# Parameterization of Compiler Optimizations For Empirical Tuning

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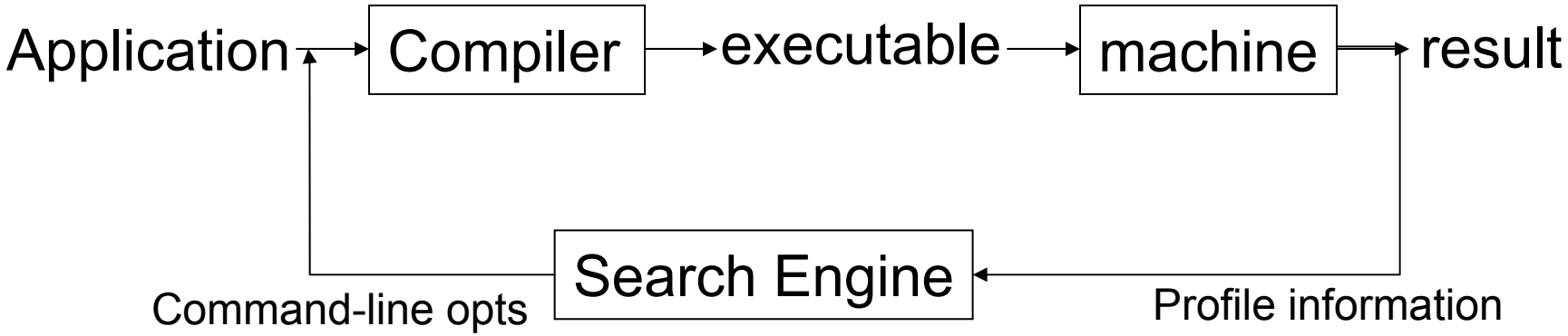
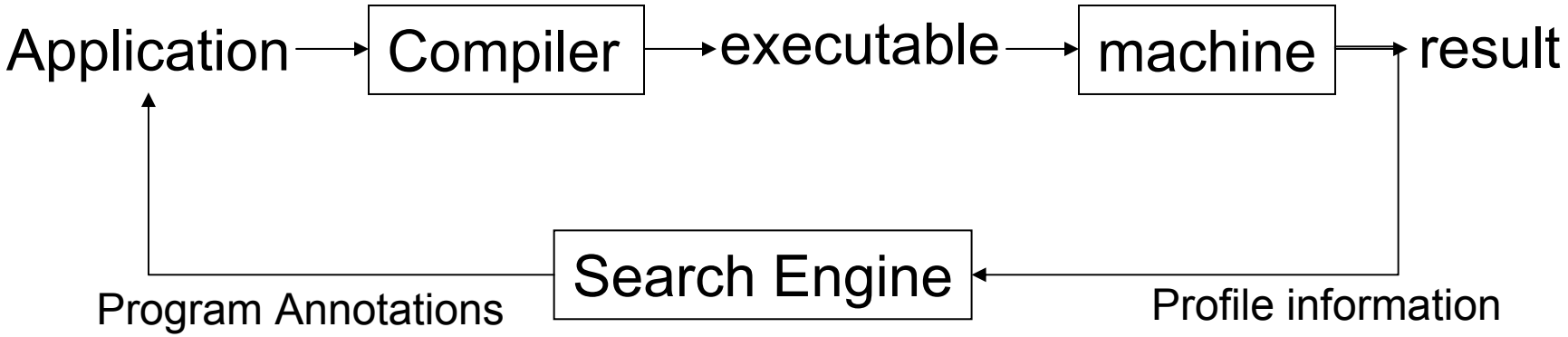
# Empirical Tuning of Compiler Optimizations(1)



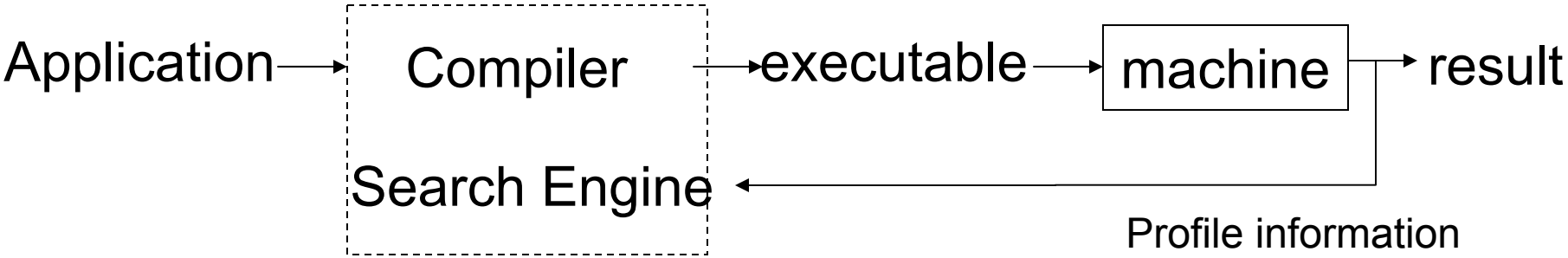

- Approach1: use compiler command-line options
  - Compilers can be configured in many ways
    - What strategies to use, which optimizations to apply…
  - Comand-line options offer only a few knobs
    - -O1 –O2 –O3 –fast, -g, …
  - How about different strategies for different fragments?

# Empirical Tuning of Compiler Optimizations(2)



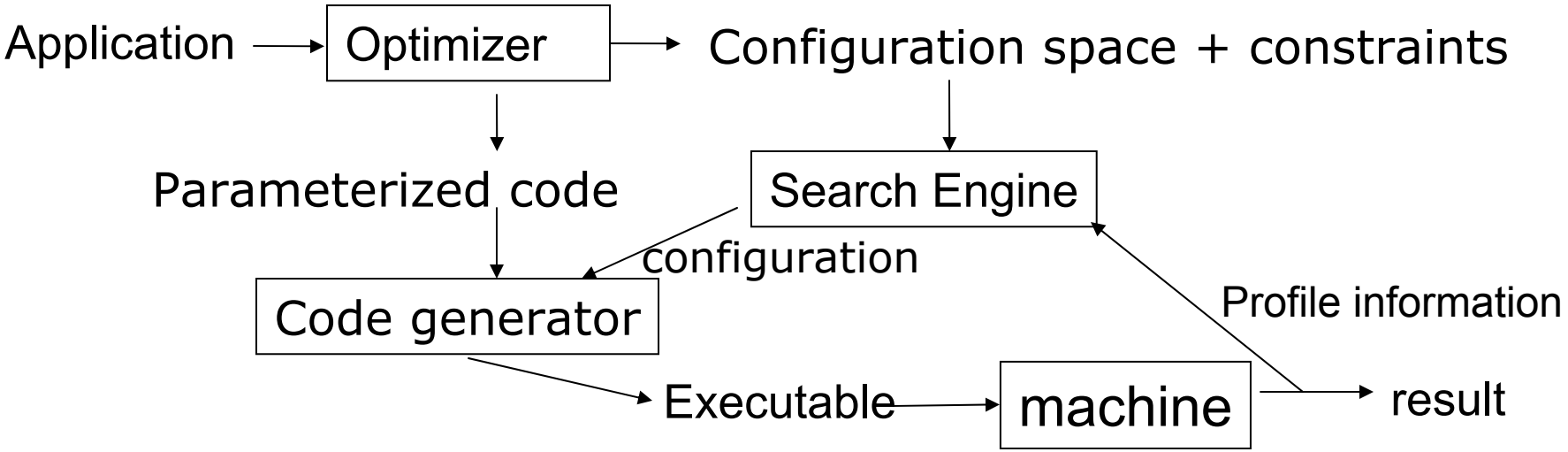

- Approach2: use program annotations
  - Can specify many different transformations
    - What strategies to use, which optimizations to apply,…
  - Allow different strategies for different fragments
  - Problem: how smart is the search engine?
    - Dependence, memory, register pressure, …
    - Needs ability to perform program analysis

# Empirical Tuning of Compiler Optimizations(3)




- Approach3: combine compiler and search engine
  - Compiler knows about the program
    - What strategies to use, which optimizations to apply,…
    - Dependence, memory, register pressure, …
  - Problem: flexibility and composibility
    - Compiler must be shipped together with application
    - Compiler must know how to exploit the search space
    - The compiler writer decides everything

# Empirical Tuning of Compiler Optimizations(4)




- Approach4: Parameterization of optimizations
  - Compiler generate parameterized output
    - What strategies to use, which optimizations to apply,…
  - Search engine exploits the configuration space
    - Use information from the compiler
    - Dependence, memory, register pressure, …
  - Code generator generates program executable
    - Applies configuration to parameterized code

# Parameterization of Optimizations---Blocking

```
do _i = 1, N, bi
   do _j = 1, N, bj
      do _k = 1, N, bk
         do i = _i, min(N,_i+bi)
            do j = _j, min(N,_j+bj)
               do k = _k,min(N,_k+bk)
                  C(i,j) = C(i,j)+A(i,k)*B(k,j)
```

- Parameter: blocking sizes
- Configuration space bi(1..N) * bj(1..N) * bk(1..N)
  - Tunable at both installation and run time

# Parameterization of Optimizations--- Unrolling

```
do i = 1, N, bi
<repeat  #i:i=>i+bi>
C(#i,j) = C(#i,j)+A(#i,k)*B(k,j)
</repeat>
```

- Parameter: unroll size
- Configuration space bi
- Need code generator to produce executable
  - Not tunable at runtime

# Work in progress---Challenges

- Not all transformations can be  parameterized
  - Loop fusion, loop interchange, scalar replacement, memory reorganization,…
- Transformations interact with each other
  - Exponential combinations of configurations
  - Interactions may not be parameterizable
- How to encode program analysis results from compiler
  - Dependence constraints, insight about programs
  - Information useful to the empirical search engine

# Current status

- Loop transformations
  - Parameterizaton of loop fusion, unrolling, interchange
  - Tuning at installation time and at runtime
- Collaborations
  - Rice university
  - LLNL
  - U. of Tennessee at Knoxville
  - U. of Texas at San Antonio