No Overhead?

Zero-Cost Lua C API Abstraction

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https://github.com/ThePhD/sol2/

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No Problem.

Lua & Lua C API

- Lua
  - 
- Lua C API
  - stateful, stack-based
  - well-documented
  - mostly clear semantics / mappings

Limitations of Lua C API

- Stack-Based
  - Hard to grok sometimes
  - Must clean up or following operations will overflow the stack
- Simple in Lua ≠ Simple in API
  - Incredible amounts of boilerplate
  - *Efficient* stack management is hard

Lua C API can do Simple Things

- `my_table["a"]`
  - get 'my_table' global
  - get field
  - lua_to{x} value

- `my_func(2)`
  - push `my_func` global function
  - push argument
  - call, get return(s)

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- `other_func(`
  `    my_table[“a”][“b”], my_func(2)`
  `)`

- Lua C API does not scale
  - amount of necessary boilerplate
  - developer time

Limitations of C

- No overloading
  - “which one do I need, again?”
  - Hard to specialize general-purpose routines

```
lua_gettable()
lua_getglobal(const char*)
lua_getfield(const char*)
lua_geti(int) [5.3+]

lua_rawgeti(int)
lua_rawget()
lua_rawgetp(void*)
```

Okay… so we wrap it?

- Type tells us what we need to do
  - Overloading/Dispatching to cover up the base
  - Stuff implementation details into various functions

More ~~Meat~~Power

- Higher-level, complex operations
  - Calling a function
    - with complex arguments
  - Tables
    - with nested lookup
  - Structured data
    - Mimicking C, C++ structures

Sol2

- Started by Danny Y. “Rapptz”
  - Unmaintained because he has other great ideas
  - Pull requests sitting dead in repository

- Rewritten, developed into Sol2

Disclaimers

- I'm the author of sol2

- I did not author the 12 other benchmarked libraries
  - E-mailed every single library author, however
  - All of them got back to me with proper usage notes

- Great benchmarking technology
  - nonius: https://nonius.io/
  - statistically-significant benchmarking
  - much better than my hand-rolled loops

sol::stack

- The core of the API; usually never seen

```
lua_State* L = ...;
sol::stack::get_field<true>(L, "some_key");
int the_value = sol::stack::get<int>(L, -1);
lua_pop(L, 1);

lua_createtable(L, 0, 2);
sol::stack_reference ref(L, -1);
sol::stack::set_field(L, 1, "val1");
sol::stack::set_field(L, 2, "val2", ref.stack_index());
ref.pop();
```

http://sol2.readthedocs.io/en/latest/api/stack.html

Basics

- Demonstrating some basics
  - Load a config file, mess with it

config.lua

```
number = 24
number2 = 24.5
important_string = 'woof woof'
some_table = { value = 48 }
function bark (val)
        print(val .. ' waf waf!')
end
```

Basics - tables

```
sol::state lua;
lua.open_libraries(sol::lib::base);
lua.script_file("config.lua");

int number = lua["number"];
std::string important_string = lua["important_string"];
int value = lua["some_table"]["value"];

sol::optional<int> safe = lua[“this_is"]["not_real"];
int default_value = safe ? safe.value() : 24; // 24
```

http://sol2.readthedocs.io/en/latest/tutorial/all-the-things.html

Basics - functions

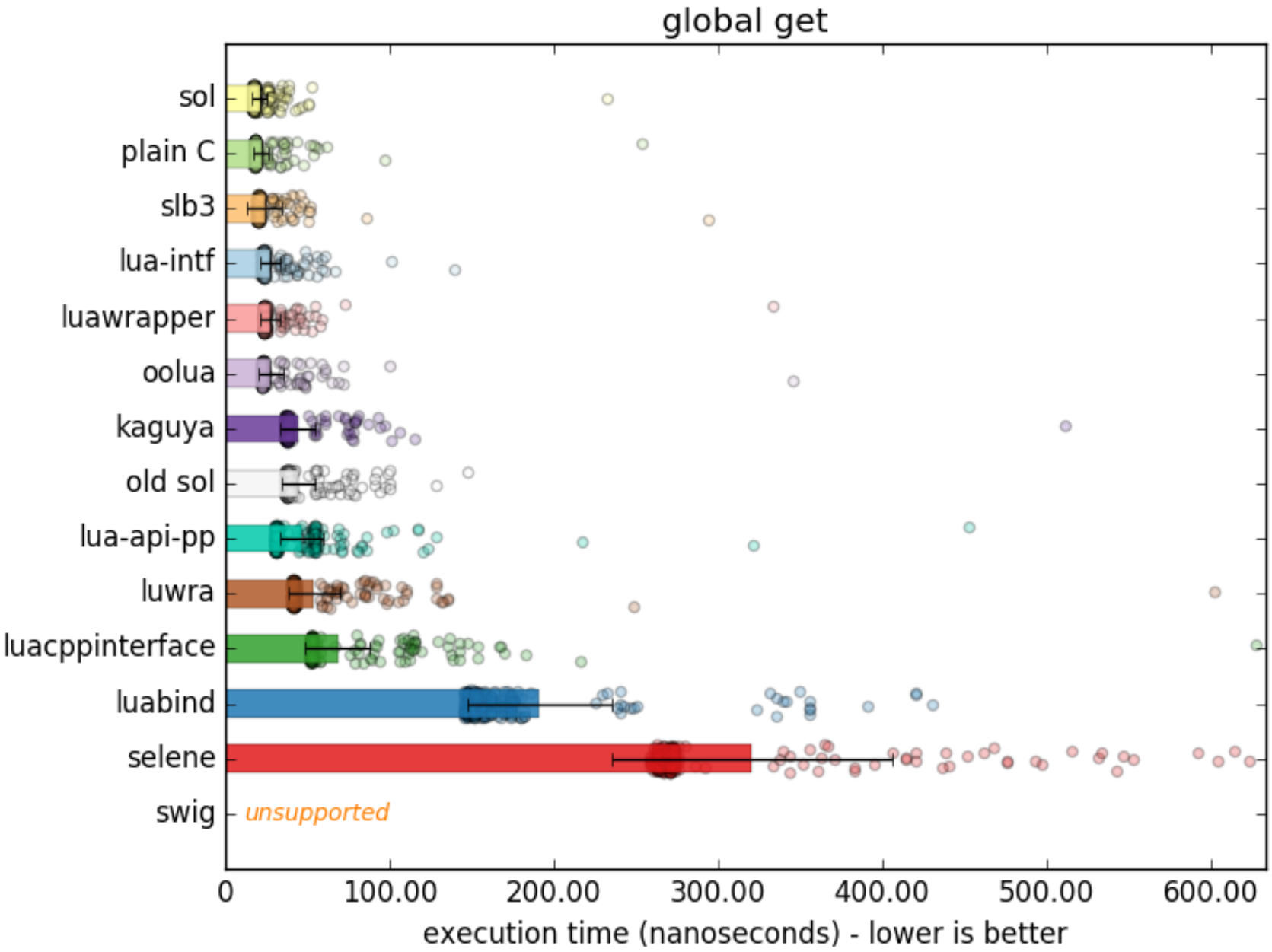
```
sol::function bark = lua["bark"];
bark(lua["important_string"]); // woof woof waf waf!

lua["woof"] = []() { std::cout << "Hey there!" << std::endl; };

lua.script("woof()"); // prints "Hey there!"
```

- Very easy to use
  - Painless to set up
  - Can be used without `sol::state`; just `lua_State*`

http://sol2.readthedocs.io/en/latest/tutorial/functions.html


global get
sol
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lua-intf
luawrapper
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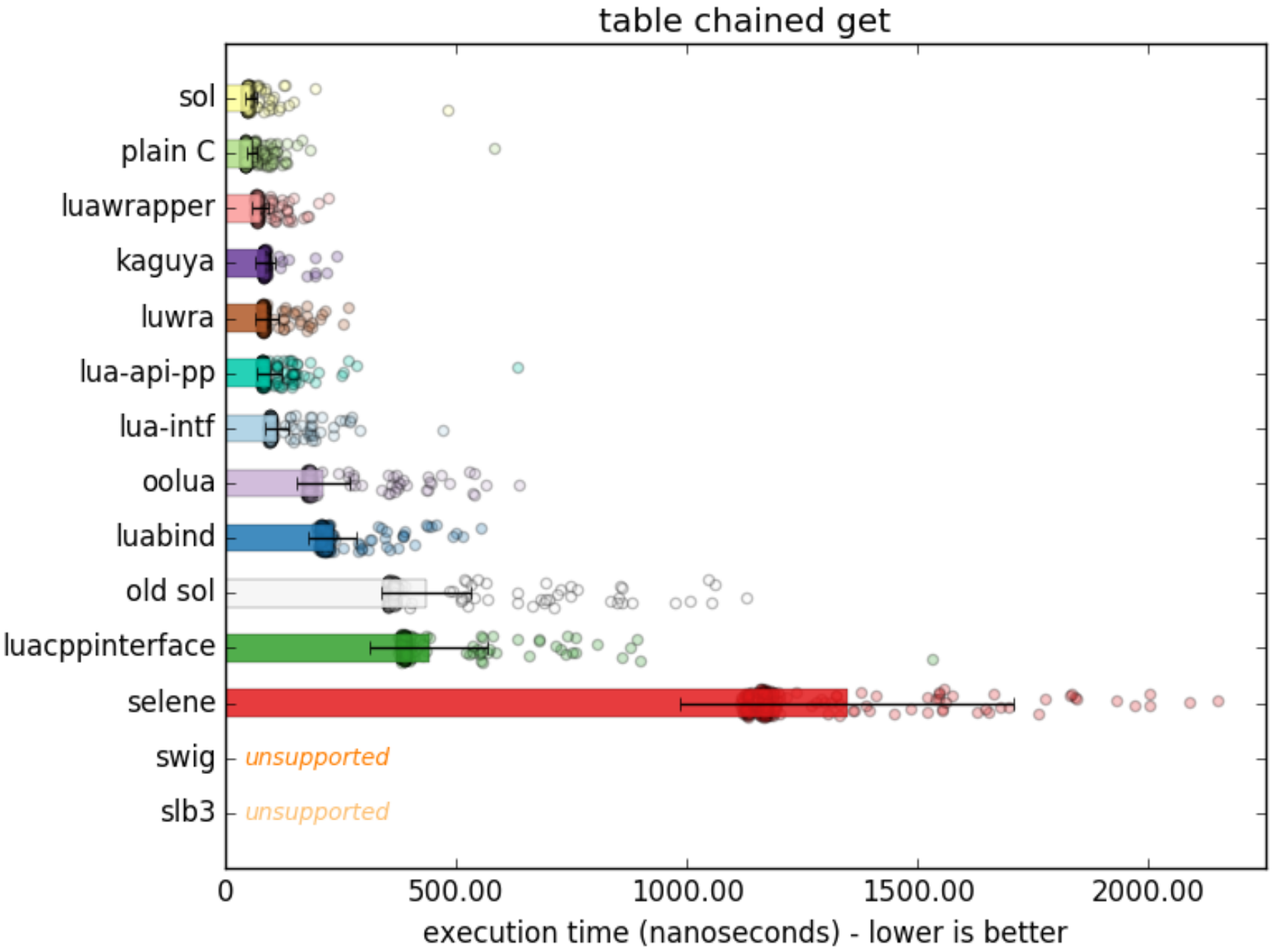
execution time (nanoseconds) - lower is better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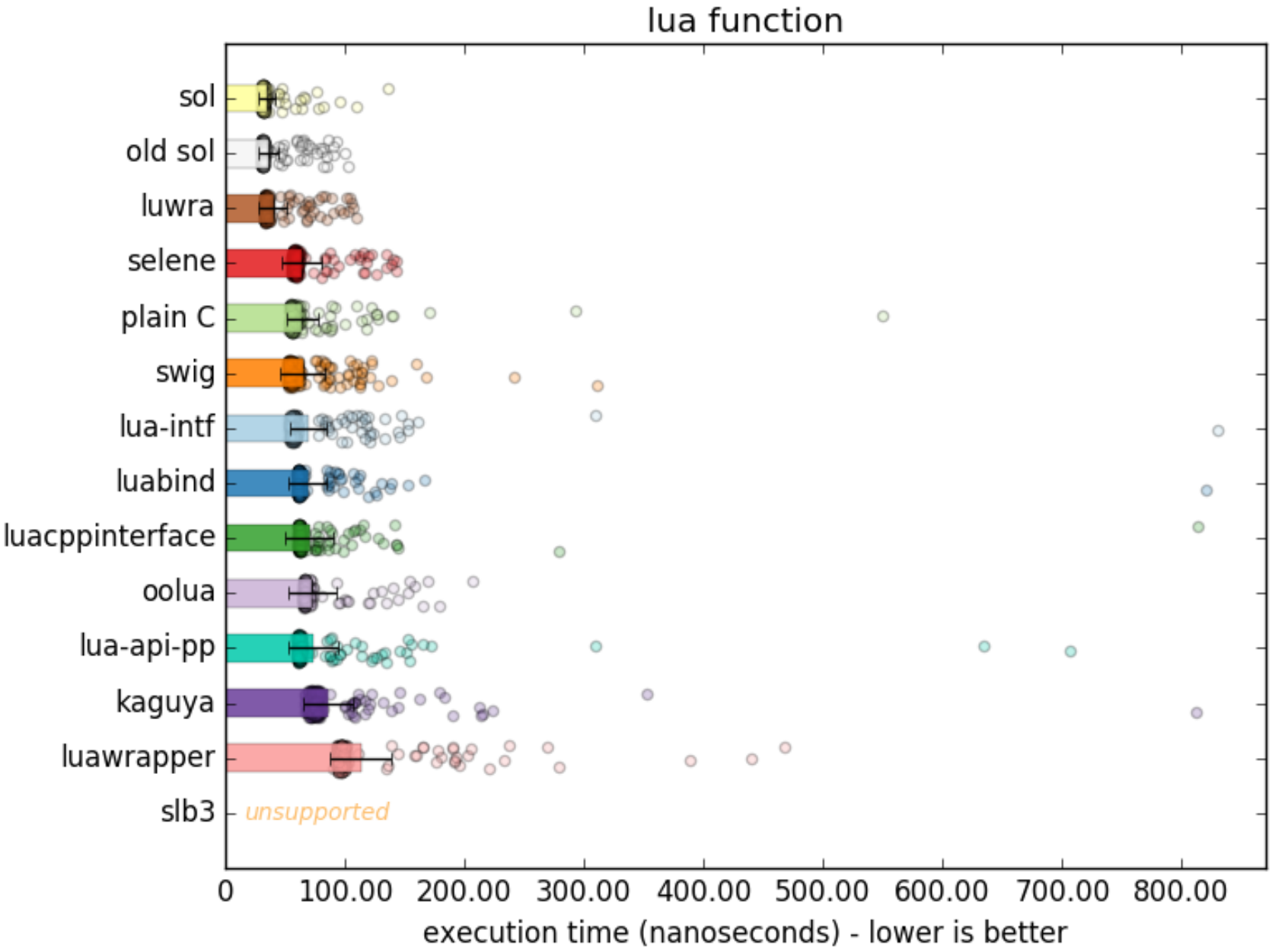
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usertype

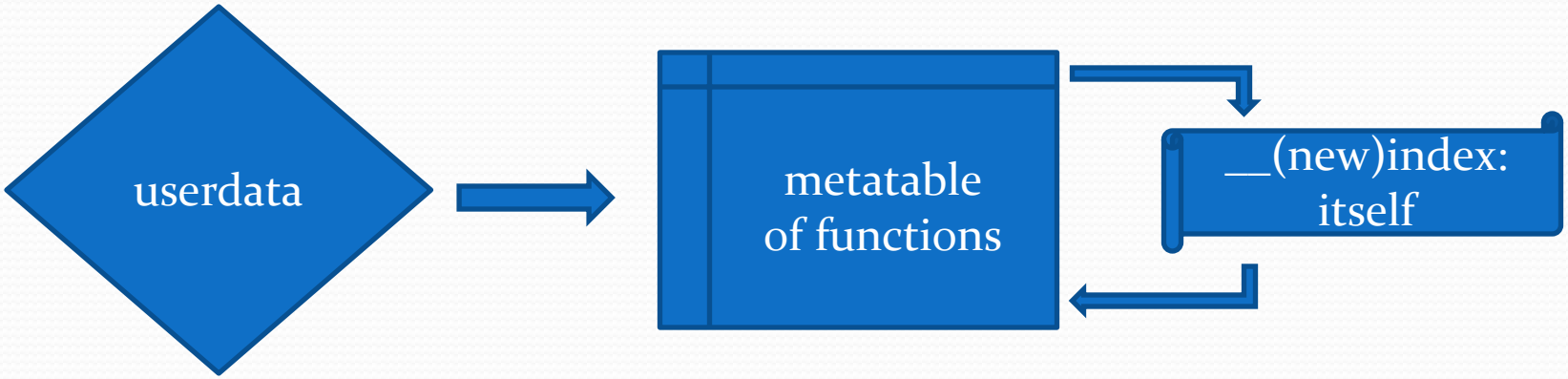
- The Big One™ - best part of Sol2
  - member function/variable bindings
  - metamethod
    - automatically generated equality/comparison methods
  - properties (like luabind)!
  - static functions as member functions
    - Take self argument
  - static variables, functions
  - (simple_usertype) runtime extensible

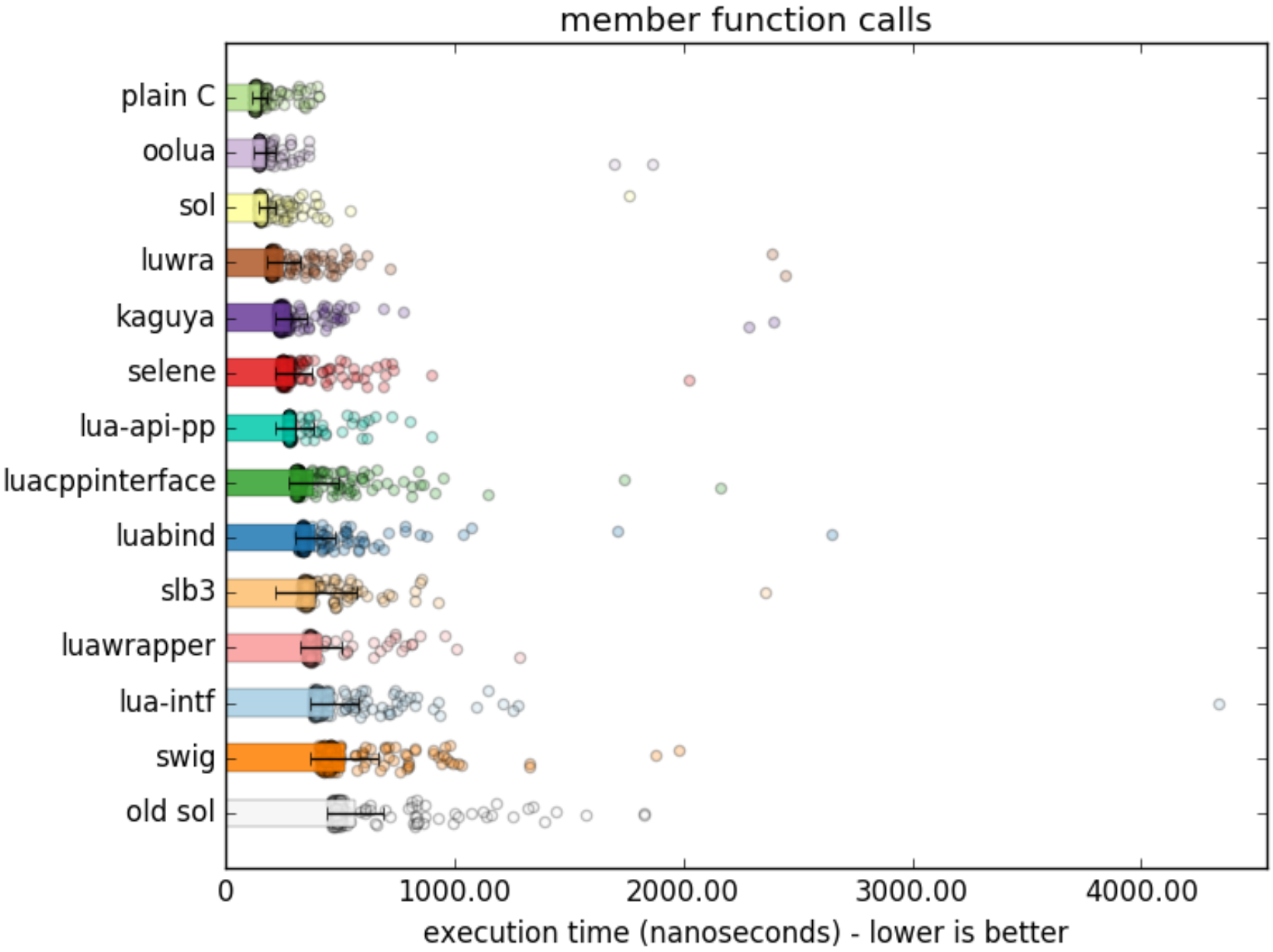
http://sol2.readthedocs.io/en/latest/api/usertype.html

usertype – a live example

```
#define SOL_CHECK_ARGUMENTS

#include "sol.hpp"
#include <iostream>

struct vars {

    void add_jump() {
        ++jumps;
    }
    int get_jumps() const {
        return jumps;
    }

    double speed() const {
        return boost * 2.5 + velocity;
    }

    void set_speed(double v) {
        velocity = v;
    }

public:
    int boost = 5;
private:
    int jumps = 0;
    double velocity = 5;
};


int main(int, char*[]) {

    sol::state lua;
    lua.open_libraries();

    lua.new_usertype<vars>( "vars",
```

Implementation - functions




member function calls
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lua-intf
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2000.00
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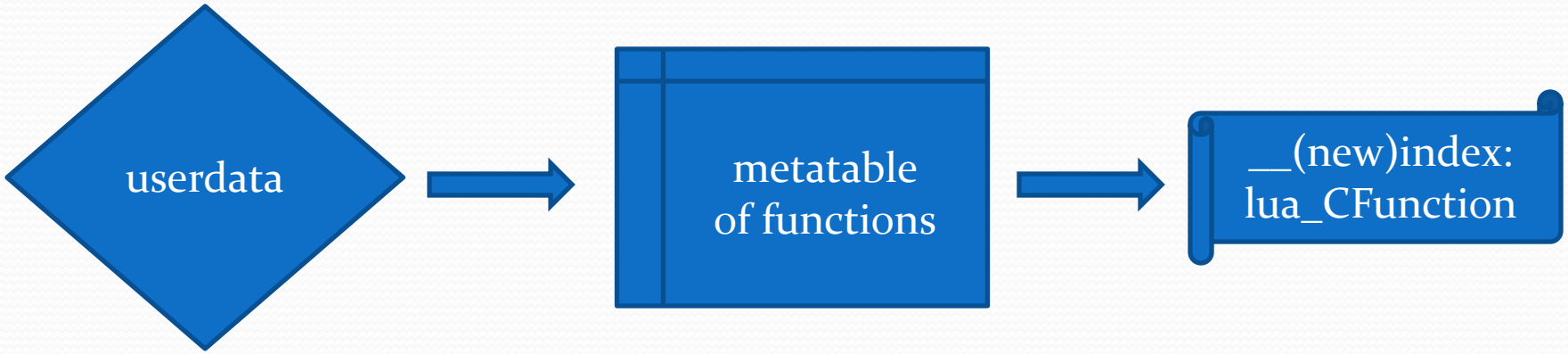
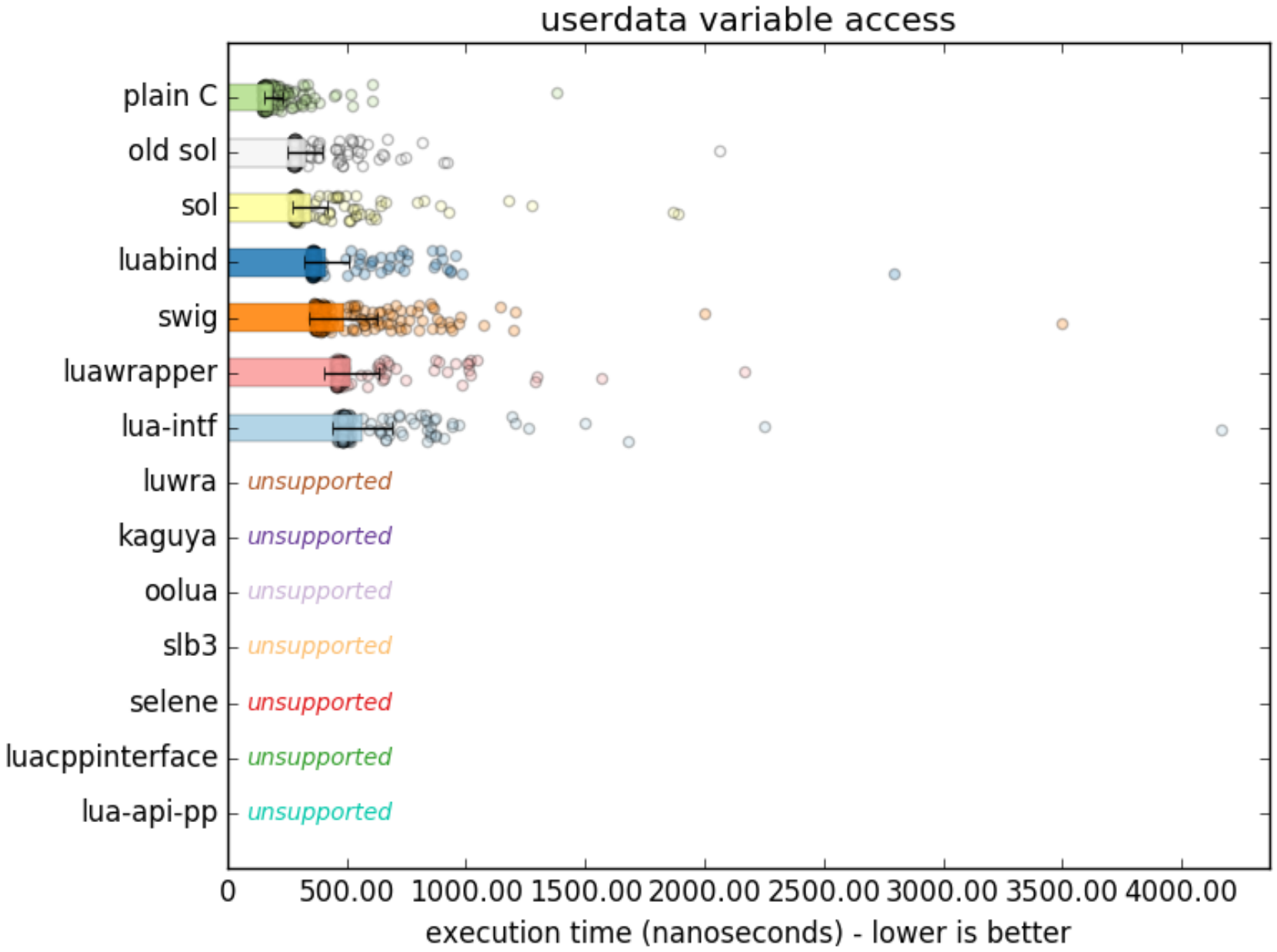
Implementation - variables




userdata variable access
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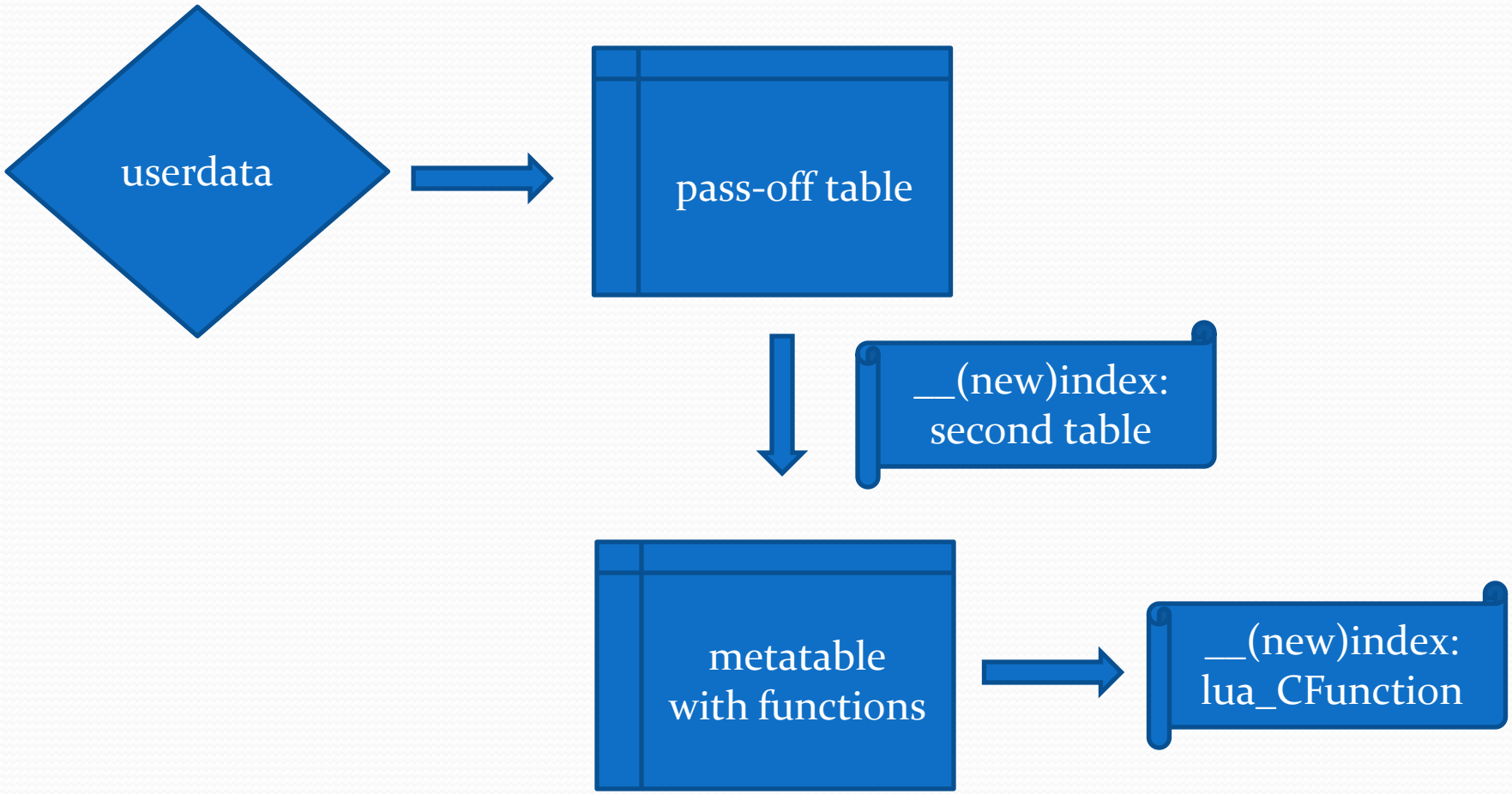
Implementation – variables, speed



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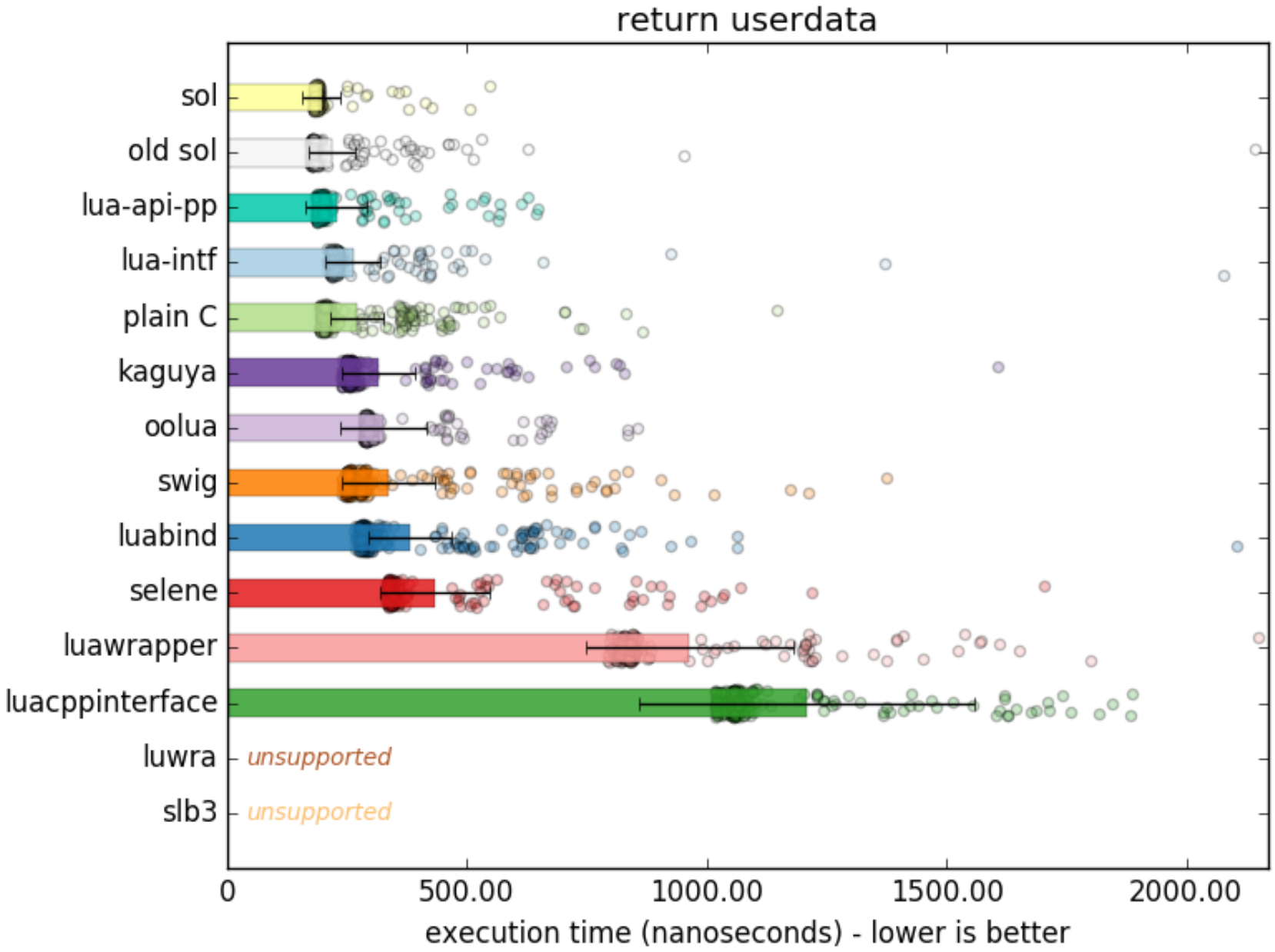
- Can't use the speed method
  - userdata not 'failed lookup' item
  - metatable is the 'failed lookup' item
  - 2x-4x performance hit for ALL methods/variables
- Karel Tuma patched item in his LuaJIT fork
- metatable-per-userdata?


return userdata
sol
old sol
lua-api-pp
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kaguya
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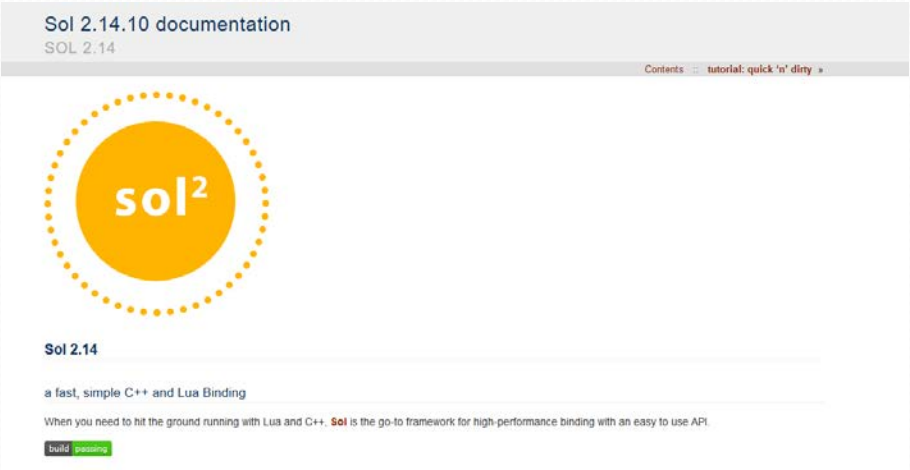
“I ***think*** it’s better than Selene”

- - Shohnwal, March 21, 2016
- Sol2 had better support at the time
  - Failure to communicate, so improved: http://sol2.rtfd.io



https://github.com/ThePhD/sol2/issues/36

Benchmarks

"To be honest with you, Sol2 is the first binding library I have compared against where I have had to disable runtime checks in OOLua"
– Liam Devine, OOLua,
https://github.com/ThePhD/sol2/issues/156#issuecomment-236913783

https://github.com/ThePhD/lua-bench

Lua wants

- __index/__newindex extra argument fix
  - add the original userdata / table that triggers the whole lookup cascade as the last argument
  - keeps backwards compatibility, enable efficient member function lookup
- New GC
  - corsix is on it with LuaJIT !

Thanks To

- Professor Gail E. Kaiser
  - COMS E6156 – Advanced Software Engineering
- Iris Zhang
  - Vetted documentation
- Kevin Brightwell ( : Nava2)
  - Took great interest in sol2 before anyone else
  - Vastly improved the CI
    - https://travis-ci.org/ThePhD/sol2

Thanks To

- Lounge<C++>
- Elias Daler (@EliasDaler), Eevee (@eevee)
  - Blogposts (https://eev.ee, https://elias-daler.github.io)
- Jason Turner (@lefticus)
  - Encouraged me to present, talk about Sol2
  - Runs CppCast (http://cppcast.com)

Thank You!

- Questions and/or Comments?
  - If you end up using Sol2, tell me about it here: https://github.com/ThePhD/sol2/issues/189
- Thoughts about Future Direction?
- Concerns?
  - .... Lunch?~

Bug Hunting

- “The road to success in Software Development is paved with the tears of your failed tests and the sleepless nights over your Heisenbugs.” - Some Poor Developer

Lua

- Very few actual bugs in the implementation, except…!
- Investigating one now
  - Compile with C++
  - pcall from a C function that throws an exception
    - returns -1 (not a defined error)
    - does not even clean stack?

Clang

- “internal linkage” bugs
- Excessively pedantic
  - “condition is the result of a constant”
    - it’s a template argument, clang, please stop torturing me with all these warnings :<
- apple-clang’s only purpose is to literally introduce new strange, build-breaking, progress-stopping bugs
  - negative value on enum breaks demangler
  - forced us to parse from `__PRETTY_FUNCTION__`

VC++ (Visual Studio)

- Help

  Me… !

GCC

- Less compiler bugs
  - auto&& in lambda declaration
- More actual unsupported features
  - has_* vs. is_* trait debacle
  - extended constexpr not backported to GCC 4.x.x