Network construction:

For each node

N={0,1,2,…,n,n+1,…,2n,2n+1}

Decision variables:

: The arrival time to node i

: The load when leaving node j

: Penalty of late/early arrival

Input:

: The reward of picking up demand at node i

: travel time between node i and j

: Expected arrival time at a node

Objective function:

Max

Constraints:

Constraints 1 and 2 ensure the trip start and end at the pseudo depot. Constraint 3 ensure that once a customer is picked up will be delivered. Constraint 4 and 5 state that each node can be visited at most once. Constraint 6 represent inflow outflow conservative at each node. Constraint 7 ensure that the

|  |  |  |
| --- | --- | --- |
|  | Start from the pseudo depot | (2) |
|  | End at the pseudo depot | 3 |
|  | AV start and end with empty load | 4 |
|  | When visit a pick up node, the load increase by one | 5 |
|  | 6 |
|  | When visit a deliver node, the load decrease by one | 7 |
|  | 8 |
|  | Capacity constraints | 9 |
|  | All pick up will be delievered | 11 |
|  | All demand will be pick up at most once | 12 |
|  | All deliver will be delivered at most once | 13 |
|  | Inflow outflow conservative | 14 |
|  | The visit time to node j has to be later than j if vehicle go from I to j | 15 |
|  | Deliver after pick up | 16 |
|  | Late arrival penalty | 17 |
|  | Early arrival penalty | 18 |
|  |  | 19 |
|  |  | 20 |
|  |  |  |