Supervised Learning
Bagian - II

18 April 2024

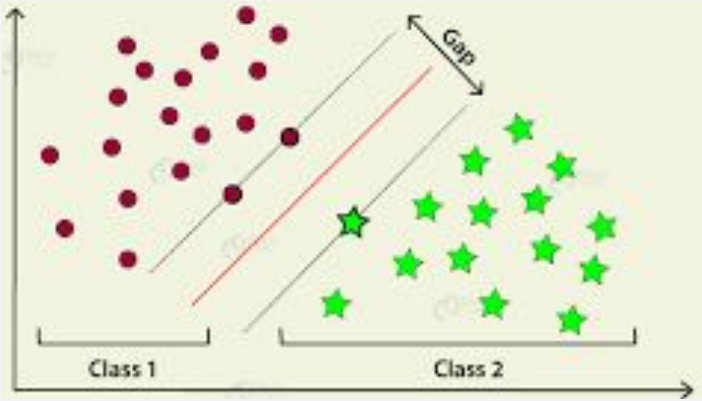
Materi Hari Ini

Kita akan mempelajari antara lain:

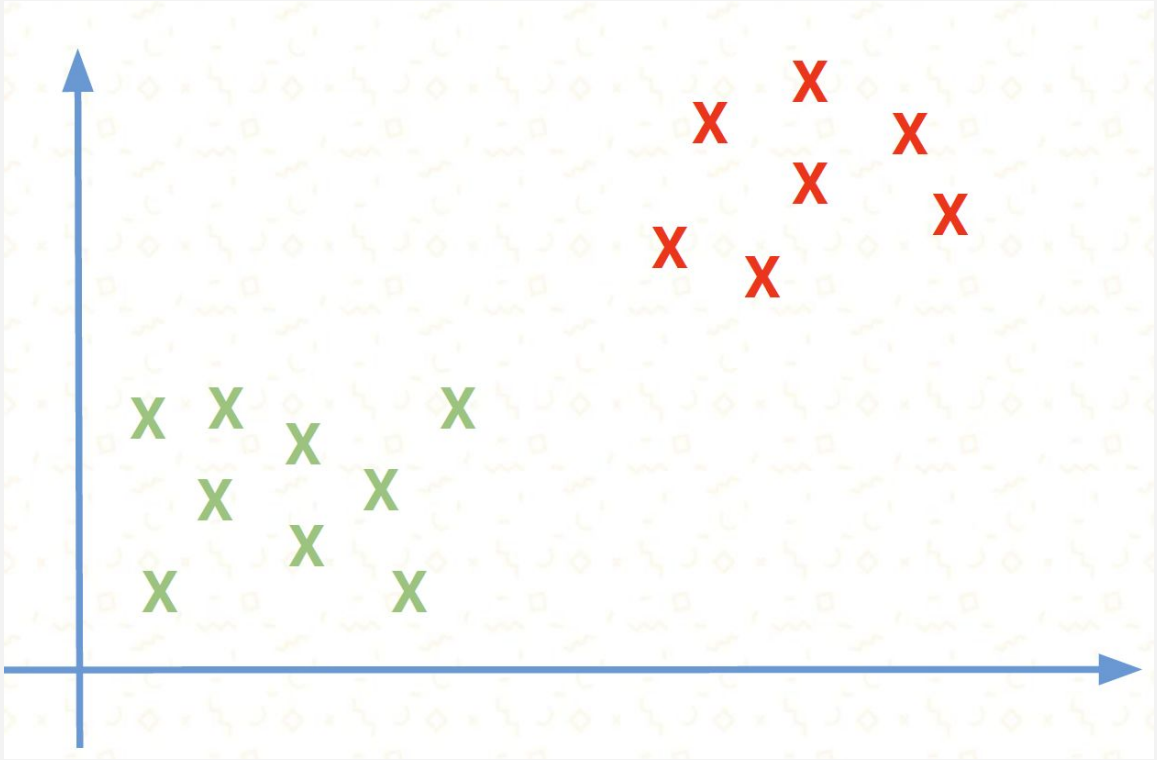
1. Pengantar SVM (Support Vector Machine)
2. Multiclass Classifier

Pengantar SVM (Support Vector Machine)

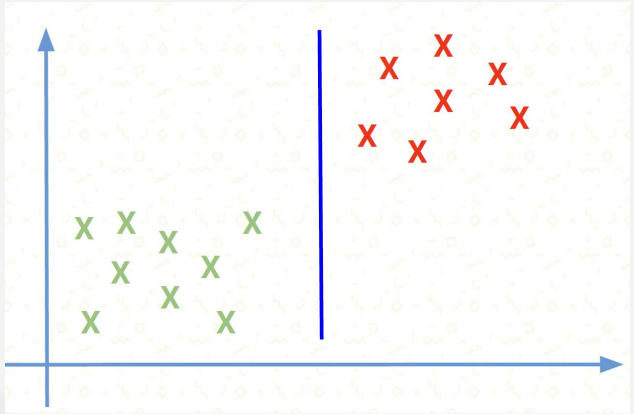
Apa dan Bagaimana

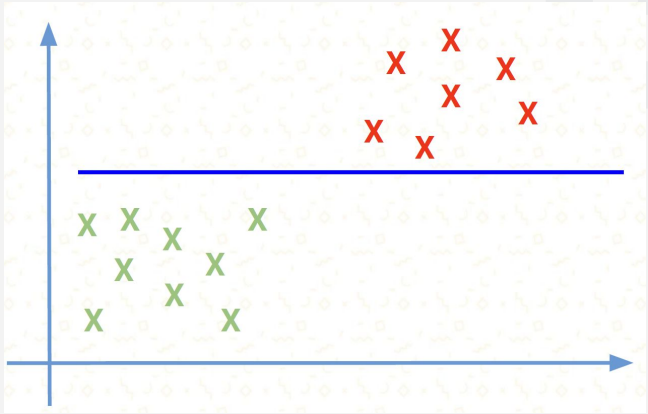


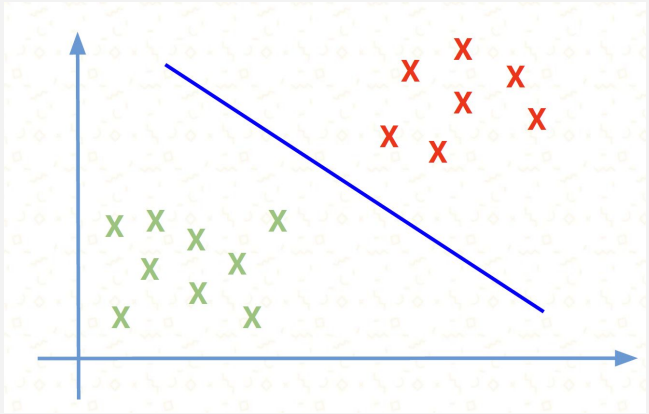
Permasalahan



Permasalahan

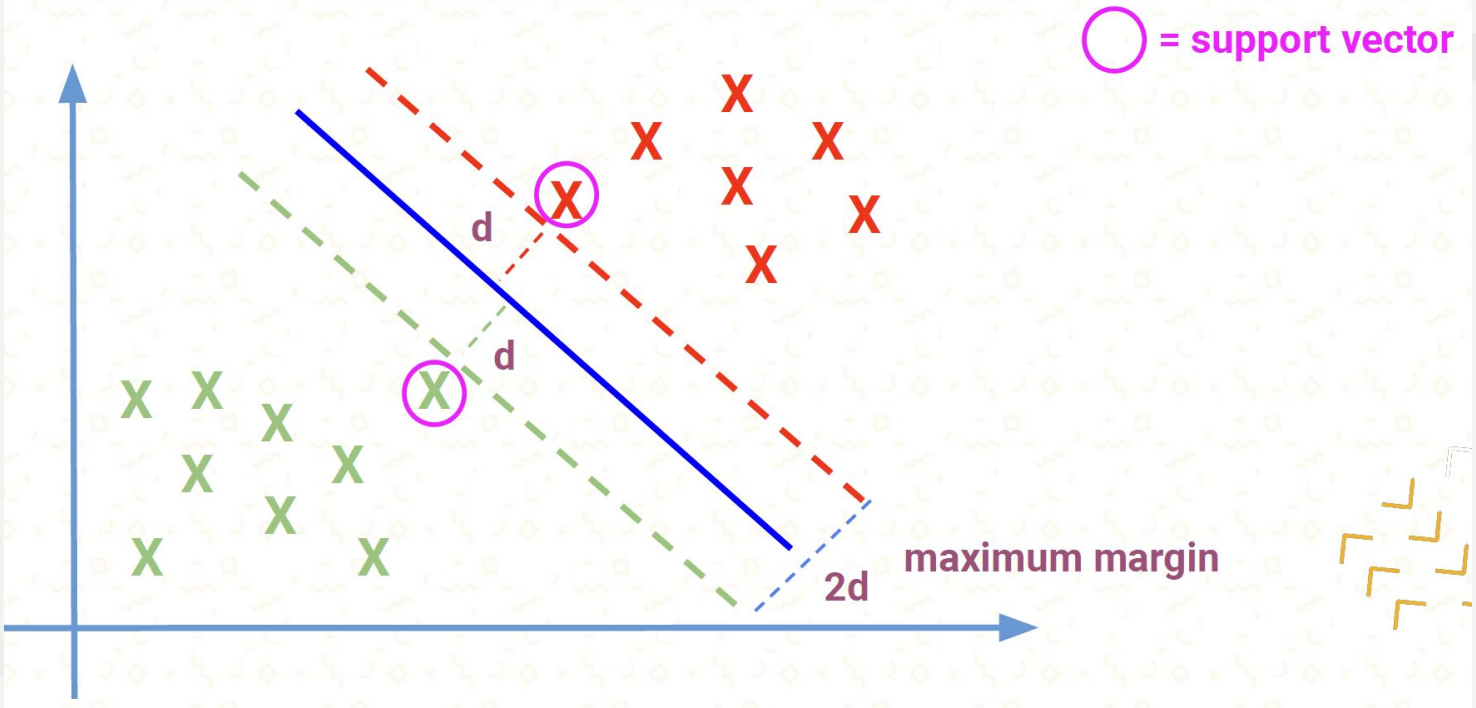




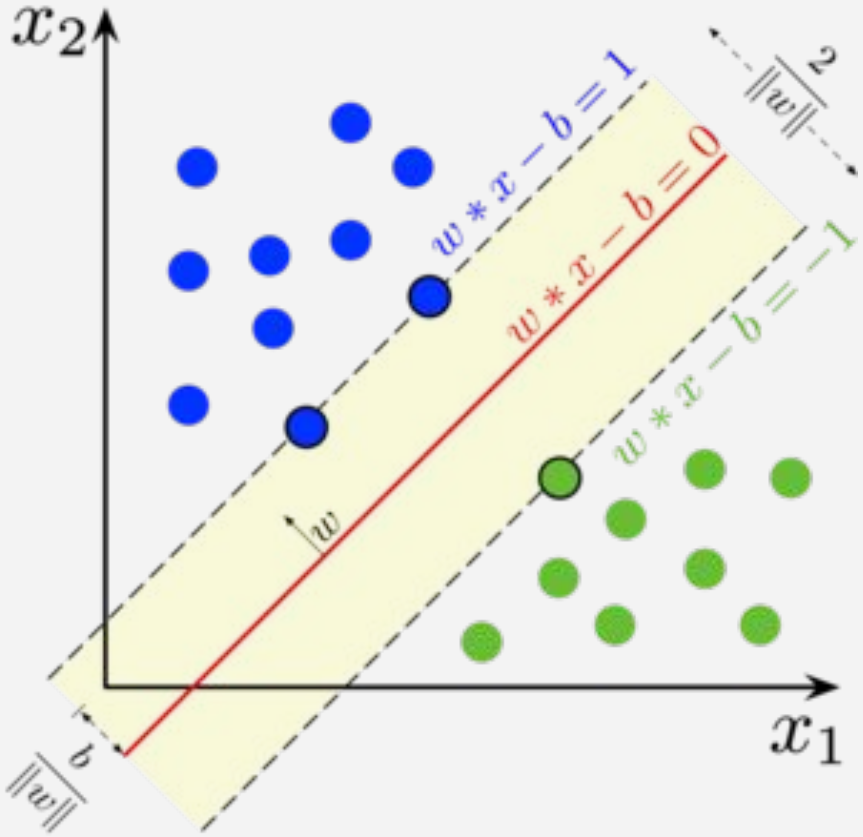


Garis Separasi mana yang terbaik?

Support Vector



Pendekatan Geometris



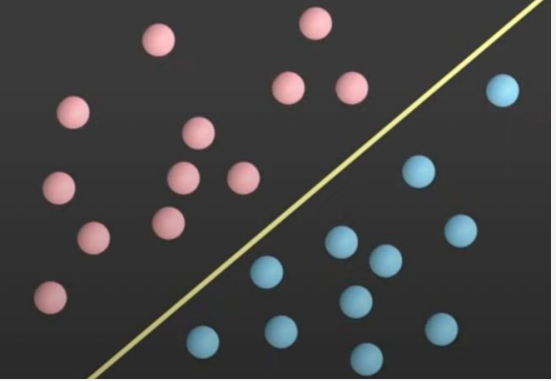
SVM Sebagai Convex Optimization Problem

Convex Optimization Problem

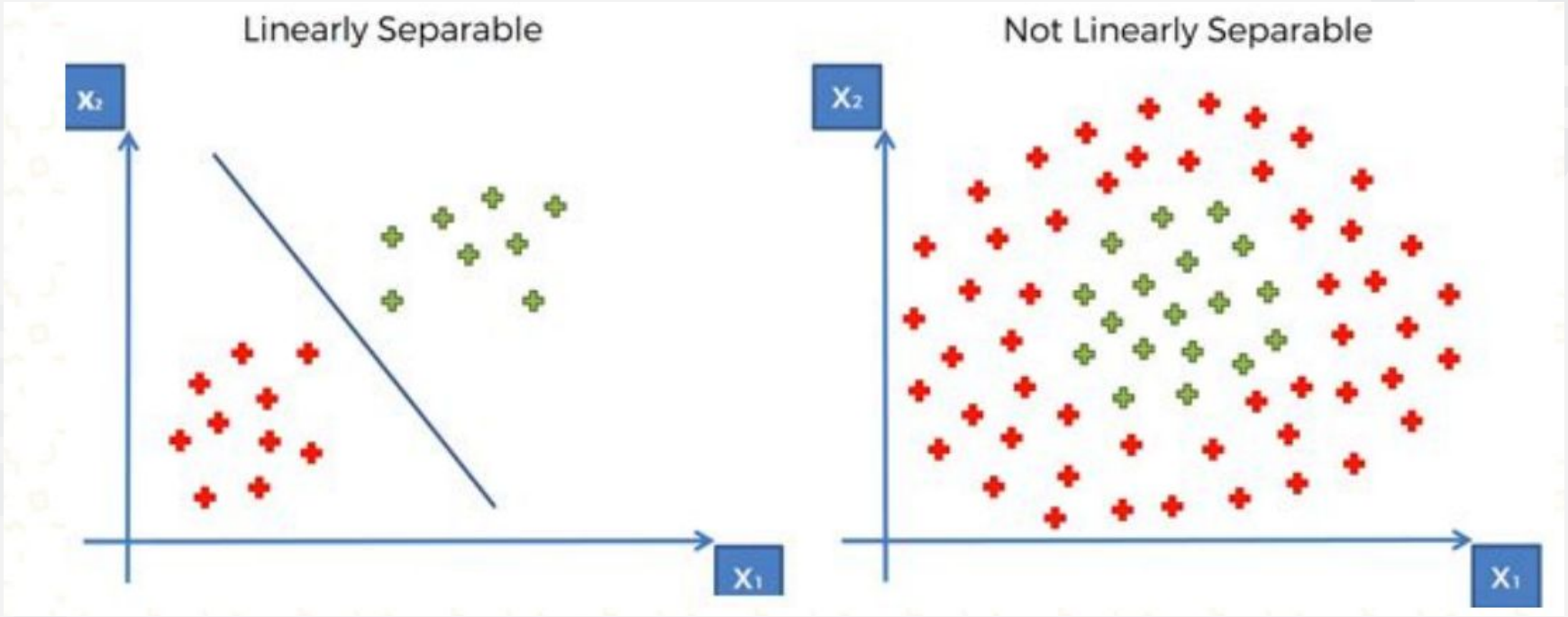
$$\max_{w,b} \quad ||w||^{-2}$$

$$w^T x + b \geq 1 \quad \forall x \in C_1$$

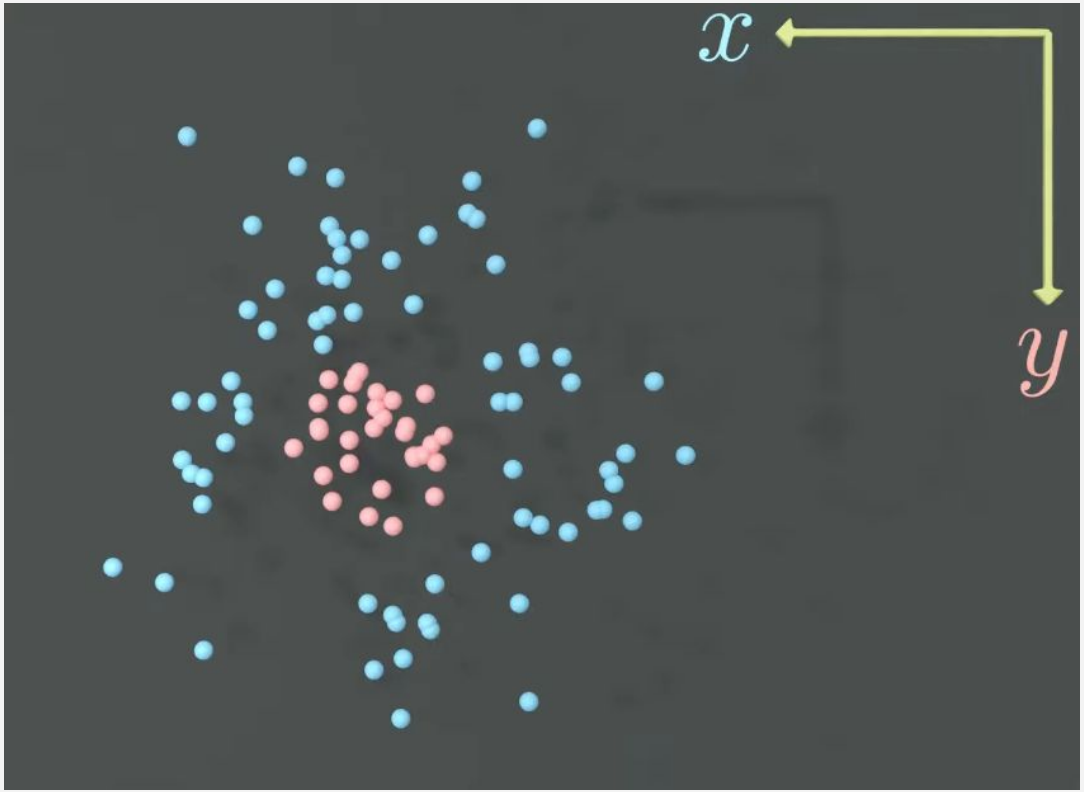
$$w^T x + b \leq -1 \quad \forall x \in C_2$$



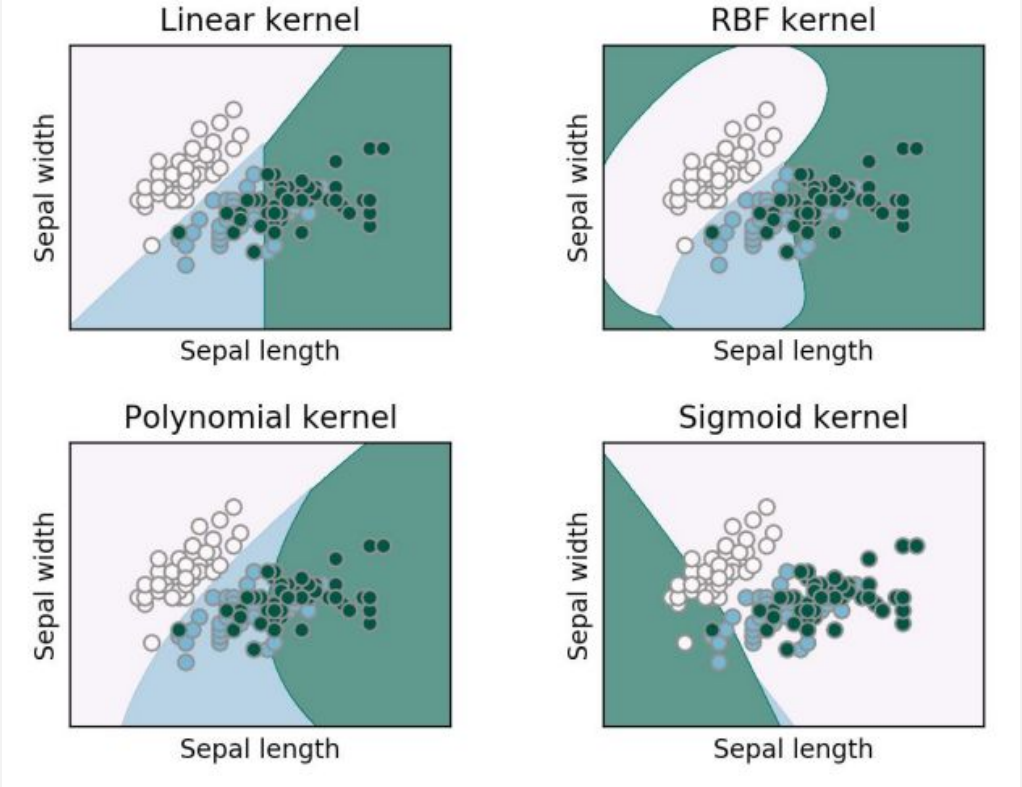
Kasus Lain



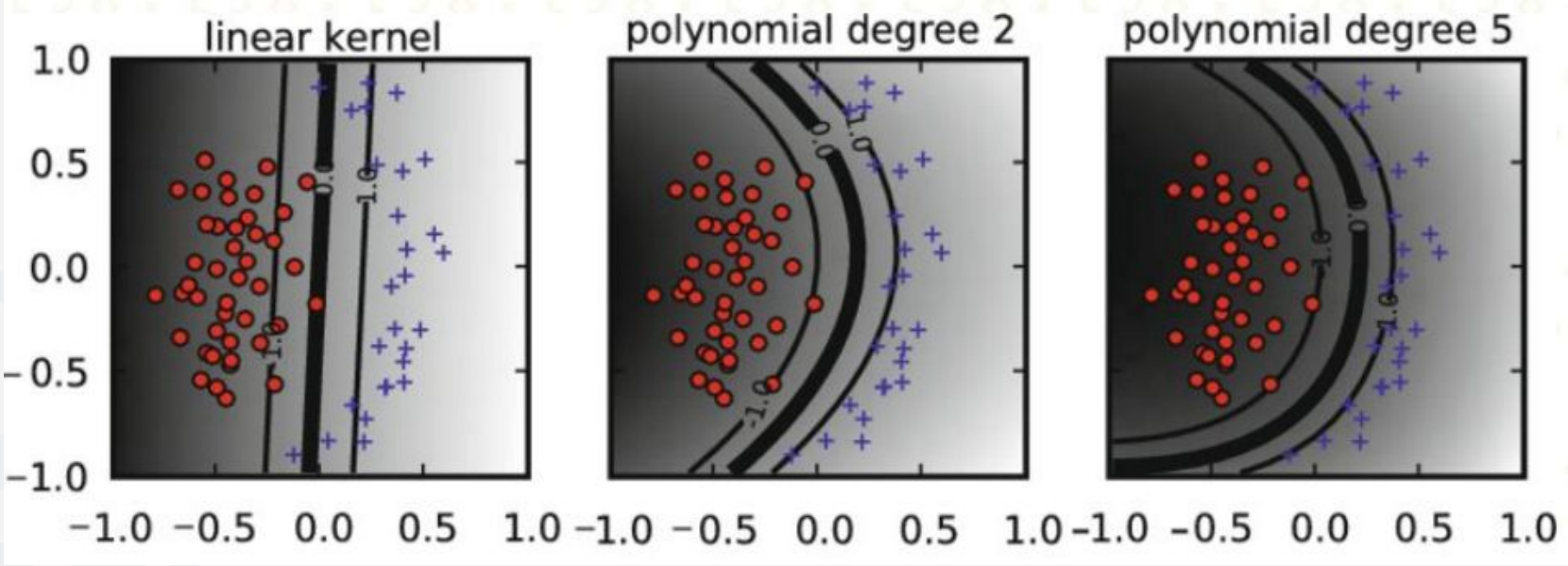
Kasus Lain



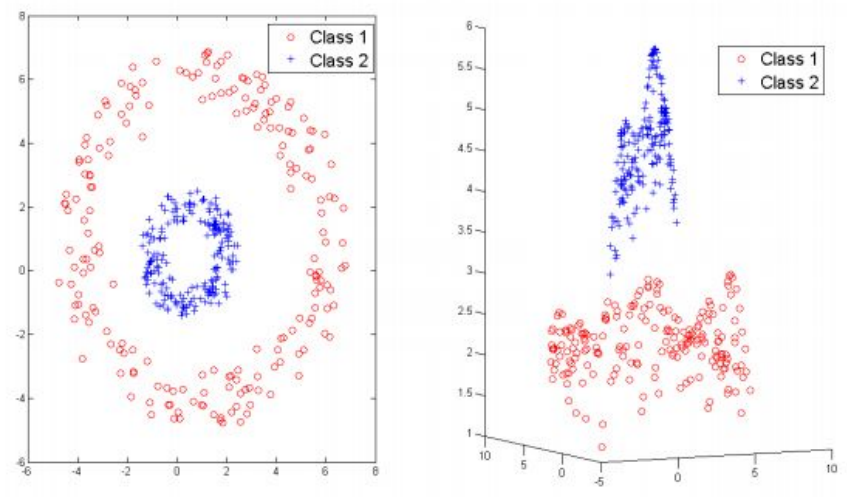
Fungsi-Fungsi Kernel Pada SVM

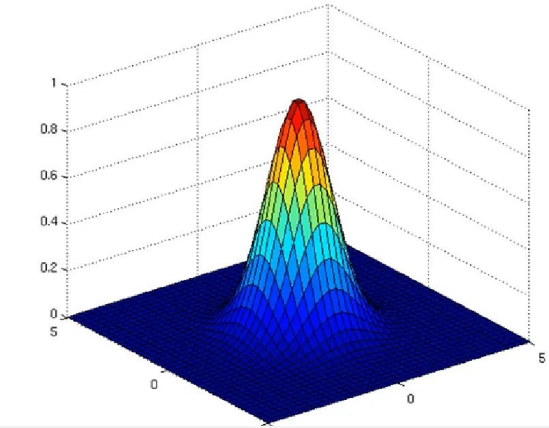


Kernel Polynomial



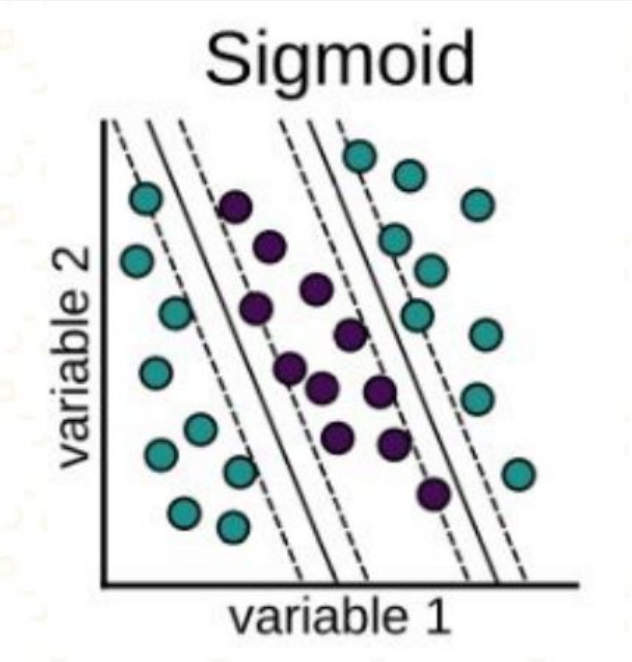
Kernel Radial Basis Function (RBF) (Gaussian Kernel)

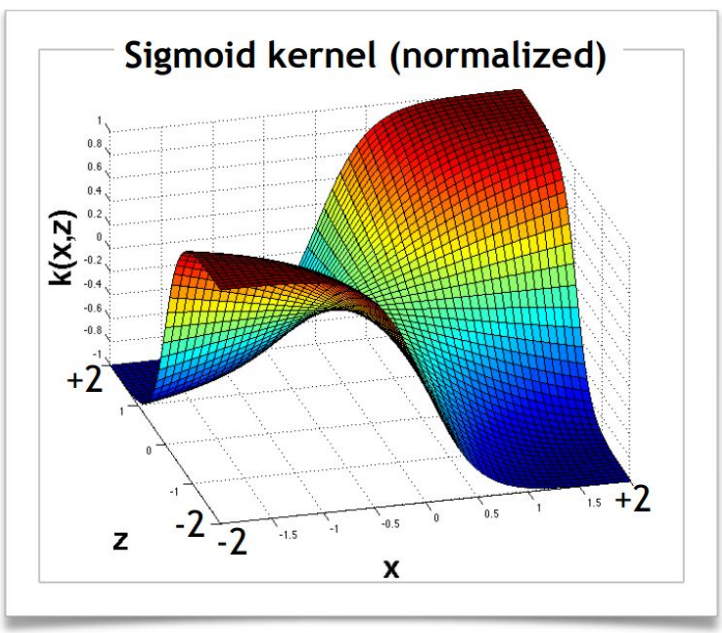




$$K(\vec{x}, \vec{l}^i) = e^{-\frac{\|\vec{x}-\vec{l}^i\|^2}{2\sigma^2}}$$

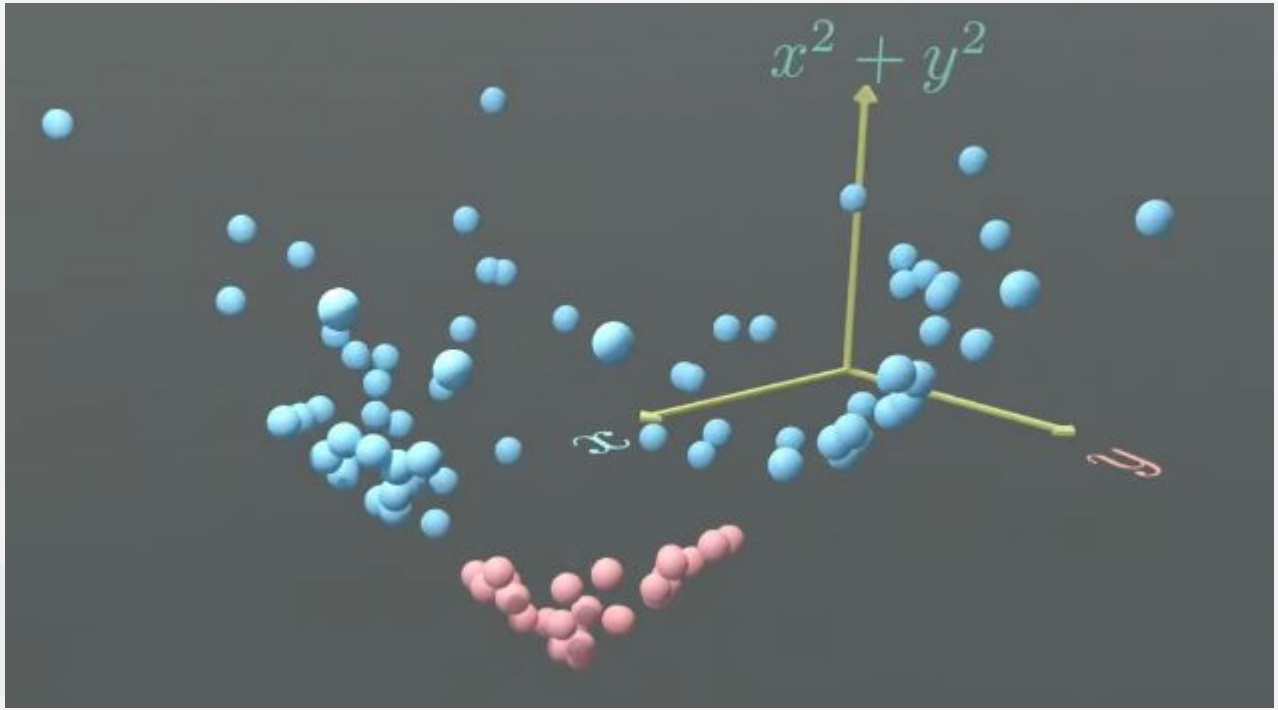
Kernel Sigmoid



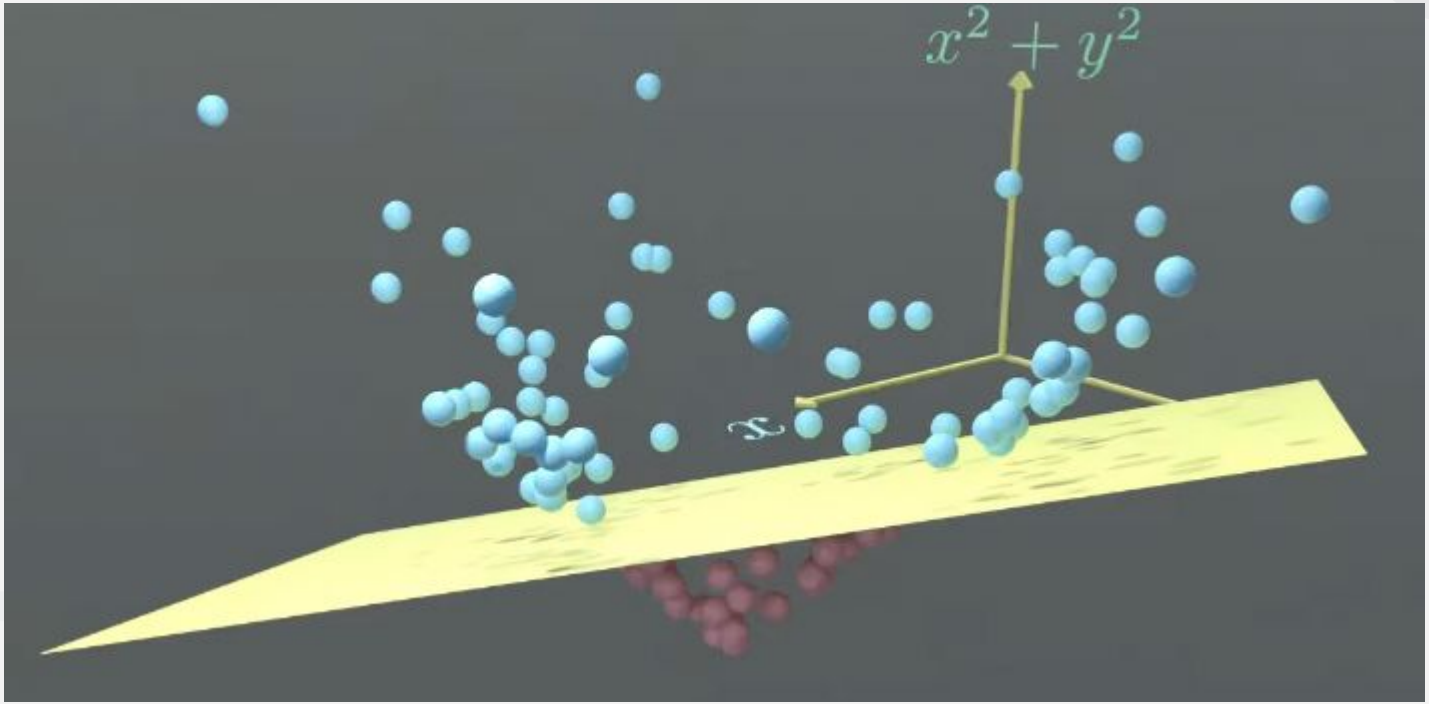


$$k_S\left(\frac{\mathbf{x}}{\sqrt{p}}, \frac{\mathbf{z}}{\sqrt{p}}\right) = \tanh\left(\frac{a}{p} \cdot \mathbf{x}^T\mathbf{z} + r\right)$$

Fungsi Kernel: Data Augmentation



Fungsi Kernel:
Untuk Data NOT Linearly Separable



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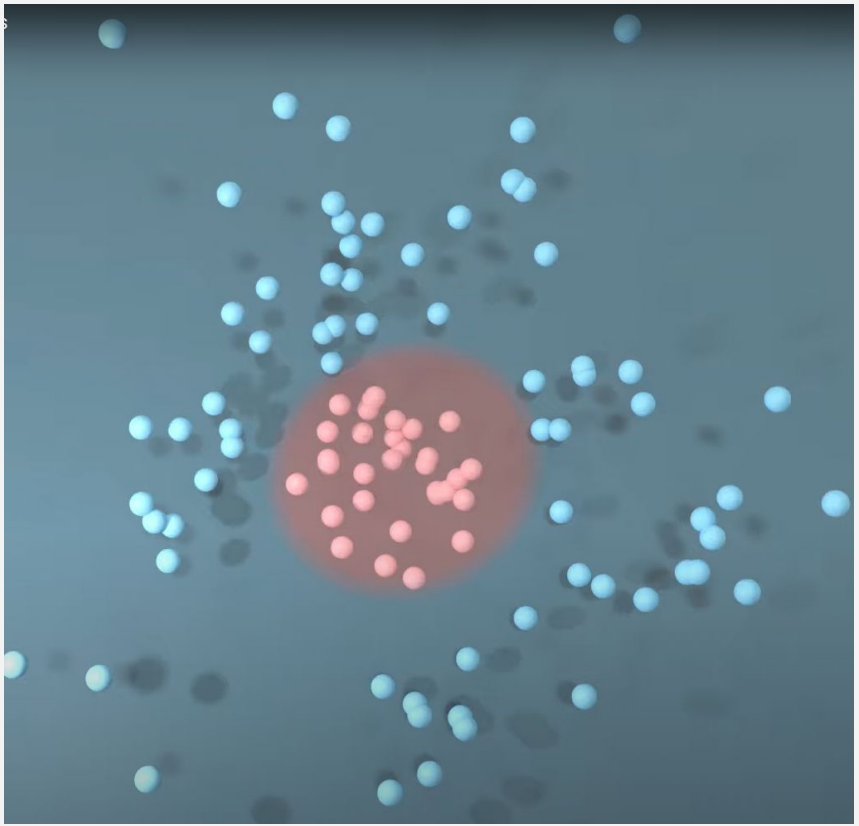
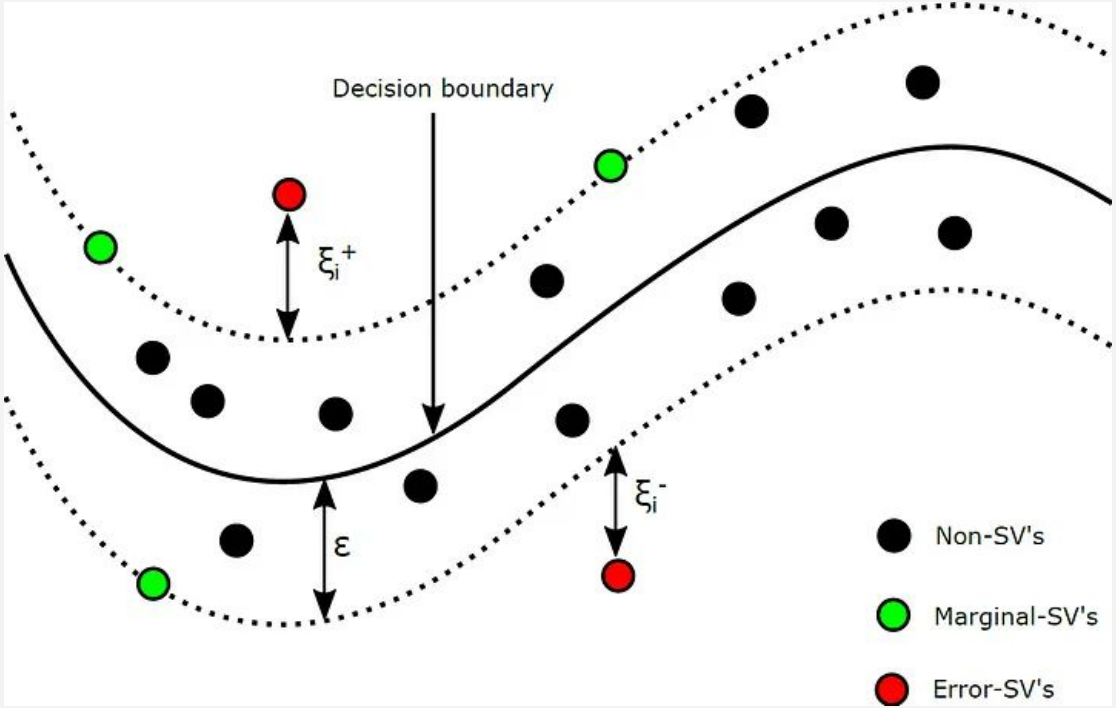


KERNEL TRICK

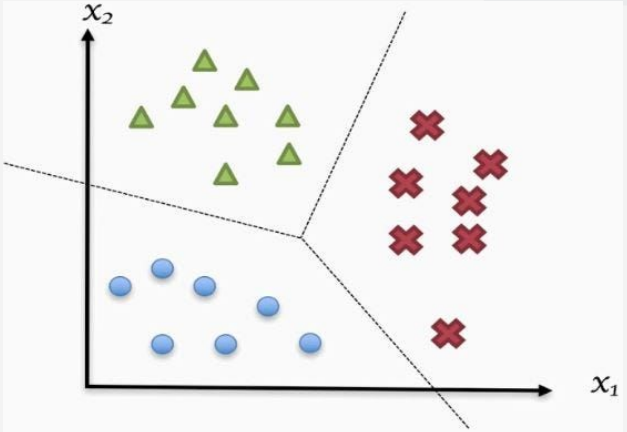
SVM Untuk Regresi: SVR



Source: Link

Multiclass Classifier

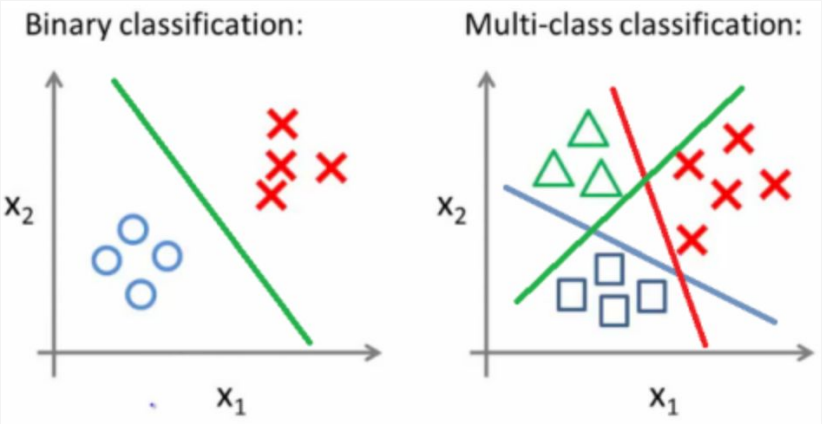
Apa dan Bagaimana



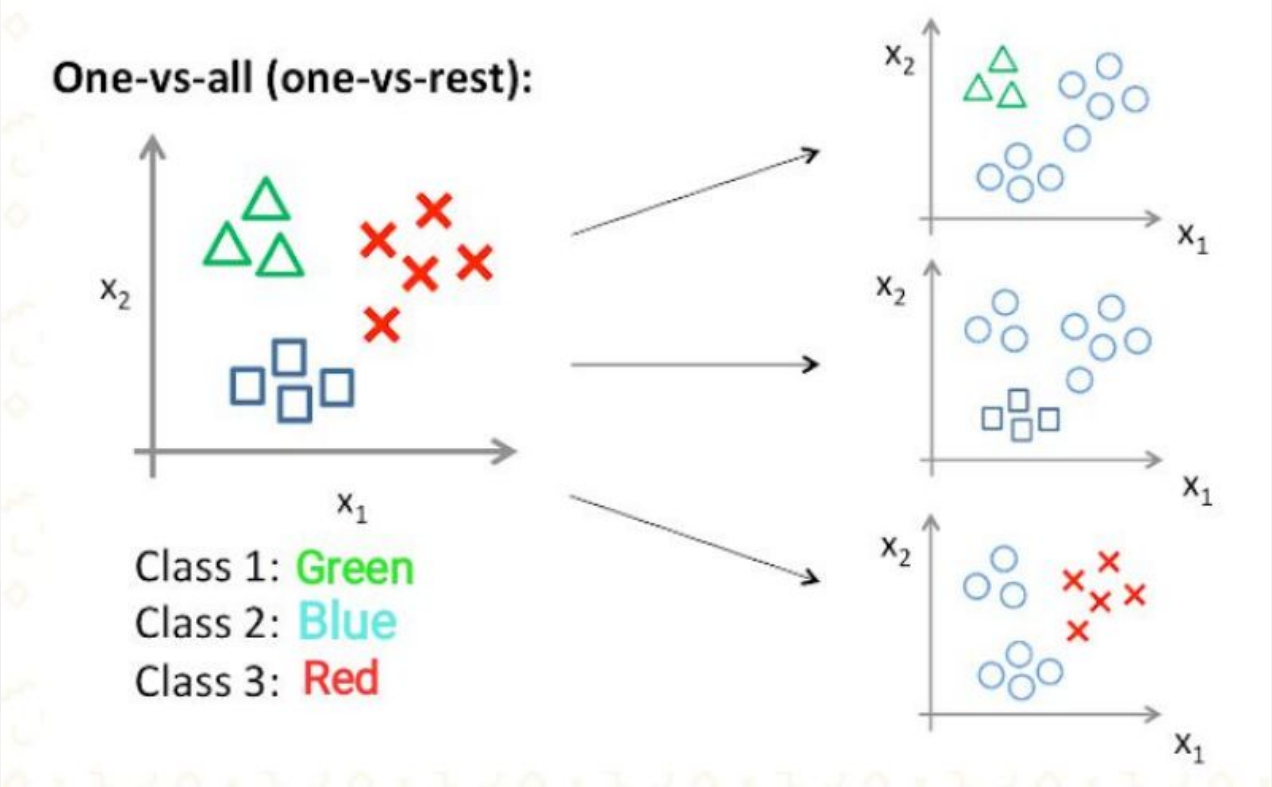
Multiclass Classifier

Konsep multiclass classifier bisa dilakukan pendekatan seperti binary classifier dengan metode:

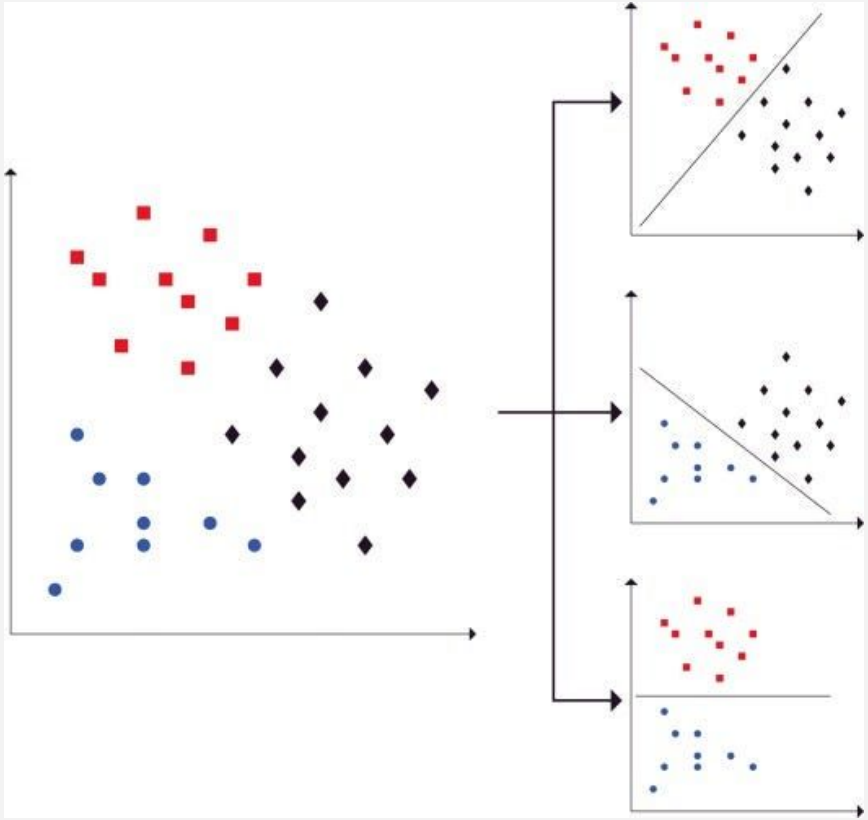
1. One vs Rest (OvR)
2. One vs One (OvO)



One vs. Rest (OvR)



One vs. One (OvO)



Memilih Antara OvR dan OvO

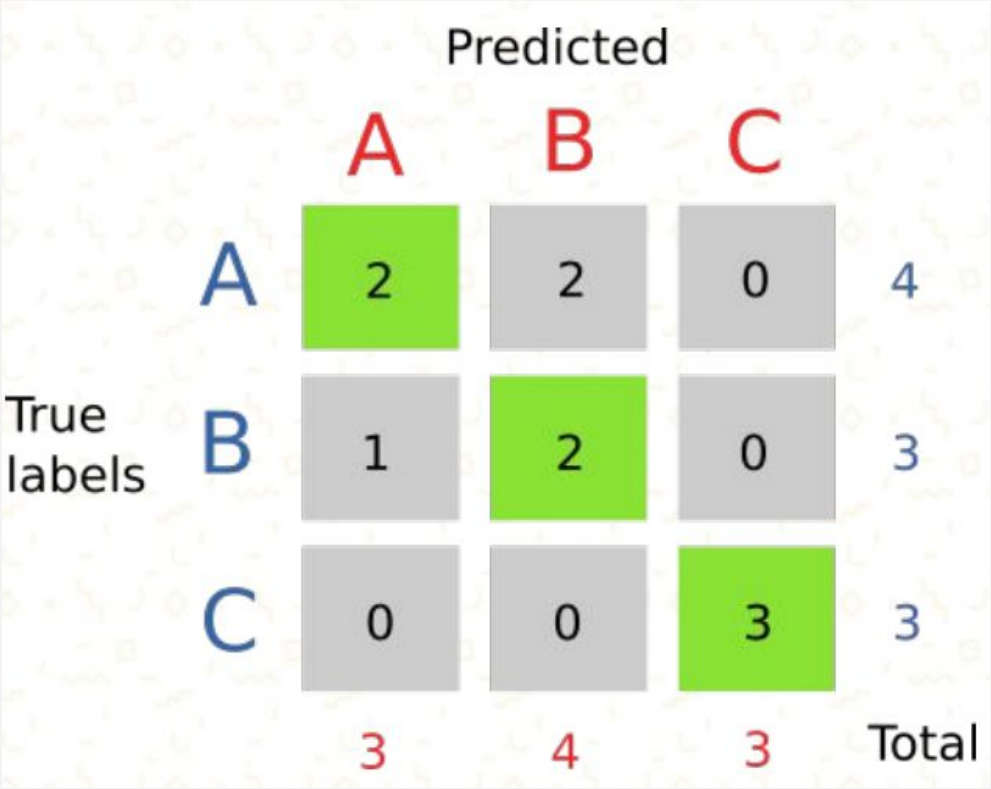
1. **Ukuran Dataset:** Untuk dataset berukuran kecil hingga menengah, kedua strategi dapat dipertimbangkan. Untuk dataset berukuran besar, OvR sering lebih praktis karena efisiensinya dalam komputasi.

2. **Jumlah Kelas:** OvO mungkin lebih baik ketika jumlah kelas sedikit, dan sumber daya komputasi bukanlah batasan. OvR umumnya lebih dapat diukur untuk jumlah kelas yang besar.

3. **Kelas yang Tidak Seimbang:** Jika kelas-kelas tidak seimbang, OvO mungkin lebih baik karena setiap klasifikasi biner dilatih pada subset yang seimbang. Namun, OvR dapat lebih efisien secara komputasi.

4. **Sumber Daya Komputasi:** Pertimbangkan sumber daya komputasi yang tersedia. OvO menjadi tidak praktikal untuk jumlah kelas yang besar, sedangkan OvR lebih scalable.

Multiclass Confusion Matrix



Evaluation Metric

$$Accuracy = \frac{TP + TN}{TP + TN + FP + FN}$$

$$Precision = \frac{TP}{TP + FP}$$

$$Recall = \frac{TP}{TP + FN}$$

$$F1\text{-}score = \frac{2 \times \text{Precision} \times \text{Recall}}{\text{Precision} + \text{Recall}}$$

	precision	recall	f1-score	support
Cat	0.308	0.667	0.421	6
Fish	0.667	0.200	0.308	10
Hen	0.667	0.667	0.667	9
accuracy			0.480	25
macro avg	0.547	0.511	0.465	25
weighted avg	0.581	0.480	0.464	25

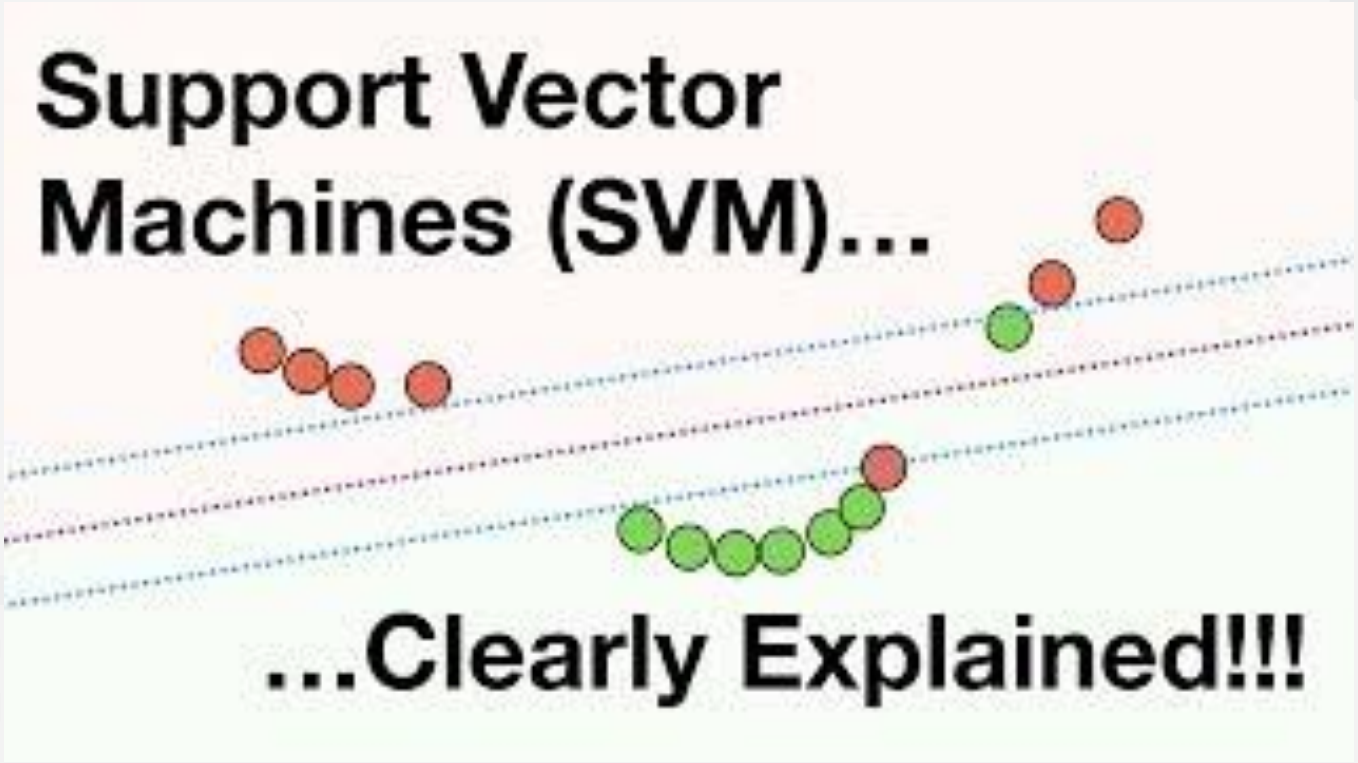
Evaluation Metric

Label	True Positive (TP)	False Positive (FP)	False Negative (FN)	Precision	Recall	F1 Score
Airplane	2	1	1	0.67	0.67	2 * (0.67 * 0.67) / (0.67 + 0.67) = **0.67**
Boat	1	3	0	0.25	1.00	2*(0.25 * 1.00) / (0.25 + 1.00) = **0.40**
Car	3	0	3	1.00	0.50	2 * (1.00 * 0.50) / (1.00 + 0.50) = **0.67**

Label	Per-Class F1 Score	Macro-Averaged F1 Score
Airplane	0.67	$\frac{0.67 + 0.40 + 0.67}{3}$ = **0.58**
Boat	0.40	
Car	0.67	

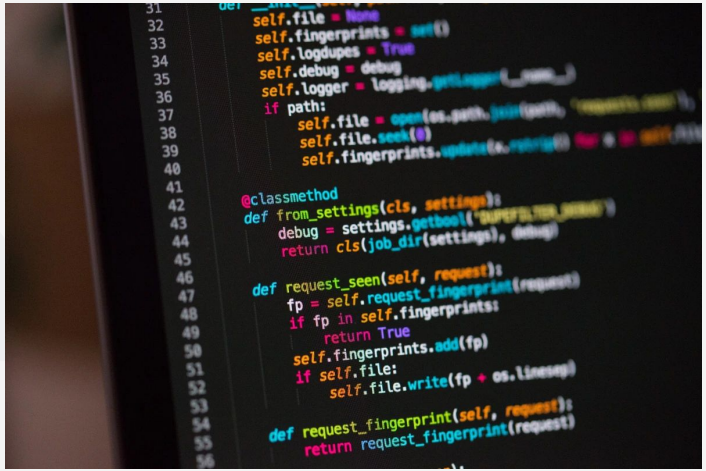
Label	Per-Class F1 Score	Support	Support Proportion	Weighted Average F1 Score
Airplane	0.67	3	0.3	$(0.67 * 0.3) + (0.40 * 0.1) + (0.67 * 0.6)$ = **0.64**
Boat	0.40	1	0.1	
Car	0.67	6	0.6	
Total	-	10	1.0	

Materi Tambahan



Implementasi

- SVM for Classification & Regression
- Hands-on Coding in Google Colab



Thank You