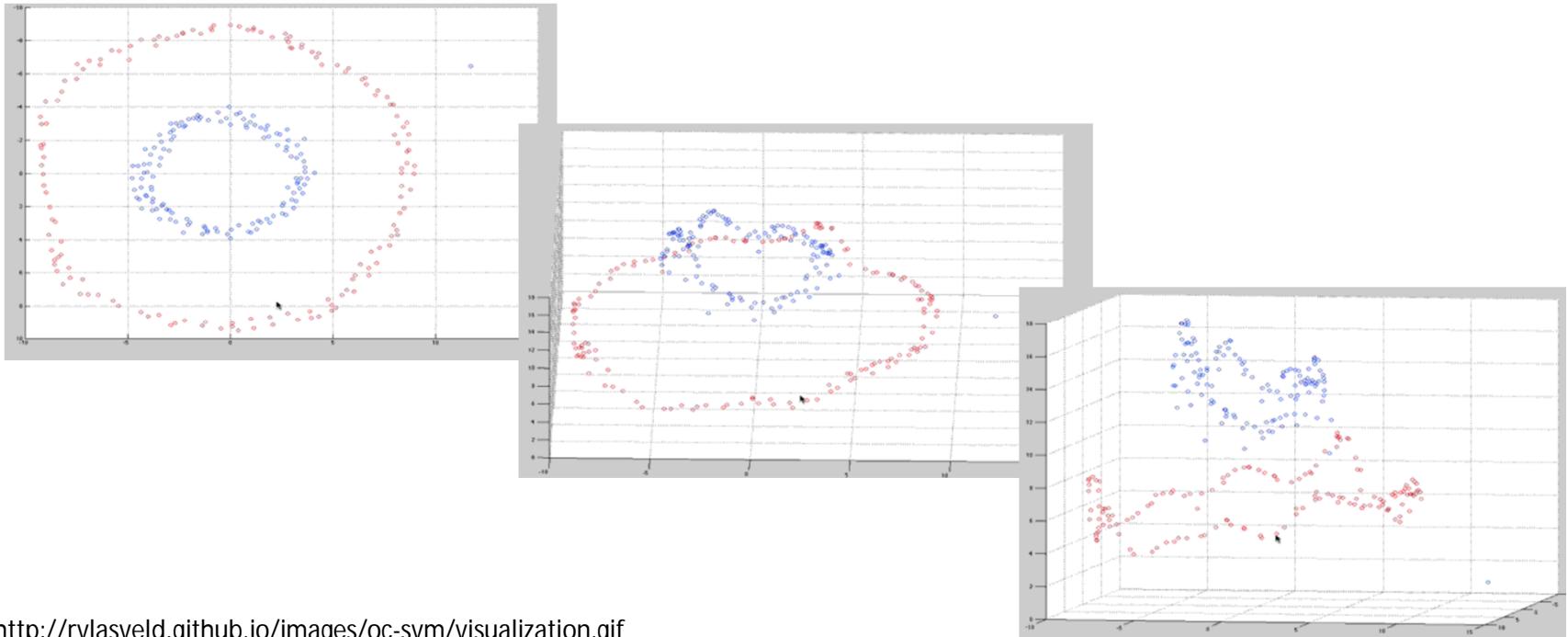


# What is Kernel trick?



<http://rvlasveld.github.io/images/oc-svm/visualization.gif>

# Agenda

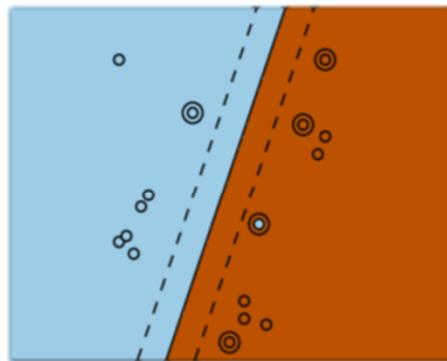
- What is SVM?
  - Ideology behind SVM
  - Intuition Development
  - Terminologies used in SVM
  - How does it work?
  - What is Kernel trick?
- 
- Types of kernels
    - Polynomial Kernel
    - Gaussian RBF Kernel
  - Support Vector Regression
  - Pros and Cons of SVM
  - Data preparation for SVM
  - Use Case - House Prices

# Types of kernels

1. Linear kernel
2. Polynomial kernel
3. Radial basis function kernel (RBF)/ Gaussian Kernel

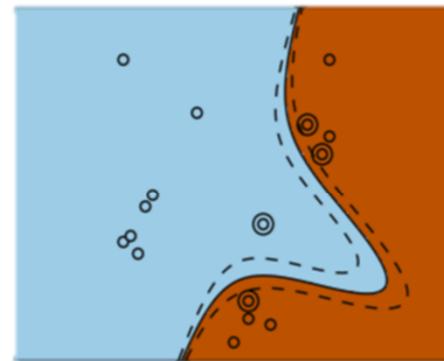
# Types of kernels

**Linear Kernel**



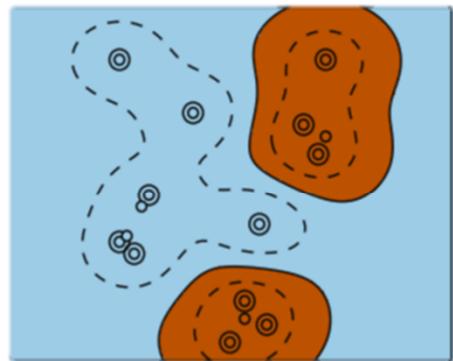
*C* hyperparameter

**Polynomial Kernel**



*C plus gamma, degree and coefficient* hyperparameters

**RBF Kernel**



*C plus gamma* hyperparameter

# Types of kernels

- We will be focusing on the **Polynomial** and **RBF / Gaussian** kernel since they are most commonly used.

# Agenda

- What is SVM?
  - Ideology behind SVM
  - Intuition Development
  - Terminologies used in SVM
  - How does it work?
  - What is Kernel trick?
- 
- Types of kernels
    - Polynomial Kernel
    - Gaussian RBF Kernel
  - Support Vector Regression
  - Pros and Cons of SVM
  - Data preparation for SVM
  - Use Case - House Prices

# Polynomial Kernel

- In general, the polynomial kernel is defined as:

$$k(x,y) = (\alpha x^T + c)^d$$

**$\alpha$  = slope**

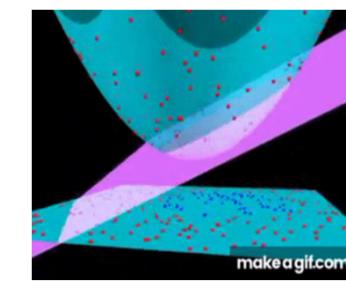
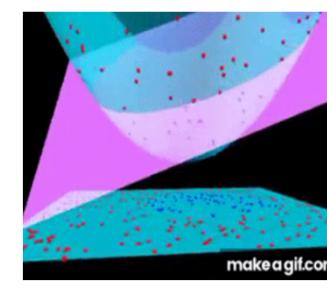
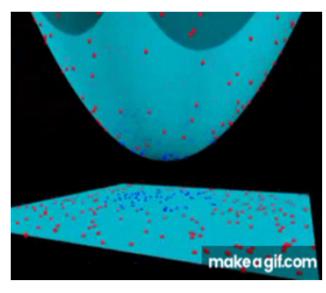
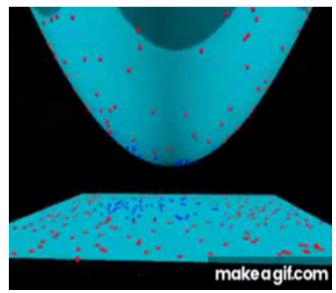
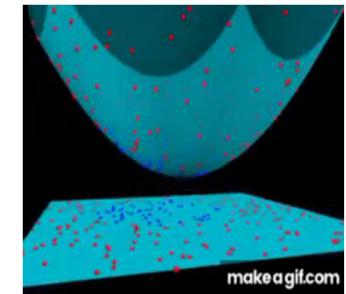
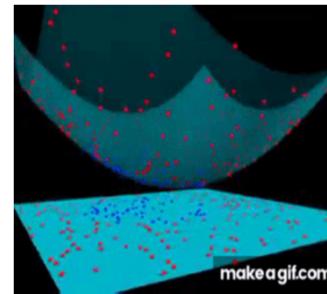
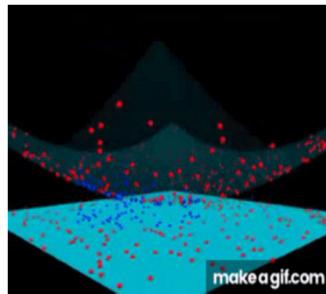
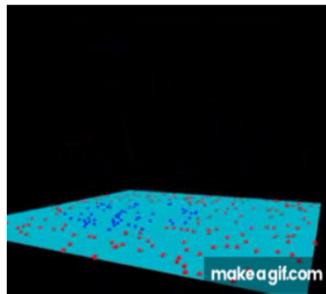
**$c$  = constant term**

**$d$  = degree of kernel**

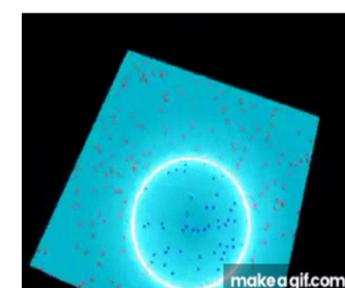
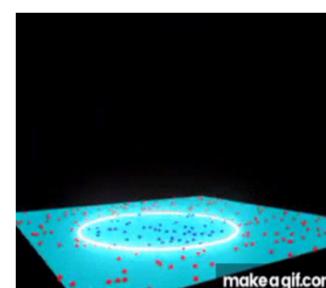
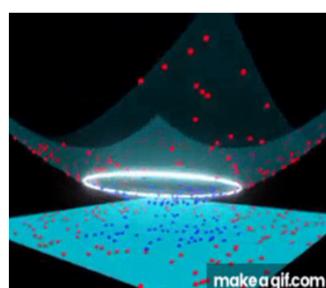
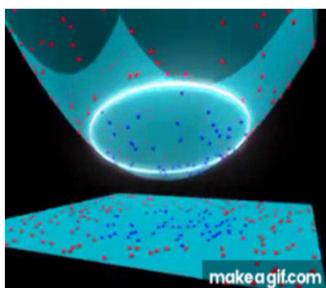
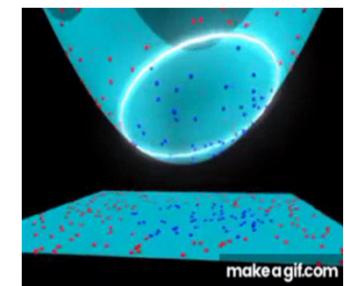
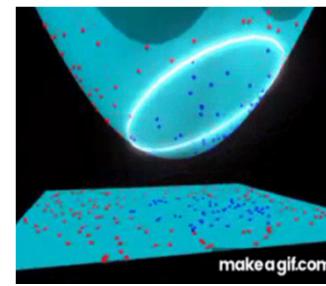
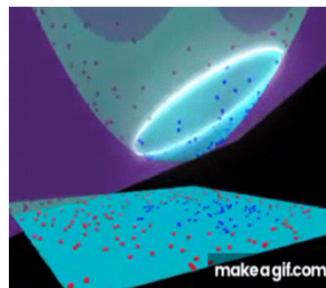
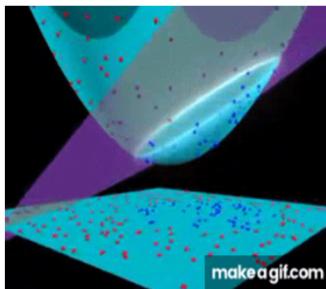
- In the polynomial kernel, we simply calculate the dot product by **increasing the power of the kernel**.

# Polynomial Kernel Visualization

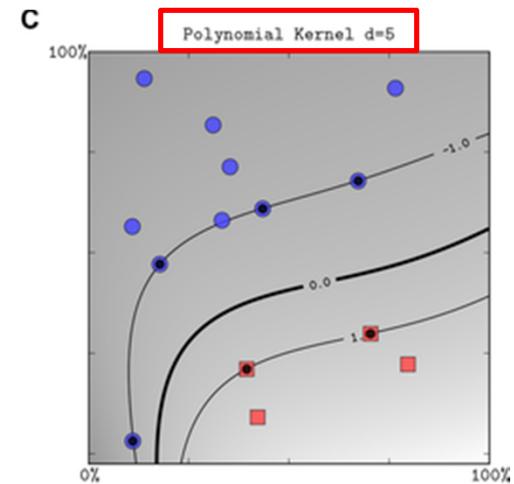
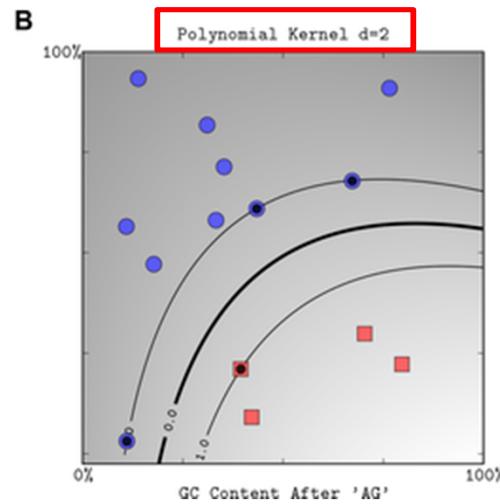
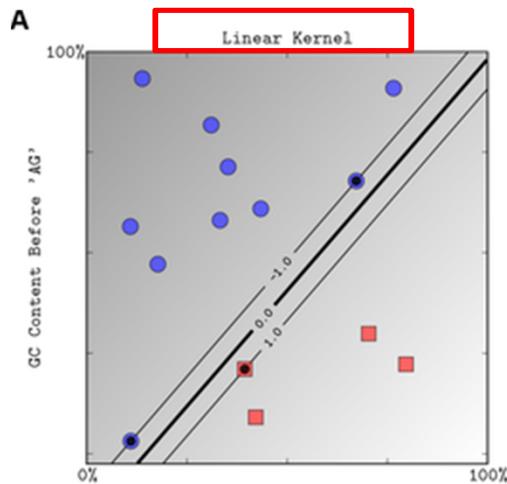
<https://www.youtube.com/watch?v=3liCbRZPrZA>



# Polynomial Kernel Visualization



# Polynomial Kernel



# Agenda

- What is SVM?
  - Ideology behind SVM
  - Intuition Development
  - Terminologies used in SVM
  - How does it work?
  - What is Kernel trick?
- 
- Types of kernels
    - Polynomial Kernel
    - Gaussian RBF Kernel
  - Support Vector Regression
  - Pros and Cons of SVM
  - Data preparation for SVM
  - Use Case - House Prices

# Radial basis function kernel (RBF)/ Gaussian Kernel

- **Gaussian RBF(Radial Basis Function)** is another popular Kernel method used in SVM models.
- RBF kernel is a function whose value depends on the distance from the origin or from some point.

# Gaussian RBF Kernel

- **Note:** *Similarity is the angular distance between two points.*

# Gaussian RBF Kernel

## Parameters – C and γ

- **C** : Inverse of the strength of regularization.

### Behavior

- As the value of '**C' increases** the model **overfits**.
- As the value of '**C' decreases** the model **underfits**.

# Gaussian RBF Kernel

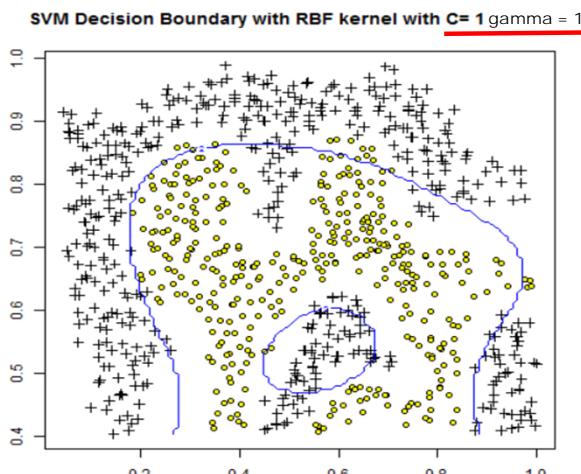
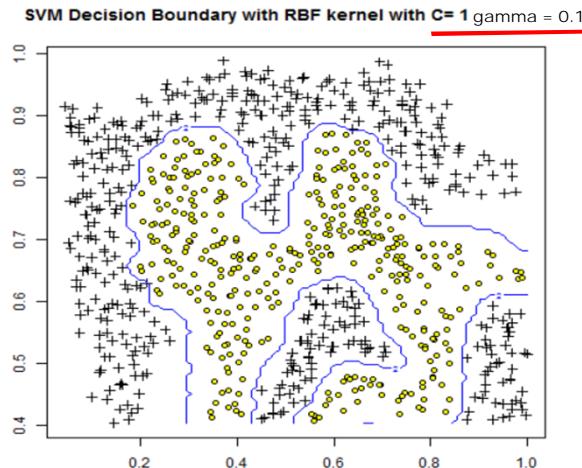
- $\gamma$  : Gamma (used only for RBF kernel)

## Behavior

- As the value of ' $\gamma$ ' increases the model overfits.
- As the value of ' $\gamma$ ' decreases the model underfits.

# Gaussian RBF Kernel

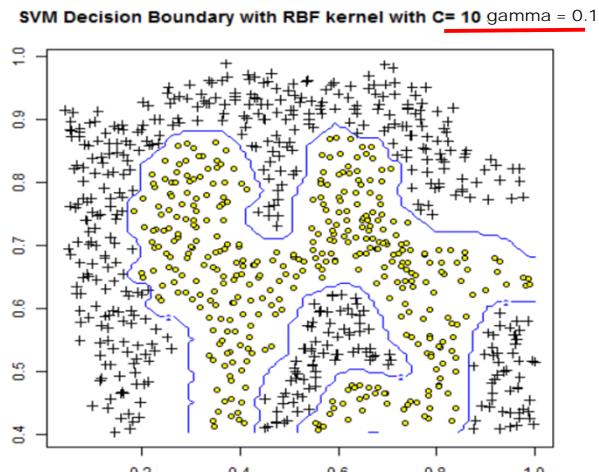
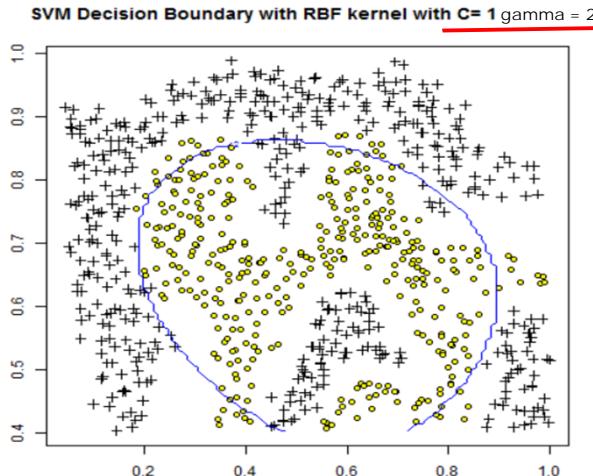
Observe the **change in Decision Boundary** for **different values of C and gamma**



<https://sandipanweb.files.wordpress.com/2016/07/svm3.gif>

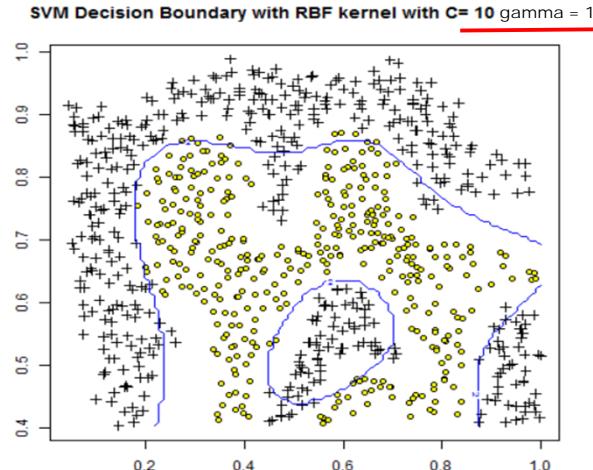
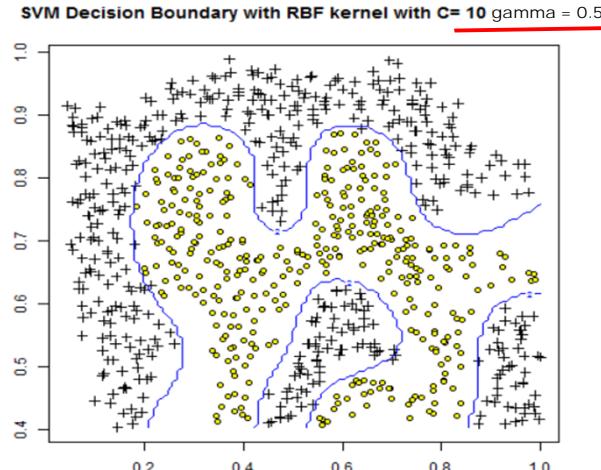
# Gaussian RBF Kernel

Observe the **change in Decision Boundary** for **different values of C and gamma**



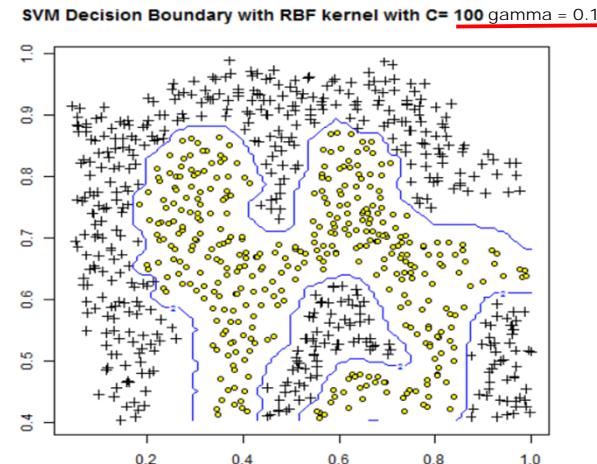
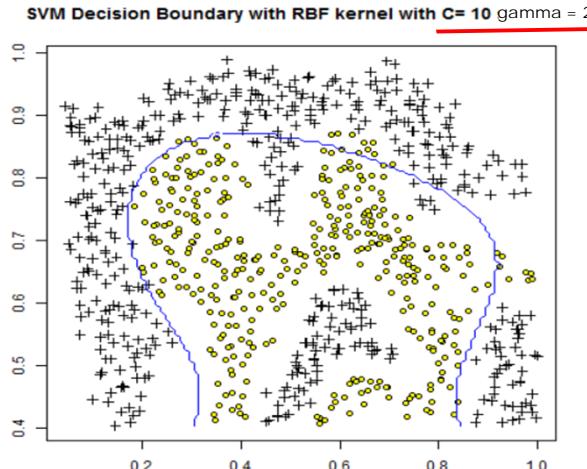
# Gaussian RBF Kernel

Observe the **change in Decision Boundary** for **different values of C and gamma**



# Gaussian RBF Kernel

Observe the **change in Decision Boundary** for **different values of C and gamma**



# Gaussian RBF Kernel

Observe the **change in Decision Boundary** for **different values** of **C** and **gamma**

