

All Quiet in Column Generation on Coverage with Jobs Determined

When I initialized coverage locations, I decided to allow a coverage place as long as there was at least one job within its radius. While it seemed an innocuous decision, this was to have interesting consequences for the problem ahead.

My current framework is to first solve the job vehicles problem (done with PT NyVA \geq), and then solve coverage "around" it using much the same approach. Indeed, I attacked the latter with a column generation algorithm. This worked well, and I created a formulation that yielded some results.

I initialized a set of routes that started from the depot, went to a coverage place to stay until the last possible moment, and then came back. Not every route was necessary, but I got an answer that used 6 of these routes.

The path with negative reduced cost didn't exist. This was literally the answer. It makes sense, because the framing of the times makes switching coverage disadvantageous.

This approach is detailed in the notebook "cg-on-coverage.ipynb". The objective is 1'931. Added to our jobs' objective of 2'845, we get a grand total of **4'776**.

An alternate approach is if we give a sequential order to the generation of coverage locations, and then only include if new, *previously uncovered* jobs can be unearthed with the addition of a new coverage location. To clarify: previously, as long as a job was close enough to a coverage spot, we added that spot. Now, we give the spots an order, and only add a spot if previously-uncovered spots can be covered with that spot.

Instead of 25 spots, this gives us 12. But the column generation expressed there is also not interesting. It doesn't add any new path, and we are left with the same situation: 6 paths which have a route going to one spot, and then coming back later. The total cost this time (owing to the removal of many of the 25) is 2'068, yielding a grand total of **4'913**.

Why does this happen?

When the jobs have already been solved, and time windows set, etc., it should be noted that the cost of switching coverage vehicles is immense. In particular, we never switch horses in the middle of the river. If I'm not done covering a set of jobs which is still going, why would I get out and/or let another coverage vehicle do it? Not only do we drop coverage, we also lose mobility, and needlessly increase the cost. In fact, if time windows aren't particularly different between covering neighborhoods (= sets of jobs all covered by a particular spot), I can't use the same vehicle to visit both spots.

As a result, the best coverage strategy is for one single vehicle to stay there for as long as is necessary and hold down the fort. This is why we see 6 paths with vehicles going to one spot and staying there, then coming back to the depot. There is no upgrade from that, no cost reduction.