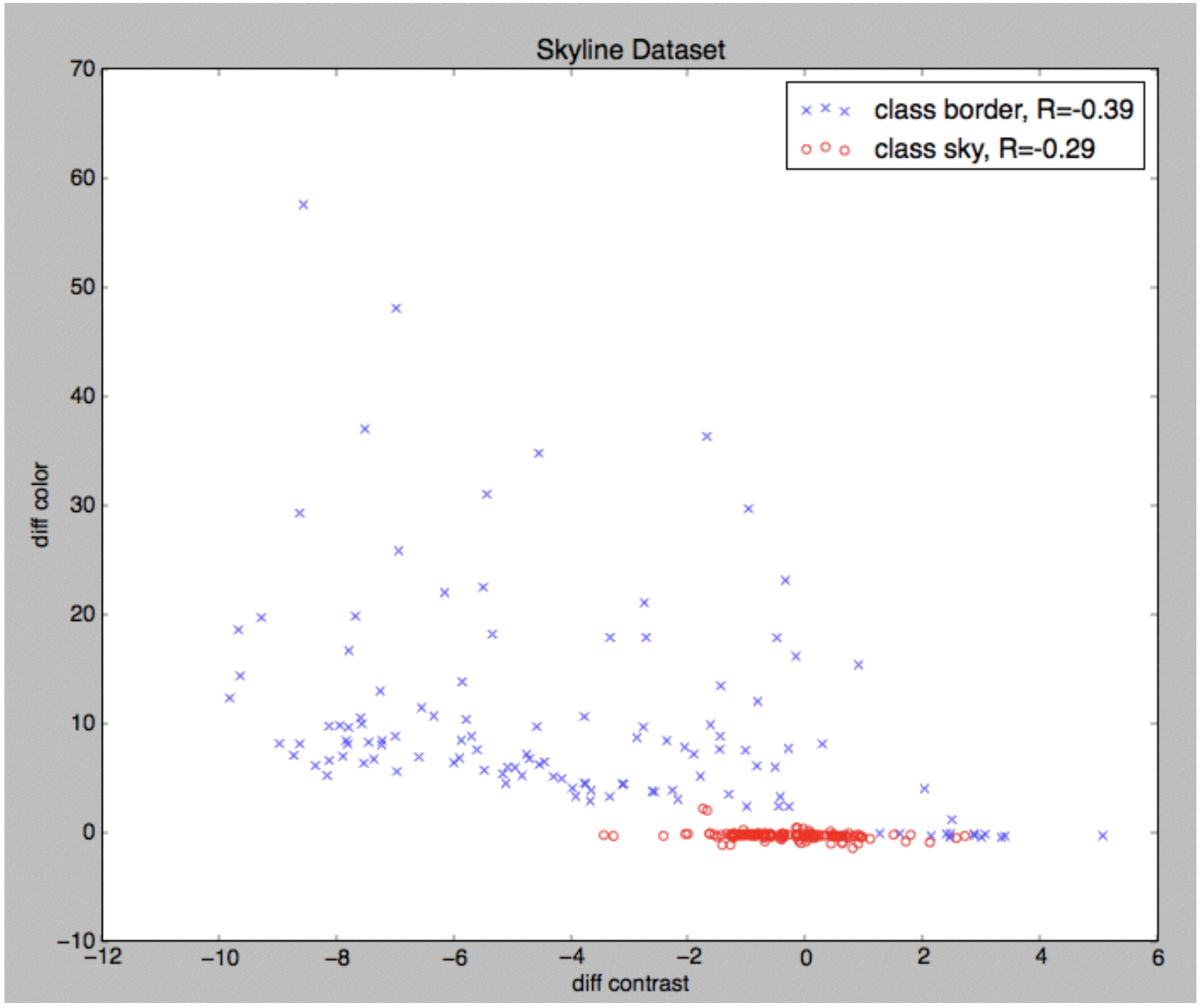
stats using 24 neighbors

Venturi mtn range, image 1



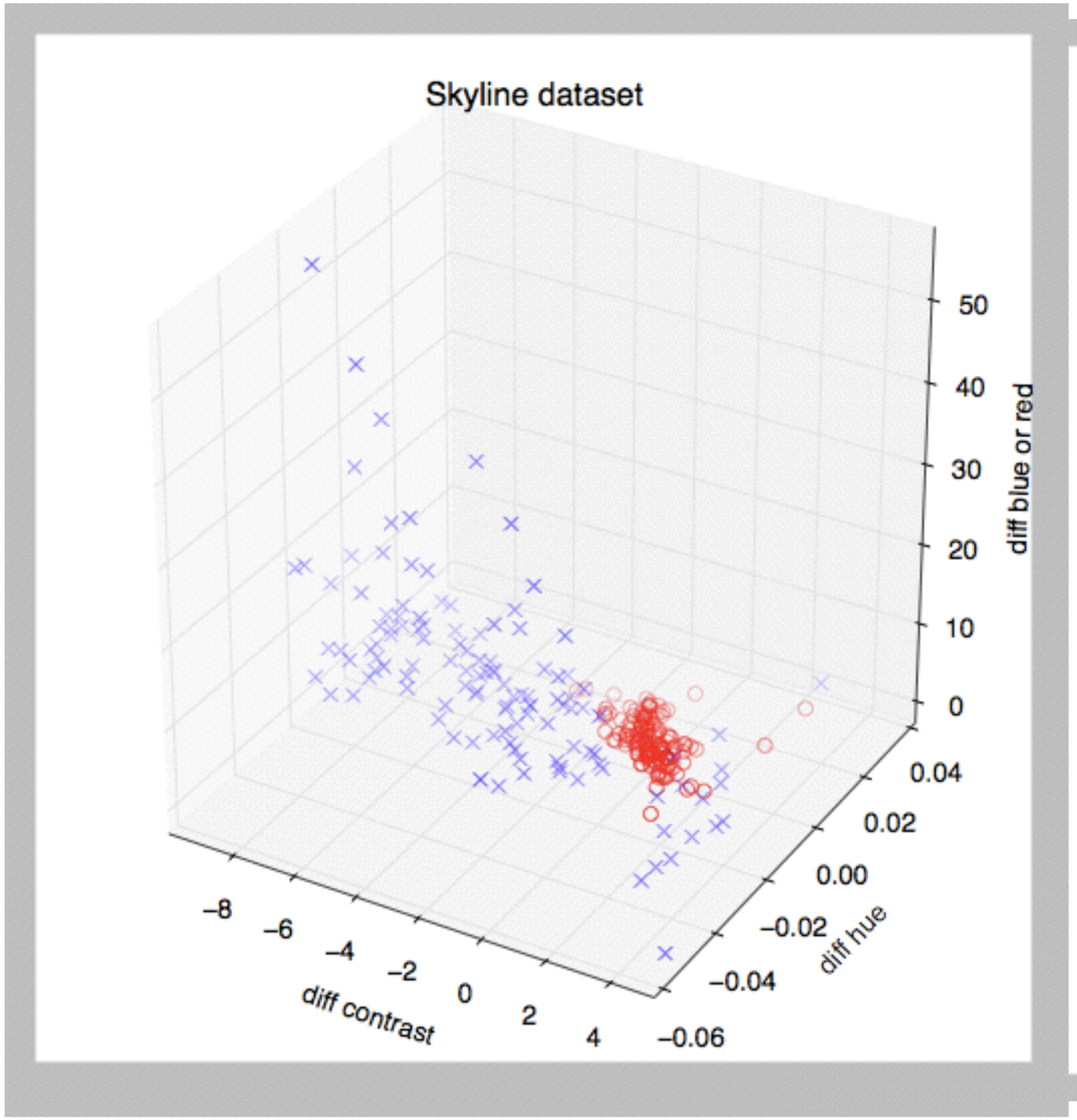
stats using 24 neighbors

Venturi mtn range, image 1

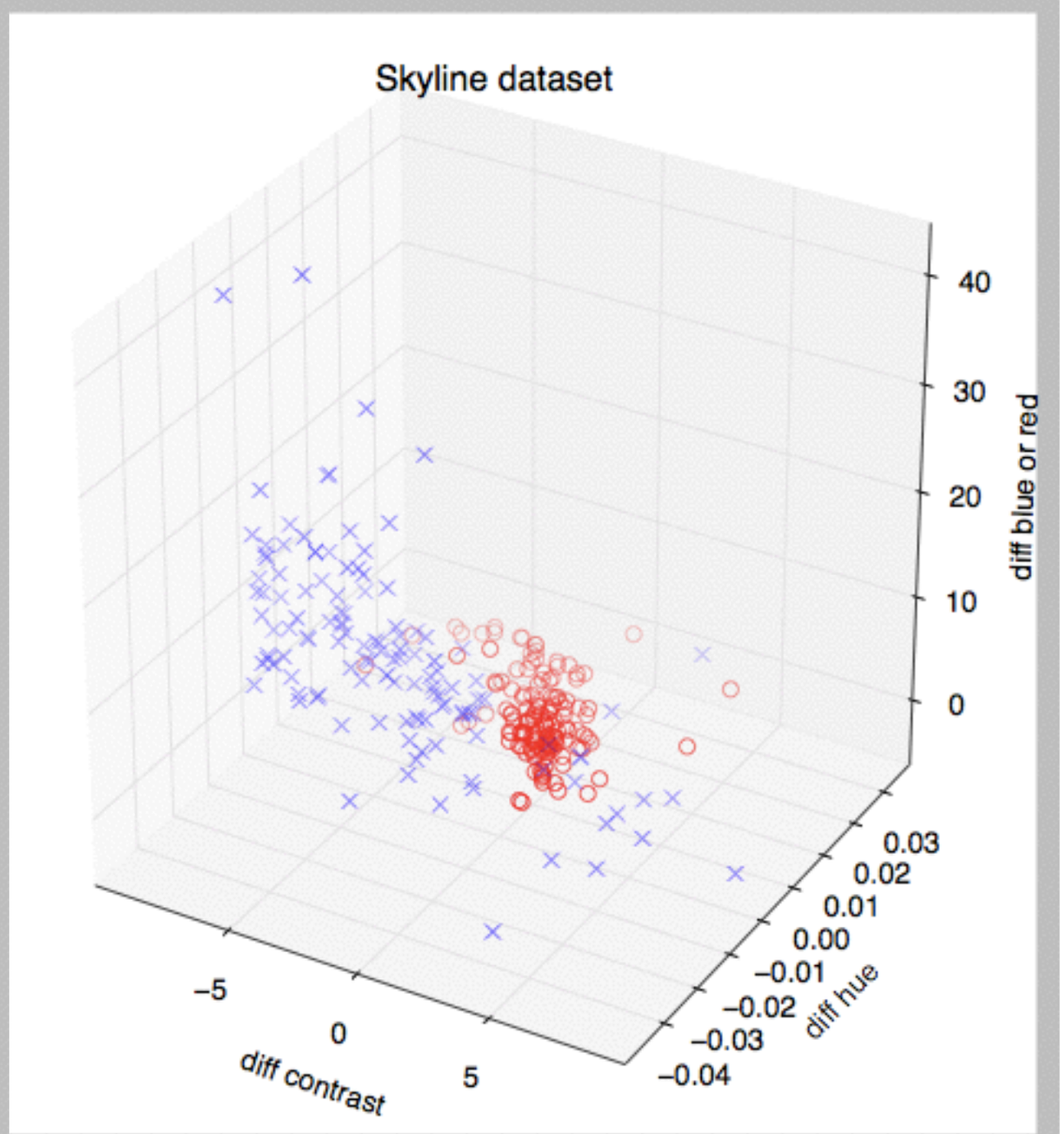


stats using 24 neighbors

Venturi mtn range, image 1

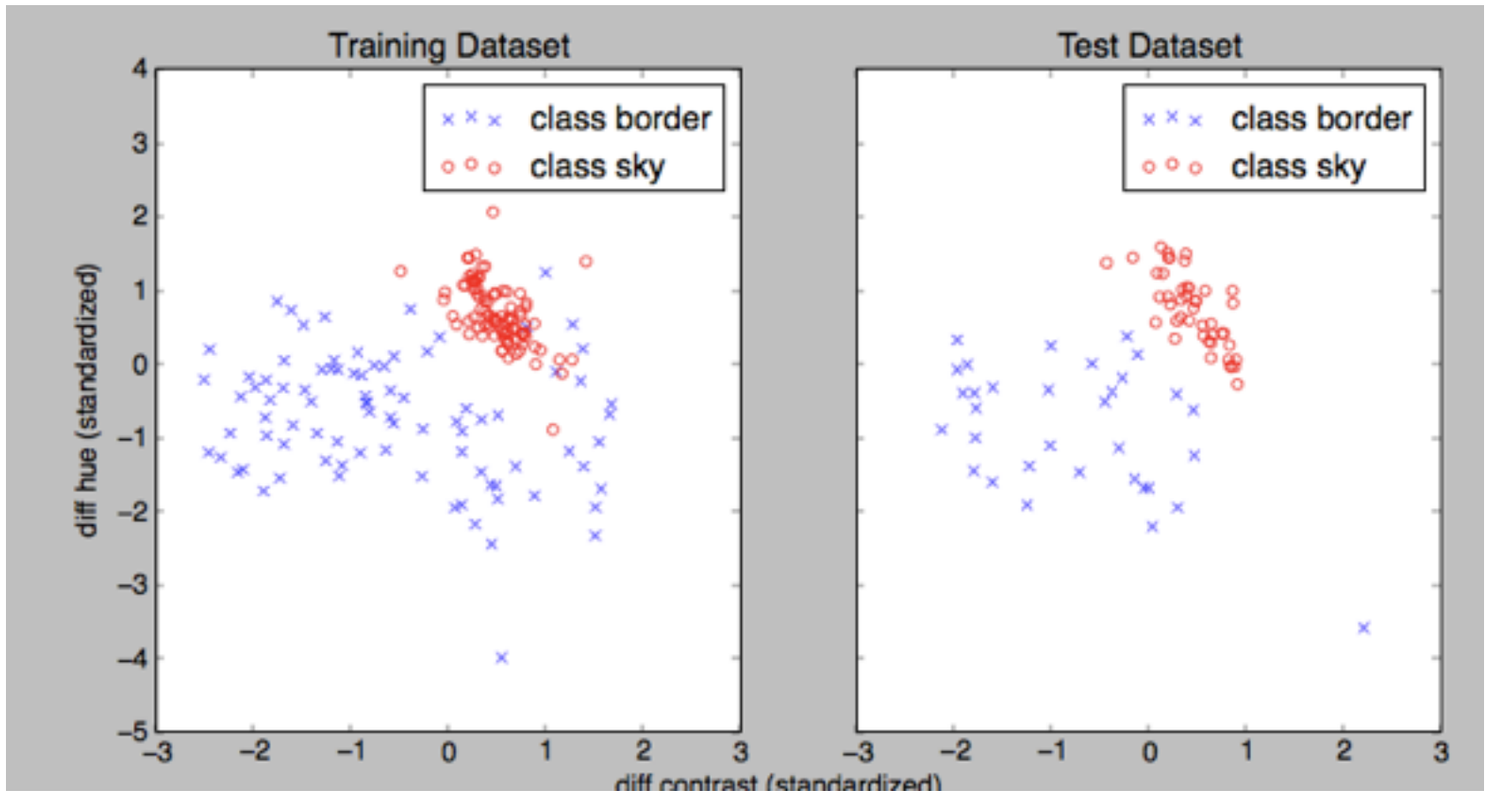


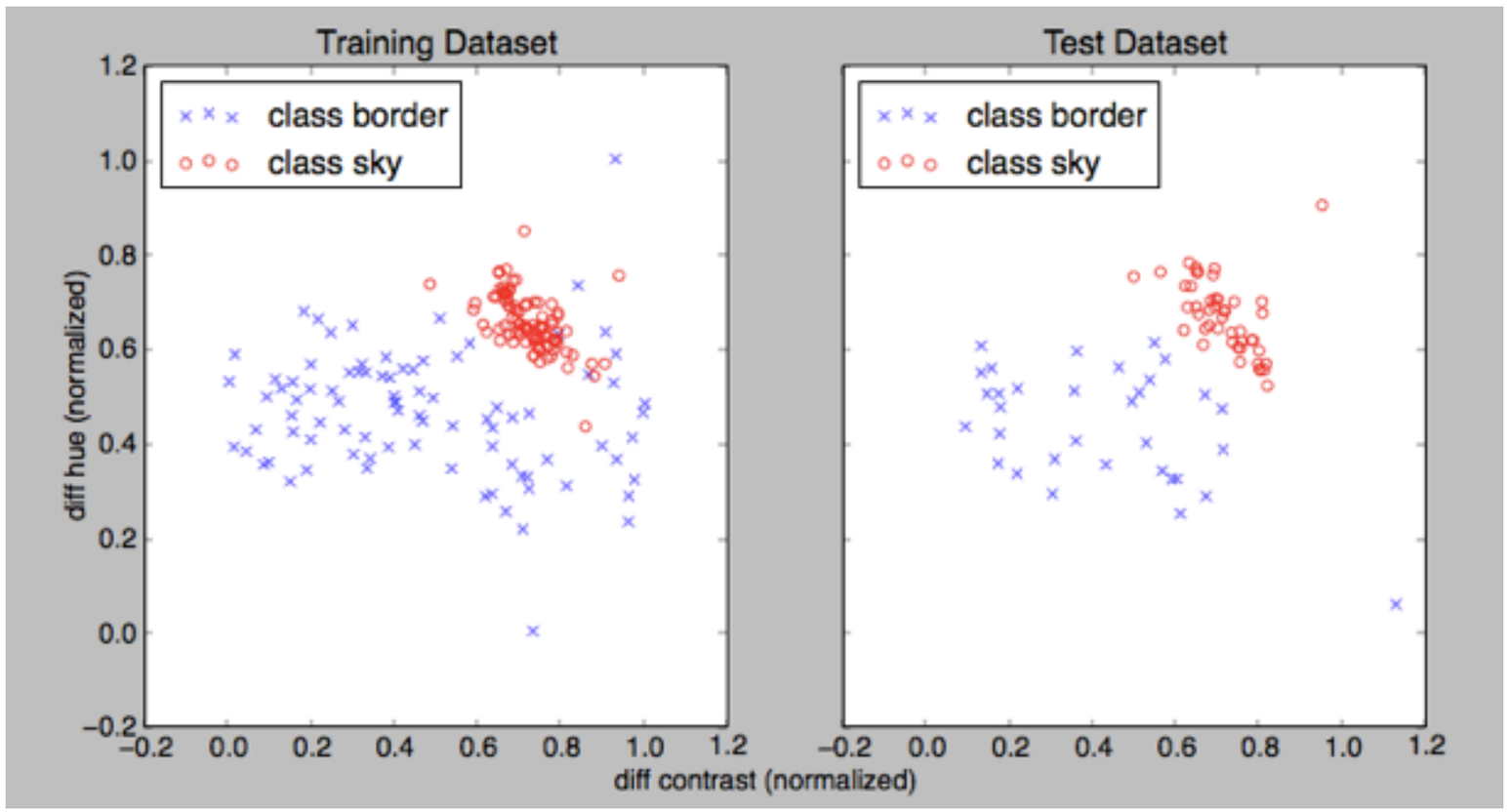
stats using 24 neighbors



stats using 8 neighbors

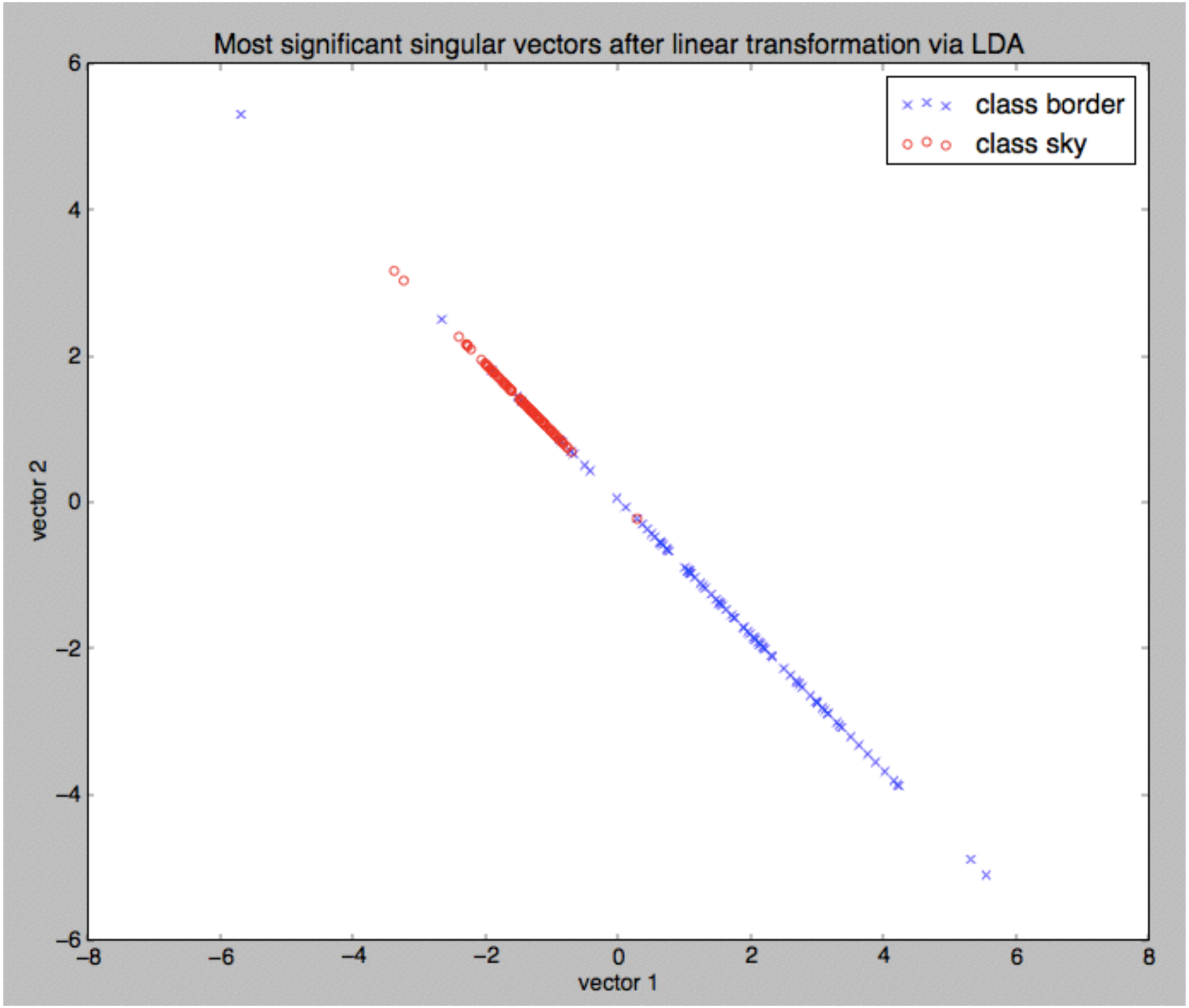
Venturi mtn range, image 1





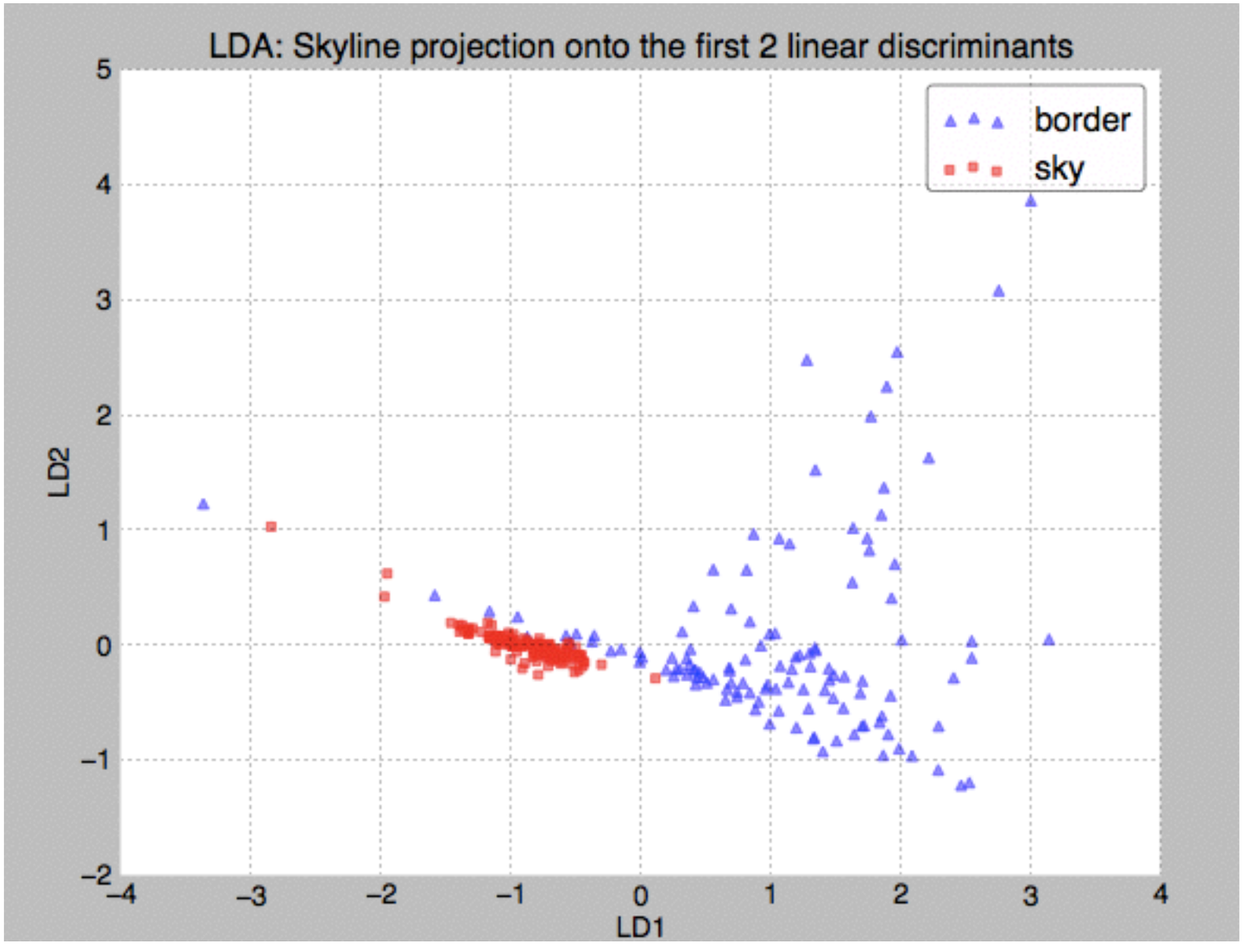
stats using 24 neighbors

Venturi mtn range, image 1



stats using 24 neighbors

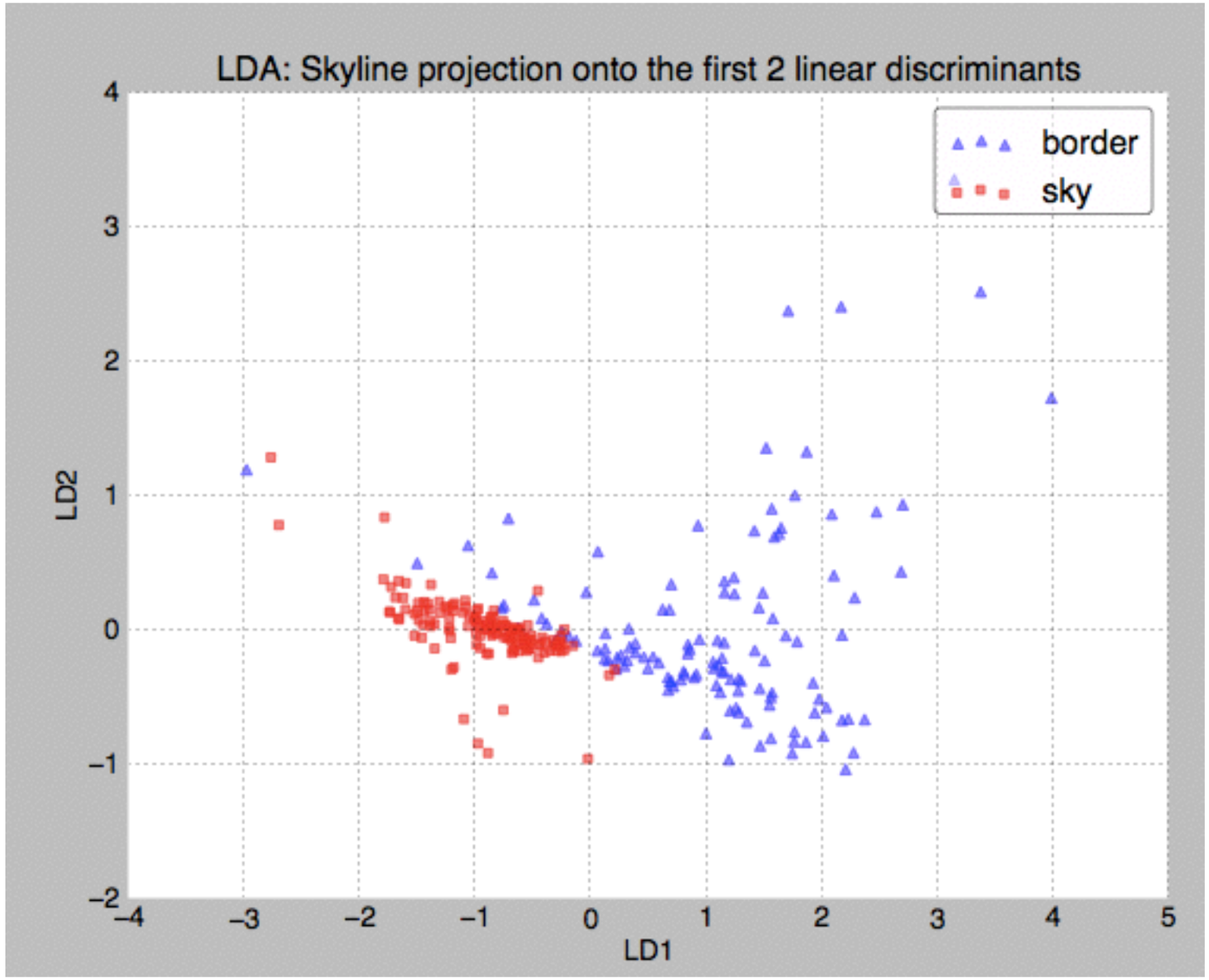
Venturi mtn range, image 1




```
                        contrast  hue     BorR
Mean Vector class 1: [-0.6022 -0.7636  0.6539]

Mean Vector class 2: [ 0.5168  0.6553 -0.5612]

('within-class Scatter Matrix:\n',
array([[ 180.4607,  -34.2094,  -65.7596],
       [ -34.2094,  130.9027,  -34.346 ],
       [ -65.7596,  -34.346 ,  165.8548]]))
('between-class Scatter Matrix:\n',
array([[ 246.4277,  311.9811, -263.8149],
       [ 311.9811,  395.1018, -334.9979],
       [-263.8149, -334.9979,  290.2456]]))

Eigenvector 1:
[[-0.5373]
 [-0.8377]
 [ 0.0975]]
Eigenvalue 1: 5.61e+00

Eigenvector 2:
[[-0.7457]
 [ 0.6608]
 [ 0.0849]]
Eigenvalue 2: -3.83e-16

Eigenvector 3:
[[ 0.441 ]
 [ 0.3521]
 [ 0.8255]]
Eigenvalue 3: 5.54e-02
ok
Eigenvalues in decreasing order:

5.61435797825
0.0554408654804
3.82727650849e-16
Variance explained:

eigenvalue 1: 99.02%
eigenvalue 2: 0.98%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.5373, -0.8377,  0.0975],
       [ 0.441 ,  0.3521,  0.8255]]))
```

stats using 24 neighbors

Venturi mtn range, image 1

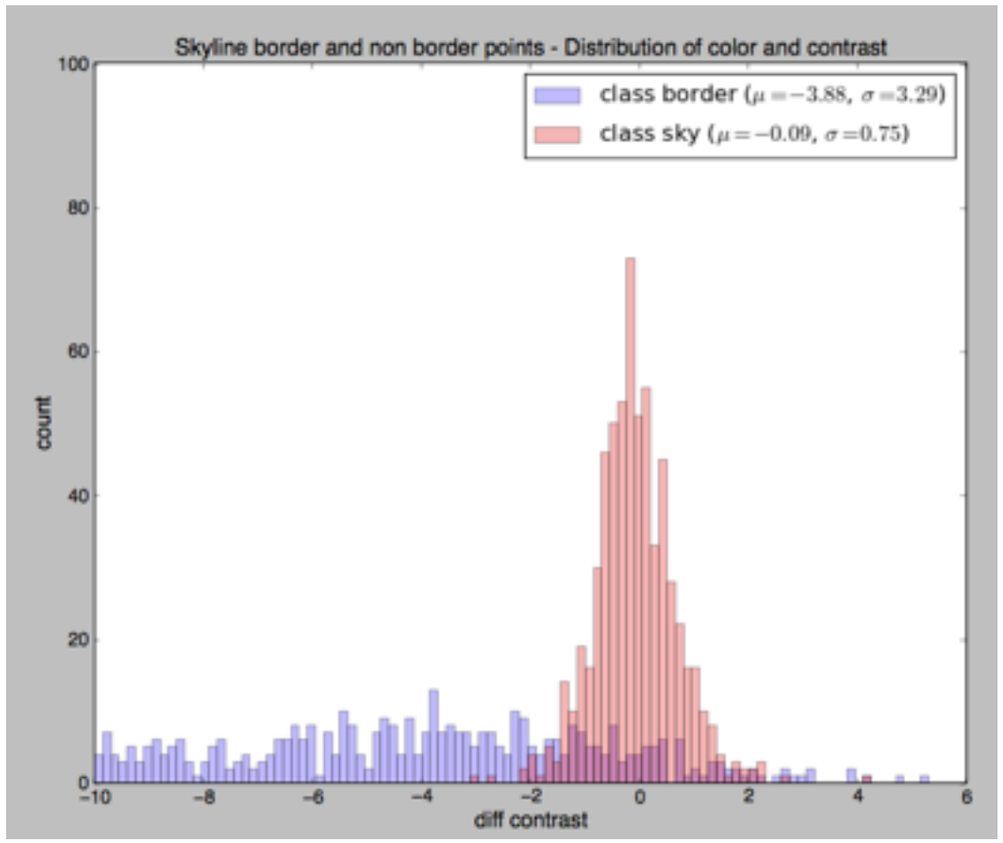



```
                        contrast  hue     BorR
Mean Vector class 1: [-0.4823 -0.7366  0.6801]

Mean Vector class 2: [ 0.4272  0.6525 -0.6023]

('within-class Scatter Matrix:\n',
array([[ 209.6069,  -38.8914,  -78.5168],
       [ -38.8914,  137.1159,  -29.6406],
       [ -78.5168,  -29.6406,  155.8602]]))
('between-class Scatter Matrix:\n',
array([[ 164.2464,  250.295 , -229.0169],
       [ 250.295 ,  381.7193, -350.3459],
       [-229.0169, -350.3459,  325.4864]]))

Eigenvector 1:
[[-0.4013]
 [-0.8675]
 [ 0.2939]]
Eigenvalue 1: 4.77e+00

Eigenvector 2:
[[-0.7657]
 [ 0.6283]
 [ 0.1375]]
Eigenvalue 2: -8.22e-16

Eigenvector 3:
[[ 0.4803]
 [ 0.402 ]
 [ 0.7796]]
Eigenvalue 3: 4.05e-02
ok
Eigenvalues in decreasing order:

4.77036733009
0.0405101484074
8.22079194997e-16
Variance explained:

eigenvalue 1: 99.16%
eigenvalue 2: 0.84%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.4013, -0.8675,  0.2939],
       [ 0.4803,  0.402 ,  0.7796]]))
```

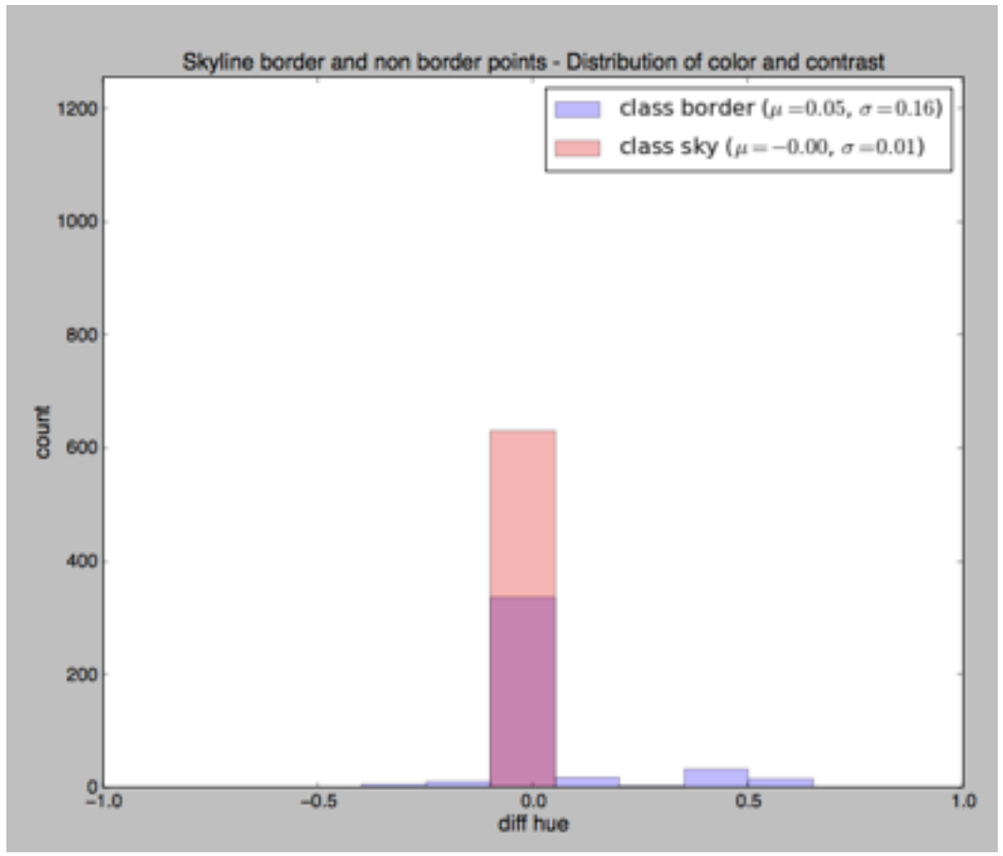
stats using 24 neighbors

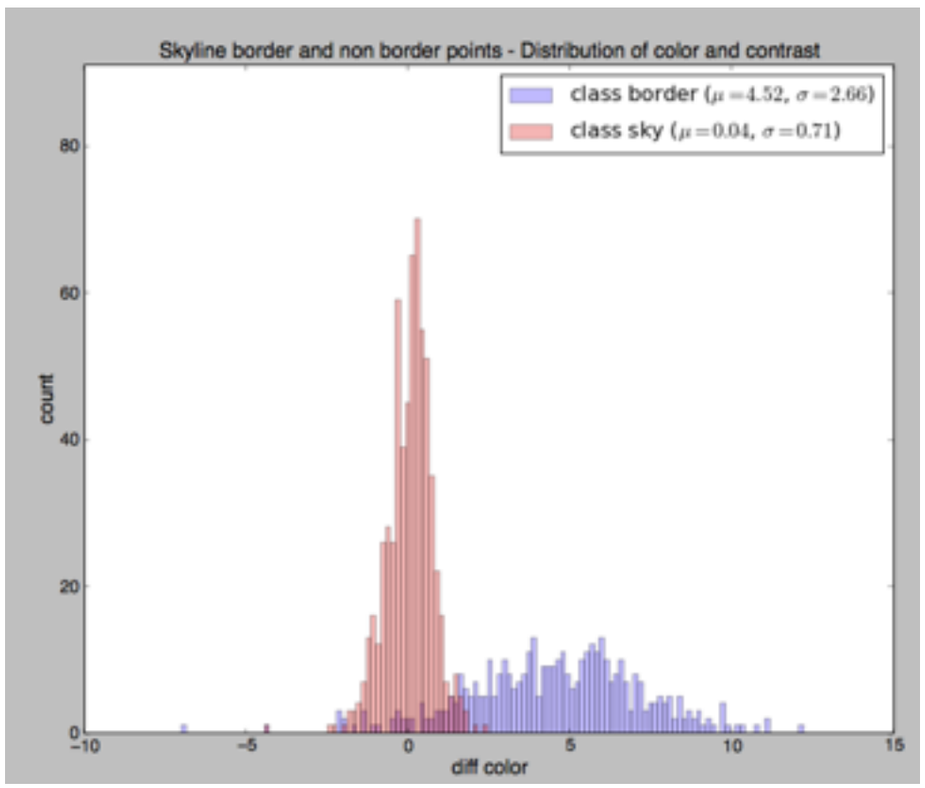
seattle test image

seattle test image

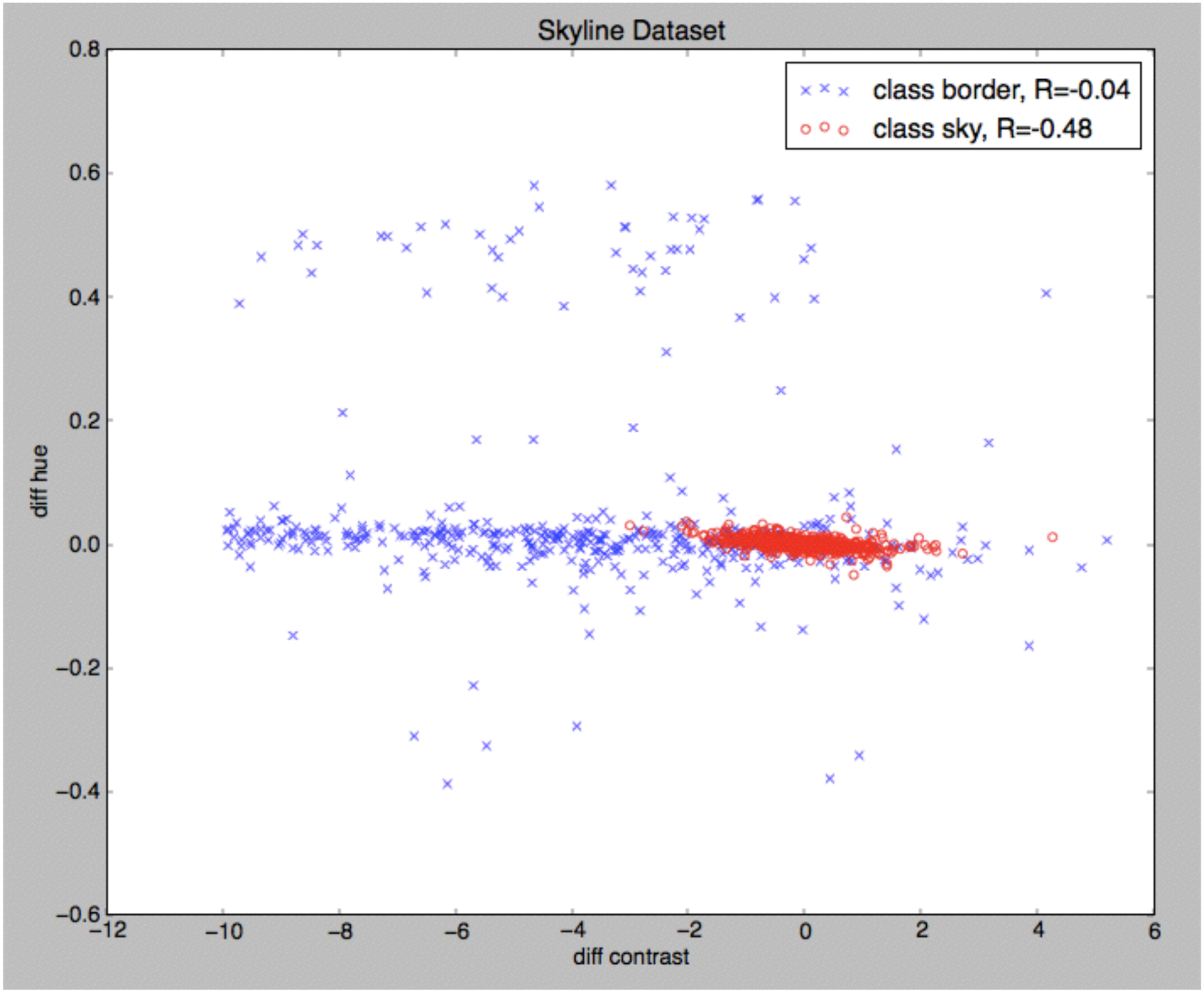


*note: the largest contrasts were removed from analysis for plot visibility

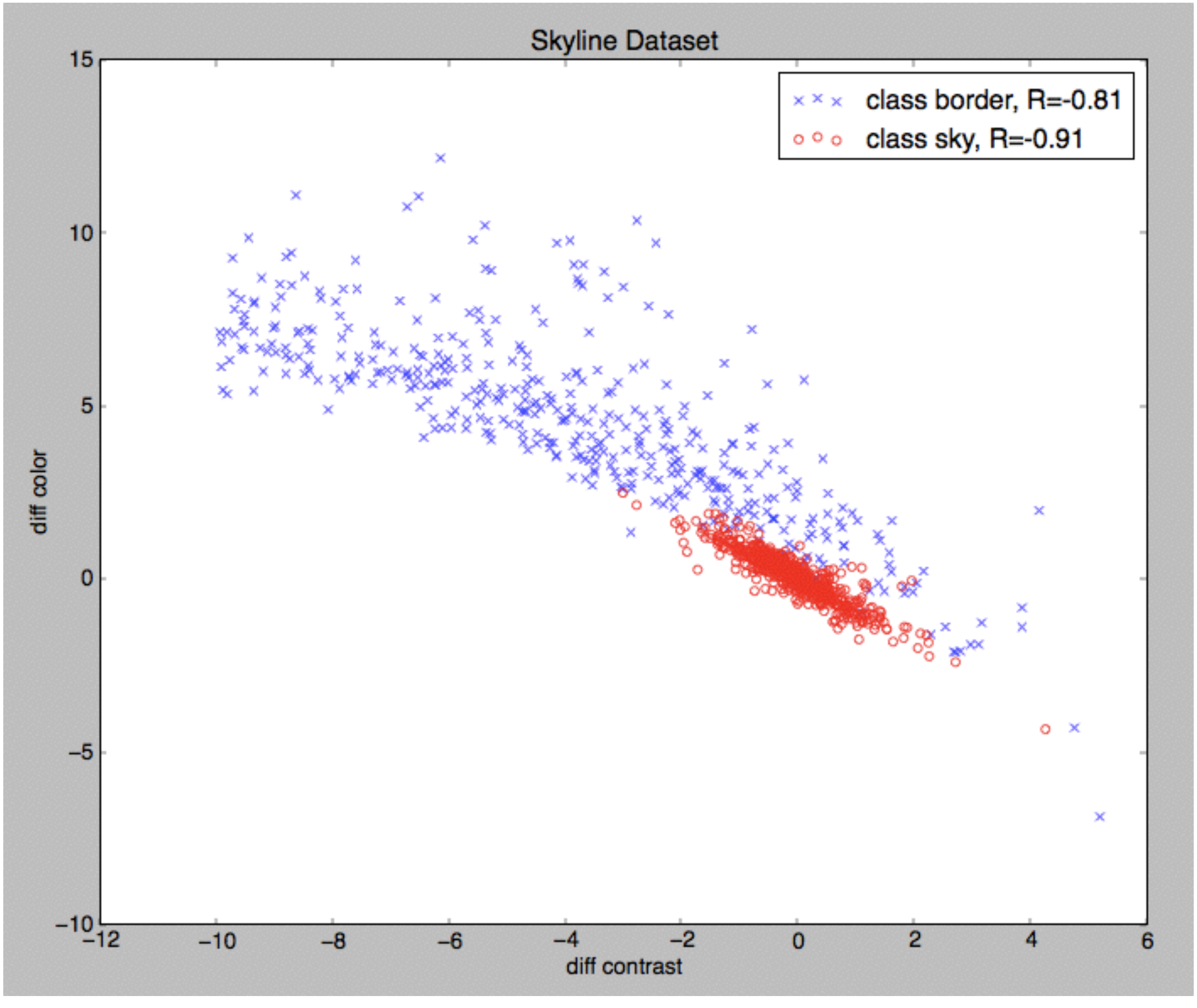




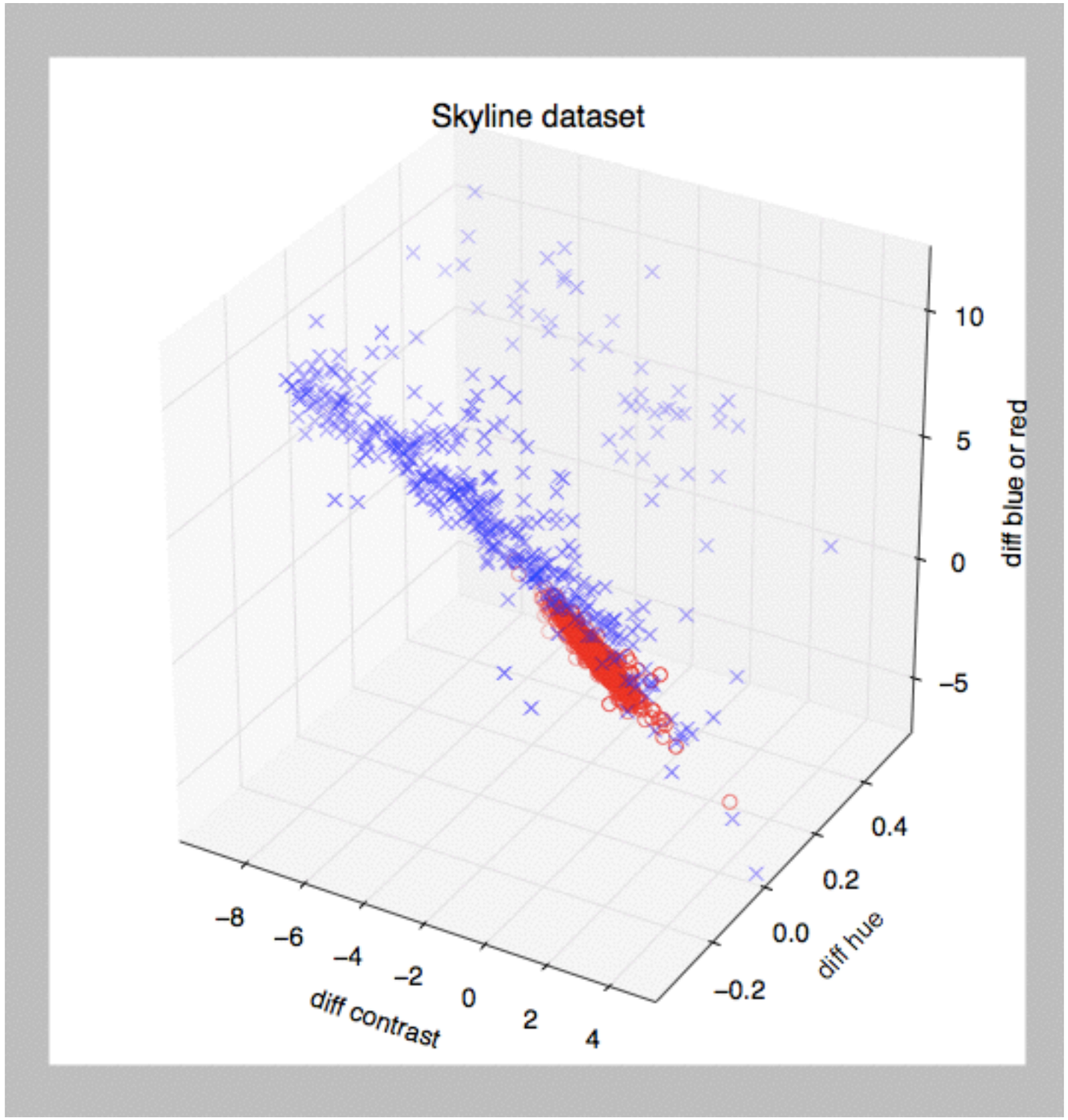
[seattle test image]



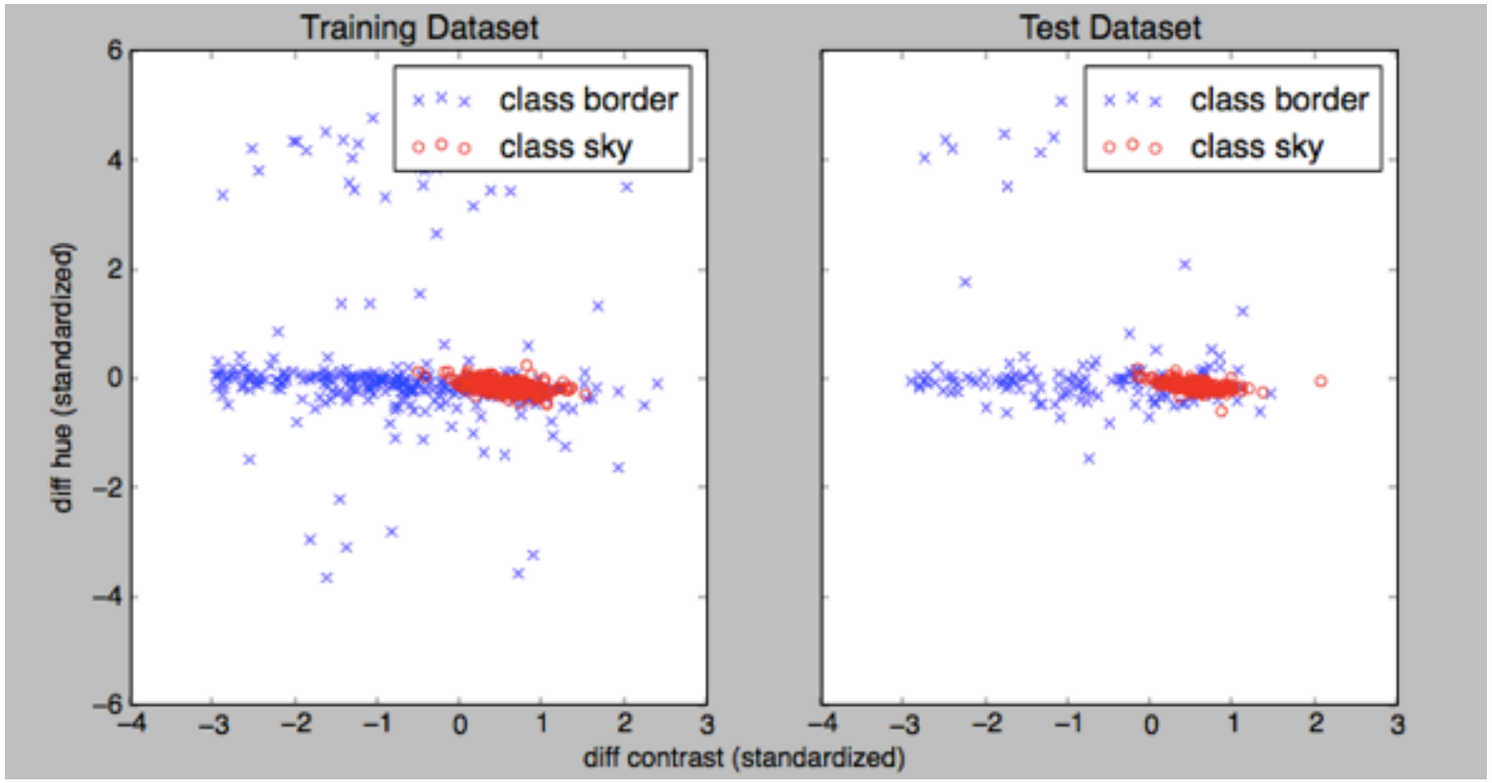
[seattle test image]

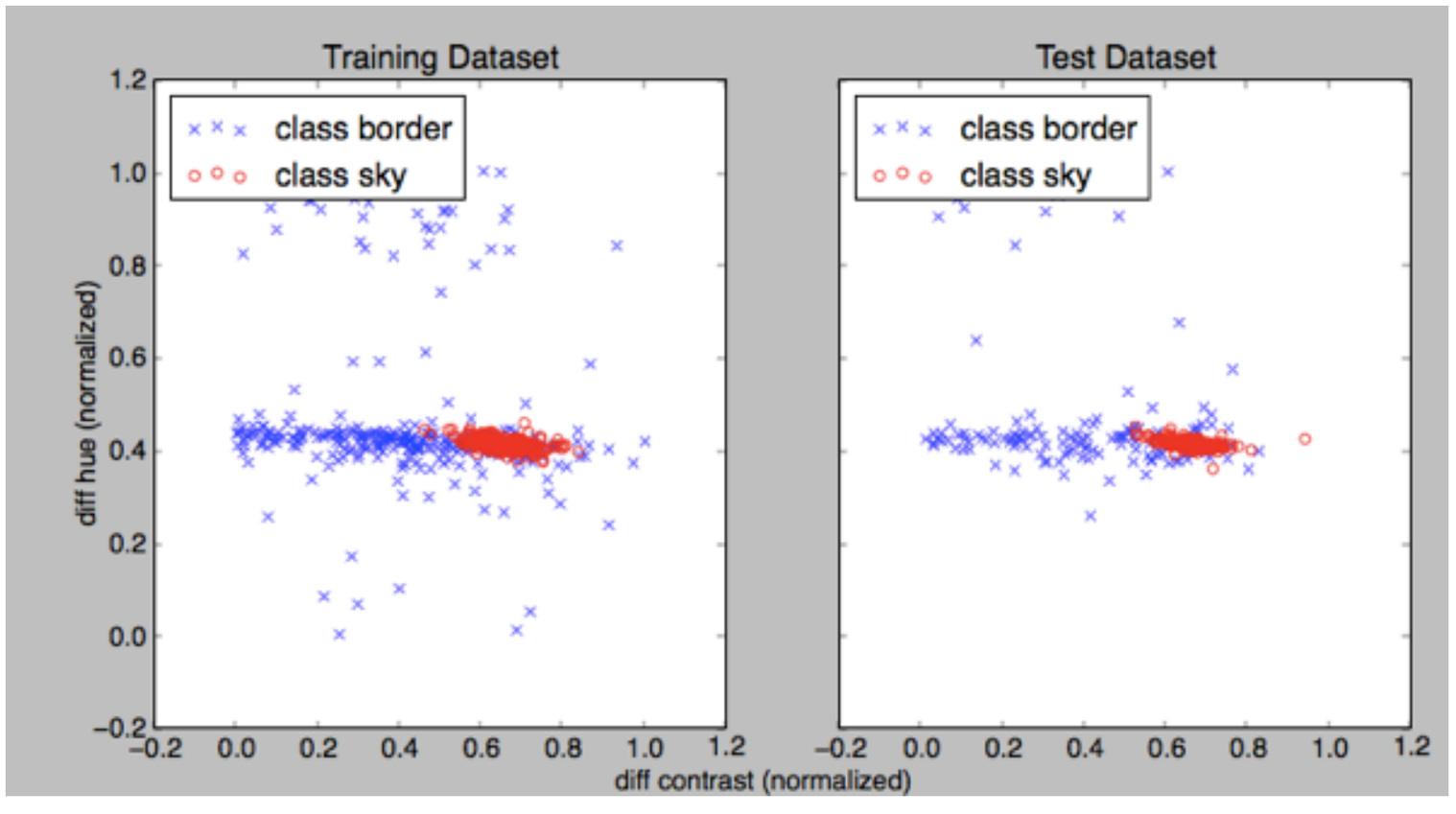


seattle test image

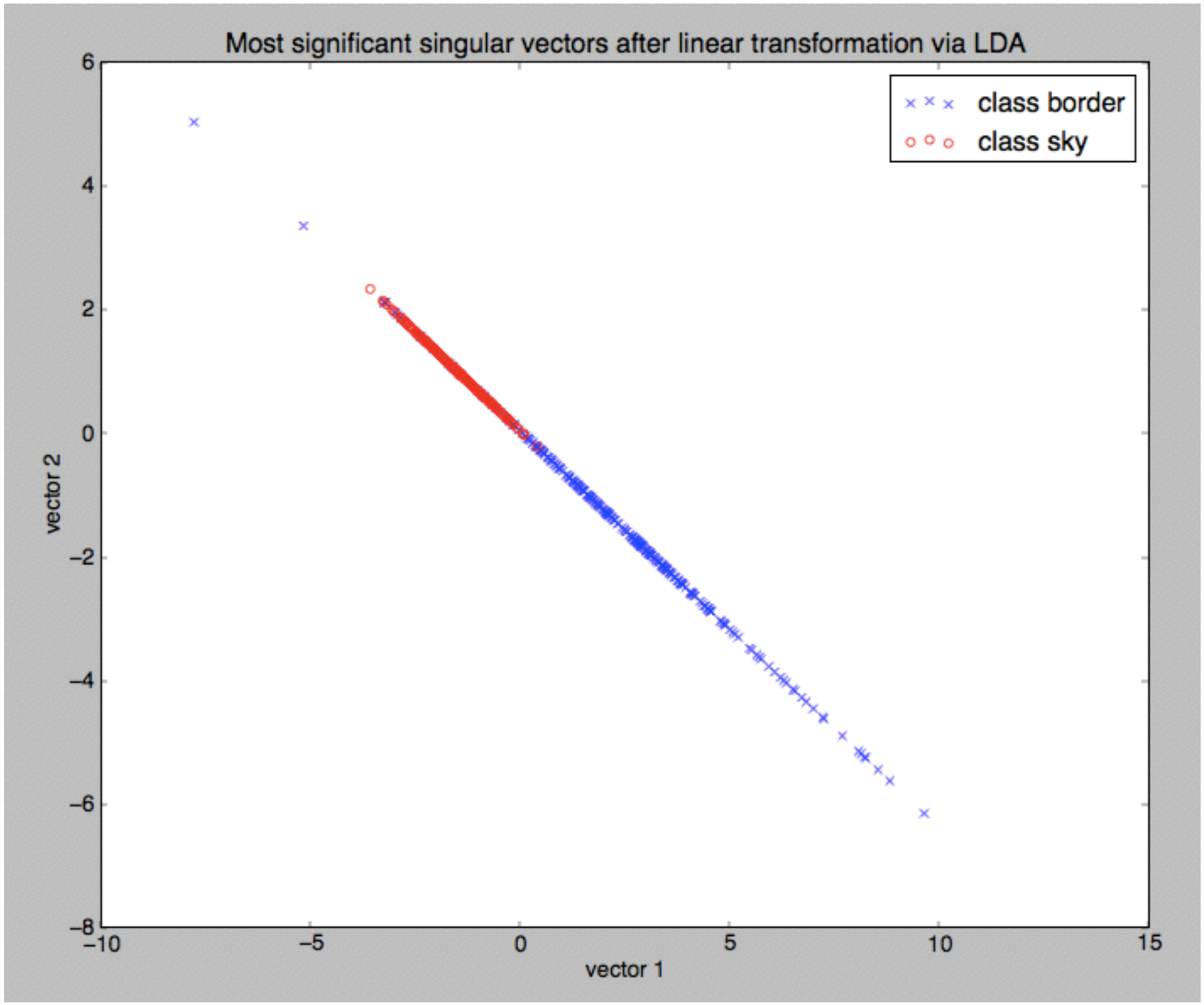


seattle test image

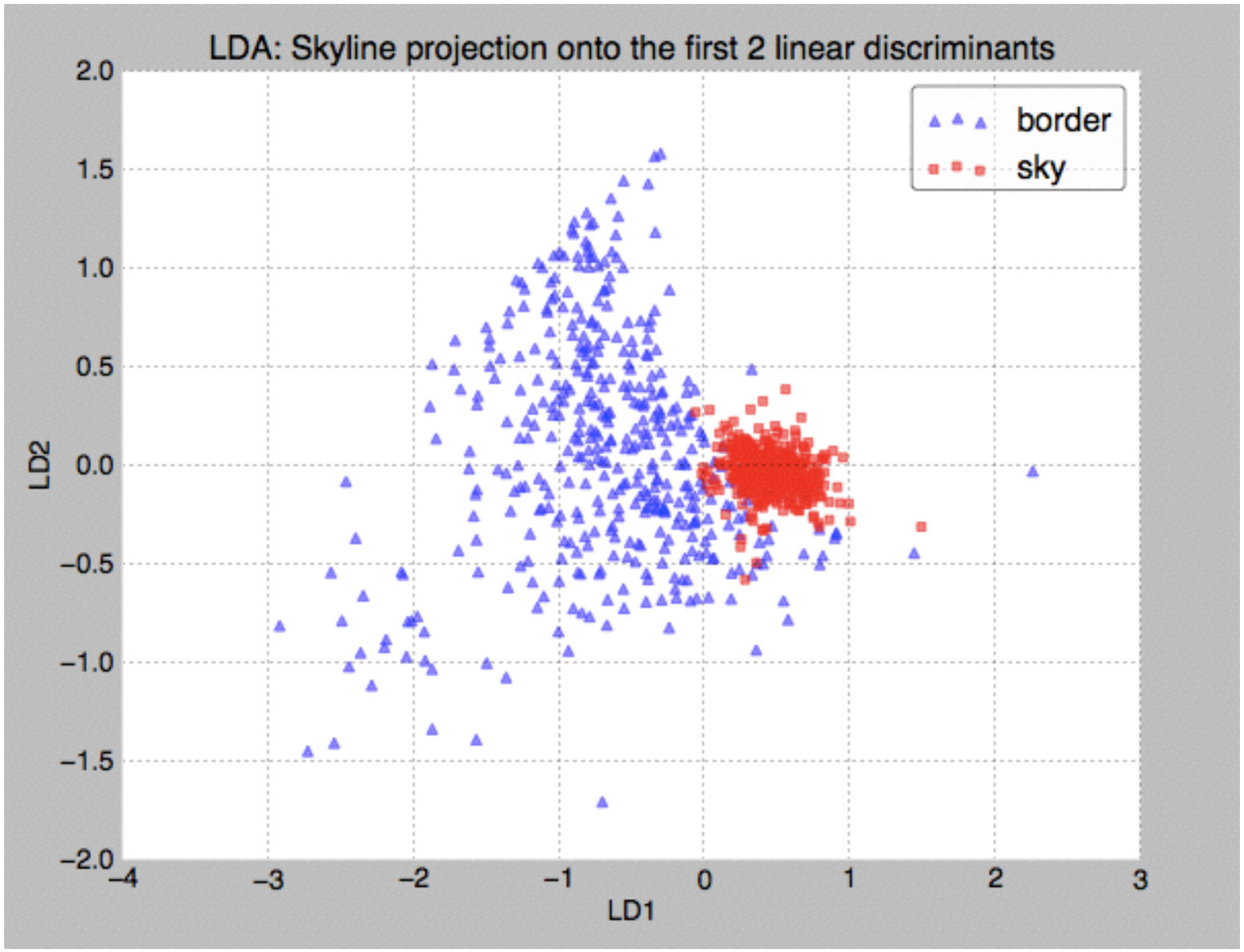




seattle test image



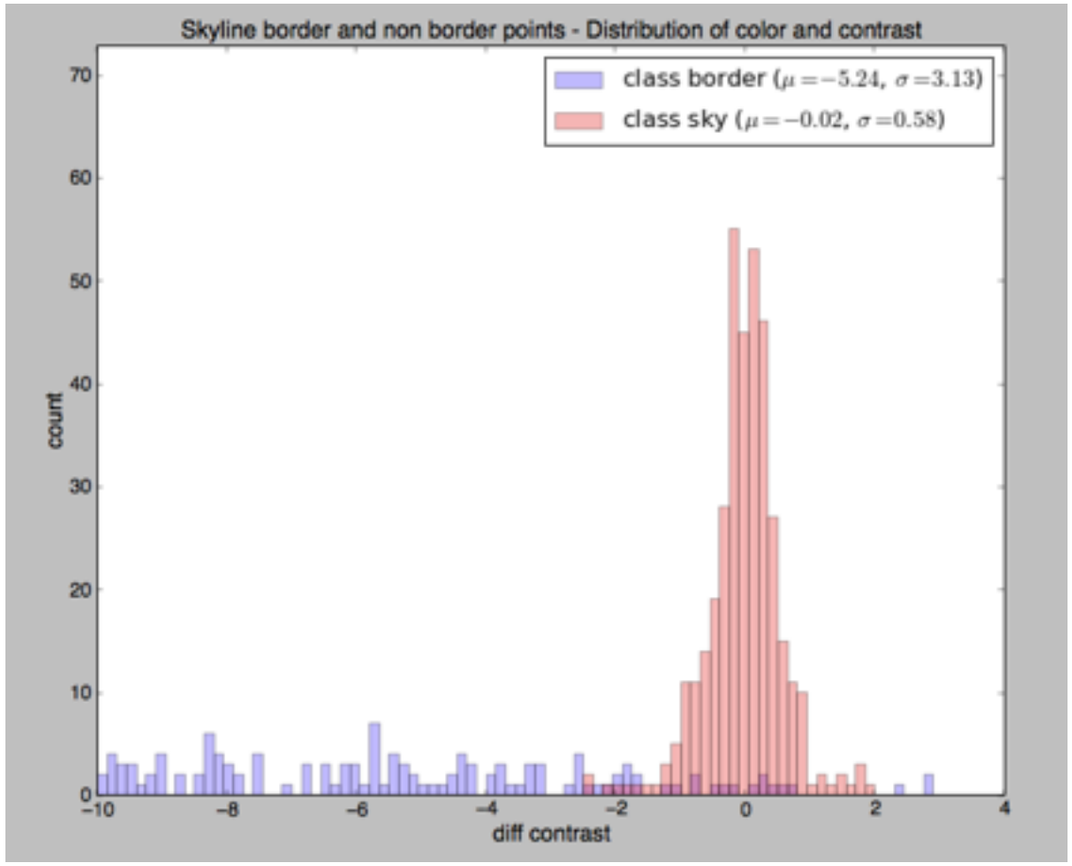
seattle test image



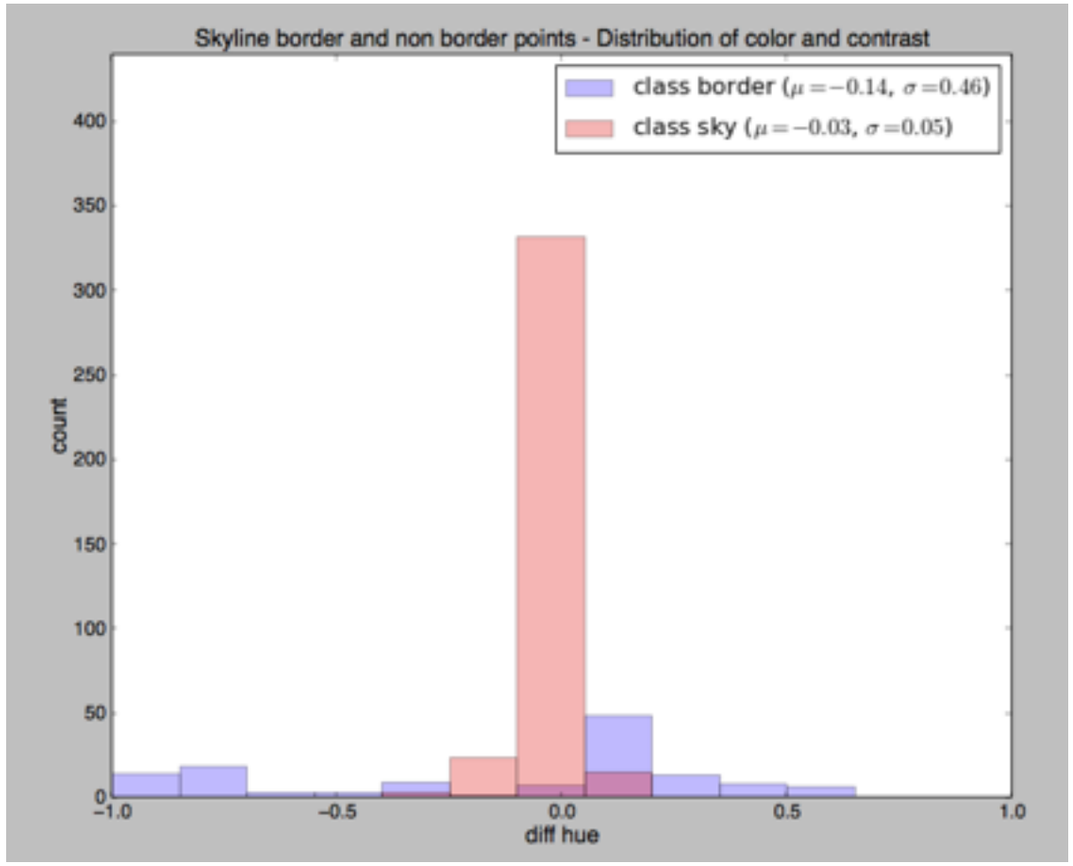

```
                        contrast  hue     BorR
Mean Vector class 1: [-0.7979  0.2884  0.9527]

Mean Vector class 2: [ 0.5328 -0.1926 -0.6362]

('within-class Scatter Matrix:\n',
array([[ 603.0896,  -40.0089, -406.6303],
       [ -40.0089,  990.742 ,   87.2074],
       [-406.6303,   87.2074,  413.2026]]))
('between-class Scatter Matrix:\n',
array([[ 1384.8533,  -436.4072, -1550.2439],
       [ -436.4072,   221.8961,   624.4976],
       [-1550.2439,   624.4976,  1954.5143]]))

Eigenvector 1:
[[-0.2991]
 [-0.0201]
 [-0.954 ]]
Eigenvalue 1: 5.15e+00

Eigenvector 2:
[[-0.7999]
 [-0.0233]
 [-0.5997]]
Eigenvalue 2: 7.06e-01

Eigenvector 3:
[[ 0.3069]
 [-0.8087]
 [ 0.5018]]
Eigenvalue 3: -1.46e-16
ok
Eigenvalues in decreasing order:

5.15261790736
0.706269126932
1.45634103903e-16
Variance explained:

eigenvalue 1: 87.95%
eigenvalue 2: 12.05%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.2991, -0.0201, -0.954 ],
       [-0.7999, -0.0233, -0.5997]]))
```

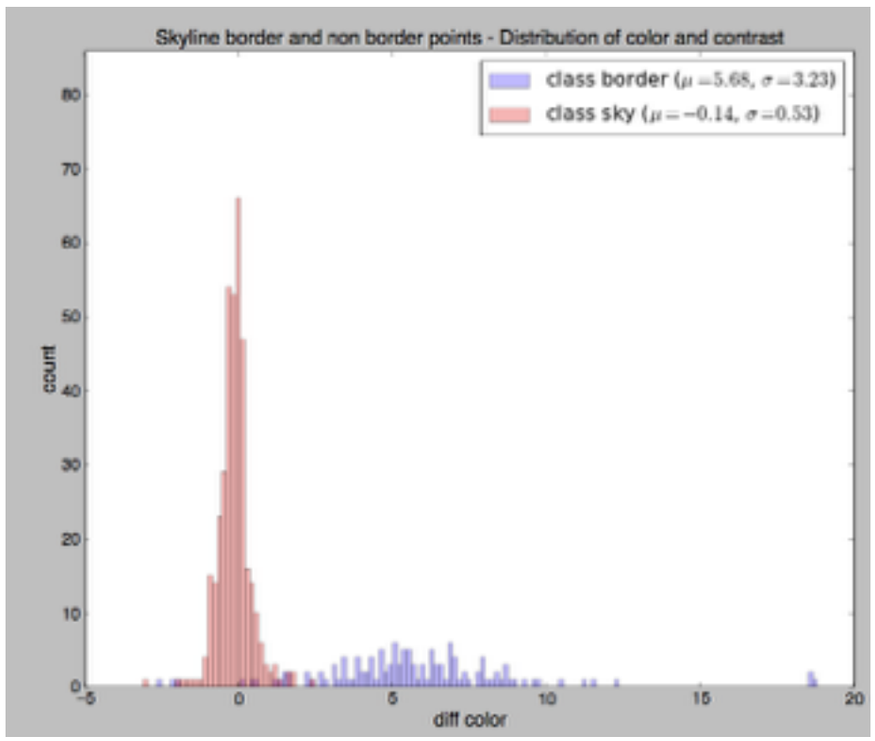
arches test image

arches test image

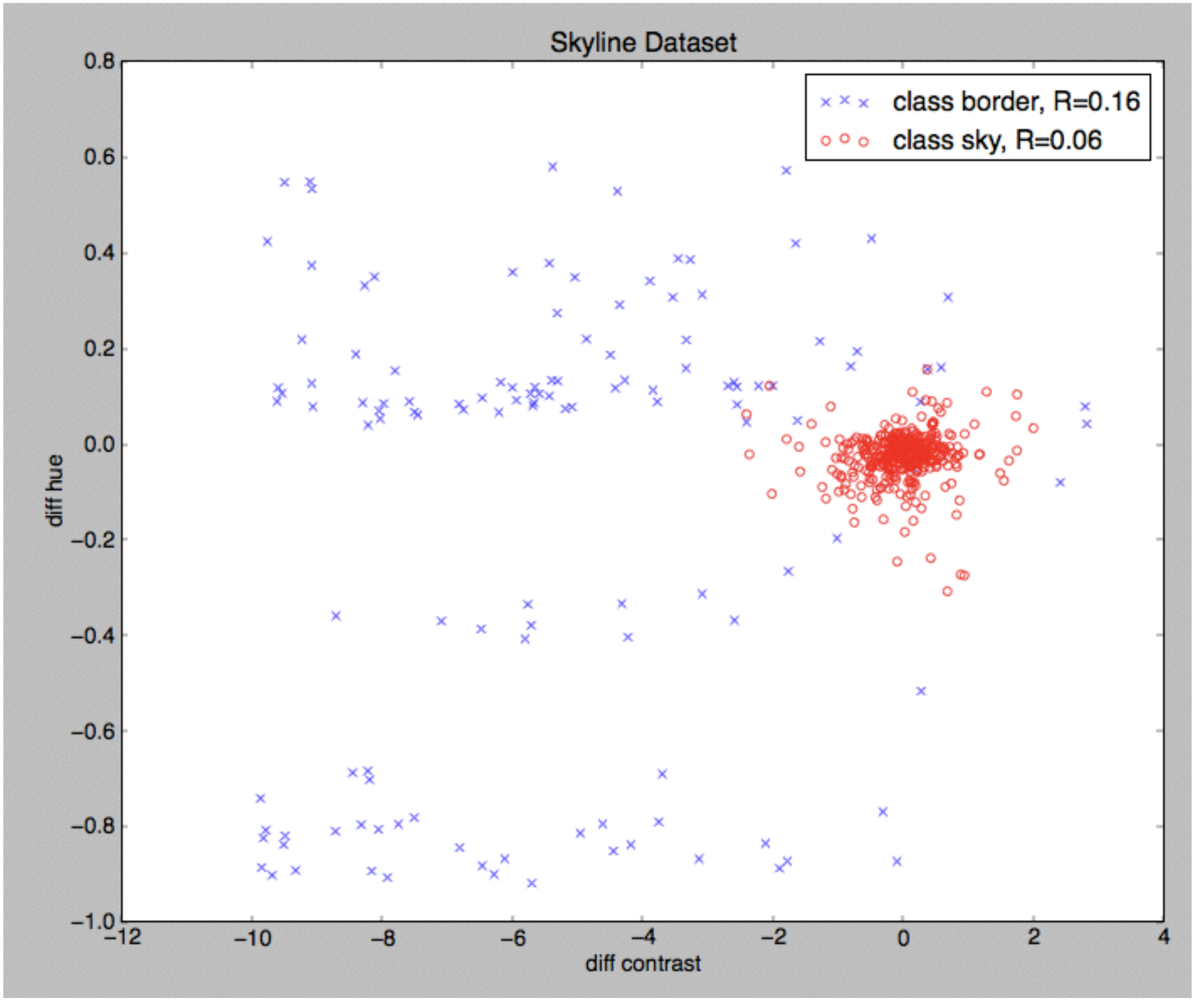


*note: the largest contrasts were removed from analysis for plot visibility

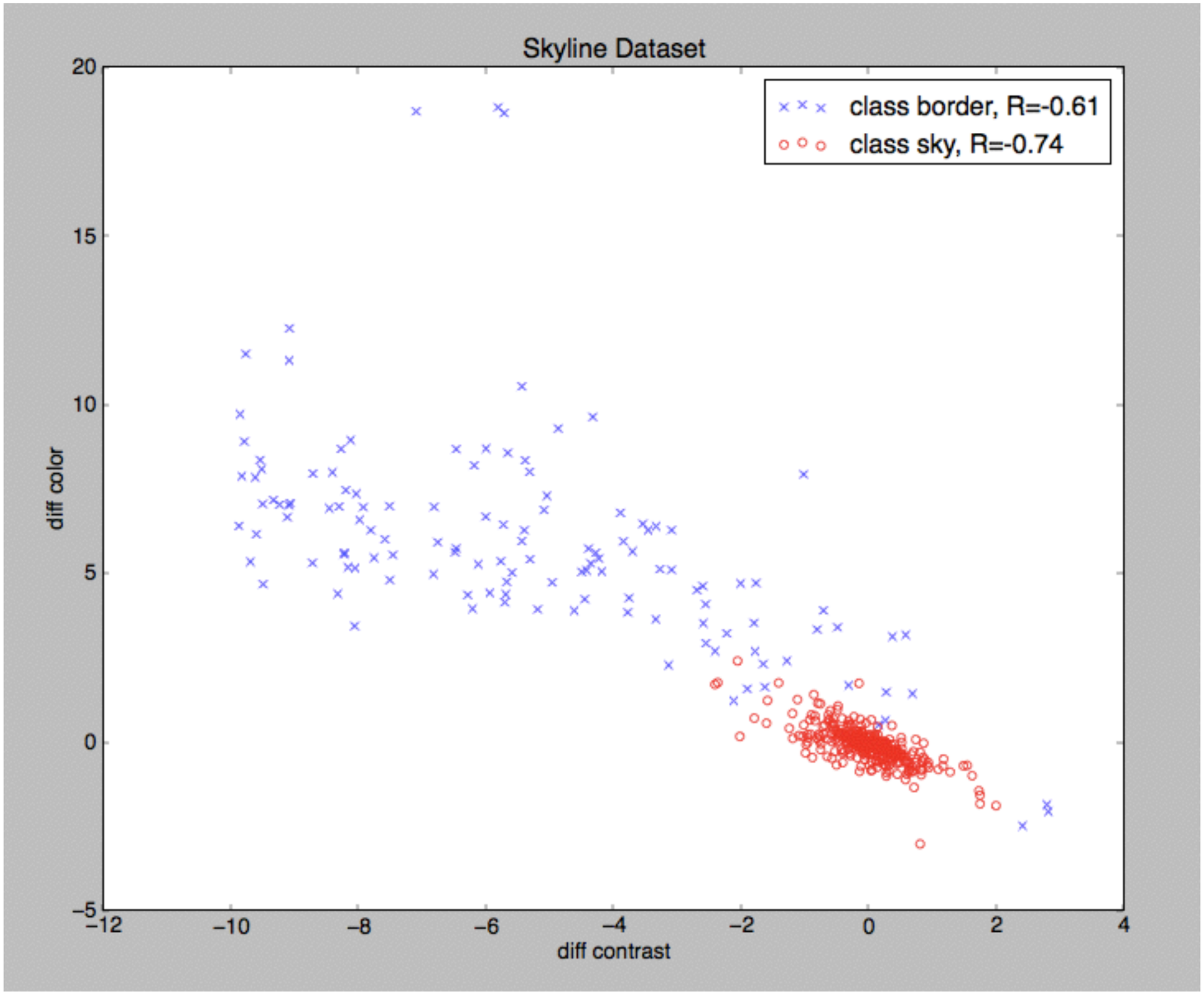




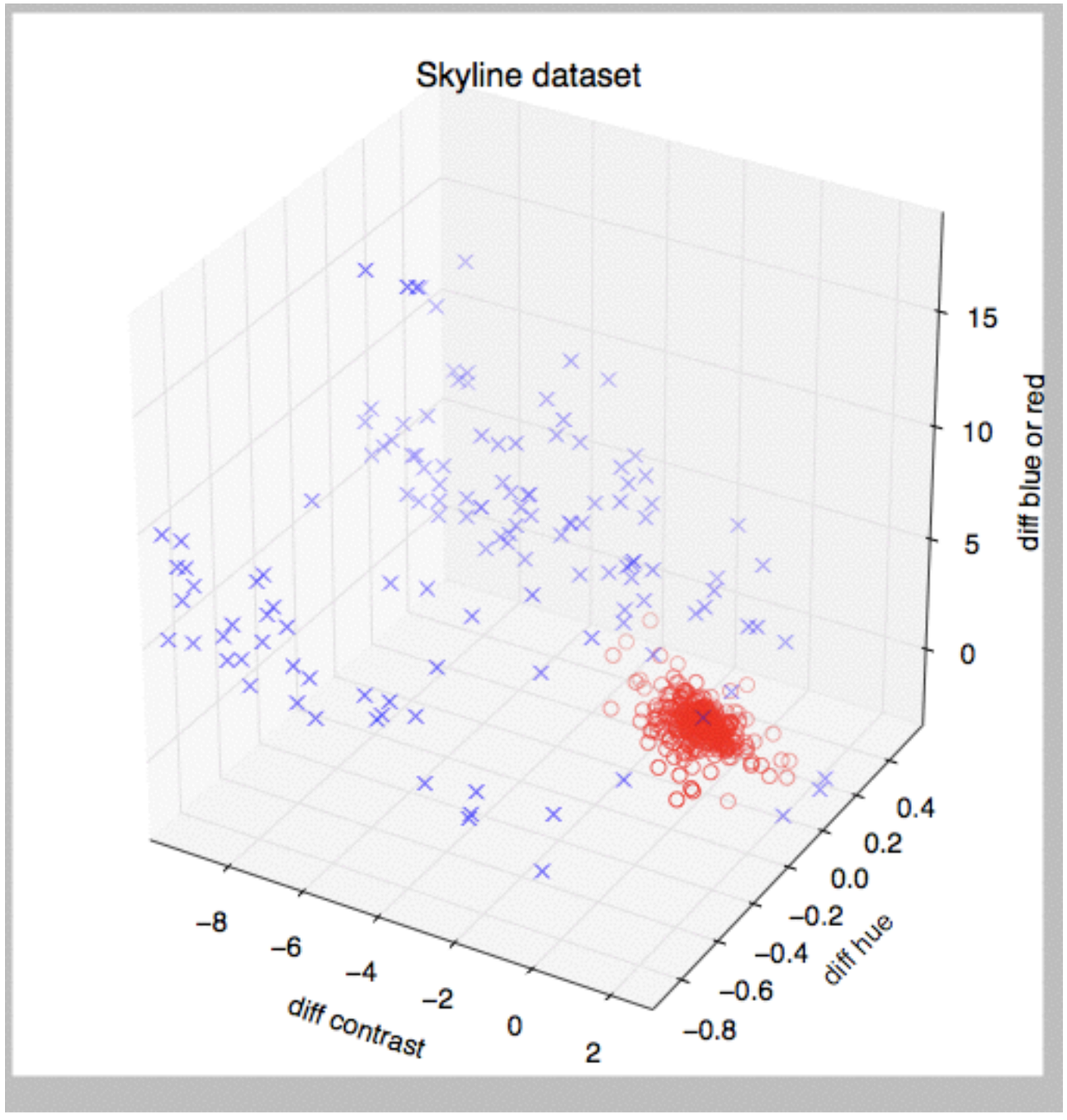
[arches test image]



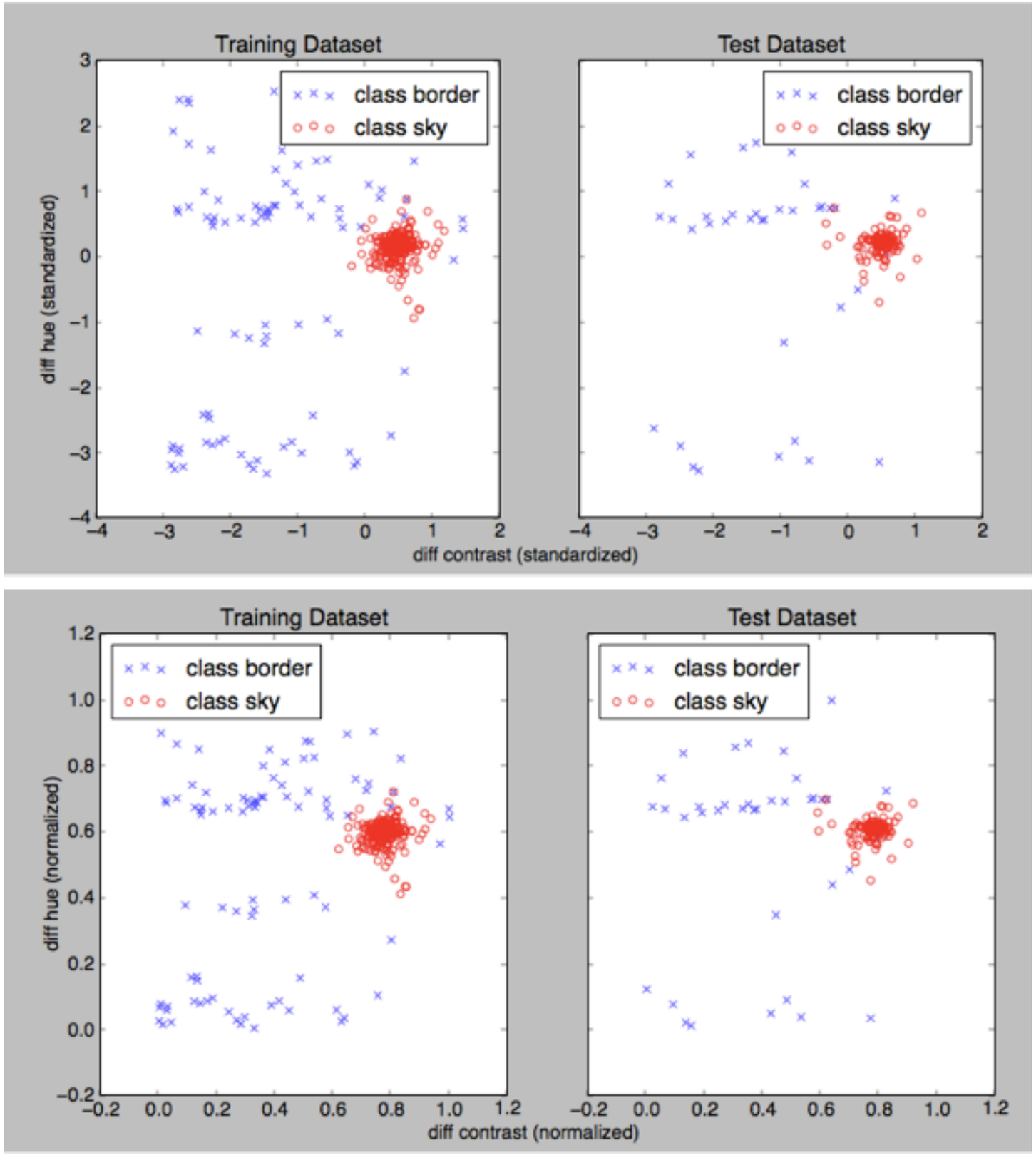
[arches test image]



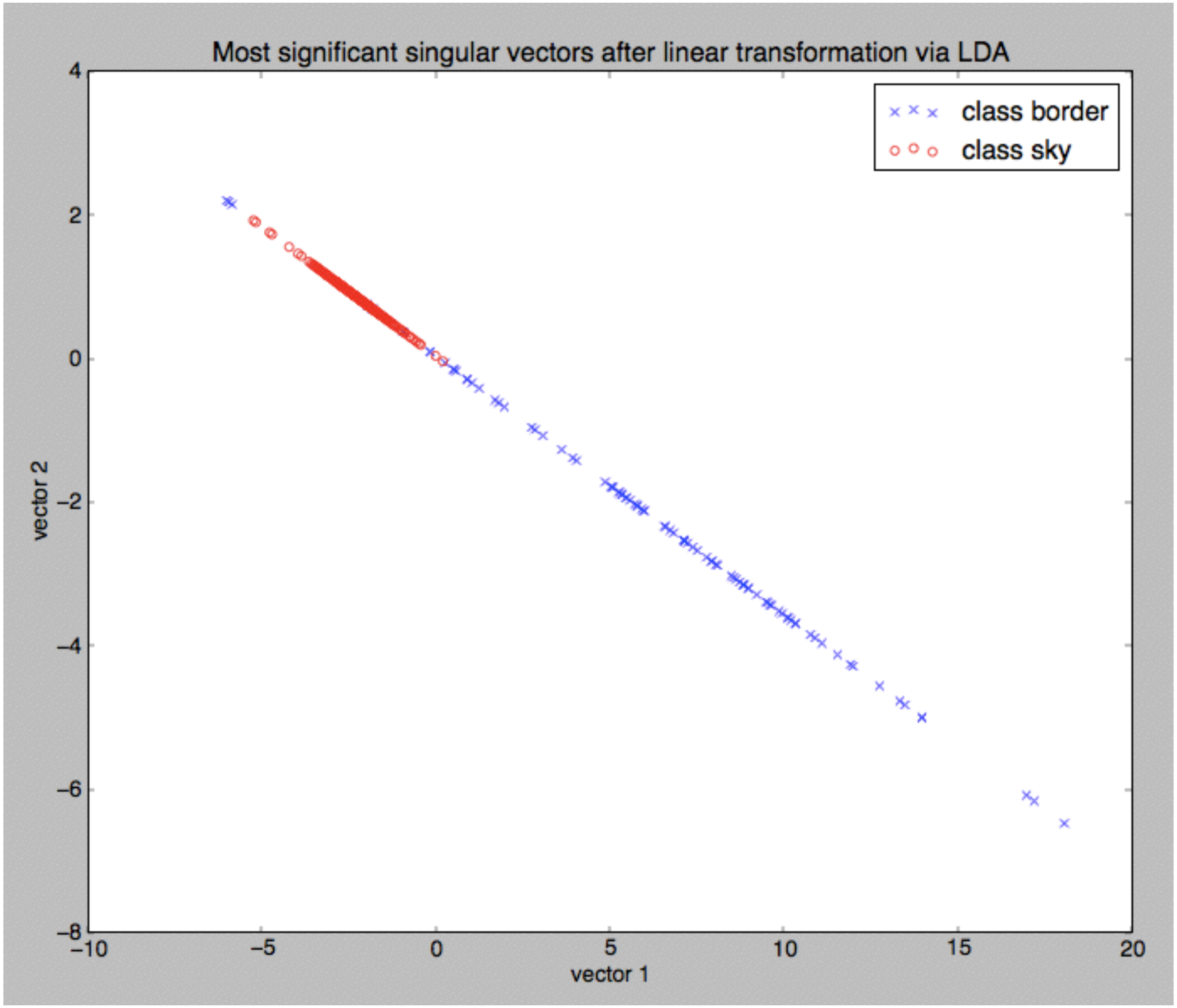
arches test image



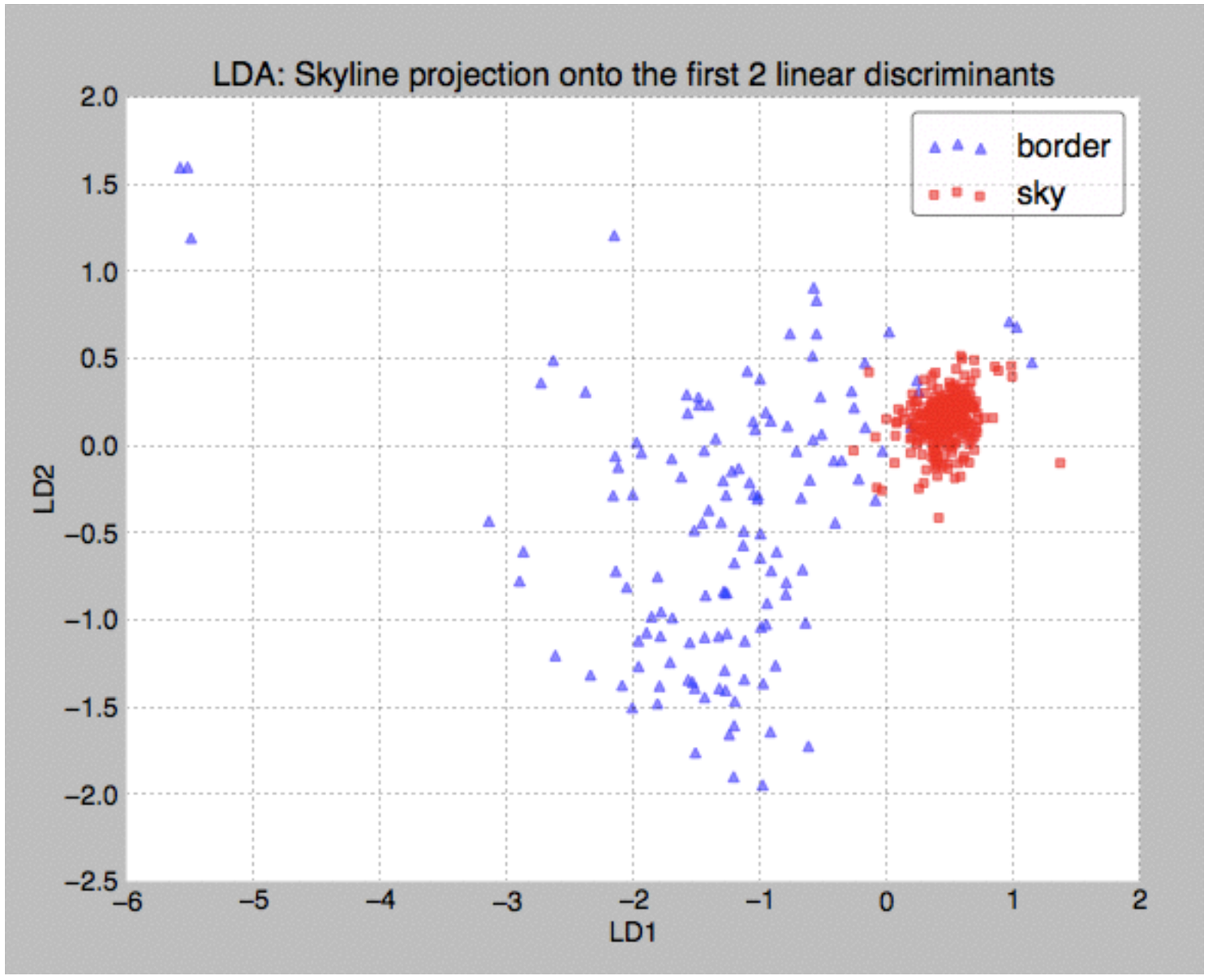
arches test image



[arches test image]

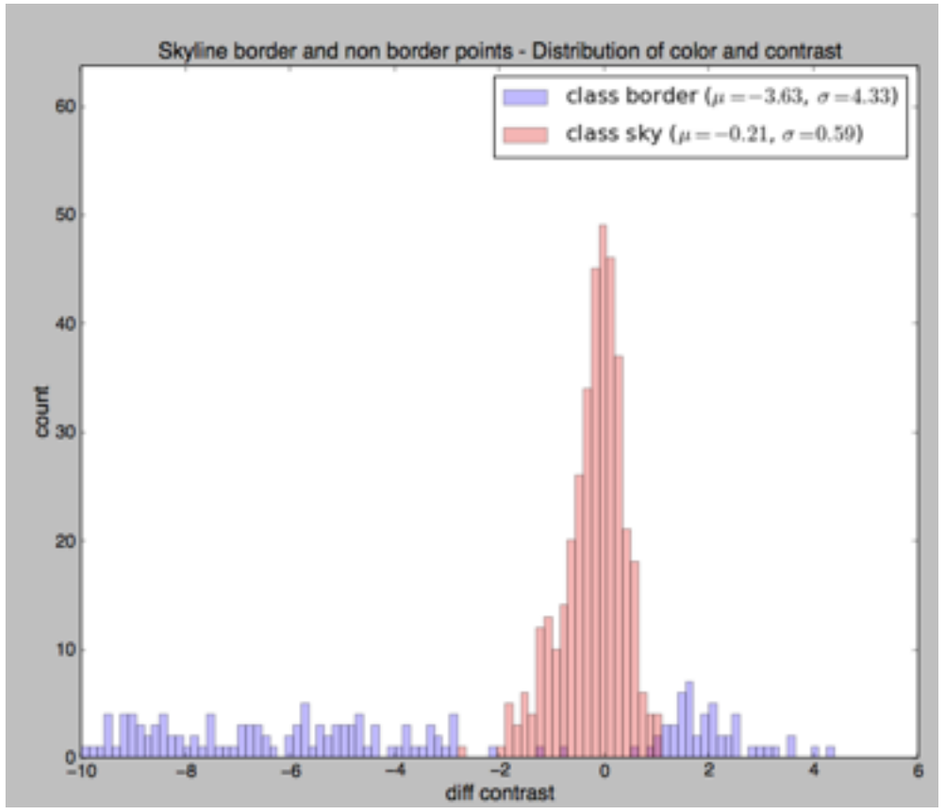


[arches test image]

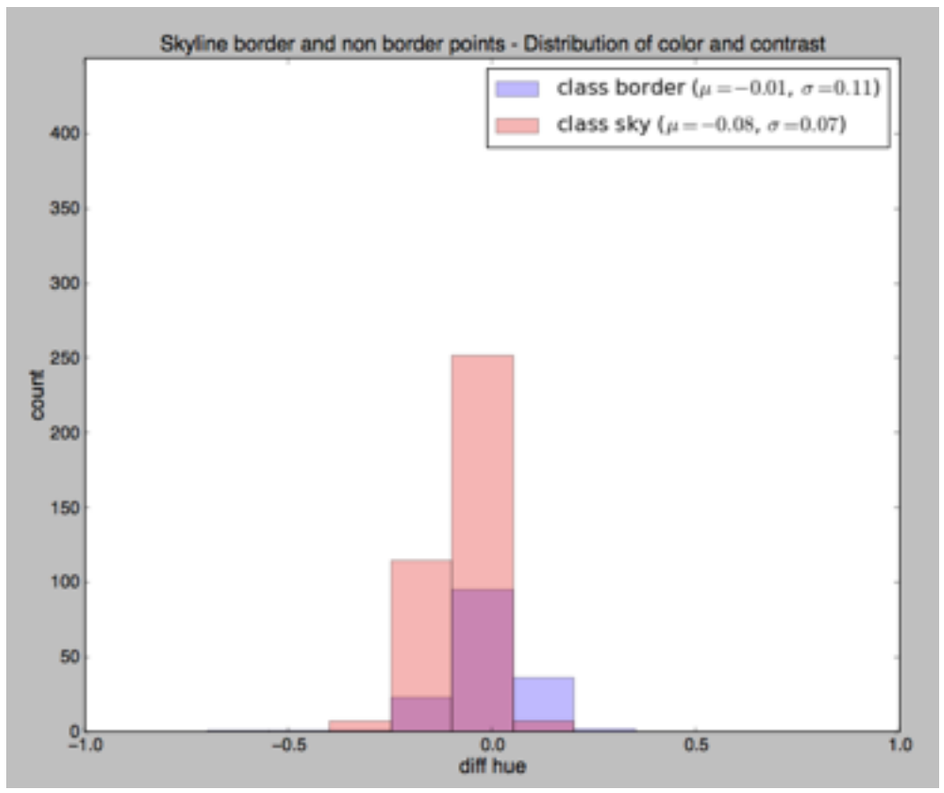


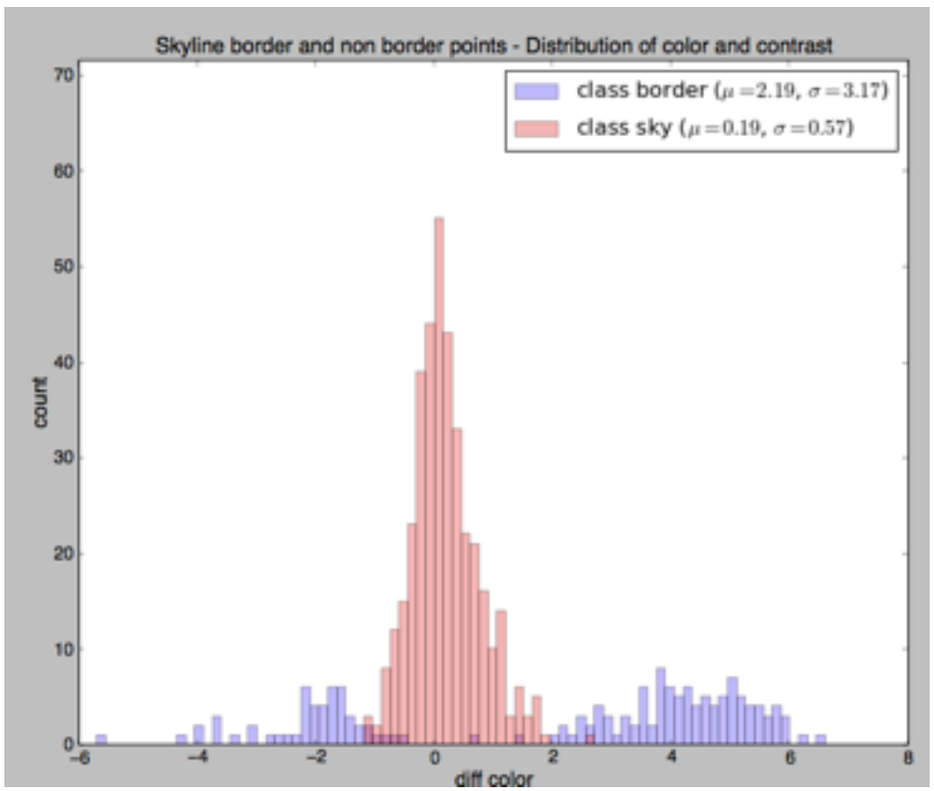
stinson test image

stinson test image



*note: the largest contrasts were removed from analysis for plot visibility





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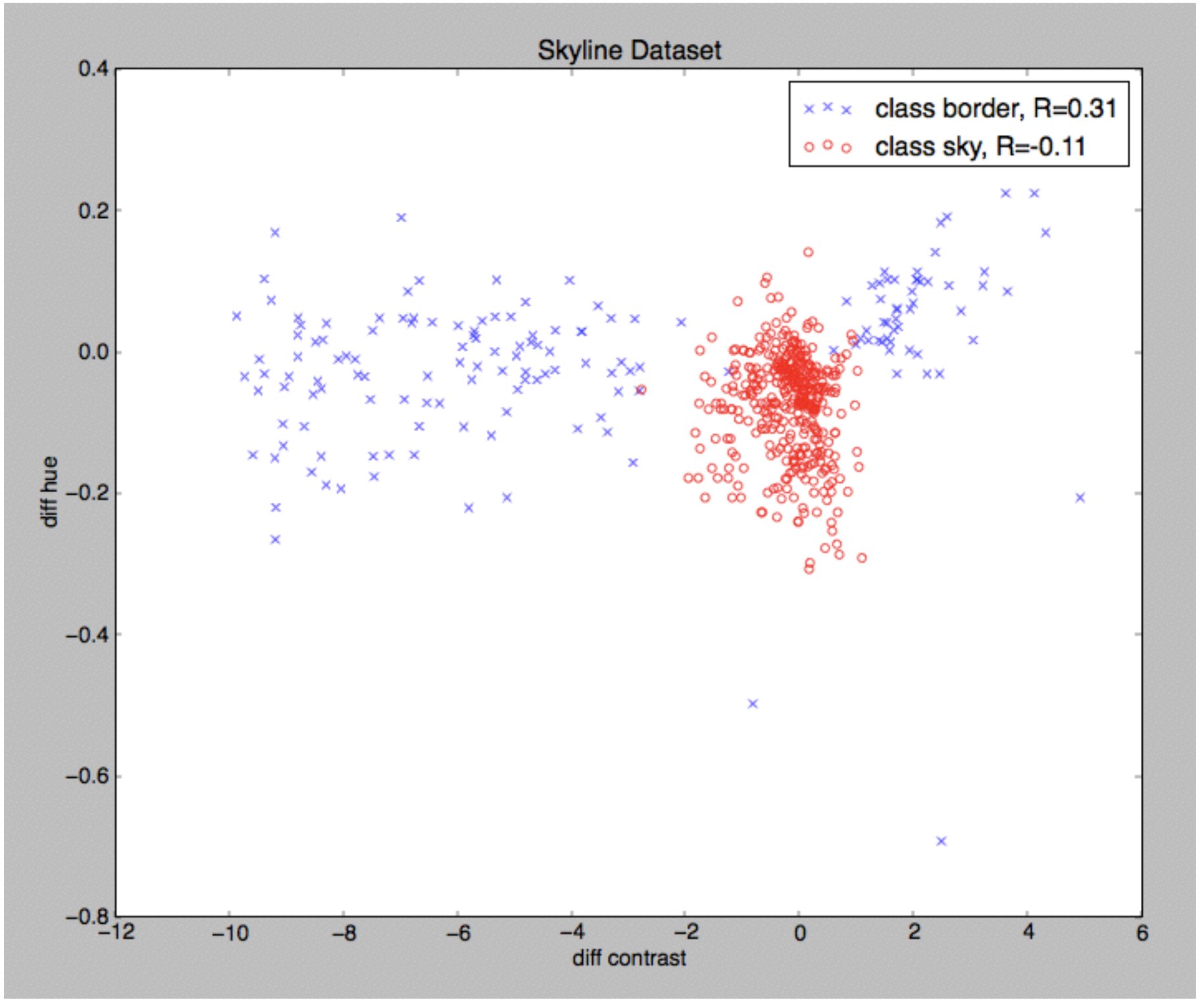
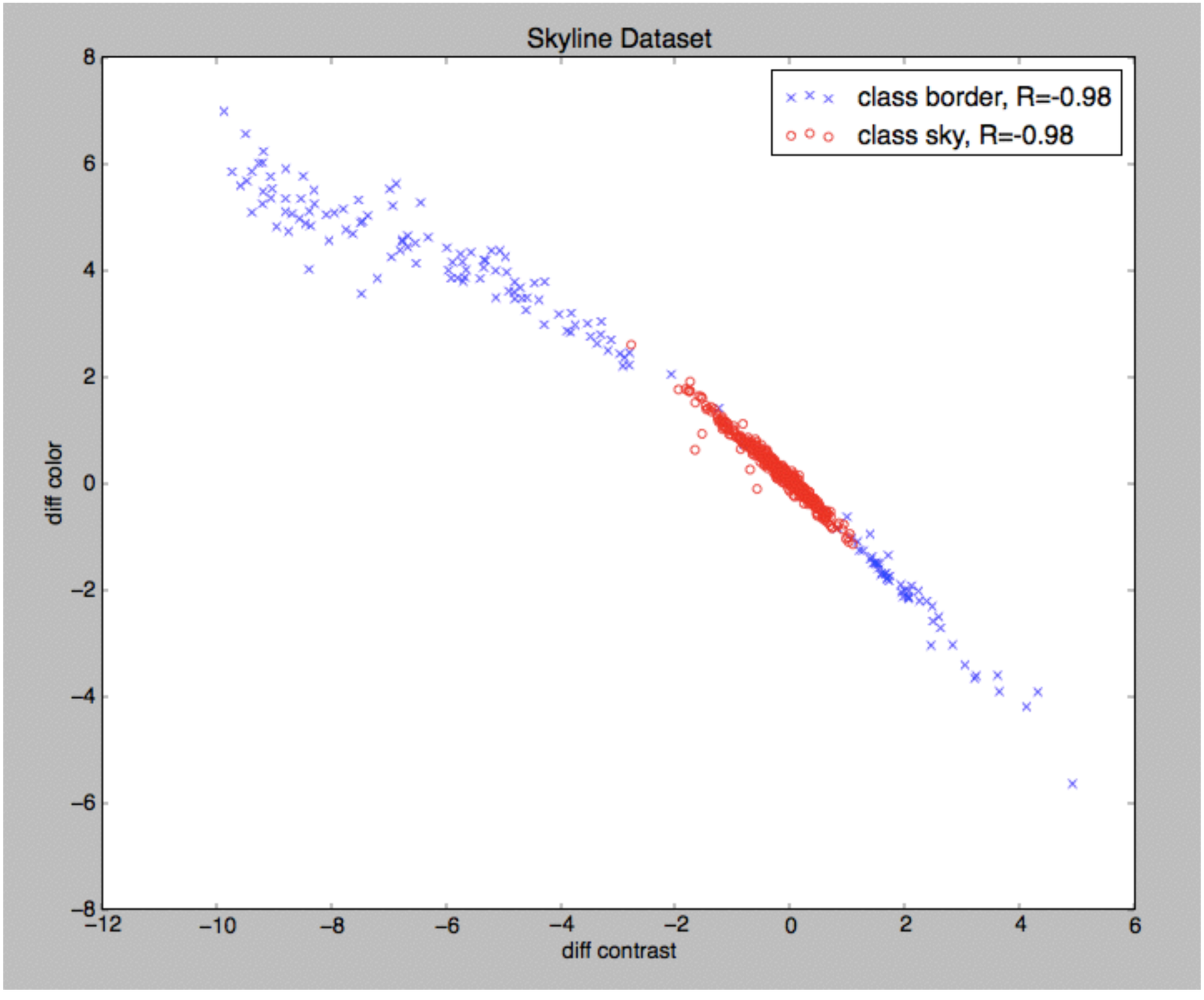
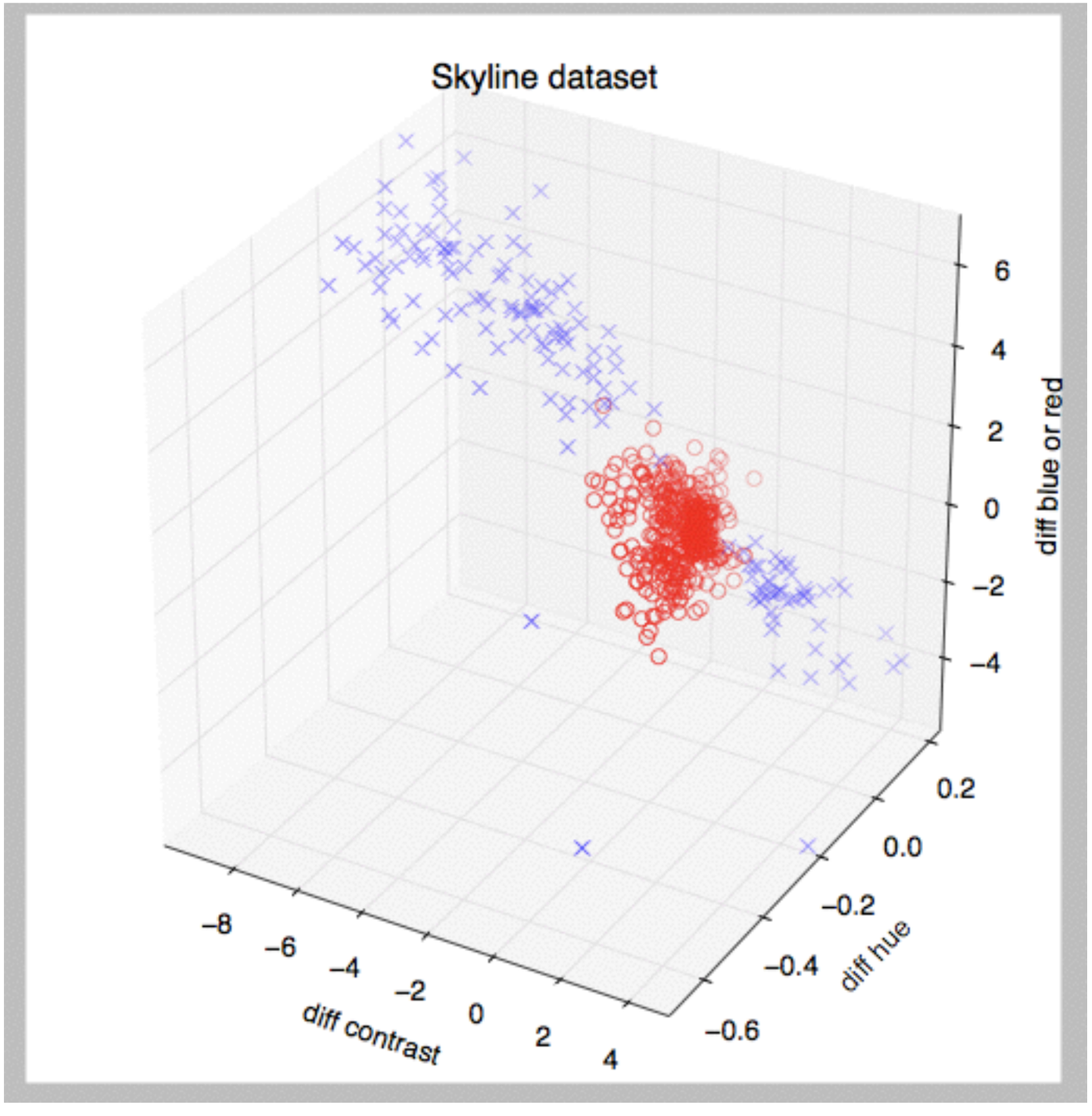


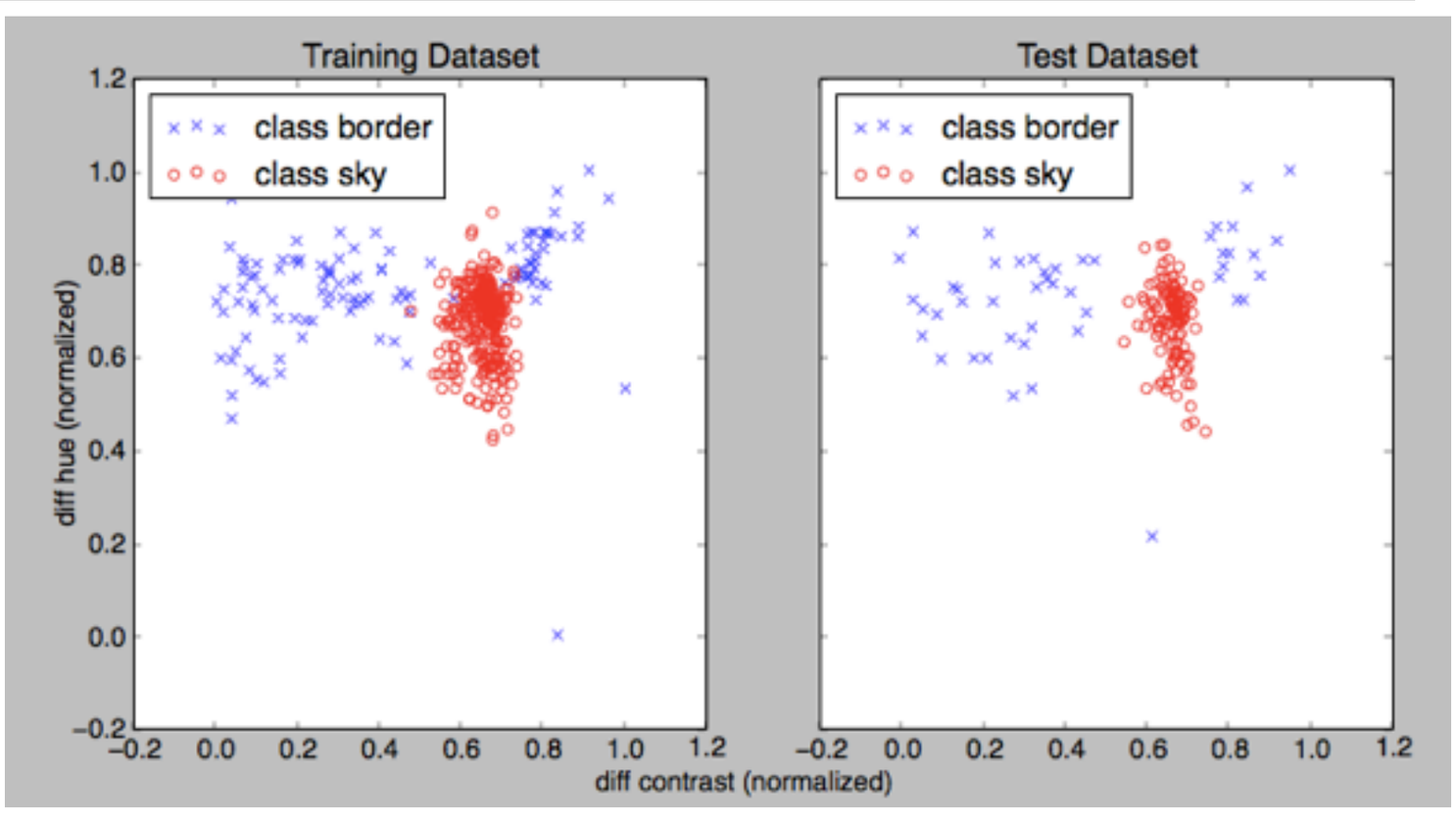
stinson test image



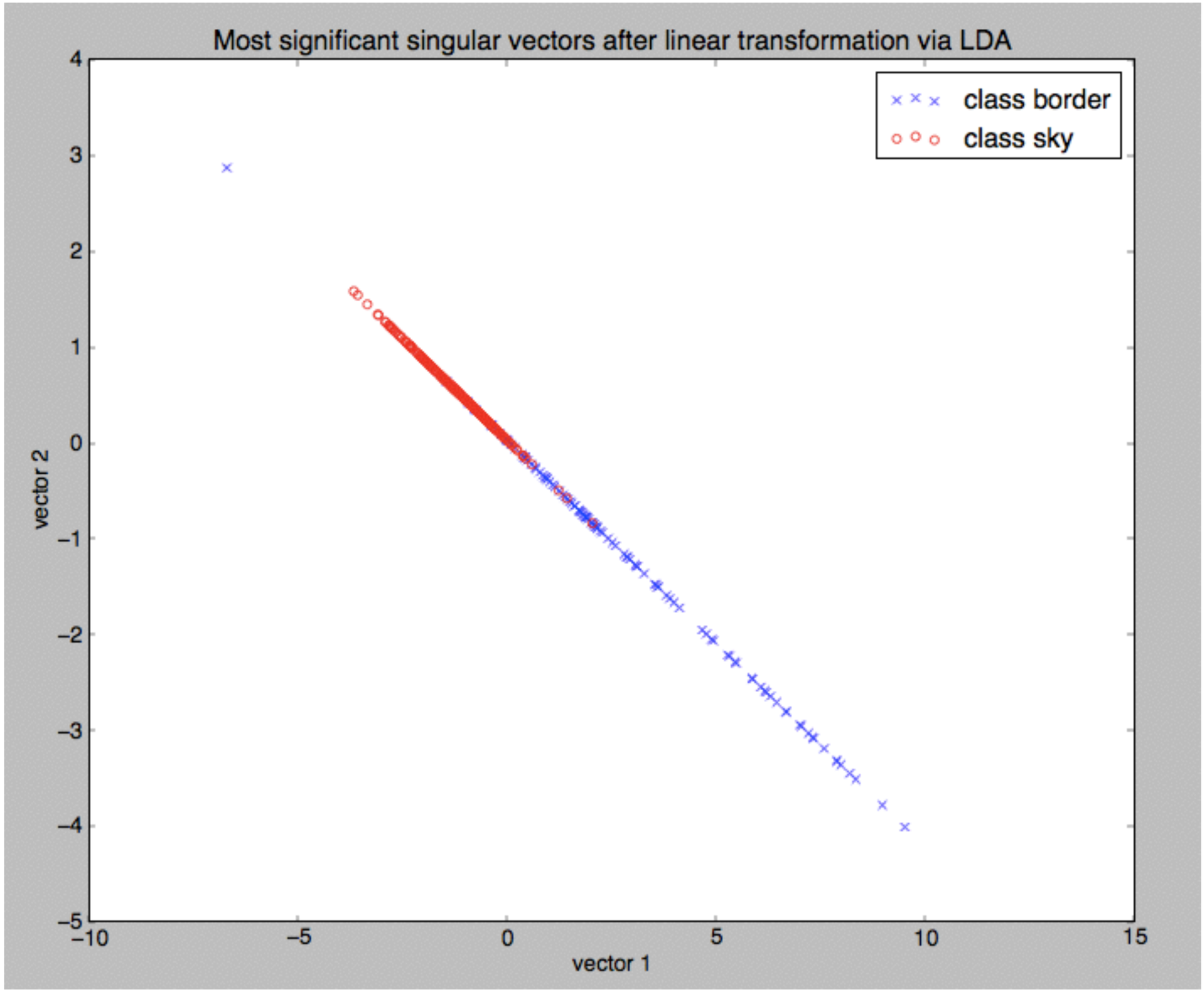
stinson test image



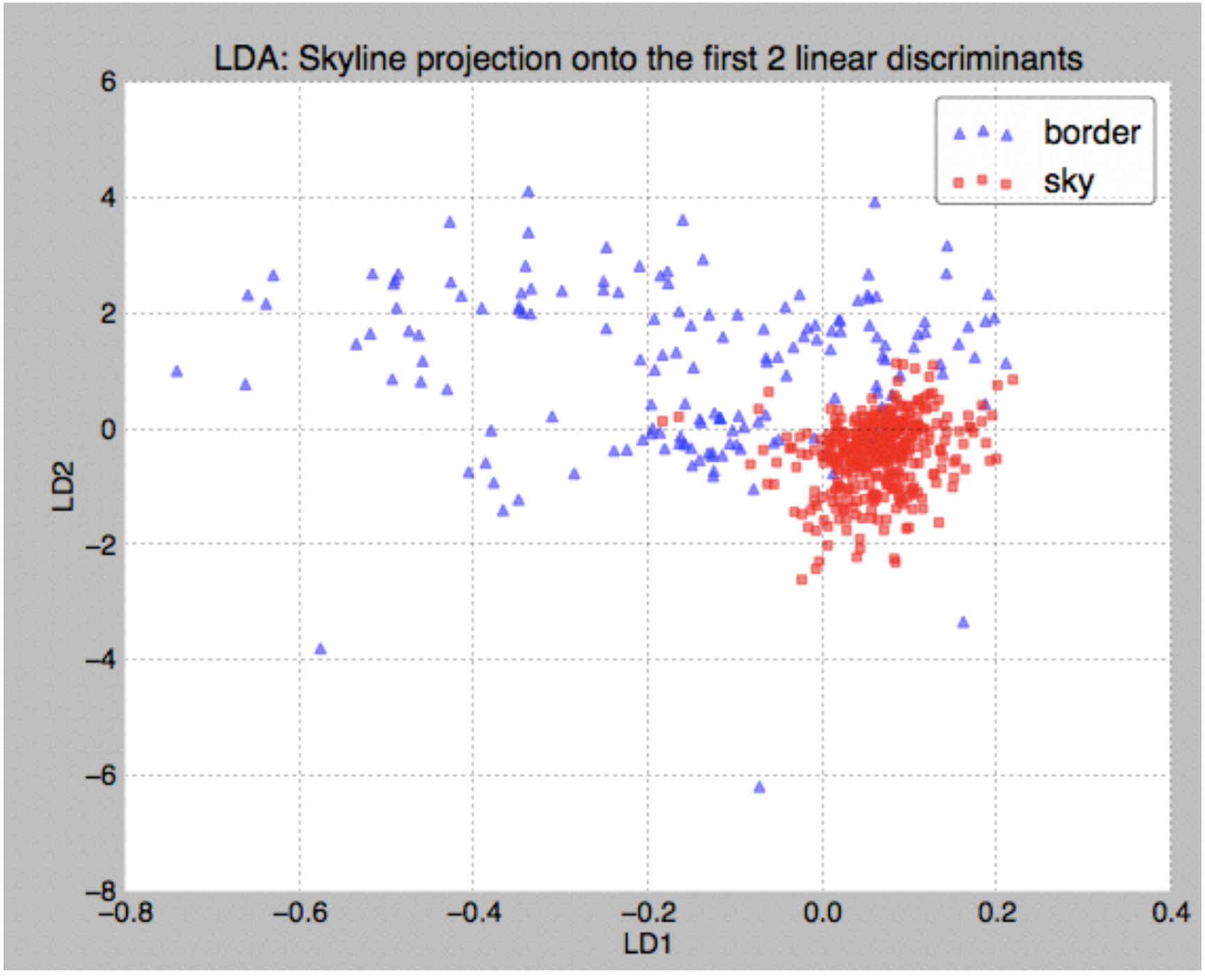
[stinson test image]



[stinson test image]

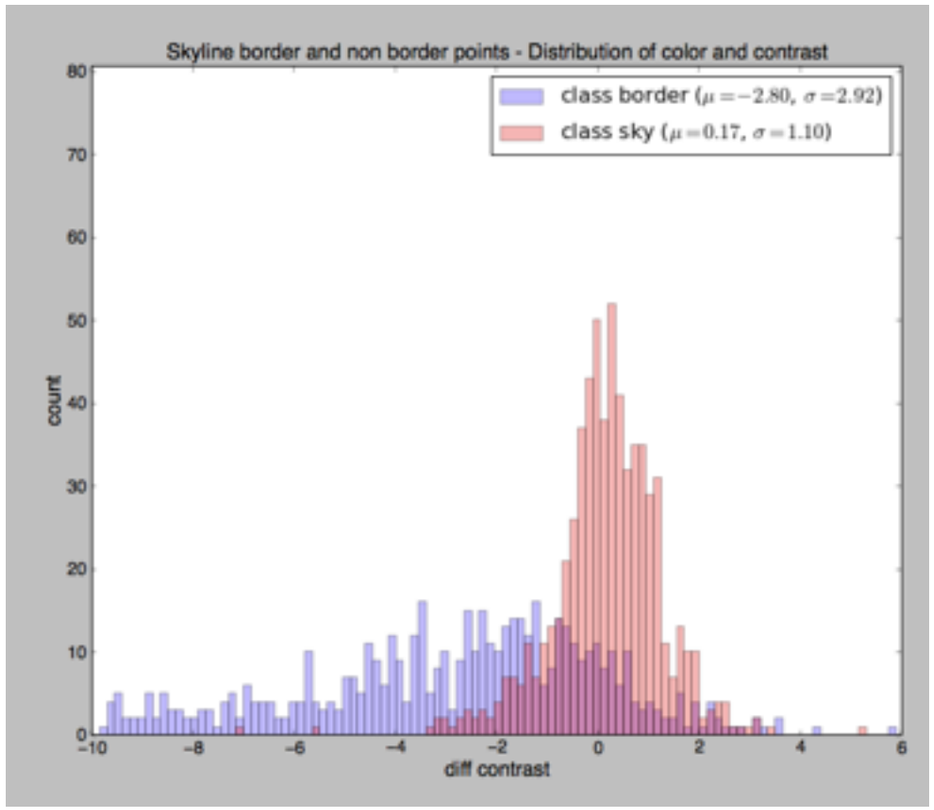


[stinson test image]

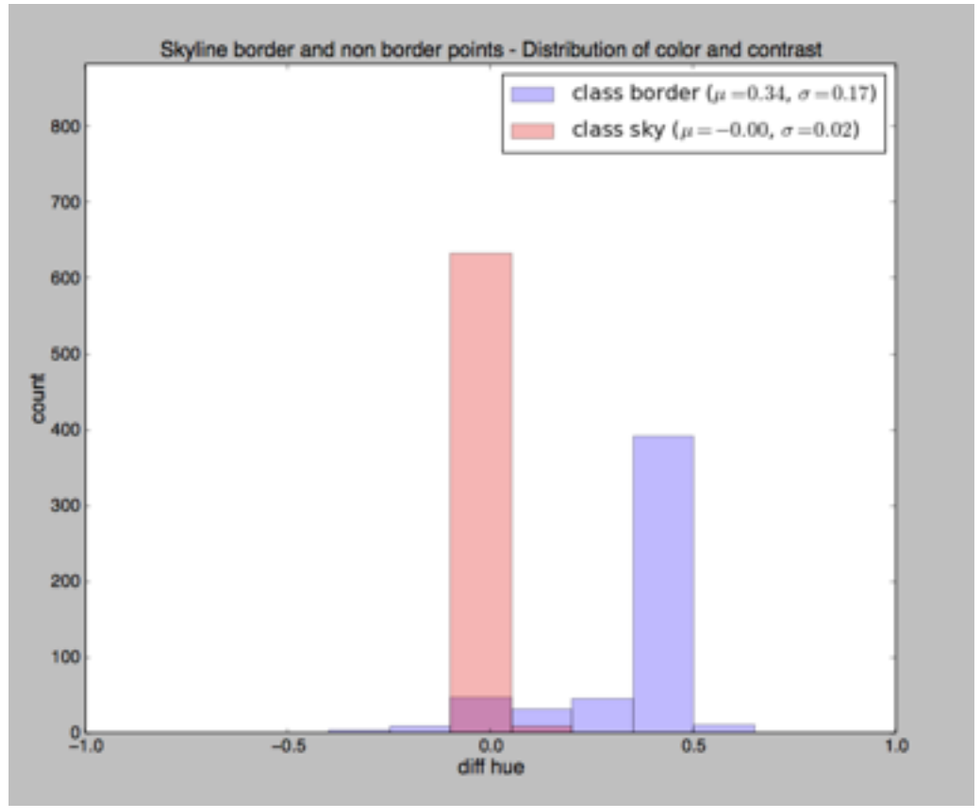


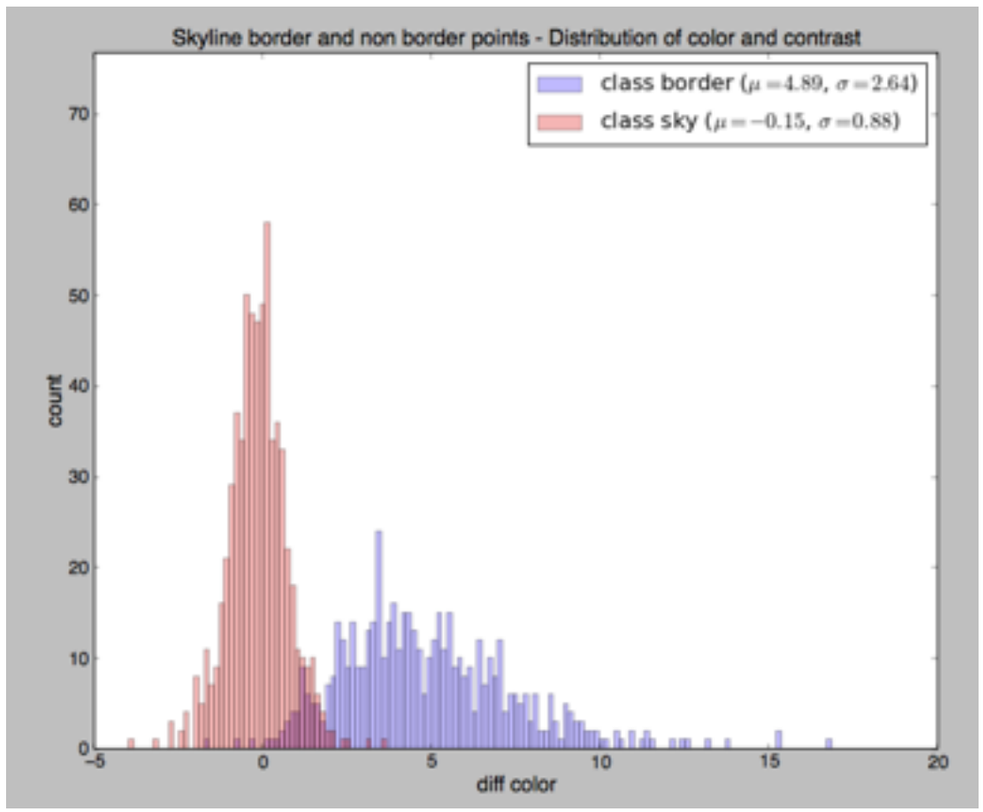
cloudy san jose test image

[cloudy san jose test image]

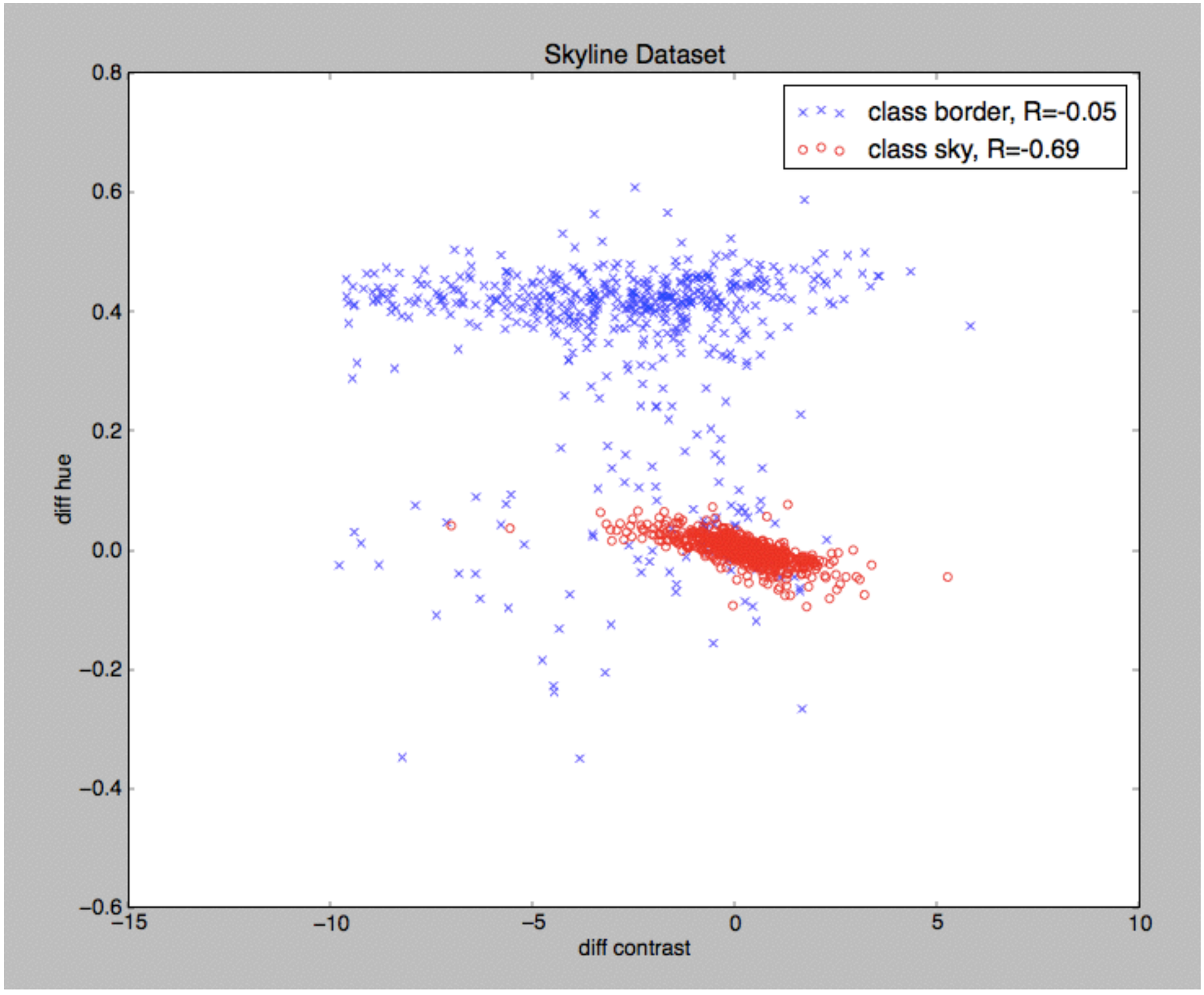


*note: the largest contrasts were removed from analysis for plot visibility

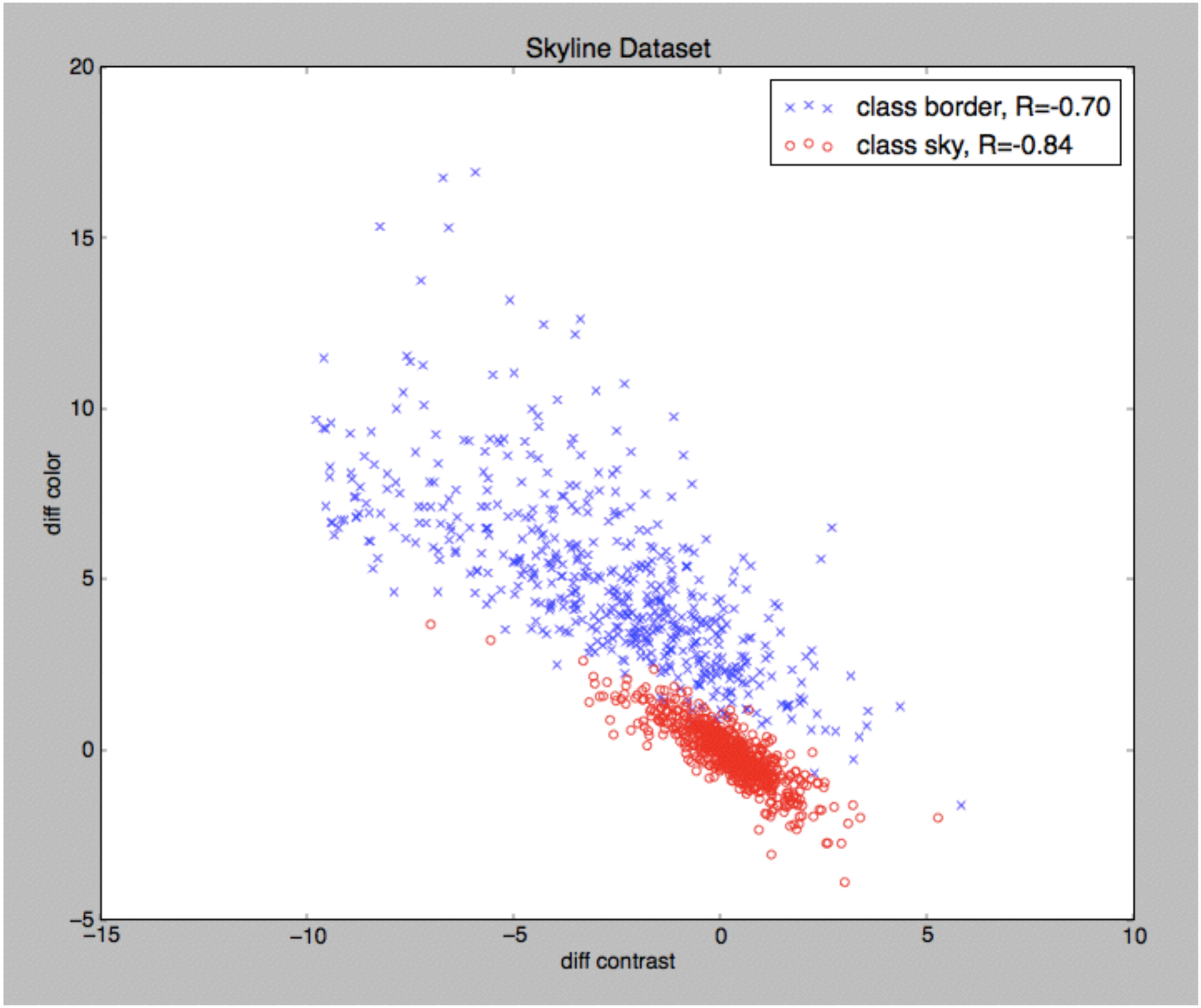




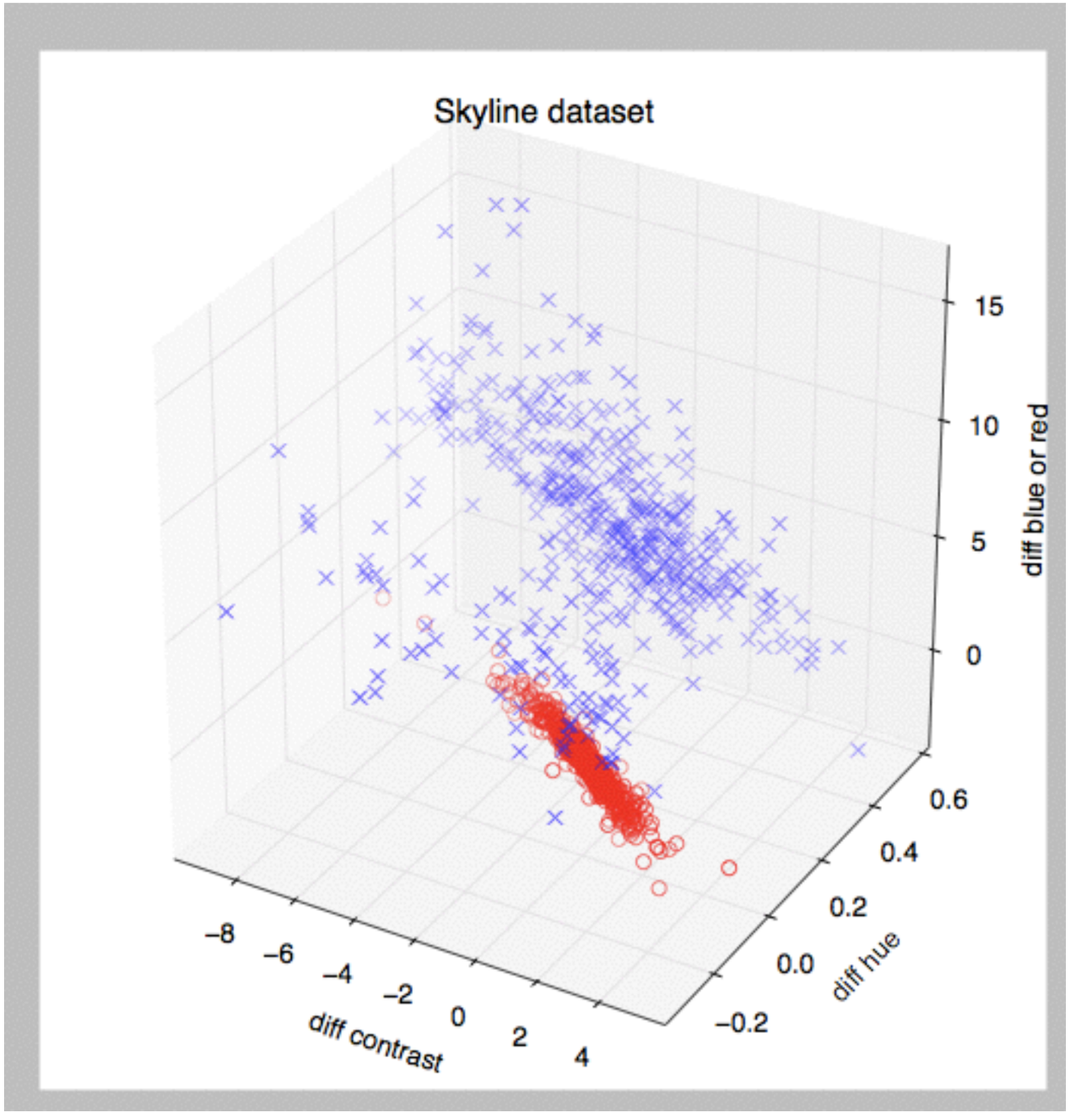
[cloudy san jose test image]



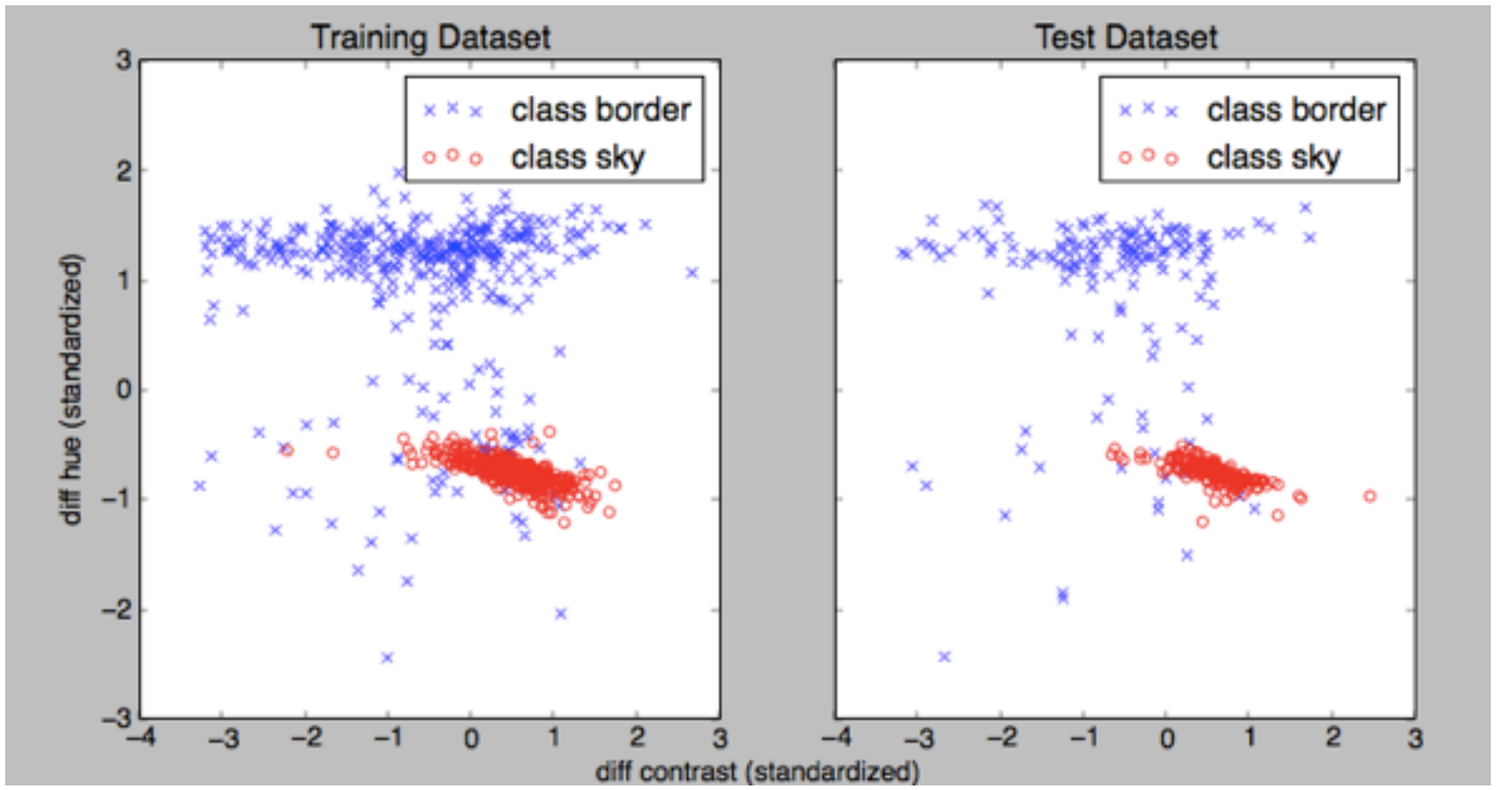
[cloudy san jose test image]

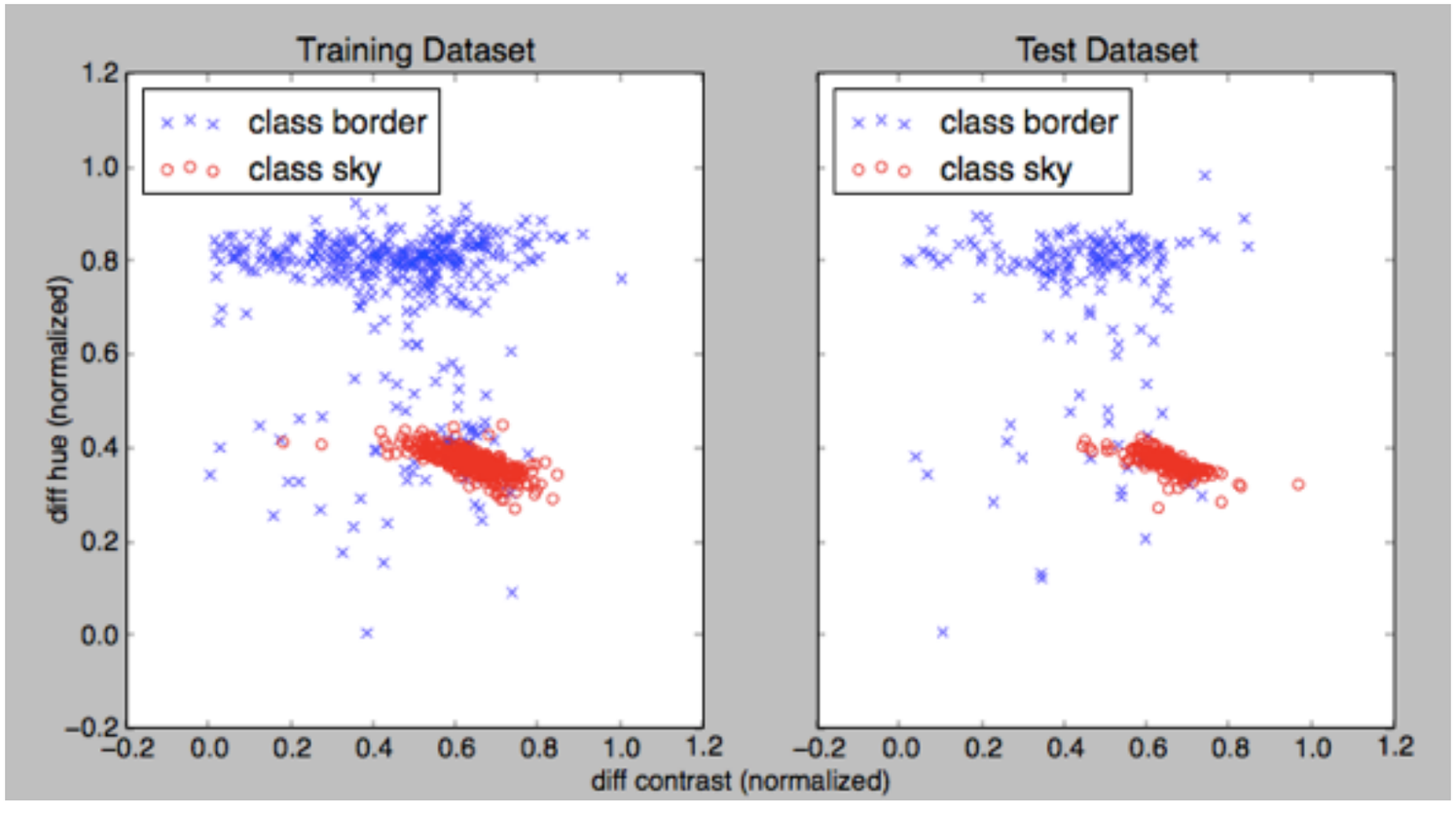


cloudy san jose test image

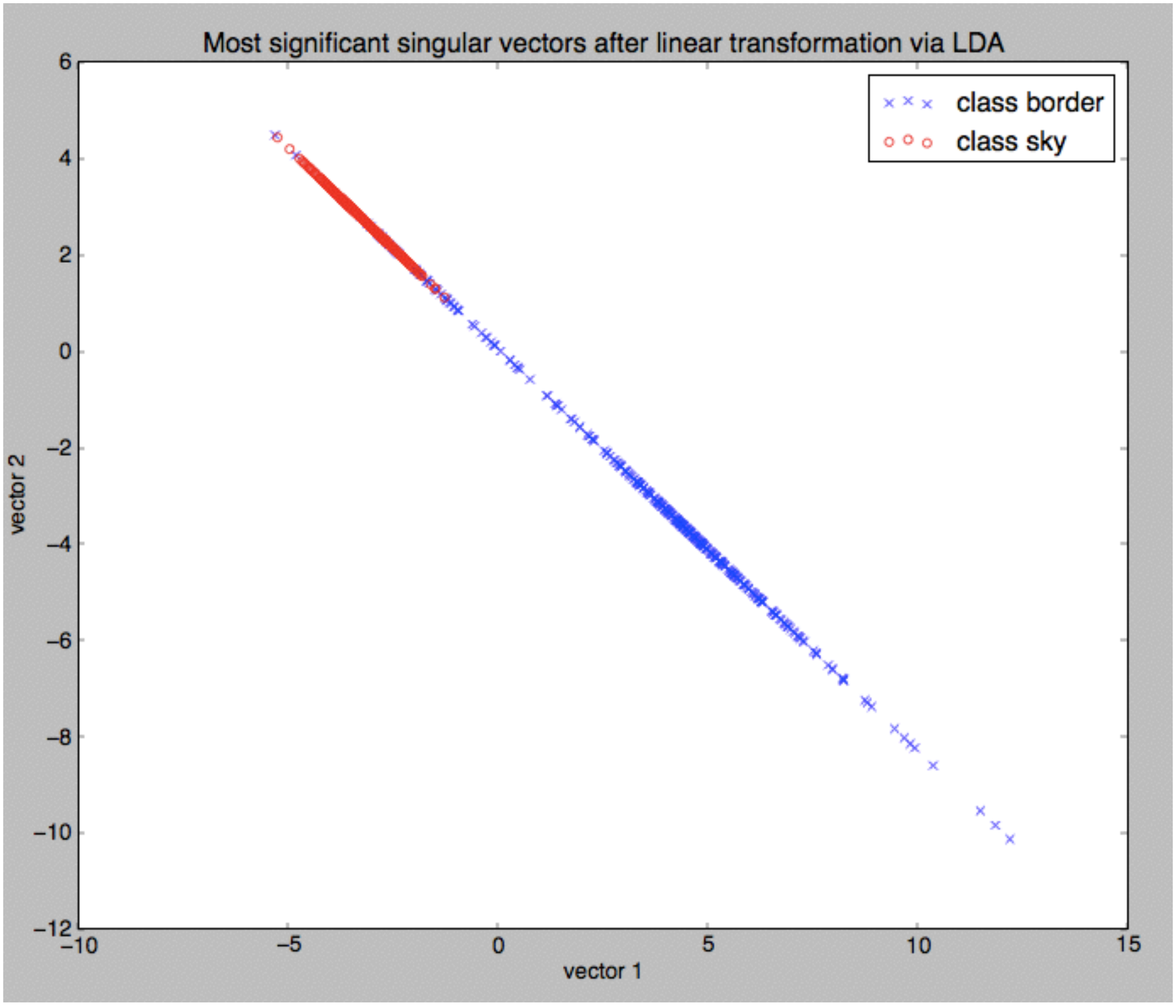


cloudy san jose test image

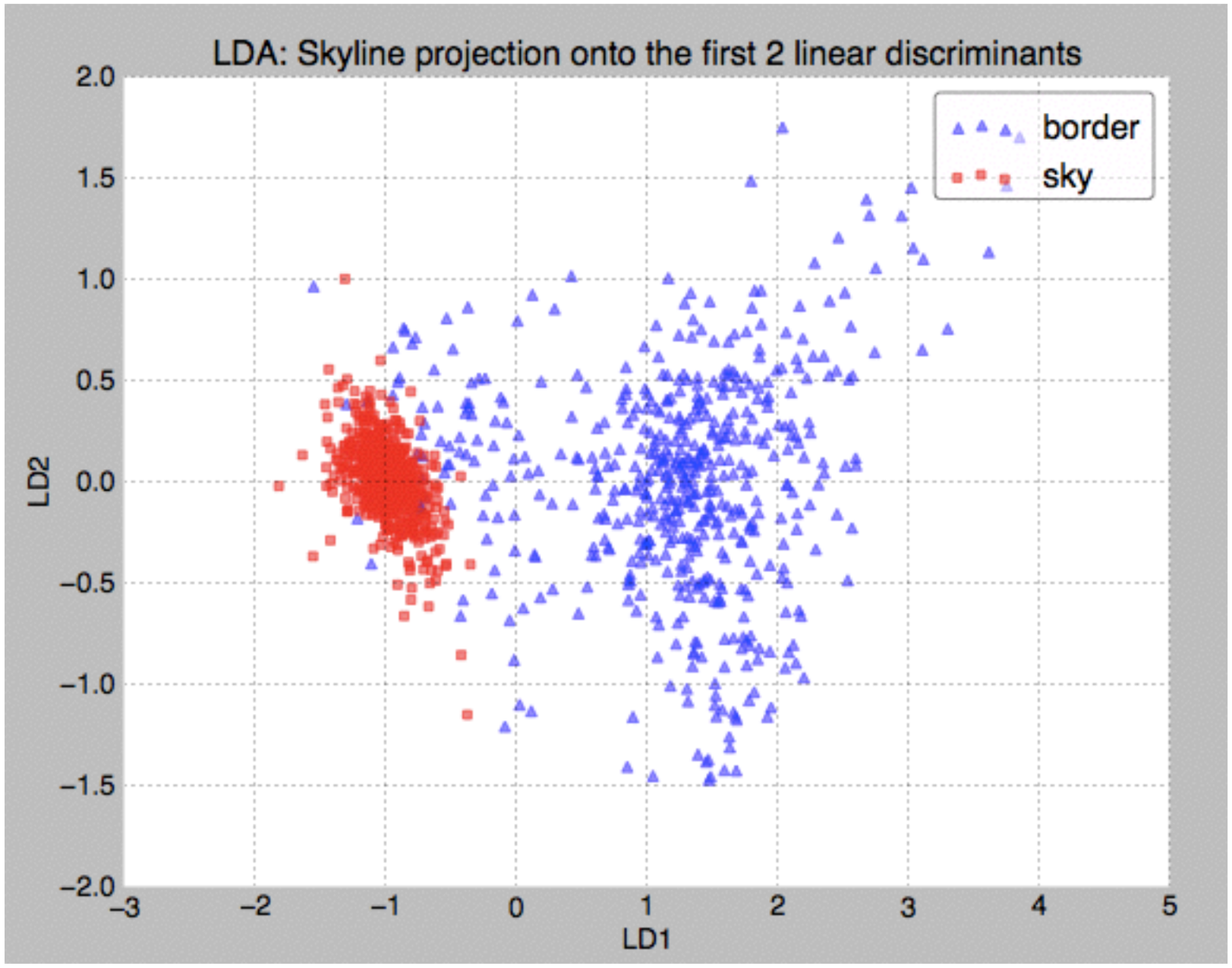




cloudy san jose test image



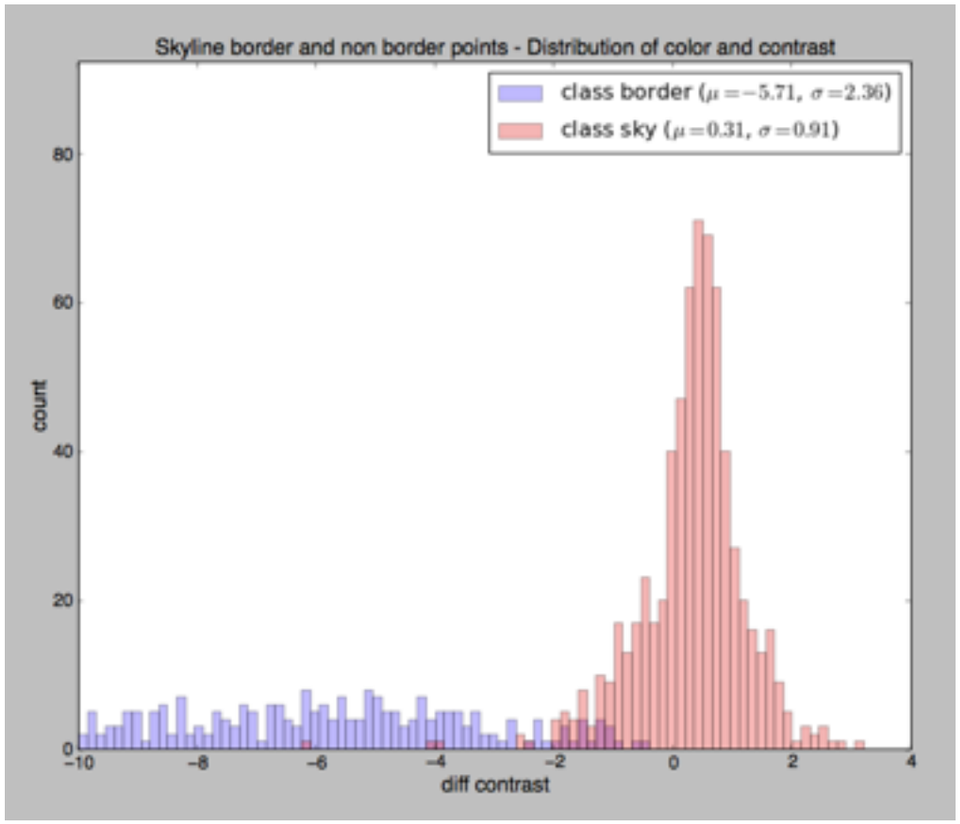
cloudy san jose test image



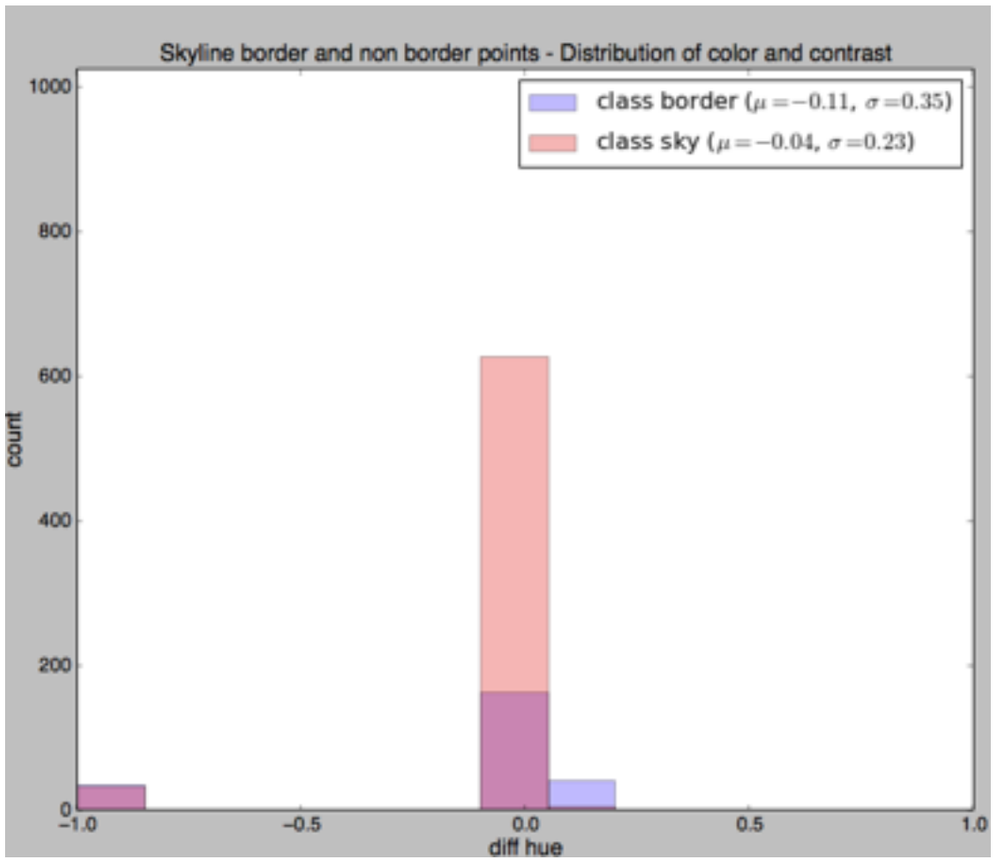

```
                        contrast  hue     BorR
Mean Vector class 1: [-0.6249  0.915   0.8745]

Mean Vector class 2: [ 0.5206 -0.7623 -0.7285]

('within-class Scatter Matrix:\n',
array([[ 792.7025,  -45.451 , -419.4417],
       [ -45.451 ,  355.4534,  103.9867],
       [-419.4417,  103.9867,  426.4421]]))
('between-class Scatter Matrix:\n',
array([[ 1163.2016, -1662.9155, -1588.5417],
       [-1662.9155,  2474.949 ,  2366.0545],
       [-1588.5417,  2366.0545,  2261.9829]]))

Eigenvector 1:
[[ 0.1214]
 [ 0.7336]
 [ 0.6686]]
Eigenvalue 1: 9.84e+00

Eigenvector 2:
[[ 0.6999]
 [-0.1895]
 [ 0.6886]]
Eigenvalue 2: 1.29e-01

Eigenvector 3:
[[-0.0189]
 [-0.6975]
 [ 0.7163]]
Eigenvalue 3: 1.85e-15
ok
Eigenvalues in decreasing order:

9.84005195578
0.128680128928
1.85202129573e-15
Variance explained:

eigenvalue 1: 98.71%
eigenvalue 2: 1.29%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.1214,  0.7336,  0.6686],
       [ 0.6999, -0.1895,  0.6886]]))
```

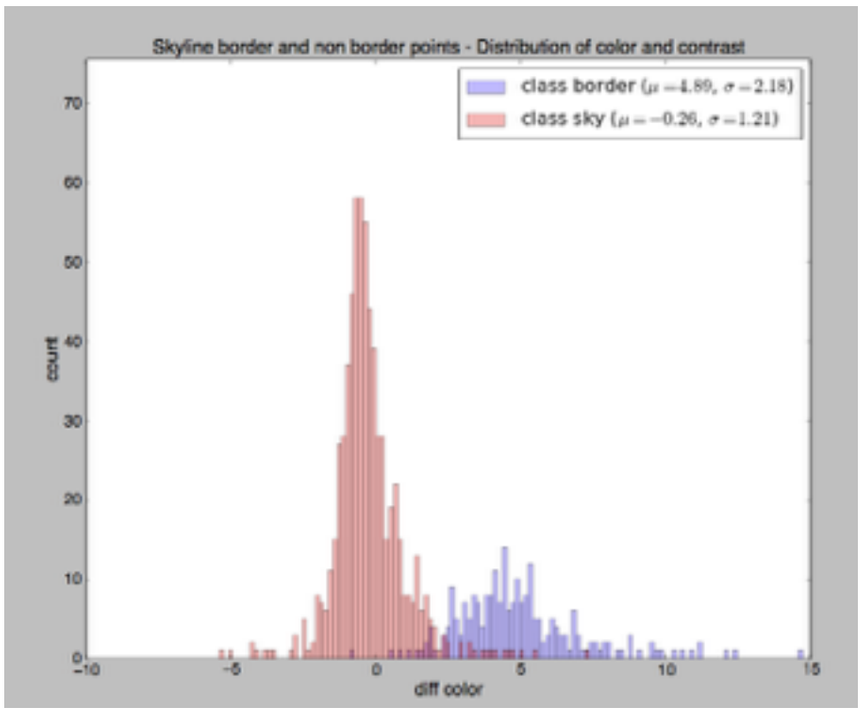
stonehenge test image

stonehenge test image

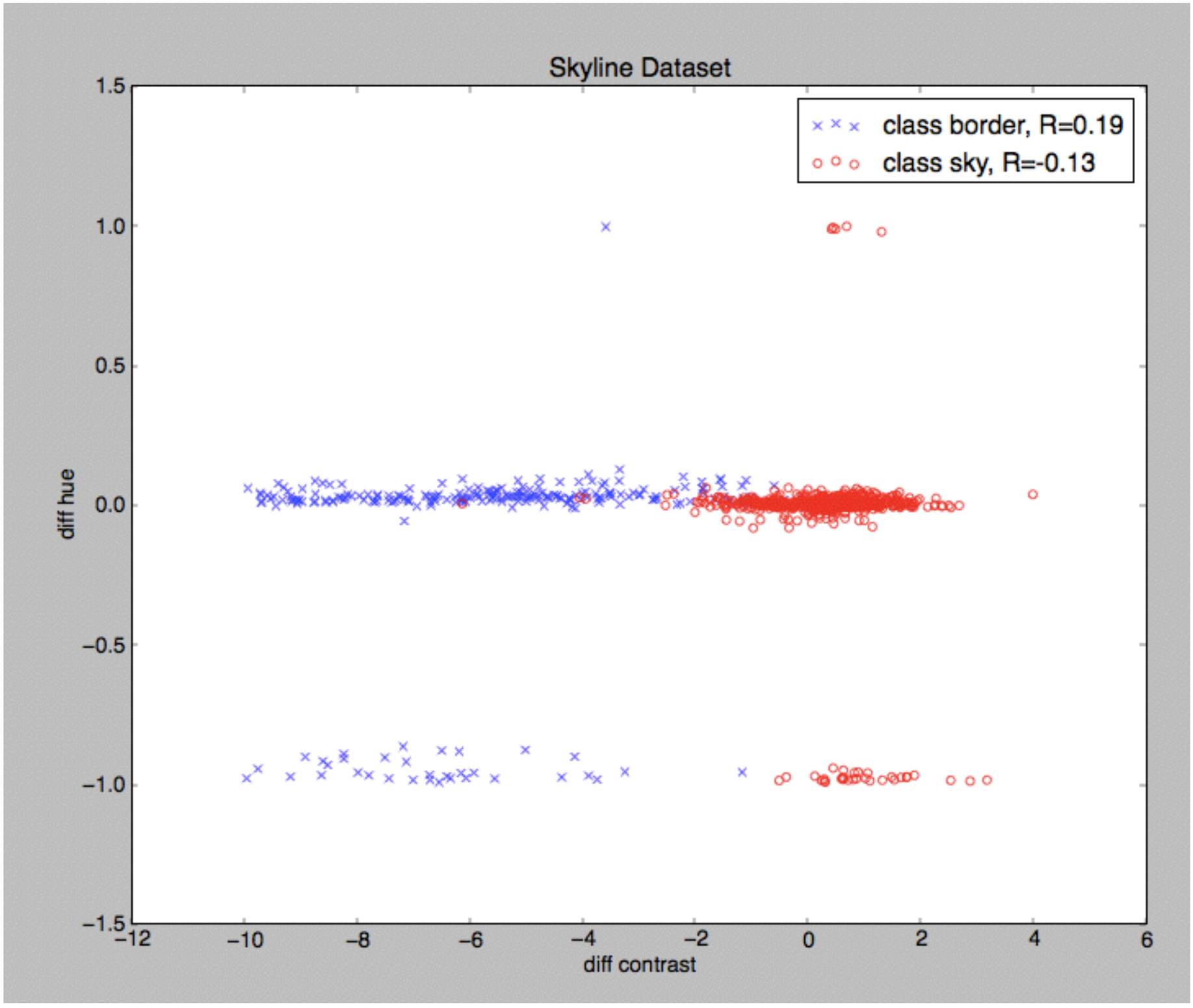


*note: the largest contrasts were removed from analysis for plot visibility

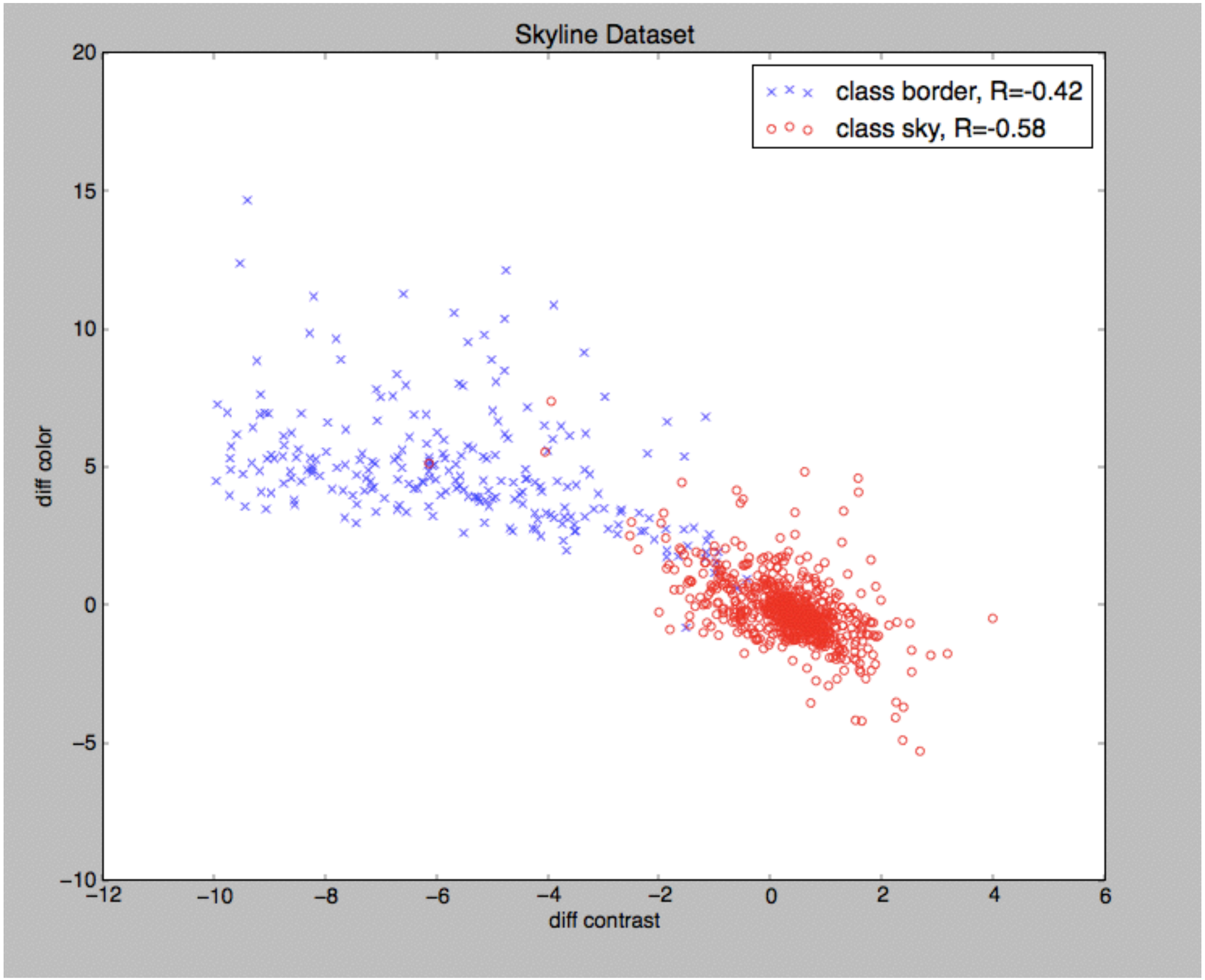




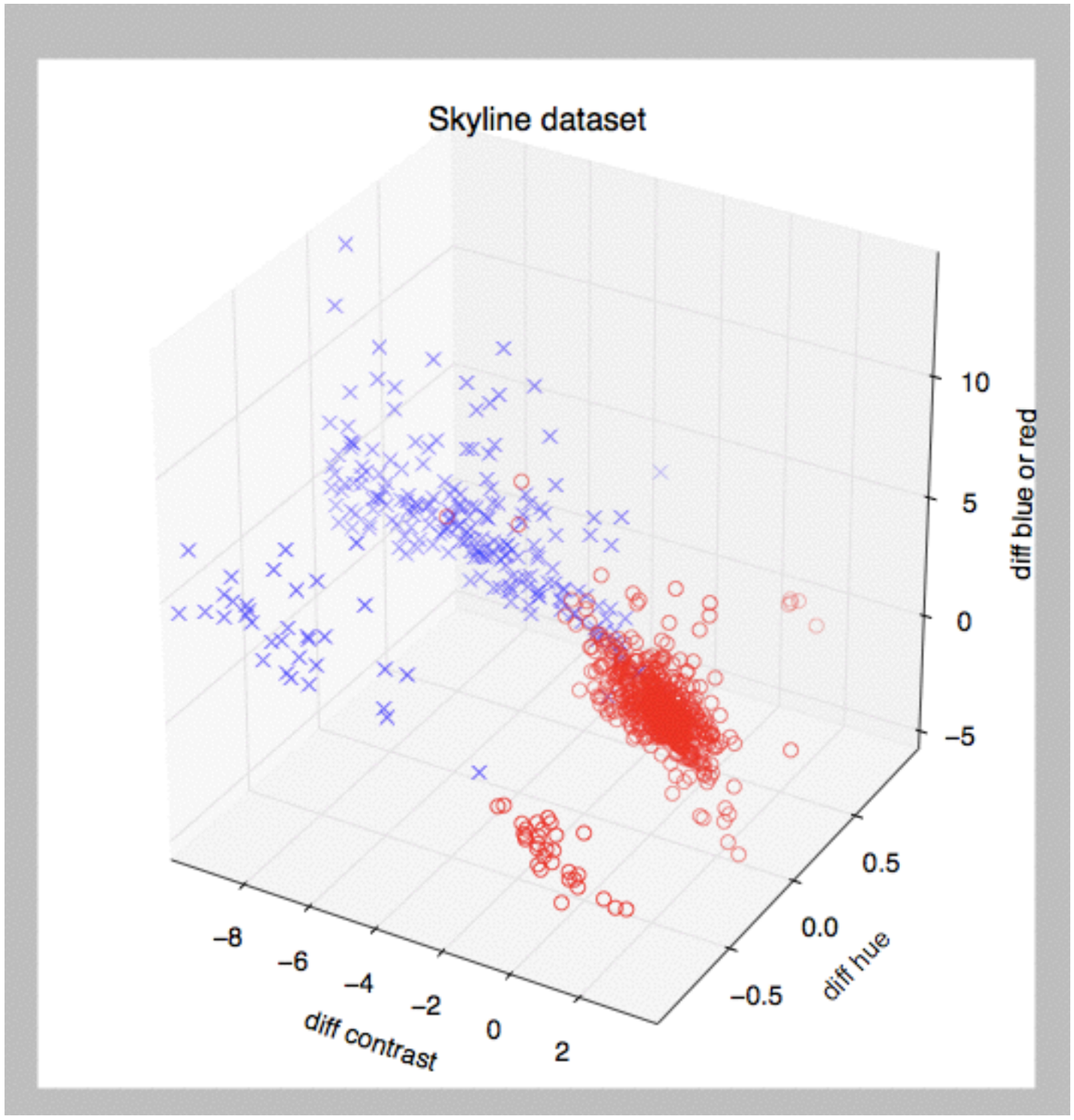
[stonehenge test image]



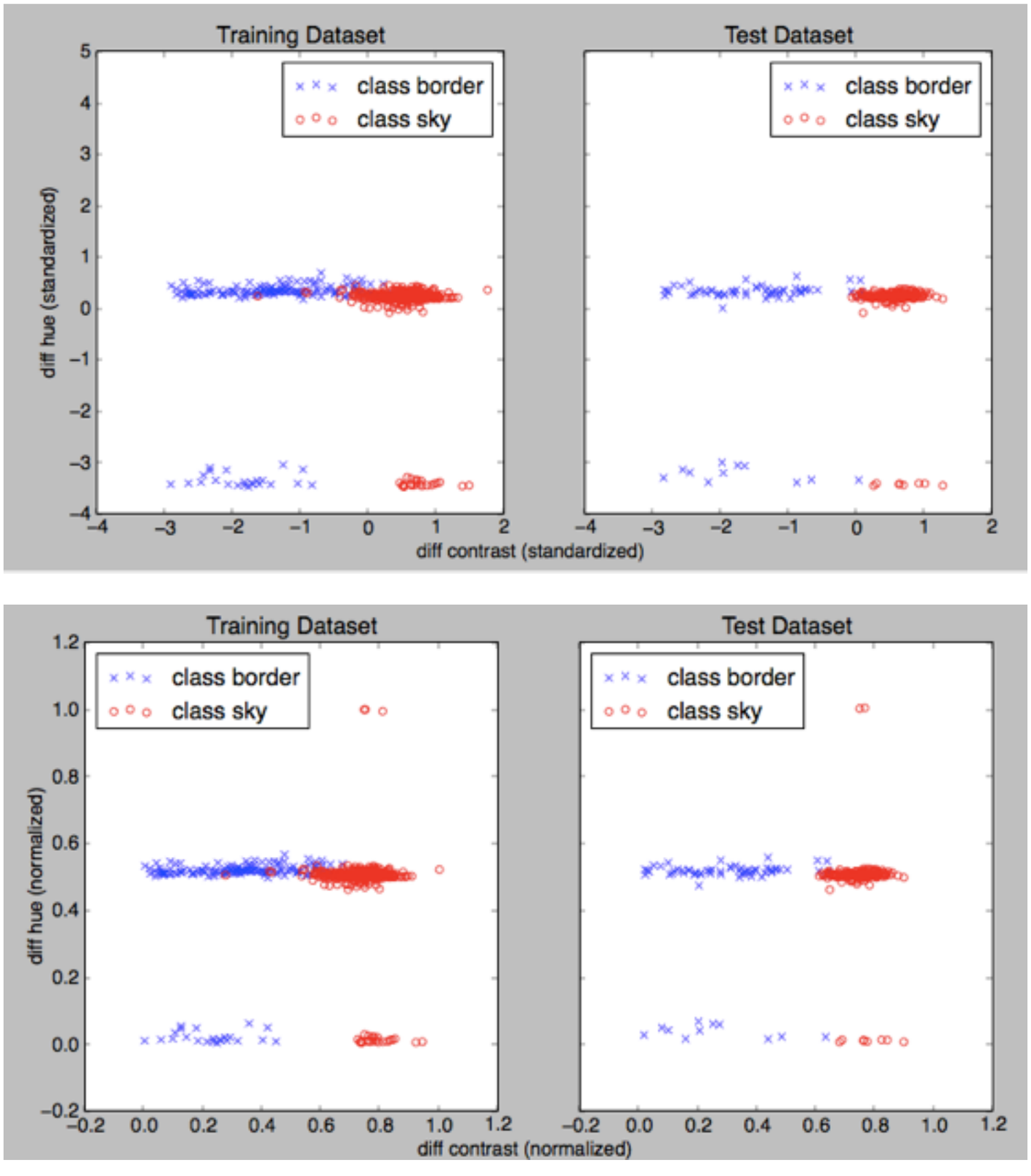
[stonehenge test image]



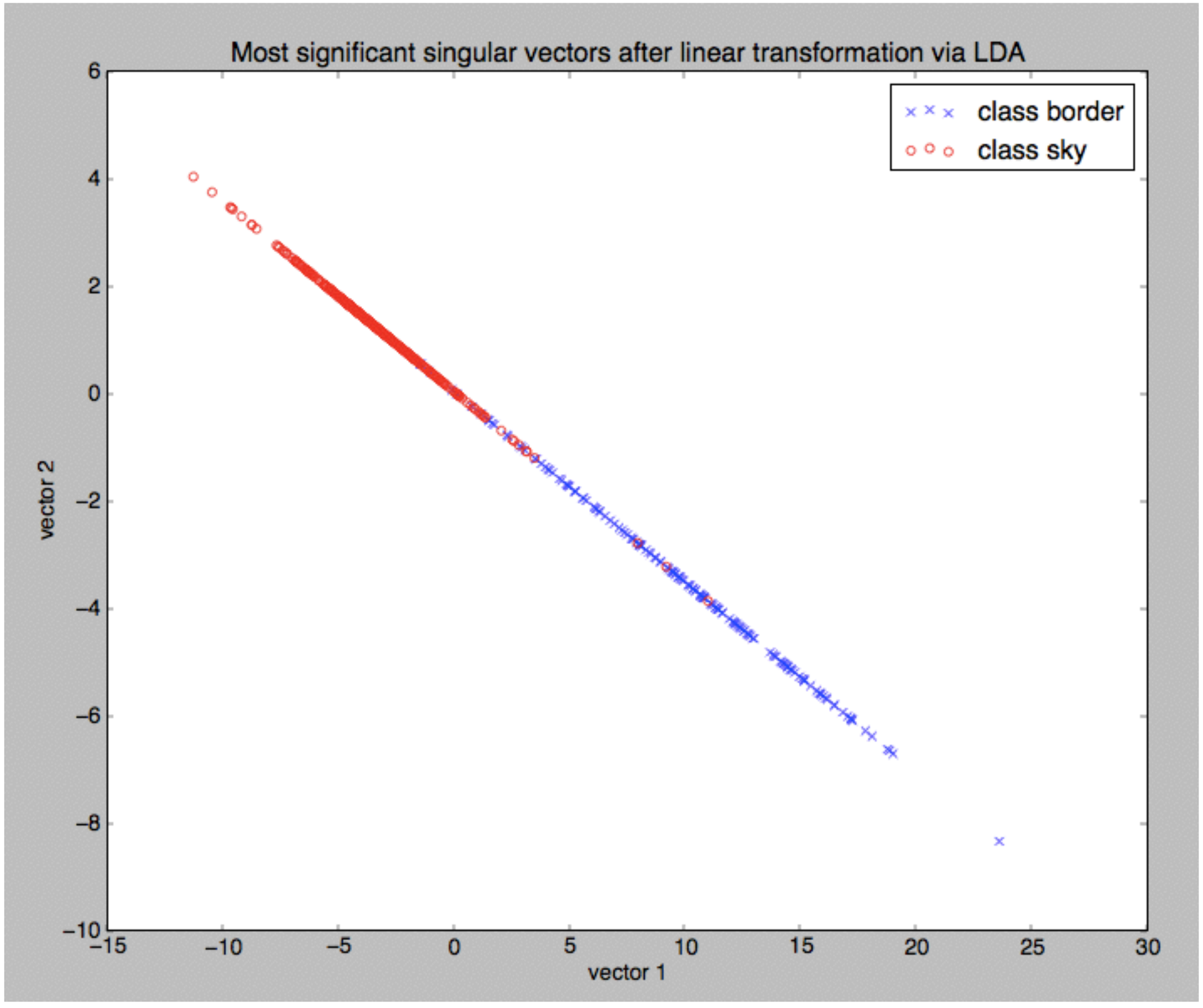
[stonehenge test image]



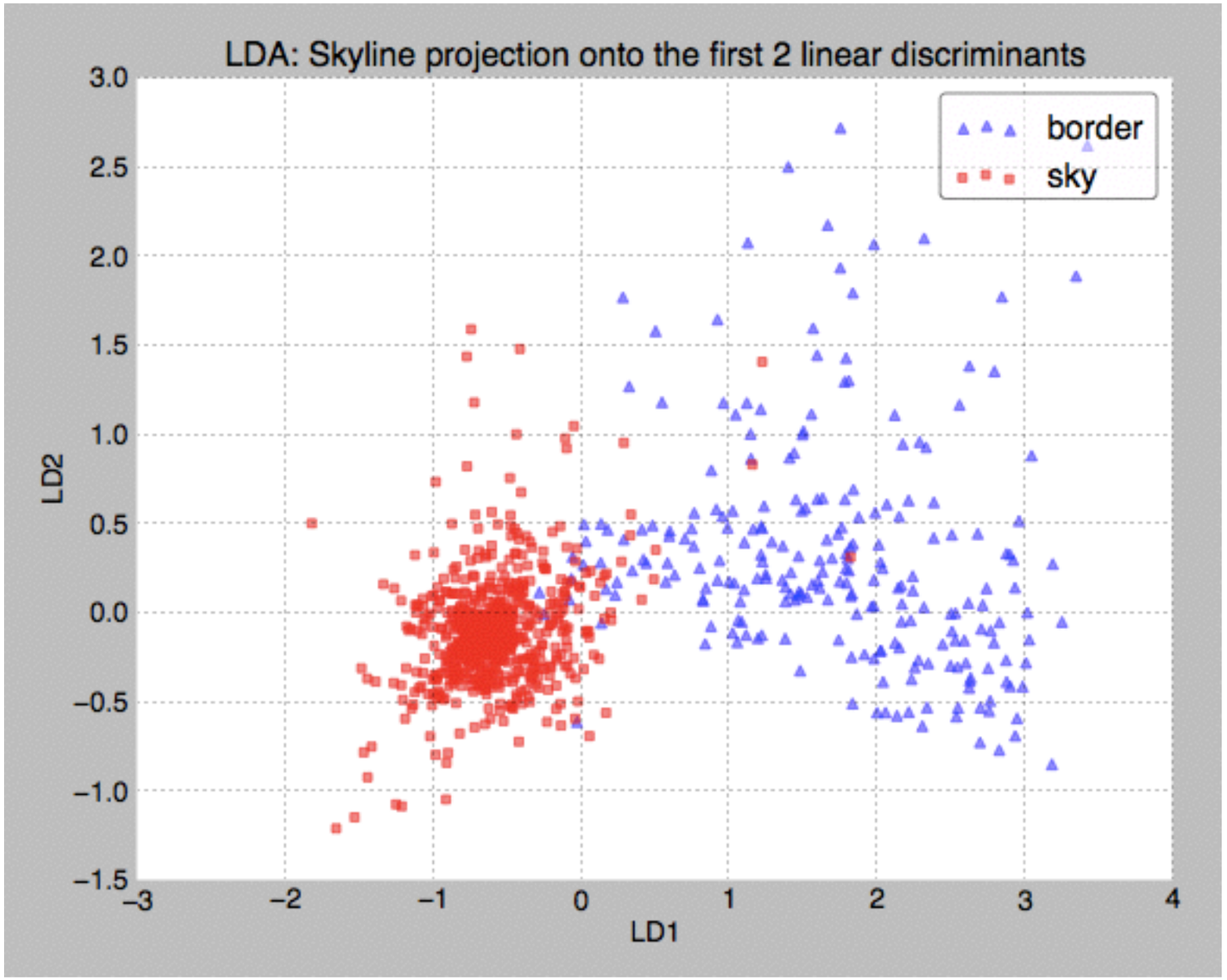
[stonehenge test image]



[stonehenge test image]

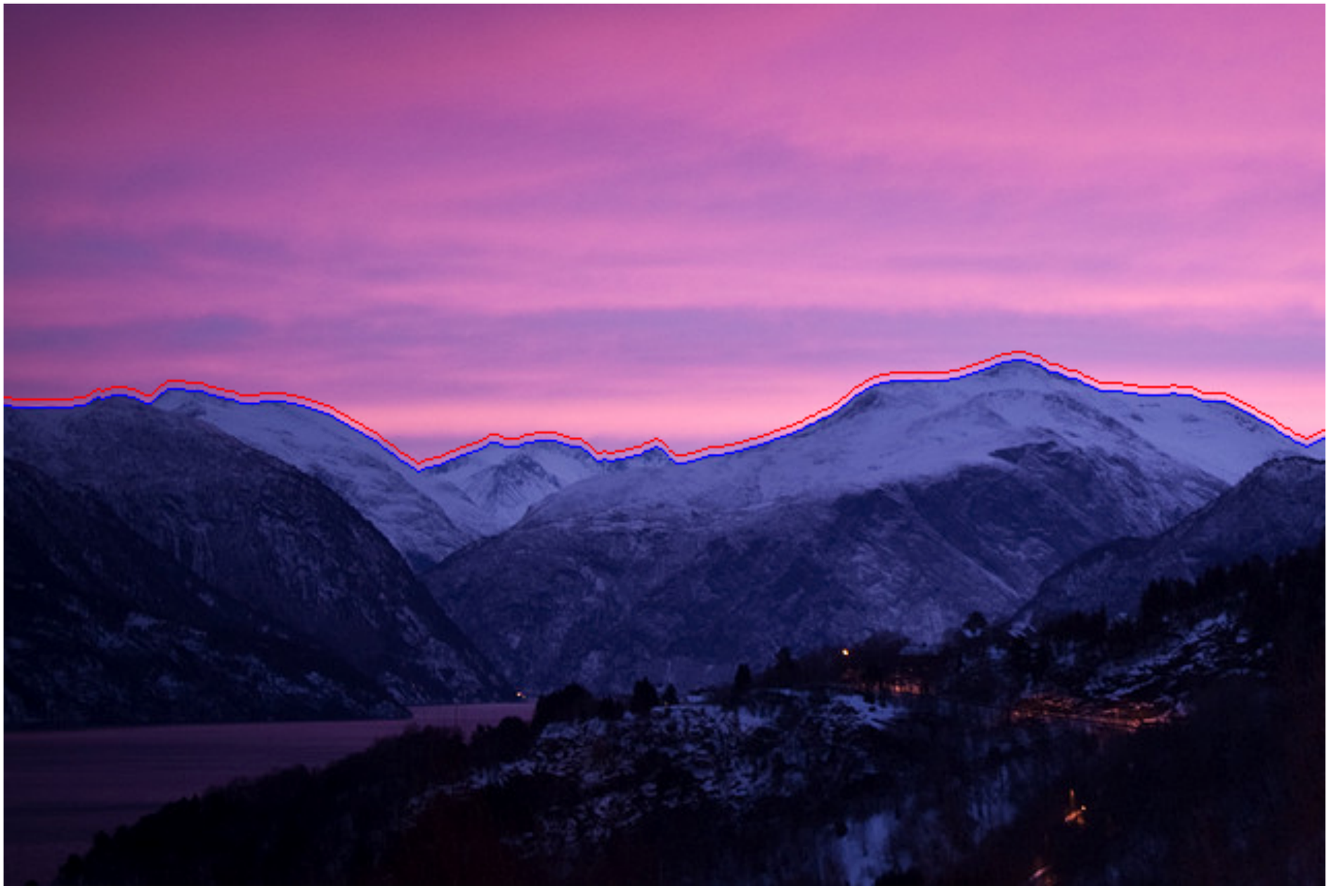


cloudy san jose test image

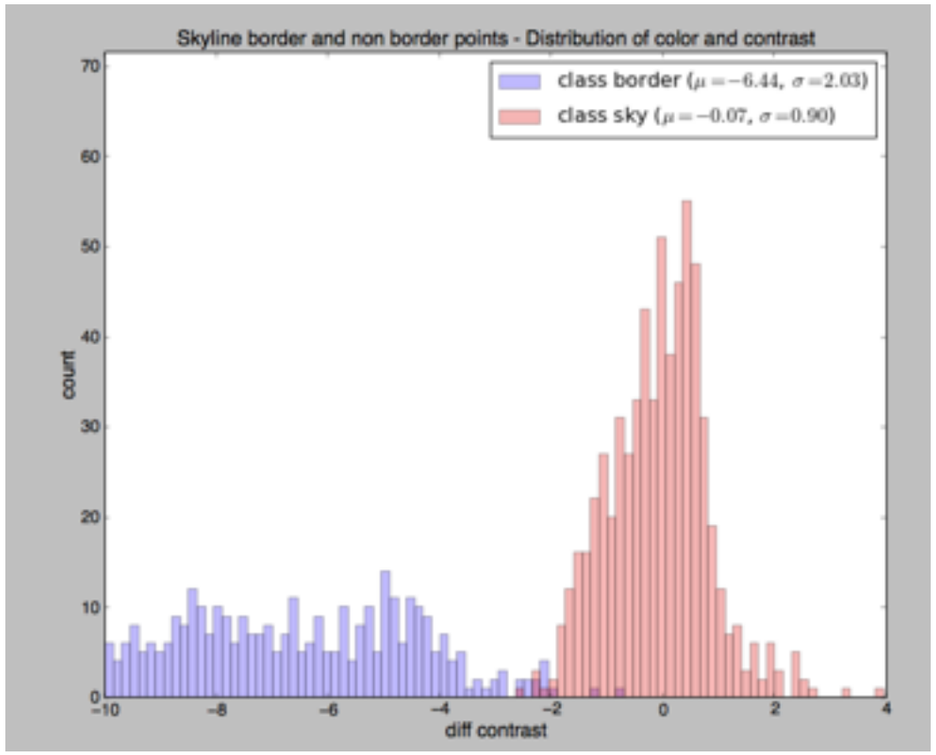



```
                        contrast  hue     BorR
Mean Vector class 1: [-1.4794 -0.1936  1.3958]

Mean Vector class 2: [ 0.522   0.0683 -0.4925]

('within-class Scatter Matrix:\n',
array([[ 205.145 ,   23.1388, -112.9972],
       [  23.1388,  889.0816,   14.9999],
       [-112.9972,   14.9999,  281.5866]]))
('between-class Scatter Matrix:\n',
array([[ 2481.3731,   667.0138, -1575.7598],
       [  667.0138,   429.5633,   136.0448],
       [-1575.7598,   136.0448,  2252.0482]]))

Eigenvector 1:
[[-0.9876]
 [-0.0366]
 [ 0.1525]]
Eigenvalue 1: 1.23e+01

Eigenvector 2:
[[-0.4505]
 [ 0.815 ]
 [-0.3645]]
Eigenvalue 2: 0.00e+00

Eigenvector 3:
[[ 0.5591]
 [ 0.0716]
 [ 0.826 ]]
Eigenvalue 3: 5.80e+00
ok
Eigenvalues in decreasing order:

12.3043384159
5.80051974387
0.0
Variance explained:

eigenvalue 1: 67.96%
eigenvalue 2: 32.04%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.9876, -0.0366,  0.1525],
       [ 0.5591,  0.0716,  0.826 ]]))
```

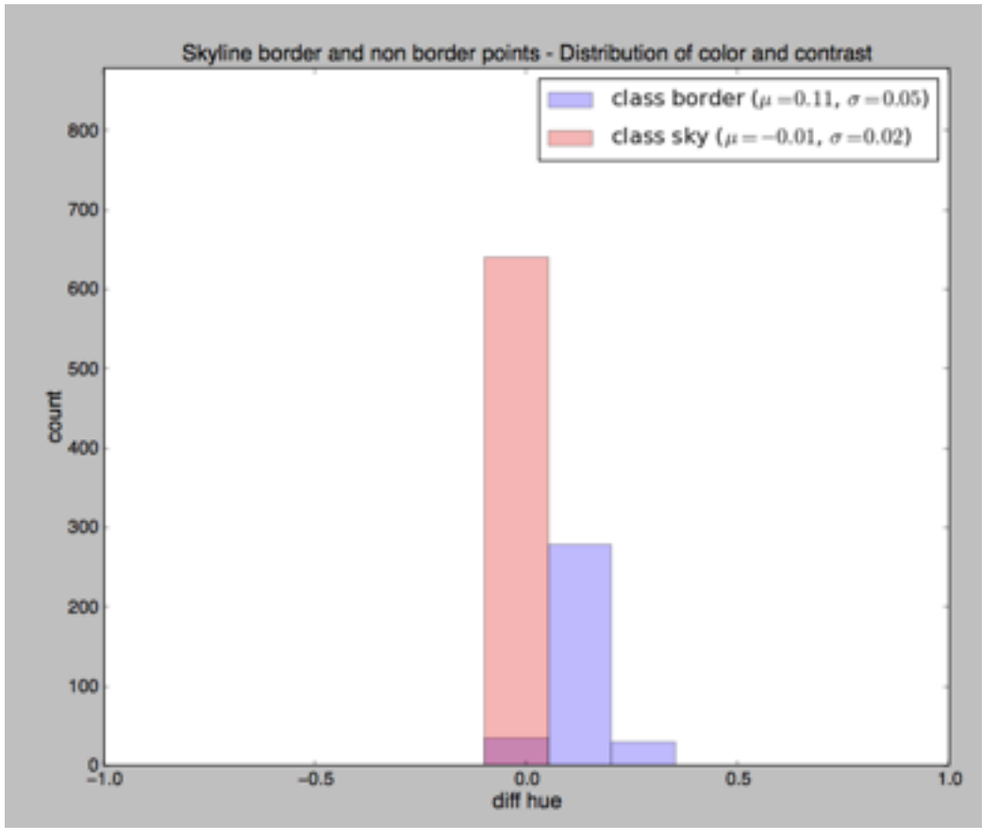
norwegian mtn range test image

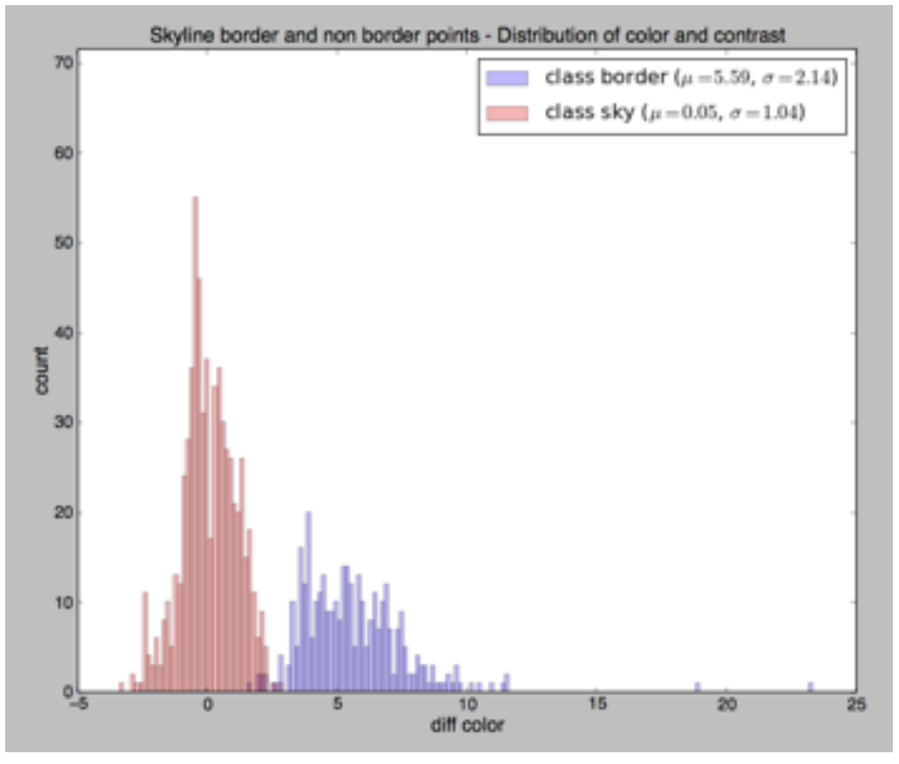


[norwegian mtn range test image]

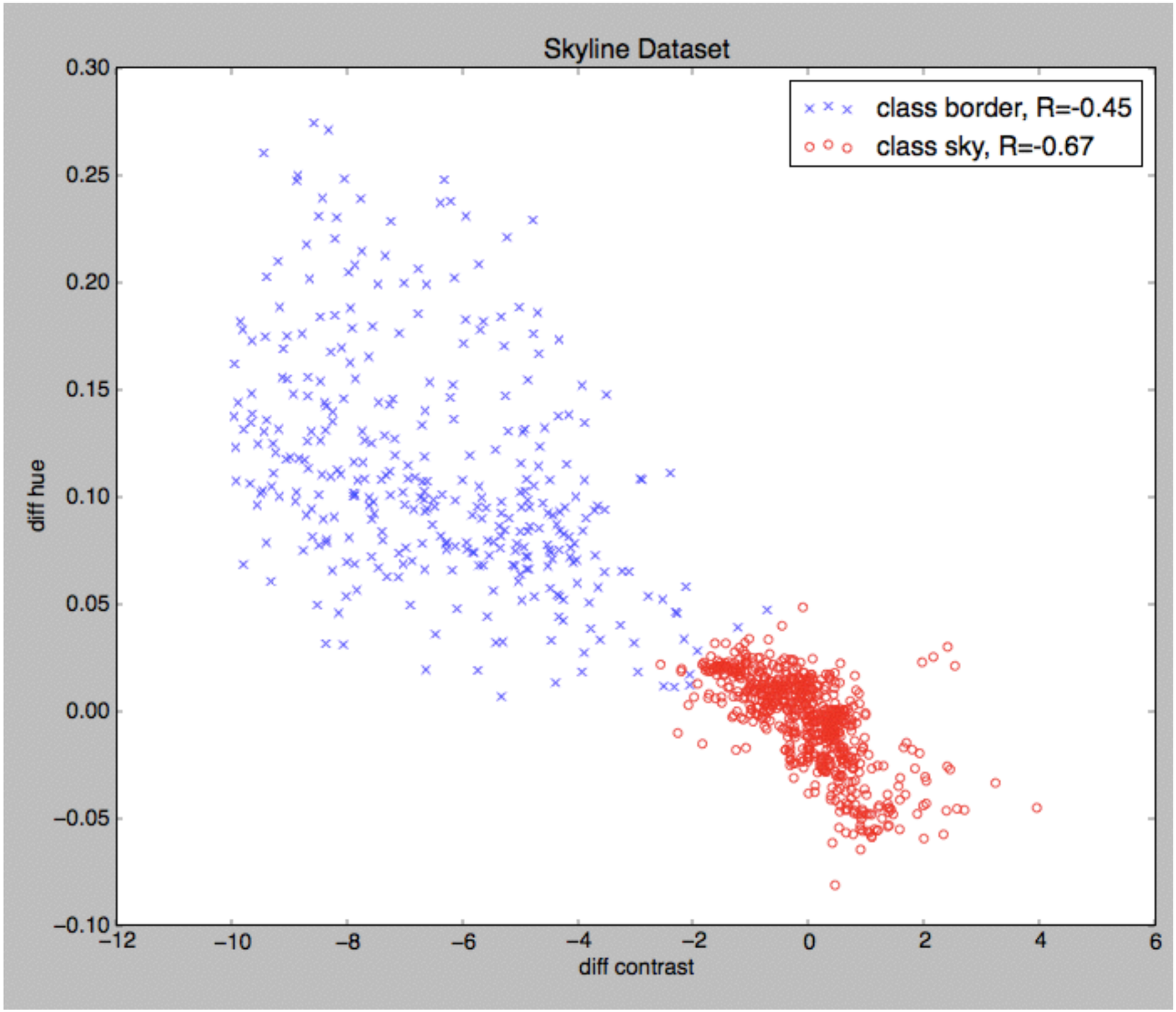


*note: the largest contrasts were removed from analysis for plot visibility

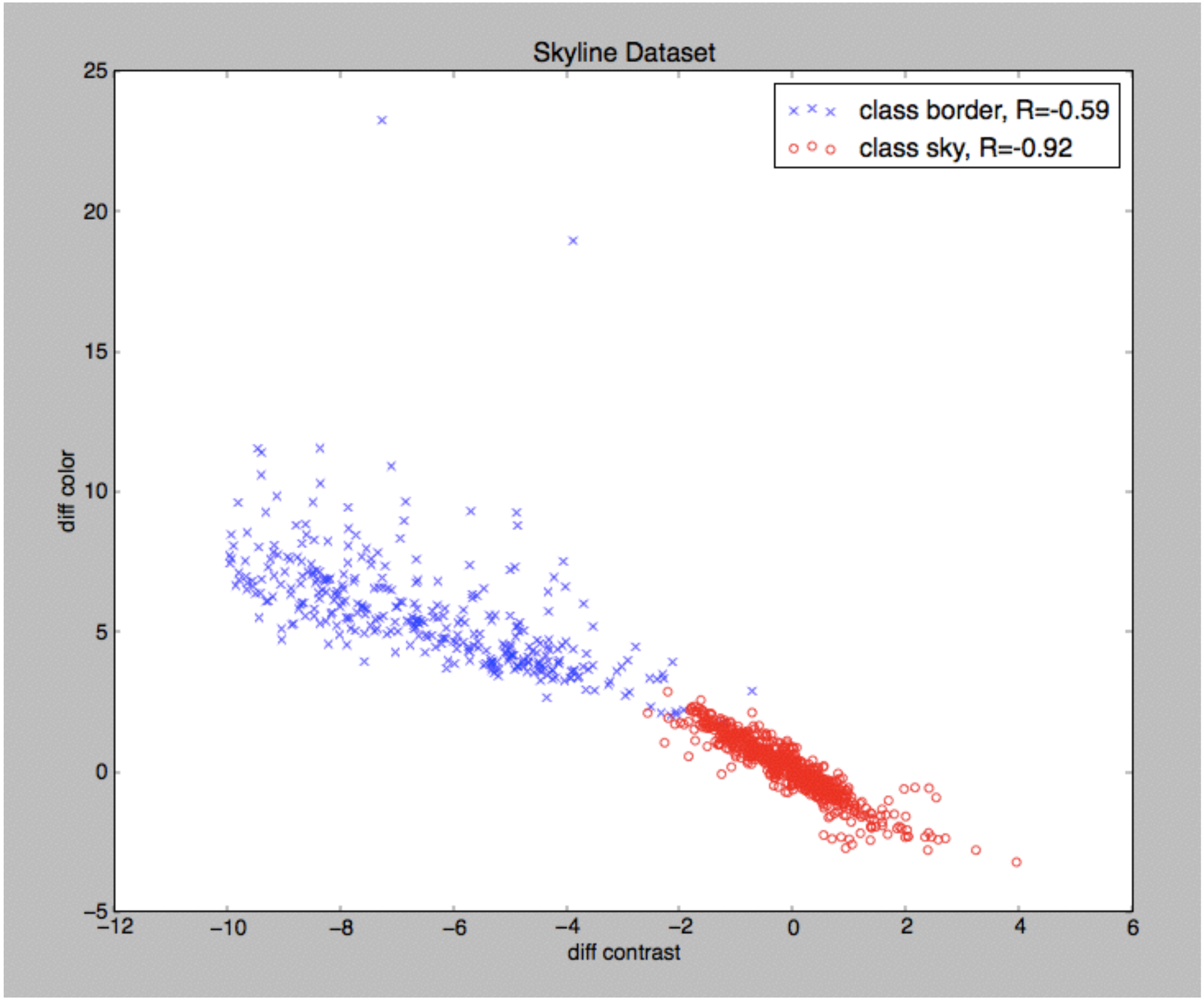




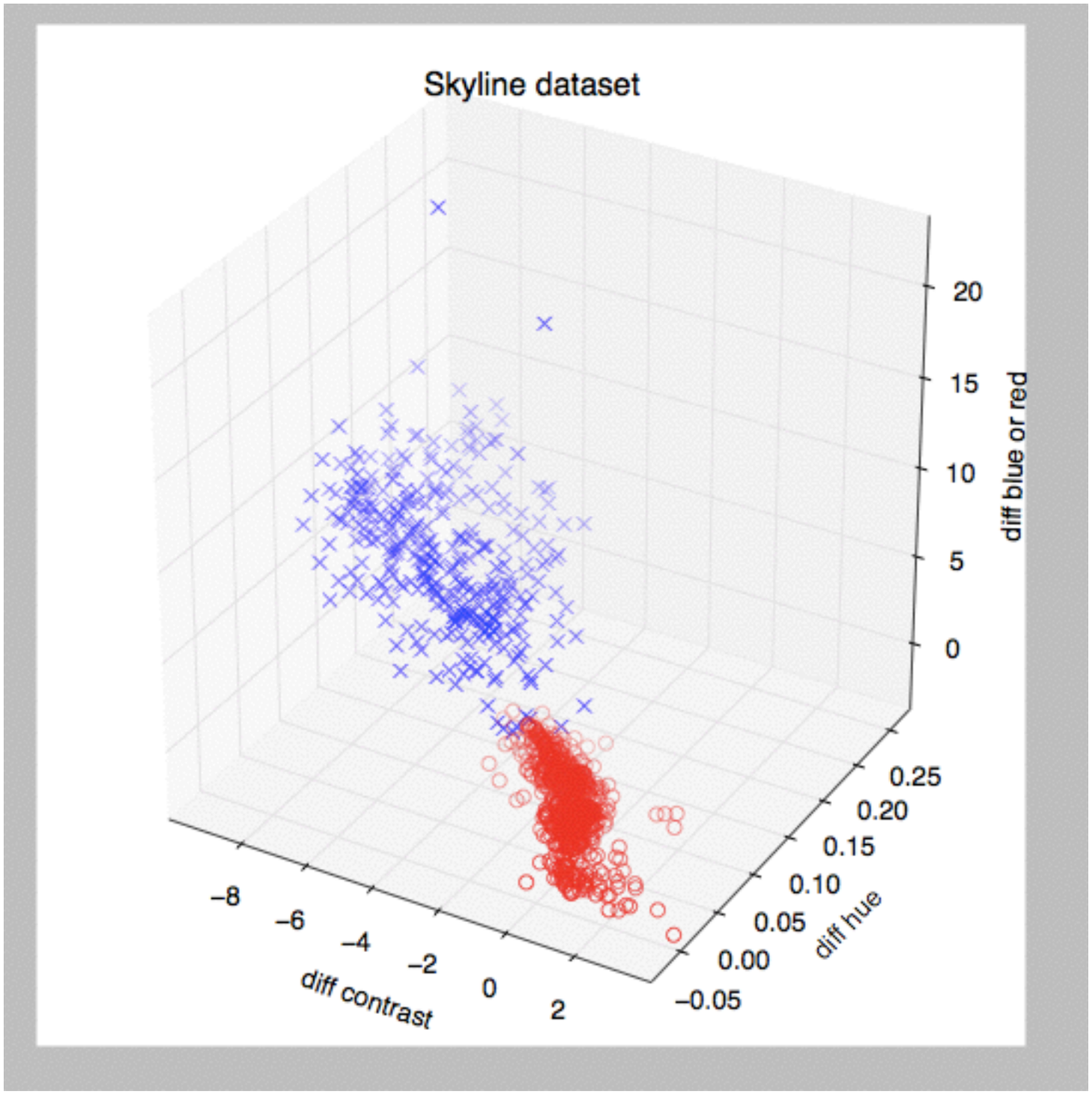
[norwegian mtn range test image]



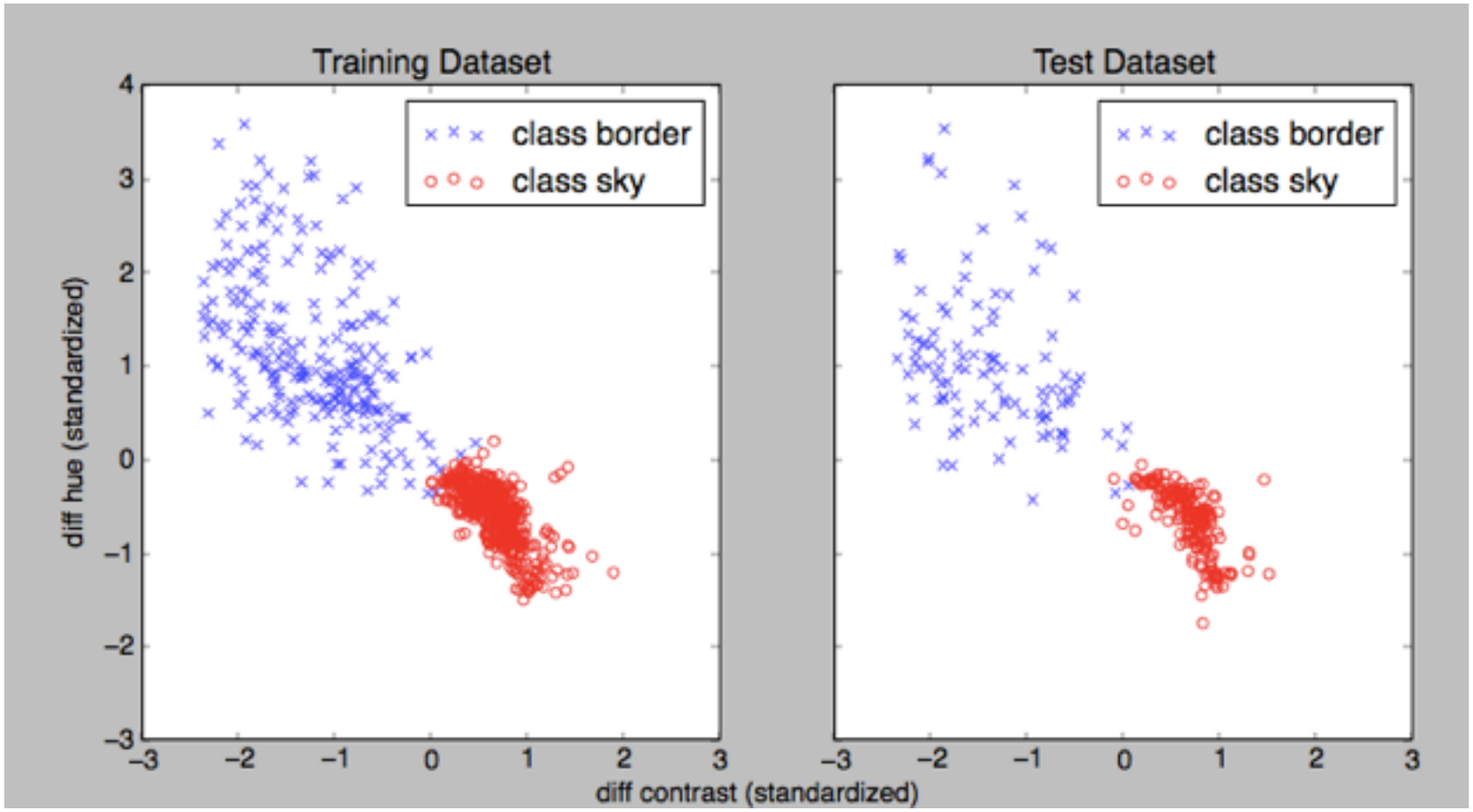
[norwegian mtn range test image]

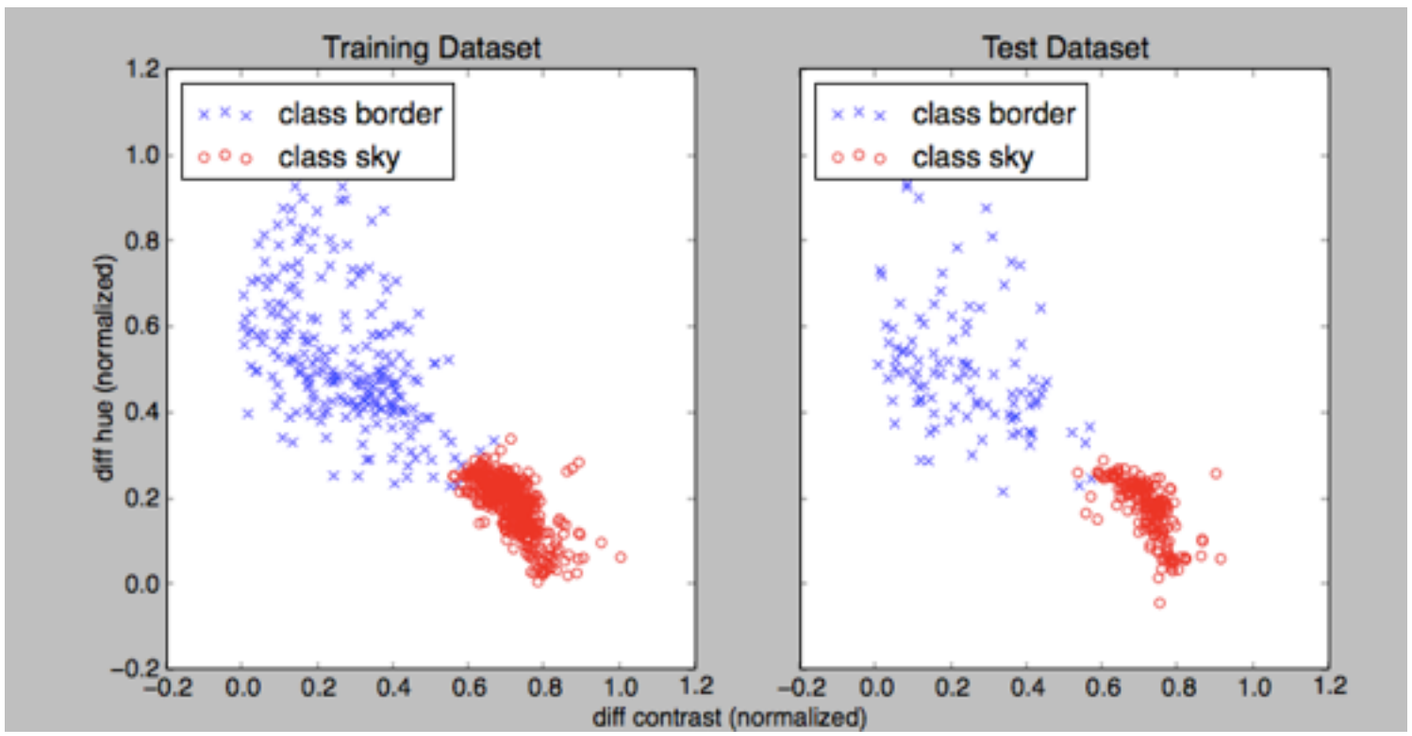


[norwegian mtn range test image]

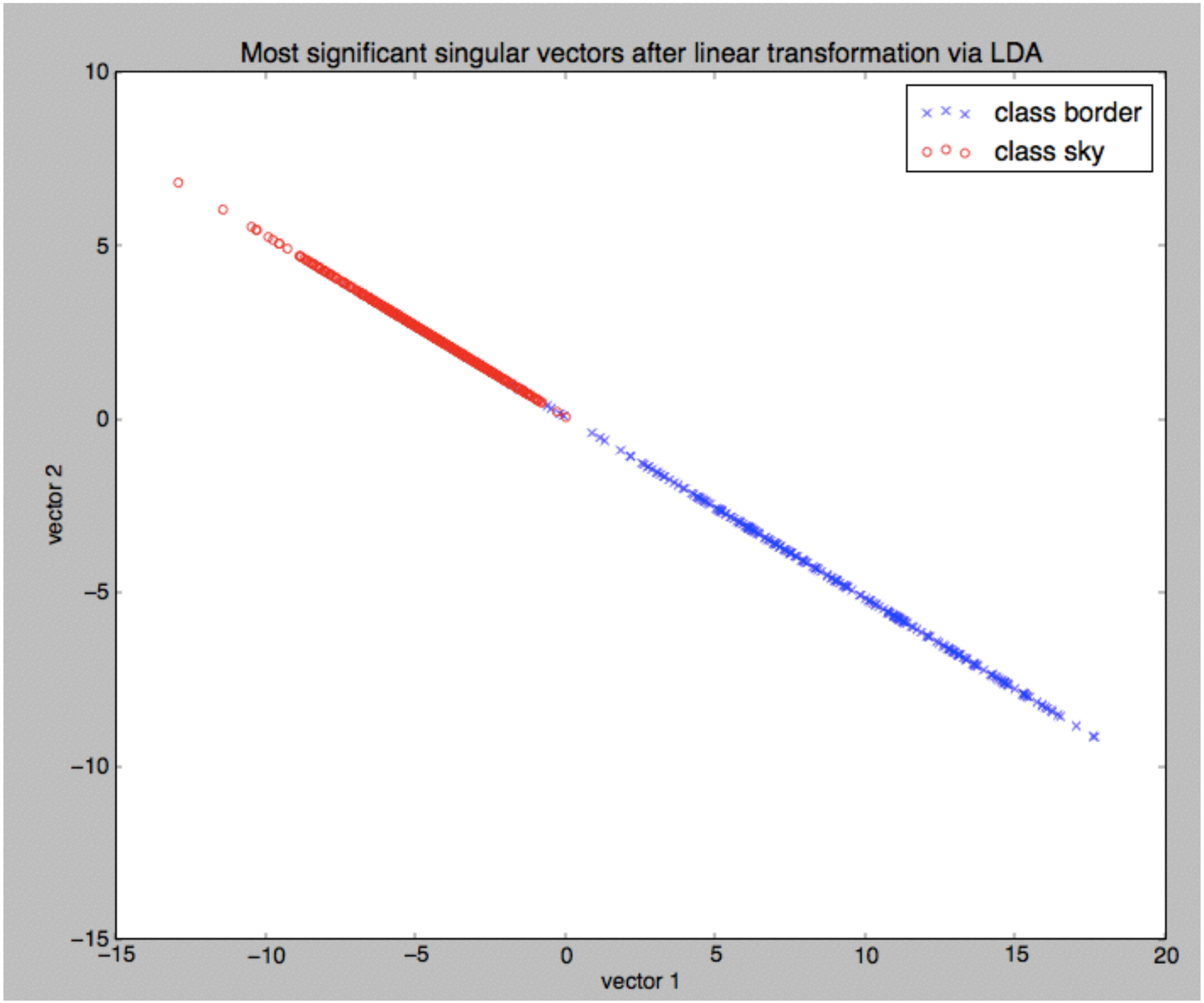


[norwegian mtn range test image]

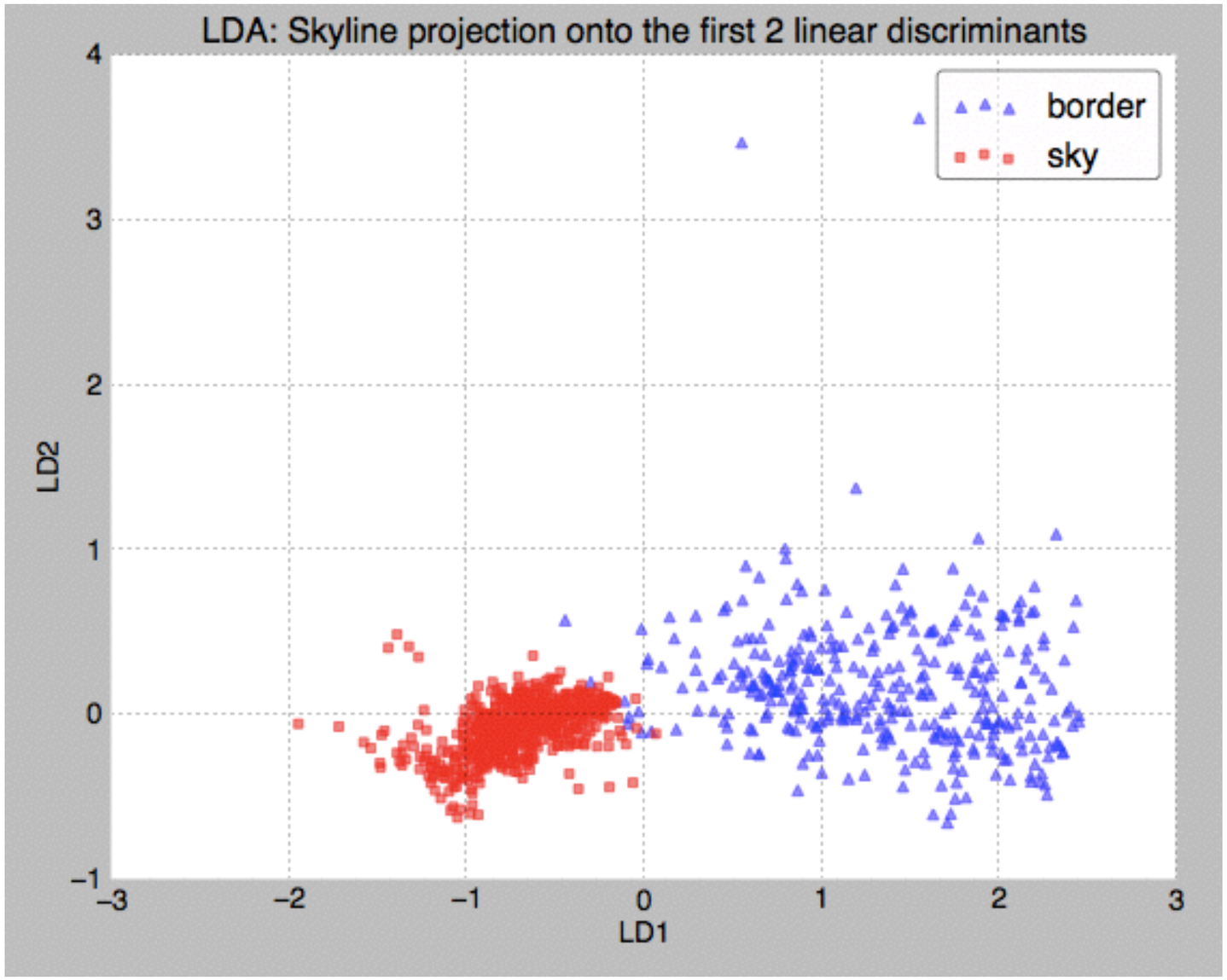




[norwegian mtn range test image]



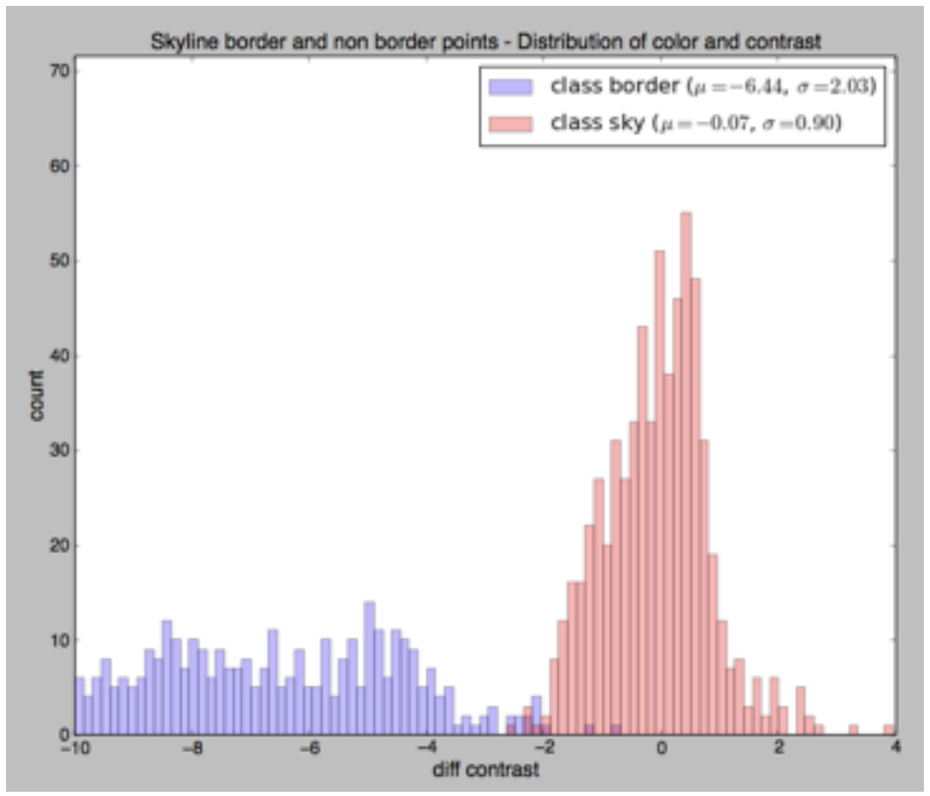
[norwegian mtn range test image]



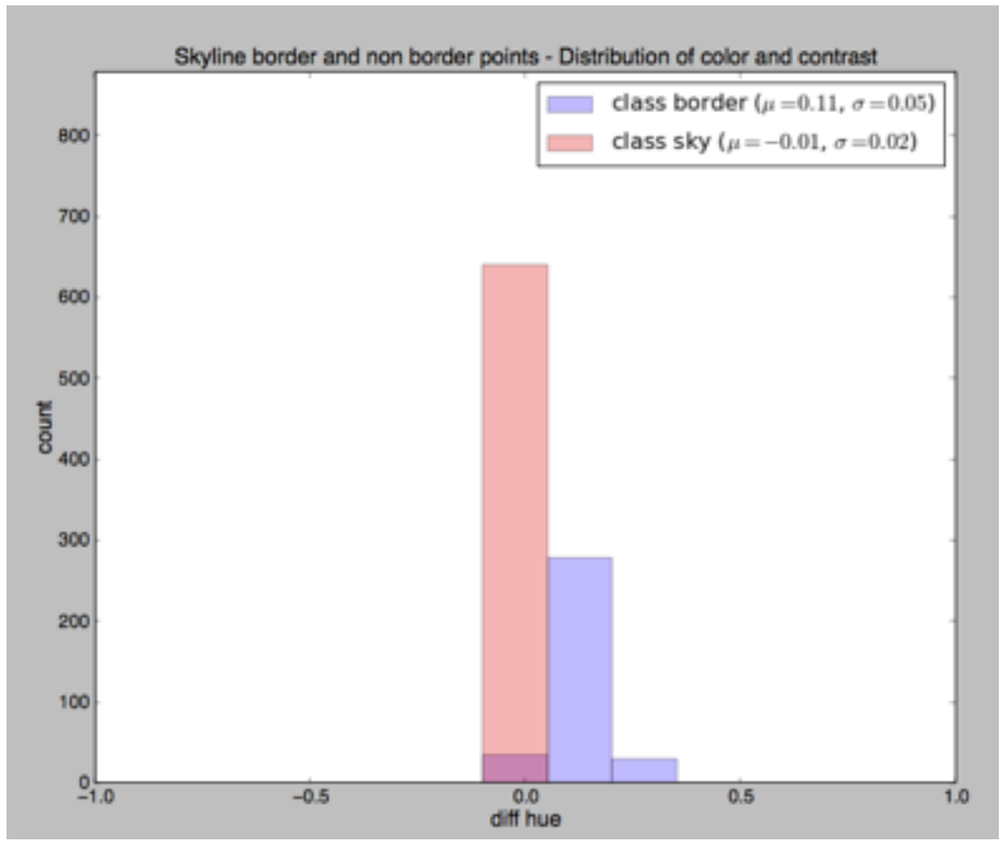

```
                        contrast  hue     BorR
Mean Vector class 1: [-1.2421  1.1407  1.1862]

Mean Vector class 2: [ 0.6638 -0.6096 -0.6339]

('within-class Scatter Matrix:\n',
array([[ 172.341 , -113.9692, -139.7582],
       [-113.9692,  299.1902,  110.5439],
       [-139.7582,  110.5439,  243.642 ]]))
('between-class Scatter Matrix:\n',
array([[ 2655.2496, -2004.3297, -2093.2883],
       [-2004.3297,  2274.702 ,  2356.3953],
       [-2093.2883,  2356.3953,  2441.3467]]))

Eigenvector 1:
[[-0.9955]
 [ 0.0941]
 [-0.0136]]
Eigenvalue 1: 1.55e+01

Eigenvector 2:
[[-0.0134]
 [ 0.7137]
 [-0.7003]]
Eigenvalue 2: 8.88e-16

Eigenvector 3:
[[ 0.7335]
 [ 0.3168]
 [ 0.6014]]
Eigenvalue 3: 8.59e+00
ok
Eigenvalues in decreasing order:

15.5410055133
8.59498303985
8.881784197e-16
Variance explained:

eigenvalue 1: 64.39%
eigenvalue 2: 35.61%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.9955,  0.0941, -0.0136],
       [ 0.7335,  0.3168,  0.6014]]))
```

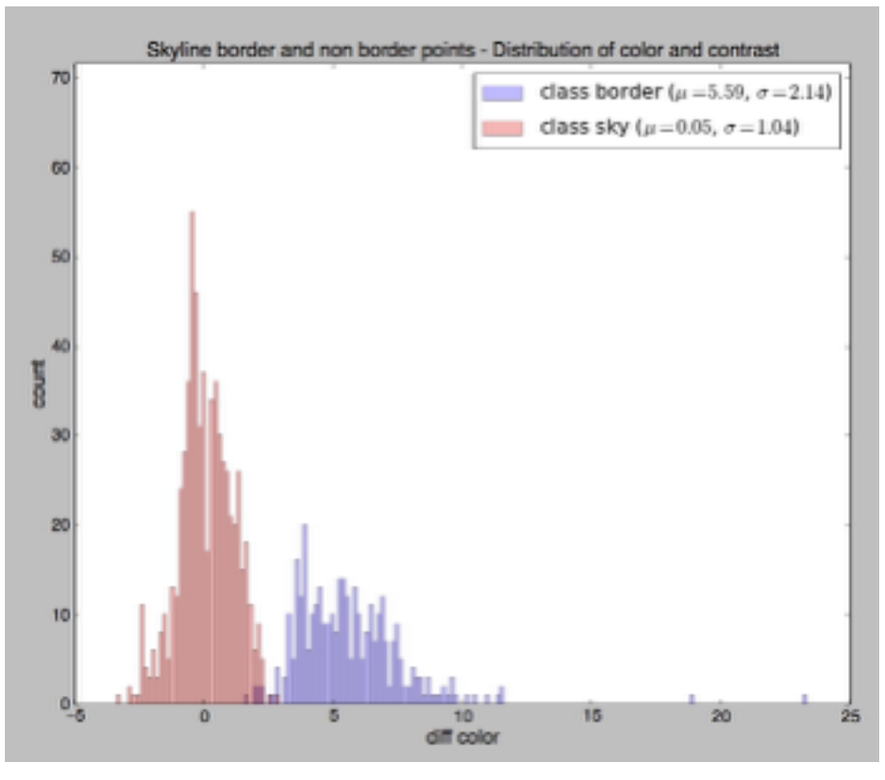
half dome test image

half dome test image

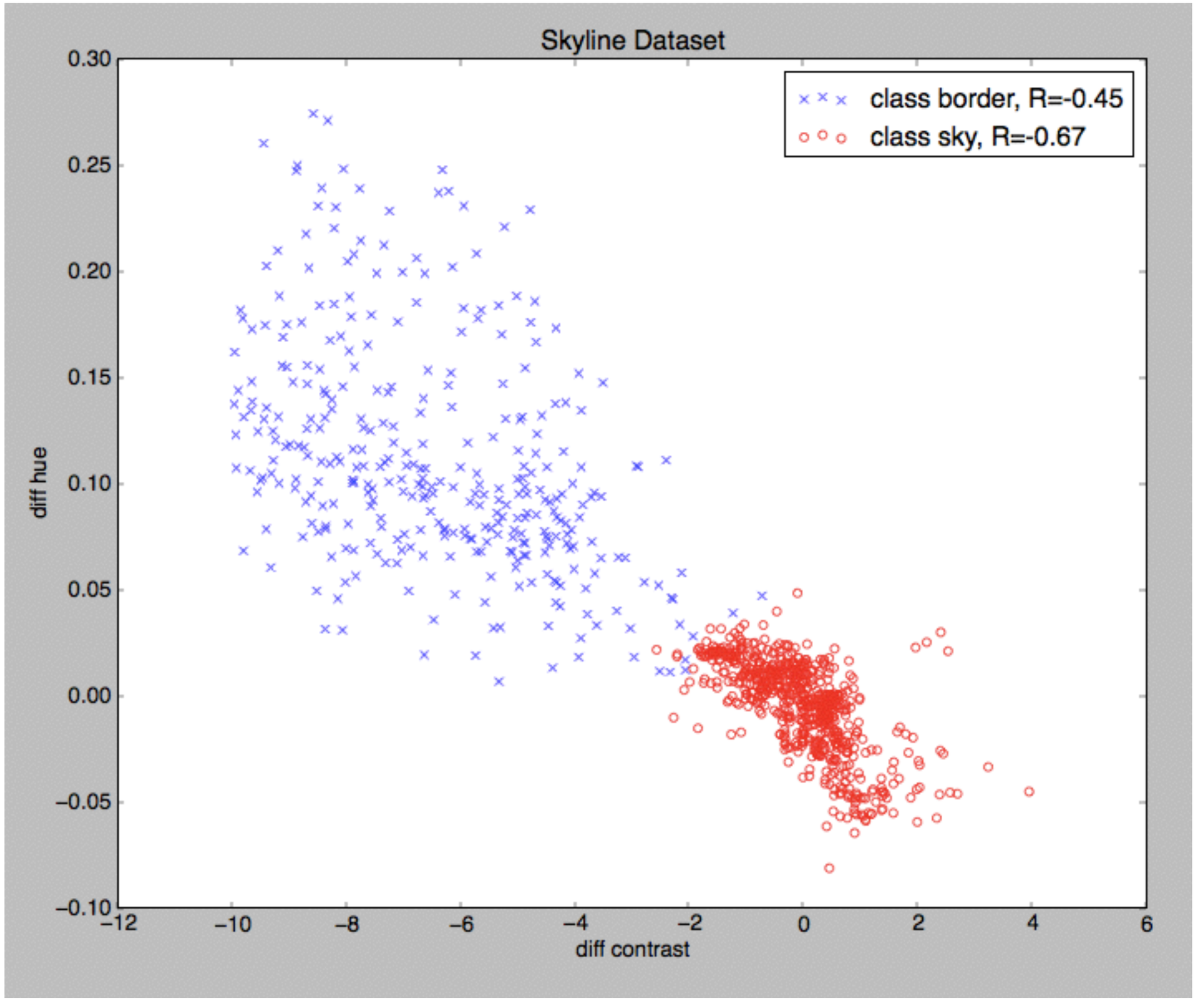


*note: the largest contrasts were removed from analysis for plot visibility

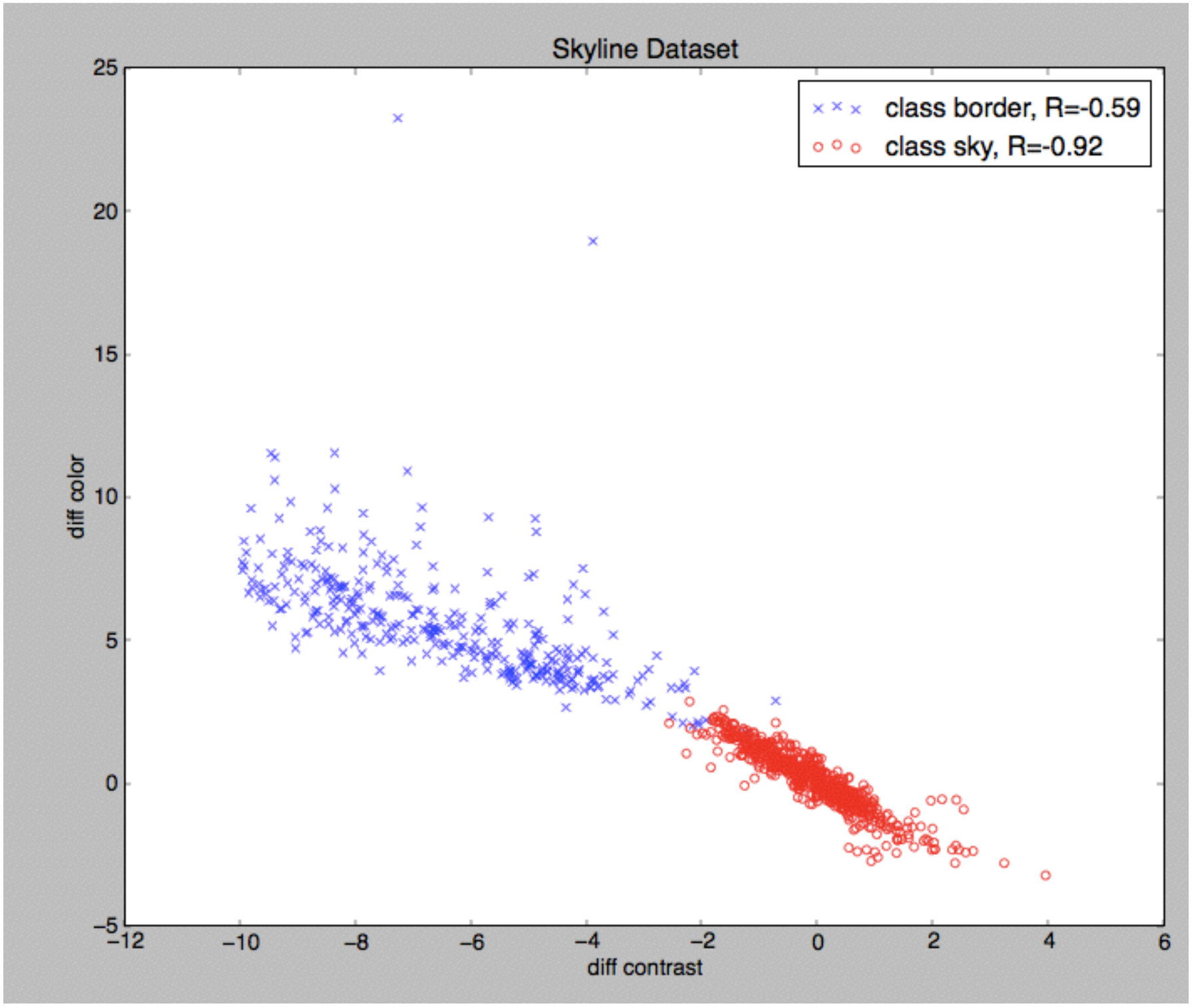




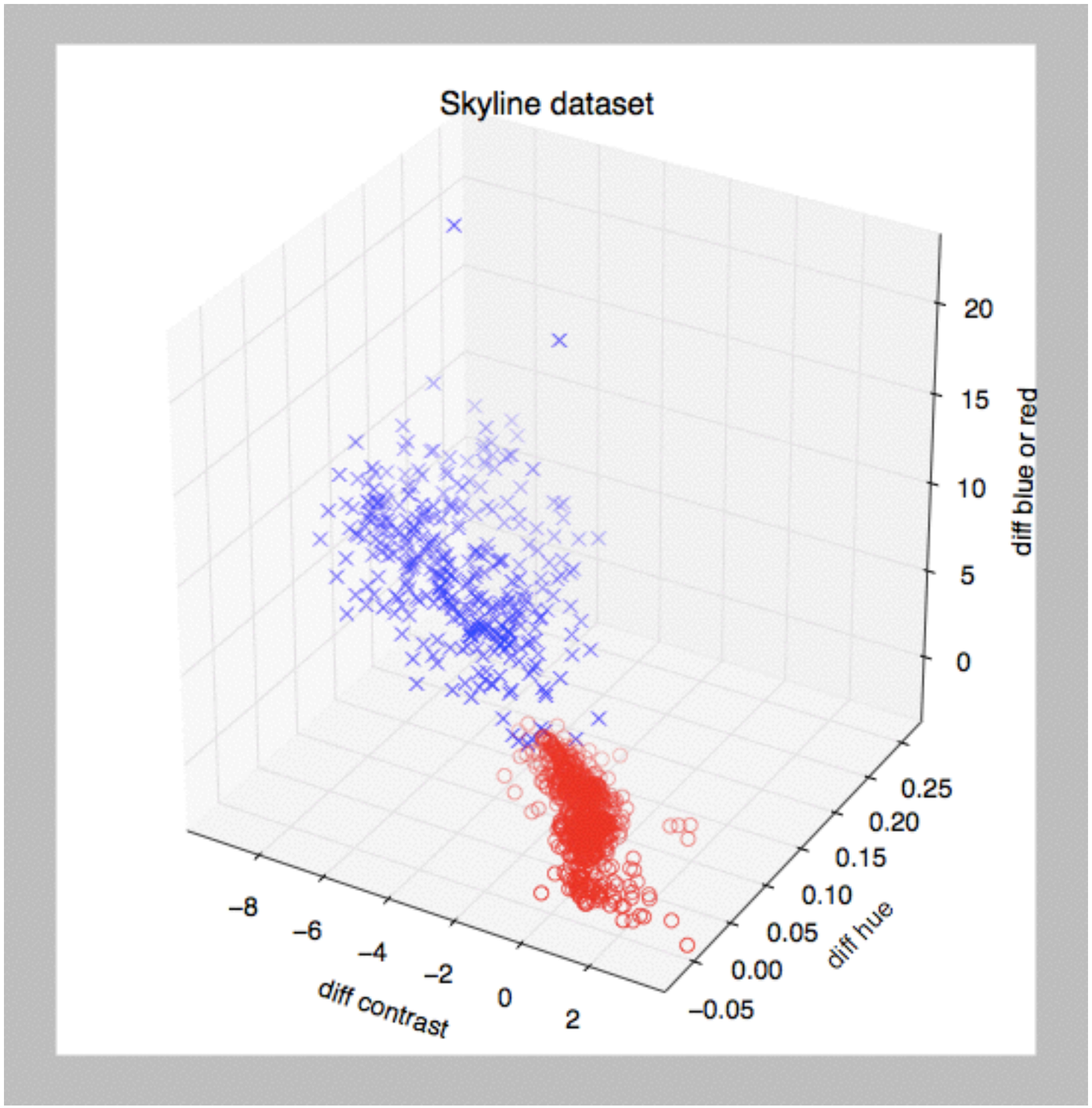
[half dome test image]



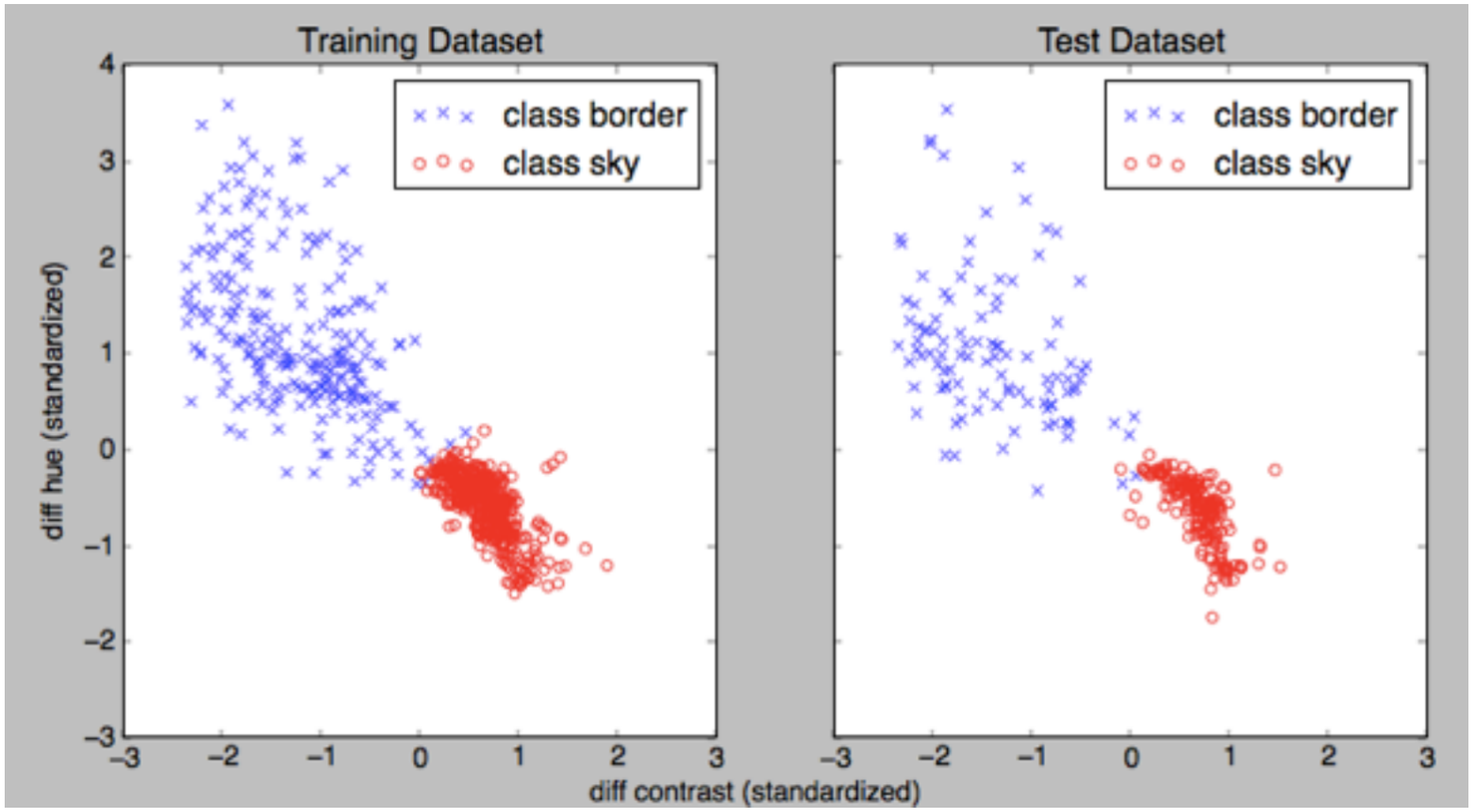
[half dome test image]

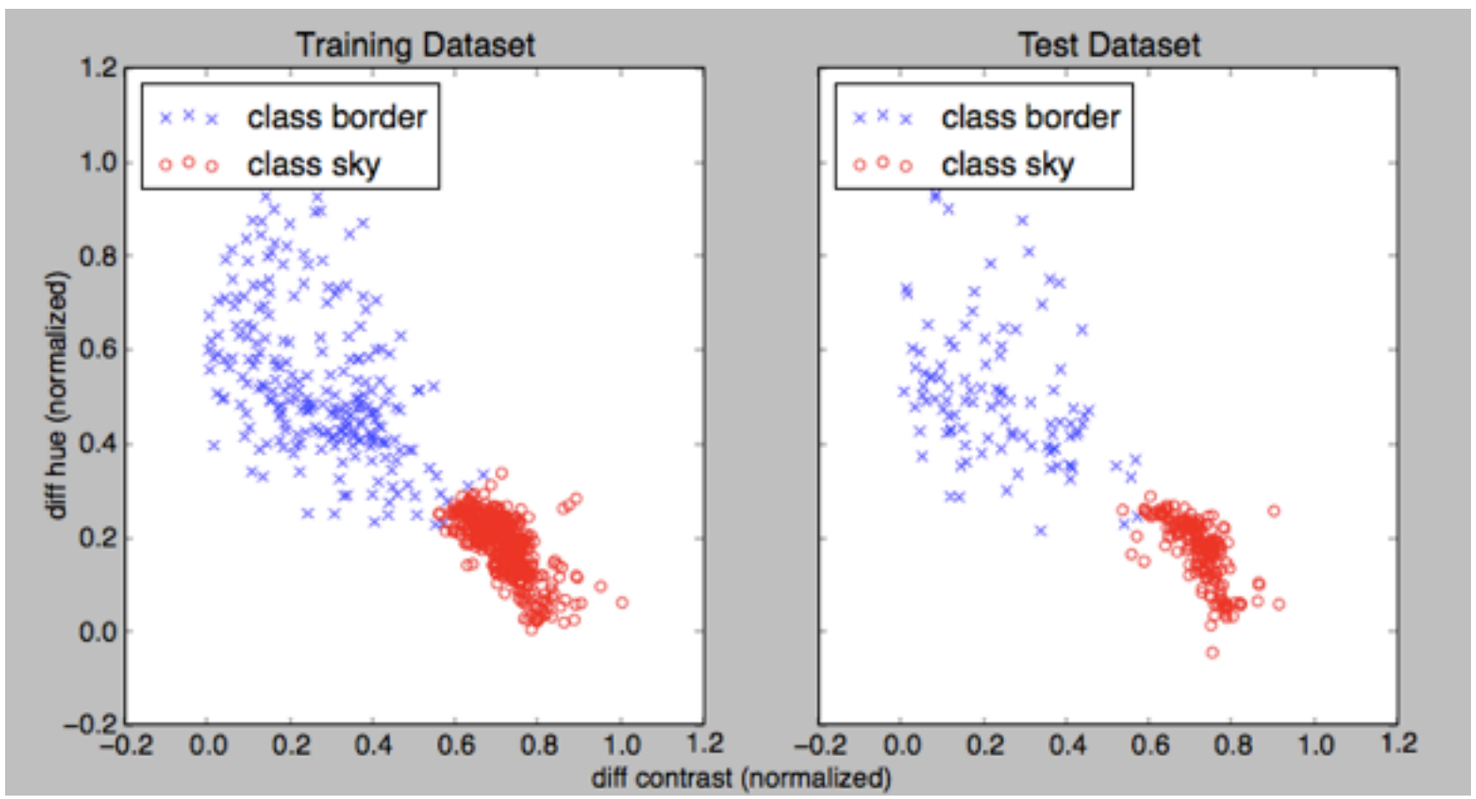


half dome test image

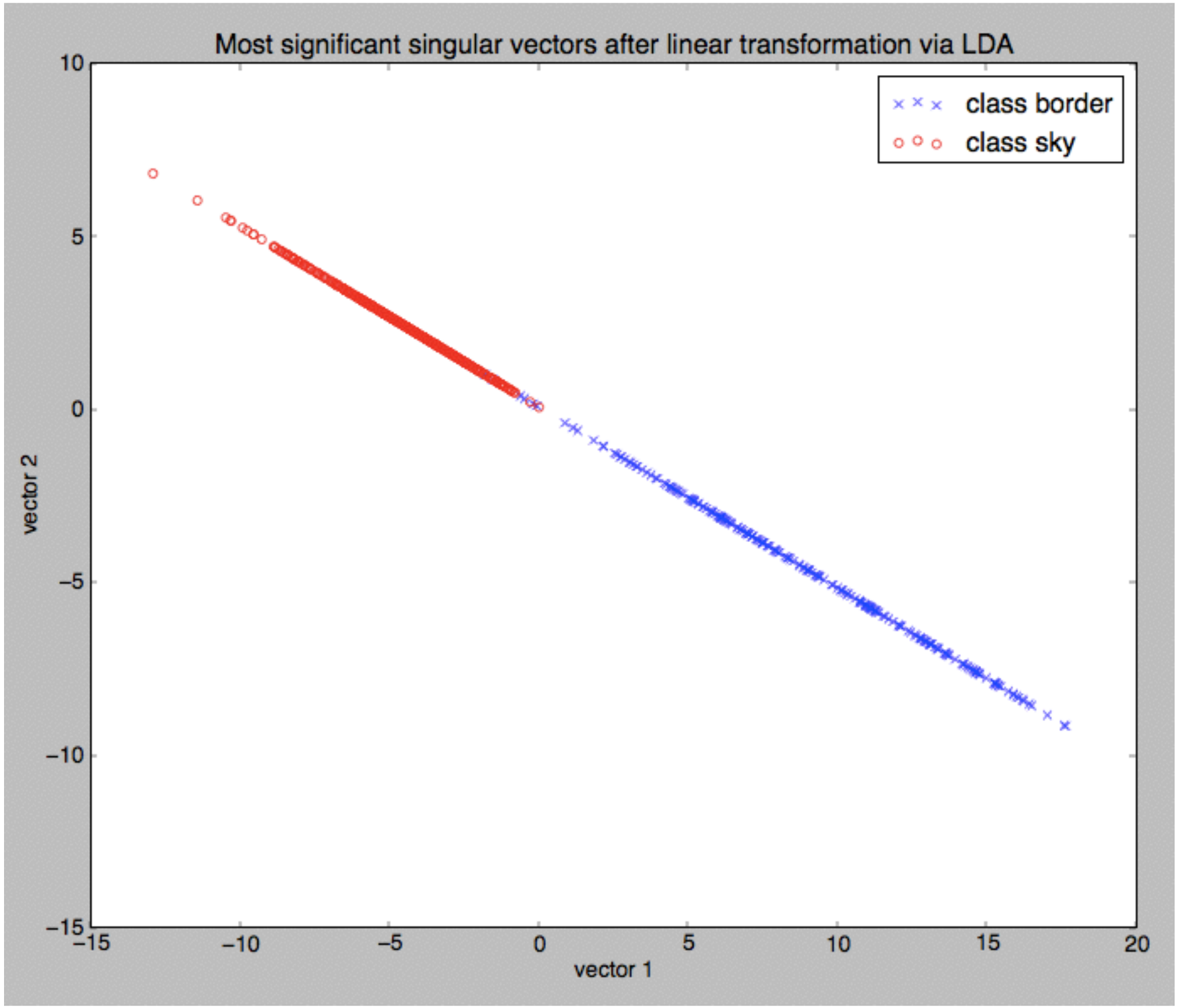


half dome test image

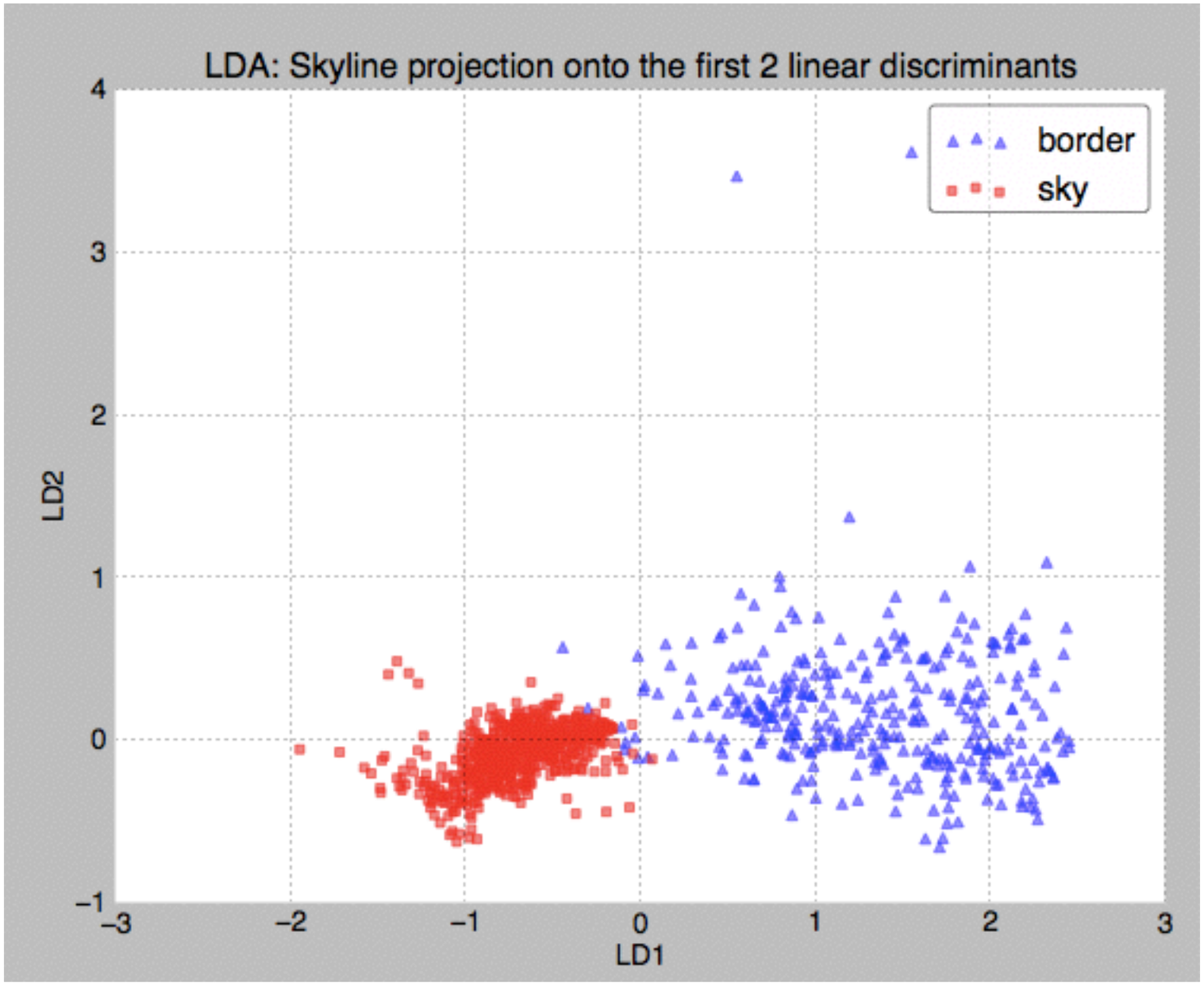




half dome test image



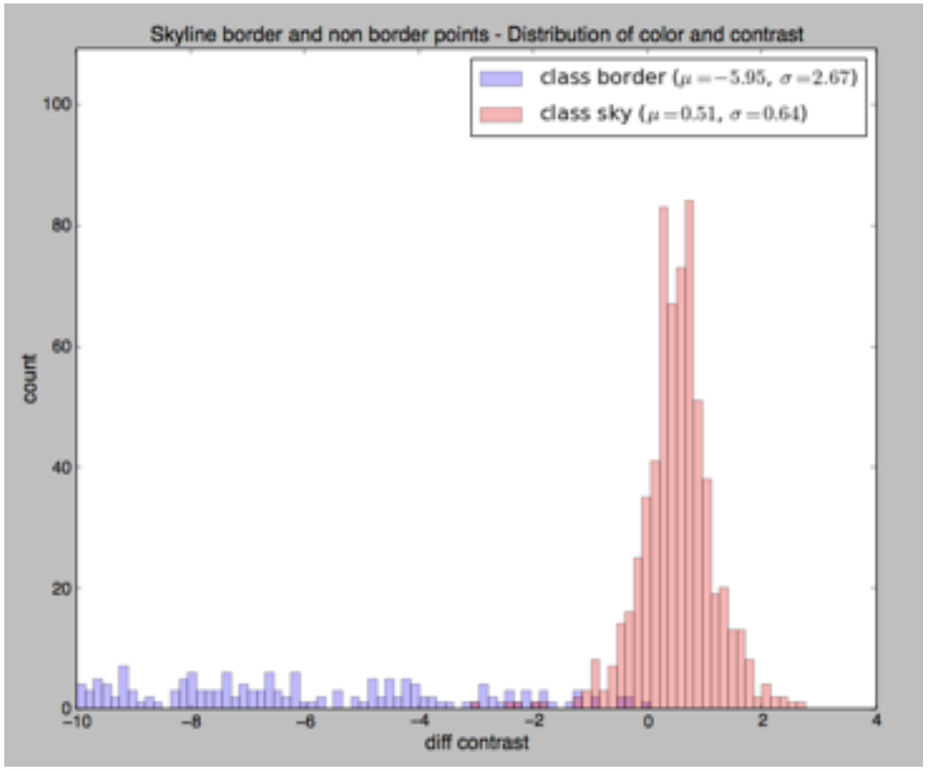
half dome test image



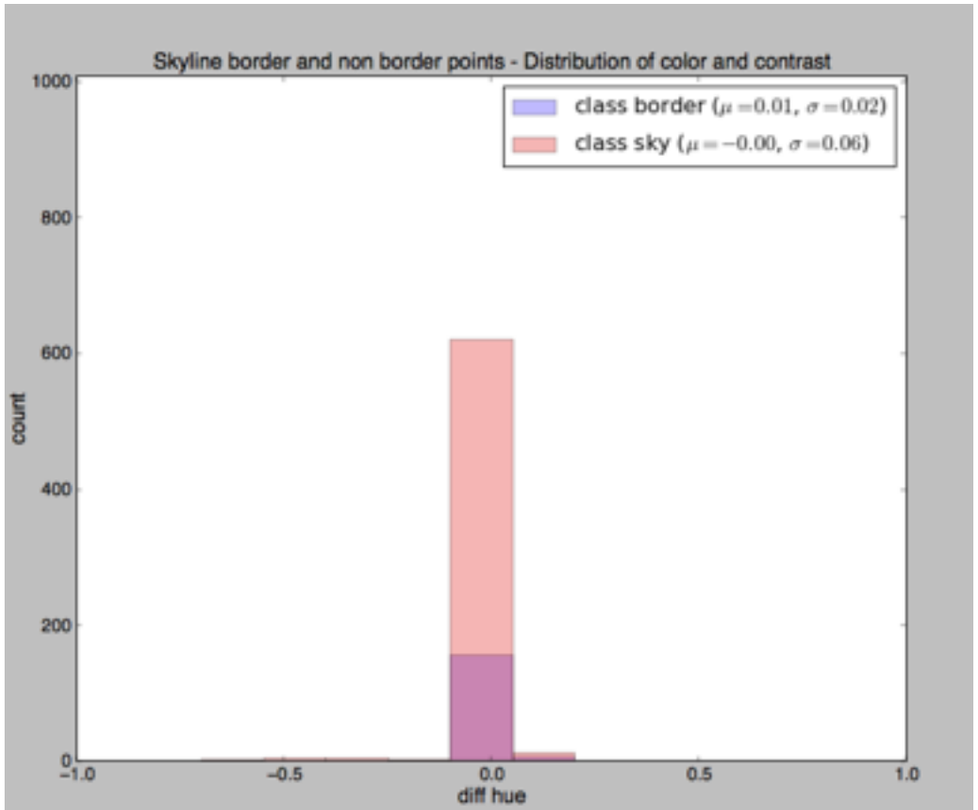

```
                        contrast  hue     BorR
Mean Vector class 1: [-1.2421  1.1407  1.1862]

Mean Vector class 2: [ 0.6638 -0.6096 -0.6339]

('within-class Scatter Matrix:\n',
array([[ 172.341 , -113.9692, -139.7582],
       [-113.9692,  299.1902,  110.5439],
       [-139.7582,  110.5439,  243.642 ]]))
('between-class Scatter Matrix:\n',
array([[ 2655.2496, -2004.3297, -2093.2883],
       [-2004.3297,  2274.702 ,  2356.3953],
       [-2093.2883,  2356.3953,  2441.3467]]))

Eigenvector 1:
[[-0.9955]
 [ 0.0941]
 [-0.0136]]
Eigenvalue 1: 1.55e+01

Eigenvector 2:
[[-0.0134]
 [ 0.7137]
 [-0.7003]]
Eigenvalue 2: 8.88e-16

Eigenvector 3:
[[ 0.7335]
 [ 0.3168]
 [ 0.6014]]
Eigenvalue 3: 8.59e+00
ok
Eigenvalues in decreasing order:

15.5410055133
8.59498303985
8.881784197e-16
Variance explained:

eigenvalue 1: 64.39%
eigenvalue 2: 35.61%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.9955,  0.0941, -0.0136],
       [ 0.7335,  0.3168,  0.6014]]))
```

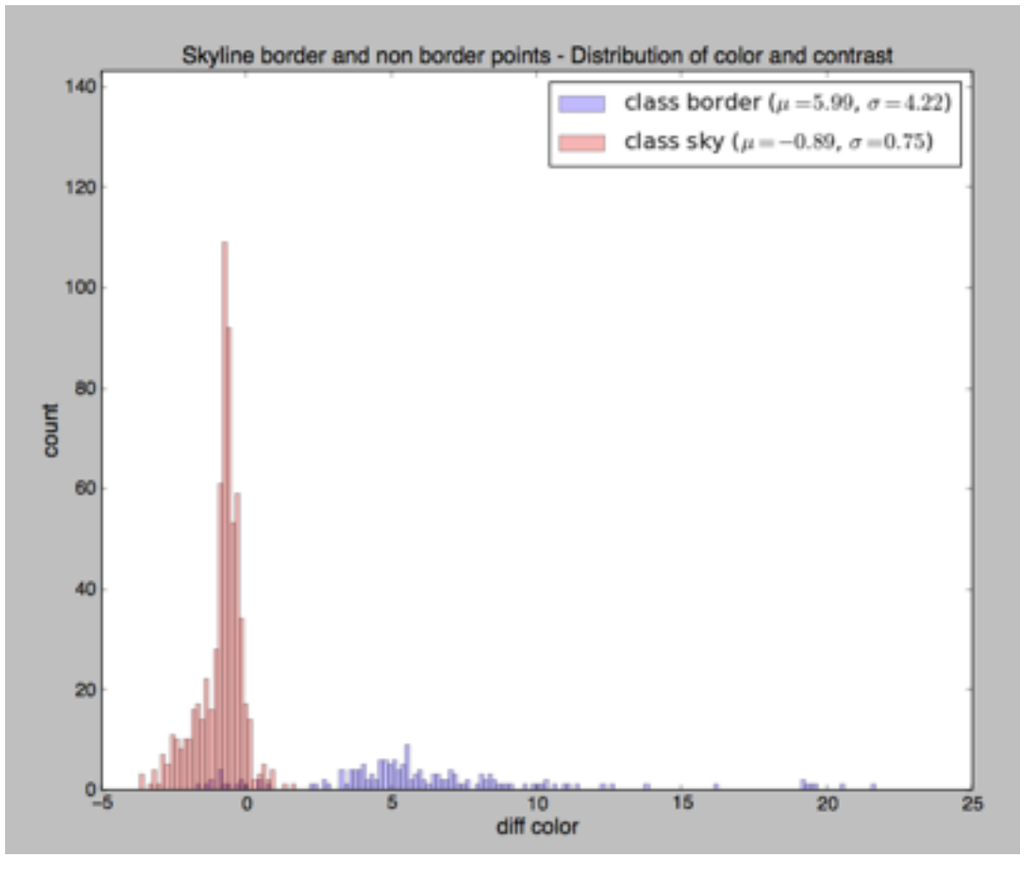
costa rica test image

costa rica test image

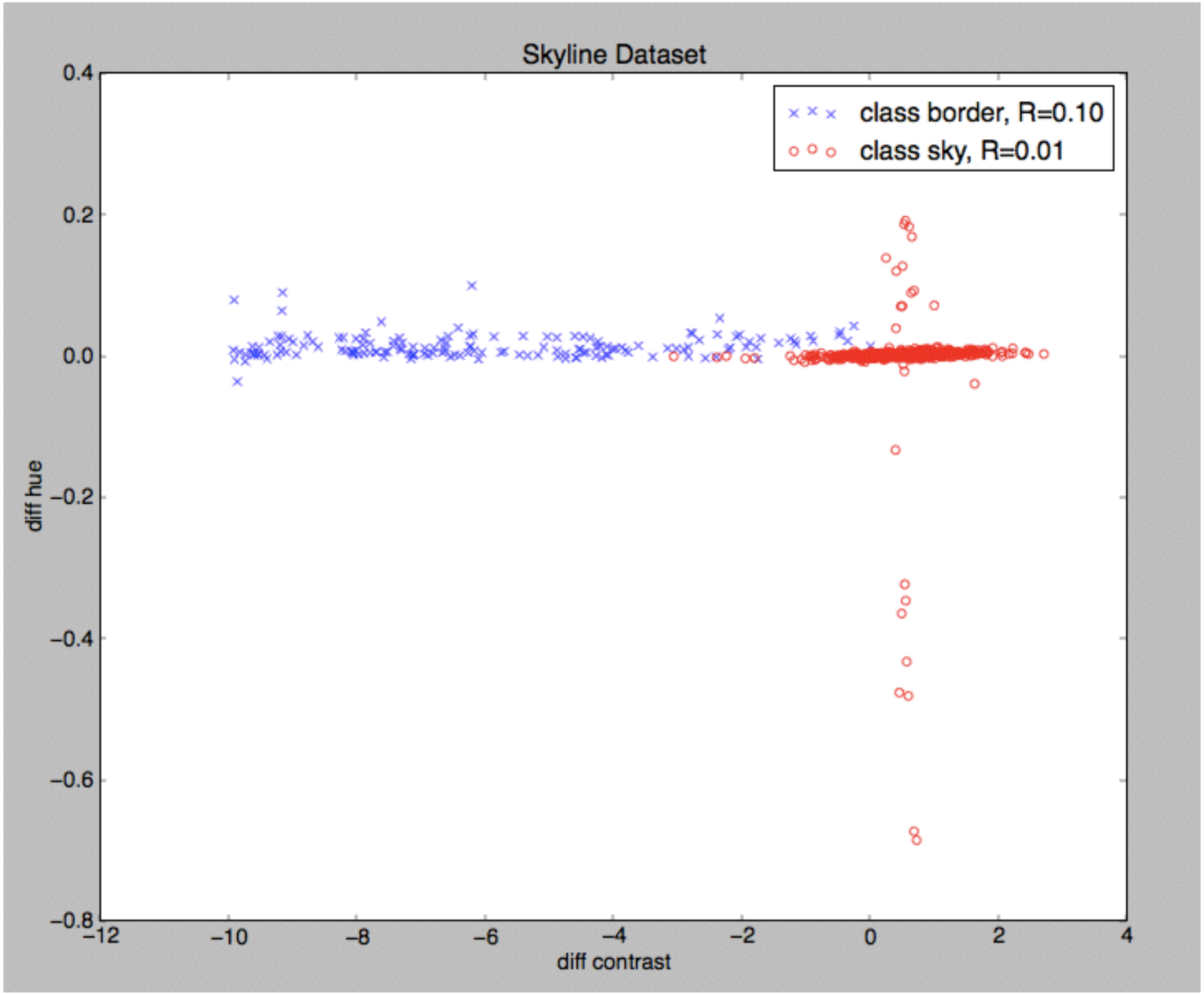


*note: the largest contrasts were removed from analysis for plot visibility

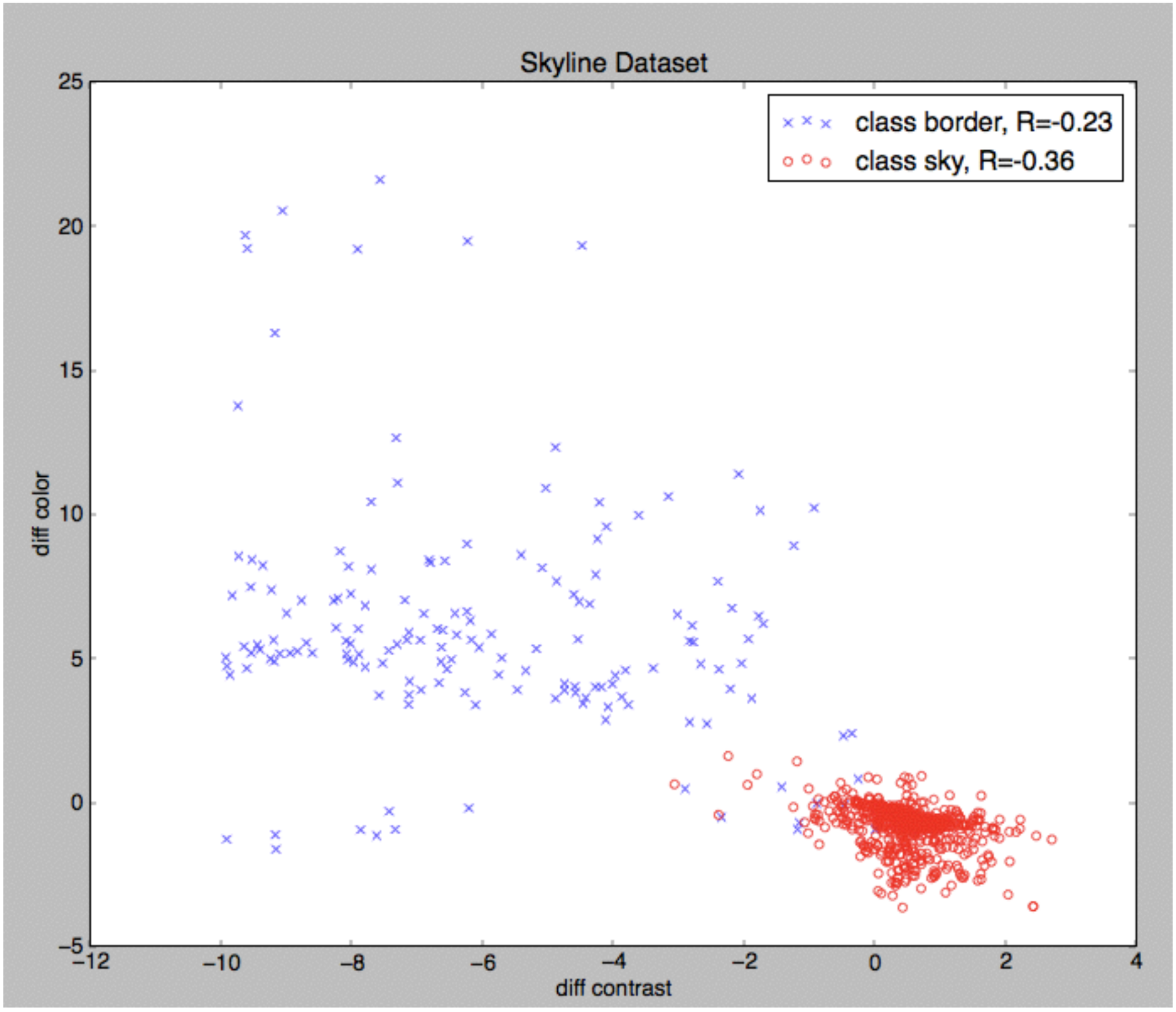




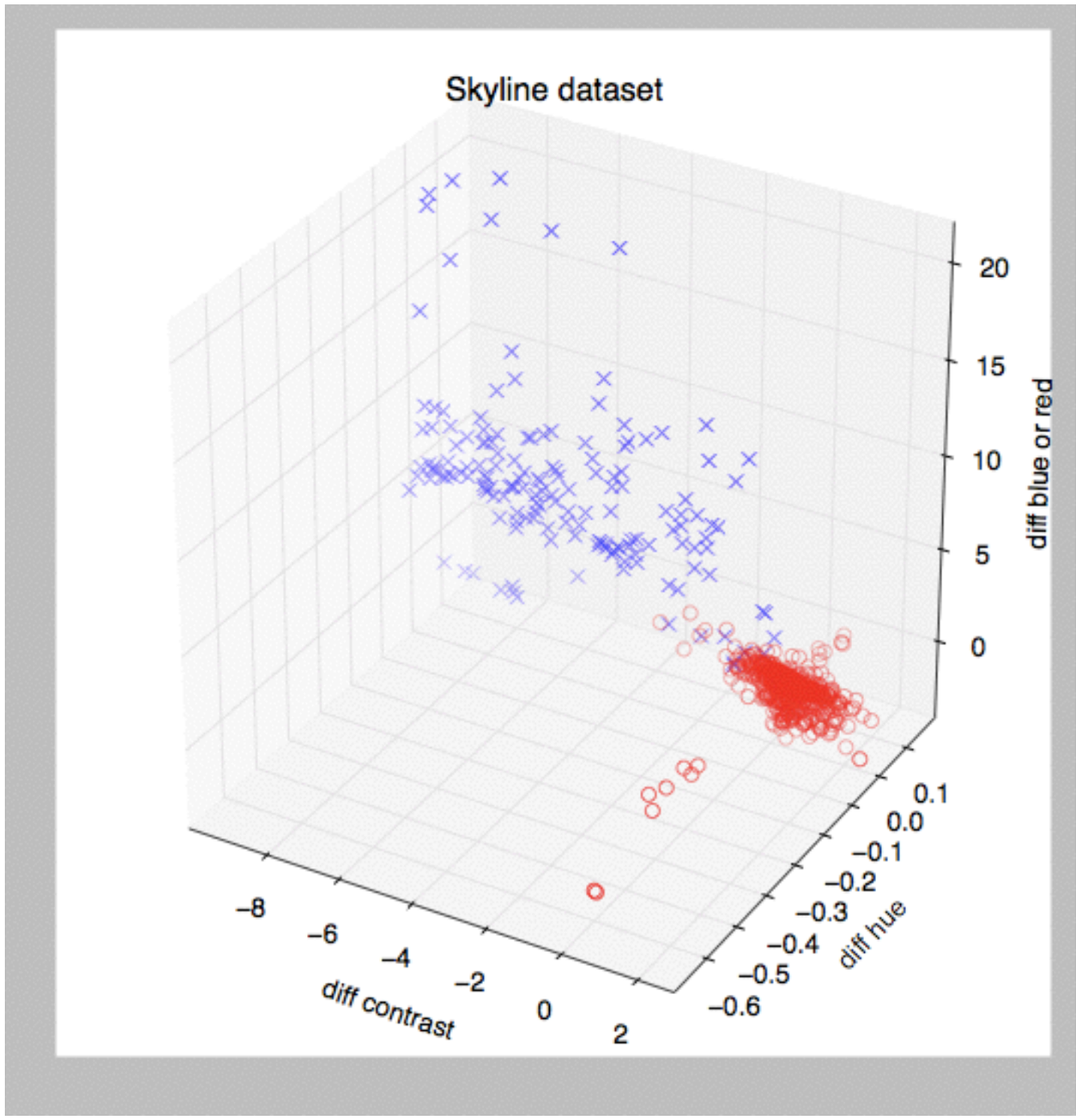
[costa rica test image]



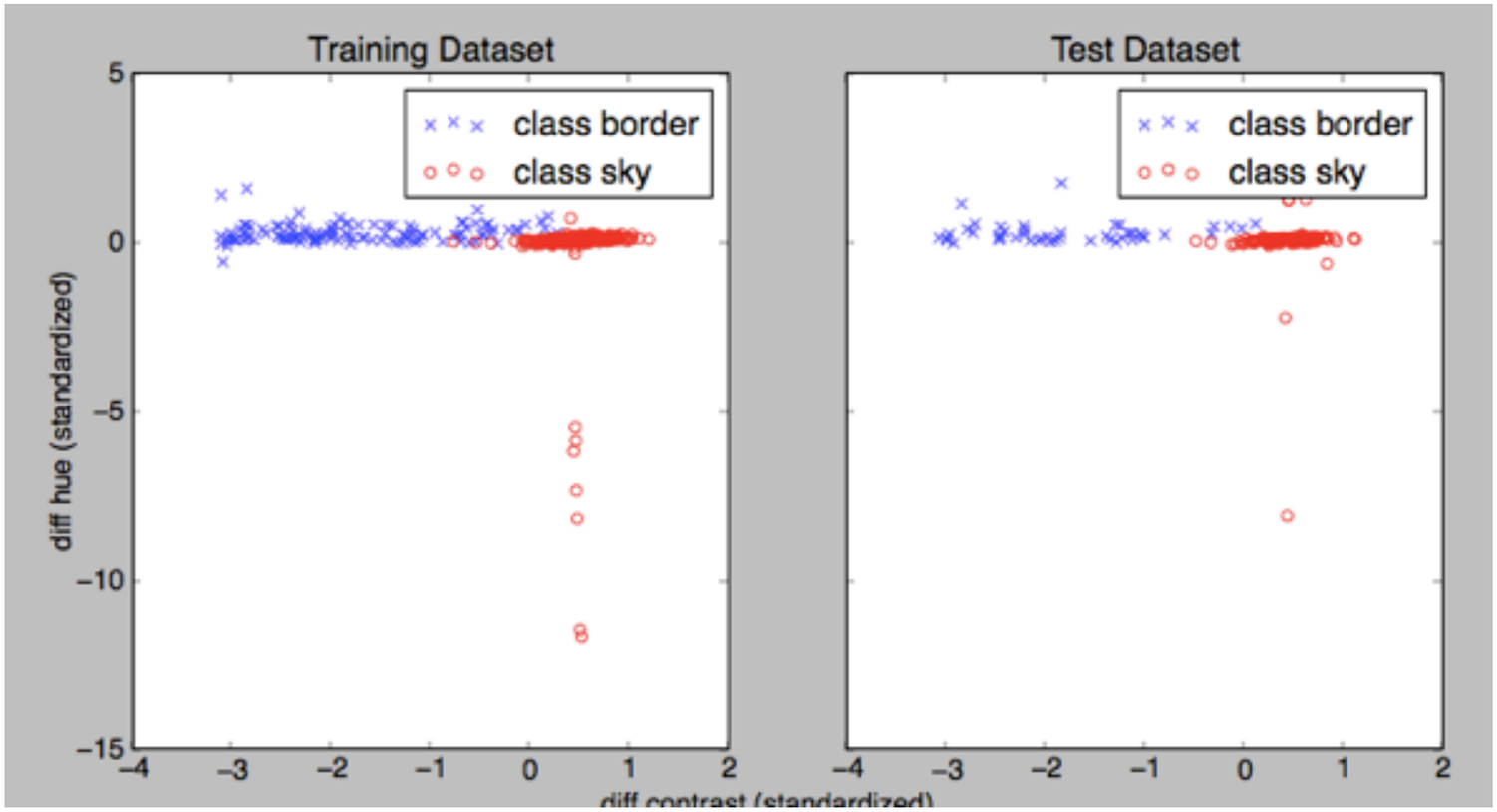
[costa rica test image]

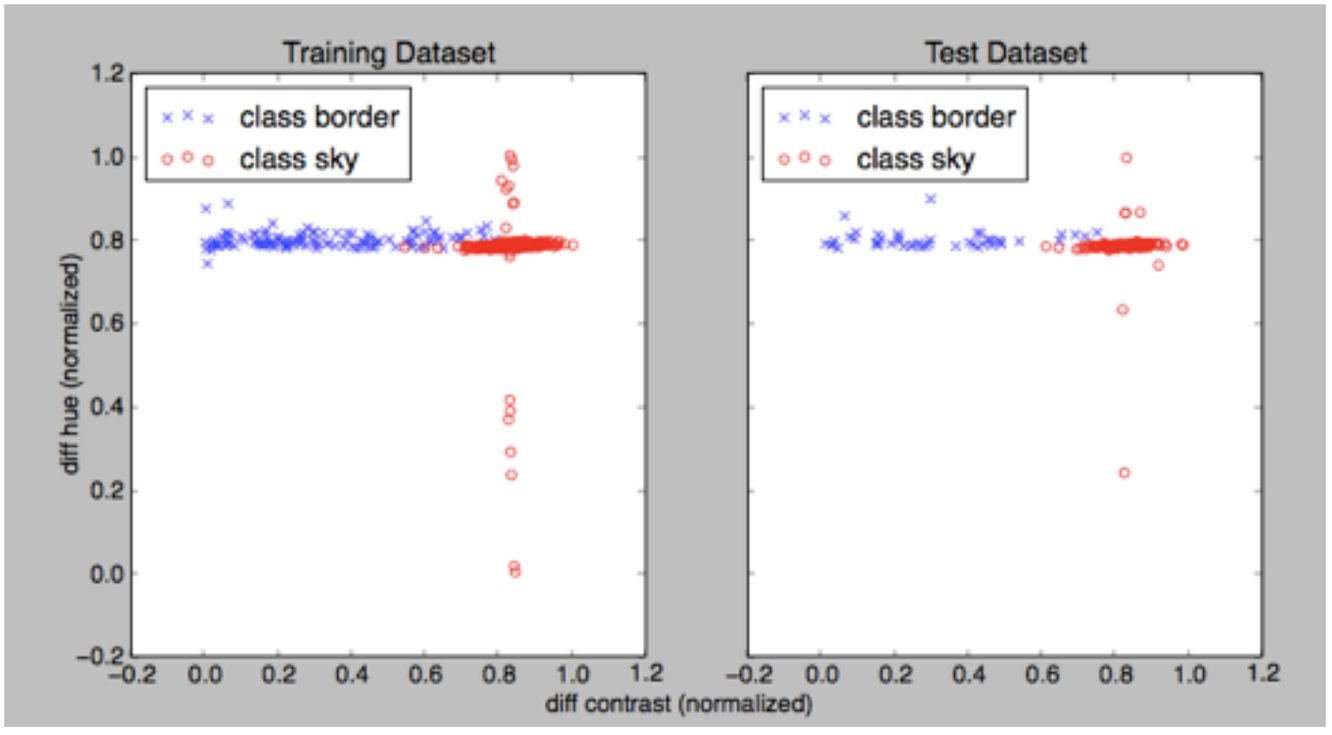


costa rica test image

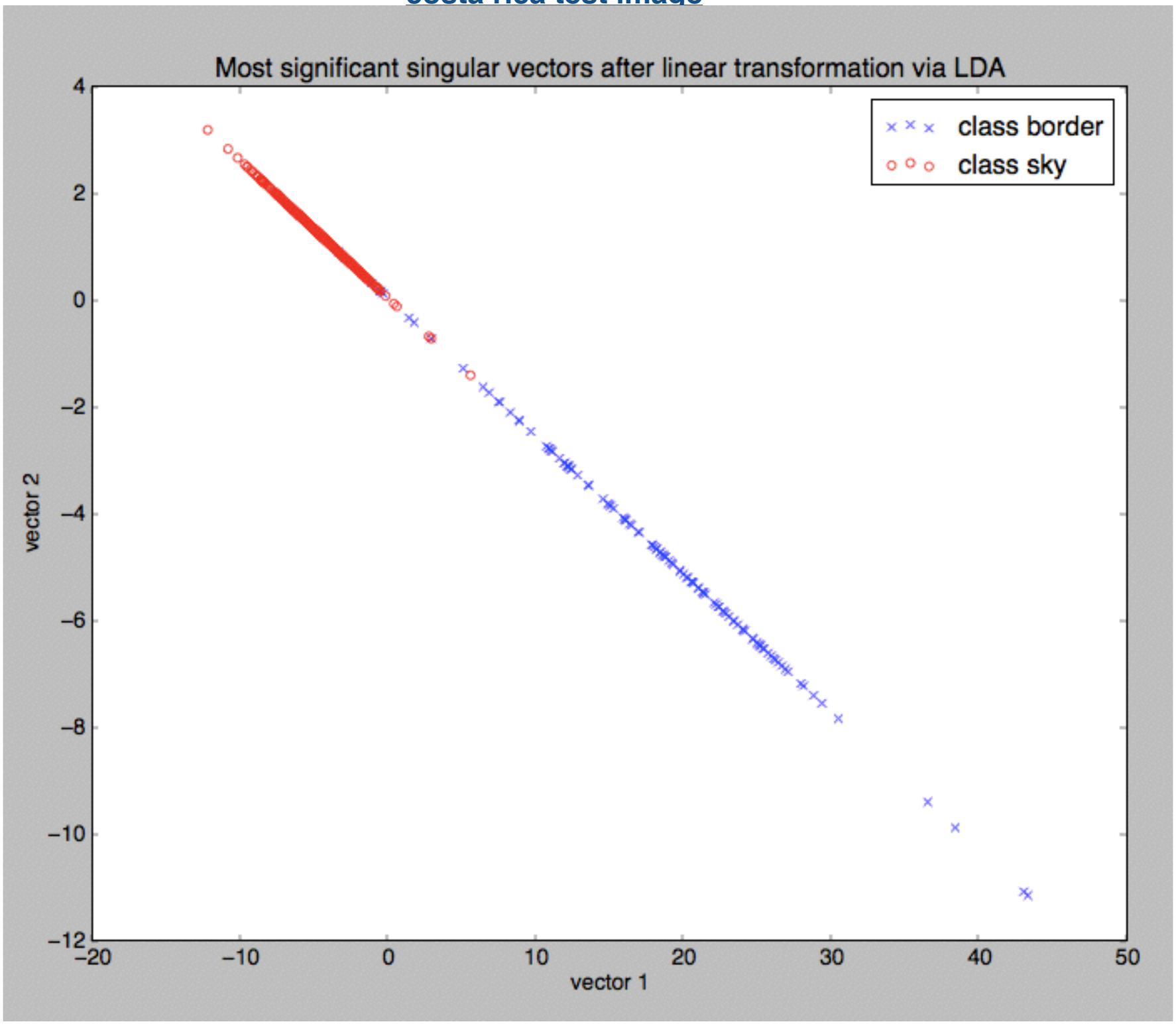


costa rica test image

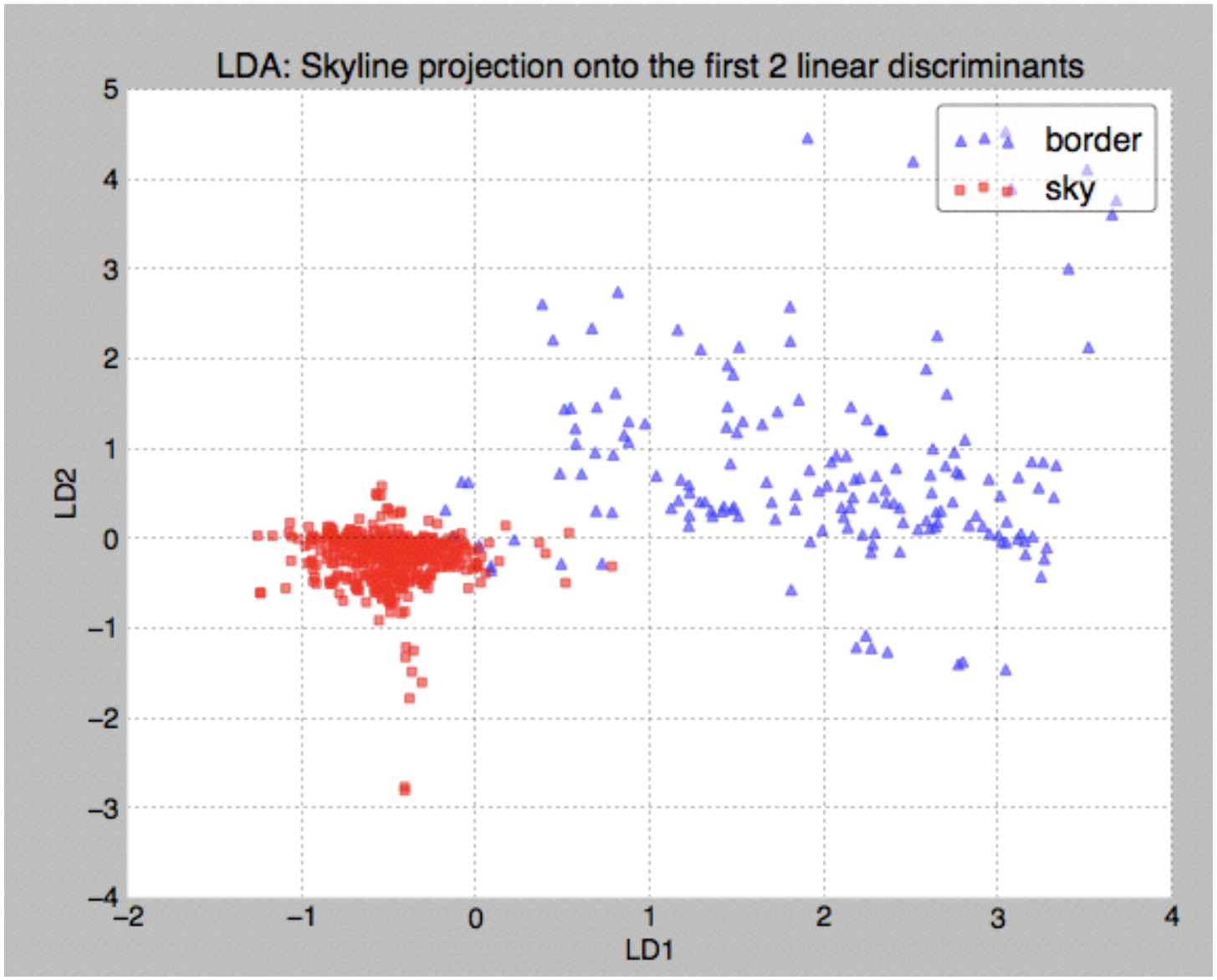




costa rica test image



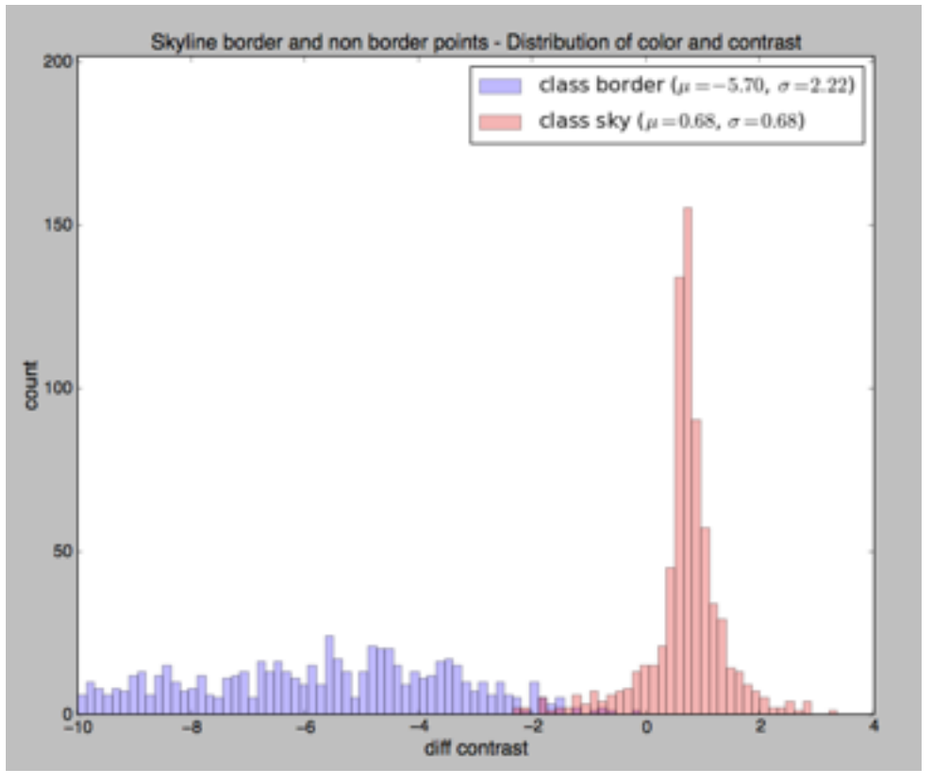
costa rica test image



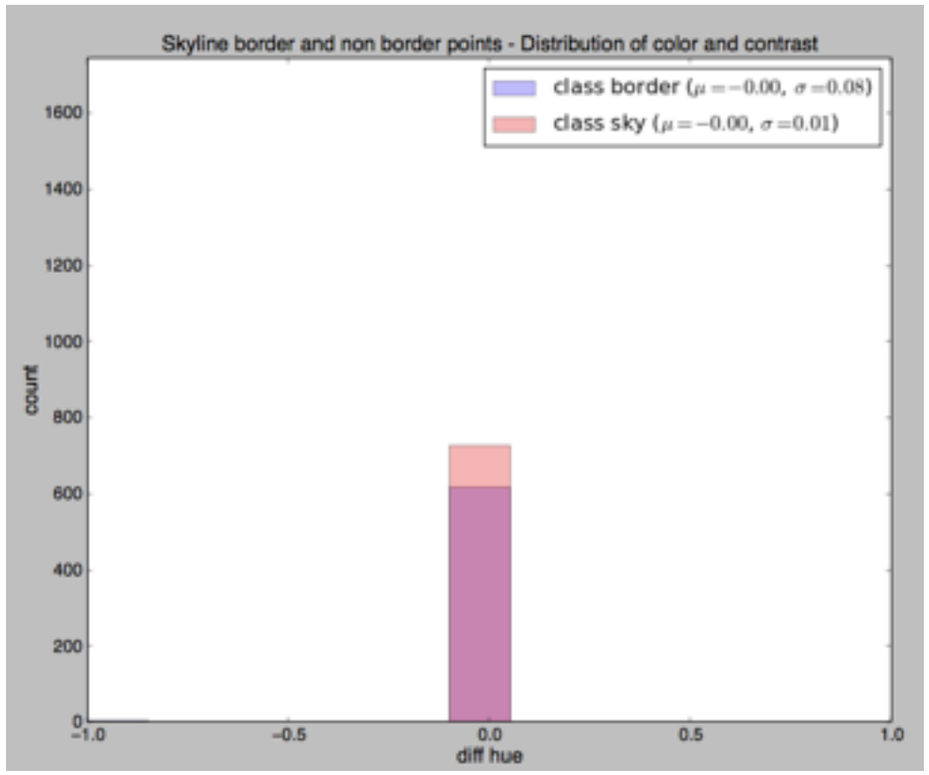

```
                        contrast  hue     BorR
Mean Vector class 1: [-1.7744  0.2375  1.6116]

Mean Vector class 2: [ 0.4464 -0.0597 -0.4054]

('within-class Scatter Matrix:\n',
array([[ 166.5698,    6.8544,  -52.5003],
       [   6.8544,  789.6358,  -30.2555],
       [ -52.5003,  -30.2555,  277.6674]]))
('between-class Scatter Matrix:\n',
array([[ 2554.1195,   396.0976, -1077.8011],
       [  396.0976,   684.9215,   882.1842],
       [-1077.8011,   882.1842,  2220.8267]]))

Eigenvector 1:
[[-0.9931]
 [-0.0112]
 [ 0.1171]]
Eigenvalue 1: 1.55e+01

Eigenvector 2:
[[-0.3294]
 [ 0.8117]
 [-0.4823]]
Eigenvalue 2: 1.17e-15

Eigenvector 3:
[[ 0.4155]
 [ 0.2067]
 [ 0.8858]]
Eigenvalue 3: 7.81e+00
ok
Eigenvalues in decreasing order:

15.5386024436
7.80996914968
1.16573417586e-15
Variance explained:

eigenvalue 1: 66.55%
eigenvalue 2: 33.45%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[-0.9931, -0.0112,  0.1171],
       [ 0.4155,  0.2067,  0.8858]]))
```

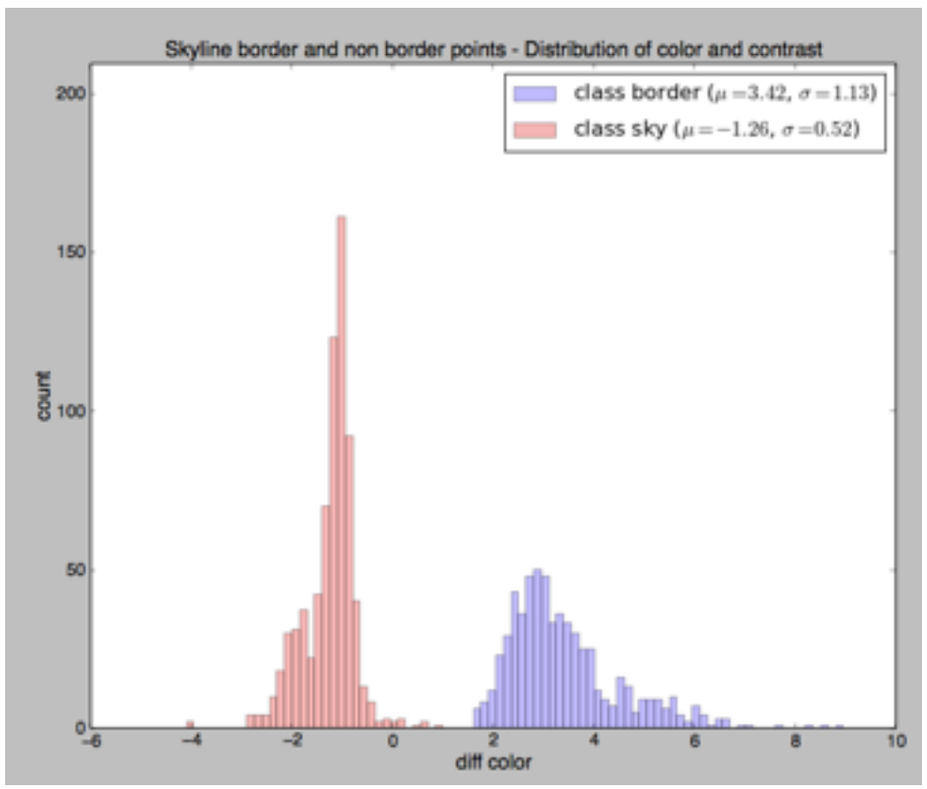
new mexico test image

[new mexico test image]

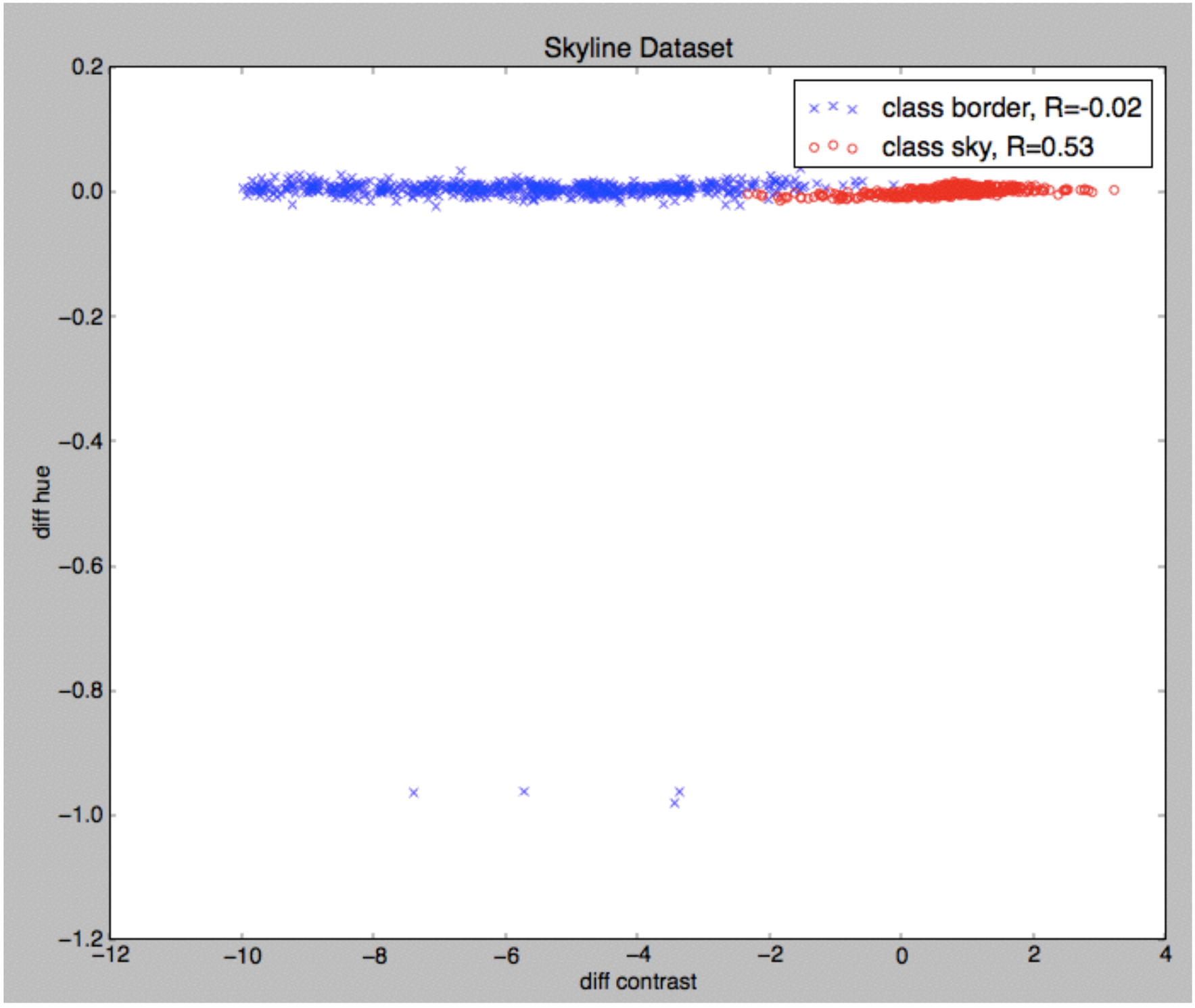


*note: the largest contrasts were removed from analysis for plot visibility

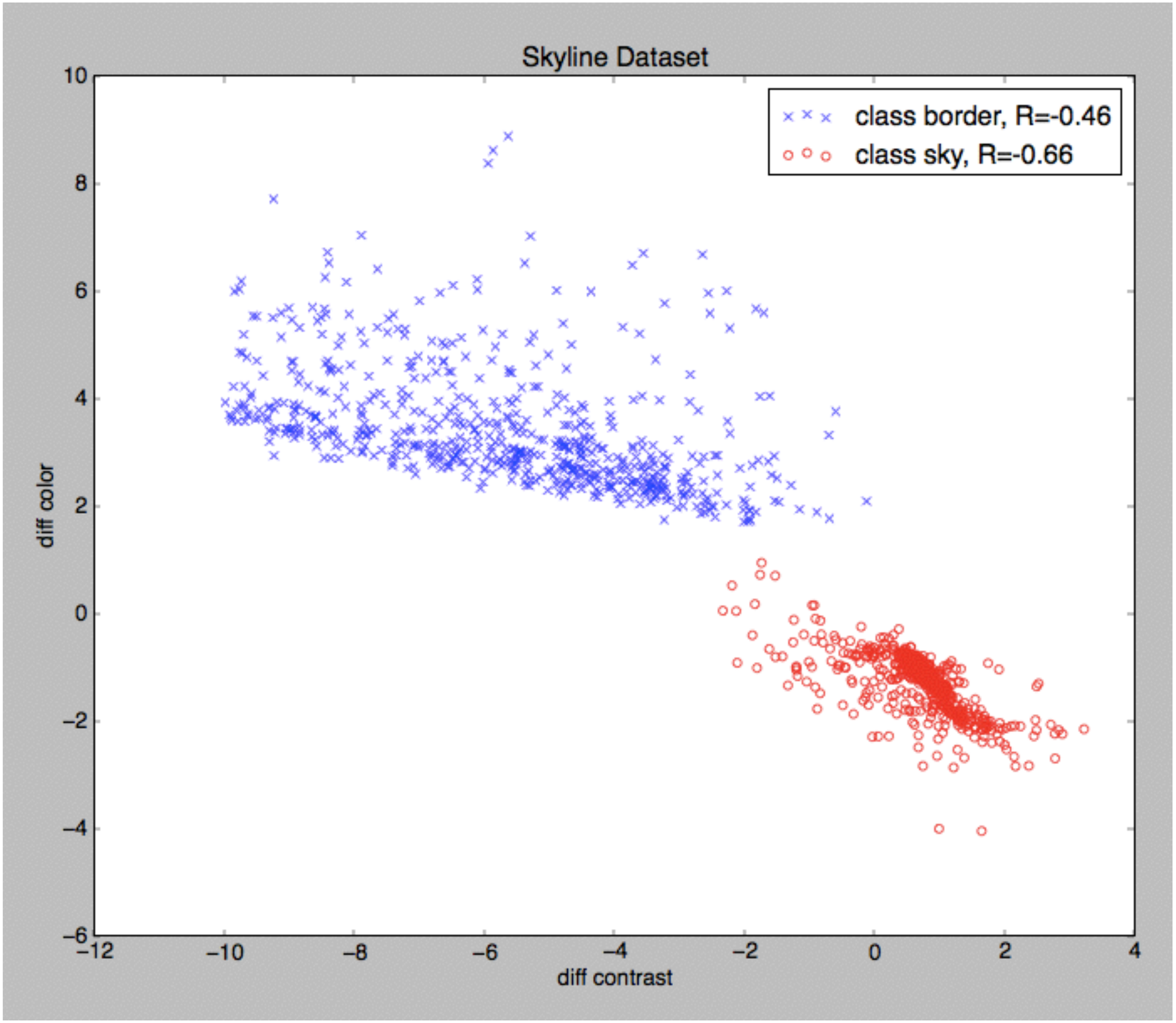




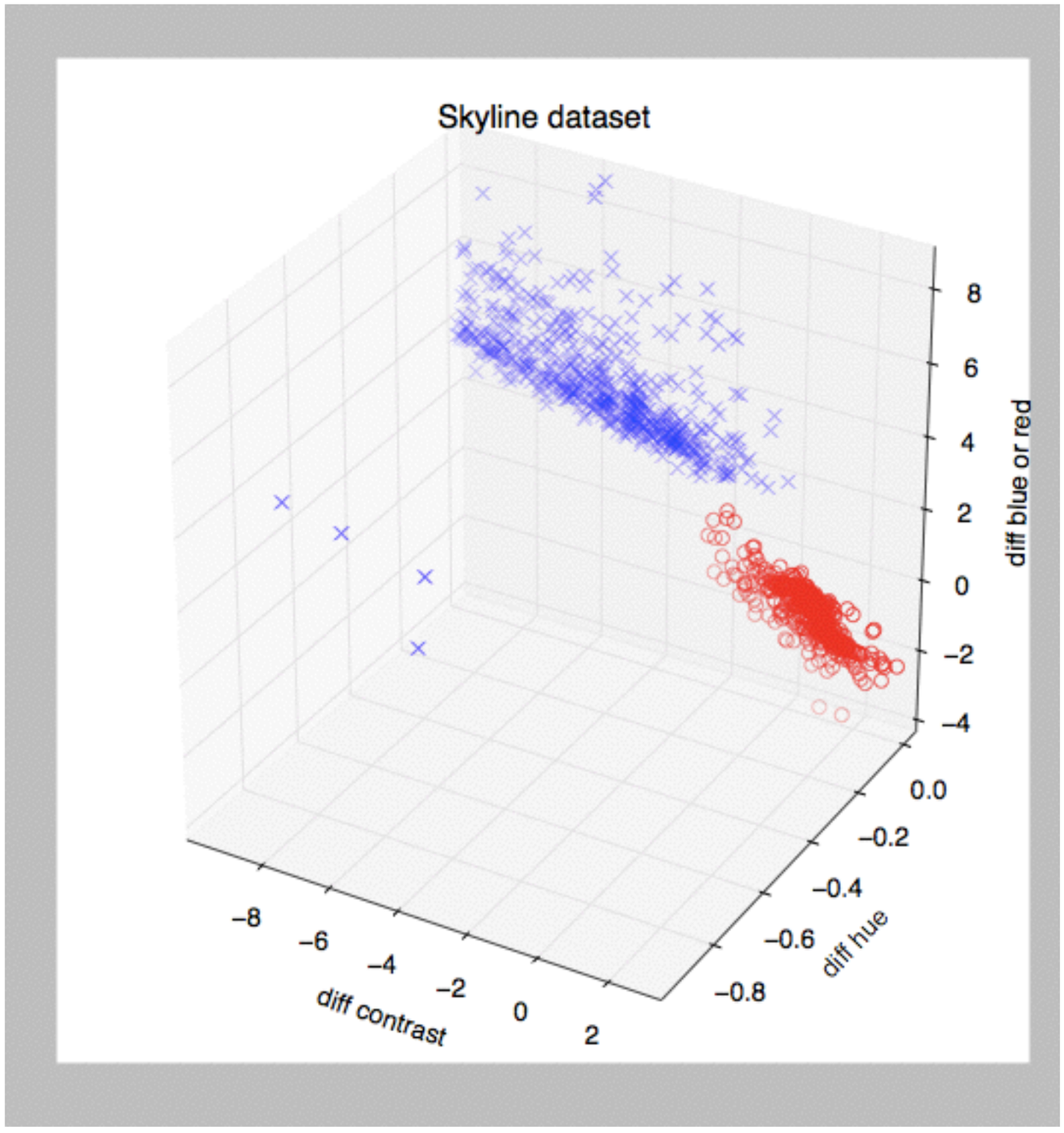
[new mexico test image]



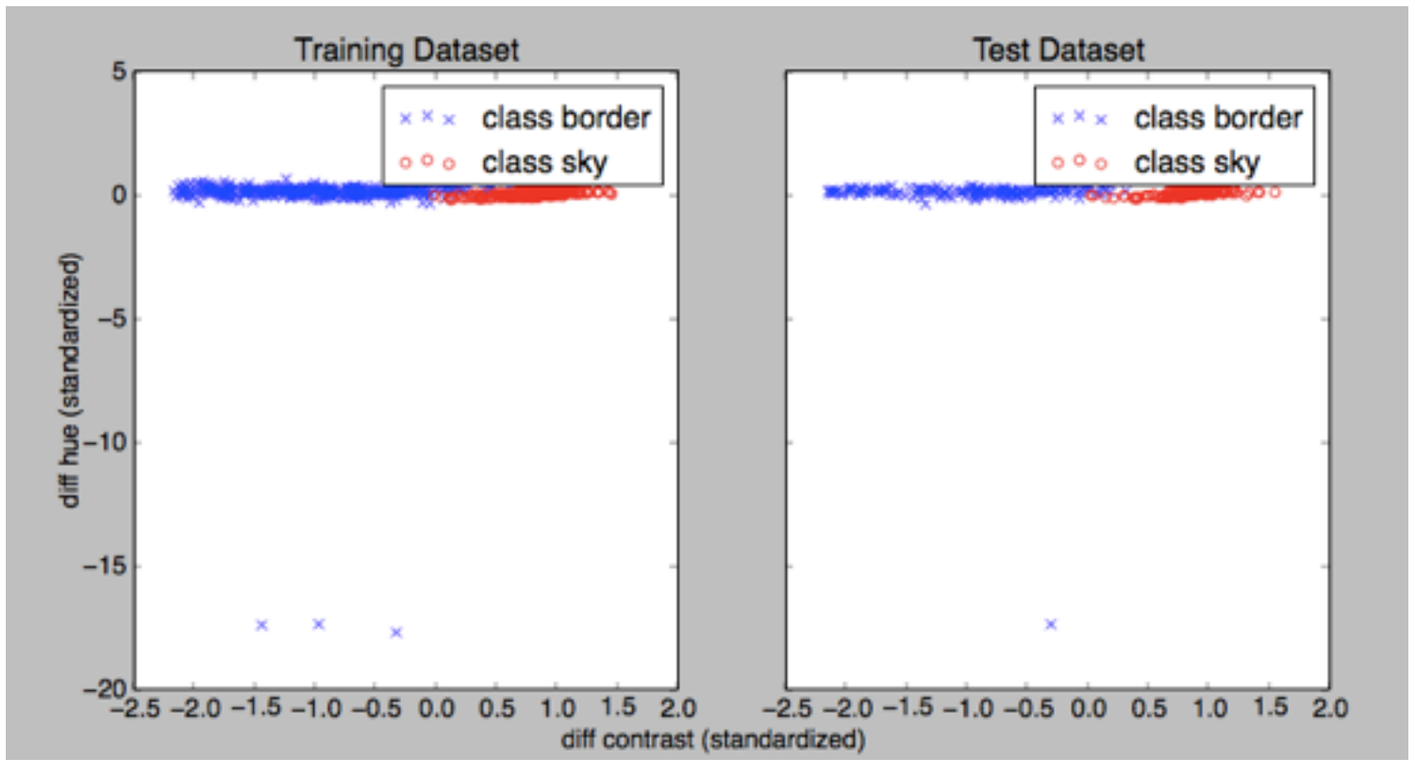
[new mexico test image]

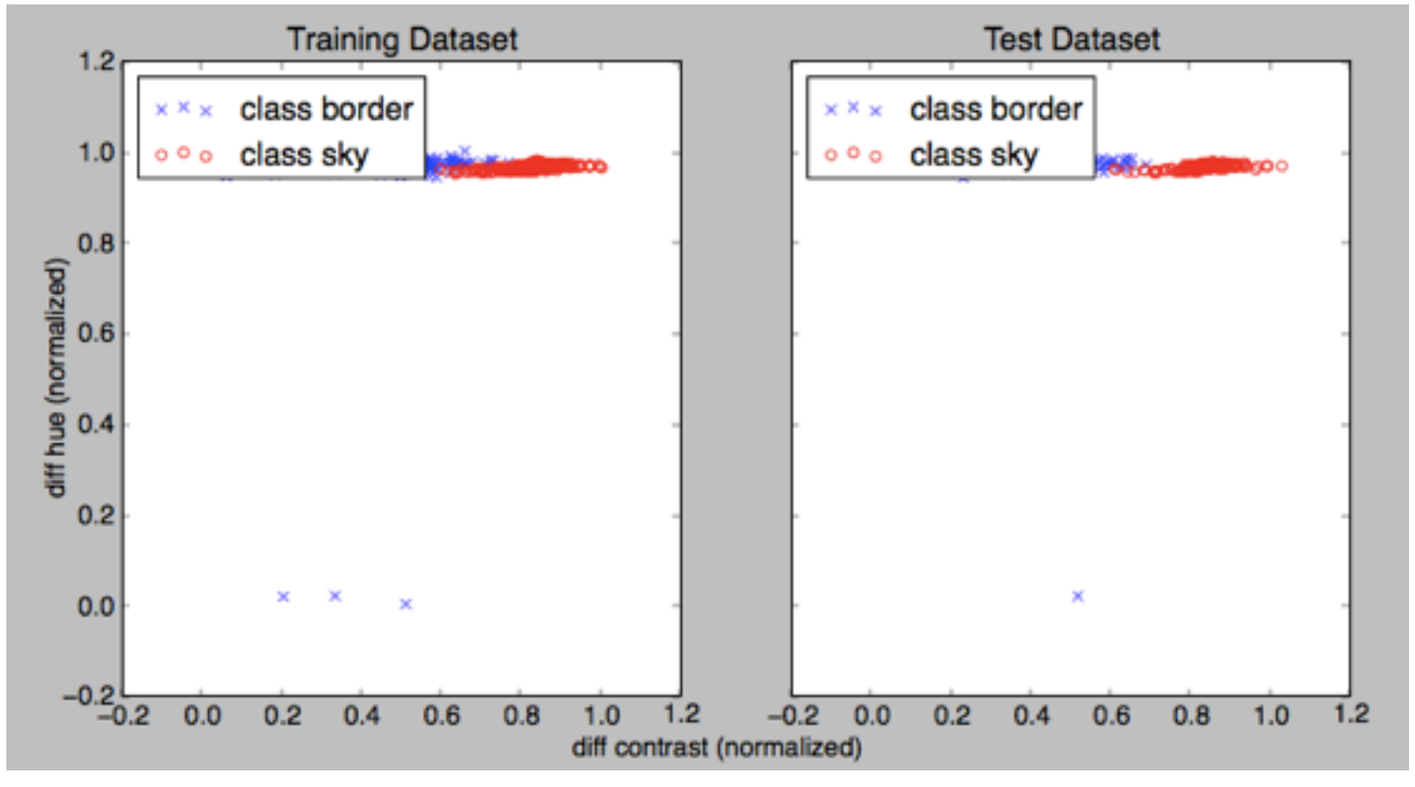


new mexico test image

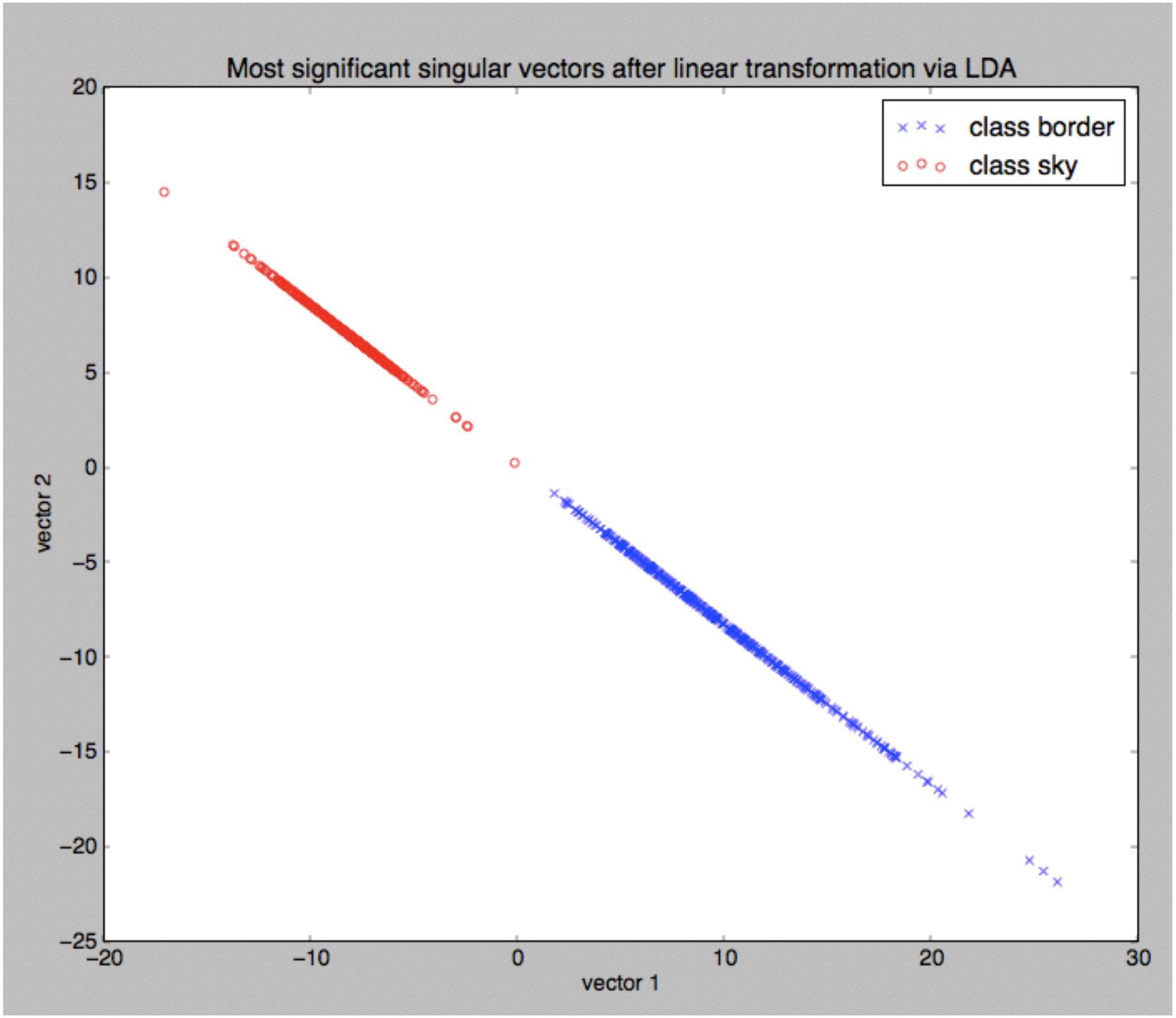


new mexico test image

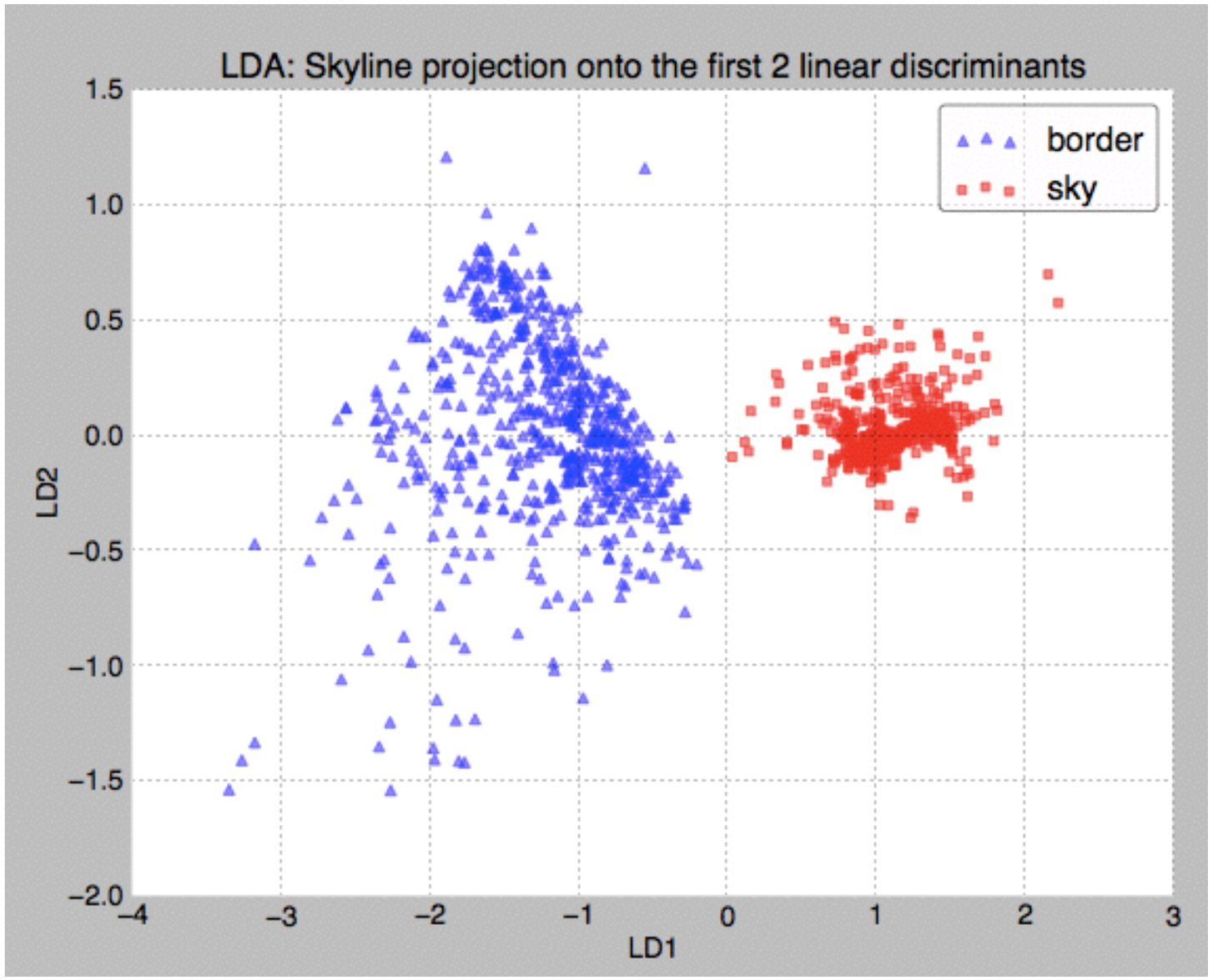




new mexico test image



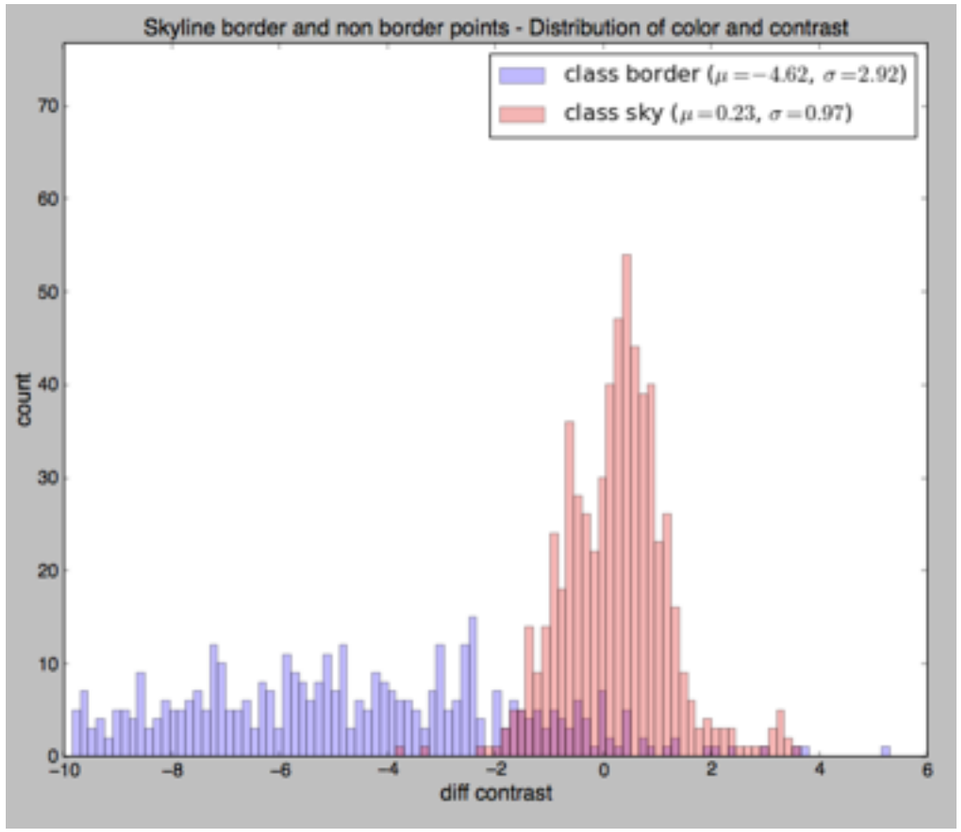
new mexico test image



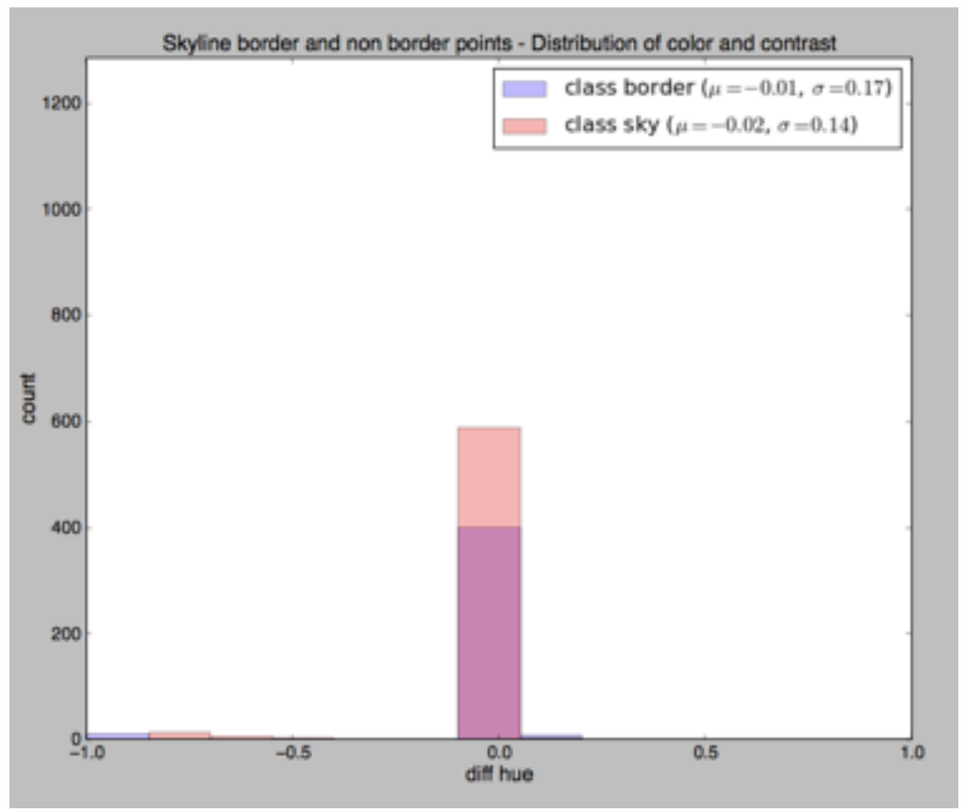

```
                        contrast  hue     BorR
Mean Vector class 1: [-0.9673 -0.0244  1.0153]

Mean Vector class 2: [ 0.8272  0.0209 -0.8683]

('within-class Scatter Matrix:\n',
array([[  268.8979,    -6.2717,   -99.9184],
       [   -6.2717,  1344.3154,   -29.6696],
       [  -99.9184,   -29.6696,   159.2336]]))
('between-class Scatter Matrix:\n',
array([[ 3242.1798,    95.2984, -3374.9391],
       [   95.2984,    15.9273,   -71.5997],
       [-3374.9391,   -71.5997,  3571.1727]]))

Eigenvector 1:
[[ 0.2783]
 [-0.017 ]
 [-0.9603]]
Eigenvalue 1: 2.42e+01

Eigenvector 2:
[[-0.7224]
 [-0.0797]
 [-0.6868]]
Eigenvalue 2: 2.55e-01

Eigenvector 3:
[[ 0.428 ]
 [-0.8162]
 [ 0.3881]]
Eigenvalue 3: 8.18e-16
ok
Eigenvalues in decreasing order:

24.2346515941
0.254794059977
8.17964421251e-16
Variance explained:

eigenvalue 1: 98.96%
eigenvalue 2: 1.04%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.2783, -0.017 , -0.9603],
       [-0.7224, -0.0797, -0.6868]]))
```

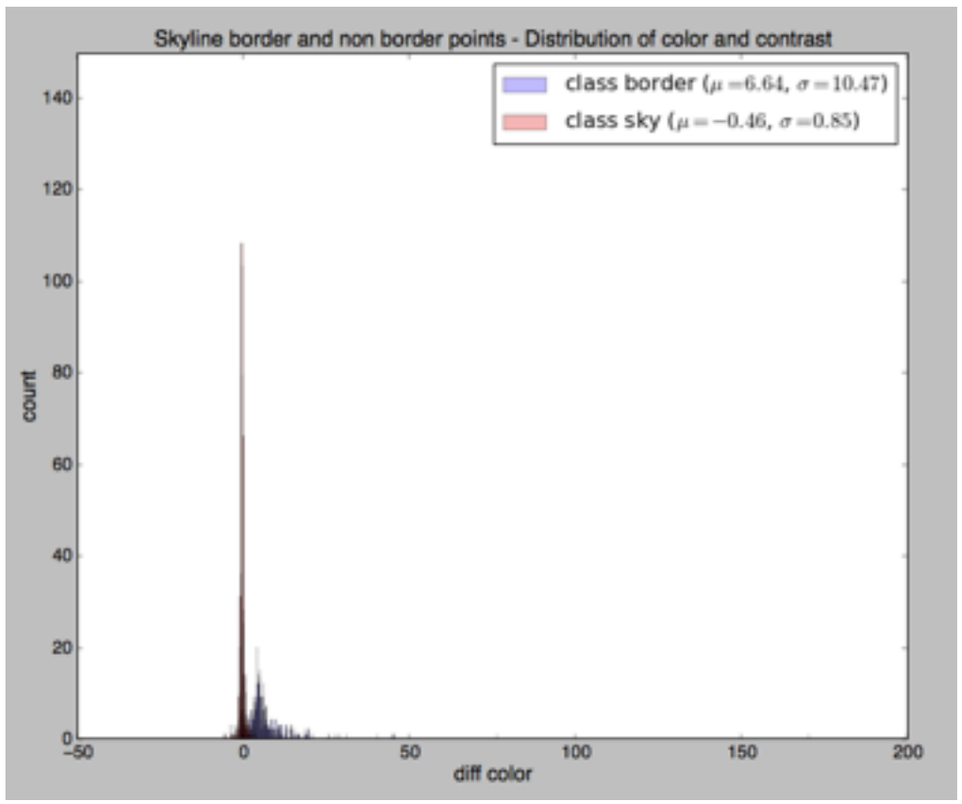
arizona test image

[arizona test image]

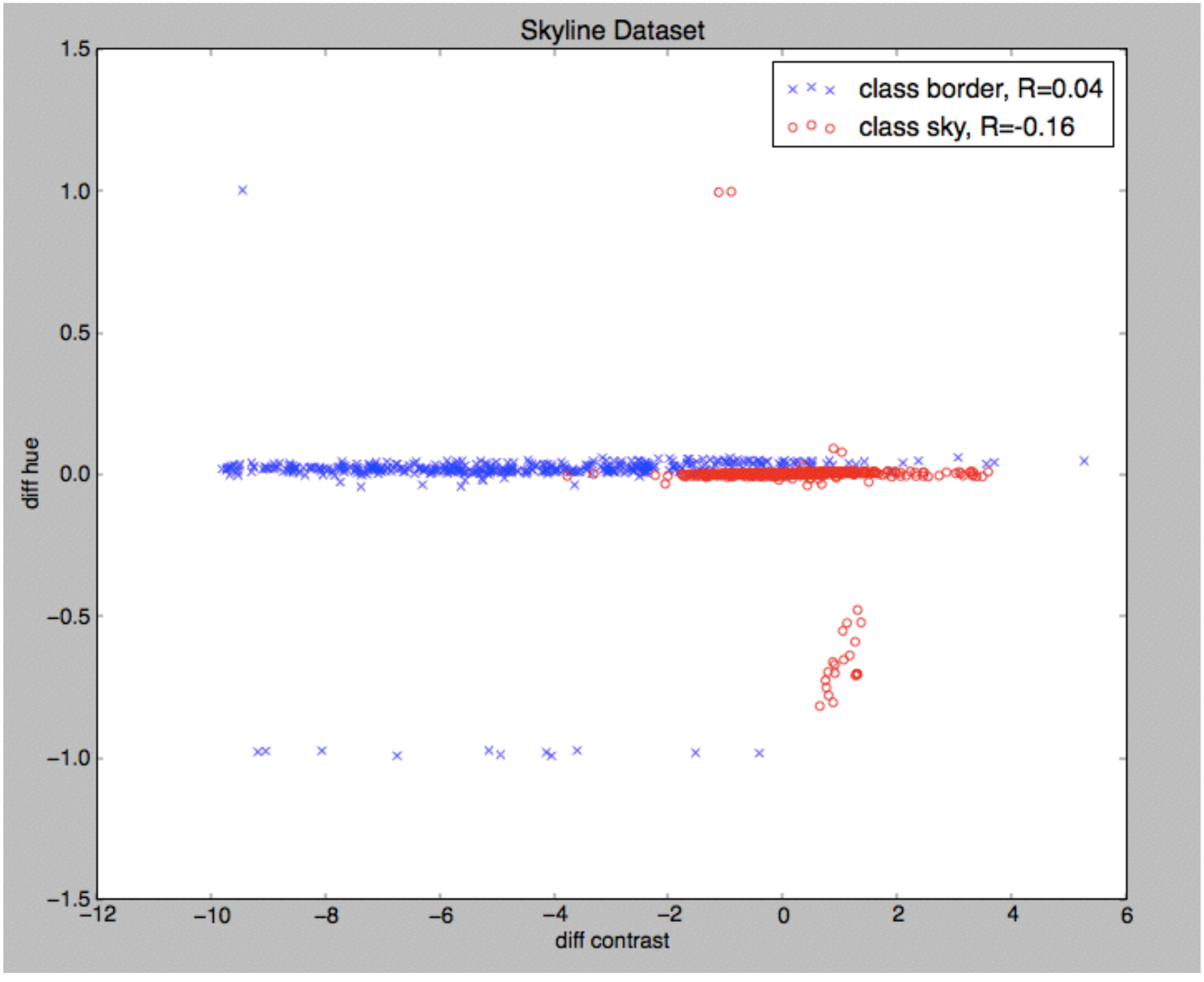


*note: the largest contrasts were removed from analysis for plot visibility

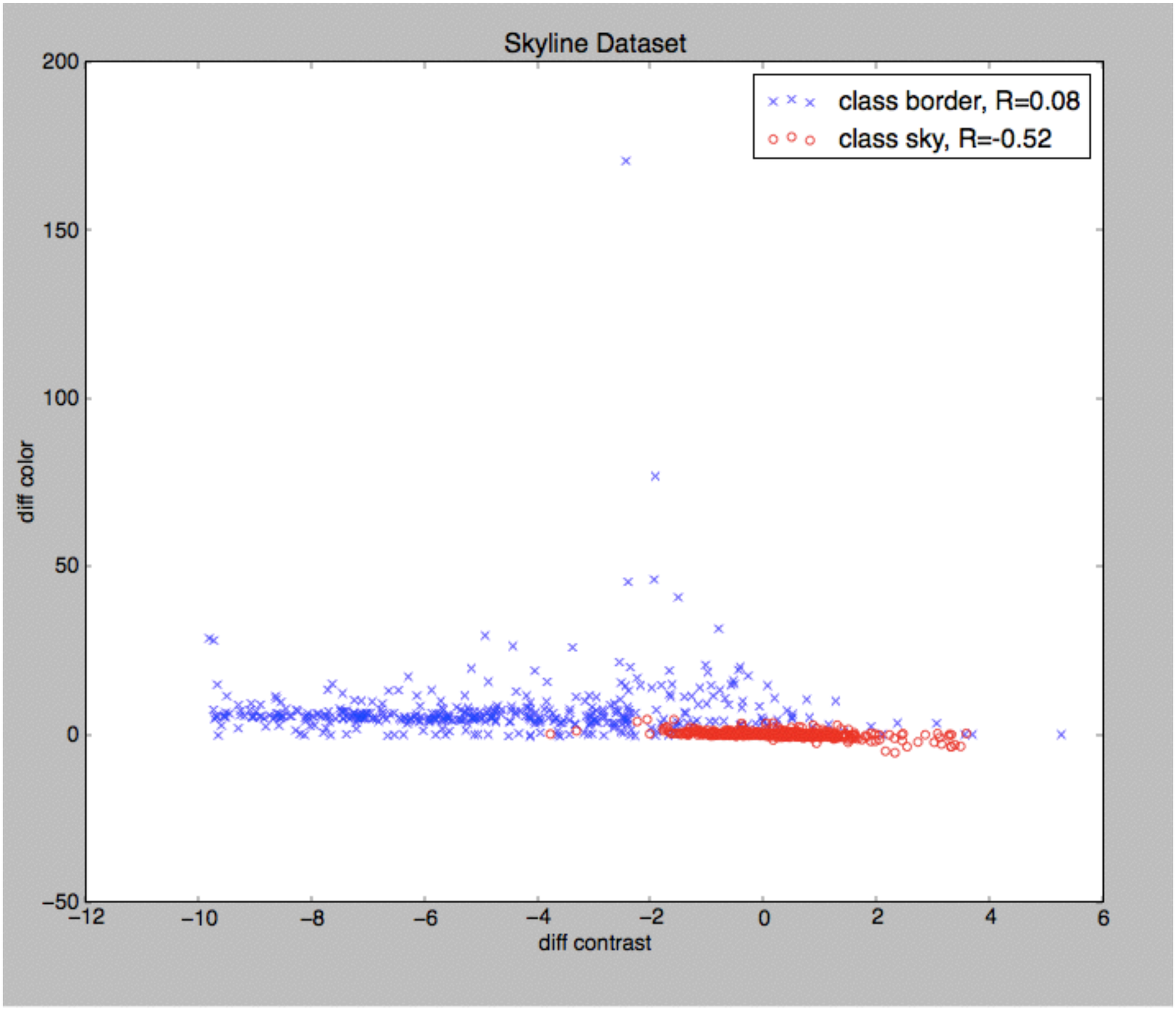




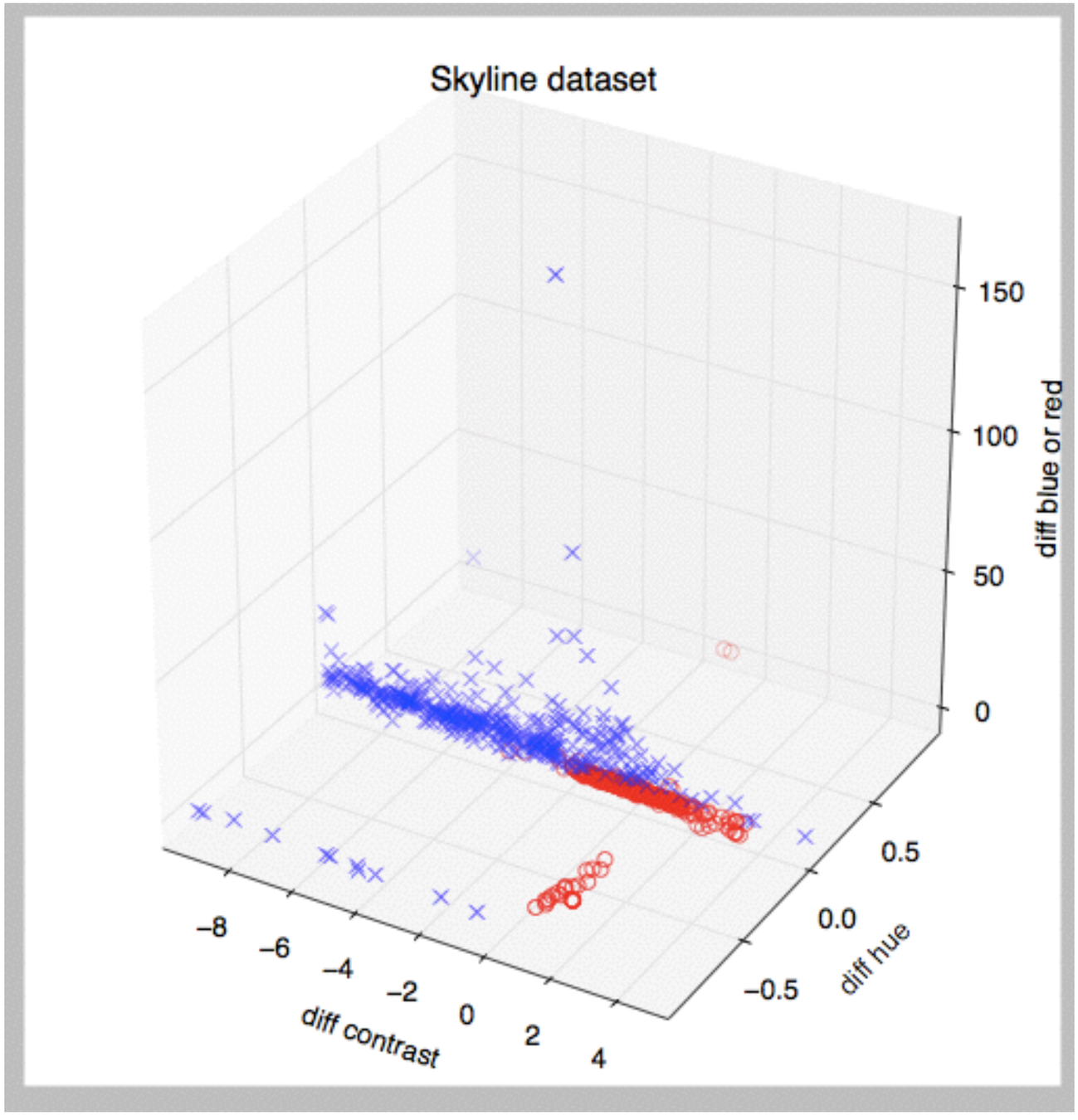
[arizona test image]



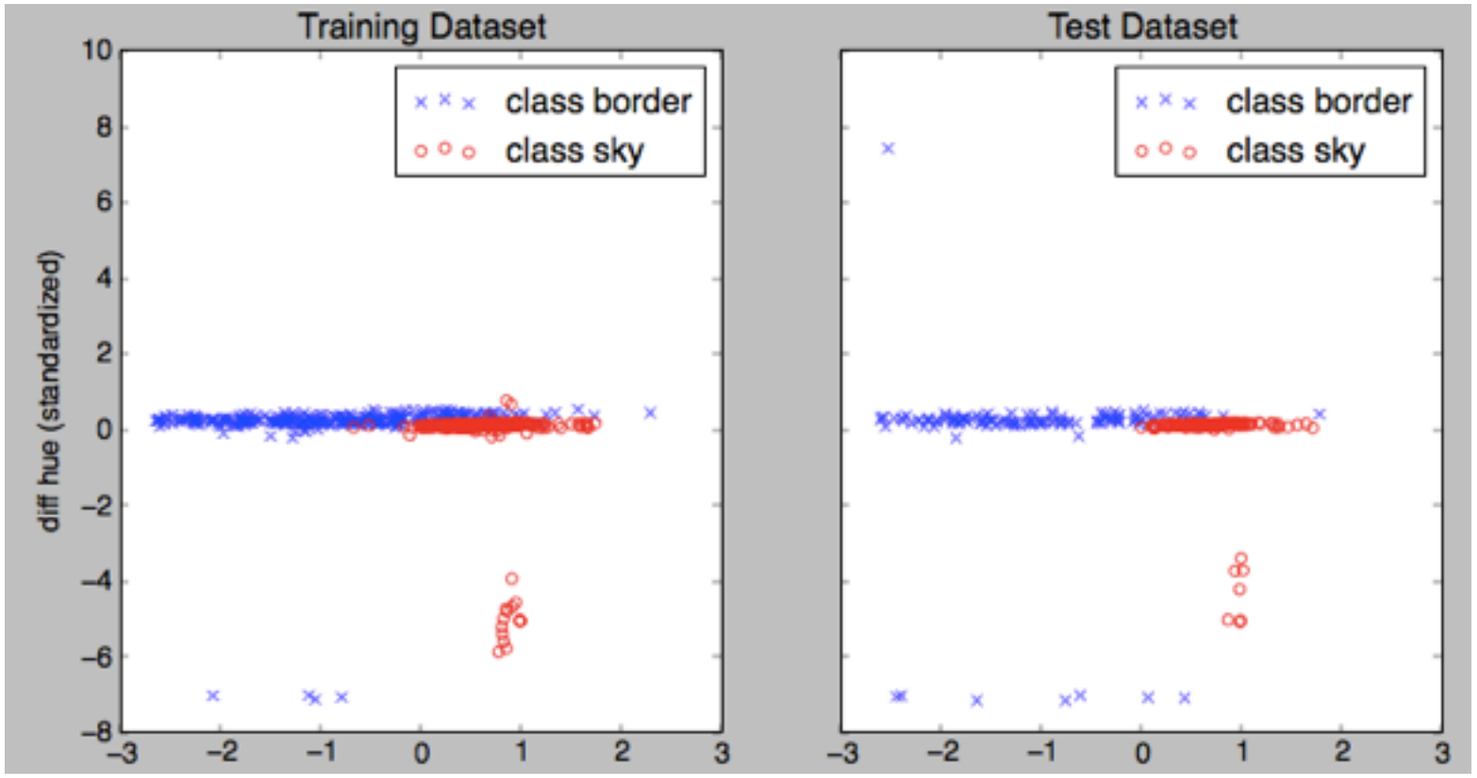
arizona test image

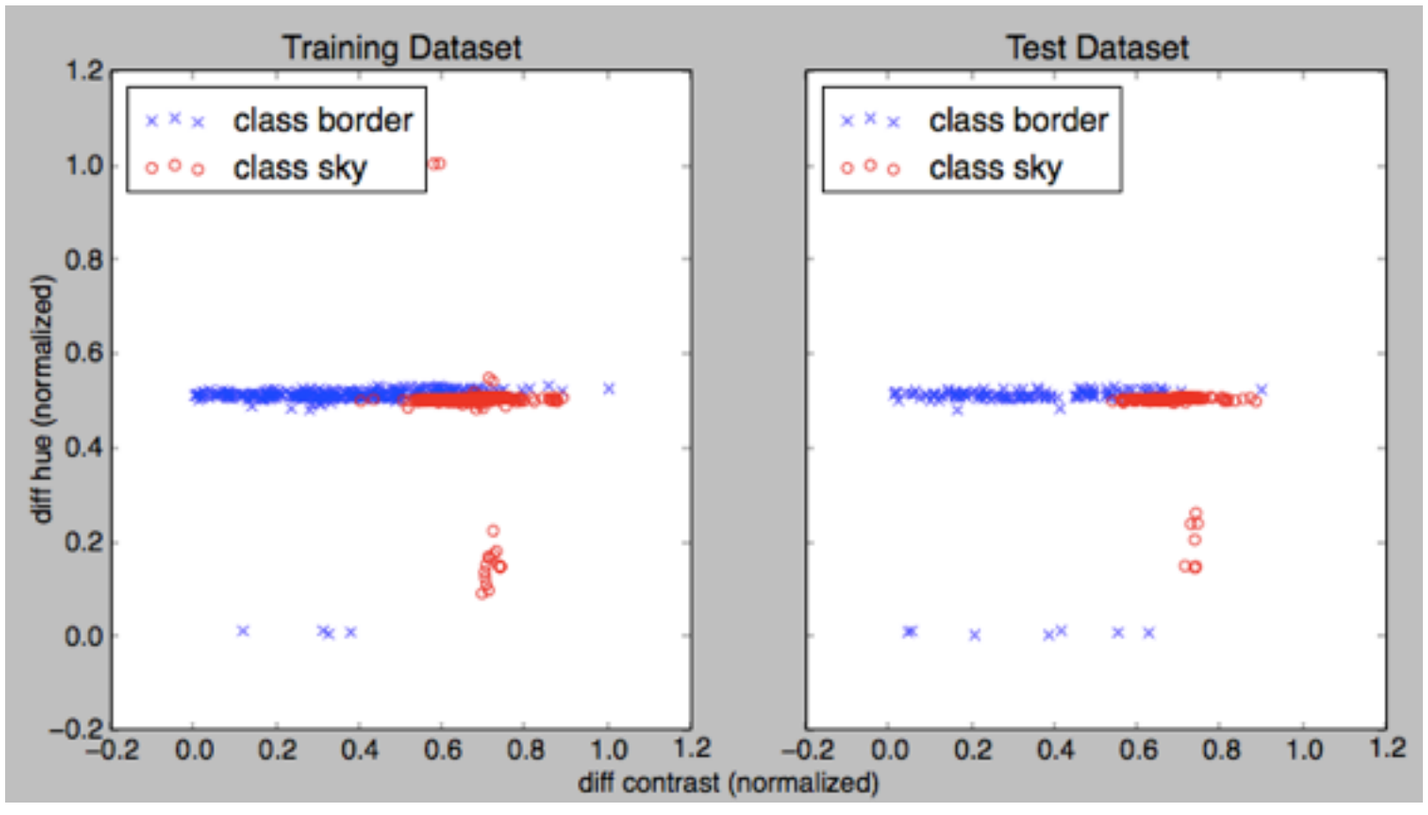


[arizona test image]

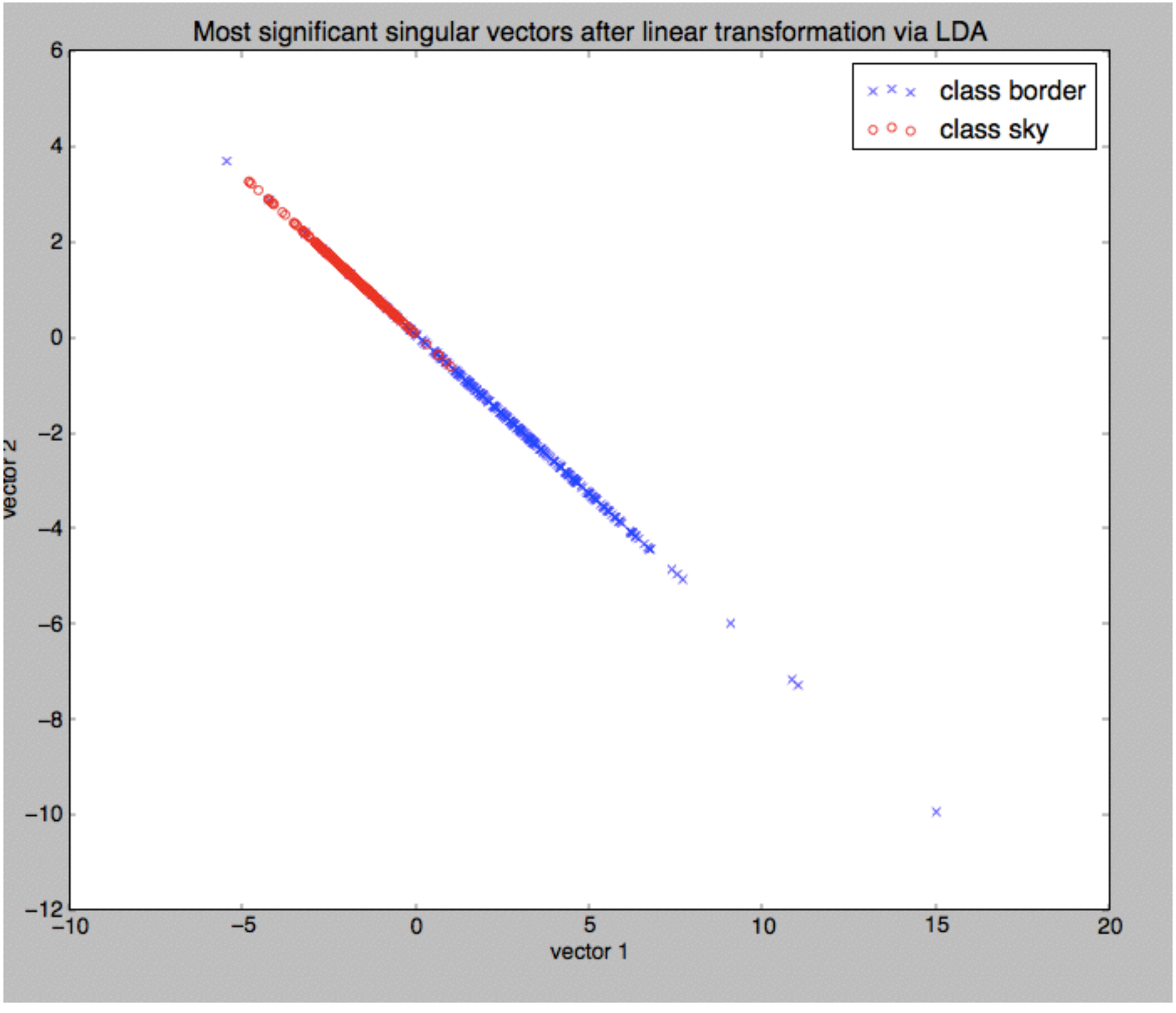


arizona test image

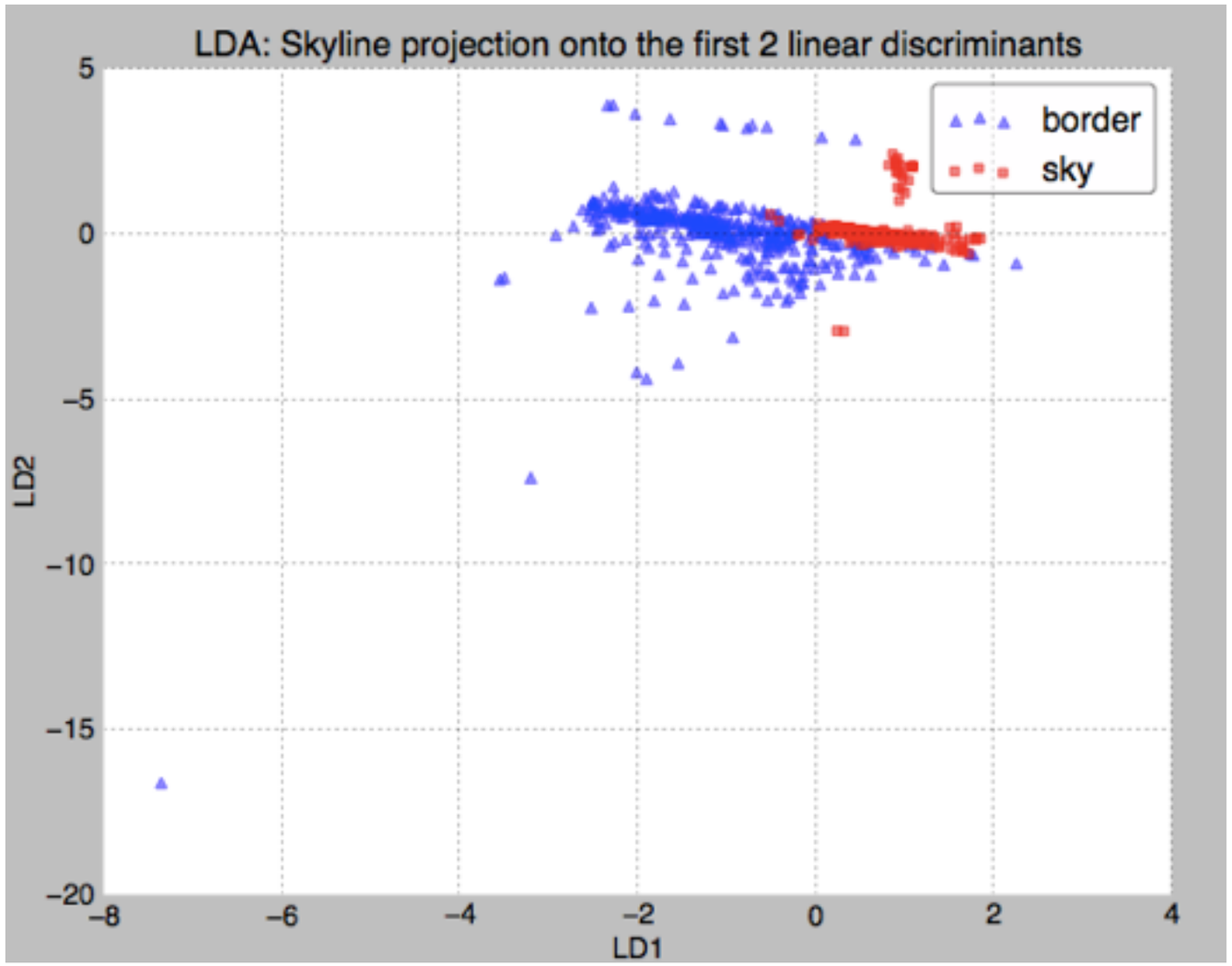




[arizona test image]



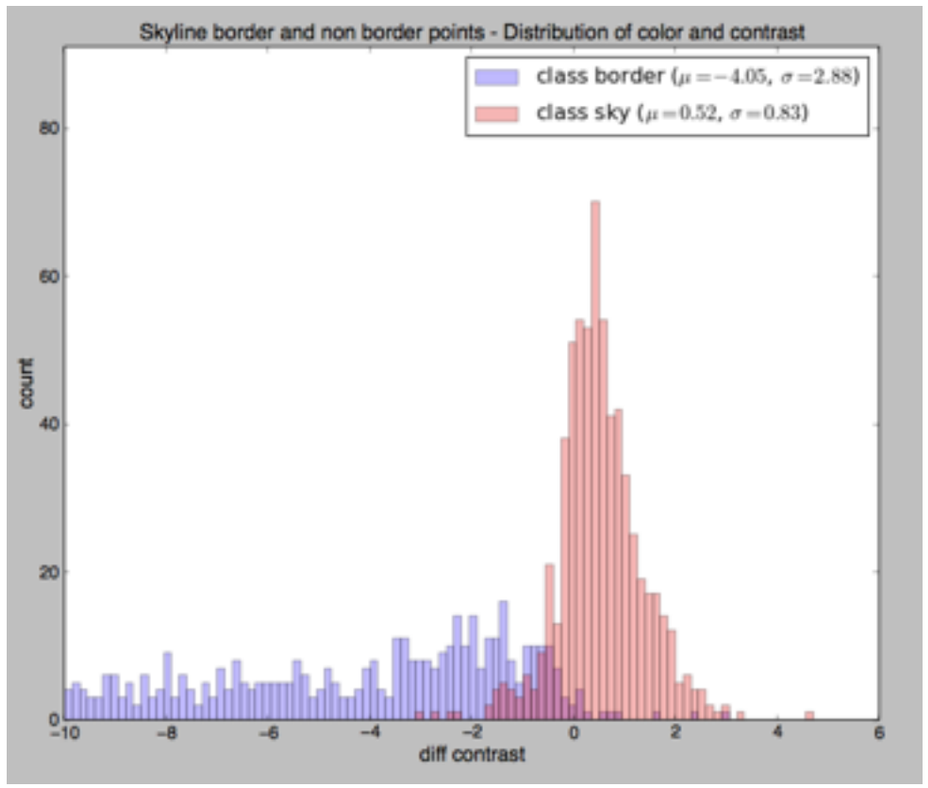
arizona test image



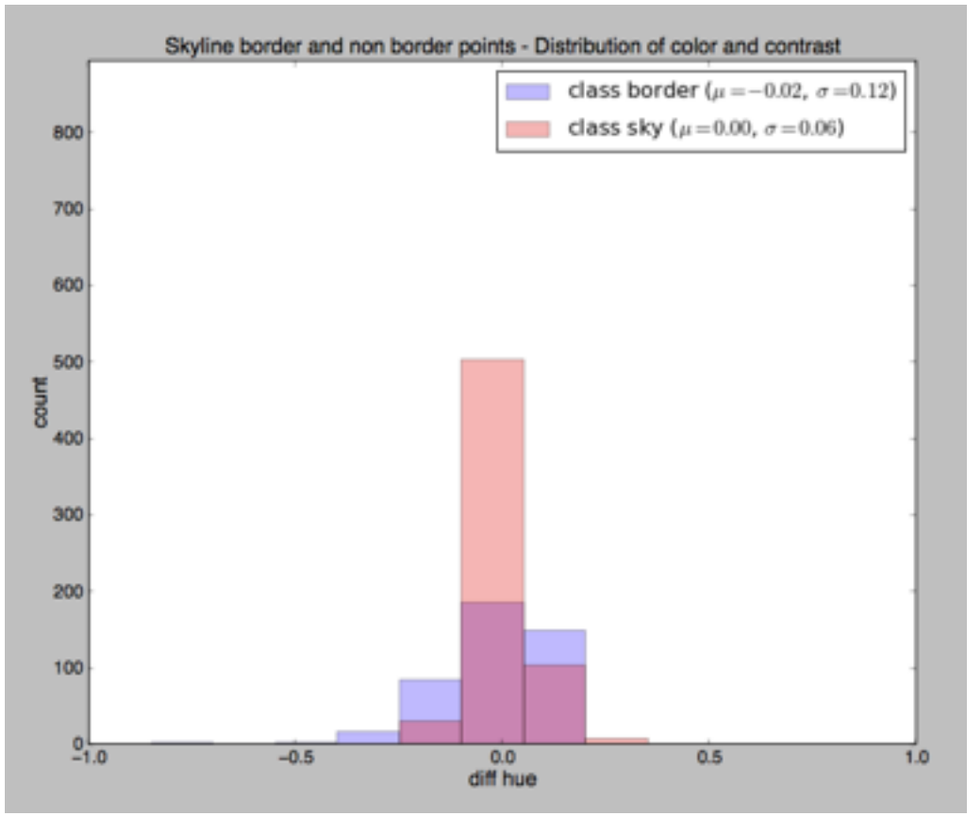

```
                        contrast  hue     BorR
Mean Vector class 1: [-0.9274  0.0676  0.5582]

Mean Vector class 2: [ 0.6329 -0.0462 -0.3809]

('within-class Scatter Matrix:\n',
array([[  426.6628,    -9.4933,    32.1831],
       [   -9.4933,  1029.7744,    30.872 ],
       [   32.1831,    30.872 ,   813.3243]]))
('between-class Scatter Matrix:\n',
array([[ 1849.6528,  -102.0323, -1064.2459],
       [ -102.0323,    40.3181,   110.4992],
       [-1064.2459,   110.4992,   689.6683]]))

Eigenvector 1:
[[ 0.9469]
 [-0.0058]
 [-0.3216]]
Eigenvalue 1: 5.32e+00

Eigenvector 2:
[[-0.4694]
 [-0.4678]
 [-0.7489]]
Eigenvalue 2: 1.07e-01

Eigenvector 3:
[[ 0.2646]
 [-0.8012]
 [ 0.5367]]
Eigenvalue 3: -5.80e-17
ok
Eigenvalues in decreasing order:

5.31932034283
0.107340722064
5.80177595038e-17
Variance explained:

eigenvalue 1: 98.02%
eigenvalue 2: 1.98%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.9469, -0.0058, -0.3216],
       [-0.4694, -0.4678, -0.7489]]))
```

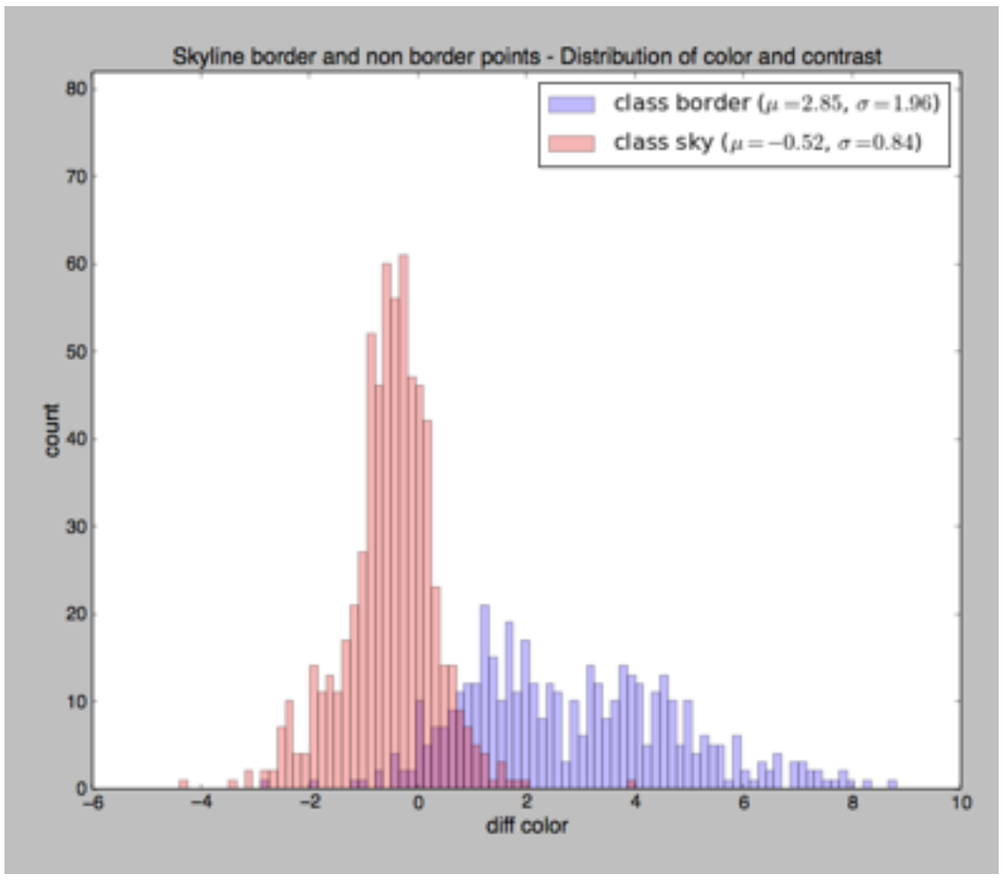
rainbow test image

rainbow test image

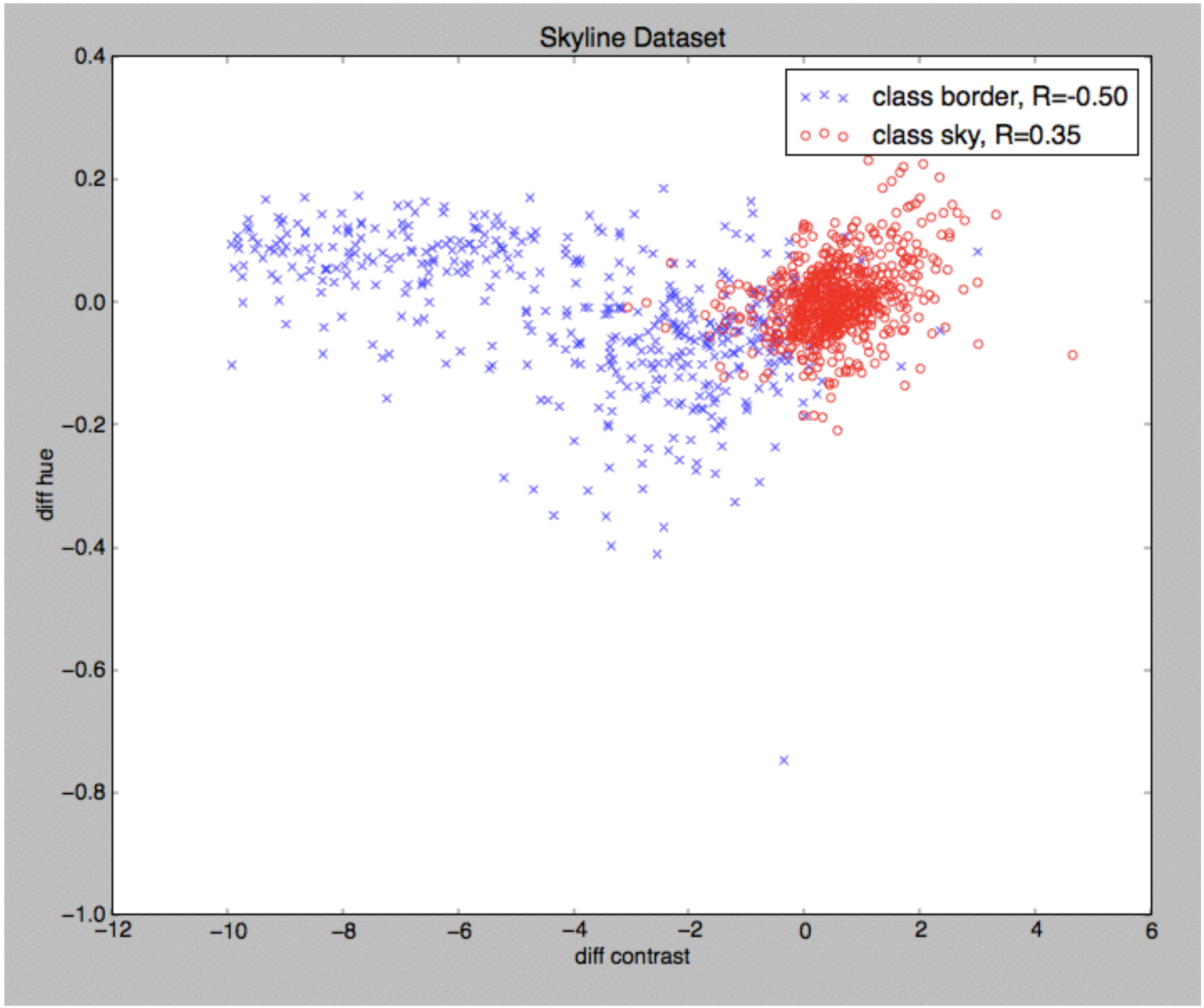


*note: the largest contrasts were removed from analysis for plot visibility

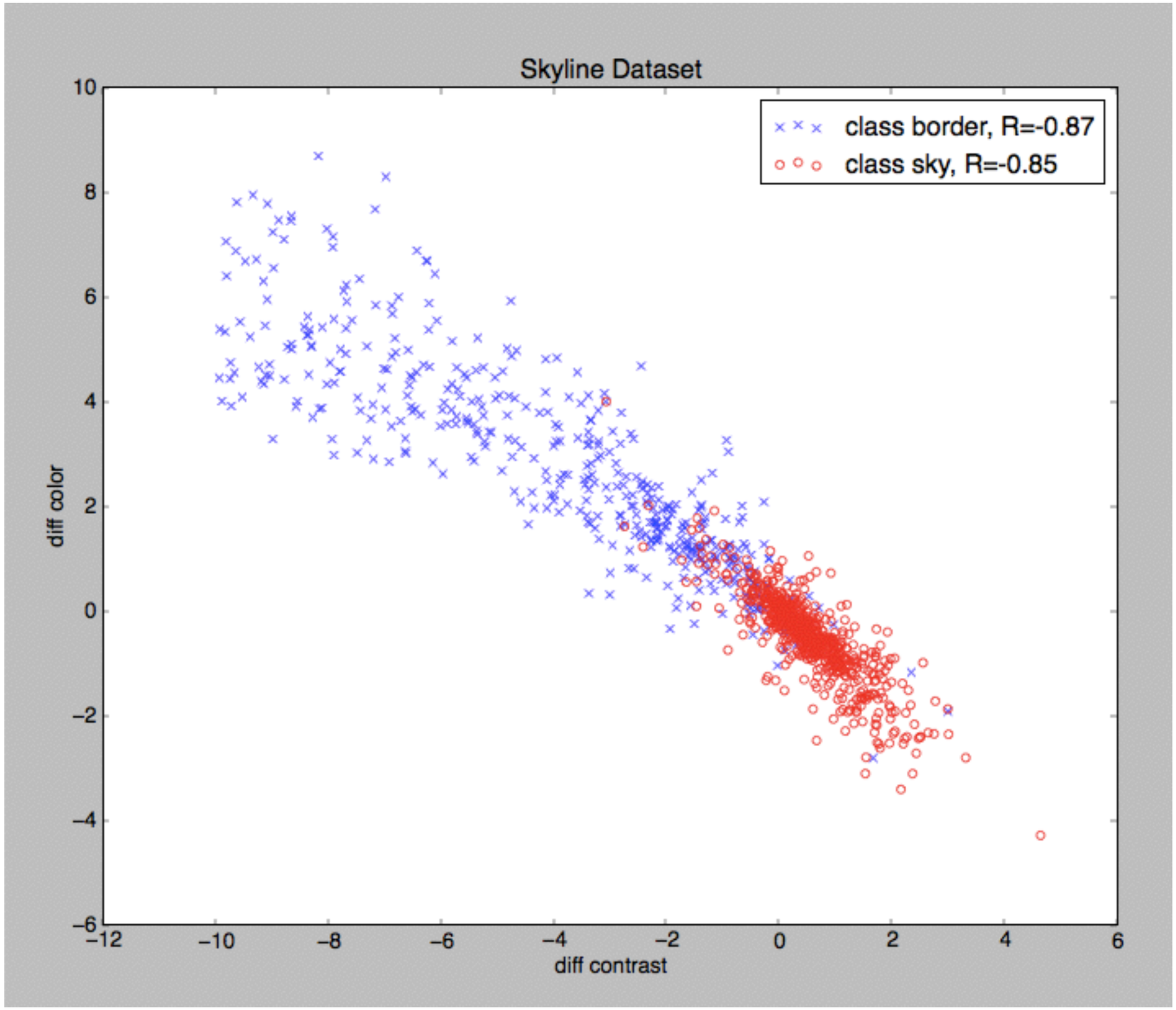




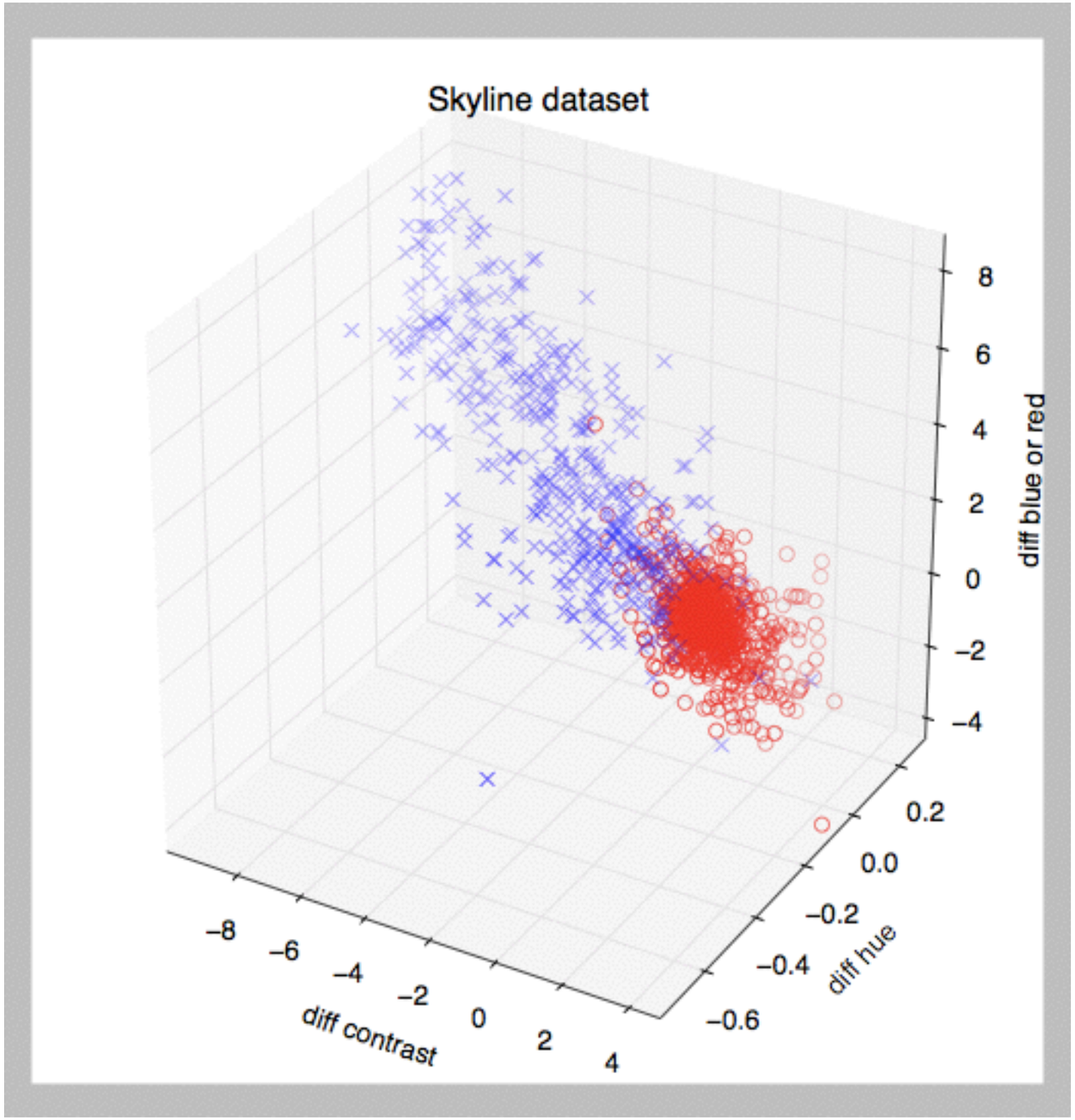
[rainbow test image]



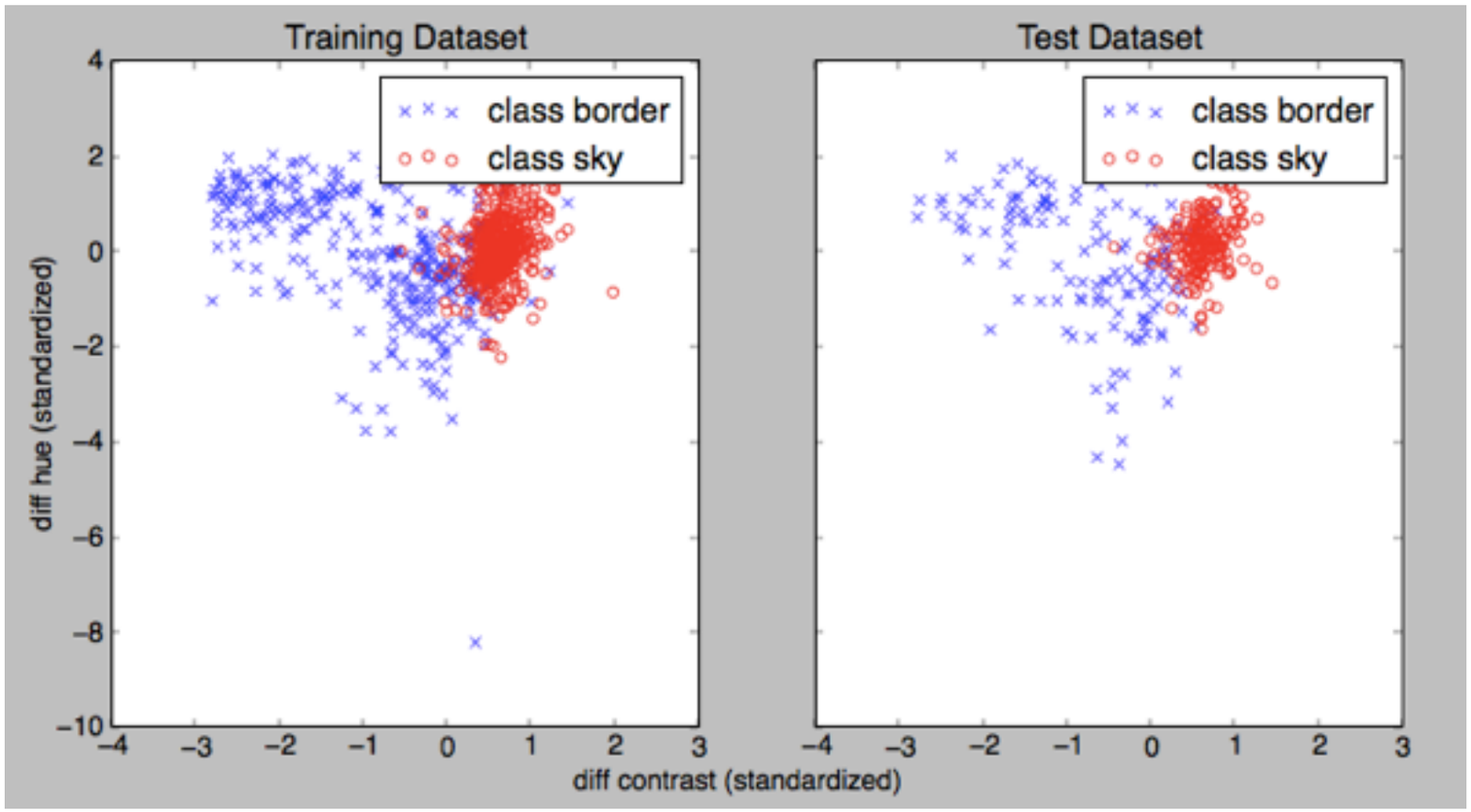
[rainbow test image]

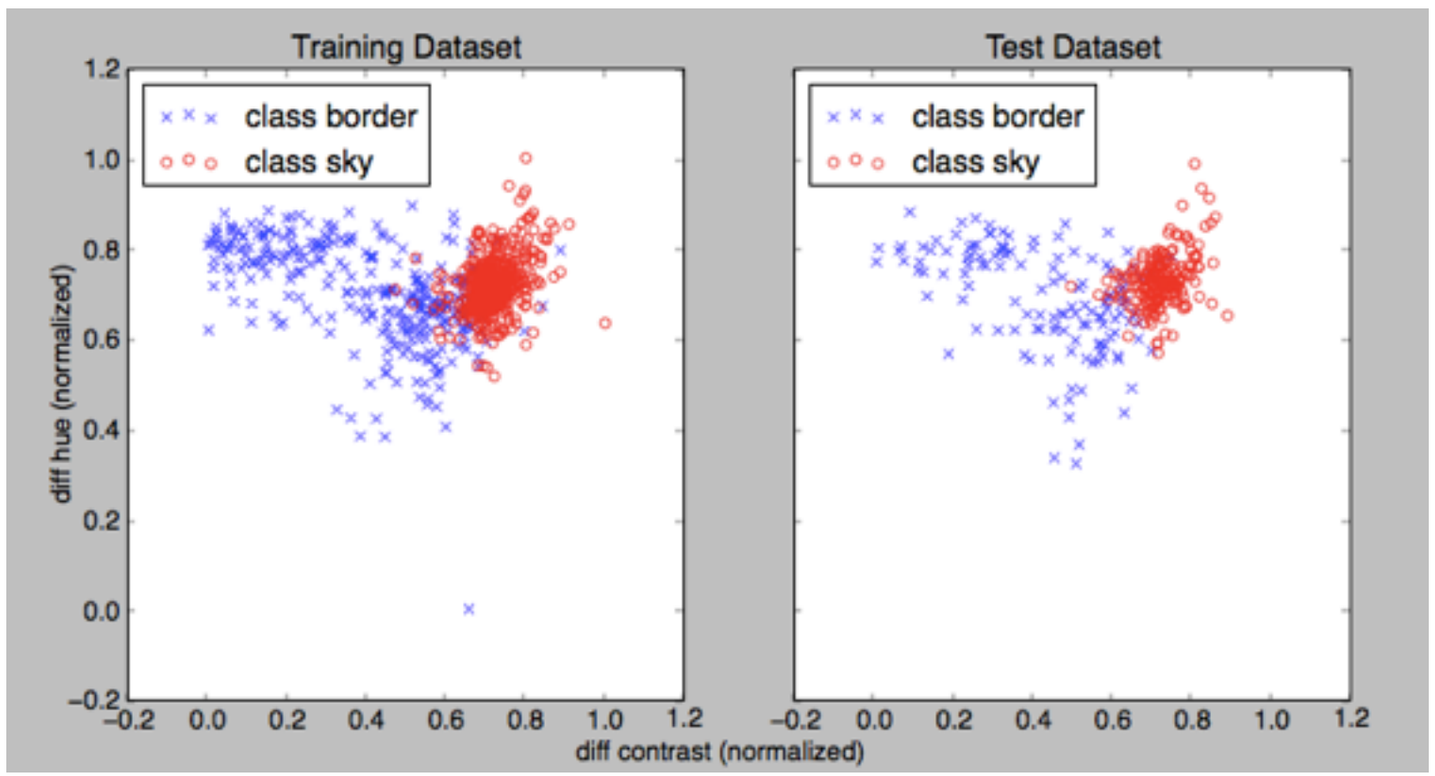


[rainbow test image]

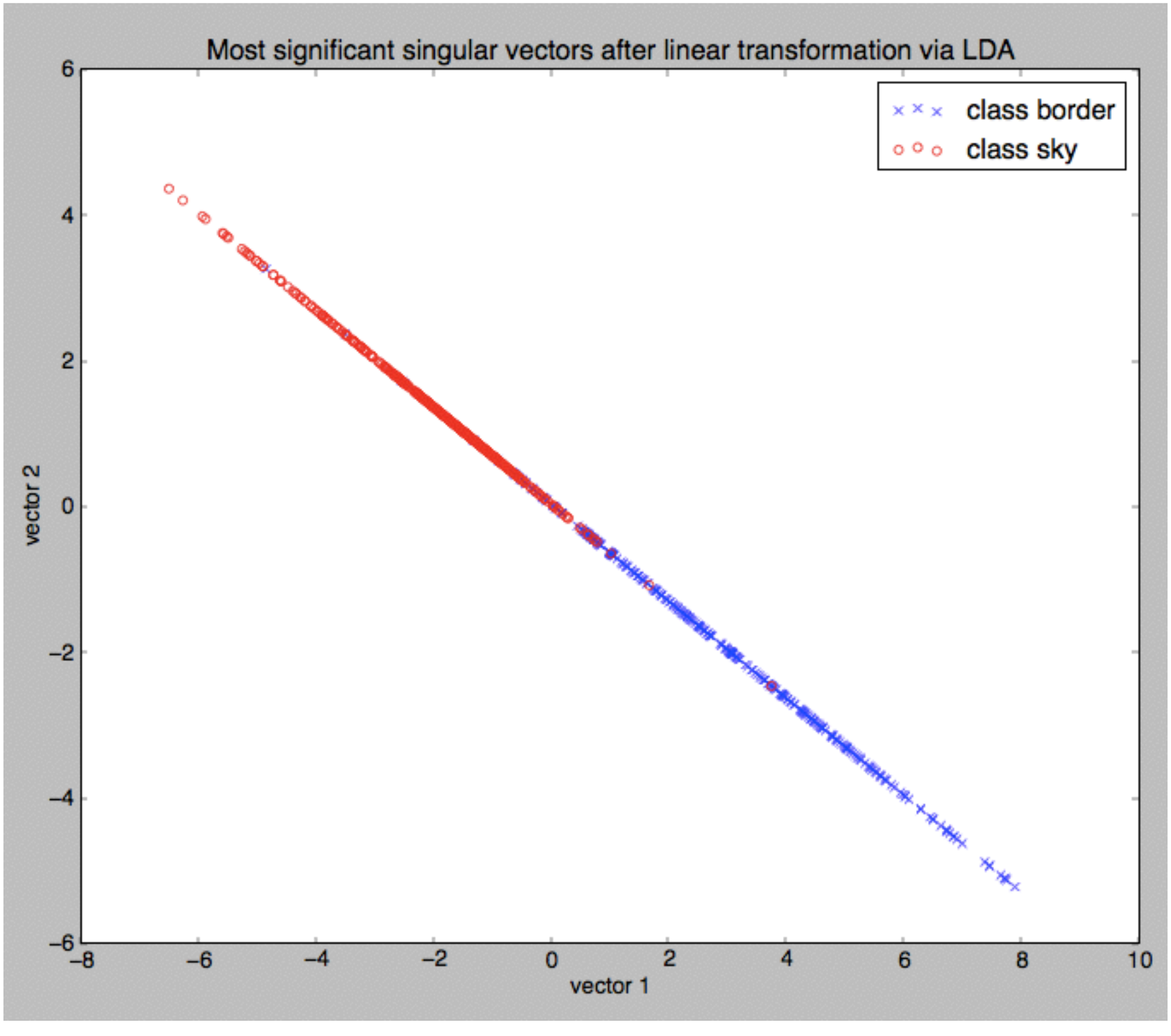


rainbow test image

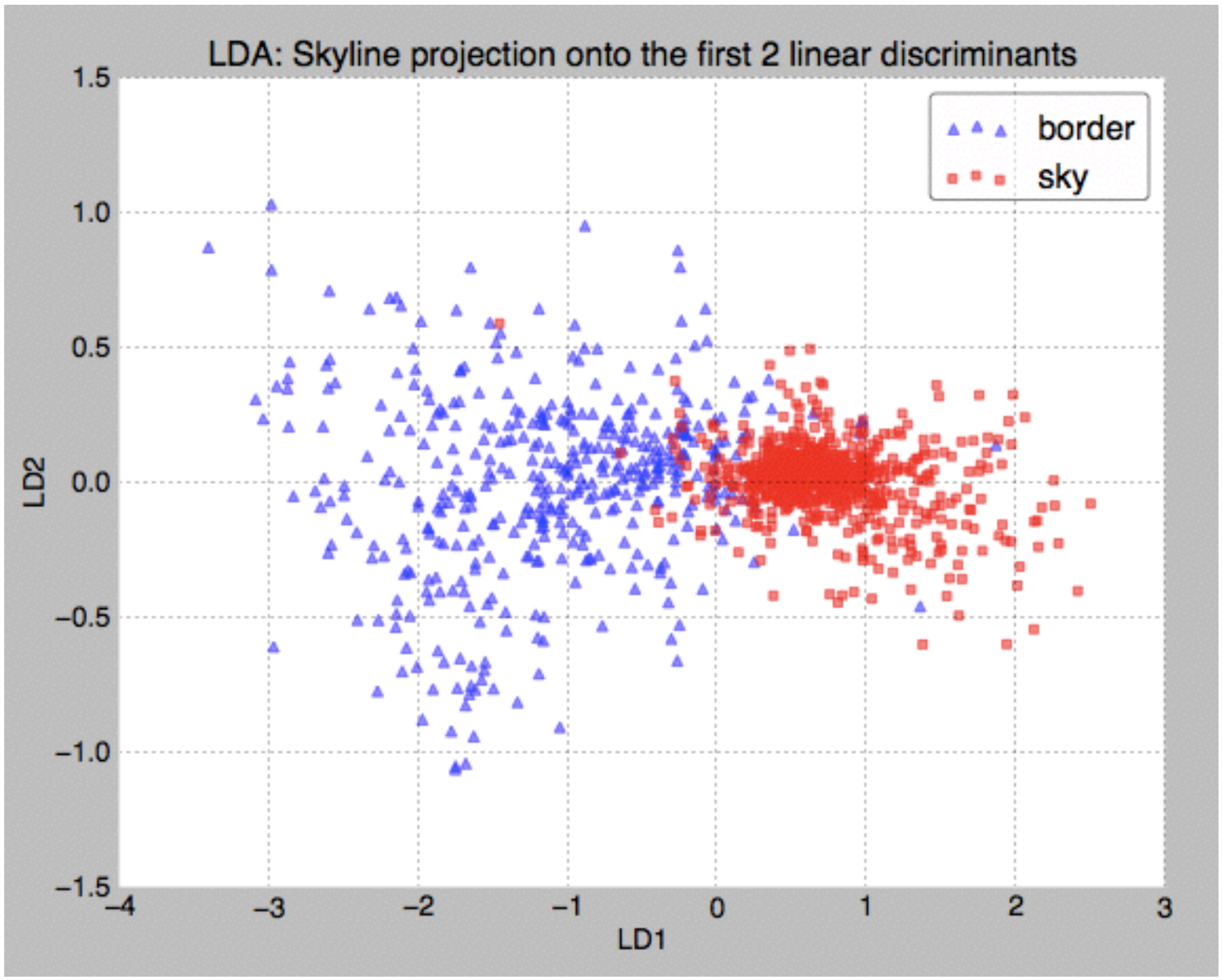




[rainbow test image]

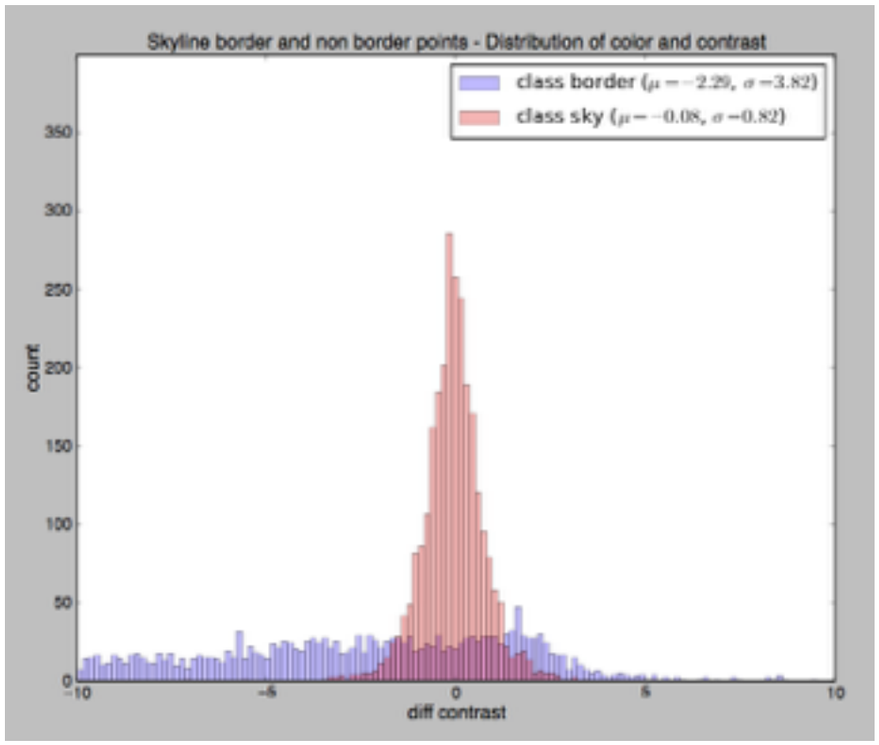


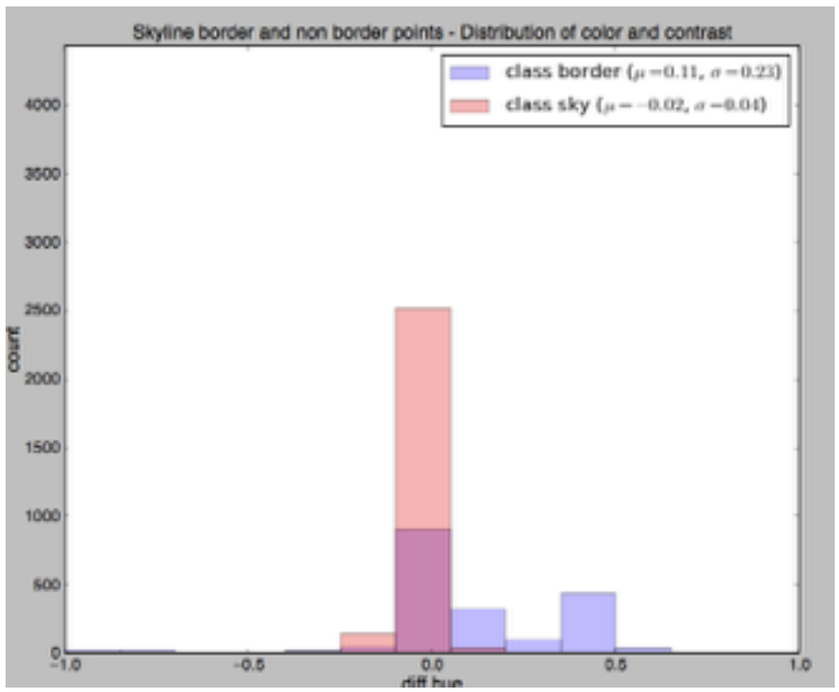
rainbow test image

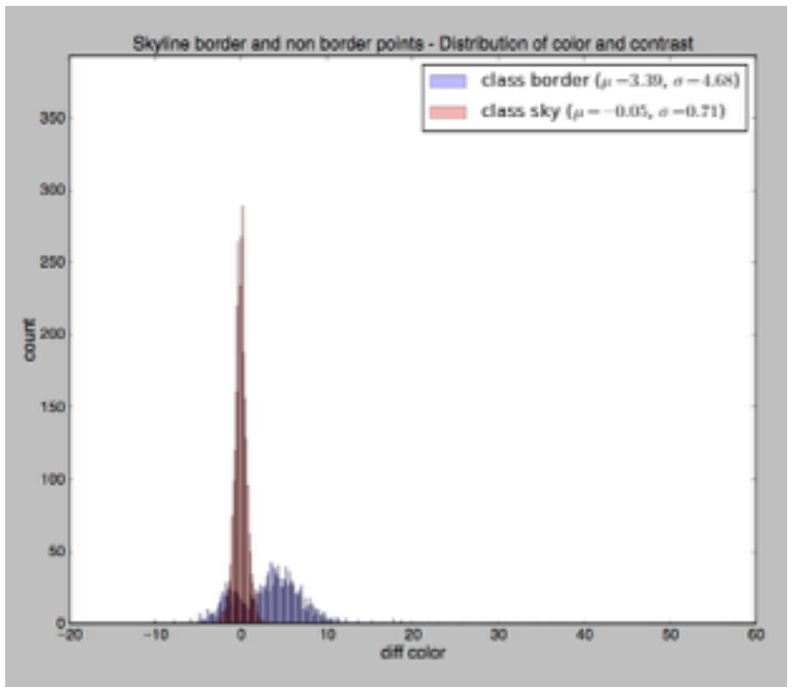



```
                        contrast  hue     BorR
Mean Vector class 1: [-0.9182 -0.1511  0.925 ]

Mean Vector class 2: [ 0.6231  0.1025 -0.6277]

('within-class Scatter Matrix:\n',
array([[  460.4303,  -229.9637,  -390.5265],
       [ -229.9637,  1059.3262,   310.4501],
       [ -390.5265,   310.4501,   451.1894]]))
('between-class Scatter Matrix:\n',
array([[ 1894.5371,   351.7602, -1812.6911],
       [  351.7602,    97.8492,  -258.3772],
       [-1812.6911,  -258.3772,  1922.2598]]))

Eigenvector 1:
[[ 0.2433]
 [ 0.372 ]
 [-0.8958]]
Eigenvalue 1: 5.89e+00

Eigenvector 2:
[[ 0.7143]
 [-0.0049]
 [ 0.6998]]
Eigenvalue 2: 1.46e+00

Eigenvector 3:
[[-0.4745]
 [ 0.8127]
 [-0.3382]]
Eigenvalue 3: -2.42e-16
ok
Eigenvalues in decreasing order:

5.88771162291
1.46408665497
2.41960351699e-16
Variance explained:

eigenvalue 1: 80.09%
eigenvalue 2: 19.91%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.2433,  0.372 , -0.8958],
       [ 0.7143, -0.0049,  0.6998]]))
```

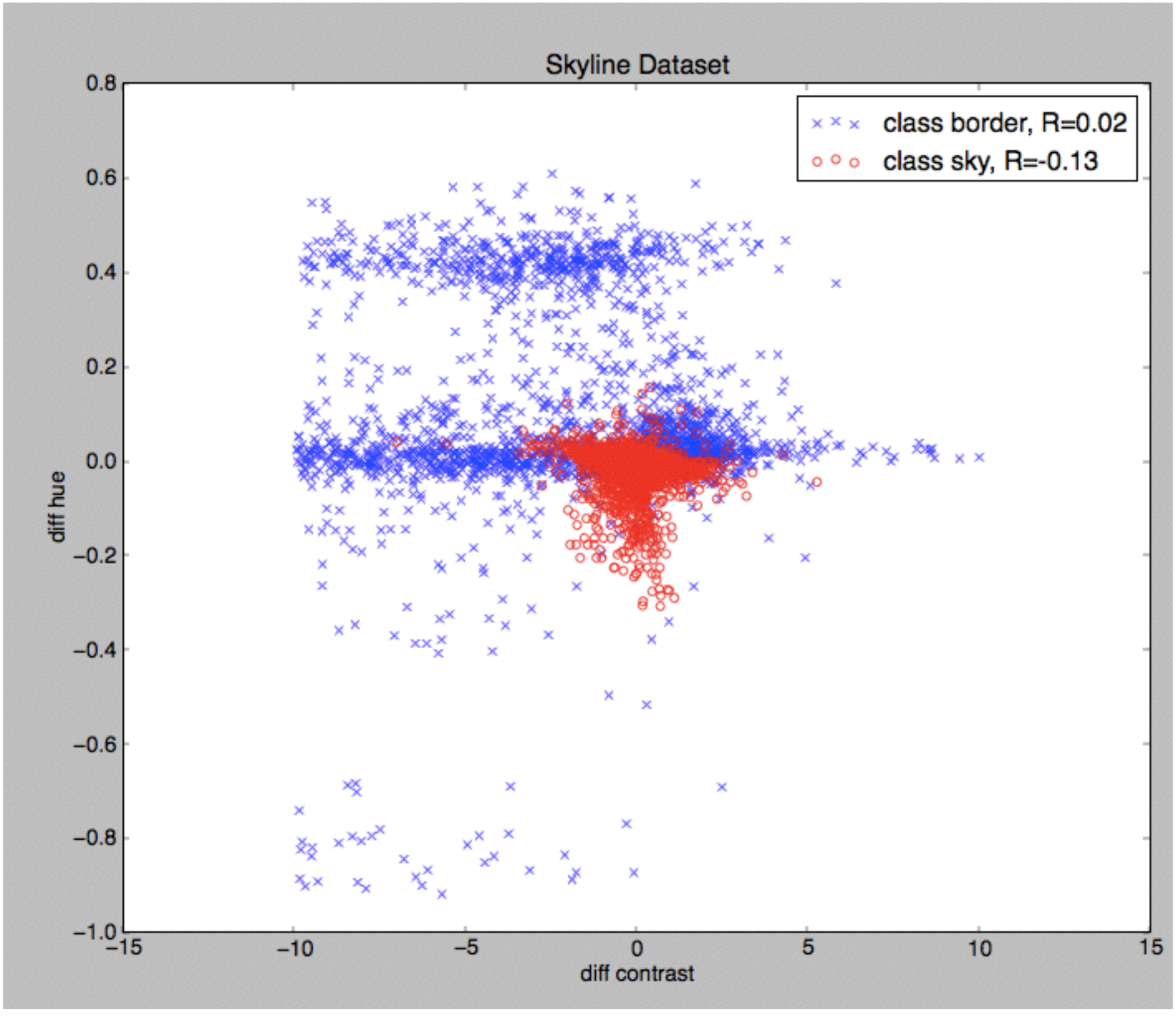
All BLUE SKY data in one:



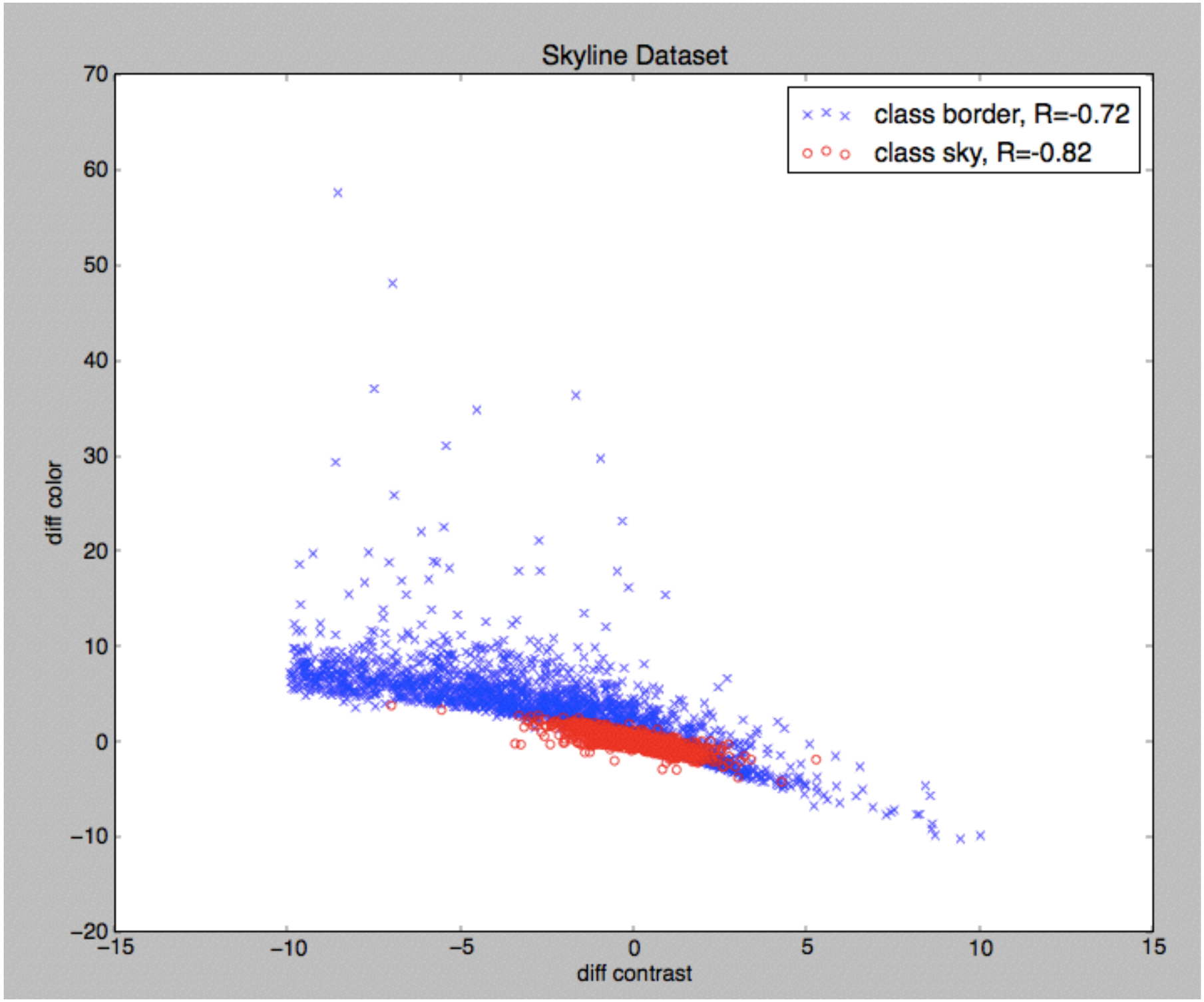




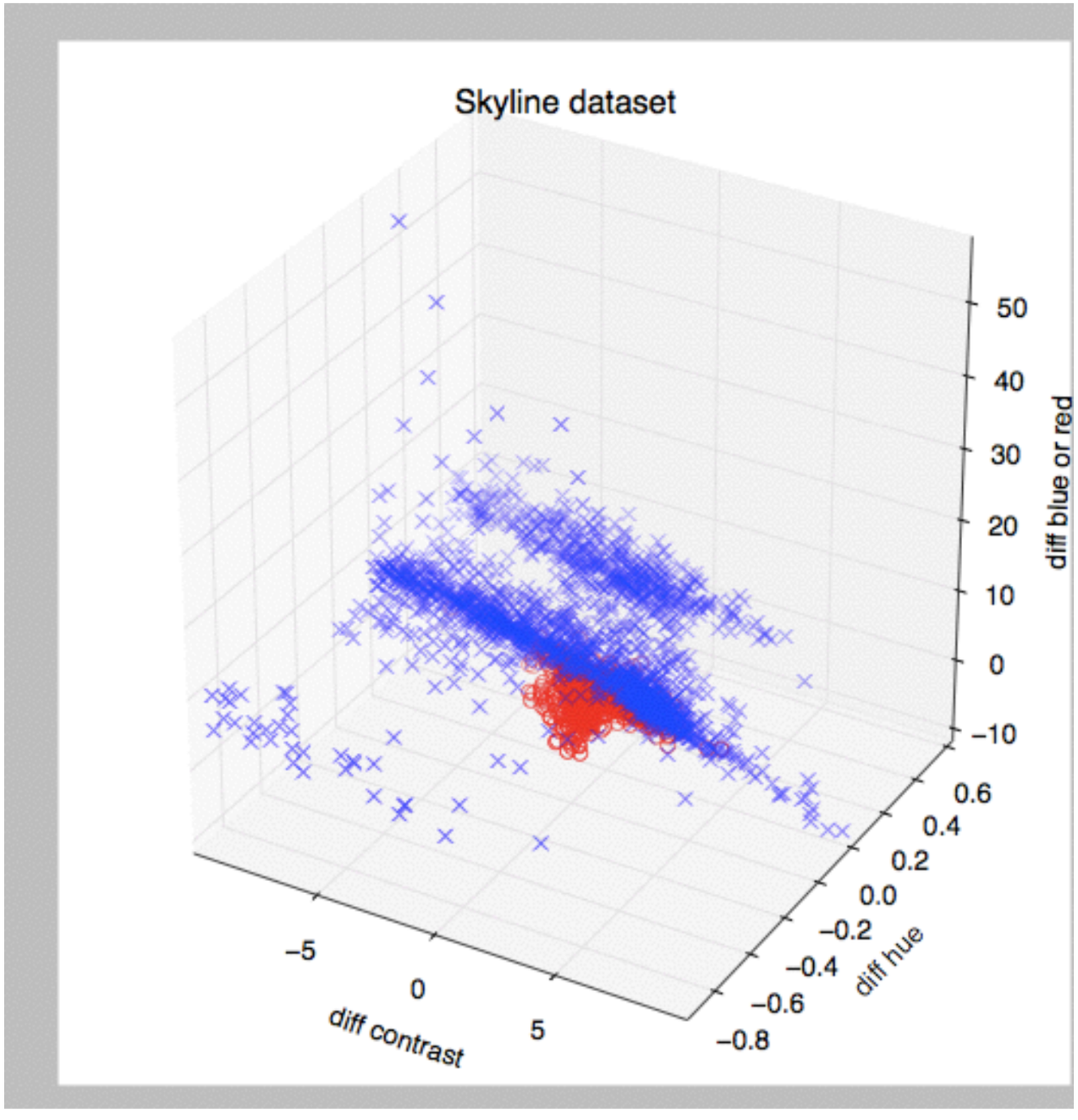
All BLUE SKY data in one:



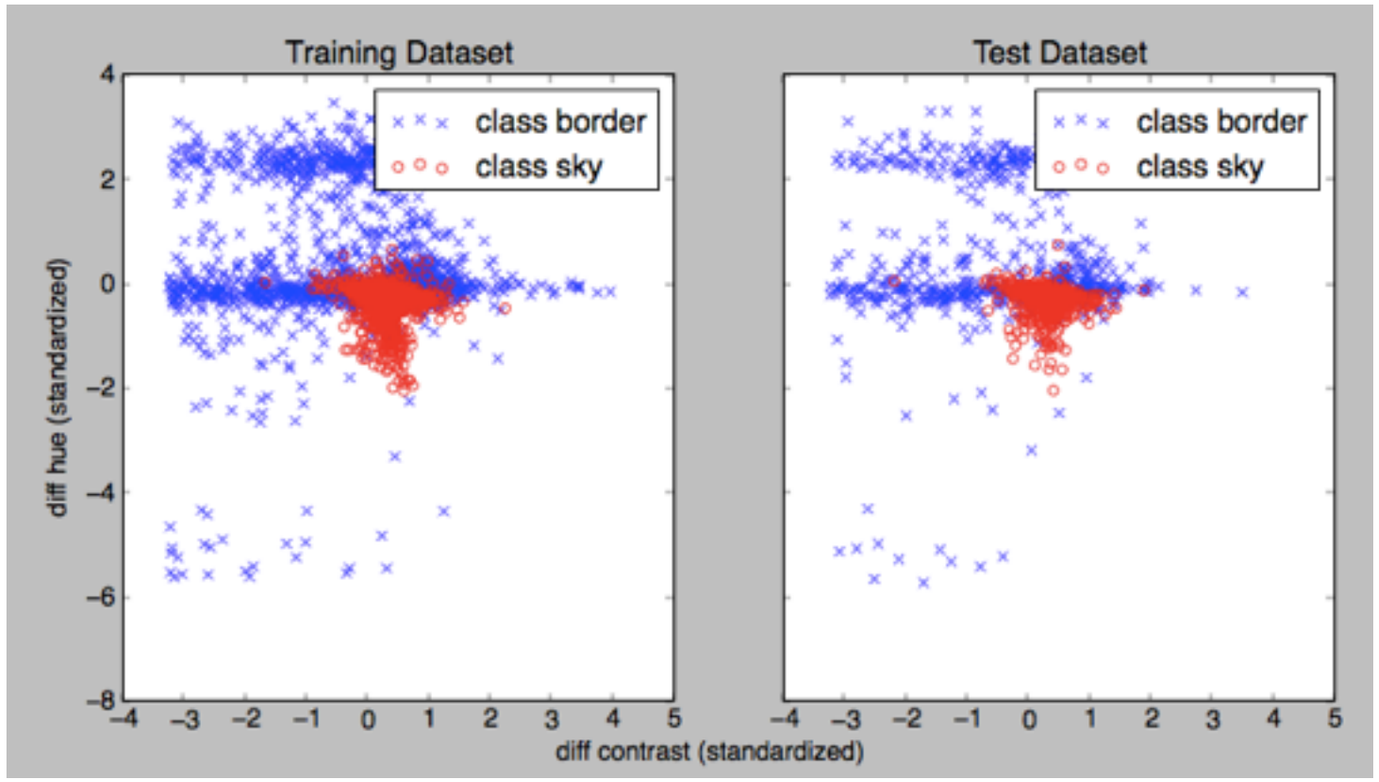
All BLUE SKY data in one:

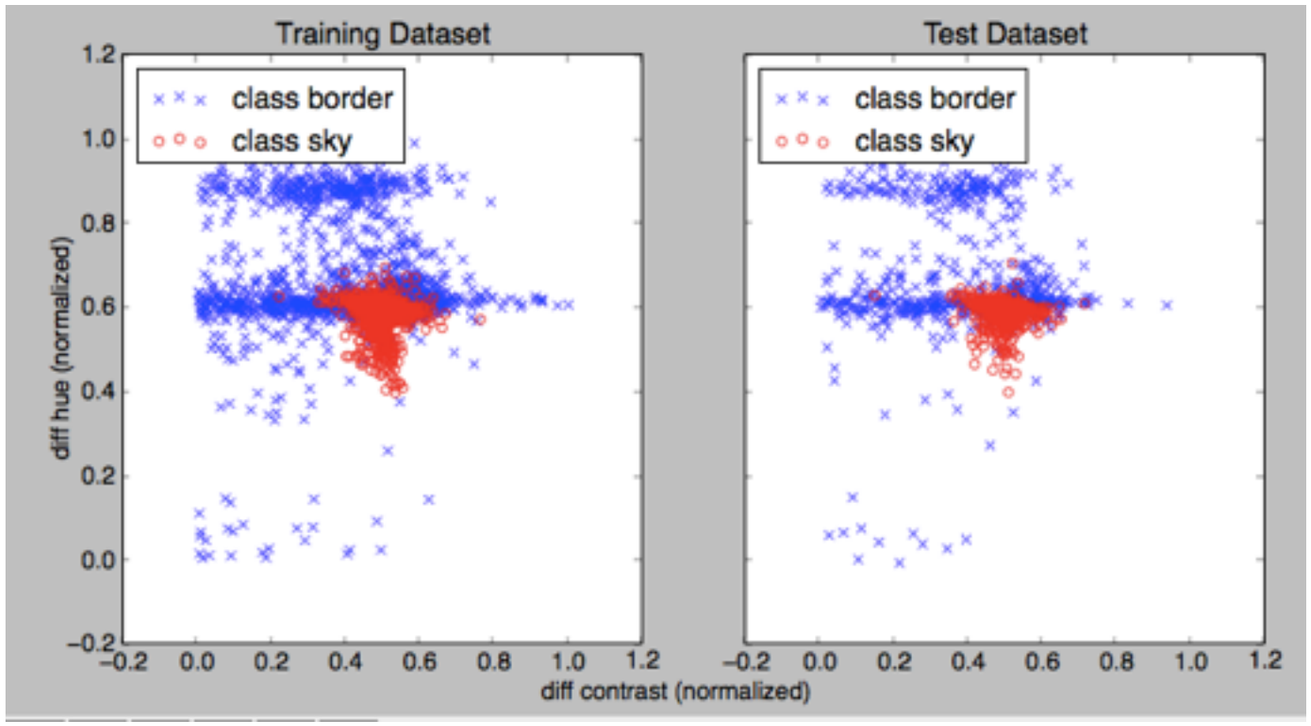


All BLUE SKY data in one:

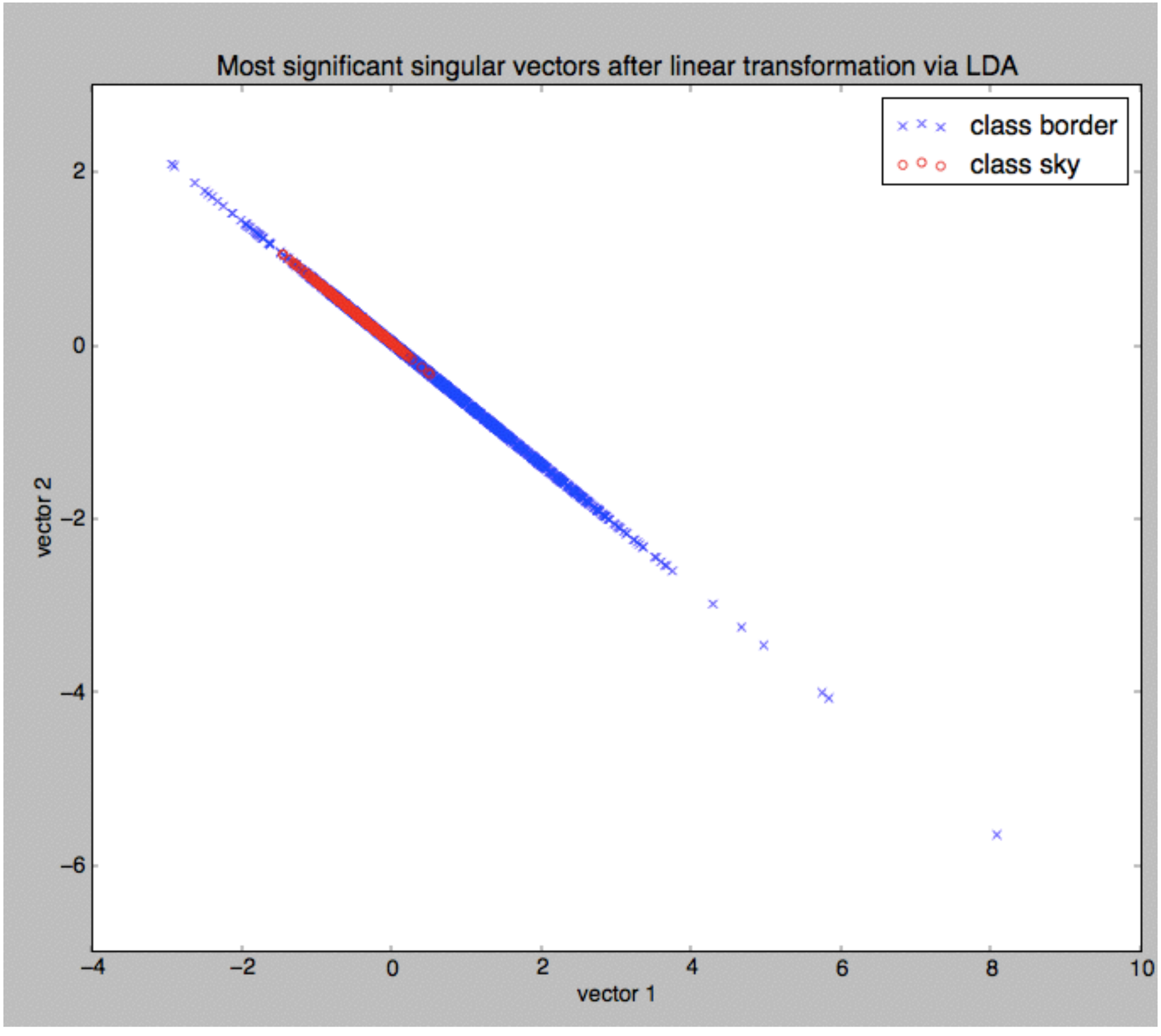


All BLUE SKY data in one:

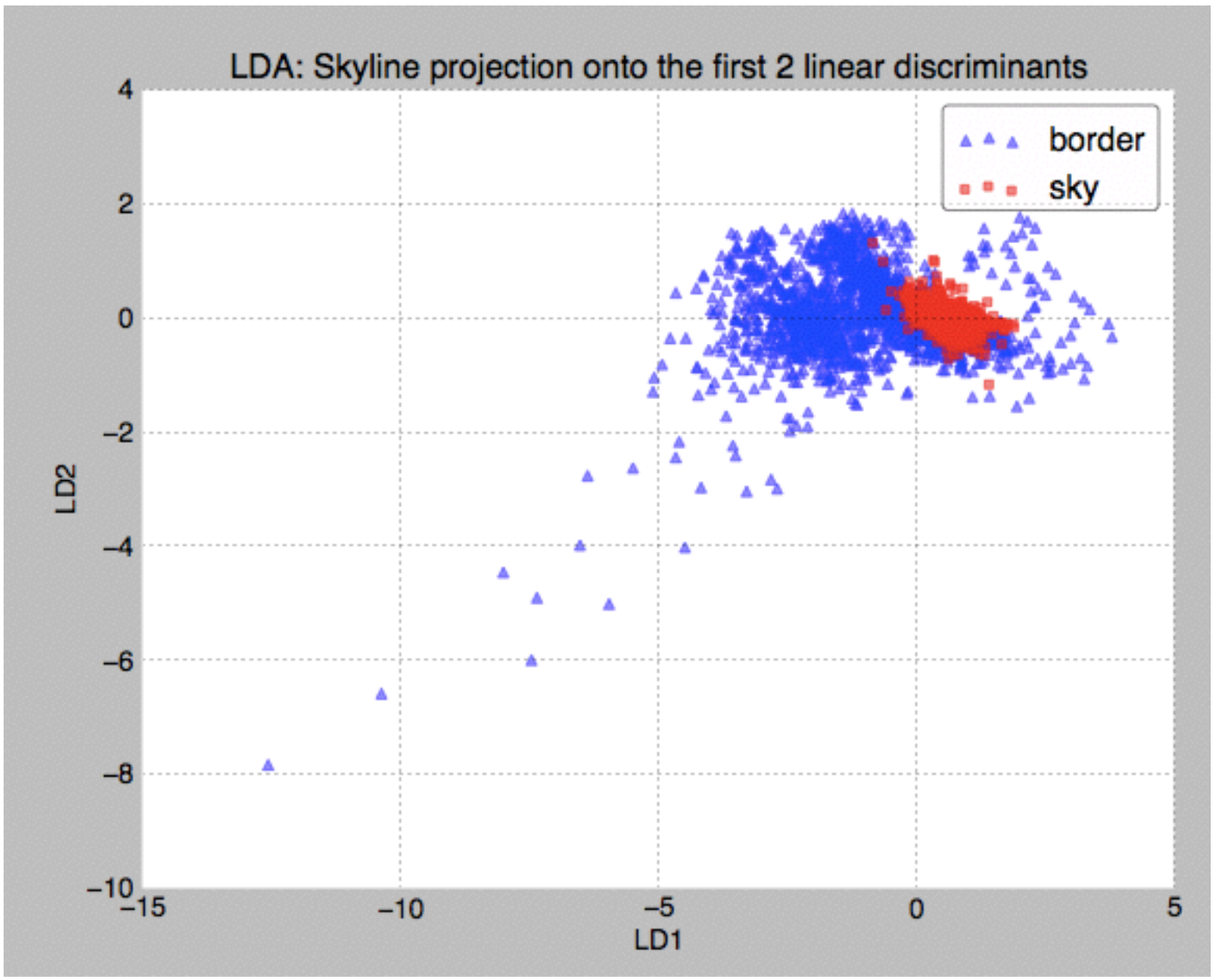




All BLUE SKY data in one:



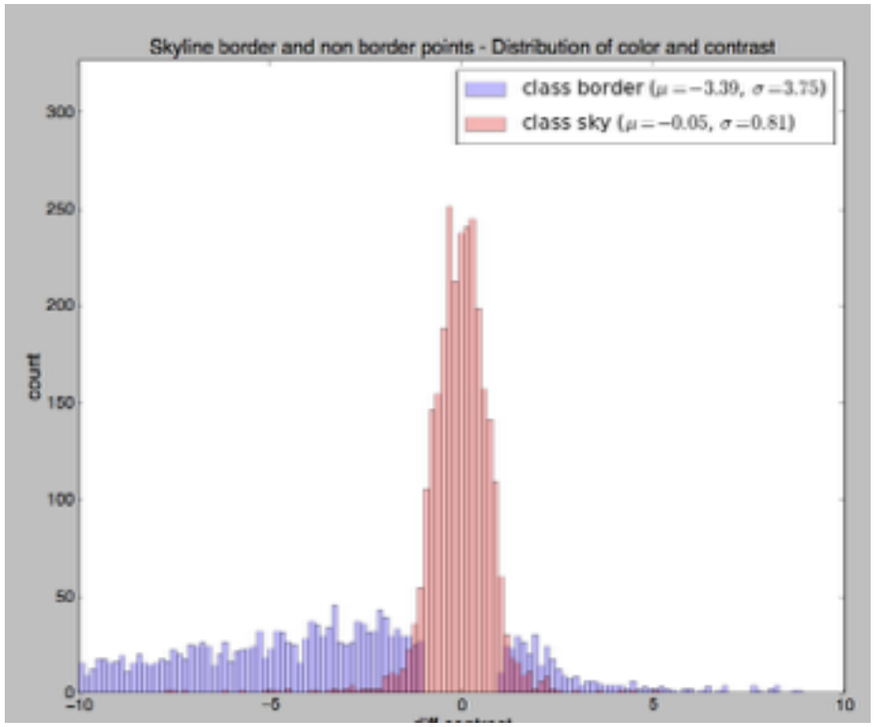
All BLUE SKY data in one:

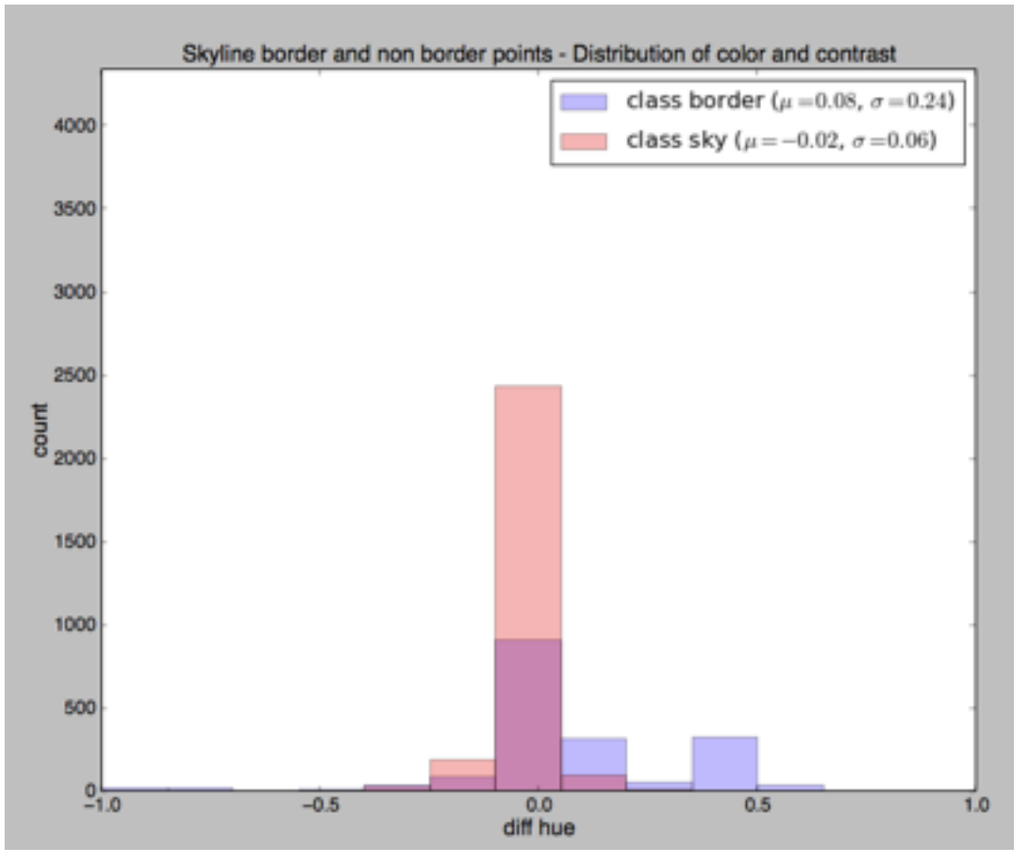


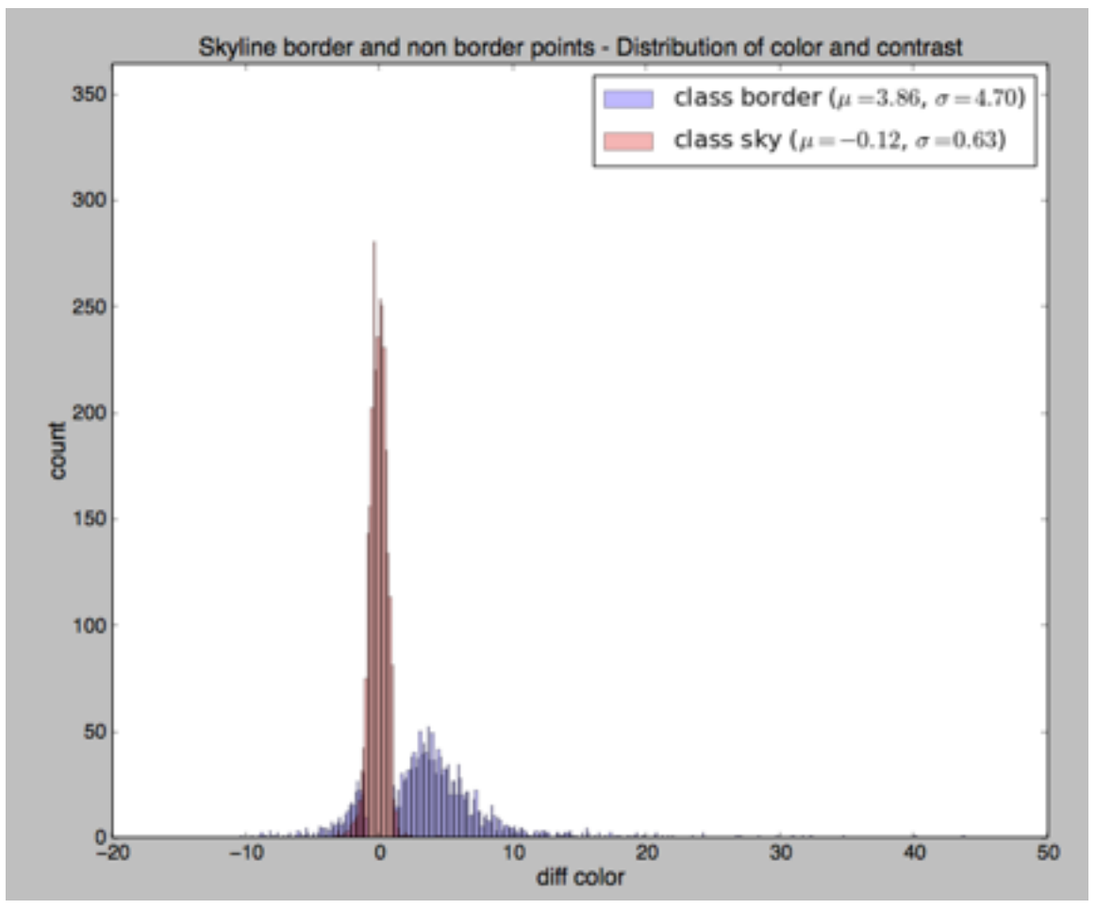

```
                        contrast  hue     BorR
Mean Vector class 1: [-0.4744  0.4674  0.5813]

Mean Vector class 2: [ 0.3308 -0.3259 -0.4053]

('within-class Scatter Matrix:\n',
array([[ 3843.5444,    53.0605, -2649.4272],
       [   53.0605,  3864.5696,   408.9796],
       [-2649.4272,   408.9796,  3484.9201]]))
('between-class Scatter Matrix:\n',
array([[ 2227.9542, -2033.0065, -2548.2621],
       [-2033.0065,  2164.8785,  2672.5068],
       [-2548.2621,  2672.5068,  3303.827 ]]))

Eigenvector 1:
[[ 0.1524]
 [-0.6194]
 [-0.7701]]
Eigenvalue 1: 1.37e+00

Eigenvector 2:
[[-0.7826]
 [ 0.0184]
 [-0.6223]]
Eigenvalue 2: 1.44e-01

Eigenvector 3:
[[ 0.0802]
 [-0.7438]
 [ 0.6636]]
Eigenvalue 3: 1.54e-16
ok
Eigenvalues in decreasing order:

1.37332016972
0.143688582104
1.5419479718e-16
Variance explained:

eigenvalue 1: 90.53%
eigenvalue 2: 9.47%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.1524, -0.6194, -0.7701],
       [-0.7826,  0.0184, -0.6223]]))
```

From images, can see that a pre-filter to only keep those points with math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 might produce better separation.

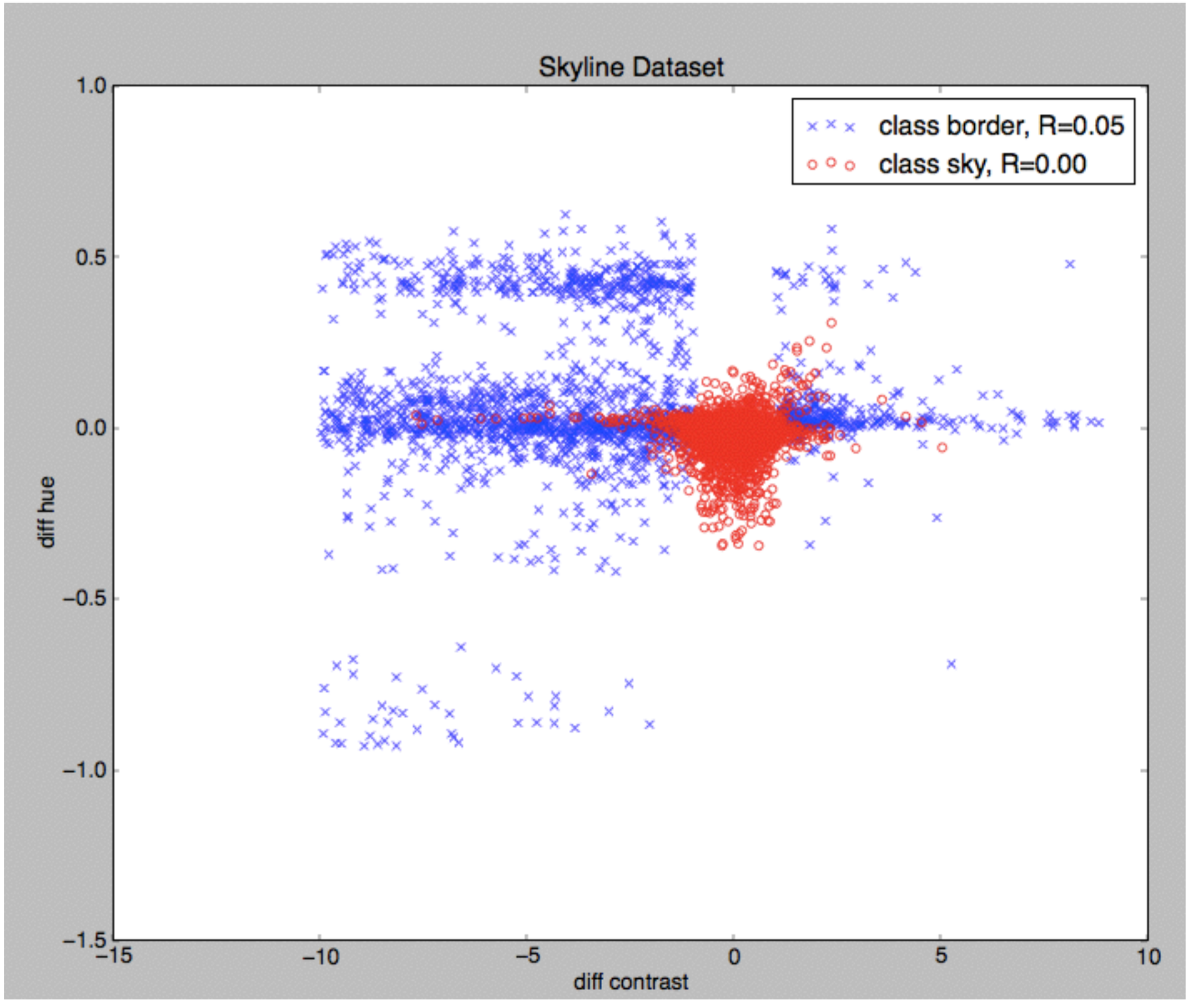
All BLUE SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:



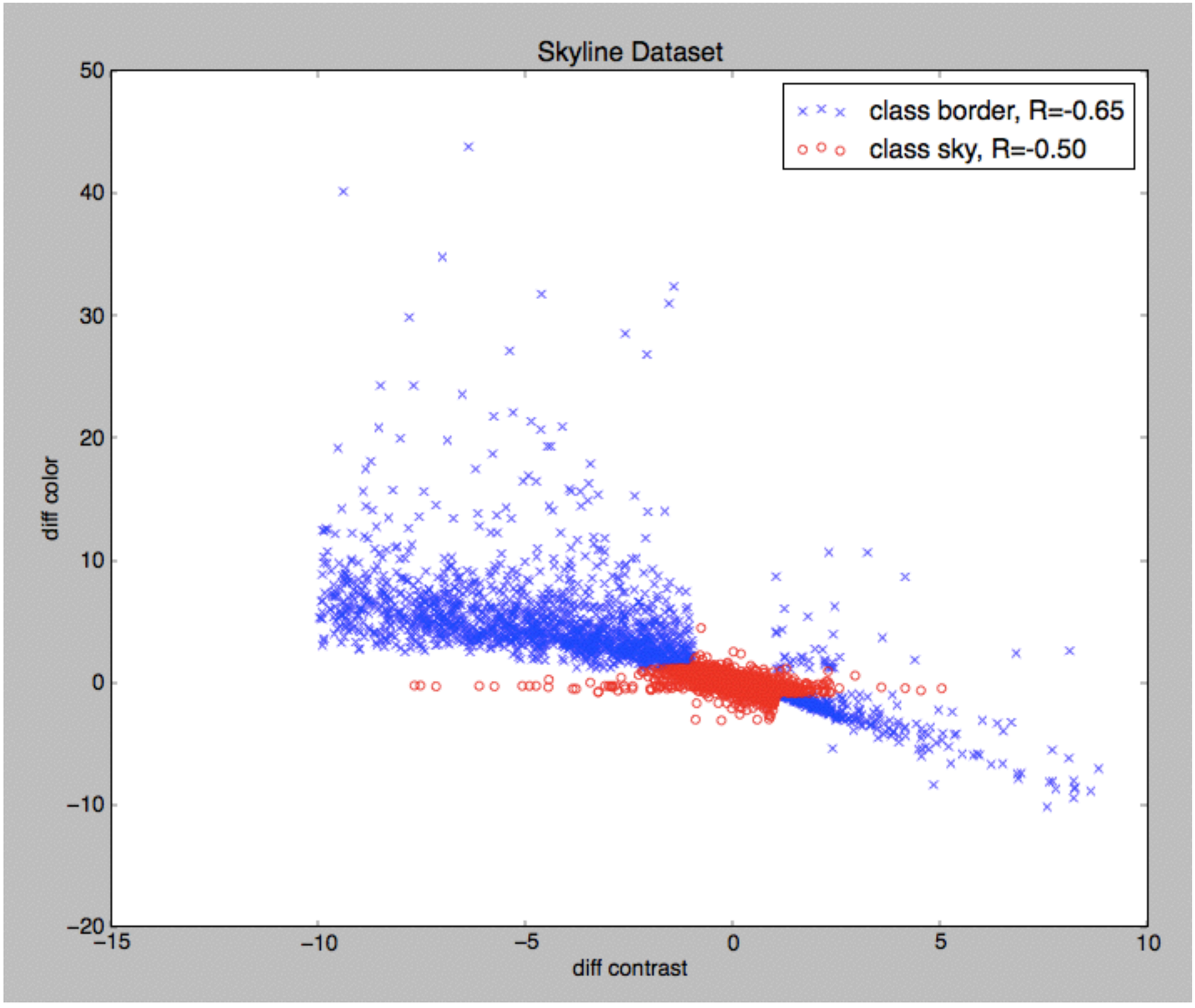




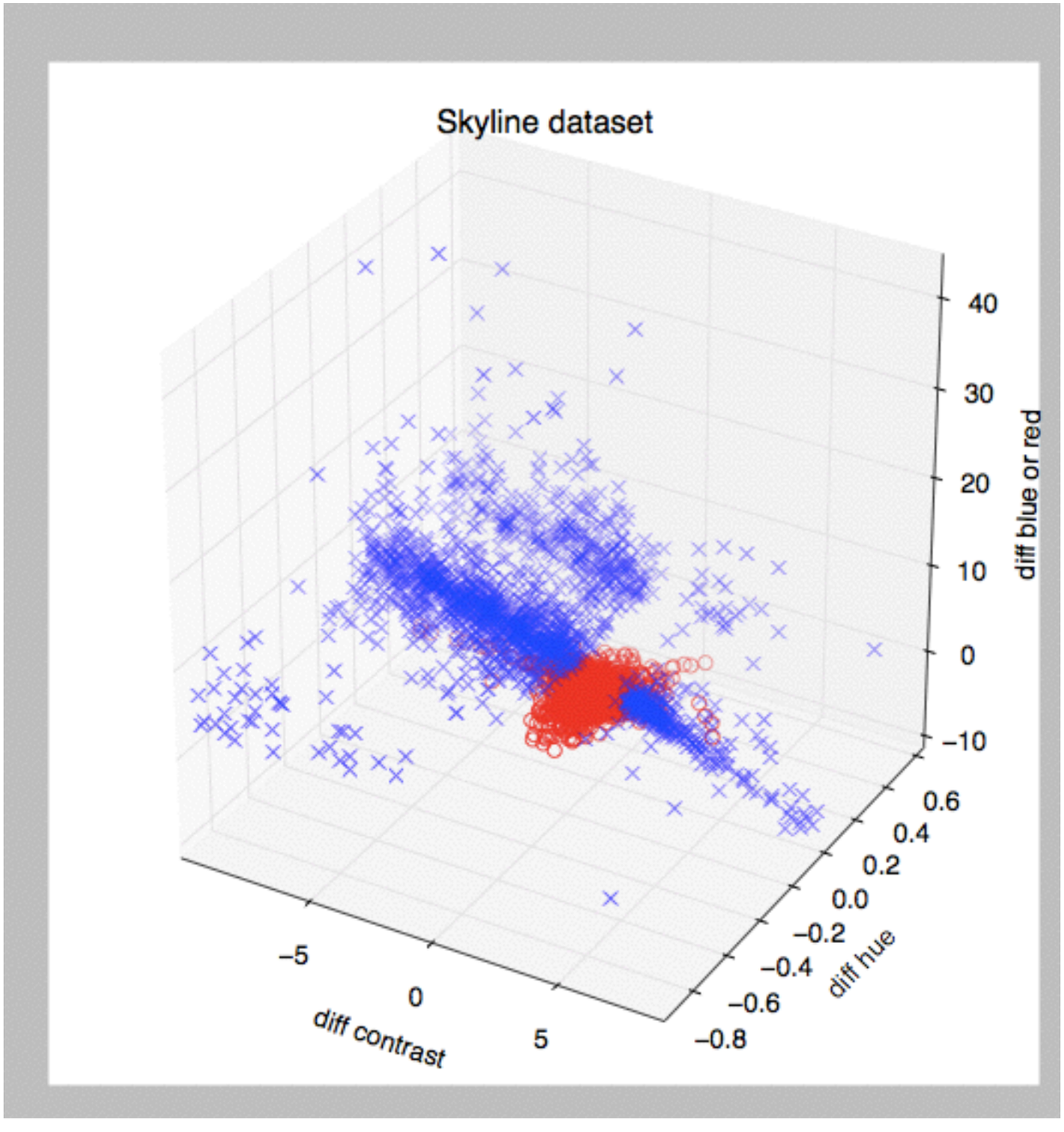
<u>All BLUE SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>



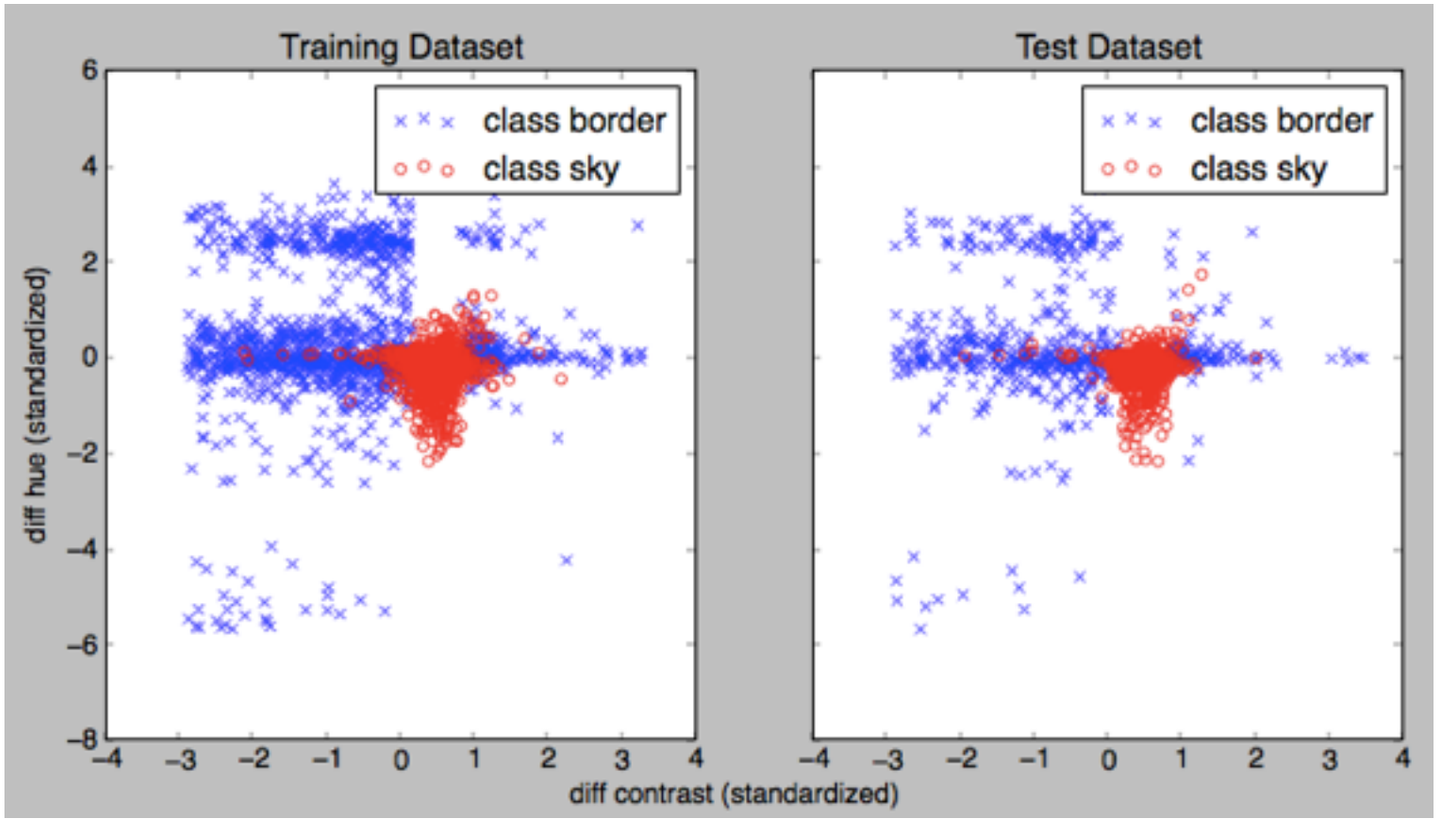
<u>All BLUE SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>

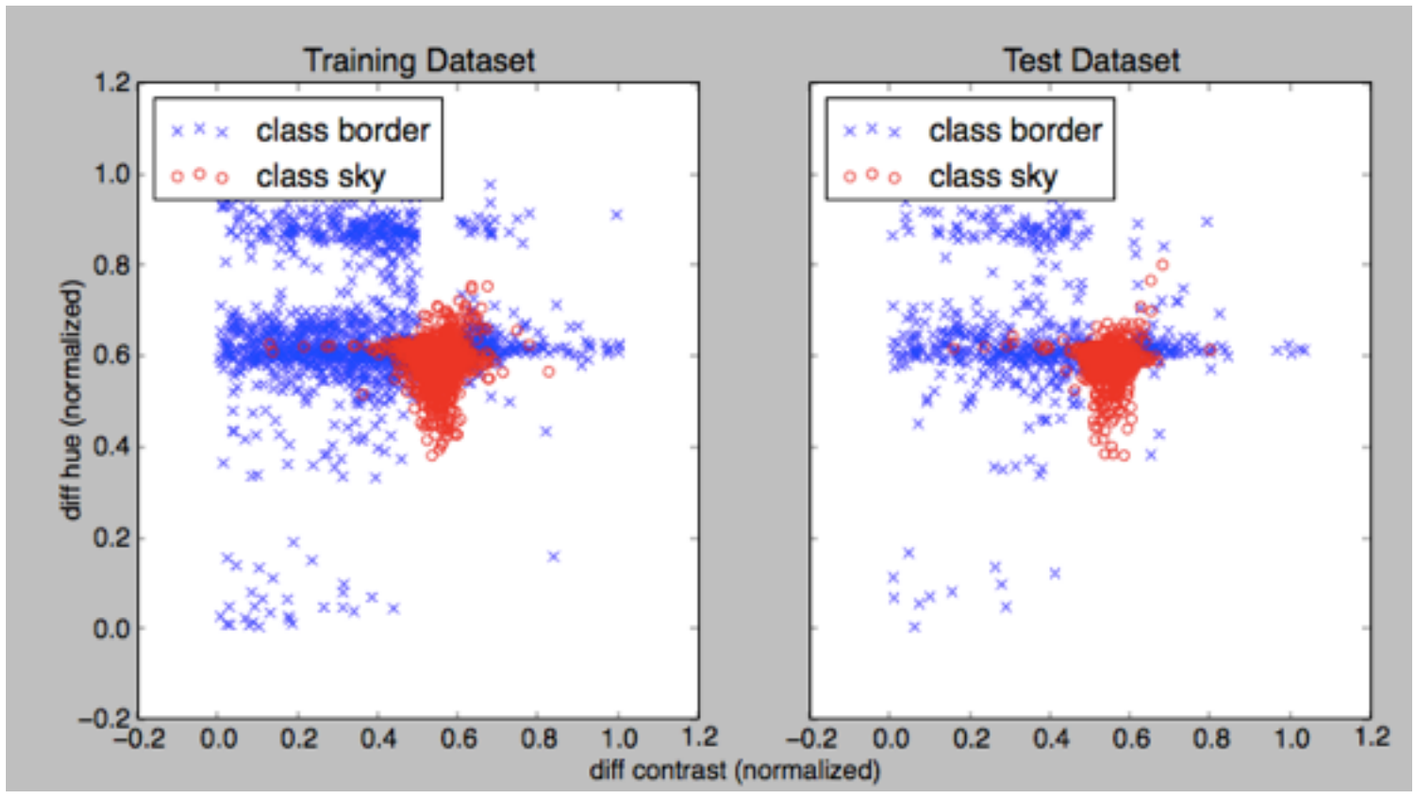


All BLUE SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:

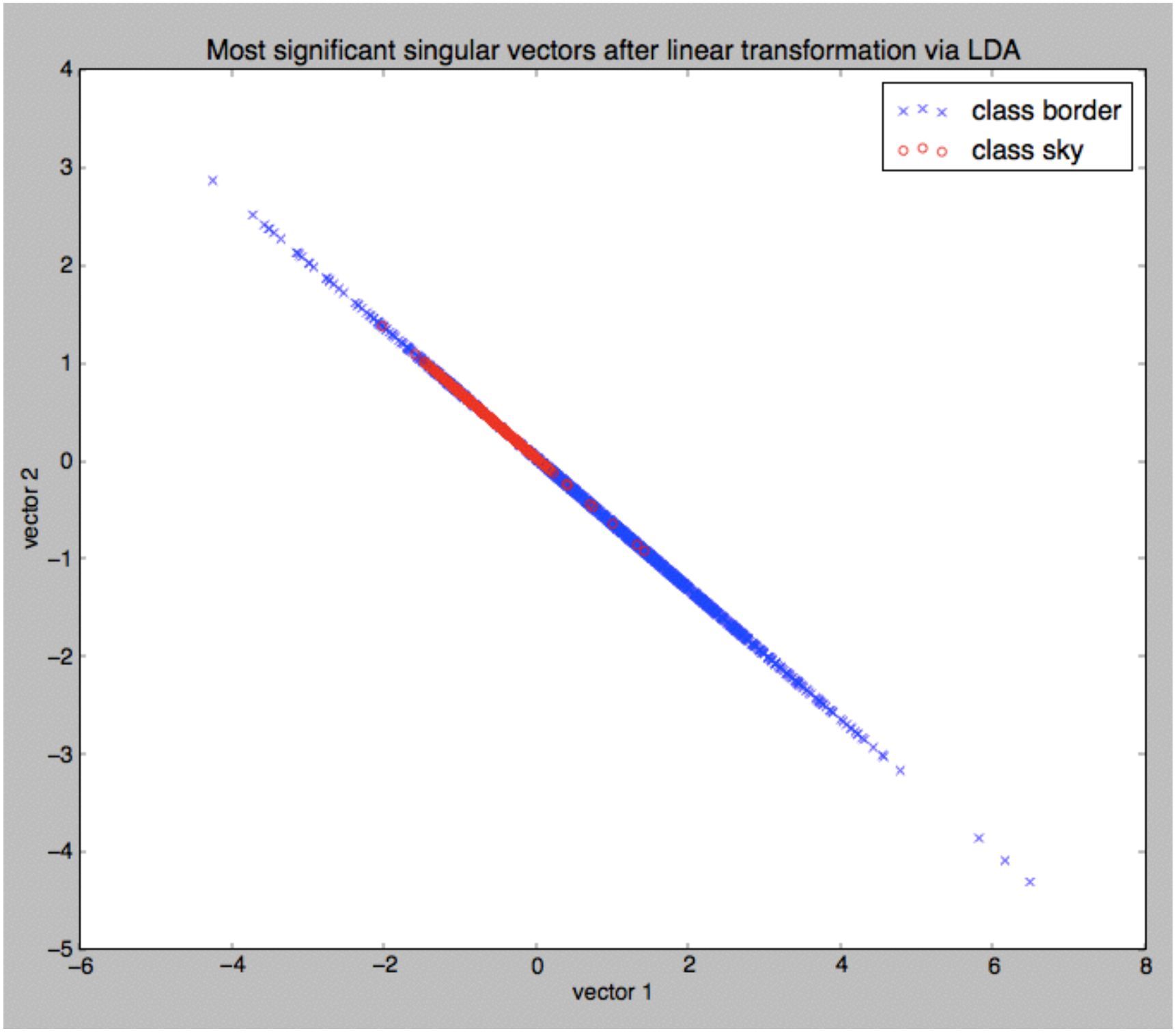


<u>All BLUE SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>

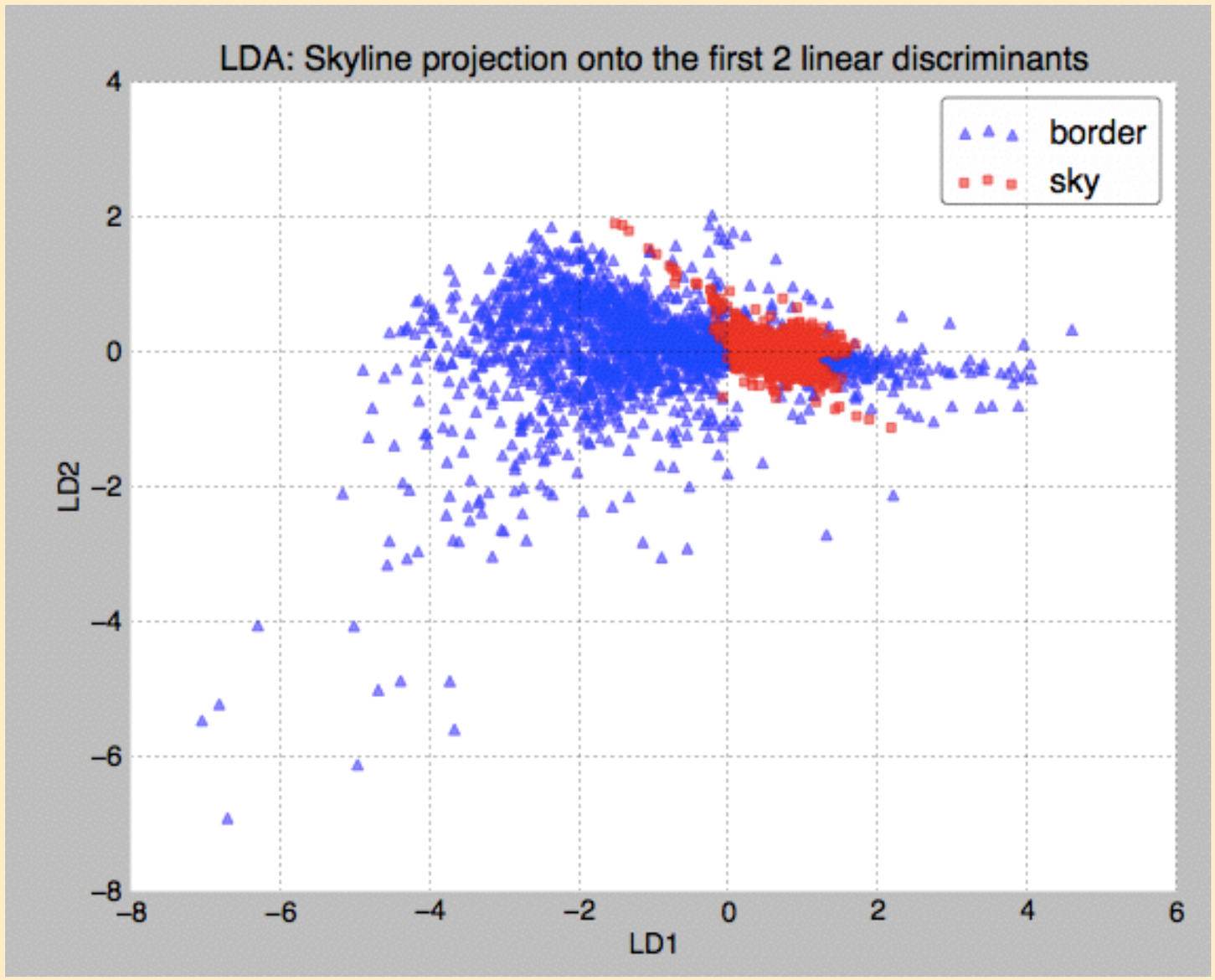




All BLUE SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:

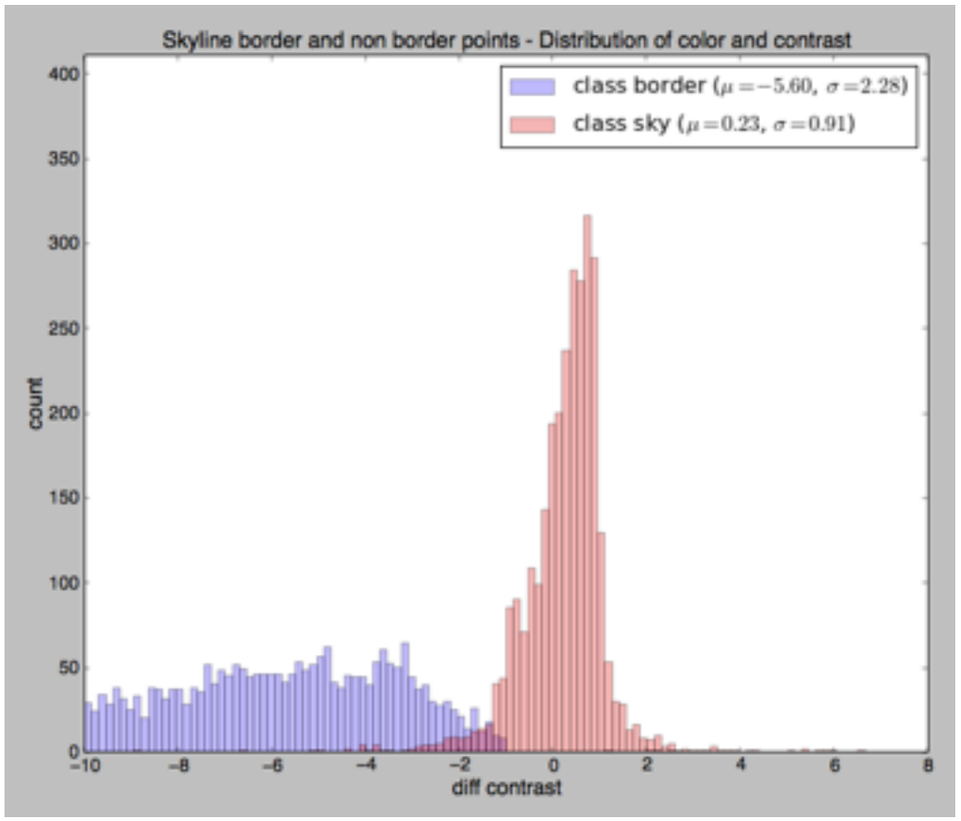


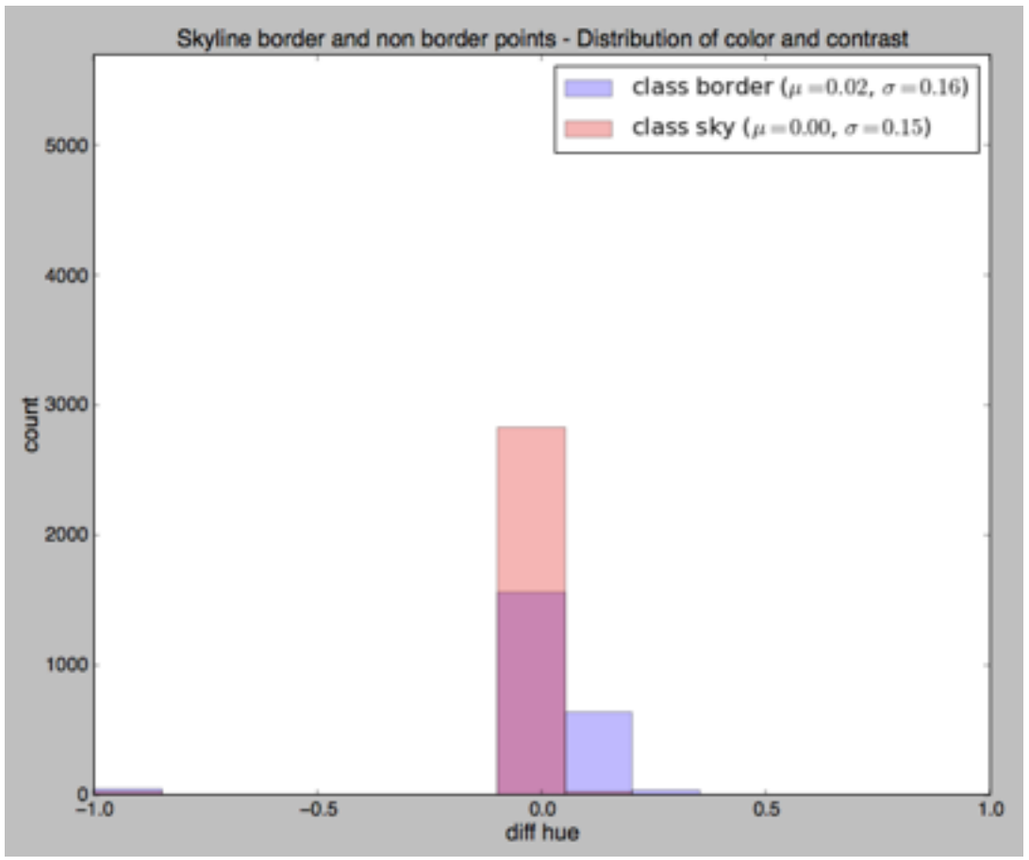
<u>All BLUE SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>

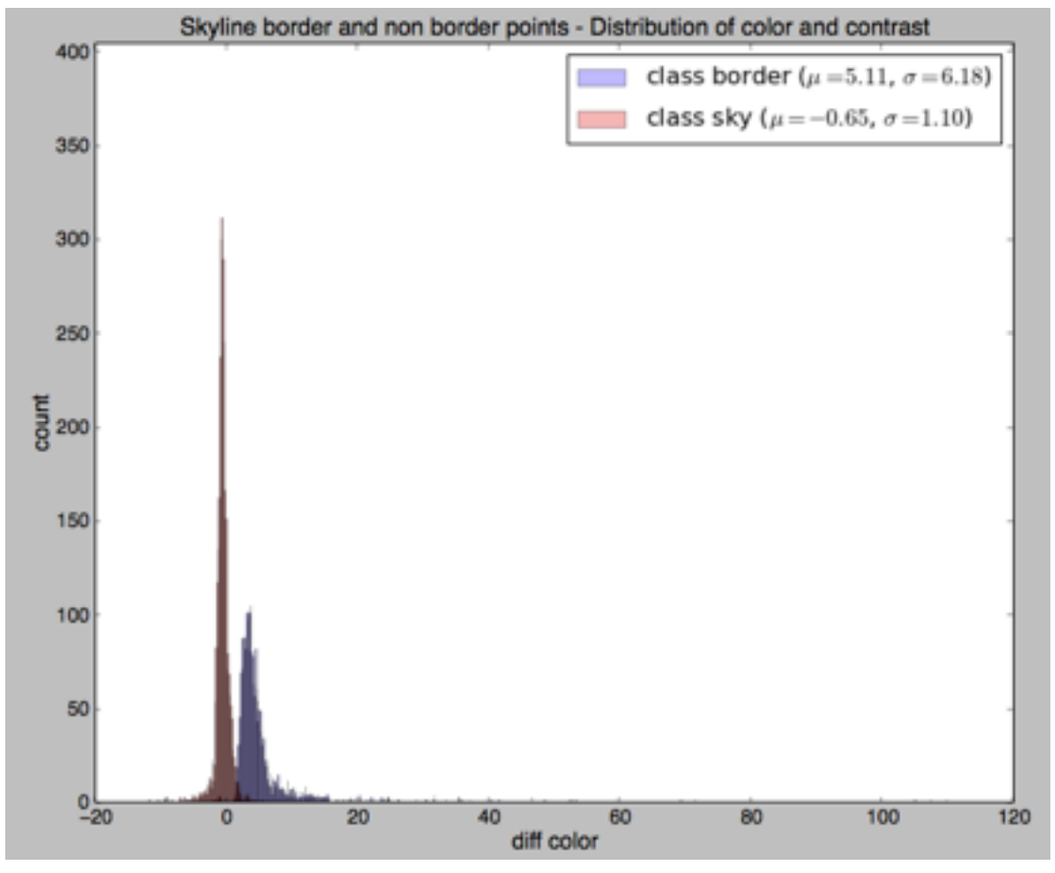



```
                        contrast  hue     BorR
Mean Vector class 1: [-0.6897  0.3628  0.6747]

Mean Vector class 2: [ 0.4501 -0.2368 -0.4403]

('within-class Scatter Matrix:\n',
array([[ 3113.2221,   160.9688, -2025.8939],
       [  160.9688,  4127.1548,   520.2551],
       [-2025.8939,   520.2551,  3173.7055]]))
('between-class Scatter Matrix:\n',
array([[ 4350.0481, -2067.3108, -3968.8936],
       [-2067.3108,  1308.2502,  2308.4918],
       [-3968.8936,  2308.4918,  4168.5979]]))

Eigenvector 1:
[[ 0.793 ]
 [-0.4   ]
 [-0.4595]]
Eigenvalue 1: 1.83e+00

Eigenvector 2:
[[-0.7188]
 [-0.0772]
 [-0.6909]]
Eigenvalue 2: 2.65e-01

Eigenvector 3:
[[ 0.1781]
 [-0.7791]
 [ 0.601 ]]
Eigenvalue 3: 7.82e-17
ok
Eigenvalues in decreasing order:

1.82901036994
0.264605188323
7.81626903672e-17
Variance explained:

eigenvalue 1: 87.36%
eigenvalue 2: 12.64%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.793 , -0.4   , -0.4595],
       [-0.7188, -0.0772, -0.6909]]))
```

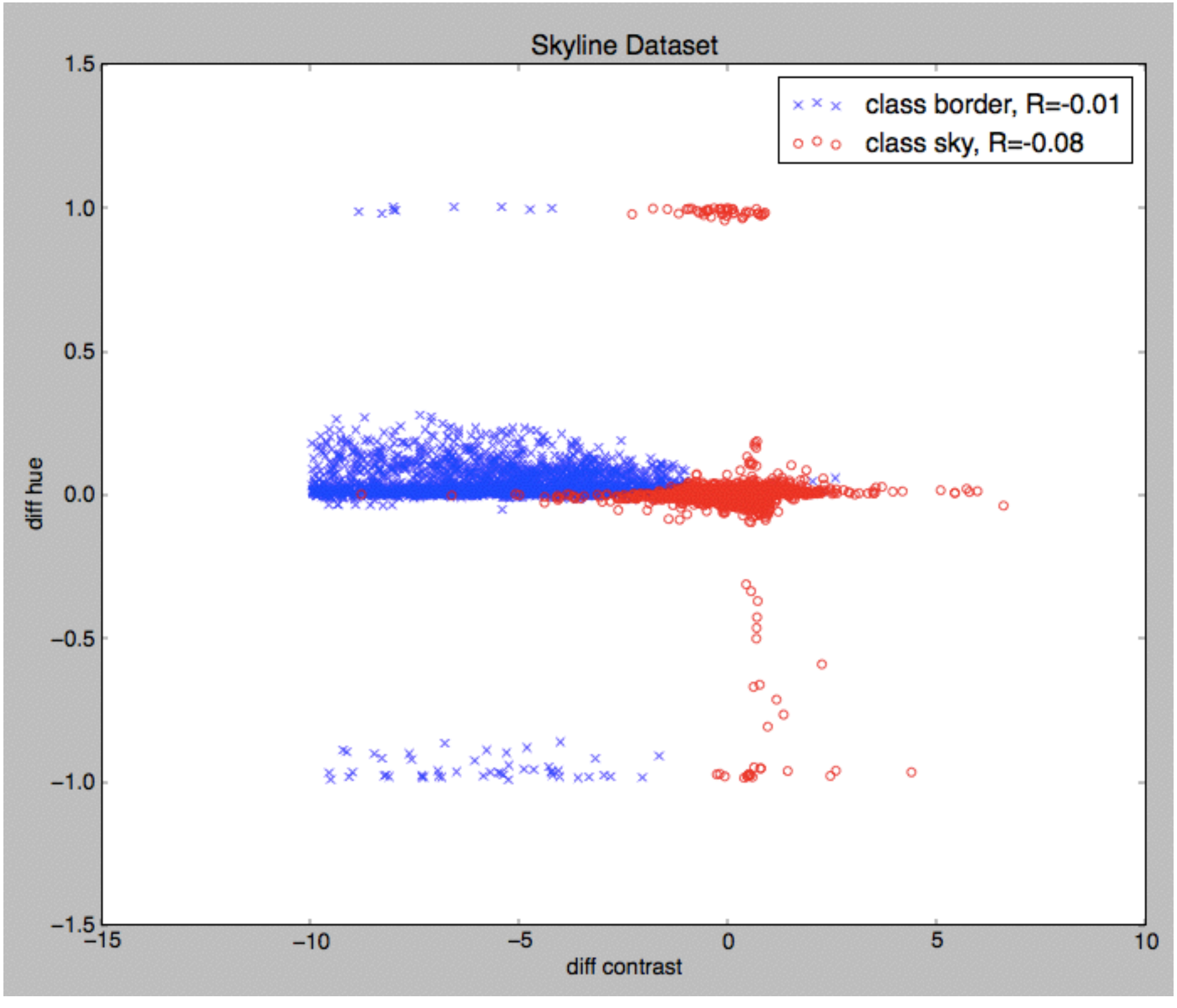
All RED SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:



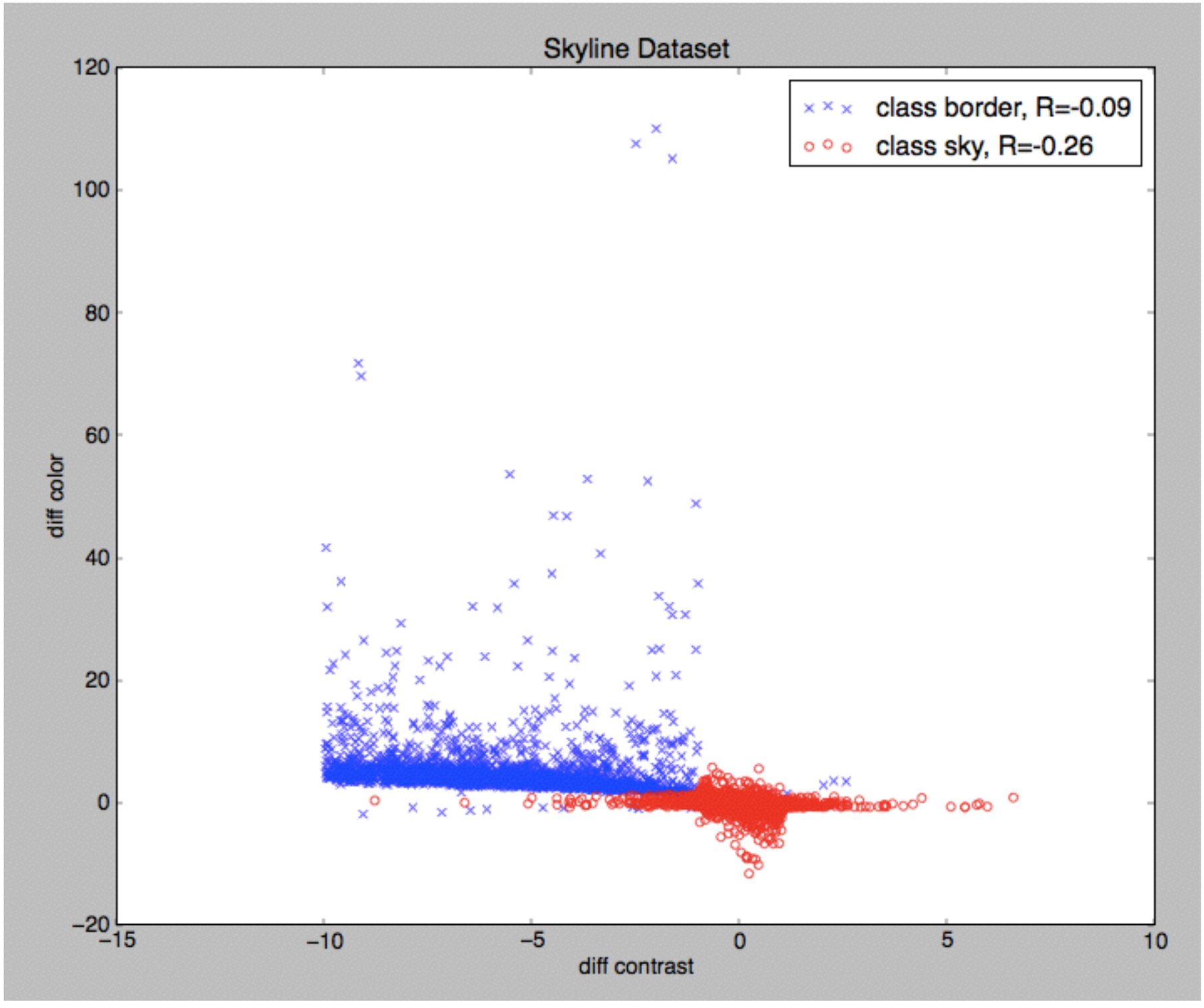




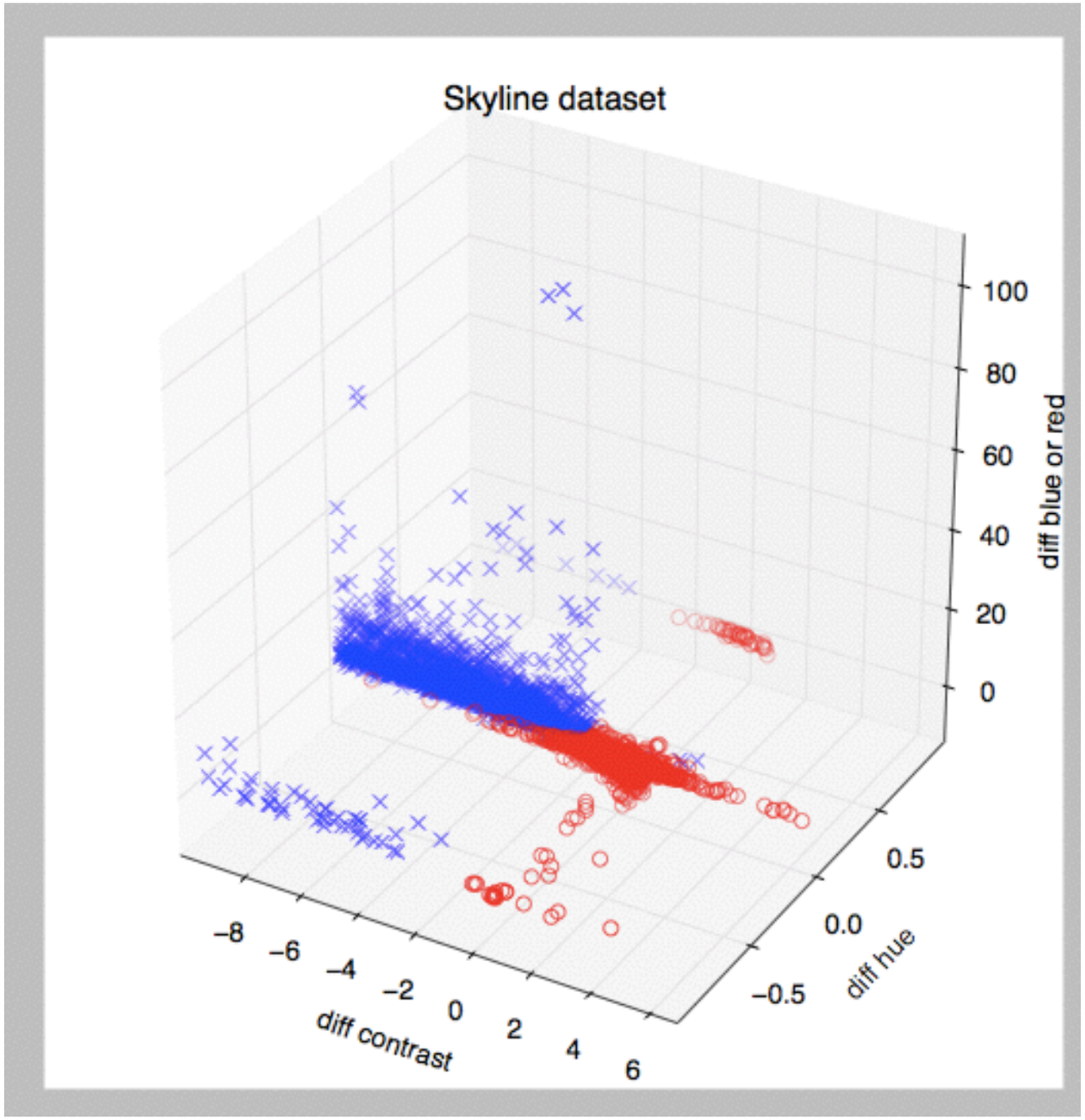
<u>All RED SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>



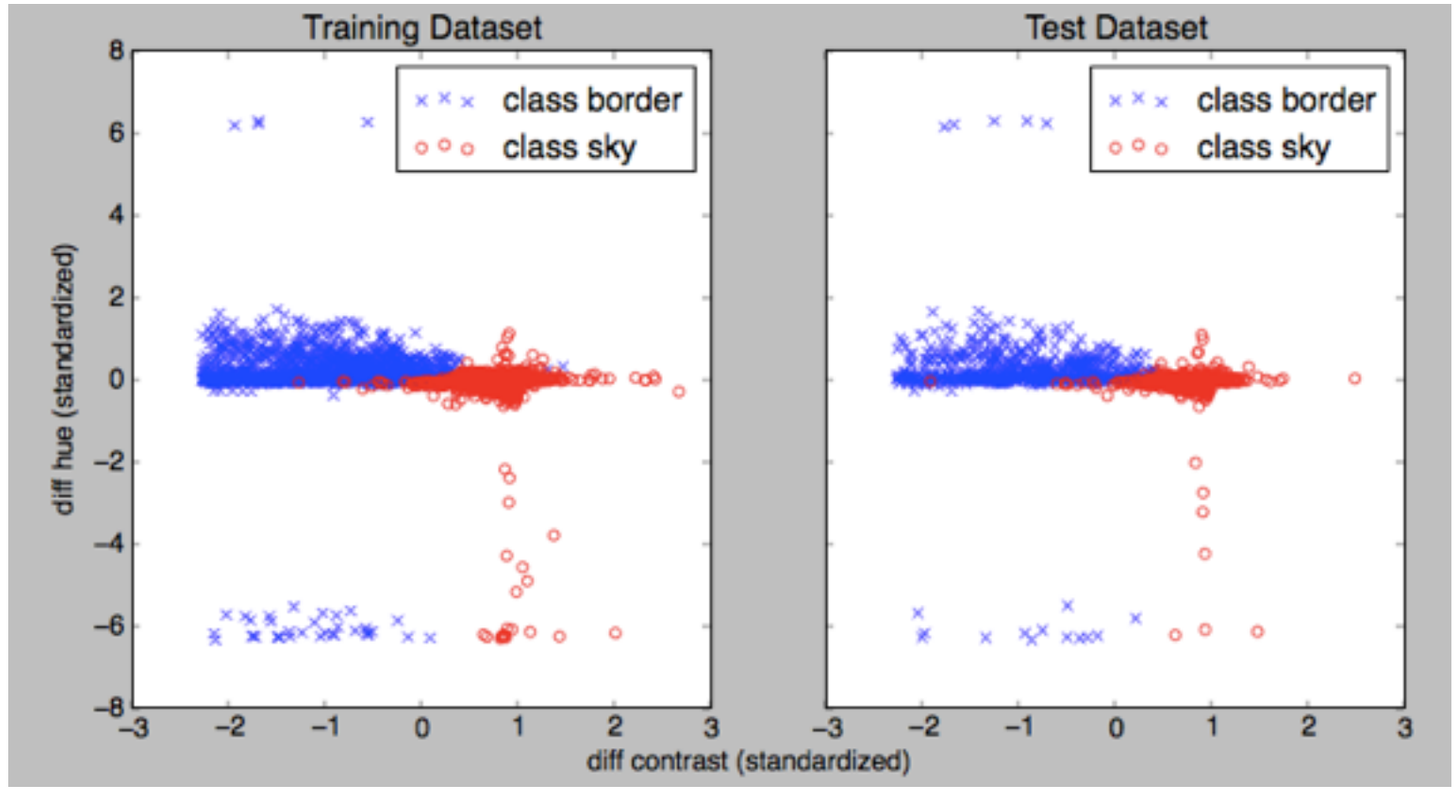
All RED SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:

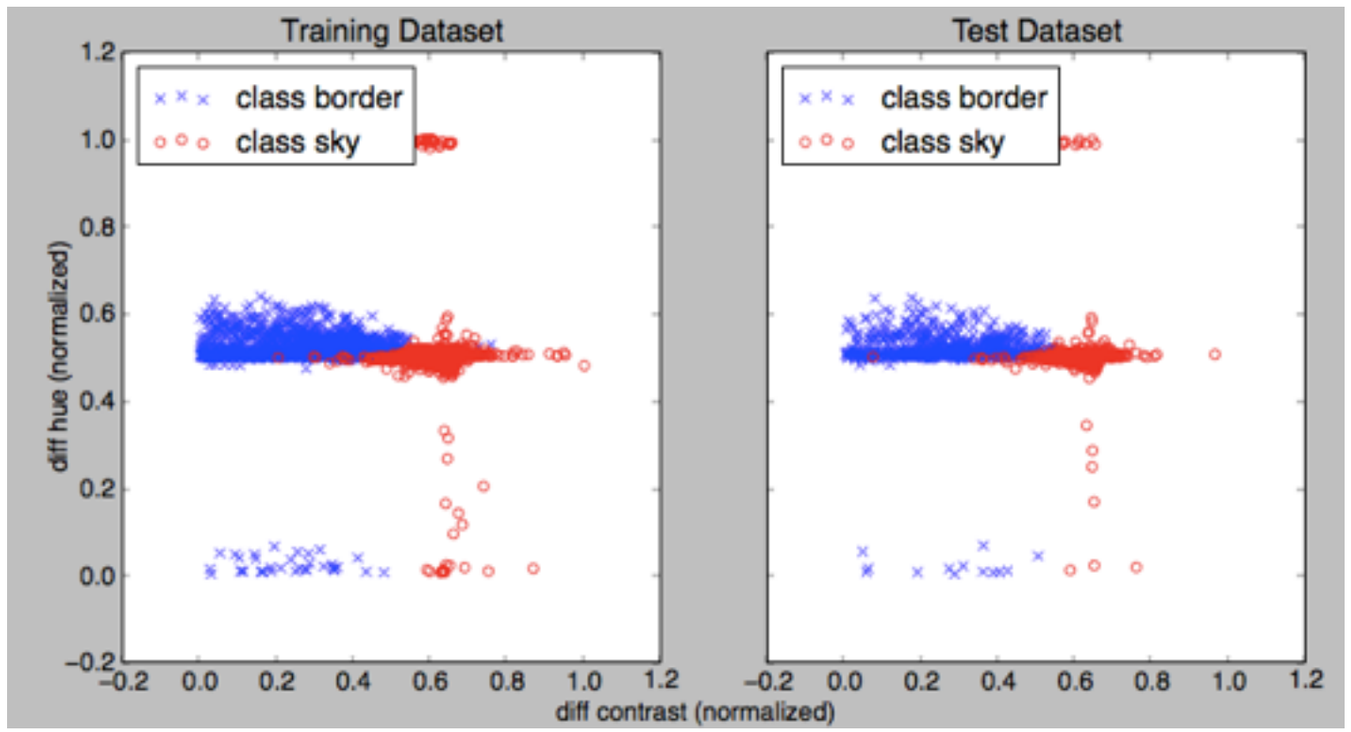


<u>All RED SKY data in one</u>, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points<u>:</u>

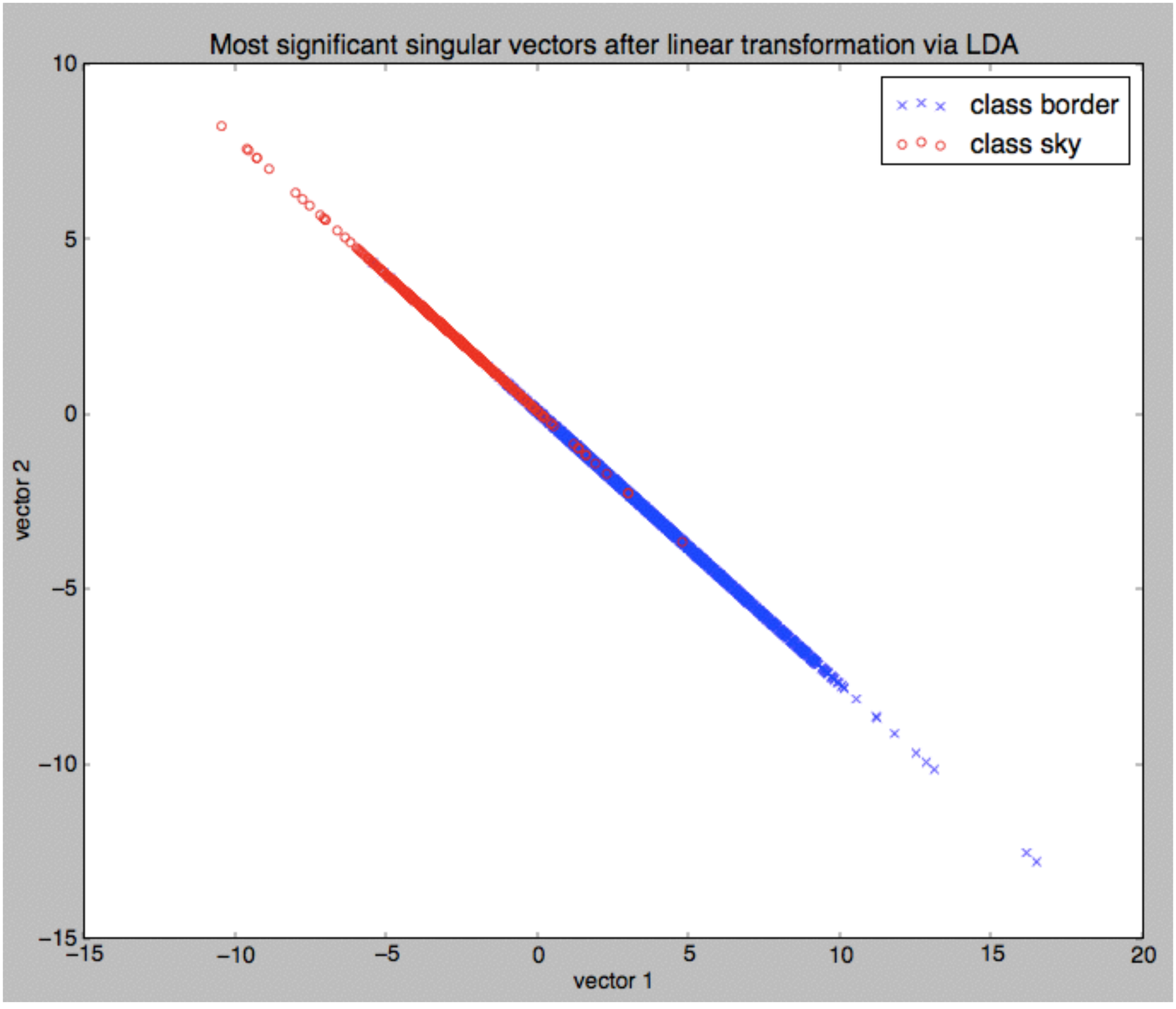


All RED SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:

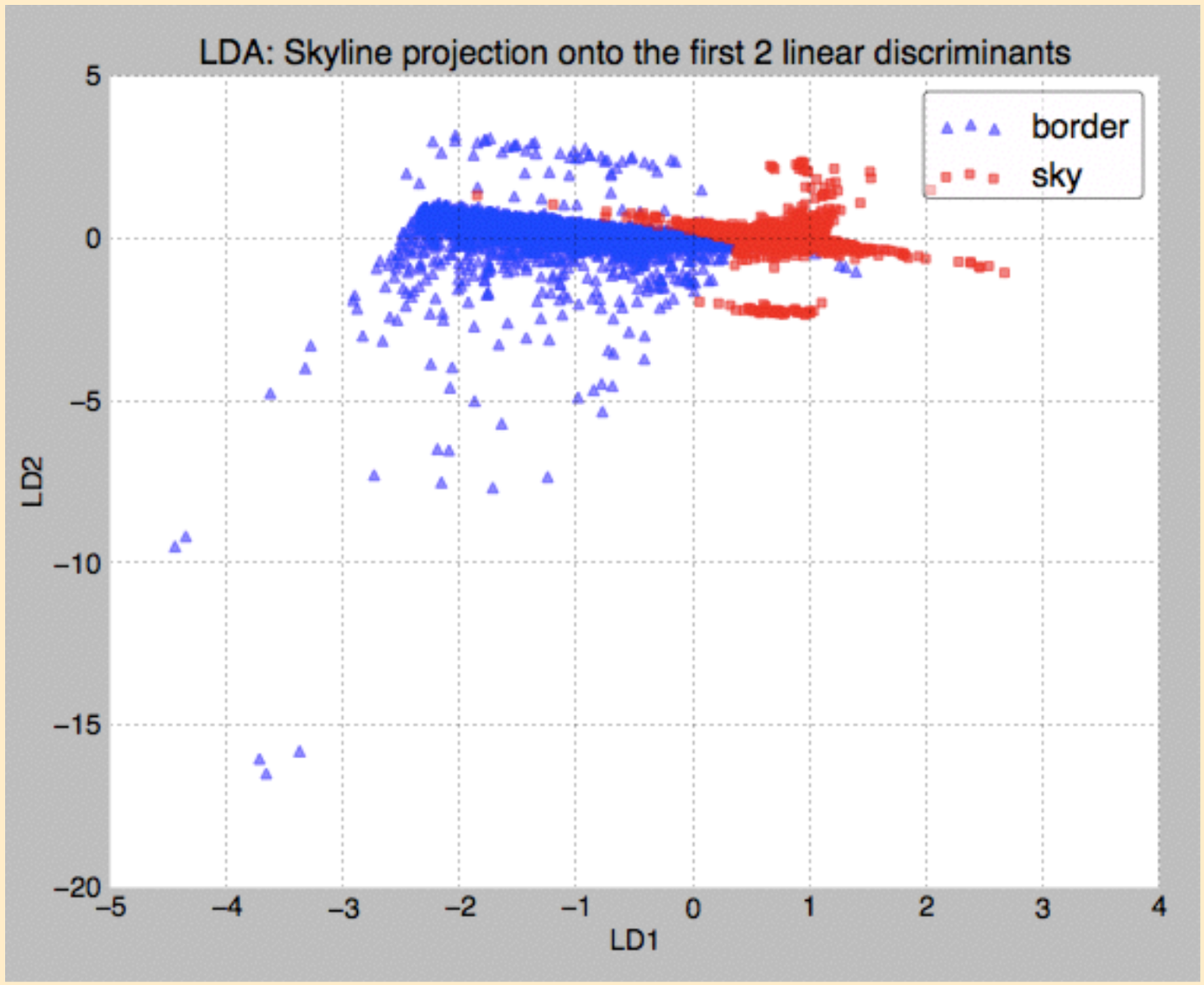




All RED SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:



All RED SKY data in one, filtered for math.abs(contrastDiff) > 1 AND math.abs(blueOrRedDiff) > 1 for border points and the opposite for sky points:




```
                          contrast  hue     BorR
Mean Vector class 1: [-0.9787  0.0736  0.6369]

Mean Vector class 2: [ 0.7684 -0.0578 -0.5   ]

('within-class Scatter Matrix:\n',
array([[ 1289.4202,   -72.0988,  -218.7712],
       [  -72.0988,  5177.8552,    32.4727],
       [ -218.7712,    32.4727,  3543.9363]]))
('between-class Scatter Matrix:\n',
array([[ 11813.9258,   -800.6449,  -7552.3092],
       [  -800.6449,    148.6207,    656.6938],
       [ -7552.3092,    656.6938,   5050.3773]]))

Eigenvector 1:
[[ 0.9843]
 [-0.0028]
 [-0.1763]]
Eigenvalue 1: 9.91e+00

Eigenvector 2:
[[-0.521 ]
 [-0.3655]
 [-0.7713]]
Eigenvalue 2: 7.65e-02

Eigenvector 3:
[[ 0.2804]
 [-0.8043]
 [ 0.5239]]
Eigenvalue 3: 5.32e-17
ok
Eigenvalues in decreasing order:

9.91019554062
0.0764600359464
5.3151735263e-17
Variance explained:

eigenvalue 1: 99.23%
eigenvalue 2: 0.77%
eigenvalue 3: 0.00%
('Matrix W:\n', array([[ 0.9843, -0.0028, -0.1763],
       [-0.521 , -0.3655, -0.7713]]))
```