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COMS W4701 - Artificial Intelligence
Professor Ansaf Salleb-Aouissi
HW3 Write Up

1.2.b - Compare the convergence rate when alpha is small versus large

The convergence rate for small alphas is much slower than for larger alphas, up to one. When the learning rate is one for gradient descent, the betas do not update at all and the risk function stays quite high.

1.2.c - Which alpha is best? Use this alpha to run gradient descent and report the betas

The best alpha for this dataset would appear to be 0.05

The result betas are [1.0120936613679314, 0.095420836579281229, 0.033200339840097515]

1.2.d - Use the beta vector from part c to make a height prediction (5-year old, 20 kilos)

The height of a 5-year old girl weighing 20 kilos is: 1.0084142985968787

2.5 - Discuss which classification method is best suited for this dataset and why

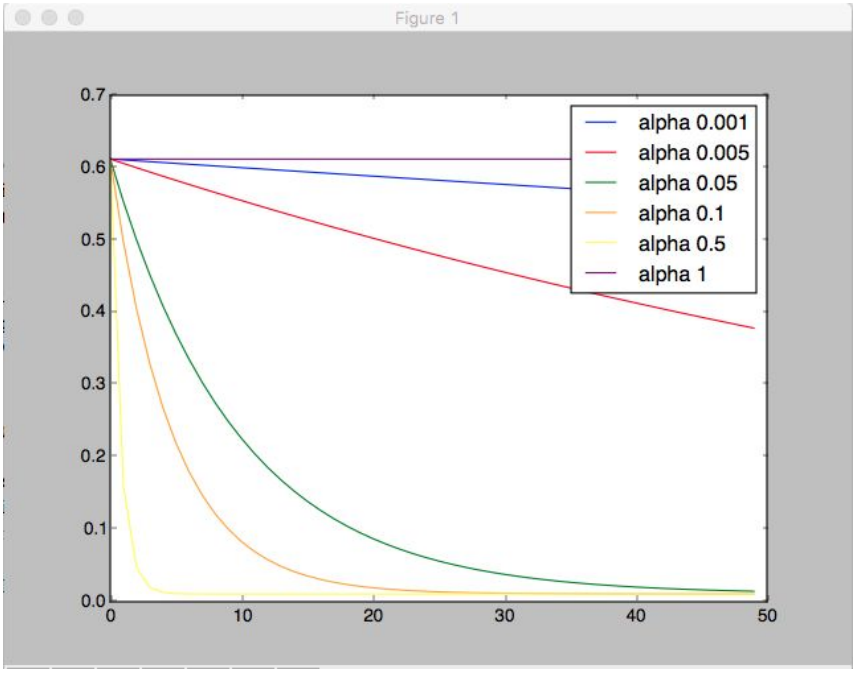
Decision trees works the best because it classifies into rectangular sections and for this dataset, that almost perfectly matches the distribution of the data

3.1 Report and comment on results

Please find attached recreation of original image after deconstruction and resulting clustered image. I found that k=3 allows for finding enough distinct colors that most of the detail of the photo is conserved. In experimenting with different k, it was clear that higher meant more preservation (with a threshold of about 7 in my case). k=3 seemed optimal for reducing number of colors and preserving detail to still be able to comprehend the picture

PLOTS

Part 1:



Part 2:

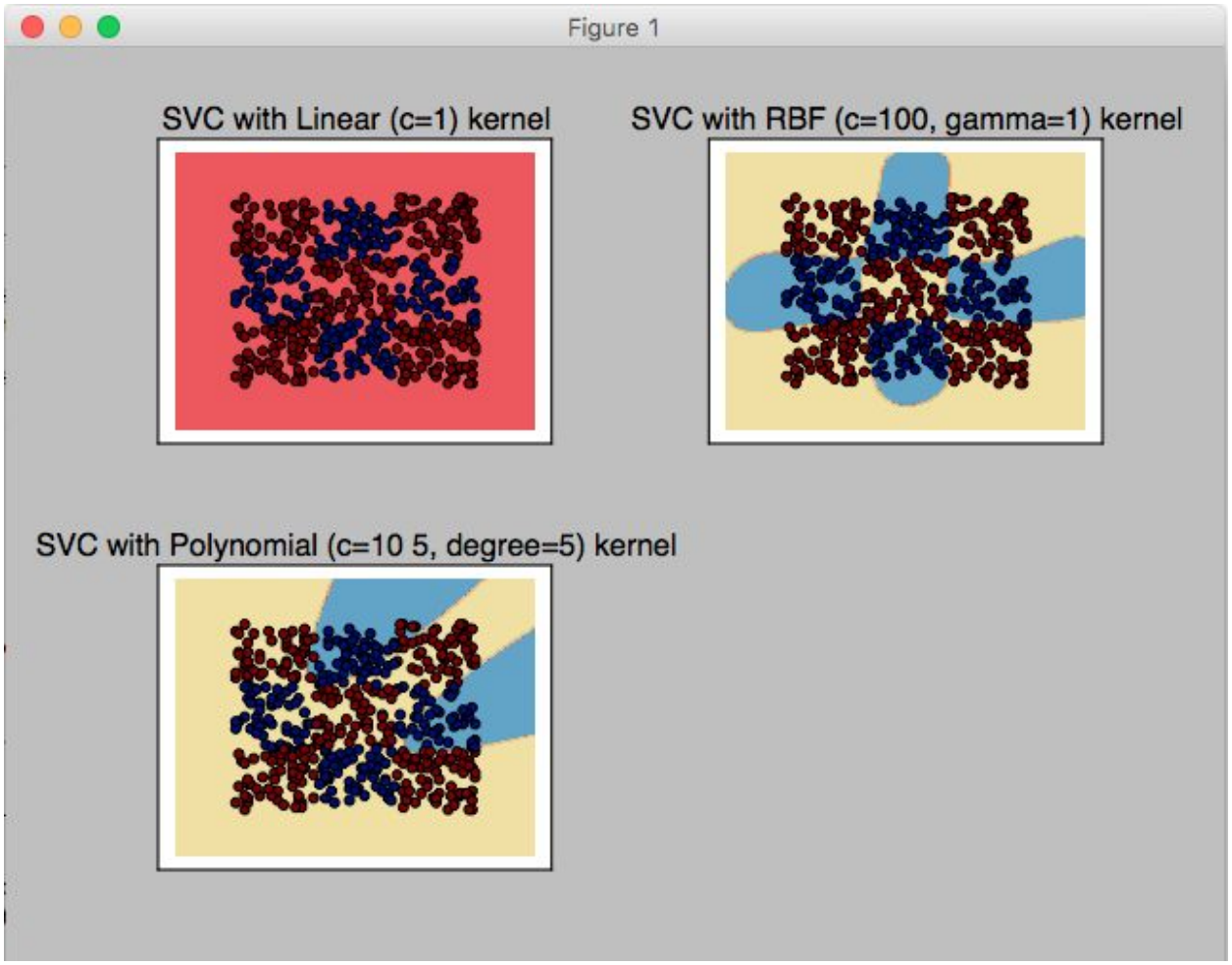


Figure 1
SVC with Linear (c=1) kernel
SVC with RBF (c=100, gamma=1) kernel
SVC with Polynomial (c=10 5, degree=5) kernel

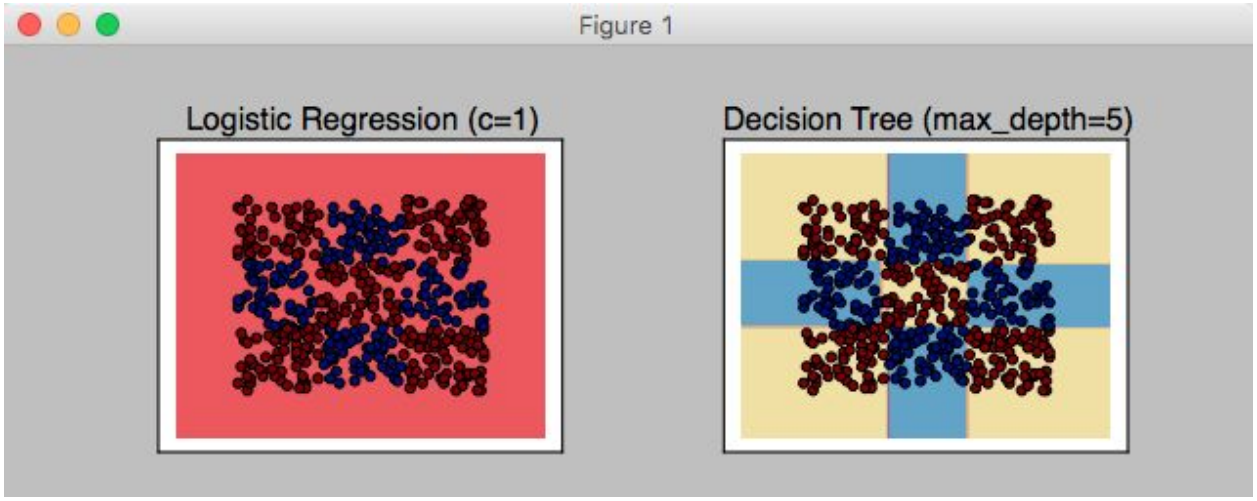


Figure 1
Logistic Regression (c=1)
Decision Tree (max_depth=5)

PROBLEM 2 - OUTPUT OF PROGRAM ON PARAMETER CONVERGENCE

RBF SVM - Parameters C (1-1000), Gamma (1-5)
RBF C=1.0 Gamma=0.001
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=1.0 Gamma=0.01
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=1.0 Gamma=0.1
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=1.0 Gamma=1
[0.83606557 0.8852459 0.88333333 0.93220339 0.96610169]
RBF accuracy: 0.92000000000000004
RBF C=1.0 Gamma=10.0
[0.85245902 0.91803279 0.91666667 0.93220339 1.]
RBF accuracy: 0.95499999999999996
RBF C=10.0 Gamma=0.001
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=10.0 Gamma=0.01
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=10.0 Gamma=0.1
[0.60655738 0.62295082 0.5 0.59322034 0.61016949]

RBF accuracy: 0.62
RBF C=10.0 Gamma=1
[0.85245902 0.8852459 0.91666667 0.93220339 0.96610169]
RBF accuracy: 0.96999999999999997
RBF C=10.0 Gamma=10.0
[0.8852459 0.91803279 0.91666667 0.94915254 0.98305085]
RBF accuracy: 0.94499999999999995
RBF C=100.0 Gamma=0.001
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=100.0 Gamma=0.01
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995
RBF C=100.0 Gamma=0.1
[0.75409836 0.7704918 0.65 0.89830508 0.83050847]
RBF accuracy: 0.85499999999999998
RBF C=100.0 Gamma=1
[0.8852459 0.90163934 0.9 0.98305085 0.96610169]
RBF accuracy: 0.97999999999999998
RBF C=100.0 Gamma=10.0
[0.8852459 0.93442623 0.88333333 0.96610169 0.98305085]
RBF accuracy: 0.95999999999999996
RBF C=1000.0 Gamma=0.001
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
RBF accuracy: 0.56499999999999995

RBF C=1000.0 Gamma=0.01
[0.68852459 0.60655738 0.63333333 0.57627119 0.61016949]
RBF accuracy: 0.52000000000000002
RBF C=1000.0 Gamma=0.1
[0.81967213 0.90163934 0.88333333 0.94915254 0.93220339]
RBF accuracy: 0.92500000000000004
RBF C=1000.0 Gamma=1
[0.96721311 0.95081967 0.86666667 1. 0.98305085]
RBF accuracy: 0.97499999999999998
RBF C=1000.0 Gamma=10.0
[0.8852459 0.93442623 0.88333333 0.96610169 0.98305085]
RBF accuracy: 0.95999999999999996

Polynomial SVM - Parameters C (1-1000), Degrees(1-5)
Poly C=1.0 Deg=1
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=1.0 Deg=2
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=1.0 Deg=3
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=1.0 Deg=4
[0.60655738 0.6557377 0.6 0.77966102 0.6779661]
polynomial accuracy: 0.70999999999999996

Poly C=1.0 Deg=5
[0.70491803 0.67213115 0.66666667 0.74576271 0.71186441]
polynomial accuracy: 0.71999999999999997
Poly C=10.0 Deg=1
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=10.0 Deg=2
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=10.0 Deg=3
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=10.0 Deg=4
[0.67213115 0.67213115 0.65 0.77966102 0.6779661]
polynomial accuracy: 0.71999999999999997
Poly C=10.0 Deg=5
[0.68852459 0.67213115 0.75 0.72881356 0.71186441]
polynomial accuracy: 0.72499999999999998
Poly C=100.0 Deg=1
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=100.0 Deg=2
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=100.0 Deg=3
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]

polynomial accuracy: 0.56499999999999995
Poly C=1000.0 Deg=1
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=100.0 Deg=4
[0.72131148 0.67213115 0.65 0.77966102 0.6779661]
polynomial accuracy: 0.70999999999999996
Poly C=100.0 Deg=5
[0.73770492 0.68852459 0.76666667 0.71186441 0.69491525]
polynomial accuracy: 0.72499999999999998
Poly C=1000.0 Deg=2
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=1000.0 Deg=3
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
polynomial accuracy: 0.56499999999999995
Poly C=1000.0 Deg=4
[0.72131148 0.63934426 0.65 0.71186441 0.66101695]
polynomial accuracy: 0.69499999999999995
Poly C=1000.0 Deg=5
[0.67213115 0.6557377 0.63333333 0.74576271 0.6779661]
polynomial accuracy: 0.72499999999999998

Linear SVM - Parameter C (1-1000)
Linear C=1.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]

linear accuracy: 0.56499999999999995
Linear C=10.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
linear accuracy: 0.56499999999999995
Linear C=100.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
linear accuracy: 0.56499999999999995
Linear C=1000.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
linear accuracy: 0.56499999999999995

Logistic Regression - Parameter C (1-1000)
Log Reg C=1.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
logistic regression accuracy: 0.56499999999999995
Log Reg C=10.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
logistic regression accuracy: 0.56499999999999995
Log Reg C=100.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
logistic regression accuracy: 0.56499999999999995
Log Reg C=1000.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
logistic regression accuracy: 0.56499999999999995

Decision Tree - Parameter Max Depth (1-10)
Decision Tree max_depth=1.0
[0.60655738 0.60655738 0.6 0.61016949 0.61016949]
Decision Tree accuracy: 0.56499999999999995
Decision Tree max_depth=2.0
[0.63934426 0.60655738 0.6 0.6440678 0.76271186]
Decision Tree accuracy: 0.70499999999999996
Decision Tree max_depth=3.0
[0.7704918 0.62295082 0.8 0.71186441 0.79661017]
Decision Tree accuracy: 0.73999999999999999
Decision Tree max_depth=4.0
[0.91803279 0.57377049 0.98333333 0.88135593 0.98305085]
Decision Tree accuracy: 0.96999999999999997
Decision Tree max_depth=5.0
[0.95081967 0.70491803 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0
Decision Tree max_depth=6.0
[0.95081967 0.81967213 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0
Decision Tree max_depth=7.0
[0.95081967 0.93442623 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0
Decision Tree max_depth=8.0

[0.95081967 0.93442623 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0
Decision Tree max_depth=9.0
[0.95081967 0.93442623 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0
Decision Tree max_depth=10.0
[0.95081967 0.93442623 0.98333333 0.98305085 1.]
Decision Tree accuracy: 1.0

PROBLEM 3 - IMAGES