the Jacobian

- The Jacobian matrix is a matrix of all first-order partial derivatives of a vector-valued function. It generalizes the concept of a derivative to multiple variables and dimensions.

- Measures how a function transforms space:
  It describes the local scaling, rotation, or shearing of a function.

- Useful in nonlinear transformations

- The Jacobian determinant represents the factor by which the transformation stretches or squishes the $n-$dimensional volumes around a certain input.

linear and non-linear transformation