Pattern Recognition And Machine Learning: Assignment #3

Vaisakh Shaj

Problem 1

Implement SMO for Classification

Solution

The SMO algorithm was implemented on MATLAB.. The Codes are attached.. The psuedocode for algorithm is shown below :

- Initialize $\alpha_i = 0, \forall i, \quad b = 0$.
- Initialize $passes = 0$.
- **while** $(passes < max\_passes)$
  - $num\_changed\_alphas = 0$.
  - **for** $i = 1, \ldots m$,
    - Calculate $E_i = f(x^{(i)}) - y^{(i)}$ using (2).
    - **if** $((y^{(i)}E_i < -tol \quad \&\& \quad \alpha_i < C) \;||\; (y^{(i)}E_i > tol \quad \&\& \quad \alpha_i > 0))$
      - Select $j \neq i$ randomly.
      - Calculate $E_j = f(x^{(j)}) - y^{(j)}$ using (2).
      - Save old α's: $\alpha_i^{(\text{old})} = \alpha_i$, $\alpha_j^{(\text{old})} = \alpha_j$.
      - Compute L and H by (10) or (11).
      - **if** $(L == H)$
        continue to next i.
      - Compute η by (14).
      - **if** $(\eta >= 0)$
        continue to next i.
      - Compute and clip new value for α_j using (12) and (15).
      - **if** $(|\alpha_j - \alpha_j^{(\text{old})}| < 10^{-5})$
        continue to next i.
      - Determine value for α_i using (16).
      - Compute b_1 and b_2 using (17) and (18) respectively.
      - Compute b by (19).
      - $num\_changed\_alphas := num\_changed\_alphas + 1$.
    - **end if**
  - **end for**
  - **if** $(num\_changed\_alphas == 0)$
    $passes := passes + 1$
  - **else**
    $passes := 0$
- **end while**

If $y^i \neq y^j L = max(0, \alpha_j - \alpha_i), H = min(C, C + \alpha_j - \alpha_i)$ —-(10)

If $y^i = y^j L = max(0, \alpha_j - \alpha_i - C), H = min(C, \alpha_j + \alpha_i)$ ——-(11)

$\alpha_j = \alpha_j - \frac{y_i - (E_i - Ej)}{\eta}$ ——-(12)

$\eta = 2 \times \langle x^i, x^j \rangle - \langle x(i), x(i) \rangle - \langle x^j, x^i \rangle$——-(14)

$$\alpha_j = \begin{cases} H & \text{if } \alpha_j > H \\ \alpha_j & \text{if } L \leq \alpha_j \leq H \\ L & \text{if } \alpha_j < L \end{cases}$$

——— (15)

$\alpha_i = alpha_i + y^i y^j (\alpha_j - \alpha i)$ —— (16)

$b_1 = b - E_i - y^i(\alpha_i - \alpha_{iold})\langle x^i, x^j \rangle$ ——— (17)

$b_2 = b - E_j - y^i(\alpha_i - \alpha_{iold})\langle x^j, x^j \rangle$ ——— (18)

$$b = \begin{cases} b1 & \text{if } 0 < \alpha_i < C \\ b2 & \text{if } 0 < \alpha_j < C \\ \frac{b1+b2}{2} & \text{if } otherwise \end{cases}$$

————(19)

Problem 2

Analyze ionosphere data using SMO

Ionosphere data was downloaded from UCI Web Repository.. The data is 34 attribute 2 class classification data, with the classes being good or bad.. The Good(g)class is represented as 1 and Bad(b) Class is represented as 0.
The classification was done using SVM(with SMO algorithm used for optimization) with different kernels and the accuracy and F measure were compared.. Linear Kernel gave the best result

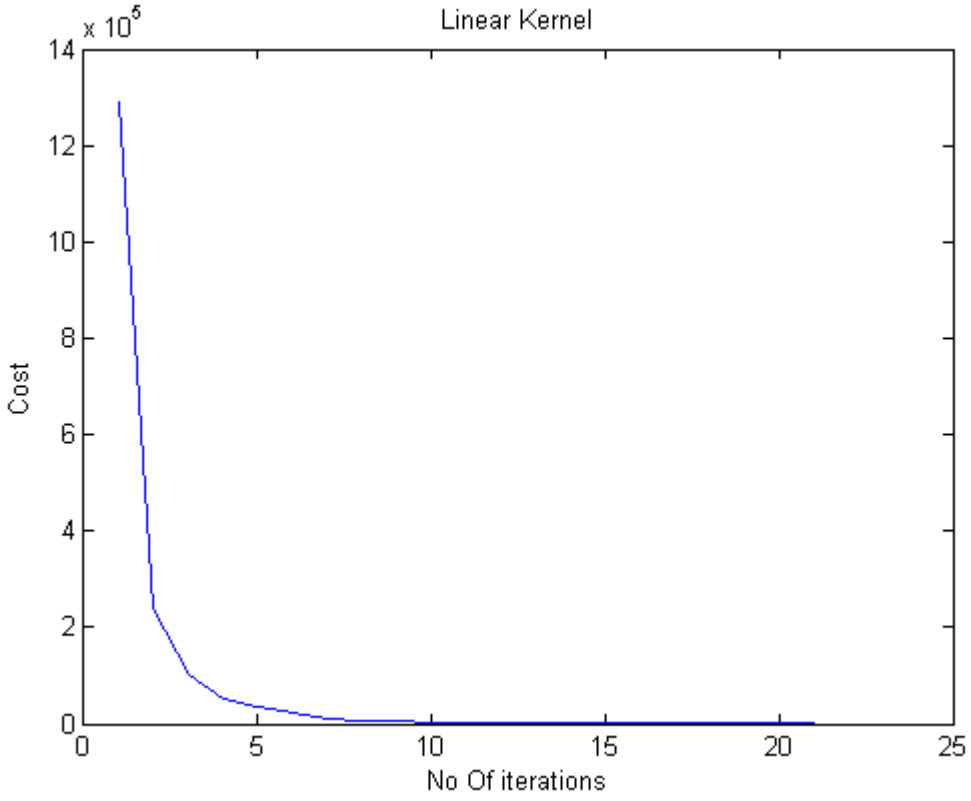
Kernel	C value	Accuracy	F Score
Linear	.1	.92	1
Guassian(Sigma=3)	.01	.85	1
Polynomial(d=5)	.001	.8171	1

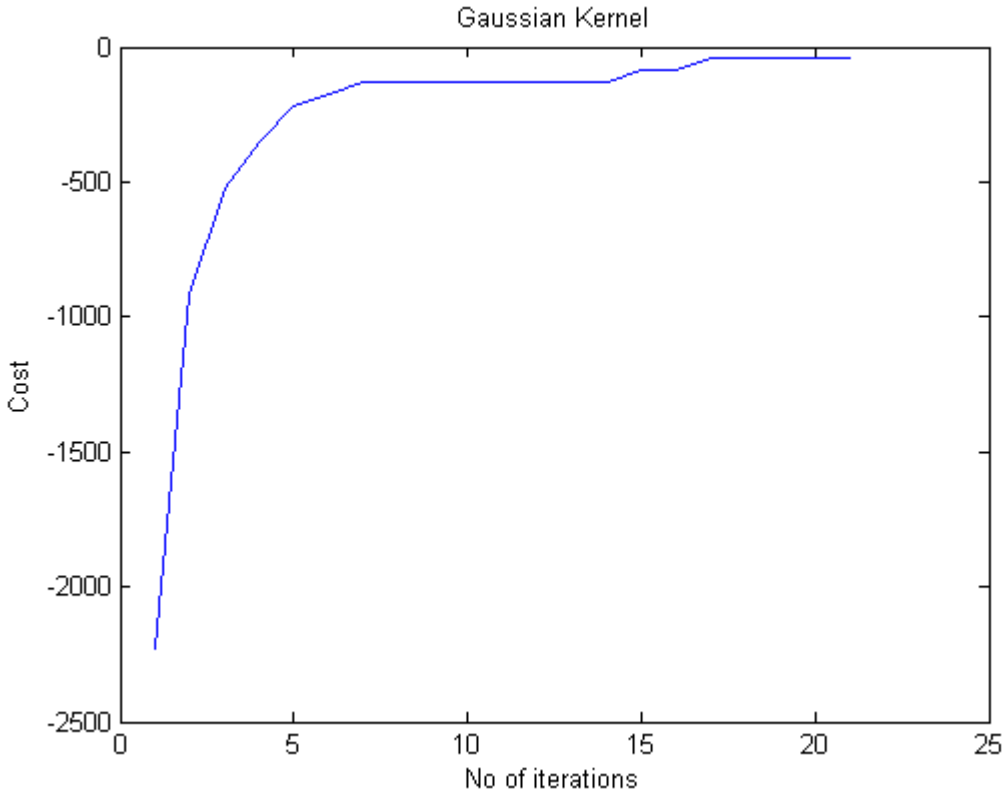
Problem 3

Plot the cost function values over iterations

Solution

The Convergence curve of SMO Algorithm with Linear and Gaussian Kernels are shown below :


Linear Kernel
x 10^5
14
12
10
8
6
4
2
0
Cost
0
5
10
15
20
25
No Of iterations


Gaussian Kernel
0
-500
-1000
-1500
-2000
-2500
Cost
0
5
10
15
20
25
No of iterations