Rajaraman and Wong Clustering

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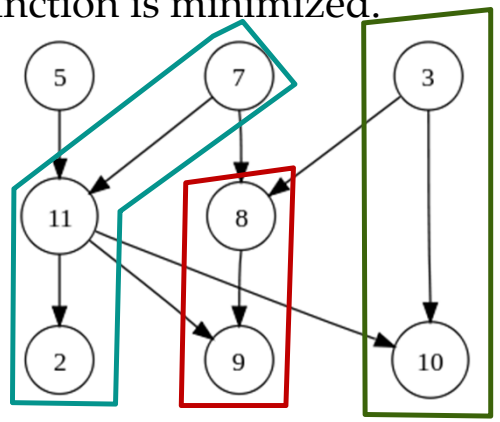
What is Clustering

- Grouping gates into multiple clusters such that the cost function is minimized.

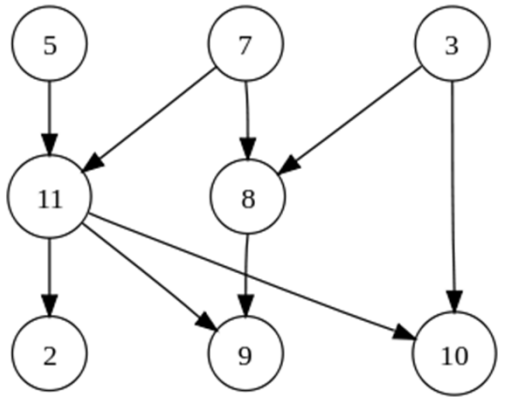


- Cost Functions examples:
  - Inter-cluster connections.
  - Longest path delay.
- Different algorithms work on different cost functions.
- Rajaraman and Wong clustering minimizes longest path delay in clustered-level circuit.
- WHY CLUSTERING?

✓ Used as a pre process before partitioning and placement to reduce complexity.

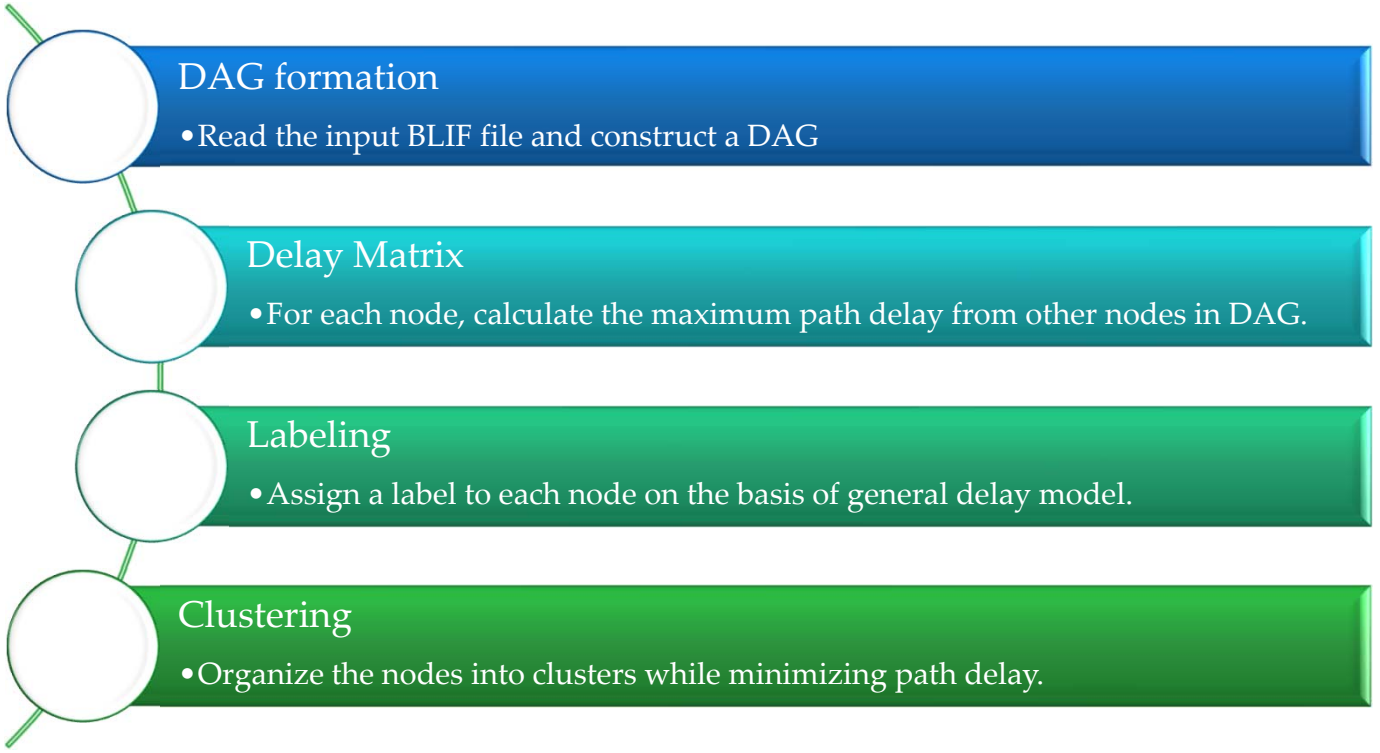
Rajaraman and Wong Clustering

- Works on Directed Acyclic graph (DAG) and uses general delay model.
- General delay model: each node has same delay, inter-cluster delay is constant and intra-cluster edge does not incur any delay.
- Two phases:
  - Labeling
  - Clustering



DAG

Program Flow



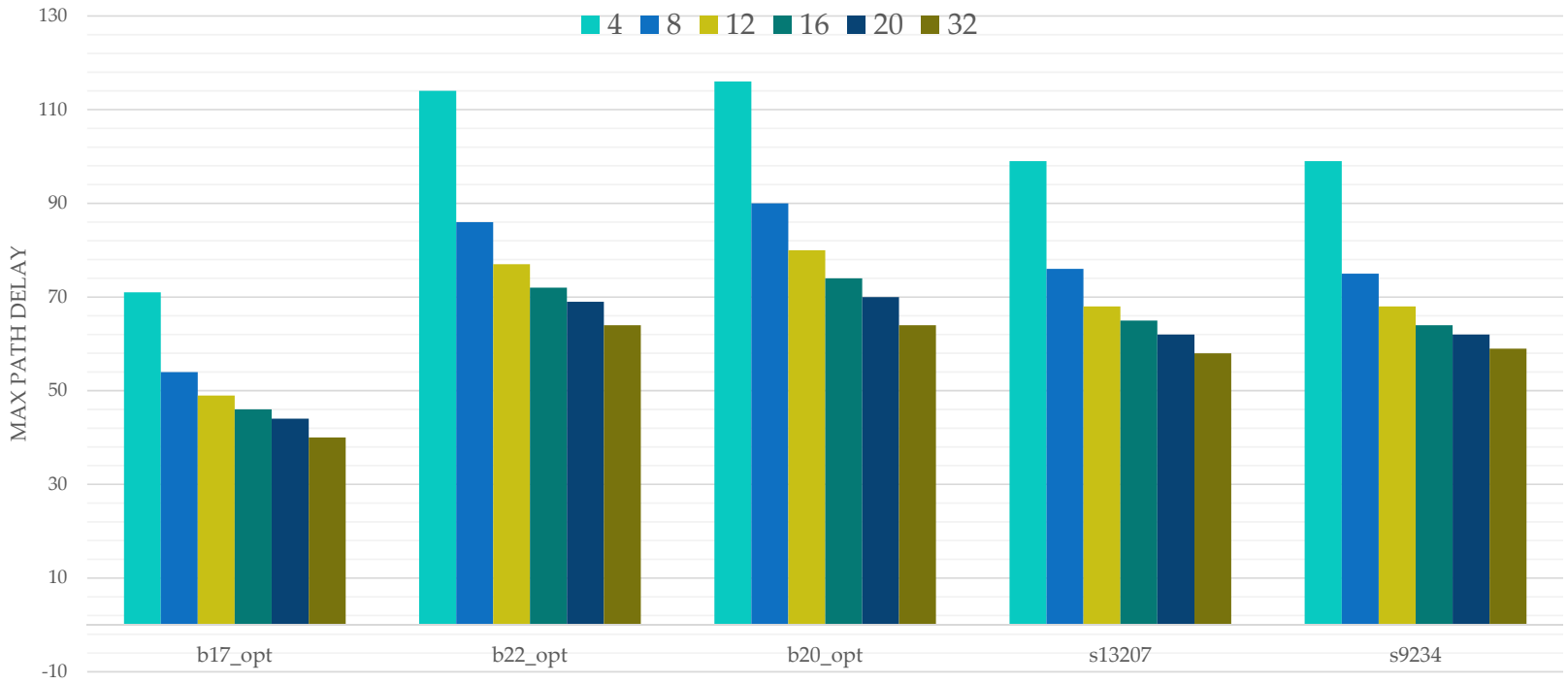
Programming and Data Structures

- We have used C++ to implement all the steps of the clustering algorithm.
- Primary Data structure used is Map of maps
  - Benefits- Fast lookup, avoids multiple matrix manipulations, fast update.
- For GUI, we have used JavaScript and HTML to display the different steps in clustering algorithm.

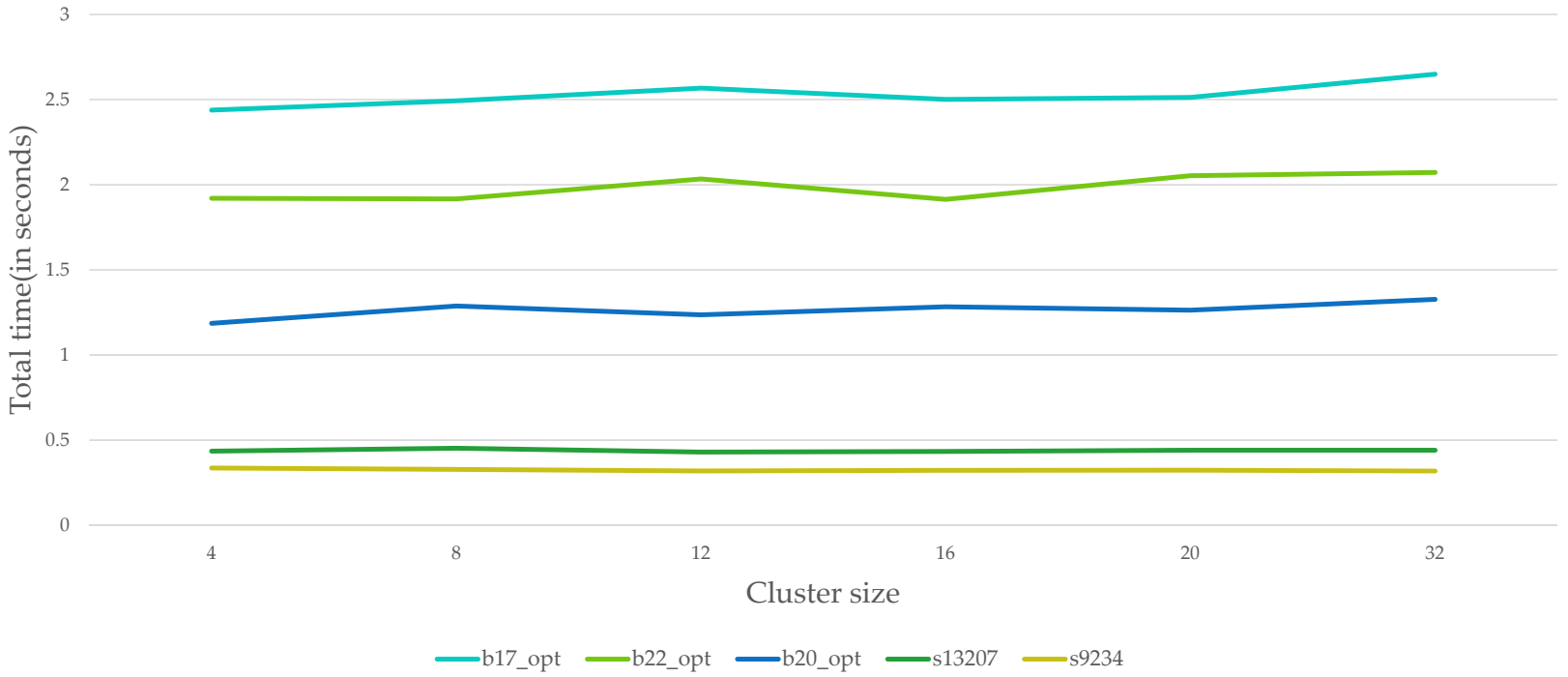
Results (Max Cluster size 8, Inter-cluster delay 3)

Circuit	No. of nodes	No. of clusters	Max Path delay	Matrix Formation time(sec)	Labelling time(sec)	Clustering time(sec)	Total time(sec)
b17_opt	25719	1536	54	2.144	2.429	0.064	**4.637**
b22_opt	18789	946	86	1.666	1.749	0.168	**3.583**
b20_opt	12991	660	90	1.045	1.198	0.09	**2.333**
s13207	8728	424	76	0.315	0.388	0.065	**0.768**
s9234	5845	132	75	0.281	0.309	0.02	**0.61**

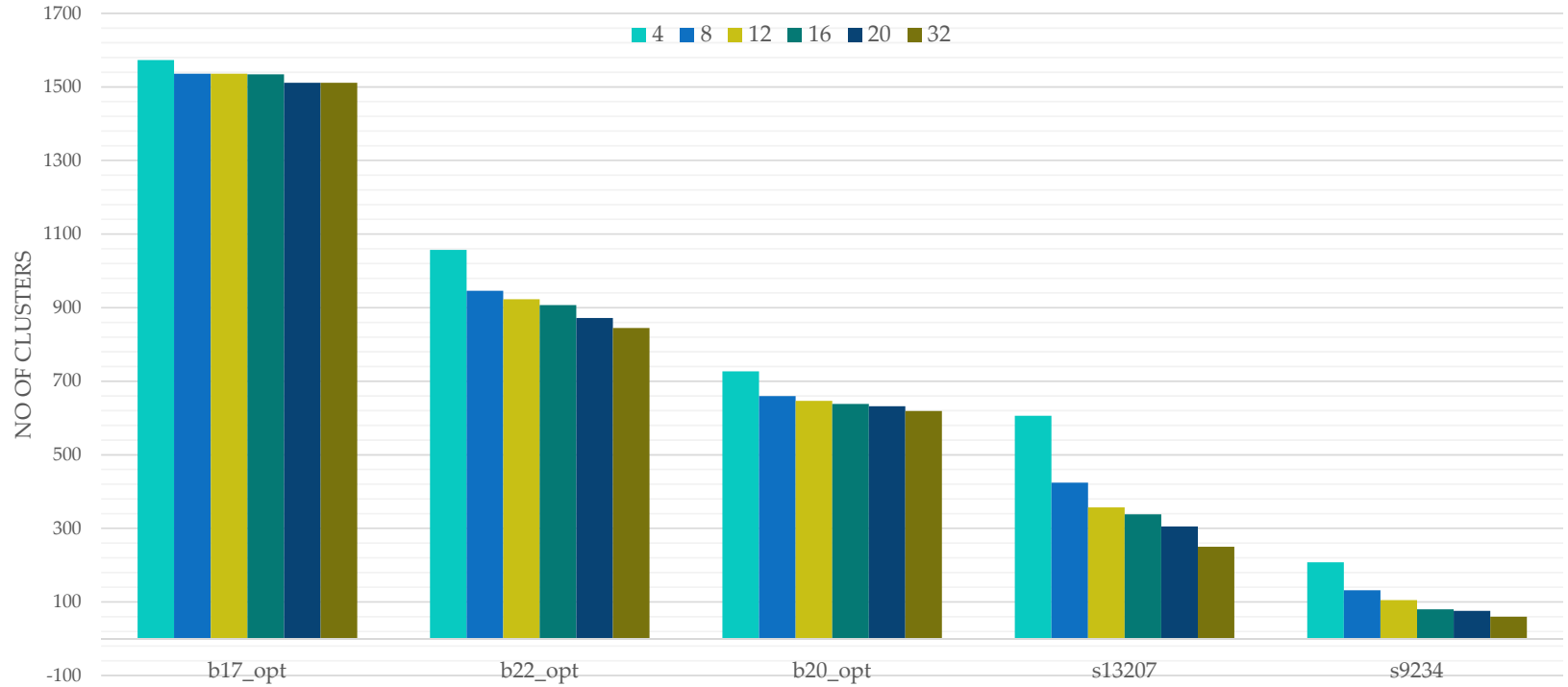
Performance Comparison(Cluster size vs Delay)



Performance Comparison(Cluster size vs Runtime)



Performance Comparison(Cluster size vs #Clusters)



Our Optimizations

- Avoided matrix manipulations using intelligent data structures.
- Reduced average time complexity of clustering algorithm by using advanced data structures and algorithms.
- Better Scalability: Our runtime remains almost constant for increasing cluster sizes.
- Small and efficient program code:
  - Only 500 lines of code.

Tasks to be done…

- EXTENSION:

✓Reduce the number of clusters by implementing a merging algorithm.

✓Further improve the algorithm runtime.

GUI Demonstration


Thank You