Ad-hoc Big-Data Analysis with Lua

And LuaJIT

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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.com
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 ;-)

OS

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.

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

```lua
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

```lua
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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