SCHOOL OF COMPUTER SCIENCES
UNIVERSITI SAINS MALAYSIA
Semester II Session 2023/2024

CPT113 – Programming Methodology & Data Structures
Tutorial Week 12
Postfix Expressions and Recursion

Learning Outcomes:

- Using stack to calculate postfix expressions.
- How to write and convert iterative programs to recursive programs.

1- What is the result of the following postfix expression?

5 2 * 3 3 2 2 + * + - *

a. 25
b. 23
c. 21
d. No correct answer
e. Imbalanced postfix notation

2- Assuming a series of character is pushed into a stack in the order of: A, B, C, D and E. Which of the following is the possible answer(s) sequence can be obtained from series of the stack operation? Select all correct combination.

a. C, B, D, E, A
b. E, D, C, B, A
c. A, B, C, E, D
d. C, D, E, A, B
e. E, A, B, C, D
f. E, D, C, A, B

3- Identify practical application of the stack data type

a. tracking nested loops in programming
b. storage of local variables in computer system
c. tracking nested function calls in computer system
d. taking turn buying groceries in Tesco during COVID
e. completing task to do everyday
f. I and V
g. I, II and III
h. II, and V
i. III, IV and V

4- Given an input sequence 1, 2, 3, 4, 5. Assuming this stack operates push and pop randomly. Select all the possible incorrect output sequence in order to empty a stack.

a. 3, 4, 5, 1, 2
b. 3, 4, 5, 2, 1
c. 1, 5, 2, 3, 4
d. 5, 4, 3, 1, 2
e. I and II
f. II and III
g. III and IV
h. I, III and IV

5- Convert the following prefix expression into infix expression: −∗+ABC∗−DE+FG.

6- Assume that the operators +, -, × are left associative and ^ is right associative. The order of precedence (from highest to lowest) is ^, ×, +, -. What is the postfix expression corresponding to the infix expression a+b×c-d^e^f ?

7- Write a recursive function, “vowels”, that returns the number of vowels in a string. Also, write a program to test your function.

8- Write a recursive function named sumSquares which returns the sum of the squares of the numbers from 0 to num, in which num is a nonnegative int variable. Do not use global variables; use the appropriate parameters. Also write a program to test your function.

9- Write a recursive function that finds and returns the sum of the elements of an int array. Also, write a program to test your function.

10- A palindrome is a string that reads the same both forward and backward. For example, the string "madam" is a palindrome. Write a program that uses a recursive function to check whether a string is a palindrome. Your program must contain a value-returning recursive function that returns true if the string is a palindrome and false otherwise. Do not use any global variables; use the appropriate parameters.

11- Write a recursive function that returns both the smallest and the largest element in an int array. Also, write a program to test your function.

12- Write a recursive function that returns true if the digits of a positive integer are in increasing order; otherwise, the function returns false. Also, write a program to test your function.

13- Write a recursive function, reverseDigits, that takes an integer as a parameter and returns the number with the digits reversed. Also, write a program to test your function.

14- Write a recursive function, sumDigits, that takes an integer as a parameter and returns the sum of the digits of the integer. Also, write a program to test your function.

15- Write a recursive function, power, that takes as parameters two integers x and y such that x is nonzero and returns xy. You can use the following recursive definition to calculate x^y. If y >= 0:

$$power(x,y) = \begin{cases} 1 & if\ y = 0 \\ x & if\ y = 1 \\ x \times\ power(x, y-1) & if\ y > 1 \end{cases}$$

$$if\ y < 0;$$

$$power(x,y) = \frac{1}{power(x,-y)}$$

16- The Ackermann's function is defined as follows:

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

in which m and n are nonnegative integers. Write a recursive function to implement Ackermann's function. Also write a program to test your function. What happens when you call the function with m = 4 and n = 3?

17- Write a recursive function to generate the following pattern:

```
   *
  * *
 * * *
* * * *
 * * *
  * *
   *
```