PySchedCL: A Framework for Automatically Exploiting Concurrency in Heterogeneous Data-Parallel Applications

M.Tech Project - II Thesis report submitted to

Indian Institute of Technology Kharagpur

in fulfilment for the award of the degree of

Dual Degree (B.Tech + M.Tech)

in

Computer Science and Engineering

by

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(15CS30032)

Under the supervision of

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Spring Semester, 2019-20

June 2, 2020

DECLARATION

I certify that

(a) The work contained in this report has been done by me under the guidance of my supervisor.

(b) The work has not been submitted to any other Institute for any degree or diploma.

(c) I have conformed to the norms and guidelines given in the Ethical Code of Conduct of the Institute.

(d) Whenever I have used materials (data, theoretical analysis, figures, and text) from other sources, I have given due credit to them by citing them in the text of the thesis and giving their details in the references. Further, I have taken permission from the copyright owners of the sources, whenever necessary.

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

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CERTIFICATE

This is to certify that the project report entitled "**PySchedCL: A Framework for Automatically Exploiting Concurrency in Heterogeneous Data-Parallel Applications**" submitted by **Siddharth Singh** (Roll No. 15CS30032) to Indian Institute of Technology Kharagpur towards partial fulfilment of requirements for the award of degree of Dual Degree (B.Tech + M.Tech) in Computer Science and Engineering is a record of bona fide work carried out by him under my supervision and guidance during Spring Semester, 2019-20.

Date: June 2, 2020

Place: Kharagpur

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Abstract

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Degree for which submitted: **Dual Degree (B.Tech + M.Tech)**

Department: **Department of Computer Science and Engineering**

Thesis title: **PySchedCL: A Framework for Automatically Exploiting Concurrency in Heterogeneous Data-Parallel Applications**

Thesis supervisor: **Professor Soumyajit Dey**

Month and year of thesis submission: **June 2, 2020**

In the past decade, high performance compute capabilities exhibited by heterogeneous GPGPU platforms have led to the popularity of data parallel programming languages such as CUDA and OpenCL. Such languages, however, involve a steep learning curve as well as developing an extensive understanding of the underlying architecture of the compute devices in heterogeneous platforms. This has led to the emergence of several High Performance Computing frameworks which provide high-level abstractions for easing the development of data-parallel applications on heterogeneous platforms. However, the scheduling decisions undertaken by such frameworks do not sufficiently exploit the concurrency inherent in a data parallel application to its full potential. We propose a framework called *PySchedCL*, whose design philosophy is along similar lines as that of other HPC frameworks, with a specific focus on exploring fine-grained concurrency aware scheduling decisions that completely harness the power of heterogeneous CPU/GPU architectures. We showcase the efficacy of such scheduling decisions over popular dynamic scheduling

schemes by conducting extensive experimental evaluations for a Machine Learning based inferencing application. We also experiment with automated coarse-grained scheduling algorithm that rely on Machine learning to schedule heterogenous applications.

Acknowledgements

I am deeply grateful to my supervisor **Prof. Soumyajit Dey** who gave me the opportunity to work on this project. I am thankful for his aspiring guidance, invaluably constructive friendly advice during the course of the project. I am sincerely grateful to him for sharing his truthful and illuminating views on a number of issues related to the project. I owe a lot to my teachers in the Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur, who have instilled in me the scientific spirit of inquiry, experimentation, observation and inference, without which I would not have been able to produce this work. Also, I am very thankful to **Mr. Anirban Ghose** involved in this project who constantly motivated me to overcome all the challenges and helped me whenever I faced any issues.

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1.1 Introduction

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Appendix A

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