**Problem 3：檢查碼問題**

**子題 2：**

漢明碼(Haming Code)

1. 具有自動偵錯與更正錯誤一個位元的功能，兩個位元有誤只能偵測。

2. m個位元資料，須 r 個同位元查出錯誤。 m+r+1≦2^r

3. 同位元(Parity)放置位置為2^(r-1)

m：資料位元長度 r：檢查位元長度 (2^r) n：總傳送位元數 ( n= m+ r )

舉例來說，如果需要傳送7 個位元 110 0001 資料，則 m = 7，7+4+1 < =2^4，r= 4，n = 7 + 4，

檢查位元需要4 個位元。

同位元檢查，分為兩種，一種為奇同位檢查另一種為偶同位檢查，以偶同位例子來說，

0110110，已經有4 個1，所以偶同位元就填入0，資料加偶同位為01101100。接下來的計算

都用偶同位。

假設，要傳的字元為a，對應到7 個位元的ASCII 為110 0001，則其漢明碼的檢查碼分別為1011

但是要跳過為 1 2 4 8 這幾個位置，如下圖：

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 位置 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|  | P1 | P2 | 1 | P3 | 1 | 0 | 0 | P4 | 0 | 0 | 1 |

目前檢查位元P1 P2 P3 P4 是未知的，需要透過同位元檢查來取得，如下圖：

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 位置 | 二進位數字 | | | |
| 1 | 0 | 0 | 0 | P1 |
| 2 | 0 | 0 | P2 | 0 |
| 3 | 0 | 0 | 1 | 1 |
| 4 | 0 | P3 | 0 | 0 |
| 5 | 0 | 1 | 0 | 1 |
| 6 | 0 | 0 | 0 | 0 |
| 7 | 0 | 0 | 0 | 0 |
| 8 | P4 | 0 | 0 | 0 |
| 9 | 0 | 0 | 0 | 0 |
| 10 | 0 | 0 | 0 | 0 |
| 11 | 1 | 0 | 1 | 1 |
| 同位元檢查 | 1 | 1 | 0 | 1 |

要注意的是位置3、5、11 為1，所以在二進位數字那邊就要填入0011、0101、1011 其他填0000。

同位元檢查那邊以P1 那一欄來說，那一欄一共有3 個1，所以P1 需要填入1，P2P3P4 以此類

推，字元為a， ASCII 為110 0001，漢明碼P1P2P3P4 檢查碼為1011，最後所傳送的資料為

10111001001。

輸入說明：

第1 行的數字n 代表有幾筆字元資料要計算，接下來資料為傳送字元[a-zA-Z0-9]。

輸出說明：

輸出為字元對應的漢明碼P1P2P3P4 檢查碼。

輸入範例：【檔名：in-3-2-1.txt】

3

H

a

m

輸入範例：【檔名：in-3-2-2.txt】

2

c

e

輸出範例：【檔名：out-3-2.txt】

0010

1011

1100

1110

0010

程式碼：

Imports System.IO

Public Class Form1

Dim fr As New FileInfo("in-3-2-1.txt")

Dim fr2 As New FileInfo("in-3-2-2.txt")

Dim fw As New FileInfo("out-3-2.txt")

Dim sw As StreamWriter = fw.CreateText

Dim ii, x, ia, n As Integer

Dim ia2(10), gg(10, 3), oa(11, 3) As Byte

Private Sub Form1\_Load(ByVal sender As System.Object, ByVal e As System.EventArgs) Handles MyBase.Load

If fr.Exists = False Or fr2.Exists = False Then

End

ElseIf fw.Exists = False Then

fw.Create()

End If

Dim sr As StreamReader = fr.OpenText

Dim sr2 As StreamReader = fr2.OpenText

gg(0, 3) = 1

For i = 0 To 9 '照順序輸入4位元的碼

For j = 0 To 3

If gg(i, j) = 1 Then

For k = 3 To 0 Step -1

If gg(i, k) = 0 And k > j Then

For l = 0 To 3

gg(i + 1, l) = gg(i, l)

Next

For l = k + 1 To 3

gg(i + 1, l) = 0

Next

gg(i + 1, k) = 1 : Exit For

ElseIf gg(i, k) = 0 And k < j Then

gg(i + 1, k) = 1

Exit For

End If

Next

End If

Next

Next

For i = 0 To 1 '2個輸入檔

If i = 0 Then ii = sr.ReadLine

If i = 1 Then ii = sr2.ReadLine

For j = 1 To ii '每個輸入檔有幾筆資料要運算

If i = 0 Then ia = Asc(Trim(sr.ReadLine))

If i = 1 Then ia = Asc(Trim(sr2.ReadLine))

n = 10 : x = 0

Do '將asc碼轉換成2進位資料

ia2(n) = ia Mod 2

If ia Mod 2 = 1 Then x += 1

ia \= 2 : n -= 1

If n = 0 Or n = 1 Or n = 3 Or n = 7 Then '除掉1 2 4 8 的位置

n -= 1

End If

If ia = 1 Then

ia2(n) = 1 : Exit Do

End If

Loop

ReDim oa(11, 3)

For k = 0 To 10

If ia2(k) = 1 Then

For l = 0 To 3

oa(k, l) = gg(k, l)

Next

End If

Next

x = 0

For k = 0 To 3

For l = 0 To 10 '算出第k處有幾個1

If oa(l, k) = 1 Then x += 1

Next

If x Mod 2 = 1 Then : oa(11, k) = 1 '檢查是偶數個1還是基數個1

Else : oa(11, k) = 0

End If

x = 0

Next

For k = 3 To 0 Step -1

sw.Write(oa(11, k))

Next

sw.WriteLine()

Next

Next

sw.Flush() : sw.Close() : End

End Sub

End Class