



# Multivariate Normals

## 1 Why

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

## 2 Definition

Let  $f : \mathbf{R}^d \rightarrow \mathbf{R}$  be a density. If there exists  $\mu \in \mathbf{R}^d$  and  $\Sigma \in \mathbf{S}^d$  with  $\Sigma \succ 0$  such that for all  $x \in \mathbf{R}^d$

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

then  $f$  is a *multivariate normal density*. Since this definition generalizes the normal density, we also refer to these as *normal densities*.

### 2.1 Notation