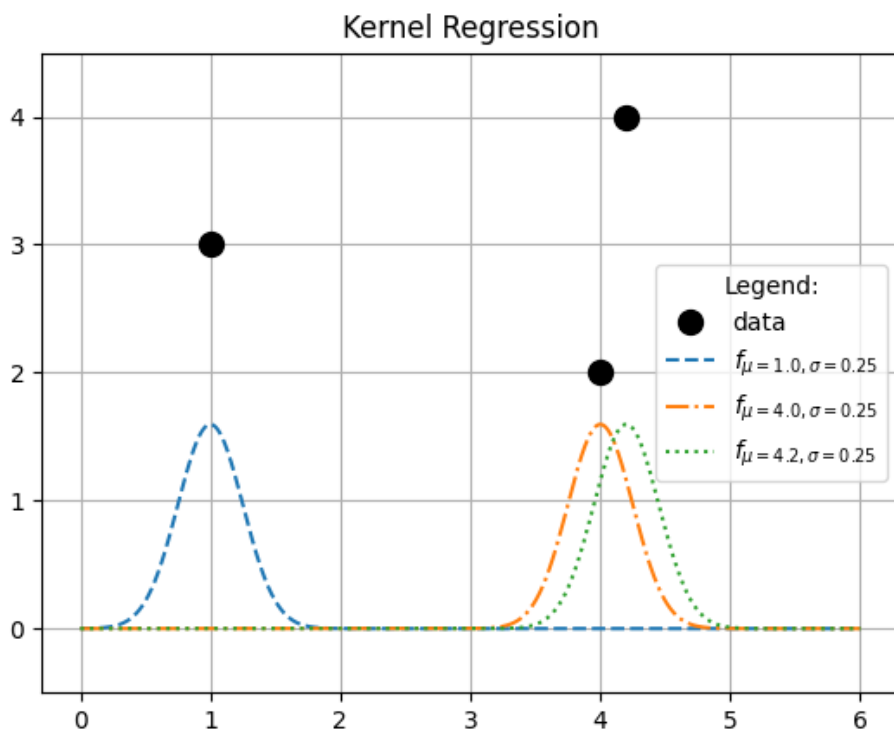


GroupH Practice

- Here is a graph of $\{(\mathbf{x}_i, y_i)\} = \{(x_i, y_i)\} = \{(1, 3), (4, 2), (4.2, 4)\}$ (each $\mathbf{x}_i$ is 1D) along with corresponding Gaussian curves $\{f_{\mu=x_i, \sigma=b}(x)\}$ made with bandwidth $b = 0.25$:



- Use kernel regression to estimate $y = f(x)$ for $x = 4.1$.

Based on the plot, the estimate is $\hat{y} \approx$.

ANSWER:

$\hat{y}$ at x is a weighted average of the $\{y\}$ values $\{3, 2, 4\}$ given by $f(x) = \sum_{i=1}^N w_i y_i$, where

$w_i = \frac{k\left(\frac{x-x_i}{b}\right)}{\sum_{j=1}^N k\left(\frac{x-x_j}{b}\right)}$, which is the height of the i th density curve at x divided by the

sum of the heights of all the curves at x . (Well, it's b times the height of the i th curve divided by b times the sum—the b 's cancel.)

At $x = 4.1$, the weights are $\approx \{0, 1.5, 1.5\} / (0 + 1.5 + 1.5) \approx \{0, 0.5, 0.5\}$, so $\hat{y} \approx 0 \times 3 + 0.5 \times 2 + 0.5 \times 4 \approx 3$.

Note that the answer does not depend on the approximate density value being exactly 1.5. The answer is 3 for any choice of first density near zero with second and third densities equal and nonzero.

(b) Estimate $y = f(x)$ for $x = 1$.

Based on the plot, the estimate is $\hat{y} \approx$.

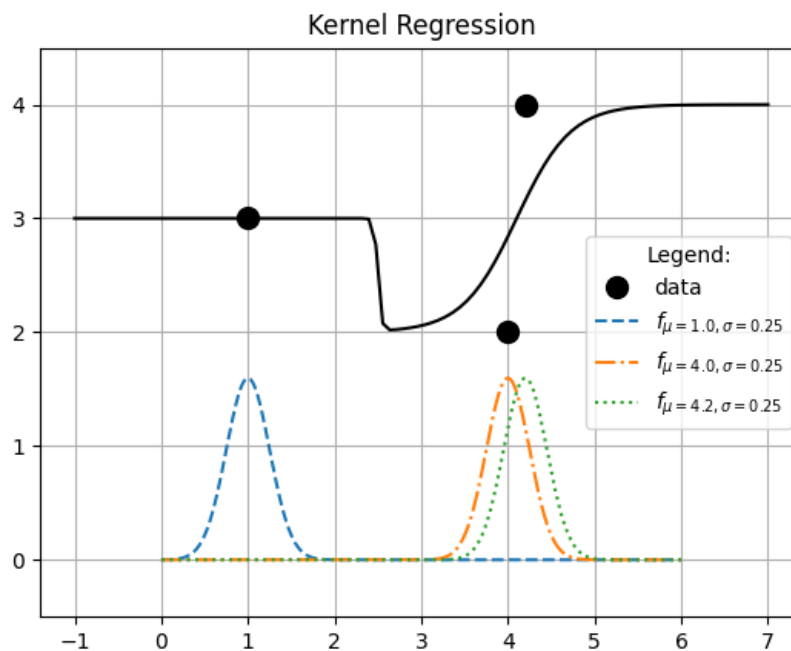
ANSWER:

We can see at $x = 1$ that $w_1 \approx 1$, $w_2 \approx 0$, and $w_3 \approx 0$, so $\hat{y} \approx 1 \cdot 3 + 0 \cdot 2 + 0 \cdot 4 = 3$.

(c) On the figure above, draw the estimated regression function over the interval $[0, 6]$. Hints:

- Use your $\hat{y}$ estimate at $x = 1$.
- The weights are approximately constant over $x \in (-\infty, \approx 2.5)$, which includes $x = 1$.
- Just right of ≈ 2.5 , the dash-dot curve dominates.
- Use your $\hat{y}$ estimate at $x = 4.1$.
- Moving further right shifts weight from the dash-dot curve to the dotted curve, which dominates as $x \rightarrow \infty$.
- (This question is a little too painful. Try to learn from it anyway.)

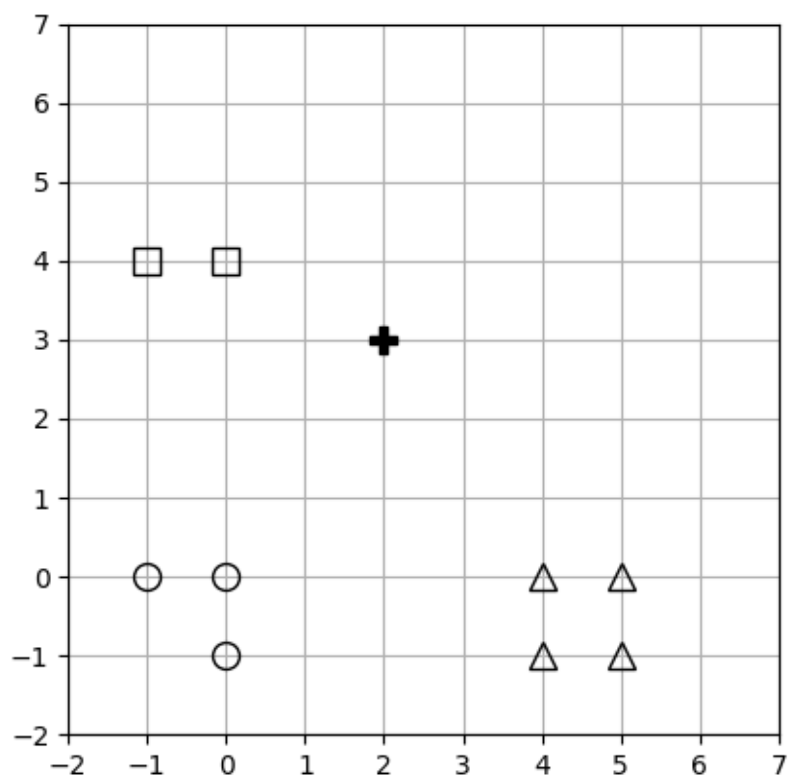
ANSWER:



Anything close is ok, where “close” includes having $\hat{y}$:

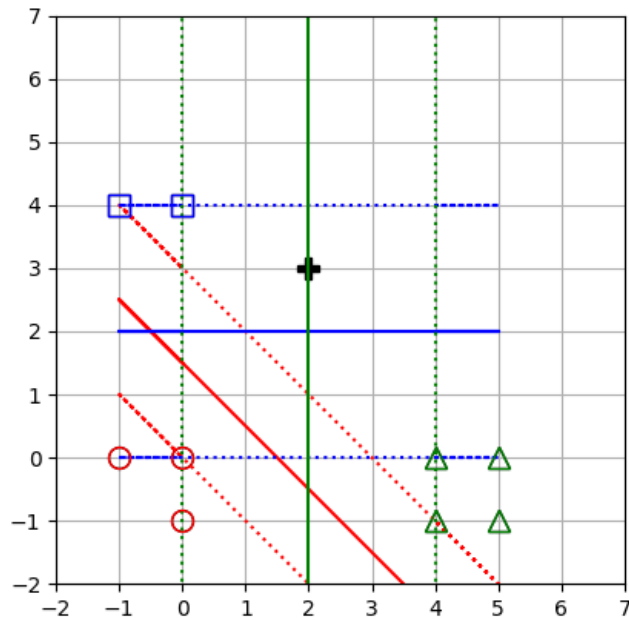
- ≈ 3 over $x \in (-\infty, \approx 2.5)$
- increasing from ≈ 2 to ≈ 4 over $(\approx 2.5, \infty)$
- ≈ 3 at $x = 4.1$
- increasing toward 4 over $(4.1, \infty)$

2. Consider a one-vs.-rest linear SVM classifier trained on the following data depicted by circles, squares, and triangles:



- (a) On the graph above, draw the three binary classifiers required by this method.

ANSWER:



(b) How does this classifier classify the point indicated by “+”?

_____ circle
 _____ square
 _____ triangle

ANSWER:

_____ circle
X square
 _____ triangle

From the graph in (a), note that:

- The blue boundary indicates that “+” is a square by the square-vs.-rest classifier (with a distance of 1 from the boundary).
- The green boundary indicates that “+” could be a triangle or not by the triangle-vs.-rest classifier (with a distance of 0 from the boundary).
- The red boundary indicates that “+” is not a circle by the circle-vs.-rest classifier (with a distance of about 2.5 on the wrong side of the boundary).

So the “+” is a square.

(c) Which category is ranked second by this classifier’s decision method for the “+”?

_____ circle
 _____ square
 _____ triangle

ANSWER:

- ☐ circle
- ☐ square
- ☒ triangle

Since the “+” is on the boundary for triangle but on the “not circle” side for circle, the second choice would be triangle.