**Example.** Consider the measurements shown in Table 3.2. The arithmetic mean of the execution times is easily calculated using the sum of the total times. The execution rates are calculated by dividing the total number of floating-point operations executed in each program by its corresponding execution time. Calculating the harmonic mean of these rates is slightly more complicated than simply applying Equation (3.8), however. The difficulty in this case is that the number of floating-point operations performed by each program is not the same. Consequently, Equation (3.8) must be modified to use a weighted mean. As described in Section 3.3.5, the weighted harmonic mean is

$$\overline{x}_{H,w} = \frac{1}{\sum_{i=1}^{n} w_i/x_i}. \tag{1}$$

In this example, the weight for each program $i$, $w_i$, is the number of floating-point operations performed by the program divided by the total number of floating-point operations performed by all of the programs, giving

$$w_i = \frac{F_i}{\sum_{j=1}^{n} F_j}. \tag{2}$$

The weighted harmonic mean of these rates then is

$$\overline{M}_H = \frac{1}{\left(\frac{130}{844}\right)\frac{1}{405} + \left(\frac{160}{844}\right)\frac{1}{367} + \left(\frac{115}{844}\right)\frac{1}{405} + \left(\frac{252}{844}\right)\frac{1}{419} + \left(\frac{187}{844}\right)\frac{1}{388}} = 397. \tag{3}$$

Notice that this value is the same as that obtained by taking the ratio of the total number of floating-point operations executed by all of the programs to the sum of their execution times, that is, $844/2.124 = 397$ MFLOPS. $\diamond$

Table 1: An example of calculating the harmonic mean.

| Measurement ($i$) | $T_i$ (sec) | $F_i$ ($\times 10^9$ FLOP) | $M_i$ (MFLOPS) |
|---|---|---|---|
| 1 | 321 | 130 | 405 |
| 2 | 436 | 160 | 367 |
| 3 | 284 | 115 | 405 |
| 4 | 601 | 252 | 419 |
| 5 | 482 | 187 | 388 |
| $\sum_{i=1}^{5} x_i$ | 2124 | 844 | |
| $\overline{T}_A$ | 425 | | |
| $\overline{M}_H$ | | | 397 |