Concepts in Programming **Due:** Friday, November 8, 2024, 12:00 PM
Problem Set 3 *Originals by W. Mulzer*

Problem 1 Conditionals *10 pts*

(a) Consider a programming language that provides only the primitive `if-then` construct (sans `elif` and `else` branches). Demonstrate how one might simulate a general `if-then-elif-else` construct.

(b) Research the `switch-case` construct in C and the `match-case` construct introduced in Python 3.10. Compare and contrast their properties.

(c) Describe how one might simulate C's `switch-case` construct using Python's conditional branching mechanisms.

Problem 2 Loops *10 pts*

(a) Construct a program utilizing a `for` loop to generate the following numerical triangle:

```
      1
     121
    12321
   1234321
  123454321
 12345654321
1234567654321
```

(b) Implement a program that computes $\sum_{i=1}^{n} i$ utilizing a 'for' loop. Additionally, consider if there exists a more elegant solution.

(c) Research the semantics of Python's `break` and `continue` control primitives, providing illustrative examples. What are their behavioral characteristics in the context of nested loop structures?

(d) Develop a program that continuously accepts numerical input until encountering a sentinel value of 0, whereupon it shall compute and output the arithmetic mean of the provided sequence.

Problem 3 A Random Walk *10 pts*

Consider a stochastic process on $\mathbb{N}_0$ defined as follows:
Let X_t be our position at time t, its initial state being $X_0 = 0$.

The transition probabilities are:

$$P(X_{t+1}|X_t = 0) = 1$$
$$P(X_{t+1} = z + 1|X_t = z) = P(X_{t+1} = z - 1|X_t = z) = \frac{1}{2}, \forall z > 0$$

Implement this random walk in Python and use your program to answer the following questions. Consult the Python documentation to find a function for generating random numbers.

(a) Calculate $\min t : X_t = k$ for $k \in \{10, 20, 30, 50\}$. Come up with a hypothesis for a general formula with $k = n$

(b) Study the distribution of X_t for $t \in \{100, 100\}$. Try to plot it.