DISTRIBUTED PROGRAMMING IN LUA

NOEMI RODRIGUEZ
PUC-RIO

DISTRIBUTED PROGRAMMING

- shift to wide area
  - loose-coupling
  - asynchronism
  - highly dynamic execution conditions
- different settings require different paradigms and abstractions

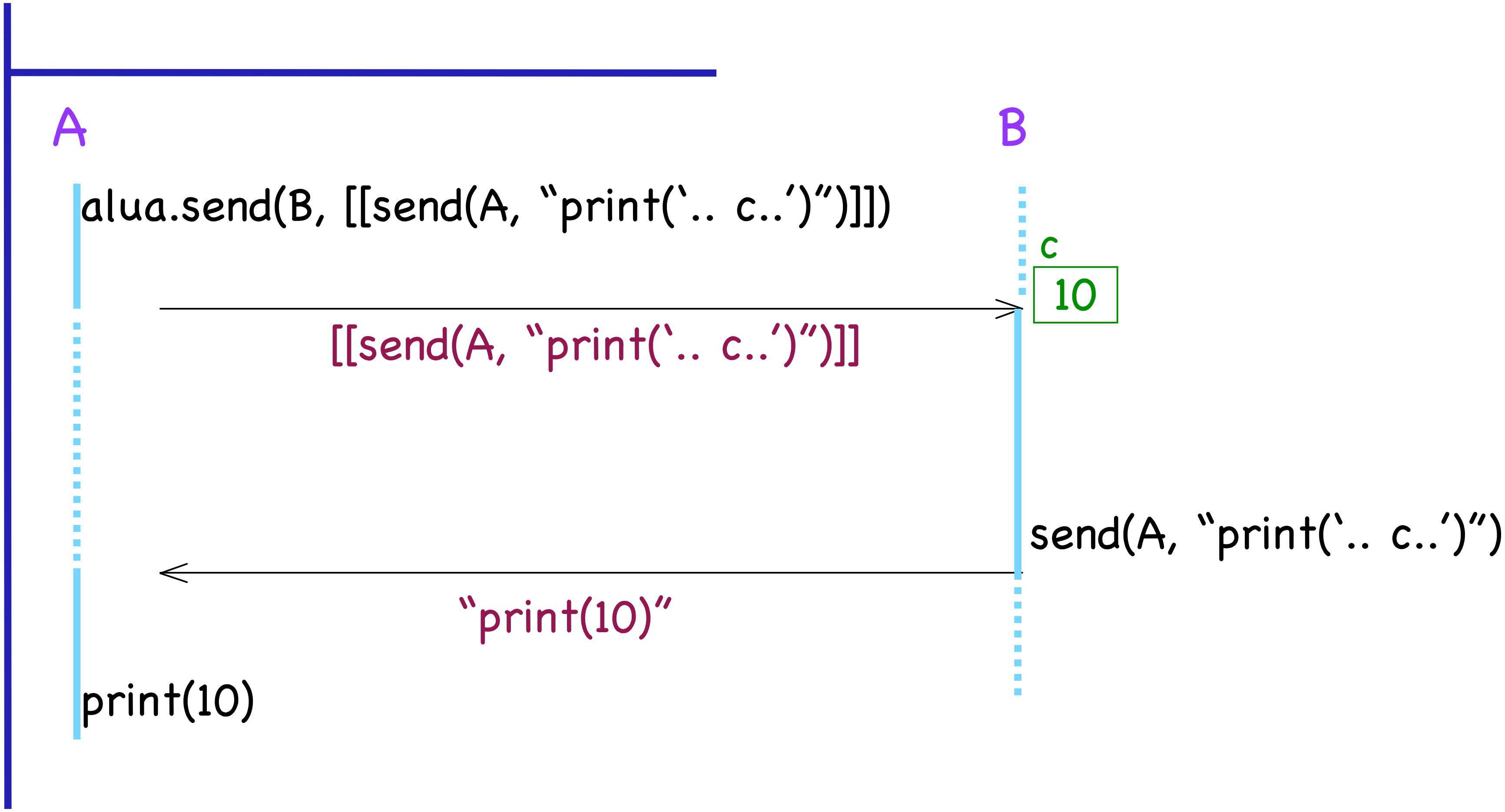
how can programming language features help?

ALua - Asynchronous Lua

- asynchronism
  - wide area computing

  `alua.send (dest, <string_with_chunk_of_code>)`
- arrival of message is an event
- handler executes chunk of code

ALua



A

B

alua.send(B, [[send(A, “print(‘.. c..’)”)]])

c

10

[[send(A, “print(‘.. c..’)”)]]

send(A, “print(‘.. c..’)”)

“print(10)”

print(10)

alua.inf.puc-rio.br

ALUA PROGRAMMING MODEL

- compatible with interpreted languages
  - highly flexible but not very secure
- single-threaded
  - each event is handled to completion

EXAMPLE: JOB MANAGEMENT WITH ALUA

- local resource manager for Globus
- direct use of ALua
- allocation, deallocation, and migration(?)
- system aspects
  - CPU and memory variability
- application aspects
  - bad parameters or starting points

➔ importance of interactivity

PROGRAMMING MODELS

- ALua: low abstraction level
  - programs as state machines
  - lots of string manipulation
- many settings require more support...

HIGHER-LEVEL ABSTRACTIONS: CLASSIFICATION

- libraries
  - awkward APIs
  - freely combined in applications
- specific languages
  - easier to use
  - support for specific paradigms
- reflection and extension
  - combined advantages...

ALua & abstractions

- DALua - distributed algorithms
- LuaRPC
- LuaTS - tuple space
- LuaPS - publish/subscribe
- ...

⇨ ease of integration: research & education

IMPORTANT FEATURES OF LUA

- functions as first-class values and other functional mechanisms
  - closures
- reflexive mechanisms allow us to redefine language behavior in case of exceptions
  - invocation of non-existing methods
- cooperative concurrency (coroutines)

→ high level abstractions can be easily built

DALua

- distributed algorithms library
  - very near to basic model
  - important as teaching tool
- DA classically described as a series of responses to events

example: classical Ricart&Agrawala algorithm for mutual exclusion

```
on request(ts, id) do
  ...
on oktogo do
  ...
```

EXAMPLE: MUTUAL EXLUSION

CLASSICAL RICART&AGRAWALA

```
function mutex.enterCS (func)
  logicalclock = logicalclock + 1
  waiting = true
  local thisreq = { ["timestamp"] = logicalclock,
                    ["proc"] = ad.self() }
  local procs = dalua.processes ("myapp")
  dalua.send(procs, "mutex.request", thisreq)
  thisreq.pending = table.getn(procs)
  thisreq.critical_section = func
  table.insert(requests, thisreq)
end
```

EXAMPLE: MUTUAL EXLUSION

CLASSICAL RICART&AGRAWALA

```
function mutex.request (newreq)
  logicalclock = max(logicalclock, newreq.timestamp) + 1
  if busy then table.insert(deferred, newreq)
  elseif waiting then
    -- check if new request was issued earlier
    if haspriority(newreq, requests[1]) then
      dalua.send(newreq.proc, "mutex.oktogo", ad.self(),
               newreq.timestamp, logicalclock)
    else
      table.insert(deferred, newreq)
    end
  else -- not interested in critical region
    dalua.send(newreq.proc, "mutex.oktogo", ad.self(),
             newreq.timestamp, logicalclock)
  end
end
```

RPC

- RPC is often more comfortable than responses to events
  - critics
- LuaRPC
  - how to combine RPC view with asynchronism
  - and with "single-threadedness"

  - asynchronous invocations as a basis

LUARPC - ASYNCHRONOUS CALLS

```
function request()
  local acc, repl = 0, 0
  local peers = dalua.processes("myapp")
  local expected = table.getn(peers)
  function avrg (val)
    repl = repl+1
    acc = acc + val
    if (repl==expected) then print ("Current Value: ", acc/repl)
    end
  end
  for _,p in ipairs (peers) do
    luarpc.async(p, "currValue", avrg)()
  end
end
```

- ➛ closures help deal with "unwinding the stack" problem
- ➛ async fcts are 1st class as any other fct value

LuaRPC

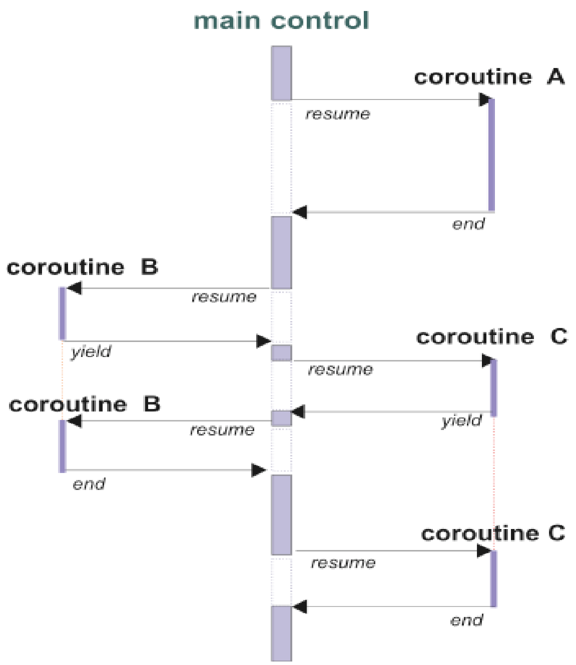
- still, sometimes it is nice to work with synchronous view
  - synchronous RPC
  - futures

```
f = luarpc.sync(p, callback)
f(arg1, arg2)
```

SYNCHRONOUS INVOCATIONS

- "blocking" semantics should allow incoming messages
- use of coroutines:
  - each new invocation is executed in a new coroutine
  - sync call invokes asynchronously and yields

ALua with sync calls



- possible inconsistent handling of globals but only at explicit points
  - investigation of compatible synchonization scheme

COMBINING PARADIGMS

- one same application can freely use different interaction paradigms
  - p/s, RPC, messages, ...
  - example: distributed ME algorithm can be used as part of RP implementation
- language features allow all of them to be seamlessly integrated into the language