

Entregable 2

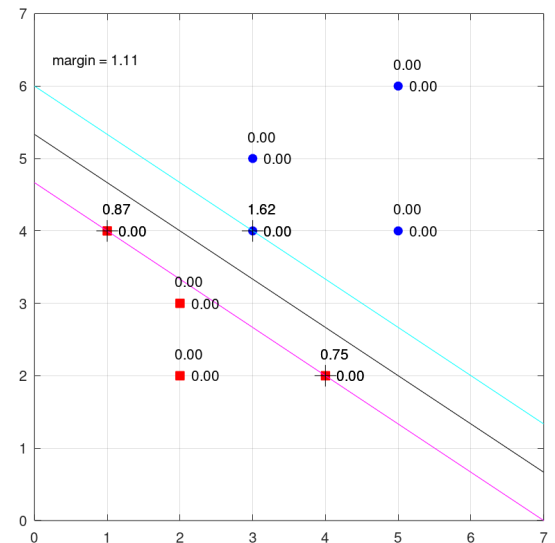
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Ejercicio 1

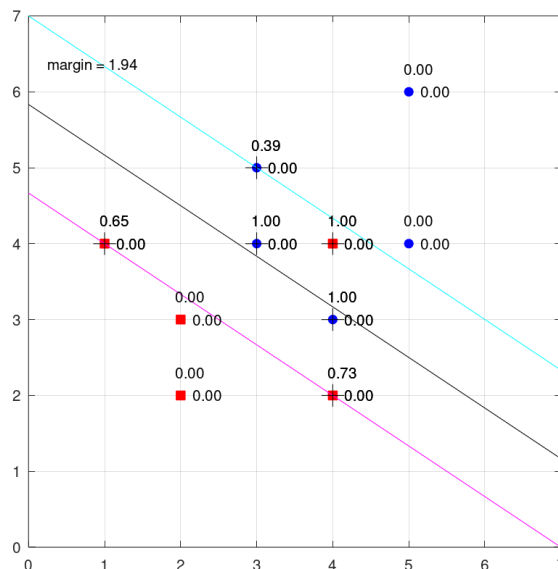
Para el caso separable con (*trSep.dat*, *trSeplabels.dat*) y $C = 1000$:

- Coeficientes de *Lagrange* = [0.87472 0.74989 -1.62461].
- Vector soporte
 - (1, 1) -> 1
 - (2, 1) -> 4
 - (3, 1) -> 3
 - (1, 2) -> 4
 - (2, 2) -> 2
 - (3, 2) -> 4
- Vector de pesos = [-0.99955 -1.49978].
- Umbral de la función discriminante = 7.9987.
- Margen = 1.1097.
- Función discriminante -> $y = -(0.66647)x - (-5.3332)$.



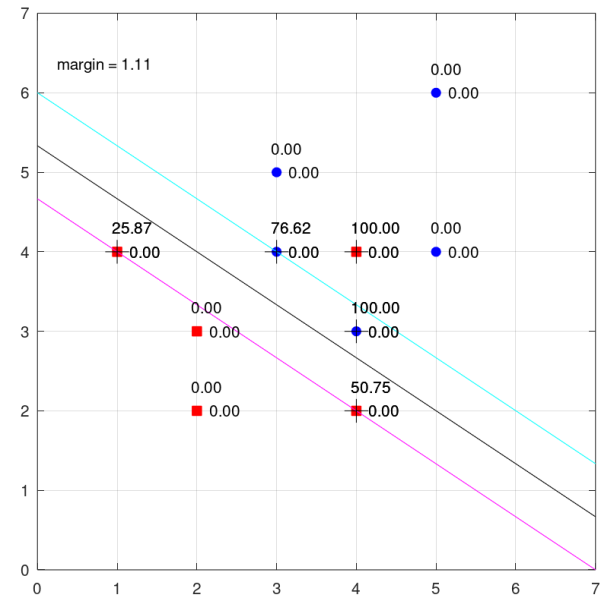
Para el caso no separable con y $C = 1$:

- Coeficientes de *Lagrange* = [0.65306 0.73472 1.0 -1.0 -0.38778 -1.0].
- Vector soporte
 - (1, 1) -> 1
 - (2, 1) -> 4
 - (3, 1) -> 4
 - (4, 1) -> 3
 - (5, 1) -> 3
 - (6, 1) -> 4
 - (1, 2) -> 4
 - (2, 2) -> 2
 - (3, 2) -> 4
 - (4, 2) -> 4
 - (5, 2) -> 5
 - (6, 2) -> 3
- Vector de pesos = [-0.57139 -0.85722].
- Umbral de la función discriminante = 5.0003.
- Margen = 1.9414.
- Función discriminante -> $y = -(0.66657)x - (-5.8331)$.



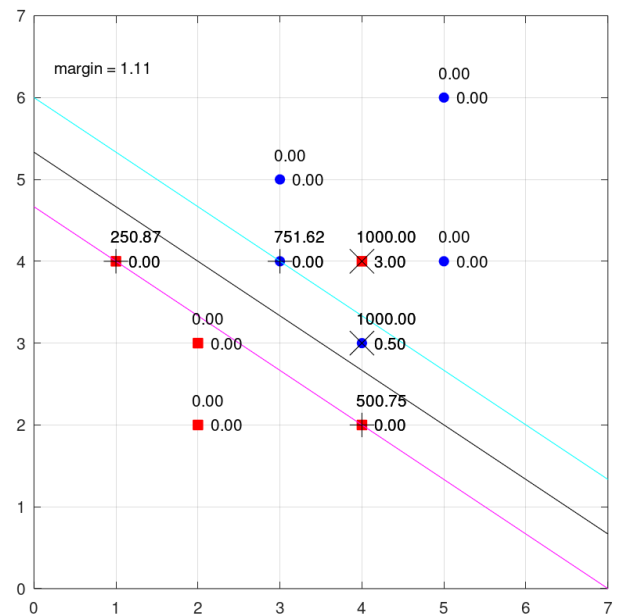
Para el caso no separable con γ y $C = 100$:

- Coeficiente de *Lagrange* = [25.875 50.750 100.0 -76.625 -100.0].
- Vector soporte
 - (1, 1) -> 1
 - (2, 1) -> 4
 - (3, 1) -> 4
 - (4, 1) -> 3
 - (5, 1) -> 4
 - (1, 2) -> 4
 - (2, 2) -> 2
 - (3, 2) -> 4
 - (4, 2) -> 4
 - (5, 2) -> 3
- Vector de pesos = [-0.99955 -1.49978].
- Umbral = 7.9987.
- Margen = 1.1097.
- Función discriminante -> $y = -(0.66647)x - (-5.3332)$



Para el caso no separable con γ y $C = 1000$:

- Coeficiente de *Lagrange* = [250.87 500.75 1000.00 -751.62 -1000.00].
- Vector soporte
 - (1, 1) -> 1
 - (2, 1) -> 4
 - (3, 1) -> 4
 - (4, 1) -> 3
 - (5, 1) -> 4
 - (1, 2) -> 4
 - (2, 2) -> 2
 - (3, 2) -> 4
 - (4, 2) -> 4
 - (5, 2) -> 3
- Vector de pesos = [-0.99955 -1.49977].
- Umbral = 7.9986.
- Margen = 1.1097.
- Función discriminante -> $y = -(0.66647)x - (-5.3332)$.



Ejercicio 2

Ver anexo para visualizar todos los resultados obtenidos por pca+svm-exp.m

PCA = 50

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 2 | 100 | 0.1 | 0.950000 | 0.001744 |
| 2 | 100 | 0.01 | 0.961667 | 0.001536 |
| 2 | 100 | 0.001 | 0.946667 | 0.001798 |
| 2 | 100 | 0.0001 | 0.921667 | 0.002150 |
| 2 | 100 | 1,00E-05 | 0.906667 | 0.002328 |

PCA = 100

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 2 | 100 | 0.1 | 0.910000 | 0.002290 |
| 2 | 100 | 0.01 | 0.968333 | 0.001401 |
| 2 | 100 | 0.001 | 0.928333 | 0.002064 |
| 2 | 100 | 0.0001 | 0.928333 | 0.002064 |
| 2 | 100 | 1,00E-05 | 0.906667 | 0.002328 |

PCA = 200

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 2 | 10 | 0.1 | 0.860000 | 0.002776 |
| 2 | 10 | 0.01 | 0.968333 | 0.001401 |
| 2 | 10 | 0.001 | 0.933333 | 0.001996 |
| 2 | 10 | 0.0001 | 0.911667 | 0.002271 |
| 2 | 10 | 1,00E-05 | 0.778333 | 0.003324 |

Los mejores resultados que hemos obtenido han sido con un *Kernel Gaussiano* (T=2) aplicando $PCA = 50$ con $C = 100$ y $PCA = 100$ con $C = 10$ y un valor *gamma* $G = 0.01$. Por lo que usaremos estos valores para la parte de evaluación , además. Hemos podido observar que, al aplicar *PCA* para la solución óptima y proyectando a pocas dimensiones, empeora el valor óptimo.

Ejercicio 3

PCA = 100

| T | C | G | acierto | intervalo |
|---|-----|------|---------|-----------------|
| 2 | 10 | 0.01 | 98.370 | [98.112 98.618] |
| 2 | 100 | 0.01 | 98.350 | [98.100 98.600] |

PCA = 200

| T | C | G | acierto | intervalo |
|---|-----|------|---------|-----------------|
| 2 | 10 | 0.01 | 98.280 | [98.025 98.535] |
| 2 | 100 | 0.01 | 98.280 | [98.025 98.535] |

Al ejecutar *pca+svm-eva.m* para un *Kernel Gaussiano* ($T=2$) aplicando $PCA = 50$ o $PCA = 100$ y con $C = 100$ o $C = 10$ y un valor *gamma* $G = 0.01$. Hemos observado que los parámetros que mejor resultado nos ofrecen son $PCA = 100$, $T = 2$, $C = 10$ y $G = 0.01$ con un error de clasificación del 1.63% al compararlo con el de *MNIST*, que es de un 1.4%.

| | | |
|----------------------|------|-----|
| SVM, Gaussian Kernel | none | 1.4 |
|----------------------|------|-----|

ANEXO

PCA = 50

| T | C | acierto | intervalo |
|---|---|----------|-----------|
| 0 | 1 | 0.925000 | 0.002108 |

| T | C | D | acierto | intervalo |
|---|---|---|----------|-----------|
| 1 | 1 | 1 | 0.920000 | 0.002171 |
| 1 | 1 | 2 | 0.961667 | 0.001536 |
| 1 | 1 | 3 | 0.950000 | 0.001744 |
| 1 | 1 | 4 | 0.926667 | 0.002086 |
| 1 | 1 | 5 | 0.893333 | 0.002470 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 2 | 1 | 0.1 | 0.945000 | 0.001824 |
| 2 | 1 | 0.01 | 0.956667 | 0.001629 |
| 2 | 1 | 0.001 | 0.910000 | 0.002290 |
| 2 | 1 | 0.0001 | 0.773333 | 0.003350 |
| 2 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 3 | 1 | 0.1 | 0.503333 | 0.004001 |
| 3 | 1 | 0.01 | 0.916667 | 0.002212 |
| 3 | 1 | 0.001 | 0.888333 | 0.002520 |
| 3 | 1 | 0.0001 | 0.508333 | 0.004000 |
| 3 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | acierto | intervalo |
|---|----|----------|-----------|
| 0 | 10 | 0.911667 | 0.002271 |

| T | C | D | acierto | intervalo |
|---|----|---|----------|-----------|
| 1 | 10 | 1 | 0.923333 | 0.002129 |
| 1 | 10 | 2 | 0.951667 | 0.001716 |
| 1 | 10 | 3 | 0.958333 | 0.001599 |
| 1 | 10 | 4 | 0.941667 | 0.001875 |
| 1 | 10 | 5 | 0.941667 | 0.001875 |

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 2 | 10 | 0.1 | 0.950000 | 0.001744 |
| 2 | 10 | 0.01 | 0.960000 | 0.001568 |
| 2 | 10 | 0.001 | 0.920000 | 0.002171 |
| 2 | 10 | 0.0001 | 0.906667 | 0.002328 |
| 2 | 10 | 1,00E-05 | 0.775000 | 0.003341 |

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 3 | 10 | 0.1 | 0.488333 | 0.004000 |
| 3 | 10 | 0.01 | 0.913333 | 0.002251 |
| 3 | 10 | 0.001 | 0.921667 | 0.002150 |
| 3 | 10 | 0.0001 | 0.888333 | 0.002520 |
| 3 | 10 | 1,00E-05 | 0.508333 | 0.004000 |

| T | C | acierto | intervalo |
|---|---|---------|-----------|
|---|---|---------|-----------|

| | | | |
|---|-----|----------|----------|
| 0 | 100 | 0.905000 | 0.002346 |
|---|-----|----------|----------|

| T | C | D | acierto | intervalo |
|---|-----|---|----------|-----------|
| 1 | 100 | 1 | 0.908333 | 0.002309 |
| 1 | 100 | 2 | 0.953333 | 0.001688 |
| 1 | 100 | 3 | 0.958333 | 0.001599 |
| 1 | 100 | 4 | 0.940000 | 0.001900 |
| 1 | 100 | 5 | 0.930000 | 0.002042 |

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 2 | 100 | 0.1 | 0.950000 | 0.001744 |
| 2 | 100 | 0.01 | 0.961667 | 0.001536 |
| 2 | 100 | 0.001 | 0.946667 | 0.001798 |
| 2 | 100 | 0.0001 | 0.921667 | 0.002150 |
| 2 | 100 | 1,00E-05 | 0.906667 | 0.002328 |

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 3 | 100 | 0.1 | 0.503333 | 0.004001 |
| 3 | 100 | 0.01 | 0.888333 | 0.002520 |
| 3 | 100 | 0.001 | 0.930000 | 0.002042 |
| 3 | 100 | 0.0001 | 0.921667 | 0.002150 |
| 3 | 100 | 1,00E-05 | 0.888333 | 0.002520 |

PCA = 100

| T | C | acierto | intervalo |
|---|---|----------|-----------|
| 0 | 1 | 0.906667 | 0.002328 |

| T | C | D | acierto | intervalo |
|---|---|---|----------|-----------|
| 1 | 1 | 1 | 0.923333 | 0.002129 |
| 1 | 1 | 2 | 0.953333 | 0.001688 |
| 1 | 1 | 3 | 0.896667 | 0.002436 |
| 1 | 1 | 4 | 0.518333 | 0.003998 |
| 1 | 1 | 5 | 0.246667 | 0.003449 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 2 | 1 | 0.1 | 0.906667 | 0.002328 |
| 2 | 1 | 0.01 | 0.961667 | 0.001536 |
| 2 | 1 | 0.001 | 0.913333 | 0.002251 |
| 2 | 1 | 0.0001 | 0.775000 | 0.003341 |
| 2 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 3 | 1 | 0.1 | 0.508333 | 0.004000 |
| 3 | 1 | 0.01 | 0.918333 | 0.002191 |
| 3 | 1 | 0.001 | 0.893333 | 0.002470 |
| 3 | 1 | 0.0001 | 0.508333 | 0.004000 |
| 3 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | acierto | intervalo |
|---|----|----------|-----------|
| 0 | 10 | 0.888333 | 0.002520 |

| T | C | D | acierto | intervalo |
|---|----|---|----------|-----------|
| 1 | 10 | 1 | 0.913333 | 0.002251 |
| 1 | 10 | 2 | 0.960000 | 0.001568 |

| | | | | |
|---|----|---|----------|----------|
| 1 | 10 | 3 | 0.958333 | 0.001599 |
| 1 | 10 | 4 | 0.923333 | 0.002129 |
| 1 | 10 | 5 | 0.756667 | 0.003433 |

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 2 | 10 | 0.1 | 0.910000 | 0.002290 |
| 2 | 10 | 0.01 | 0.965000 | 0.001471 |
| 2 | 10 | 0.001 | 0.930000 | 0.002042 |
| 2 | 10 | 0.0001 | 0.906667 | 0.002328 |
| 2 | 10 | 1,00E-05 | 0.776667 | 0.003333 |

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 3 | 10 | 0.1 | 0.505000 | 0.004001 |
| 3 | 10 | 0.01 | 0.906667 | 0.002328 |
| 3 | 10 | 0.001 | 0.923333 | 0.002129 |
| 3 | 10 | 0.0001 | 0.893333 | 0.002470 |
| 3 | 10 | 1,00E-05 | 0.508333 | 0.004000 |

| T | C | acierto | intervalo |
|---|-----|----------|-----------|
| 0 | 100 | 0.890000 | 0.002504 |

| T | C | D | acierto | intervalo |
|---|-----|---|----------|-----------|
| 1 | 100 | 1 | 0.906667 | 0.002328 |
| 1 | 100 | 2 | 0.958333 | 0.001599 |
| 1 | 100 | 3 | 0.961667 | 0.001536 |
| 1 | 100 | 4 | 0.943333 | 0.001850 |
| 1 | 100 | 5 | 0.933333 | 0.001996 |

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 2 | 100 | 0.1 | 0.910000 | 0.002290 |
| 2 | 100 | 0.01 | 0.968333 | 0.001401 |
| 2 | 100 | 0.001 | 0.928333 | 0.002064 |
| 2 | 100 | 0.0001 | 0.928333 | 0.002064 |
| 2 | 100 | 1,00E-05 | 0.906667 | 0.002328 |

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 3 | 100 | 0.1 | 0.505000 | 0.004001 |
| 3 | 100 | 0.01 | 0.876667 | 0.002631 |
| 3 | 100 | 0.001 | 0.913333 | 0.002251 |
| 3 | 100 | 0.0001 | 0.923333 | 0.002129 |
| 3 | 100 | 1,00E-05 | 0.893333 | 0.002470 |

PCA = 200

| T | C | acierto | intervalo |
|---|---|----------|-----------|
| 0 | 1 | 0.901667 | 0.002383 |

| T | C | D | acierto | intervalo |
|---|---|---|----------|-----------|
| 1 | 1 | 1 | 0.916667 | 0.002212 |
| 1 | 1 | 2 | 0.905000 | 0.002346 |
| 1 | 1 | 3 | 0.391667 | 0.003906 |
| 1 | 1 | 4 | 0.138333 | 0.002763 |
| 1 | 1 | 5 | 0.123333 | 0.002631 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 2 | 1 | 0.1 | 0.846667 | 0.002883 |
| 2 | 1 | 0.01 | 0.960000 | 0.001568 |
| 2 | 1 | 0.001 | 0.913333 | 0.002251 |
| 2 | 1 | 0.0001 | 0.776667 | 0.003333 |
| 2 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | G | acierto | intervalo |
|---|---|----------|----------|-----------|
| 3 | 1 | 0.1 | 0.526667 | 0.003995 |
| 3 | 1 | 0.01 | 0.923333 | 0.002129 |
| 3 | 1 | 0.001 | 0.895000 | 0.002453 |
| 3 | 1 | 0.0001 | 0.510000 | 0.004000 |
| 3 | 1 | 1,00E-05 | 0.123333 | 0.002631 |

| T | C | acierto | intervalo |
|---|----|----------|-----------|
| 0 | 10 | 0.898333 | 0.002418 |

| T | C | D | acierto | intervalo |
|---|----|---|----------|-----------|
| 1 | 10 | 1 | 0.923333 | 0.002129 |
| 1 | 10 | 2 | 0.965000 | 0.001471 |
| 1 | 10 | 3 | 0.906667 | 0.002328 |
| 1 | 10 | 4 | 0.430000 | 0.003961 |
| 1 | 10 | 5 | 0.165000 | 0.002970 |

| T | C | G | acierto | intervalo |
|---|----|-----|----------|-----------|
| 2 | 10 | 0.1 | 0.860000 | 0.002776 |

| | | | | |
|---|----|----------|----------|----------|
| 2 | 10 | 0.01 | 0.968333 | 0.001401 |
| 2 | 10 | 0.001 | 0.933333 | 0.001996 |
| 2 | 10 | 0.0001 | 0.911667 | 0.002271 |
| 2 | 10 | 1,00E-05 | 0.778333 | 0.003324 |

| T | C | G | acierto | intervalo |
|---|----|----------|----------|-----------|
| 3 | 10 | 0.1 | 0.513333 | 0.003999 |
| 3 | 10 | 0.01 | 0.915000 | 0.002232 |
| 3 | 10 | 0.001 | 0.926667 | 0.002086 |
| 3 | 10 | 0.0001 | 0.895000 | 0.002453 |
| 3 | 10 | 1,00E-05 | 0.510000 | 0.004000 |

| T | C | acierto | intervalo |
|---|-----|----------|-----------|
| 0 | 100 | 0.898333 | 0.002418 |

| T | C | D | acierto | intervalo |
|---|-----|---|----------|-----------|
| 1 | 100 | 1 | 0.900000 | 0.002400 |
| 1 | 100 | 2 | 0.953333 | 0.001688 |
| 1 | 100 | 3 | 0.965000 | 0.001471 |
| 1 | 100 | 4 | 0.906667 | 0.002328 |
| 1 | 100 | 5 | 0.491667 | 0.004000 |

| T | C | G | acierto | intervalo |
|---|-----|--------|----------|-----------|
| 2 | 100 | 0.1 | 0.860000 | 0.002776 |
| 2 | 100 | 0.01 | 0.965000 | 0.001471 |
| 2 | 100 | 0.001 | 0.936667 | 0.001949 |
| 2 | 100 | 0.0001 | 0.928333 | 0.002064 |

| | | | | |
|---|-----|----------|----------|----------|
| 2 | 100 | 1,00E-05 | 0.911667 | 0.002271 |
|---|-----|----------|----------|----------|

| T | C | G | acierto | intervalo |
|---|-----|----------|----------|-----------|
| 3 | 100 | 0.1 | 0.516667 | 0.003999 |
| 3 | 100 | 0.01 | 0.883333 | 0.002569 |
| 3 | 100 | 0.001 | 0.926667 | 0.002086 |
| 3 | 100 | 0.0001 | 0.926667 | 0.002086 |
| 3 | 100 | 1,00E-05 | 0.895000 | 0.002453 |