SymEngine
Symbolic Execution of OpenCL Kernels

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Optimize code for GPUs

Optimize Memory Accesses
GPU Memory Transactions

Coalesced Access

**GPU Core**  
1 Load Request = 4 Bytes per Thread

32 Threads

L1 Cache

128 Bytes

1 Cache Line

GPU Memory
GPU Memory Transactions

**UnCoalesced Access**

**GPU Core**

1 Load Request = 4 Bytes per Thread

- 32 Threads
- L1 Cache
- GPU Memory
- 512 Bytes
- 4 Cache Lines
GPU Memory Transactions

UnCoalesced Access

GPU Core 1 Load Request = 4 Bytes per Thread

32 Threads

L1 Cache

512 Bytes 4 Cache Lines

Wasted Bandwidth

GPU Memory
SymEngine

Statically Detect Suboptimal Accesses to Memory
SymEngine

Statically Detect Suboptimal Accesses to Memory

OpenCL Kernel

```c
int threadID = get_global_id(0);
    sX = x[threadID];
sY = y[threadID];
sZ = z[threadID];
sQr = Qr[threadId];
sQi = Qi[threadId];

for (int kIndex = 0; (kIndex < KERNEL_ELEMS_PER_GRID); kIndex ++,
    kGlobalIndex ++) {
    float expArg = PIx2 * (ck[kIndex].Kx * sX + ck[kIndex].Ky * sY +
        ck[kIndex].Kz * sZ);
    sQr += ck[kIndex].PhiMag * cos(expArg);
    sQi += ck[kIndex].PhiMag * sin(expArg);
}

Qr[threadId] = sQr;
Qi[threadId] = sQi;
```
Symbolic Execution

OpenCL Code

Warp-Id

Number of Threads

Input Values

SymEngine

Hardware Memory Transactions
Symbolic Execution

Threads in a Warp

| 0 | 1 | 2 | 3 | 4 | ... | 29 | 30 | 31 |

- Memory Instruction
- Memory Instruction
- Memory Instruction
- Memory Instruction
- Memory Instruction

SCEV
SCEV
SCEV
SCEV

Address
Address
Address
Address

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Symbolic Execution

Threads in a Warp

0  1  2  3  4  ...  29  30  31

Memory Instruction  Memory Instruction  Memory Instruction  ...  Memory Instruction

SCEV  SCEV  SCEV  ...  SCEV

Address  Address  Address  ...  Address

Number of Cache lines touched  Transaction Number
Validation – Nvidia GTX480
Against Hardware Performance counters

Total HW Transactions for Black-Scholes
Validation – **Nvidia GTX480**

Against Hardware Performance counters

**Total HW Transactions for Black-Scholes**

![Graph showing total HW transactions for Black-Scholes](image-url)
Validation – Nvidia GTX480
Validation – Nvidia GTX480

0.99 correlation with HW counters
It's on GitHub!

http://github.com/HariSeldon/SymEngine