

HW7 Optimization Application: Support Vector Machines

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The basic idea of this project is to use small samples from foreground and background of an image to train SVM to obtain a full segmentation of the image. Feature vectors include both color and position. I tried several ways to represent the position. The basic representation is $[r, g, b, x, y]$. One variation is replace $[x, y]$ with their distance with the image center. We can further normalize the distance with respect to the dimension of the image. One last variation is to compute the L-2 norm of $[x, y]$, i.e. the Euclidean distance of the pixel from the image center.

The problem is formulated as follows:

$$\begin{aligned} \text{minimize} \quad & ||w||_2 + \lambda(\mathbf{1}^T u + \mathbf{1}^T v) \\ \text{subject to} \quad & w^T x_i + b \geq 1 - u_i, \quad i = 1, \dots, M \\ & w^T x_i + b \leq -1 + v_i, \quad i = 1, \dots, N \\ & u \succcurlyeq 0 \\ & v \succcurlyeq 0 \end{aligned} \tag{1}$$

where x_i is the feature vector and $\mathbf{1}^T u + \mathbf{1}^T v$ is the slackness.