A Persian Folk Method of Figuring Interest

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I recently learned a very quick and effective way of estimating monthly payments on a loan. My father showed me the method, having learned it himself from my grandfather, who was a merchant in nineteenth century Iran. While its origins remain a mystery, the method is still in use among merchants all around Iran, and perhaps elsewhere.

My father used the formula:

\[ \text{Monthly payment} = \frac{1}{\text{Number of months}} \times (\text{Principal} + \text{Interest}); \]

he calculated the interest as

\[ \text{Interest} = \frac{1}{2} \times \text{Principal} \times \text{Number of years} \times \text{Annual interest rate}. \]

The *exact* formula, assuming interest accrued monthly, can be found in any basic finance textbook:

\[ C = \frac{r(1 + r)^N P}{(1 + r)^N - 1}, \]

where \( C \) is the (exact) monthly payment, \( r \) is the monthly interest rate (1/12 the annual interest rate), \( N \) is the total number of months, and \( P \) is the principal. With this notation, the folk formula becomes

\[ C_f = \frac{1}{N} \left( P + \frac{1}{2} PNr \right). \]

In many cases, \( C_f \) is a surprisingly good approximation to \( C \). As an example, for a 4-year auto loan of $10,000 at an annual rate of 7% compounded monthly, the exact formula gives monthly payments of $239.46 while the folk estimate gives $237.50.

To see why the approximation works, we regard \( C \) as a function of \( r \), with all other quantities held fixed. (The singularity in (1) at \( r = 0 \) can be cancelled out.) A straightforward calculation shows that the first order Maclaurin polynomial for \( C(r) \) has the form

\[ C(r) = \frac{1}{N} \left( P + \frac{1}{2} P(N + 1)r \right), \]

which closely resembles the definition of \( C_f \). For a fixed \( P \), when \( r \) is sufficiently small and \( N \) sufficiently large, the difference between (2) and (3) is small.