CGS600A: Computational Tools in Cognitive Science

Assignment #5: Python-4

Max marks:115
Due on/before:15 Sep.18, 23.59 7-Sep.-2018

All programs are to be written in Python. The data types below are standard ones and code will be available on the internet and in books but pl. try to implement without borrowing code from elsewhere.

1. A *stack* is a container type that has 3 operations. If S is a stack and e is a value: push(e, s) - returns a stack with e 'pushed' on the stack, pop(S) - returns the last value pushed on the stack (assumes S is not empty) and removes it from the stack, isEmpty(S) - returns True if there is no value in the stack and False otherwise. The behaviour can be described by the following equations:
   pop(push(e, S))=e
   isEmpty(push(e, S))=False
   if isEmpty(S)==False then push(pop(S), S')=S, where S' is the stack S after the pop operation.

   This behaviour is often called Last In First Out (or LIFO).

   A *queue* is another container type that also has 3 operations. If Q is a queue and e a value: enqueue(e, Q) - returns a queue with e added to the end of the queue, dequeue(Q) - returns the element that is at the front of the queue (assumes Q is not empty) and removes it from the queue, isEmpty(Q) - is True if the queue is empty and false otherwise. The behaviour can be described by the following equations:

   If isEmpty(Q)==True then let Q'=enqueue(e2, enqueue(e1, Q)), e3=dequeue(Q'), e4=dequeue(Q"), where Q" is the queue after dequeue(Q') then e3=e1 and e4=e2.
   If isEmpty(Q)==True then e=dequeue(enqueue(e, Q))
   isEmpty(enqueue(e, Q))==False

   The behaviour of a queue is called First In First Out (or FIFO).

   (a) Implement a Stack and Queue as classes.

   (b) Simulate the behaviour of a stack data type using only queue objects. This means you have to implement push, pop and isEmpty operations but you can use only queue objects (no lists, tuples etc.).

   (c) Simulate a queue data type using only stack objects.

   (d) Define a new queue called the Indian queue. In this queue values that join the queue are of two types Male or Female. If the value to be enqueued is a Male the value is added to the end of a queue (like a normal queue). If the value to be added is Female then this value is added immediately after the last Female in the queue. If there is no Female in the queue then this value is added at the front of the queue. Define a class that implements an Indian queue. Use only stack and/or queue objects in your implementation.

[10,15,15,15=55]

2. Arithmetic expressions can be written in the standard infix notation or the post-fix notation where the operator is written after the operands. For example: 2+3*4 = 2 3 4 * +
(2+3)*4 = 2 3 + 4 *

   You have to write a program that interconverts between post-fix and infix expressions. Assume that operands are single digit integers and the operations are +, -, *, /, _ (unary minus is the underscore character). The conversion to infix should use the minimum number of parentheses. Operator precedence for infix expressions is the standard one: (*, /)>(+, -). Infix expressions can have a binary operator and the unary negation operator in succession e.g. 2+_3. Operands and operators are separated with whitespace in post-fix expressions. In infix expressions there is no whitespace between operators and operands or operator and operator (for unary minus) - see examples above.

   Assume that each expression is in a single line.

   [15+15=30]

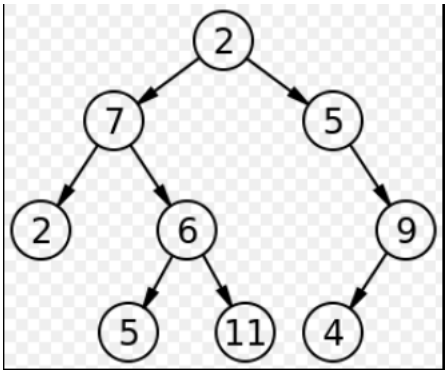
3. A binary tree is a data type that can be recursively defined as follows:

   a) An empty tree is a binary tree.

   b) A single node is a binary tree.

   c) A root node with a left sub-tree and a right sub-tree both of which are binary trees is also a binary tree.

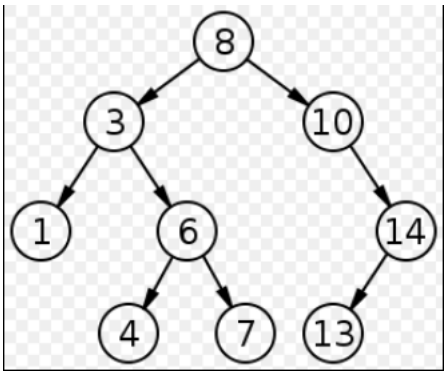
   Typically, each node stores a value. The figure below (src Wikipedia) shows a binary tree where the value at each node is a positive integer.



   A leaf in a binary tree is a node that has no sub trees. The height of a binary tree is the maximum distance from the root to a leaf in the tree. If the height difference between any right sub tree and left sub tree at any node is at most 1 then the binary tree is called a *balanced binary tree*.

   In the figure the root node is 2 and leaf nodes are 2 (second 2), 5, 11, 4. The height is 3.

   A binary search tree (BST) is a balanced binary tree where for every node the values stored at the nodes in the left sub tree are less than or equal to the node value and the values stored in the right subtree are greater than the value at the node. A binary seach tree is shown below (src Wikipedia):



A BST has 4 operations. add and element to the tree, delete and element from the tree, search for an element in the tree, check if the tree is empty or not.

Define a class that implements a binary search tree. [30]