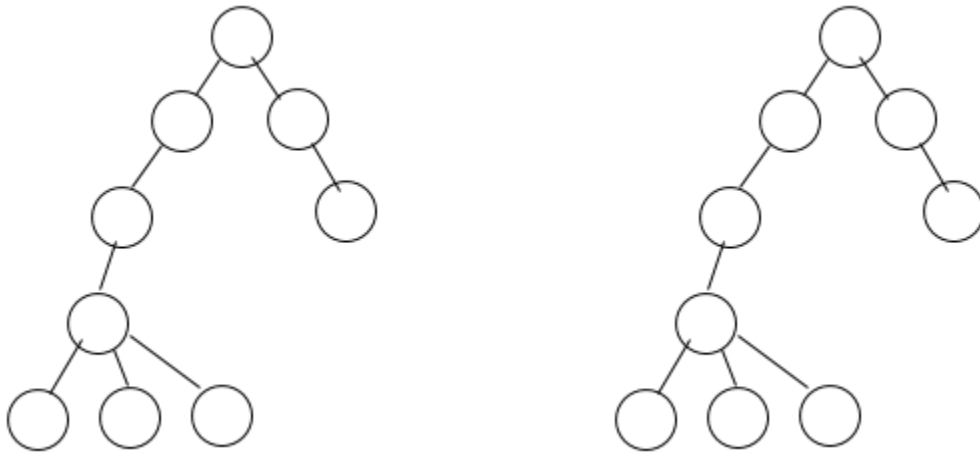


1. Select **all** of the following statements about the bin packing problem that are true?
 - a) The bin packing problem can be solved using a recursive algorithm.
 - b) The set-partition problem can reduce to the decision version of the bin packing problem.
 - c) There exists a 1-approximation polynomial time algorithm for the bin packing problem.
 - d) The decision version of the bin packing problem is in P.
 - e) First-Fit is a 2-approximation algorithm for the bin packing problem.
2. If P does not equal NP, then there must exist a polynomial-time algorithm for 3-SAT.
 - True
 - False
3. Every problem in P can be reduced to 3-SAT.
 - True
 - False
4. Every problem in P is also in NP.
 - True
 - False
5. You are using a polynomial time 2-approximation algorithm to find a tour t for the traveling salesman problem. Which of the following statements is true.
 - The tour t is never optimal.
 - The cost of tour t is at most twice the cost of the optimal tour.
 - The cost of tour t is always 2 times the cost of the optimal tour.
 - The ratio of the cost of the optimal tour divided by the cost of tour t is 2.
 - All of the above.
6. If you discover a polynomial time algorithm for the 0-1 knapsack problem this will imply that $P=NP$.
 - True
 - False

7.

- Verbally describe an efficient greedy approximation algorithm that finds a minimum vertex cover specifically for graphs that are **trees**.
- What is the running time of the algorithm?
- Use the graphs below to compare your algorithm to the 2-OPT approximation algorithm for vertex cover in that selects edges.



8. Show that the Hamiltonian Cycle problem for directed graphs is in NP-Complete.

9. **4-SAT**: Given a CNF formula Φ with four literals per clause, is there a satisfying assignment? Prove that 4-SAT is NP-complete.

Example $\Phi = (x_1 \vee \neg x_1 \vee \neg x_2 \vee \neg x_3) \wedge (x_1 \vee x_3 \vee x_2 \vee x_4)$

10. Use induction to prove the correctness of Merge-Sort

MERGE-SORT(A,p,r)

if $p < r$

$q = (p+r)/2$

MERGE-SORT(A,p,q)

MERGE-SORT(A,q+1,r)

MERGE(A,p,q,r)