ISPC: clang-based front-end
2014 LLVM Developers’ Meeting, Oct 28-29

ISPC Language

ISPC is a C-based language built on the SPMD (single program, multiple data) programming model. The ISPC programming model efficiently maps to the SIMD vector units of modern CPUs without the need for complex analysis and autovectorization. The key concept for achieving this is varying data types, which in cases of built-in types are simply equivalent to vectors of built-in types. For user-defined data types, ISPC generates Structure-of-Arrays style data layout that better maps to SIMD hardware. Varying data types are also allowed in control-flow statements (such as if statements), triggering “varying control flow”.

Varying types
- Varying types get a separate copy for each SIMD lane, while uniform types are shared by all instances.

Varying control flow
- SIMD hardware has to do the same thing in each lane, by definition.
- Conditional statements based on varying values may have different results in each lane. When this occurs, control flow is divergent because different lanes might take different paths.
- ISPC transforms divergent control flow into data flow. An execution mask is used to only commit results in lanes that are actively participating in computation.

Varying structures propagate variability to their members, producing Structure-Of-Arrays style types, which are optimal for vector code.

Varying control flow
- ISPC code generation

ISPC Language Concepts

Structures may have members with bound variability.

Varying control flow
- Varying control flow is a new property of Type class, but not a new type in the Type hierarchy.
- Variability may be varying/uniform/unbound.
- Variability is “enabled” only for selected types, when it makes sense (BuiltInType, PointerType, etc)
- All structs/classes are parsed as templates with implicit variability arguments

Implementation of ISPC concepts in clang

Step 1: Value Transformation
Step 2: Promotion or Conversion
Step 3: Varying Splat

ISPC Code Generation

CodeGenFunction

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