Introduction to Computer Science
Constructor University
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Module: CH-232
Date: 2023-11-03
Due: 2023-11-10

Problem Sheet #9

Problem 9.1: *triangle display* (2+2+2 = 6 points)

The leadership of a company decided that all meeting rooms should have an indicator outside displaying how the room is used. A smart room monitoring system has been installed to determine a room's occupancy number, reported as a value in the range 0 (empty) to 6 (full). Your task is to design a display using light emitting diodes (LEDs). The display should resemble the form of a triangle with LEDs positioned as follows:

```
  a
 b c
d e f
```

The numbers 0 to 6 are displayed as follows (a star indicates a LED producing light, a circle indicates an LED currently off).

```
  o       *       o       *       *       *       *
 o o     o o     * *     * *     * *     * *     * *
o o o   o o o   o o o   o o o   o * o   * o *   * * *
```

Your display is driven by three input lines x_2, x_1, x_0 indicating a binary number.

a) Write a truth table defining the boolean functions driving the differnet LEDs.

b) Provide (simple) boolean expressions for the boolean functions.

c) Create a digital circuit using https://simulator.io/. Submit an image of your digital circuit and a link resolving to your digital circuit on https://simulator.io/.

Problem 9.2: *map function equivalence proof in haskell* (2 points)

The `map` function is defined as follows:

```
map :: (a -> b) -> [a] -> [b]
map f [] = []
map f (x:xs) = f x : map f xs
```

Using structural induction, proof that `map (f . g) = map f . map g`.

Problem 9.3: *left and right folds in haskell* (1+1 = 2 points)

The `foldl` and `foldr` functions are defined as follows:

```
foldl :: (b -> a -> b) -> b -> [a] -> b
foldl f e [] = e
foldl f e (x:xs) = foldl f (f e x) xs

foldr :: (a -> b -> b) -> b -> [a] -> b
foldr f e [] = e
foldr f e (x:xs) = f x (foldr f e xs)
```

a) Show step-by-step how the expression `foldl (/) 50 [4,2,5]` is evaluated.

b) Show step-by-step how the expression `foldr (/) 50 [4,2,5]` is evaluated.