Faster Programs with Guile 3

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this talk

What?

- Your programs are faster with Guile 3!

How?

- The path to Guile 3

Where?

- The road onward

results

Guile 3 – it's Guile, but faster!

Sum 10 million element f32vector

- 2.7x as fast

Expand `(sxml ssax)`

- 1.5x as fast

Guix graft

- … as fast

And it will only get faster!

back the truck up

In 2006, I had Guile programs that ran too slowly.

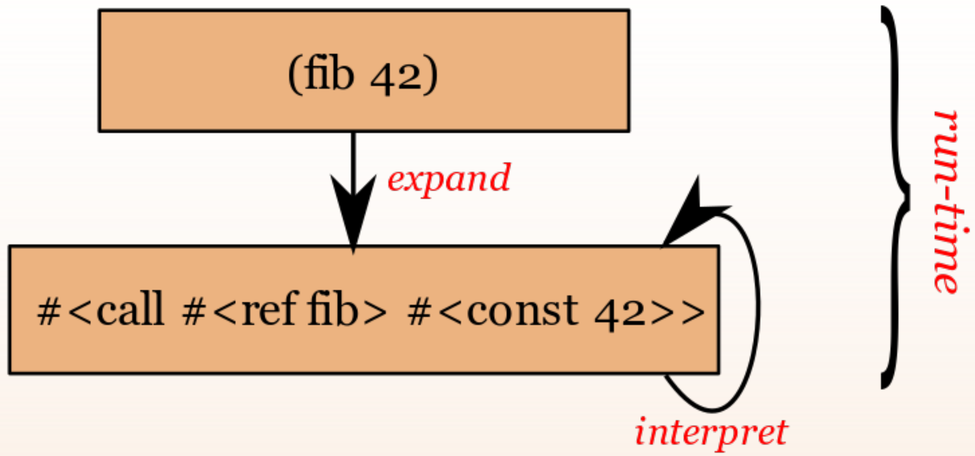
I did everything

- C hot-paths
- Extensive cacheing/memoizing
- Built a profiler…

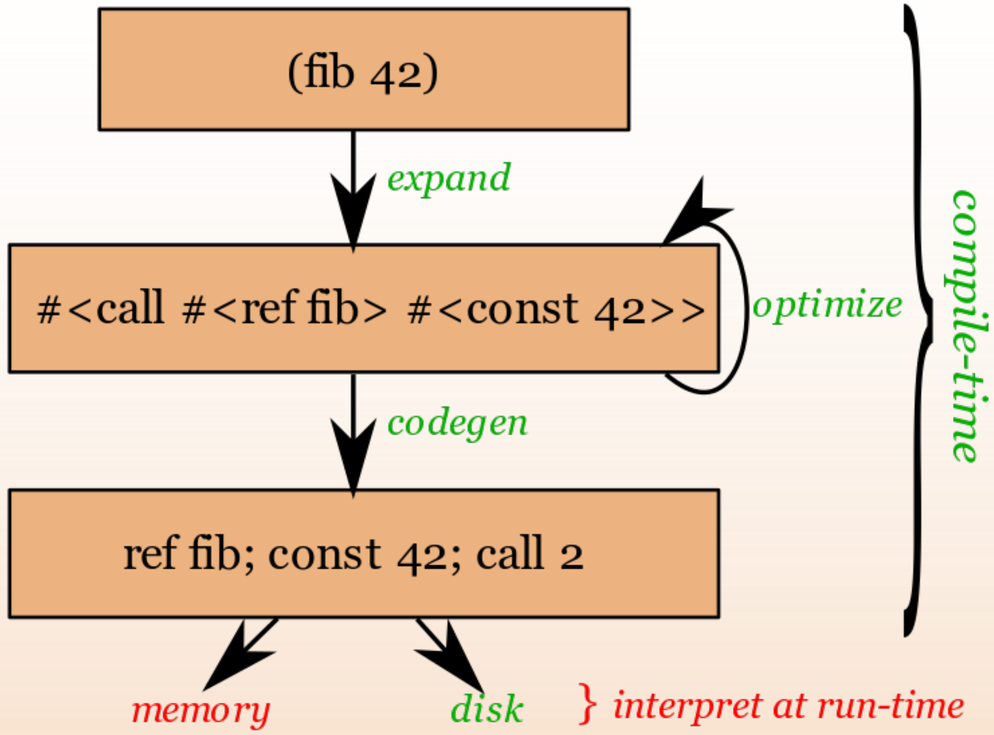
In the end, problem was: Guile ran Scheme code too slowly.

Solution: make Guile faster.

Guile in 2006



Guile in 2010



running bytecode

At run-time: interpret instructions from bytecode

Bytecode interpreter: `vm.c`

Like turing machine: bytecode is the tape

Interpreter sometimes called “virtual” machine

- Defined on top of “native” machine (e.g. x86, C, ...)

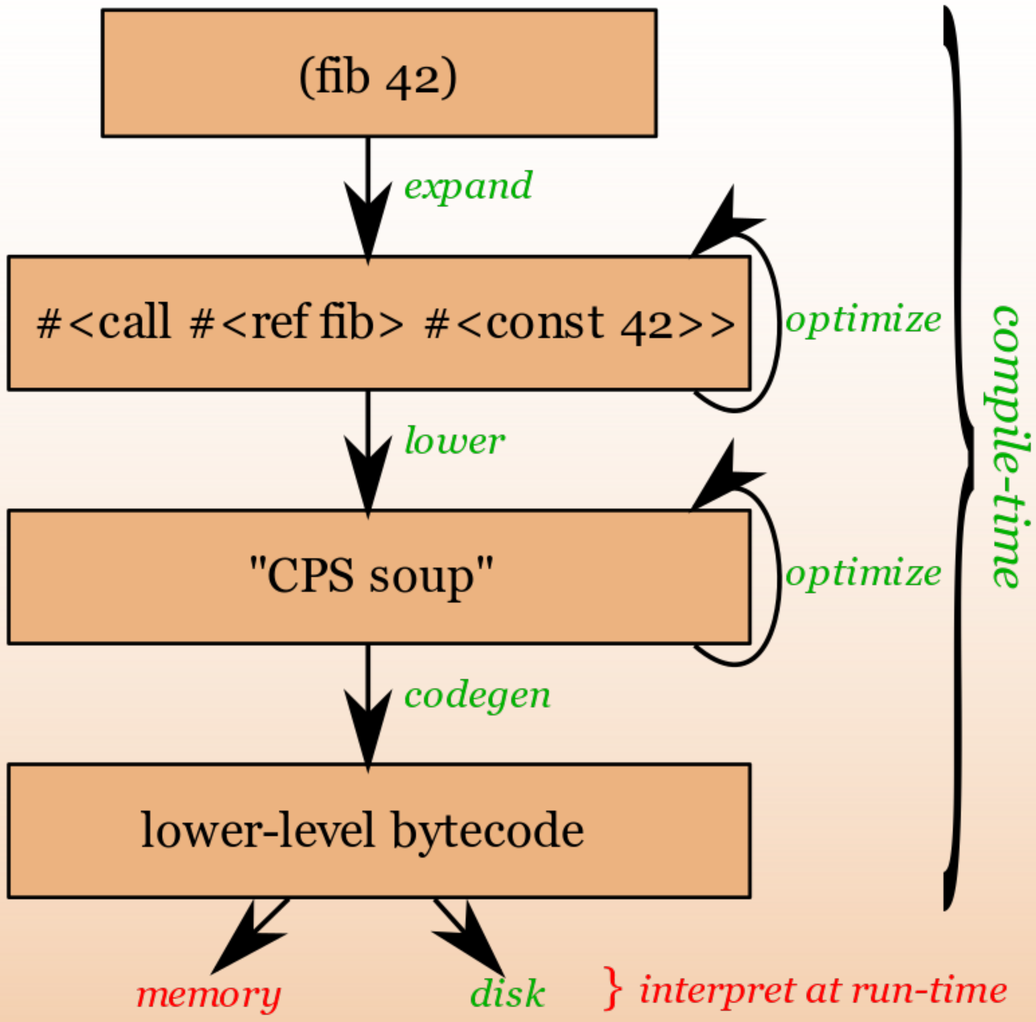
but then

A faster Guile means more kinds of programs can be written in Guile

Also, I got hooked – making compilers is fun

- This is my job now

Guile in 2017



current Guile needs

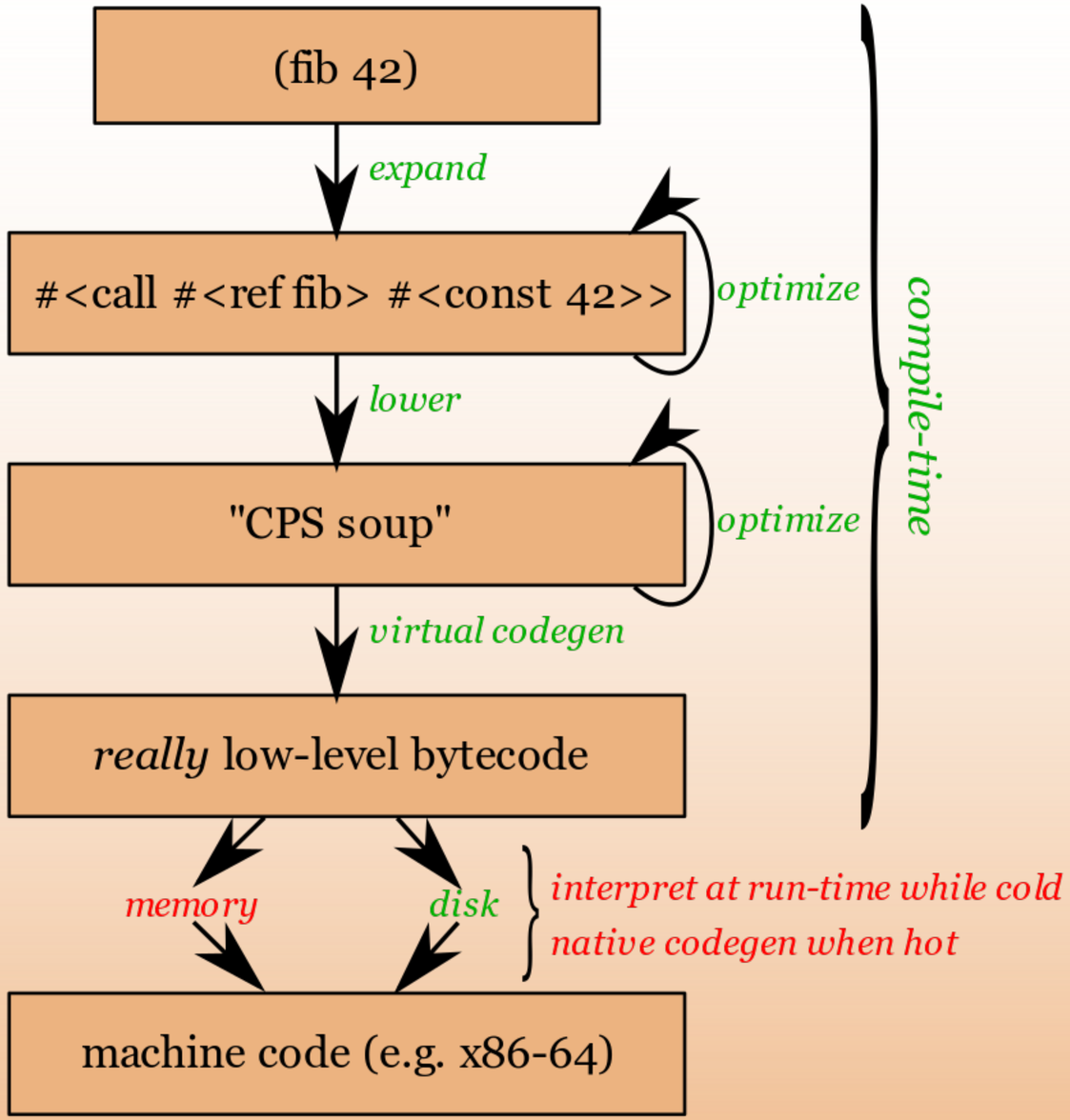
Language needs to evolve

- Approach Racket (frontend work)

Guile itself could be faster

- Enlarge set of Guile-appropriate problems
- Speed inception: speed up Guile, speed up compiler
- Maintain low-latency programming
- I am a junkie

Guile in 2019



Guile in 2019

(This is the Guile 3 work)

Next step in incremental, compatible improvement

2.9.1 released October 2018

“Done”-ish

Guile 3 goal

Generate good native code

- Avoid code bloat
- Limit complexity of implementation
- Keep support for all platforms

Two steps:

- Lower-level bytecode
- Generate native code

lower-level bytecode

Guile 2.2:

```
scheme@(guile-user)> ,x (lambda (x) (vector-ref x 0))
   0    (assert-nargs-ee/locals 2 0)
   1    (vector-ref/immediate 0 0 0)
   2    (handle-interrupts)
   3    (return-values 2)
```

lower-level bytecode

Guile 3.0:

```
scheme@(guile-user)> ,x (lambda (x) (vector-ref x 0))
   0    (instrument-entry 229)
   2    (assert-nargs-ee/locals 2 0)    ;; 2 slots (1 arg
   3    (immediate-tag=? 0 7 0)         ;; heap-object?
   5    (jne 15)                        ;; -> L2
   6    (heap-tag=? 0 127 13)           ;; vector?
   8    (jne 12)                        ;; -> L2
   9    (word-ref/immediate 1 0 0)
  10    (ursh/immediate 1 1 8)
  11    (imm-s64<? 1 0)
  12    (jnl 5)                         ;; -> L1
  13    (scm-ref/immediate 1 0 1)
  14    (reset-frame 1)                 ;; 1 slot
  15    (handle-interrupts)
  16    (return-values)
L1:
  17    (make-short-immediate 1 2)      ;; 0
  18    (throw/value+data 1 177) ;; #(out-of-range ...)
L2:
  20    (throw/value+data 0 201) ;; #(wrong-type-arg ...
```

compared to Guile 2.2

- Instructions closer to machine code
- More instructions
- More control flow
- More optimization opportunities (e.g. elide type checks)
- More work for optimizer

compared to Guile 2.2

Compile time *could* be longer

- More instructions means more work for compiler

Run time *could* be longer

- More instructions means more work at run-time for instruction dispatch

But…

code generation

Interpreter:

```
/* make-short-immediate dst:8 low-bits:16
 *
 * Make an immediate whose low bits are
 * LOW-BITS, and whose top bits are 0.
 */
 {
   uint8_t dst;
   scm_t_bits val;

   UNPACK_8_16 (op, dst, val);
   SP_SET (dst, SCM_PACK (val));
   NEXT (1);
 }
```

Compiler:

```
jit_movi (T0, SCM_UNPACK (val));
jit_stxi (8 * dst, SP, T0);
```

code generation

GNU Lightning: implementations of `jit_movi`, etc for all common architectures

Native code performs same operations on Guile stack that VM interpreter would

- No register allocation yet
- Tier-up possible anywhere
- Tier-down anywhere to debug

Complete JIT support in 5 kLOC

Only 1 reserved reg (current thread)

when: AOT?

Ahead-of-time (AOT) code generation perfectly possible

Native code currently a pure function of bytecode, not specialized on run-time values

Store result in ELF

Not yet implemented

when: JIT?

Just-in-time (JIT): generate native code at run-time

But when, specifically?

- Need to avoid codegen for bytecode that doesn't matter

Guile: per-function counter incremented at call and loop iteration

Configurable tier-up threshold

status

GNU Lightning impedance probs :(

Lightning 1: Close! But limited platforms

Lightning 2: API good, but...

- Crashes in optimizer sometimes :(
- Do not want optimizer
- Regalloc useless for Guile
- Custom calling conventions hard

Need solution before 3.0

next?

Register allocation

Consistently comparable perf to Chez

WASM backend! (Depends on "GC" proposal)

Racketification

(Figure out how I can play well with others!)

questions?

https://gnu.org/s/guile

https://wingolog.org/

#guile on freenode

@andywingo

Happy hacking!

oh no
it’s the
bonus
slides

JIT environment variables

`GUILE_JIT_THRESHOLD=50000`: When to JIT; -1 for never, 0 for always

- Call increments by 2, loop by 30
- High default == JIT slow currently

`GUILE_JIT_LOG=0`: Log level; up to 4.

`GUILE_JIT_STOP_AFTER=0`: Stop JIT compilation after this many functions. Useful for debug.

`GUILE_JIT_PAUSE_WHEN_STOPPING=0`: Pause for GDB to attach after stopping JIT.