

What is Frequency?

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Ever since Fourier Transform is widely applied in data analysis, people tend to think everything in terms of waves. Then, the notion of frequency becomes an indispensable quantity to specify the characteristics of complicate data, for the data are invariably transformed into frequency domain when the variation of the data in the time domain becomes too confused or random to track. Unfortunately, Fourier analysis is based on the underlying stationary and linear assumptions and the answer given are always independent of temporal or spatial variations. In reality, physical processes are highly variable, which call for the true frequency be a function of both time and location variables. This instantaneous frequency values contain rich information of the underlying properties of the data. In order to define such a versatile frequency values, we have to give up the comfort of a priori basis and develop a totally new adaptive data analysis approach. Indeed, many of the difficulties we encounter in data analysis could actually be traced back to the lack of correct definition for frequency, a critical physical quantity. In fact, once the frequency can be properly extracted from the data, many difficulties such as quantification of degree of nonlinearity and nonstationarity could be achieved easily. Furthermore, the elusive definition and the method of determination the trend of a given data set can also be accomplished. A rigorous and logic definition of frequency will be given, and a new data analysis method would be introduced in this presentation. Examples of various nonstationary and nonlinear process would be used to illustrate the new view of data that would conform with physical perception rather than abstract mathematical views.