

Brightness of Brain Contest

Problem C

Time limit: 5 second Memory: 1 MB

Normal Distribution

The Problem

One of the most important of the many distributions which occur in the study of statistics is the *normal*, or *Gaussian distribution*. The equation of the normal curve is

$$f(x) = \frac{1}{\sqrt{2\pi}} e^{-(x-\mu)^2/2\sigma^2} \quad \text{-----} \quad [1]$$

where $f(x)$ is the *frequency function*. The total area under this curve, from $x = -\infty$ to $x = +\infty$, is one square unit. Therefore the area between any two points, say from $x=a$ to $x=b$, is the proportion of cases which lie between the two points. A plot of Eq. 1 yields a bell-shaped curve having a maximum ordinate at $x = \mu$ and decreasing to zero at both $+\infty$ and $-\infty$. If the standard deviation σ is small, the curve is tall and thin; if σ is large, the curve is short and broad; see the **Figure 1** below-

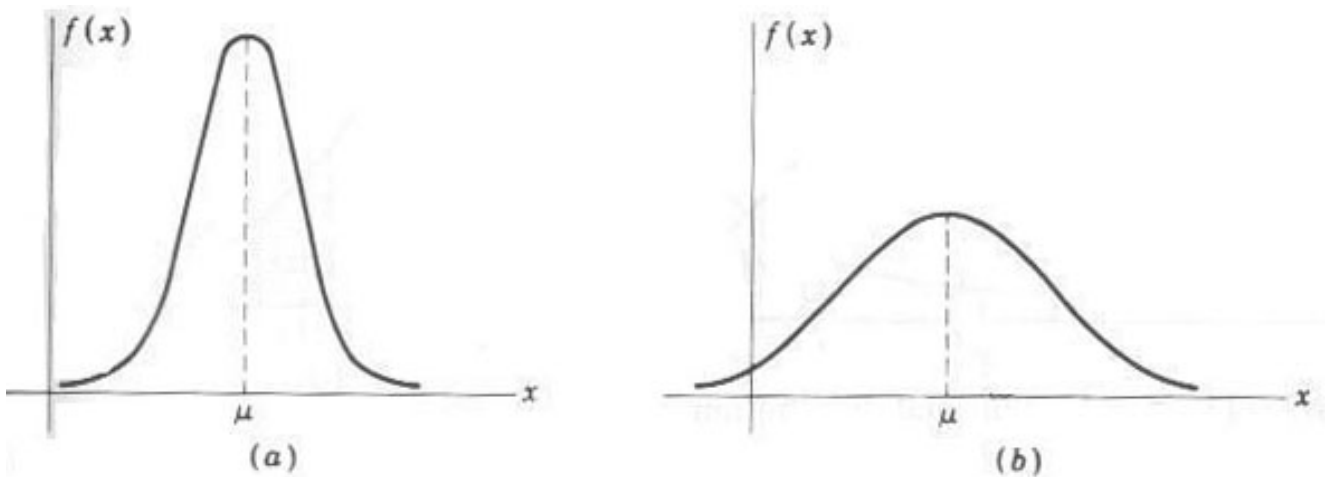


Figure 1 : The Shape of the normal distribution curve (a) Small (b) Large

In order to analyze different statistical cases, it is convenient to replace x in Eq. 1 with the *standard variable* z defined as

$$z = \frac{x - \mu}{\sigma} \quad \text{-----} \quad [2]$$

where now x is to be normally distributed with a mean of zero. **Equation 1** then becomes a *unit normal distribution* and is written as

$$f(z) = \frac{1}{\sqrt{2\pi}} e^{-z^2/2} \quad \text{-----} \quad [3]$$

The distribution is illustrated in the following figure, **Figure 2**.

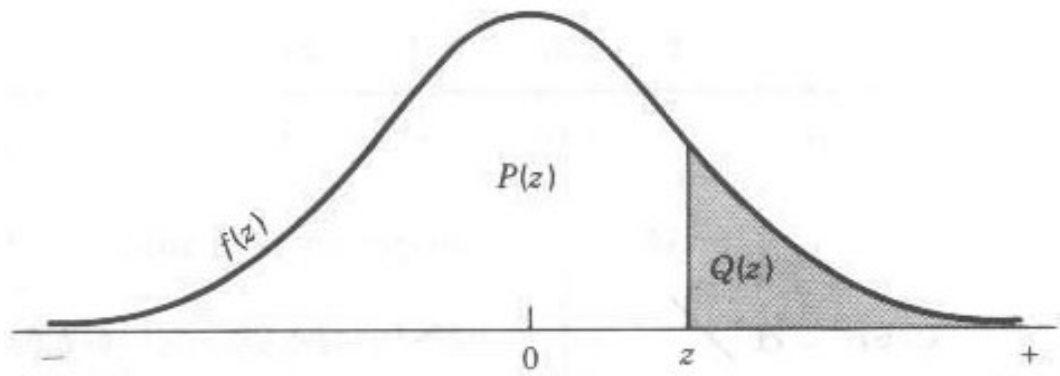


Figure 2 : The standard normal distribution

The ordinate at z is $f(z)$, obtained using Eq 3. The areas $Q(z)$ and $P(z)$ under the curve can be found in statistical tables or approximated. Since the total area under the curve is unity

$$P(z) = 1 - Q(z) \quad \text{-----} \quad [4]$$

The term $Q(z)$ is obtained by integrating the area under the curve. It can be approximated and then programmed for calculation using a polynomial expansion (Hewlett-Packard *Applications Book*, op. cit., p. 107). The results area found to be

$$Q(z) = f(z)(b_1 t + b_2 t^2 + b_3 t^3 + b_4 t^4 + b_5 t^5) + A(z) \quad \text{-----} \quad [5]$$

where

$$t = \frac{1}{1 + p|z|}, \quad |z| < 7.5 \times 10^{-8}$$

$$p = 0.2316419 \quad b_1 = 0.319381530$$

$$b_2 = -0.356563782 \quad b_3 = 1.781477937$$

$$b_4 = -1.821255978 \quad b_5 = 1.330274429$$

From the above equation we can calculate $Q(z)$ for any distribution.

In this problem you have to determine the standard deviation and mean of some given data. Then for some given value find the number of population falling in the region $Q(z)$ and $P(z)$.

The Input

The input consists of several segments. The first line of input of each segment is an integer ' N ' ($0 < N < 2^{31}$) indicating the population. The next line contains ' N ' real numbers describing the population data (such as age of people, length of shaft or diameter of bearing etc.). The following line contains an integer ' Q ' ($0 < Q < 1000$) number of query. And the next line similarly contains ' Q ' number describing the query.

The Output

For each set of input output the data set number followed by mean, standard deviation, then $3Q$ numbers answering the queries. Each answer to query describes $P(z)$ then $Q(z)$ and then percentage of population ' T ' falling in $Q(z)$ area. Every

number must be rounded to the nearest fourth digit after the decimal point.

Sample Input

```
11
96 93 90 86 86 80 78 76 68 84 100
2
60 100
13
78 60 74 82 96 68 94 86 78 90 87 56 88
3
100 30 59
```

Sample Output

```
Data Set #1
Mean = 85.1818
Standard Deviation = 9.3895
P(z) = 0.9963, Q(z) = 0.0037, T = 0.0403
P(z) = 0.9427, Q(z) = 0.0573, T = 0.6299

Data Set #2
Mean = 79.7692
Standard Deviation = 12.4777
P(z) = 0.9475, Q(z) = 0.0525, T = 0.6821
P(z) = 1.0000, Q(z) = 0.0000, T = 0.0004
P(z) = 0.9520, Q(z) = 0.0480, T = 0.6241
```