

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 2012

Part 1

About GCC Resource Center

- About GCC Resource Center
- Workshop Plan



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



National Resource Center for F/OSS, Phase II

Notes



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



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 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 (experiments 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 construction and illustrating them with the help of GCC | Lectures, demonstrations, and practicals (experiments 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 |



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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



Our Canvas

- Version: GCC 4.6.2
- Language: C
- Targets: i386, spim (mips simulator)



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



Philosophy and Pedagogy

- *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.



Coverage

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

Will be clear after the technical overview



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 on Day 1 (Saturday 30 June 2012)

| Lecture Topics | Lab Topics |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Introductory remarks, Workshop plan • An overview of compilation and GCC • Gray box probing of GCC • Configuration and building • (Optional) make, byobu, ctags, ddd, cscope, patch files | <ul style="list-style-type: none"> • Gray box probing of GCC • Configuration and building |



Coverage on Day 2 (Sunday 1 July 2012)

| Lecture Topics | Lab Topics |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Module binding mechanisms in GCC • Adding passes to gcc • gcc control flow • Manipulating GIMPLE IR • Link time optimization (LTO) • Introduction to data flow analysis, pointer analysis | Adding GIMPLE passes <ul style="list-style-type: none"> • Intraprocedural, • Interprocedural (translation unit level) • Interprocedural (program level) |



Coverage on Day 4 (Tuesday 3 July 2012)

| Lecture Topics | Lab Topics |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> • Introduction to Parallelization and Vectorization • Parallelization and Vectorization in GCC | Parallelization and Vectorization OR Pointer Analysis OR Machine descriptions in specRTL |



Coverage on Day 3 (Monday 2 July 2012)

| Lecture Topics | Lab Topics |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| <ul style="list-style-type: none"> • Introduction to machine descriptions • Spim machine descriptions • specRTL based machine descriptions • The retargetability mechanism of GCC | Machine Descriptions |



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
- Use handouts to make notes against the slides



Video Recording of the Course

- Several requests received in past
Last request from the GCC Developers' Meet
- Lectures will be recorded by the *Talk to A Teacher* project of IITB
- Videos will be released in the open source free of cost
- You are requested to sign a consent form
- **There are sensitive microphones near you to catch your gossip :-)**
 - ▶ Please do not disturb them!
 - ▶ They will catch the vibrations of your mobile phones too!



Announcements and Questions

- Dinner and breakfast arrangements
 - ▶ Breakfast available in the hostels
 - ▶ Tea: Available in the foyer
 - ▶ Dinner: Sat, Sun, Mon: 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

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

- Receipts of payments
 - ▶ If you have sent the DD earlier, or have made electronic payment, your receipt may be ready.
 - ▶ 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



Two Visitors Who Could Not be Accommodated ...

We usually are very selective but sometime some folks gate crash

Time: 02:00 a.m. Thursday 28 June 2012

Venue: A parking shed of a colleague's quarter



Some Precautions: And then the Good News

- Confining yourself to the main road should not be a problem
- If possible, move out in groups
- In past forty years, only two persons were injured
Calculate the probability by considering the number of people who have been on the campus in forty years
- Unless you bother them, the visitors would not bother you



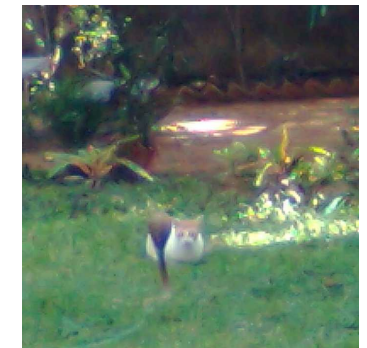
Some Precautions: First the Caution

- Do not stray into secluded areas and deserted bylanes from evening until morning
- Trying to save yourself by hiding behind bushes and thick vegetation on the lake side or hill side may not help
Leopards ('s' as in plural) may be hiding there
- Evening walks by the lake are best avoided



Some Precautions: Further Information ...

- Snakes are regular residents, don't bother them
- So are monkeys and cattle



The Support Team

- | | | |
|---------------------|--------------------------|----------------------|
| 1. Aboli Aradhya | 10. Karan Kalra | 19. Rahul Asati |
| 2. Amitkumar Patil | 11. Mukta Joglekar | 20. Raj Agrawal |
| 3. Anup Naik | 12. Netra Shetty | 21. Rohan Padhye |
| 4. BalKrishna Jeph | 13. Nikhil Sapre | 22. Sreenivas M N |
| 5. Dhananjay Sathe | 14. Nisha Biju | 23. Swati Rathi |
| 6. Deepak Jayanth | 15. Prachee Yogi | 24. Senthilkumaran N |
| 7. Harbaksh Chhabra | 16. Prashant Singh Rawat | 25. Sudakshina Das |
| 8. Gaurav Bhagwat | 17. Pritam Gharat | 26. Sumit Jamgade |
| 9. Gokul Ramaswamy | 18. Rahul Agrawal | 27. Vini Kanvar |

