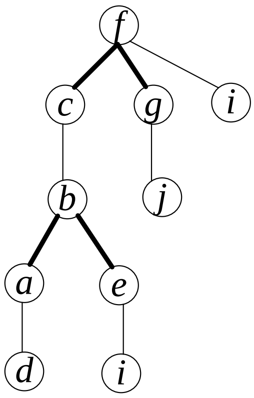
<u>評分標準</u>

有關第 2 題裡頭建造 BFS-like alternating tree 時，不少同學抄襲到同一份錯誤的答案，情況如下：



在這個圖裡頭，由於 *f* 已經是 matched node，不可當 root。注意：alternating tree 的 root 必須是 single node，不可以是 matched node。所以只要畫出此圖，一律扣 10 分。

對於第 3 題，同學大部分抄襲到二種版本。

第一種版本如下：
Let F be a Boolean formula in CNF. For each literal in F, we will make a vertex in the graph, i.e. (x1+x2+x3)(x1+x2+x3) has 6 vertices.
Let k be the number of clause in F. We will connect each vertex to all of the other vertices that are logically compatible except for the ones that are in the same clause. Now if we have a satisfying vertices will all be connected to one another. Thus we can use clique to solve 3SAT. So clique problem is NP-complete.
首先，這個文法錯誤很多，特別是「a satisfying vertices」--名詞前面有 a，vertices 就不能使用複數。此外，什麼是「satisfying vertices」？從未聽聞。如果是同學自己發明的專有名詞，必須告訴我們「satisfying vertices」的定義。但最糟糕的是：「Thus we can use clique to solve 3SAT」….這話很怪，完全沒告訴我們如何用 clique 解 3SAT。所以只要是寫這個答案，一律扣 10 分。

第二種版本是抄襲網路的答案，如下：
Given a 3-CNF formula F of m clauses over n variables, we construct a graph as follows.
For each clause c of F we create one node for every assignment to variables in c that satisfies c. E.g., say
F = (x1 OR x2 OR not(x4)) AND (not(x3) OR x4) AND (not(x2) OR not(x3)) AND ...

Then in this case we would create nodes like this:

(x1=0,x2=0,x4=0) (x3=0,x4=0)　(x2=0,x3=0) ...
(x1=0,x2=1,x4=0) (x3=0,x4=1)　(x2=0,x3=1)
(x1=0,x2=1,x4=1) (x3=1,x4=1)　(x2=1,x3=0)
...

Then we put an edge between two nodes if the partial assignments are consistent. Note: max possible clique size is m. And, if the 3-SAT problem does have a satisfying assignment, then in fact there IS an m-clique. Claim is this is true in the other direction too. If the graph has an m-clique, then there is a satisfying assignment: namely, just read off the assignment given in the nodes of the clique. So, this graph has a clique of size m iff F was satisfiable. Also, our reduction is poly time since the total size of graph is at most quadratic in size of formula (O(m) nodes, O(m^2) edges). Therefore Max-Clique is NP-complete.

我看了一下這個證明，最大問題出在:「F = (x1 OR x2 OR not(x4)) AND (not(x3) OR x4) AND (not(x2) OR not(x3)) AND ...」這個 Boolean formula 裡頭，括弧的裡頭 Boolean 變數居然可以只有 2 個，這並非 3SAT 的型式。翻開課本第 1082 頁，按 3SAT 的定義，括弧的裡頭 Boolean 變數必須剛好（或至少）3 個 Boolean 變數。我再查一下網站 https://www.cs.cmu.edu/afs/cs/academic/class/15451-f05/www/lectures/lect1108.txt，這裡頭提到 3SAT 的定義如下：「3-SAT: Given: a CNF formula (AND of ORs) over n variables x1,...,xn, where each clause has at most 3 variables in it.　(x1 OR x2 OR not(x3)) AND (not(x2) OR x3) AND (x1 OR x3) AND ...　Goal: find an assignment to the variables that satisfies the formula if one exists.」
這網站說，在 3SAT 的問題裡頭，括弧裡頭的 Boolean 變數最多是 3 個。這個 3SAT 的定義是錯的，因為如果我們允許括弧裡頭的 Boolean 變數可以只有 2 個，那麼這種變形的 SAT problem 將不再是 NP-complete，而是落在 P 裡頭（參考課本 1049 頁或者 http://en.wikipedia.org/wiki/2-satisfiability）。所以只要是抄襲這個版本，一律扣 5 分。