

**PCA derivation****Video:** Welcome to module 4

1 min

**Reading:** Vector spaces

20 min

**Reading:** Orthogonal complements

20 min

**Video:** Problem setting and PCA objective

7 min

**Reading:** Multivariate chain rule

20 min

**Practice Quiz:** Chain rule practice

3 questions

**Video:** Finding the coordinates of the projected data

5 min

**Video:** Reformulation of the objective

10 min

**Reading:** Lagrange multipliers

20 min

**Video:** Finding the basis vectors that span the principal subspace

7 min

**PCA algorithm****Video:** Steps of PCA

4 min

**Video:** PCA in high dimensions

5 min

**Lab:** Principal Components Analysis (PCA)

# Lagrange multipliers

Check out the basics of Lagrange multipliers at the corresponding [Wikipedia page](#).

The important things are

1. We can solve a constrained optimization problem of the form  $\min_x f(x), s.t. g(x) = 0$  where  $g(x)$  is an equality constraint.
2. The constraints can be absorbed into a single objective function, the Lagrangian, which combines the original loss function and the constraints as  $\mathcal{L}(x, \lambda) = f(x) - \lambda g(x)$ .  $\lambda$  is called a Lagrange multiplier.
3. We solve the constrained optimization problem by computing the partial derivatives  $\partial \mathcal{L} / \partial x$  and  $\partial \mathcal{L} / \partial \lambda$ , setting them to 0 and solving for  $\lambda$  and  $x$ .

✓ Complete

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