

Ad-hoc Big-Data Analysis with Lua And LuaJIT



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Lua Workshop 2015
Stockholm

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- ▶ CTO, co-owner at LogicEditor
- ▶ In love with Lua since 2005

The Problem

- ▶ You have a dataset to analyze,
- ▶ which is too large for "small-data" tools,
- ▶ and have no resources to setup and maintain (or pay for) the Hadoop, Google Big Query etc.
- ▶ but you have some processing power available.

Goal

- ▶ Pre-process the data so it can be handled by R or Excel or your favorite analytics tool (or Lua!).
- ▶ If the data is dynamic, then *learn to* pre-process it and build a data processing pipeline.

An approach

- ▶ Use Lua!
- ▶ And (semi-)standard tools, available on Linux.
- ▶ Go minimalistic while exploring, avoid frameworks,
- ▶ Then move on to an industrial solution that fits your newly understood requirements,
- ▶ Or roll your own ecosystem! ;-)

Assumptions

Data format

- ▶ Plain text
- ▶ Column-based (csv-like), optionally with free-form data in the end
- ▶ Typical example: web-server log files

Data Format Example: raw data

```
2015/10/15 16:35:30 [info] 14171#0: *901195  
[lua] index:14: 95c1c06e626b47dfc705f8ee6695091a  
109.74.197.145 *.example.net  
GET 123456.gif?q=0&step=0&ref= HTTP/1.1 example.com
```

NB: This is a single, tab-separated line from a time-sorted file.

Data Format Example: intermediate data

alpha.example.com	5
beta.example.com	7
gamma.example.com	1

NB: These are several tab-separated lines from a key-sorted file.

Hardware

- ▶ As usual, more is better: Cores, cache, memory speed and size, HDD speeds, networking speeds...
- ▶ But even a modest VM (or several) can be helpful.
- ▶ Your fancy gaming laptop is good too ;-)

Linux (Ubuntu) Server.

This approach will, of course, work for other setups.

Filesystem

- ▶ Ideally, have data copies on each processing node, using identical layouts.
- ▶ Fast network should work too.
- ▶ Use of network filesystem of one kind or another are not a requirement.

Examples

Bash script example

```
time pv /path/to/uid-time-url-post.gz \  
| pigz -cdp 4 \  
| cut -d$'\t' -f 1,3 \  
| parallel --gnu --progress -P 10 --pipe --block=16M \  
  $(cat <<"EOF"  
    luajit ~me/url-to-normalized-domain.lua  
EOF  
  ) \  
| LC_ALL=C sort -u -t$'\t' -k2 --parallel 6 -S20% \  
| luajit ~me/reduce-value-counter.lua \  
| LC_ALL=C sort -t$'\t' -nrk2 --parallel 6 -S20% \  
| pigz -cp4 >/path/to/domain-uniqs_count-merged.gz
```

Lua Script Example: url-to-normalized-domain.lua

```
for l in io.lines() do
    local key, value = l:match("^([^\t]+\t(.*)")
    if value then
        value = url_to_normalized_domain(value)
    end
    if key and value then
        io.write(key, "\t", value, "\n")
    end
end
```


Lua Script Example: reduce-value-counter.lua 1/3

```
-- Assumes input sorted by VALUE
-- a  foo --> foo  3
-- a  foo      bar  2
-- b  foo      quo  1
-- a  bar
-- c  bar
-- d  quo
```

Lua Script Example: reduce-value-counter.lua 2/3

```
local last_key = nil, accum = 0

local flush = function(key)
  if last_key then
    io.write(last_key, "\t", accum, "\n")
  end
  accum = 0
  last_key = key -- may be nil
end
```

Lua Script Example: reduce-value-counter.lua 3/3

```
for l in io.lines() do
    -- Note reverse order!
    local value, key = l:match("^(.-)\t(.*)$")
    assert(key and value)

    if key ~= last_key then
        flush(key)
        collectgarbage("step")
    end

    accum = accum + 1
end

flush()
```

Tying it all together

Basically:

- ▶ You work with sorted data,
- ▶ mapping and reducing it line-by-line,
- ▶ in parallel where at all possible,
- ▶ while trying to use as much of available hardware resources as practical,
- ▶ and without running out of memory.

The Tools

The Tools

- ▶ parallel
- ▶ sort, uniq, grep
- ▶ cut, join, comm
- ▶ pv
- ▶ compression utilities
- ▶ LuaJIT

LuaJIT?

Up to a point:

- ▶ 2.1 helps to speed things up,
- ▶ FFI bogs down development speed.
- ▶ Go plain Lua first (run it with LuaJIT),
- ▶ then roll your own ecosystem as needed ;-)

Parallel

- ▶ xargs for parallel computation
- ▶ can run your jobs in parallel on a single machine
- ▶ or on a "cluster"

Compression

- ▶ gzip: default, bad
- ▶ lz4: fast, large files
- ▶ pigz: fast, parallelizable
- ▶ xz: good compression, slow
- ▶ ...and many more,
- ▶ be on lookout for new formats!

GNU sort tricks

```
LC_ALL=C \  
sort -t$'\t' --parallel 4 -S60% \  
-k3,3nr -k2,2 -k1,1nr
```

- ▶ Disable locale.
- ▶ Specify delimiter.
- ▶ Note that parallel x4 with 60% memory will consume $0.6 * \log(4) = 120\%$ of memory.
- ▶ When doing multi-key sort, specify parameters after key number.

grep

<http://stackoverflow.com/questions/9066609/fastest-possible-grep>

Notes and Remarks

Why Lua?

Perl, AWK are traditional alternatives to Lua, but, if you're not very disciplined and experienced, they are much less maintainable.

Start small!

- ▶ Always run your scripts on small representative excerpts from your datasets, not only while developing them locally, but on actual data-processing nodes too.
- ▶ Saves time and helps you learn the bottlenecks.
- ▶ Sometimes large run still blows in your face though:
- ▶ Monitor resource utilization at run-time.

Discipline!

- ▶ Many moving parts, large turn-around times, hard to keep tabs.
- ▶ Keep journal: Write down what you run and what time it took.
- ▶ Store actual versions of your scripts in a source control system.
- ▶ Don't forget to sanity-check the results you get!

Questions?

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