
# ArrayFire Webinar:
# OpenCL and CUDA Trade-Offs and Comparisons

# GPU Software Features

**Programmability**

**Portability**

**Scalability**

**Performance**

**Community**

# Leading GPU Computing Platforms

**Programmability**

**Portability**


**Scalability**

**Performance**

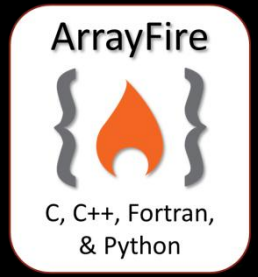

**Community**

# Performance

- Both CUDA and OpenCL are fast
- Both *can* fully utilize the hardware
- Devil in the details:
  - Hardware type, algorithm type, code quality

# Performance

- ArrayFire results at end of webinar




# Scalability

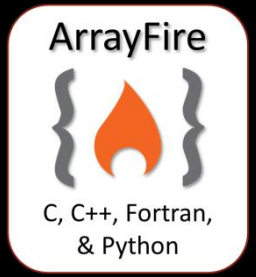
- Laptops --> Single GPU Machine
  - Both CUDA and OpenCL scale,  no code change
- Single GPU Machine --> Multi-GPU Machine
  - User managed, low-level synchronization
- Multi-GPU Machine --> Cluster
  - MPI

# Scalability

Interesting developments:

- Memory Transfer Optimizations
  - CUDA GPUDirect technology
- Mobile GPU Computing
  - OpenCL available on ARM, Imgtec, Freescale, …

# Scalability




- Laptops --> Single GPU Machine
  - ArrayFire's JIT optimizes for GPU type
- Single GPU Machine --> Multi-GPU Machine
  - ArrayFire's *deviceset()* function is super easy
- Multi-GPU Machine --> Cluster
  - MPI

# Portability

- CUDA is NVIDIA-only
  - Open source announcement
  - Does not provide CPU fallback
- OpenCL is the open industry standard
  - Runs on AMD, Intel, and NVIDIA
  - Provides CPU fallback

# Portability

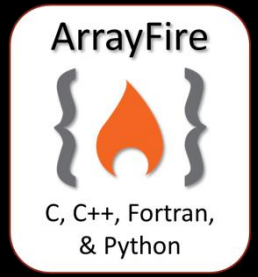

- ArrayFire is *fully* portable
  - Same ArrayFire code runs on CUDA or OpenCL
  - Simply select the right library

# Community

- NVIDIA CUDA Forums – 26,893 topics
- AMD OpenCL Forums – 4,038 topics

- Stackoverflow CUDA Tag – 1,709 tags
- Stackoverflow OpenCL Tag – 564 tags

# Community

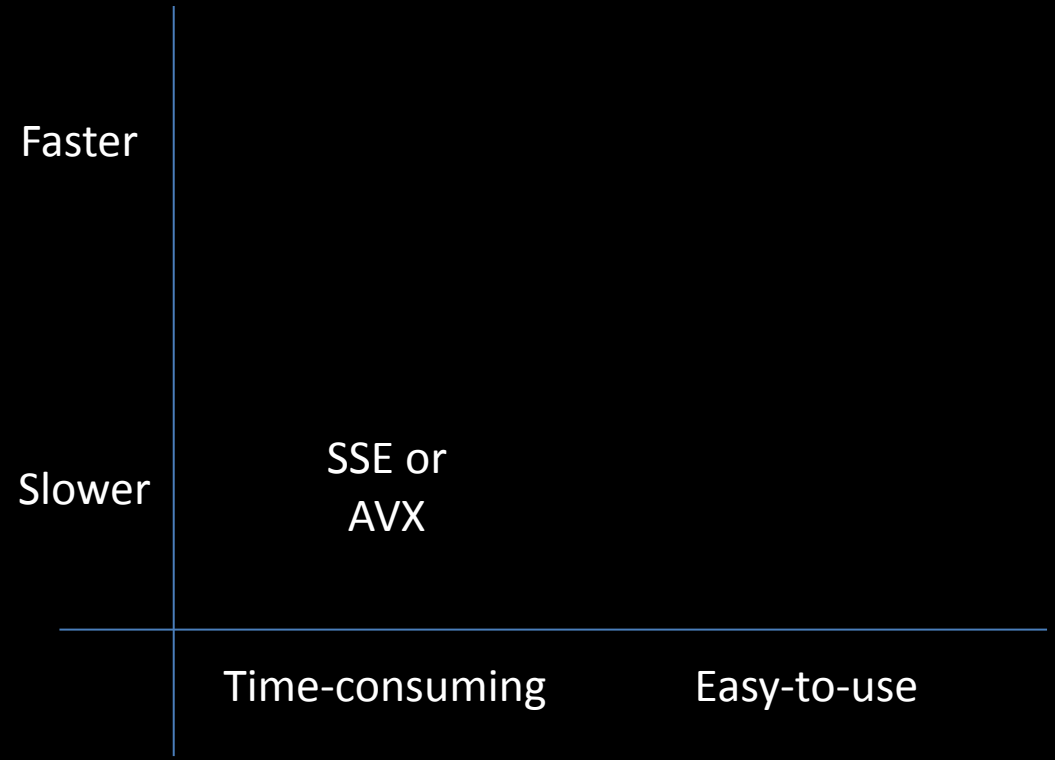



- AccelerEyes GPU Forums – 1,435 topics
  - Largest GPU forums by a software company
- Next largest
  - PGI GPU Forums – 485 topics

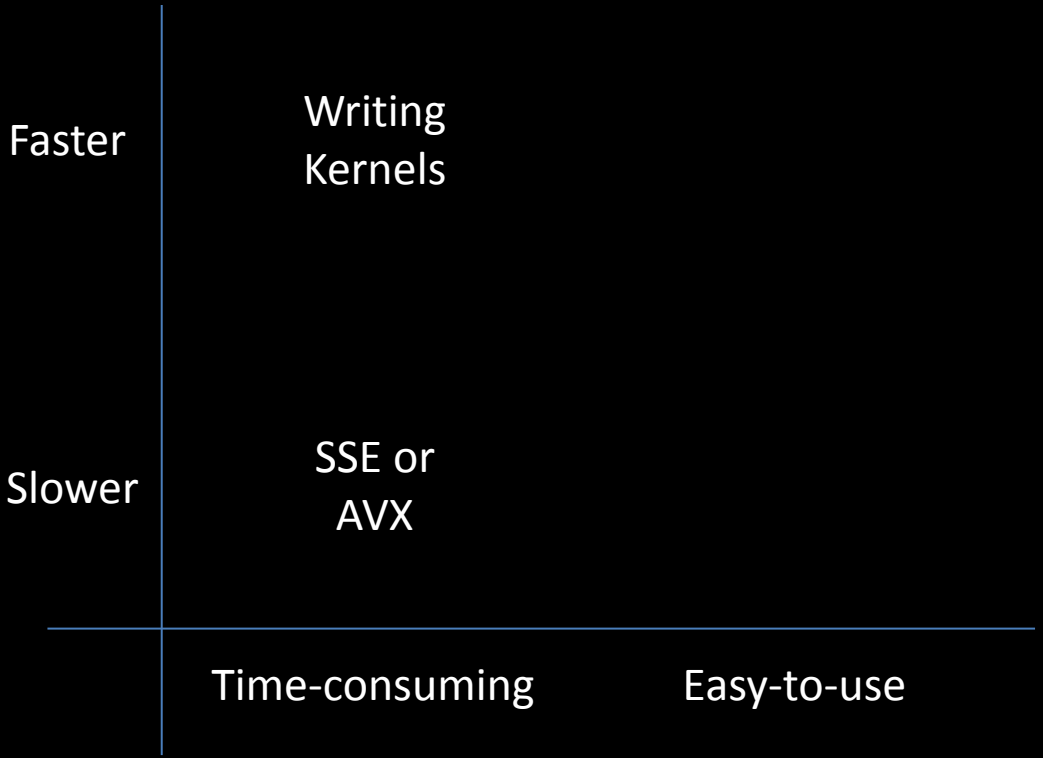
# Programmability

- Both CUDA and OpenCL are low-level
  - Time consuming kernel development
  - Data-parallel algorithm design
- Focus on programmability interfaces

# Programmability




# Programmability

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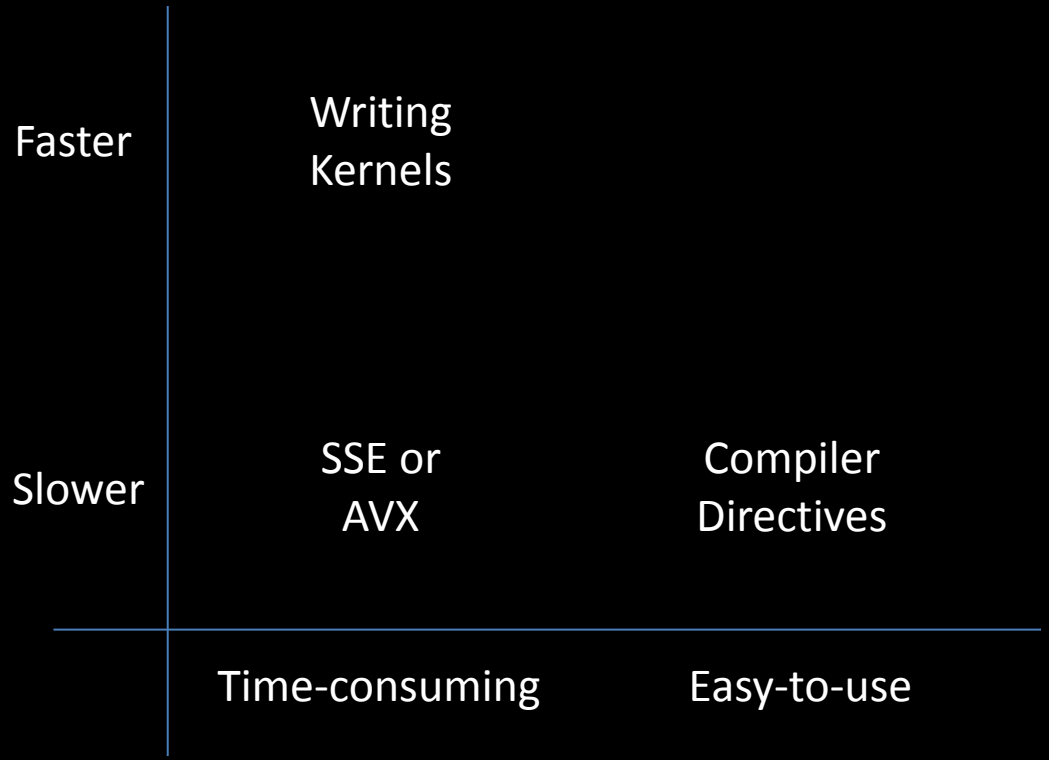


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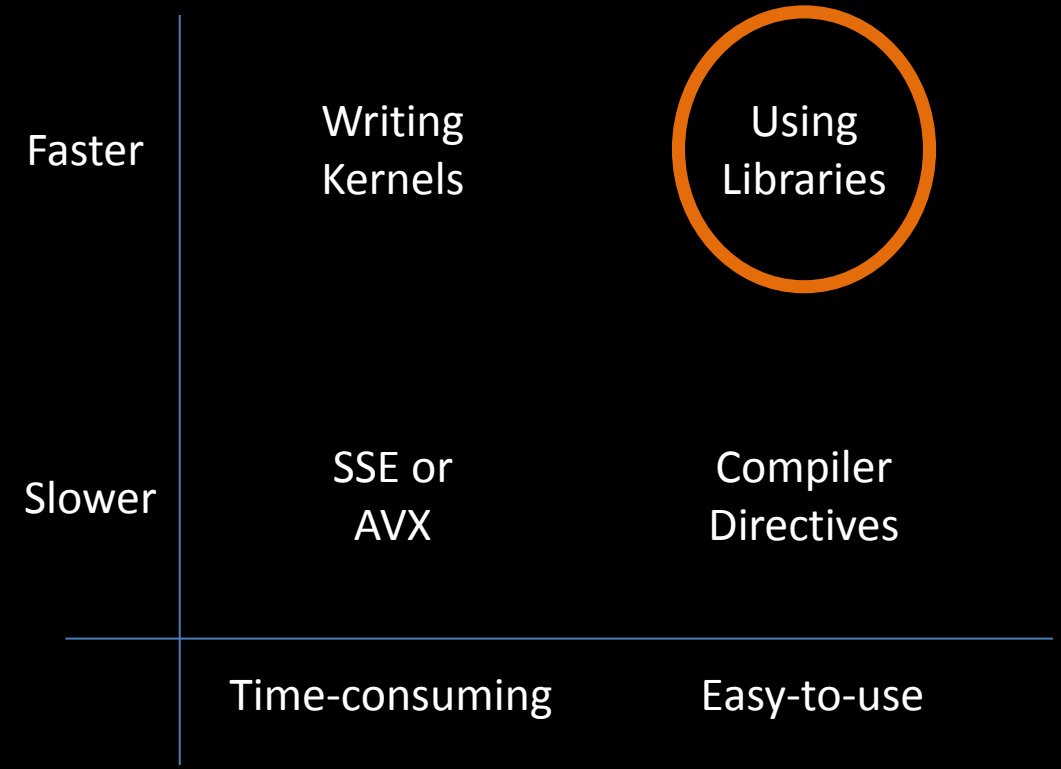


# Libraries Make the Difference

Raw math libraries in NVIDIA CUDA

- CUBLAS, CUFFT, CULA, Magma
  - Provides *all* BLAS, LAPACK, and FFT routines necessary for most dense matrix operations
- CUSPARSE
  - A good start for sparse linear algebra

# Libraries Make the Difference

Raw math libraries in AMD OpenCL

- clAmdBlas, clAmdFft
  - Provides most important Blas routines
  - Provides radix 2, 3, and 5 FFT routines
  - No LAPACK support
  - No sparse data support

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  - Provides most important Blas routines
  - Provides radix 2, 3, and 5 FFT routines
  - No LAPACK support
  - No sparse data support
  - *Runs on any OpenCL-compliant device*

# ArrayFire Code and Benchmarks