Problem 5: SVM (18 Points)

Part A (2 Points)

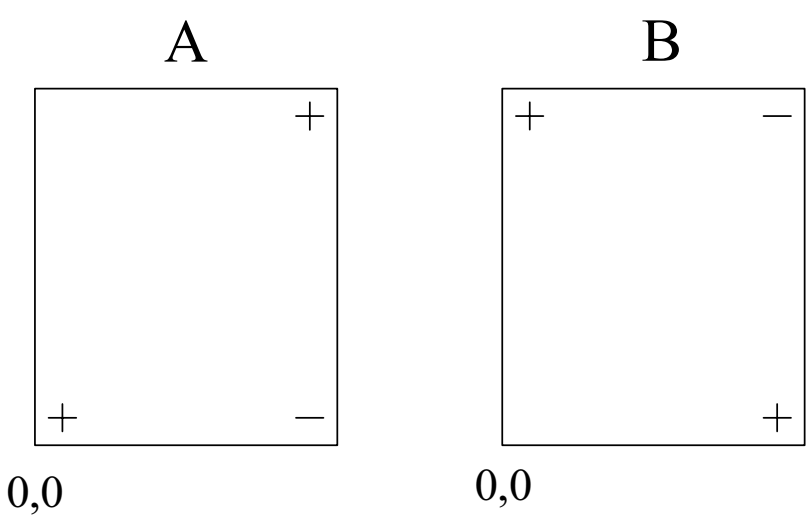
Consider the two arrangements of + and – points in drawings A and B, in which the arrangement in B is produced by rotating the arrangement in A around the center. Then select true or false for the following assertions:

Given a radial-basis kernel, $\kappa(v_1, v_2) = e^{\frac{-\|v_1 - v_2\|^2}{0.5}}$, the boundary separating the + and – points in B can be aligned with the boundary in A by a combination of translation and rotation.

- True
- False

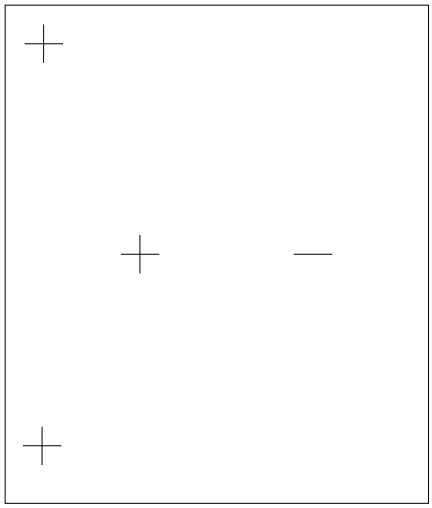
Given a polynomial kernel, $\kappa(v_1, v_2) = (v_1 \cdot v_2)^2$, where the vectors are drawn from the origin, the boundary separating the + and – points in B can be aligned with the boundary in A by a combination of translation and rotation..

- True
- False



Part B (4 Points)

Assume that a support vector machine is to learn to separate the + and – points in the following diagrams. Sketch the -1 or +1 lines (gutters of the widest street) and circle the points corresponding to support vectors assuming a polynomial kernel, $\kappa(v_1, v_2) = (v_1 \cdot v_2)^1$



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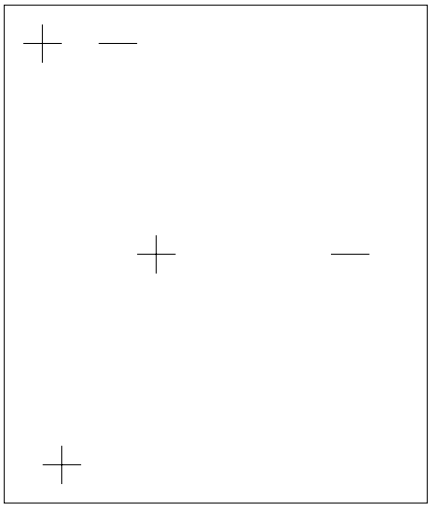

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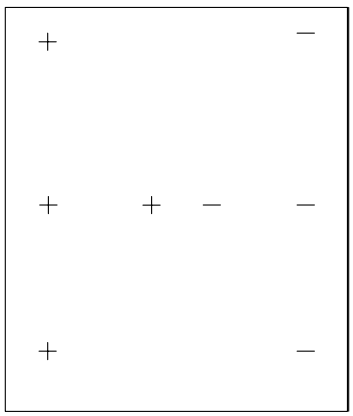
Part C.1(2 Points)

Assume that a support vector machine is to learn to separate the + and – points in the following diagram. Sketch the ***decision boundary*** (the 0 line, not the -1 or +1 lines) and circle the points corresponding to support vectors assuming a radial basis kernel, $\kappa(v_1, v_2) = e^{\frac{-\|v_1 - v_2\|^2}{2\sigma^2}}$, and a ***very large sigma***.



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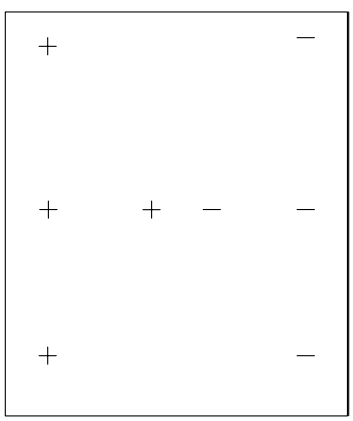
Part C.2(2 Points)

Assume that a support vector machine is to learn to separate the + and – points in the following diagram. Sketch the ***decision boundary*** (the 0 line, not the -1 or +1 lines) and circle the points corresponding to support vectors assuming a radial basis kernel, $\kappa(v_1, v_2) = e^{\frac{-\|v_1 - v_2\|^2}{2\sigma^2}}$, and a ***very small sigma***.



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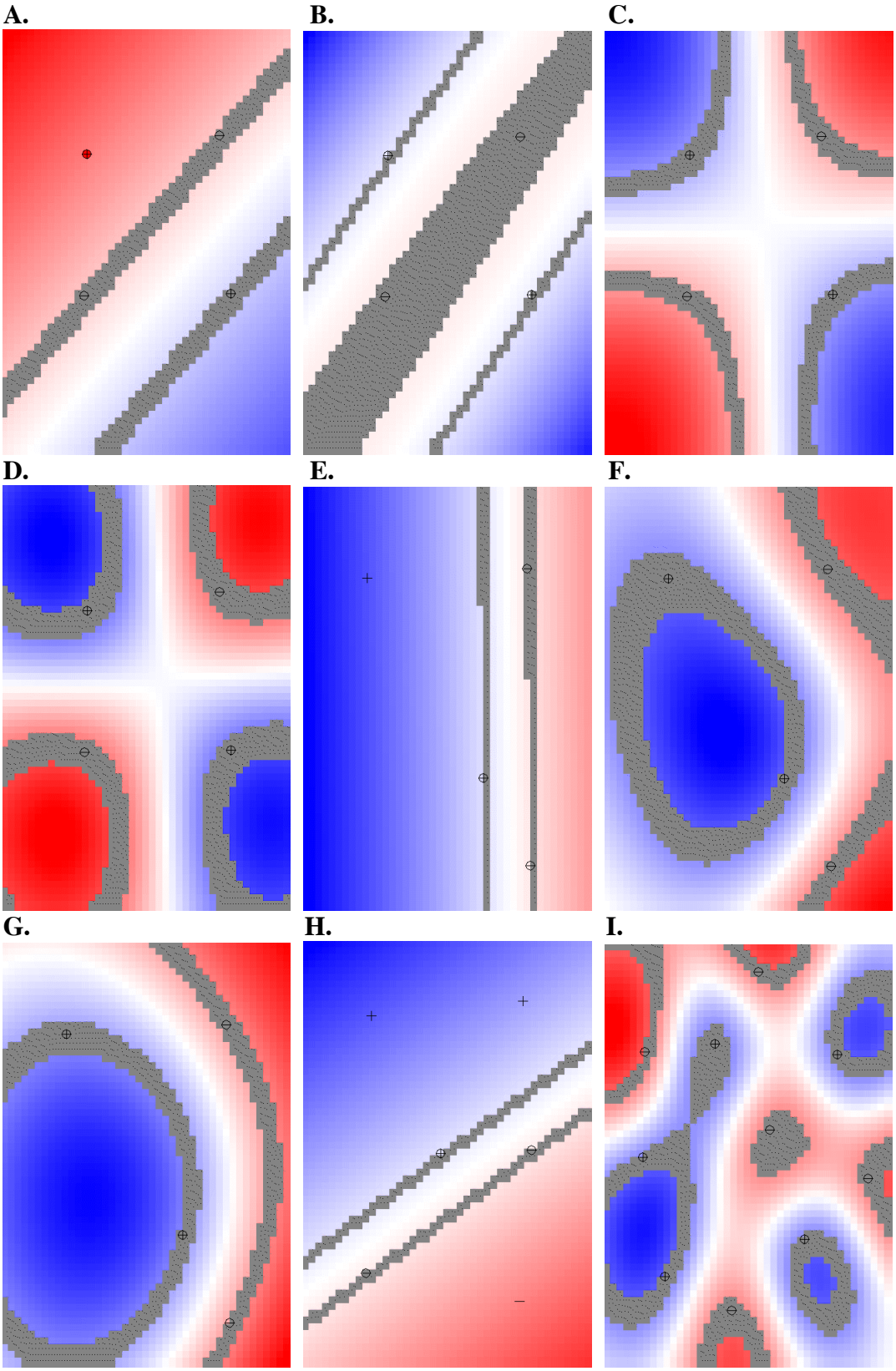
Part D (8 Points)

On the separate sheet, there are nine colored diagrams, labeled A through I, representing graphs of SVMs trained to separate pluses (+) from minuses (-). Indicate which diagram results from using which kernel function by writing the letter of the diagram next to the corresponding kernel.

<u>Note that the points are the same in diagrams A, B, C, and D. They are also the same in E, F, and G.</u>

$\kappa(v_1, v_2) = (v_1 \cdot v_2)^1$		$\kappa(v_1, v_2) = e^{\frac{-\lVert v_1 - v_2 \rVert^2}{0.5}}$	
$\kappa(v_1, v_2) = (v_1 \cdot v_2)^2$		$\kappa(v_1, v_2) = e^{\frac{-\lVert v_1 - v_2 \rVert^2}{0.22}}$	
$\kappa(v_1, v_2) = (v_1 \cdot v_1)^2$		$\kappa(v_1, v_2) = e^{\frac{-\lVert v_1 - v_2 \rVert^2}{0.08}}$	


A.
B.
C.
D.
E.
F.
G.
H.
I.