2\. a. $H_{\hat{\beta}_0, \hat{\beta}} = \{X : \hat{\beta}_0 + \hat{\beta}^T X = 0\} \subset \mathbb{R}^p$

From Lecture 14 Page 81 $\hat{d} = \frac{1}{\|\hat{\beta}\|}$

We want to shift all X a distance $\hat{d}$ in the direction orthogonal to $\beta \rightarrow X^{\pm} = X \pm \frac{\hat{d}\beta}{\|\beta\|}$ d

$X = X^{+} - \frac{d\beta}{\|\beta\|}$

$X = X^{-} + \frac{d\beta}{\|\beta\|}$

$$\boxed{\begin{aligned} H^{+} &= \{X^{+} : \hat{\beta}_0 + \beta^T (X^{+} - \tfrac{d\beta}{\|\beta\|}) = 0\} \\ H^{-} &= \{X^{-} : \hat{\beta}_0 + \beta^T (X^{-} + \tfrac{d\beta}{\|\beta\|}) = 0\} \end{aligned}}$$

$$H^{+} = \{X^{+} : \hat{\beta}_0 + \beta^T (X^{+} - \tfrac{\beta}{\|\beta\|^2}) = 0\}$$

$$H^{-} = \{X^{-} : \hat{\beta}_0 + \beta^T (X^{-} + \tfrac{\beta}{\|\beta\|^2}) = 0\}$$

$$\boxed{\begin{aligned} H^{+} &= \{X^{+} : \hat{\beta}_0 + \beta^T X^{+} = 1\} \\ H^{-} &= \{X^{-} : \hat{\beta}_0 + \beta^T X^{-} = -1\} \end{aligned}}$$

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