Does Training Input Selection Matter for Feedback-Directed Optimizations?

Paul Berube
berube@cs.ualberta.ca
University of Alberta
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Outline

• Background and motivation
• Aestimo: an FDO evaluation tool
• Workload Selection
• Results
What Is FDO?

Feedback-Directed Optimization:

- compile
- train
- compile
- evaluate
What Is FDO?

Feedback-Directed Optimization:

compile → train → compile → evaluate

training input → profile → eval input
Performance Evaluation Space

Evaluation Inputs

Static optimization

Programs
Performance Evaluation Space

- Evaluation Inputs
- Training Inputs
- FDO
- Programs
Performance Evaluation Space

- Evaluation Inputs
- Training Inputs
- Programs

- Usually 1 *Ref input*
- Only 1 *Train input*
The Big Question

- Does the selection of training inputs matter for feedback-directed optimization?
  - Different transformation decisions?
  - Different performance?
Aestimo

• An FDO evaluation tool
• Automates training and evaluating on a large number of inputs
• Isolates individual transformations
  – Fewer experiment variables
  – Results vary by transformation
• Measures:
  – Differences in transformation decisions
  – Performance differences
An Overview of Aestimo

Program Workload

Compile

Binaries

Optimization Logs

Execute

Analyze
An Overview of *Aestimo*

- Compile
- Binary
- Execute
- Analyze
- One Per Input
- Optimization Logs
- Program Workload

Program Workload → Compile → Binaries → Execute → Analyze → Optimization Logs
An Overview of Aestimo

Program Workload

Compile

Binaries

Optimization Logs

Execute

Binary X Input 5 times each

Analyze
An Overview of Aestimo

Program Workload

Compile

Binaries

Execute

Analysis

Optimization Logs

Workload Performance
An Overview of Aestimo

Program Workload

Compile

Binaries

Optimization Logs

Execute

Analyze

Workload Performance

Transformation Differences
An Overview of *Aestimo*

Program Workload → Compile → Binaries → Execute → Analyze → Optimization Logs

- Workload Performance
- FDO vs. Static
- Transformation Differences
An Overview of *Aestimo*

Program Workload

 Compile

 Binaries

 Execute

 Analysis

 Optimization Logs

 Workload Performance

 FDO vs. Static

 Resubstitution

 Transformation Differences
Compilation Process

Source

Static Compile

Static Binary

Optimization Log
Compilation Process

Source → Static Compile
          ↓
          Static Binary
          ↓
          Optimization Log

Instr. Compile → Instrumented Binary

Profile → Training Run

FDO Compile → FDO Binary

Training Input
Compilation Process

Source

Static Compile

Static Binary

Optimization Log

Instr. Compile

Instrumented Binary

Training Run

Profile

Training Input

FDO Compile

FDO Binary

Optimization Log

Static Compile

Final Binary
Compilation Process

- Source
  - Static Compile
    - Static Binary
    - Optimization Log
  - Instr. Compile
  - Instrumented Binary
  - Training Run
    - Profile
    - Training Input
  - FDO Compile
    - FDO Binary
    - Optimization Log
  - Static Compile
  - Final Binary
Workload Selection

- SPEC CINT2000 Benchmark inputs
  - 8 programs, 32 input
- 84 Additional Inputs
  - Contacted benchmark authors
  - Varied representative inputs
  - Existing collections
  - Synthetic input generator
Results

• ORC compiler
• **Inlining** and if conversion
• **Itanium** and Itanium 2 processors
Workload Performance: bzip2

% Faster than Static

Training Dataset

- combined
- compressed
- docs
- gap
- graphic
- jpeg
- log
- mp3
- mpeg
- pdf
- program
- random
- reuters
- source
- static
- xml

Inlining
Itanium
Workload Performance:

Training Input Selection Matters!

% Faster than Static

Training Dataset

combined  compressed  docs  gap  graphic  jpeg  log  mp3  mpeg  pdf  program  random  reuters  source  static  xml

Inlining Itanium
Summary of Contributions

- Training input selection does impact optimization decisions and performance

- *Aestimo:*
  - Automates training and evaluating on a large number of inputs
  - Isolates individual transformations

- A large collection of representative inputs for SPEC CINT2000 programs
Thank You

Questions?
Performance: bzip2 trained on xml

Evaluation Input

% Faster than Static

combined  compressed  docs  gap  graphic  jpeg  log  mp3  mpeg  pdf  program  random  reuters  source  xml

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Performance: bzip2.combined

% Faster than Static

Evaluation Input

Inlining
Itanium