



**Why**

We generalize the normal density to  $d$ -dimensional space.

**Definition**

Let  $f : \mathbf{R}^d \rightarrow \mathbf{R}$  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  $\mu \in \mathbf{R}^d$ ,  $\Sigma \in \mathbf{S}^d$ , 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 *gaussians* instead of normals.<sup>1</sup>

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,  $\mu \in \mathbf{R}^d$ .

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



