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

30 June 2011

Part 1

About GCC Resource Center

Outline

- About GCC Resource Center
- Workshop Plan

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)
  - Translation validation of GCC
- 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

GRC Training Programs

Title	Target	Objectives	Mode	Duration
Workshop on Essential Abstractions in GCC	People interested in deploying or enhancing GCC	Explaining the essential abstractions in GCC to ensure a quick ramp up into GCC Internals	Lectures, demonstrations, and practicals (experiements and assignments)	Three days
Tutorial on Essential Abstractions in GCC	People interested in knowing about issues in deploying or enhancing GCC	Explaining the essential abstractions in GCC to ensure a quick ramp up into GCC Internals	Lectures and demonstrations	One day
Workshop on Compiler Construction with Introduction to GCC	College teachers	Explaining the theory and practice of compiler contruction and illustrating them with the help of GCC	Lectures, demonstrations, and practicals (experiements and assignments)	Seven days
Tutorial on Demystifying GCC Compilation	Students	Explaining the translation sequence of GCC through gray box probing (i.e. by examining the dumps produced by GCC)	Lectures and demonstrations	Half day

GRC Training Programs

Title	Target	Objectives	Mode	Duration
Workshop on Essential Abstractions in GCC	People interested	Explaining the essential abstractions in GCC	Lectures,	Three days
Tutorial on Essential Abstractions in GCC	People interested enhancing GCC	Explaining the essential GCC Internals	Lectures and	One day
Workshop on Compiler Construction with Introduction to GCC	College teachers	Explaining the theory and help of GCC	Lectures,	Seven days
	Students			Half day

3, 4, and 5 Jul '09 IIT Bombay, Mumbai

5-8 Jul '10 IIT Bombay, Mumbai

(modified version) 9 Jan '10 ACM PPoPP, Banglore

2 Apr '11 CGO, Chamonix, France

7-13 Dec '09, IIT Bombay, Mumbai

10-15 Jul '10 MIT, Pune

20 Jan '10 Cummins College Pune

20 Feb '10 IIITDM, Jabalpur

06 Mar '10 SGGS IET, Nanded

27 Mar '10 RSCoE , Pune

25 Apr '10 Punjabi University Patiala

13 Sep '10 IITM Chennai

GRC Training Programs

CS 715: The Design and Implementation of GNU Compiler Generation Framework

- 6 credits semester long course for M.Tech. (CSE) students at IIT Bombay
- Significant component of experimentation with GCC
- Introduced in 2008-2009

Part 2

Workshop Plan

Motivation Behind this Workshop

- 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 complilers to an industry strength compiler

Our Canvas

- Version: GCC 4.6.0
- Language: C
- Targets: i386, spim (mips simulator)

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
  - 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.

Day 1 Schedule (Thursday 30 June 2011)

09:45 to 10:00	Introductory remarks, Workshop plan	Lecture
10:00 to 10:30	An overview of compilation and GCC	Lecture
10:30 to 11:00	An external view of GCC	Lecture
11:00 to 11:30	Tea break	
11:30 to 12:15	First level gray box probing of GCC	Lecture
11:30 to 12:15	Gray box probing for machine independent optimizations	Lecture
13:00 to 14:00	Lunch	
14:00 to 15:30	Gray box probing of GCC	Lab
15:30 to 15:45	Tea break	
15:45 to 16:15	Gray box probing of GCC	Lab
16:15 to 17:15	Configuration and building	Lecture
17:15	High Tea	
Optional	ctags, cscope, ddd, shell, make, screen, patch files	Demo
20:30	Dinner	
Participants can continue to do the lab work until dinner		

Day 2 Schedule (Friday 1 July 2011)

09:30 to 11:00	Module Binding Mechanisms in GCC	Lecture
11:00 to 11:30	Tea break	
11:30 to 13:00	Adding Passes to GCC: Manipulating GIMPLE and RTL IRs	Lecture
13:00 to 14:00	Lunch	
14:00 to 15:30	Adding GIMPLE interprocedural and intraprocedural passes	Lab
15:30 to 15:45	Tea break	
15:45 to 17:15	Adding GIMPLE interprocedural and intraprocedural passes	Lab
17:15	High Tea	
20:30	Dinner	
Participants can continue to do the lab work until dinner		

Day 3 Schedule (Saturday 2 July 2011)

09:30 to 10:00	Introduction to Machine Descriptions	Lecture
10:00 to 10:30	Spim machine descriptions Levels 0, 1	Lecture
10:30 to 11:00	Machine description assignments	Lab
11:00 to 11:30	Tea break	
11:30 to 13:00	Machine description assignments	Lab
13:00 to 14:00	Lunch	
14:00 to 14:30	Spim machine descriptions Levels 2, 3, 4	Lecture
14:30 to 15:00	Advanced issues in machine descriptions	Lecture
15:00 to 15:30	Machine description assignments	Lab
15:30 to 15:45	Tea break	
15:45 to 16:45	Machine description assignments	Lab
16:45 to 17:15	The Retargetability Mechanism of GCC	Lecture
17:15	High Tea	
20:30	Dinner	
Participants can continue to do the lab work until dinner		

Day 4 Schedule (Sunday 3 July 2011)

09:30 to 10:15	Introduction to Parallelization and Vectorization	Lecture
10:15 to 11:00	Parallelization and Vectorization in GCC	Lecture
11:00 to 11:30	Tea break	
11:30 to 13:00	Parallelization and Vectorization in GCC	Lecture
13:00 to 14:00	Lunch	
14:00 to 15:30	Parallelization and Vectorization in GCC	Lab
15:30 to 15:45	Tea break	
15:45 to 17:15	Concluding Sesssion	
17:15	High Tea	

Announcements and Questions

Lecture and lab schedule

- Flexible
- Duration, time may be changed dynamically based on how well things are being received
- Lab and lectures may be interchanged too

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: Thu, Fri, Sat: Available at 20:30 in foyer
- Important requirement from the security:
  Please continue to wear your name badge throughout the IITB campus

Announcements and Questions

- Receipts of payments
  - If you have sent the DD earlier, your receipt may be ready.
  - Please collect from Nisha on Saturday 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 Workshop Team

1. Aboli Ajit Aradhye
2. Ankita Mathur
3. Amit Kulkarni
4. BalKrishna Jeph
5. Dhritiman Das
6. Harbaksh Chhabra
7. Gokul Ramaswamy
8. Jubi Taneja
9. Mradul Maheshwari
10. Netra Shetty
11. Nisha Biju
12. Prachee Yogi
13. Prashant Singh Rawat
14. Prateek Sharma
15. Prerna Budhkar
16. Rahul Agrawal
17. Sayali Vilas Borawake
18. Soumya Prasad Ukil
19. Sreenivas M N
20. Swati Rathi
21. Vineet Singh
22. Vini Kanvar

Overall coordination: Uday Khedker, Supratim Biswas, Amitabh Sanyal