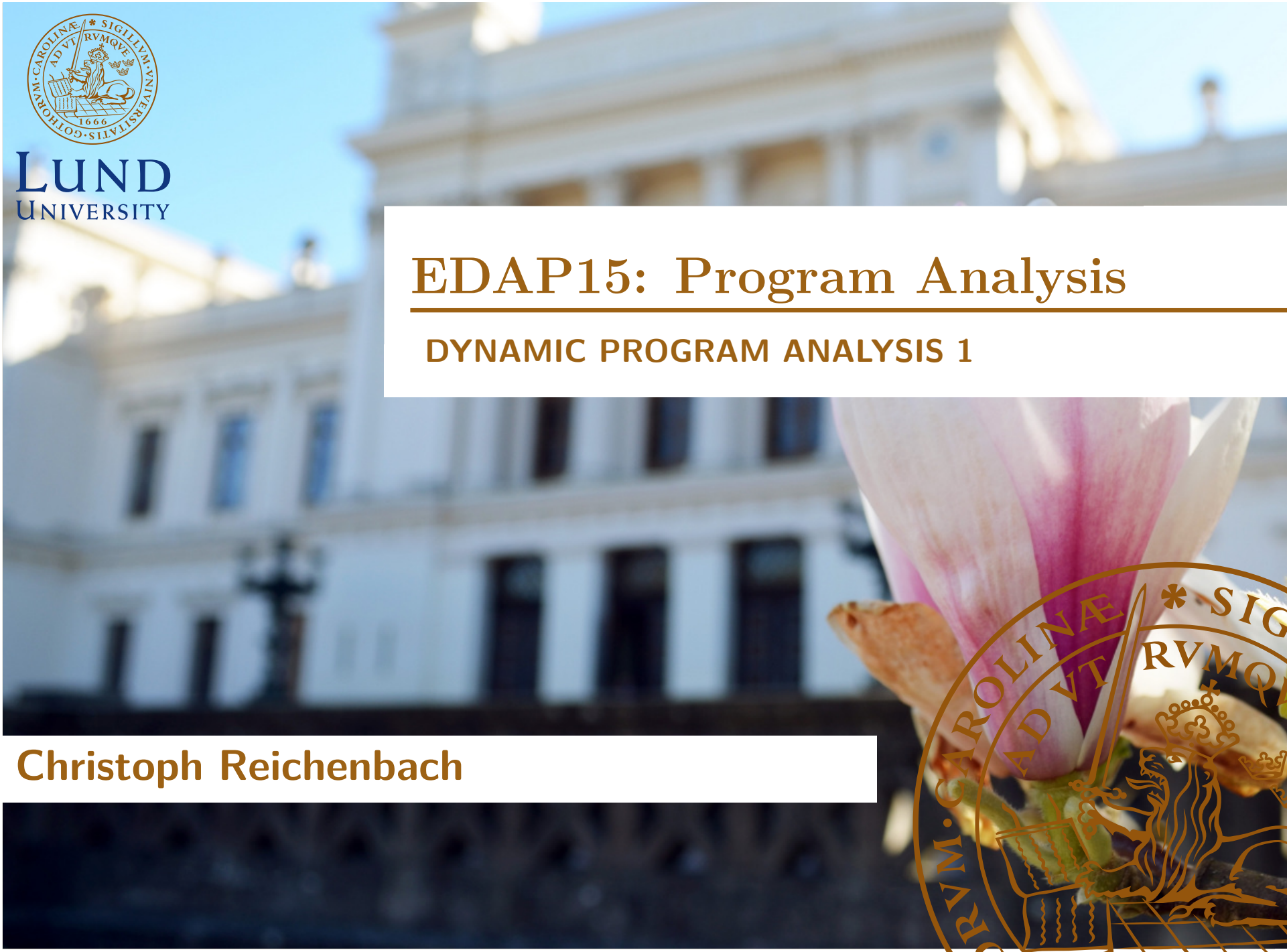


LUND UNIVERSITY

EDAP15: Program Analysis

DYNAMIC PROGRAM ANALYSIS 1

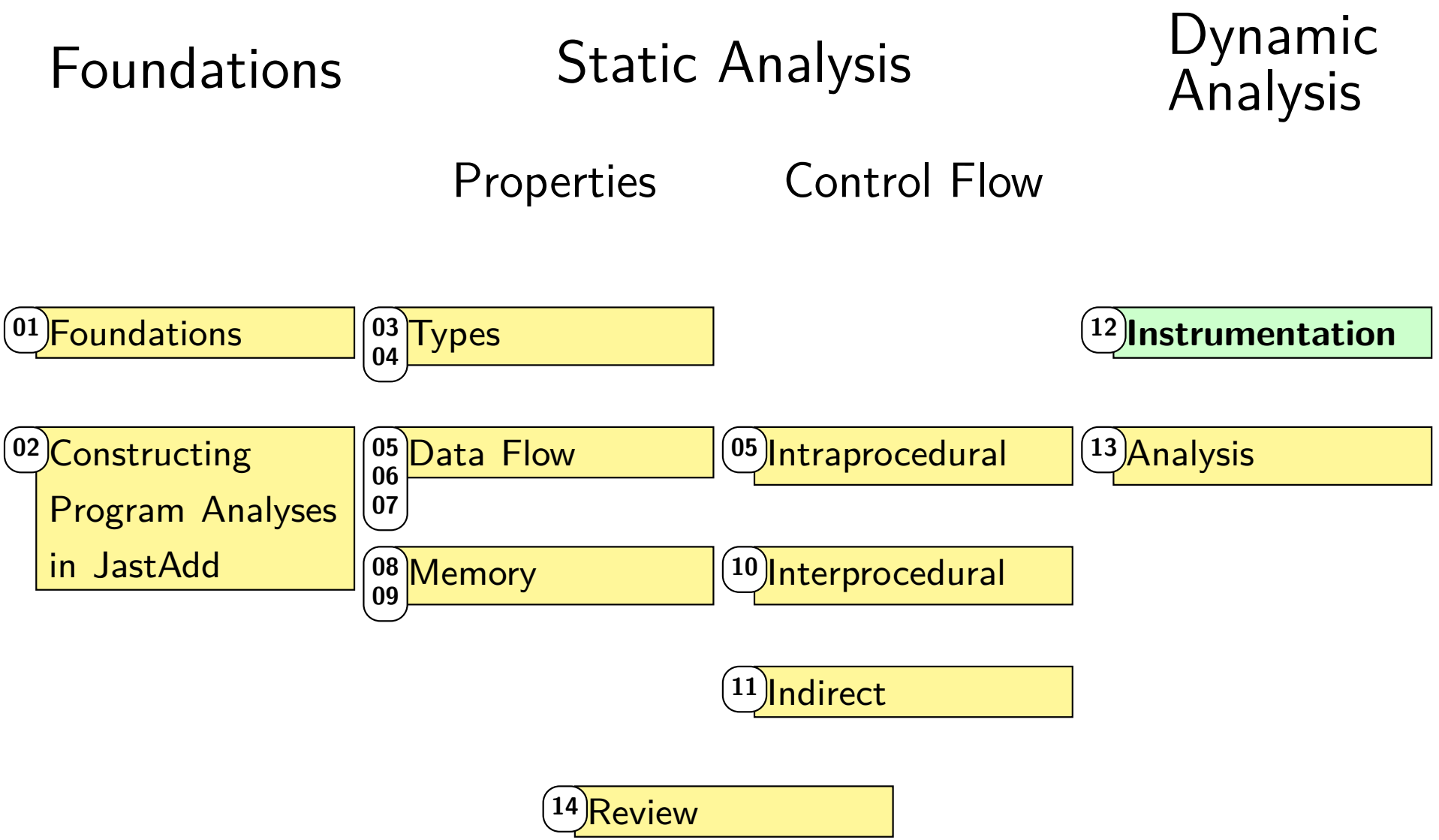
Christoph Reichenbach

Welcome back!

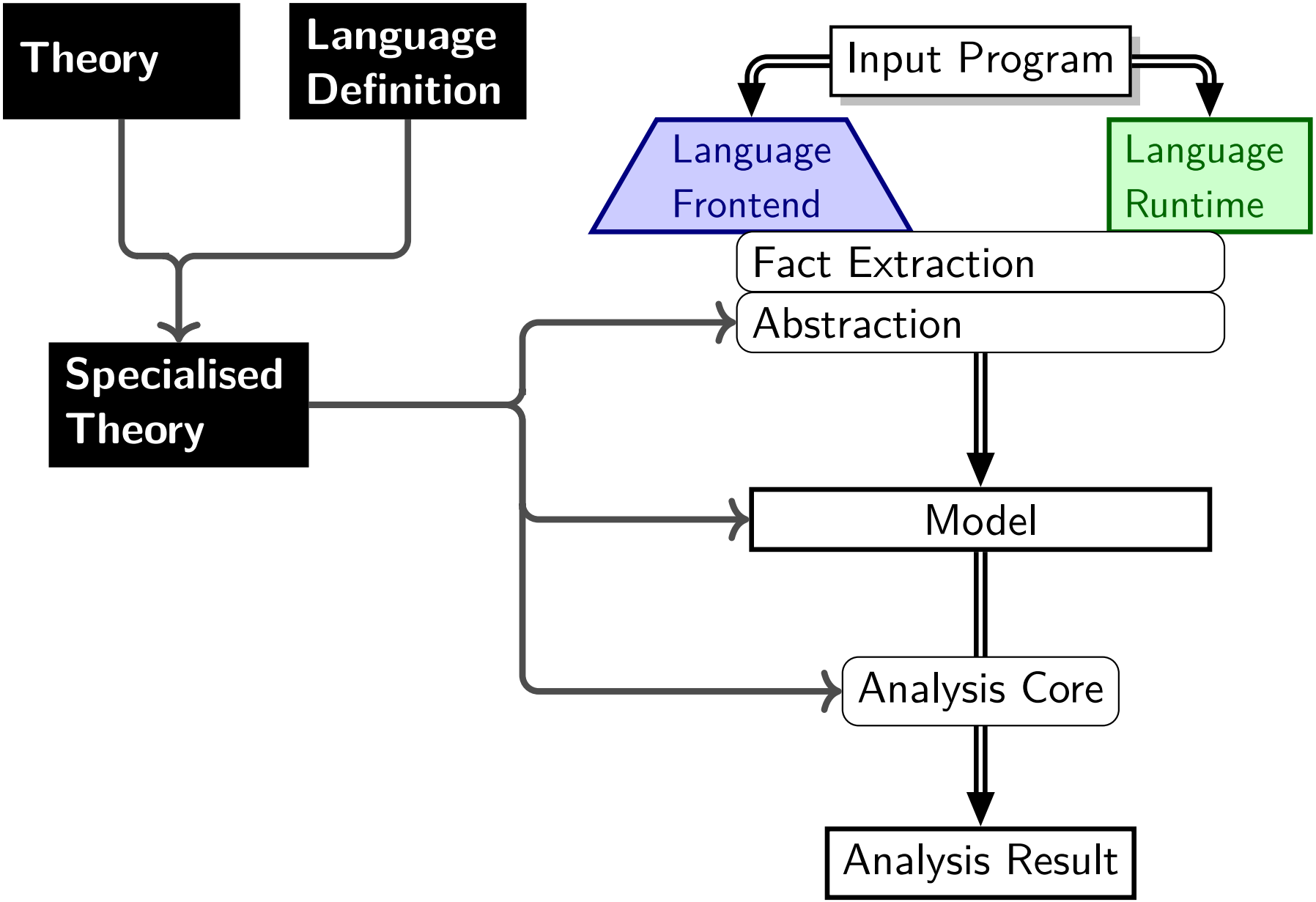
- Lab 3: Fixes available upstream (git) for Task 1
  - `nullReport()` → `nullReports()` in task description and code-prober script
  - If you followed only the `.jrag` / `.java` code, you might not have noticed the discrepancy
  - Fixes merged in if you hadn't pushed any updates yet

Questions?

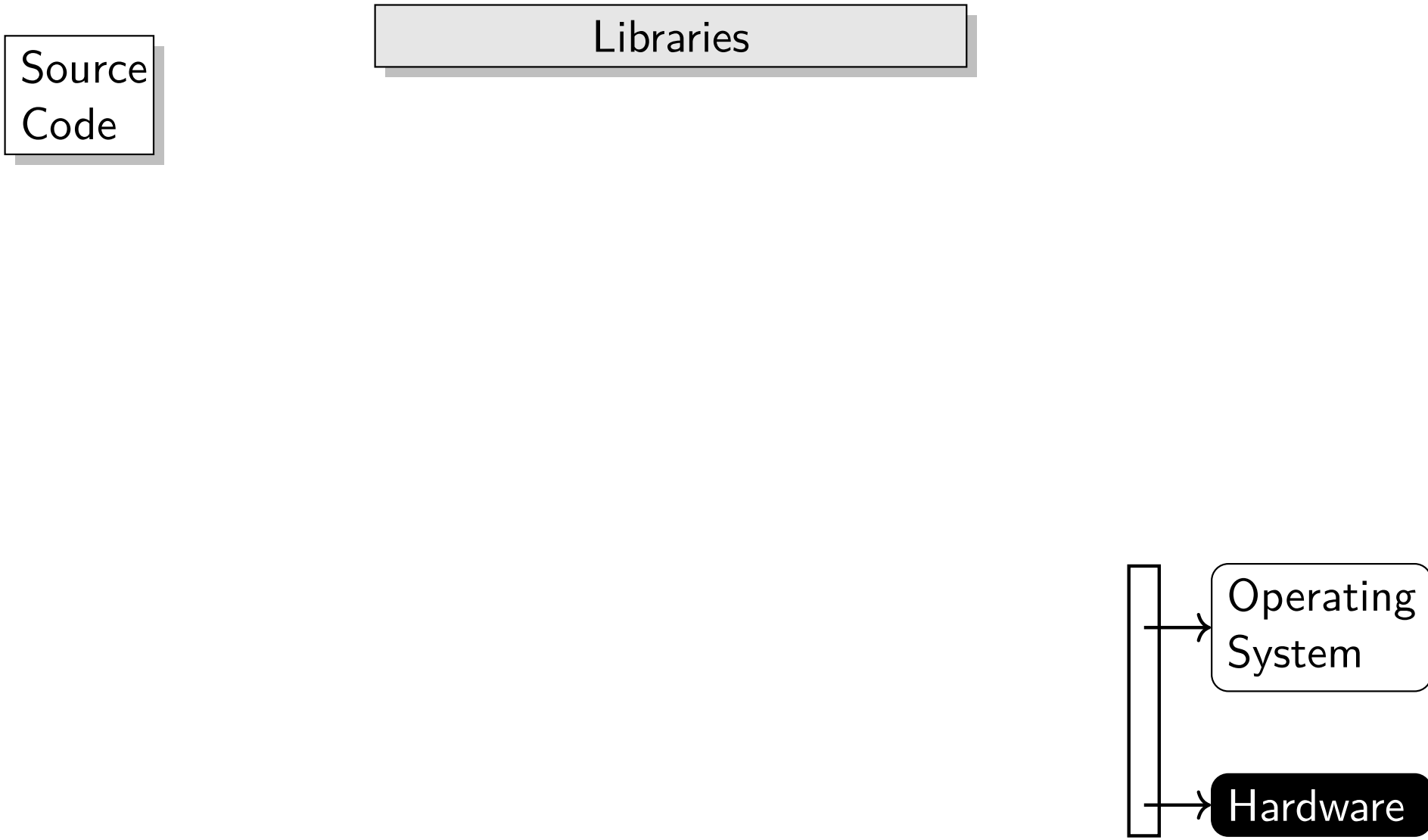
Lecture Overview



Building a Program Analysis



Program Execution Pipeline

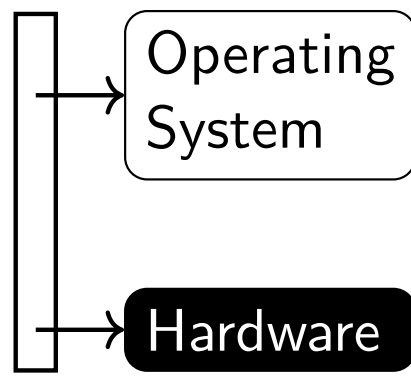


Program Execution Pipeline

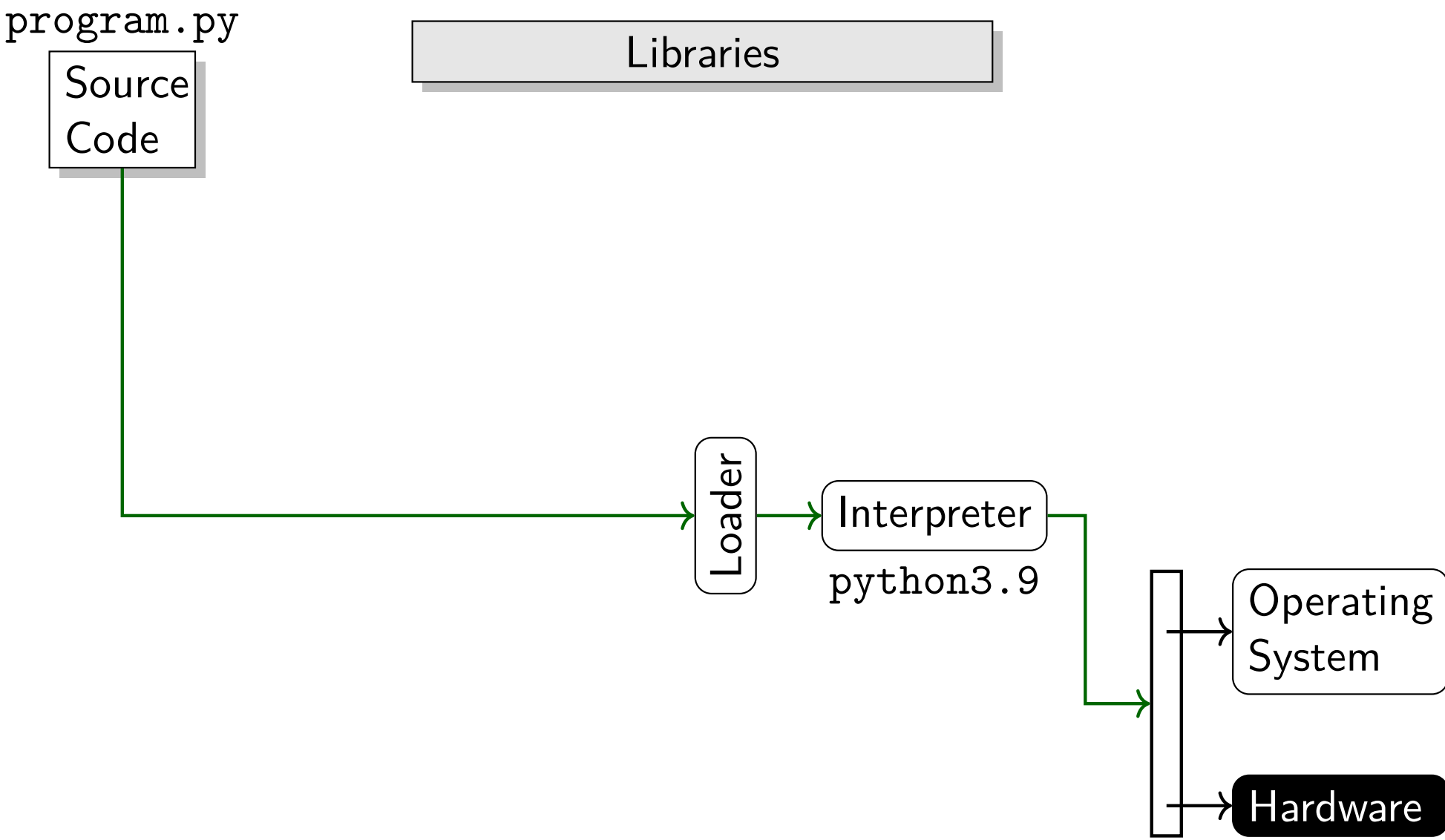
`program.py`

Source Code

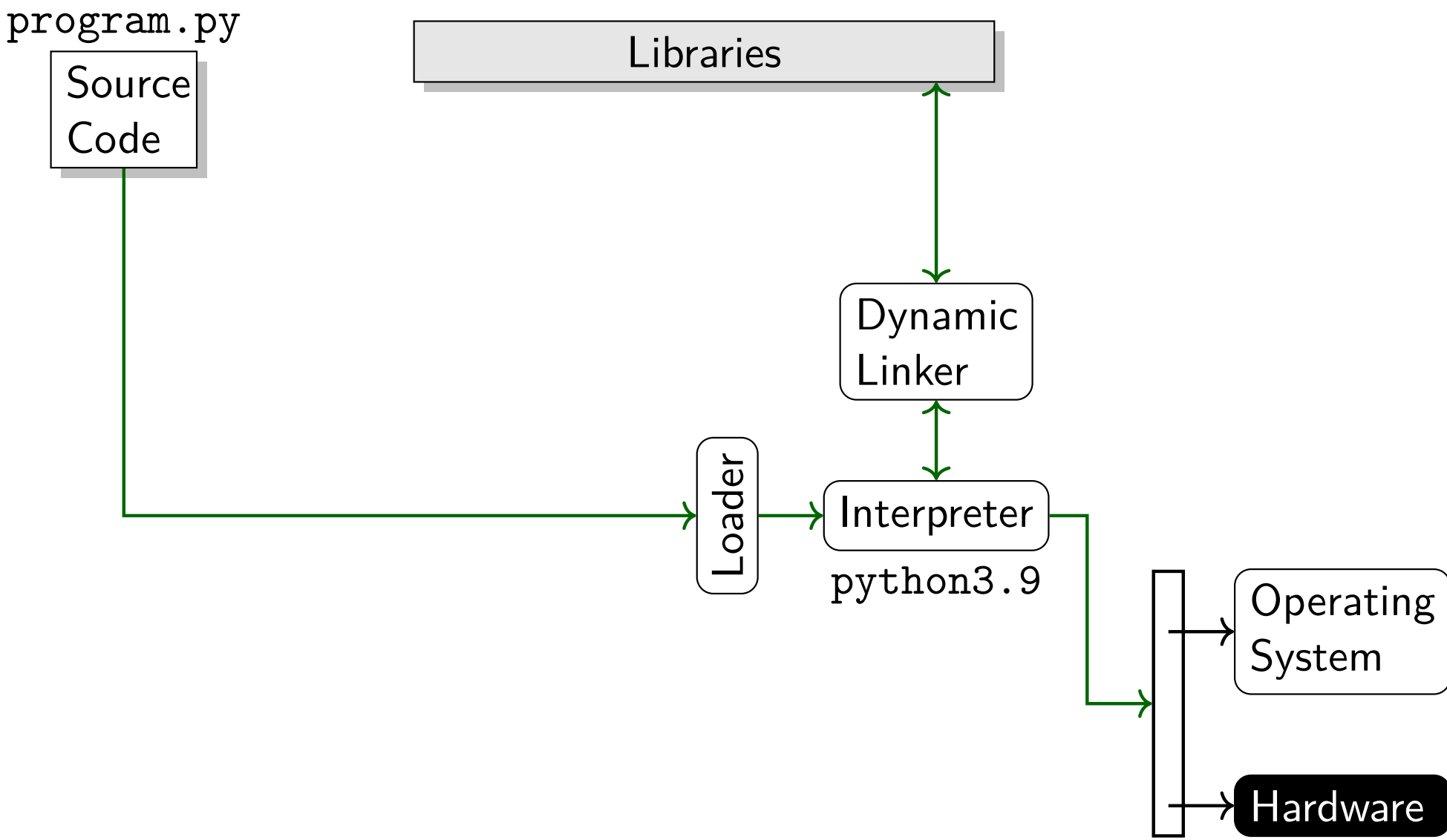
Libraries



Program Execution Pipeline



Program Execution Pipeline

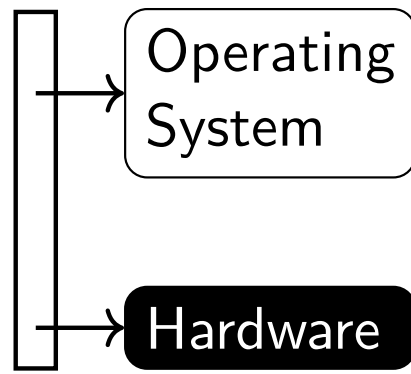


Program Execution Pipeline

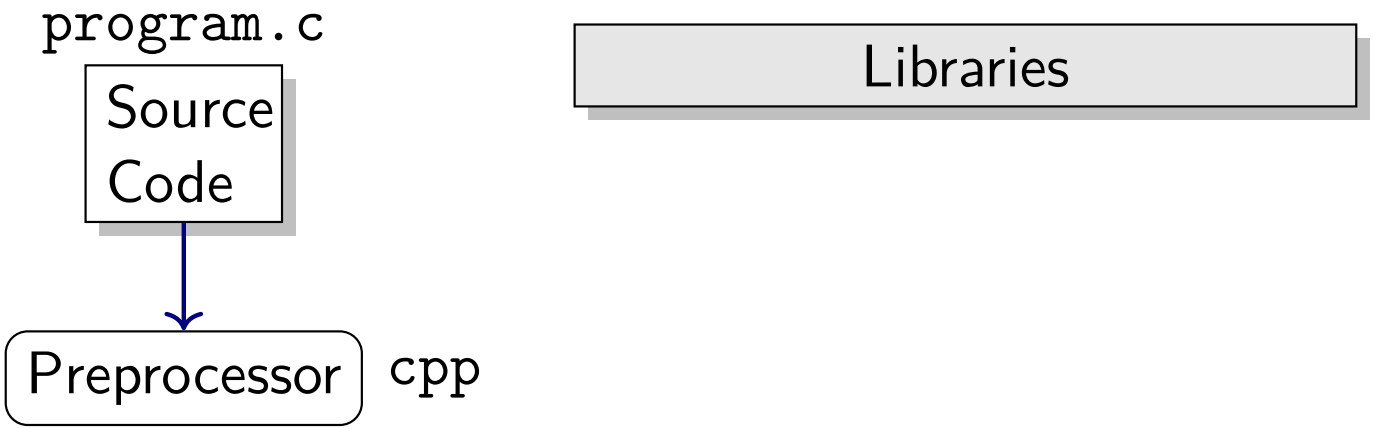
`program.c`

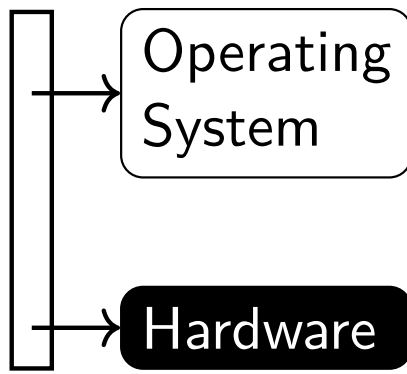
Source Code

Libraries

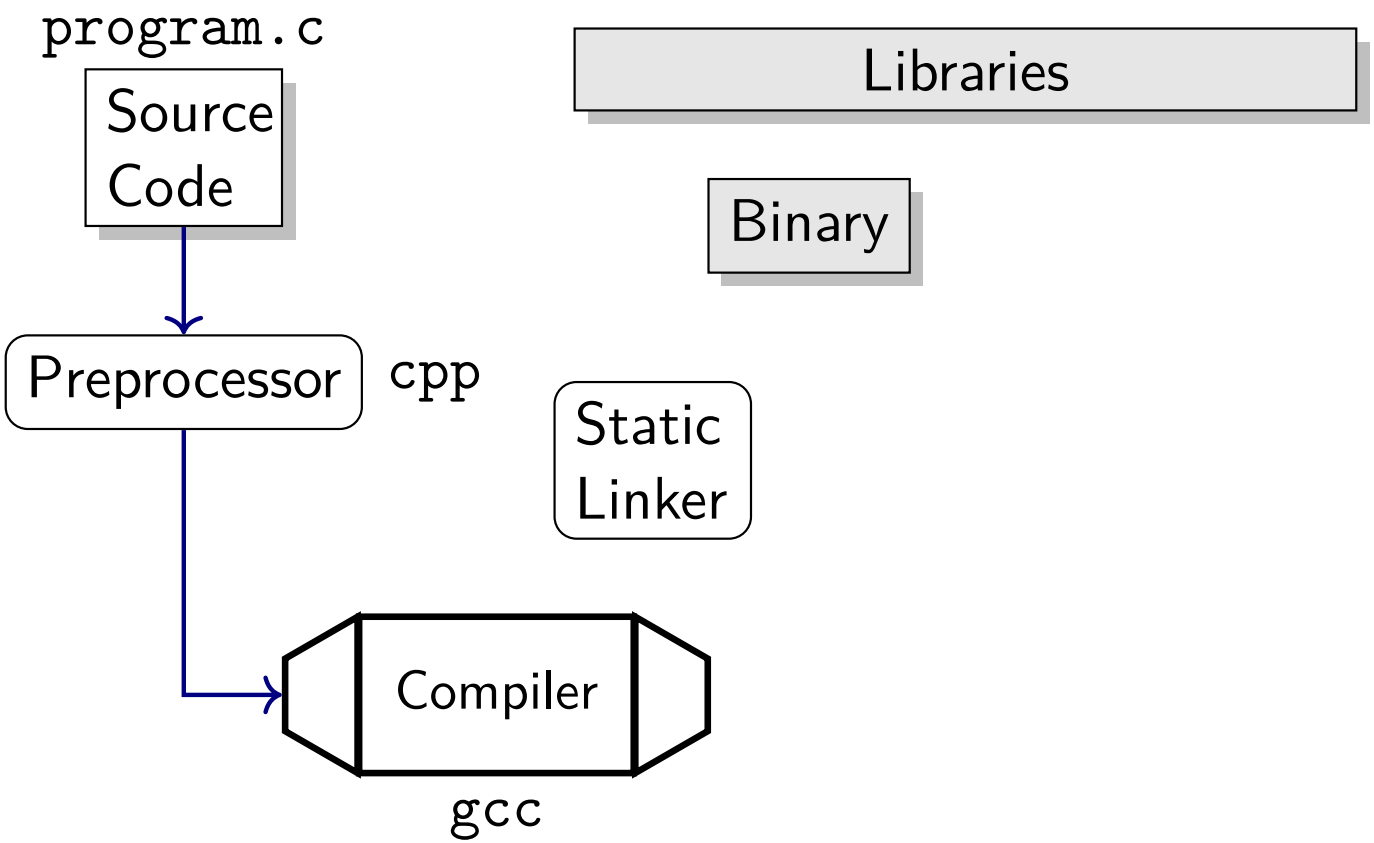


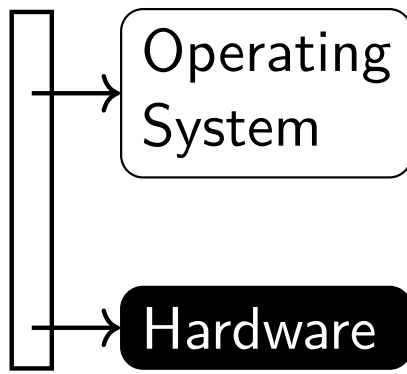
Program Execution Pipeline



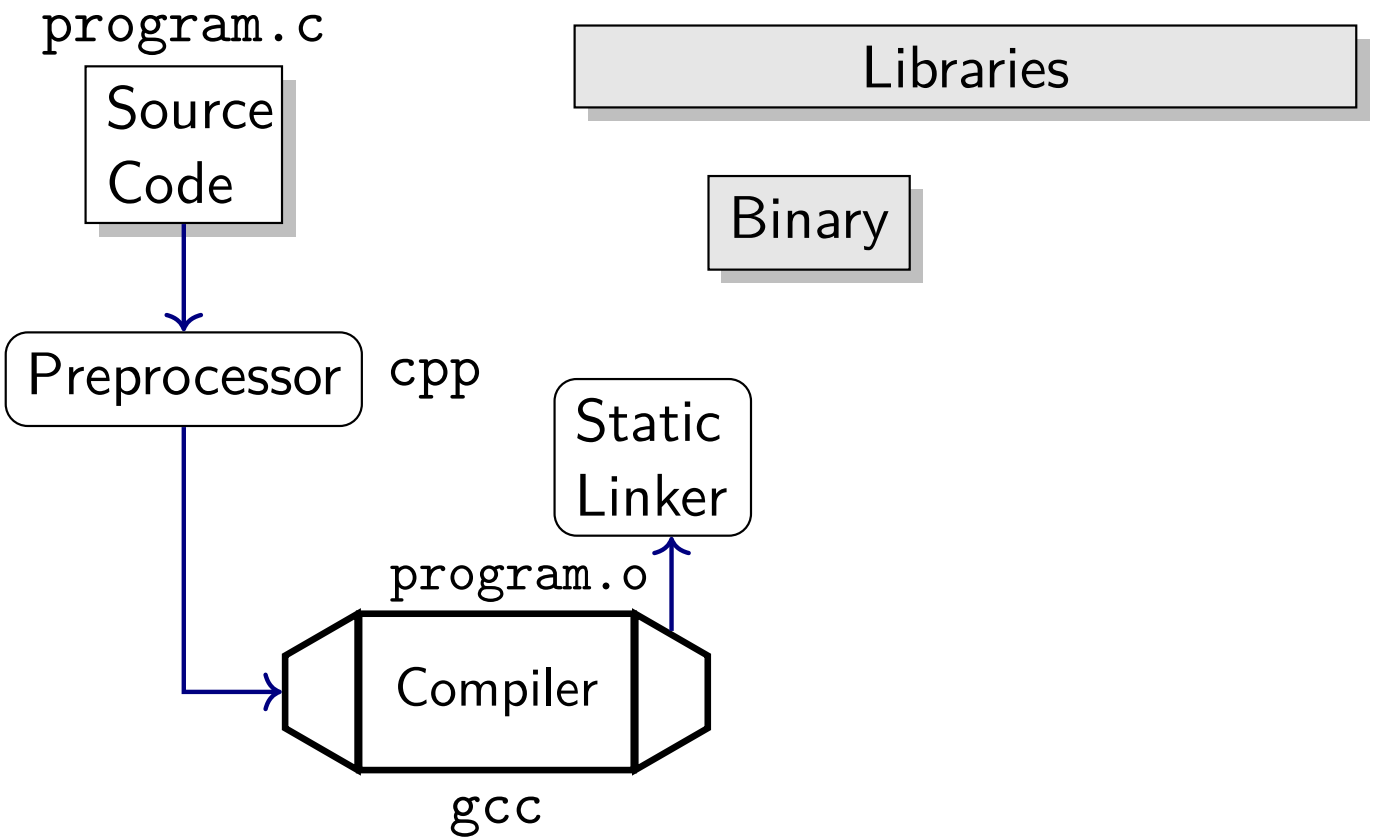


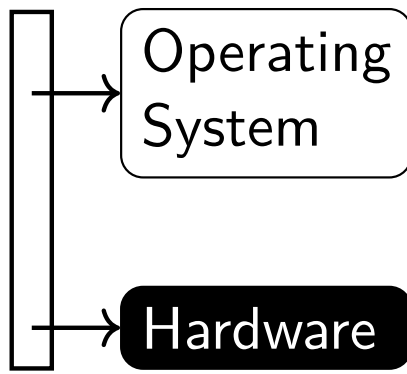
Program Execution Pipeline



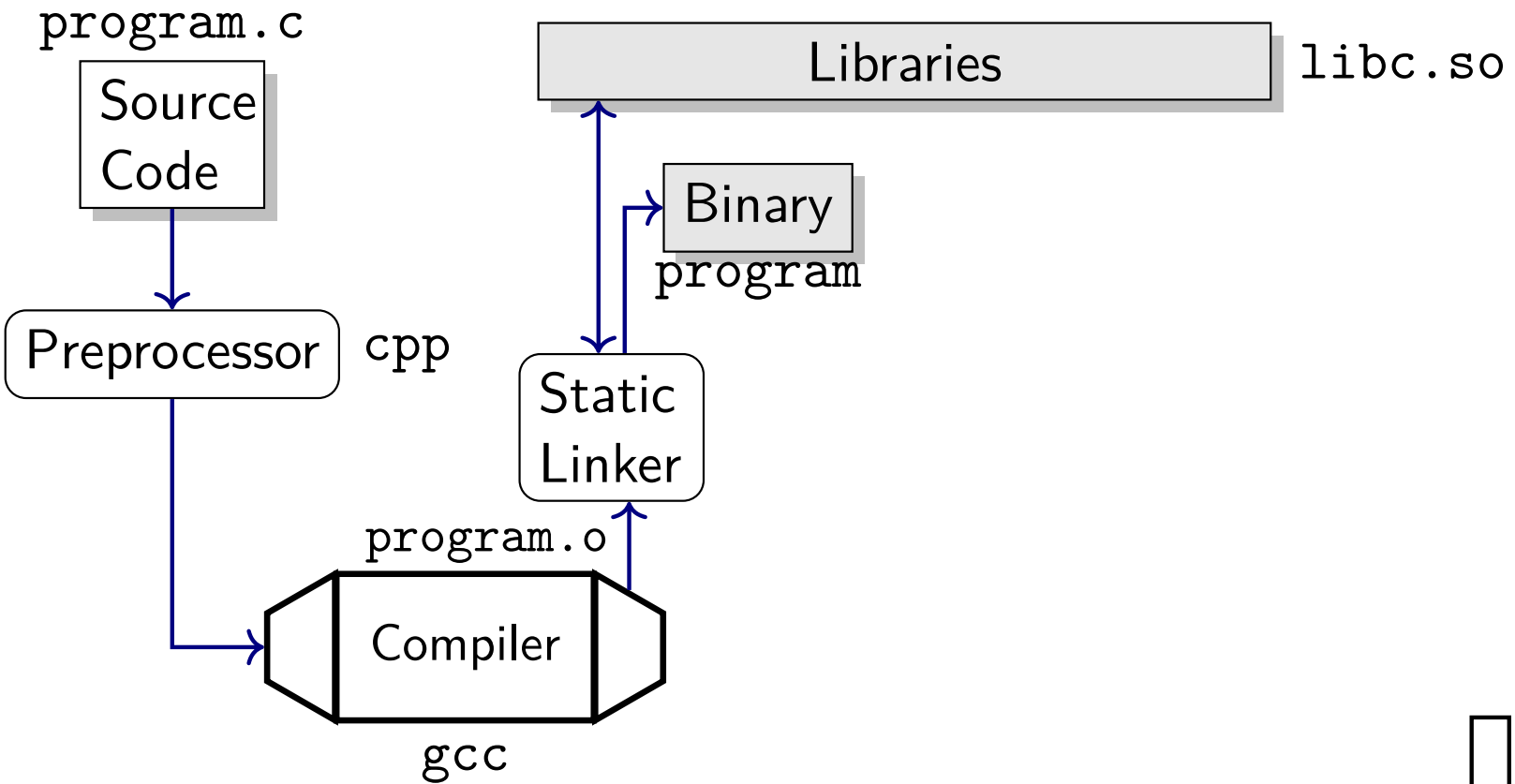


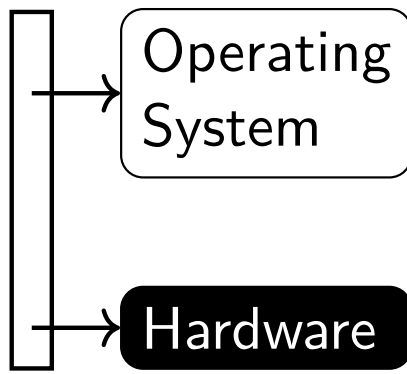
Program Execution Pipeline



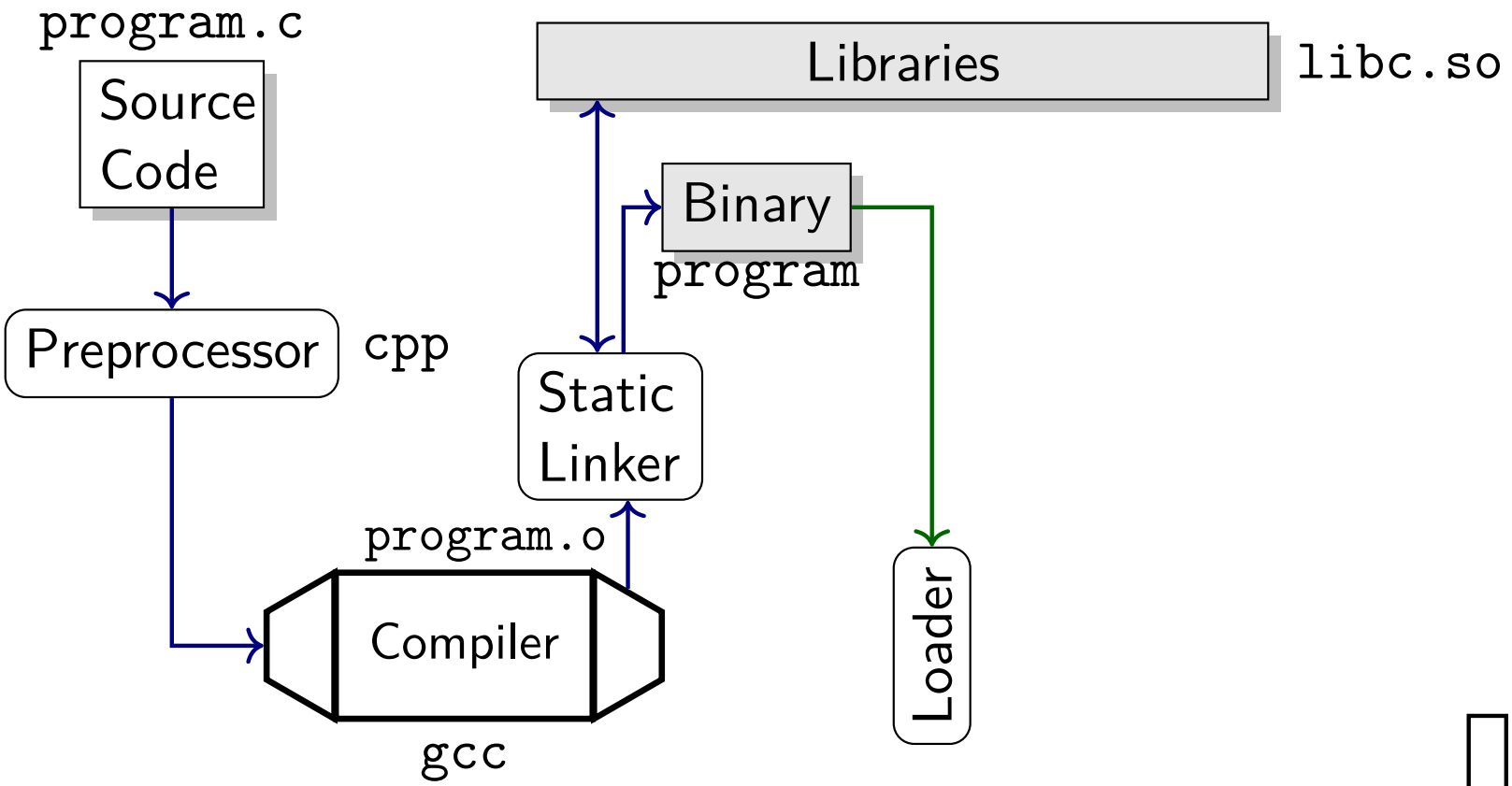


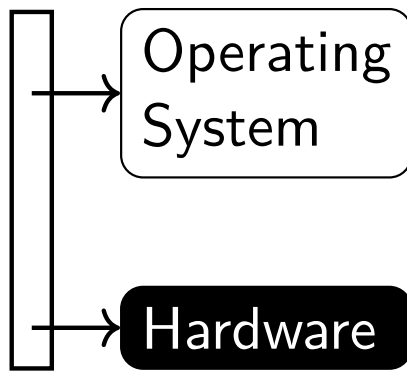
Program Execution Pipeline



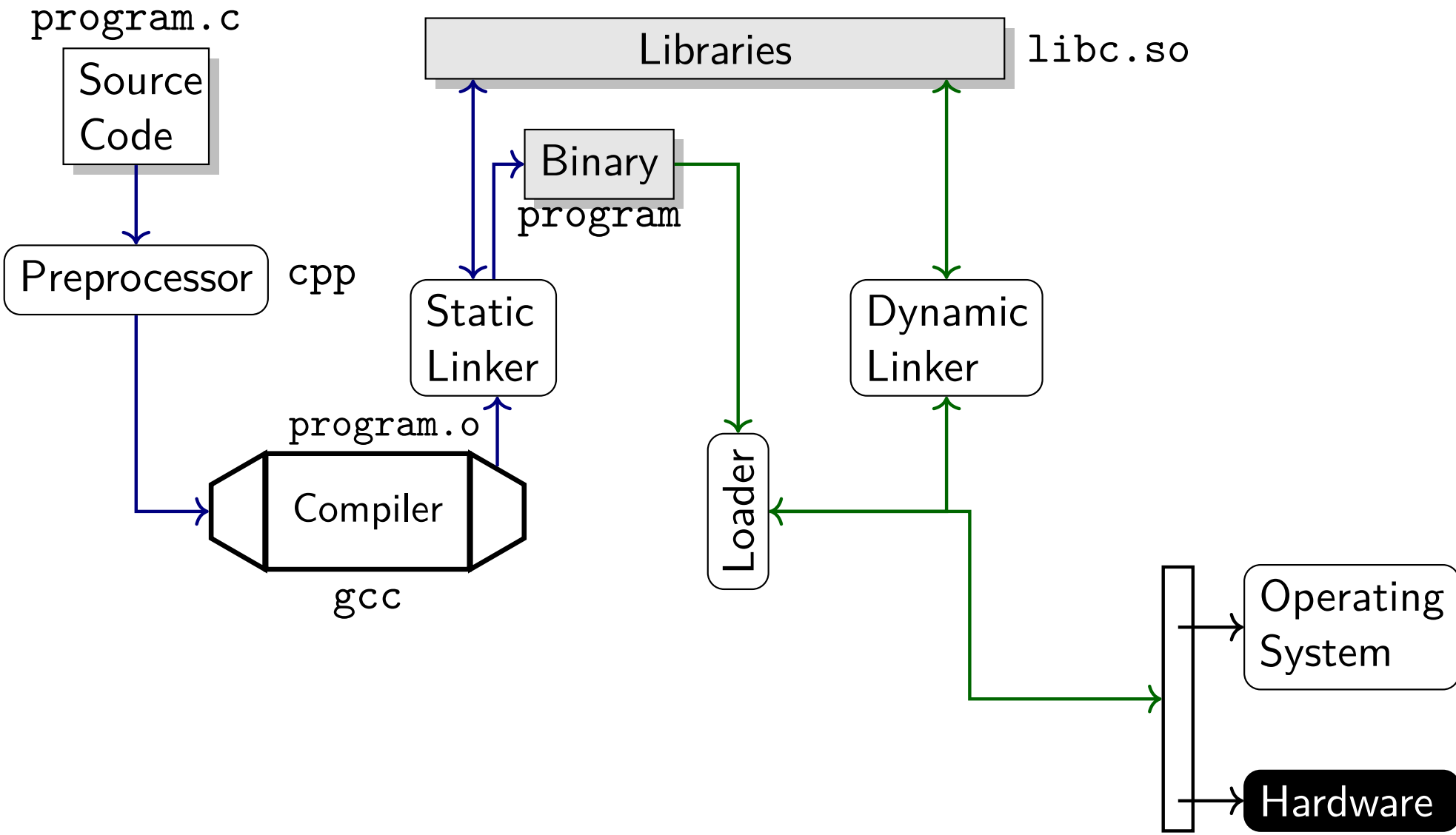


Program Execution Pipeline





Program Execution Pipeline



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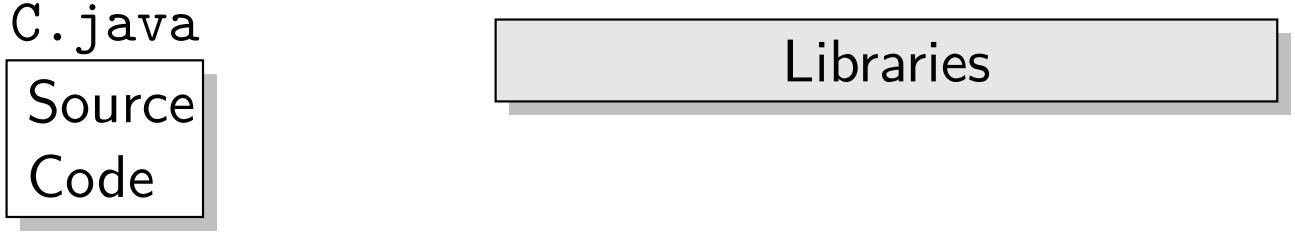
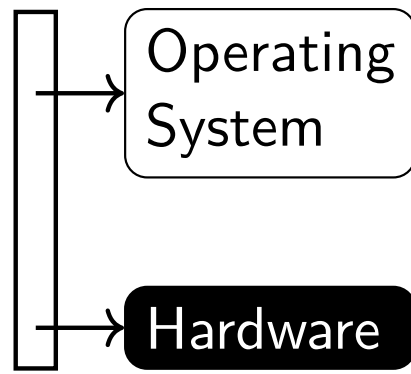
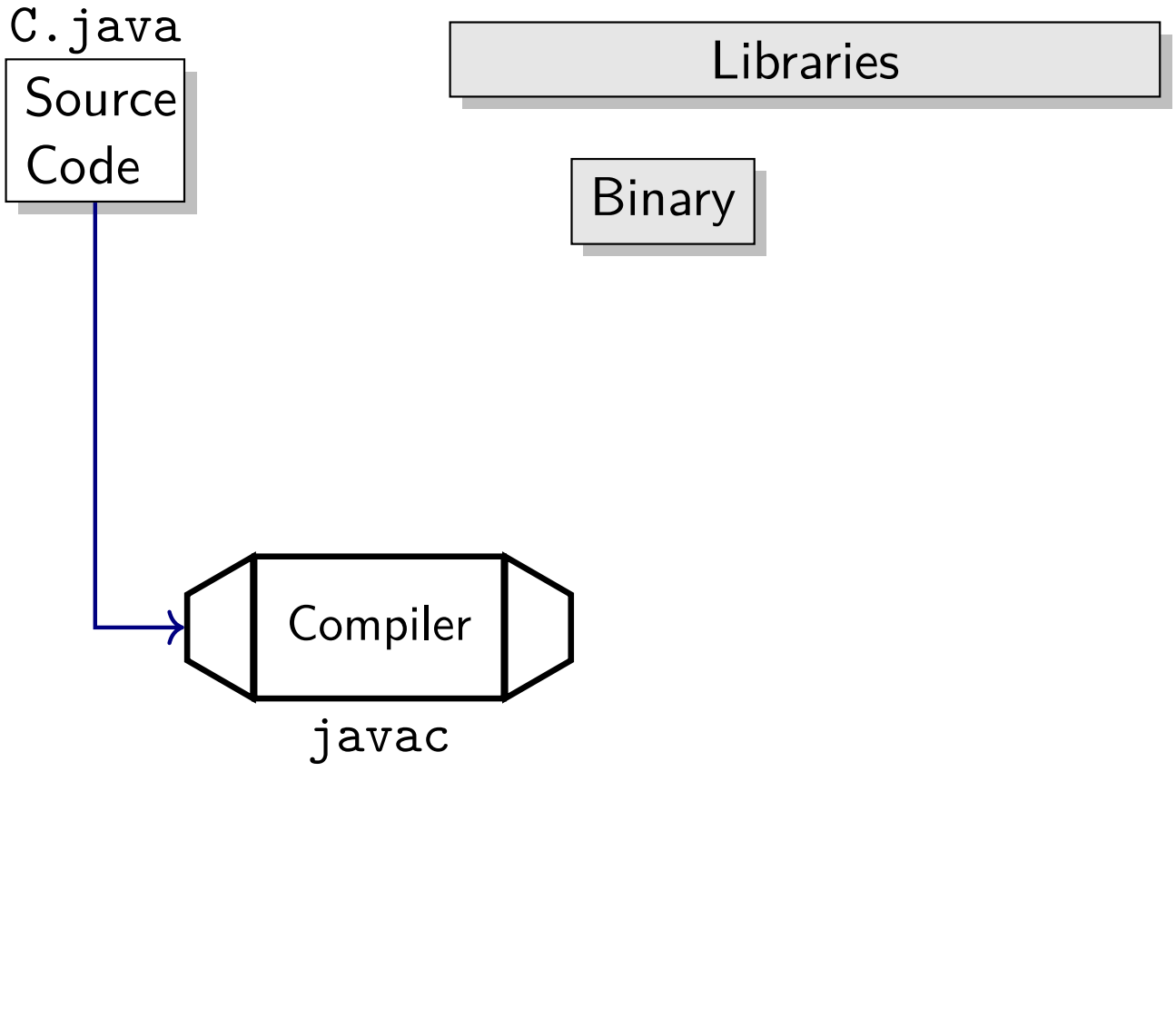
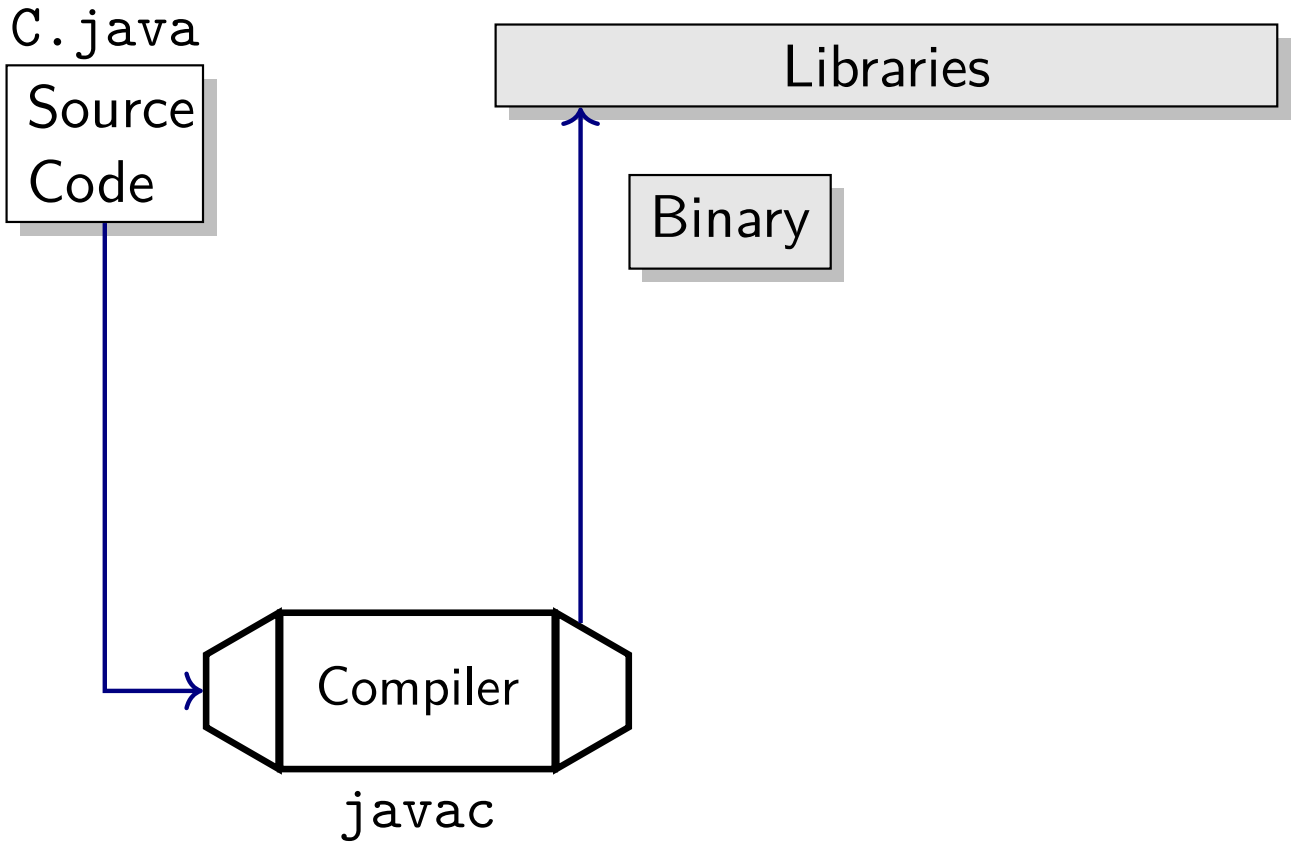


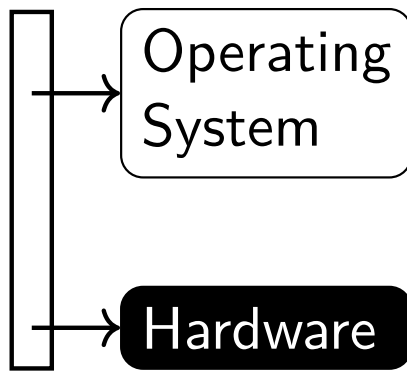


Program Execution Pipeline

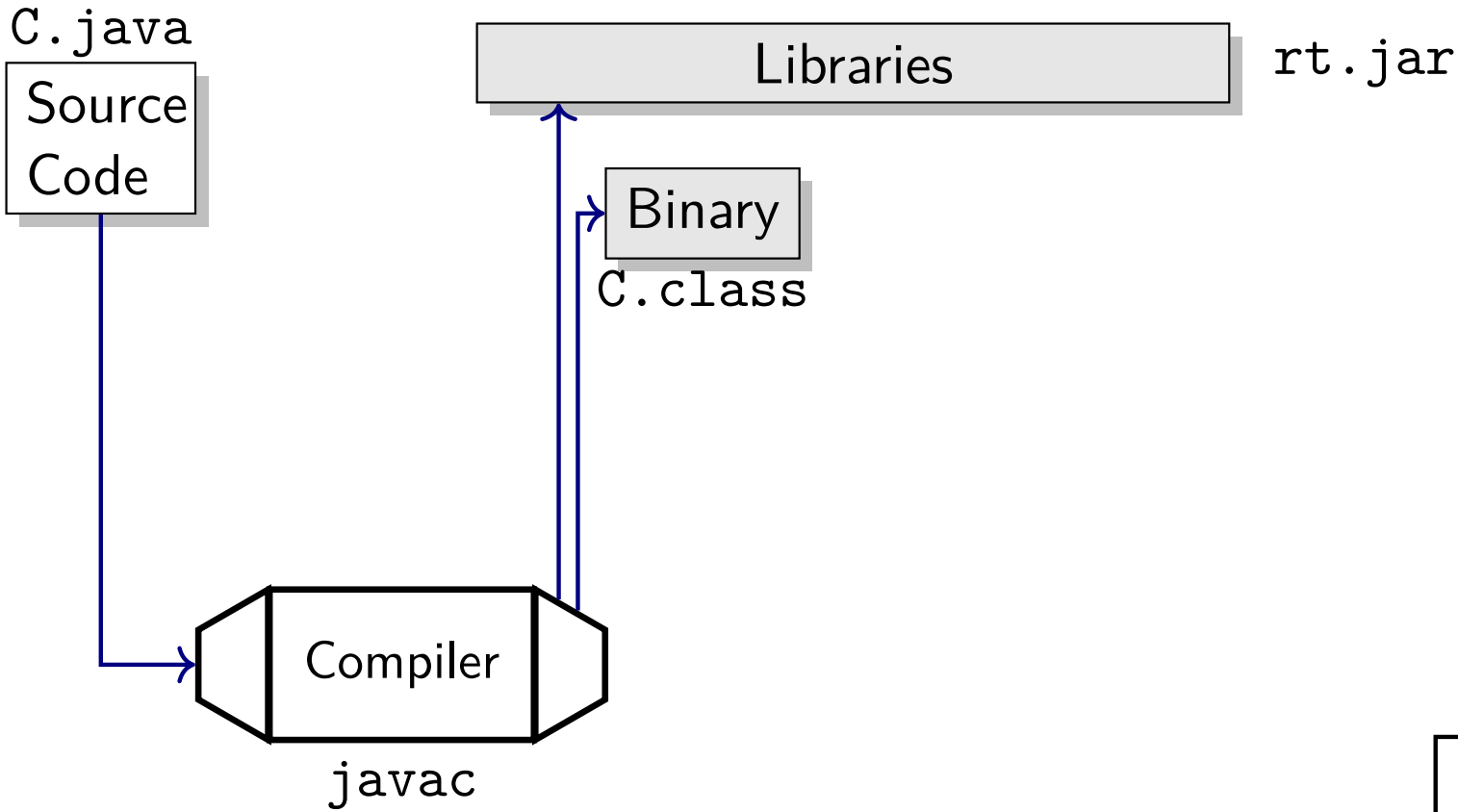


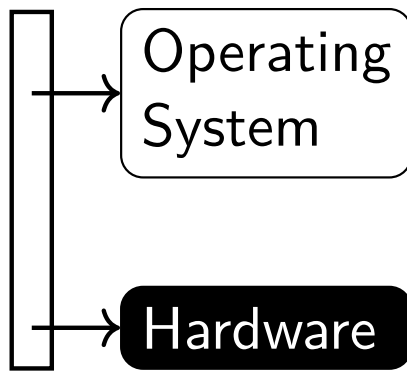
Program Execution Pipeline



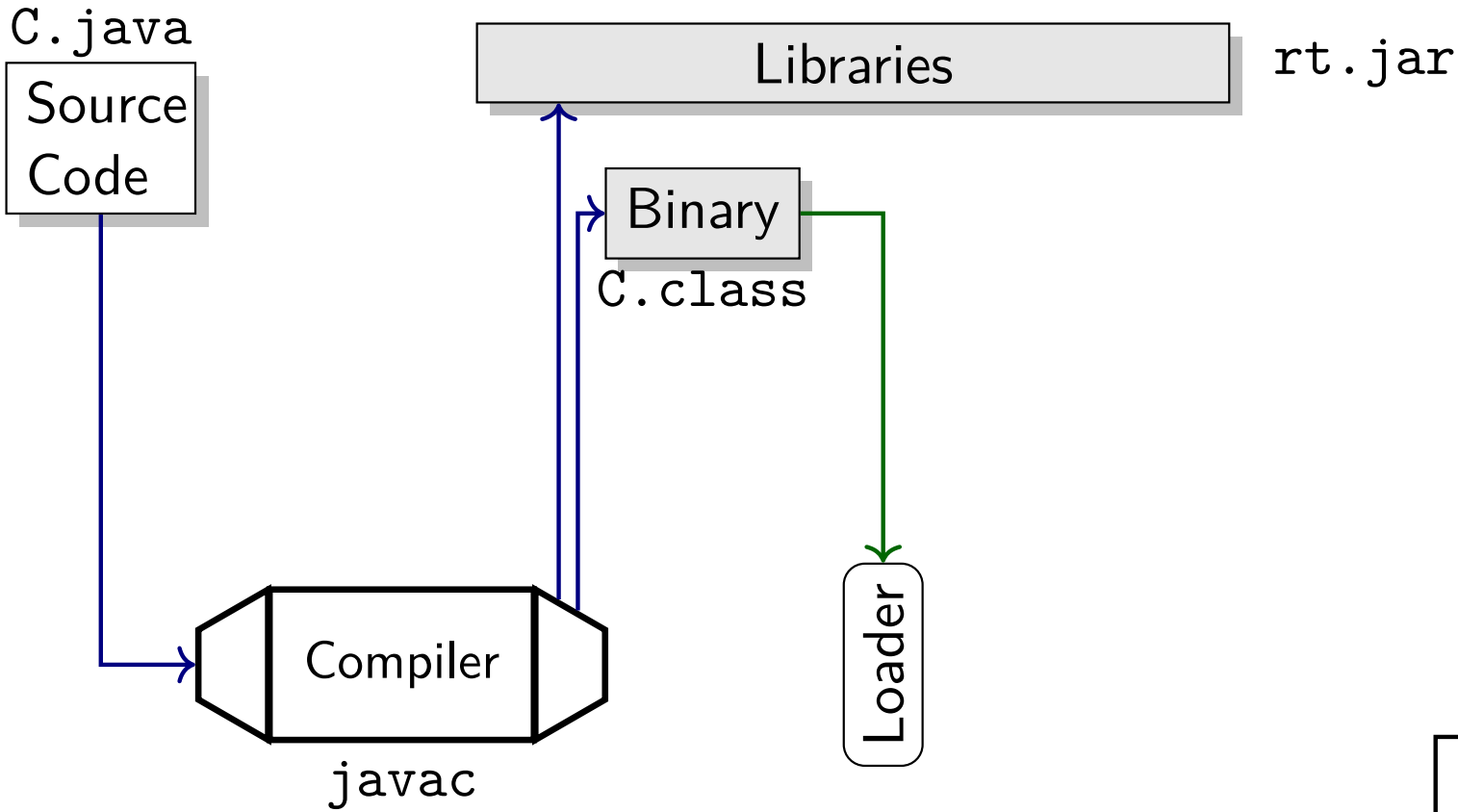


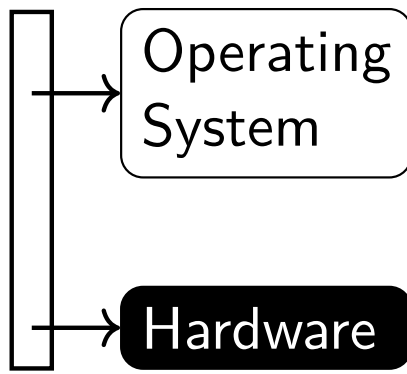
Program Execution Pipeline



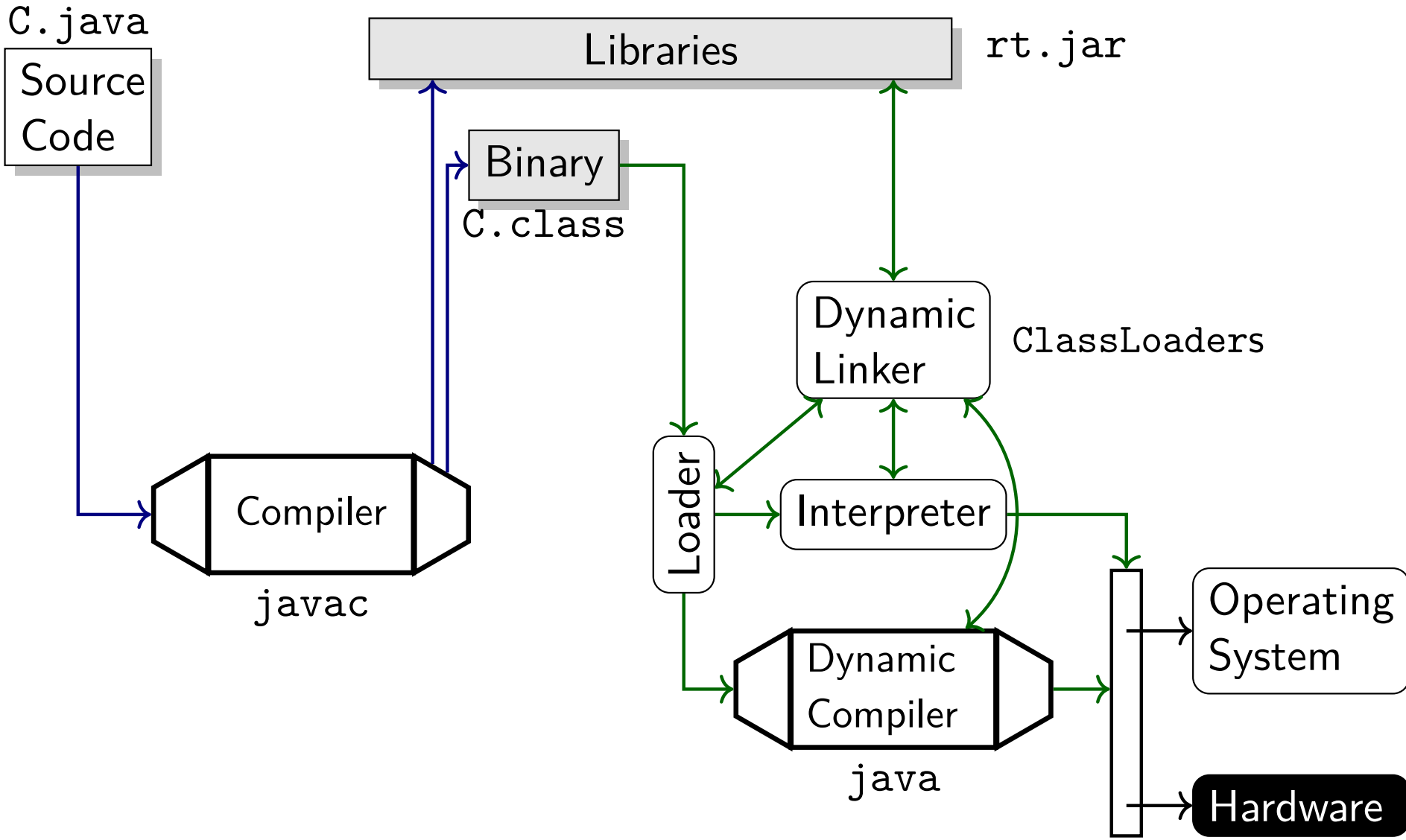


Program Execution Pipeline

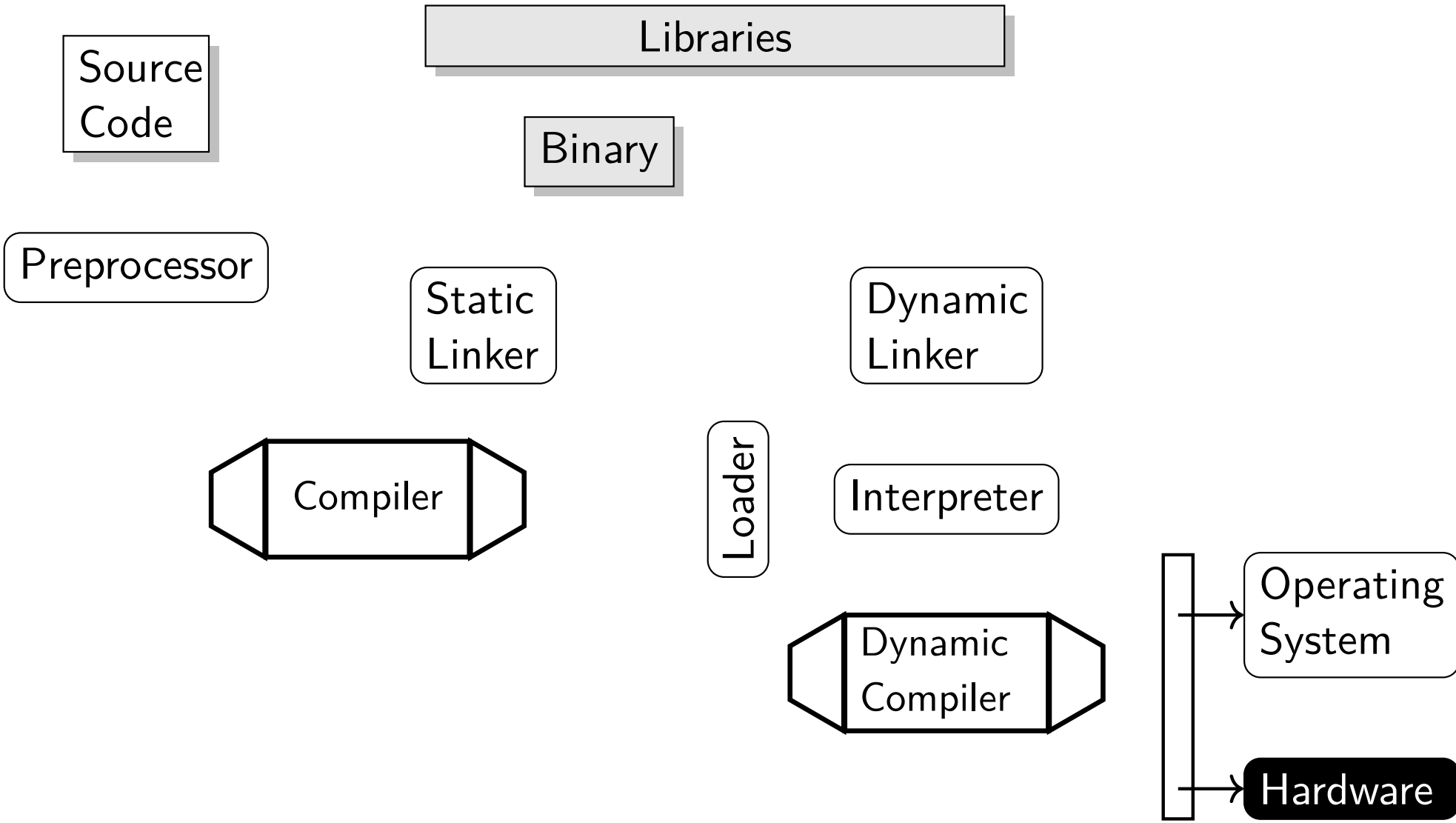




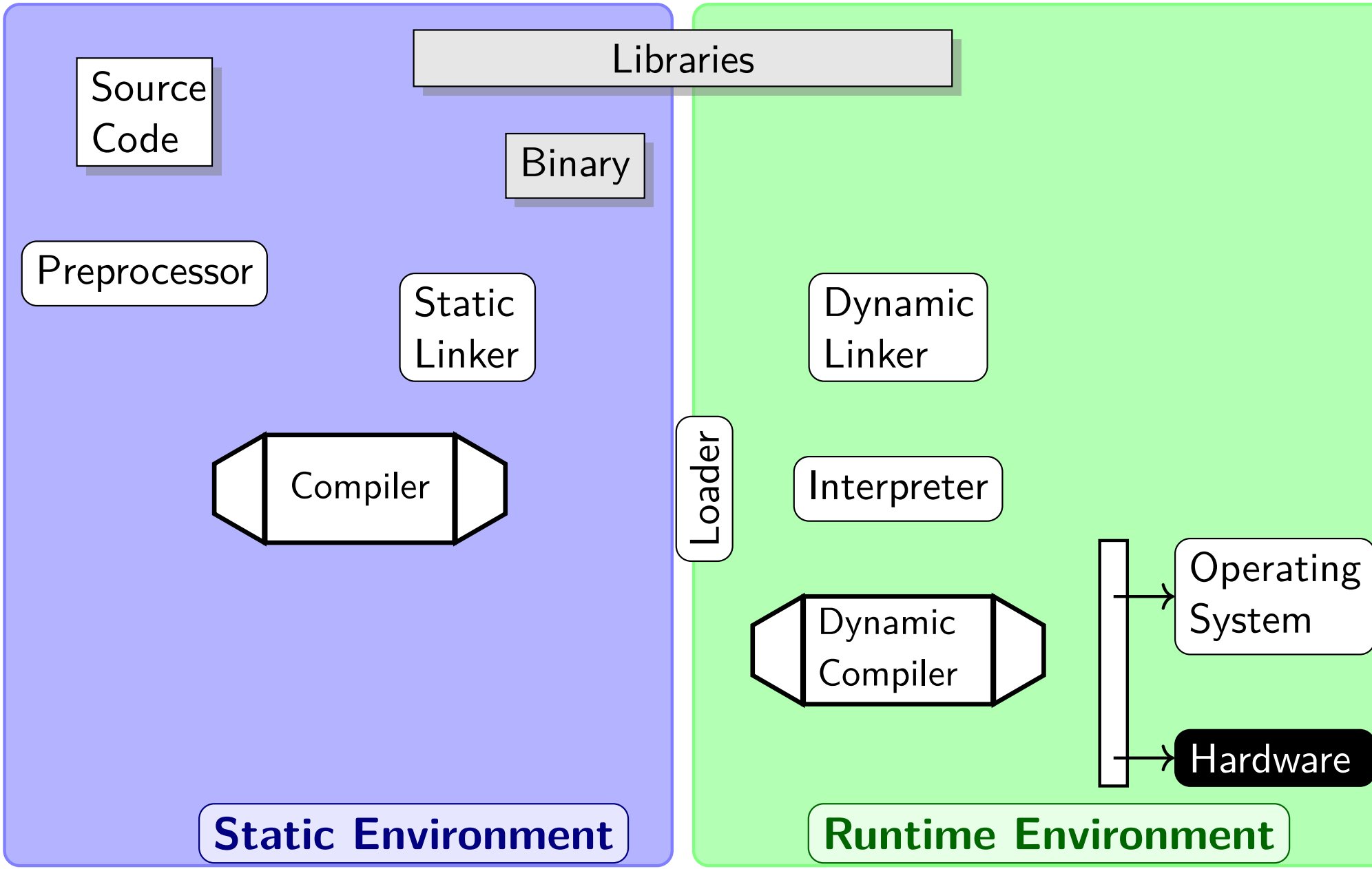
Program Execution Pipeline



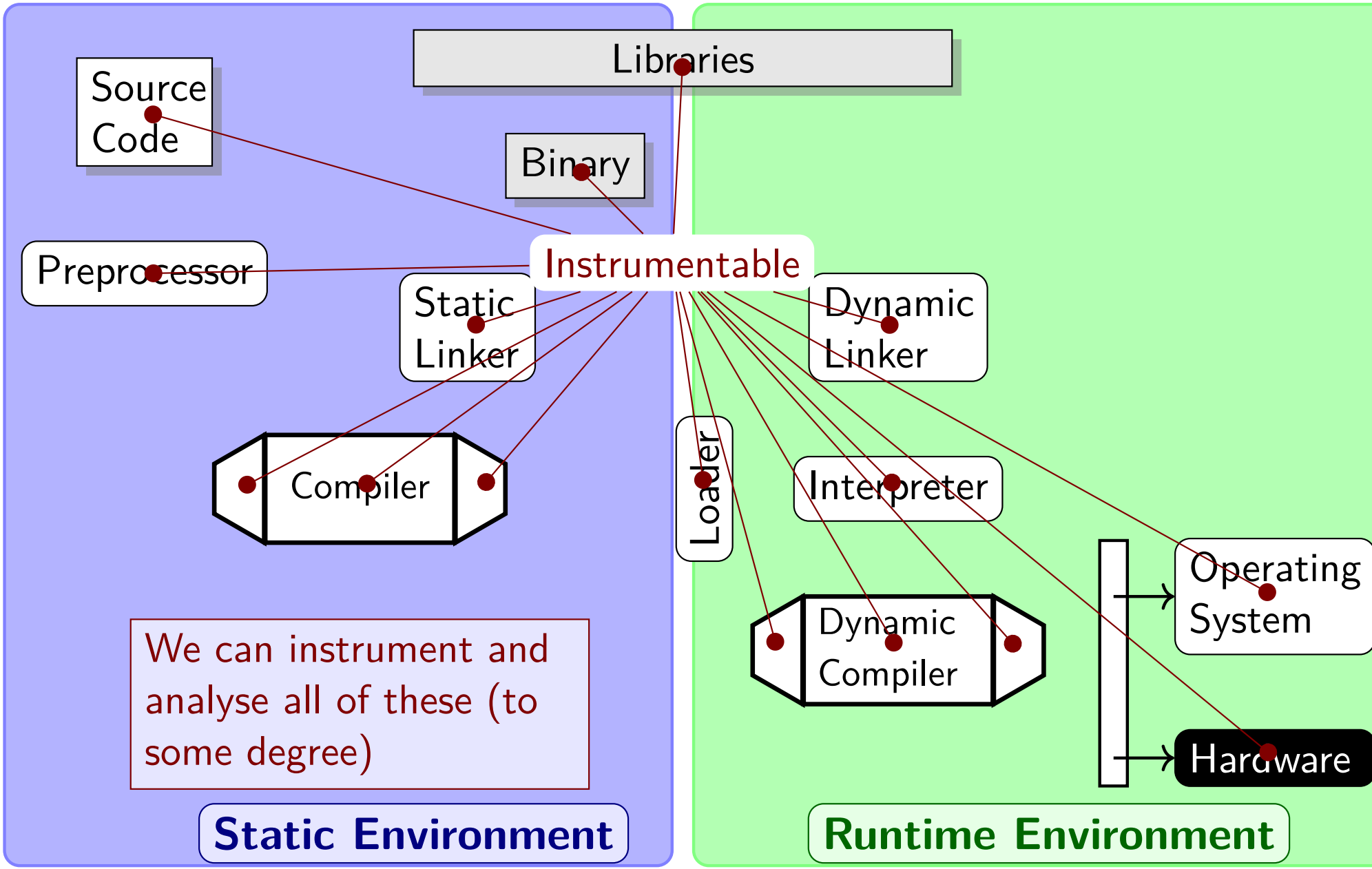
Program Execution Pipeline



Program Execution Pipeline



Program Execution Pipeline



Focus on Dynamic Analysis

- Recall: **Precise** but **Unsound**
- False positives: *none*
  (if what you are measuring is *observable*!)
- False negatives: *unbounded*
  (no insight over how much we are missing)

Unit Tests

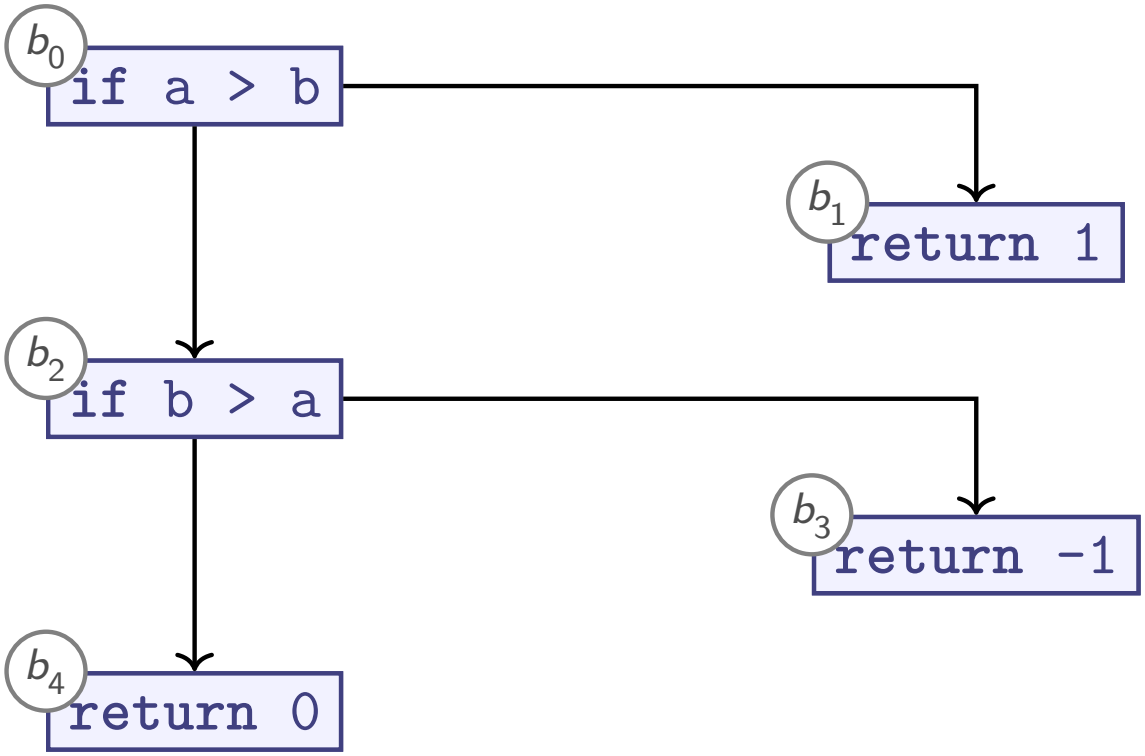
Teal

```
fun cmp(a, b) = {
  if a > b {
    return 1;
  }
  if a < b {
    return -1;
  }
  return 0;
}

fun test() = {
  assert cmp(1, 2) == -1;
  assert cmp(2, 1) == 1;
}
```

Unit tests are a simple form of dynamic program analysis

Unit Test Quality

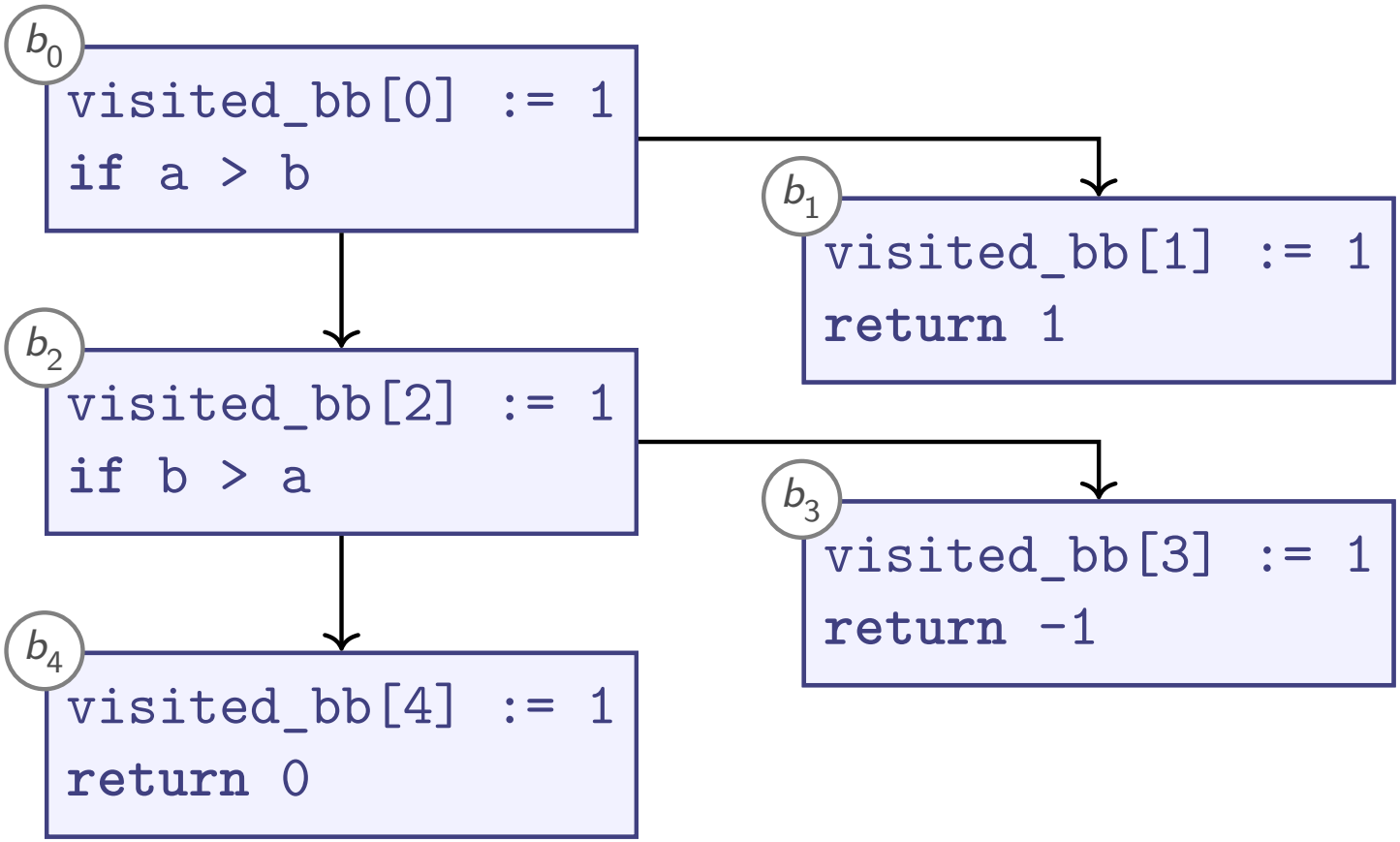


Teal

```
fun test() = {
  assert cmp(1, 2) == -1;
  assert cmp(2, 1) == 1;
}
```

Have I tested all behaviours?

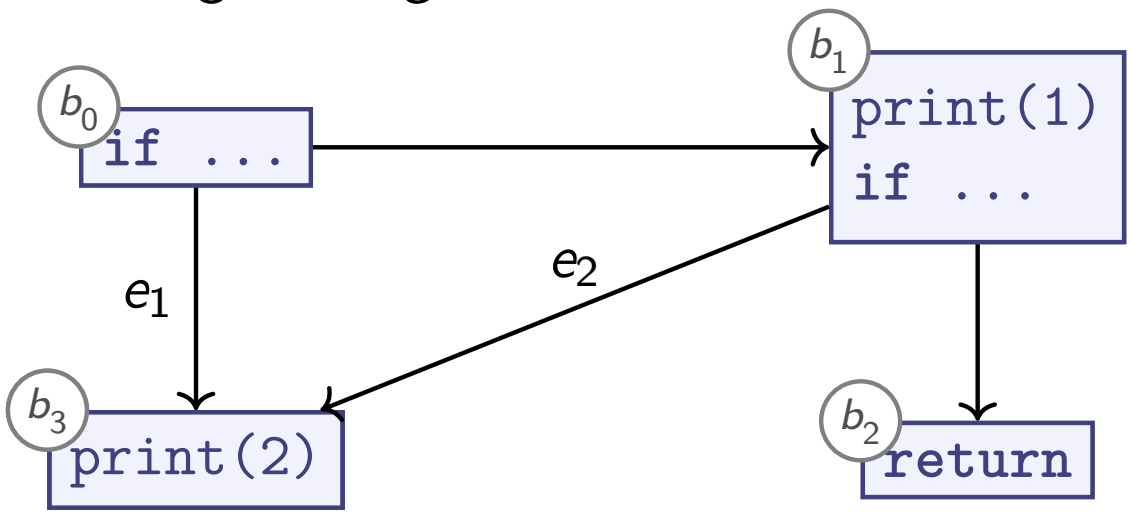
Test Coverage



- Test coverage = fraction of `visited_bb` elements updated

Test Coverage Properties

- **Statement Coverage**: % of executed CFG nodes
  or "Basic Blocks" of contiguous non-branching operations
  - Mark nodes/blocks as visited while testing
- **Edge Coverage**: % of taken CFG edges
  - Challenge: distinguish *edge* e_1 from e_2?



Test Coverage Properties

- **Statement Coverage**: % of executed CFG nodes
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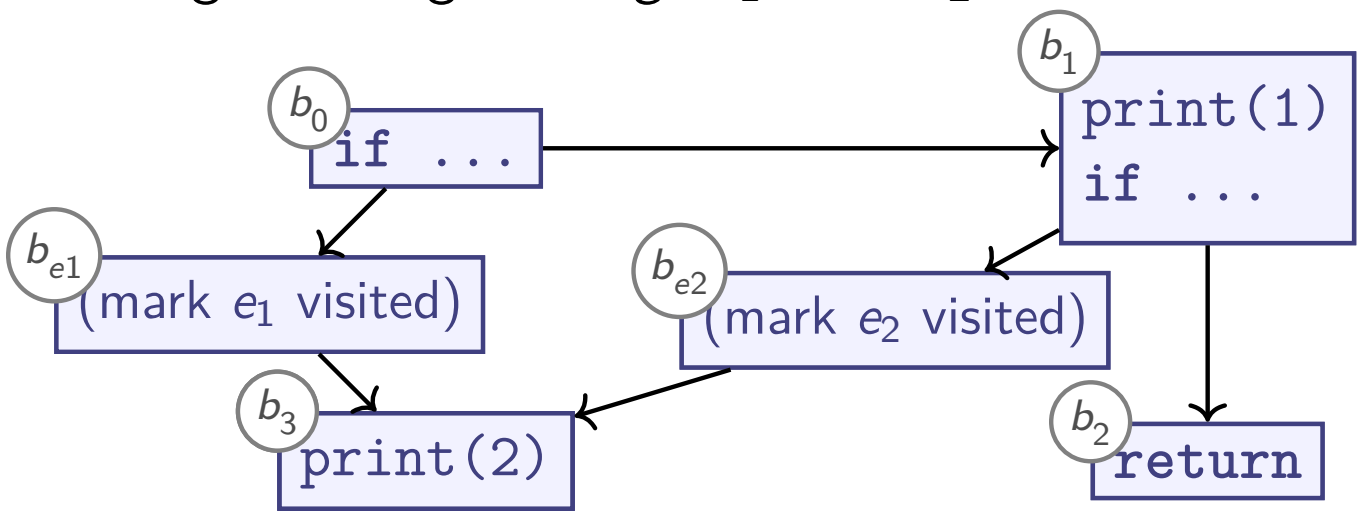

- Alternative: track last CFG node ID
- **Path Coverage**: % of CFG paths (less common)

Summary

- **Unit Tests** are a simple form of dynamic program analysis
  - Minimal tooling needed
  - Custom checks
  - Limited to what underlying language can express directly
- **Test Coverage** tells us how much of our code gets analysed by at least one unit test
- Implement by setting markers on relevant CFG nodes / blocks
  - Source-level: e.g. via DMCE (C/C++)
  - Binary-level: e.g. via JaCoCo/JCov (Java)
- Different criteria, such as:
  - **Statement Coverage**
  - **Edge Coverage**: may require helper CFG nodes
  - **Path Coverage**: paths through CFG (usually excluding loops)

Outlook

- No quizzes for today

`http://cs.lth.se/EDAP15`