Programming Language, Assignment 4
Due: May 12th, 11:59 pm

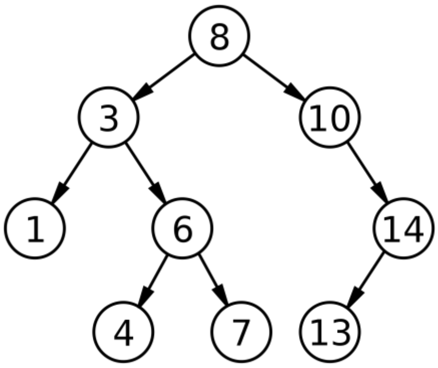
Submission

Write the functions in problem 1 – 3 in a single file, named "sol4.rkt". Implement the code in Racket programming language. Then upload the file to the course homepage (assignment 4). The function names should be the same as is described for each problem. There should be no error when using the file in repl in DrRacket.
Because we are going to test your solution with an automated script, if our script cannot import your file with then your score for this assignment will be zero. So, make sure you test your code.
Important: Your source code should start with the following two lines:
#lang racket
(provide (all-defined-out))

Problems

1. `check_bst` (20 pts)

Binary search tree (BST) is a data structure that stores values in a tree structure. In BST, all the values stored on the left branch are smaller than the value in the current node, and all the values stored on the right branch are larger than the value in the current node. For example, the following diagram shows a binary search tree where the root node stores the value 8, and its left branch stores values that are smaller than 8 (maximum 7) and the right branch stores values that are larger than 8 (minimum 10).



In Racket, a BST can be represented in a list. A BST node is represented as a Racket list having three elements; the first element is the value in the node, and the second element is the left branch and the third element is the right branch. For example, ' (6 (4 () ()) (7 () ())) is a BST where the root node stores 6, its left child (a leaf node) stores 4, and its right child (also a leaf node) stores 7. The above tree is represented in the following list: ' (8 (3 (1 () ()) (6 (4 () ()) (7 () ()))) (10 () (14 (13 () ()) ())))

Write a function `check_bst` that takes a tree node represented in the above list form, and returns a boolean value; it returns true if the given tree node is a proper BST node, and false otherwise. For example, `(check_bst '(6 (4 ()()) (7 ()())))` returns `#t` because the argument is a proper BST node; however, `(check_bst '(6 (7 ()()) (8 ()())))` returns `#f` because it does not satisfy the BST constraint that the values in the left child are smaller than the current value. You can assume that the list is in a proper form – for example, all the lists and nested lists have three elements (or null).

2. `apply` (20 pts)

For the BST described in the previous problem, write a function `apply` that takes a function `f` and a BST, and applies the function to each value in the tree node; `apply` returns a new binary tree where the values in each node are the return values of the function `f`. Note that the returned tree may not be binary search tree. For example, `(apply (lambda (v) (+ v 1)) '(7 (6 ()()) (8 ()())))` returns `'(8 (7 ()()) (9 ()()))`

You can assume that for the second argument of `apply`, `check_bst` returns `#t`.

3. `equals` (bonus, 5 pts)

For the BST described in the previous problem, write a function `equals` that takes two BSTs and returns `#t` if the two BSTs have the same values, and `#f` otherwise. For example, `(equals '(7 (6 ()()) (8 ()())) '(6 () (7 () (8 ()()))))` returns `#t` , but `(equals '(7 (6 ()()) (8 ()())) '(7 (6 ()()) (8 ()(9 () ()))))` returns `#f`.