Women in Compilers and Tools Virtual Meetup Series

From Packing Decimals With Cobol to Optimizing Tweets With Scala: A Journey Through Space, Time, & Culture with Compilers

Uma Srinivasan
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@umatweep
#TwitterVMTeam
What is a Compiler?
**X is a compiler**

<table>
<thead>
<tr>
<th>Input Purist</th>
<th>Output Purist</th>
<th>Output must be binary</th>
</tr>
</thead>
<tbody>
<tr>
<td>gcc is a compiler</td>
<td>gcc is a compiler</td>
<td>prettier is a compiler</td>
</tr>
<tr>
<td>Input Neutral</td>
<td>Output Neutral</td>
<td>Output must be instructions</td>
</tr>
<tr>
<td>Microsoft Word is a compiler</td>
<td>Microsoft Word is a compiler</td>
<td>Javadoc is a compiler</td>
</tr>
<tr>
<td>Input Rebel</td>
<td>Output Rebel</td>
<td>Output can be anything</td>
</tr>
<tr>
<td>A coin flip is a compiler</td>
<td>Bop It! is a compiler</td>
<td>The sun is a compiler</td>
</tr>
</tbody>
</table>

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I'm a compiler, you're a compiler, it's compilers all the way down.
It’s compilers all the way down.....

......

Compilers in the 1980s....

Compilers in the 1990s....

Compilers in the 2000s....

Compilers in the 2010s....

Compilers in the 2020s....

......
Compilers in the 1980s ….

- Many programming languages
  - Cobol, RPG, Transact, Pascal, Fortran, C and ….. Ada
- 1 target hardware architecture & implementation - PA-RISC
  - A common backend code generator - written in Pascal
  - IRs - Ucode, SLLIC
  - Low level optimizer - both machine dependent & independent opts - in C
- 1 Operating System - HPUX
  - Released once every couple of years
- Cobol Packed Decimal code generation & [ANDF]
- Questions
  - Why was C following a different codegen path?
  - What should Ada follow?
  - How about a machine independent optimizer?
  - Which backend? Apollo or HP?
  - Automatic code gen?

Hewlett-Packard Journal January 1986 Volume 37 Number 1

June 29, 1987
Method for improved code generation in reduced instruction set computers

**$subprograms$**

```c
#include 'globopts.h'
#include 'condit.h'
```

**Date who routine modification created module**

02-01-86 ubb

including implement the last digits of two decimal operators.

Function `do_gadd_req` and `millicode` to allocate.

```c
begin (do_gadd_req)
  CGDID doesn't use long pointers. (yet)
  assert (reg_loc.base.reg)  assert_failures
  assert (reg_loc.base.reg)  assert_failures
  Allocate alias nets:
  alias_loc(used_by_reg_loc_loc2.loclags); alias_loc(used_by_reg_loc_loc2.loctags);
  
  (create pointers)
  adjust location reg_loc)
  adjust location reg_loc)
  (load pairs)
  emit qr_copy reg_loc_base.reg, ARG0
  emit qr_copy l_reg_base.reg, ARG1
  emit qr_copy l_reg_base.reg, ARG2
  
  if (do_millicode) then
    
  
  else if (do_millicode)
```

Bif 'don't'

```c
if (don't)
  
  result_reg = get_scratch_reg();
  result_reg = get_scratch_reg();
```

**call millicode routine**

**debug dumps**
From India to the USA

IIT Madras
- *Fortran* 77, wrote programs, typed on punch cards, IBM 360
- 8080 assembly
- VAX workstation, prototyped x86 code generator in *C*
- Computers were only available in air conditioned labs, quite a distance from the dorm

U. of Wisconsin, Madison
- First compiler course, project - developing an *Ada* code generator
- Computer labs in the basement of the department building
- TA in the Mac lab - *Pascal* compiler UI reported syntax errors even as you typed - WoW!
HP Work Culture *The HP Way*

- **Team work**
  - Entirely local team - HP Cupertino Bldg 47 Lower
  - Favorite restaurants: Cicero’s, La Fiesta, Florentine’s,...
    - hardly any vegetarian and no vegan options then
  - Apollo acquisition and friction
  - Open cubicles, code printouts, dumb terminals, solid wooden desk to hide under - Loma Prieta earthquake
  - Engineers did not travel except for conferences

- **Women were respected and in influential positions in CLL (Compiler Language Lab)**
  - My interviewers, first and hiring manager, second level manager, lots of women managers, no dual ladder in the engineering labs, family friendly

- **Benefits and Incentives**
  - Profit sharing, ESPP, Stock awards and options
  - Leave accumulation across years
Role Models, Mentors, Colleagues, Friends and Family


Fran Allen

Ada

#AdaLoveLaceDay
Hewlett-Packard Precision Architecture Compiler Performance by Karl W. Pettis and William B. Buzbee

Register Reassociation in PA-RISC Compilers by Vatsa Santhanam


one of 6 girls in a batch of 240 students!!

look, a CRAY-2 poster

USA
dorm
wearing contact lenses

Calcutta, INDIA
Santa Clara, CA
IIT-M
campus
Univ. of Wisconsin Madison - Commons

dancing \|/

my personal phone :-)

ME
Compilers in the 1990s

- High Level Optimizer
- Code Generator - in C
- 1 LLO per target machine architecture
  - Loop unrolling, Instruction Scheduling, Code layout
- My first publication & patent **CC’ 94, Intelligent Loop Unrolling**

*Compiler Optimizations for the PA-8000 - IEEE COMPCON 97*
Compilers in the 1990s

- The Itanium compiler - EPIC code generation and optimization
- **Compiling for IA-64**
  - Modulo Scheduling
  - Optimizing IA-64 Math Functions
- **PACT 2000 papers & patents**
  - Control & Data Speculation framework
  - Modulo Scheduling
    - Uncounted loops
    - Data Speculation
    - Rotating register assignment
Work Culture

- Dual ladder for career advancement
- Teamwork and collaboration across the country, orgs and companies
  - CLL (California), MLL (Massachusetts) and then Texas (Compaq) compiler teams
  - HP Research Labs and Production R&D teams
  - HP & Intel Itanium compiler teams
- Benefits
  - Family leave, Telecommuting (ISDN), beginnings of WFH
  - Significant other
Role Models, Mentors, Colleagues, Friends and Family

Bob Rau, Peter Markstein, HP Labs

Anne is a member of technical staff at Uber. Anne has over 20 years of experience as a software engineer at companies including VMware, Omnisift Technologies, Transmeta and HP. She holds a master’s degree in computer science from Duke University and a Doctorate in computer science from University of Virginia.

Anne Holler
Software Engineer
Uber
Role Models, Mentors, Colleagues, Friends and Family

Madras, India

Oregon?, USA

California, USA

Scotland - CC'94
Compilers in the 2000s

● Middle-ends in production - first paper in CGO

● Java JITs
  ○ First JavaOne talk "Improving the performance of Java technology on IA-64 processors" - JavaOne 2001
  ○ Oracle/Sun Hotspot JVM on Itanium Linux/Windows
    ■ Intel/Sun joint session "Maximizing Enterprise Java™ Performance on Multi-core Platforms" - JavaOne 2008
    ■ PMU based optimizations

● Hardware software co-design in earnest
  ○ Performance study of 2 bioinformatics applications on x86
  ○ In-order Atom (x86) processor compilation - superblock scheduling
  ○ Hardware atomicity for reliable software speculation - ISCA 2007
Intel Work Culture

● Shifting from being entirely Hardware centric to one of growing Software awareness
  ○ In production TIMING is everything
    ■ roadmaps, TPMs & PMs galore, Disagree & Commit
  ○ More women being hired into the workforce
  ○ Research labs under pressure to connect with production teams

● Globalization of engineering workforce
  ○ had managers in Oregon, Folsom, east coast
  ○ team members across the US, China, Russia, Australia, Argentina, Poland, Israel
  ○ Intel Jet available to all employees - frequent day trips to Hillsboro (OR), Folsom
  ○ Travels to Novosibirsk, Gdansk

● Results oriented, Meritocracy

● Women @ Intel
  ○ Anita Borg Institute - GHC - a panel on HW/SW co-design, met with Fran Allen
  ○ First Women Fellows

● Benefits
  ○ RSUs, Sabbatical leave

Explaining “Shangri-La – Domain Specific Programming System for Multi-core Architectures” to Paul Otellini on Research @ Intel Day 2005
Role Models, Mentors, Colleagues, Friends and Family

Carole DuLong, Tatiana Shpeisman,
Intel Research Labs

Women Who Code @WomenWhoCode · Mar 2
Grace Hopper was one of the first programmers of the Harvard Mark I computer and invented the first compiler for a computer programming language!
#InternationalWomensHistoryMonth #IWD #IWD2021 #WomeninSTEM #WomeninScience

“Humans are allergic to change. They love to say, ‘We’ve always done it this way.’ I try to fight that. That’s why I have a clock on my wall that runs counterclockwise.”
Grace Hopper
Computer Scientist

Association for Computing Machinery @TheOfficialAcm · Dec 9, 2020
Grace Hopper was born on this day in 1906. Hopper helped devise the theory of machine-independent programming languages. She was instrumental in the development of the COBOL, which went on to become the most ubiquitous language for business ever.

with Sandhya Viswanathan - Intel JVM Compiler Engineer
Role Models, Mentors, Colleagues, Friends and Family

The lineage of Gurus and my Chinmaya family

2 nieces graduated: MS & PhD, Computer Science majors, UCB, Stanford
Compilers in the 2010s

- HW/SW co-design continues
  - With GPUs
    - CGO 2012 - Keynote - **Hardware Software Co-design for Visual Computing**
    - Gen Graphics Architecture Development
      - Performance impact of Gen architectural features evaluated to provide recommendations
      - FP16 performance evaluation, feature enhancements on Gen8+ architectures with 3D (OpenGL) and Compute (OpenCL) workloads
    - New LLVM based shader compiler - **IGC**
  - Dataflow machines - **patent**
    - LLVM based code generation prototype for spatial accelerators
    - Co-design with an ex-VAX/Alpha HW architect and an ex-Multiflow/Itanium compiler architect

- Scala compilation and tools
  - Front end written in Scala
    - Heavy dependence on IDE and tools - **Scalafix @ Twitter scale**
  - VM **Graal** compiler - written in Java - the **Graal workshop @ CGO**
    - **Twitter & Graal, Scala ❤️ Graal, Autovectorization, Neuroevolution based inlining**
First Graal workshop @ CGO 2019 (Keynote)

What is Graal?
Applications of Graal

- JIT compiler for apps written in JVM languages (openjdk/hotspotVM/JVMCI)
- Specialized compiler for JVM apps (jruby-graal)
- AOT compiler for apps in JVM languages (subtrateVM/native-image)
- JIT for dynamic languages
- JIT for native languages
- Tool for embedding languages (Oracle DB, MySQL)
Twitter Culture

#OneTeam

- A new meaning for Inclusion & Diversity
  - BRGs - @womeng, twitter-women, twitter-asians, twitter-faith, twitter-open, ....
  - from Boomers to Gen Z
  - #TechWomen, maleallies
  - #WomenWhoCode, #GirlsWhoCode

- Lines fudged
  - Work and Family
  - Onsite open offices and Home offices
  - Customers and employees
  - Humans, pets and plants belong in the family - each have their own identity on Twitter ;-) 

- Benefits
  - Meditation rooms
  - Unlimited leave
  - Free lunches

#TechWomen @twitter 2018
Role Models, Mentors, Colleagues, Friends and Family

@intel

- **Sylvia Downing** - GPU Architect and the GPU architecture team
- the Graphics Compiler (IGC) team - several women engineers on this team
- the Dataflow architecture team
Role Models, Mentors, Colleagues, Friends and Family

@twitter

- @jack and staff … Leslie, Vijaya
- @jenniferfraser (#TechWomen), @kevino (#maleallies)
- @womeng friends - @dordogh, @catia3045, @elizdeng
- @igb & the #TwitterVMTeam - Nora, Yunjie, Maura
Role Models, Mentors, Colleagues, Friends and Family

- daughter graduated: BS & MEd, Cognitive Science & Education majors, UCLA

- 2 grand nephews & 1 grand niece
Compilers in the 2020s.....

- Compilers for ML
  - C4ML workshop @ CGO

- ML for Compilers
  - Autotune - Performance tuning Twitter services with Graal and Machine Learning
  - Improving Compiler optimizations by employing machine learning
    - Graal workshop @ CGO 2021
  - Compiler 2.0: Using ML to modernize compiler technology - C4ML workshop @ CGO 2020

- Compilers for Accelerators, TPUs, …
  - The Golden Age of Compiler Design… - ASPLOS 2021 keynote

- Twitter Women@ML
My Learnings

Life is one heck of a Deep Learning Neural Network

....experiences/inferences depend on the input/training received...

.....heavily weighted by role models, mentors, colleagues, friends & family
What are yours?

Thoughts may be fleeting but Tweets live forever…..

@umatweep would love to get your tweets #WiCTUma21