CHAPTER 9  IDENTIFICATION NUMBERS

US POSTAL SERVICE MONEY ORDER
11 DIGIT CODE
THE LAST DIGIT SERVES AS AN ERROR-DETECTING CODE

ADD THE 1ST 10 DIGITS. DIVIDE THE SUM BY 9. THE ELEVENTH DIGIT IS THE REMAINDER.

EXAMPLE:
DETERMINE THE CHECK DIGIT FOR A MONEY ORDER WITH IDENTIFICATION NUMBER 7234541780?

\[
7 + 2 + 3 + 4 + 5 + 4 + 1 + 7 + 8 + 0 = 41
\]

\[
\frac{41}{9} = \frac{36}{9} + 5 = R
\]

THE LAST DIGIT (CHECK DIGIT) IS 5.

SUPPOSE WE HAVE A NUMBER GIVEN AS FOLLOWS: 63054383845 IS IT CORRECT?

\[
6 + 3 + 0 + 5 + 4 + 3 + 8 + 3 + 8 + 4 = 44
\]

\[
\frac{44}{9} = \frac{36}{9} + 8 \neq 5
\]

THE REMAINDER DOES NOT EQUAL THE CHECK DIGIT. THUS, THIS NUMBER IS NOT CORRECT.

THIS METHOD DOES NOT DETECT THE ERROR OF REPLACING A 0 WITH A 9 OR A 9 WITH A 0. IT ALSO DOES NOT DETECT TRANSPOSITION OF DIGITS.

AMERICAN EXPRESS AND VISA TRAVELER’S CHECKS UTILIZE A CHECK DIGIT DETERMINED BY DIVISION BY 9. IN THIS CASE THE SUM OF ALL DIGITS INCLUDING THE CHECK DIGIT MUST BE DIVISIBLE BY 9.

AIRLINE TICKETS, FEDERAL EXPRESS, UPS, AVIS, AND NATIONAL CAR RENTALS ASSIGN THE REMAINDER UPON DIVISION BY 7 OF THE NUMBER ITSELF AS THE CHECK DIGIT.

EXAMPLE:
DETERMINE THE CHECK DIGIT FOR THE AVIS RENTAL CAR WITH IDENTIFICATION NUMBER 540047

\[
\frac{540047}{7} = \frac{38575}{7} + 2 = R
\]

THE CHECK DIGIT IS 4

THIS METHOD WILL NOT DETECT THE SUBSTITUTION OF 0 FOR 7 OR 7 FOR 0
1 FOR 8 OR 8 FOR 1
2 FOR 9 OR 9 FOR 2
IT WILL DETECT TRANSPositionS OF ADJACENT DIGITS WITH THE EXCEPTIONS OF THE PAIRS
0 AND 7; 1 AND 8; AND 2 AND 9.

UNIVERSAL PRODUCT CODE (UPC)
THIS CODE IS USED ON GROCERY PRODUCTS.
12 DIGITS
1ST DIGIT IDENTIFIES A BROAD CATEGORY OF GOODS
NEXT 5 DIGITS - MANUFACTURER
NEXT 5 DIGITS - PRODUCT
LAST (12TH) DIGIT - CHECK DIGIT

AN EXAMPLE TO SHOW HOW THIS WORKS.
EXAMPLE:
DETERMINE THE CHECK DIGIT FOR THE UPC NUMBER 38137009213
ADD DIGITS IN POSITIONS 1, 3, 5, 7, 9, 11
3 + 1 + 7 + 0 + 2 + 3 = 16
MULTIPLY RESULT BY 3: 3 x 16 = 48
ADD THIS RESULT TO THE SUM OF THE REMAINING DIGITS
48 + 8 + 3 + 0 + 9 + 1 = 69
THE CHECK DIGIT IS 1: THE NUMBER WE CAN ADD TO 69 TO MAKE IT END IN A 0.
THIS SCHEME DETECTS ALL SINGLE POSITION ERRORS AND ABOUT 89% OF ALL OTHER KINDS OF ERRORS.

US BANKING SYSTEM
EACH BANK HAS AN 8-DIGIT IDENTIFICATION NUMBER TOGETHER WITH A 9TH CHECK DIGIT.
\[ a_1 a_2 a_3 a_4 a_5 a_6 a_7 a_8 a_9 \]
Weights: 7, 3, 9
CALCULATE:
\[ 7a_1 + 3a_2 + 9a_3 + 7a_4 + 3a_5 + 9a_6 + 7a_7 + 3a_8 = ? \]
THE CHECK DIGIT \( a_9 \) IS THE LAST DIGIT OF THE ABOVE NUMBER.
EXAMPLE:
DETERMINE THE CHECK DIGIT FOR THE BANK NUMBER 09100001
7(0) + 3(9) + 9(1) + 7(0) + 3(0) + 9(0) + 7(0) + 3(1) = 39
THUS THE CHECK DIGIT \( a_9 = 9 \) AND THE BANK NUMBER BECOMES 091000019.
ALL SINGLE DIGIT ERRORS AND MOST TRANSPOSITION ERRORS ARE DETECTED BY THIS SCHEME.

CODABAR SYSTEMS
THESE ARE USED BY ALL MAJOR CREDIT CARD COMPANIES, BLOOD BANKS, PHOTOFINISHING COMPANIES, GERMAN BANKS, WISCONSIN AND SOUTH DAKOTA DRIVER’S LICENSE DEPARTMENTS.
16 DIGITS
AN EXAMPLE WILL ILLUSTRATE THIS TECHNIQUE.

EXAMPLE:
DETERMINE IF THE MASTER CARD NUMBER 3541 0232 0033 2270 IS VALID.
ADD DIGITS IN POSITIONS ODD POSITIONS  1,3,5,7,9,11,13,15
3+4+0+3+0+3+2+7 = 22
DOUBLE THE RESULT :  2(22) =44
COUNT THE NUMBER OF DIGITS IN THE ODD POSITIONS THAT EXCEED 4
    IN THIS EXAMPLE 7 IS THE ONLY ONE THUS THERE IS 1.
ADD THIS TO THE TOTAL : 44 + 1 = 45
NOW ADD THE REMAINING DIGITS TO THIS TOTAL: 45+5+1+2+0+3+2+0 = 60
THE RESULTING NUMBER MUST END IN A 0. THEREFORE, THIS NUMBER IS A
VALID MASTER CARD NUMBER.
THIS METHOD DETECTS 100% OF SINGLE POSITION ERRORS AND ABOUT 98%
OF OTHER COMMON ERRORS.

ISBN   INTERNATIONAL STANDARD BOOK NUMBER
        10 DIGITS
DETECTS ALL SINGLE POSITION ERRORS AND ALL TRANSPOSITION ERRORS.

AN EXAMPLE WILL BE USED TO ILLUSTRATE THE METHOD.
EXAMPLE:
10\(\alpha_1\) + 9\(\alpha_2\) + 8\(\alpha_3\) + 7\(\alpha_4\) + 6\(\alpha_5\) + 5\(\alpha_6\) + 4\(\alpha_7\) + 3\(\alpha_8\) + 2\(\alpha_9\) + \(\alpha_{10}\)
IS EVENLY DIVISIBLE BY 11
10(0)+9(6)+8(6)+7(9)+6(3)+5(3)+4(9)+3(0)
+2(7) = 248
\[
\begin{array}{r}
22 \\
11 \big| 248 \\
22 \\
28 \\
22 \\
6
\end{array}
\]
248+5 = 253 AND 253=23(11)  THUS THE CHECK DIGIT IS 5 AND THE ISBN IS
0   -   669   -  33907   -   5
published in  Publisher  Particular book  Check
inglish     speaking assigned by    digit
speaking country publisher

TO SEE THAT THIS DETECTS 100% OF SINGLE POSITION ERRORS.
SUPPOSE \(\alpha_1\alpha_2\alpha_3\alpha_4\alpha_5\alpha_6\alpha_7\alpha_8\alpha_9\alpha_{10}\) IS INCORRECTLY REPORTED AS
\(\alpha_1\alpha_2\alpha_3\alpha_4\alpha_5\alpha_6\alpha_7\alpha_8\alpha_9\alpha_{10}\)
10\alpha_1 + 9\alpha_2 + 8\alpha_3 + 7\alpha_4 + 6\alpha_5 + 5\alpha_6 + 4\alpha_7 + 3\alpha_8 + 2\alpha_9 + 1\alpha_{10}

is divisible by 11.

If \(10\alpha_1 + 9\alpha_2 + 8\alpha_3 + 7\alpha_4 + 6\alpha_5 + 5\alpha_6 + 4\alpha_7 + 3\alpha_8 + 2\alpha_9 + 1\alpha_{10}\)

is also divisible by 11, then the difference is divisible by 11.

But the difference is \(9\alpha_2 - 9\alpha_2 = 9(\alpha_2 - \alpha_2)\) thus \(\alpha_2 - \alpha_2\)

must be divisible by 11. But \(\alpha_2\) and \(\alpha_2\)

are single digits and hence their difference is not divisible by 11. Thus a single position error cannot go undetected.

**Drawback to the ISBN scheme:**

The check digit may need to be “10”. But this is not a digit. To keep the ISBN as a 10-digit number, use X for the 10 when needed.

The **Code 39** system uses both alphabetic and numeric characters

  UPPERCASE A-Z (ASSIGNED 10-35)
  DIGITS 0-9

15 character codes

\[15\alpha_1 + 14\alpha_2 + 13\alpha_3 + 12\alpha_4 + 11\alpha_5 + 10\alpha_6 + 9\alpha_7 + 8\alpha_8 + 7\alpha_9 + 6\alpha_{10} + 5\alpha_{11} + 4\alpha_{12} + 3\alpha_{13} + 2\alpha_{14} + 1\alpha_{15}\]

is divisible by 36.

**Example:**

Determine the check character for the Code 39 number

\[210SA0162305ZA?\]

\[15(2)+14(1)+13(0)+12(28)+11(10)+10(0)+9(1)+8(6)+7(2)+6(3)+5(0)+4(5)+3(35)+2(10)\]

\[=724\]

\[\frac{36}{32}  \quad R=4\]

36-4=32 724+32=756=36(21)

Thus the check character is W (32).

**ZIP codes**

ZIP + 4 code  see p.332

**Bar codes**

A series of dark bars and light spaces that represent characters.

**Postnet code (10 digits)** used on business reply cards by US postal service.

SEE EXAMPLE P. 336
3 0 7 2 2 ? 9 0 1 7
3+7+2+2+9+1+7=31
CHECK DIGIT IS 9

SOUNDEX CODING SYSTEM
USED FOR ENCODING PERSONAL DATA
SEE P. 342