Exam Cheat Sheet

Discriminative Functions for Classifiers

Naive Bayes

$$P(y|x) = \frac{P(x|y)P(y)}{P(x)} \tag{1}$$

$$P(x|y) = \prod_{i=1}^{n} P(x_i|y) \tag{2}$$

Fisher's Linear Discriminant Analysis

$$w = S_W^{-1}(\mu_1 - \mu_2) \tag{3}$$

$$S_W = \sum_{i=1}^{N}(x_i - \mu_{c(x_i)})(x_i - \mu_{c(x_i)})^T \tag{4}$$

$$S_B = (\mu_1 - \mu_2)(\mu_1 - \mu_2)^T \tag{5}$$

Logistic Regression

$$\sigma(z) = \frac{1}{1 + e^{-z}} \tag{6}$$

$$J(\theta) = -\frac{1}{m}[y^T \log(\sigma(X\theta)) + (1-y)^T \log(1 - \sigma(X\theta))] \tag{7}$$

Perceptron Algorithm

$$\mathcal{E}_p(\mathbf{w}, w_0) = -\sum_{n \in M} t_n(\mathbf{w} \cdot \mathbf{x}_n + w_0), \text{ where } M \text{ is misclass} \tag{8}$$

Gradient Descent

$$\theta := \theta - \alpha \nabla_\theta J(\theta) \tag{9}$$

Support Vector Machines

Kernel Machines

$$K(x, x') = \exp(-\frac{\|x - x'\|^2}{2\sigma^2}) = \exp(-\gamma\|x - x'\|^2) \tag{10}$$

$$\gamma = \frac{1}{2\sigma^2} \tag{11}$$

Hard Margin SVM

$$\min_{w,b} \frac{1}{2}\|w\|^2 \text{ s.t. } y_i(w^T x_i + b) \geq 1 \tag{12}$$

$$\mathcal{L}(\mathbf{w}, w_0, \alpha) = \frac{1}{2}\|\mathbf{w}\|^2 - \sum_{i=1}^{N} \alpha_i[t_i(\mathbf{w}^T\mathbf{x}_i + w_0) - 1] \tag{13}$$

Soft Margin SVM

$$\mathcal{L}(\mathbf{w}, w_0, \alpha, \mu) = \frac{1}{2}\|\mathbf{w}\|^2 + C\sum_{i=1}^{N}\xi_i - \sum_{i=1}^{N}\alpha_i[t_i(\mathbf{w}\cdot\mathbf{x}_i + w_0) - 1 + \xi_i] - \sum_{i=1}^{N}\mu_i\xi_i \tag{14}$$

Performance Metrics

Confusion Matrix

$$\begin{bmatrix} TP & FP \\ FN & TN \end{bmatrix} \tag{15}$$

Precision

$$\frac{TP}{TP + FP} \tag{16}$$

Recall

$$\frac{TP}{TP + FN} \tag{17}$$

F1 Score

$$\frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}} \tag{18}$$

Accuracy

$$\frac{TP + TN}{TP + FP + FN + TN} \tag{19}$$

ROC Curve

$$\text{TPR} = \frac{TP}{TP + FN} \tag{20}$$

$$\text{FPR} = \frac{FP}{FP + TN} \tag{21}$$

Dimensionality Reduction

PCA

$$\mathbf{X} = \mathbf{X} - \bar{\mathbf{X}} \tag{22}$$

$$\mathbf{Cov} = \frac{1}{N-1}\mathbf{X}^T\mathbf{X} \tag{23}$$

$$\mathbf{Covv} = \lambda\mathbf{v} \tag{24}$$