For these exercises, it will be helpful to review the notes on Linear Classifiers

1) Feature representation

For the following feature, pick what might be the best encoding for linear classification. The assumption is that there are other features in the data set.

The point of this question is to think about alternatives; there are many options, many not mentioned here.

Car make, e.g. Chevy, Ford, Toyota, VW, for predicting gas mileage (lo, hi).

4 unary features (one-hot): 1000, 0100, 0010, 0001

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2) Feature mapping

Consider the following, one-dimensional, data set. It is not linearly separable in its original form.

1. $x^{(1)} = -1,\ y^{(1)} = +1$
2. $x^{(2)} = 0,\ y^{(2)} = -1$
3. $x^{(3)} = 1,\ y^{(3)} = +1$

Ex2.a.: Which of these feature transformations leads to a separable problem?

1. $\phi(x) = 0.5 * x$
2. $\phi(x) = |x|$
3. $\phi(x) = x^3$
4. $\phi(x) = x^4$
5. $\phi(x) = x^{2k}$ for any positive integer k

Enter a Python list with a subset of the numbers 1, 2, 3, 4, 5. [2,4,5]

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Solution: `[2, 4, 5]`

Explanation:

The original dataset has a -1 point at the origin and +1 points at ± 1.
1. $\phi(x) = 0.5 \cdot x$ scales the points down by 0.5, such that the +1 points are still on opposite sides of the origin, so (1) does not separate the data.
2. $\phi(x) = |x|$ maps the +1 points to 1 and the -1 point to 0, so (2) separates the data.
3. $\phi(x) = x^3$ maps the data to itself, so it does not separate the data.
4. $\phi(x) = x^4$ performs the same feature mapping as (2).
5. $\phi(x) = x^{2k}$ performs the same feature mapping as (2), regardless of the integer k.

Ex2.b.: Your friend Kernelius uses feature transformation $\phi(x) = (x, x^2)$ on the data above. In the new space, the linear classifier with $\theta = (0, 1)$ and $\theta_0 = -0.25$ achieves perfect accuracy. What points from the original space $\mathbb{R}$ map to this linear classifier in $\mathbb{R}^2$? (It may be helpful to find the equation of the separator.)

Enter a Python list with all values of x which constitute this separator. [-0.5,0.5]

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Solution: `[-0.5, 0.5]`

Explanation:

With $\theta = (0, 1)$ and $\theta_0 = -0.25$, our separator is the line $y = 0.25$ in $\mathbb{R}^2$. From our original space $\mathbb{R}$, points mapped onto the separator are those for which $x^2 = 0.25$, leading to $x = \pm 0.5$