

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.

- Write a truth table defining the boolean functions driving the different LEDs.
- Provide (simple) boolean expressions for the boolean functions.
- 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 $\text{map } (f \circ g) = \text{map } f \circ \text{map } g$.

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)

```

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