Workshop on Essential Abstractions in GCC

Introduction and Opening Remarks

GCC Resource Center

(www.cse.iitb.ac.in/grc)

Department of Computer Science and Engineering,

Indian Institute of Technology, Bombay

29 June 2013

Outline

- About GCC Resource Center
- Workshop Plan

Part 1

About GCC Resource Center

National Resource Center for F/OSS, Phase II

GCC Resource Center is a part of NRCFOSS (II)

- Sponsored by Department of Information Technology (DIT), Ministry of Information and Communication Technology
- CDAC Chennai is the coordinating agency of NRCFOSS (II)
- Participating agencies

  CDAC Chennai, CDAC Mumbai, CDAC Hyderabad, IIT Bombay, IIT Madras, Anna University,
- Project investigators of GCC Resource Center

Uday Khedker:	Professor, Dept. of CSE, IIT Bombay
Supratim Biswas:	Professor, Dept. of CSE, IIT Bombay
Amitabha Sanyal:	Professor, Dept. of CSE, IIT Bombay

Objectives of GCC Resource Center

1. To support the open source movement

   Providing training and technical know-how of the GCC framework to academia and industry.

2. To include better technologies in GCC

   Whole program optimization, Optimizer generation, Tree tiling based instruction selection.

3. To facilitate easier and better quality deployments/enhancements of GCC

   Restructuring GCC and devising methodologies for systematic construction of machine descriptions in GCC.

4. To bridge the gap between academic research and practical implementation

   Designing suitable abstractions of GCC architecture

Broad Areas of Interests

- Program Analysis and Optimization
- Translation Validation
- Retargetable compilation
- Parallelization and Vectorization for SIMD and MIMD Architectures

General explorations applied in the context of GCC

Broad Research Goals of GCC Resource Center

- Using GCC as a means
  - Adding new optimizations to GCC
  - Adding flow and context sensitive analyses to GCC (In particular, pointer analysis)
  - Automatic validation of GCC translation
- Using GCC as an end in itself
  - Changing the retargetability mechanism of GCC
  - Cleaning up the machine descriptions of GCC
  - Systematic construction of machine descriptions
  - Facilitating optimizer generation in GCC

Our Deliverables: Research and Development

- Technologies:
- Tools:
- Methodologies:
- Concepts:

Our Deliverables: Research and Development

- Technologies:
  Precise Pointer Analysis, Optimizer Generation, specRTL for Simplifying Machine Descriptions
- Tools:
  Build broswer, compilation broswer
- Methodologies:
  Gray box probing, Incremental construction of machine descriptions
- Concepts:
  Essential abstractions in GCC

Our Deliverables: Human Resource Development

- Teaching material
- Outreach programmes
- Formal courses

Our Deliverables: Human Resource Development

- Teaching material
  - The official GCC HOWTO pages have a link to our training material
  - Request by GCC developer community for videos of our lectures
  - Designed suitable abstractions of GCC architecture
  - Devised useful methodologies and built tools to understand GCC
- Outreach programmes
  - Conducted annual workshops and tutorials in India
  - Conducted tutorials in prestigious international conferences
  - Projects for external students
- Formal courses
  - Designed and taught Master's course on GCC
  - Designed GCC related lab assignments for UG compiler course

Part 2

Workshop Plan

Motivation Behind this Workshop

- To understand GCC well :-)

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- To understand GCC well :-)
- Reasonably quickly

Philosophy and Pedagogy

Twin goals of this workshop:

- *Learning how to learn GCC*

  Our focus will be on

  - giving you some core information
  - showing you how to discover more information

- *Striking a balance between theory and practice*

  Our focus will be on showing you how to

  - discover concepts in a large code base and build abstractions
  - take concepts and update a large code base
  - relate the class room concepts of compilers to an industry strength compiler

Our Canvas

- Version: GCC 4.7.2
- Language: C, C++
- Targets: i386, spim (mips simulator)

Philosophy and Pedogogy

- We will

- You will

Philosophy and Pedogogy

- We will
  - Explain configuration and building of GCC
  - Explain essential abstractions related to compilation
    The key intermediate representations and their manipulations
  - Explain essential abstractions related to program analysis in GCC
  - Explain essential abstractions related to generation of a compiler
    The machine descriptions and their influence on compilation
- You will

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    The machine descriptions and their influence on compilation
- You will
  - Build and run GCC
  - Examine various IR dumps produced by GCC
  - Add passes to GCC
  - Add a new machine description and systematically enhance it

Takeaways from this Workshop

- A programmer will get a better compiler
- A compiler professional will be able to deploy and enhance GCC much more easily.
- A compiler researcher will be able to use GCC for research much better.
- A compiler teacher will be able to strike a better balance between theory and practice.
- A compiler student will be exposed to issues in real compilers.

Schedule on All Days

- 09:30. Commencement of the pre-lunch session
- 11:00. Tea Break
- 13:00. Lunch Break
- 14:00. Commencement of the post-lunch session
- 15:30. Tea Break
- 17:15. High Tea (Formal sessions end. Participants can continue to work on the assignments)
- 20:30. Dinner

Coverage

- A day wise coverage follows
- The big picture of coverage and logical connections between the topics?

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  Will be clear after the technical overview

Coverage on Day 1 (Saturday 29 June 2013)

Lecture Topics	Lab Topics
• Introductory remarks, Workshop plan • An overview of compilation and GCC • Gray box probing of GCC • Adding passes to gcc • (Optional) make, byobu, ctags, ddd, cscope, patch files	• Gray box probing of GCC • Adding intraprocedural GIMPLE passes

Coverage on Day 2 (Sunday 30 June 2013)

Lecture Topics	Lab Topics
• Module binding mechanisms in GCC • Gcc control flow • Manipulating GIMPLE IR • Link time optimization (LTO) • Configuration and building	• Adding interprocedural GIMPLE passes • Configuration and building

Coverage on Day 3 (Monday 1 July 2013)

Lecture Topics	Lab Topics
• Introduction to machine descriptions • Spim machine descriptions • The retargetability mechanism of GCC	Machine Descriptions

Coverage on Day 4 (Tuesday 2 July 2013)

Lecture Topics	Lab Topics
• Introduction to Parallelization and Vectorization • Parallelization and Vectorization in GCC	Parallelization and Vectorization

Coverage on Day 5 (Wednesday 3 July 2013)

Lecture Topics	Lab Topics
Nothing :-)	Complete remaining assignments

Optional Coverage

- If you are keen on knowing about the following
  - Data flow analysis in GCC, pointer analysis in GCC
  - Context sensitive interprocedural analysis
  - Optimizer generation
  - specRTL based machine descriptions
- May lead to possible collaboration with us

Lecture and Lab Schedule

- Lab and lectures will be interleaved
- Flexible schedule
- Duration, time, sequencing may be changed dynamically based on how well things are being received

Announcements and Questions

Lab arrangements:

- Assignments have to be done in groups of two.
  - Please use the tea time to finalize your group
  - A sheet will be circulated after the tea for group details
  - If you need a laptop, we will issue it during lunch. You will need to return it in the evening.
- Doing the assignments.
  - Do all exercises on your laptop, or
  - Use your laptop and log into our servers,
  - Use our laptop and log into our servers.
- How to connect to server?

  Separate information sheet has been provided.
- Teaching assistants will help you in doing the assignments

Announcements and Questions

- Dinner and breakfast arrangments
  - Breakfast available in the hostels
  - Tea: Available in the foyer
  - Dinner: Sat, Sun, Mon, Tue: Available at 20:30 in foyer
- We need to know who all would like to stay back for
  - dinner on Tuesday night
  - the Wednesday morning session (incuding the lunch)
- Important requirement from the security:

  Please continue to wear your name badge throughout the IITB campus

Announcements and Questions

- Receipts of payments
  - Most receipts should be ready
  - Please collect from Nisha on Tuesday during the lunch time

Announcements and Questions

- Receipts of payments
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  - Please collect from Nisha on Tuesday during the lunch time
- Concluding session
  - Informal discussions
  - Brief (10 minute) presentations by participating organizations/individuals
    If you are interested, please contact me today or latest tomorrow
  - Feedback forms
  - Announcement of best Teaching Assistant

The Organizing Team

1. Amitkumar Patil
2. Amitabha Sanyal
3. Aniket Deole
4. Avantika Gupta
5. Barnali Basak
6. Himanshu Sharma
7. Kalyani Zope
8. Mayank Gupta
9. Mahendra Kaklij
10. Mukta Joglekar
11. Nisha Biju
12. Pritam Gharat
13. Rohan Padhye
14. Sheweta Tharani
15. Swati Rathi
16. Sudakshina Das
17. Supratim Biswas
18. Sumit Jamgade
19. Uday Khedker
20. Vini Kanvar
21. Vinit Deodhar