

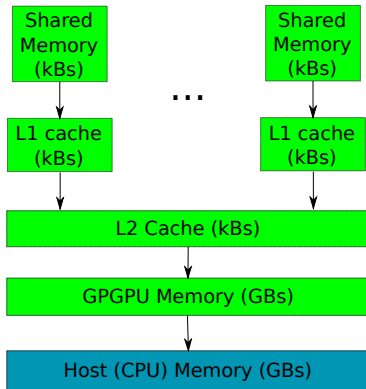
POSTER: Optimizing GPU Programs By Partial Evaluation

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Saint Petersburg University

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GPGPU memory hierarchy



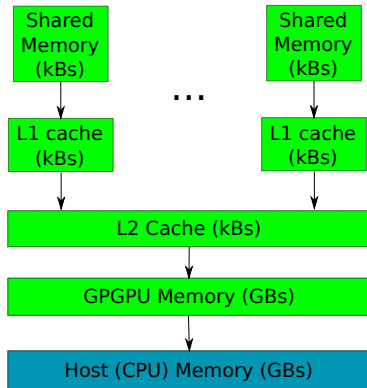
GPGPU Architecture

GPGPU memory hierarchy

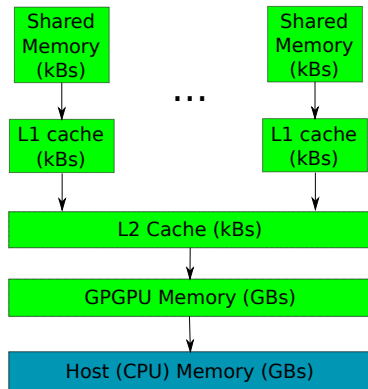
- Global memory

😊 Big

😞 Slow



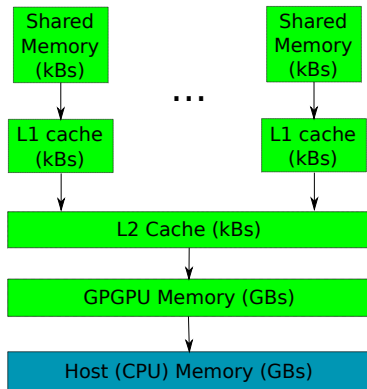
GPGPU Architecture



GPGPU memory hierarchy

- Global memory
 - 😊 Big
 - 😞 Slow
- Shared memory
 - 😊 Fast
 - 😞 Relatively small
 - 😞 Manual allocation management

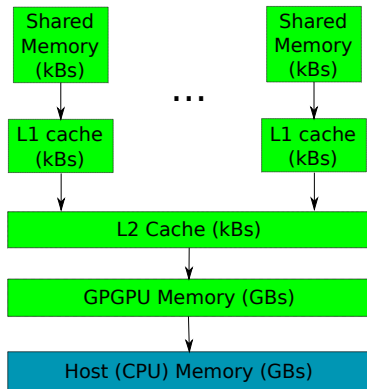
GPGPU Architecture



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- Global memory
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 - ☹ Slow
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- Constant memory
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 - ☹ Only for appropriate access pattern
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 - ☹ Static allocation

GPGPU Architecture



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 - 😞 Only for appropriate access pattern
 - 😞 Small
 - 😞 Static allocation
- Memory traffic is a bottleneck

Data Processing

- Substring matching
- Filtering by using Hidden Markov Models (HMM)

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__global__ void estimateSimilarity
                (int* filterParams, int* data, ...)
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How can we use this fact to optimize our procedure?

Partial Evaluation



[Scipy] Sparse matrices multiplication by using **Scipy** in **Python**

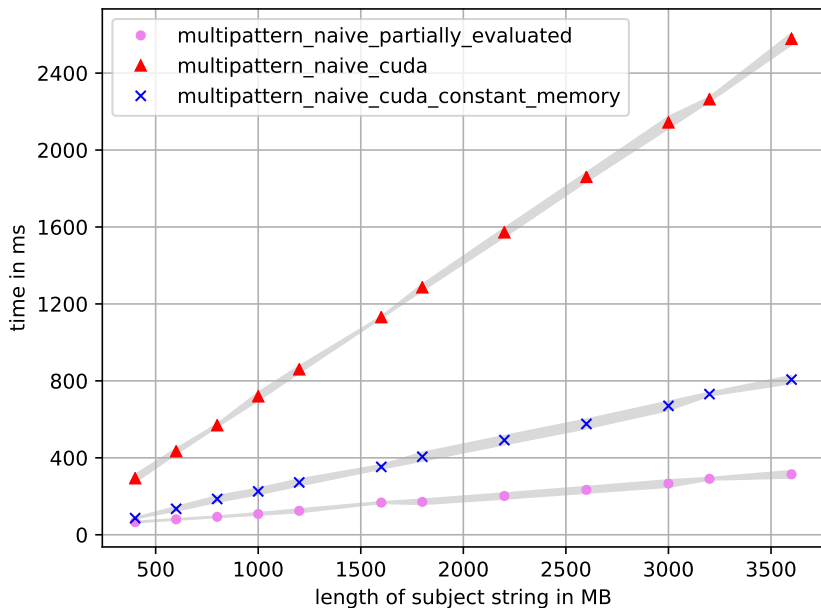
[Scipy] Sparse matrices multiplication by using **Scipy** in **Python**

[M4RI] Dense matrices multiplication by using **m4ri** library which implements the Method of Four Russians in **C**

Evaluation setup

- Environment
 - ▶ Environment
 - ▶
- Algorithms
 - ▶ Naïve multiple substring matching
 - ▶

Evaluation: Data Curving



Limitations

[RDF]

- ▶ The set of the real-world RDF files (ontologies)

- ▶ Queries:

$$G_4 : s \rightarrow SCOR\ s\ SCO \mid TR\ s\ T \mid SCOR\ SCO \mid TR\ T$$

$$G_5 : s \rightarrow SCOR\ s\ SCO \mid SCO$$

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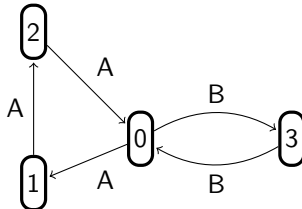
- ▶ Queries:

$G_4 : s \rightarrow SCOR\ s\ SCO \mid TR\ s\ T \mid SCOR\ SCO \mid TR\ T$

$G_5 : s \rightarrow SCOR\ s\ SCO \mid SCO$

[Worst]

- ▶ The input graph is two cycles of coprime lengths with one shared vertex



- ▶ Query: $G_1 : s \rightarrow A\ s\ B \mid A\ B$

- [Full]
- ▶ The input graph is sparse, but the result is a full graph
 - ▶ Queries:
 $G_2 : s \rightarrow s \ s \mid A$
 $G_3 : s \rightarrow s \ s \ s \mid A$

[Full]

- ▶ The input graph is sparse, but the result is a full graph

- ▶ Queries:

$$G_2 : s \rightarrow s \ s \mid A$$

$$G_3 : s \rightarrow s \ s \ s \mid A$$

[Sparse]

- ▶ Sparse graphs are generated by GTgraph

- ▶ Query: $G_1 : s \rightarrow A \ s \ B \mid A \ B$

Conclusion

- Just In Time speciaization
-
-
-

- Switch to CUDA C partial evaluator
- Reduce specialization overhead
- Integrete with shared memory register spilling
- Evaluate on real-world examples

Contact Information

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- Daniil Berezun: daniil.berezun@jetbrains.com
- Dataset and algorithm implementations:
<https://github.com/SokolovYaroslav/CFPQ-on-GPGPU>

Thanks!