Discrete Optimization

Large Neighborhood Search

Goals of the Lecture

- Large neighborhood search (LNS)
  - hybridization of local and CP/MIP search

Large Neighborhood Search (LNS)

- Combination of CP and Local Search
  1. start with a feasible solution (CP)
  2. select a neighborhood (LS)
  3. optimize the neighborhood (CP)
  4. repeat from step 2
- What is the neighborhood?
  - fix a subset of variables to their values in the best solution found so far
  - which subset?
    - problem-specific
    - exploit the problem structure

Large Neighborhood Search (LNS)

- Combination of CP and Local Search
  1. start with a feasible solution (CP)
  2. select a neighborhood (LS)
  3. optimize the neighborhood (CP)
  4. repeat from step 2
- Why LNS?
  - CP is good to find feasible solutions
  - CP is good in optimizing small combinatorial spaces
- Generalize to MIP directly of course!

Asymmetric TSP with Time Windows

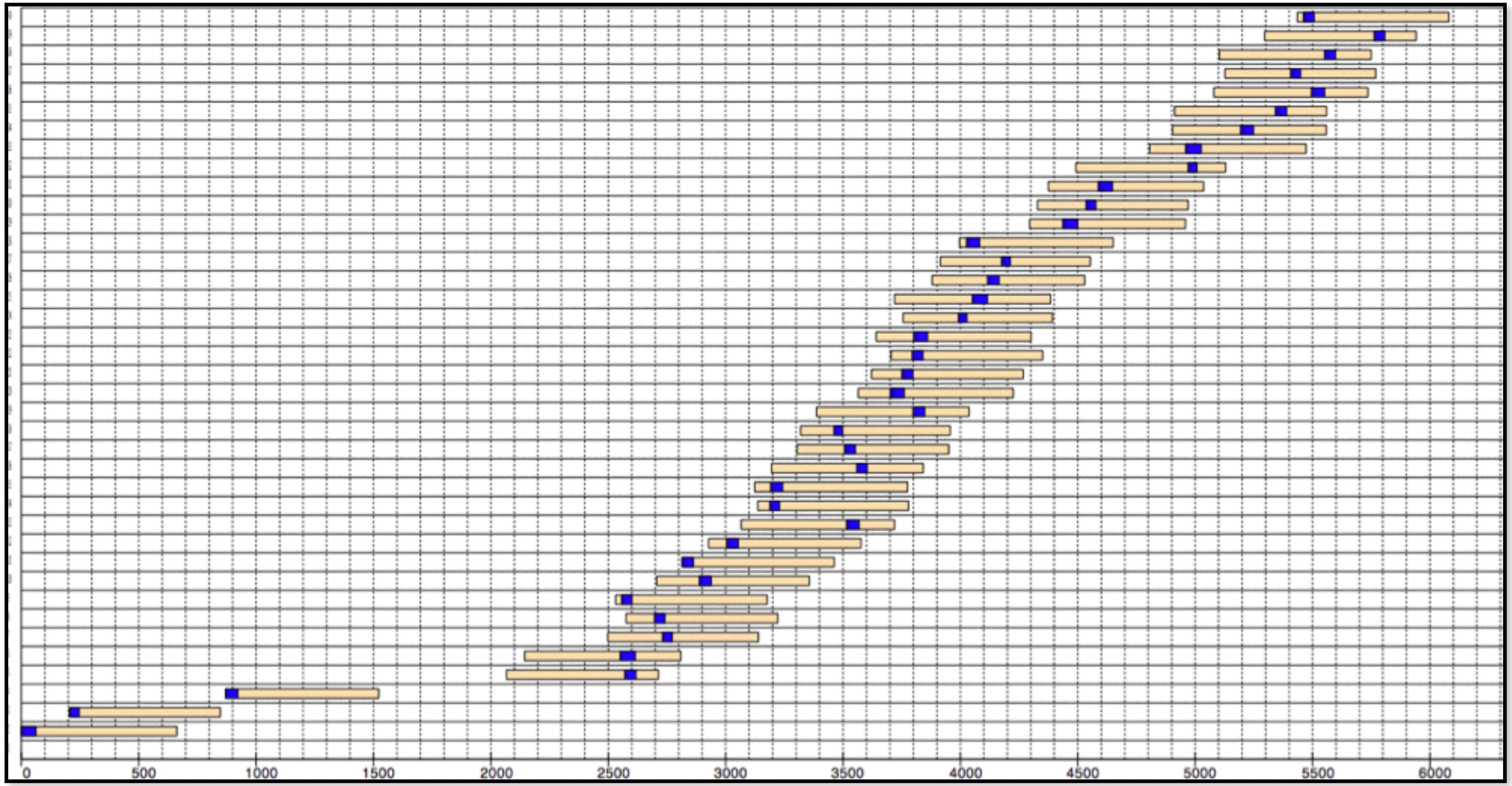
- Given
  - a set of locations to visit
  - a service time for each location
  - a time window for each location
  - a possibly asymmetric distance between locations
- Find a Hamiltonian path
  - satisfying the time windows
  - minimizing the total travel distance

Asymmetric TSP with Time Windows

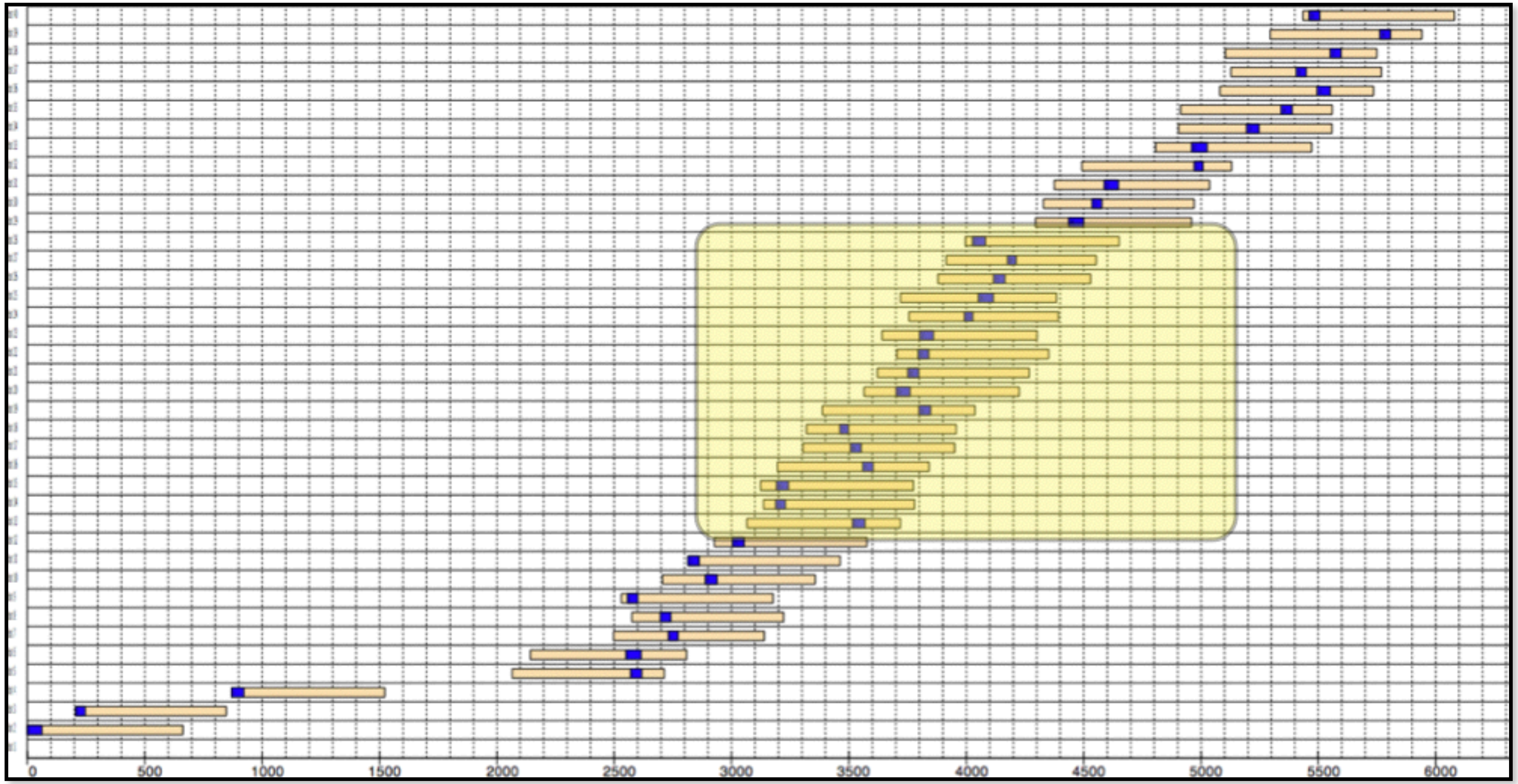
```
Scheduler sched(horizon);
Activity act[a in Activities](sched,service[a]);
UnaryResource vehicle(sched,transitionTimes);

minimize
   vehicle.transitionTimes
subject to {
   forall(a in Activities) {
      act[a].start >= ws[a];
      act[a].start <= we[a];
      act[a] requires vehicle;
   }
}
```

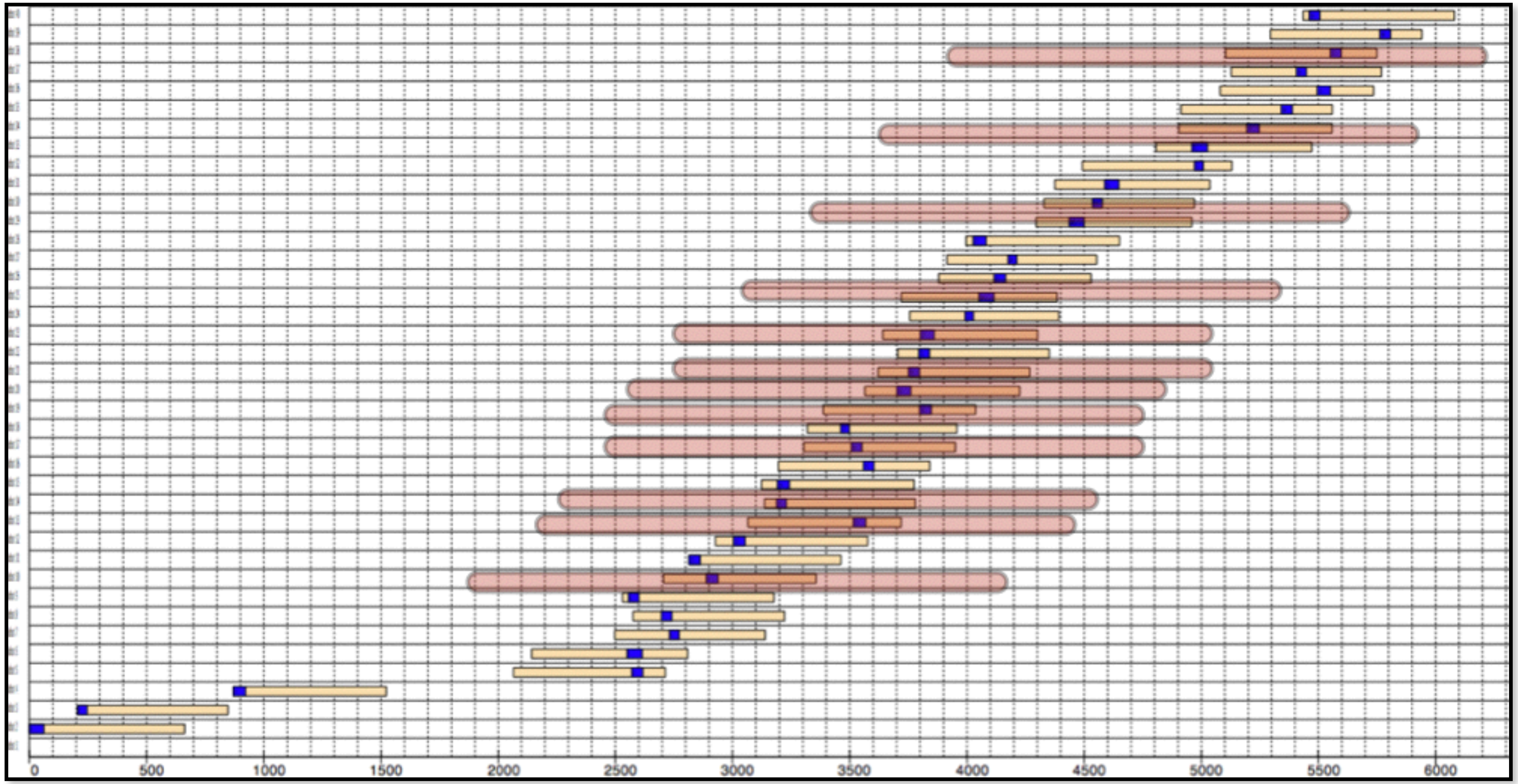
Asymmetric TSP with Time Windows



LNS for the ATSPTW



LNS for the ATSPTW



LNS for the ATSPTW

Size	BK
40	386
48	492
49	488
50	414
67	1048
86	1052
92	1111
125	1410
132	1400
152	1792
172	1897
193	2452
201	2296
233	2786

Until Next Time