



# **Summary: Activity analysis for reverse-mode differentiation of (CUDA) GPU kernels**

**Mentors: Vassil Vassilev, David Lange**

**13.11.2025**

# Main goals

- Removing excessive atomicAdd's
- Reworking Varied Analysis using VarData

# atomicAdd

```
__global__ void kernel_call(double *out, double *in) {
    int index = threadIdx.x + blockIdx.x * blockDim.x;
    out[index] = in[index];
}
void fn(double *out, double *in) {
    kernel_call<<<1, 16>>>(out, in);
}

{
    out[index0] = _t2;
    double _r_d0 = _d_out[index0];
    _d_out[index0] = 0.;
    atomicAdd(&_d_in[index], _r_d0);
}
_d_in[index] += _rd0;
```

# How did it do?

- Primitive example with single atomic: up to 5x
- LULESH: up to 5%

Problem size = 875  
Elapsed time = 0.07316 (s)  
Grind time (us/z/c) = 83.611429 (per dom)  
FOM = 11.960087 (z/s)

Elapsed time = 0.06990 (s)  
Grind time (us/z/c) = 78.856  
FOM = 12.681343 (z/s)

Problem size = 31408  
Elapsed time = 0.62164 (s)  
Grind time (us/z/c) = 19.792478  
FOM = 50.524257 (z/s)

# atomicAdd

---

- >Add liveness check for removing atomics ✓

#1483 by ovdiiuv was merged on Aug 13 • Approved

- Don't create CUDA atomics for basic indices ✓

#1441 by ovdiiuv was merged on Aug 4 • Approved

---

- Recompute the values of CUDA built-in index functions ✓

#1430 by ovdiiuv was merged on Jul 7 • Approved

# Varied Analysis

- Reimplemented using VarData
- Added support for pointers and OOP
- Enabled VA on all gradient tests numerically

# Varied Analysis

---

- ↳ **Move TBR infrastructure to AnalysisBase ✓**

#1456 by ovdiiuv was merged on Aug 14 • Approved

- ↳ **Check if m\_AnalysisDC is valid ✓**

#1459 by ovdiiuv was merged on Aug 2 • Approved

---

- ↳ **Reimplement VA using AnalysisBase infrastructure ✓**

#1508 by ovdiiuv was merged on Sep 7 • Approved

---

- ↳ **Add support for OOP and enable respective numerical tests ✓**

#1612 by ovdiiuv was merged 2 weeks ago • Approved

---

- ↳ **Fix range-based loops and add early traverse for regular loops in VA ✓**

#1536 by ovdiiuv was merged on Sep 18 • Approved

**questions?**