

2. a)

$$\min \|Y - B\theta - B_a \theta_a\|_2^2 + \lambda \theta^T \Omega \theta + \gamma \|\theta_a\|_1$$

$$\Omega = D^T D$$



2nd term

$$\lambda (D\theta)^T D\theta$$

$$(Y - B\theta - B_a \theta_a)^T (Y - B\theta - B_a \theta_a)$$

$$(Y^T - \theta^T B^T - \theta_a^T B_a^T) (Y - B\theta - B_a \theta_a)$$

$$Y^T Y - Y^T B \theta - Y^T B_a \theta_a - \theta^T B^T Y + \theta^T B^T B \theta + \theta_a^T B_a^T B_a \theta_a$$

combine

$$- \theta_a^T B_a^T Y + \theta_a^T B_a^T B_a \theta_a + \theta_a^T B_a^T B \theta$$

$$Y^T Y - 2 \theta^T B^T Y - 2 \theta_a^T B_a^T Y - 2 \theta^T B^T B \theta + \theta^T B^T B \theta + \theta_a^T B_a^T B_a \theta_a$$

$$\frac{\partial}{\partial \theta} \text{first term} = -2 B^T Y - 2 \theta_a^T B_a^T B + 2 B^T B \theta$$

$$\frac{\partial^2}{\partial^2 \theta} \text{first term} = 2 B^T B$$

$$\frac{\partial}{\partial \theta} \text{second term} = 2 \lambda D^T D \theta \quad \text{all pos}$$

$$\frac{\partial^2}{\partial^2 \theta} \text{sec term} = 2 \lambda D^T D$$

$$\frac{\partial}{\partial \theta_a} \text{first term} = -2 B_a^T Y - 2 B_a^T B \theta + 2 B_a^T B_a \theta_a$$

$$\frac{\partial^2}{\partial \theta_a} \text{first term} = +2 B_a^T B_a$$

$$\frac{\partial}{\partial \theta_a} \text{third term} = \gamma \quad \text{all pos}$$

$$\frac{\partial^2}{\partial \theta_a} \text{third term} = 1$$