1. According to lagrange multiplier,

$$l(\lambda) = f(x) - \lambda\, g(x)$$

$f(a) = a^T B a$

$g(a) = a^T W a - 1 = 0$ (equating $g(a) = 0$ according to the law)

$$l(\lambda) = a^T B a - \lambda(a^T W a - 1)$$

$$\frac{dl}{da} = \frac{d}{da}(a^T B a) - \lambda \frac{d}{da}(a^T W a - 1)$$

$$= (1 \times Ba) + a^T \cancel{\ } (B \times \cancel{1}) - \lambda(1 \times Wa + a^T \cancel{\ } W \times 1 - 0)$$

$$= Ba + a^T B - \lambda(Wa + a^T W)$$

$$= Ba + B^T a - \lambda(Wa + W^T a) \quad \left[\begin{array}{l} B \,\&\, W \text{ are} \\ \text{co-variance \&} \\ \text{symmetrical} \end{array}\right]$$

$$= a(B + B^T) - \lambda(W + W^T) a$$

To find the maxima, let it equal to 0.

$$a(B + B^T) - \lambda a (W + W^T) = 0$$

$[(W + W^T)]^{-1}(B + B^T) a = \lambda a$. Assuming W & B are symmetric, this is a standard eigenvalue problem.