Parallel Programming Technology Lab Proposal

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1 Background

A data dependency means that a program instruction depends on data which has been defined or used before in the program [1]. The analysis of finding such dependencies is called dependence analysis [1].
Dependence analysis therefore also determines whether it is safe to reorder or parallelize statements. As the number of software grows and programs become more complex, dependence analysis plays an important role for their optimization and ensuring that the program does what it is supposed to do. It can be performed without executing the program (static program analysis) and during runtime (dynamic program analysis).

2 Motivation

Executing static data dependency techniques and comparing them with other existing techniques (dynamic and static) will give us understanding of how important each technique is in terms of program analysis and which technique is the most favorable. Thus, the results of our project will help to improve the performance of programs.

3 Objectives

The first objective of this project is to apply static techniques to extract data dependencies from program code. The second objective is to convert results to the DiscoPoP format and then compare the used techniques to two other data dependencies extracting techniques.
First of two other existing techniques is dynamic technique DiscoPoP and second is static technique PLUTO. The results of applying these two techniques are readily available and represented in DiscoPoP format.

4 Proposed Solution including Software Design

A suitable tool for our purpose is LLVM [2]. It is a powerful instrument that is used to construct, optimize and produce intermediate and/or binary machine code.
For our aim we can use it to extract data dependencies. The techniques we propose to apply are, namely, Use-Def Chain analysis, Alias analysis and Inter-procedural analysis.
A Use-Definition Chain [3] (UD Chain) is a data structure that consists of a use, U, of a variable, and all the definitions, D, of that variable that can reach that use without any other intervening definitions. A definition can have many forms, but is generally taken to mean the assignment of some value to a variable (which is different from the use of the term that refers to the language construct involving a data type and allocating storage). Making the use-define chains is a step in liveness analysis, so that logical representations of all the variables can be identified and tracked through the code.
Alias analysis [4] is a technique in compiler theory, used to determine if a storage location may be accessed in more than one way. Two pointers are said to be aliased if they point to the same location. In general, alias analysis determines whether or not separate memory references point to the same area of memory. This allows the compiler to determine what variables in the program will be affected by a statement.
Inter-procedural analysis [5] uses calling relationships among procedures to analyze call-return and parameter passing mechanisms, local variable of the function and function recursion.
In this project we will use LLVM to execute these techniques on benchmark suits, which are exactly Polybench, NPB and BOTS.
As the next step we will apply available from previous research python-script to convert our results to DiscoPoP format.
Since dynamic data dependencies extracting technique DiscoPoP and static data dependencies extracting technique PLUTO were already executed on mentioned above benchmark suits and their results are represented in DiscoPoP format, we will be able to compare them with the results of our experiment.

5 Expected Results

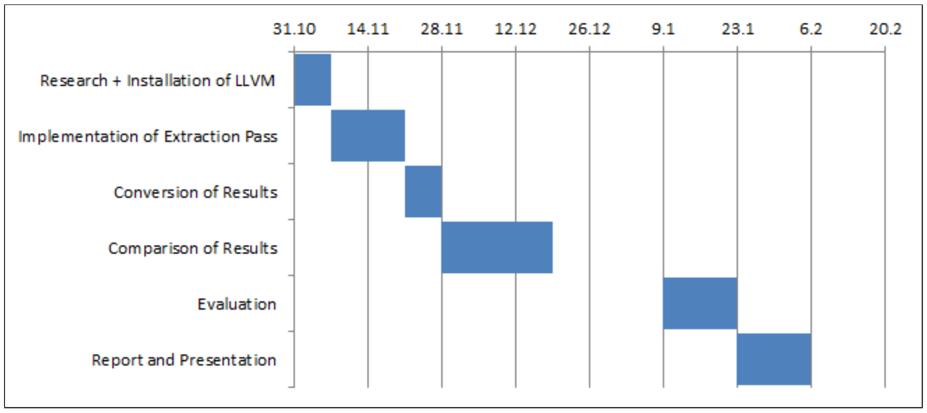
We expect that with static data dependencies extracting techniques more data dependencies will be found as by applying several combined techniques on benchmark suits we cover more possible dependency chains. We also aim to show that the presented static techniques can complement other existing techniques and combining their results will increase the total number of data dependencies detected on the benchmark suits.

6 Work Plan

6.1 Responsibilities

The work required for this project will be divided between two students. Both students will be responsible for conducting the execution of one or two static data dependencies techniques and then convert the results of the experiments to the DiscoPoP format. After applying these techniques, their results will be incorporated and compared to other existing techniques (DiscoPoP, PLUTO) by both students together.

6.2 Time Line



7 References

[1] Data dependency: https://en.wikipedia.org/wiki/Data_Dependency
[2] LLVM overview: http://llvm.org/docs/
[3] Use-Def Chain: https://en.wikipedia.org/wiki/Use-define_chain
[4] Alias analysis: https://en.wikipedia.org/wiki/Alias_analysis
[5] Inter-procedural optimization:
https://en.wikipedia.org/wiki/Interprocedural_optimization