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Ancient Indian Mathematician - Baudhayana and The Value of √2

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Abstract
Baudhayana was an ancient Indian mathematician and the author of Shulba Sutra and Shrauta Sutra. These Sutras were composed in the 8th-7th century BC, Baudhayana's Shulba Sutras contain theorems of early mathematics and geometry, including, the Pi value, the square root of 2, and a statement of the Pythagorean theorem. One of his notable achievements of Baudhayana was the estimation of the square root of 2. According to his method, one can find, approximate value of the square root of 2 with remarkable accuracy. Baudhayana's approach demonstrates a sophisticated understanding of numerical approximations and shows that ancient Indian mathematicians had advanced techniques for solving complex mathematical problems.
Keywords: *Baudhayana; Pythagorean theorem; Shrauta sutra; Shulba sutra; Square root.*

1. Introduction
Sage Baudhayana was an ancient mathematician of India, and was the author of Shulba Sutra and Shrauta Sutra. The sutras are in the Sanskrit language, and related to religion, daily rituals, mathematics, etc, and were composed in the 8th-7th century BC, Bodhayana's Shulba sutras contain theorems of early mathematics and geometry, including, the Pi value, the square root of 2, and a statement of the Pythagorean theorem.

1.1. Biography of Baudhayana
Sage Baudhayana was a priest and an architect, with keen interest in Mathematical calculations. Sulbasutra, is a boon given to India during the period 8th-7th century BC, Sulbasutra, is nothing but rules needed for rituals. According to Panini, a Sanskrit scholar, in his Ashtadhyayi, has described Baudhayana as a guru and a great scholar of philosophy, mathematician. Baudhayana was proficient with life-useful use of mathematics, through which he was described as a craftsman who constructed sacrificial altars of the highest quality.[1]

1.2. The Baudhayana Sūtras Consist of Six Texts [2]
1. The Śrautasûtra, probably in 19 Praśnas (questions),
2. The Karmāntasûtra in 20 Adhyāyas (chapters),
3. The Dwaidhasûtra in 4 Praśnas,
4. The Grihyasutra in 4 Praśnas,
5. The Dharmasûtra in 4 Praśnas and
6. The Śulbasûtra in 3 Adhyāyas.

where, Baudhāyana's Śulbasûtra contain several mathematical formulas , and one among them is square root of 2.

2. Contribution of Baudhayana in Square Root of 2
Bodhayana verse number i.61-2 (explained in Apastamba i.6) explain the method of finding the square root of 2.[3] Figure 1 shows Sanskrit Shloka.

समस्य द्विकर्णि प्रमाणं तृतीयेन वर्धयेत।
तच् चतुर्थेनात्मचतुस्त्रिंशोनेन सविशेषः ।।

Figure 1 Sanskrit Shloka

2.1. Shloka in English
samasya dvikaraṇī. pramāṇaṃ tṛtīyena vardhayettac caturthenātmacatustriṃśonena saviśeṣaḥ

2.2. Meaning of the Shloka
Sama – Square;
Dvikarani – Diagonal (dividing the square into two), or Root of Two
Pramanam – Unit measure;
tṛtīyena vardhayet – increased by a third
Tat caturtena (vardhayet) – that itself increased by a fourth, Atma – itself;
Caturtrimsah savisesah – is in excess of 34th part.

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Meaning: To get the value of the diagonal of a square, by adding one-third to the side, then adding one-fourth of it, then subtracting thirty-fourth of it, what is obtained is approximately the value of the diagonal.

3. Figures

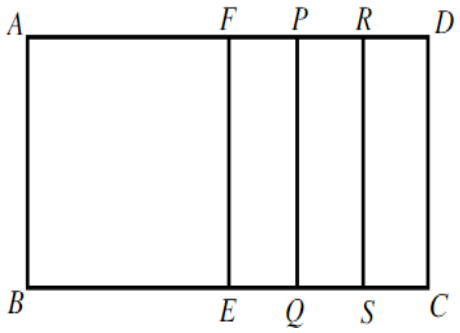

Figure 2 Two Equal Squares, Each with the Side of One Unit were taken

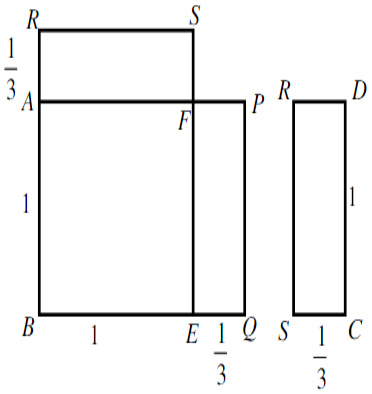

Figure 3 One Square divided into Three Triangles

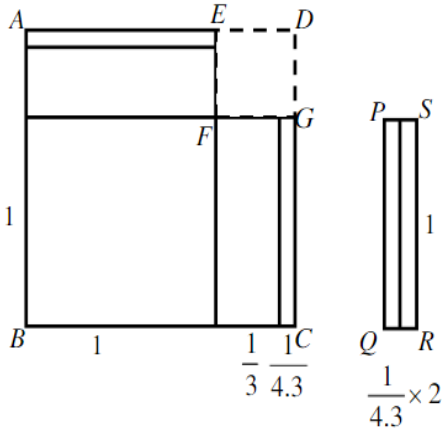

Figure 3 Square of a Side 1+1/3

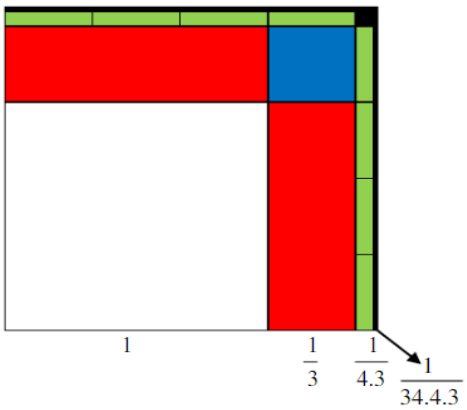

Figure 4 The First Approximate Value Of (1+1/3) for √2

3.1. Explanation

Two equal squares, each with the side of one unit were taken. One of the squares was vertically divided into three rectangles. Two pieces of the above were placed along the two adjacent sides of the square to form an approximate square of a side 1+1/3, but for missing a small square 1/3×1/3. This was also made up by using a piece from the remaining rectangle. Hence we get the first approximate value of (1+1/3) for √2.

$$\sqrt{2} = 1 + 1/3 + ¼\,(1/3) = 17/12$$

But as per the sulba-sutra above, this is in excess by the 34th part of the previous amount.
Hence:

$$\sqrt{2} = 1 + 1/3 + ¼\,(1/3) - 1/34[(¼\,(1/3)]$$
$$= 1 + 1/3 + 1/(3*4) + 1/(3*4*34) = 577/408$$
$$= \textbf{approximately 1.4142}$$

Conclusion

Baudhayana's method for finding the square root of 2 is a computational process, in which a series of steps are considered to get the exact value. He also explained various mathematical algorithms in a diagrammatic way, through which one can understand more complex algorithms in a simple manner. Furthermore, in the history of mathematics, Baudhayana's work changed the complex view into a simple manner. His contributions towards Mathematics lead further advancement and development in the research area and changed the concept of Indian Mathematics in the world.

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