Essential Ingredients for a WCET Annotation Language

Timing Analysis Cluster Meeting

Munich, March 13, 2007

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Joint work within ARTIST2 of the Compilers Activity and the Timing Analysis Activity

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Overview

- The WCET Annotation Language Challenge
- Fundamentals
- First steps towards a common WCET annotation language
- Attributes of timing information
- List of timing information
- Future work
The WCET Annotation Language Challenge

- Announced in July 2007

- Motivation:
  Mastering the WCET Annotation Language Challenge is essential for consolidating and advancing the state-of-the-art:
  Precision and performance of WCET analysis depends on expressiveness and usability of the annotation language

- Goal:
  Define a common WCET annotation language to enable the annotation of benchmarks in a tool-independent way.
Fundamentals

- Using the name of “timing annotations” rather than “WCET annotations”

- The annotation language does not need to be as expressive as the programming language
  - only properties of the program behavior have to be described, there is no need to describe the full program semantics
  - avoiding unnecessary expressiveness in the annotation language keeps the WCET analysis efficient.

- Distinction between timing information and timing annotations

- Flow information is subset of timing information

- Analysis of existing tools and papers to extract timing annotation constructs
- Description of existing annotation constructs in a language-independent way
- Identification of additional constructs (e.g., invariants/overrules, annotation layers, selective use by grouping)
- Timing information that is not connected with the program code is left out of the annotation language
- Summarization of the results in a technical report to collect feedback
Attributes of Timing Information

- Annotation class: invariant vs. overrule
  \[ SB_F \subseteq SB(I_{inv}) \]
  overrule: \[ \neg (SB_F \subseteq SB(I_{ovr})) \]
  overrules can be used to describe application modes

- Annotation layer:
  program, platform, operation

- Annotation groups:
  - symbolic name with a textual description
    (no predefined semantics)
  - groups may be nested
  - use: selective use of timing information (e.g., multiple platforms, different sets of overrules)
Layered Timing Annotations

Timing Facts

- Program Annotations (default)
- Build and Run Annotations
- Operating System Annotations
- Hardware Annotations
- Operation Annotations

a) Layered System View

Platform-Independent Program Semantics

- Control-Flow Structure

Invariants | Overrules

Program

- Operation
- Operation Environment
- Platform Properties

b) System Behavior Described by Telescoping Timing Facts

different annotation layers

invariants vs. overrules
High-level Annotations

- Loop bounds
- Recursion bounds
- Linear flow constraints
- Variable value restrictions
- Summaries of external functions (e.g., side effects, value ranges of results)
  - used to describe an external function for which no code is available
Addressable Units

- Control-flow addressable units
  - basic blocks
  - control-flow edges
  - subgraphs
- Loop contexts
- Call contexts
- Control-flow paths
Control-flow Information

- Specification of unreachable code
- Specification of predicate evaluation
- Control-flow reconstruction
Hardware-specific Low-level Annotations

- Specification of clock rate
- Specification of memory map and memory accesses
- Absolute time bounds
Future Work

- Discussion within the ARTIST2 Timing Analysis Activity to get a common view on the requirements of a timing annotation language.

- Setting up a homepage to collect and publish different proposals towards the common timing annotation language.

- **Local meetings** with WCET tool vendors and research groups to discuss the instantiation of concrete timing annotation languages.