Exercises: Substitution Ciphers

Spreadsheet Exercise

To begin with, download the Excel spreadsheet: `00-ISBN.xlsx`. We will use some basic functions to allow us to check ISBN codes. The functions we see here will appear a lot over the remaining topics, but should be fairly straightforward to get to grips with this week.

Some general Excel tips:

- A box in Excel is called a 'cell'. Each cell is described by a letter followed by a number. The letter is the column name and the number is the row. E.g., cell M32 is in column M and row 32.
- To enter text/numbers into a cell, either single-click the cell and start typing, or double click to 'enter' the cell and then start typing. Press enter to end the entry and move down a row, or press tab to end the entry and move across a column.
- You can select a range of cells by clicking and dragging.
- All Excel functions start with an equals sign: '='. Without this, Excel just sees the formula as a text string.

1. There is an ISBN-10 code in cell B1. Leave this as it is for now. Similarly, leave the words in column A as they are, as well as the 'Position' numbers in row 2.
2. Clicking on Cell B3 you should see that there is a formula in the bar above: '=MID(B1,11-B2,1)'. If you double-click Cell B3 you will go 'into' the cell and you can see the formula appear there. This uses the MID function to split the ISBN code apart into single digits.
    - The first argument points to cell B1 as the text/number we want to split apart. The dollar signs are important here as we will 'drag' the function across the columns. This will copy the formula and update the formula, but won't change anything with a dollar sign in front of it meaning it will always point at Cell B1 for the text.
    - The second argument takes the value in Cell B2 and finds the difference with this and 11 - this is really just giving the position values back in reverse order. E.g., 11 - 10 = 1, giving the first position.

- The third and final argument is just the number of characters to return from the string.

You should see the first digit from the ISBN in Cell B3. This should be a '1'.

3. With the formula successfully typed into Cell B3, we can automatically fill the other columns by 'dragging' the formula across. Single-click on Cell B3 to highlight it - this should give the cell an outline (usually green) with a small square box at the bottom right-hand corner of the cell. Click and hold this small box/dot and drag across to Cell K3. If this has worked, you should see the rest of the ISBN digits appear in the columns C-K.

4. In Cell B4 we will now enter a new formula to find the product of each ISBN digit with its position value. In Cell B4, enter the formula '=B2*B3', without any dollar signs. After pressing enter, this should give the value of '10'.

5. As before, drag this formula across to column K.

6. In Cell B5, we will enter a new formula using the MOD function. This will reduce each of the products down, using modulo 11. Enter the formula '=MOD(B4,11)' in Cell B4 and then drag the result across to column K again.

7. We now need to find the sum, modulo 11. Below 'Sum' in column M, use the SUM function to find the sum of the values in the cells B5 to K5. To do this, enter the formula '=SUM(B5:K5)' in Cell M5.

8. Use the MOD function again to find the sum modulo 11 in Cell N5. Do this by using the formula '=MOD(M5,11)'. If this has all worked correctly, the result should be 0.

9. We can add a check in Cell O5 to tell us if the ISBN is valid or not, using the IF function. Enter the formula '=IF(N5=0,"Valid","Invalid")' in Cell O5. Check that it works.

Exercises

In the questions about ISBNs and barcodes, the dashes are just there to space the numbers out and can be ignored. Try to do the calculations by hand and then use your spreadsheet to check your working. For the ISBN-13 questions, you will need to update the second sheet with some calculations in a similar way to what you did above. (Be aware that ISBN-13/barcodes work with modulo 10, not modulo 11.)

1. (a) A book distributor received orders for the following books, described by their ISBN-10s, but the clerk who made out the order was a bit careless. Which of the orders should the distributor query?

$$1-84046-521-2 \qquad\qquad 0-90455-874-7$$

(b) A check digit needs adding on the end of this ISBN-10 number to replace the question mark. What should it be?

$$1 - 789 - 14132 - ?$$

(c) The number where the question mark is in the ISBN-10 below has been smudged. What number should it be?

$$1 - 78 - 1310?6 - 4$$

2. (a) Here are some identifiers copied from bar codes. Which have been copied correctly?

9781916355378 5014437800436

(b) A check digit needs adding to this product number to make it into a barcode. What should it be?

088903001761

3. One book I have has an ISBN-13 number of $978 - 1 - 857 - 02889 - 8$ and an ISBN-10 number of $1 - 85702 - 889 - 9$. Another has an ISBN-10 number of $0 - 413 - 42240 - 2$ and a number at the bottom of the bar code which is 9780413422408.

I have a book which has an ISBN number of $0 - 00 - 771883 - 7$. What would its ISBN-13 number be?

Solutions

1. (a) $1 - 84046 - 521 - 2$ is a valid ISBN-10; $0 - 90455 - 874 - 7$ is not a valid ISBN-10.

(b) $1 - 789 - 14132 - X$

(c) $1 - 78 - 131056 - 4$

2. (a) 9781916355378 is a valid barcode; 5014437800436 is not a valid barcode.

(b) 0889030017611

3. The ISBN-13 would be 9780007718832. Add 978 to the front of the number, then recalculate the check digit.