MACHINE LEARNING WITH PYTHON

SUPPORT VECTOR MACHINES

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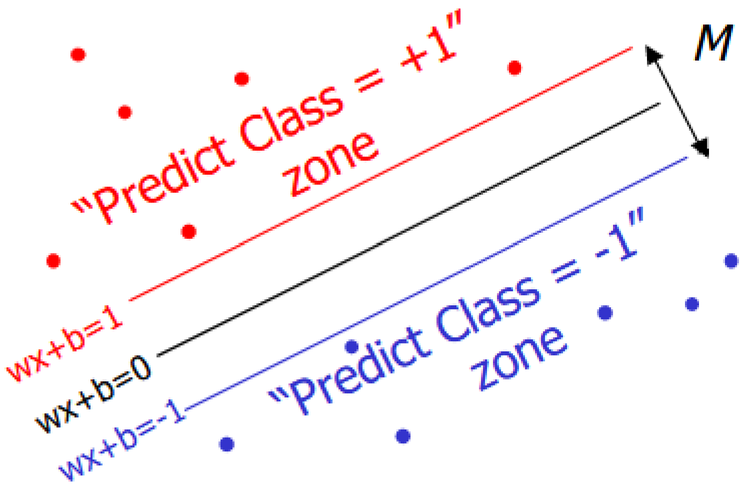
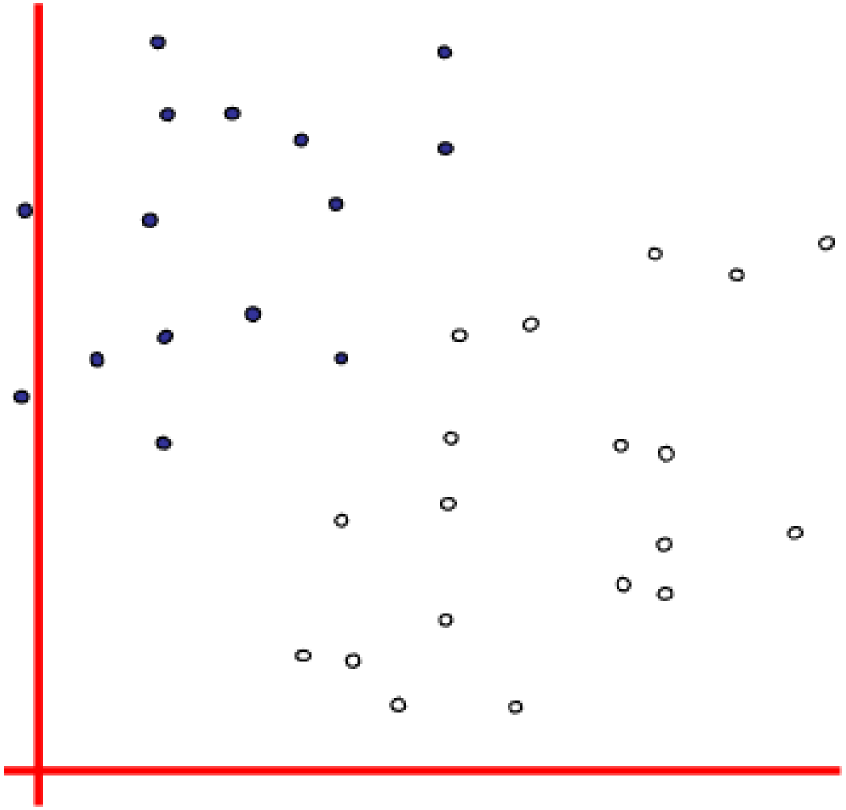
Maximum Margin

- Find optimal w, b to maximize the margin



$$M = \frac{2}{\sqrt{\mathbf{w} \cdot \mathbf{w}}}$$

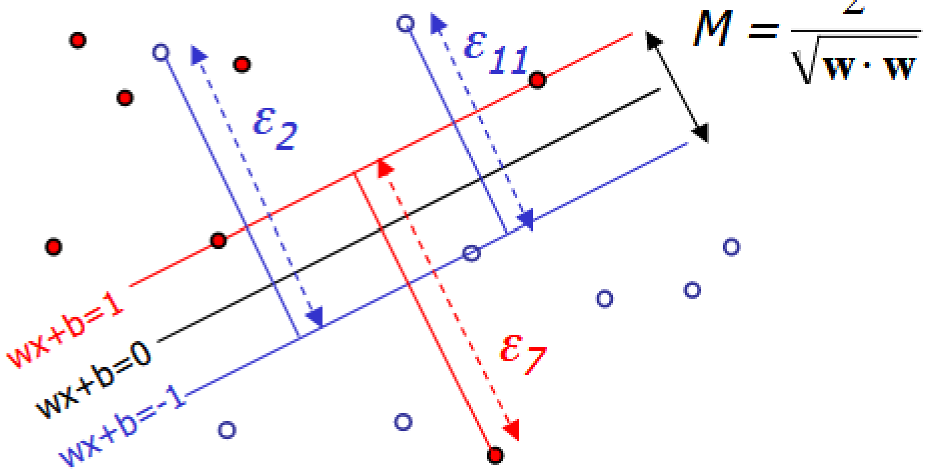


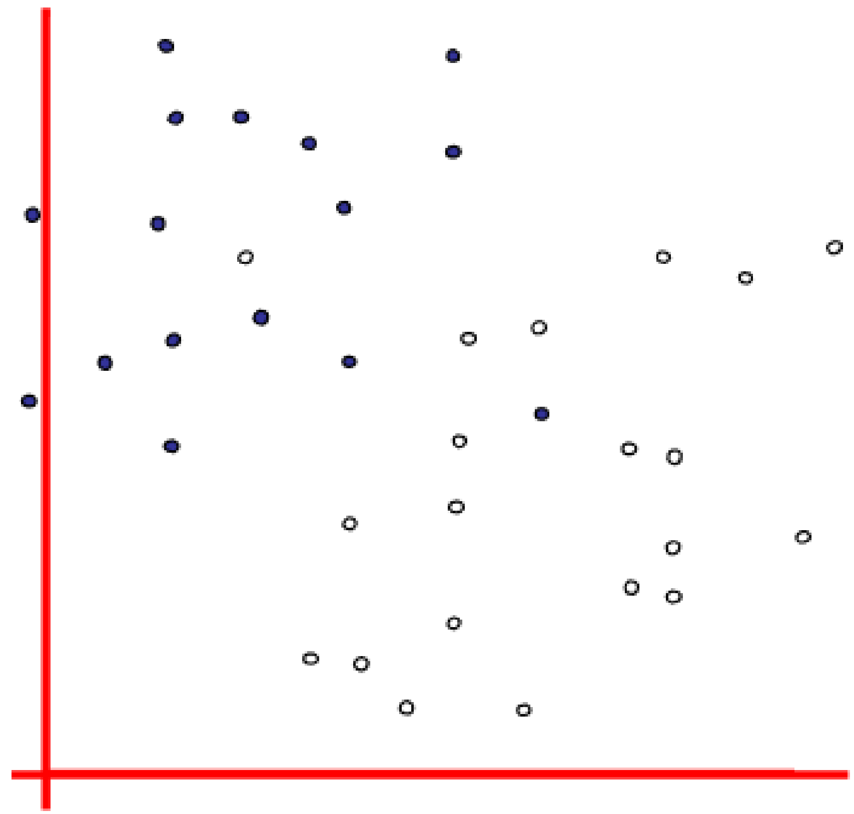
- Minimize $\frac{1}{2} w \cdot w$

Source: http://www.csd.uwo.ca/~dlizotte/teaching/slides/svm_1.pdf

Maximum Margin with Noise

- Allow misclassification errors





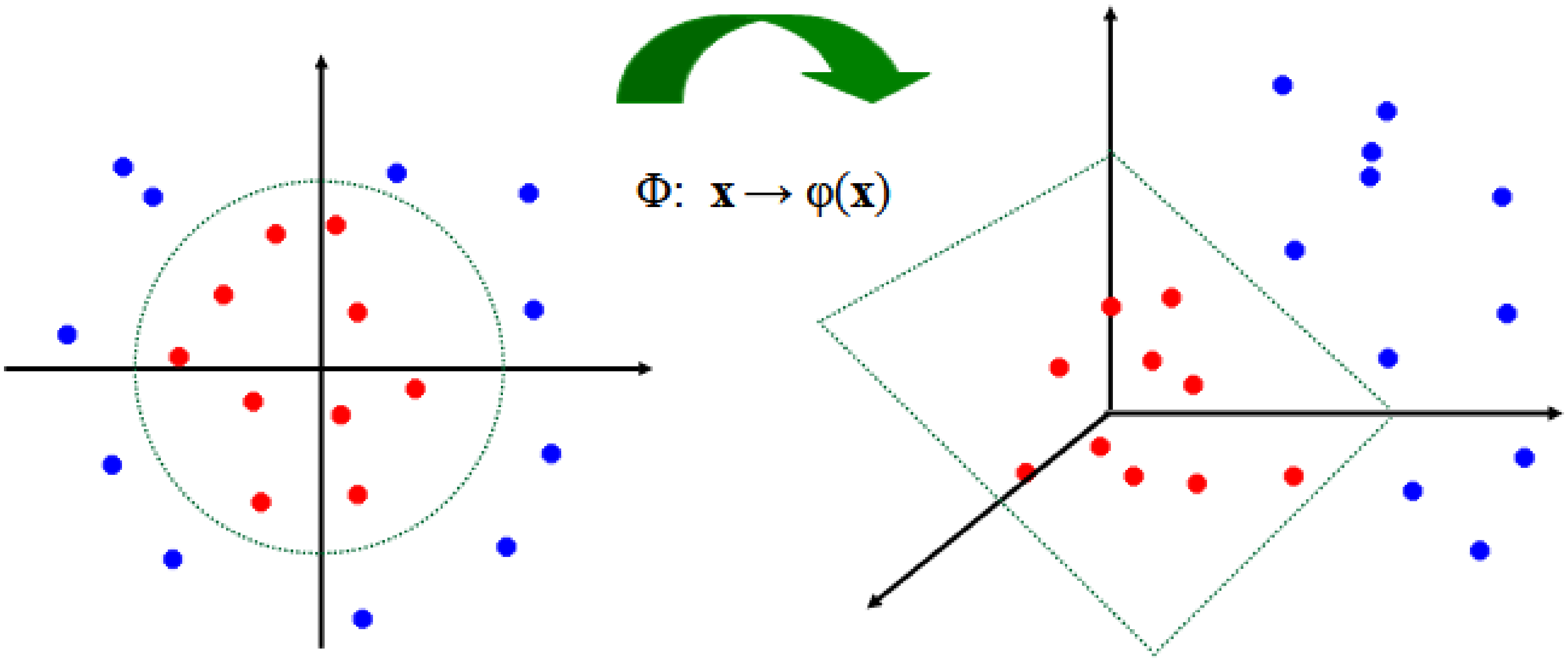
- Minimize $\frac{1}{2} w \cdot w + C \sum_k \varepsilon_k$

controls tolerance of misclassification

Source: http://www.csd.uwo.ca/~dlizotte/teaching/slides/svm_1.pdf

Transformation with Kernels

- Non-linearly separable data → linearly separable data

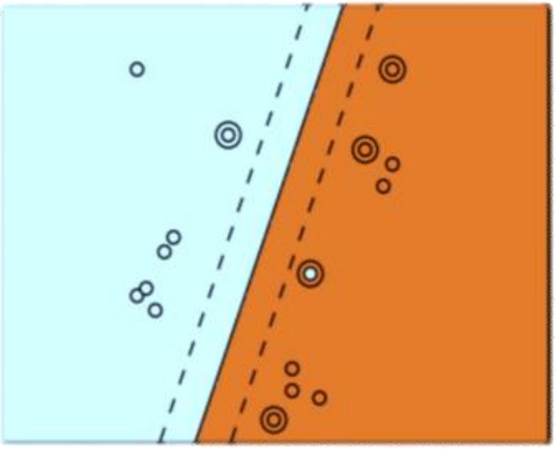


- Kernel trick: $K(x, x') = \varphi(x)^T \varphi(x')$
- Linear, Polynomial, tanh

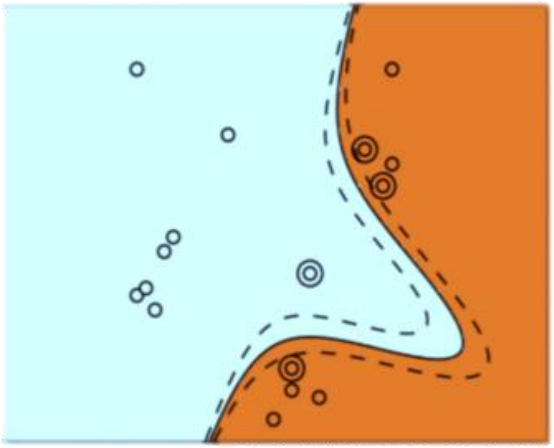
Source: https://www.slideshare.net/pbpimpale/support-vector-machine-24419322

Different types of Kernels

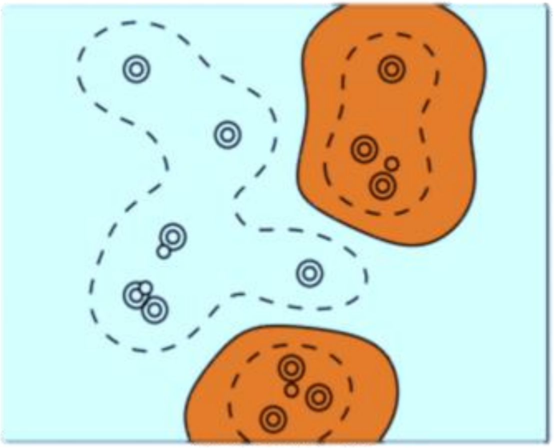
Linear Kernel



Polynomial Kernel



RBF Kernel



$$K(x,x') = x^T x'$$

$$K(x,x') = \left(x^T x' + 1\right)^d$$

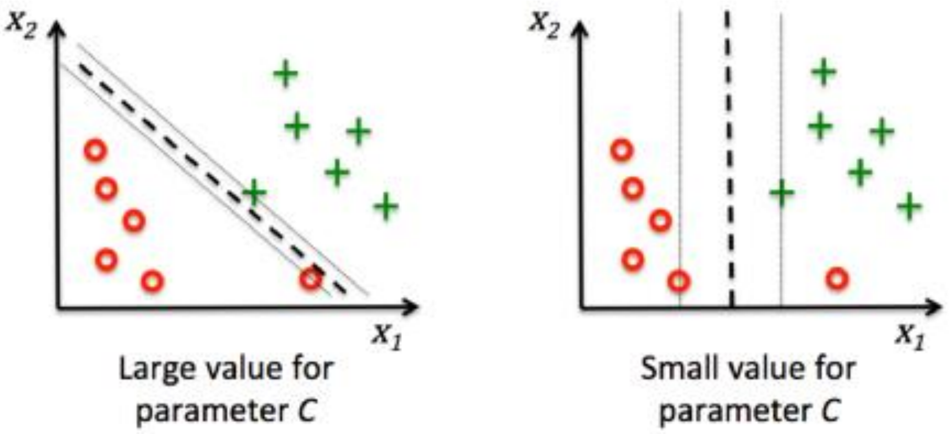
$$K(x,x') = e^{-\|x-x'\|^2 / 2\sigma^2}$$

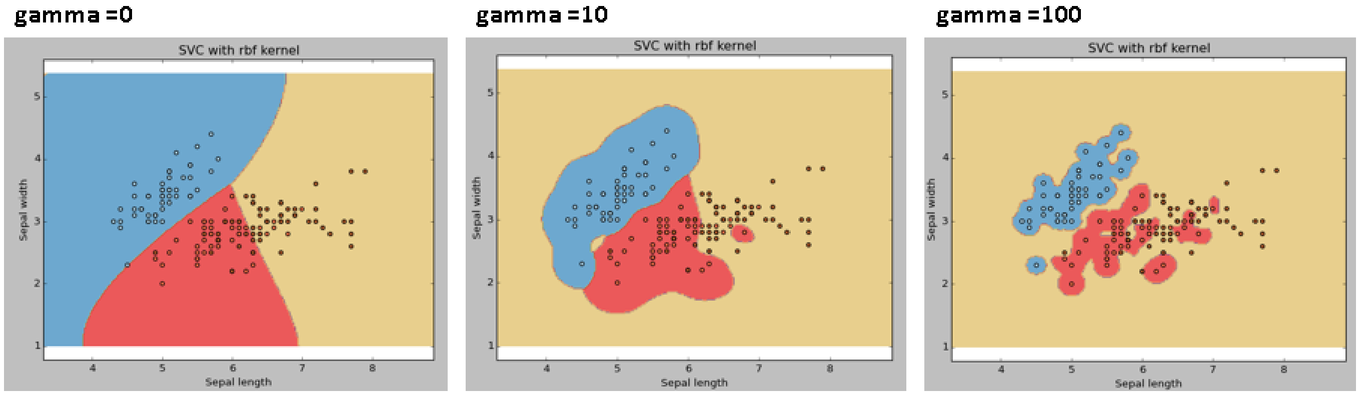
***$1/2\sigma^2 = \gamma$* controls the width of the RBF kernel**

Source: http://beta.cambridgespark.com/courses/jpm/05-module.html

Overfitting

- Parameter C
  - Large C → More error penalization
  - Small C → Allow more errors
- Parameter gamma
  - Large gamma → Exact data fit
  - Small gamma → Generalization



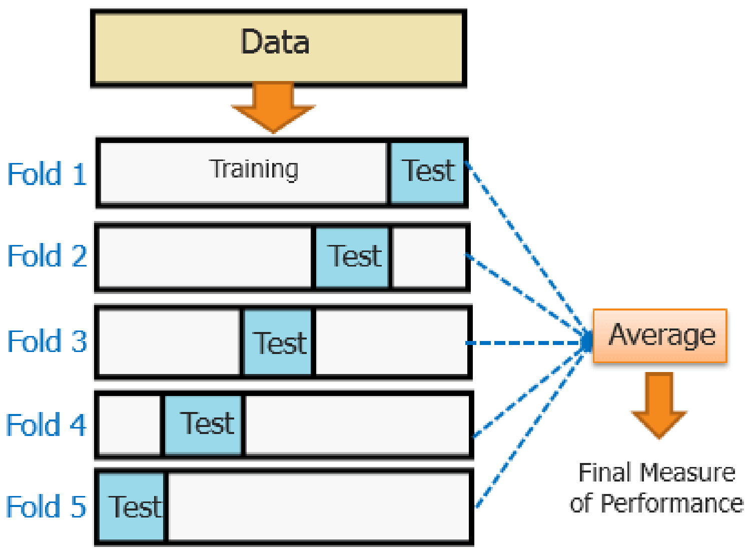


Sources: https://www.analyticsvidhya.com/blog/2017/09/understaing-support-vector-machine-example-code/
https://www.bogotobogo.com/python/scikit-learn/scikit_machine_learning_Support_Vector_Machines_SVM.php

Validation

- Split data in two parts
  - Use 1 part for training and 1 part for testing
  - Compare the errors

- Cross-validation
  - Divide dataset in k-folds
  - Use k-1 parts for training and 1 for testing
  - Repeat for all folds
  - Determine a metric value



Source: https://blog.contactsunny.com/data-science/different-types-of-validations-in-machine-learning-cross-validation