

# Performance Analysis of Parallel Languages for Android

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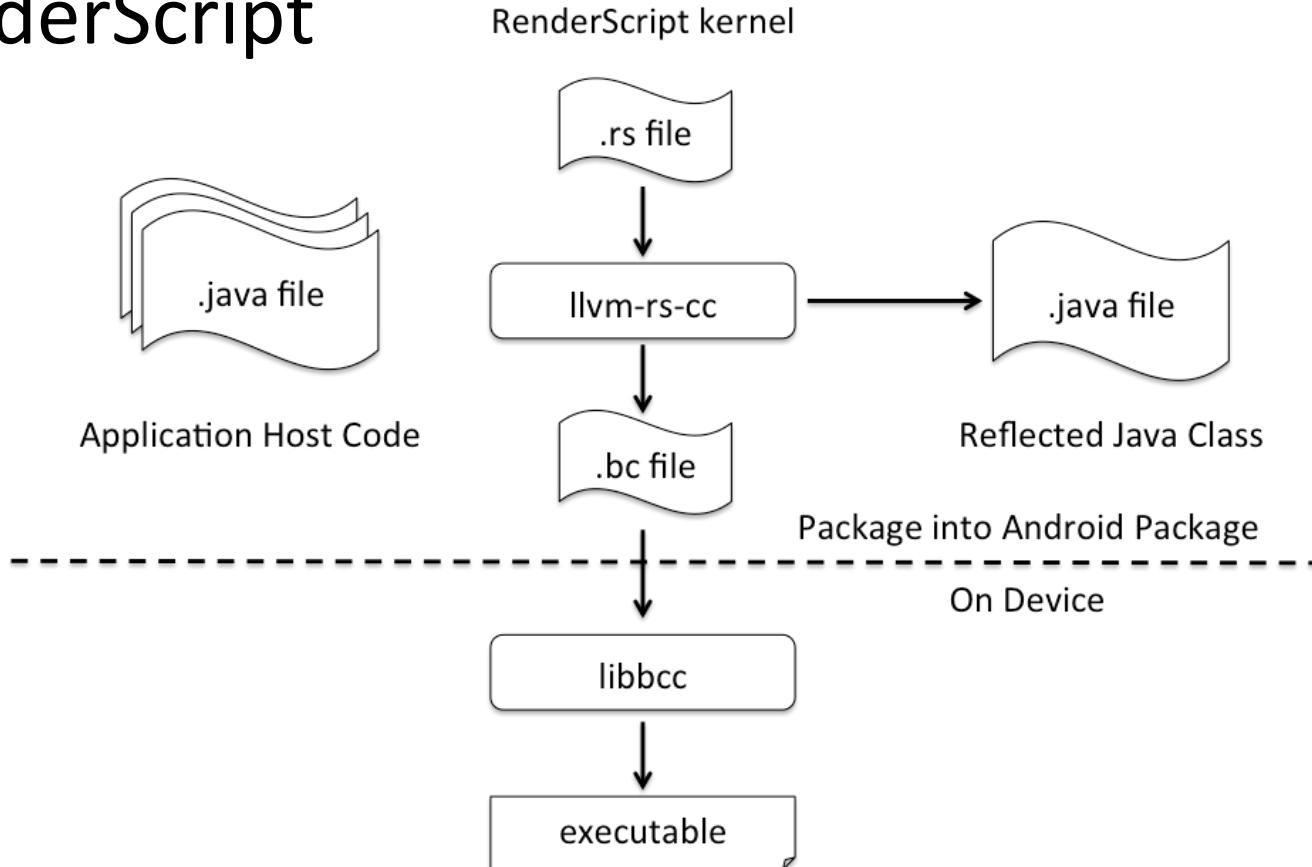
# Overview



# RenderScript

- Alternative of CUDA and OpenCL on Android
- **Hide** architectural details
- Does not unify memory
- Runtime selects best device to run on to maximize performance while minimizing energy usage

# RenderScript



# Implementation



# Benchmarks

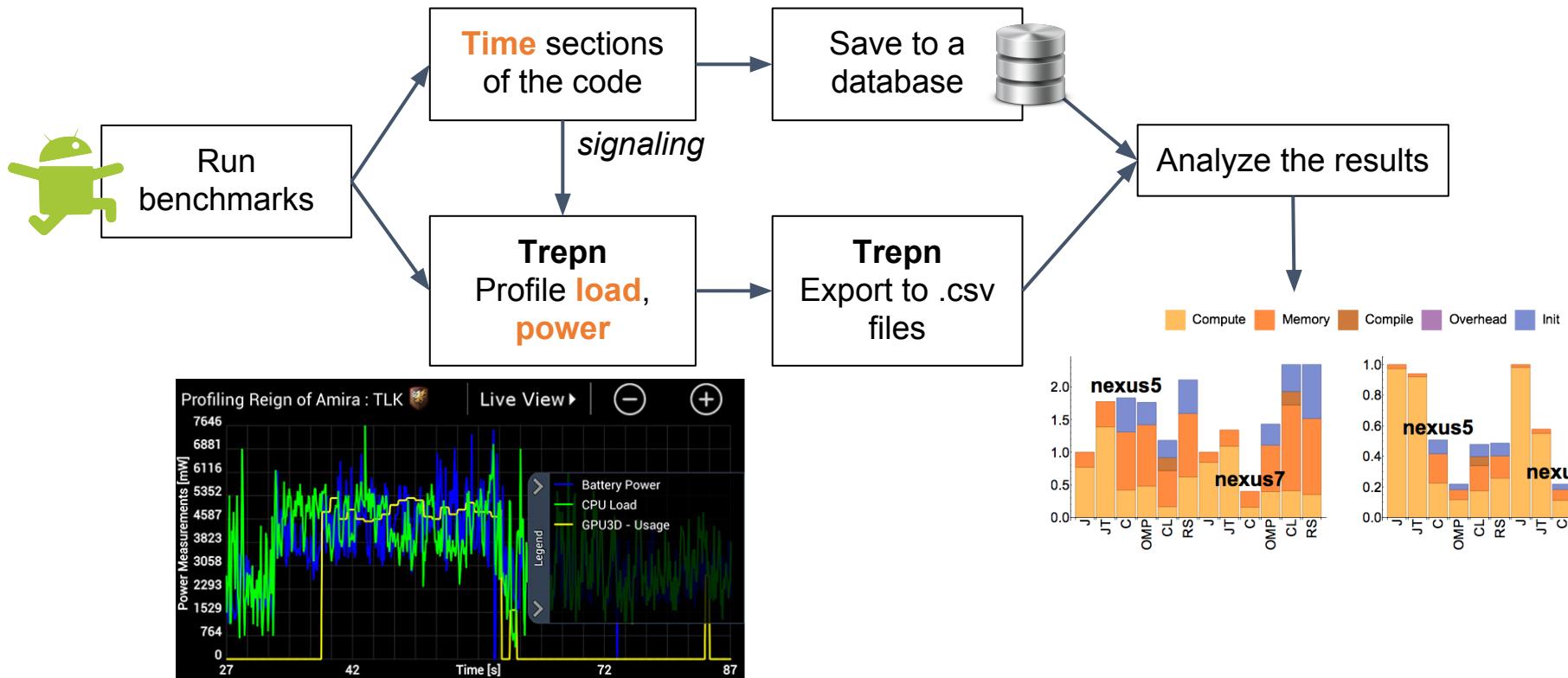
- Ported 7 Parboil benchmarks in 6 different programming models for Android
- A total of 38 implementations

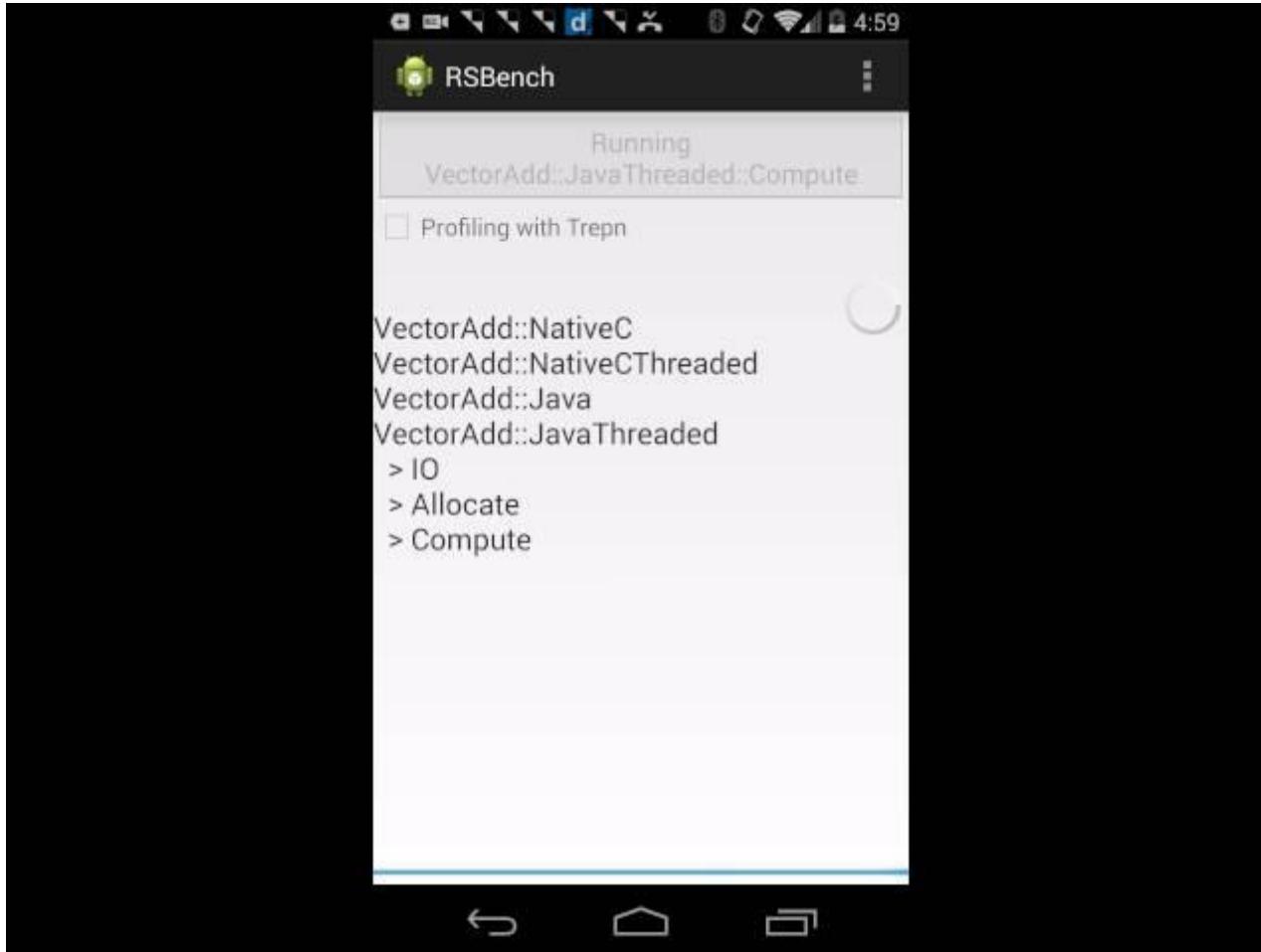
Language	Line Count
Java	7549
RenderScript	1000
JNI/C++	2048
OpenCL	480

Benchmark	Implementations					
	NC	OMP	J	JT	OCL	RS
<b>VectorAdd</b>	C	C	C	C	C	C
<b>SGEMM</b>	C	C	C	C	C	C
<b>Stencil</b>	C	C	C	C	C	C
<b>CUTCP</b>	N	N	C	C	C	C
<b>MRIQ</b>	N	N	C	C	C	C
<b>TPACF</b>	B	B	C	C	C	C
<b>Histogram</b>	C	B	C	C	C	C
<b>BFS</b>					N	
<b>MRIG</b>					N	
<b>SAM</b>					N	
<b>SPMV</b>					N	
<b>LBM</b>					N	

Table 1: Parboil Benchmark Porting Status. **NC**: Native C; **OMP**: Native C with OpenMP; **JT**: Threaded Java; **OCL**: OpenCL; **RS**: RenderScript; **C**: Completed; **N**: No Implementation; **B**: a bug causes the benchmark to crash.

# Benchmarking Flow





# Analysis



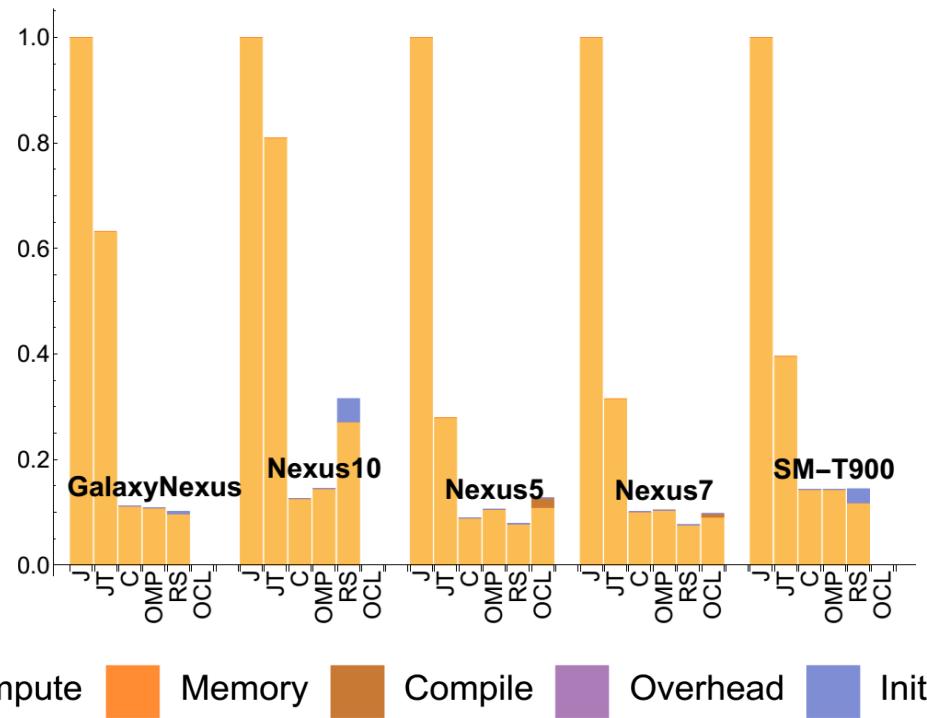
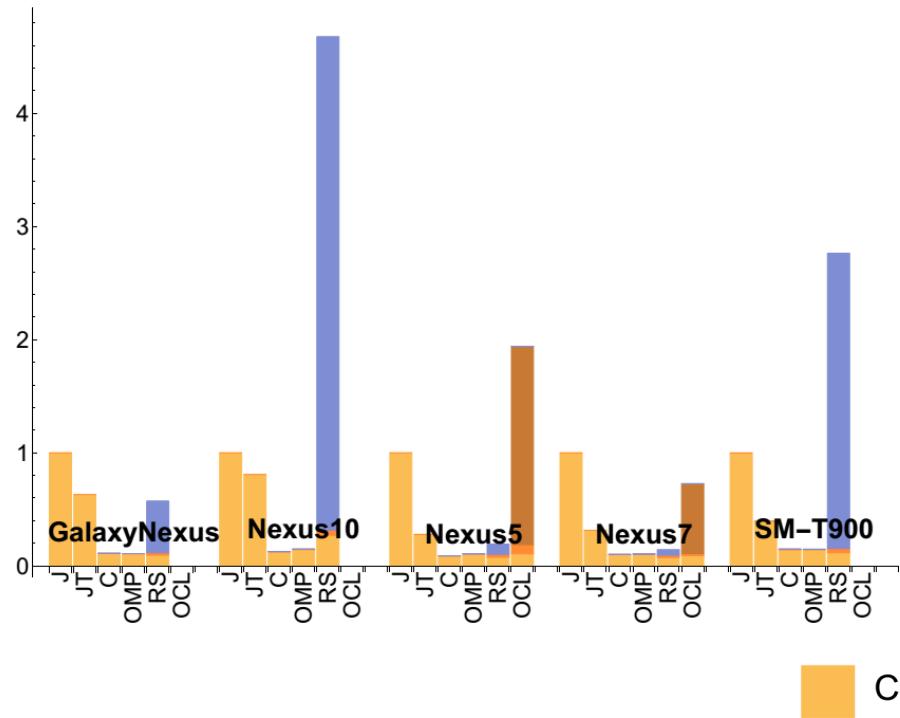
# Devices

Name	CPU	GPU	Memory
<b>Galaxy Nexus</b> \$150	ARMv7, 2 cores, 1200 Mhz, SIMD NEON	PowerVR-SGX 540	694Mb
<b>Nexus 5</b> \$350	Qualcomm Snapdragon S4 Pro 1.5GHz	Adreno 320 400MHz	2Gb
<b>Nexus 7</b> \$230	Qualcomm Snapdragon 800 2.26GHz	Adreno 330 450MHz	2Gb
<b>Nexus 10</b> \$450	DualCore 1.7GHz Cortex-A15	Mali T604	2Gb
<b>SM-T900</b> \$550	QuadCore 1.9GHz Cortex-A15	Mali T628	3Gb

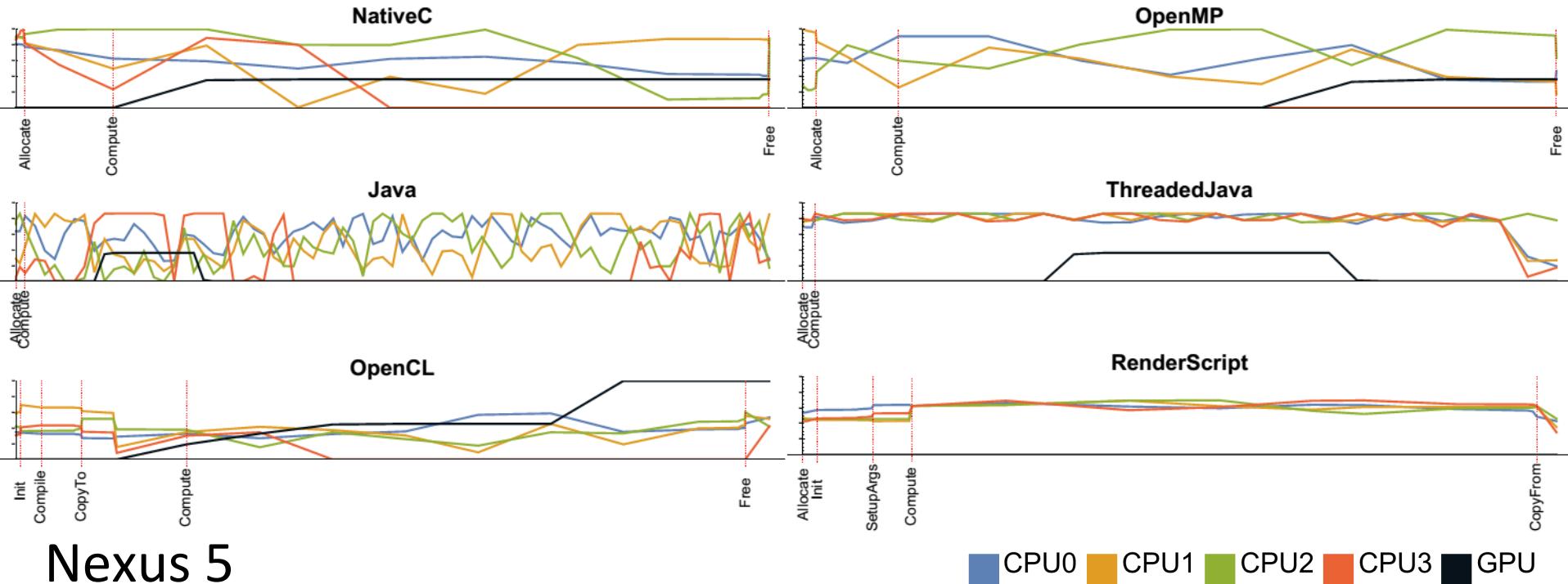
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# SGEMM Performance

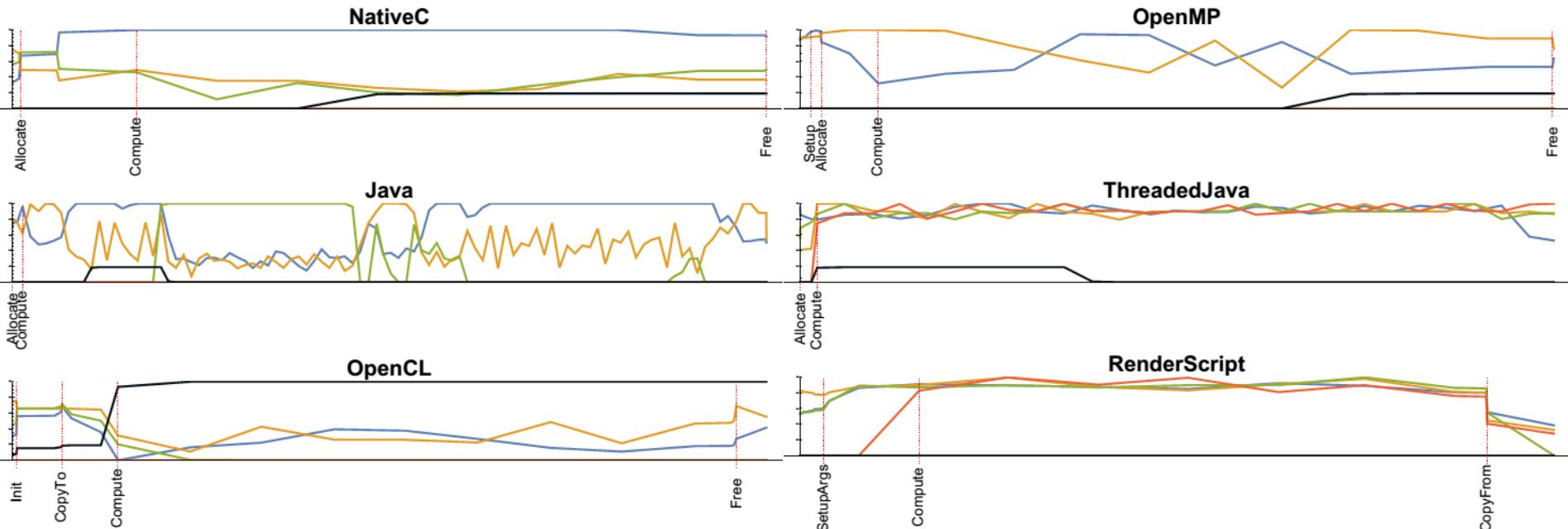


# SGEMM Processor Utilization



Nexus 5

# SGEMM Processor Utilization



Nexus 7

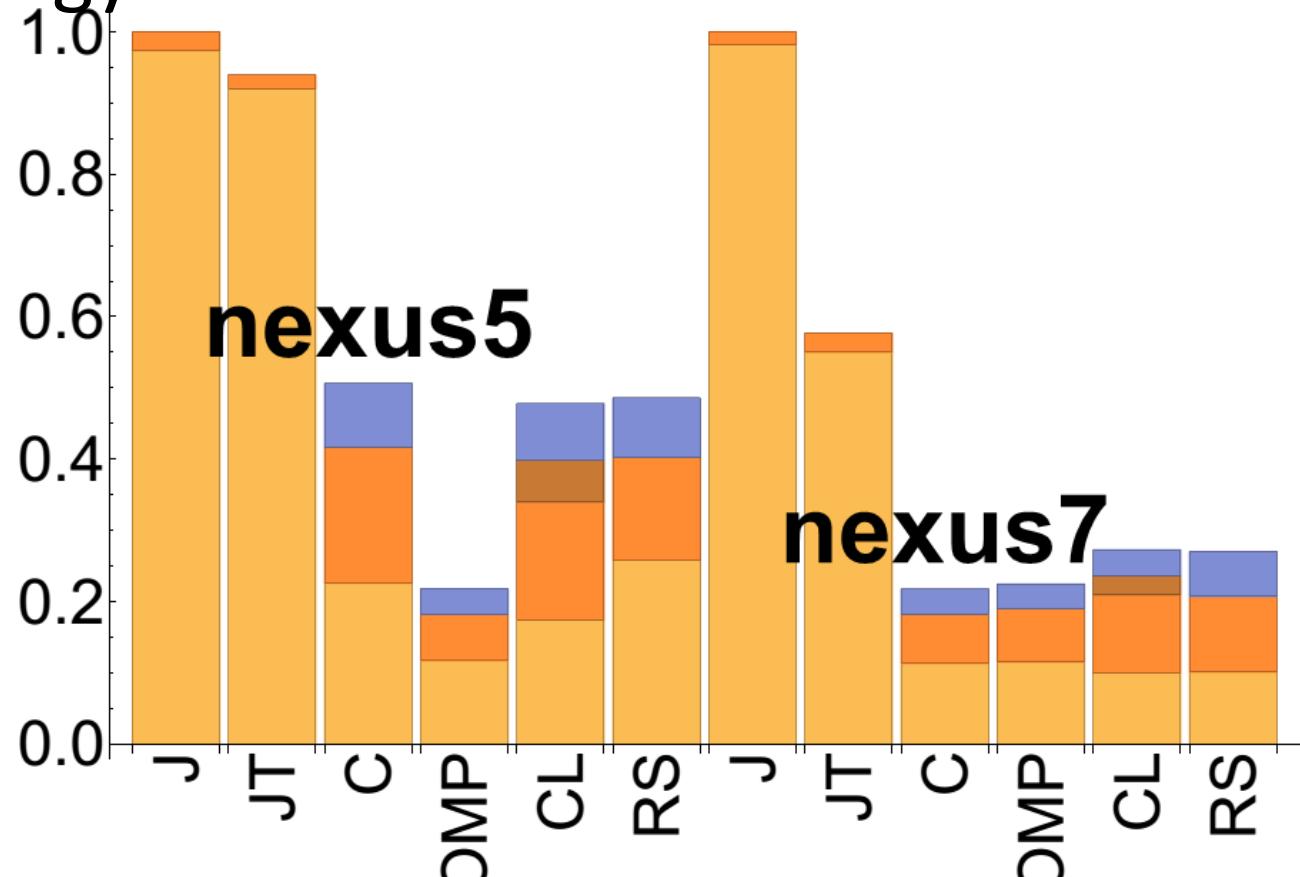
CPU0 CPU1 CPU2 CPU3 GPU

# SGEMM Energy

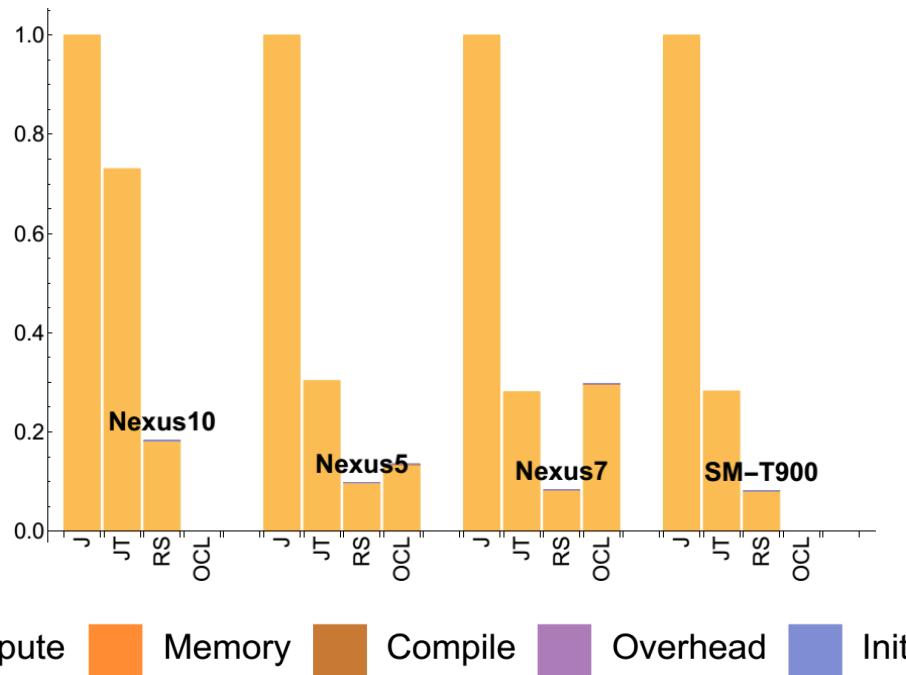
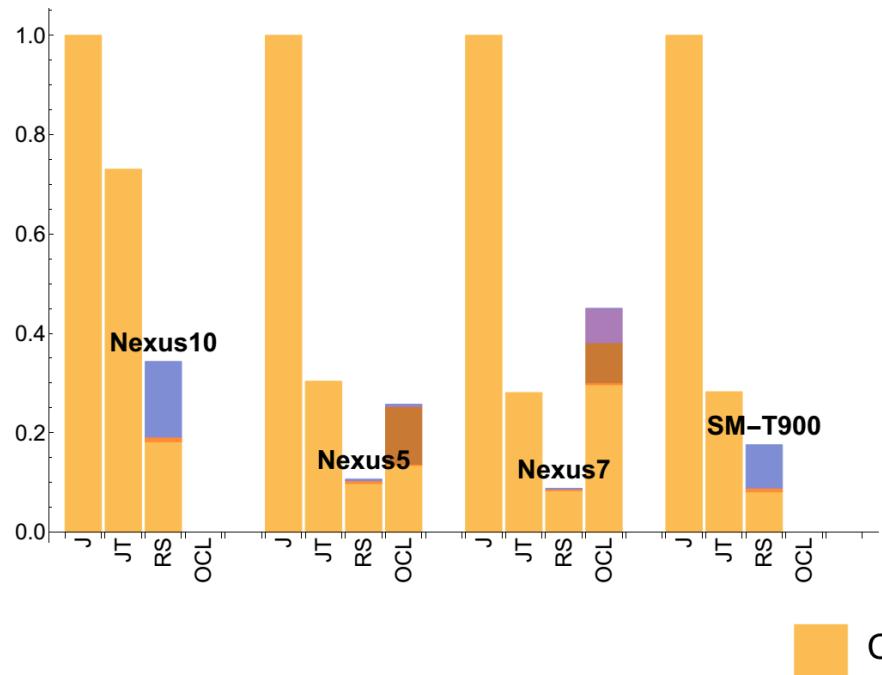
Compute Memory Compile Overhead Init

**nexus5**

**nexus7**



# MRIQ Performance



# Nexus 5

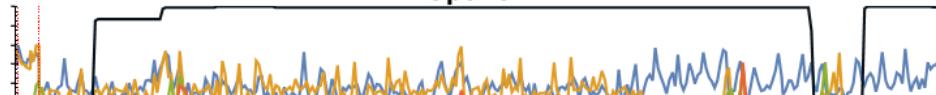
Java



ThreadedJava



OpenCL



RenderScript



# Nexus 7

Java



ThreadedJava



OpenCL



RenderScript

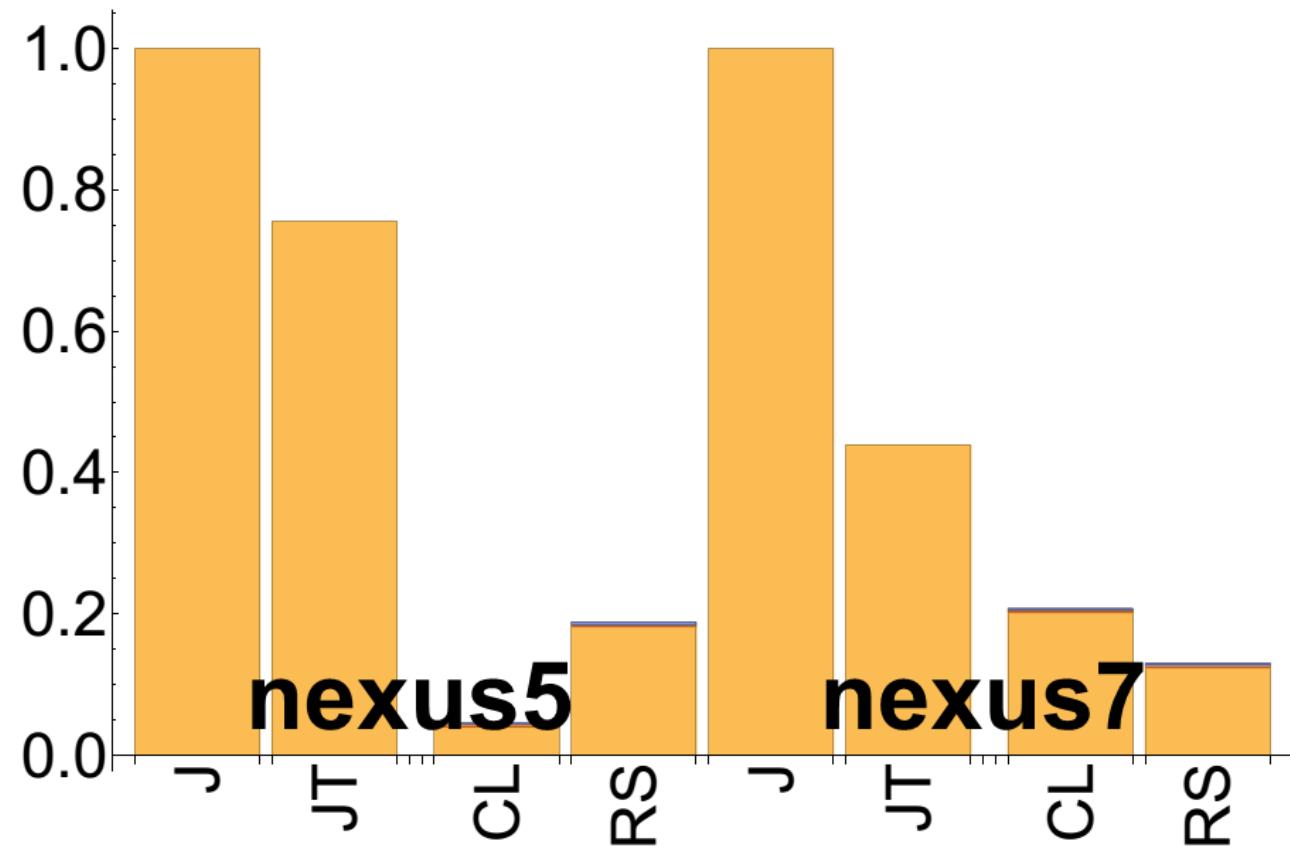


CPU0 CPU1 CPU2 CPU3 GPU

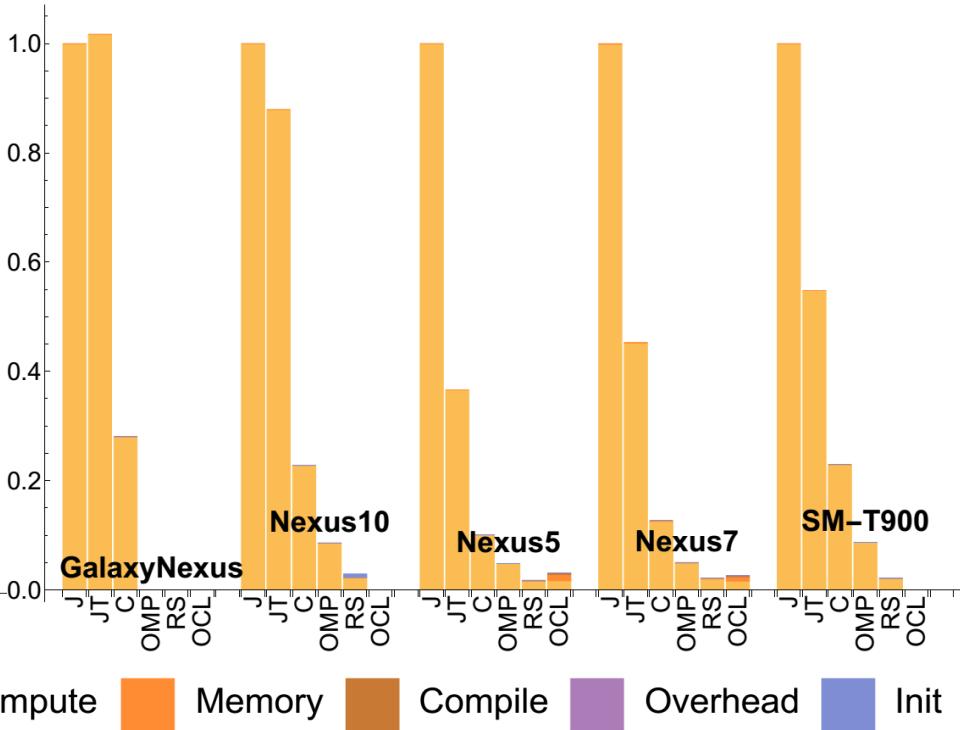
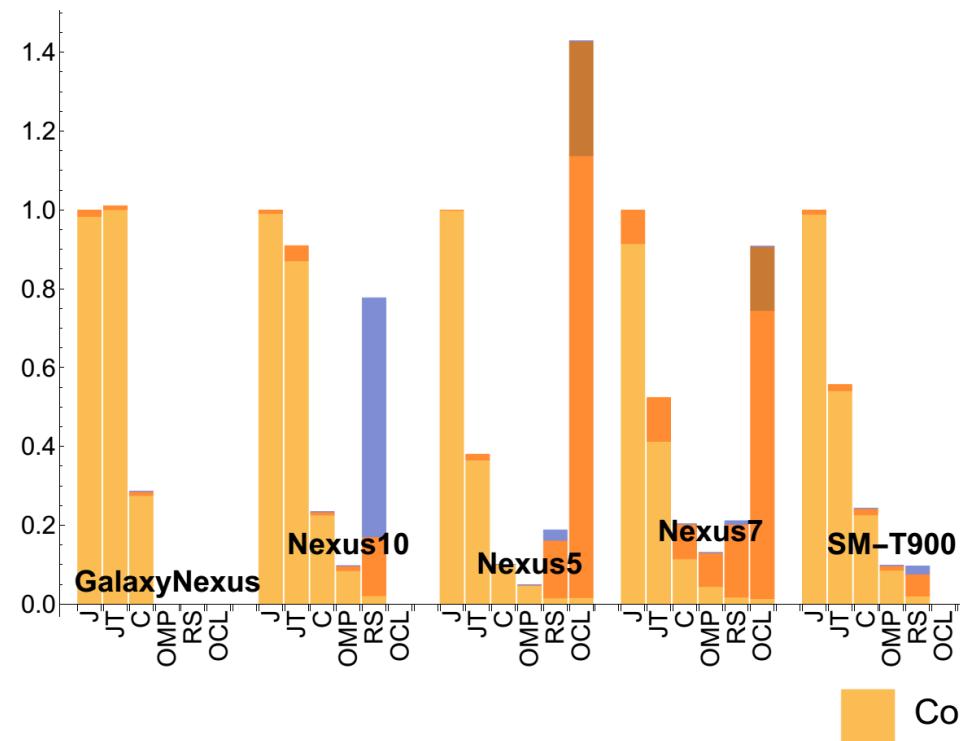
MRIQ Processor Utilization

# MRIQ Energy

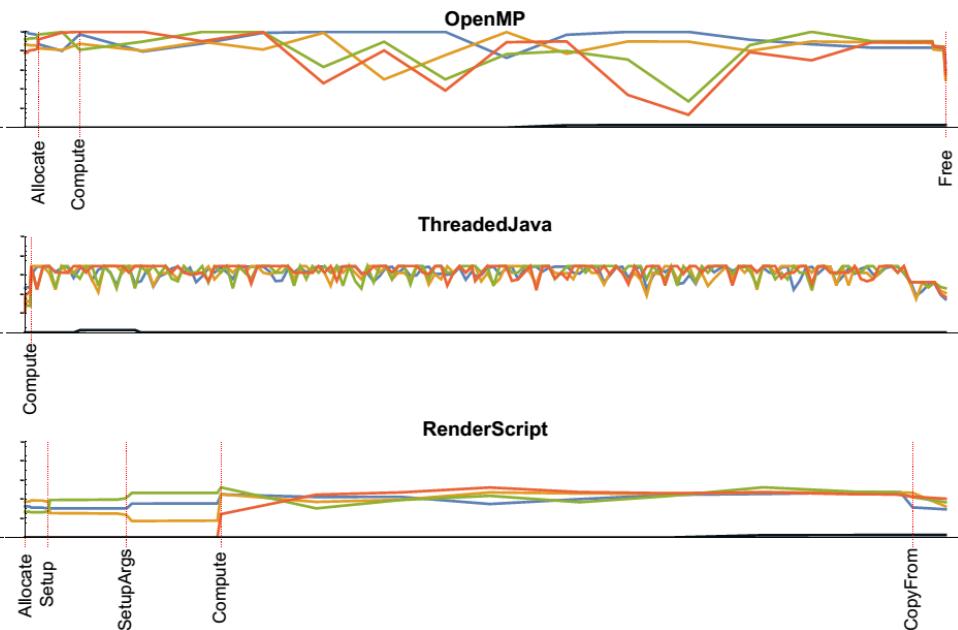
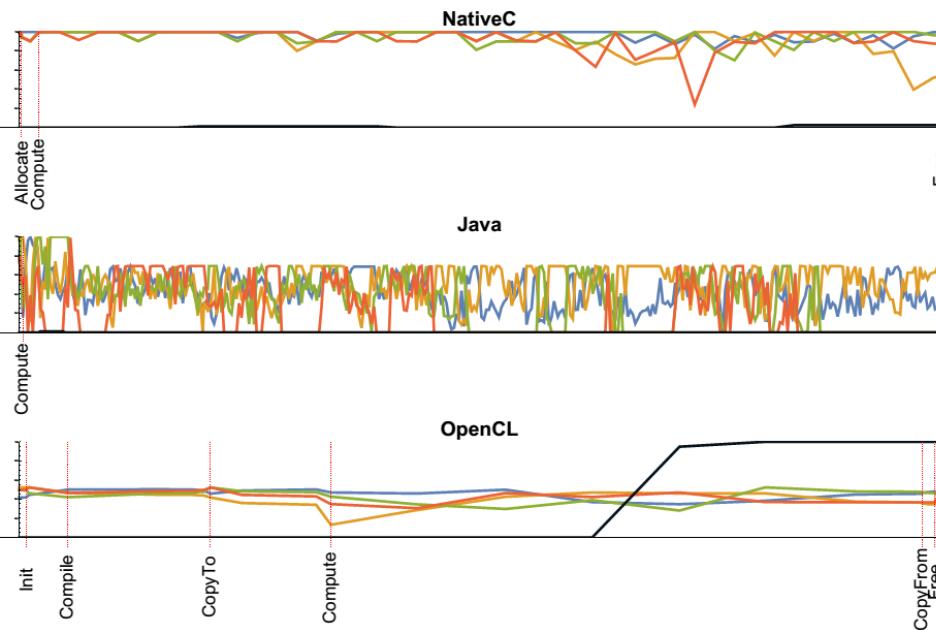
Compute Memory Compile Overhead Init



# Stencil Performance

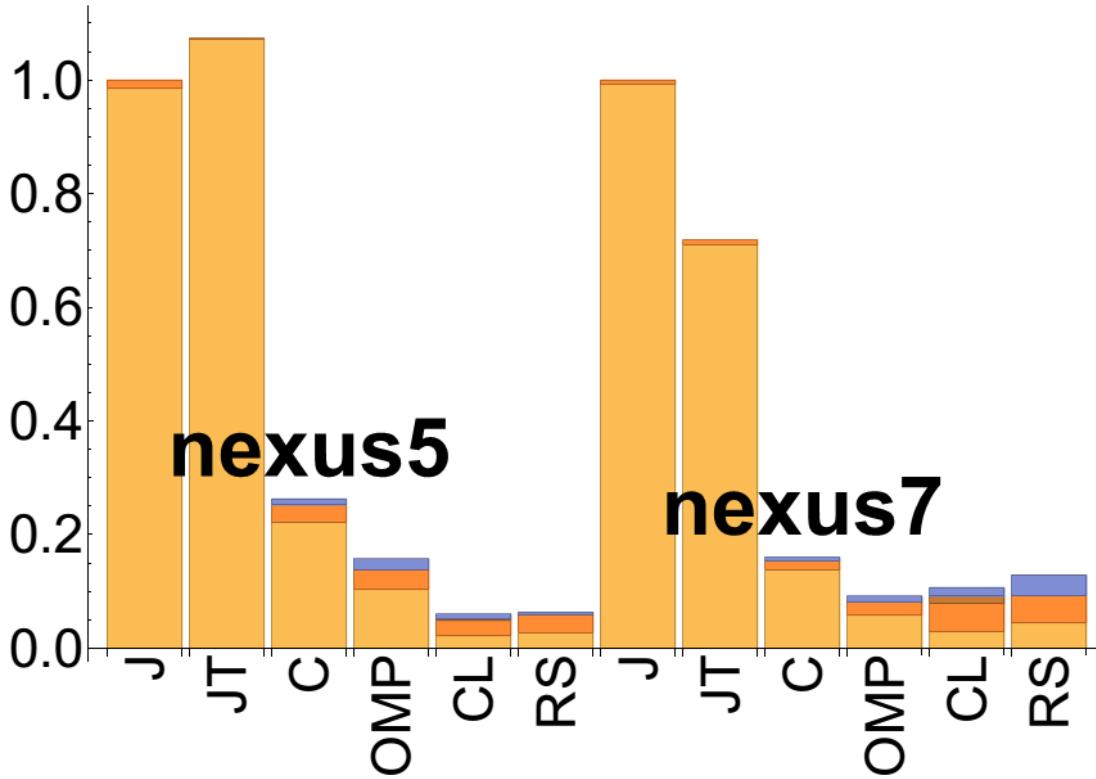


# Stencil Utilization on Nexus 5





# Stencil Power Utilization on Nexus 5



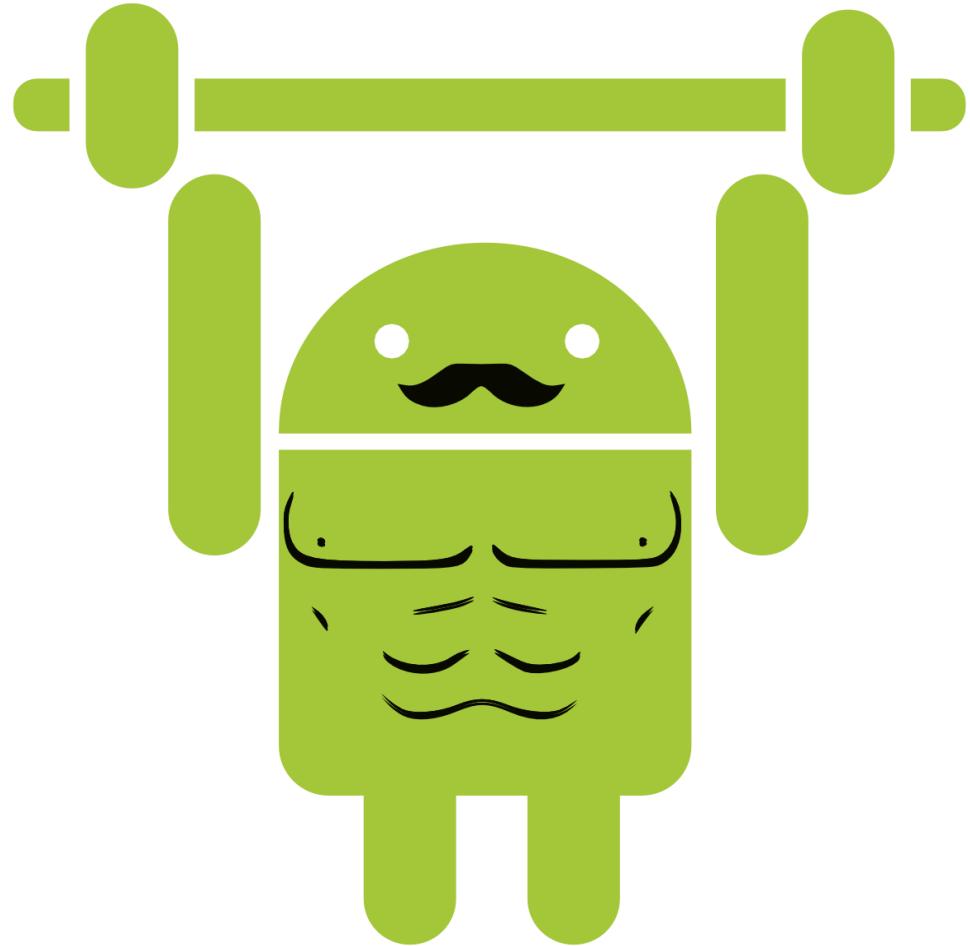
# RenderScript Programmability



- |                                                                                                                                                           |                                                                                                                                                                                                                                      |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"><li>✓ Performance Portability</li><li>✓ Debug Support</li><li>✓ Memory Operations</li><li>✓ Familiar Language</li></ul> | <ul style="list-style-type: none"><li>✗ Multi-Dimensional Parallelism</li><li>✗ Lack of Synchronization Intrinsics</li><li>✗ Non-Unified Memory</li><li>✗ Lack of Standardization</li><li>✗ Why remove support for OpenCL?</li></ul> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

If you mustache us

# Questions



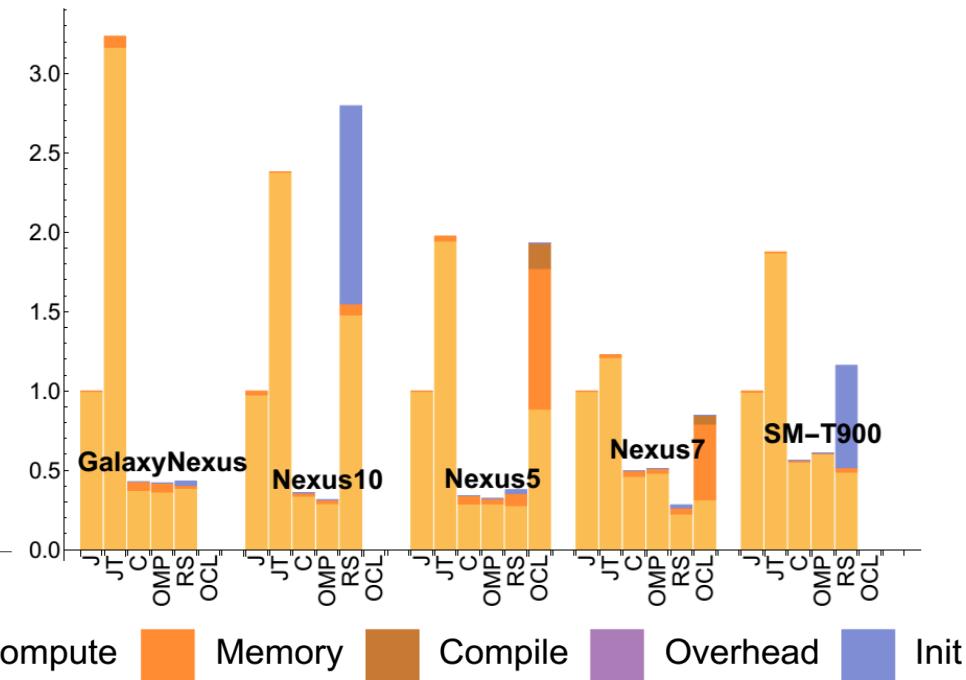
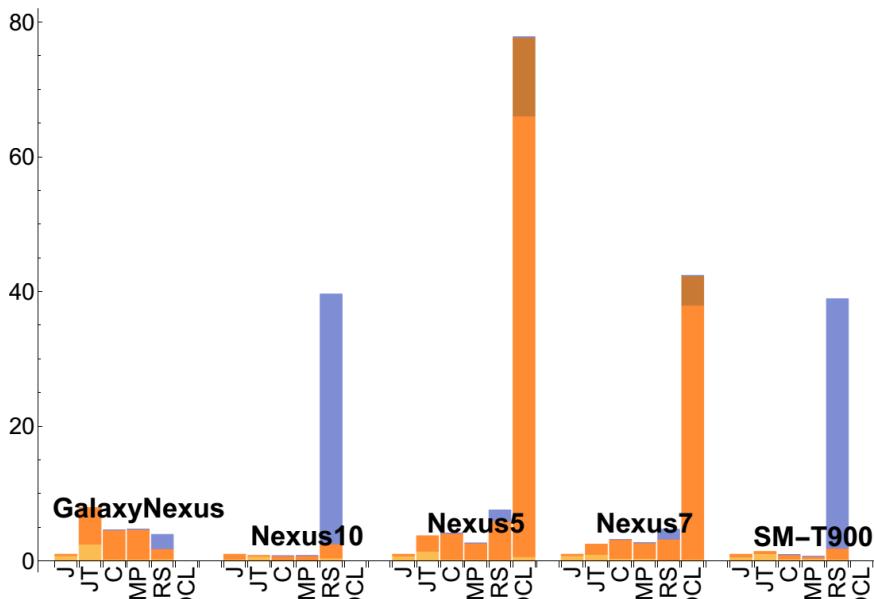
# Thank you

[github.com/cmpham/RSBench](https://github.com/cmpham/RSBench)

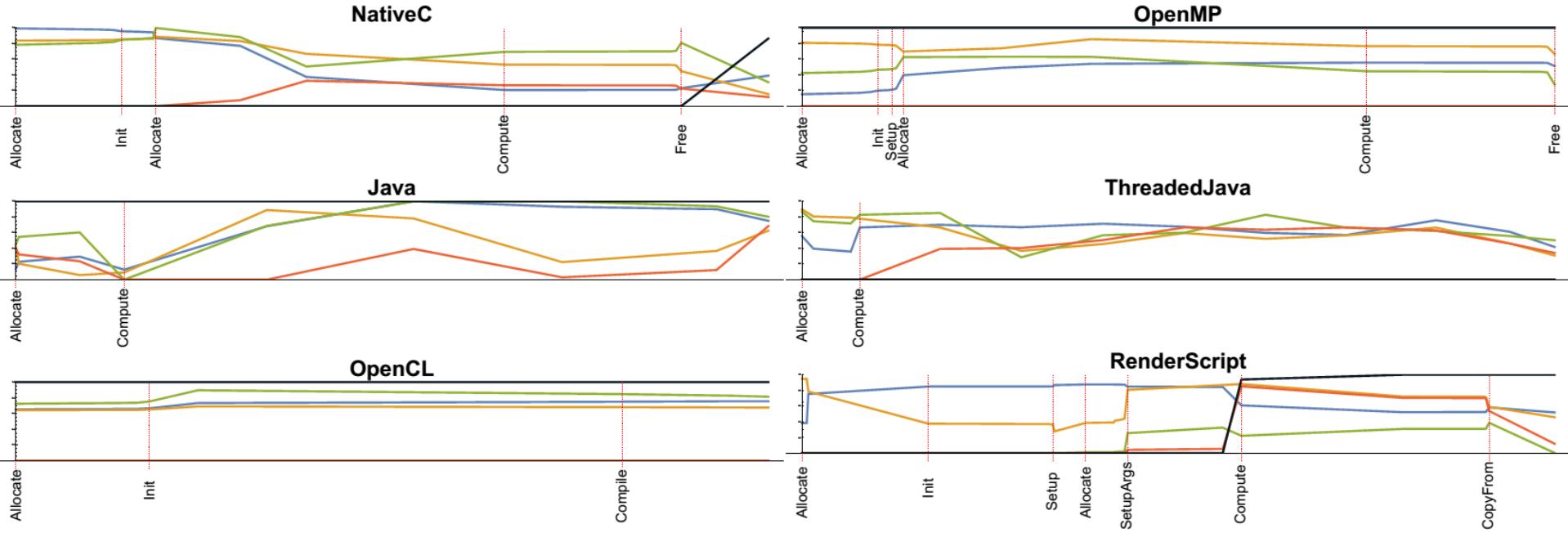
# Backup Slides



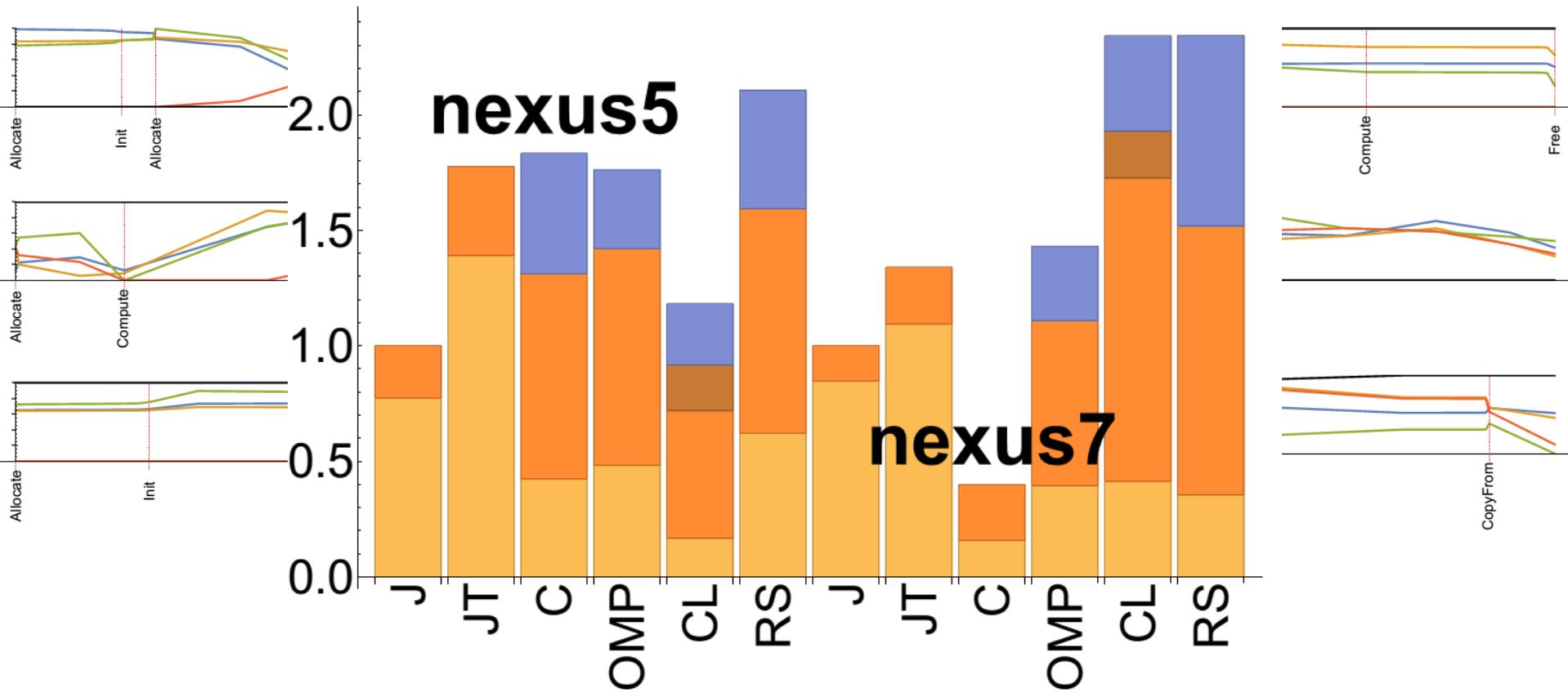
# Vector Add Performance



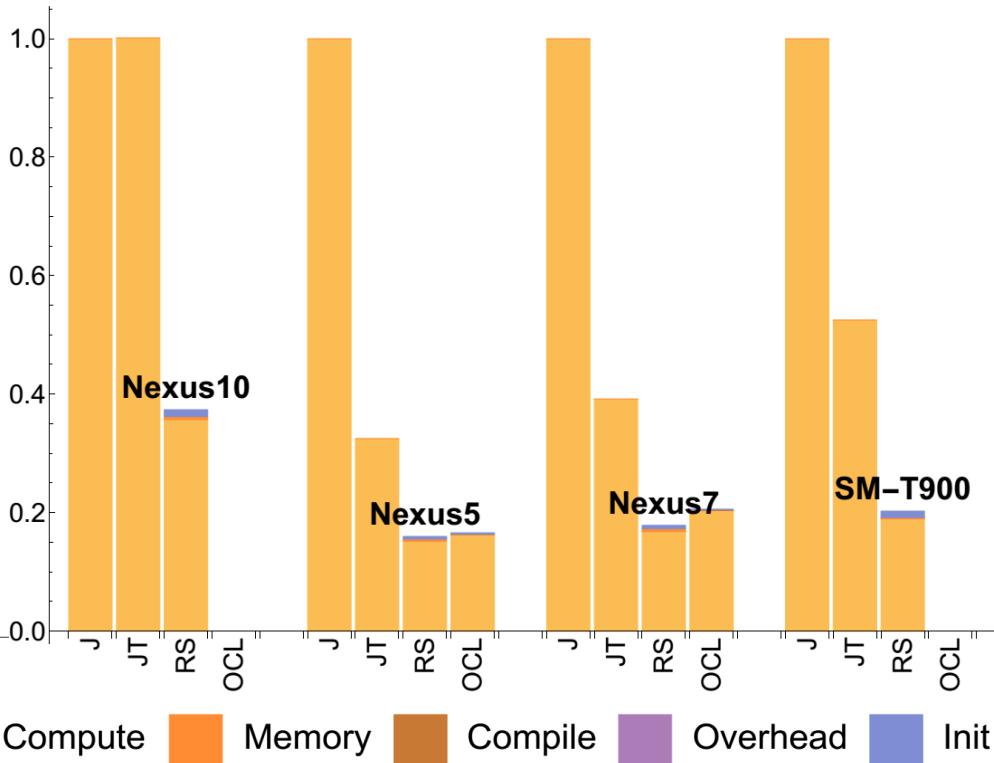
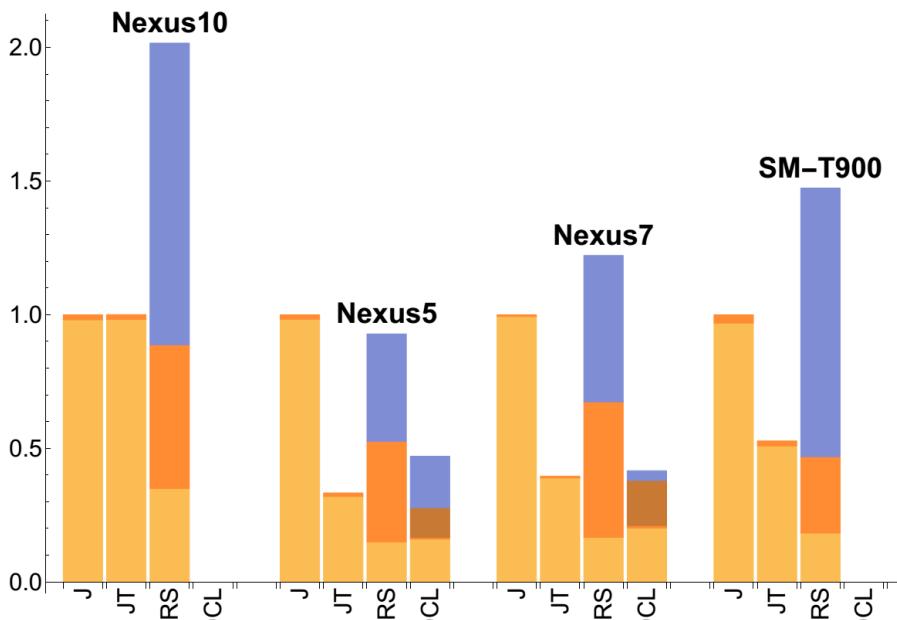
# Vector Add Utilization on Nexus 5



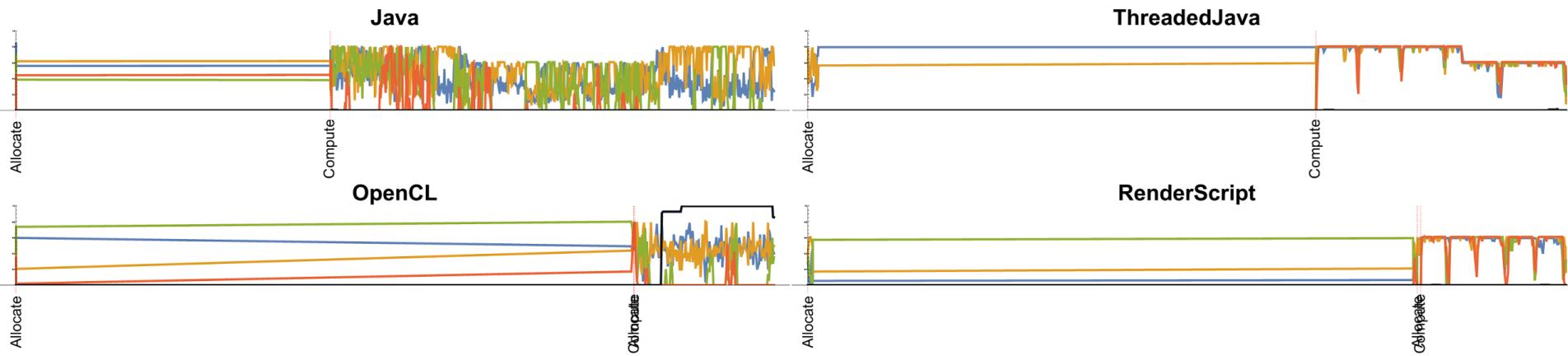
# Vector Add Utilization on Nexus 5



# TPACF Performance



# TPACF Utilization on Nexus 5



# TPACF Utilization on Nexus 5

