DiffTrace: Efficient Whole-Program Trace Analysis and Diffing

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ABSTRACT

Abstract to be written

KEYWORDS

diffing, tracing, debugging

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1 INTRODUCTION

Ganesh will write

I have some stuff in intro.tex (commented for now)

2 DFFTRACE COMPONENTS

2.1 General Idea

Here is a general overview of DiffTrace and its components

- Motivating example
- Problem statement
- Potential Approaches and Related Work
- Next subsections will explain the components that we have in our framework and the corresponding related work and background

2.2 Fault Injection

2.3 ParLOT

2-3 paragraph explanation about ParLOT and its mechanism [40]

2.4 Filter

Include a table with all filters and their regular expressions

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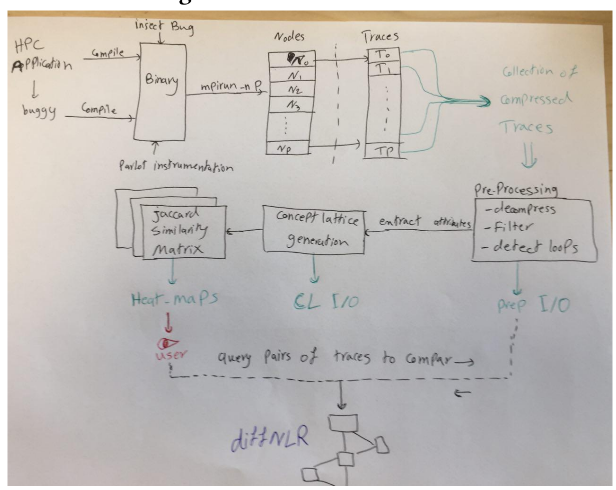
Figure 1: diffTrace Overview



2.4.1 *General Filters.*

- Returns
- .plt
- Memory
- Network
- Polling
- String
- Customize
- IncludeEverything

2.4.2 *Target Filters.*

- MPI_
- MPIall
- MPI_ Collectives
- MPI_ Send/Recv
- OMPall
- OMPcritical
- OMPmutex

2.5 Nested Loop Recognition

2.5.1 *Background.*

2.5.2 *Implementation.*

2.6 Concept Lattice Analysis

2.6.1 Background.

- FCA (formal concept analysis) background and citations
- FCA applications in all areas
- FCA applications in Data Mining and Information Retrieval
- FCA applications in distributed systems (Garg's work)
- intro to Concept, Object, Attribute and other definitions

2.6.2 Objects/Attributes. Mapping of Object/Attribute (general) to Trace/Attribute (clTrace)

What do we expect to gain by doing so

- Single entity represents the whole execution of HPC application (can be used as signature/model in ML)
- Classifying similar behavior objects(traces)
- Efficient Incremental CL building makes it scalable
- Efficient full pair-wise Jaccard Similarity Matrix extraction

2.6.3 CL generation.

- background
- current approach

2.6.4 Jaccard Similarity Matrix.

- background
- LCA
- Benefits

2.7 diffNLR

- motivation
- diff algorithm
- visualization

2.8 FP-Trace

3 BACKGROUND AND RELATED WORK

3.1 STAT

Parallel debugger STAT[1]

- STAT gathers stack traces from all processes
- Merge them into prefix tree
- Groups processes that exhibit similar behavior into equivalent classes
- A single representative of each equivalence can then be examined with a full-featured debugger like TotalView or DDT

What STAT does not have?

- FP debugging
- Portability (too many dependencies)
- Domain-specific
- Loop structures and detection

3.2 Program Understanding

- Score-P [23]
- TAU [38]
- ScalaTrace: Scalable compression and replay of communication traces for HPC [35]
- Barrier Matching for Programs with Textually unaligned barriers [43]
- Pivot Tracing: Dynamic causal monitoring for distributed systems - Johnathan mace [29]
- Automated Charecterization of parallel application communication patterns [37]
- Problem Diagnosis in Large Scale Computing environments [31]
- Probablistic diagnosis of performance faults in large-scale parallel applications [25]
- detecting patterns in MPI communication traces - robert preissl [36]
- D4: Fast concurrency debugging with parallel differntial analysis - bozhen liu [28]
- Marmot: An MPI analysis and checking tool - bettina krammer [24]
- MPI-checker - Static Analysis for MPI - Alexandrer droste [14]
- STAT: stack trace analysis for large scale debugging - Dorian Arnold [1]
- DMTracker: Finding bugs in large-scale parallel programs by detecting anomaly in data movements [16]
- SyncChecker: Detecting synchronization errors between MPI applications and libraries - [10]
- Model Based fault localization in large-scale computing systems - Naoya Maruyama [30]
- Synoptic: Studying logged behavior with inferred models - ivan beschastnikh [4]
- Mining temporal invariants from partially ordered logs - ivan beschastnikh [6]
- Scalable Temporal Order Analysis for Large Scale Debugging - Dong Ahn [2]
- Inferring and asserting distributed system invariants - ivan beschastnikh - stewart grant [19]
- PRODOMETER: Accurate application progress analysis for large-scale parallel debugging - subatra mitra [32]
- Automaded : Automata-based debugging for dissimilar parallel tasks - greg [8]
- Automaded : large scale debugging of parallel tasks with Automaded - ignacio [26]
- Inferring models of concurrent systems from logs of their behavior with CSight - ivan [5]

3.3 Trace Analysis

- Trace File Comparison with a hierarchical Sequence Alignment algorithm [41]
- structural clustering : matthias weber [42]
- building a better backtrace: techniques for postmortem program analysis - ben liblit [27]
- automatically charecterizing large scale program behavior - timothy sherwood [39]

3.4 Visualizations

- Combing the communication hairball: Visualizing large-scale parallel execution traces using logical time - katherine e isaacs [21]
- recovering logical structure from charm++ event traces [20]
- ShiViz - Debugging distributed systems - [7]

Filter	Attributes	Top Process diffNLR Candidates	Top Thread diffNLR Candidates
11.mpi.cust.0K10	sing.log10	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(2)r259.10694.2,(78)r265.20116.3 2:(17)r259.10697.2,(64)r265.20113.4 3:(49)r265.20110.4,(58)r265.20112.3
11.mpi.cust.0K10	doub.orig	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(32)r259.10700.2,(54)r265.20111.4 2:(14)r259.10696.4,(74)r265.20115.4 3:(53)r265.20111.3,(53)r265.20111.3
11.mpicol.cust.0K10	doub.orig	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(32)r259.10700.2,(54)r265.20111.4 2:(14)r259.10696.4,(74)r265.20115.4 3:(53)r265.20111.3,(53)r265.20111.3
01.mpicol.0K10	doub.orig	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(32)r259.10700.2,(54)r265.20111.4 2:(14)r259.10696.4,(74)r265.20115.4 3:(53)r265.20111.3,(53)r265.20111.3
11.mpicol.cust.0K10	sing.orig	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(2)r259.10694.2,(78)r265.20116.3 2:(17)r259.10697.2,(64)r265.20113.4 3:(49)r265.20110.4,(58)r265.20112.3
01.mpicol.0K10	doub.actual	1:(25)r259.10699.0,(65)r265.20114.0 2:(20)r259.10698.0,(75)r265.20116.0 3:(0)r259.10694.0,(55)r265.20112.0	1:(32)r259.10700.2,(54)r265.20111.4 2:(14)r259.10696.4,(74)r265.20115.4 3:(53)r265.20111.3,(53)r265.20111.3

Figure 2: Recommendation Table Sample for one of the bugs

3.5 Concept Lattice and LCA

- Vijay Garg - Applications of lattice theory in distributed systems
- Dimitry Ignatov [?] - Concept Lattice Applications in Information Retrieval
- [15] [18] [3] [17] [33]

3.6 Repetitive Patterns

- [11] [22] [34] [13] [12]

4 RESULTS

Table 1 describes the bug that I injected to ILCS-TSP

4.1 MPI Bugs

5 CASE STUDIES

5.0.1 Case Study: ILCS. ILCS [9]

5.0.2 Case Study: MFEM.

6 DISCUSSION AND FUTURE WORK

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Table 1: Injected Bugs to ILCS-TSP

ID	Level	Bugs	Description
1	MPI	allRed1wrgOp-1-all-x	Different operation (MPI_MAX) in only one (buggyProc) for first MPI_ALLREDUCE() – L229:ilcsTSP.c
2		allRed1wrgSize-1-all-x	Wrong size in only one (buggyProc) for first MPI_ALLREDUCE() – L229:ilcsTSP.c
3		allRed1wrgSize-all-all-x	Wrong Size in all processes for first MPI_ALLREDUCE() – L229:ilcsTSP.c
4		allRed2wrgOp-1-all-x	Different operation (MPI_MAX) in only one (buggyProc) for first MPI_ALLREDUCE() – L277:ilcsTSP.c
5		allRed2wrgSize-1-all-x	Wrong size in only one (buggyProc) for first MPI_ALLREDUCE() – L277:ilcsTSP.c
6		allRed2wrgSize-all-all-x	Wrong Size in all processes for second MPI_ALLREDUCE() – L277:ilcsTSP.c
7		bcastWrgSize-1-all-x	Wrong Size in only one (buggyProc) of MPI_Bcast() – L290:ilcsTSP.c
8		bcastWrgSize-all-all-x	Wrong Size n all processes for MPI_Bcast() – L240:ilcsTSP.c
9	OMP	misCrit-1-1-x	Missing Critical Section in buggyProc and buggyThread – L170:ilcsTSP.c
10		misCrit-all-1-x	Missing Critical Section in buggyThread and all prcoesses – L170:ilcsTSP.c
11		misCrit-1-all-x	Missing Critical Section in buggyProc and all threads – L170:ilcsTSP.c
12		misCrit-all-all-x	Missing Critical Section in all procs and threads – L170:ilcsTSP.c
13		misCrit2-1-1-x	Missing Critical Section in buggyProc and buggyThread – L230:ilcsTSP.c
14		misCrit2-all-1-x	Missing Critical Section in buggyThread – L230:ilcsTSP.c
15		misCrit2-1-all-x	Missing Critical Section in buggyProc and all threads – L230:ilcsTSP.c
16		misCrit2-all-all-x	Missing Critical Section in all procs and threads – L230:ilcsTSP.c
17		misCrit3-1-all-x	Missing Critical Section in buggyProc and all threads – L280:ilcsTSP.c
18		misCrit3-all-all-x	Missing Critical Section in all procs and threads – L280:ilcsTSP.c
19	General	infLoop-1-1-1	Injected an infinite loop after CPU_EXEC() in buggyProc,buggyThread & buggyIter L164:ilcsTSP.c

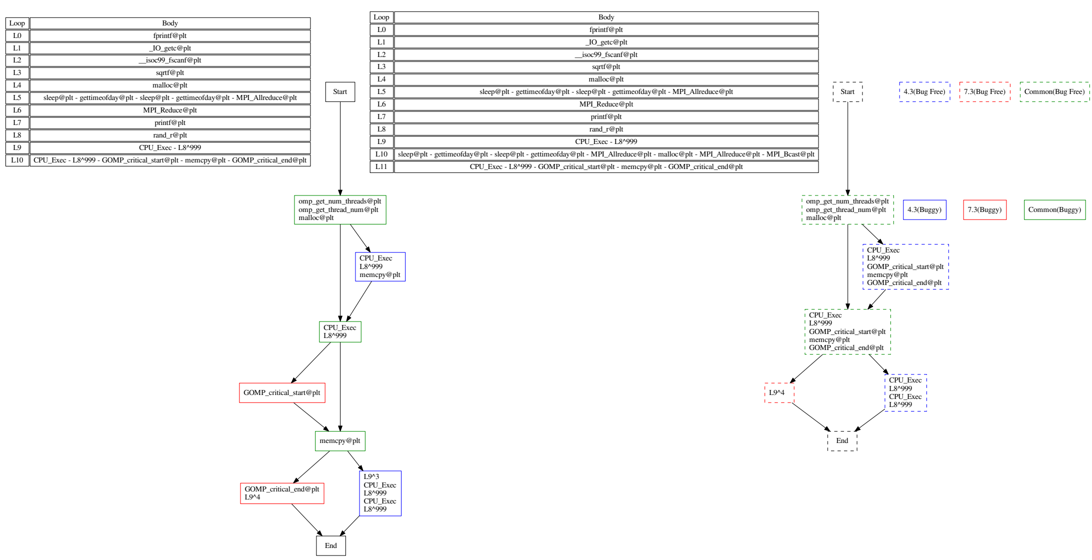

Figure 3: sample diffNLR

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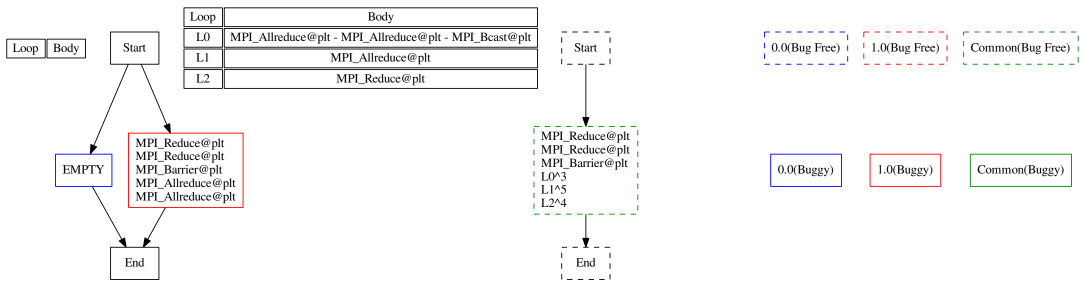

Figure 4: sample diffNLR2

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