



Bantam Java Compiler Project: Experiences and Extensions

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Educational Impact of Compilers

Compiler projects can have significant impact on students:

- Deeper understanding of source programming language (and similar languages)
- Invaluable software development experience
- Better understanding of computer systems

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This Work

Demonstrate effectiveness of a compiler project in classroom
(at least, qualitatively)

Use Bantam Java Compiler Project [SIGCSE '08]

- Designed for the classroom
- Source language similar to Java
- Well documented
- Customizable

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Goals

- Encourage the use of compiler projects in classroom
- Share our experiences using Bantam Java Compiler Project with the computer science community
- Extend and improve the Bantam Java Compiler Project
- Promote the Bantam Java Compiler Project

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Outline of Remainder of Talk

Bantam Java Compiler Project

Experiences with Bantam Java

Extensions to Bantam Java
(e.g., extended language, etc.)

Future Work

Compiler Projects in the Classroom

Commercial compiler

=> real but often overly complex for classroom

Compilers for simple (e.g., non-object oriented) languages

=> doable in one semester but less appealing to student

Object-oriented, educational-based compiler

- COOL [Aiken, '96]
=> source significantly different from commercial languages
- MiniJava [Appel and Palsberg, '02]
=> tightly tied to textbook, lack of support code
- Bantam Java [SIGCSE '08]

Bantam Java Compiler Project

Compiler designed for the classroom

Source language similar to Java

- Excludes some features so doable in single semester (e.g., arrays, exceptions, static members, etc.)
- Emphasizes object orientation (including inheritance and object casting)

Well documented

- Free, comprehensive, student lab manual (PDF)
- API generated from javadoc on Web

Customizable

- Lexer/parser generators: JLex/Java Cup or JavaCC
- Targets: MIPS/SPIM (emulated), x86/Linux (native)

Bantam Java Usage

Seven institutions (worldwide) have used Bantam Java

Institution	Instructor	Semester
Chinese University of Hong Kong	Kam-Wing Ng	Spring 2009
Dublin City University	Geoff Hamilton	Fall 2008
Hobart and William Smith Colleges	Marc Corliss	Spring 2009
SUNY Geneseo	Scott Russell	Fall 2009
Universidad Adventista de Centroamerica	Osman Alejandro Longa	Fall 2009
University of Wisconsin Oshkosh	David Furcy	Fall 2008, Fall 2009
Wofford College	David Sykes	Fall 2008

Instructor Feedback

Feedback from all instructors overwhelmingly positive
(one instructor even became a collaborator and co-author)

One quote (from a non-collaborator):

[Students] spoke so highly of the course and how it helped them to tie a lot of other courses together (including theory of computation, computer architecture, and programming languages) that we are adding it to our catalog.

Another quote (from a non-collaborator):

I couldn't have done the course as well as I did without using Bantam.

Instructor Feedback Continued

Some (minor) complaints:

- One instructor found arrays too challenging for students
- One instructor found parser generator solution code hard to follow and work with
- Students spent a significant amount of time coding

Can't conclude anything quantitatively but results are positive

Student Feedback

Student feedback was also mostly positive
(note: gathered from co-author classes only)

One representative quote:

The projects taught me a lot about building a compiler hands on that I could not have figured out from just learning the theory.

A few students complained about difficulty and/or work load:

I've really enjoyed the projects so far, even though the process can be really frustrating. It's really nice to finally get the projects working!

Extensions to Bantam Java

We also made several significant extensions to toolset:

- **Extended language** -- contains several features (e.g., arrays) that were omitted from original (base) language
- **Java Virtual Machine (JVM) target** -- similar to Java compiler and thus more realistic
- **Ant-based build process** -- for building compiler with Ant (as opposed to make), can build on non-Unix machines (e.g., Windows)

Extensions Continued

We also made several significant extensions to toolset:

- **Optimizer assignment** -- enables students to write an optimization component, which includes a dataflow analysis
- **Interpreter assignment** -- enables students to write an interpreter for Bantam Java, could replace code generator in time-pressed course

Extension Usage

Extension	Institutions
Extended language	University of Wisconsin Oshkosh (Fall 2009) Wofford College (Fall 2008)
JVM target	University of Wisconsin Oshkosh (Fall 2008, Fall 2009)
Ant-based build process	University of Wisconsin Oshkosh (Fall 2009)
Optimization assignment	Hobart and William Smith Colleges (Spring 2009)
Interpreter assignment	Unused

Extensions worked well in most cases

Some complaints about difficulty of the extended language

- In future we will create an "intermediate" language

Future Work

We have a couple directions of future work:

- Additional extensions to make project more customizable
 - Create an intermediate source language
 - Create an assignment (in C) in garbage collection
- Quantitative study on importance of a compiler course
 - Like to gather data from several institutions to assess this
 - Anyone interested?

Conclusions

We found Bantam Java is effective in the classroom

- Both instructors and students spoke favorably of it

We made several improvements/extensions to toolset

- Extended language
- JVM target
- Ant-based build process
- Optimization and Interpreter assignments

Last Words

We thank the HWS Provost's Office for supporting Lori's work on this project in the summer of 2007

We hope you try it out and enjoy it!
URL: <http://www.bantamjava.com>

We welcome and encourage feedback on ways for improvement