Estimation of the reaction efficiency in Polymerase Chain Reaction

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Abstract: Polymerase Chain Reaction (PCR) is largely used in molecular biology for increasing the copy number of a specific DNA fragment. The succession of 20 replication cycles makes it possible to multiply the quantity of the fragment of interest by a factor of one million. The PCR technique has revolutionized genomics research. Several quantification methodologies are available to determine the DNA replication efficiency of the reaction which is the probability of replication of a DNA molecule at a replication cycle. We elaborate a quantification procedure based on the exponential phase and the early saturation phase of PCR. The reaction efficiency is supposed to be constant in the exponential phase, and decreasing in the saturation phase. We propose to model the PCR amplification process by a branching process which starts as a Galton-Watson branching process followed by a size-dependent process. Using this stochastic modelling and the conditional least squares estimation method, we infer the reaction efficiency from a single PCR trajectory.

Keywords: Branching process; Conditional least squares estimation; Polymerase Chain Reaction.

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