

A PROJECT ON ERROR DETECTION OF ISBN CHECK-DIGIT

USING CONGRUENCE AND C PROGRAMMING



Submitted By :

Nipan Baishya

PG 3rd Sem

Roll No.:PS-221-019-0001

Registration No.: 287323

Jawaharlal Nehru College, Boko

DECLARATION

I hereby declare that this project report has been prepared by me during the year 2023-24 under the guidance of Dr. Dipankar Sarma Sir in the partial fulfilment of the syllabus for 3rd semester of M.Sc Degree.

I also declare that this project report represents largely my own understandings and words in this topic. This report has been prepared without resorting to plagiarism and adhered to all principles of academic honesty and integrity. No falsified or fabricated data or information has been presented.

Finally, I declare that this project report is the outcome of my own efforts and that it has not been submitted elsewhere for the award of any degree.

Nipan Baishya
.....

Nipan Baishya

(PS-221-019-0001)

CERTIFICATE

It is certified that the work contained in this project report entitled "***A Project Report On error detection of ISBN check digit using congruence and C Program***" submitted by Nipan Baishya for the partialfulfilment of the syllabus for 3rd semester for the degree of Master of Science is absolutely based on his own work carried out under my guidance and this report has not been submitted elsewhere for any degree.

.....
Dr. Dipankar Sarma

Department of Mathematics

Jawaharlal Nehru College, Boko

CONTENT

Sl. No.	Topic			Page No.
1	Acknowledgement			1
2	Abstract			2
3	Introduction			3-4
4	Objectives			5
5	Structure of ISBN		10-digit	6-7
			13-digit	7-8
6	Importance and Uses of ISBN			9-11
7	Methodology			12-13
8	Congruence Formula		for 10-digit ISBN	14-16
			for 13-digit ISBN	17-19
9	C Program	for 10-digit ISBN	to check valid or not	20-21
			to find actual check digit	21-22
		for 13-digit ISBN	to check valid or not	23-24
			to find actual check digit	24-25
10	Results and discussion			26
11	Reference table			27
12	Conclusion			28
13	Bibliography			29

Acknowledgement

To increase the practical knowledge about project, **Gauhati University** authority has provided Project in PG 3rd semester (Mathematics) Course. So, I offer thanks to **Gauhati University** for this initiative.

I convey my heartfelt thanks to our honourable **Principal Sir** and **faculty members** of Department of Mathematics, **Jawaharlal Nehru College** for their encouragement and well wishes. I specially offer my gratitude to **Dr. Dipankar Sarma** Sir , HOD of Department of Mathematics, **Jawaharlal Nehru College** for their constant guidance and supervision during the project work.

Finally, I would like to thank my family members whose cheerfulness and enthusiasm support made the project successful.

With Thanks and Respect

Nipan Baishya .

Yours faithfully

Nipan Baishya

PG 3rd Sem

Roll No : PS-221-019-0001

Abstract:

This project aims to demonstrate how congruence and C program can be used to detect errors in International Standard Book Number (ISBN) check digit. The project will implement a program that checks the validity of an ISBN by computing the check digit. The program will compare the calculated check-digit with the given check digit of the ISBN to determine if there was an error in the code.

Introduction :

The International Standard Book Number (ISBN) is a unique identifier used worldwide to identify books and related products. It serves as a crucial tool in the publishing industry, facilitating the efficient distribution and sale of books. The ISBN system consists of a 10-digit or 13-digit number that provides essential information about a particular book, including its publisher, country, language, edition and format.

The International Standard Book Number (ISBN) is a unique identifier assigned to every book published worldwide. It is crucial for identifying and cataloging books accurately.

The International Standard Book Number (ISBN) is an important identification system used in the publishing industry. It consists of a unique code assigned to each edition and variation of a book. Errors can occur during data entry or transmission, leading

to an invalid ISBN. Therefore, a mechanism is required to detect these errors and ensure the integrity of ISBN codes.

Objectives:

The main objectives of this project are as follows —

- To understand the concept of ISBN and its structure.
- To implement the congruence formula for calculating the check digit.
- To develop a program that can validate the correctness of an ISBN number and find the actual value if there is an error.
- To test the program with different inputs and analyse the results.

Structure of ISBN:

An International Standard Book Number (ISBN) is a unique numeric identifier assigned to each edition and variation of a book. The structure of an ISBN differs depending on whether it is a 10-digit or 13-digit number.

10-digit ISBN:

The 10-digit ISBN is divided into four parts, usually separated by blocks -

- Group or Country identifier: The first part identifies the country or language of the publisher. It is usually a single digit or a limited range of digits.
- Publisher identifier: The second part identifies the specific publisher or imprint within the country or language group. It can range from 1 to 7 digits.
- Title identifier: The third part identifies the specific book title or edition. It can range from 1 to 6 digits.
- Check digit: The fourth part is a single digit that serves as a mathematical validation code based on the previous digits. It ensures the accuracy of the ISBN. The check digit has

eleven possible values : 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10. If the check digit is 10, then it is replaced by X.

13-digit ISBN :

The 13-digit ISBN follows a similar structure to the 10-digit, but with a different arrangement. It is divided by five parts, again usually separated by hyphens. -

- Prefix element : The first three digits are a prefix that identifies the book industry or group. It is basically "978" or "979".
- Group or country identifier : The following one to five digits identify the country or language group of the publisher.
- Publisher identifier : The next part identifies the specific publisher or imprint within the country or language group. It can range from 1 to 7 digits.
- Title identifier : The fourth part identifies the specific book title or edition. It can range from 1 to 6 digits.
- Check digit : This is same as the 10-digit ISBN and serves as a mathematical validation code.

It is important to note that the last digit of both the 10-digit and 13-digit ISBN is calculated using a specific algorithm to ensure accuracy and to detect errors.

Importance and uses of ISBN:

The International Standard Book Number (ISBN) is a unique identifier assigned to each edition and format of a book. It plays a crucial role in the publishing industry and has several important uses.

- Identifying and cataloging books: ISBN help in organizing and structuring book databases. They provide a globally recognized and standardized way of identifying and cataloging books, making it easier for libraries, booksellers, and readers to locate and access specific titles.
- Book ordering and distribution: ISBN are used in the book supply chain to track and manage inventory. Publishers, distributors, and bookstores rely on ISBNs to place orders, keep track of levels, and ensure accurate shipping and distribution.
- Book marketing and promotion: ISBNs are commonly used in marketing and promotional materials, including advertisements, catalogues, websites, and book reviews. This enable publishers and retailers to effectively promote and sell books by highlighting

their unique identifiers, making it easier for potential readers to find and purchase them.

→ Authentication and copyright protection: ISBNs play a role in copyright protection as they serve as proof of ownership. They help authors and publishers establish their intellectual property rights and track unauthorized copies or editions of their books.

→ International book trade: ISBNs are essential when it comes to the global sale and distribution of books. Each country has its own ISBN agency that manages and assigns unique identifiers. The use of ISBN ensures seamless communication and trade across borders.

→ E-book and digital publication management: With the rise of e-books and digital publishing, ISBNs have become crucial in managing and identifying electronic publications. They enable accurate tracking and distribution of digital formats, ensuring proper identification and access for readers.

→ Data collection and analysis: ISBNs contribute to the collection of valuable data for the book industry. By tracking sales and distribution, publishers and

booksellers can analyse market trends, consumer behaviour and demand patterns to make informed business decisions.

Overall, ISBNs are of significant importance in the book publishing and distribution ecosystem. They enable efficient cataloging, ordering, marketing, copyright protection, and data analysis, facilitating the smooth functioning of the publishing industry worldwide.

Methodology :

This project can be divided into the following steps -

→ Understanding ISBN :

- Study the concept of ISBN
- Understand the structure of ISBN and how the check digit is calculated.

→ Implementing congruence formula :

- Apply the congruence formula to calculate the checkdigit.
- Compare the calculated checkdigit with the actual checkdigit in the ISBN.
- Determine if the ISBN is valid or invalid based on the comparison.

→ Developing the program :

- Develop a C program to check the ISBN.
- Apply the C program to calculate the check-digit.
- Compare the calculated checkdigit with the actual checkdigit in the ISBN.
- Test the program with different inputs to ensure its correctness.

→ Testing and Analysis :

- a. Test the program with various ISBN numbers, including both valid and invalid ones.
- b. Analyse the results to determine the accuracy of the error detection mechanism.

Congruence formula for 10-digit ISBN:

The process for calculating the check digit for a 10-digit ISBN is slightly different. The formula is as follows —

- Multiply each of the first 9 digit of the ISBN by sequential weights, starting from 10.
- Add up all the products obtained in step a.
- Take the sum obtained in step b and find the remainder when divided by 11 ie modulo 11. This remainder is referred to as the "modulo 11 remainder".
- If the "modulo 11 remainder" is 0, the checkdigit is 0.
- If the "modulo 11 remainder" is not 0, subtract it from 11 to determine the check-digit.

It is important to note that the 10-digit ISBNs were used prior to January 1, 2007. The checkdigit is used to ensure the accuracy and integrity of the ISBN.

Suppose the first 9 digit $x_9, x_8, x_7, x_6, x_5, x_4, x_3, x_2, x_1$ are chosen, then the check digit x_{10}

which is one of 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, x is determined by the congruence

$$1x_1 + 2x_2 + 3x_3 + 4x_4 + 5x_5 + 6x_6 + 7x_7 + 8x_8 + 9x_9 + 10x_{10} \equiv 0 \pmod{11}$$

$$\Rightarrow \sum_{i=1}^9 ix_i + 11x_{10} - x_{10} \equiv 0 \pmod{11}$$

$$\Rightarrow \sum_{i=1}^9 ix_i - x_{10} \equiv 0 \pmod{11}$$

$$\Rightarrow \sum_{i=1}^9 ix_i \equiv x_{10} \pmod{11}$$

where x_{10} is the required checkdigit

eg: ① ISBN number of Rigid Dynamics by Dr. Md Motiur Rahman is 8173812241

Now, $8 + 2 \times 1 + 3 \times 7 + 4 \times 3 + 5 \times 8 + 6 \times 1 + 7 \times 2 + 8 \times 2 + 9 \times 4$

$$= 8 + 2 + 21 + 12 + 40 + 6 + 14 + 16 + 36$$

$$= 155$$

We have $155 \equiv 1 \pmod{11}$

$\therefore$ check digit is 1. which is same as the given check digit.

$\therefore$ The ISBN number is valid.

eg: ② ISBN number of Elementary number theory by David M Burton is 1259025764

$$\begin{aligned}
 \text{Now, } & 1 \times 1 + 2 \times 2 + 3 \times 5 + 4 \times 9 + 5 \times 0 + 6 \times 2 + 7 \times 5 + 8 \times 7 + 9 \times 6 \\
 & = 1 + 4 + 15 + 36 + 0 + 12 + 35 + 56 + 54 \\
 & = 213
 \end{aligned}$$

We have $213 \equiv 4 \pmod{11}$

$\therefore$ check digit is 4 so the ISBN is valid

eg: ③ ISBN number of Mathematical analysis by Apostol T.M is 818501566X

$$\begin{aligned}
 \text{Here, } & 8 \times 1 + 1 \times 2 + 8 \times 3 + 5 \times 4 + 0 \times 5 + 1 \times 6 + 5 \times 7 + 6 \times 8 + 6 \times 9 \\
 & = 8 + 2 + 24 + 20 + 0 + 6 + 35 + 48 + 54 \\
 & = 197
 \end{aligned}$$

Now, $197 \equiv 10 \pmod{11}$

$\therefore$ check digit is X, so the ISBN is valid

eg: ④ Let us take an ISBN number 8185015709

$$\begin{aligned}
 \text{Here, } & 8 \times 1 + 1 \times 2 + 8 \times 3 + 5 \times 4 + 0 \times 5 + 1 \times 6 + 5 \times 7 + 7 \times 8 + 0 \times 9 \\
 & = 8 + 2 + 24 + 20 + 0 + 6 + 35 + 56 + 0 \\
 & = 151
 \end{aligned}$$

Now $151 \equiv 8 \pmod{11}$

$\therefore$ check digit is 8 but it is not same as the given check digit. so the ISBN is invalid.

Congruence formula for 13-digit ISBN:

The congruence formula to find the check digit of a 13-digit ISBN is as follows -

a. Multiply each of the first 12 digits of the ISBN by alternating weights of 1 and 3. The first digit is multiplied by 1, the second by 3, the third by 1, the fourth by 3 and so on.

b. Add up all the products obtained in step a.

c. Take the sum obtained in step b and find the remainder when divided by 10 (modulo 10).

This remainder is referred to as the "modulo 10 remainder".

d. Subtract the "modulo 10 remainder" from 10.

e. If the result of step d is 10, the check digit is 0. Otherwise, the check digit is equal to the result of step d.

It is important to note that the 13-digit ISBN is used for book published after January 1, 2007. The check digit is used to ensure the accuracy and integrity of the ISBN.

Suppose the first 12-digits $x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9, x_{10}, x_{11}, x_{12}$ of an ISBN are chosen,

then the check digit x_{13} is determined by the congruence -

$$1x_1 + 3x_2 + 1x_3 + 3x_4 + 1x_5 + 3x_6 + 1x_7 + 3x_8 + 1x_9 + 3x_{10} + 1x_{11} + 3x_{12} + x_{13} \equiv 0 \pmod{10}$$

$$\Rightarrow (x_1 + x_3 + x_5 + x_7 + x_9 + x_{11}) + 3(x_2 + x_4 + x_6 + x_8 + x_{10} + x_{12}) + x_{13} \equiv 0 \pmod{10}$$

$$\Rightarrow \sum_{i \in \{1, 3, 5, 7, 9, 11\}} x_i + 3 \sum_{j \in \{2, 4, 6, 8, 10, 12\}} x_j \equiv -x_{13} \pmod{10}$$

where x_{13} is the required check digit.

eg: ① ISBN number of Combinatorics and graph Theory by Dr. Dipankar Sarma is

9789391158132

Here, $(9+7+3+1+5+1) + 3(7+9+9+1+8+3)$

$$= 27 + 111$$

$$= 138$$

Now $138 \equiv 8 \pmod{10}$

$$\Rightarrow 138 \equiv (10-2) \pmod{10}$$

$$\Rightarrow 138 \equiv -2 \pmod{10}$$

$\therefore$ check digit is 2 which is same as the given check digit. Therefore ISBN is valid.

eg: ② ISBN number of 'আমার বুক' by সাদমান
মোহাম্মদ হুসাইন is 9788193799327

$$\text{Here, } (9+8+1+3+7+3) + 3(7+8+9+9+9+2) \\ = 31 + 132 = 163$$

$$\text{Now } 163 \equiv 3 \pmod{10}$$

$$\Rightarrow 163 \equiv -7 \pmod{10}$$

$\therefore$ check digit is 7. $\therefore$ The ISBN is valid.

eg: ③ Let us take an ISBN number 9788125912117

$$\text{Here, } (9+8+1+5+1+1) + 3(7+8+2+9+2+1) \\ = 25 + 87 = 112$$

$$\text{We have } 112 \equiv 2 \pmod{10}$$

$$\Rightarrow 112 \equiv -8 \pmod{10}$$

$\therefore$ check digit is 8 which is not same as the given check digit

$\therefore$ The ISBN is invalid.

Program for 10-digit ISBN:
To check valid or not;

```
#include <stdio.h>
```

```
#include <string.h>
```

```
int main ( )
```

```
{
```

```
    char isbn[11];
```

```
    int i, sum = 0;
```

```
    printf("Enter the 10-digit ISBN: ");
```

```
    scanf("%s", isbn);
```

```
    if (strlen(isbn) != 10)
```

```
    {
```

```
        printf("Invalid ISBN: ISBN should be exactly  
        10 characters long");
```

```
        return 0;
```

```
    }
```

```
    for (i = 0; i < 10; i++)
```

```
    {
```

```
        if (isbn[i] < '0' || isbn[i] > '9')
```

```
        {
```

```
            printf("Invalid ISBN: ISBN should  
            contain only digits");
```

```
            return 0;
```

```
        }
```

```
sum += (isbn[i] - '0') * (i+1);
```

```
}
```

```
if (sum % 11 == 0)
```

```
{
```

```
    printf("Valid ISBN");
```

```
}
```

```
else
```

```
{
```

```
    printf("Invalid ISBN");
```

```
}
```

```
return 0;
```

```
}
```

→ To find actual check digit:

```
#include <stdio.h>
```

```
#include <string.h>
```

```
int main ()
```

```
{
```

```
    char isbn[10];
```

```
    int i, checkdigit, sum = 0;
```

```
    printf("Enter a 10-digit ISBN number(  
        without checkdigit):");
```

```
scanf ("%s", isbn);  
for (i=0; i<9; i++)  
{  
    sum += (isbn[i] - '0') * (i+1);  
}  
checkdigit = sum % 11;  
if (checkdigit == 10)  
    isbn[9] = 'x';  
else  
    isbn[9] = checkdigit + '0';  
printf ("The ISBN number with checkdigit  
is : %s, isbn);  
return 0;
```

Program for 13-digit ISBN:

To check valid or not:

#include <stdio.h>

#include <string.h>

int main ()

{ char isbn[14];

int i, sum=0, weight=1;

printf("Enter the 13-digit ISBN:");

scanf("%s", isbn);

if (strlen(isbn) != 13)

{
printf("Invalid ISBN: ISBN should be
exactly 13 characters long");
return 0;

}

for (i=0; i<13; i++)

{

if (isbn[i] < '0' || isbn[i] > '9')

{

printf("Invalid ISBN: ISBN should contain
only digits");

return 0;

}

sum += (isbn[i] - '0') * weight;

Reference Table :

There are various codes for Language and Countries. Some of these are given below —

Codes	Country
0	(English) UK, US, Australia, NZ, Canada
1	(English) South Africa, Zimbabwe
2	(French) France, Belgium, Canada, Switzerland
3	(German) Germany, Austria, Switzerland
4	Japan
5	USSR
7	China
65	Brazil
81, 93	India
602, 979	Indonesia
9938, 99946	Nepal
624	Sri Lanka
627, 969	Pakistan

Conclusion :

The project report presents the implementation of error detection of ISBN using congruence. The program successfully validate the correctness of ISBN numbers by calculating and comparing the checkdigit. The project highlights the importance of error detection mechanisms in ensuring the accuracy and integrity of data. Further improvements can be made to handle variations in ISBN formats and detect other types of errors.