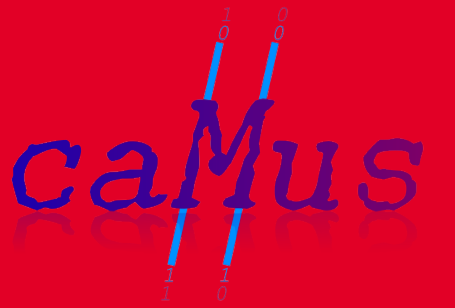


APOLLO

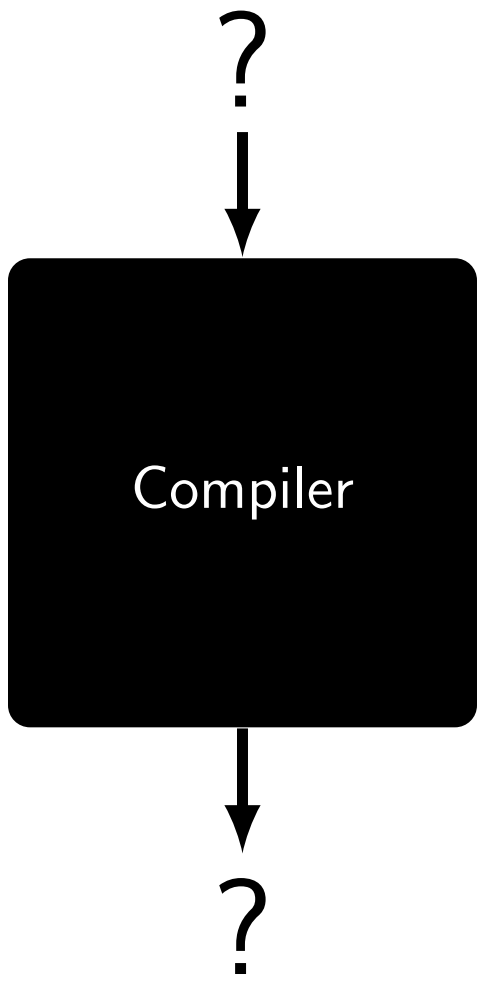
Automatic speculative POLyhedral Loop Optimizer

Juan Manuel Martinez Caamaño, Aravind Sukumaran-Rajam, Artiom Baloian, Manuel Selva, Philippe Clauss

INRIA CAMUS, ICube lab., CNRS
University of Strasbourg, France

Summary

What is a Compiler?



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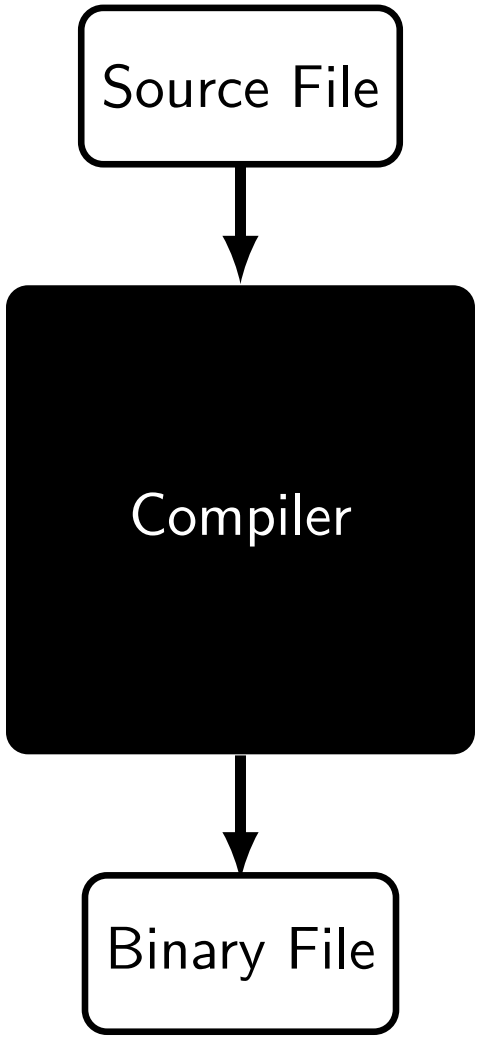

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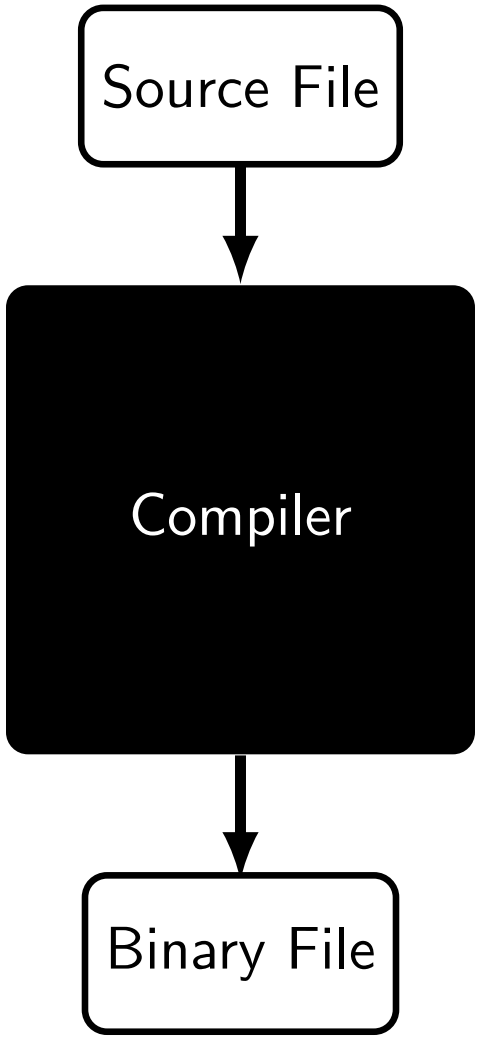
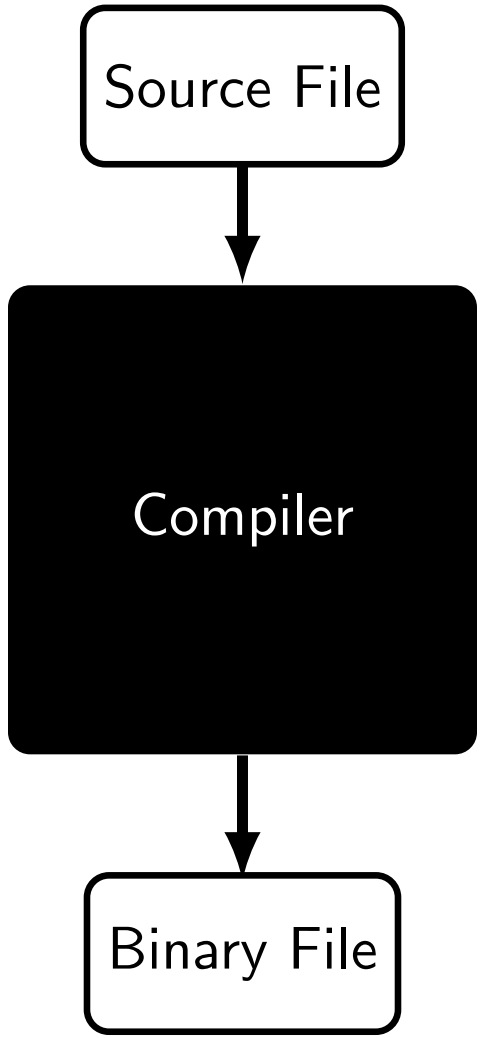


Compiler goals?

What is a Compiler?



Compiler goals?

- Correctness
- Performance of the code
- Size of the code

Polyhedral Compilation

```
for (int i = 0; i < 3; i++)
  for (int j = 0; j < 3; j++)
    z[i+j] += x[i] * y[j];
```

Polyhedral Compilation

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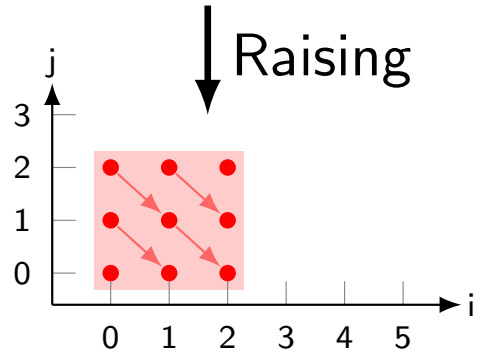

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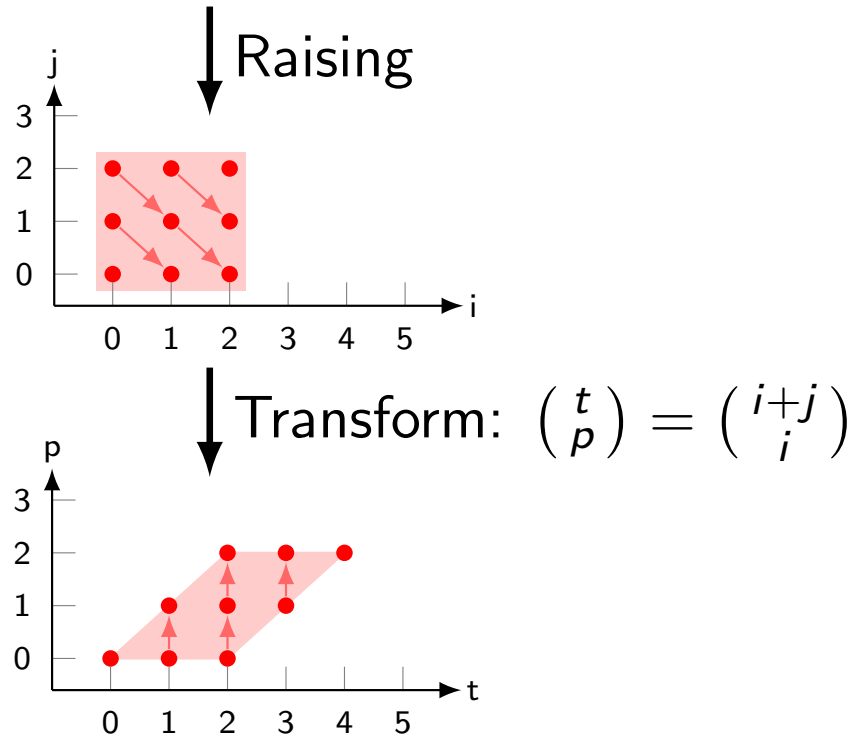

Polyhedral Compilation

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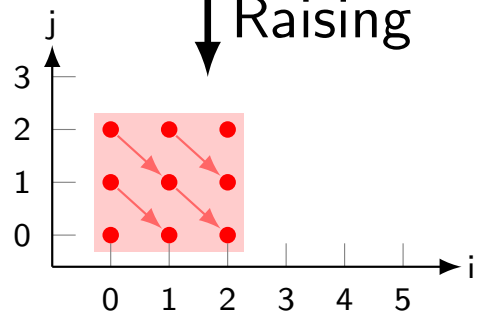
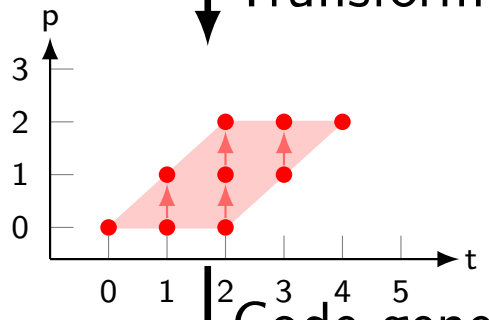
Raising



Transform: $\begin{pmatrix} t \\ p \end{pmatrix} = \begin{pmatrix} i+j \\ i \end{pmatrix}$

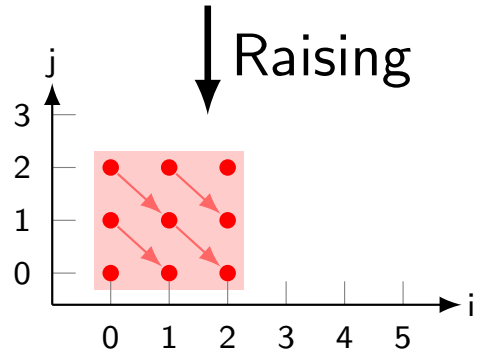


Code generation

```
#pragma omp parallel for
for (int t = 0; p < 5; p++)
  for (int p = max(0,t-2); p <= min(2,t); p++)
    z[t] += x[p] * y[t-p];
```

Polyhedral Compilation

```
for (int i = 0; i < 3; i++)
  for (int j = 0; j < 3; j++)
    z[i+j] += x[i] * y[j];
```



Raising on Static Control Parts (SCoPs) only

- Affine loop bounds
- Affine conditionals
- Affine memory accesses

Polyhedral Compilation

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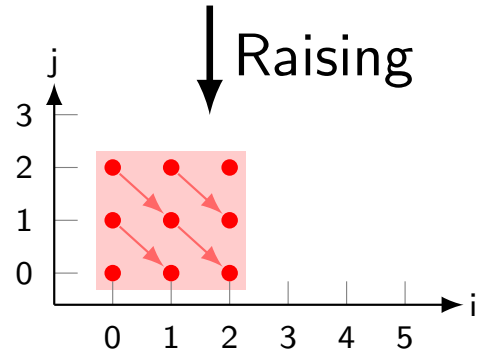


Raising on Static Control Parts (SCoPs) only

- Affine loop bounds
- Affine conditionals
- Affine memory accesses

SCoPs cannot always be detected statically

- Need for runtime mechanisms
- APOLLO

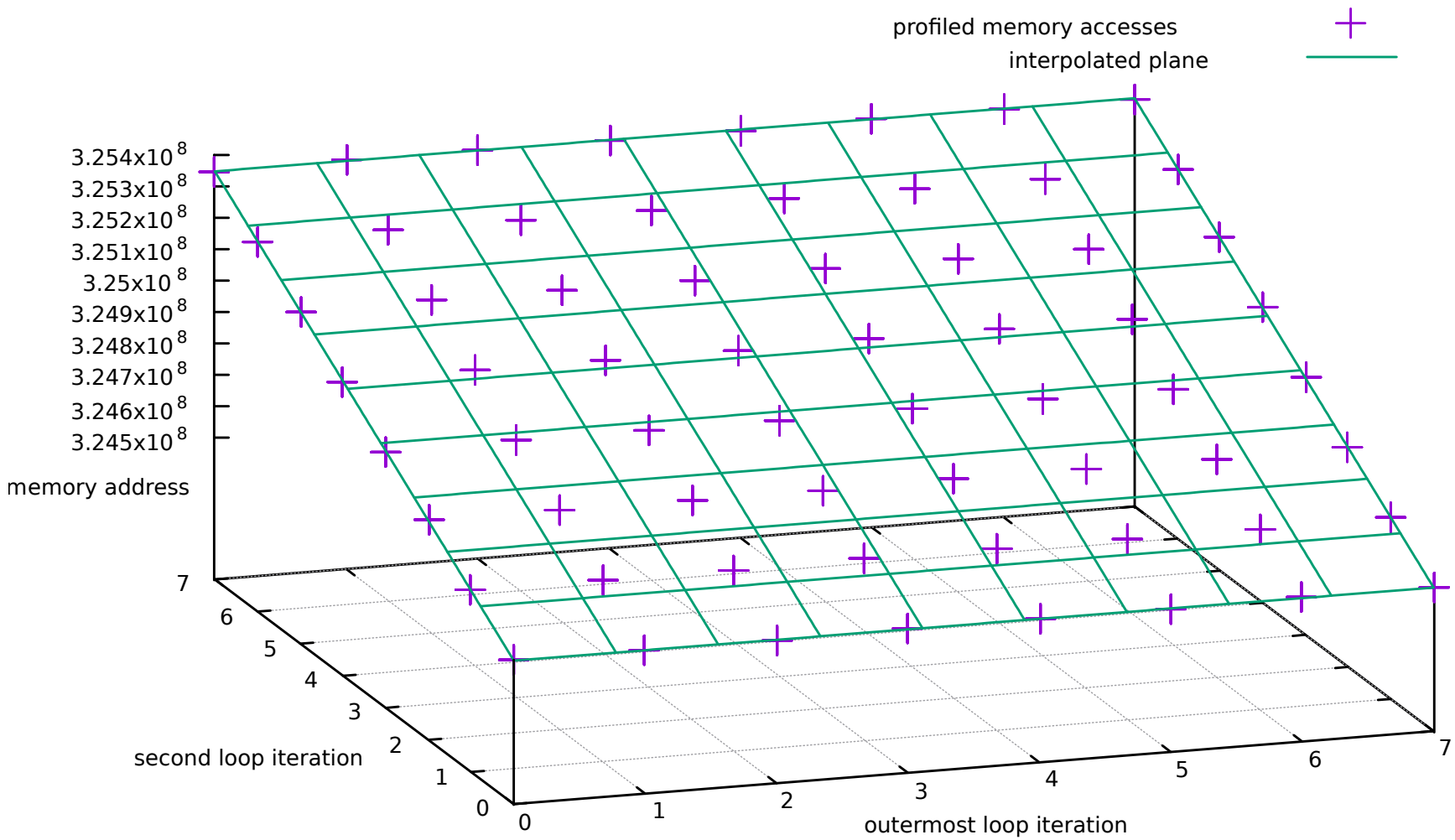
Sparse Matrix ∗ Dense Matrix

```
// Iterate over rows of sparse matrix
for (i = 1; i <= left->size; i++) {
  elem = left->firstInRow[i];

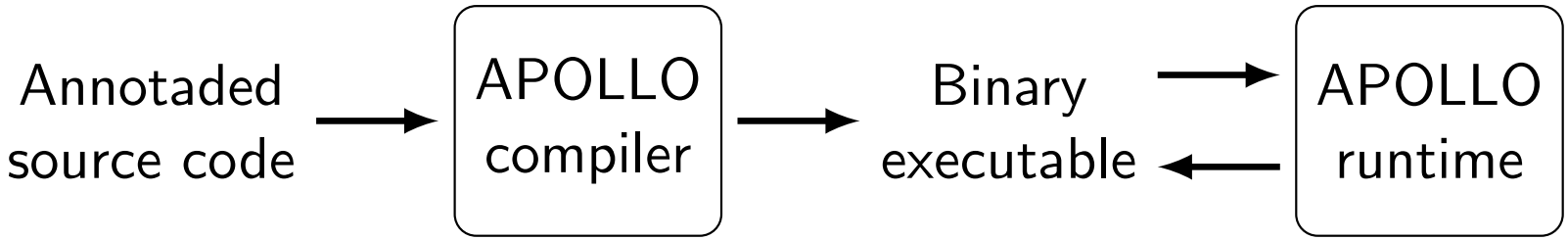
  // Iterate elements in row of spare matrix
  while (elem) {

    // Iterate over columns in dense matrix
    for (col = 1; col <= cols; col++) {
      res[row][col] +=
          elem->value * right[elem->col][col];
    }
    elem = elem->next;
  }
}
```

Sparse Matrix ∗ Dense Matrix - At Runtime



APOLLO - Automatic Speculative POLyhedral Loop Optimizer



APOLLO Compiler

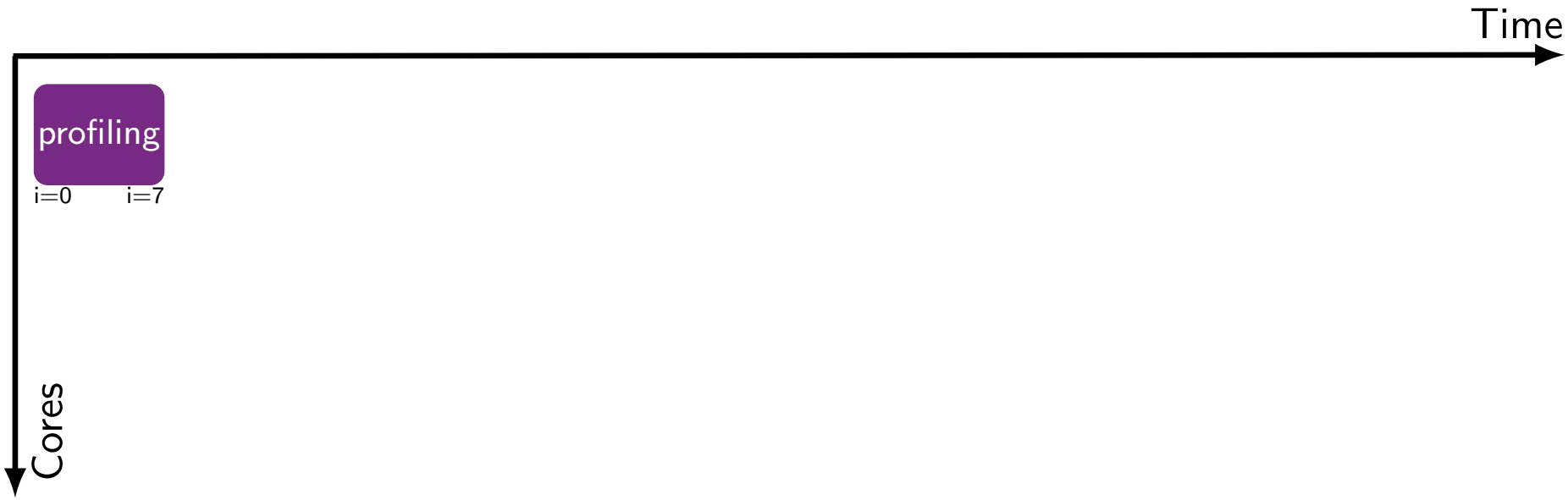
Virtual Iterators - Handling any kind of loop consistently

- Inserted at each level of the target loop nest
- Starting at zero with step one

Extraction of Code-Bones

- Assembled at runtime for optimization

APOLLO Runtime

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for (i = 1; i <= left->size; i++) {
  elem = left->firstInRow[i];
  while (elem) {
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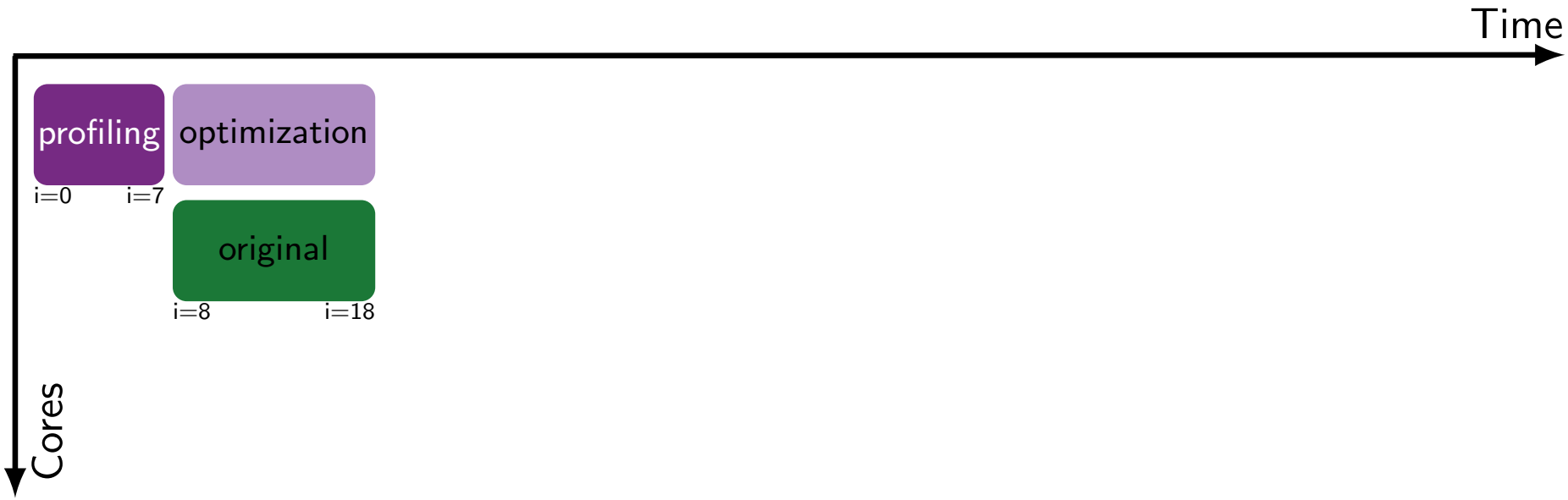
APOLLO Runtime

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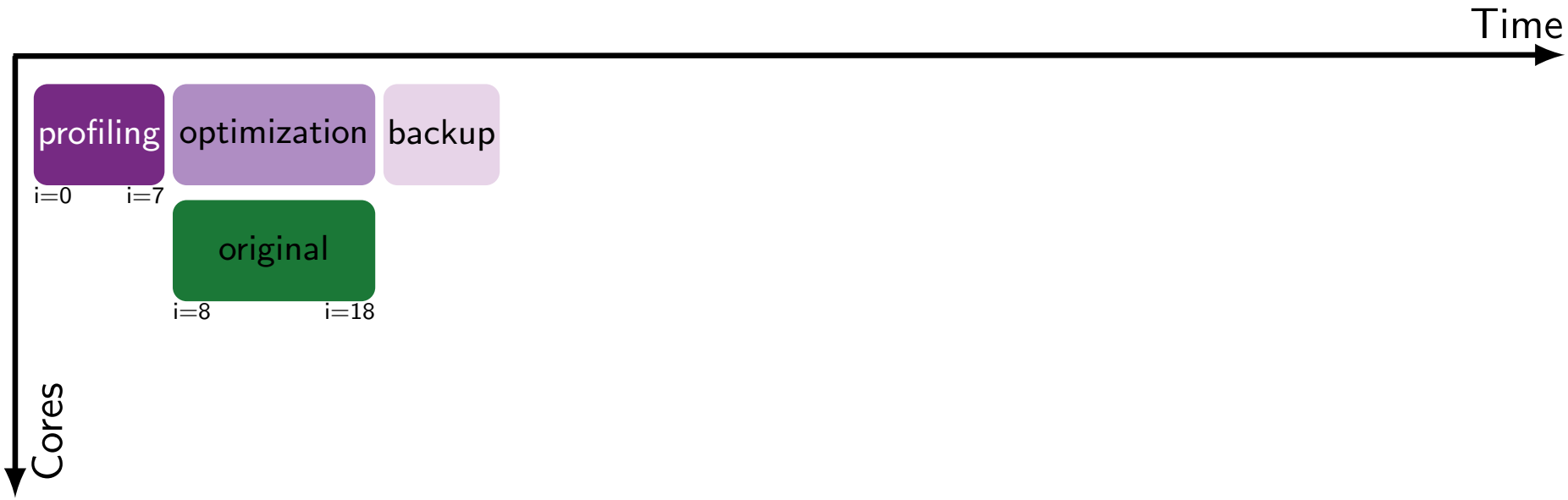
APOLLO Runtime

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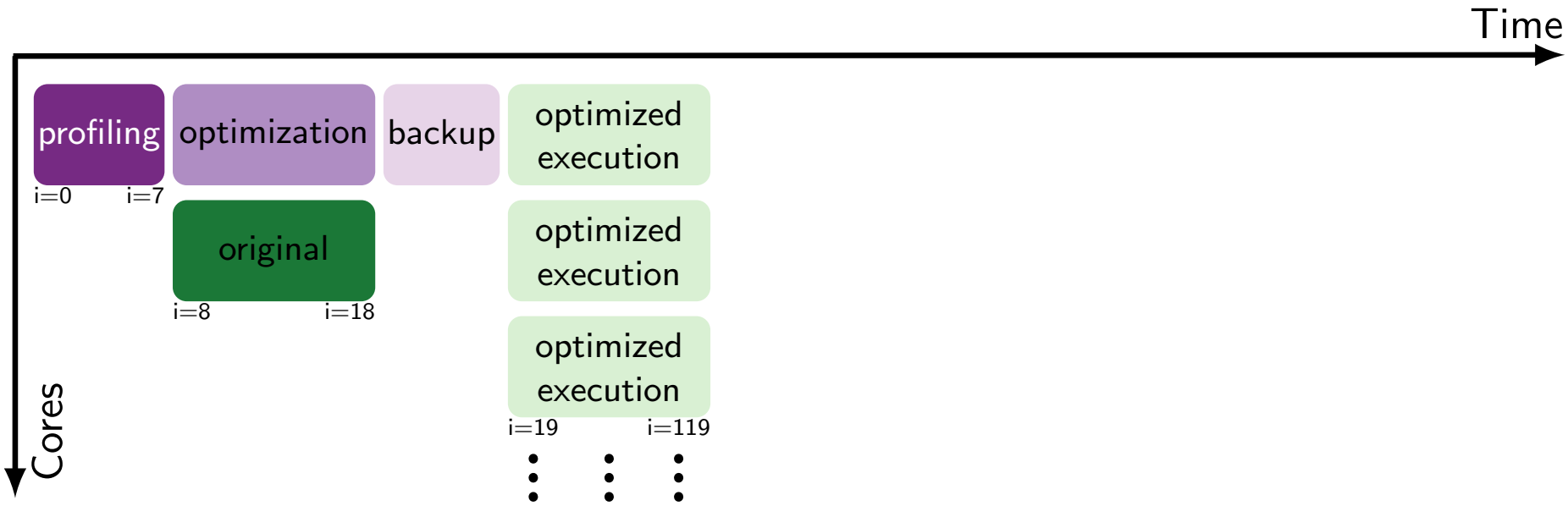
APOLLO Runtime

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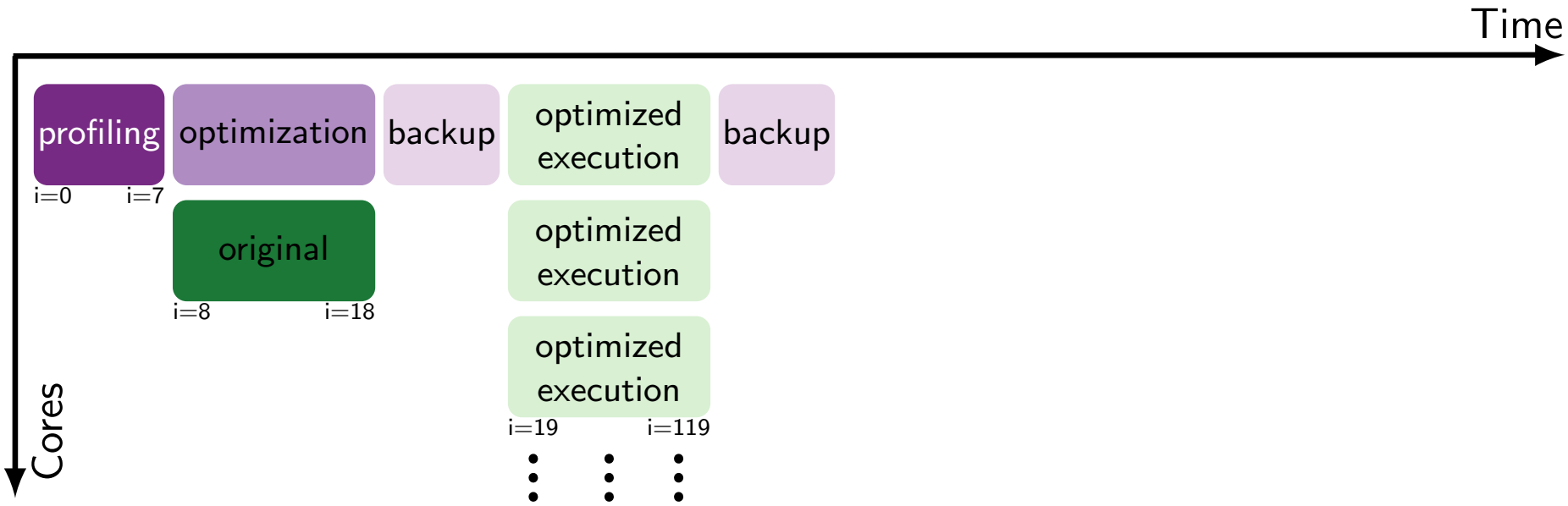
APOLLO Runtime

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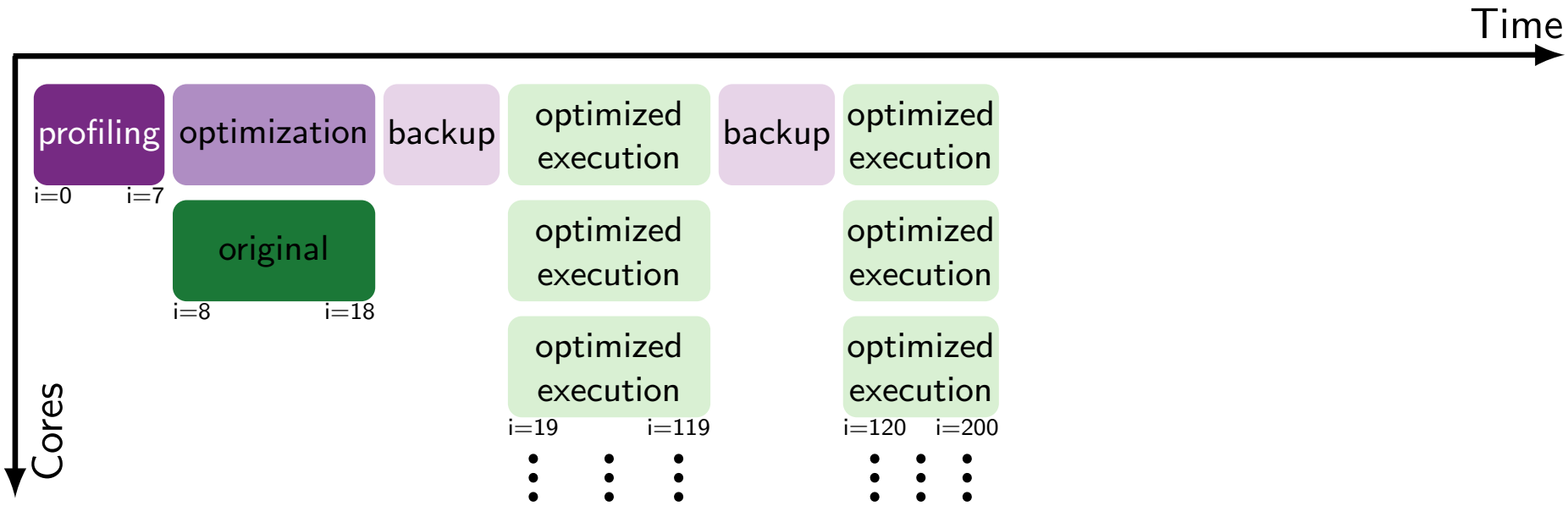
APOLLO Runtime

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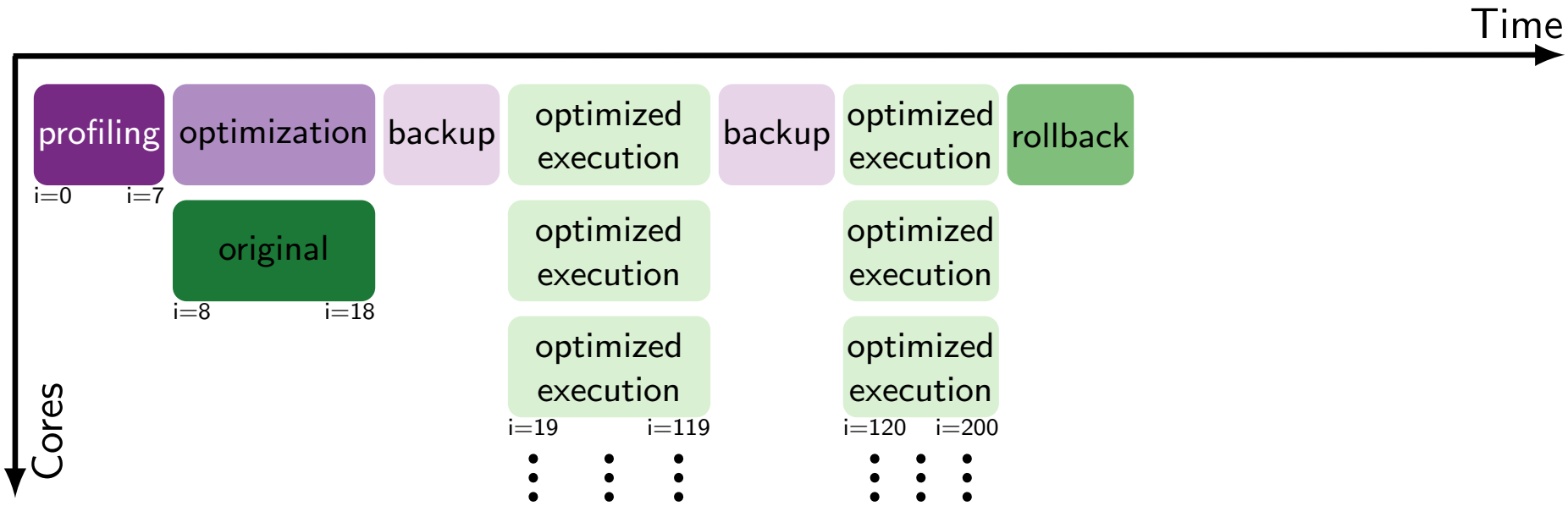
APOLLO Runtime

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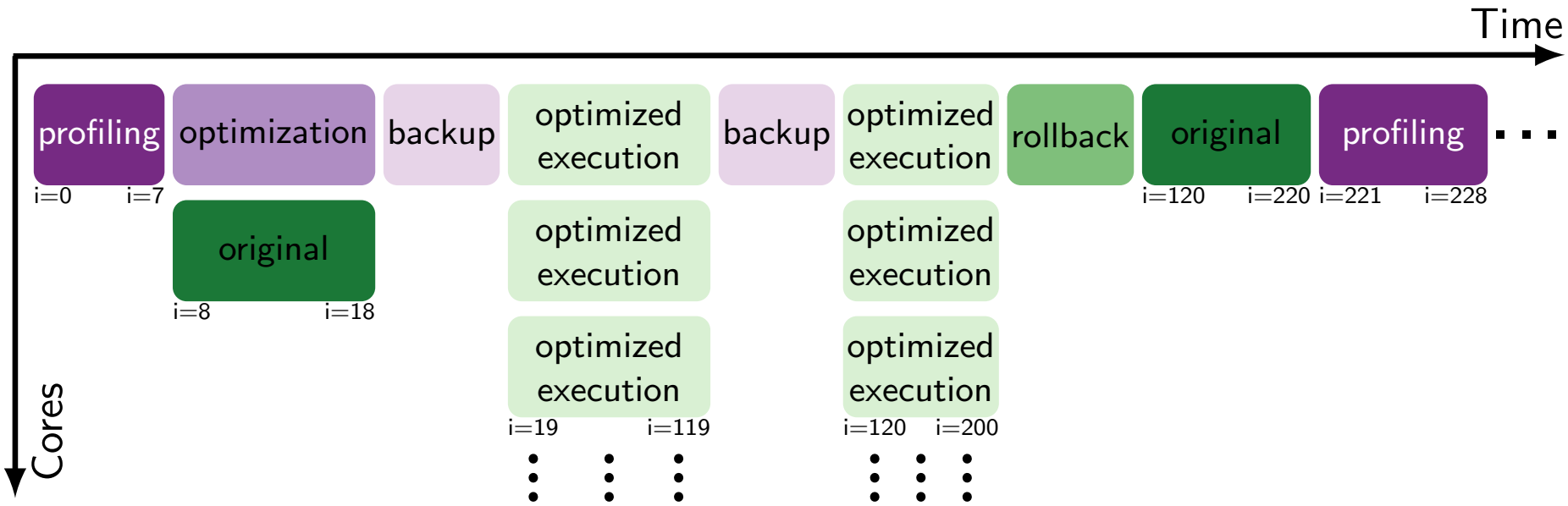
APOLLO Runtime

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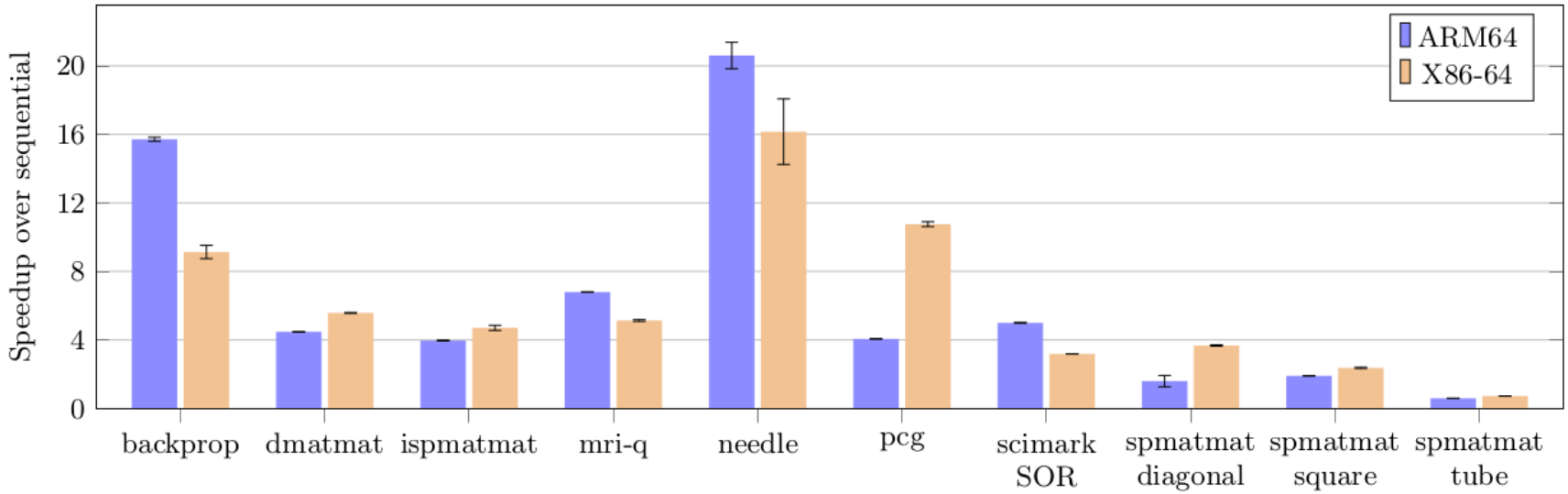
```

Results



- 8 threads
- Speedups over `clang -O3`

Conclusion

Open source software

- APOLLO 1.1.0[1]
- APOLLO Benchmarks 1.0.0[2]

On going work

- Polyhedral profiler based on APOLLO
- Memory reallocation (virtually) to fit SCoPs
- Polyhedral optimization for dynamic languages (JavaScript)

[1] `http://apollo.gforge.inria.fr`

[2] `https://scm.gforge.inria.fr/anonscm/git/apollo-benchs`

THANK YOU

University of Strasbourg
INRIA, ICube lab., CNRS
http://team.inria.fr/camus