

# Recursion: Instructions

When you're ready to submit your solution, go to the [assignments list](#).

## Mechanics

Download the [recfun.zip](#) handout archive file and extract it somewhere on your machine.

This assignment counts towards your final grade. Please refer to the [Grading Policy](#) for more details.

Do not forget to submit your work using the `submit` task from SBT. Please refer to the [example assignment](#) for instructions.

## Exercise 1: Pascal's Triangle

The following pattern of numbers is called *Pascal's triangle*.

```
  1
 1 1
1 2 1
1 3 3 1
1 4 6 4 1
...
```

The numbers at the edge of the triangle are all `1`, and each number inside the triangle is the sum of the two numbers above it. Write a function that computes the elements of Pascal's triangle by means of a recursive process.

Do this exercise by implementing the `pascal` function in `Main.scala`, which takes a column `c` and a row `r`, counting from `0` and returns the number at that spot in the triangle. For example, `pascal(0,2)=1`, `pascal(1,2)=2` and `pascal(1,3)=3`.

```
def pascal(c: Int, r: Int): Int
```

## Exercise 2: Parentheses Balancing

Write a recursive function which verifies the balancing of parentheses in a string, which we represent as a `List[Char]` not a `String`. For example, the function should return `true` for the following strings:

- (if (zero? x) max (/ 1 x))
- I told him (that it's not (yet) done). (But he wasn't listening)

The function should return `false` for the following strings:

- :-)
- ()()

The last example shows that it's not enough to verify that a string contains the same number of opening and closing parentheses.

Do this exercise by implementing the `balance` function in `Main.scala`. Its signature is as follows:

```
def balance(chars: List[Char]): Boolean
```

There are three methods on `List[Char]` that are useful for this exercise:

- `chars.isEmpty: Boolean` returns whether a list is empty
- `chars.head: Char` returns the first element of the list
- `chars.tail: List[Char]` returns the list without the first element

**Hint:** you can define an inner function if you need to pass extra parameters to your function.

**Testing:** You can use the `toList` method to convert from a `String` to a `List[Char]`: e.g. `"(just an) example".toList`.

## Exercise 3: Counting Change

Write a recursive function that counts how many different ways you can make change for an amount, given a list of coin denominations. For example, there are 3 ways to give change for 4 if you have coins with denomination 1 and 2: 1+1+1+1, 1+1+2, 2+2.

Do this exercise by implementing the `countChange` function in `Main.scala`. This function takes an amount to change, and a list of unique denominations for the coins. Its signature is as follows:

```
def countChange(money: Int, coins: List[Int]): Int
```

Once again, you can make use of functions `isEmpty`, `head` and `tail` on the list of integers `coins`.

**Hint:** Think of the degenerate cases. How many ways can you give change for 0 CHF? How

many ways can you give change for  $>0$  CHF, if you have no coins?

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