Falcon: A Graph Manipulation Language for Heterogeneous Systems

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4. Supports parallel execution of different algorithms on multiple devices.
5. Supports partitioning of Graph objects and execution of a single algorithm using multiple devices. Used when graph object does not fit in a single device.
6. Supports mutation of Graph object.
7. Allows viewing Graph in different way(say collection of triangles).

Language constructs for parallelization and Synchronization in Falcon

single(t1) {stmt block1} **else** {stmt block2}	The thread that gets a lock on item t1 executes stmt block1 and other threads execute stmt block2.
single(coll) {stmt block1} **else** {stmt block2}	The thread that gets a lock on all elements in the collection executes stmt block1 and others execute stmt block2.

Table 1. single statement(Synchronization) in Falcon

Data Type	Iterator	Description
Graph	points	iterate over all points in graph
Graph	edges	iterate over all edges in graph
Graph	pptyname	iterate over all elements in new ppty.
Point	nbrs	iterate over all neighboring points
Point	outnbrs	iterate over dst point of outgoing edges (Directed Graph)
Edge	nbrs	iterate over neighbor edges
Set	item	iterate over all items in Set
Collection	item	iterate over all items in Collection

Table 2. Iterators for foreach(parallelization) statement in Falcon

parallel sections- for Multiple parallel regions on different devices.

shortest path

```
1  int <GPU> changed = 0; // Variable on GPU
2  relaxgraph(Point <GPU>p, Graph <GPU>graph) {
3      foreach (t In p.outnbrs)
4        MIN(t.dist, p.dist + graph.getWeight(p, t), changed);
5  }
6  main(int argc, char *argv[]) {
7      Graph hgraph; // graph on CPU
8      hgraph.addPointProperty(dist, int);
9      hgraph.getType() <GPU>graph; // graph on GPU
10     hgraph.read(argv[1]); // read graph on CPU
11     graph = hgraph; // copy graph to GPU
12     foreach (t In graph.points)t.dist=MAX_INT;//INFinity
13     graph.points[0].dist = 0; // source has dist 0
14     while( 1 ){
15         changed = 0;
16         foreach (t In graph.points) relaxgraph(t,graph);
17         if (changed == 0) break; //reached fix point
18     }
19     for (int i = 0; i <graph.npoints; ++i)
20           printf("i=%d dist=%d\n", i, graph.points[i].dist);
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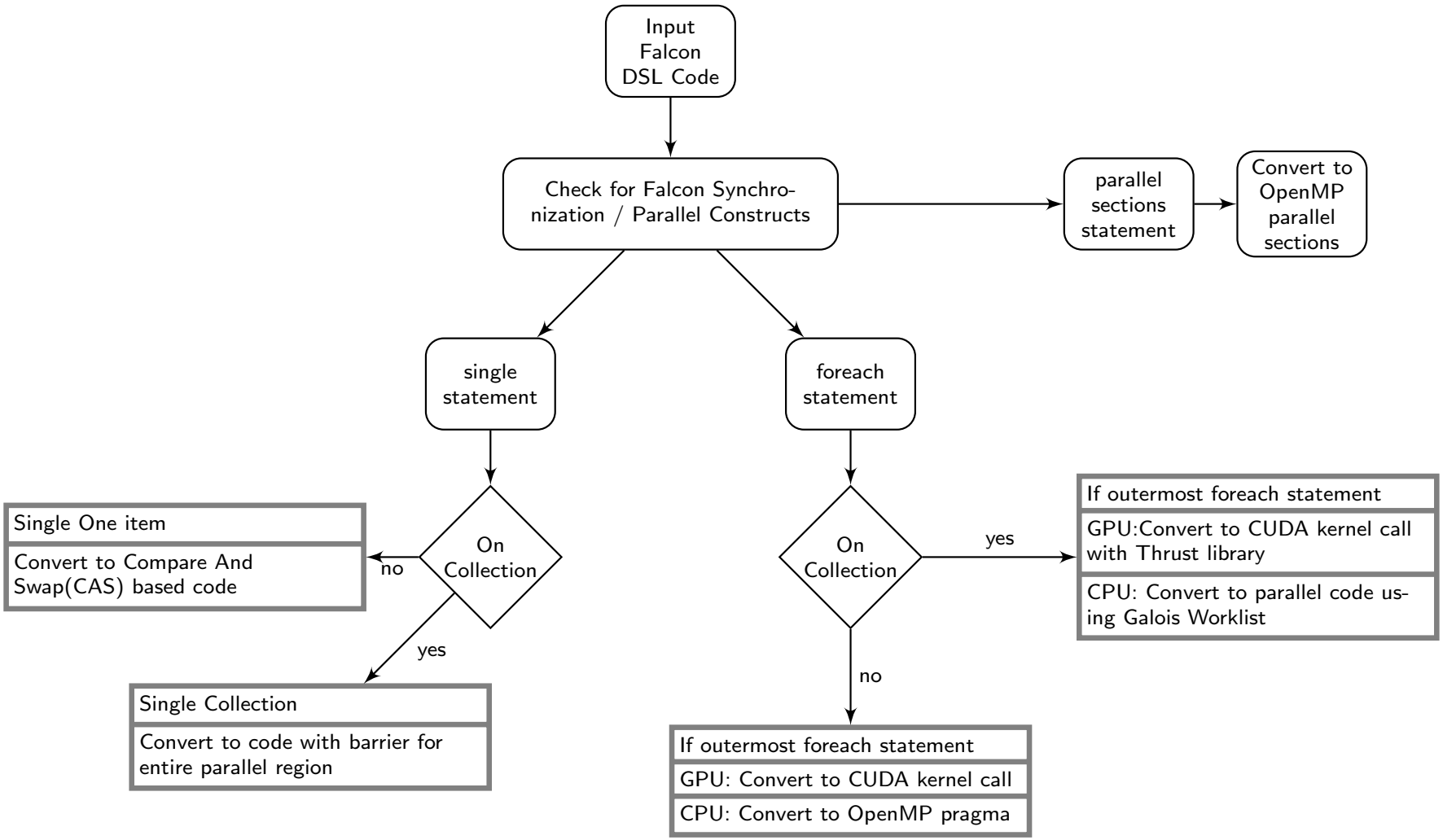
Falcon Compiler Code Genaration (Synchronization and parallelization constructs)



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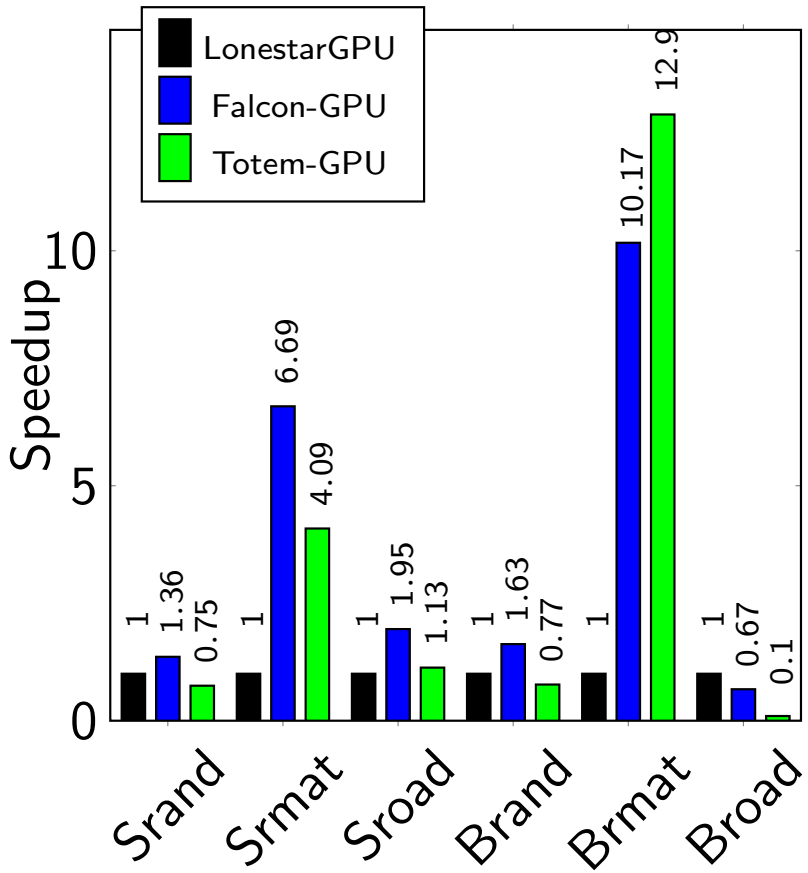
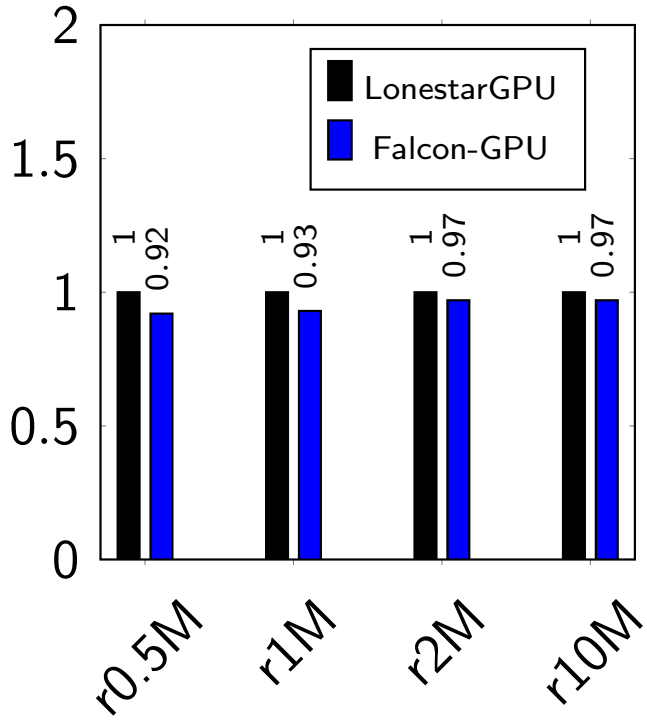
8. Publication- http://dl.acm.org/citation.cfm?id=2842618(ACM TACO,2015)

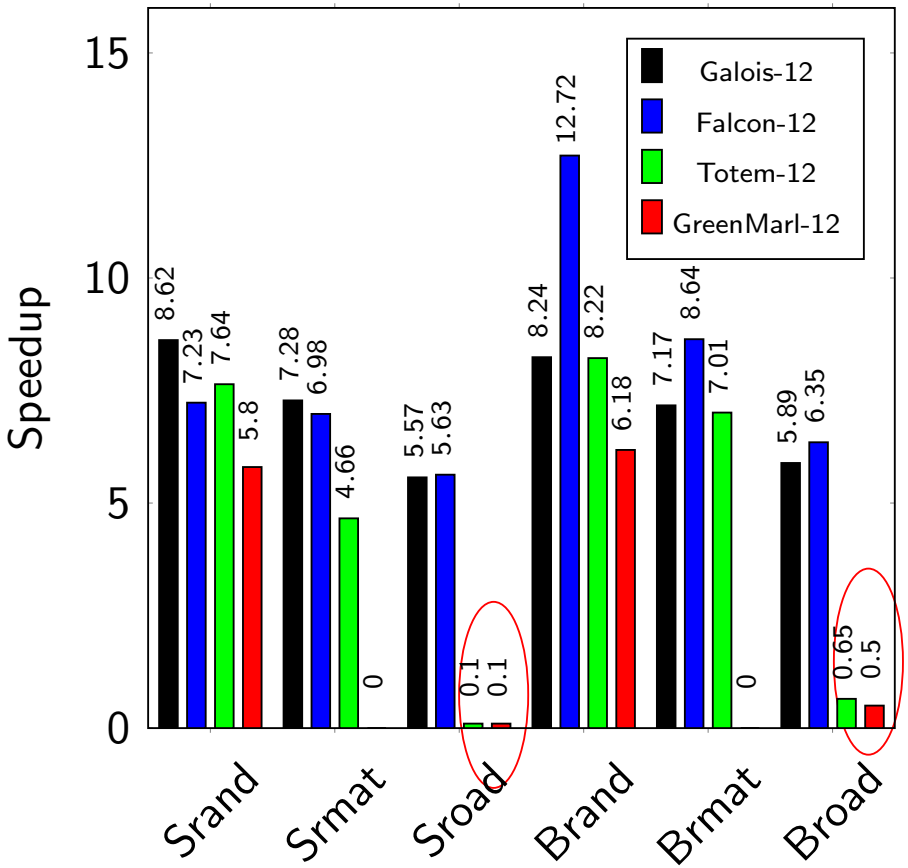
(Points,Edges) rand(32M,128M),rmat(20M,200M)
road(23M,58M)



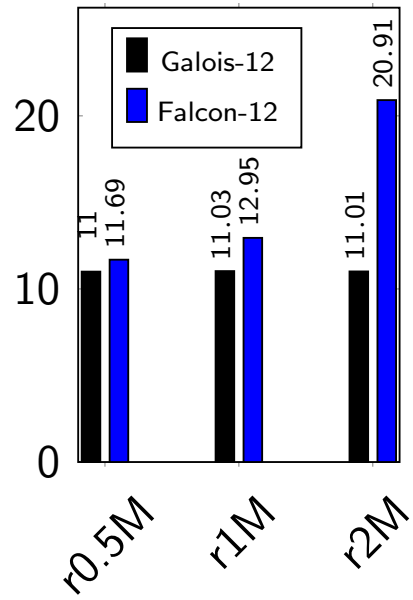
(a) Speedup of SSSP & BFS on GPU



(b) DMR speedup over LonestarGPU

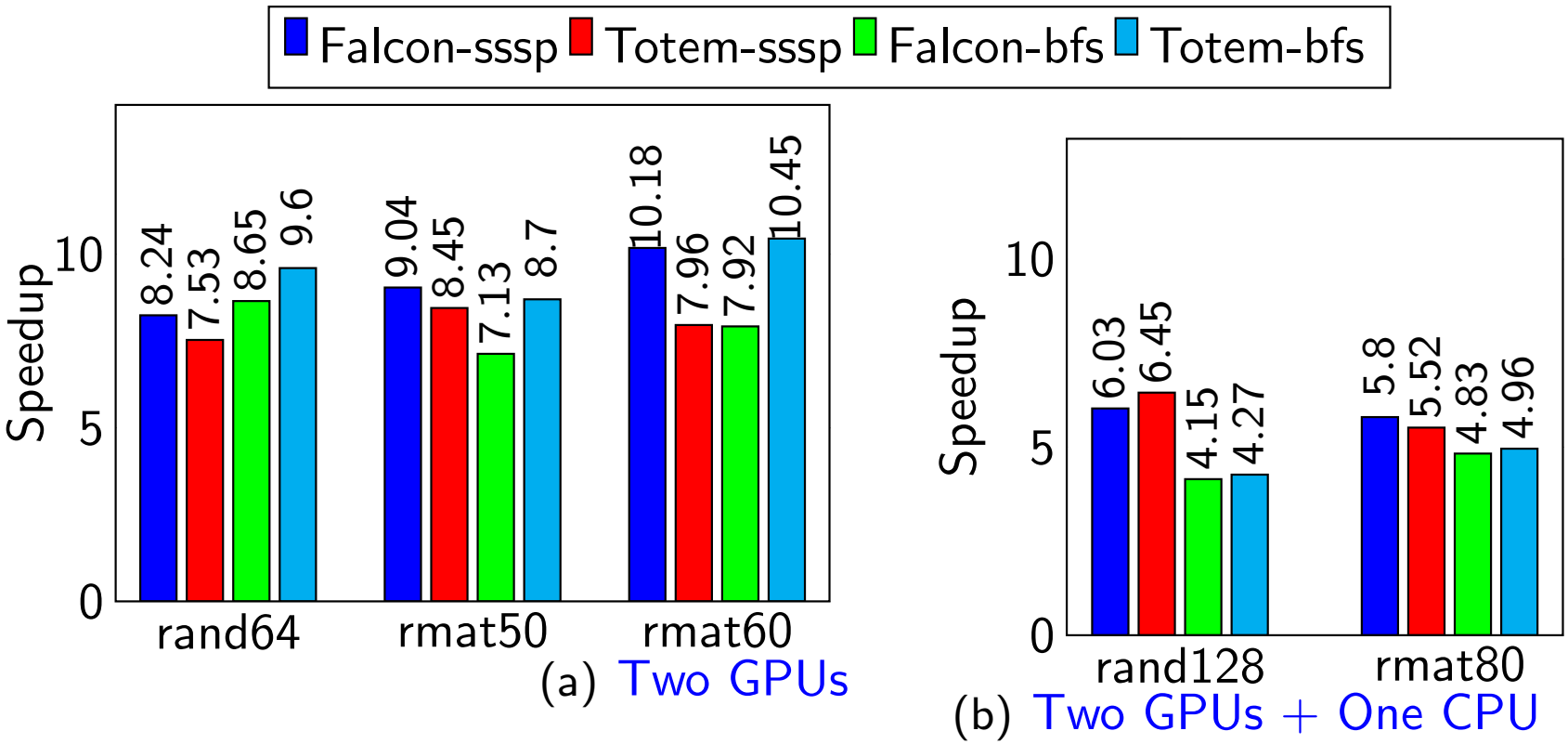


(a) SSSP & BFS speedup over Galois Single



(b) DMR speedup over Galois single

Speedup over single threaded CPU code



Heterogeneous Execution-SSSP and BFS speedup

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4. for queries email me on unni_c@csa.iisc.ernet.in.

Questions??