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A study on the convergence of $\sum_{n=1}^{\infty} A_n$; $A_n = \frac{1}{1+\sum_{i=1}^{n} a_i}$ in terms of the convergence of $\sum_{n=1}^{\infty} a_n$

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The convergence or divergence of a given series is determined by the behavior of its partial sum. Various tests can be used to examine the convergence or the divergence of the series even in the absence of an explicit analytic expression for the corresponding partial sums of the series. In this paper, we study on the convergence of the series $\sum_{n=1}^{\infty} A_n$; $A_n = \frac{1}{1+\sum_{i=1}^{n} a_i}$ in terms of a given series $\sum_{i=1}^{\infty} a_n$ of non-negative terms. We first prove that the series is divergent if the given series is convergent. When the given series is convergent, we study the behavior of $\sum_{n=1}^{\infty} A_n$; $A_n = \frac{1}{1+\sum_{i=1}^{n} a_i}$ under three possible cases on the limiting value of a_n and then prove that the series is divergent in two of these cases. By giving two counterexamples, we show that the convergence outcome is inconclusive in the other case.

Keywords: Convergence, Divergence, Infinite series, Partial sum