monotonically increasing for non-negative arguments.

$$\boldsymbol{c}^* = \arg\min_{\boldsymbol{c}} ||\boldsymbol{x} - g(\boldsymbol{c})||_2^2. \tag{2.55}$$

The function being minimized simplifies to

$$(\boldsymbol{x} - g(\boldsymbol{c}))^\top (\boldsymbol{x} - g(\boldsymbol{c})) \tag{2.56}$$

(by the definition of the L^2 norm, equation 2.30)

$$= \boldsymbol{x}^\top \boldsymbol{x} - \boldsymbol{x}^\top g(\boldsymbol{c}) - g(\boldsymbol{c})^\top \boldsymbol{x} + g(\boldsymbol{c})^\top g(\boldsymbol{c}) \tag{2.57}$$

(by the distributive property)

$$= \boldsymbol{x}^\top \boldsymbol{x} - 2\boldsymbol{x}^\top g(\boldsymbol{c}) + g(\boldsymbol{c})^\top g(\boldsymbol{c}) \tag{2.58}$$

(because the scalar $g(\boldsymbol{c})^\top \boldsymbol{x}$ is equal to the transpose of itself).

We can now change the function being minimized again, to omit the first term, since this term does not depend on $\boldsymbol{c}$:

$$\boldsymbol{c}^* = \arg\min_{\boldsymbol{c}} -2\boldsymbol{x}^\top g(\boldsymbol{c}) + g(\boldsymbol{c})^\top g(\boldsymbol{c}). \tag{2.59}$$

To make further progress, we must substitute in the definition of $g(\boldsymbol{c})$:

$$\boldsymbol{c}^* = \arg\min_{\boldsymbol{c}} -2\boldsymbol{x}^\top \boldsymbol{D}\boldsymbol{c} + \boldsymbol{c}^\top \boldsymbol{D}^\top \boldsymbol{D}\boldsymbol{c} \tag{2.60}$$

$$= \arg\min_{\boldsymbol{c}} -2\boldsymbol{x}^\top \boldsymbol{D}\boldsymbol{c} + \boldsymbol{c}^\top \boldsymbol{I}_l \boldsymbol{c} \tag{2.61}$$

(by the orthogonality and unit norm constraints on $\boldsymbol{D}$)

$$= \arg\min_{\boldsymbol{c}} -2\boldsymbol{x}^\top \boldsymbol{D}\boldsymbol{c} + \boldsymbol{c}^\top \boldsymbol{c} \tag{2.62}$$

We can solve this optimization problem using vector calculus (see section 4.3 if you do not know how to do this):

$$\nabla_{\boldsymbol{c}}(-2\boldsymbol{x}^\top \boldsymbol{D}\boldsymbol{c} + \boldsymbol{c}^\top \boldsymbol{c}) = \boldsymbol{0} \tag{2.63}$$

$$-2\boldsymbol{D}^\top \boldsymbol{x} + 2\boldsymbol{c} = \boldsymbol{0} \tag{2.64}$$

$$\boldsymbol{c} = \boldsymbol{D}^\top \boldsymbol{x}. \tag{2.65}$$