

# Parallel computing for Image convolution

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2019

# Image convolution

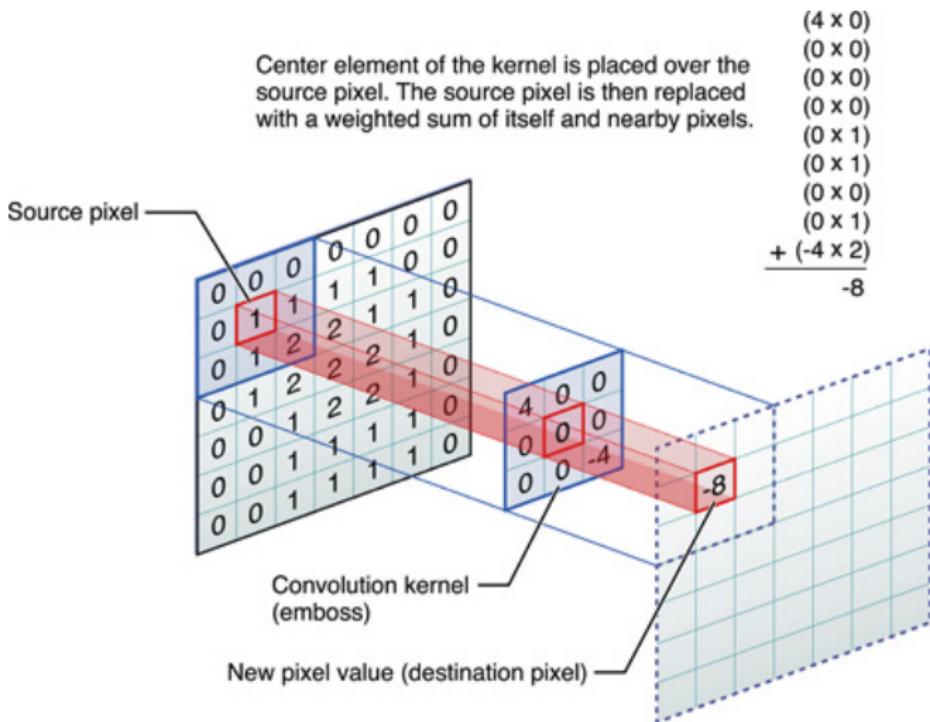


Figure 1: Image Convolution

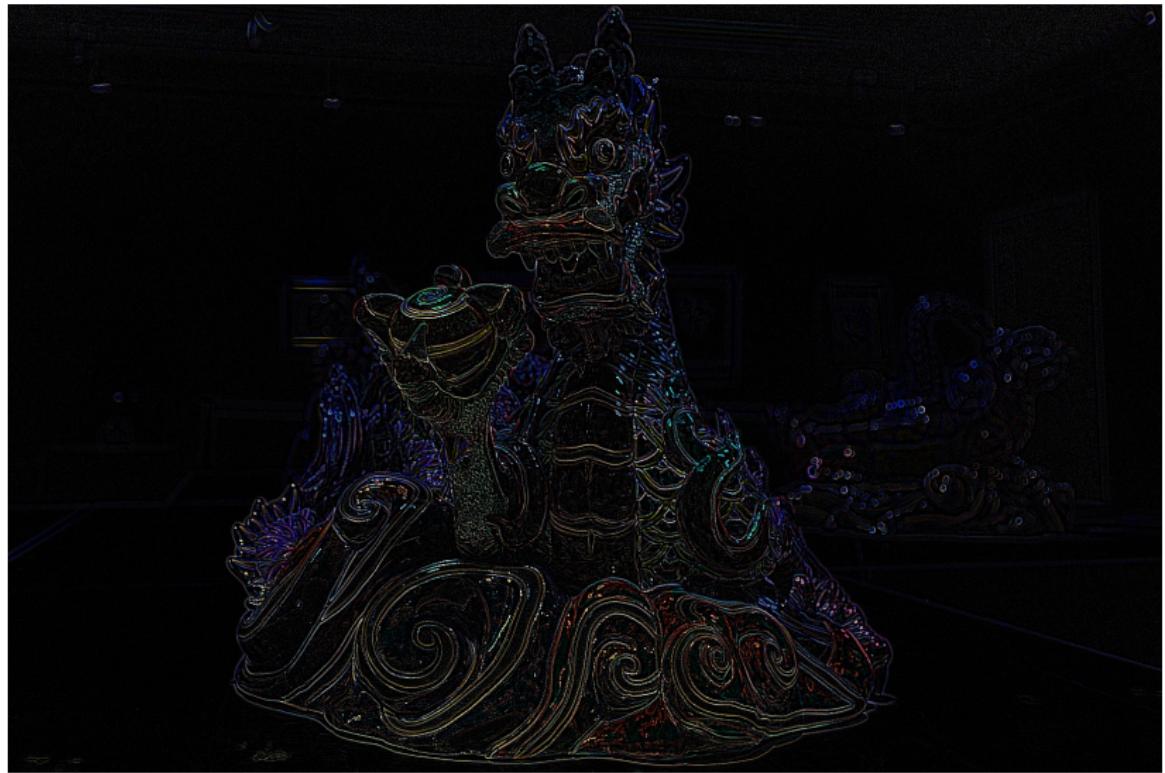
# Application



# Gaussian blur



# HighPass filter



# Emboss filter



# Parallelization: SIMD

Serial

input1, register A



Operator

input2, register B



out, register C

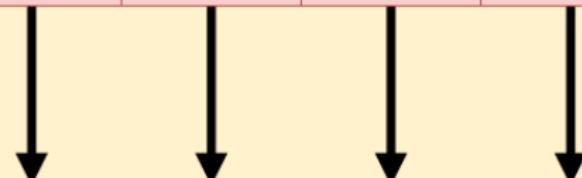
Single Instruction, Multi Data (SIMD)

input1\_1, register A | input1\_2, register A | input1\_3, register A | input1\_4, register A



Vectization operator

input2\_1, register B | input2\_2, register B | input2\_3, register B | input2\_4, register B



out\_1, register C

out\_2, register C

out\_3, register C

out\_4, register C

# Parallelization: OpenMP

## Scheduling

static: smallest overhead

## Chunk size

default:  $N_{\text{chunks}} / N_{\text{threads}}$

## Parallel section

```
#pragma omp parallel
{
#pragma omp /*parallel*/ for
for{;};
#pragma omp /*parallel*/ for
for{;};
}
```

## Parallelization: OpenMP cont

### collapse

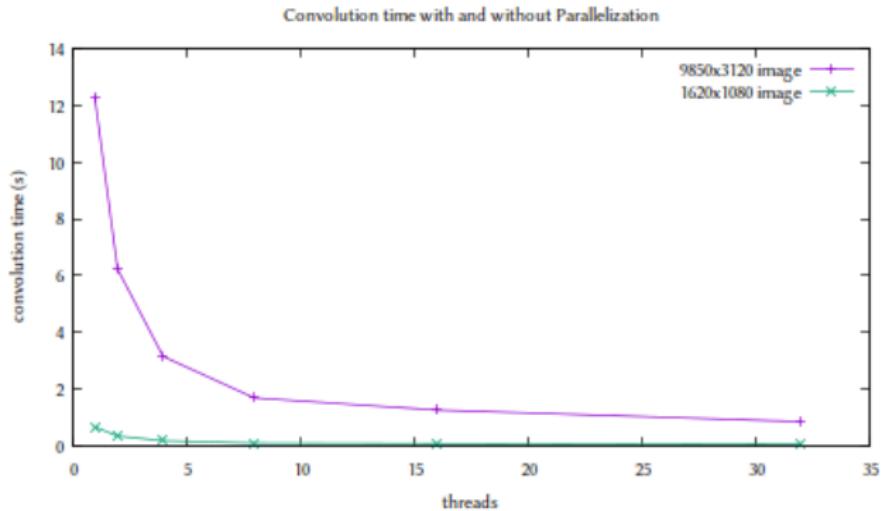
```
for(;;){  
    for(;;){  
  
    }  
}
```

Use `#pragma omp collapse(N)`

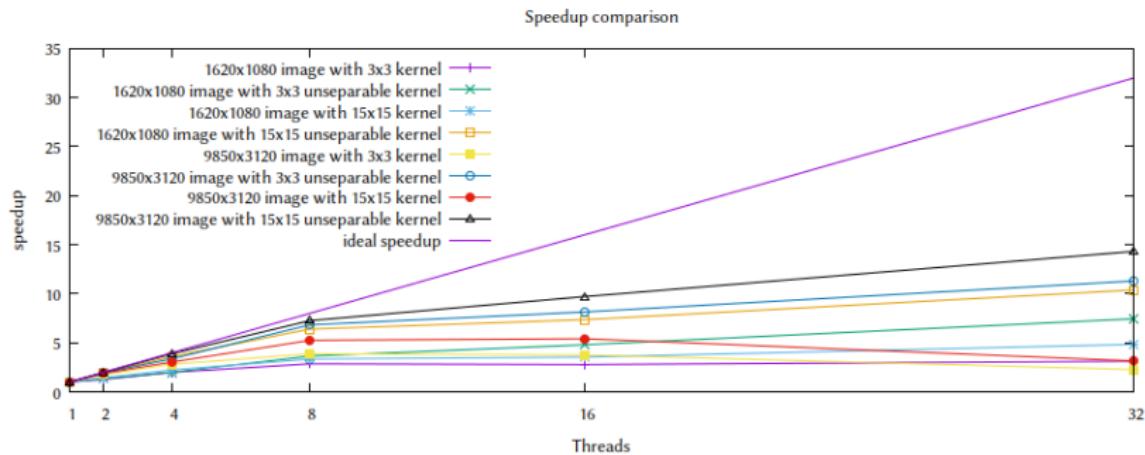
### shared()

Share read-only variable. If you write into a variable `x`, `private(x)`.

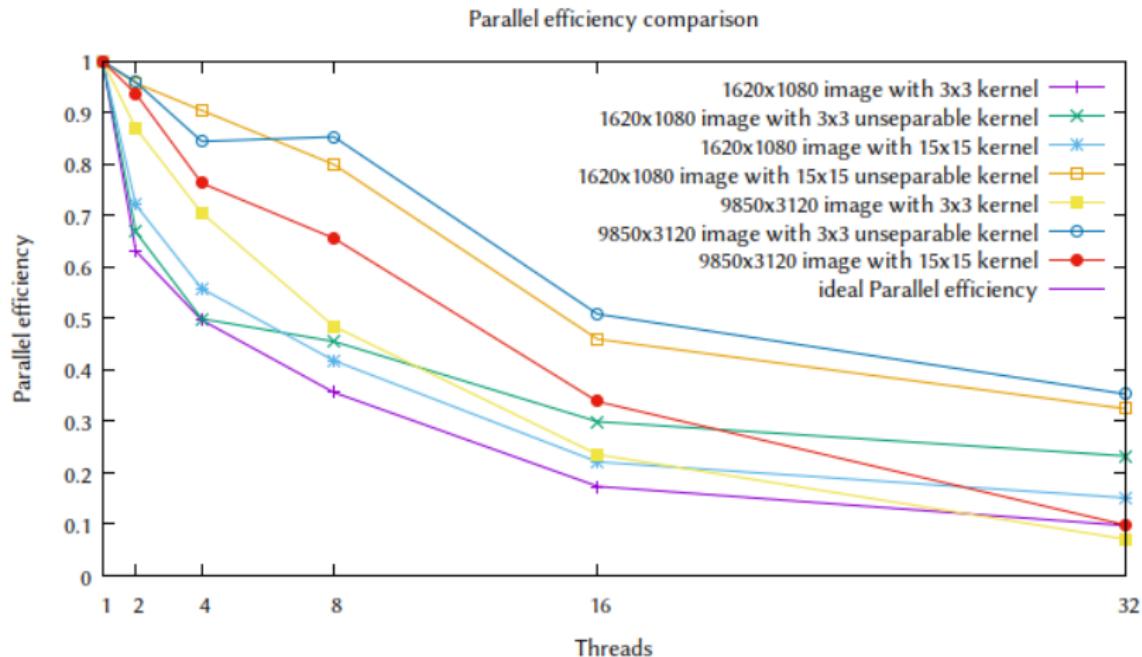
# Performance: Serial vs Parallel



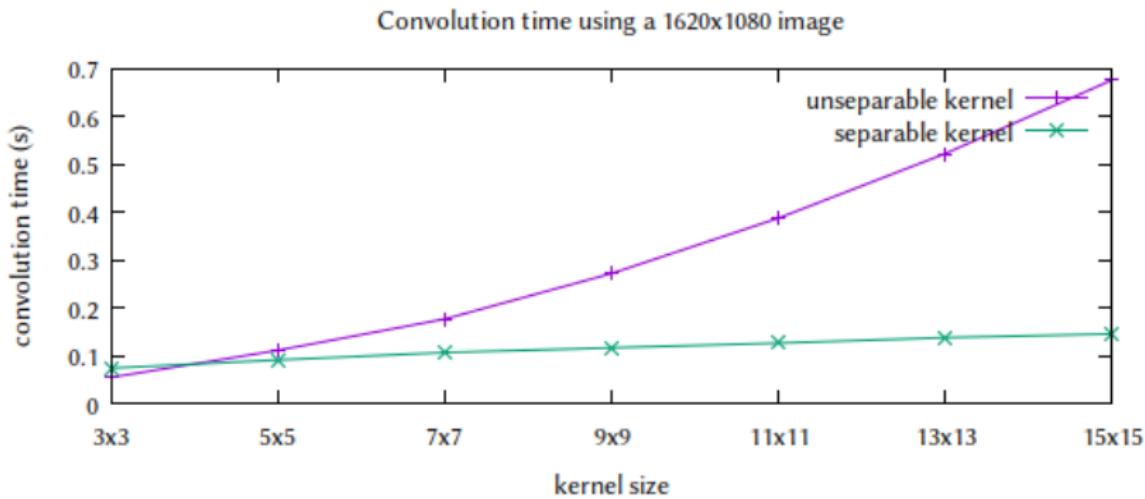
# Performance: Speedup



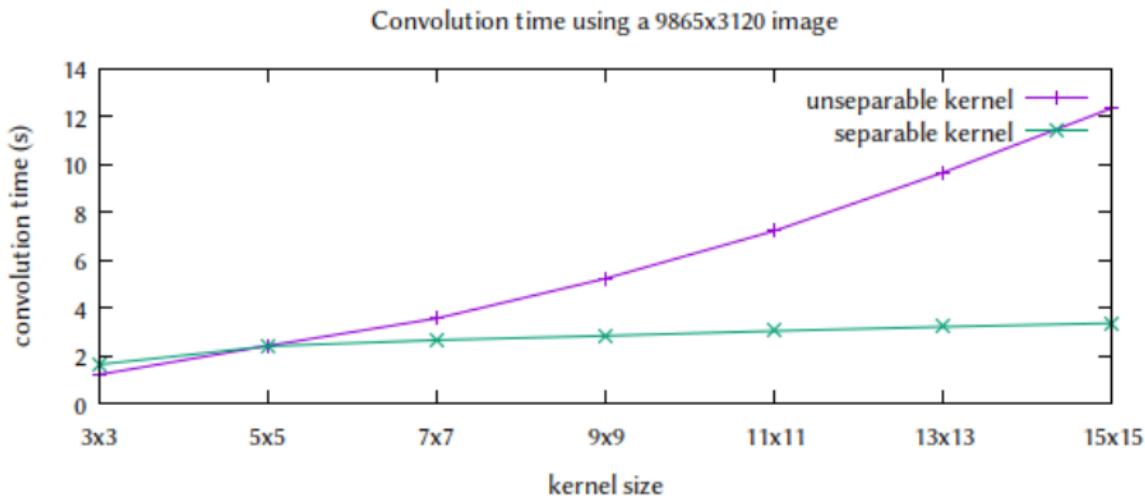
# Performance: Parallel efficiency



# Performance: Convolution time



# Performance: Convolution time



# Validations

```
e10715005@cluster2 ~e10715005/final_project/ImageConvolutionOpenMP $ OMP_NUM_THREADS=1 ./main.exe images/dragon.jpg kernels/box_blur3 tmp1.jpg  
1620x1080 3x3 1 0.0982336 0.122991 0.017676  
e10715005@cluster2 ~e10715005/final_project/ImageConvolutionOpenMP $ OMP_NUM_THREADS=4 ./main.exe images/dragon.jpg kernels/box_blur3 tmp2.jpg  
1620x1080 3x3 4 0.0988733 0.0624255 0.020923  
e10715005@cluster2 ~e10715005/final_project/ImageConvolutionOpenMP $ diff tmp1.jpg tmp2.jpg  
e10715005@cluster2 ~e10715005/final_project/ImageConvolutionOpenMP $ diff tmp1.jpg images/dragon.jpg  
Binary files tmp1.jpg and images/dragon.jpg differ  
e10715005@cluster2 ~e10715005/final_project/ImageConvolutionOpenMP $ |
```

# References

parallel algorithm using python

Matrix convolution using Parallel Programming

3 different parallel programming models for 2D image convolution