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Introduction to Computer Science, Winter Semester 2016
Practice Assignment 9

Discussion: 24.12.2016 - 29.12.2016

Exercise 9-1

Given a list of characters represented by their Unicode in decimal, write a Python program that produces the corresponding String by concatenating all characters of the list. Test your algorithm with the following input list:

65203	65248	65268	65250

Solution:

```
A = eval(input())
n = len(A)
i = 0
B= [""]*n
while(i < n):
  B[i] = chr(A[i])
  i += 1

i=0
while (i < n):
  print(B[i],end="")
  i+=1
```

Exercise 9-2

Given the following RGB representation of a color, represent its corresponding hexadecimal value.

```
R= 255
G= 197
B= 217
```

Solution:

Hexadecimal representation: #FFC5D9

Exercise 9-3

Given a list of 1's and 0's representing one row in an image, write a Python program that stores the pixel's color in a list of Strings as black and white. Assume that black pixels are represented as 0's and white pixels as 1's.

Solution:

```
A = eval(input())
n = len(A)
i = 0
B= [""]*n
while(i < n):
  if(A[i]==1):
    B[i] = "W"
  else:
    B[i] = "B"
  i += 1
print(B)
```

Exercise 9-4

Given a list of 1's and 0's representing one row in an image, write a Python program that inverts the image, i.e. invert white pixels to black and vice versa. Assume that black pixels are represented as 0's and white pixels as 1's.

Solution:

```
A = eval(input())
n = len(A)
i = 0
while(i < n):
  A[i] = 1 - A[i]
  i += 1
print(A)
```

Exercise 9-5

Given the following truth table, where P, X, and Y are the input variables and S and C are the output variables:

P	X	Y	S	C
0	0	0	0	0
0	0	1	1	0
0	1	0	1	0
0	1	1	0	1
1	0	0	1	0
1	0	1	0	1
1	1	0	0	1
1	1	1	1	1

a) Use the sum-of-products-algorithm to determine the boolean expressions that correspond to the truth table.

Solution:

a) Using the sum-of-products-algorithm

$$\begin{aligned} S &= P'X'Y + P'XY' + PX'Y' + PXY \\ C &= P'XY + PX'Y + PXY' + PXY \end{aligned}$$

Exercise 9-6

Using truth tables, show that:

$X'Y + Y'Z + XZ' = XY' + YZ' + X'Z$

Solution:

- Truth table for $X'Y + Y'Z + XZ'$

X	Y	Z	X'Y	Y'Z	XZ'	X'Y + Y'Z + XZ'
0	0	0	0	0	0	0
0	0	1	0	1	0	1
0	1	0	1	0	0	1
0	1	1	1	0	0	1
1	0	0	0	0	1	1
1	0	1	0	1	0	1
1	1	0	0	0	1	1
1	1	1	0	0	0	0

- Truth table for $XY' + YZ' + X'Z$

X	Y	Z	XY'	YZ'	X'Z	XY' + YZ' + X'Z
0	0	0	0	0	0	0
0	0	1	0	0	1	1
0	1	0	0	1	0	1
0	1	1	0	0	1	1
1	0	0	1	0	0	1
1	0	1	1	0	0	1
1	1	0	0	1	0	1
1	1	1	0	0	0	0

Exercise 9-7

A circuit should be designed to perform the operation $(A - 1)$ where A represents a number in sign/magnitude notation consisting of 2 bits.

a) How many output variables are needed? Justify your answer.

Solution:

3 output variables are needed. 2 bits in sign magnitude can represnet a range of $[-1, 1]$. Thus the output of calculating $-1 - 1$, which is equal to -2, needs 3 bits to represent it in sign/magnitude notation (110).

b) Construct the truth table for this circuit.

Solution:

A1	A2	O1	O2	O3
0	0	1	0	1
0	1	0	0	0
1	0	1	0	1
1	1	1	1	0

c) Use the sum-of-products algorithm to find the boolean expressions that corresponds to the truth table.

Solution:

$$\begin{aligned} O1 = &\quad A1'A2' &+A1A2' + A1A2 \\ O2 = &\quad A1A2 & \\ O3 = &\quad A1'A2' &+A1A2' \end{aligned}$$

Exercise 9-8

A circuit should be designed to perform the modulus operation of two numbers consisting of two bits each.

Assume that for any number N, $N\%0 = 3$.

a) How many input and output variables are needed?

Solution:

Four input variables and two output variables are needed.

b) Construct the truth table for this circuit

Solution:

A	B	C	D	O1	O2
0	0	0	0	1	1
0	0	0	1	0	0
0	0	1	0	0	0
0	0	1	1	0	0
0	1	0	0	1	1
0	1	0	1	0	0
0	1	1	0	0	1
0	1	1	1	0	1
1	0	0	0	1	1
1	0	0	1	0	0
1	0	1	0	0	0
1	0	1	1	1	0
1	1	0	0	1	1
1	1	0	1	0	0
1	1	1	0	0	1
1	1	1	1	0	0

c) Using the sum-of-products method, find the Boolean expressions that correspond to the constructed truth table.

Solution:

$$O1 = A'B'C'D' + A'BC'D' + AB'C'D' + AB'CD + ABC'D'$$

$$O2 = A'B'C'D' + A'BC'D' + A'BCD' + A'BCD + AB'C'D' + ABC'D' + ABCD'$$