

## MULTIVARIATE NORMALS

## Why

We generalize the normal density to d-dimensional space.

## Definition

Let  $f: \mathbb{R}^d \to \mathbb{R}$  be a density such that

$$f(x) = \frac{1}{\sqrt{(2\pi)^d \det \Sigma}} \exp\left(-\frac{1}{2}(x-\mu)^\top \Sigma^{-1}(x-\mu)\right)$$

where  $\mu \in \mathbb{R}^d$ ,  $\Sigma \in \mathbb{S}^d$ , and  $\Sigma \succ 0$ . We call f a multivariate normal density. A multivariate normal density with d=1 is a normal density, so we refer to multivariate normal densities as normal densities without ambiguity. We frequently use the word normal as a substantive, and refer to normals when we mean multivariate normal densities. Many people call a multivariate normal distribution a multivariate gaussian distribution and speak of qaussians instead of normals.

We call  $\mu$  the mean and  $\Sigma$  the covariance matrix. We call  $\Sigma^{-1}$  the precision matrix.

## Maximum

The maximum of a normal density is its mean,  $\mu \in \mathbb{R}^d$ .

<sup>&</sup>lt;sup>1</sup>We avoid this usage in accordance with the project's policy on historical names.

