Database Compression on Graphics Processors

Seminar: Techniques for implementing main memory database systems

Maximilian Springer

26.11.2018

Why query processing on GPUs?

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GPUs are very fast for **simple**, **highly-parallelizable**, **branchless** workflows.

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Max Mem Size	128 GB	11 GB

Why query processing on GPUs? - Drawbacks

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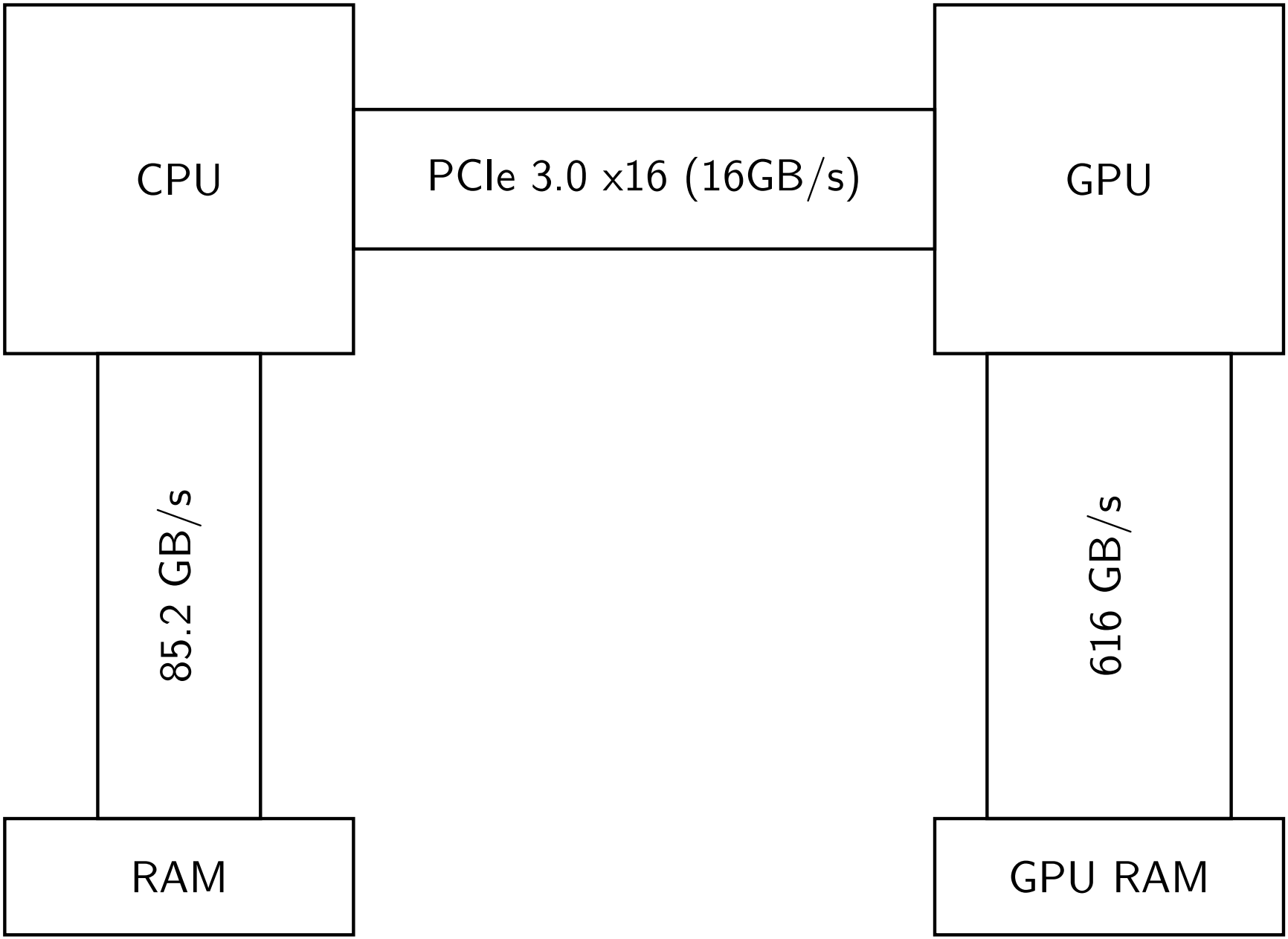

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- GPU code should be *branchless*, *simple* and *non-diverging*

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  - Transfer compressed data onto the GPU

Compression on GPU

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- Focus on easy compression techniques
  - Prevent branching
  - Simple code
  - Less diverging between threads
- Chain them together to achieve better ratios

Compression techniques[5]

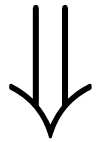
NS	Null Suppression with Fixed Length
NSV	Null Suppression with Variable Length
DICT	Dictionary
BITMAP	Bitmap
RLE	Run-Length-Encoding
DELTA	Delta

Cascaded compression

```
RLE, [[DELTA, NS] | NS]
```

Cascaded compression

RLE, [[DELTA, NS] | NS]



Cascaded compression

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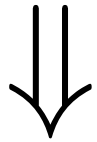

RLE

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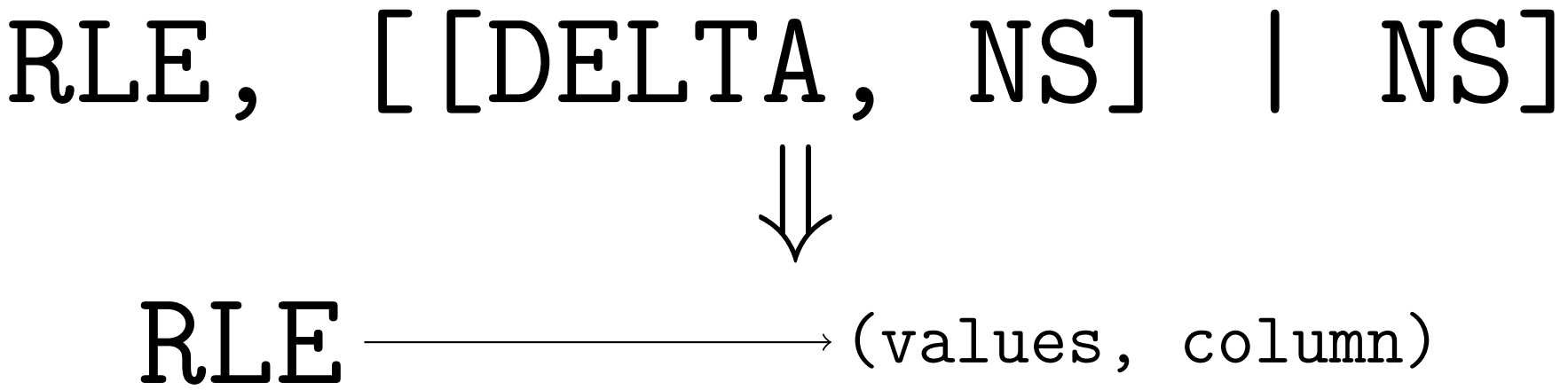

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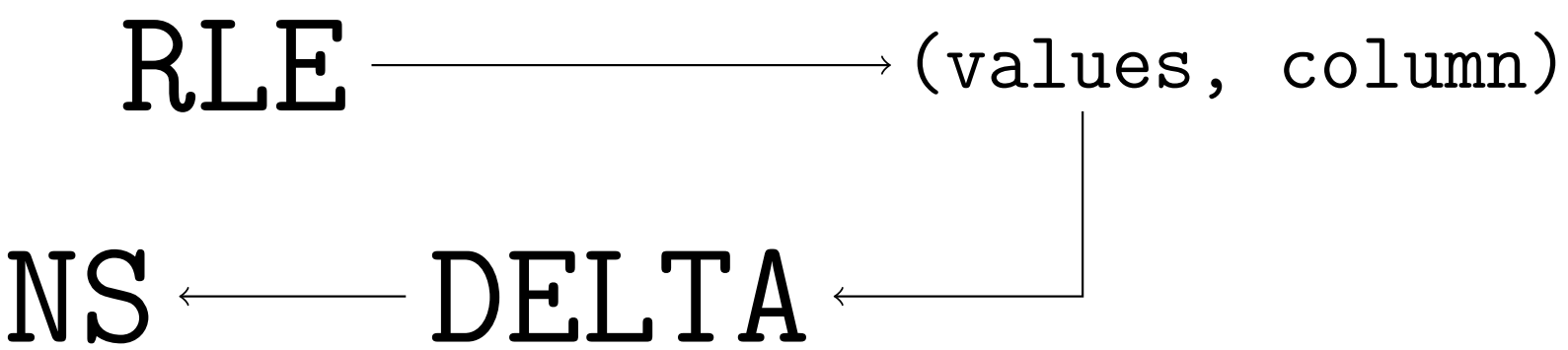

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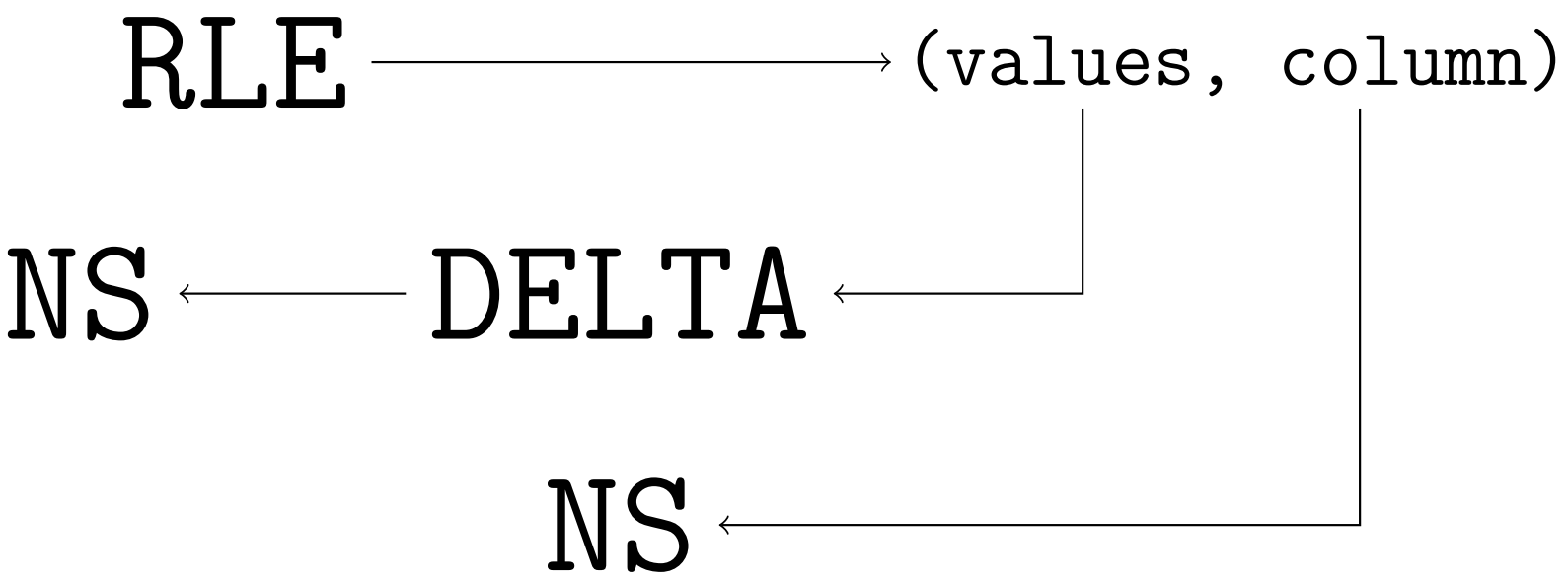

Architecture

GPU Architecture[6]

In CUDA the thread model is a **grid**

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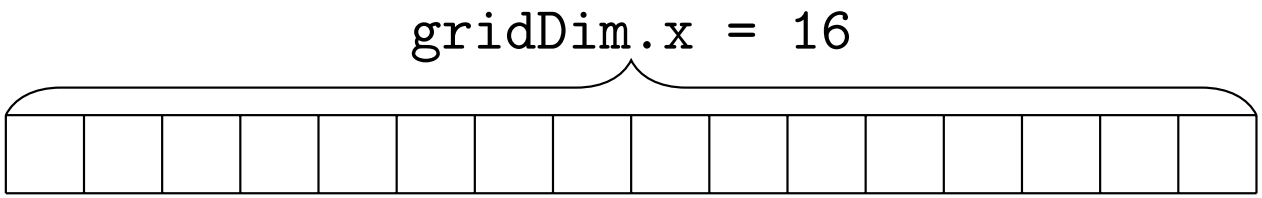

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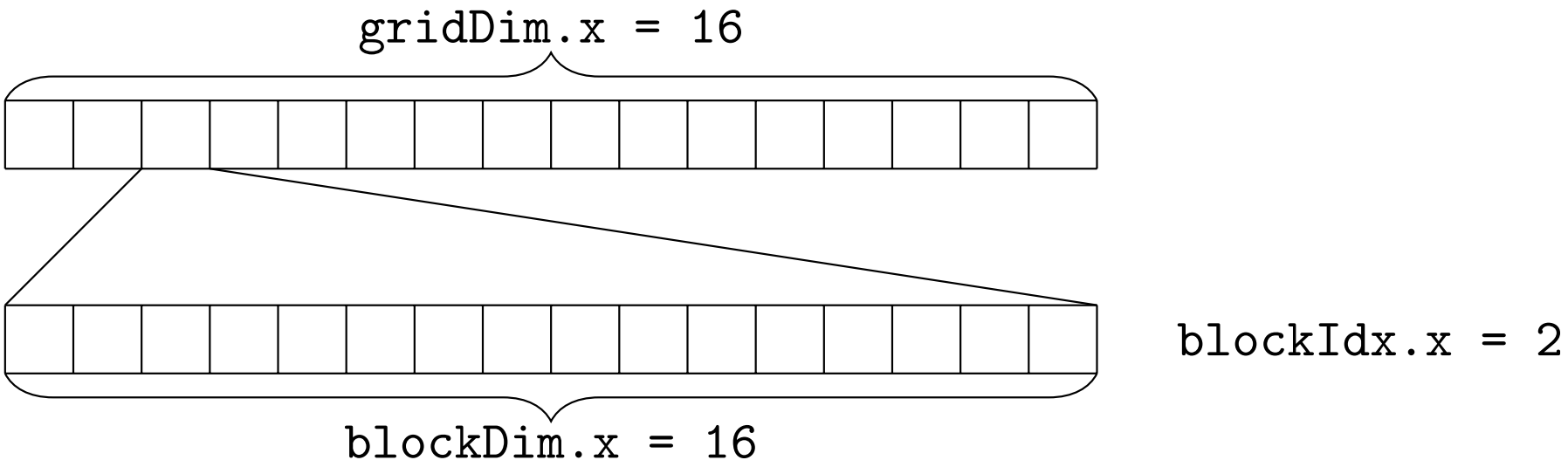

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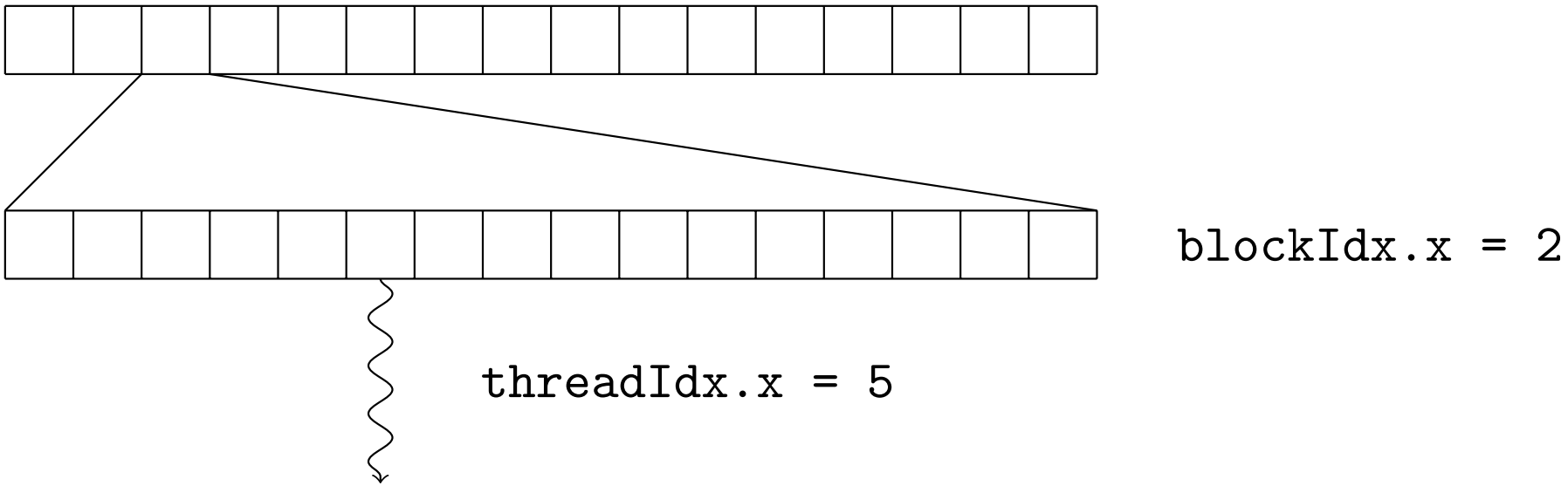

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- *Warp* code similar to *SIMD*

CUDA usage[6]

- Standard way: Compile CUDA code that can be invoked from host

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  - Allows optimization of compression schema code
  - Simplify combination of compression code
  - Allow custom optimization

Primitives

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- Map

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  - One thread per element in the array executing the map function

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  - Divide and conquer workload utilizing warp instructions and blocks

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- Allows modelling of primitives via kernels
- Minimize wasted GPU processor time

Optimizations

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- Create LLVM `Pass`[10] to check whether kernel invocation and kernels allow this

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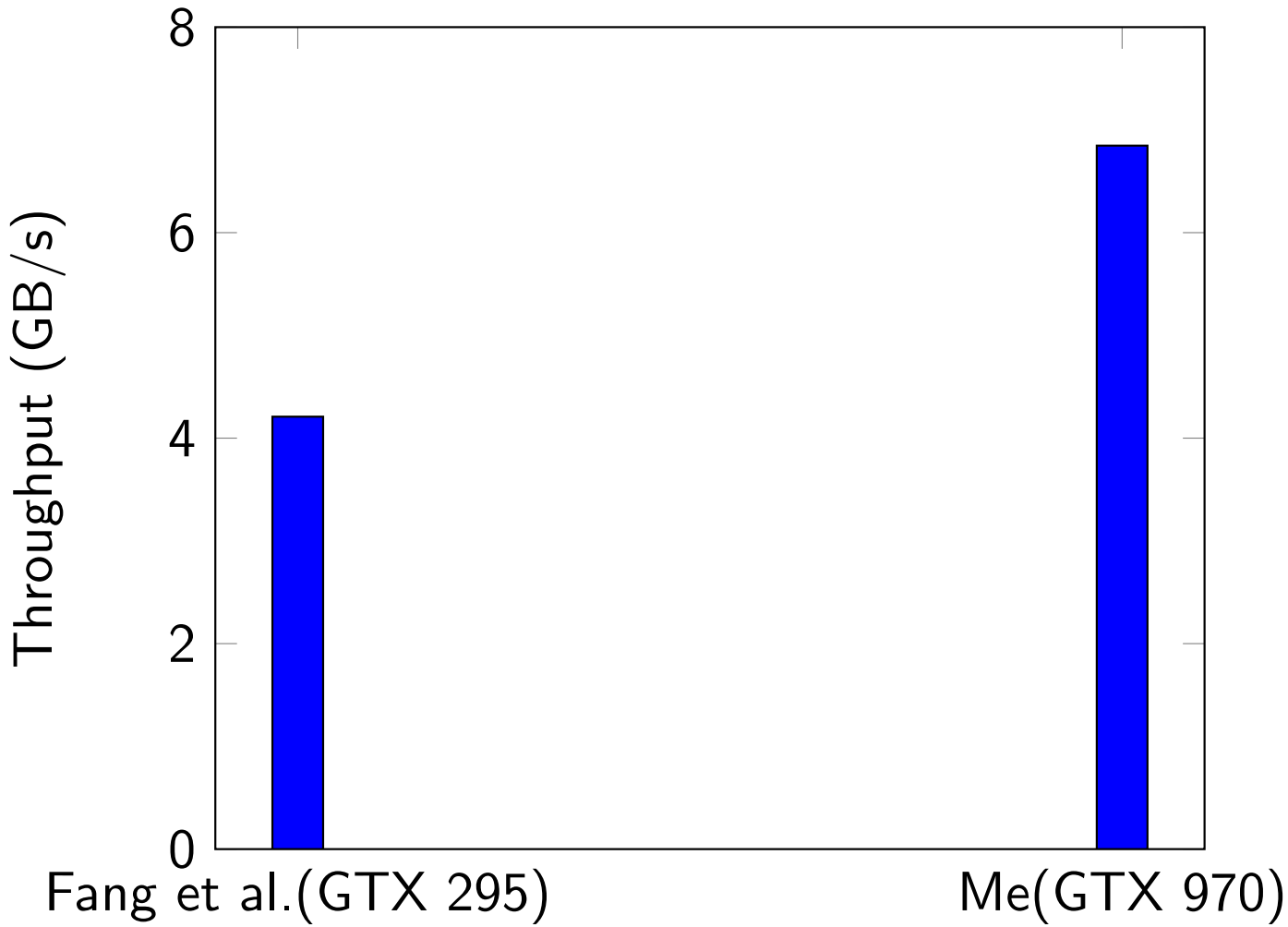
- Create LLVM `Pass`[10] to check whether kernel invocation and kernels allow this
- Combine frequents combined primitives together

Benchmarks

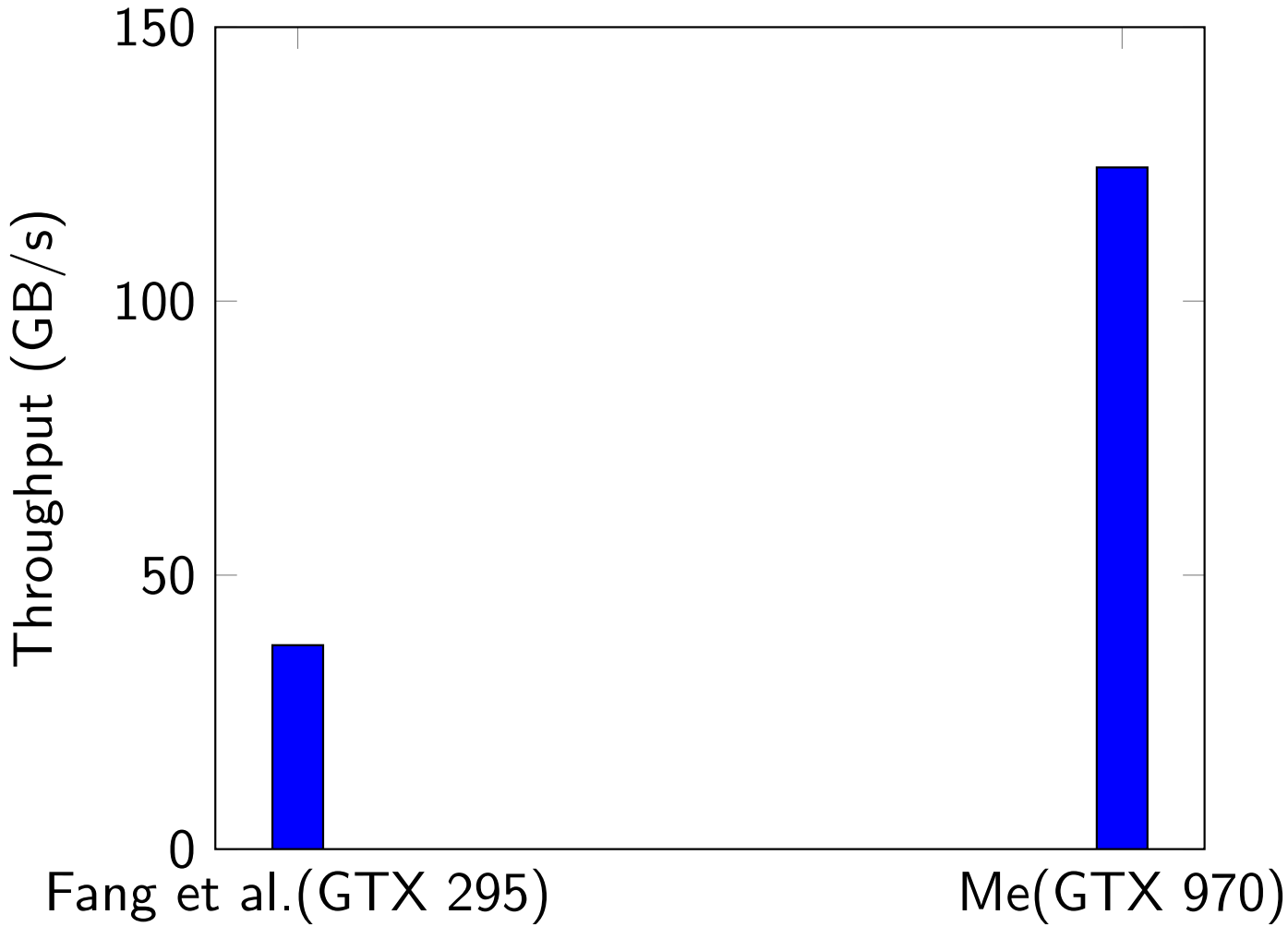
l_partkey(RLE(6.6%))

l_partkey column from TPC-H (scale = 10, 60M rows)



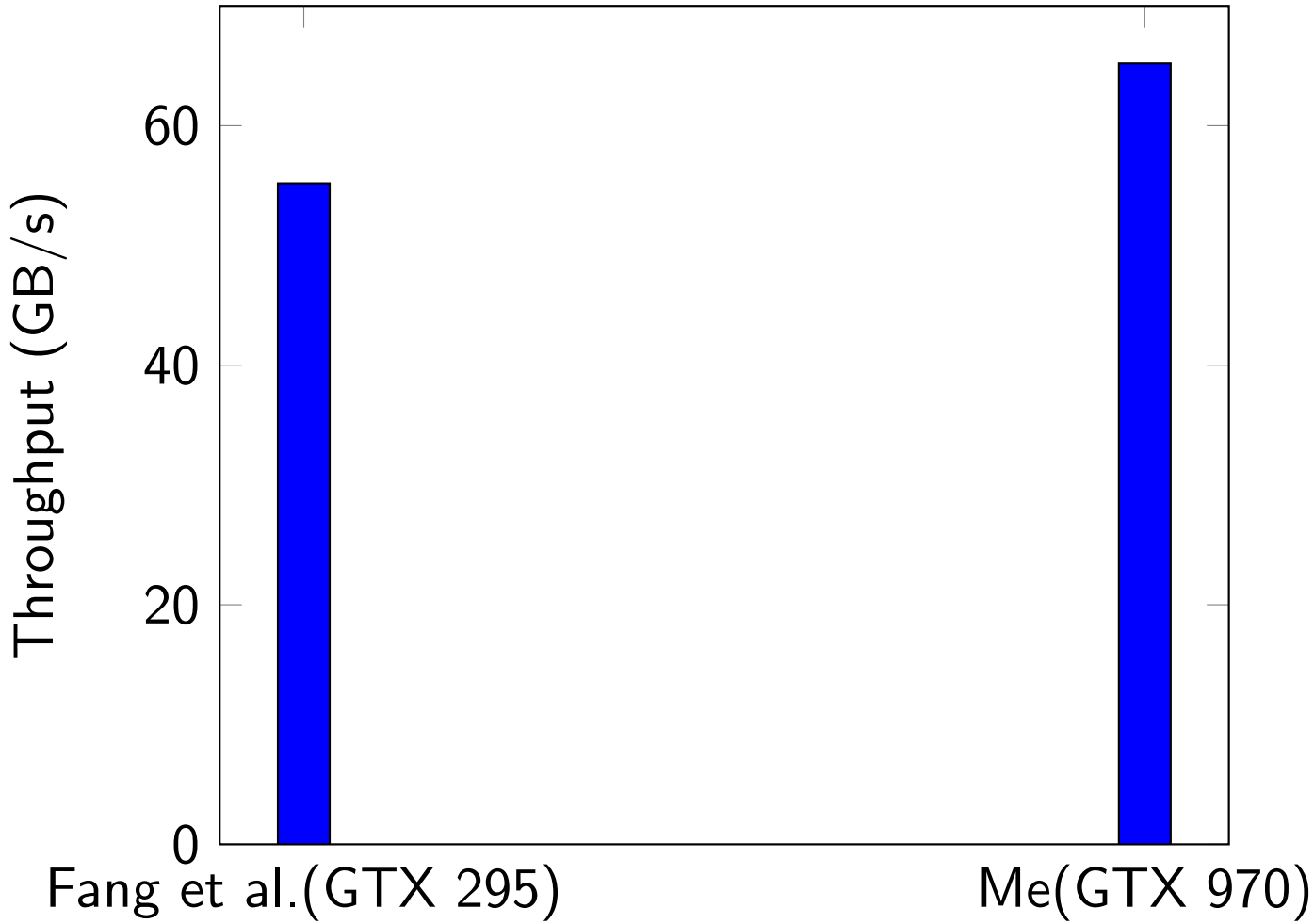
l_shipmode(DICT(50%))

l_shipmode column from TPC-H (scale = 10, 60M rows)



l_quantity(NS(75%))

l_quantity column from TPC-H (scale = 10, 60M rows)



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Thank You!
Questions?