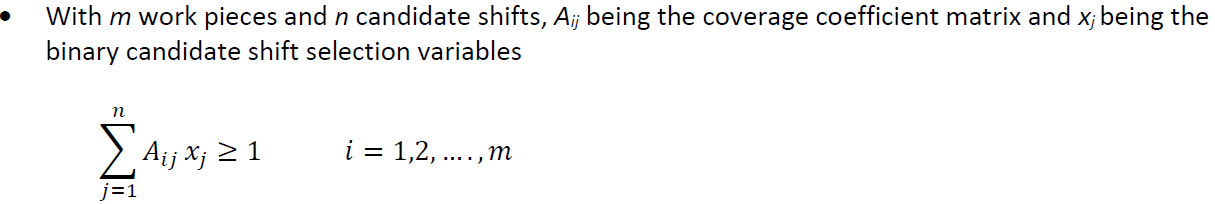
Question 1:

1. The lower / upper bounds and average diagram length at a depot constraints.

Each work piece must be covered by at least one selected shift.



1. (i) Greedy heuristic is to pre-processed the input before it going to the select phase. And the dataset can be large, because it build all possible shifts. So greedy heuristic can help to reduce the size of candidate shifts. Some of the work pieces are less important. Greedy heuristic find the optimal solutions for each aspects, then it comes up to the global optimal solutions.

Heuristic是不是排除掉重复的东西，重复的选项

1. Choose from the pot a random candidate shift S. If all the work pieces of S are covered by more than one candidate shifts, S is redundant and discarded. Otherwise S is retained.
2. This is repeated until the number of shifts remaining in the pot plus those shifts already retained equals to the target, or there is no more candidate shift remaining in the pot.
3. Then, all the shifts remaining in the pot are also retained.

(ii) Minimise the number of candidate shifts covering work piece. And try to increase the set of work pieces covered by one shift. And re-compute until the pot size meets the size target.

？？？是不是只能起到一个保证的作用

The heuristic ensures that it will be possible to yield a feasible solution from the retained candidate shifts at the end.

When the target is set too low, the number of candidate shifts retained will be higher than the target before the iteration loop is terminated with no more candidate shifts remaining in the pot.

(iii) Reduce number of relief opportunities. These work pieces that are highly covered are less important should be deleted.

重复的越多就删掉就好

Choose the least coverage count amongst all the work pieces of a candidate shift as the candidate shift’s ranking value.

A low ranking value implies the candidate shift would be more likely to be needed for covering a certain work piece.

Candidate shifts with a higher ranking value is prioritised for deletion.

(c) (i) ？？？？Stage 1: solve the relaxed LP by using the Revised Simplex Method.

Relaxed LP. Ignores the integer constraints. And the solution is not final, except the continuous solution are all-integer. Or using relaxed LP solver. Solve the LP using only a small pot of candidate shifts, which computationally very fast.

A relaxed LP is solved in which the integer requirement is ignored for all the shift variables.

Stage 2: derive an all-integer solution. Employs the commonly used Branch-and-Bound technique. Progressively adds extra constraints to the LP and solving it.

The sum of the fractional values in the relaxed LP solution is rounded up 去以成整数 as an upper bound target for the number of integral shifts to be used. A new constraint is added for the upper bound target.

Branch-and-bound 分支界限 is used to find an all integer solution in stage 2

A specialised branch-and-bound algorithm is used, which exploits certain features found in the continuous relaxed LP solution obtained in the process.

(ii) Using specific characteristics can divide the pot of candidate shifts. And add extra constraints to the LP and soving it. Adding constraints to a branch is implemented by a banning status variable on each candidate shift, instead of mathematically add. For example, we may add a relief opportunity R that one station has dinning hall. Then one branch bans all shifts using R. Another branch using R. It can divide the search space more efficiently. Disable stations for changing coupling formations. And full utilisation of arc flow potentials.

Branching based on a problem characteristic P so that on one of the branches the candidate shifts do not exhibit characteristic P and on the other branch they do.

Relevant candidate shifts are physically eliminated on each branch, which is more efficient than inserting many equivalent constraints into the LP.

For example, P may focus on a particular relief opportunity R identified as critical. One branch bans the use of R in the candidate shifts and the other branch allows R to be used.

Question 2:

1. As for long term planning (LTP), it advance pre-planning for a new public timetable usually lasting 6 months. Also to set such LTP, it much more harder and takes more time to implement when it compares to the short one. The advantages for LTP is that, it can minimise total crew cost, like the number of shifts and total hours paid, all work covered, it’s conflict free with the vehicle schedule. For public transport, bus and train scheduling can be different. Bus scheduling can be feasible. Train scheduling must cover all the trips in a fixed timetable.
2. Very long term planning. For many years into the future in franchise or local council tender bids.

Ball park estimates.

1. Long term planning, for regular operations such as half-yearly timetables.

Optimisation is critically important because the daily schedules are operated repeatedly over many months.

1. Short term planning, re-scheduling in advance of predictable service changes.

Minimum change from the regular long term schedules are desirable

Importance of schedule robustness against dalys increases.

1. Very short term planning, re-scheduling on the day of operation due to unplanned disruptions

A lot of real time information needed.

The re-scheduling process has to be very fast.

1. (i) By seeing if the timetable have conflicts, like if two course take place in the same room at the same time. And whether the rooms are suitable for each class’s requirement, including room capcaticy, etc.

Quantitative measures (数量测定) of hard and soft constraint violations should be used in the assessment.

Weighted sum of the quantitative measures forms an overall penalty value to be minimised.

Huge weights for hard constraint violation.

(ii) Define LLH1 as swap individually in rows, LLH2 as swap in columns. LLH3 as swap both rows and columns. Exceute each LLH repeatly until this LLH doesn’t improve any performance, then switch to the next LLH. If the solution is good enough then stop.

Construction of a crude initial solution.

In each iteration, the hyper-heuristic controller selects one of the LLHs to be executed based on their historical perormance statistics

At the end of an LLH execution, the performance of the LLH in that iteration is measured by the improvement on the current best solution the LLH has achieved.

Infrequently used LLH might gradually be given added priority to be selected.

1. ？？？Single Hubble Space Telescope,

The job is predictable, clairvoyant and pre-emption needed, minimize weighted job unit pentalty.

clv-predictable behaviour of the target objects to be observed

prec-there are precedence relationships between some jobs

pmtn-job pre-emption is allowed.

Question 3:

1. There are shortcuts in the initial matrix, and these matrix may be improved by shortest path algorithms. Could search for a shorter path for each matrix cell and update its value. It would be more efficient to consider each location as a via location and test which matrix cell could benefit using it.

Shortest path algorithms enable the main scheduling algorithms to **consider the feasibility of redistributing resources to other locations for their futher deployment.**

Is there sufficient time to make the connection?

How much does it cost to make the connection?

There is a trade-off between incurring idle time of keeping a resource stay put and redistribution it to other location.

Helps when supply and demand of resources is imbalanced across the network, especially when often there is peak and off-peak traffic in opposite directions.

1. Vertices: Each trip in the bus timetables is represented by a graph vertex.

Edges: Graph edges are inserted between any pair of trip vertices in which the same bus vehicle cannot serve both trips.

1. One uncoloured vertex is chosen at a time to be coloured.

Choice criterion: maximum saturation degree

Tie: the tied vertex that has the largest degree (number of edges connected to the vertex)

Assuming the colours are sequentially numbered, use the lowest feasible colour number.

1. 1. A network is set up as a directed acyclic graph (DAG)

Graph vertices represent train trips plus a source (from which all train units begin) and a sink (to which all train units end)

Graph edges are inserted to represent feasible potential links between the vertices.

2. Seek optimal paths from source to sink, each path is the schedule for a train unit.

Minimsing operational costs

Covering all the train trips in the timetable

Meeting passenger seat demands

Satisfying operational constraints

3. Each train unit type is a commodity type, and each path from source to sink has an associated flow value being the number of units of a certain unit type.