Speculative Compilation in ORC
ORC

- LLVM Modular Just in Time Compilation Library
- Custom compilers, program representations...
- Supports concurrent compilation
**JIT Variants**

- **Eager JIT** - high startup time, zero compiler interactions at runtime

- **Lazy JIT** - startup time, compilation overhead on first call

Can we do better? Can we have benefits of two worlds? 😐
Let’s guess it!

```c
void Driving(Signal S)
{
    switch(S){
    case red: stop(); tweet();
        break;
    case yellow:
        like_reply_to_a_tweet(); break;
    case green: think_next_tweet();
        break;
    }
}
```

What if we guess the signal’s outcome and do action!

Likewise, we guess control flow path and compile the *likely* functions before calling them.
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{
    switch(S){
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    }
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Let’s guess it!

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Speculative Decisions

- Compile only the most likely next executable functions
- Speculate based on CFG edge probabilities and hot blocks heuristics
- Implemented as SpeculateQuery function objects, you can try your own ideas 😊
  
  ○ Map<Function, LikelyFunctionSymbols> SpeculateQuery(Function& F);

  ➜ “Jump into JIT through IR Instrumentation”
Mix’n’Match

ObjectLinkingLayer LinkLayer;

IRCompileLayer<...> CompileLayer(LinkLayer, ConcurrentCompiler);

IRSpeculationLayer SpeculateLayer(..., CompileLayer, Speculator, SpeculateQuery)

CompileOnDemandLayer<...> CODLayer(SpeculateLayer, ...);

CODLayer.addModule(Mod, MemMgr, SymResolver);

auto FooSym = CODLayer.findSymbol("foo", true);

auto Foo = reinterpret_cast<int(*)()>(FooSym.getAddress());

int Result = Foo(); // --- Call foo’s stub.
Before

define dso_local void @Driving(i32 %Signal)

    switch i32 %Signal, label %exit[i32 0, label %red

        i32 1, label %yellow i32 2, label %green]

red:

    call void @stop() call void @tweet() yellow:

    call void @like_reply_to_a_tweet() green:

    call void @think_next_tweet()
After...

```cpp
@__orc_speculator = external global %Class.Speculator
declare void @__orc_speculate_for(%Class.Speculator* %0, i64 %1)

define dso_local void @Driving(i32 %0) #0 {
    call void @__orc_speculate_for(%Class.Speculator* @__orc_speculator,
        i64 ptrtoint (i32 ()* @Driving to i64)) // Jump into JIT 🧪
...
switch i32 %3, label %7 [ i32 0, label %Red
    i32 1, label %Yellow
    i32 2, label %Green]
...
```
Performance

7× Speed-Down 💔💔

Multiple Jumps into JIT ❌

ExecutionSession::Lookup’s are not free✅
We want Performance

- Relatively easy fix, guard the orc_speculate_for call
- Jump into JIT only on the first call
- This will give us - what we want
@__orc_speculate.guard.for.main = internal local_unnamed_addr global i8 0, align 1

define dso_local void @Driving(i32 %0) {

__orc_speculate.decision.block:

  %guard.value = load i8, i8* @__orc_speculate.guard.for.main

  %compare.to.speculate = icmp eq i8 %guard.value, 0

  br i1 %compare.to.speculate, label %__orc_speculate.block, label %program.entry

__orc_speculate.block:

call void @__orc_speculate_for(%Class.Speculator* @__orc_speculator,

  i64 ptrtoint (i32 ()* @Driving to i64))

  store i8 1, i8* @__orc_speculate.guard.for.main

  br label %program.entry
Performance

We see significant speedup with our proof-of-concept speculative jit

For SPEC 403.gcc benchmark, reduce exec time from 17.4 seconds to 10.5 seconds (4 threads) 😊
What’s Next?

- Finish dynamic profiling support to collect branch probability information
- Reduce the scope of speculation region in a function
- Implementing more SpeculateQueries
- Performance tuning
Thank you so much - Lang Hames and David Blaikie

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