

# Exercises

## Functions

1. Using library functions, define a function  
haskell stuff  
that splits an even-lengthed list into two halves. For example:

```
*Main> halve [1,2,3,4,5,6]
([1,2,3],[4,5,6])
*Main>
```

2. Define a function *third*

```
nthird o+ow :: p[nap] o+ow -> na
```

that returns the third element in a list that contains at least this many elements using:

- (a) *head* and *tail*;
  - (b) list indexing *!!*;
  - (c) pattern matching.
3. Consider a function *safetail* that behaves in the same way as *tail*, except that *safetail* maps the empty list to the empty list, whereas *tail* gives an error in this case. Define *safetail* using:
    - (a) a conditional expression;
    - (b) guarded equations;
    - (c) pattern matching.
  4. In a similar way to ~~EE~~ in this section's slides, show how the disjunction operator `||` can be defined in four different ways using pattern matching.  
**Hint:** the library function *null* :: [a] -> Bool can be used to test if a list is empty.
  5. Show how the meaning of the following curried function definition can be formalised in terms of lambda expressions:

```
nmult o+ow :: k+ktInt o+ow -> k+ktInt o+ow -> k+ktInt o+ow -> k+ktInt
nmult nx ny nz o+ow = nxo*nyo*nz
```

6. The *Luhn Algorithm* is used to check bank card numbers for simple errors such as mistyping a digit and proceeds as follows:

- consider each digit as a separate number;
- moving left, double every other number from the second last;
- subtract 9 from each number that is now greater than 9;
- add all the resulting numbers together;
- if the total is divisible by 10, the card number is valid.

Define a function

```
luhnDouble o+ow:: k+ktInt o+ow-> k+ktInt
```

that doubles the a digit and subtracts 9 if the number is greater than 9.  
For example

```
*Main> luhnDouble 6
3
*Main> luhnDouble 3
6
*Main>
```

Using *luhnDouble* and the integer remainder function *mod*, define a function

```
luhn o+ow:: k+ktInt o+ow-> k+ktInt+ow-> k+ktInt+ow-> k+ktInt+ow-> k+ktBool
```

that decides if a four digit number is valid. For example:

```
*Main> luhn 1 7 8 4
True
*Main> luhn 4 7 8 3
False
*Main>
```