5e.

A whiteboard with writing on it

Description automatically generated with low confidence

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Array *after* rotation shown in each figure:  
 i 14, 3, 27  
 ii 14, 3, 31, NULL, NULL, 27, 39  
 iii 31, 14, 39, 3, 27, NULL, 42  
 iv 31, 14, 42, 3, 27, 39, 55  
 v 31, 14, 42, 3, 27, 39, 70, NULL, NULL, NULL, NULL, NULL, NULL, 55, 74  
 vi 31, 14, 70, 3, 27, 42, 74, NULL, NULL, NULL, NULL, 39, 55, NULL, 81  
 vii 31, 14, 70, 3, 27, 42, 81, NULL, NULL, NULL, NULL, 39, 55, 74, 85  
 viii 70, 31, 81, 14, 42, 74, 85, 3, 27, 39, 55, NULL, NULL, NULL, 93  
 ix 70, 31, 81, 14, 42, 74, 93, 3, 27, 39, 55, NULL, NULL, 85, 98 <- resulting AVL array

5f. 4 comparisons

5g. 3, 27, 39, 55, 85, 98

Problem 6

6a. 98, 85, 93, 74, 81, 42, 55, 70, 31, 14, 39, 27, 3

Diagram

Description automatically generated

6b.

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Diagram

Description automatically generated

Text

Description automatically generated with medium confidence

Graphical user interface, text

Description automatically generated

Problem 7

7a.

i Weighted Adjacency List

|  |  |  |  |
| --- | --- | --- | --- |
| A | B, 10 | K, 3 |  |
| B | A, 10 | C, 36 |  |
| C | B, 36 | D, 3 |  |
| D | C, 3 | K, 16 | X, 1 |
| E | X, 22 | I, 3 | H, 10 |
| F | X, 10 |  |  |
| G | t, 9 |  |  |
| H | E, 10 | Z, 13 | O, 4 |
| I | E, 3 | N, 4 | n, 1 |
| J | K, 18 | L, 16 | n, 1 |
| K | A, 3 | D, 16 | J, 18 |
| L | J, 16 | Y, 3 |  |
| M | N, 21 | n, 4 |  |
| N | I, 4 | M, 21 | Z, 16 |
| O | H, 4 | h, 13 | T, 8 |
| P | h, 17 | Y, 6 | S, 4 |
| Q | Z, 4 |  |  |
| R | h, 27 |  |  |
| S | Y, 8 | P, 4 | U, 9 |
| T | O, 8 | V, 16 | U, 1 |
| U | S, 9 | T, 1 | t, 1 |
| V | T, 16 |  |  |
| W | t, 8 |  |  |
| X | D, 1 | E, 22 | F, 10 |
| Y | L, 3 | S, 8 | P, 6 |
| Z | N, 16 | Q, 4 | H, 13 |
| h | R, 27 | O, 13 | P, 17 |
| n | I, 1 | J, 1 | M, 4 |
| t | G, 9 | U, 1 | W, 8 |

ii Weighted Adjacency Matrix

For readability, infinite values are represented by blank space.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | h | n | t |
| A |  | 10 |  |  |  |  |  |  |  |  | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| B | 10 |  | 36 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| C |  | 36 |  | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| D |  |  | 3 |  |  |  |  |  |  |  | 16 |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |  |  |  |  |
| E |  |  |  |  |  |  |  | 10 | 3 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 22 |  |  |  |  |  |
| F |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 10 |  |  |  |  |  |
| G |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 9 |
| H |  |  |  |  | 10 |  |  |  |  |  |  |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  | 13 |  |  |  |
| I |  |  |  |  | 3 |  |  |  |  |  |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |
| J |  |  |  |  |  |  |  |  |  |  | 18 | 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  |
| K | 3 |  |  | 16 |  |  |  |  |  | 18 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| L |  |  |  |  |  |  |  |  |  | 16 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  |  |  |
| M |  |  |  |  |  |  |  |  |  |  |  |  |  | 21 |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  |
| N |  |  |  |  |  |  |  |  | 4 |  |  |  | 21 |  |  |  |  |  |  |  |  |  |  |  |  | 16 |  |  |  |
| O |  |  |  |  |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  | 8 |  |  |  |  |  |  | 13 |  |  |
| P |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  |  |  |  |  | 6 |  | 17 |  |  |
| Q |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  |  |  |
| R |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 27 |  |  |
| S |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  |  |  |  | 9 |  |  |  | 8 |  |  |  |  |
| T |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 8 |  |  |  |  |  | 1 | 16 |  |  |  |  |  |  |  |
| U |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 9 | 1 |  |  |  |  |  |  |  |  | 1 |
| V |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 16 |  |  |  |  |  |  |  |  |
| W |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 8 |
| X |  |  |  | 1 | 22 | 10 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Y |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  |  | 6 |  |  | 8 |  |  |  |  |  |  |  |  |  |  |
| Z |  |  |  |  |  |  |  | 13 |  |  |  |  |  | 16 |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| h |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 13 | 17 |  | 27 |  |  |  |  |  |  |  |  |  |  |  |
| n |  |  |  |  |  |  |  |  | 1 | 1 |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| t |  |  |  |  |  |  | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  | 1 |  | 8 |  |  |  |  |  |  |

7b. Stack Snapshot History

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  | Z.25.8 |  |
|  |  |  |  |  | N.23.7 | N.24.9 |  |
|  |  |  |  |  | I.22 | I.22.10 |  |
|  |  |  |  |  | n.21 | n.21.11 |  |
|  |  |  |  | J.19.6 | J.20 | J.20.12 | h.28.15 |
|  |  |  |  | L.18 | L.18 | L.18.13 | P.27.16 |
|  |  |  |  | Y.17 | Y.17 | Y.17.14 | Y.26.17 |
|  |  | t.13.3 | t.14.4 | S.16 | S.16 | S.16 | S.16.18 |
|  |  | U.12 | U.12.5 | U.15 | U.15 | U.15 | U.15.19 |
|  | T.10.2 | T.11 | T.11 | T.11 | T.11 | T.11 | T.11.20 |
|  | O.9 | O.9 | O.9 | O.9 | O.9 | O.9 | O.9.21 |
|  | H.8 | H.8 | H.8 | H.8 | H.8 | H.8 | H.8.22 |
|  | E.7 | E.7 | E.7 | E.7 | E.7 | E.7 | E.7.23 |
| X.5.1 | X.6 | X.6 | X.6 | X.6 | X.6 | X.6 | X.6.24 |
| D.4 | D.4 | D.4 | D.4 | D.4 | D.4 | D.4 | D.4.25 |
| C.3 | C.3 | C.3 | C.3 | C.3 | C.3 | C.3 | C.3.26 |
| B.2 | B.2 | B.2 | B.2 | B.2 | B.2 | B.2 | B.2.27 |
| A.1 | A.1 | A.1 | A.1 | A.1 | A.1 | A.1 | A.1.28 |

Vertices Order: A, B, C, D, X, F, E, H, O, T, V, U, t, W, G, S, Y, L, J, K, n, I, N, M, N, Q, P, h, R

7c.

Diagram, schematic

Description automatically generated

Problem 9

9a.

|  |  |
| --- | --- |
| Tree Vertices (V­T) | Remaining Vertices (V - V­T) |
| A(-, -) | B(A, 10), K(A, 3), ?(-, ∞) |
| A(-, -), K(A, 3) | B(A, 10), D(K, 16), J(K, 18), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10) | D(K, 16), J(K, 18), C(B, 26), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16) | J(K, 18), C(D, 3), X(D, 1), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1) | J(K, 18), C(D, 3), F(X, 10), E(X, 22), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3) | J(K, 18), F(X, 10), E(X, 22), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10) | J(K, 18), E(X, 22), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18) | E(X, 22), n(J, 1), L(J, 16), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1) | E(X, 22), L(J, 16), I(n, 1), M(n, 4), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1) | E(I, 3), L(J, 16), M(n, 4), N(I, 4), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3) | L(J, 16), M(n, 4), N(I, 4), H(E, 10), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4) | L(J, 16), N(I, 4), H(E, 10), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4) | L(J, 16), H(E, 10), Z(N, 16), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10) | L(J, 16), Z(H, 13), O(H, 4), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4) | L(J, 16), Z(H, 13), T(O, 8), h(O, 13), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8) | L(J, 16), Z(H, 13), h(O, 13), U(T, 1), V(T, 16), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1) | L(J, 16), Z(H, 13), h(O, 13), V(T, 16), t(U, 1), S(U, 9), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1) | L(J, 16), Z(H, 13), h(O, 13), V(T, 16), S(U, 9), W(t, 8), G(t, 9), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8) | L(J, 16), Z(H, 13), h(O, 13), V(T, 16), S(U, 9), G(t, 9), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9) | L(J, 16), Z(H, 13), h(O, 13), V(T, 16), G(t, 9), Y(S, 8), P(S, 4), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4) | L(J, 16), Z(H, 13), h(O, 13), V(T, 16), G(t, 9), Y(P, 6), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6) | L(Y, 3), Z(H, 13), h(O, 13), V(T, 16), G(t, 9), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3) | Z(H, 13), h(O, 13), V(T, 16), G(t, 9), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9) | Z(H, 13), h(O, 13), V(T, 16), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9), Z(H, 13) | h(O, 13), V(T, 16), Q(Z, 4), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9), Z(H, 13), Q(Z, 4) | h(O, 13), V(T, 16), ?(-, ∞) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9), Z(H, 13), Q(Z, 4), h(O, 13) | V(T, 16), R(h, 27) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9), Z(H, 13), Q(Z, 4), h(O, 13), V(T, 16) | R(h, 27) |
| A(-, -), K(A, 3), B(A, 10), D(K, 16), X(D, 1), C(D, 3), F(X, 10), J(K, 18), n(J, 1), I(n, 1), E(I, 3), M(n, 4), N(I, 4), H(E, 10), O(H, 4), T(O, 8), U(T, 1), t(U, 1), W(t, 8), S(U, 9), P(S, 4), Y(P, 6), L(Y, 3), G(t, 9), Z(H, 13), Q(Z, 4), h(O, 13), V(T, 16), R(h, 27) |  |

Illustration

Schematic

Description automatically generated with medium confidence

9b. Total weight of 28 edges is 210

9c. 11 steps costing 59