[CSED490C] Assignment Report: Lab1_cuda

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1. Answering follwing questions

Q: How many floating point operations are being performed in your vector add kernel? Explain.

A: `inputLength` . Floating point operation only occurs once when the calculating the single element of output vector whose leangth is `inputLength` .

Q: How many global memory reads are being performed by your kernel? Explain.

A: `2*inputLength` . Each add operation for a single element in output vector need total 2 global memory reads for `in1[idx]` and `in2[idx]` . And total length of the output vector is `inputLength` .

Q: How many global memory writes are being performed by your kernel? Explain.

A: `inputLength` . Global memory write occurs only once when saving the calculated value to the output vector whose length is `inputLength` .

2. Template.cu

```
#include <gputk.h>

__global__ void vecAdd(float *in1, float *in2, float *out, int len) {
  //@@ Insert code to implement vector addition here
  int index = threadIdx.x + blockIdx.x * blockDim.x;;
  if(index < len)
    out[index] = in1[index] + in2[index];
}

int main(int argc, char **argv) {
  gpuTKArg_t args;
  int inputLength;
  float *hostInput1;
  float *hostInput2;
  float *hostOutput;
  float *deviceInput1;
  float *deviceInput2;
  float *deviceOutput;

  args = gpuTKArg_read(argc, argv);

  gpuTKTime_start(Generic, "Importing data and creating memory on host");
  hostInput1 =
      (float *)gpuTKImport(gpuTKArg_getInputFile(args, 0), &inputLength);
  hostInput2 =
      (float *)gpuTKImport(gpuTKArg_getInputFile(args, 1), &inputLength);
  hostOutput = (float *)malloc(inputLength * sizeof(float));
  gpuTKTime_stop(Generic, "Importing data and creating memory on host");

  gpuTKLog(TRACE, "The input length is ", inputLength);

  gpuTKTime_start(GPU, "Allocating GPU memory.");
  //@@ Allocate GPU memory here
  cudaMalloc((void **)&deviceInput1, inputLength * sizeof(float));
  cudaMalloc((void **)&deviceInput2, inputLength * sizeof(float));
  cudaMalloc((void **)&deviceOutput, inputLength * sizeof(float));

  gpuTKTime_stop(GPU, "Allocating GPU memory.");

  gpuTKTime_start(GPU, "Copying input memory to the GPU.");
  //@@ Copy memory to the GPU here
  cudaMemcpy(deviceInput1, hostInput1, inputLength * sizeof(float), cudaMemcpyHostToDevice);
  cudaMemcpy(deviceInput2, hostInput2, inputLength * sizeof(float), cudaMemcpyHostToDevice);

  gpuTKTime_stop(GPU, "Copying input memory to the GPU.");

  //@@ Initialize the grid and block dimensions here
  const int THREADS_PER_BLOCK = 128;

  dim3 gridDim_((inputLength + THREADS_PER_BLOCK -1) / THREADS_PER_BLOCK, 1, 1);
  dim3 blockDim_(THREADS_PER_BLOCK, 1, 1);

  gpuTKTime_start(Compute, "Performing CUDA computation");
  //@@ Launch the GPU Kernel here
  vecAdd<<<gridDim_, blockDim_>>>(deviceInput1, deviceInput2, deviceOutput, inputLength);

  cudaDeviceSynchronize();
  gpuTKTime_stop(Compute, "Performing CUDA computation");
```

```
  gpuTKTime_start(Copy, "Copying output memory to the CPU");
  //@@ Copy the GPU memory back to the CPU here
  cudaMemcpy(hostOutput, deviceOutput, inputLength * sizeof(float), cudaMemcpyDeviceToHost);

  gpuTKTime_stop(Copy, "Copying output memory to the CPU");

  gpuTKTime_start(GPU, "Freeing GPU Memory");
  //@@ Free the GPU memory here
  cudaFree(deviceInput1);
  cudaFree(deviceInput2);
  cudaFree(deviceOutput);

  gpuTKTime_stop(GPU, "Freeing GPU Memory");

  gpuTKSolution(args, hostOutput, inputLength);

  free(hostInput1);
  free(hostInput2);
  free(hostOutput);

  return 0;
}
```

3. Execution times

Execution Systems

All compilation and the executions are made on docker container.

TITANRTX

```
srun -p TITANRTX -N 1 -n 8 -t 02:00:00 --gres=gpu:1 --pty /bin/bash -l
```

- Driver Version : `530.30.02`
- Cuda Version : `12.1`
- Docker Image : `nvidia:cuda/12.1.0-devel-ubuntu22.04`

3090

```
srun -p 3090 -N 1 -n 8 -t 02:00:00 --gres=gpu:1 --pty /bin/bash -l
```

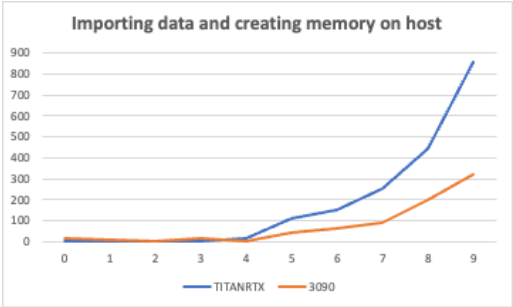
- Driver Version : `530.30.02`
- Cuda Version : `12.1`
- Docker Image : `nvidia:cuda/12.1.0-devel-ubuntu22.04`

Execution Times

All the time measurement unit is millisecond(ms).

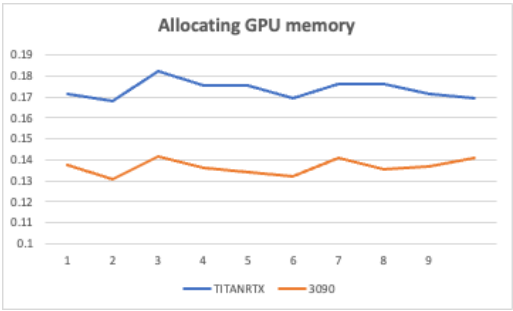
1 [Importing data and creating memory on host]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	4.60396	2.25838	2.39982	2.73972	14.1392	109.145	149.509	250.292	443.713	855.705
3090	18.874	9.00381	1.62638	15.673	5.2051	41.1913	65.2419	90.0817	197.491	322.492



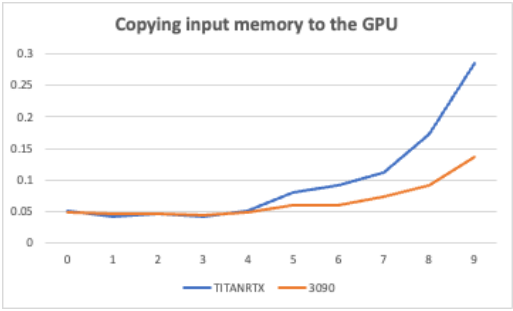
2 [Allocating GPU memory]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	0.171383	0.167926	0.182018	0.175451	0.175444	0.169549	0.176271	0.175839	0.171201	0.169616
3090	0.137378	0.130478	0.141608	0.136248	0.134208	0.132088	0.141138	0.135248	0.136598	0.140859



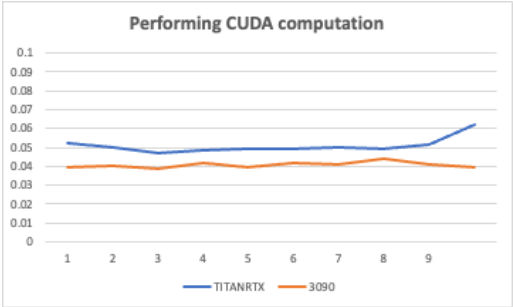
3 [Copying input memory to the GPU]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	0.051758	0.0424	0.046765	0.042084	0.050485	0.079116	0.091149	0.111952	0.173234	0.285482
3090	0.049169	0.046259	0.045349	0.043389	0.048949	0.058779	0.060329	0.074059	0.092389	0.137429



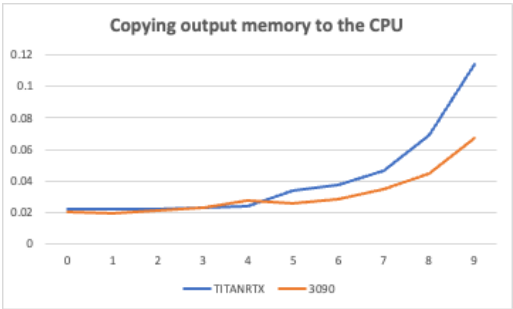
4 [Performing CUDA computation]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	0.051921	0.050101	0.047293	0.048382	0.049446	0.049603	0.050109	0.049458	0.051683	0.062116
3090	0.039319	0.04053	0.03906	0.041749	0.039719	0.041409	0.04114	0.04397	0.040869	0.03946



5 [Copying output memory to the CPU]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	0.022061	0.021986	0.022419	0.022597	0.023551	0.033841	0.037131	0.046682	0.069277	0.114213
3090	0.02028	0.01976	0.02114	0.02258	0.02789	0.02544	0.028009	0.034789	0.04434	0.066979



6 [Freeing GPU Memory]

	0	1	2	3	4	5	6	7	8	9
TITANRTX	0.240961	0.140013	0.131853	0.132165	0.132493	0.131748	0.144005	0.13896	0.138082	0.142221
3090	0.127438	0.123898	0.123428	0.125798	0.126268	0.127708	0.132269	0.130278	0.125409	0.124548