PPoPP 2020

POSTER: Optimizing GPU Programs By Partial Evaluation

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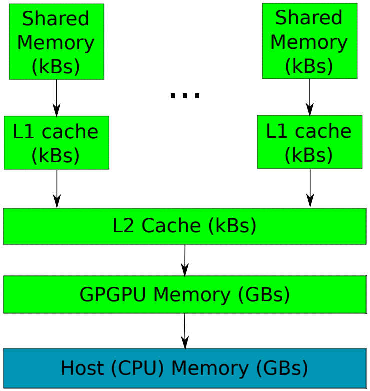
February 24, 2020

GPGPU Architecture

GPGPU memory hierarchy



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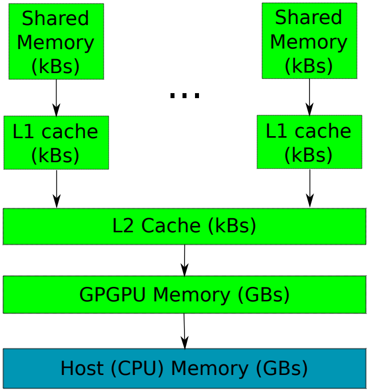

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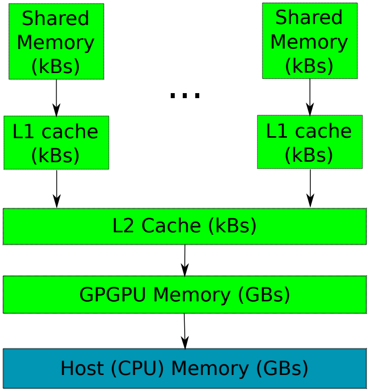

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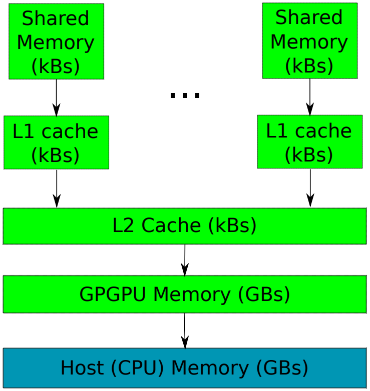

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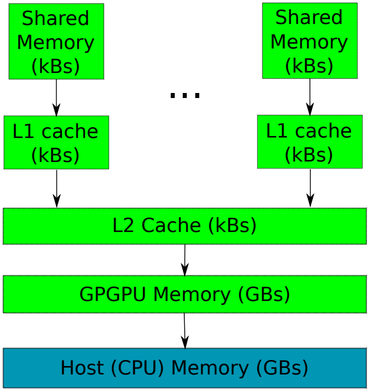

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- **Memory traffic is a bottleneck**

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How can we use this fact to optimize our procedure?

Partial Evaluation or Specialization

$$[\![\underbrace{handleData}_{handleData}]\!][filterParams, data] = \underbrace{[\![[\![\overbrace{mix}^{\text{partial evaluator}}]\!][handleData, filterParams]]\!]}_{handleData_{mix}}[data]$$

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handleData (filterParams, data)
{
  res = new List()
  for d in data
     for e in filterParams
        if d % e == 0
        then res.Add(d)
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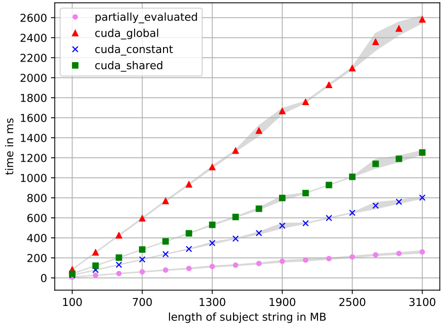
- Environment

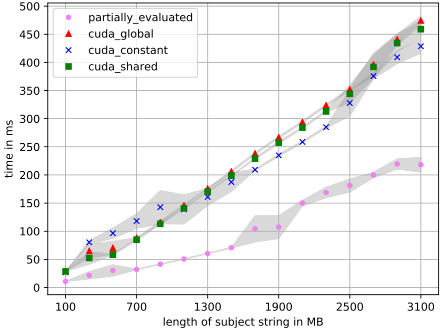
GTX-1070	Environment
T4	

Evaluation: Substring Matching

- Application: data curving
- Subject string: byte sequence from real hard drive
- Patterns: 16 file signatures from GCK's file signatures table[1]



Results for GTX-1070

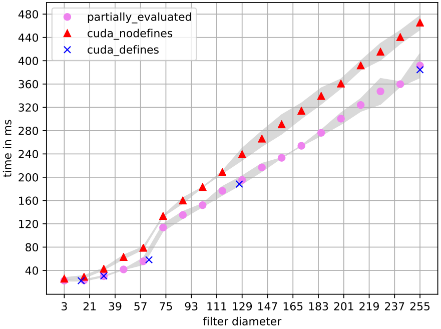


Results for T4

[1]https://www.garykessler.net/library/file_sigs.html

Evaluation: 2D Convolution

- Application: image processing
- Subject image: random image (16384 * 16384) 1Gb size
- Filters: random sqare filters with fiameter 13 to 255



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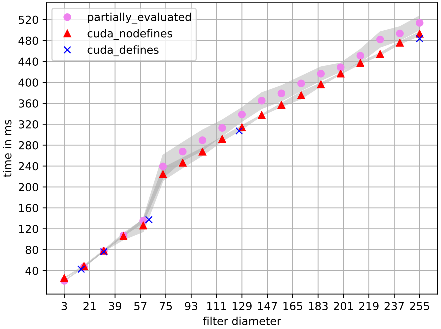

Results for T4

Conclusion

- Partial evaluation improves performance of GPGPU procedures
  - !!!
  - !!!

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- Switch to CUDA C partial evaluator
  - LLVM.mix: partial evaluator for LLVM IR

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  - “RegDem: Increasing GPU Performance via Shared Memory Register Spilling” (Putt Sakdhnagool et.al. 2019)

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- Integrete with shared memory register spilling
  - "RegDem: Increasing GPU Performance via Shared Memory Register Spilling" (Putt Sakdhnagool et.al. 2019)
- Evaluate on real-world examples
  - Homology search in bioinformatics
  - Graph processing
  - Graph database querying

Contact Information

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  - Semen.Grigorev@jetbrains.com
- Aleksey Tyurin: alekseytyurinspb@gmail.com
- Daniil Berezun: daniil.berezun@jetbrains.com

- Dataset and algorithm implementations: https://github.com/SokolovYaroslav/CFPQ-on-GPGPU

Thanks!