Swabs2Labs

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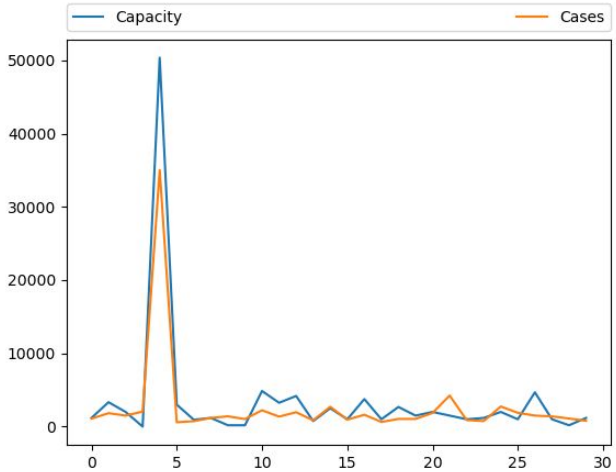
Problem Statement

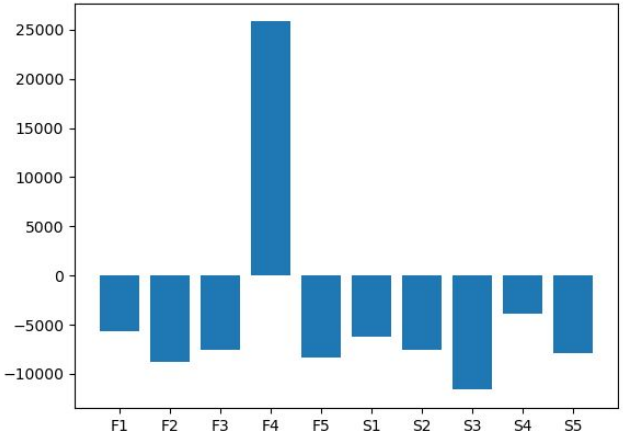
- Cost efficient allocation of swabs from districts to labs in Karnataka.
- Two types of labs: private (cost per sample: ₹1600) or public (cost per sample: ₹800).
- Each lab has a fixed per-day capacity; only lab's own district can overload 100 samples (with a penalty of ₹5000 per load). With a high penalty (₹10,000), sample can be kept as backlog.
- Previous day's backlog effectively acts as new samples the next day. We thus optimize on a day-to-day basis, taking each day as an independent input.
- When transferring samples to external labs, the distance to a 'centroid' of a chosen 'cluster' of labs (provided any pair of labs in the cluster is within 40km of each other) can be taken as a fair approximation of transport costs (when multiplied by ₹1000 per km).

Data Exploration

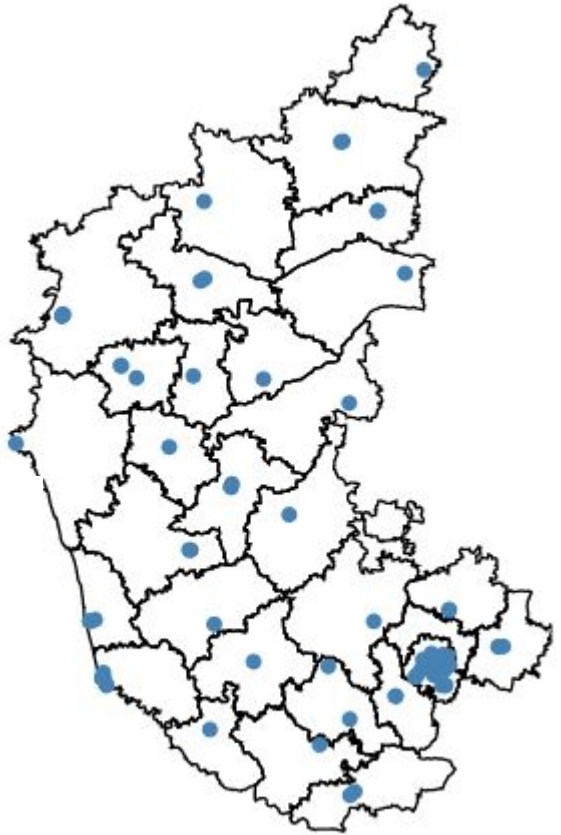
- Finding pairs of labs within 40 km of each other
- Comparing cases and capacity per district
- Bangalore Urban district has a cluster of 34 labs, all within 40km of each other.
- Capacity deficit on samples



Comparison of capacity vs cases in each district

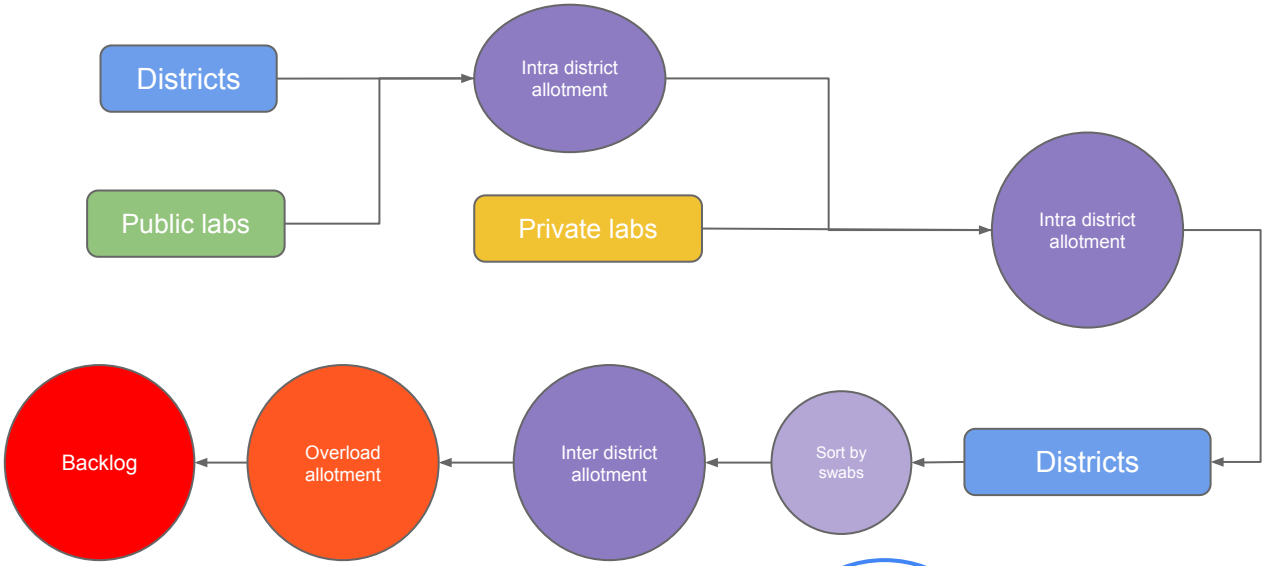


∑Capacity - ∑Samples on different dataset



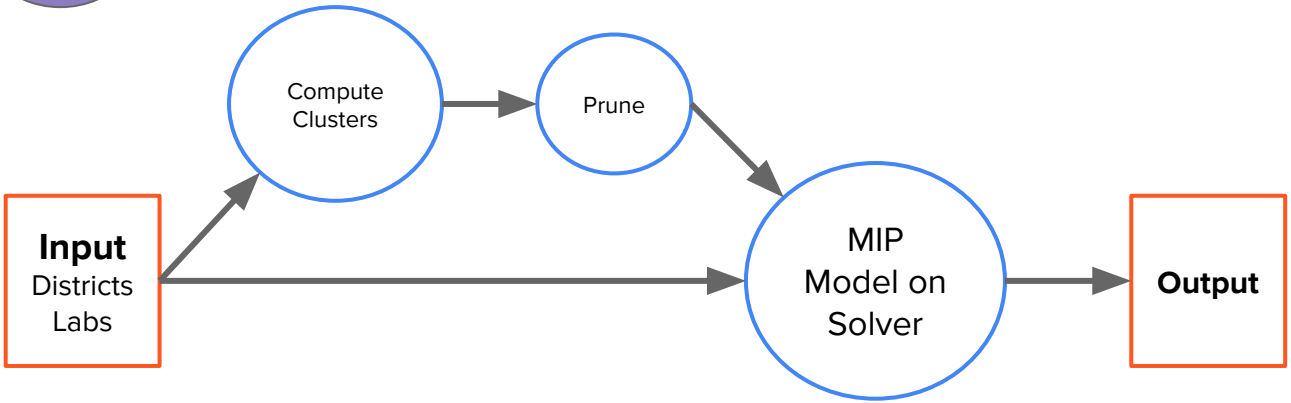
Geographic distribution of labs

Approaches



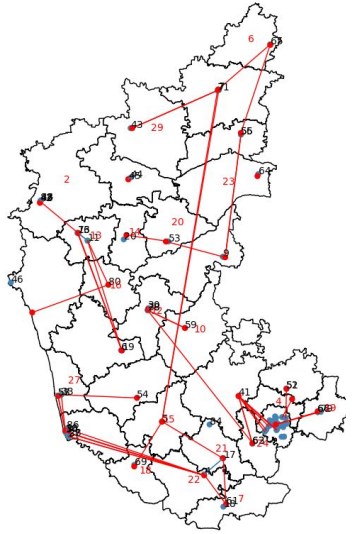
Baseline Algorithm

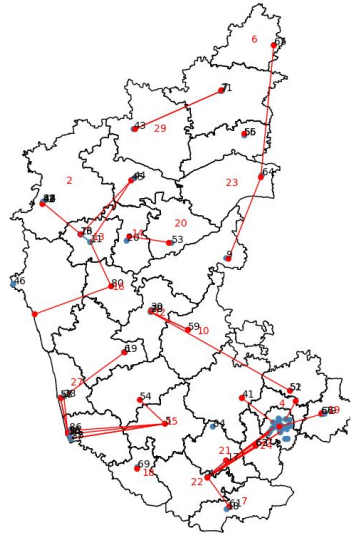
Mixed Integer Programming



Testing and Results

- Calculating lower bounds and margin of closeness
- Benchmarked all approaches against the sample outputs
- Performance testing on varying case load
- Output comparisons on short and long runs of MIP solver in Python 3.6 using PythonMIP library.

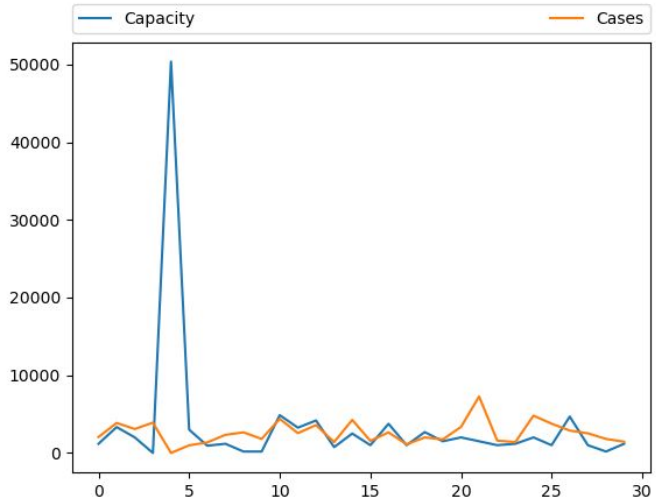




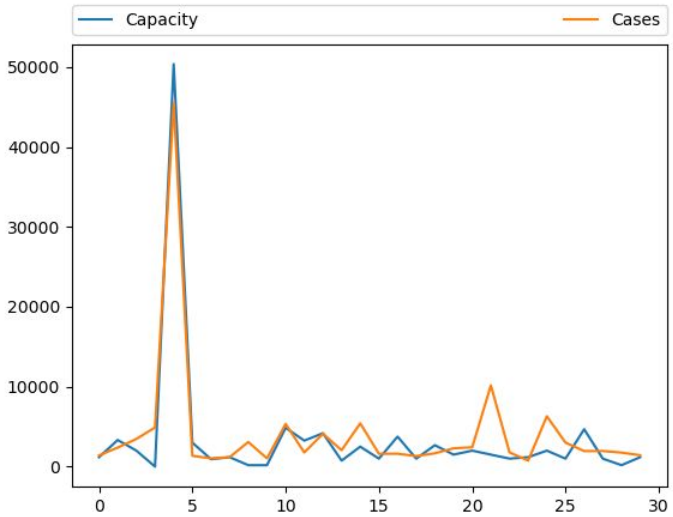
Baseline	MIP (10mins)	MIP (30 mins)	Best Score	Closeness
138,782,153	121,942,529	121,779,813	121,403,144	99.807%
162,357,199	142,503,116	142,459,632	142,407,282	99.817%
151,810,345	131,316,815	130,934,769	130,814,729	99.853%
124,178,874	110,211,626	110,196,392	110,180,913	99.863%
157,921,190	139,749,409	138,749,708	138,607,286	99.878%

Robustness

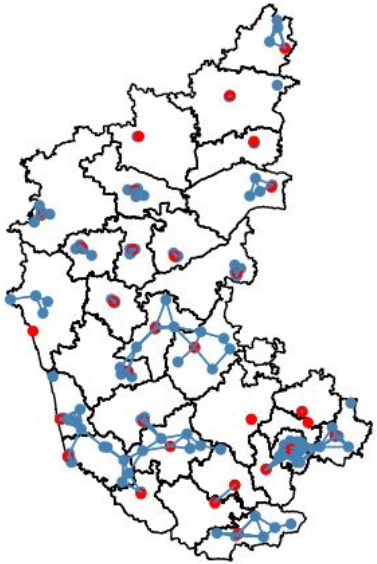
Dataset	MIP (in 10mins)	Lower Bound	Closeness
Bangalore - 0 Rest - 1.8x	112,886,508	112,777,320	99.903%
(1 - 2.5)x load	553,013,565	552,861,237	99.972%
More labs made	425,153,802	423,837,100	99.689%



Drastic change in sample distribution
(Bangalore now has 0 samples)



Samples far exceeding capacity (congestion)



Much more labs (155 in above!)

Thank You

For more details on our solution, check out: https://github.com/kjain1810/cnihack