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Pandey's Method of Cube Root Extraction: Is it Better than Aryabhata's Method?

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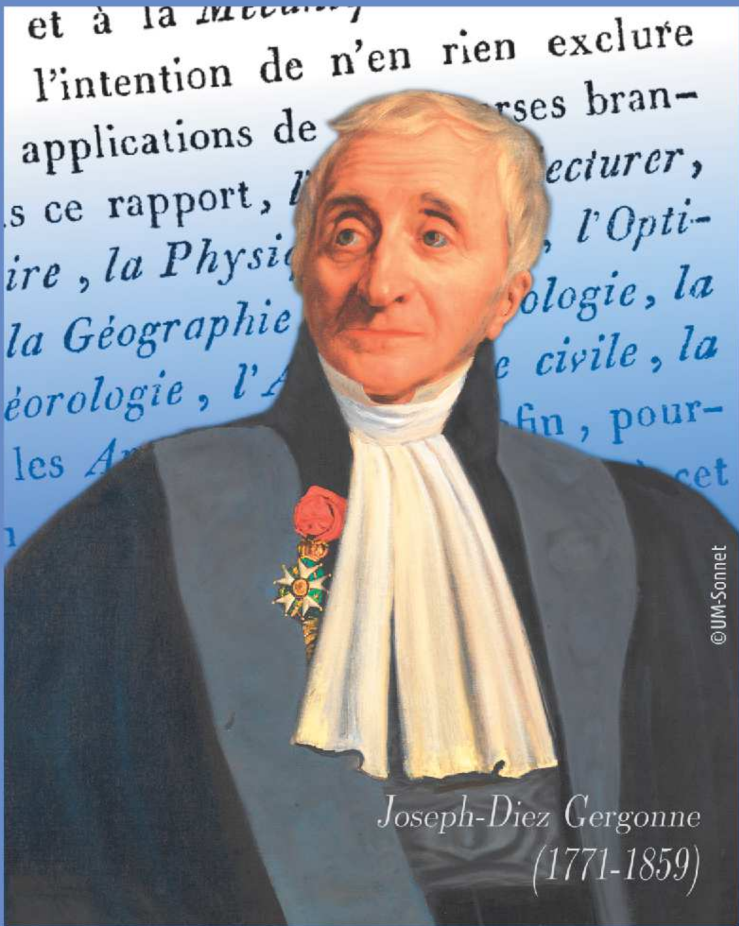

Joseph-Diez Gergonne
(1771-1859)

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PANDEY'S METHOD OF CUBE ROOT EXTRACTION: IS IT BETTER THAN ARYABHATA'S METHOD?

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1 Gopal Pandey and Aryabhata's method for cube root extraction

Gopal Pandey (?1847-1921) occupies an important place in the history of Nepalese mathematics. His book *Vyakta Chandrika* (1884) is the first mathematics book written in Nepali (Basyal, 2015).

Pant (1980) observes that Aryabhata's method (AM) (499) for finding the cube root is adopted by Brahmagupta (628), Sridhara (~750), Aryabhata II (~950), Sripati (1039), Bhaskara II (1148) and Narayana (1356), and the rules given by Chandrashekhara (1869), and Pandey's teacher Bapudeva Shastri (1883) are slight modifications of the AM. On the other hand Parakh (2006) points out that the root extraction rules taught today in schools are essentially an extension of AM. To extract the cube root of N using AM, the binomial expansion of $N = (a+b)^3 = a^3 + 3a^2b + 3ab^2 + b^3$ is reversed. Briefly, AM separates N into groups of three digits starting from the unit place, subtracts the biggest possible cube from the left-most group to produce digit a in the root, and divides the next group in N by $3a^2$. The quotient thus produced will be an estimate say $\hat{b}$ for b. We observe $\hat{b} \geq b$. An example of finding the cube root by AM can be found in p. 126 of Plofker (2009).

1.1 Pandey's method (PM) uses the Rule of Three

The rule of three provides three quantities A, B and C and seeks $\hat{b}$ such that $\frac{A}{B} = \frac{C}{\hat{b}}$. The PM sets $A = 1000[(a+1)^3 - a^3]$, $B = 10$, and $C = (Two\ leftmost\ groups\ in\ N) - (10a)^3$, and seeks $\hat{b}$. Unlike in AM, the PM produces $\hat{b}$ such that $b - 2 < \hat{b} < b + 1$.

Thus, we note that PM may round $\hat{b}$ down (as in AM) or up to get b. To handle this situation PM suggests rounding up or down according to $\hat{b} < 5$ and $\hat{b} > 5$ respectively. This trick works most of the time, however, it does not always guarantee b. So what is the value of discussing PM? We note that sometimes $\hat{b}$ produced by AM is no better than $\hat{b}$ produced by PM because the former is not bounded above as nicely as the latter. I plan to publish a detailed analysis of PM in the near future.

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