Hilbert Space Encyclopedia Article

Hilbert Space

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Hilbert Space

A Hilbert **space** is an infinite dimensional functional space. That is to say, it is a vector space composed of an infinite set of orthogonal **functions**. The orthogonality of a Hilbert space is defined by the integral over the appropriate **interval** of the product of two functions from the space, with a weighting **factor**. If this integral equals the **Kronecker delta**, the space is orthogonal; usually the weighting factor includes a normalization factor as well. Because of the centrality of this relation, sometimes a Hilbert space is called a complete inner product space. Most proofs concerning Hilbert spaces use the orthogonality or orthonormality property extensively.

As a functional space, the Hilbert space can have linear operations performed on the space itself. The whole infinite space can thus be shifted. This result sometimes produces another Hilbert space and sometimes just produces an interesting group of functions, depending on which linear operator is used.

One of the most common uses of a Hilbert space is for **transformation** purposes. An arbitrary function can be expressed as the sum of components of a Hilbert space, with each component having a weighting factor overall. The famous Fourier transformation, essential to many parts of physics and engineering, is exactly this type of transformation. The orthogonality condition is used to determine generalized coefficients of the integrals of each Hilbert space function with the original function being transformed. While the **sine** and **cosine** functions used in the Fourier transformation are fairly common, polynomial expansions of functions and many other functional transformations useful in myriad applications also work this way.