Logic and Lattices for Distributed Programming

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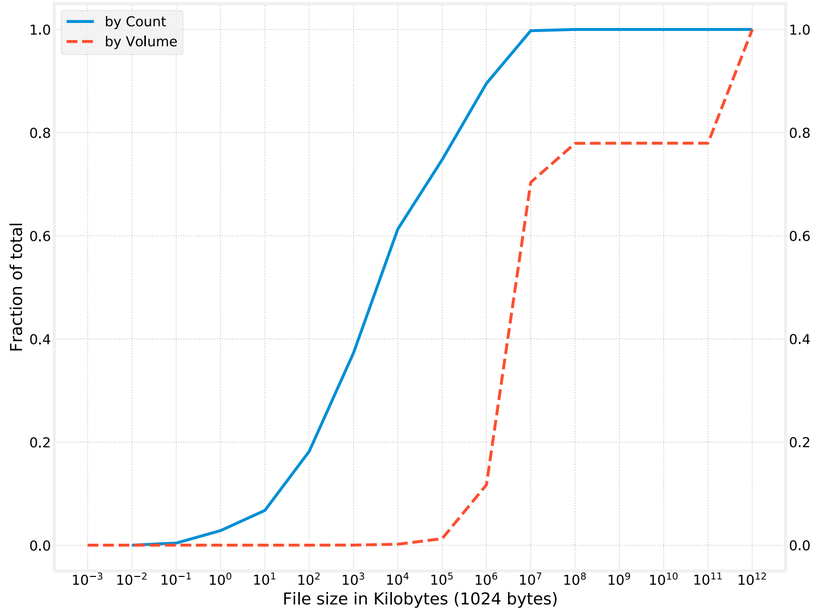
ROLLING THROUGH THE BAY


by Count
by Volume
Fraction of total
1.0
0.8
0.6
0.4
0.2
0.0
10^{-3} 10^{-2} 10^{-1} 10^{0} 10^{1} 10^{2} 10^{3} 10^{4} 10^{5} 10^{6} 10^{7} 10^{8} 10^{9} 10^{10} 10^{11} 10^{12}
File size in Kilobytes (1024 bytes)

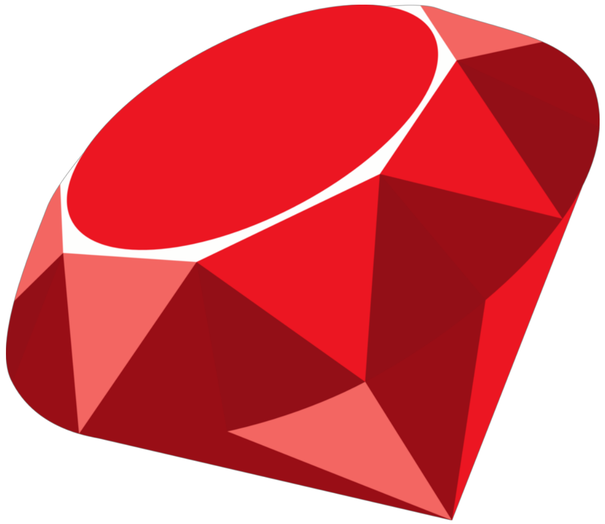
<~ bloom

Fact

Eval

Do

Timestep



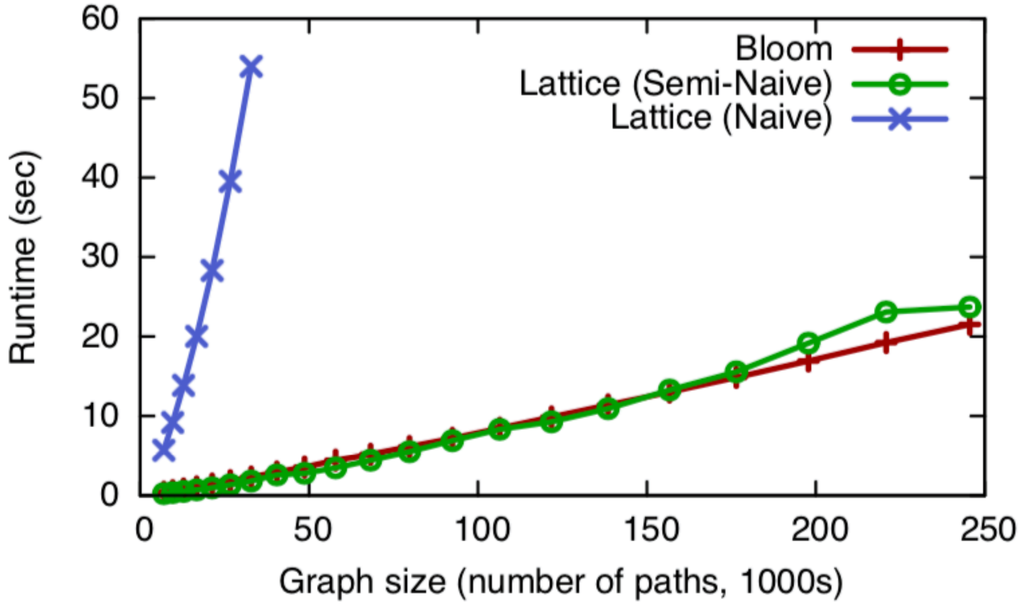
```
1  QUORUM_SIZE = 5
2  RESULT_ADDR = "example.org"

4  class QuorumVote
5    include Bud

7    state do
8      channel :vote_chn, [:@addr, :voter_id]
9      channel :result_chn, [:@addr]
10     table   :votes, [:voter_id]
11     scratch :cnt, [] => [:cnt]
12   end

14   bloom do
15     votes      <= vote_chn {|v| [v.voter_id]}
16     cnt        <= votes.group(nil, count(:voter_id))
17     result_chn <~ cnt {|c| [RESULT_ADDR] if c >= QUORUM_SIZE}
18   end
19 end
```

Figure 2: A non-monotonic Bloom program that waits for a quorum of votes to be received.

```
1  QUORUM_SIZE = 5
2  RESULT_ADDR = "example.org"

4  class QuorumVoteL
5    include Bud

7    state do
8      channel :vote_chn, [:@addr, :voter_id]
9      channel :result_chn, [:@addr]
10     lset    :votes
11     lmax    :cnt
12     lbool   :quorum_done
13   end

15   bloom do
16     votes       <= vote_chn {|v| v.voter_id}
17     cnt         <= votes.size
18     quorum_done <= cnt.gt_eq(QUORUM_SIZE)
19     result_chn  <~ quorum_done.when_true { [RESULT_ADDR] }
20   end
21 end
```

Figure 3: A monotonic Bloom^L program that waits for a quorum of votes to be received.

$$\vee \ max() \ min() \ \cup$$


Bloom
Lattice (Semi-Naive)
Lattice (Naive)
Runtime (sec)
Graph size (number of paths, 1000s)
0
10
20
30
40
50
60
0
50
100
150
200
250

```
12  module MonotoneReplica
13    include CartProtocol

15    state { lmap :sessions }

17    bloom do
18      sessions <= action_msg do |m|
19        c = LCart.new({m.op_id => [ACTION, m.item, m.cnt]})
20        { m.session => c }
21      end
22      sessions <= checkout_msg do |m|
23        c = LCart.new({m.op_id => [CHECKOUT, m.lbound, m.addr]})
24        { m.session => c }
25      end

27      response_msg <~ sessions do |session, cart|
28        cart.is_complete.when_true {
29          [cart.checkout_addr, session, cart.summary]
30        }
31      end
32    end
33  end
```

Figure 10: Cart server replica in Bloom^L that supports a monotonic (coordination-free) checkout operation.