Parallelism Module

Concurrency Parallelism & Distributed Systems

Carlos Segarra

December 19, 2019

Contents

1 Understanding Parallelism

1.1 Definition of a Distributed System

1.2 Challenges of Distributed Systems

2 OpenMP

3 MPI: Message Passing Interface

4 Programming with CUDA

4.1 GPU Architecture

CPU vs GPU Architecture:

- CPUs are designed for general purpose computing.
- Large Caches to reduce impact of long latency.
- GPUs are specialized for highly-parallel, compute-intensive computation.
- Massive number of threads.

The testbed we use in CPDS is the MinoTauro cluster:

Listing 1: Output of runing `nvidia-smi` in the cluster.

```
Thu Dec 19 11:34:34 2019
+-----------------------------------------------------------------------------+
| NVIDIA-SMI 418.67       Driver Version: 418.67       CUDA Version: 10.1     |
|-------------------------------+----------------------+----------------------+
| GPU  Name        Persistence-M| Bus-Id        Disp.A | Volatile Uncorr. ECC |
| Fan  Temp  Perf  Pwr:Usage/Cap|         Memory-Usage | GPU-Util  Compute M. |
|===============================+======================+======================|
|   0  Tesla K80           Off  | 00000000:04:00.0 Off |                    0 |
| N/A   43C    P0    59W / 149W |      0MiB / 11441MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   1  Tesla K80           Off  | 00000000:05:00.0 Off |                    0 |
| N/A   37C    P0    73W / 149W |      0MiB / 11441MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   2  Tesla K80           Off  | 00000000:85:00.0 Off |                    0 |
| N/A   35C    P0    64W / 149W |      0MiB / 11441MiB |      0%      Default |
+-------------------------------+----------------------+----------------------+
|   3  Tesla K80           Off  | 00000000:86:00.0 Off |                    0 |
| N/A   44C    P0    76W / 149W |      0MiB / 11441MiB |     92%      Default |
+-------------------------------+----------------------+----------------------+

+-----------------------------------------------------------------------------+
| Processes:                                                       GPU Memory |
|  GPU       PID   Type   Process name                             Usage      |
|=============================================================================|
|  No running processes found                                                 |
+-----------------------------------------------------------------------------+
```