IT301 - Parallel Computing

Assignment 10

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Seting up Google Collab for CUDA

```
!apt-get --purge remove cuda nvidia* libnvidia-*
!dpkg -l | grep cuda- | awk '{print $2}' | xargs -n1 dpkg --purge
!apt-get remove cuda-*
!apt autoremove
!apt-get update
```

```
!wget https://developer.nvidia.com/compute/cuda/9.2/Prod/local_installers/cuda-repo
!dpkg -i cuda-repo-ubuntu1604-9-2-local_9.2.88-1_amd64.deb
!apt-key add /var/cuda-repo-9-2-local/7fa2af80.pub
!apt-get update
!apt-get install cuda-9.2
```

```
!nvcc --version
```

```
nvcc: NVIDIA (R) Cuda compiler driver
Copyright (c) 2005-2018 NVIDIA Corporation
Built on Wed_Apr_11_23:16:29_CDT_2018
Cuda compilation tools, release 9.2, V9.2.88
```

```
!pip install git+git://github.com/andreinechaev/nvcc4jupyter.git
```

```
%load_ext nvcc_plugin
```

Program 4: Understanding device variables

```
%%cu
#include <stdio.h>
#include <stdlib.h>
#include <math.h>
__global__ void SingleLoop()
{
//int id = blockIdx.x+blockIdx.x*blockDim.x;
int idx = blockIdx.x*blockDim.x+threadIdx.x;
```

```
int idy = blockIdx.y*blockDim.y+threadIdx.y;
int idz = blockIdx.z*blockDim.z+threadIdx.z;
int id = idx + idy *blockDim.x+idz*blockDim.x*blockDim.y;
printf("GPU-i=%d Tx=%d Ty=%d Tz=%d Bx=%d By=%d Bz=%d\n",id,threadIdx.x,threadIdx.y,
blockIdx.x,blockIdx.y, blockIdx.z);
}
int main(int argc, char **argv)
{
for(int i=0;i<32;i++){
printf("CPU-i=%d\n",i);
}
dim3 grid(1,1,1);
dim3 block(2,8,2);
printf("..................\n");
SingleLoop <<<grid, block>>>();
cudaDeviceSynchronize();
return 0;
}
```

Observations

1. Threads in `x` direction is 32

   ```
   dim3 grid(1,1,1);
   dim3 block(32,1,1);
   ```

2. Threads in `x` direction is 16 and `y` is 2

   ```
   dim3 grid(1,1,1);
   dim3 block(16,2,1);
   ```

3. Threads in `x` direction is 4, `y` is 2 and `z` is 4

   ```
   dim3 grid(1,1,1);
   dim3 block(4,2,4);
   ```

4. Threads in `x` direction is 8, `y` is 4 and `z` is 1

   ```
   dim3 grid(1,1,1);
   dim3 block(8,4,1);
   ```

5. Threads in `x` direction is 2, `y` is 8 and `z` is 2

   ```
   dim3 grid(1,1,1);
   dim3 block(2,8,2);
   ```

Output(CPU Output has been removed)

1. Threads in `x` direction is 32

```
GPU-i=0 Tx=0 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=1 Tx=1 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=2 Tx=2 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=3 Tx=3 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=4 Tx=4 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=5 Tx=5 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=6 Tx=6 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=7 Tx=7 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=8 Tx=8 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=9 Tx=9 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=10 Tx=10 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=11 Tx=11 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=12 Tx=12 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=13 Tx=13 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=14 Tx=14 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=15 Tx=15 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=16 Tx=16 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=17 Tx=17 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=18 Tx=18 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=19 Tx=19 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=20 Tx=20 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=21 Tx=21 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=22 Tx=22 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=23 Tx=23 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=24 Tx=24 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=25 Tx=25 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=26 Tx=26 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=27 Tx=27 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=28 Tx=28 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=29 Tx=29 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=30 Tx=30 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=31 Tx=31 Ty=0 Tz=0 Bx=0 By=0 Bz=0
```

2. Threads in `x` direction is 16 and `y` is 2

```
GPU-i=0 Tx=0 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=1 Tx=1 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=2 Tx=2 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=3 Tx=3 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=4 Tx=4 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=5 Tx=5 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=6 Tx=6 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=7 Tx=7 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=8 Tx=8 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=9 Tx=9 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=10 Tx=10 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=11 Tx=11 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=12 Tx=12 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=13 Tx=13 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=14 Tx=14 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=15 Tx=15 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=16 Tx=0 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=17 Tx=1 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=18 Tx=2 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=19 Tx=3 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=20 Tx=4 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=21 Tx=5 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=22 Tx=6 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=23 Tx=7 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=24 Tx=8 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=25 Tx=9 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=26 Tx=10 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=27 Tx=11 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=28 Tx=12 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=29 Tx=13 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=30 Tx=14 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=31 Tx=15 Ty=1 Tz=0 Bx=0 By=0 Bz=0
```

3. Threads in `x` direction is 4, `y` is 2 and `z` is 4

```
GPU-i=0 Tx=0 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=1 Tx=1 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=2 Tx=2 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=3 Tx=3 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=4 Tx=0 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=5 Tx=1 Ty=1 Tz=0 Bx=0 By=0 Bz=0
```

```
GPU-i=6 Tx=2 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=7 Tx=3 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=8 Tx=0 Ty=0 Tz=1 Bx=0 By=0 Bz=0
GPU-i=9 Tx=1 Ty=0 Tz=1 Bx=0 By=0 Bz=0
GPU-i=10 Tx=2 Ty=0 Tz=1 Bx=0 By=0 Bz=0
GPU-i=11 Tx=3 Ty=0 Tz=1 Bx=0 By=0 Bz=0
GPU-i=12 Tx=0 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=13 Tx=1 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=14 Tx=2 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=15 Tx=3 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=16 Tx=0 Ty=0 Tz=2 Bx=0 By=0 Bz=0
GPU-i=17 Tx=1 Ty=0 Tz=2 Bx=0 By=0 Bz=0
GPU-i=18 Tx=2 Ty=0 Tz=2 Bx=0 By=0 Bz=0
GPU-i=19 Tx=3 Ty=0 Tz=2 Bx=0 By=0 Bz=0
GPU-i=20 Tx=0 Ty=1 Tz=2 Bx=0 By=0 Bz=0
GPU-i=21 Tx=1 Ty=1 Tz=2 Bx=0 By=0 Bz=0
GPU-i=22 Tx=2 Ty=1 Tz=2 Bx=0 By=0 Bz=0
GPU-i=23 Tx=3 Ty=1 Tz=2 Bx=0 By=0 Bz=0
GPU-i=24 Tx=0 Ty=0 Tz=3 Bx=0 By=0 Bz=0
GPU-i=25 Tx=1 Ty=0 Tz=3 Bx=0 By=0 Bz=0
GPU-i=26 Tx=2 Ty=0 Tz=3 Bx=0 By=0 Bz=0
GPU-i=27 Tx=3 Ty=0 Tz=3 Bx=0 By=0 Bz=0
GPU-i=28 Tx=0 Ty=1 Tz=3 Bx=0 By=0 Bz=0
GPU-i=29 Tx=1 Ty=1 Tz=3 Bx=0 By=0 Bz=0
GPU-i=30 Tx=2 Ty=1 Tz=3 Bx=0 By=0 Bz=0
GPU-i=31 Tx=3 Ty=1 Tz=3 Bx=0 By=0 Bz=0
```

4. Threads in `x` direction is 8, `y` is 4 and `z` is 1

```
GPU-i=0 Tx=0 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=1 Tx=1 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=2 Tx=2 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=3 Tx=3 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=4 Tx=4 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=5 Tx=5 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=6 Tx=6 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=7 Tx=7 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=8 Tx=0 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=9 Tx=1 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=10 Tx=2 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=11 Tx=3 Ty=1 Tz=0 Bx=0 By=0 Bz=0
```

```
GPU-i=12 Tx=4 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=13 Tx=5 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=14 Tx=6 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=15 Tx=7 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=16 Tx=0 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=17 Tx=1 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=18 Tx=2 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=19 Tx=3 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=20 Tx=4 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=21 Tx=5 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=22 Tx=6 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=23 Tx=7 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=24 Tx=0 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=25 Tx=1 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=26 Tx=2 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=27 Tx=3 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=28 Tx=4 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=29 Tx=5 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=30 Tx=6 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=31 Tx=7 Ty=3 Tz=0 Bx=0 By=0 Bz=0
```

5. Threads in `x` direction is 2, `y` is 8 and `z` is 2

```
GPU-i=0 Tx=0 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=1 Tx=1 Ty=0 Tz=0 Bx=0 By=0 Bz=0
GPU-i=2 Tx=0 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=3 Tx=1 Ty=1 Tz=0 Bx=0 By=0 Bz=0
GPU-i=4 Tx=0 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=5 Tx=1 Ty=2 Tz=0 Bx=0 By=0 Bz=0
GPU-i=6 Tx=0 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=7 Tx=1 Ty=3 Tz=0 Bx=0 By=0 Bz=0
GPU-i=8 Tx=0 Ty=4 Tz=0 Bx=0 By=0 Bz=0
GPU-i=9 Tx=1 Ty=4 Tz=0 Bx=0 By=0 Bz=0
GPU-i=10 Tx=0 Ty=5 Tz=0 Bx=0 By=0 Bz=0
GPU-i=11 Tx=1 Ty=5 Tz=0 Bx=0 By=0 Bz=0
GPU-i=12 Tx=0 Ty=6 Tz=0 Bx=0 By=0 Bz=0
GPU-i=13 Tx=1 Ty=6 Tz=0 Bx=0 By=0 Bz=0
GPU-i=14 Tx=0 Ty=7 Tz=0 Bx=0 By=0 Bz=0
GPU-i=15 Tx=1 Ty=7 Tz=0 Bx=0 By=0 Bz=0
GPU-i=16 Tx=0 Ty=0 Tz=1 Bx=0 By=0 Bz=0
GPU-i=17 Tx=1 Ty=0 Tz=1 Bx=0 By=0 Bz=0
```

```
GPU-i=18 Tx=0 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=19 Tx=1 Ty=1 Tz=1 Bx=0 By=0 Bz=0
GPU-i=20 Tx=0 Ty=2 Tz=1 Bx=0 By=0 Bz=0
GPU-i=21 Tx=1 Ty=2 Tz=1 Bx=0 By=0 Bz=0
GPU-i=22 Tx=0 Ty=3 Tz=1 Bx=0 By=0 Bz=0
GPU-i=23 Tx=1 Ty=3 Tz=1 Bx=0 By=0 Bz=0
GPU-i=24 Tx=0 Ty=4 Tz=1 Bx=0 By=0 Bz=0
GPU-i=25 Tx=1 Ty=4 Tz=1 Bx=0 By=0 Bz=0
GPU-i=26 Tx=0 Ty=5 Tz=1 Bx=0 By=0 Bz=0
GPU-i=27 Tx=1 Ty=5 Tz=1 Bx=0 By=0 Bz=0
GPU-i=28 Tx=0 Ty=6 Tz=1 Bx=0 By=0 Bz=0
GPU-i=29 Tx=1 Ty=6 Tz=1 Bx=0 By=0 Bz=0
GPU-i=30 Tx=0 Ty=7 Tz=1 Bx=0 By=0 Bz=0
GPU-i=31 Tx=1 Ty=7 Tz=1 Bx=0 By=0 Bz=0
```