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Iterations for the lemniscate constant resembling the Archimedean algorithm for π.

The lemniscate constant $L = 2.62205755429212\ldots$ is one half the perimeter of the unit lemniscate curve just as pi is one half the perimeter of the unit circle. It is well know that the Archemedian iterative algorithm

(1) $a(n+1) = 2a(n)b(n)/(a(n)+b(n))$ and

(2) $b(n+1) = \sqrt{a(n+1)b(n)}$ with initial values $a(1) = 4$ and $b(1) = 2\sqrt{2}$ converges to π.

In this paper we show that the iterative algorithm

(3) $a(n+1) = 2a(n)a(n)/(a(n)+b(n))$ and

(4) $b(n+1) = \sqrt{a(n+1)b(n)}$

with initial values $a(1) = 4$ and $b(1) = 2\sqrt{2}$ converges to the lemniscate constant L.

Notice that the only change is that $b(n)$ in (1) has been replaced by $a(n)$ in (3). (2) is exactly the same as (4) and the initial values are the same. The derivation is based on an infinite product of nested radicals given in recent years by Aaron Levin ([1] and [2]) that resembles the famous product of nested radicals for π by Vieta.

[1] Levin, A., A New Class of Infinite Products Generalizing Vi'ete's Product Formula for π, The Ramanujan Journal, 10(2005), pp. 305–324.

[2] Levin, A., A Geometric Interpretation of an Infinite Product for the Lemniscate Constant, The American Mathematical Monthly, Vol. 113, No. 6 (Jun. - Jul., 2006), pp. 510-520 (Received September 22, 2015)