Update on Ravi

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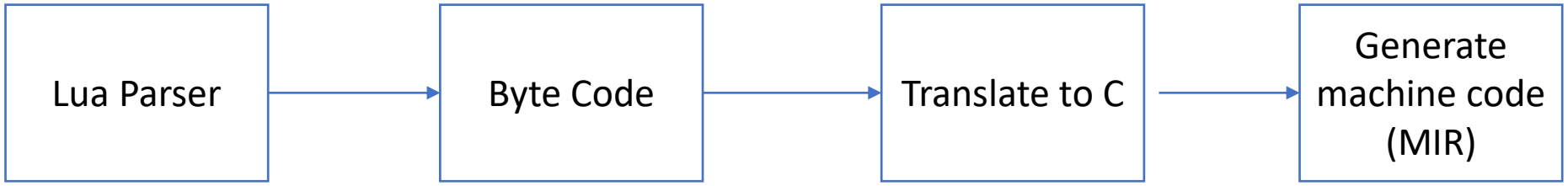
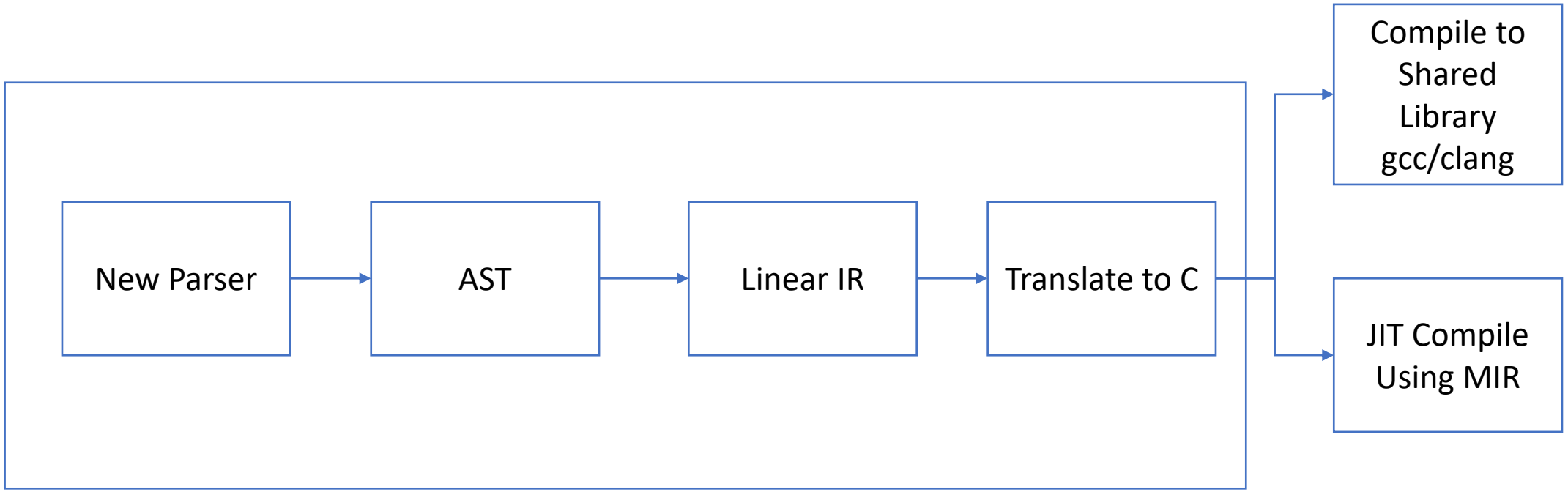
A new compiler for Ravi

- In this talk I will present the work I have been doing on a new compiler for Ravi. I will cover following areas:
- Benefits of the new compiler framework
  - C stack allocation of temporaries,
  - Ability to JIT or AOT compile
  - Two languages in one – Ravi and embedded C!
- Challenges faced
- Future directions

Previous Approach



New Approach



- Compiler project is independent of Ravi
- However final C code generated assumes it's the Ravi VM – various internal structures of Lua are referenced

Simple Example – Old Version

f = function(a: integer) local b: integer = a + a; return b * 10 end

Generated code snippet

```
ra = R(1);
rb = R(0);
rc = R(0);
setivalue(ra, ivalue(rb) + ivalue(rc));
ra = R(2);
rb = R(1);
setivalue(ra, ivalue(rb) * 10);
```

Simple Example – New Version

```
f = function(a: integer) local b: integer = a + a; return b * 10 end
```

Generated code snippet (local b eliminated)

```
// ADDii {local(a, 0), local(a, 0)} {Tint(1)}
{ raviX__i_1 = ivalue(R(0)) + ivalue(R(0)); }

// MOVi {Tint(1)} {Tint(0)}
raviX__i_0 = raviX__i_1;

// MULii {Tint(0), 10 Kint(0)} {Tint(1)}
{ raviX__i_1 = raviX__i_0 * 10; }
```

Goals

- Create a standalone lexer and parser that are re-usable
- Translate to an Intermediate Representation – not byte code
- C code generation is not generic as requires knowledge of the VM details
- Generated C functions look like Lua functions but have no bytecode

Reusable lexer and parser

- Hope is that anyone that wants to play with this should be able to do so easily
- Work in progress parser AST dump that should be readable directly in Lua (a DSL)

Example of AST dump

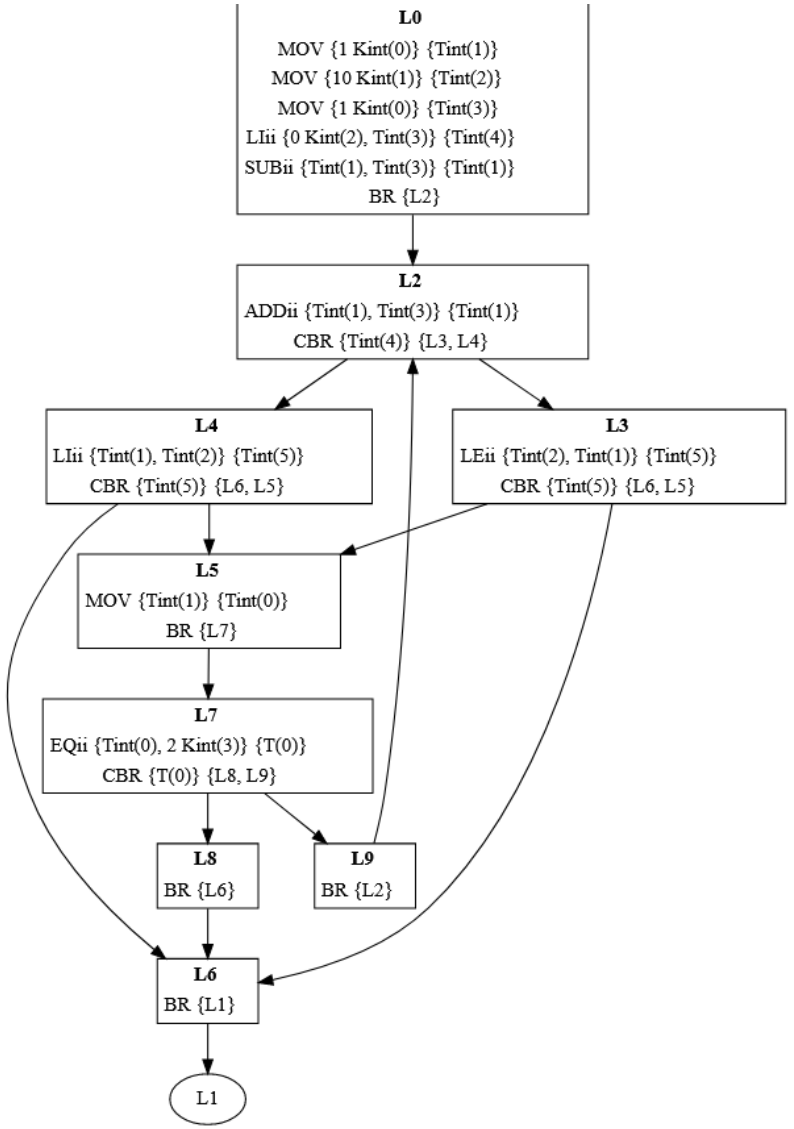
```
ExprFunction {
 function_id = 000002193E970B30,
 parent_function_id = 0000000000000000,
 type_code = closure,
 type_name = '',
 is_vararg = true,
 is_method = false,
 need_close = false,
 upvalues = {
   SymUpvalue {
    target_symbol_id = 000002193E970BC0,
    target_variable_name = _ENV,
    target_type_code = table,
    target_type_name = '',
   }
 },
 main_block =
  Scope {
   scope_id = 000002193E970B90,
   function_id = 000002193E970B30,
   parent_scope_id = 0000000000000000,
   symbols = {
   },
   need_close = false,
  }
 },
```

```
StmtReturn {
  ExprFunction {
   function_id = 000002193E970D20,
   parent_function_id = 000002193E970B30,
   type_code = closure,
   type_name = '',
   is_vararg = false,
   is_method = false,
   need_close = false,
   args = {
    SymLocalRef{ name='a', symbol_id = 000002193E970E90 }
   },
   main_block =
    Scope {
     scope_id = 000002193E970DE0,
     function_id = 000002193E970D20,
     parent_scope_id = 000002193E970B90,
     symbols = {
       SymLocal {
        symbol_id = 000002193E970E90,
        name = 'a',
        type_code = integer,
        type_name = '',
        modified = false,
        function_argument = true,
        escaped = false,
        scope_id = 000002193E970DE0,
       }
      ,
```

Linear IR

- Looks more like traditional IR with basic blocks

```
define Proc%1
L0 (entry)
        CLOSURE {Proc%2} {T(0)}
        RET {T(0)} {L1}
L1 (exit)
define Proc%2
L0 (entry)
        TOINT {local(a, 0)}
        ADDii {local(a, 0), local(a, 0)} {Tint(1)}
        MOVi {Tint(1)} {Tint(0)}
        MULii {Tint(0), 10 Kint(0)} {Tint(1)}
        RET {Tint(1)} {L1}
L1 (exit)
```



Embedding C in Ravi code

```
C__decl [[
typedef struct {
    unsigned char d;
    unsigned char m;
    short y;
    int serial;
} Date;
]]

DateFunctions = {}
function DateFunctions.make_date(d: integer, m: integer, y: integer)
    local date = C__new('Date', 1)

    C__unsafe(date, d, m, y) [[
        Date *dateptr = (Date *) date.ptr;
        dateptr->d = (unsigned char)d;
        dateptr->m = (unsigned char)m;
        dateptr->y = (short)y;
        y -= m <= 2;
        int era = (y >= 0 ? y : y - 399) / 400;
        unsigned yoe = (unsigned)(y - era * 400);      // [0, 399]
        unsigned doy = (153 * (m + (m > 2 ? -3 : 9)) + 2) / 5 + d - 1; // [0, 365]
        unsigned doe = yoe * 365 + yoe / 4 - yoe / 100 + doy;     // [0, 146096]
        dateptr->serial = era * 146097 + (int)doe - 719468 + 25569; // +25569 adjusts the serial number to match Excel
    ]]

    return date
end
```

Embedding C in Ravi code

```
function DateFunctions.print_date(date: any)
    local d: integer
    local m: integer
    local y: integer
    local j: integer
    C__unsafe(date, d, m, y, j) [[
            Date *dateptr = (Date *) date.ptr;
            d = dateptr->d;
            m = dateptr->m;
            y = dateptr->y;
            j = dateptr->serial;
    ]]
    print(d,m,y,j)
end

function DateFunctions.get_day(date: any)
    local v: integer
    C__unsafe(date, v) [[
            Date *dateptr = (Date *) date.ptr;
            v = dateptr->d;
    ]]
    return v
end
```

Embedding C in Ravi code

- Since we generate C code as intermediary – why not allow user to embed C
- How to do it safely?
- Integrate an embedded full C parser
- Enforce certain restrictions
  - Function calls not allowed
  - Pointers in structs not allowed

Optimizing code

- New parser and IR was designed so that we can write optimization passes
- However not much has been done so far
- Experimental feature – detect and replace constant upvalues with their values

Removing constant upvalues

```
define Proc%1
L0 (entry)
        MOVi {1 Kint(0)} {local(a, 0)}
        CLOSURE {Proc%2} {T(0)}
        RET {T(0)} {L1}
L1 (exit)
define Proc%2
L0 (entry)
        RET {Upval(0, Proc%1, a)} {L1}
L1 (exit)
```

```
define Proc%1
L0 (entry)
        MOVi {1 Kint(0)} {local(a, 0)}
        CLOSURE {Proc%2} {T(0)}
        RET {T(0)} {L1}
L1 (exit)
define Proc%2
L0 (entry)
        RET {1 Kint(0)} {L1}
L1 (exit)
```

Future directions

- Immediate goal is to stabilize the existing features for a production quality release, along with a small set of batteries (Suravi)
- I would like to add type inference but it’s a hard problem
- An alternative approach would be to detect types at runtime and specialize functions based on input types

Challenges

- It is a personal project in spare time, so hard to make progress quickly

Links

- https://github.com/dibyendumajumdar/ravi-compiler
- https://github.com/dibyendumajumdar/ravi
- https://github.com/dibyendumajumdar/Suravi