

Chapter 3

Producing Data

Excel provides tools for sampling from a specified population, for calculating probabilities associated with the standard models and their inverse cumulative distributions using the **Formula Palette**, and for simulating values from probability distributions using both the **RAND()** function and the **Random Number Generation** tool. In this chapter we consider both sampling without replacement and sampling with replacement (SRS) from a specified population.

3.1 Samples with Replacement

Using the Sampling Tool

Example 3.1. Simulate tossing a single die 10 times..

Solution. This is tantamount to finding a random sample of size 10 with replacement from $\{1, 2, 3, 4, 5, 6\}$. Following are the steps to obtain such a sample using the **Sampling tool**.

1. Enter the values $\{1, 2, 3, 4, 5, 6\}$ in A2:A7.

| | A | B |
|----|------------|--------|
| 1 | Population | Sample |
| 2 | 1 | 1 |
| 3 | 2 | 2 |
| 4 | 3 | 5 |
| 5 | 4 | 6 |
| 6 | 5 | 6 |
| 7 | 6 | 6 |
| 8 | | 6 |
| 9 | | 3 |
| 10 | | 3 |
| 11 | | 2 |

Figure 3.1: Sample with Replacement

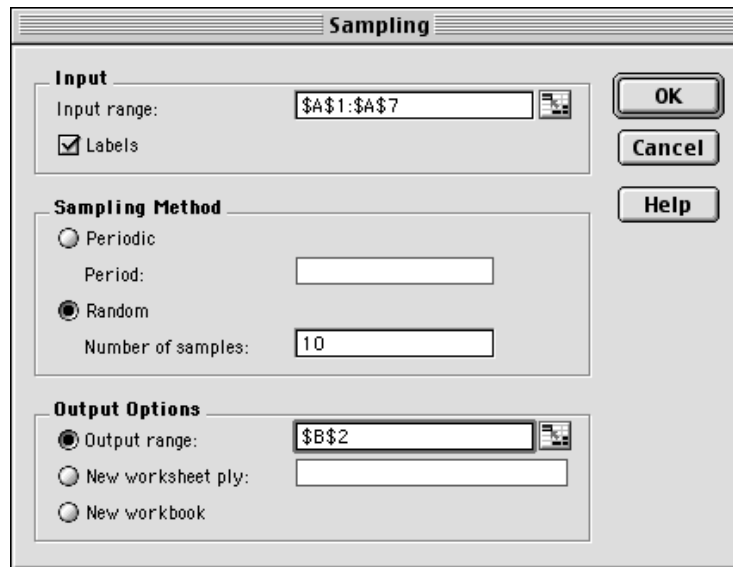


Figure 3.2: Sampling Dialog Box

2. From the Menu Bar choose **Tools – Data Analysis** and select **Sampling** from the dialog box. Click **OK**.
3. Complete the **Sampling** dialog box as shown in Figure 3.2 and click **OK**. A random sample of size 10 appears in cells B2:B11.

3.2 Simple Random Samples (SRS)

The Excel function `RAND()` picks a number uniformly on the interval $(0, 1)$. We can repeatedly select random uniform $(0, 1)$ numbers and assign them to members of a population. Then by sorting the random numbers, we obtain a random permutation of the population that provides an SRS of any desired size.

Example 3.2. (Examples 3.6 and 3.7, pages 232–236 in the text.) A food company assesses the nutritional quality of a new “instant breakfast” product by feeding it to newly weaned male white rats and measuring their weight gain over a 28-day period. A control group of rats receives a standard diet for comparison. This nutrition experiment has a single factor (the diet) with two levels. The researchers use 30 rats for the experiment and so must divide them into two groups of 15. To do this in a completely unbiased fashion, they put the cage numbers of the 30 rats in a hat, mix them up, and draw 15. These rats form the experimental group and the remaining 15 make up the control group. Show how to carry out the randomization.

| | A | B |
|----|------|------------|
| 1 | Rats | Sample |
| 2 | 1 | 0.75783563 |
| 3 | 2 | 0.25049354 |
| 4 | 3 | 0.30840101 |
| 5 | 4 | 0.01760057 |
| 6 | 5 | 0.06654875 |
| 7 | 6 | 0.78657626 |
| 8 | 7 | 0.17680760 |
| 9 | 8 | 0.63881337 |
| 10 | 9 | 0.99740651 |
| 11 | 10 | 0.74067272 |
| 12 | 11 | 0.35810086 |
| 13 | 12 | 0.11989300 |
| 14 | 13 | 0.68048251 |
| 15 | 14 | 0.23006162 |
| 16 | 15 | 0.64650203 |

Figure 3.3: Original Labels

Solution.

1. Give each rat a unique numerical label from the set $\{1, 2, 3, \dots, 30\}$ and enter the values in cells A2:A31 of a workbook. Enter the label “Rats” in cell A1 and “Sample” in cell B1.
2. Enter `= RAND()` in cell B2 and fill down to B31. The function `RAND()` selects a number uniformly in $(0,1)$. Figure 3.3 shows a portion of the workbook.

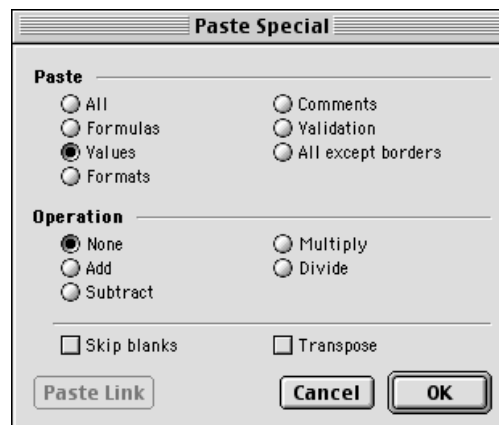


Figure 3.4: Paste Special Dialog Box

3. Select cells B2:B31 and from the Menu Bar choose **Edit – Copy**. Then, with B2:B31 **still selected**, choose **Edit – Paste Special** from the Menu Bar. (**Windows** users can click the **right mouse button** while **Macintosh** users should hold down the **Option – Command** keys and click to get the

Shortcut Menu box.) Select **Paste – Special**, and in the dialog box select the radio buttons for **Values** and **None** (Figure 3.4), which replaces the formulas in the cells of column B by the actual values they take.

4. Select cells A1:B31, from the Menu Bar choose **Data – Sort**, and in the Sort By drop-down list, click the arrow and select **Sample**. Also select the radio button for **Header Row** (Figure 3.5). Excel sorts the data in ascending order in column B and carries the order to column A, which gives a random permutation of column A.

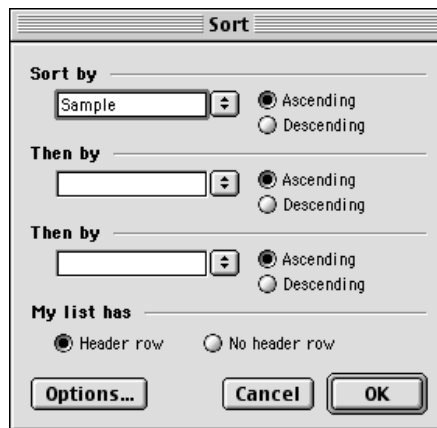


Figure 3.5: Sort Dialog Box

| | A | B |
|----|------|------------|
| 1 | Rats | Sample |
| 2 | 4 | 0.01760057 |
| 3 | 30 | 0.03019514 |
| 4 | 17 | 0.06225799 |
| 5 | 5 | 0.06654875 |
| 6 | 12 | 0.11989300 |
| 7 | 24 | 0.14218590 |
| 8 | 27 | 0.17261367 |
| 9 | 7 | 0.17680760 |
| 10 | 26 | 0.18164762 |
| 11 | 14 | 0.23006162 |
| 12 | 2 | 0.25049354 |
| 13 | 29 | 0.29302707 |
| 14 | 3 | 0.30840101 |
| 15 | 20 | 0.34814598 |
| 16 | 21 | 0.35296414 |

Figure 3.6: Sorted Sample

5. Designate cells A2:A16 to label the rats in the control group, cells A17:A31 for the rats in the experimental group. A portion of the data appears in Figure 3.6, which may be compared with the original data in Figure 3.3.

3.3 Random Digits

Figure 3.7 is a table of random digits, a list of the digits $\{0, 1, \dots, 9\}$ that has the following properties:

1. The digits in all positions in the list have the same chance of being any one of $\{0, 1, \dots, 9\}$.
2. The digits in different positions are independent in the sense that the value of one has no influence on the value of any other.

You can imagine asking an assistant (or computer) to mix the digits $\{0, 1, \dots, 9\}$ in a hat, draw one, then replace the digit drawn, mix again, draw a second digit, and so on. We did something like this in the previous section. In **Excel 97/98** this table of random digits dynamically changes when the F9 key on the keyboard is pressed. In **Excel 2000/2001** you need to hold down the Option key (Mac) or Control key (Windows) at the same time.

| | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T |
|----|-------------------------------|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Table of Random Digits | | | | | | | | | | | | | | | | | | | |
| 2 | =INT(10*(RAND())) | | | | | | | | | | | | | | | | | | | |
| 3 | | | | | | | | | | | | | | | | | | | | |
| 4 | 6 | 1 | 7 | 5 | 6 | 7 | 5 | 8 | 7 | 4 | 1 | 2 | 4 | 7 | 3 | 2 | 9 | 5 | 2 | 1 |
| 5 | 7 | 4 | 9 | 7 | 5 | 2 | 5 | 0 | 8 | 7 | 7 | 0 | 5 | 7 | 2 | 2 | 2 | 6 | 5 | 8 |
| 6 | 0 | 9 | 3 | 2 | 4 | 2 | 2 | 8 | 2 | 3 | 0 | 5 | 4 | 9 | 1 | 3 | 5 | 3 | 6 | 4 |
| 7 | 6 | 2 | 3 | 2 | 9 | 0 | 6 | 2 | 3 | 1 | 4 | 4 | 7 | 0 | 8 | 9 | 8 | 8 | 9 | 2 |
| 8 | 6 | 9 | 4 | 5 | 7 | 7 | 9 | 7 | 3 | 4 | 5 | 1 | 7 | 8 | 8 | 4 | 2 | 1 | 0 | 0 |
| 9 | 6 | 4 | 8 | 7 | 4 | 5 | 8 | 0 | 2 | 0 | 5 | 8 | 5 | 8 | 8 | 9 | 6 | 6 | 8 | 7 |
| 10 | 1 | 4 | 9 | 7 | 7 | 0 | 2 | 6 | 0 | 0 | 4 | 2 | 2 | 9 | 4 | 3 | 0 | 6 | 0 | 5 |
| 11 | 6 | 8 | 9 | 0 | 3 | 9 | 3 | 0 | 0 | 7 | 6 | 9 | 2 | 1 | 7 | 5 | 4 | 8 | 3 | 3 |
| 12 | 3 | 7 | 1 | 4 | 5 | 4 | 7 | 2 | 5 | 4 | 5 | 4 | 9 | 3 | 2 | 3 | 9 | 9 | 9 | 8 |
| 13 | 7 | 7 | 9 | 3 | 4 | 6 | 6 | 8 | 6 | 7 | 1 | 5 | 0 | 9 | 3 | 4 | 0 | 3 | 0 | 4 |
| 14 | 3 | 2 | 8 | 7 | 0 | 4 | 4 | 9 | 3 | 1 | 6 | 5 | 0 | 7 | 7 | 1 | 1 | 5 | 9 | 1 |
| 15 | 3 | 1 | 5 | 7 | 0 | 0 | 5 | 2 | 0 | 3 | 5 | 3 | 3 | 6 | 6 | 3 | 8 | 6 | 1 | 8 |
| 16 | 2 | 1 | 1 | 2 | 4 | 4 | 8 | 1 | 3 | 2 | 5 | 2 | 2 | 3 | 1 | 7 | 7 | 4 | 5 | 1 |
| 17 | 6 | 6 | 2 | 6 | 8 | 2 | 9 | 6 | 6 | 4 | 9 | 5 | 7 | 2 | 7 | 8 | 5 | 9 | 3 | 6 |
| 18 | 2 | 3 | 7 | 0 | 2 | 7 | 5 | 7 | 0 | 2 | 5 | 6 | 5 | 6 | 3 | 1 | 1 | 9 | 2 | 1 |
| 19 | 4 | 1 | 7 | 7 | 9 | 7 | 5 | 8 | 1 | 3 | 8 | 5 | 3 | 1 | 1 | 8 | 9 | 1 | 9 | 1 |
| 20 | 1 | 3 | 2 | 4 | 3 | 6 | 1 | 3 | 1 | 5 | 0 | 7 | 2 | 3 | 7 | 4 | 7 | 5 | 9 | 1 |
| 21 | 6 | 8 | 4 | 4 | 2 | 6 | 8 | 7 | 0 | 7 | 5 | 2 | 5 | 0 | 2 | 7 | 5 | 4 | 5 | 1 |
| 22 | 0 | 7 | 3 | 6 | 7 | 8 | 4 | 5 | 4 | 1 | 8 | 1 | 5 | 7 | 6 | 5 | 3 | 9 | 6 | 2 |
| 23 | 7 | 7 | 3 | 3 | 3 | 2 | 5 | 9 | 9 | 6 | 3 | 6 | 3 | 1 | 0 | 8 | 0 | 0 | 7 | 2 |
| 24 | 8 | 9 | 3 | 1 | 3 | 6 | 8 | 3 | 4 | 4 | 7 | 4 | 8 | 8 | 0 | 7 | 0 | 5 | 0 | 3 |
| 25 | 2 | 3 | 2 | 2 | 6 | 7 | 4 | 6 | 4 | 1 | 2 | 7 | 9 | 6 | 2 | 9 | 3 | 1 | 9 | 1 |
| 26 | 3 | 0 | 3 | 8 | 4 | 2 | 4 | 2 | 0 | 3 | 0 | 5 | 4 | 5 | 4 | 7 | 8 | 9 | 6 | |
| 27 | 1 | 5 | 2 | 9 | 3 | 6 | 1 | 4 | 8 | 8 | 2 | 2 | 8 | 1 | 1 | 0 | 0 | 3 | 1 | 1 |
| 28 | 6 | 5 | 0 | 1 | 0 | 0 | 3 | 4 | 4 | 9 | 8 | 9 | 9 | 0 | 1 | 0 | 9 | 6 | 1 | 6 |

Figure 3.7: Table of Random Digits

Using the RAND() Function

The Excel function INT truncates a real number to its integer value. For instance, the formula = INT(3.82) produces the value 3. By combining INT and RAND() as

$= \text{INT}(10*\text{RAND}())$ we can produce random digits from $\{0, 1, \dots, 9\}$.

Example 3.3. Produce a table of 500 random digits.

Solution

1. In cell A4 of a workbook, enter the formula $= \text{INT}(10*\text{RAND}())$.
2. Select cell A4, click the fill handle in the lower right corner, and drag across to cell T4.
3. Select cells A4:T4, click the fill handle in the lower right corner, and drag down to cell T28.

The result is shown in Figure 3.7.