① LASSO.

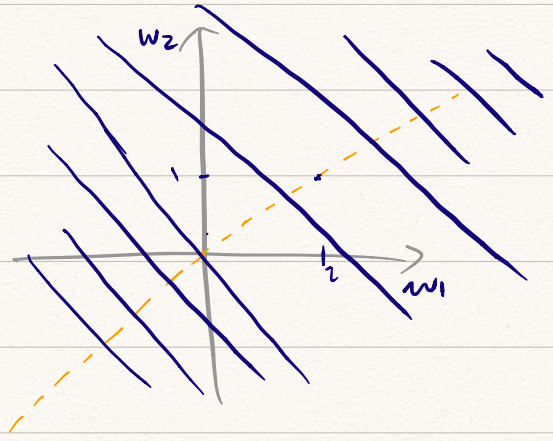
Because the hypothesis states that only a small number of genes are predicative, this means that it is a sparse solution. Using LASSO can yield a sparse solution w_L and have a small model error $w_{opt} - w_L$.

②.

a) $\text{rank}\{A\} = 1$, $\dim\{w\} = 2$.

∴ No unique solution.

b)

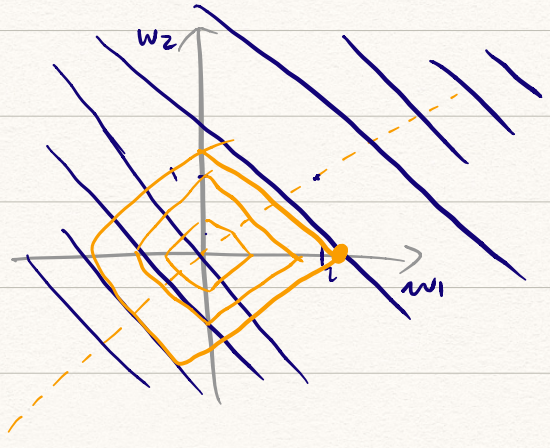


$$X^T X = \begin{bmatrix} 2 \\ 1 \end{bmatrix} \begin{bmatrix} 2 & 1 \end{bmatrix} = \begin{bmatrix} 4 & 2 \\ 2 & 1 \end{bmatrix}$$

eigen decomposition: $v_1 = \begin{bmatrix} -1 \\ 2 \end{bmatrix}$, $v_2 = \begin{bmatrix} 2 \\ 1 \end{bmatrix}$

$\lambda_1 = 0$, $\lambda_2 = 5$

c)



$w = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$

d) $w = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$