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Foundations of Iterative Learning Control

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Iterative Learning Control (ILC) is a technique for adaptive feed forward control of electro-mechanical plant that either performs programmed periodic behavior or rejects quasi-periodic disturbances. ILC can suppress particle-beam RF-loading transients in RF cavities for acceleration. This paper, for the first time, explains the structural causes of "bad learning transients" for causal and noncausal learning in terms of their eigen-system properties. This paper underscores the fundamental importance of the linear weighted-sums of the column elements of the iteration matrix in determining convergence, and the relation to the convergence of sum of squares. This paper explains how to apply the z-transform convergence criteria to causal and noncausal learning. These criteria have an enormous advantage over the matrix formulation because the algorithm scales as N^2 (or smaller) versus N^3, where N is the length of the column vector containing the time series. Finally, the paper reminds readers that there are also wave-like (soliton) solutions of the ILC equations that may occur even when all convergence criteria are satisfied. Illustrative examples are provided.

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