# Homework 4

Please email your solutions to Rongdi Huang (rh1424@nyu.edu). Solutions to programming exercises **must** be submitted electronically as plain text files. No exotic formats, please!

The deadline for Homework 4 is October 3.

## Problem 1 Stack Frames and Parameter Passing (10 Points)

(a) Many languages do not specify the order in which the actual parameters to a subroutines should be evaulated. Write a C or Java program that makes a call to a subroutine taking two arguments and that is able to figure out and report which argument was evaluated first. **(4 Points)**

(b) PLP, p. 440: 8.4 **(3 Points)**

(c) PLP, p. 441: 8.12 **(3 Points)**

## Problem 2 Recursion (10 Points)

(a) For $n, k \in \mathbb{N}$, write a recursive C function that takes $n$ and $k$ as input and computes their binomial coefficient $\binom{n}{k}$. Use the following valid identities:

$$\binom{n}{0} = 1 \qquad \binom{0}{k} = 0 \quad \text{for } k > 0 \qquad \binom{n}{k} = \binom{n-1}{k-1} + \binom{n-1}{k} \quad \text{for } n, k > 0$$

Use the type `int` for $n$, $k$, and the return value. You do not need to worry about arithmetic overflows **(4 Points)**

(b) Write a tail-recursive C function that computes binomial coefficients. Your function should use constant space, assuming the compiler performs tail-call elimination. *Hint:* a useful trick is to consider the following multiplicative identity of binomial coefficients instead of the additive identity given in part (a):

$$\binom{n}{k} = \frac{n\binom{n-1}{k-1}}{k} \quad \text{for } n, k > 0$$

Be careful not to introduce rounding errors. **(4 Points)**

(c) Measure the running times of your two versions for some values of $n$ and $k$. What do you observe? **(2 Points)**.