Credits

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“Action”? 

- Is a way to encapsulate any IR transformation 
- Provides a mechanism to instrument the compiler 

What can you do with it:
- Tracing the compiler: think “pass instrumentation” but finer grain. 
- Implement compiler “fuel” / bisection techniques to find bugs. 
- Interactive debugging of the compiler (“mlir-gdb”)
“Action” vs Pass

Pass:
- Well defined contract: “takes valid IR in, produce valid IR”
- Define a “phase” of compilation, intended to be composable (you can reorder optimization passes) => “basic block” to build the compiler.
- Is organized in a “pipeline” and scheduled by a “pass manager”
- Can be instrumented:
  - `--mlir-print-ir-after-all` (Print IR after each pass)
  - `--mlir-print-ir-after-change` (When printing the IR after a pass, only print if the IR changed)
  - `--mlir-print-ir-after-failure` (When printing the IR after a pass, only print if the pass failed)
  - `--mlir-print-ir-before=<pass-arg>` (Print IR before specified passes)
  - `--mlir-print-ir-before-all`
  - `--mlir-timing` (Display execution times)
  - `PassInstrumentation`: inject C++ code that runs before/after every pass.
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Why should this be specific to passes? Action is an opportunity to make the underlying infra and the feature set orthogonal and more generally applicable
Demo
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These are just examples to showcase the framework, the goal is to inspire you to build more of these :) 

- Add more Actions and dispatch() in MLIR, and your own project!
- Snapshot the complete IR after every transforms touching a location
- Collect statistics on timing
- Build breakpoints for your own project (ML Graph node name?)
- Tools to skip some patterns at runtime?
- Can implement a “selective -O0”: “do not optimize this range of lines in the source code”.
Implementation: Overview

- Transformations
  - Pattern Applicator
  - Pass Manager
  - Inliner
    - Any custom transformation...

- MLIRContext
  - Delegate execution
  - Register itself
  - Dispatch Actions

- Execution Context
  - (contains breakpoints, state)
    - Registered
    - Dispatch Actions
    - forward actions on match
    - return how to proceed

- Observers
  - Loggers, etc.

- Controller
  - Receives an Action and instruct the ExecutionContext on how to proceed
Performance overhead

- Cost of the dispatch: when not enabled it costs a pointer check on the MLIRContext: `~free`.

- Cost of the instrumentation: full rich traces with locations are very expensive to produce (10x-20x slowdown with very naive implementation).
  -> Won’t replace a profiler (actually could be used to emit tracy-annotations?)
  -> Complementary: much more tweakable / pluggable.
More

- DebugCounter / “Compiler fuel”
  - Bisection of a miscompile by skipping actions selectively.
  - Action framework exposes all the hooks, need to be scripted now!
    **Note:** actions are “skippable” by default, but it can be overridden per action.

- Richer returned value:

```c
struct ActionResult {
    IRUnit op; // handle to the update IRUnit (can be a new one)
    bool changed; // whether the IR was changed.
    LogicalResult status; // whether the transforms succeeded or not.
}
```

- Multiple tags: add per-dispatch tags on top of the static one. For example instead of just dispatching “pass-execution-action”, we could also include the pass name.