Parallel Computing Workshop

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Roadmap

- Introduction to GPU
- CUDA Program Flow and CPU-GPU Communication
- Thread organization (Grids, Blocks, Threads, 1D/2D)
- CUDA Memory Model
- CUDA Functions
- CUDA Thrust

Roadmap

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- CUDA Memory Model
- CUDA Functions
- CUDA Thrust

Hello World

```
#include <stdio.h>
int main() {
printf("Hello World.\n");
return 0;
}
```

Hello World

```
#include <stdio.h>
int main() {
printf("Hello World.\n");
return 0;
}
```

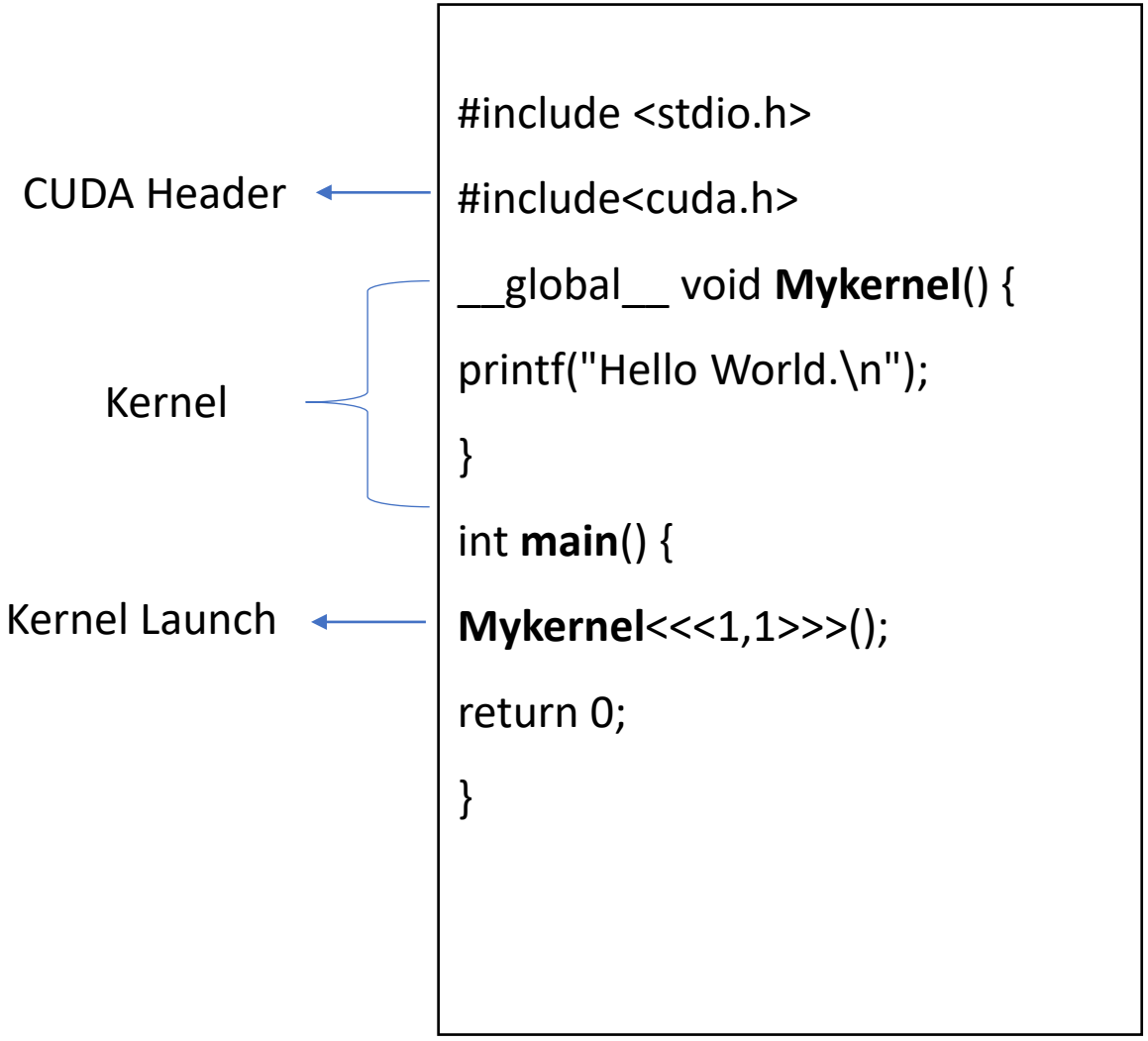
Compile: nvcc <ProgramName>.cu

Run: a.out

GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World.\n");
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

GPU Hello World program



GPU Hello World program

CUDA Header

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World.\n");
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

Note :

cuda.h is header file needs to include in order to run CUDA programs

GPU Hello World program

Kernel

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World.\n");
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

Note :

Kernel is Function that :

- Runs on the device
- Is called from host code

GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World.\n");
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

Kernel Launch

Note :

Kernel are executed N times in parallel by N different *CUDA threads.*

GPU Hello World program

CUDA Header

Kernel

Kernel Launch

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World.\n");
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

Output :

Compile: nvcc hello.cu

Run: ./a.out

----No Output----

GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,1>>>();
cudaDeviceSynchronize();
return 0;
}
```

Output:

Hello World

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,1>>>();
Mykernel<<<1,1>>>();
cudaDeviceSynchronize();
return 0; }
```

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,1>>>();
Mykernel<<<1,1>>>();
cudaDeviceSynchronize();
return 0; }
```

Output:

Hello World

Hello World

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,1>>>();
cudaDeviceSynchronize();
Mykernel<<<1,1>>>();
return 0; }
```

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,1>>>();
cudaDeviceSynchronize();
Mykernel<<<1,1>>>();
return 0; }
```

Output:

Hello World

Hello World (Optional)

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
cudaDeviceSynchronize();
return 0; }
```

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
cudaDeviceSynchronize();
return 0; }
```

Output:

Hello World 1

Hello World 2

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
cudaDeviceSynchronize();
Printf(“Inside main\n”);
return 0; }
```

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
cudaDeviceSynchronize();
Printf(“Inside main\n”);
return 0; }
```

Output:

Hello World 1

Hello World 2

Inside main

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
Printf(“Inside main\n”);
cudaDeviceSynchronize();
return 0; }
```

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
Printf(“Inside main\n”);
cudaDeviceSynchronize();
return 0; }
```

Output:

Hello World 1

Hello World 2

Inside main

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
Printf(“Inside main\n”);
cudaDeviceSynchronize();
return 0; }
```

Output:

Hello World 1

Hello World 2

Inside main

Hello World 1

Inside main

Hello World 2

More GPU Hello World program

```
__global__ void Mykernel1() {
printf("Hello World 1\n");
}
__global__ void Mykernel2() {
printf("Hello World 2\n");
}
int main() {
Mykernel1<<<1,1>>>();
Mykernel2<<<1,1>>>();
Printf(“Inside main\n”);
cudaDeviceSynchronize();
return 0; }
```

Output:

```
Hello World 1
Hello World 2
Inside main

Hello World 1
Inside main
Hello World 2

Inside main
Hello World 1
Hello World 2
```

More GPU Hello World program

```
__global__ void Mykernel() {
printf("Hello World \n");
}
int main() {
Mykernel<<<1,1>>>();
Printf(“main one\n”);
Mykernel<<<1,1>>>();
Printf(“main two\n”);
cudaDeviceSynchronize();
Printf(“main three\n”);
return 0; }
```

Identify which prints execute in parallel

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,32>>>();
return 0;
}
```

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<1,32>>>();
return 0;
}
```

Output:

Hello World

Hello World

.

32 times

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
__global__ void Mykernel() {
printf("Hello World\n");
}
int main() {
Mykernel<<<x,y>>>();
return 0;
}
```

Output:

Hello World

Hello World

.

x * y times

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
#define N 10
__global__ void Mykernel() {
printf("%d\n",N);
}
int main() {
Mykernel<<<x,y>>>();
return 0;
}
```

More GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
#define N 10
__global__ void Mykernel() {
printf("%d\n",N);
}
int main() {
Mykernel<<<x,y>>>();
return 0;
}
```

Output:

10

10

.

x * y times

GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
Const char *data = "Hello World";
__global__ void Mykernel() {
printf(“%s\n“,data);
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

GPU Hello World program

```
#include <stdio.h>
#include<cuda.h>
Const char *data = "Hello World";
__global__ void Mykernel() {
printf("%s\n",data);
}
int main() {
Mykernel<<<1,1>>>();
return 0;
}
```

Output:

ERROR

identifier "data" is undefined in device code

Thank You