Instances for Optimality Tests

Sabino Roselli

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In order to make the notation more compact, the time windows lower and upper bounds, $l_i, u_i \; \forall i \in \mathcal{K}$ respectively, are reported together using the format $\tau_i = [l_i, u_i] \; \forall i \in \mathcal{K}$.

Instance 1

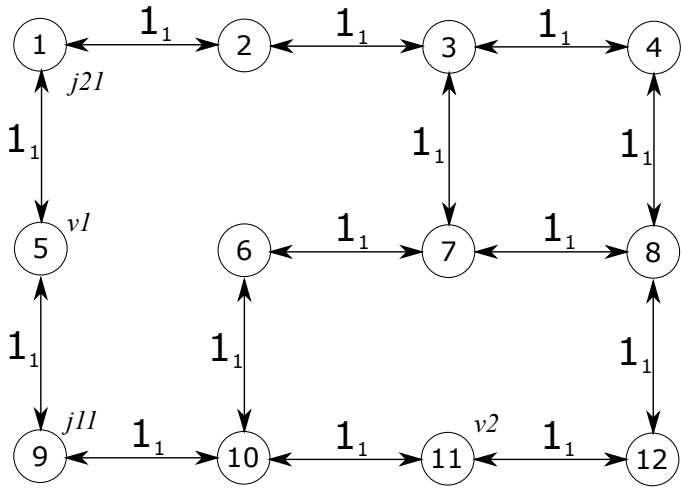

Figure 1: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 1 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 12\},\ \mathcal{N}_H = \{5, 11\},\ \mathcal{O} = \{5, 11\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (1,5), (3,7), (4,8), (6,7), (7,8), (5,9), (6,10), (8,12), (9,10), (10,11), (11,12)\}$

$\mathcal{J} = \{j1, j2\},\ \mathcal{K} = \{i1 \mid \forall i \in \mathcal{J}\}$

$L_{j11} = 9,\ L_{j21} = 1$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j21} = \emptyset$

$\tau_{j11} = [1, 2],\ \tau_{j21} = [4, 6],$

$S_{j11} = 4,\ S_{j21} = 4$

$\mathcal{V} = \{v1, v2\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\}$

$OR = 12, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 17$

Instance 2

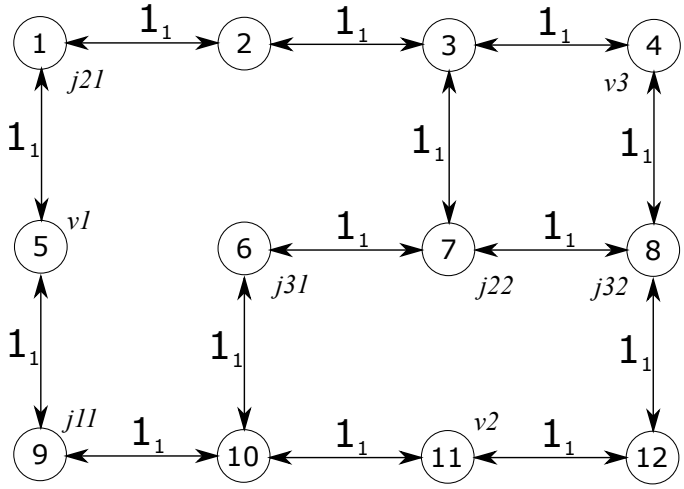

Figure 2: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 2 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 12\},\ \mathcal{N}_H = \{5, 11, 4\},\ \mathcal{O} = \{5, 11, 4\}$

$\mathcal{E} = \{(1,2),(2,3),(3,4),(1,5),(3,7),(4,8),(6,7),(7,8),(5,9),(6,10),(8,12),(9,10),(10,11),(11,12)\}$

$\mathcal{J} = \{j1, j2, j3\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J} \setminus \{j1\}\} \cup \{j11\}$

$L_{j11} = 9,\ L_{j21} = 1, L_{j22} = 7,\ L_{j31} = 6,\ L_{j32} = 8$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\}, \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\}$

$\tau_{j11} = [1, 2],\ \tau_{j21} = [4, 6],\ \tau_{j22} = [12, 14],\ \tau_{j31} = [6, 9],\ \tau_{j32} = [16, 18]$

$S_{j11} = 4,\ S_{j21} = 4, S_{j22} = 5,\ S_{j31} = 7,\ S_{j32} = 1$

$\mathcal{V} = \{v1, v2, v3\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\}$

$OR = 12, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 23$

Instance 3

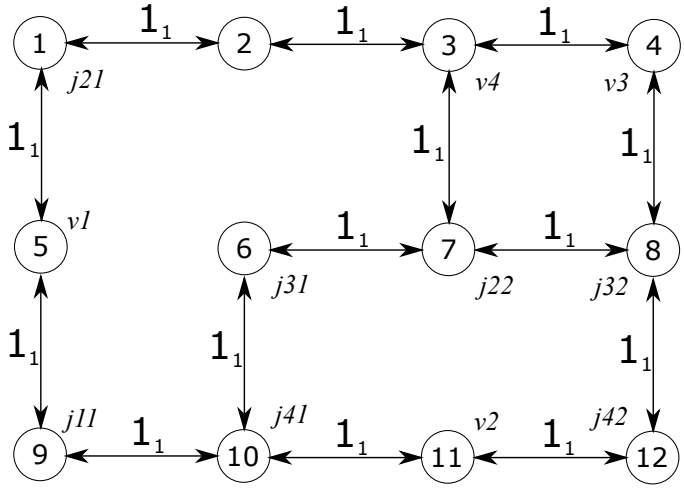

Figure 3: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 3 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 12\},\ \mathcal{N}_H = \{5, 2, 11, 4\},\ \mathcal{O} = \{5, 2, 11, 4\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (1,5), (3,7), (4,8), (6,7), (7,8), (5,9), (6,10), (8,12), (9,10), (10,11), (11,12)\}$

$\mathcal{J} = \{j1, j2, j3, j4\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J} \setminus \{j1\}\} \cup \{j11\}$

$L_{j11} = 9,\ L_{j21} = 1, L_{j22} = 7,\ L_{j31} = 6,\ L_{j32} = 8,\ L_{j41} = 10,\ L_{j42} = 12$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\}, \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\}$

$\tau_{j11} = [1, 2],\ \tau_{j21} = [4, 6],\ \tau_{j22} = [12, 14],\ \tau_{j31} = [6, 9],\ \tau_{j32} = [16, 18],\ \tau_{j31} = [3, 6],\ \tau_{j32} = [6, 8]$

$S_{j11} = 4,\ S_{j21} = 4, S_{j22} = 5,\ S_{j31} = 7,\ S_{j32} = 1,\ S_{j41} = 2,\ S_{j42} = 2$

$\mathcal{V} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\}$

$OR = 12, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 23$

Instance 4

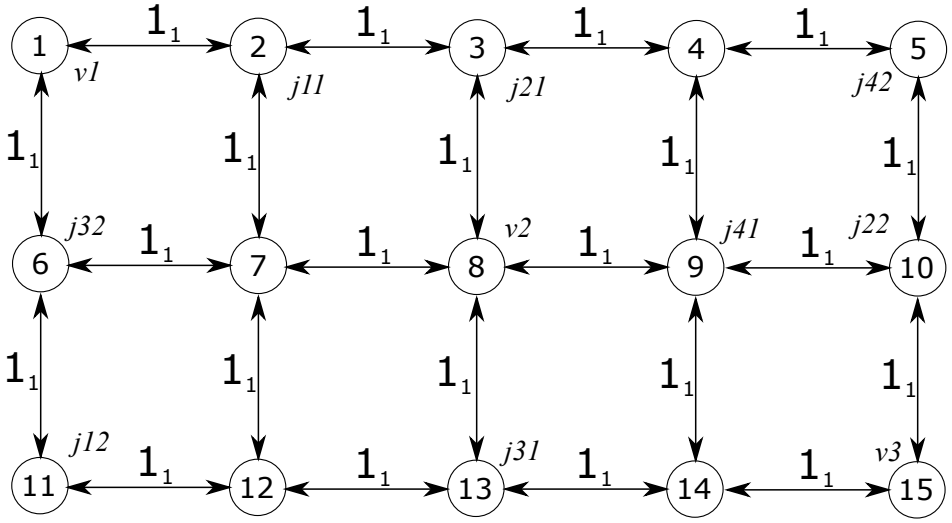

Figure 4: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 4 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 8, 15\},\ \mathcal{O} = \{1, 8, 15\}$

$\mathcal{E} = \{(1,2),(2,3),(3,4),(4,5),(1,6),(2,7),(3,8),(4,9),(5,10),(6,7),(7,8),$

$(8,9),(9,10),(6,11),(7,12),(8,13),(9,14),(10,15),(11,12),(12,13),(13,14),(14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J}\}$

$L_{j11} = 2,\ L_{j12} = 11,\ L_{j21} = 4,\ L_{j22} = 10,\ L_{j31} = 13,\ L_{j32} = 6,\ L_{j41} = 9,\ L_{j42} = 5$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [4, 8],\ \tau_{j21} = [0, T],\ \tau_{j22} = [9, 11],\ \tau_{j31} = [0, T],\ \tau_{j32} = [8, 10],\ \tau_{j41} = [0, T],\ \tau_{j42} = [6, 8]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 0,\ S_{j22} = 1,\ S_{j31} = 2,\ S_{j32} = 3,\ S_{j41} = 3,\ S_{j42} = 1$

$\mathcal{V} = \{v1, v2, v3\},\ \mathcal{V}_{j1} = \{v1, v2\},\ \mathcal{V}_{j2} = \{v2, v3\},\ \mathcal{V}_{j3} = \{v1, v2\},\ \mathcal{V}_{j4} = \{v2, v3\}$

$OR = 10, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 15$

Instance 5

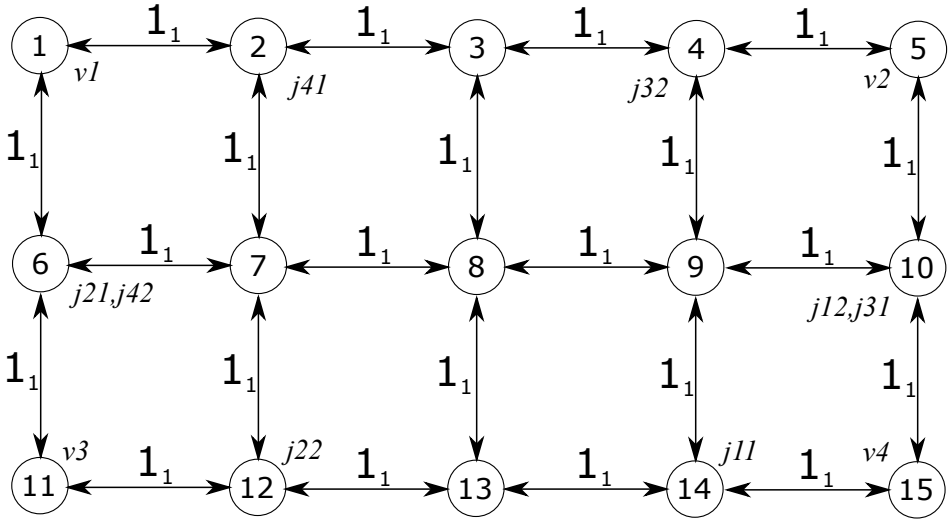

Figure 5: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 5 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 5, 11, 15\},\ \mathcal{O} = \{1, 5, 11, 15\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (4,5), (1,6), (2,7), (3,8), (4,9), (5,10), (6,7), (7,8),$

$(8,9), (9,10), (6,11), (7,12), (8,13), (9,14), (10,15), (11,12), (12,13), (13,14), (14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J}\}$

$L_{j11} = 14,\ L_{j12} = 10,\ L_{j21} = 6,\ L_{j22} = 12,\ L_{j31} = 10,\ L_{j32} = 4,\ L_{j41} = 2,\ L_{j42} = 6$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [8, 10],\ \tau_{j21} = [0, T],\ \tau_{j22} = [8, 10],\ \tau_{j31} = [0, T],\ \tau_{j32} = [8, 10],\ \tau_{j41} = [0, T],\ \tau_{j42} = [8, 10]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 1,\ S_{j22} = 1,\ S_{j31} = 1,\ S_{j32} = 1,\ S_{j41} = 1,\ S_{j42} = 1$

$\mathcal{V} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\}$

$OR = 12, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 17$

Instance 6

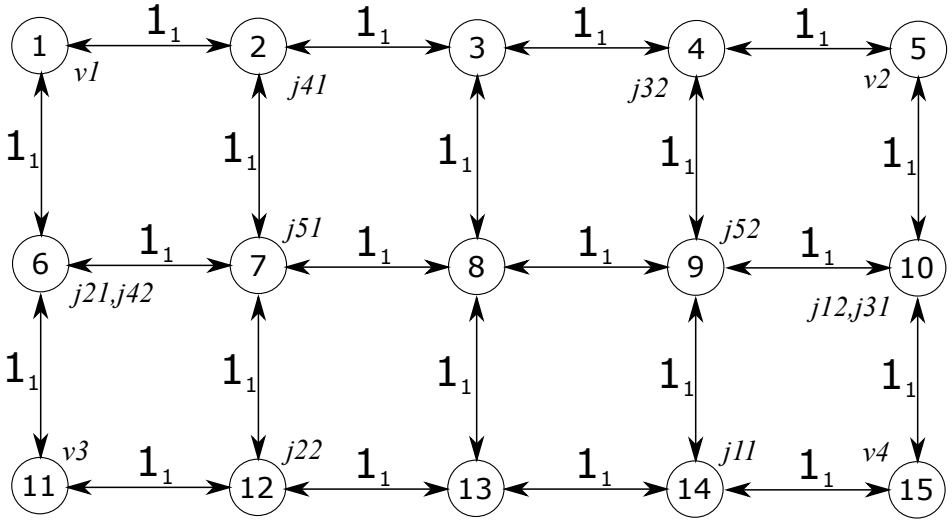

Figure 6: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 6 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 5, 11, 15\},\ \mathcal{O} = \{1, 5, 11, 15\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (4,5), (1,6), (2,7), (3,8), (4,9), (5,10), (6,7), (7,8),$

$(8,9), (9,10), (6,11), (7,12), (8,13), (9,14), (10,15), (11,12), (12,13), (13,14), (14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4, j5\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J}\}$

$L_{j11} = 14,\ L_{j12} = 10,\ L_{j21} = 6,\ L_{j22} = 12,\ L_{j31} = 10\ L_{j32} = 4,\ L_{j41} = 2\ L_{j42} = 6,\ L_{j51} = 7\ L_{j52} = 9$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset,$

$\mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset, \mathcal{P}_{j42} = \{j41\},\ \mathcal{P}_{j51} = \emptyset,\ \mathcal{P}_{j52} = \{j51\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [8, 12],\ \tau_{j21} = [0, T],\ \tau_{j22} = [8, 12],\ \tau_{j31} = [0, T],$

$\tau_{j32} = [8, 12],\ \tau_{j41} = [0, T],\ \tau_{j42} = [8, 12],\ \tau_{j51} = [0, T],\ \tau_{j52} = [2, 10]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 1,\ S_{j22} = 1,\ S_{j31} = 1,\ S_{j32} = 1,\ S_{j41} = 1,\ S_{j42} = 1,\ S_{j51} = 0,\ S_{j52} = 0$

$\mathcal{V} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\},\ \mathcal{V}_{j5} = \{v1, v2, v3, v4\}$

$OR = 12, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 17$

Instance 7

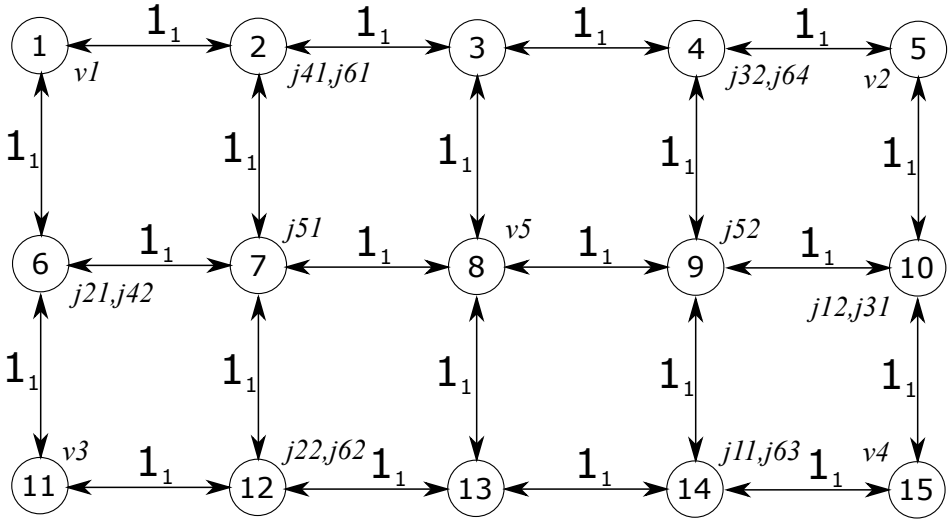

Figure 7: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 7 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 5, 8, 11, 15\},\ \mathcal{O} = \{1, 5, 8, 11, 15\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (4,5), (1,6), (2,7), (3,8), (4,9), (5,10), (6,7), (7,8),$

$(8,9), (9,10), (6,11), (7,12), (8,13), (9,14), (10,15), (11,12), (12,13), (13,14), (14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4, j5, j6\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J} \setminus \{j6\}\} \cup \{j61, j62, j63, j64\}$

$L_{j11} = 14,\ L_{j12} = 10,\ L_{j21} = 6,\ L_{j22} = 12,\ L_{j31} = 10,\ L_{j32} = 4,\ L_{j41} = 2,\ L_{j42} = 6,$

$L_{j51} = 7\ L_{j52} = 9,\ L_{j61} = 2,\ L_{j62} = 12,\ L_{j63} = 14,\ L_{j64} = 4$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset, \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\},$

$\mathcal{P}_{j51} = \emptyset,\ \mathcal{P}_{j52} = \{j51\},\ \mathcal{P}_{j61} = \emptyset,\ \mathcal{P}_{j62} = \{j61\},\ \mathcal{P}_{j63} = \{j62\},\ \mathcal{P}_{j64} = \{j63\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [8, 12],\ \tau_{j21} = [0, T],\ \tau_{j22} = [8, 12],\ \tau_{j31} = [0, T],\ l_{j32} = [8, 12],\ \tau_{j41} = [0, T],$

$\tau_{j42} = [8, 12],\ \tau_{j51} = [0, T],\ \tau_{j52} = [2, 10],\ \tau_{j61} = [0, T],\ \tau_{j62} = [0, T],\ \tau_{j63} = [0, T],\ \tau_{j64} = [10, 15]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 1,\ S_{j22} = 1,\ S_{j31} = 1, S_{j32} = 1,\ S_{j41} = 1, S_{j42} = 1,$

$S_{j51} = 0, S_{j52} = 0,\ S_{j61} = 0, S_{j62} = 0,\ S_{j63} = 0, S_{j64} = 0$

$\mathcal{V} = \{v1, v2, v3, v4, v5\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\},\ \mathcal{V}_{j5} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j6} = \{v5\}$

$OR = 14, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 20$

Instance 8

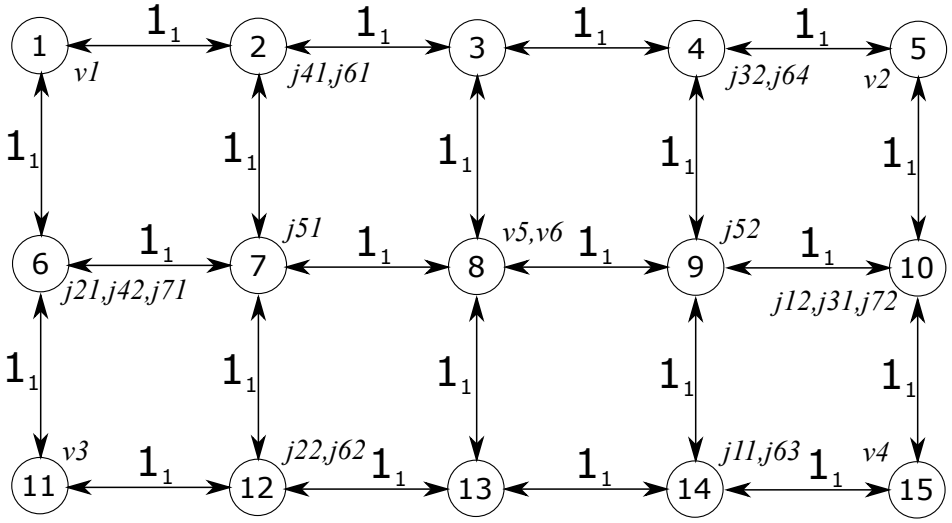

Figure 8: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 8 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 5, 8, 11, 15\},\ \mathcal{O} = \{1, 5, 8, 11, 15\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (4,5), (1,6), (2,7), (3,8), (4,9), (5,10), (6,7), (7,8),$

$(8,9), (9,10), (6,11), (7,12), (8,13), (9,14), (10,15), (11,12), (12,13), (13,14), (14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4, j5, j6, j7\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J} \setminus \{j6\}\} \cup \{j61, j62, j63, j64\}$

$L_{j11} = 14,\ L_{j12} = 10,\ L_{j21} = 6,\ L_{j22} = 12,\ L_{j31} = 10,\ L_{j32} = 4,$

$L_{j41} = 2,\ L_{j42} = 6,\ L_{j51} = 7,\ L_{j52} = 9,\ L_{j61} = 2,\ L_{j62} = 12,\ L_{j63} = 14,\ L_{j64} = 4,\ L_{j71} = 6\ L_{j72} = 10$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\},$

$\mathcal{P}_{j51} = \emptyset,\ \mathcal{P}_{j52} = \{j51\},\ \mathcal{P}_{j61} = \emptyset,\ \mathcal{P}_{j62} = \{j61\},\ \mathcal{P}_{j63} = \{j62\},\ \mathcal{P}_{j64} = \{j63\},\ \mathcal{P}_{j71} = \emptyset,\ \mathcal{P}_{j72} = \{j71\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [8, 12],\ \tau_{j21} = [0, T],\ \tau_{j22} = [8, 12],\ \tau_{j31} = [0, T],\ \tau_{j32} = [8, 12],\ \tau_{j41} = [0, T],\ \tau_{j42} = [8, 12],$

$\tau_{j51} = [0, T],\ \tau_{j52} = [2, 10],\ \tau_{j61} = [0, T],\ \tau_{j62} = [0, T],\ \tau_{j63} = [0, T],\ \tau_{j64} = [0, T],\ \tau_{j71} = [0, T],\ \tau_{j72} = [0, T]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 1,\ S_{j22} = 1,\ S_{j31} = 1, S_{j32} = 1,\ S_{j41} = 1, S_{j42} = 1,$

$S_{j51} = 0, S_{j52} = 0,\ S_{j61} = 0, S_{j62} = 0,\ S_{j63} = 0, S_{j64} = 0,\ S_{j71} = 0, S_{j72} = 0$

$\mathcal{V} = \{v1, v2, v3, v4, v5, v6\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\},$

$\mathcal{V}_{j5} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j6} = \{v5, v6\},\ \mathcal{V}_{j7} = \{v5, v6\}$

$OR = 14, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 20$

Instance 9

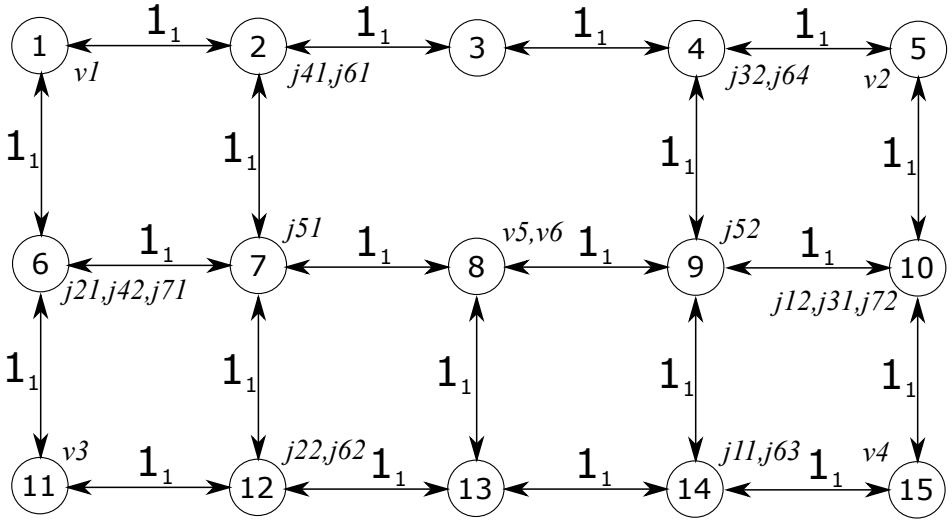

Figure 9: Finite, strongly connected, weighted, directed graph representing the plant layout for Instance 9 of the CF-EVRP.

$\mathcal{N} = \{1, \ldots, 15\},\ \mathcal{N}_H = \{1, 5, 8, 11, 15\},\ \mathcal{O} = \{1, 5, 8, 11, 15\}$

$\mathcal{E} = \{(1,2), (2,3), (3,4), (4,5), (1,6), (2,7), (4,9), (5,10), (6,7), (7,8),$

$(8,9), (9,10), (6,11), (7,12), (8,13), (9,14), (10,15), (11,12), (12,13), (13,14), (14,15)\}$

$\mathcal{J} = \{j1, j2, j3, j4, j5, j6, j7\},\ \mathcal{K} = \{i1, i2 \mid \forall i \in \mathcal{J} \setminus \{j6\}\} \cup \{j61, j62, j63, j64\}$

$L_{j11} = 14,\ L_{j12} = 10,\ L_{j21} = 6,\ L_{j22} = 12,\ L_{j31} = 10,\ L_{j32} = 4,$

$L_{j41} = 2,\ L_{j42} = 6,\ L_{j51} = 7,\ L_{j52} = 9,\ L_{j61} = 2,\ L_{j62} = 12,\ L_{j63} = 14,\ L_{j64} = 4,\ L_{j71} = 6\ L_{j72} = 10$

$\mathcal{P}_{j11} = \emptyset,\ \mathcal{P}_{j12} = \{j11\},\ \mathcal{P}_{j21} = \emptyset,\ \mathcal{P}_{j22} = \{j21\},\ \mathcal{P}_{j31} = \emptyset,\ \mathcal{P}_{j32} = \{j31\},\ \mathcal{P}_{j41} = \emptyset,\ \mathcal{P}_{j42} = \{j41\},$

$\mathcal{P}_{j51} = \emptyset,\ \mathcal{P}_{j52} = \{j51\},\ \mathcal{P}_{j61} = \emptyset,\ \mathcal{P}_{j62} = \{j61\},\ \mathcal{P}_{j63} = \{j62\},\ \mathcal{P}_{j64} = \{j63\},\ \mathcal{P}_{j71} = \emptyset,\ \mathcal{P}_{j72} = \{j71\}$

$\tau_{j11} = [0, T],\ \tau_{j12} = [8, 12],\ \tau_{j21} = [0, T],\ \tau_{j22} = [8, 12],\ \tau_{j31} = [0, T],\ \tau_{j32} = [8, 12],\ \tau_{j41} = [0, T],\ \tau_{j42} = [8, 12],$

$\tau_{j51} = [0, T],\ \tau_{j52} = [2, 10],\ \tau_{j61} = [0, T],\ \tau_{j62} = [0, T],\ \tau_{j63} = [0, T],\ \tau_{j64} = [0, T],\ \tau_{j71} = [0, T],\ \tau_{j72} = [0, T]$

$S_{j11} = 1,\ S_{j12} = 1,\ S_{j21} = 1,\ S_{j22} = 1,\ S_{j31} = 1, S_{j32} = 1,\ S_{j41} = 1, S_{j42} = 1,$

$S_{j51} = 0, S_{j52} = 0,\ S_{j61} = 0, S_{j62} = 0,\ S_{j63} = 0, S_{j64} = 0,\ S_{j71} = 0, S_{j72} = 0$

$\mathcal{V} = \{v1, v2, v3, v4, v5, v6\},\ \mathcal{V}_{j1} = \{v1\},\ \mathcal{V}_{j2} = \{v2\},\ \mathcal{V}_{j3} = \{v3\},\ \mathcal{V}_{j4} = \{v4\},$

$\mathcal{V}_{j5} = \{v1, v2, v3, v4\},\ \mathcal{V}_{j6} = \{v5, v6\},\ \mathcal{V}_{j7} = \{v5, v6\}$

$OR = 18, C = 1,\ D = 1,\ \rho = 1,\ v = 1,\ T = 23$