



Introduction to Machine Learning

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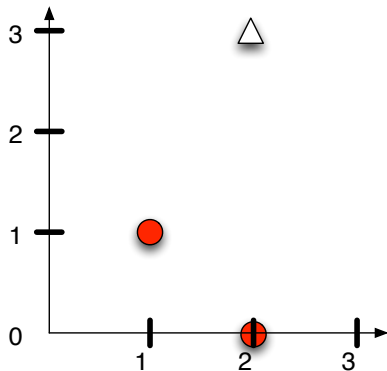
SLACK SVMS

Slides adapted from Tom Mitchell, Eric Xing, and Lauren Hannah

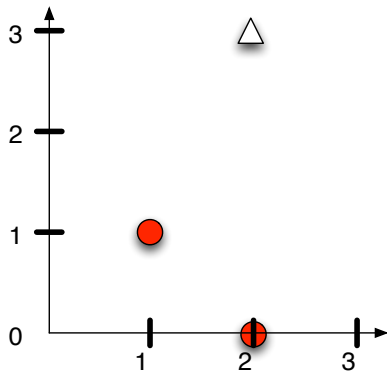
Content Questions

Administrative Questions

Find the maximum margin hyperplane



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Which are the support vectors?

Walkthrough example: building an SVM over the data shown

Working geometrically:

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- Set up system of equations

$$w_1 + w_2 + b = -1 \quad (1)$$

$$\frac{3}{2}w_1 + 2w_2 + b = 0 \quad (2)$$

$$2w_1 + 3w_2 + b = +1 \quad (3)$$

Walkthrough example: building an SVM over the data shown

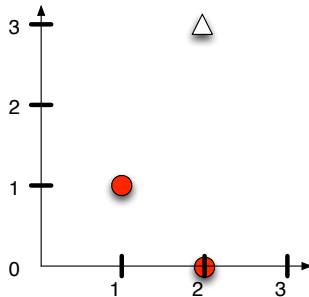
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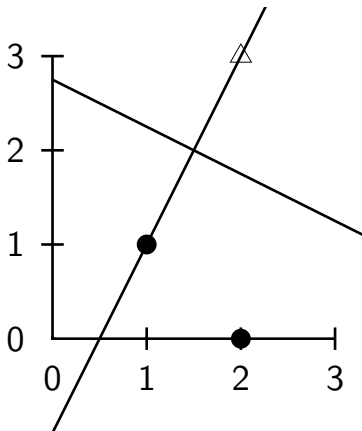
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The SVM decision boundary is:

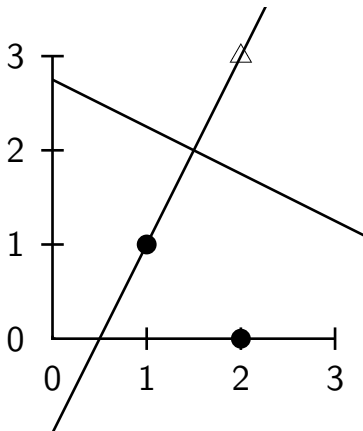
$$0 = \frac{2}{5}x + \frac{4}{5}y - \frac{11}{5}$$

Canonical Form



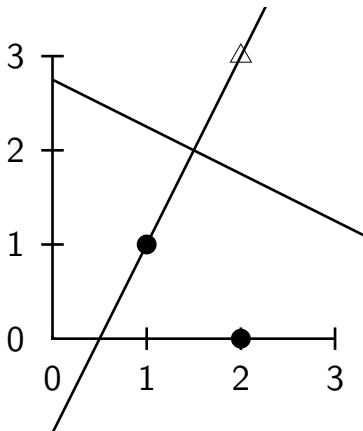
$$w_1x_1 + w_2x_2 + b$$

Canonical Form



$$.4x_1 + .8x_2 - 2.2$$

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$$.4x_1 + .8x_2 - 2.2$$

$$\blacksquare .4 \cdot 1 + .8 \cdot 1 - 2.2 = -1$$

$$\blacksquare .4 \cdot \frac{3}{2} + .8 \cdot 2 = 0$$

$$\blacksquare .4 \cdot 2 + .8 \cdot 3 - 2.2 = +1$$

What's the margin?

- Distance to closest point

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$$\frac{1}{\|w\|} = \frac{1}{\sqrt{\left(\frac{2}{5}\right)^2 + \left(\frac{4}{5}\right)^2}} = \frac{1}{\sqrt{\frac{20}{25}}} = \frac{5}{\sqrt{5}\sqrt{4}} = \frac{\sqrt{5}}{2} \quad (5)$$