Reliable Post-link Optimizations Based on Partial Information

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presented by

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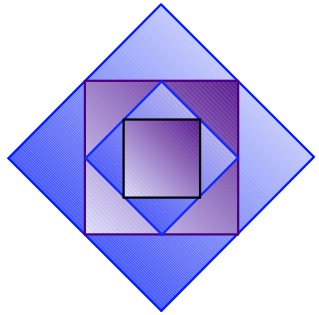
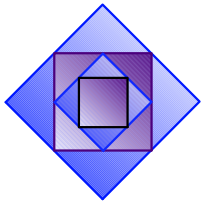
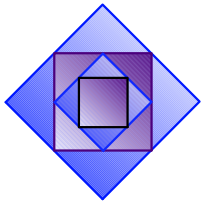




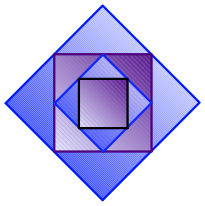
Plan of the Talk

- Introduction
- Goal
- Method of Analysis
- Experiance
- Conclusions



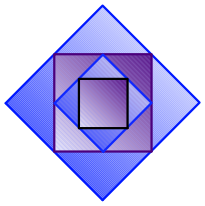
Feedback Based Post-Link Optimizations

- Complement the compiler's optimizations
- Optimize frequently traversed paths at the expense of the infrequent ones
- Global optimizations
- Compiler and linker conventions need not be preserved



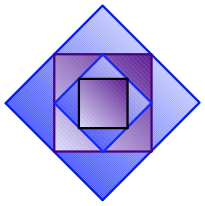
Feedback Based Post-Link Optimizations (cont.)

- **Phases**
  - Analysis --> Instrument --> Profile --> Optimize
- **References**
  - ATOM [Srivastava and Eustace 94]
  - EEL [Larus et al. 95]
  - ETCH [Romer et al. 96]
  - SPIKE [Cohn et al. 97]
  - ALTO [Muth et al. 99]
  - FDPR [Henis et al. 99]
  - .....



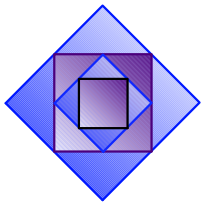
IBM FDPR Tool

- **Feedback Directed Program Restructuring**
  [Heisch 94, Nahshon and Bernstein 96, Henis et al. 99]
  - Dissects into BBs
  - Optimizations:
    - AOPT: repositions BBs,
      requires full information, **more** powerful
    - HeatShrink: repositions BB copies,
      accepts incomplete info, **less** powerful



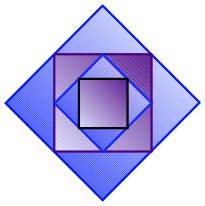
Goal

- Need of an algorithm that enables AOPT to work in incomplete information situation
- Maximize optimization by using hybrid of AOPT and HeatShrink



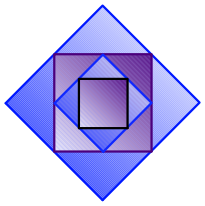
Incomplete information

- **Types of incomplete information:**
  - Basic block could not be classified as code or data
  - Data could not be classified as values or addresses
  - CFG is incomplete (statically unresolved targets)
- **Fully analyzed executable is rarely available**
- **Yet, in most cases only small portion of the information is missing**



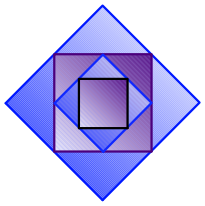
Handling incomplete information

- All BBs marked as analyzed or as Not Fully Analyzed (NFA)
- Confine NFAs within larger Partially Analyzed Areas (PAA)
- Analyzed areas treated using AOPT
- Apply special algorithms to PAAs



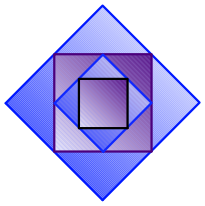
PAA

- **PAA properties and Prerequisite**
  1. Relative references within the PAA (that do not have relocation information) remain semantically correct when PAA repositioned en-bloc
  2. Absolute references from within the PAA are identifiable even for the NFA parts within the PAA
  3. Linker/Loader relocation information available
- **PAA confines the problematic nature of its NFAs**



PAA (cont.)

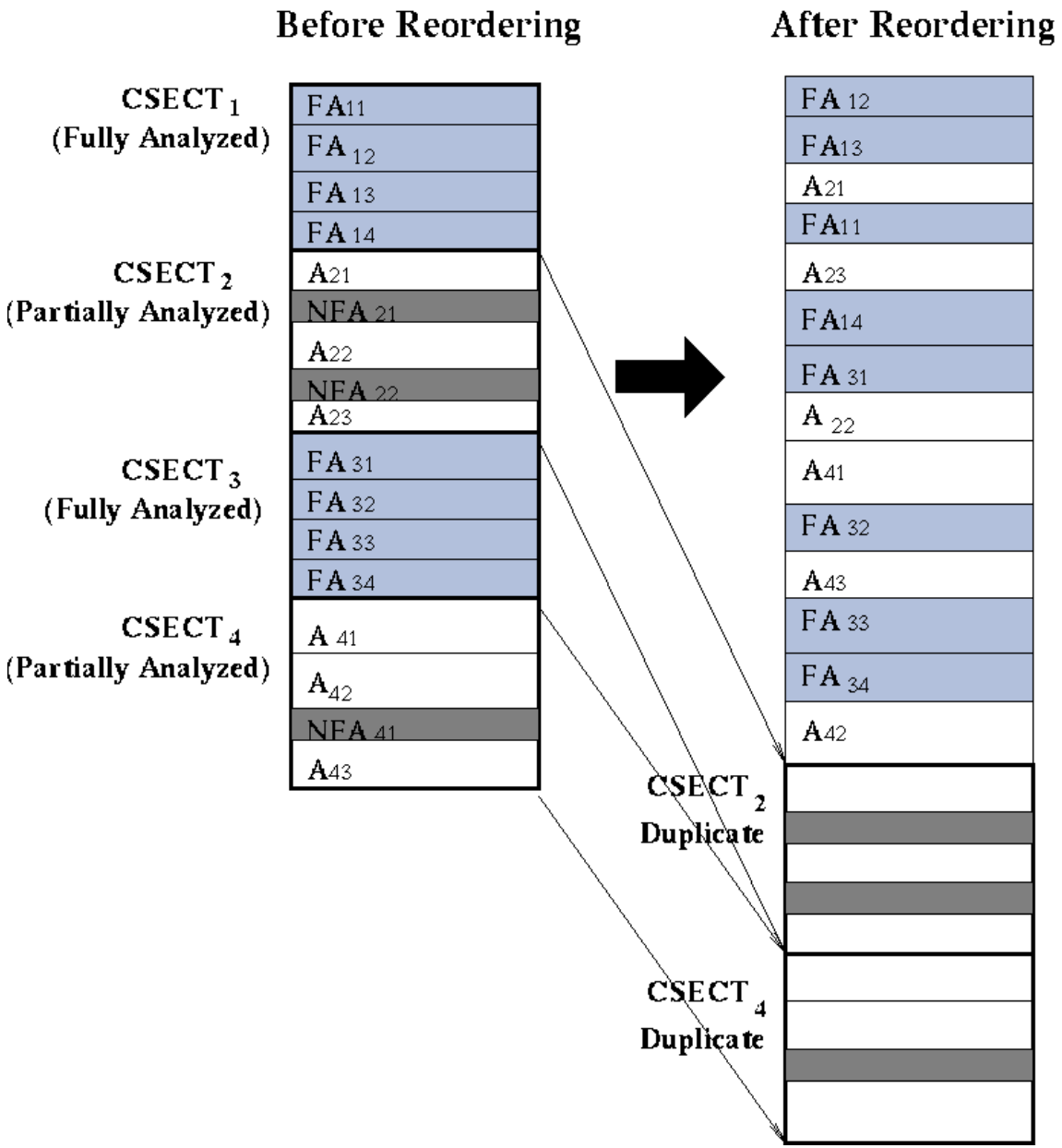
- **In AIX/PowerPC**
  - CSECT
  - Non-stripped relinkable executable
- **In NT/x86**
  - Object module
  - The executable must contain a relocation section
  - Linker map is available

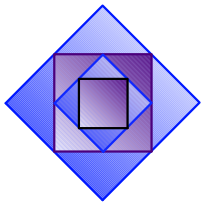


Local Movable HeatShrink Algorithm (LMH)

- **For each NFA define a containing PAA (One PAA may contain several NFAs)**
- **Perform AOPT on fully analyzed areas and on copies of analyzed portions of the PAAs**
  - Assuming the PAA is well behaved
- **Reposition PAAs en-bloc**
- **Update the references to each PAA in the entire executable**
- **Update the addresses in each PAA according to its new position**

LMH algorithm (cont.)

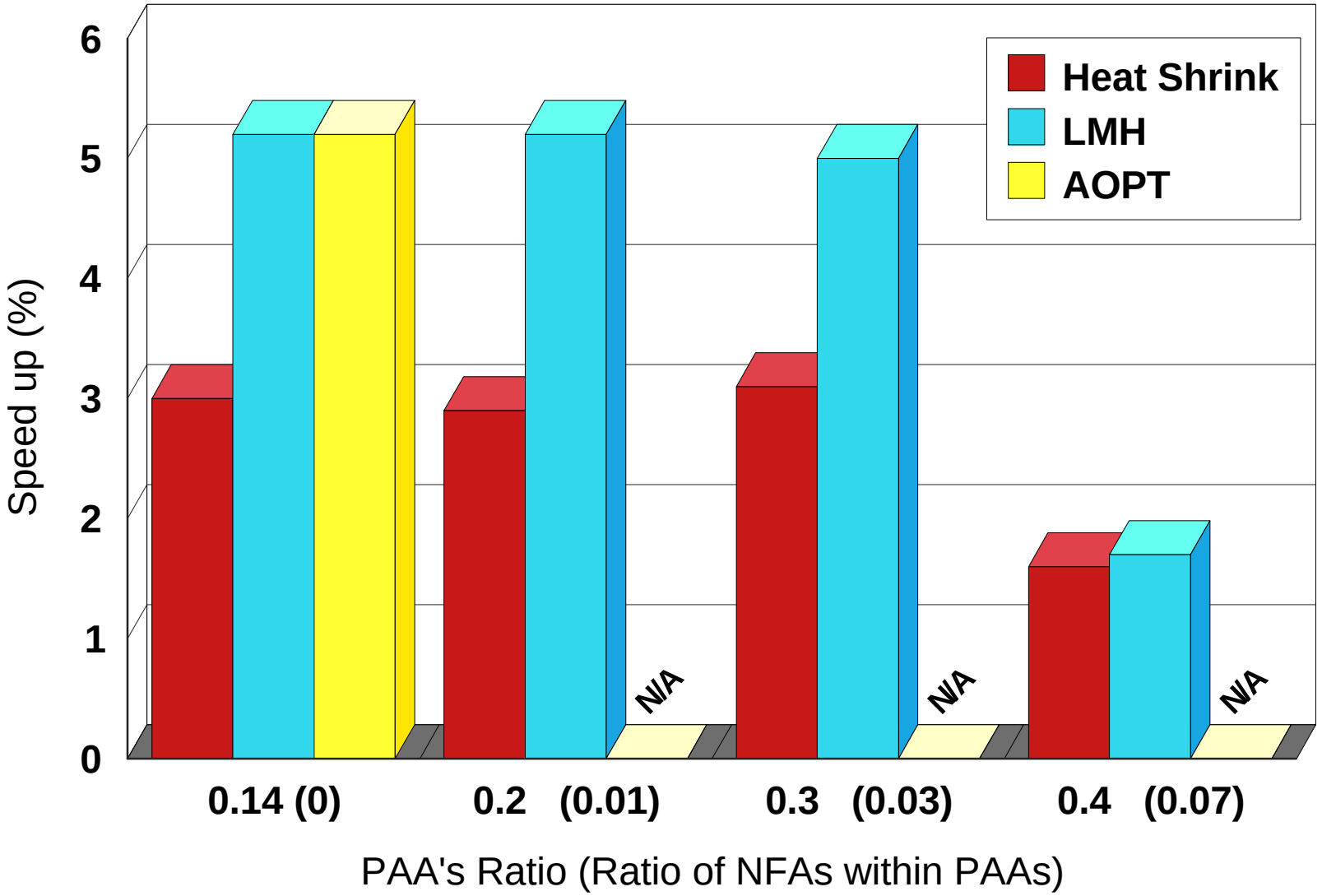




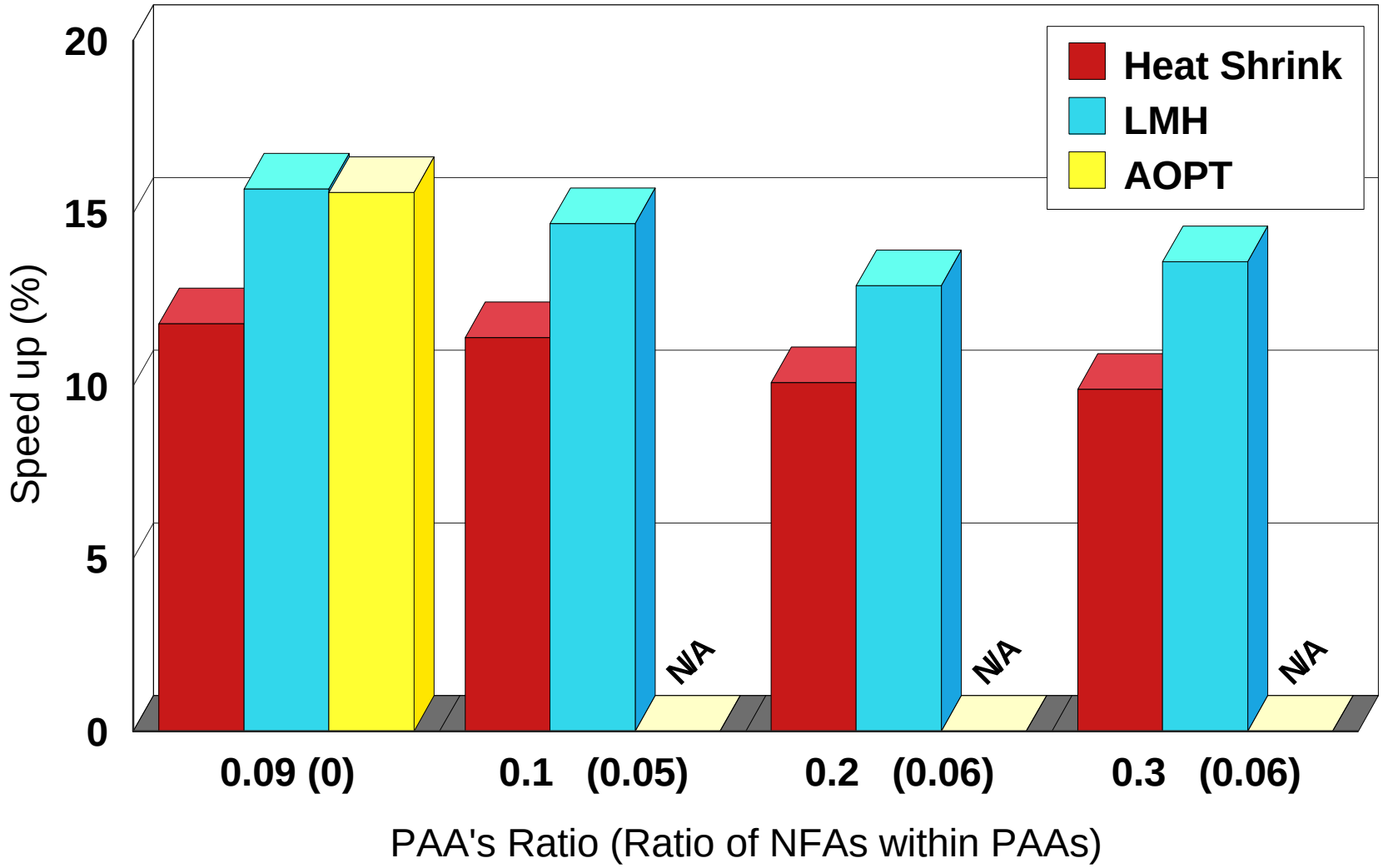
Experiments Framework

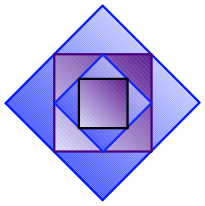
- **Applied to programs with varying amount of missing information**
- **Full information available**
  - Equivalent to AOPT
- **Artificialy information is withheld**
  - Gradual increase of PAAs from zero (full information) to 0.4
  - Up to 7% NFAs within each PAA
- **Typical case in real life applications**
  - In agreement with [Larus and Schnarr 95]
- **Done on AIX/PowerPC**

Performance Gains for perl



Performance Gains for gcc





Conclusions

- **Novel concept to enable combination of AOPT and HeatShrink**
  - Allows to better exploit available information
  - Improve performance gain due to more powerful optimization method (AOPT)
- **Reliable approach for optimization in a partial information situations**
- **Gradual degradation of performance from AOPT to HeatShrink**
  - Significant improvement over a step drop from AOPT to HeatShrink
  - In real life: only small portion of information is missing