

Finding System-Level Information and Analyzing its Correlation to FPGA Placement

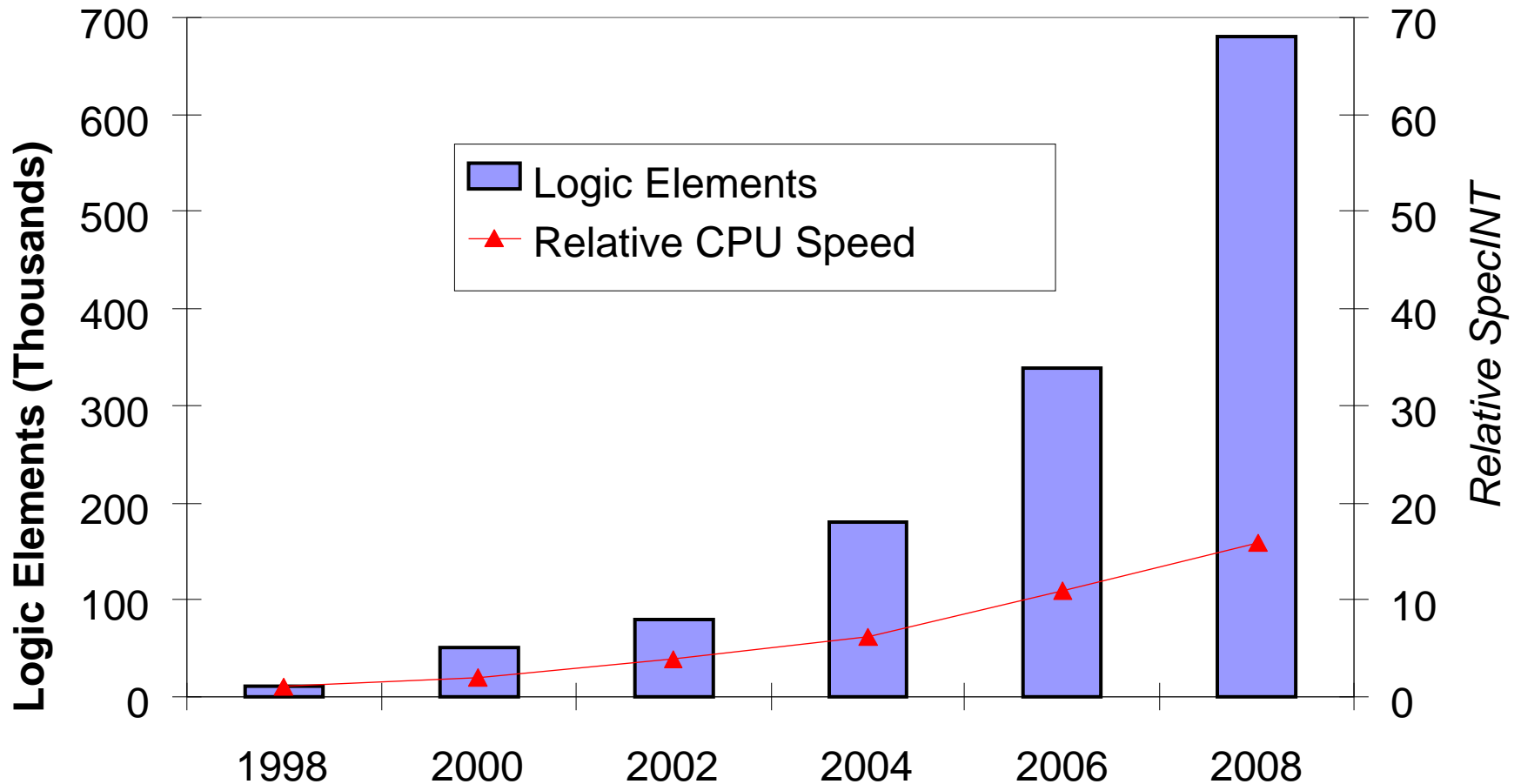
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Motivation



Motivation

- CAD flow flattens the netlist, removing system-level design information

Objective

- Is there any relationship between the original design structure (HDL) and the final FPGA placement?

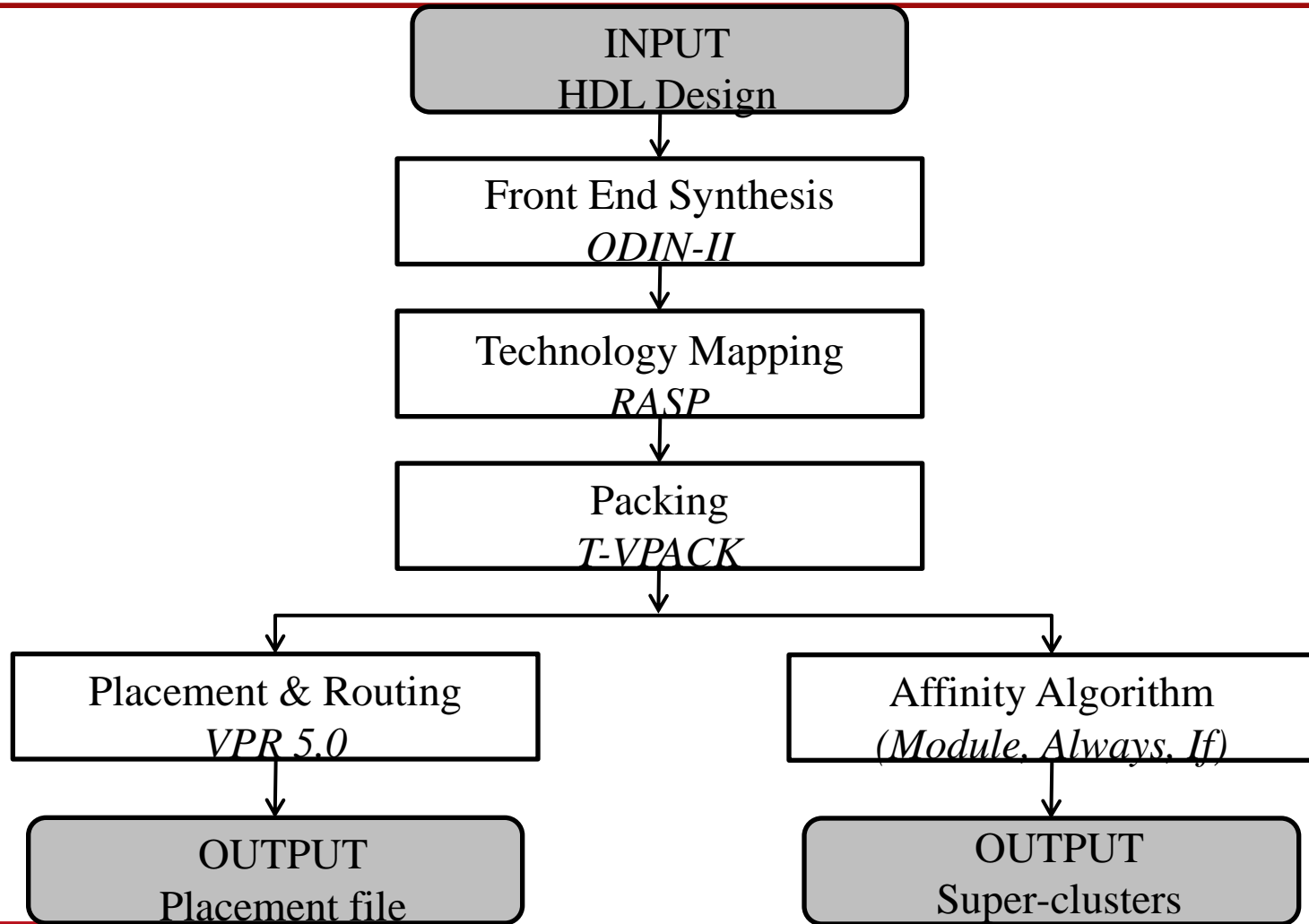
Objective

- Can a clustering algorithm be used to recreate system-level information to reduce the time needed to obtain a good placement?
- Super-cluster: cluster of clusters

Objective

- What metrics can be used to evaluate the quality of a super-cluster?

CAD Flow used in this research



What are we evaluating?

■ System-Level Info

- Module

- Always

- If

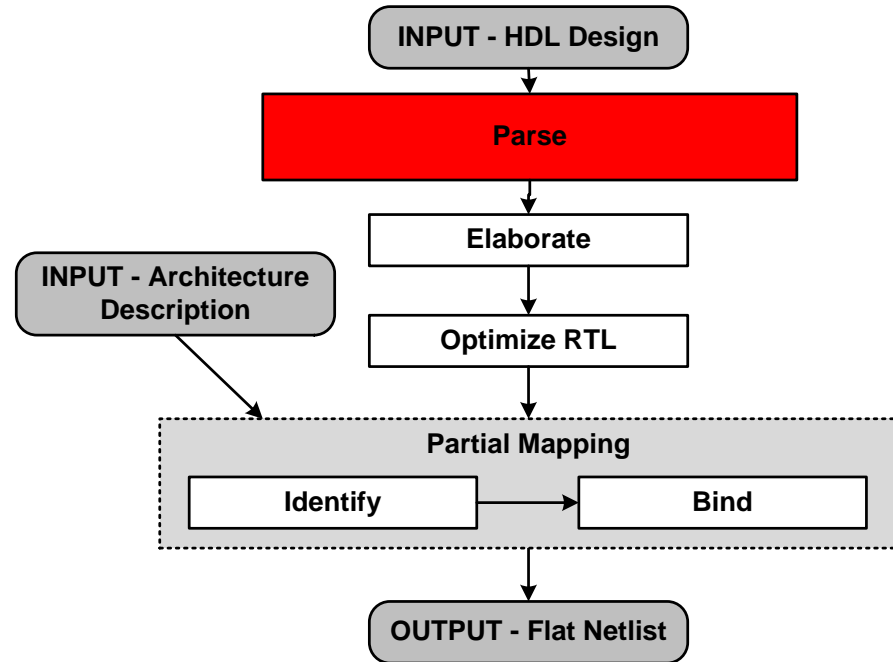
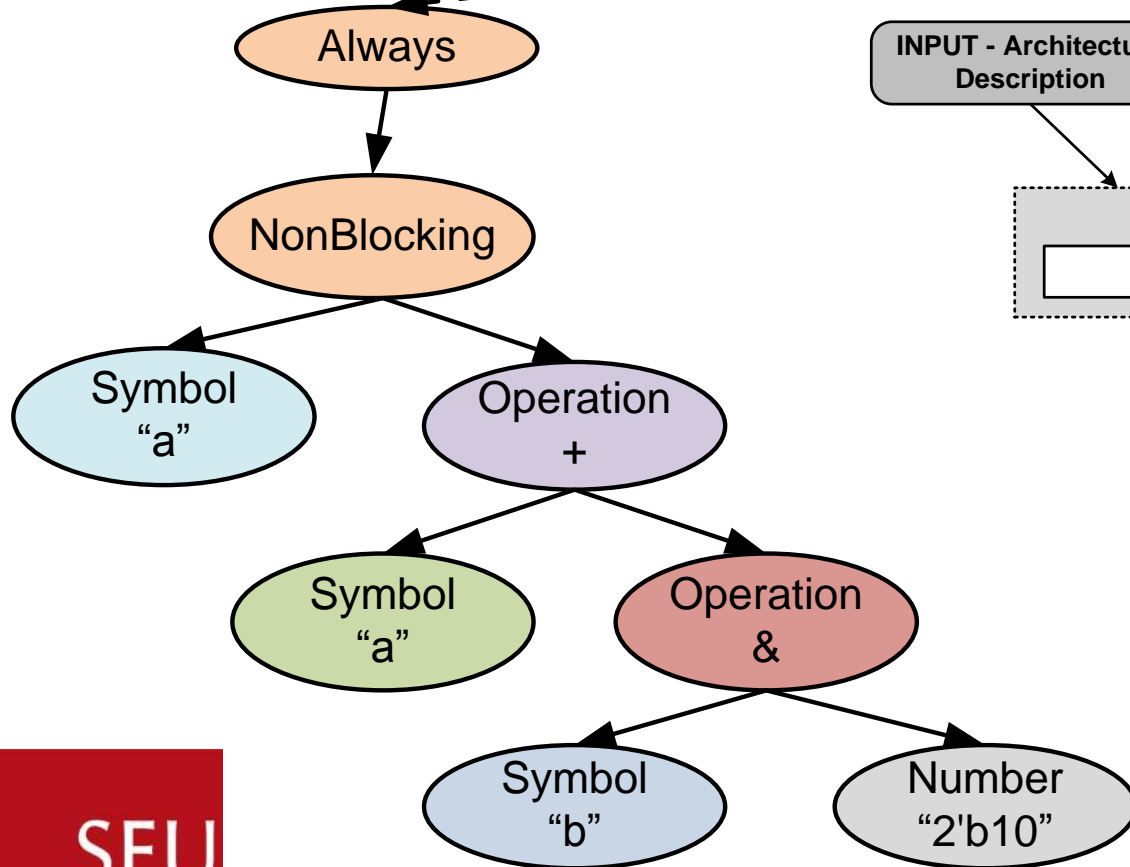
■ Clustering Algorithm

- Affinity Propagation

- Two different similarity factors

Abstract Syntax Tree in ODIN-II

```
always @(posedge clk)
begin
  a <= a + b & 2'b10;
end
```



Clustering/Partitioning Algorithms

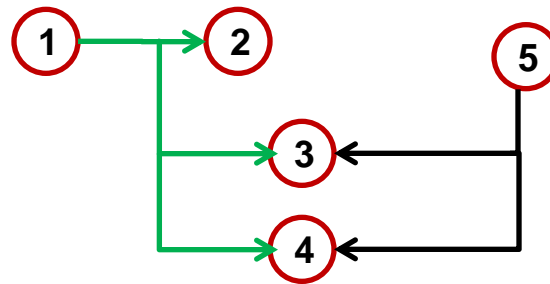
- Want to create “clusters of clusters”
 - aka *super-clusters*
- Lots of clustering/partitioning algorithms
- Typically they fix:
 - The number of super-clusters; or
 - The number of clusters per super-cluster

Affinity Algorithm

- A clustering algorithm that lets the number and composition of the super-clusters vary for a design
 - May better reflect the nature of the circuit
- Structural relationships are used to indicate “similarity”
 - Super-clusters comprise clusters that have *greater* similarity

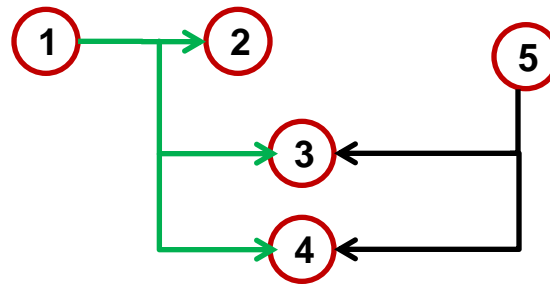
Affin 1

- Similarity Factor based on the connectivity between the clusters



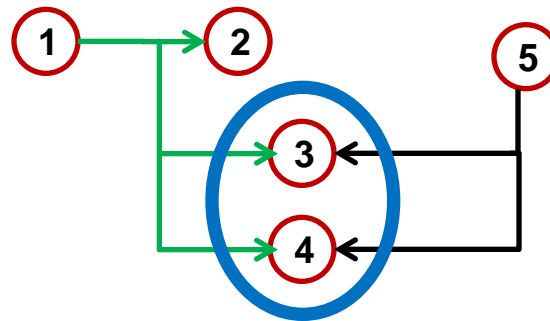
Affin2

- Similarity Factor based on connectivity *and* the number of *common* connections between clusters



Affin2

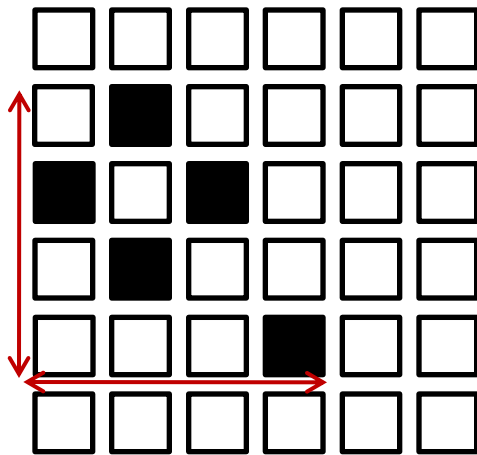
- Similarity Factor based on connectivity *and* the number of *common* connections between clusters



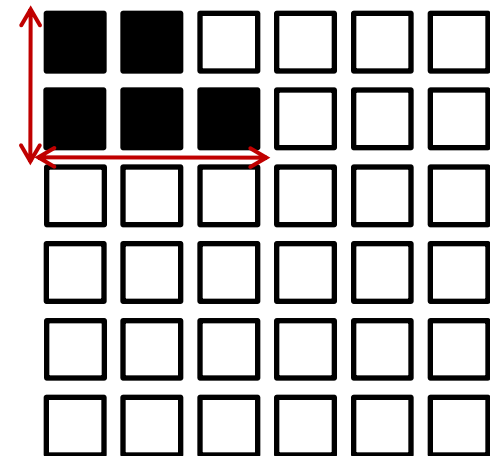
Metrics

- Normalized Manhattan Distance (MD)
- Density of Super-clusters

Metric 1 - Normalized MD

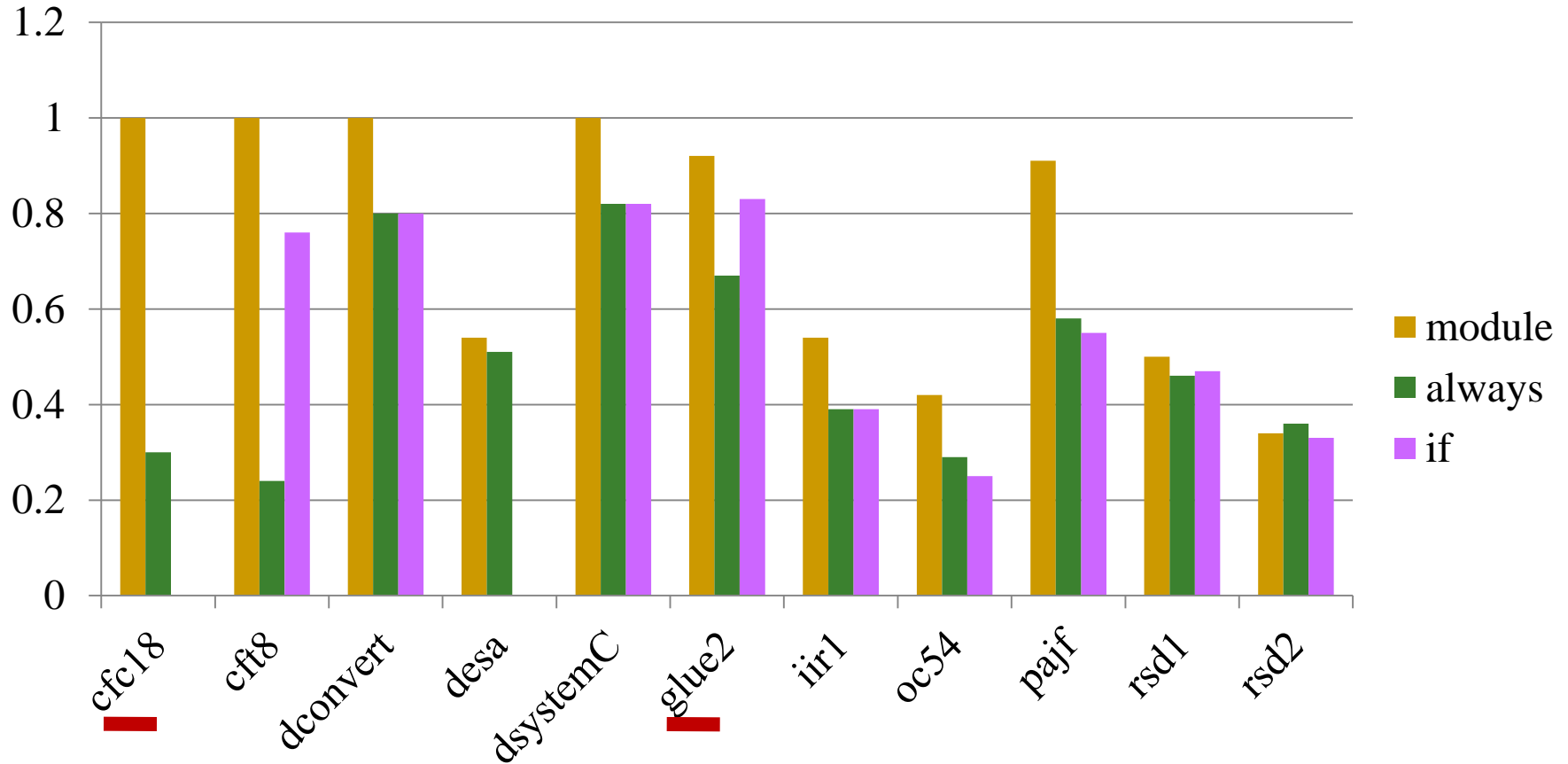


Manhattan Distance

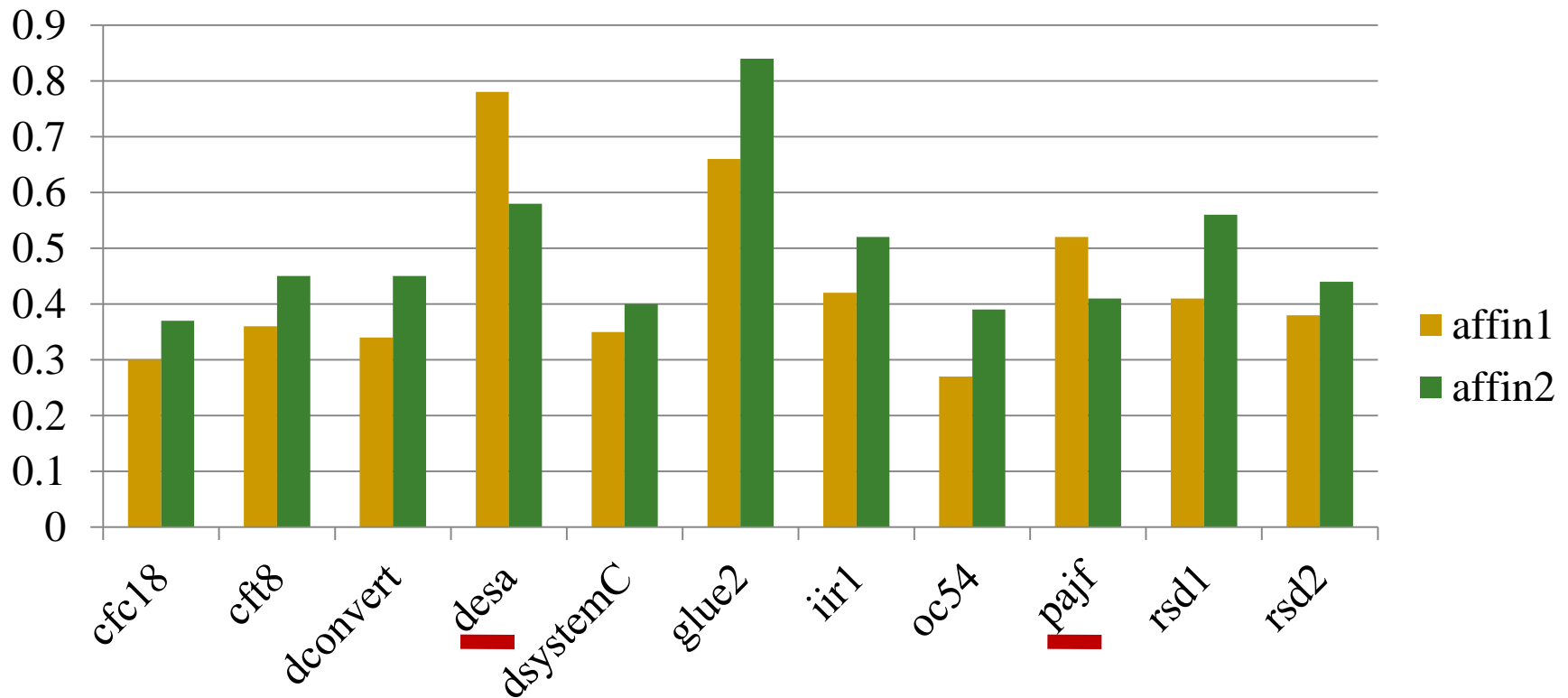


Minimum Manhattan Distance

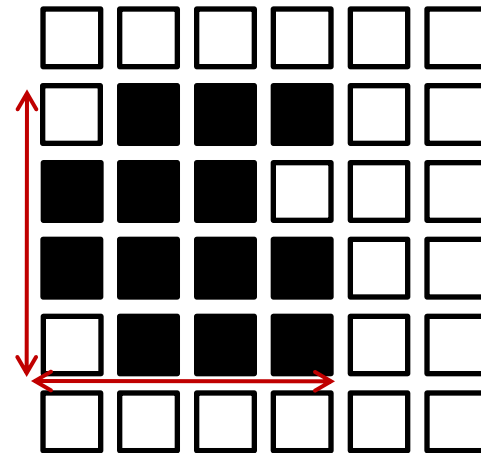
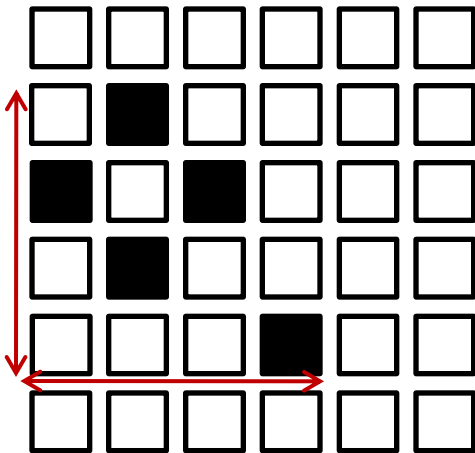
Results - Metric 1: Normalized MD



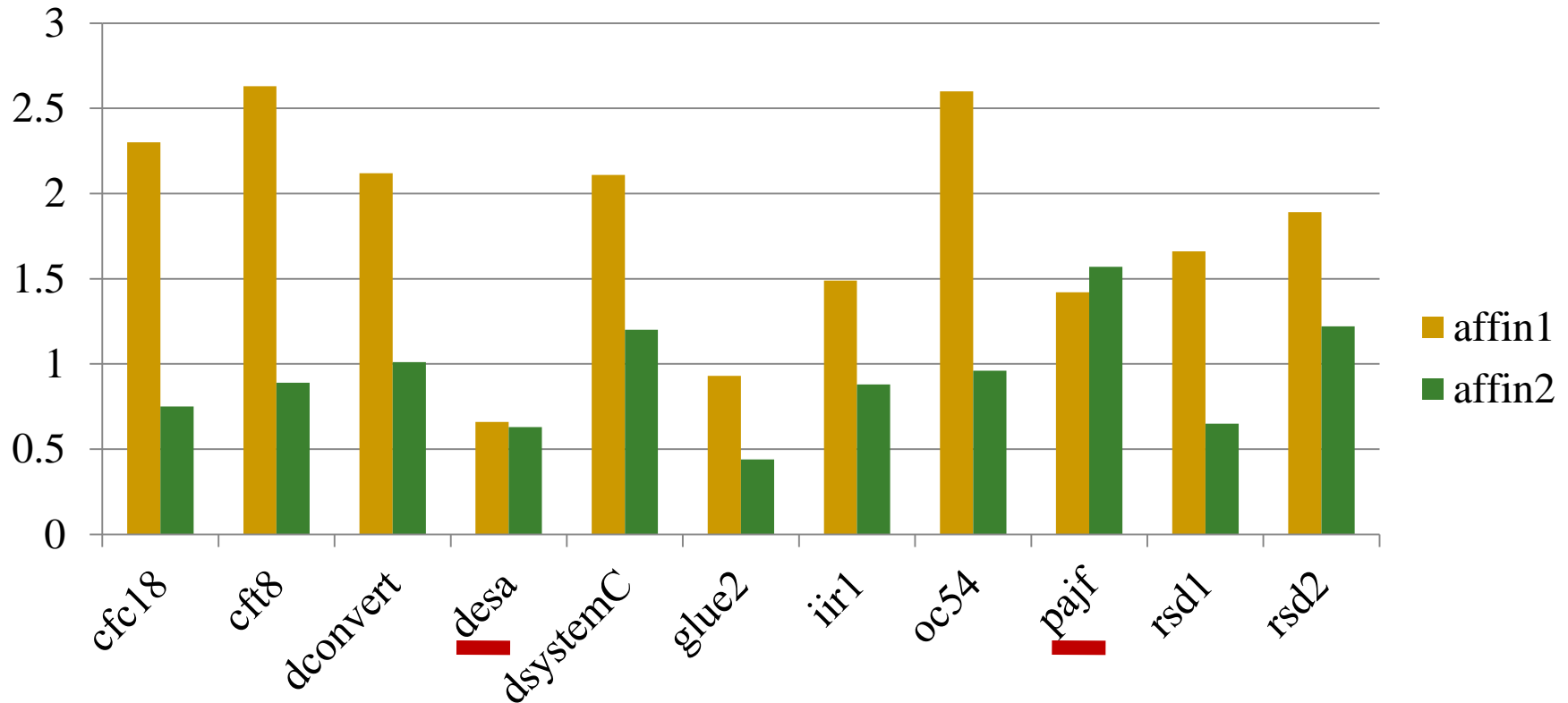
Results – Metric 1: Normalized MD



Metric 2 – Density of super-cluster



Results – Metric 2



Conclusion

- Presented metrics for evaluating the locality of coarse grain substructures within a placement.
- Demonstrated that the affinity algorithm can be used to create heterogeneous super-clusters.

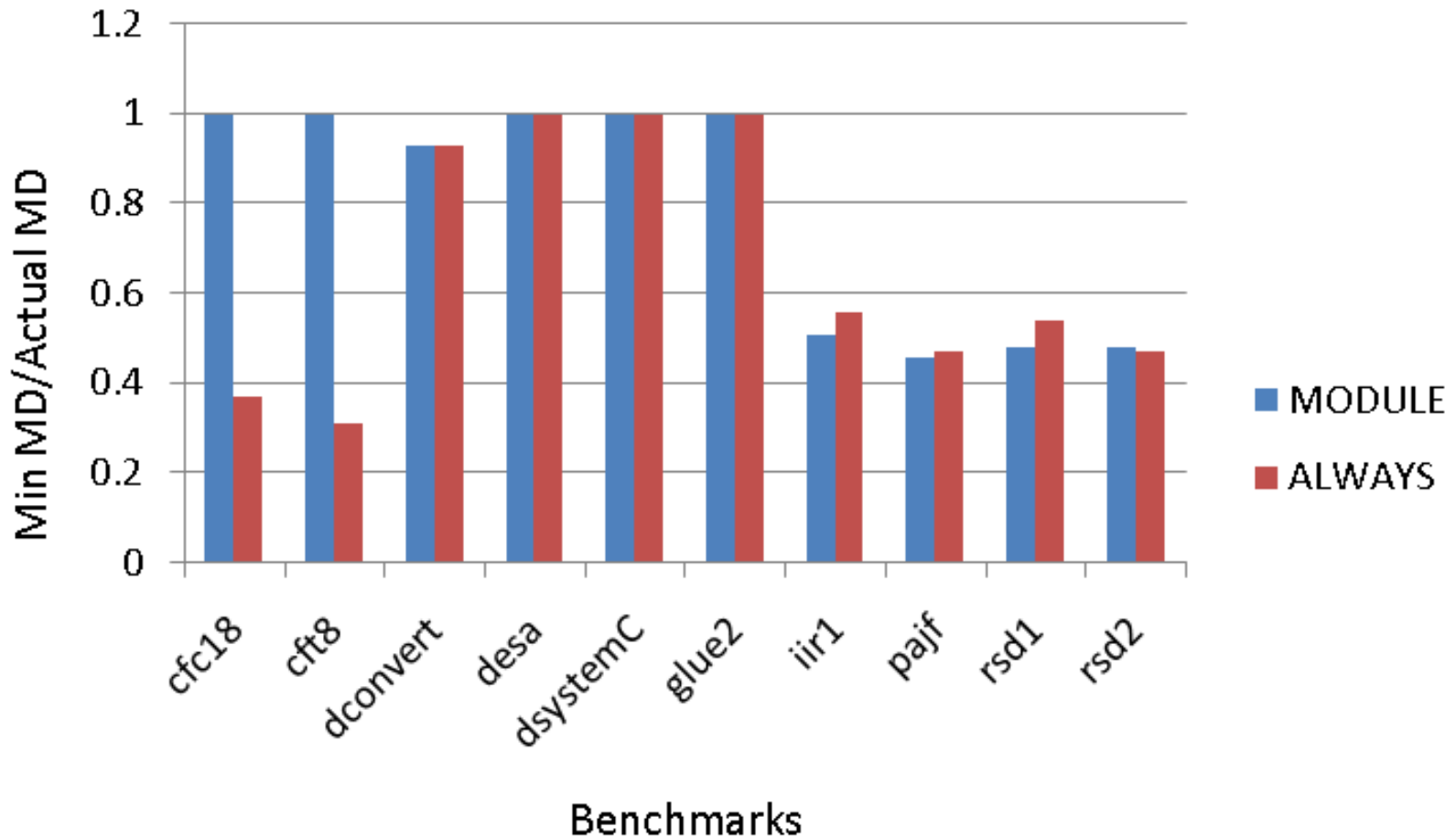
Future Work

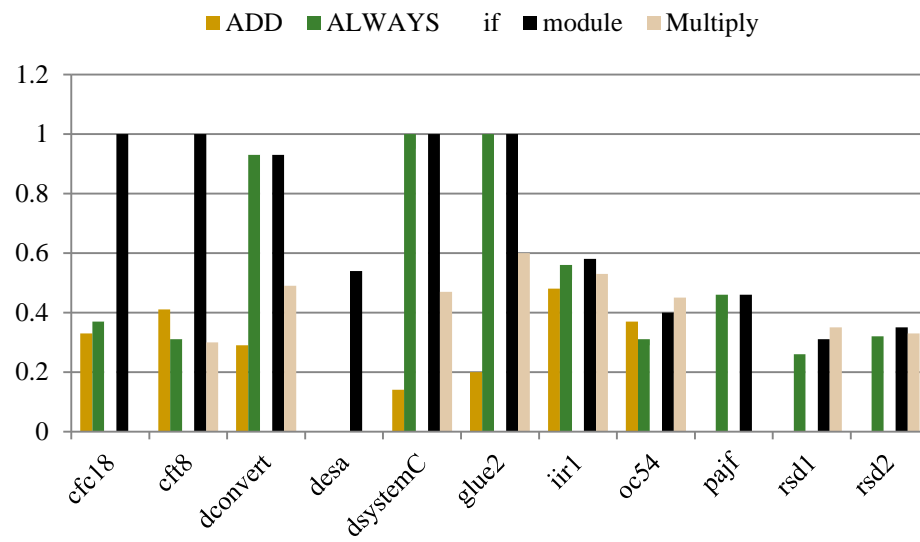
- Evaluating the correlation of other design structures (i.e., Buses and datapaths) in the final placement
- Investigating new possible similarity factors for the affinity algorithm
- Using a modified version of ABC to extract more high-level names

Thank you for your attention

Questions?

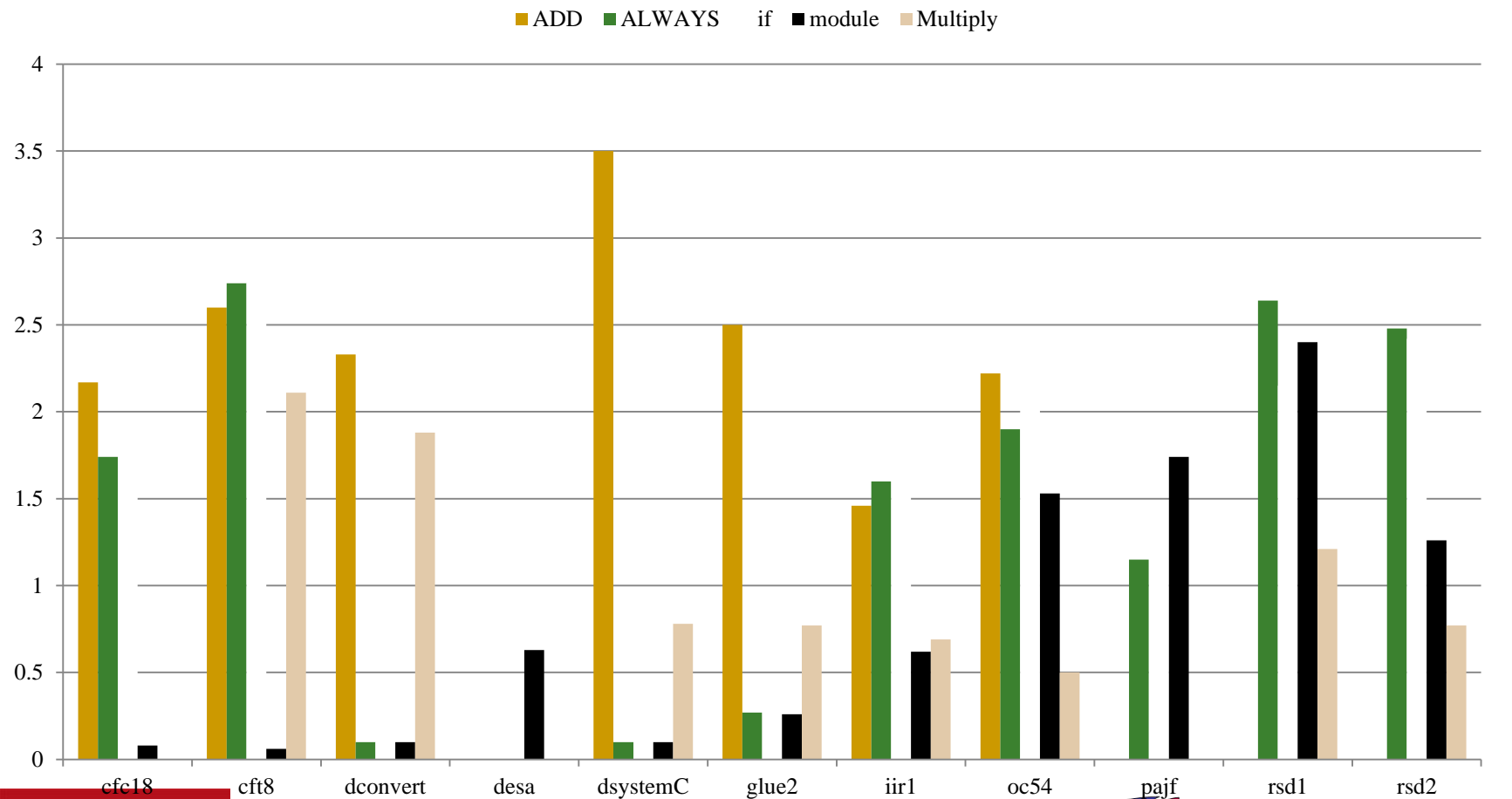
ABC Results



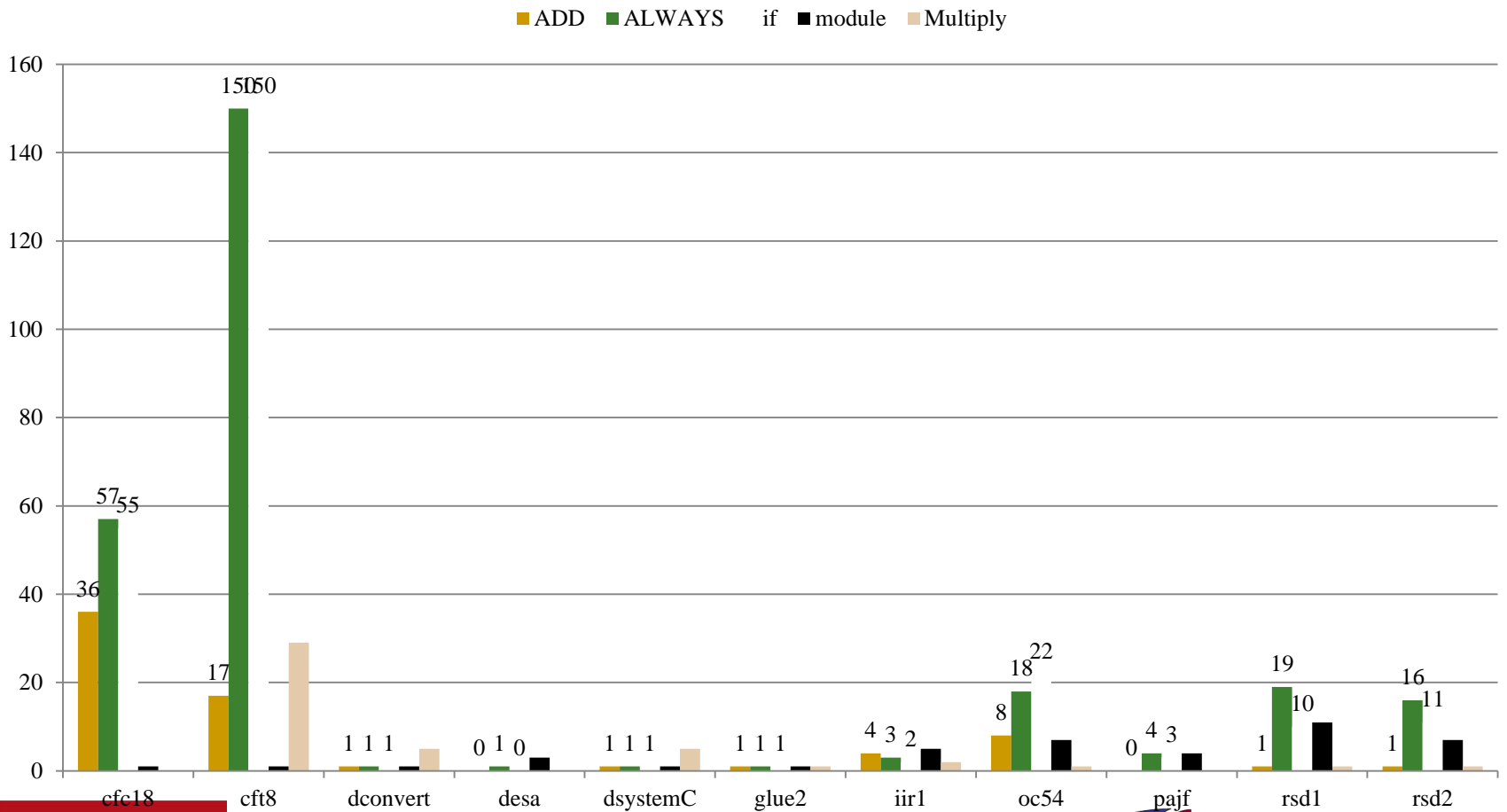


MIN MD/MD

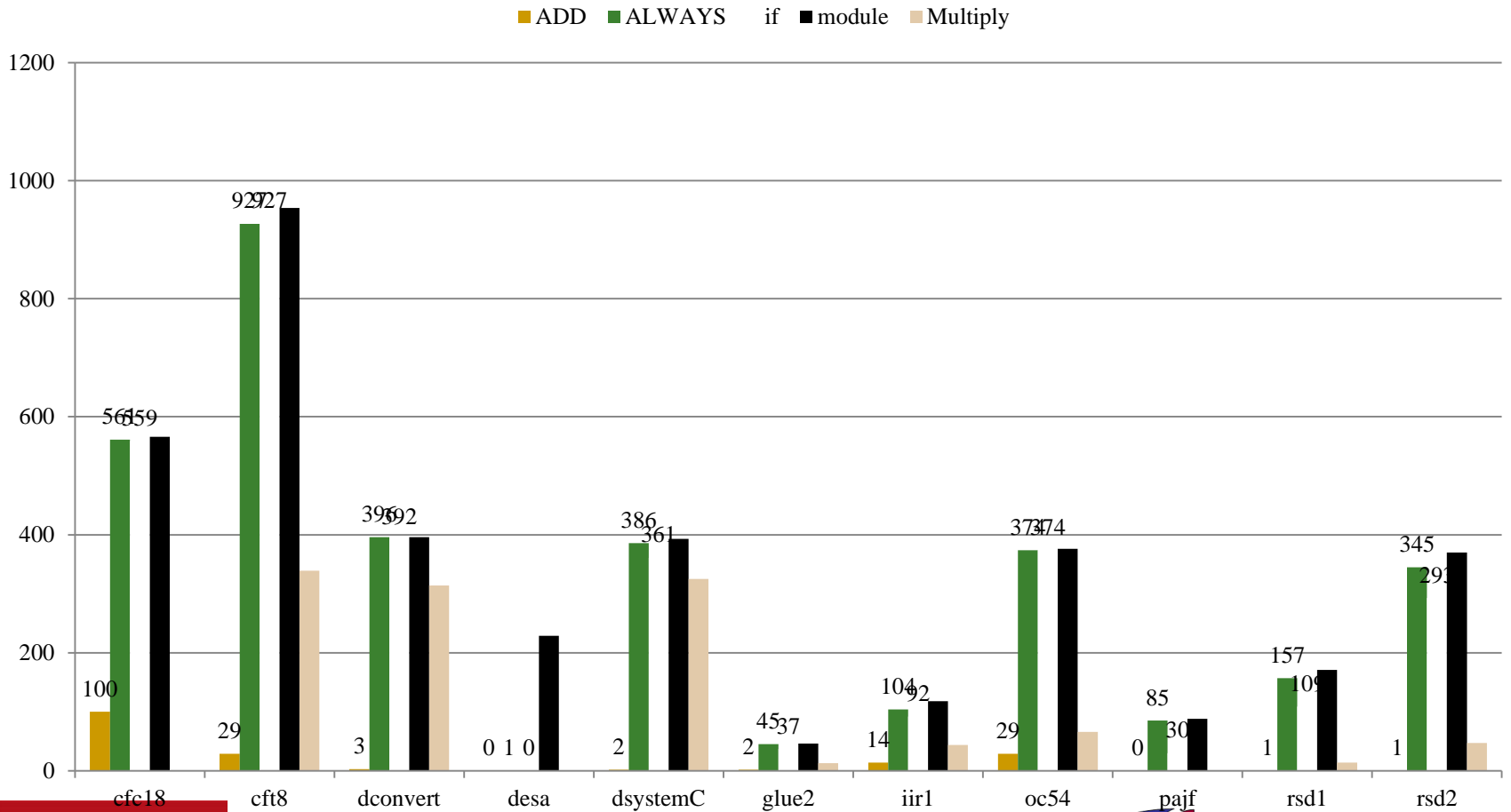
MD/# clusters



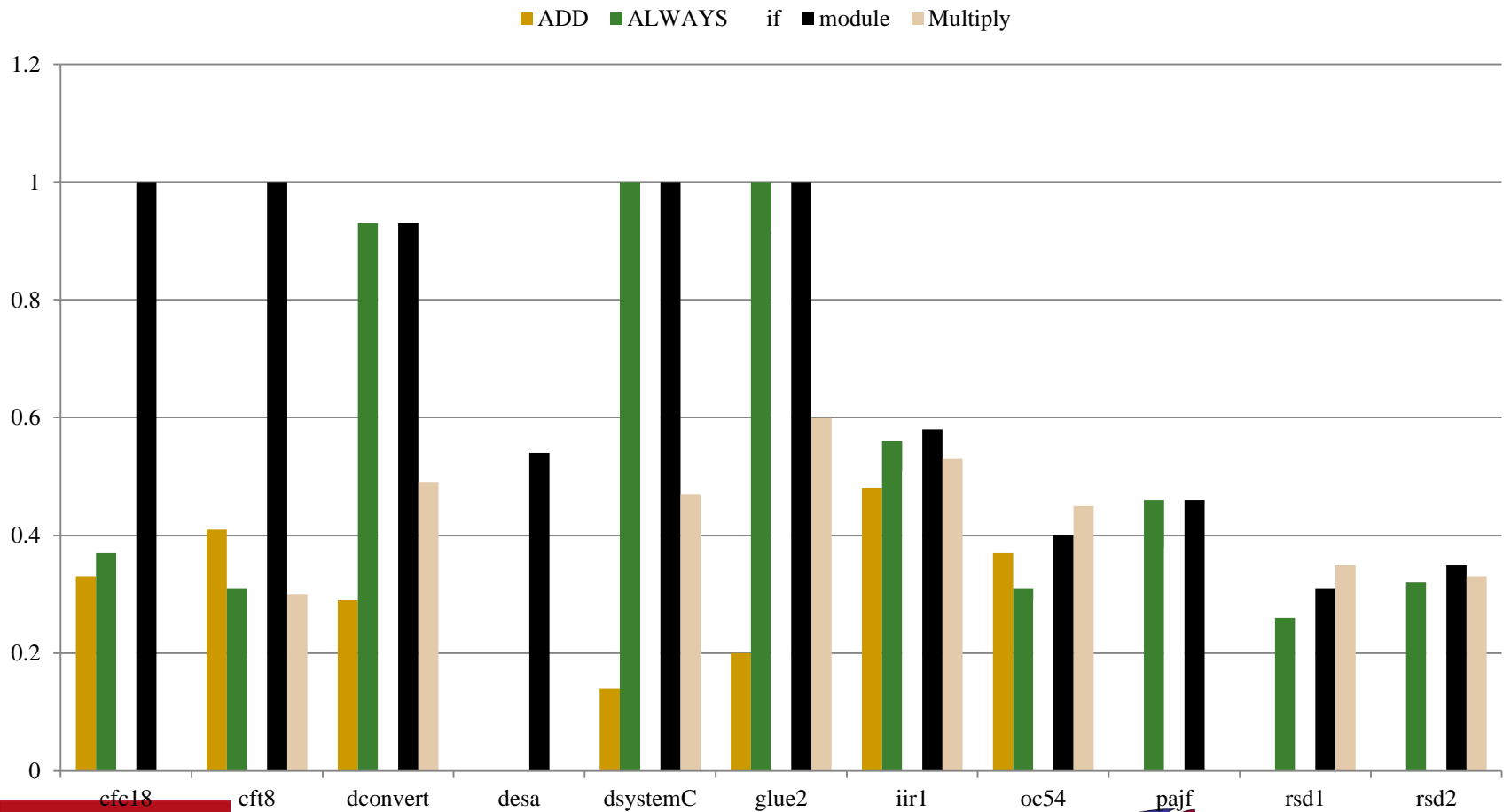
Number of clusters



Number of blocks



Min MD/MD



Benchmark	AFFIN1	AFFIN2
cfc18	65	13
cft8	91	35
cesa	6	8
iir1	15	8
oc54	43	18
rsd2	50	16
dconvert	38	25
dsystemC	37	27
glue2	6	2
rsd1	19	6