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* studies on eigenvalues & eigenfunctions *

In linear algebra, an eigenvector or characteristic vector of a linear transformation is a nonzero vector that changes at most by a scalar factor when that linear transformation is applied to it. The corresponding eigenvalue, often denoted by λ, is the factor by which the eigenvector is scaled.

Geometrically, an eigenvector, corresponding to a real nonzero eigenvalue, points in a direction in which it is stretched by the transformation and the eigenvalue is the factor by which it is streched. If the eigenvalue is negative, the direction is reversed. Loosely speaking, in a multidimensional vector space, the eigenvector is not rotated.

FORMAL DEFINITION

If T is a linear transformation from a vector space V over a field F into itself and v is a nonzero vector in V, then v is an eigenvector of T if T(v) is a scalar multiple of v. This can be written as

$$T(v) = \lambda v,$$

where, λ is a scalar in F, known as the eigenvalue, characteristic value, or characteristic root associ-ated with v.

There is a direct correspon-dence between n by n square matri-ces and linear transformations from an n-dimensional vector space. it is equivalent to define eigenvalues and eigenvectors using either the lang

-uage of matrices, or the lang
-uage of linear transformations.

If V is finite-dimensional, the above equation is equivalent to

$$Au = \lambda u.$$

where A is the matrix represen-tation of T and U is the coordina-te vector of v.

Eigenvalues and Eigenfunctions of differential operators.

The definitions of eigenvalue and eigenvectors of a linear tran-sformation T remains valid even if the underlying vector space is an infinite-dimensional Hilbert or Banach space. A widely used class of linear transformations acting on infinite-dimensional spaces are the differential operators on function spaces.

The eigenvalue equation for D is the differential equation.

$$Df(t) = \lambda f(t)$$

The functions that satisfy this equation are eigenvectors of D & are commonly called eigenfunctions.

Derivative operator example-

consider the derivative operator $\frac{d}{dt}$ with eigenvalue equation

$$\frac{d}{dt} f(t) = \lambda f(t).$$

This differential equation can be solved by multiplying both sides by $dt/f(t)$ and integrating. It's sol^n the exponential function.

$$f(t) = f(0)e^{\lambda t},$$

is the eigenfunction of the deri-vative operator. In this case the eigenfunction is itself a function of it's associated eigenvalue. In parti-cular, for $\lambda = 0$ the eigenfunction $f(t)$ is a constant.

The main eigenfunction article gives other examples.

see also -

- Antieigenvalue theory
- Eigenoperator
- Eigenplane
- Eigenvalue algorithm
- Introduction to eigenstates.