Network construction:

For each node

N={0,1,2,…,n,n+1,…,2n,2n+1}

Decision variables:

: The departure time from node j

Other variables:

: The reward of picking up demand at node i

: Penalty of late/early arrival

: travel time between node i and j

Objective function:

* Max

Constraints:

|  |  |  |
| --- | --- | --- |
|  | Start from the pseudo depot | (2) |
|  | End at the pseudo depot | 3 |
|  | AV start with empty | 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 |
|  |  | 10 |
|  | 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 | 15 |
|  | Deliver after pick up | 16 |
|  | Late arrival penalty |  |
|  | Early arrival penalty |  |
|  |  | 17 |
|  |  | 18 |
|  | The start time of first trip |  |