Making Dynamic Memory Allocation Static To Support WCET Analyses

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Current Situation

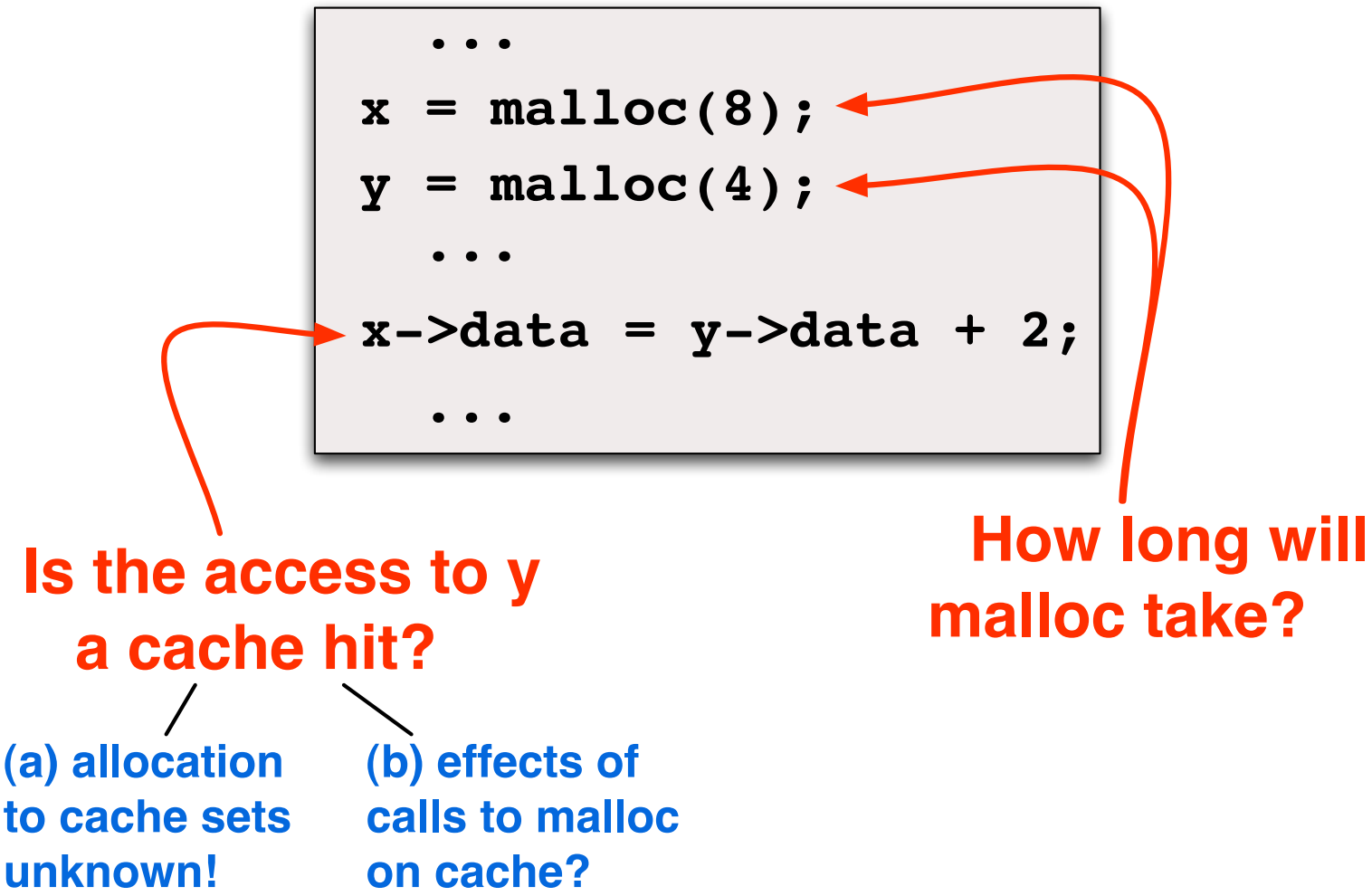
What we have ...

1. Precise WCET analysis
2. Dynamic Memory Allocation
   - often clearer program structure
   - easy memory reuse (e.g. in-situ transformations)

... but can we have both together?

Dynamic Memory Allocation & WCET Analysis

What are the challenges?

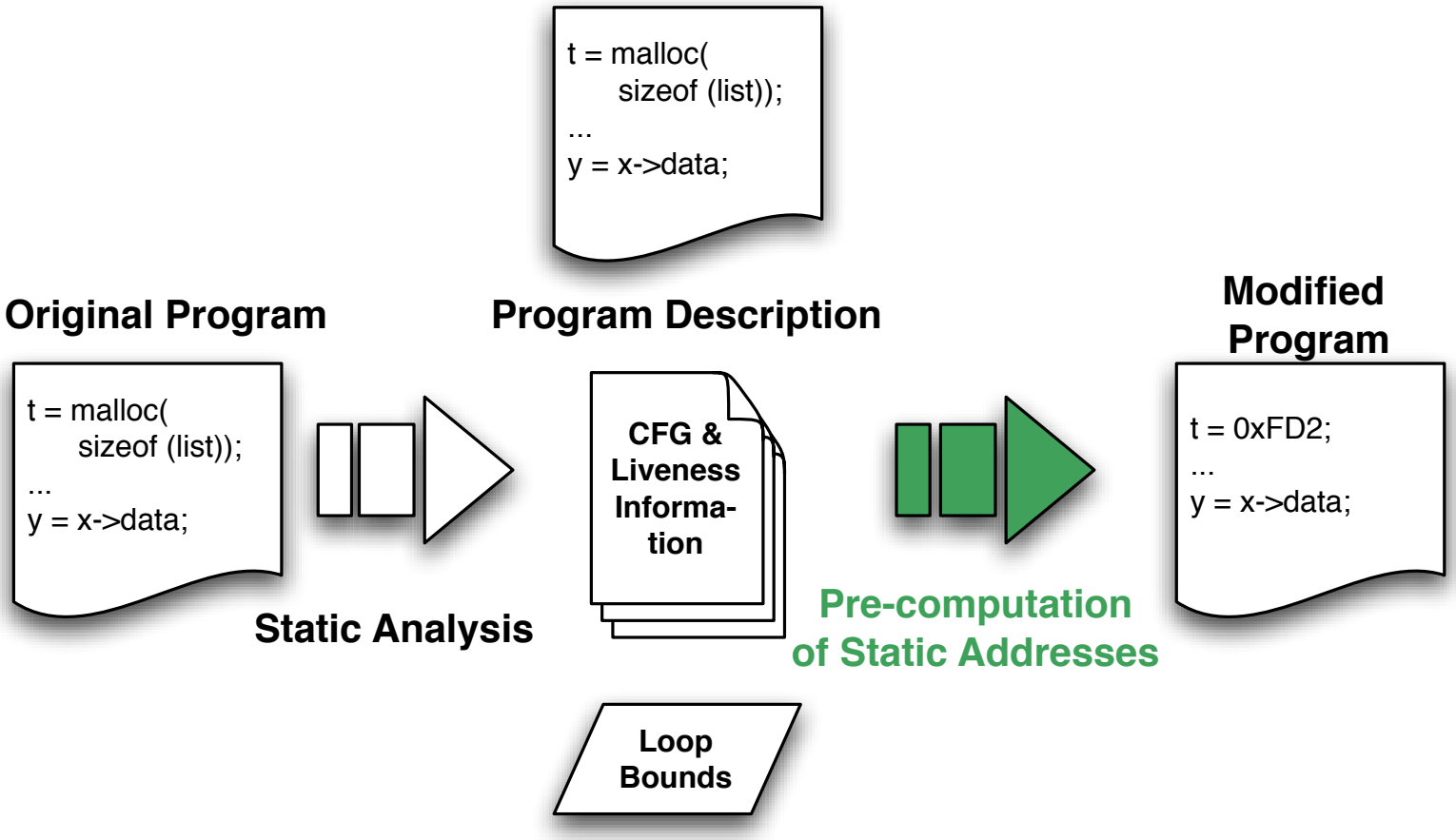


Approaches

What can be done?

- Predictable Allocator
  - J. Herter, J. Reineke, R. Wilhelm, 2008
- Predictable Hardware
  - M. Schöberl, 2009
- Replace Dynamic Allocation by Static Allocation

Big Picture


t = malloc(
sizeof (list));
...
y = x->data;
Original Program
Program Description
Modified Program
t = malloc(
sizeof (list));
...
y = x->data;
CFG & Liveness Informa-tion
t = 0xFD2;
...
y = x->data;
Static Analysis
Pre-computation of Static Addresses
Loop Bounds

What are *Good* Addresses?

What do we consider good addresses for heap allocated objects?

- Good addresses enable a subsequent WCET analysis to calculate minimal WCET bounds ...
- ... by minimal memory consumption.

How to find good addresses?

Idea for an algorithm:

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3. Select the program block with highest contribution to WCET
4. Modify addresses s.t. WCET contribution of selected block is minimized
   - Can generate an ILP to compute block-optimal addresses from liveness and basic block information!

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5. Continue at 2

Heuristics, actually ...

- ILPs to compute memory and block optimal addresses can be replaced by simulated annealing algorithms to cope with
  - more complex hardware (more cache sets)
  - more complex software (more heap allocated blocks)

Conclusions & Future Work

- Algorithm to compute static memory addresses for heap allocated objects.
- Preliminary experiments suggest feasible computational costs for addresses.

- Future Work:
  - Static (pre-) analysis to collect needed information.
  - *Fully* Automatic Transformation.