A comparison of the DWARF debugging information produced by LLVM and GCC by Keith Walker

A lightning talk at

the LLVM Conference on 7th November 2013

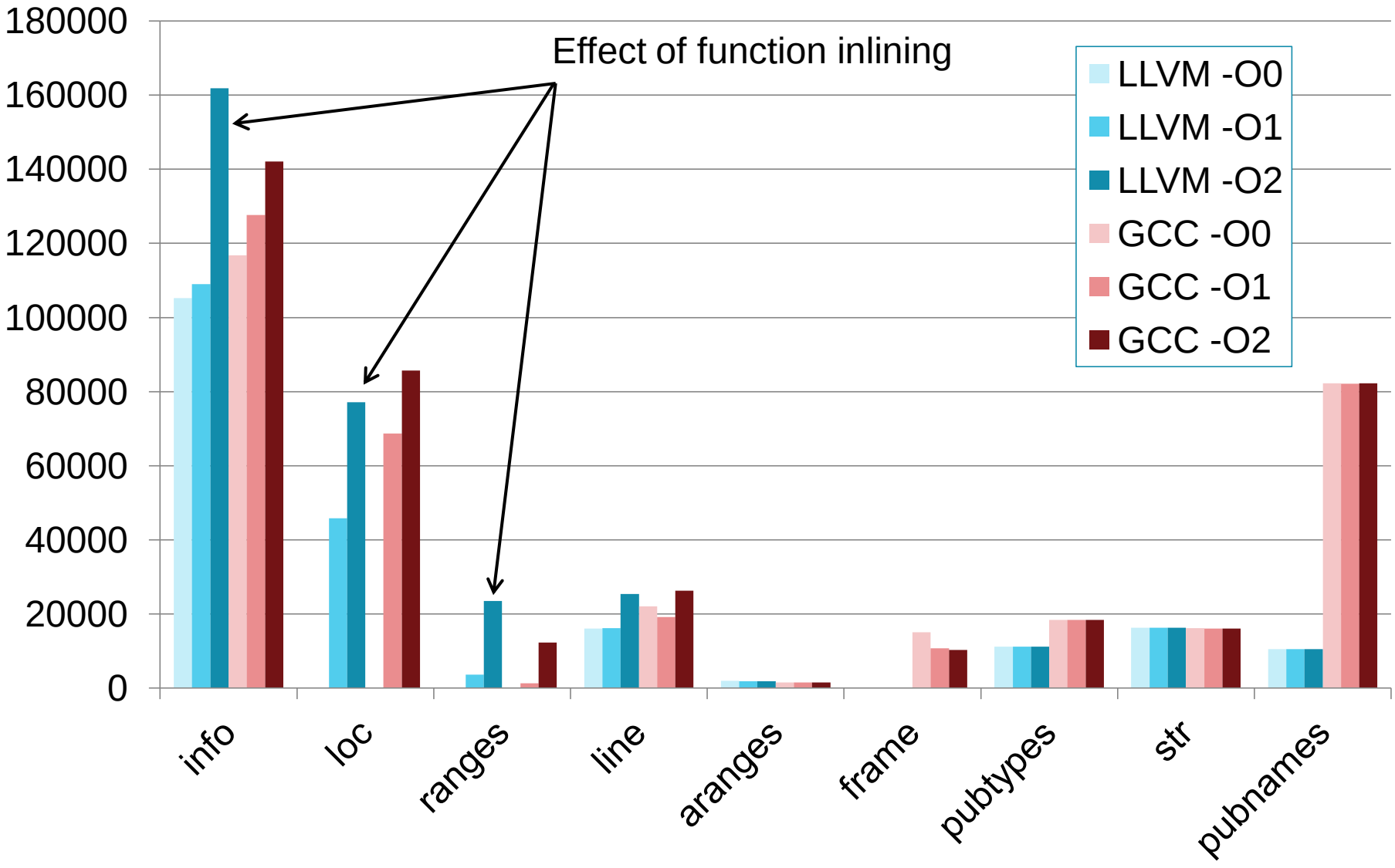
Summary

- Debug information is mostly comparable to GCC.
- LLVM is more aggressive at doing function inlining resulting in larger debug tables at –O2.
- Areas for improvement:
  - Remove duplication of inlined function parameter information.
  - Enumerators missing in pubnames.
  - System included files in line table if referenced by symbols.
  - Generate stack information for ARM.
  - Generate stack information for AARCH64 function epilogues.
  - debug_types can provide significant improvements in reducing size of the debug information.
- No sibling entries reduce debug info sizes at the cost of loading speed (change can be around 10%).

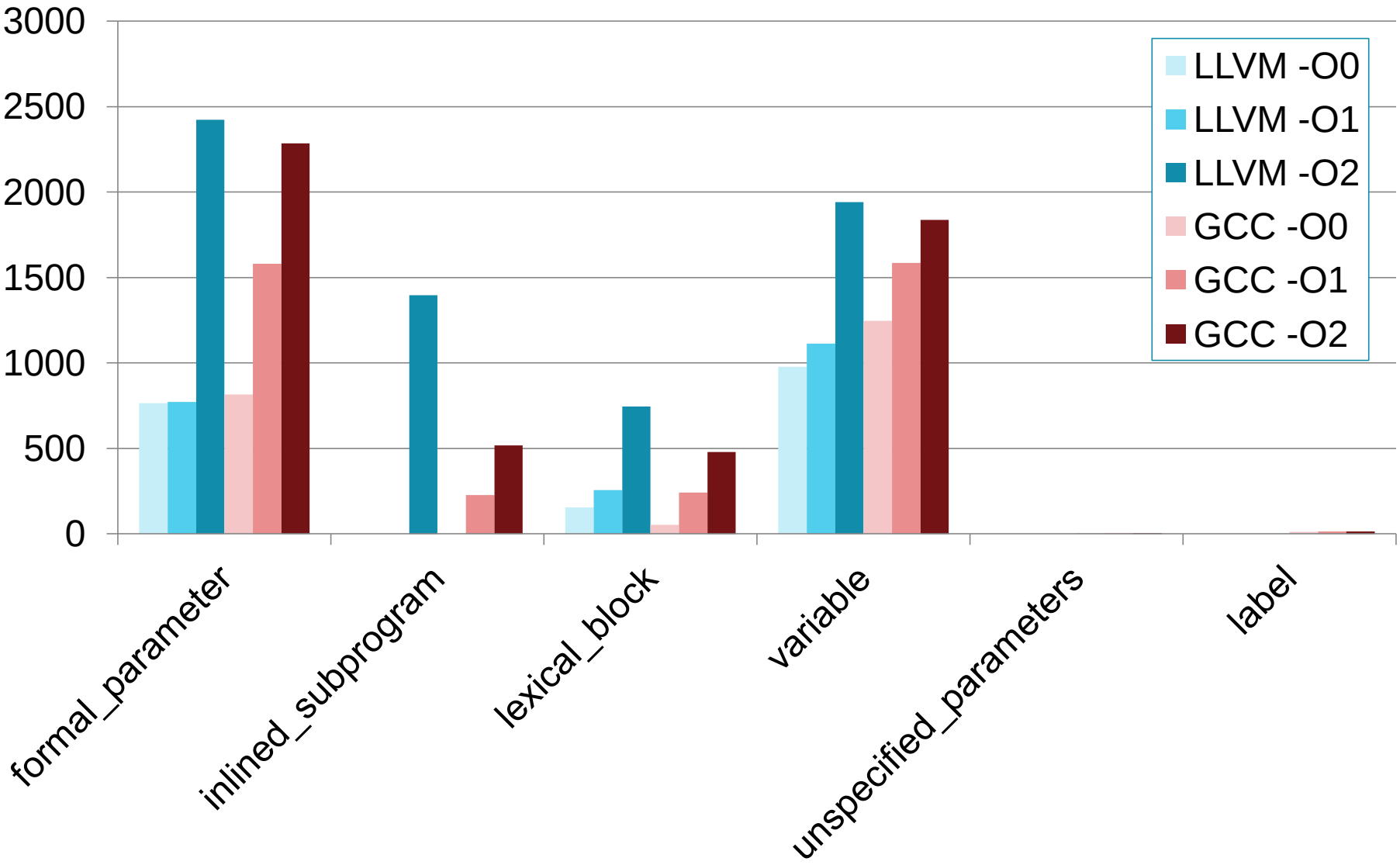
What was used in the comparison

- Comparison performed on a C program of about 70,000 lines of source in 58 source files and 16 header files
- No library code linked in ... all debug information from the compiled sources
- Uses the same header files
- GCC 4.8.2 using:
  arm-none-eabi-gcc –g –gpubnames –gstrict-dwarf
- LLVM tip of trunk using:
  clang –target=arm-none-eabi -g

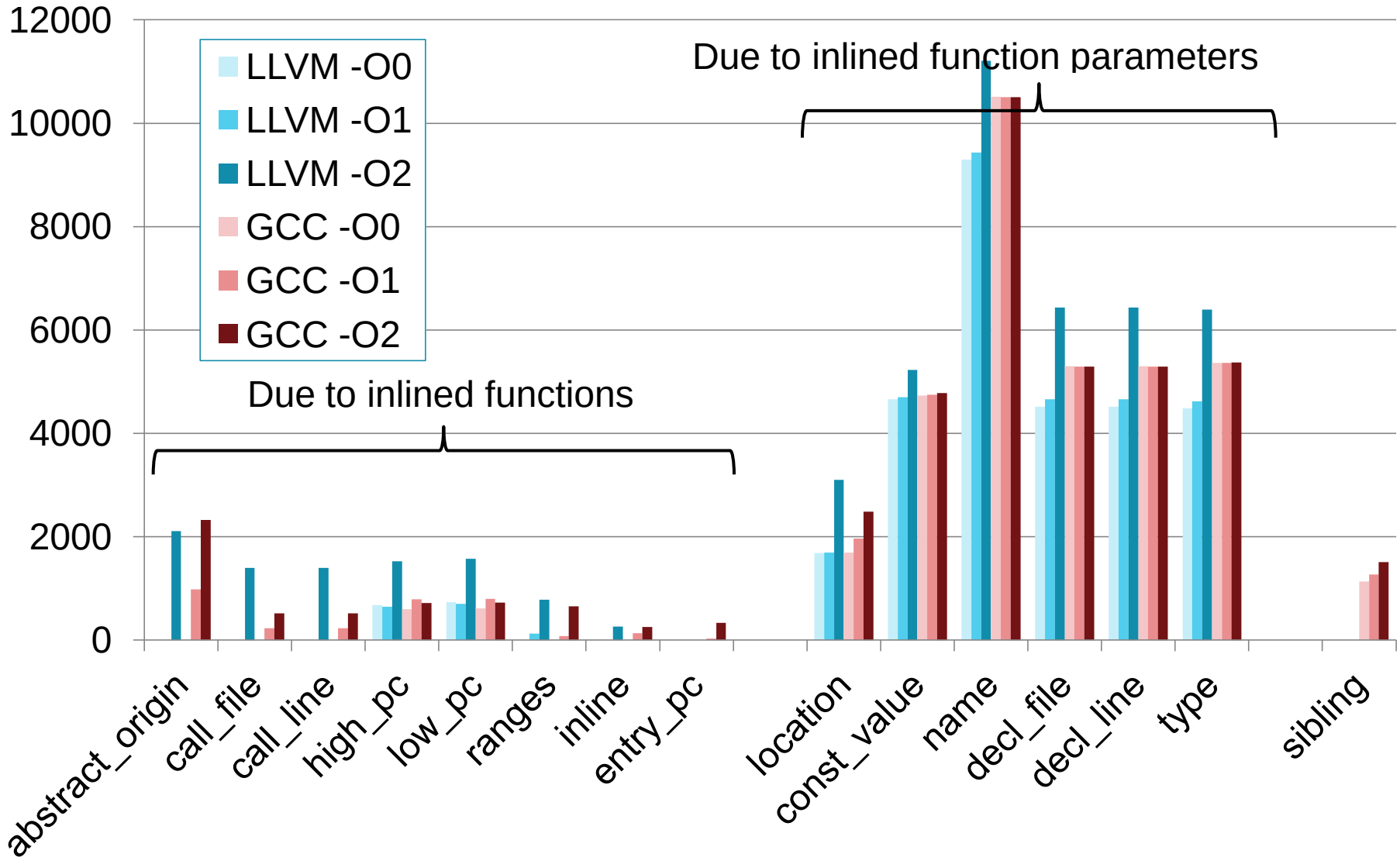
DWARF debug section sizes



DWARF Tags (symbols)



DWARF Attributes (symbol properties)



Are siblings attributes worth the space?

- LLVM deliberately does not generate entries the DW_AT_sibling attribute due to the size the occupied in the .debug_info section.
- GCC does generate DW_AT_sibling entries:
  - Take ~4% of the .debug_info section size (in this example).
  - Contribute no actual debug information.
  - Implemented using 4-byte entries.
  - ... But of 1508 entries only 96 have a value greater than 255.
- What is the effect of not having sibling entries in a debugger?
  - ... Can affect loading speed by about 10%.

Line Table Differences

- LLVM does not include system header files/directories in the line table.
  - But symbols defined in the system header files have a file/line reference .... The file entry pointing at the current source file.
- LLVM generates “End of Function Prologue” entries.
  - Needs support in debugger but will help to remove the need for heuristics used by debuggers to find the prologue end.
- LLVM (sometimes) marks the function prologue instruction as a place not to put a source level breakpoint.
- Neither compiler generates “Start of Function Epilogue” entries.

Stack Frame Differences

- LLVM does not generate .debug_frame information for the selected arm-none-eabi target.
- GCC generates the changes that occur in a function epilogue, LLVM does not (comparing AARCH64).

  The effect of this is that when instruction stepping the function epilogue in LLVM generated code, register usage in the called function may be displayed incorrectly.

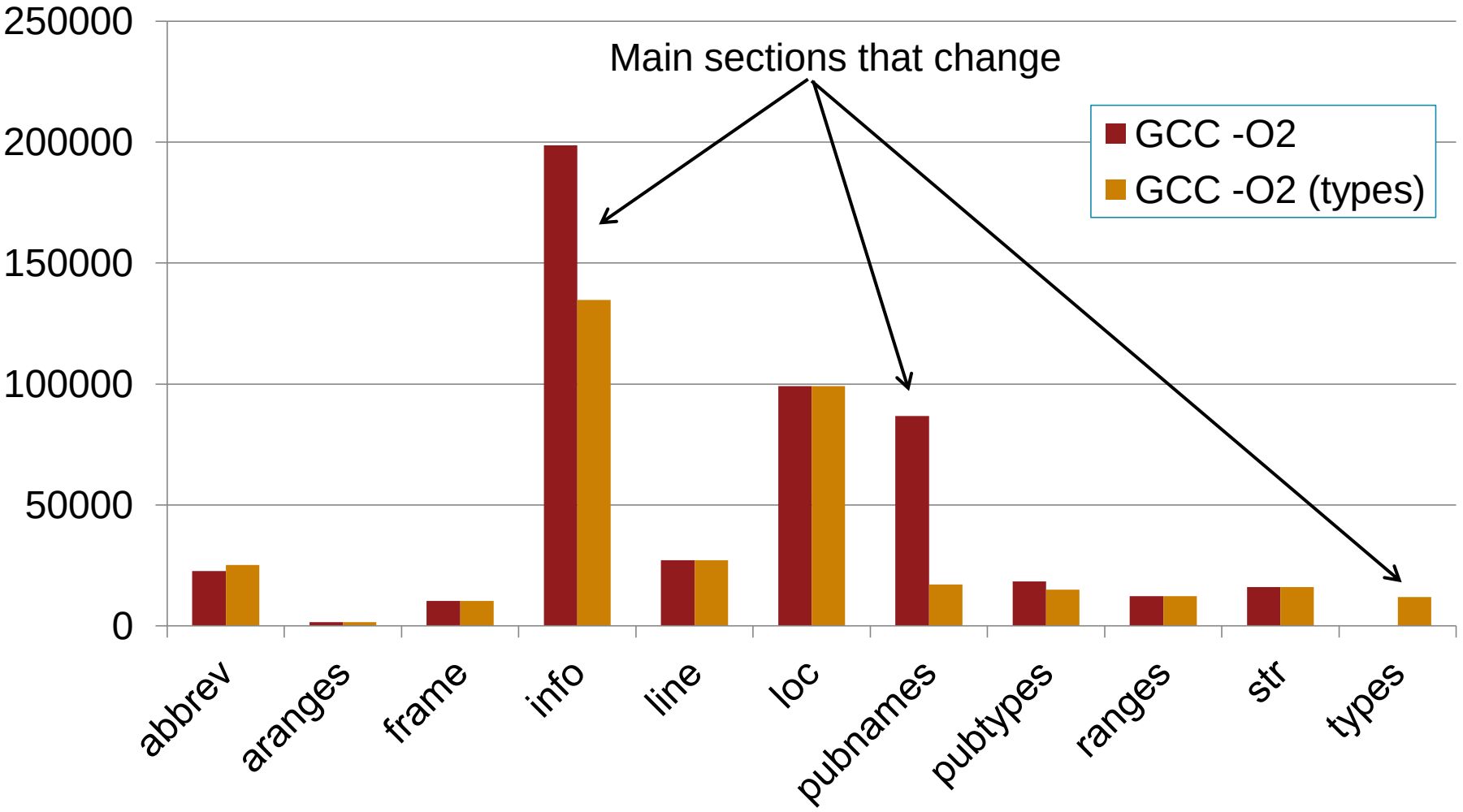
DWARF .debug_types coming soon

- The .debug_types section was added in DWARF 4 in order to help common up duplicated type information. This removal of duplicate information can results in smaller file sizes and as a consequence means debuggers have less debugging information to process and load.

- I am looking forward to the completion of the current development effort to implement support for the .debug_types section.

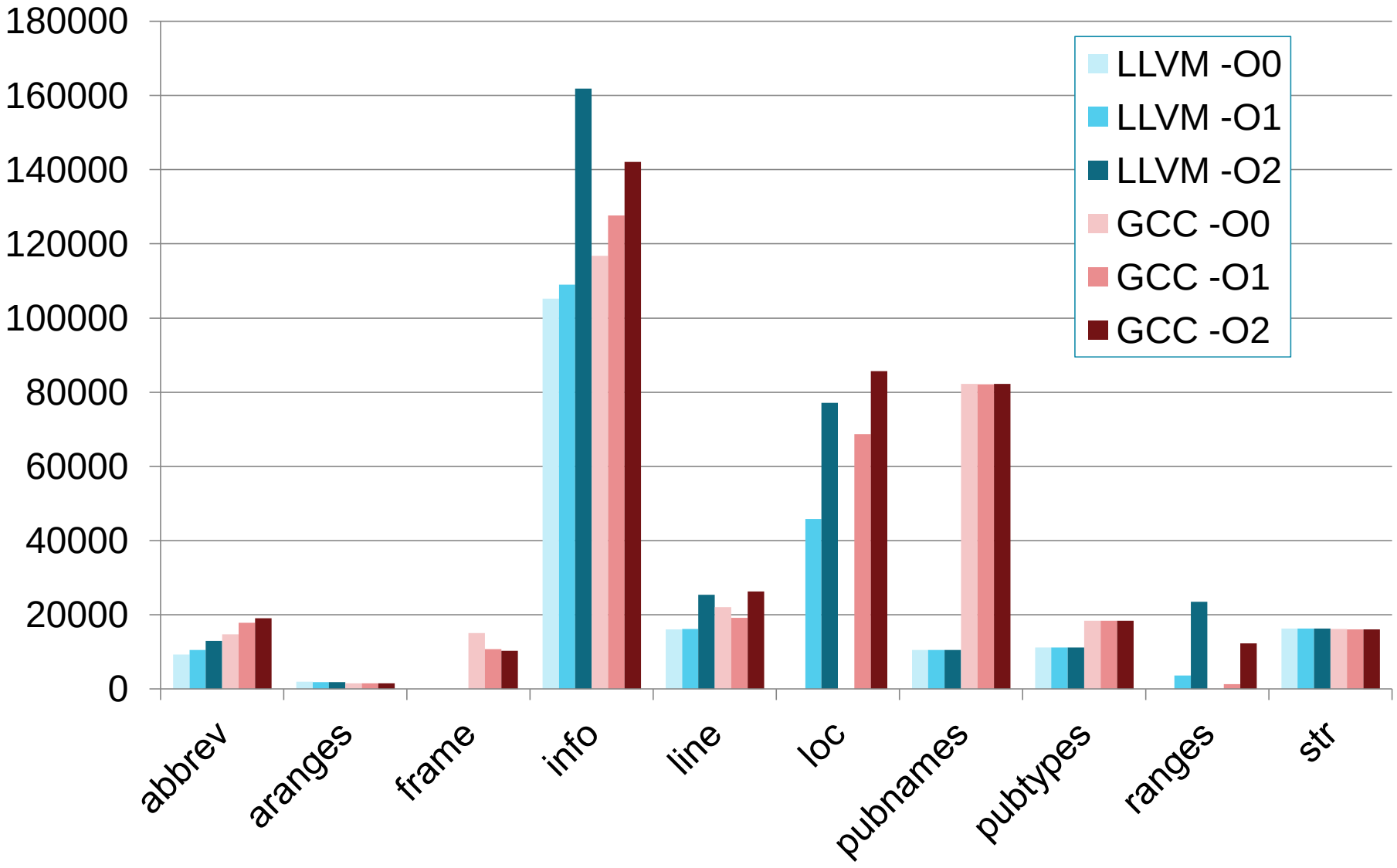
- GCC already has support for .debug_types, so we can see the possible benefits of adding this support.

DWARF Debug section sizes (GCC)



Questions?

DWARF debug section sizes



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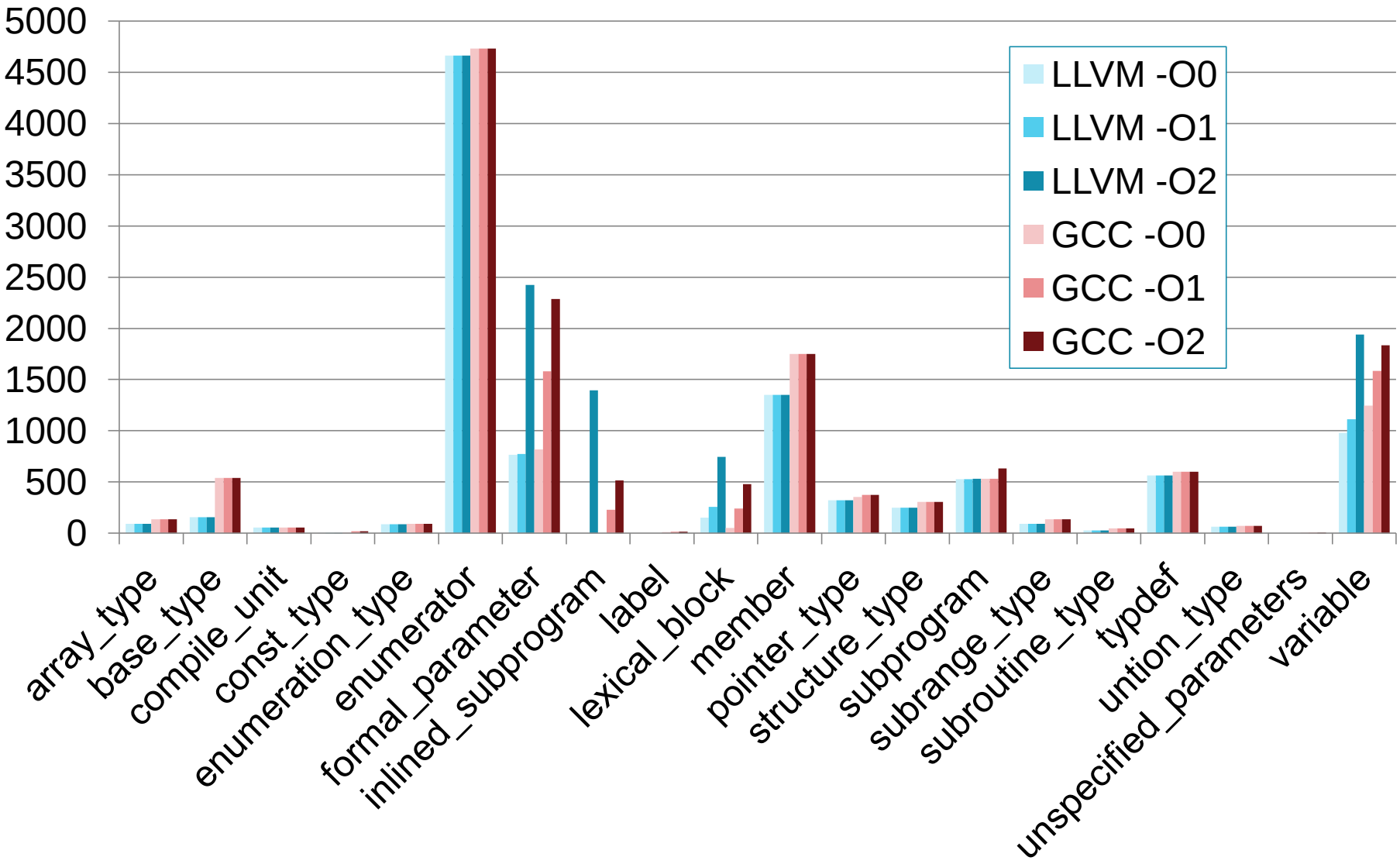
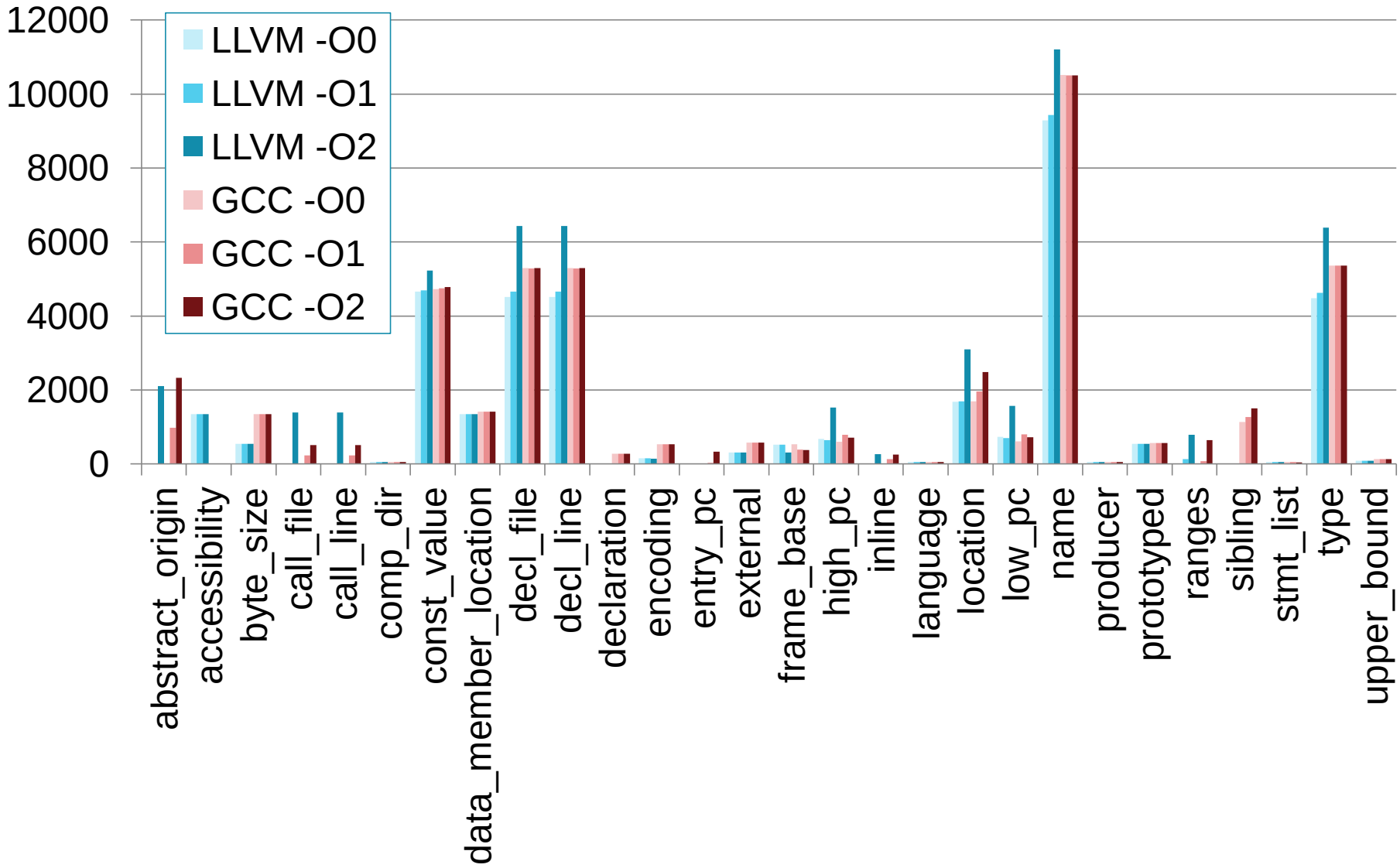


DWARF Attributes (symbol properties)



Thank You