The Design and Implementation of Gnu Compiler Collection

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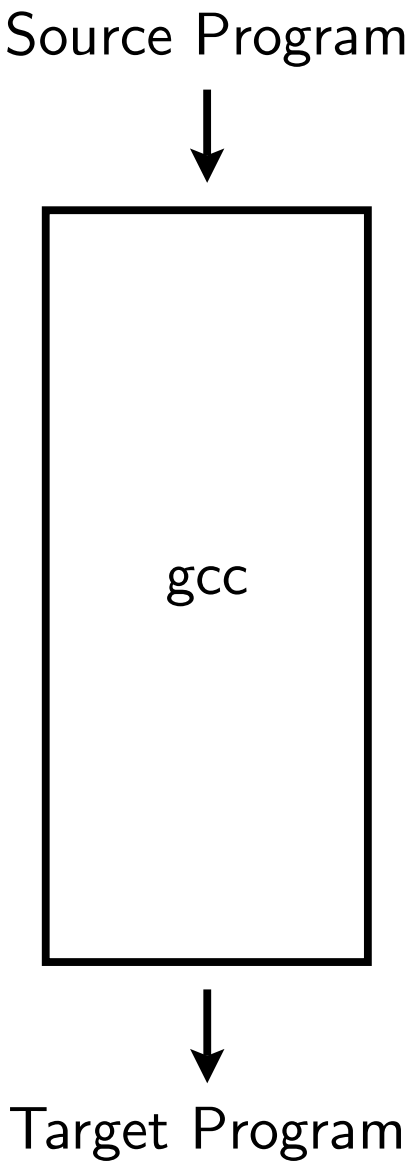
Part 1

Compilation Flow: Machine Independent Phases

The GNU Tool Chain



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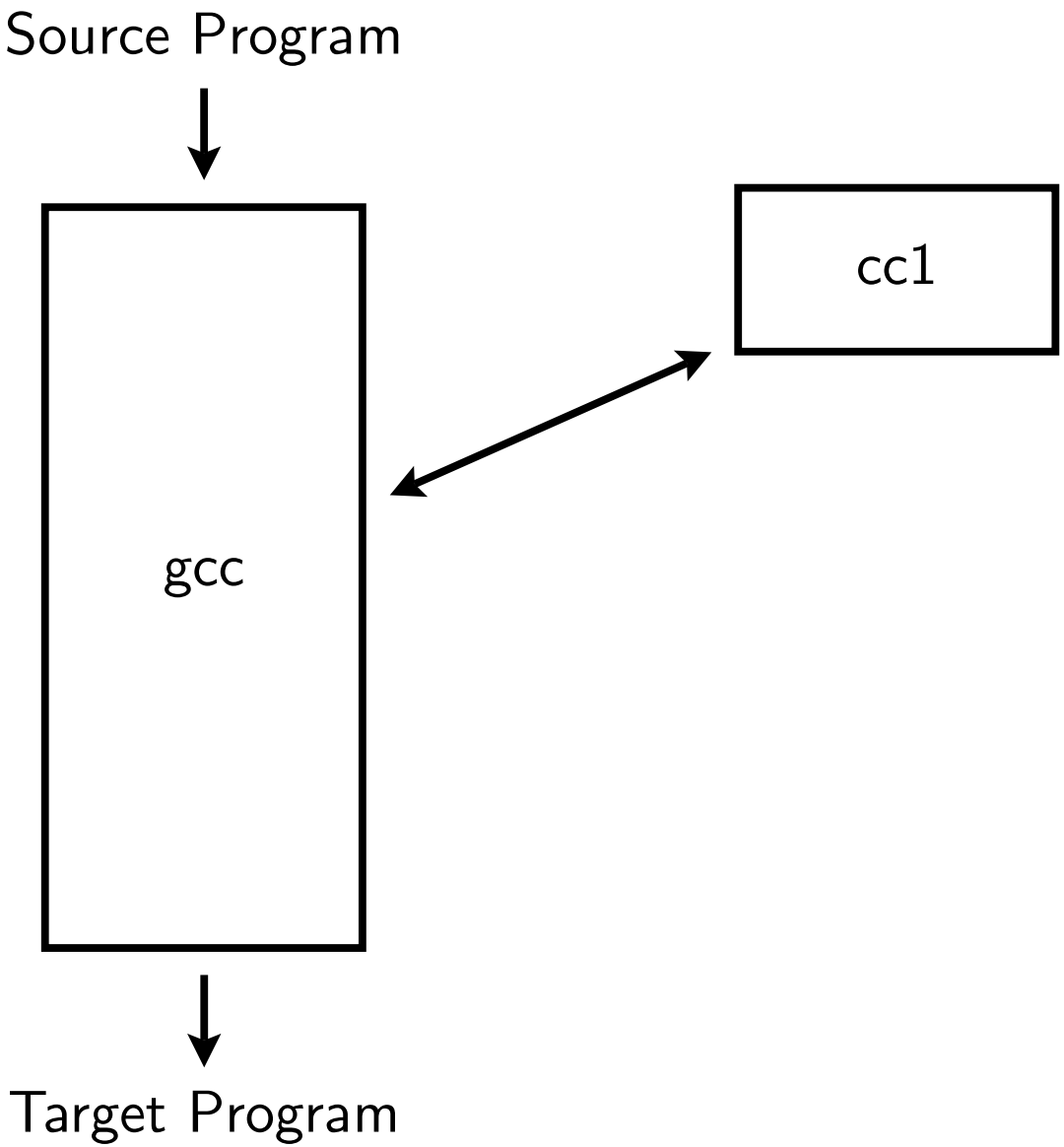

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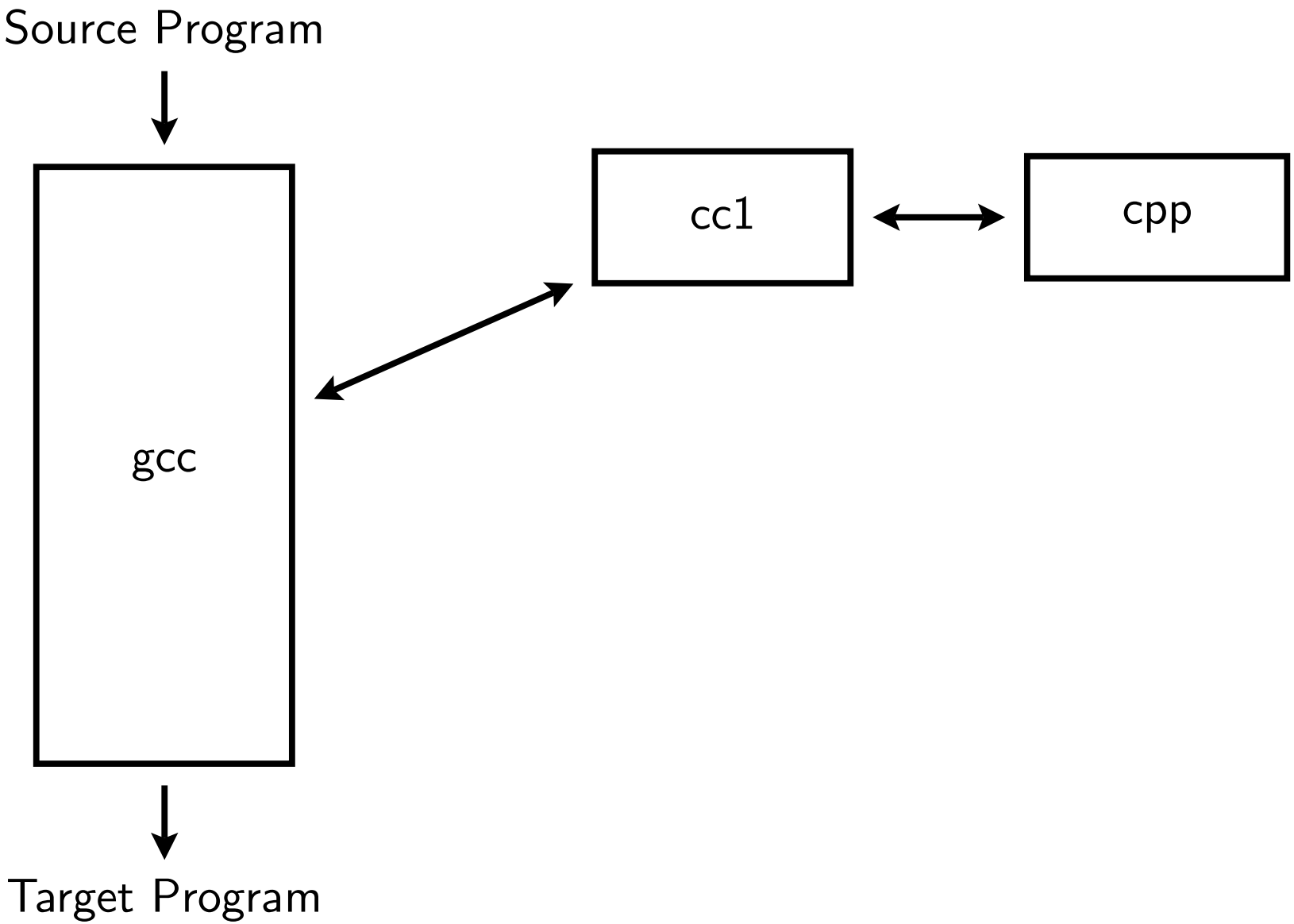

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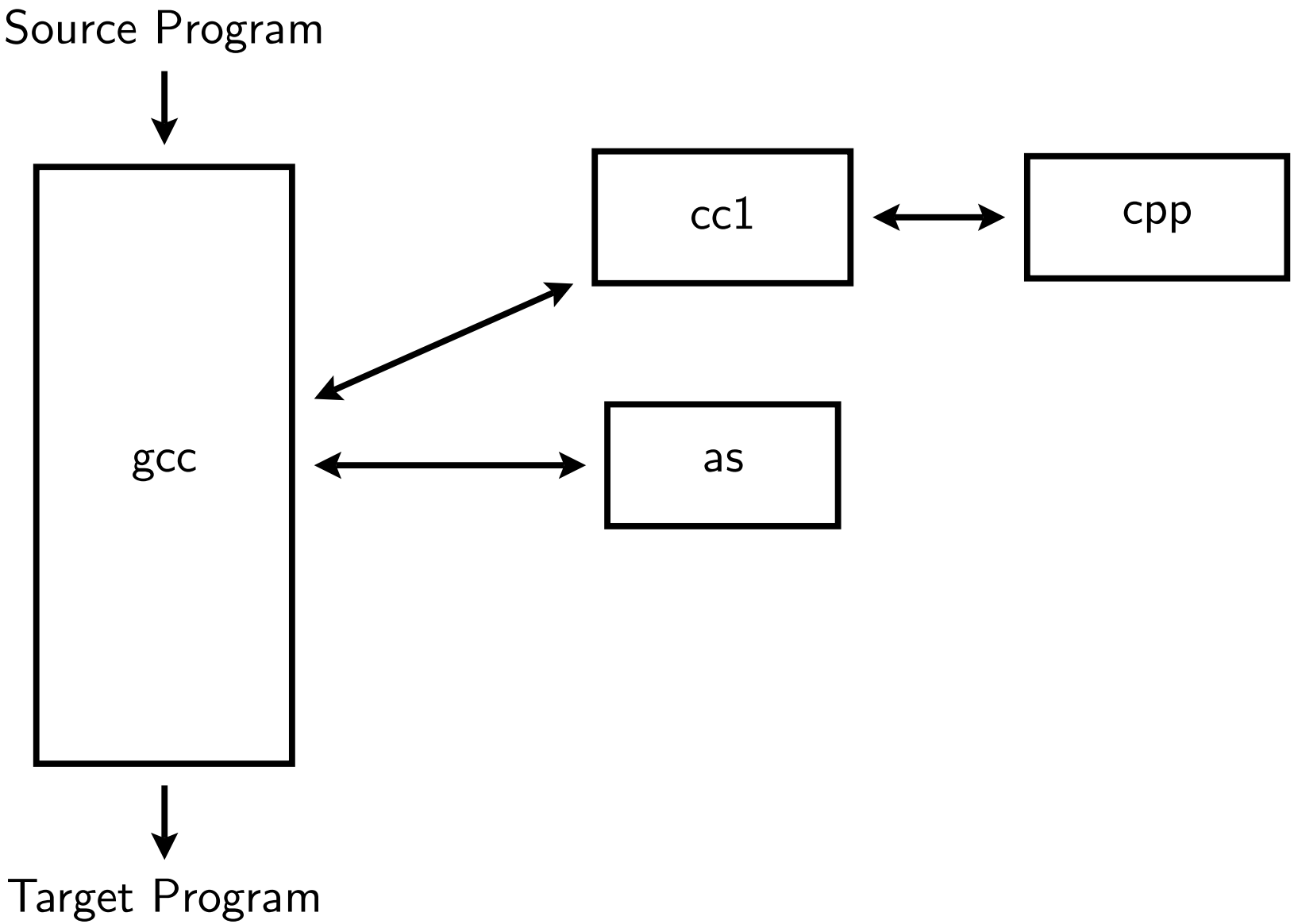

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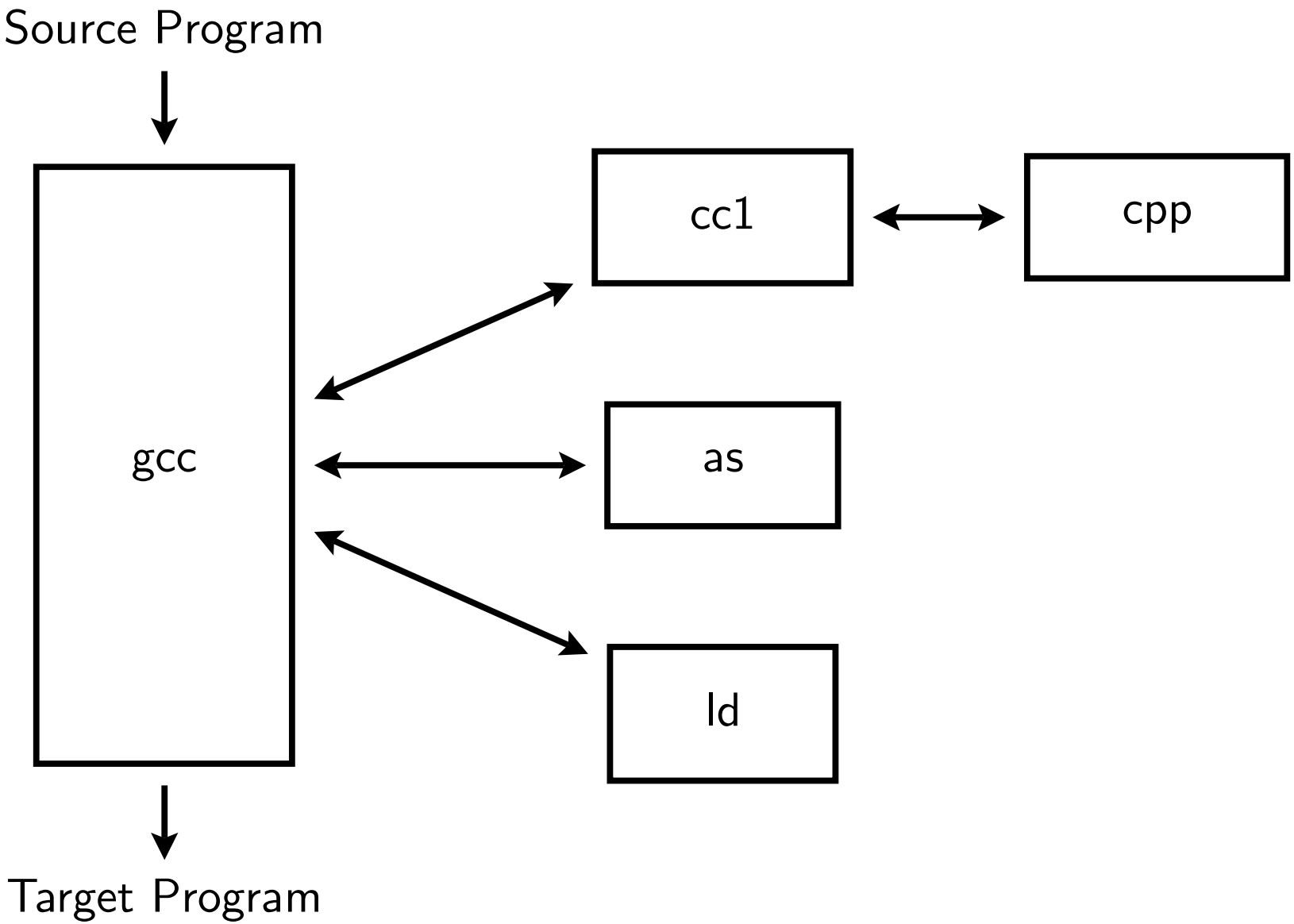

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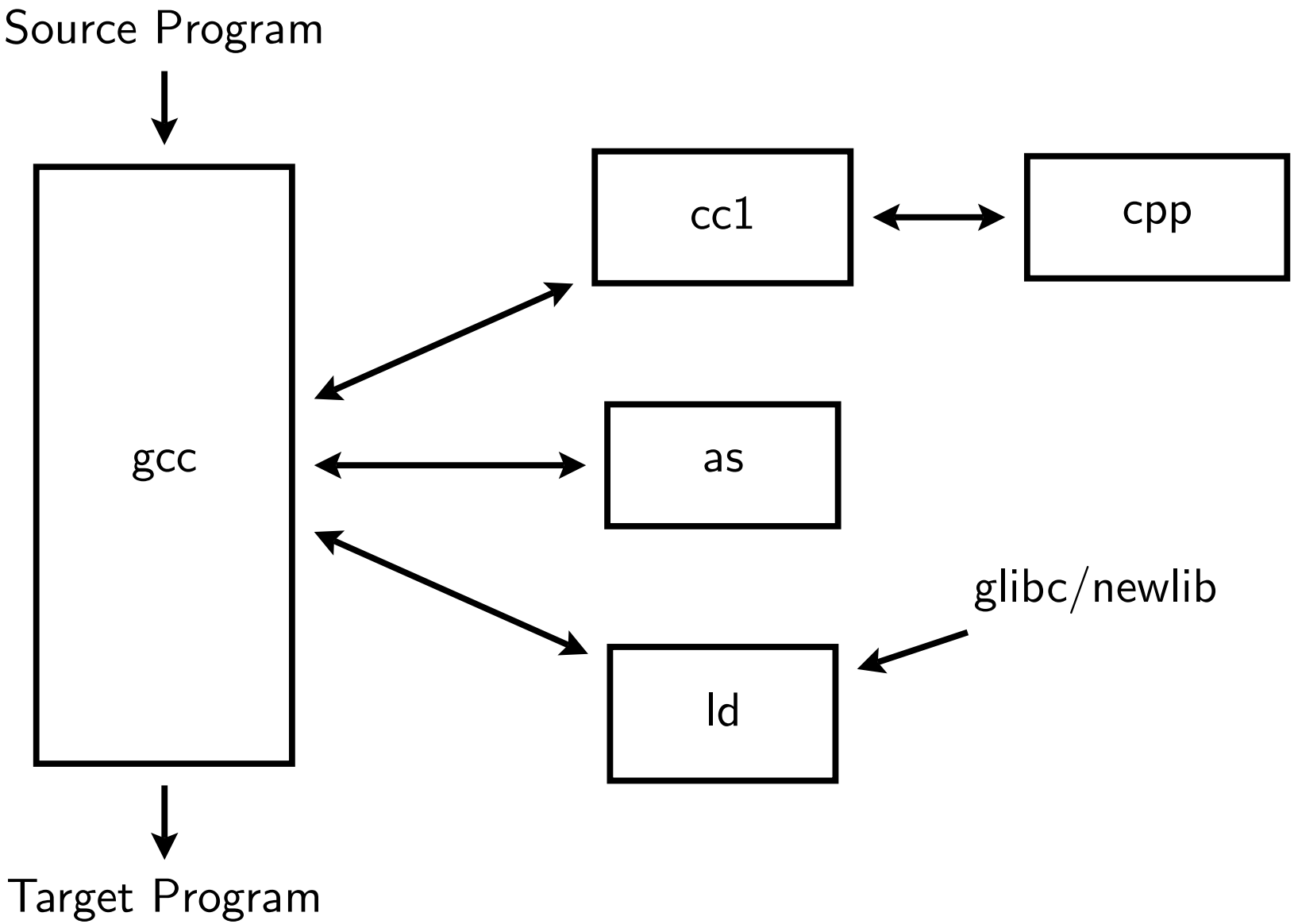
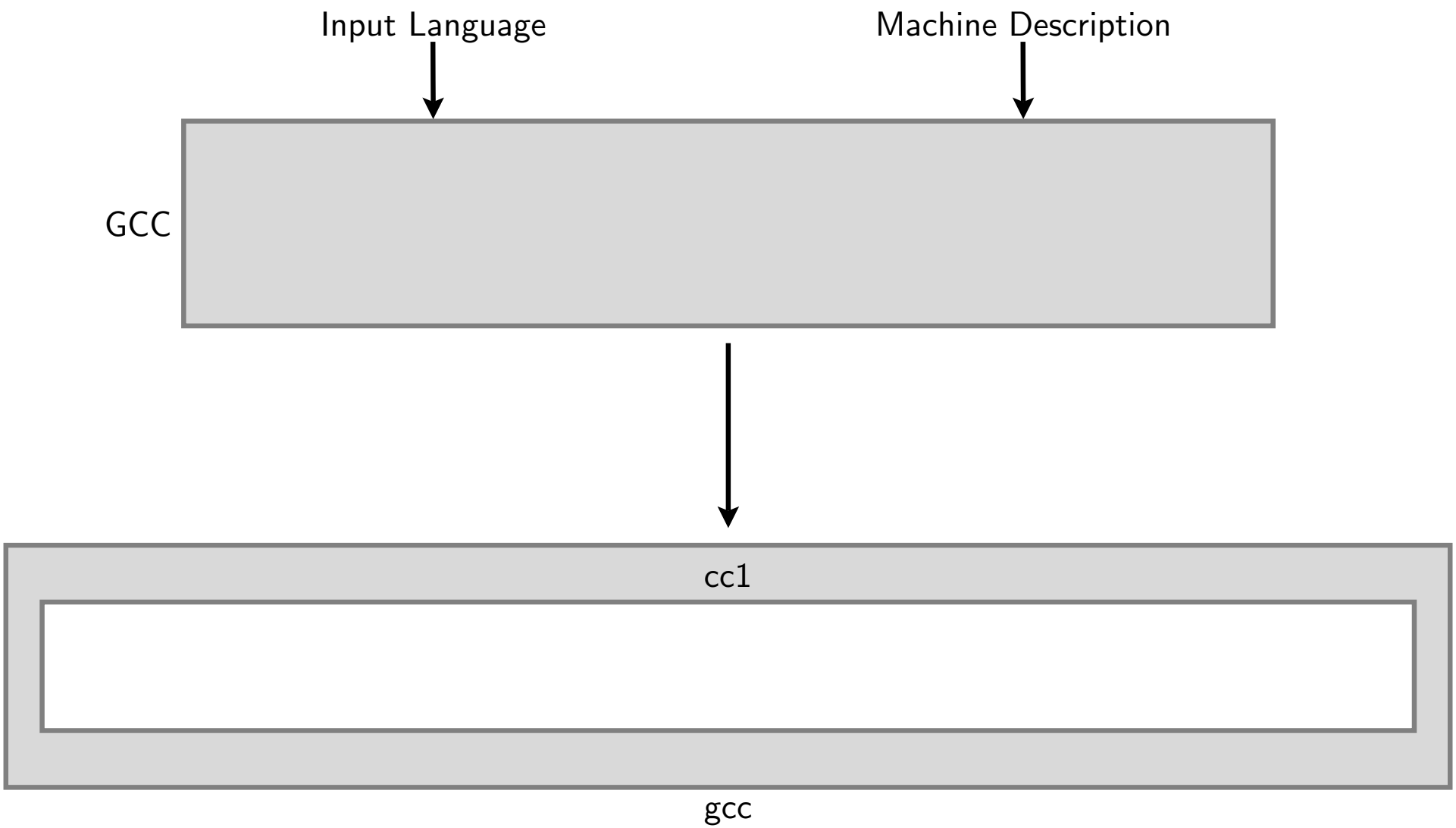


The GCC Framework



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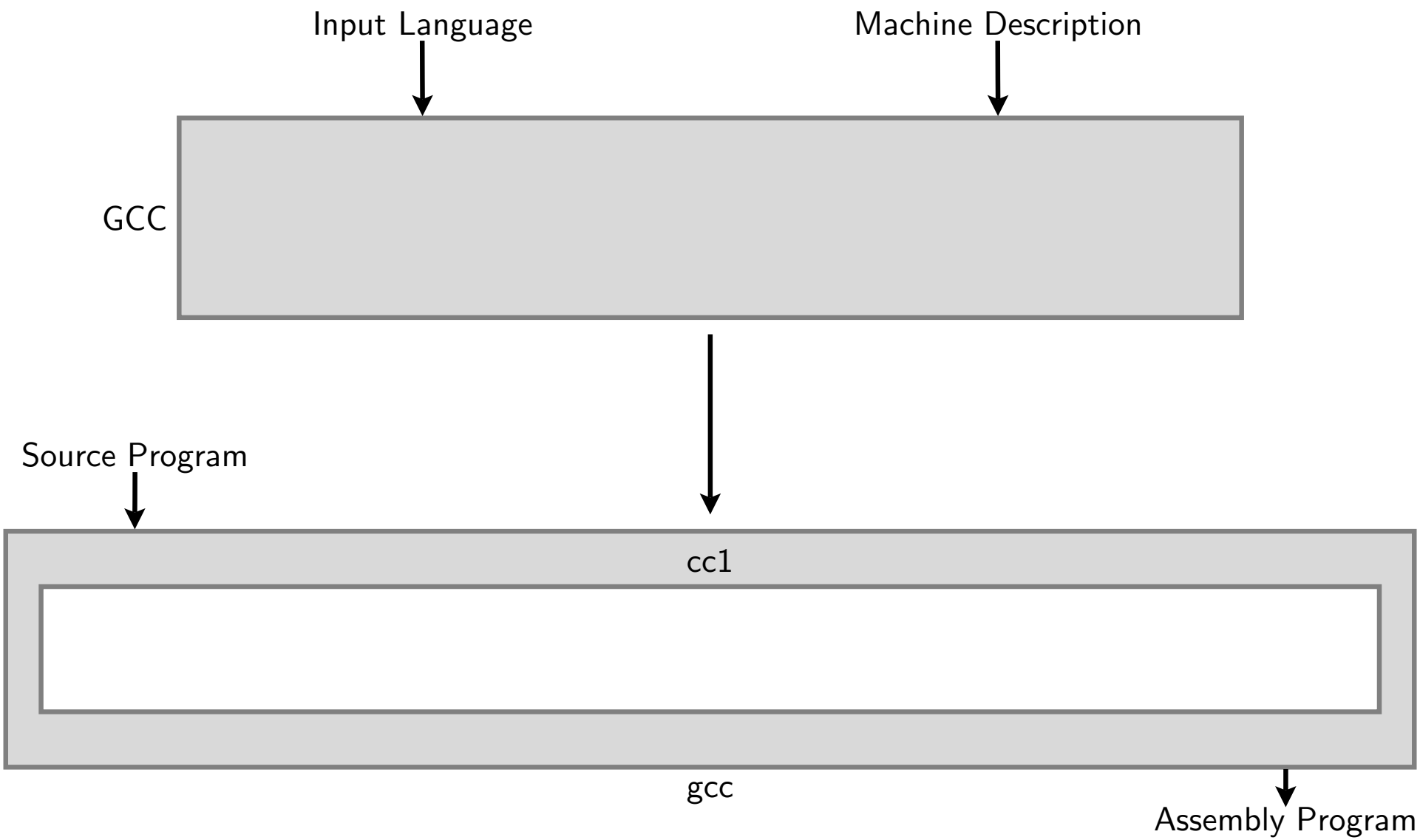

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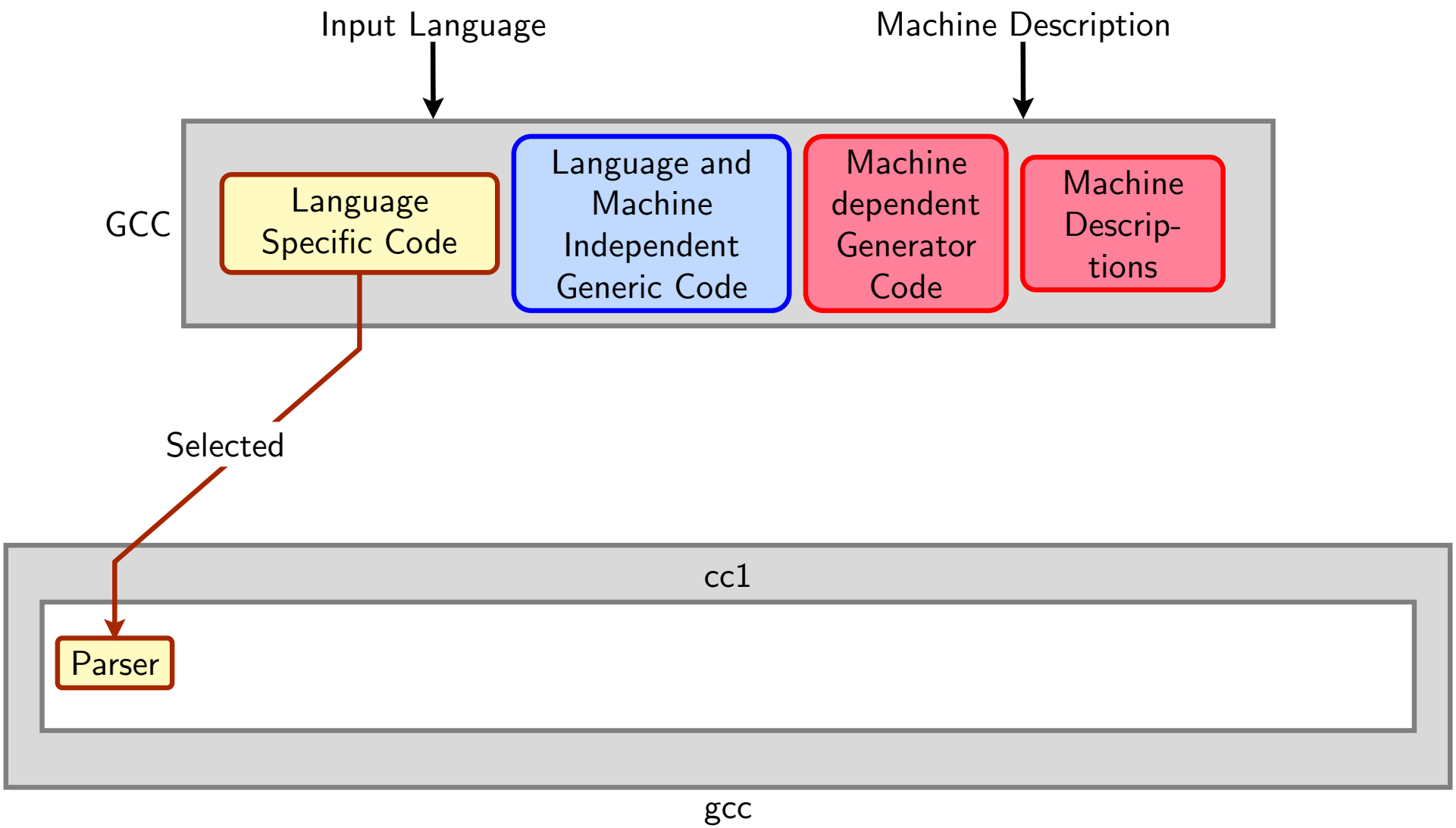

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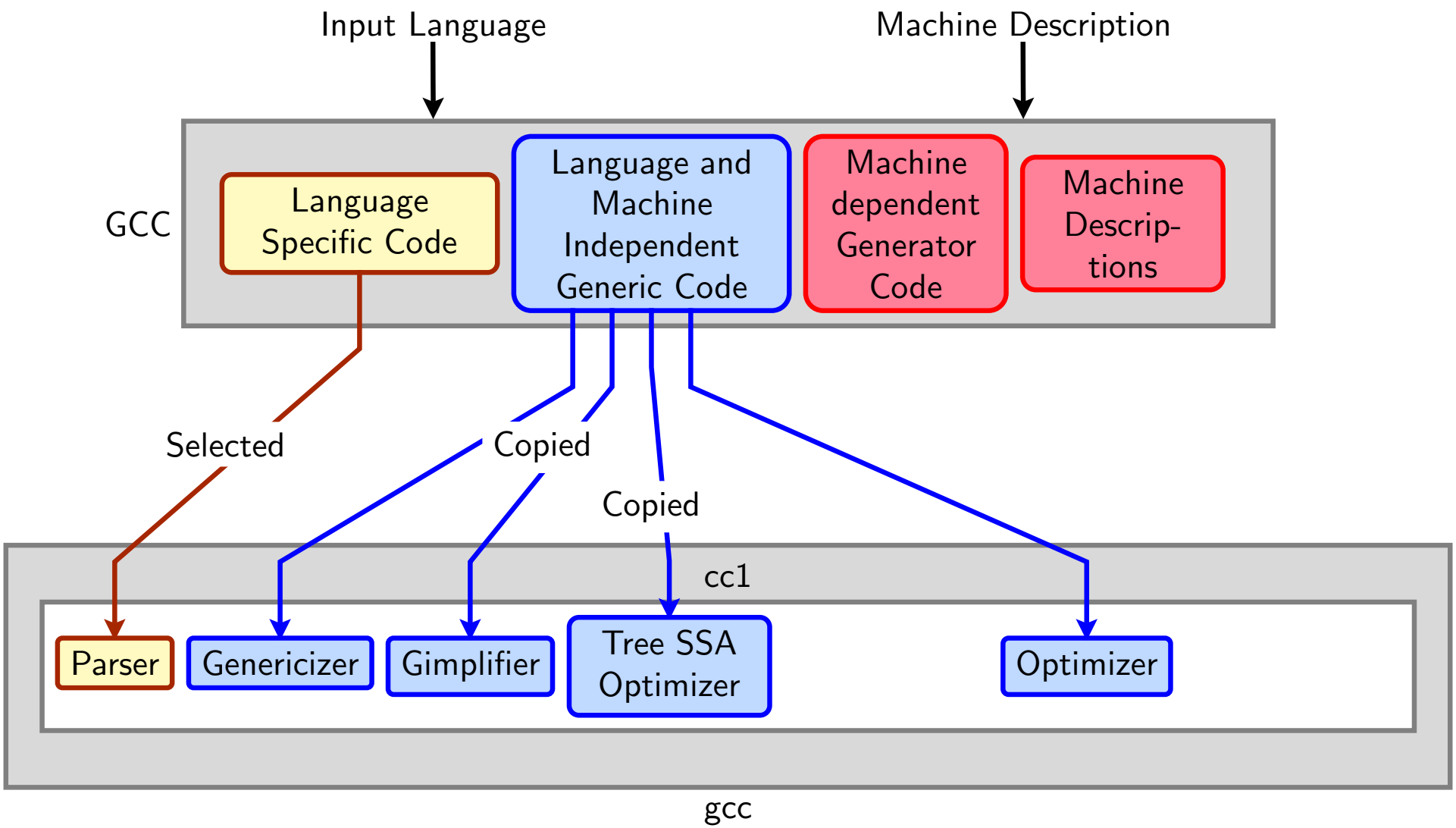

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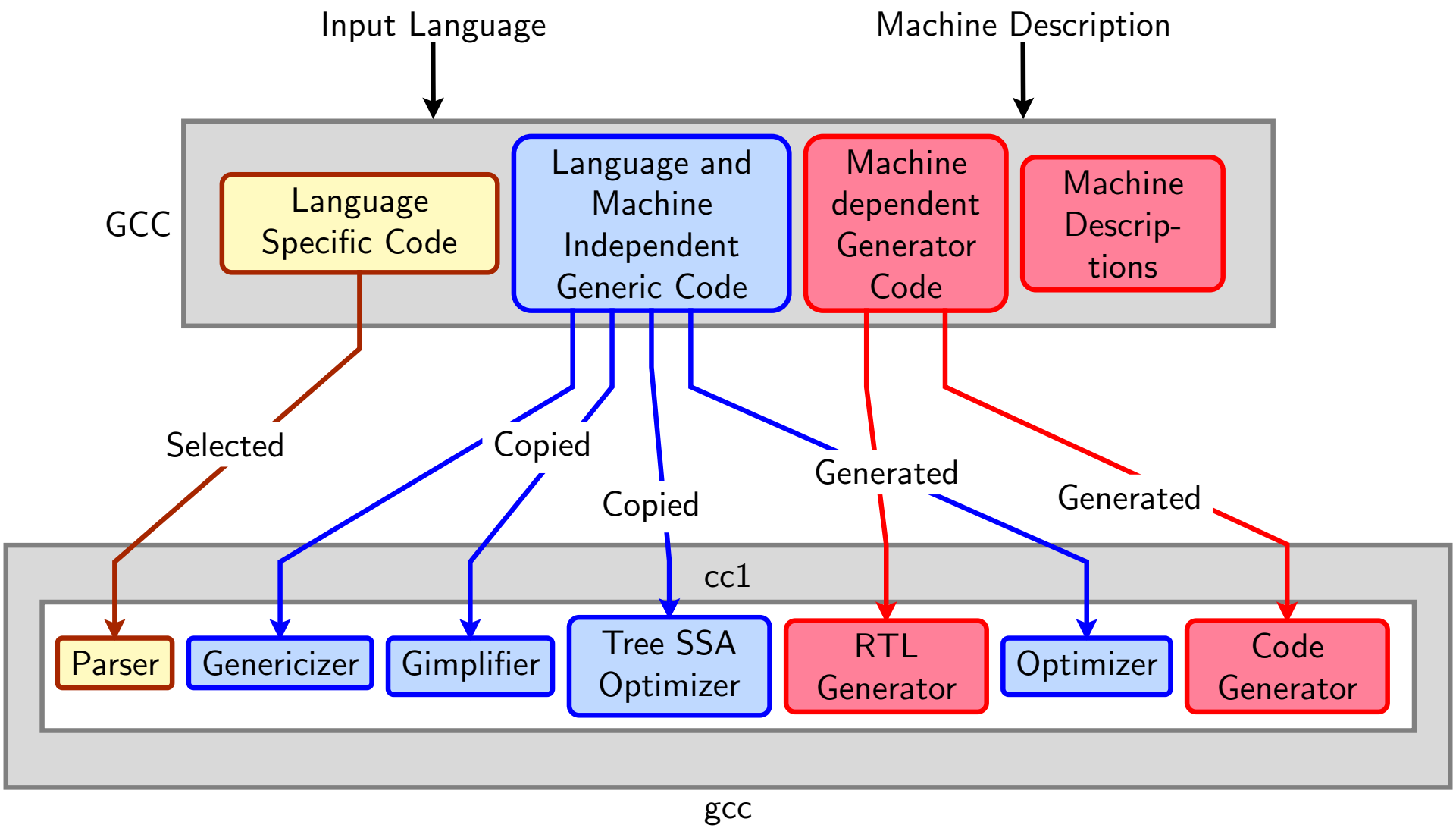

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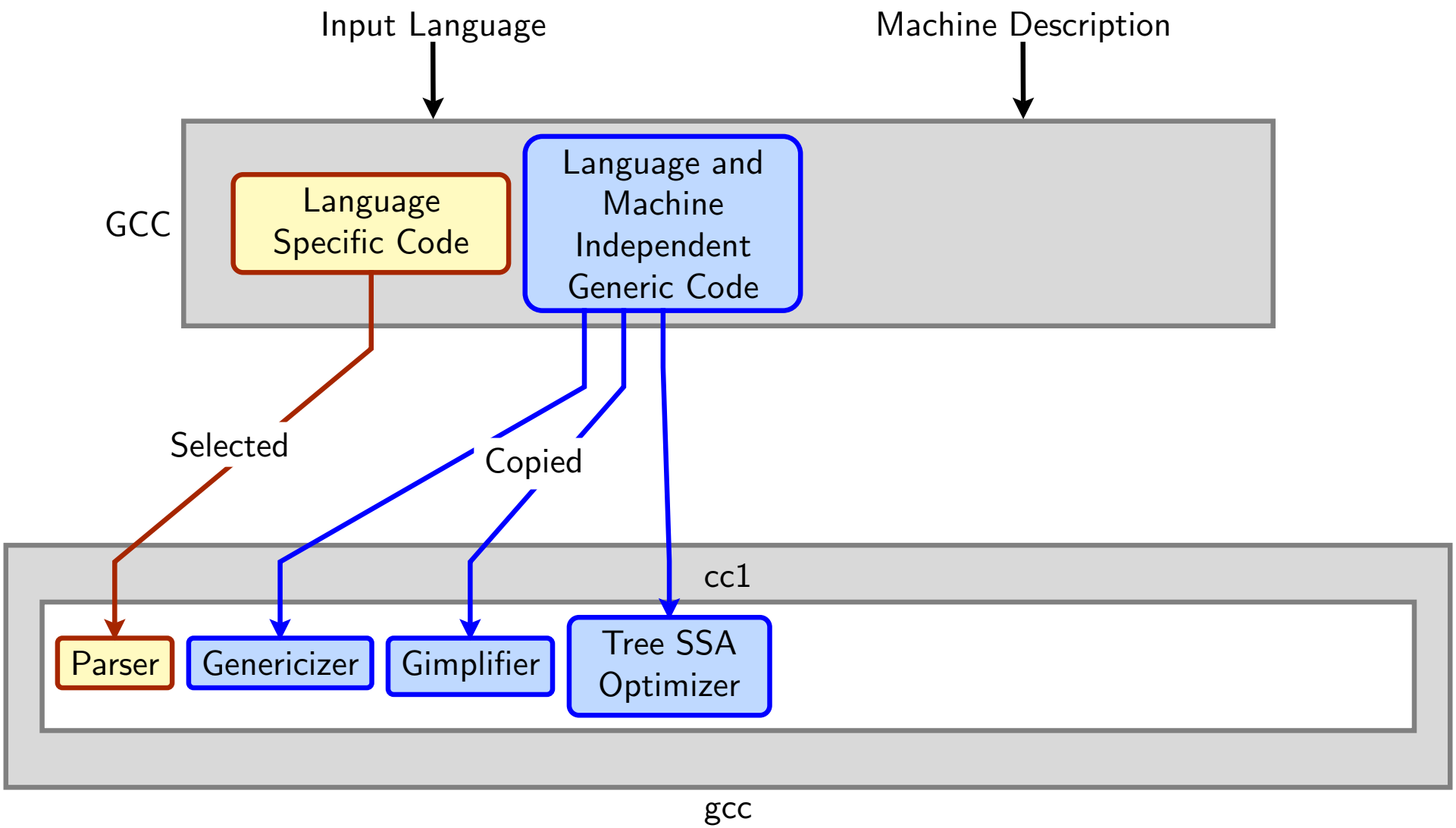


Invocation of cc1 from gcc (4.0.2)

```
main ()                                                    gcc.c
  do_spec ()                                               gcc.c
    do_spec_2 ()                                           gcc.c
      do_spec_1 ()                                         gcc.c
        execute ()                                         gcc.c
          pexecute ()                        ../libiberty/pex-unix.c
 /* TO: cc1 */
```

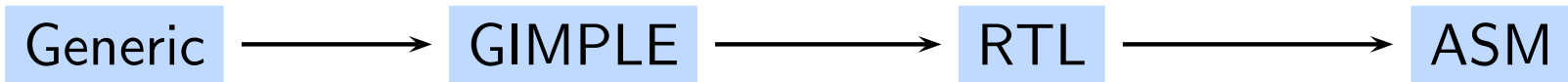
Tip

Static Inspection: Use cscope and/or ctags

Dynamic Inspection: Set breakpoints in gdb on cc1.

The `cc1` Phase Sequence as IR Chain

The GCC Phase Sequence



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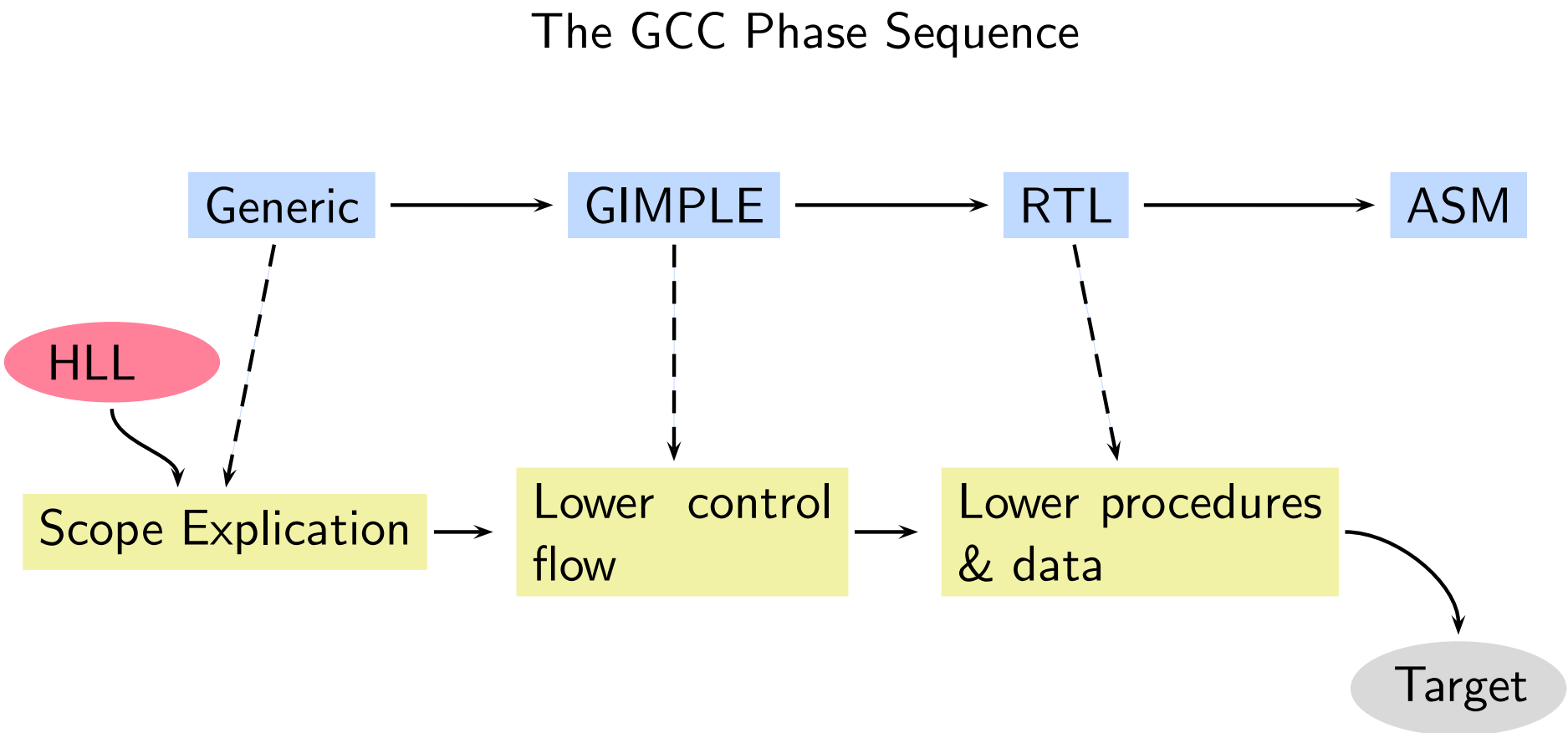

Front End Processing Sequence for C in cc1 and GCC (4.0.2)

```
toplev_main ()                                          toplev.c
  general_init ()                                       toplev.c
    init_tree_optimization_passes ()                    tree-optimize.c
  decode_options ()                                     toplev.c
  do_compile ()                                         toplev.c
    compile_file()                                      toplev.c
      lang_hooks.parse_file ()                          toplev.c
        c_common_parse_file ()                          c-opts.c
          c_parse_file ()                               c-parse.y (c-parse.c)
            finish_function ()                          c-decl.c
              c_genericize ()                           c-gimplify.c
 /* TO: Gimplification */
```

GIMPLE Phase sequence in cc1 and GCC (4.0.2)

Creating GIMPLE representation in cc1 and GCC

```
finish_function ()                                   c-decl.c
  c_genericize()                                  c-gimplify.c
    gimplify_function_tree()                        gimplify.c
      gimplify_body()                               gimplify.c
        gimplify_stmt()                             gimplify.c
          gimplify_expr()                           gimplify.c
  c_expand_body()                                     c-decl.c
    tree_rest_of_compilation()                  tree-optimize.c
      execute_pass_list()                       tree-optimize.c
        execute_one_pass()                      tree-optimize.c
        /* calls pass entry point function pointer */
    targetm.asm_out.constructor()
```

The Tree passes list (4.0.2)

(Partial) Passes list (`tree-optimize.c`) ($\sim$ 63 passes)

```
pass_remove_useless_stmts     // Pass
pass_lower_cf                 // Pass
pass_all_optimizations        // Optimiser
   pass_build_ssa             // Optimiser
   pass_dce                   // Optimiser
   pass_loop                  // Optimiser
      pass_complete_unroll    // Optimiser
      pass_loop_done          // Optimiser
   pass_del_ssa               // Optimiser
pass_warn_function_return     // Optimiser
pass_expand                   // RTL Expander
pass_rest_of_compilation      // RTL passes
```


Part 2

Adding a Pass on Gimple IR

GCC Tree Passes: Code organisation

Tree Pass Organisation

- Data structure records pass info: name, function to execute etc. (`struct tree_opt_pass` in `tree-pass.h`)
- Instantiate a `struct tree_opt_pass` variable in each pass file.
- List the pass variables (in `init_tree_optimization_passes.c`).

Adding a Pass on Gimple IR

- Step 0. Write function `cs715_main()` in file `cs715.c`.
- Step 1. Create the following data structure in file `cs715.c`.

```
struct tree_opt_pass pass_cs715 =
{ "cs715",      /* name */
  NULL,         /* gate, for conditional entry to this pass */
  cs715_main,   /* execute, main entry point */
  NULL,         /* sub-passes, depending on the gate predicate */
  NULL,         /* next sub-passes, independ of the gate predicate */
  0,            /* static_pass_number , used for dump file name*/
  0,            /* tv_id */
  0,            /* properties_required, indicated by bit position */
  0,            /* properties_provided , indicated by bit position*/
  0,            /* properties_destroyed , indicated by bit position*/
  0,            /* todo_flags_start */
  0,            /* todo_flags_finish */
  0             /* letter for RTL dump */
};
```


Adding a Pass on Gimple IR

- Step 2. Add the following line to `tree-pass.h`

```
extern tree_opt_pass pass_cs715;
```


Adding a Pass on Gimple IR

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  ```
  extern tree_opt_pass pass_cs715;
  ```
- Step 3. Include the following call at an appropriate place in the function `init_tree_optimization_passes()` in the file `tree-optimize.c`
  ```
  NEXT_PASS (pass_cs715);
  ```

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  - Either in `$SOURCE/gcc/Makefile.in`
    Reconfigure and remake
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- Step 5. Build the compiler
- Step 6. Wonder what went wrong?

Traversing Control Flow Graph

```
for(n=0; n < number_of_nodes; n++)  {
      bb = VARRAY_BB(dfs_order_bb,n);
      for( bsi =bsi_start(bb);!bsi_end_p(bsi);bsi_next(&bsi)) {









      }
}
```


Traversing Control Flow Graph

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            stmt = bsi_stmt(bsi);
            switch(TREE_CODE(stmt)) {









            }
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            stmt = bsi_stmt(bsi);
            switch(TREE_CODE(stmt)) {
                  case MODIFY_EXPR:
                        expr = TREE_OPERAND(stmt,1);
                        /* SET_BIT(GEN(current_pf_L,bb),expr); */
                        lval = TREE_OPERAND(stmt,0);
                        FOR expr_no in exprList(lval) {
                          /*  RESET_BIT(av_L[bb]->gen),expr_no); */
                          /*  SET_BIT(av_L[bb]->kill),expr_no);  */
                        }
                        break;
                  ...
            }
      }
}
```