

Data Structures (2026 Fall)

Assignment 01

Chuang-Chieh Lin

Department of Computer Science and Engineering,
National Taiwan Ocean University

1. **Ackermann's function** $A(m, n)$ is defined as

$$A(m, n) = \begin{cases} n + 1, & \text{if } m = 0, \\ A(m - 1, 1), & \text{if } m > 0 \text{ and } n = 0, \\ A(m - 1, A(m, n - 1)), & \text{otherwise.} \end{cases}$$

This function grows very quickly, even for small values of m and n . Write both a recursive version and an iterative version of this function.

2. Show that each of the following statements is correct.

- (a) $n^2 - 1000n = \Theta(n^2)$.
- (b) $n! = O(n^n)$.
- (c) $2n^2 + n \log n = \Theta(n^2)$.
- (d) $\sum_{i=0}^n i^2 = \Theta(n^3)$.
- (e) $\sum_{i=1}^n \frac{1}{i} = O(\log n)$.
- (f) $n! = o(n^n)$.
- (g) $\sum_{i=1}^n \frac{1}{\sqrt{i}} = \Theta(\sqrt{n})$.

3. Show that each of the following statements is incorrect.

- (a) $2n^2 + 1 = O(n)$.
- (b) $n \log n = \Theta(n)$.
- (c) $2 = o(1)$.

4. Rewrite the `fast_transpose` so that it uses ONLY ONE array rather than two arrays required to hold `row_items` and `starting_pos`.