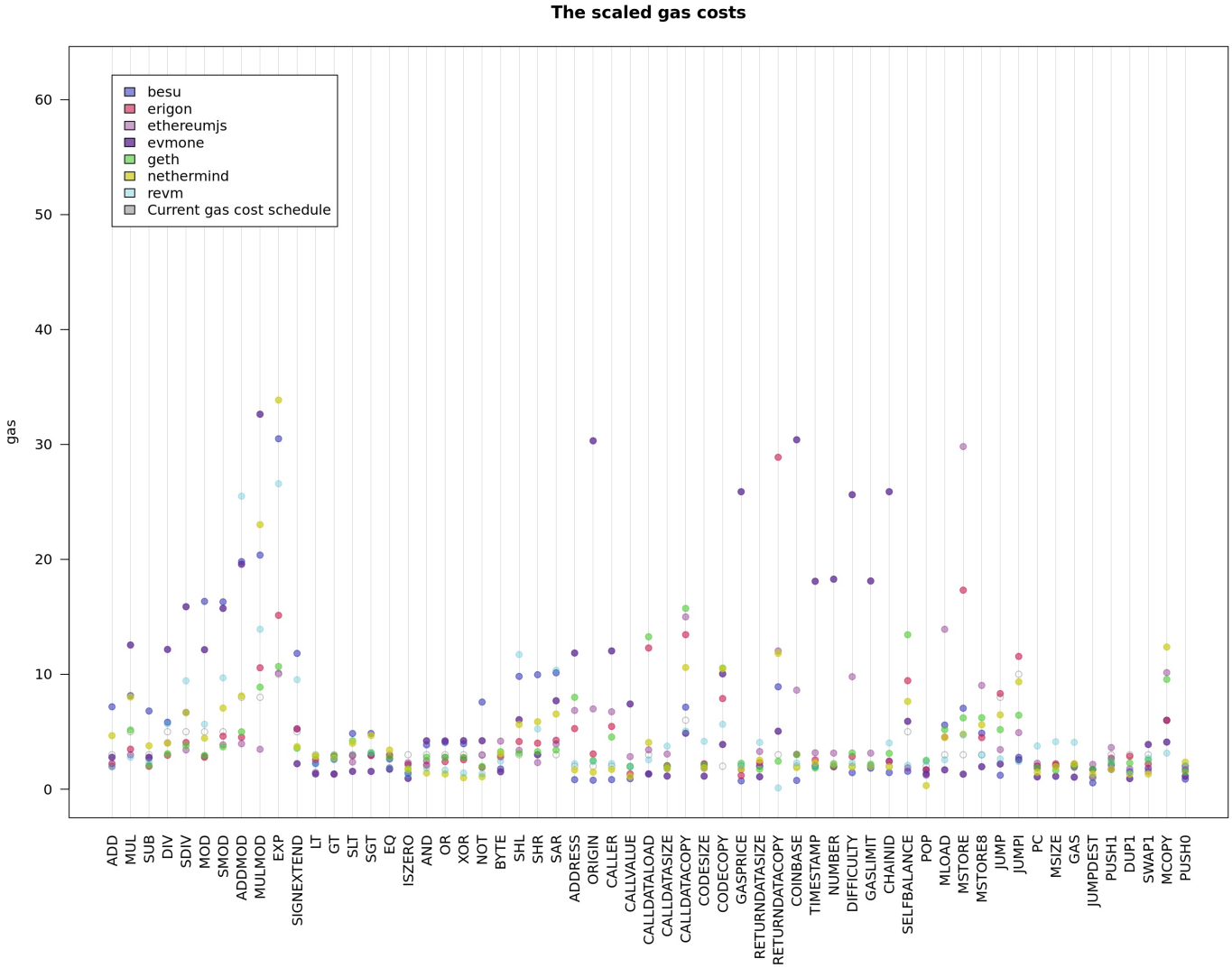
Gas Cost Estimator: comparison of obtained estimates, alternative gas cost schedule

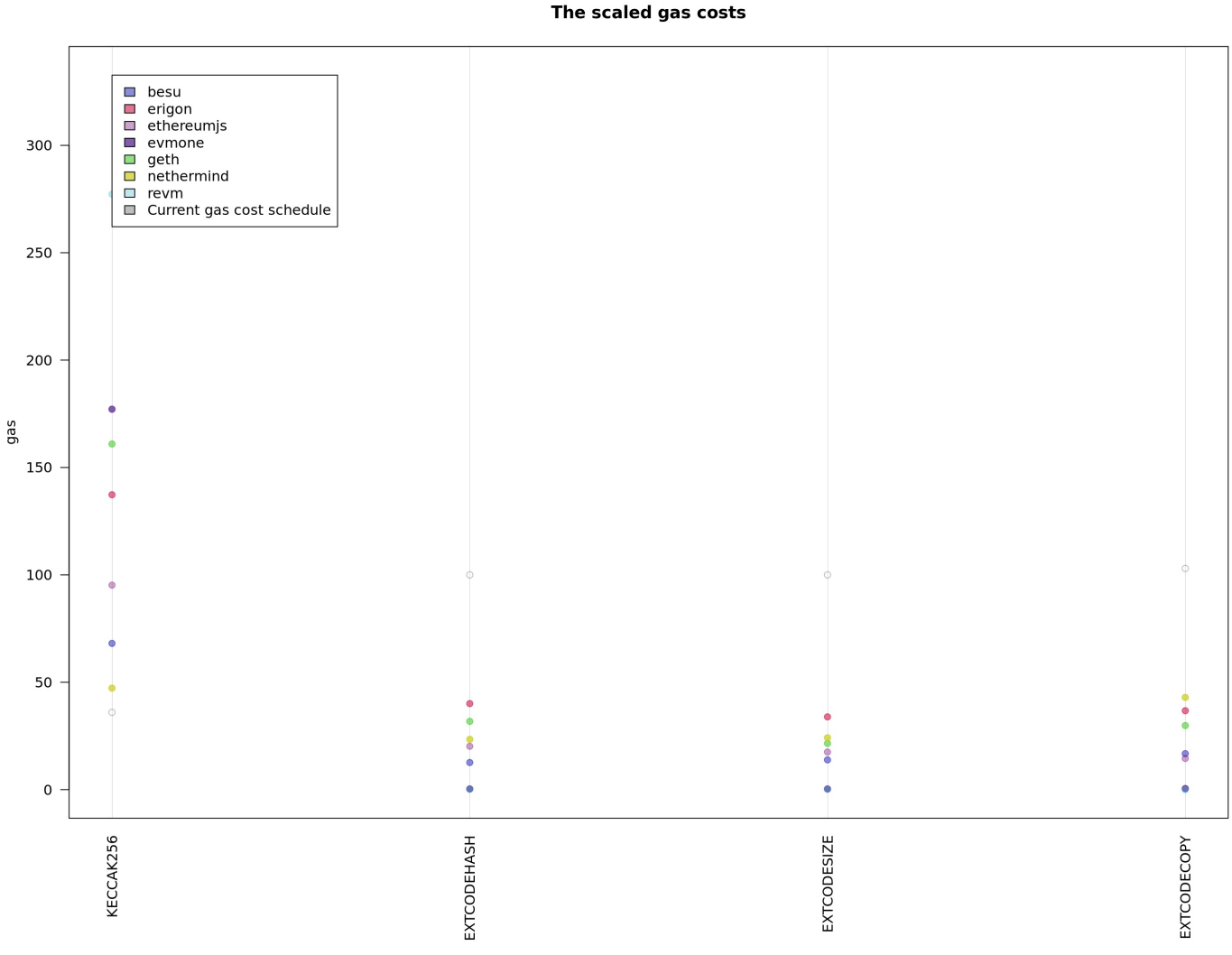
In this script we conduct the comparison procedure of the obtained estim

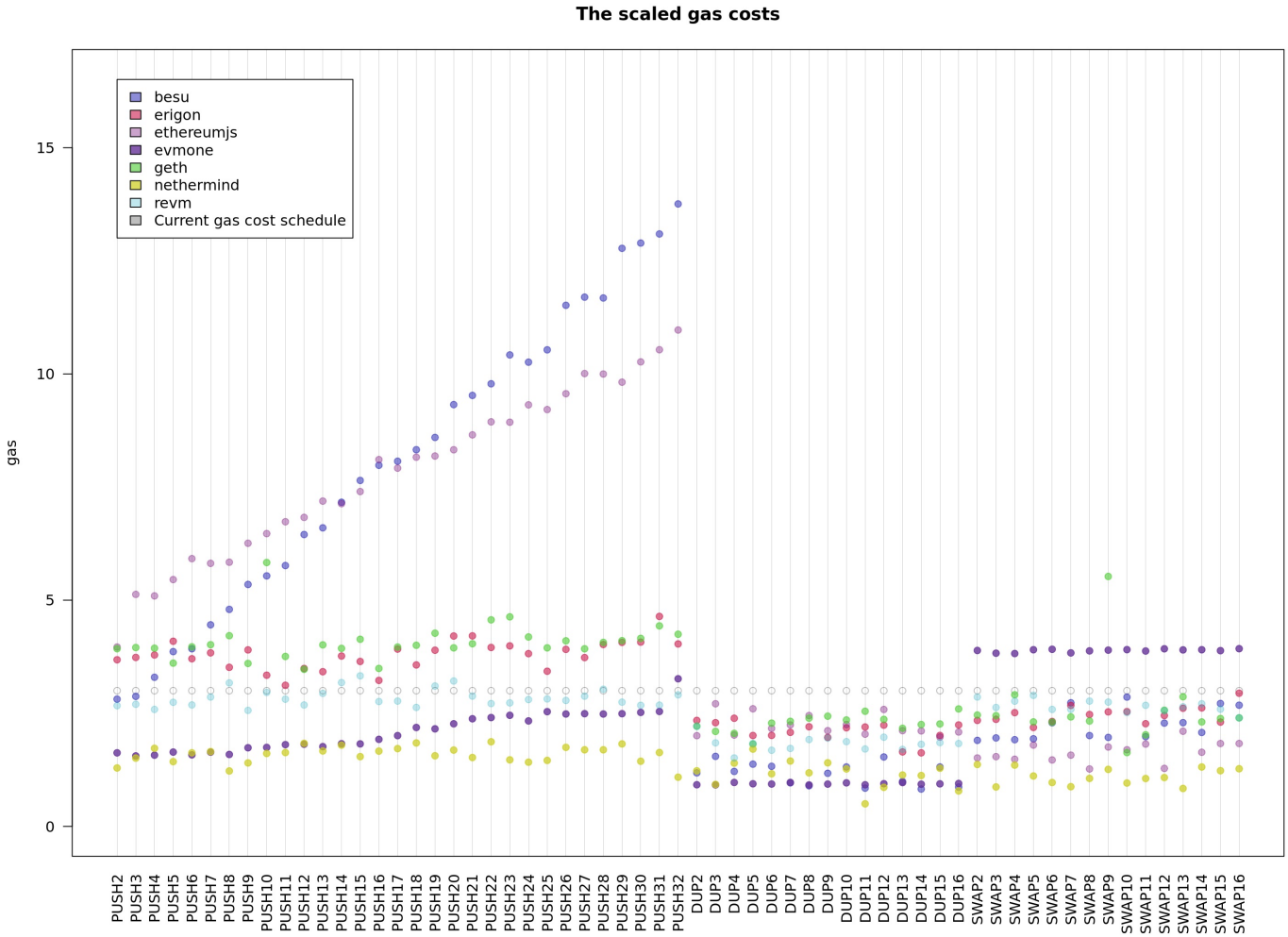
Parametrization. The comma separeted list of csv files with precomputed estimated costs for evm clients estimate_files=reports-12.01.2025/estimated_cost_marginal_create_besu.csv,reports-12.01.2025/estimated_cost_marginal_create_erigon.csv,reports-12.01.2025/estimated_cost_marginal_create_ethereumjs.csv,reports-12.01.2025/estimated_cost_marginal_create_evmone.csv,reports-12.01.2025/estimated_cost_marginal_create_geth.csv,reports-12.01.2025/estimated_cost_marginal_create_nethermind.csv,reports-12.01.2025/estimated_cost_marginal_create_revm.csv,reports-12.01.2025/estimated_cost_marginal_full_besu.csv,reports-12.01.2025/estimated_cost_marginal_full_erigon.csv,reports-12.01.2025/estimated_cost_marginal_full_ethereumjs.csv,reports-12.01.2025/estimated_cost_marginal_full_evmone.csv,reports-12.01.2025/estimated_cost_marginal_full_geth.csv,reports-12.01.2025/estimated_cost_marginal_full_nethermind.csv,reports-12.01.2025/estimated_cost_marginal_full_revm.csv,reports-12.01.2025/estimated_cost_marginal_mem_besu.csv,reports-12.01.2025/estimated_cost_marginal_mem_erigon.csv,reports-12.01.2025/estimated_cost_marginal_mem_ethereumjs.csv,reports-12.01.2025/estimated_cost_marginal_mem_evmone.csv,reports-12.01.2025/estimated_cost_marginal_mem_geth.csv,reports-12.01.2025/estimated_cost_marginal_mem_nethermind.csv,reports-12.01.2025/estimated_cost_marginal_mem_revm.csv,reports-12.01.2025/estimated_cost_marginal_precompiles_full_besu.csv,reports-12.01.2025/estimated_cost_marginal_precompiles_full_erigon.csv,reports-12.01.2025/estimated_cost_marginal_precompiles_full_evmone.csv,reports-12.01.2025/estimated_cost_marginal_precompiles_full_geth.csv,reports-12.01.2025/estimated_cost_marginal_precompiles_full_nethermind.csv,reports-12.01.2025/estimated_cost_marginal_stop_besu.csv,reports-12.01.2025/estimated_cost_marginal_stop_erigon.csv,reports-12.01.2025/estimated_cost_marginal_stop_ethereumjs.csv,reports-12.01.2025/estimated_cost_marginal_stop_geth.csv,reports-12.01.2025/estimated_cost_marginal_stop_revm.csv,reports-12.01.2025/estimated_cost_marginal_t_besu.csv,reports-12.01.2025/estimated_cost_marginal_t_erigon.csv,reports-12.01.2025/estimated_cost_marginal_t_ethereumjs.csv,reports-12.01.2025/estimated_cost_marginal_t_evmone.csv,reports-12.01.2025/estimated_cost_marginal_t_geth.csv,reports-12.01.2025/estimated_cost_marginal_t_nethermind.csv,reports-12.01.2025/estimated_cost_marginal_t_revm.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_besu.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_erigon.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_ethereumjs.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_evmone.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_geth.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_nethermind.csv,reports-12.01.2025/estimated_cost_arguments_arithmetic_revm.csv,reports-12.01.2025/estimated_cost_arguments_create_besu.csv,reports-12.01.2025/estimated_cost_arguments_more_besu.csv,reports-12.01.2025/estimated_cost_arguments_more_erigon.csv,reports-12.01.2025/estimated_cost_arguments_more_ethereumjs.csv,reports-12.01.2025/estimated_cost_arguments_more_evmone.csv,reports-12.01.2025/estimated_cost_arguments_more_geth.csv,reports-12.01.2025/estimated_cost_arguments_more_nethermind.csv,reports-12.01.2025/estimated_cost_arguments_more_revm.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_besu.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_erigon.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_ethereumjs.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_evmone.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_geth.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_nethermind.csv,reports-12.01.2025/estimated_cost_arguments_precompiles_revm.csv, the file with the reference gas cost table and groups configuration current_gas_cost=/reports/current_gas_cost.csv, used metric code metric=l1, should the details be included in the report details=FALSE.

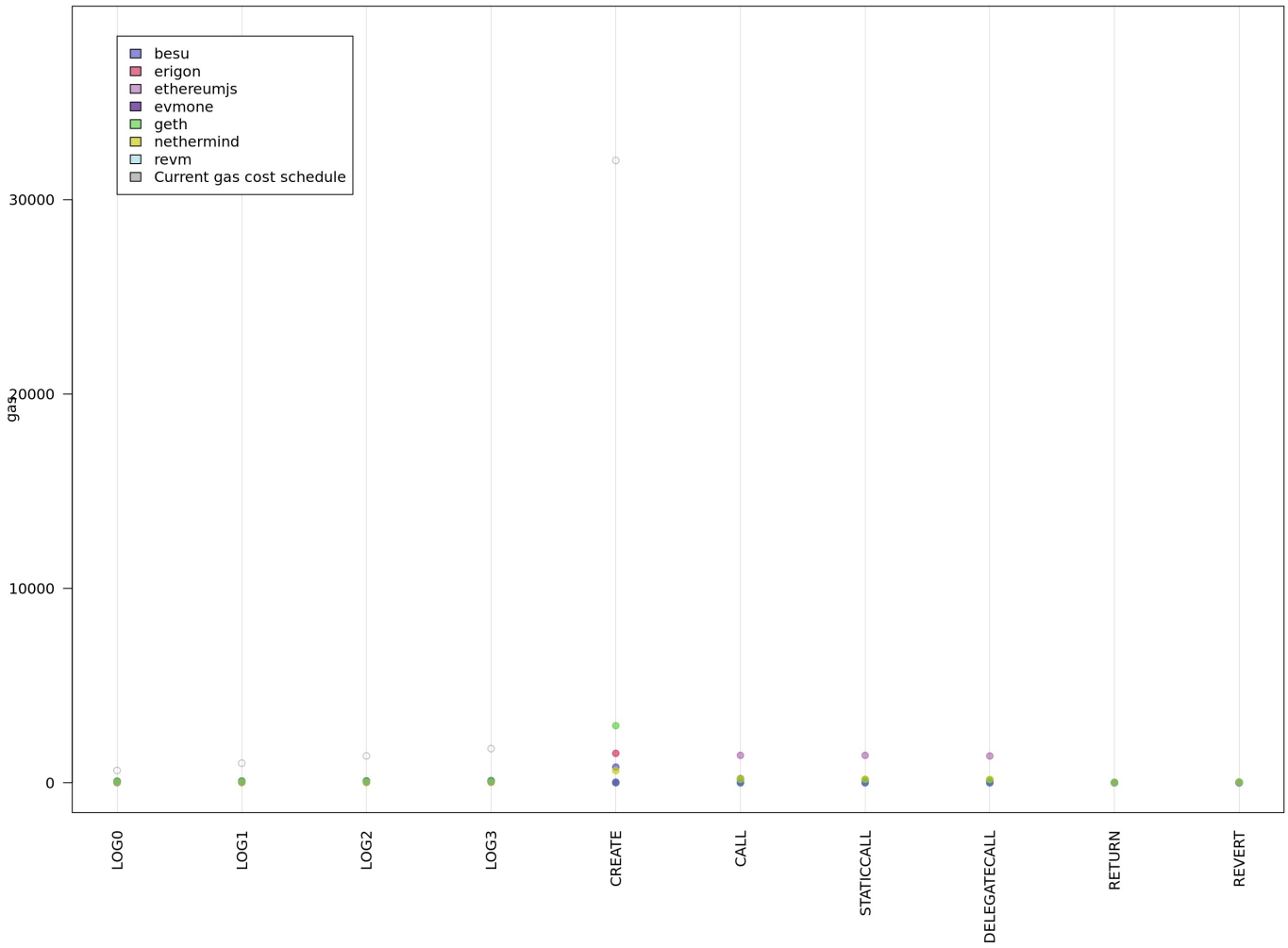
Plot the scaled gas cost schedules.

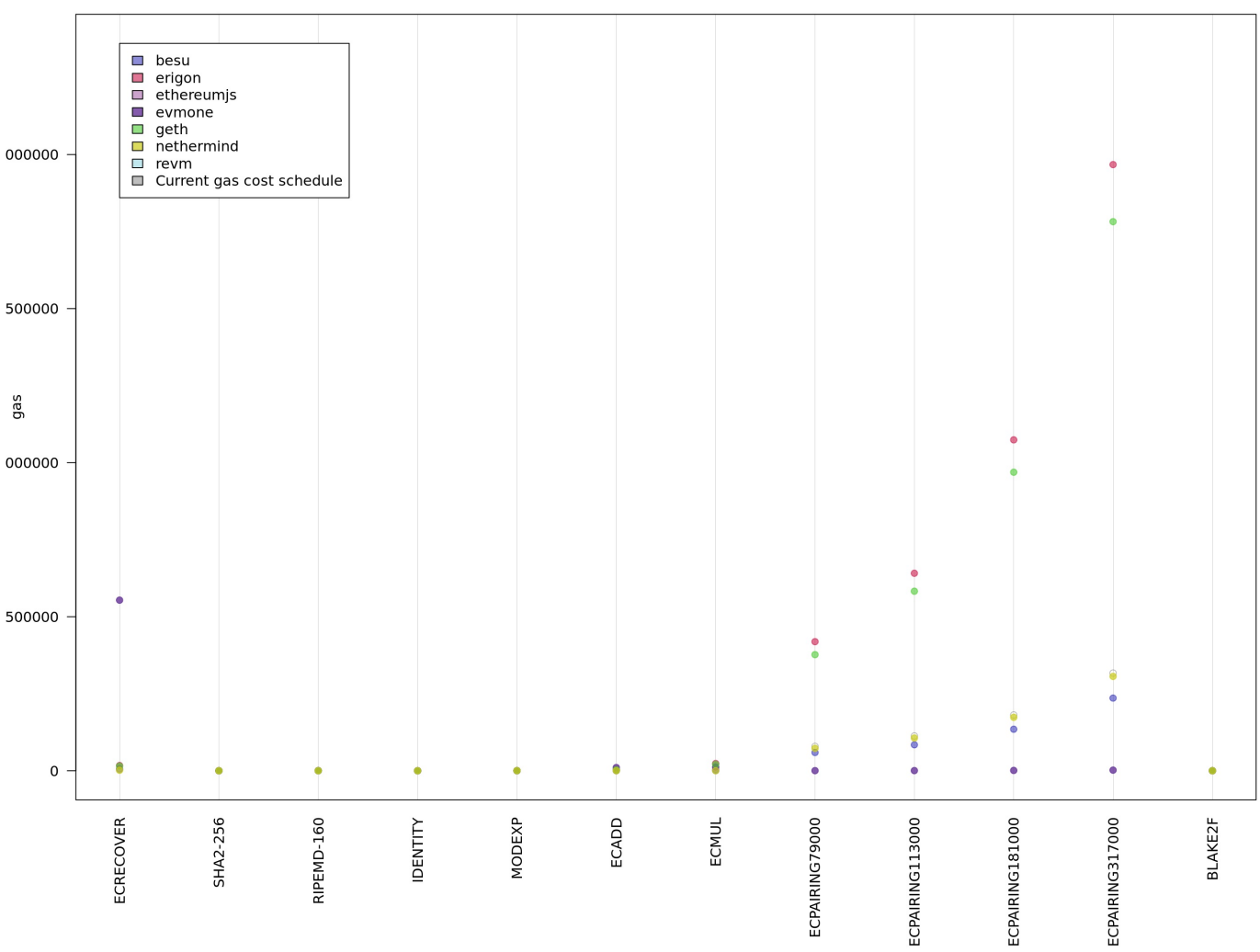
```
for (g in 0:max_groups) {
  groups_opcode <- current_gas_cost[which(current_gas_cost$groups == g), "opcode"]
  if (length(groups_opcode) == 0) {
    next
  }
  grups_gas_schedule_comparison <- gas_schedule_comparison[which(gas_schedule_comparison$opcode %in% groups_opcod
e), ]
  if (nrow(grups_gas_schedule_comparison) == 0) {
    next
  }
  maximum_gas_cost = max(grups_gas_schedule_comparison[, c(all_envs_cols, "constant_current_gas")], na.rm=TRUE)
  par(mar=c(10, 4, 4, 2) + 0.1) # default is c(5, 4, 4, 2) + 0.1
  plot(grups_gas_schedule_comparison$constant_current_gas, col='grey', xaxt='n', ylim=c(0,maximum_gas_cost * 1.2)
, xlab="", ylab="gas", las=2)
  axis(1, at=1:nrow(grups_gas_schedule_comparison), labels=grups_gas_schedule_comparison$opcode, las=2, lwd=0.1,
tck=1)
  for (i in 1:length(all_envs)) {
    points(grups_gas_schedule_comparison[, paste0(all_envs[i], "_gas")], col=env_colors[i], bg=env_colors[i], xax
t='n', pch=21)
  }
  title(main="The scaled gas costs")
  legend(1, maximum_gas_cost * 1.2, c(all_envs, "Current gas cost schedule"), fill=c(env_colors[1:length(all_envs
)], 'grey'), cex=1)
}
```

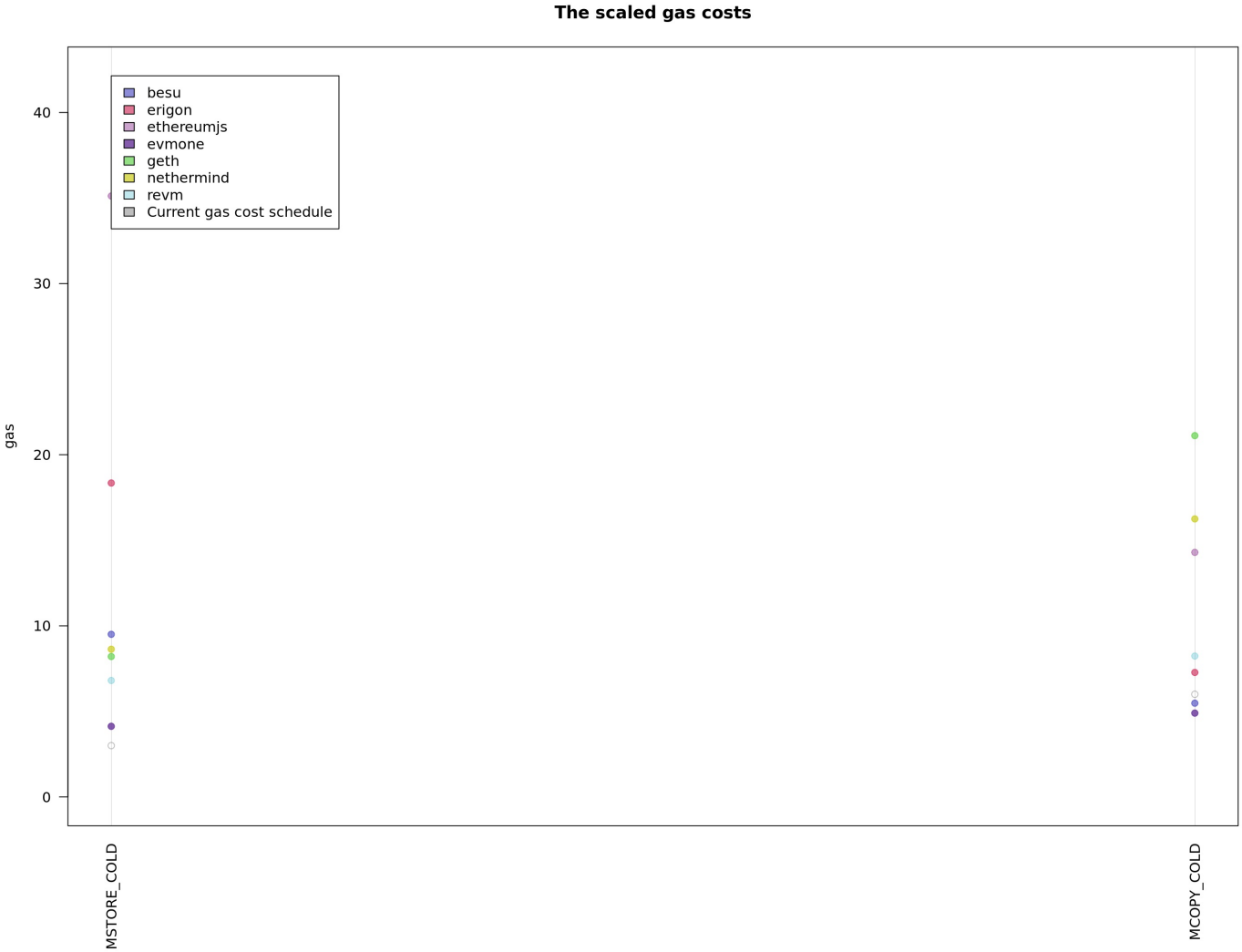

The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
0
10
20
30
40
50
60
ADD
MUL
SUB
DIV
SDIV
MOD
SMOD
ADDMOD
MULMOD
EXP
SIGNEXTEND
LT
GT
SLT
SGT
EQ
ISZERO
AND
OR
XOR
NOT
BYTE
SHL
SHR
SAR
ADDRESS
ORIGIN
CALLER
CALLVALUE
CALLDATALOAD
CALLDATASIZE
CALLDATACOPY
CODESIZE
CODECOPY
GASPRICE
RETURNDATASIZE
RETURNDATACOPY
COINBASE
TIMESTAMP
NUMBER
DIFFICULTY
GASLIMIT
CHAINID
SELFBALANCE
POP
MLOAD
MSTORE
MSTORE8
JUMP
JUMPI
PC
MSIZE
GAS
JUMPDEST
PUSH1
DUP1
SWAP1
MCOPY
PUSH0

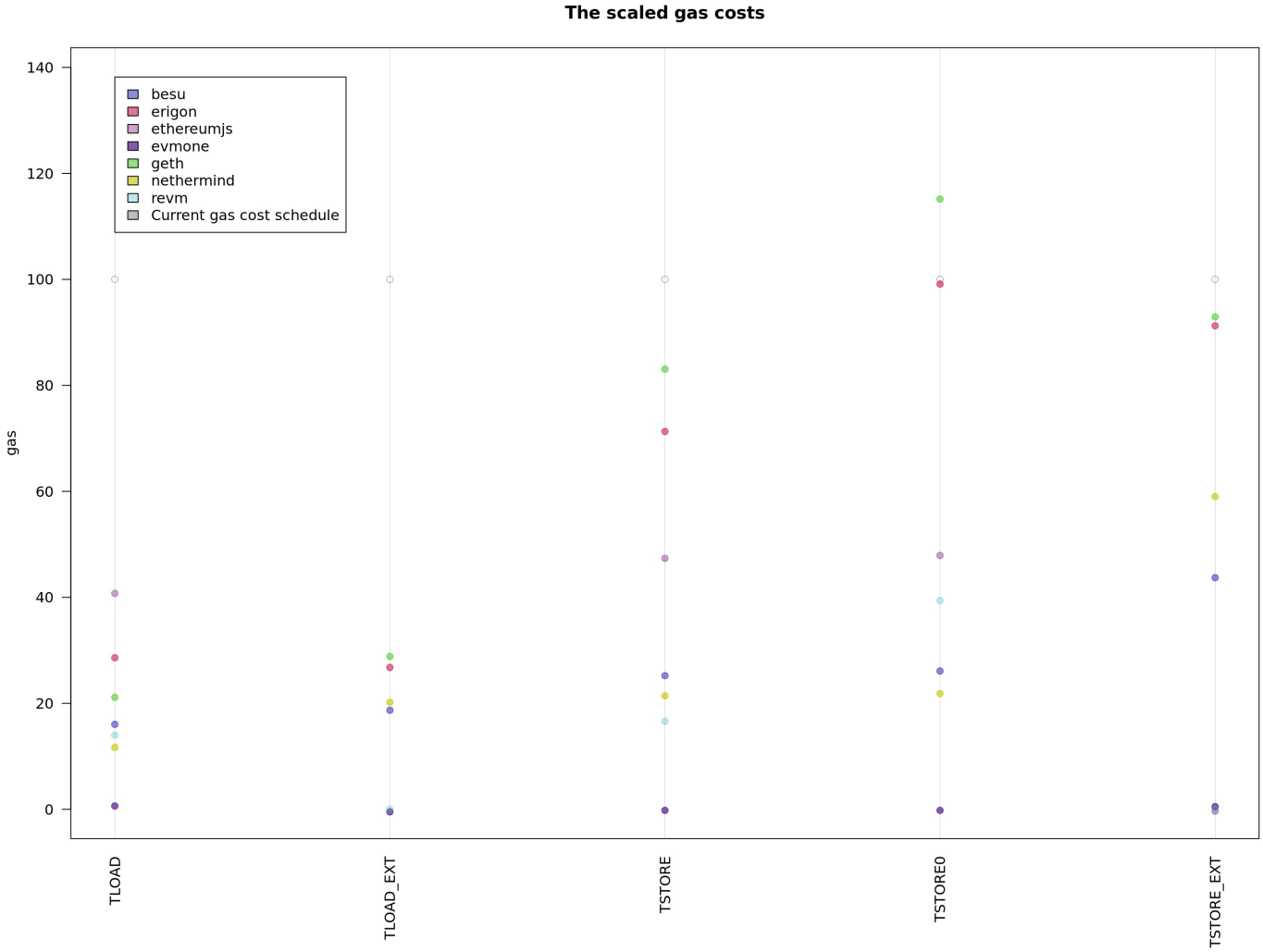

The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
0
50
100
150
200
250
300
KECCAK256
EXTCODEHASH
EXTCODESIZE
EXTCODECOPY

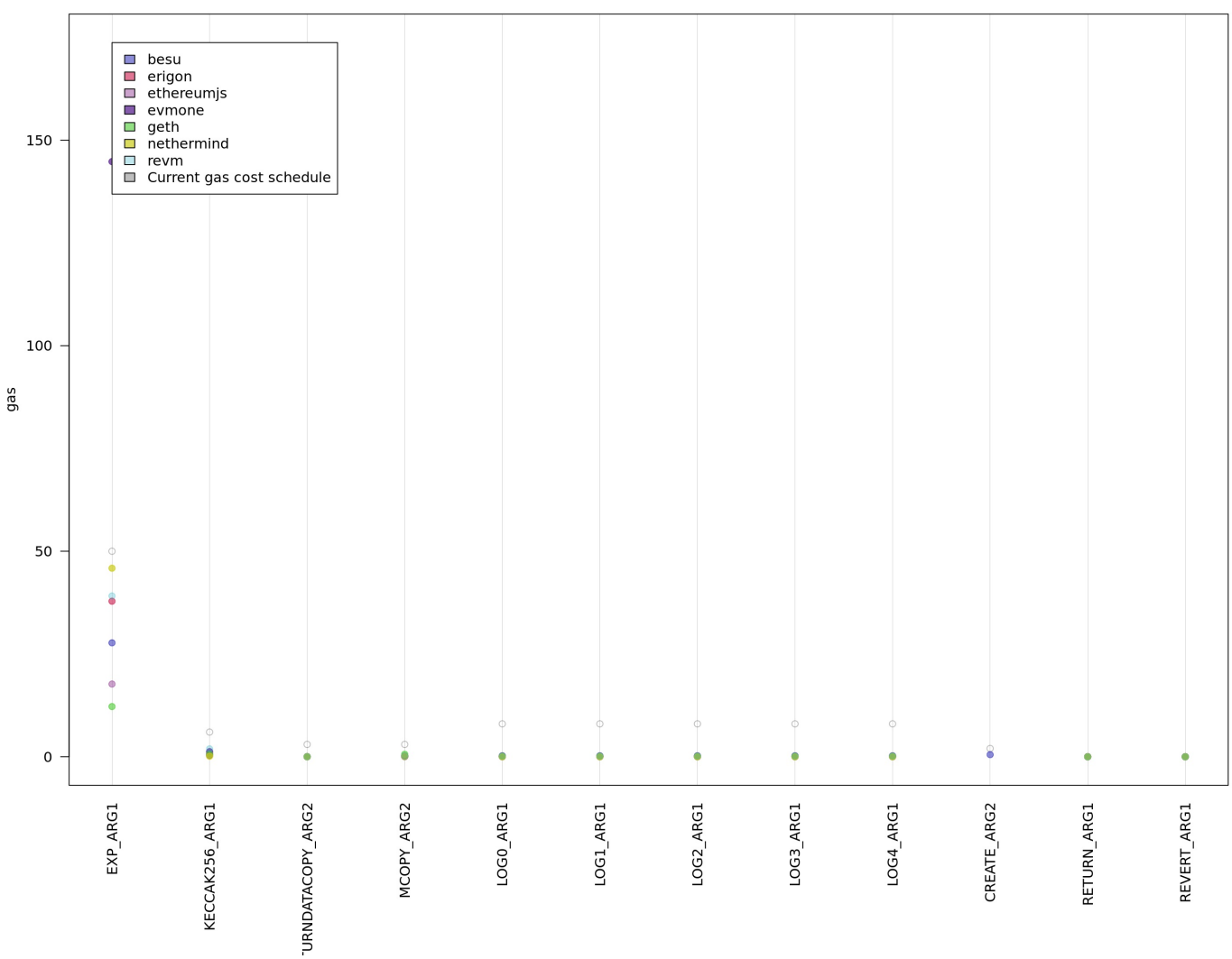

The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
0
5
10
15
PUSH2
PUSH3
PUSH4
PUSH5
PUSH6
PUSH7
PUSH8
PUSH9
PUSH10
PUSH11
PUSH12
PUSH13
PUSH14
PUSH15
PUSH16
PUSH17
PUSH18
PUSH19
PUSH20
PUSH21
PUSH22
PUSH23
PUSH24
PUSH25
PUSH26
PUSH27
PUSH28
PUSH29
PUSH30
PUSH31
PUSH32
DUP2
DUP3
DUP4
DUP5
DUP6
DUP7
DUP8
DUP9
DUP10
DUP11
DUP12
DUP13
DUP14
DUP15
DUP16
SWAP2
SWAP3
SWAP4
SWAP5
SWAP6
SWAP7
SWAP8
SWAP9
SWAP10
SWAP11
SWAP12
SWAP13
SWAP14
SWAP15
SWAP16

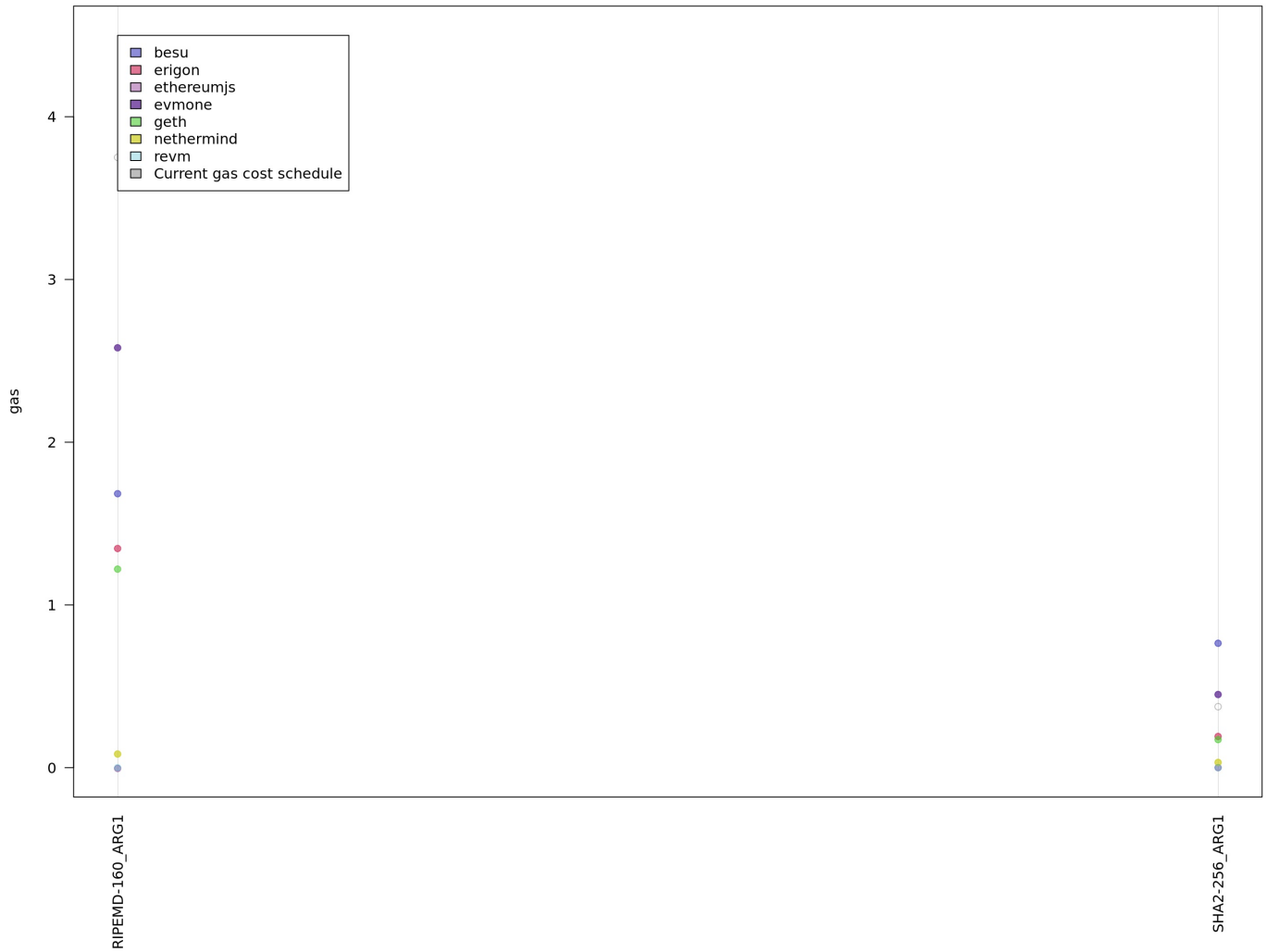

The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
30000
20000
10000
0
LOG0
LOG1
LOG2
LOG3
CREATE
CALL
STATICCALL
DELEGATECALL
RETURN
REVERT


The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
000000
500000
gas
000000
500000
0
ECRECOVER
SHA2-256
RIPEMD-160
IDENTITY
MODEXP
ECADD
ECMUL
ECPAIRING79000
ECPAIRING113000
ECPAIRING181000
ECPAIRING317000
BLAKE2F


The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
0
10
20
30
40
MSTORE_COLD
MCOPY_COLD


The scaled gas costs
gas
140
120
100
80
60
40
20
0
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
TLOAD
TLOAD_EXT
TSTORE
TSTORE0
TSTORE_EXT


The scaled gas costs
besu
erigon
ethereumjs
evmone
geth
nethermind
revm
Current gas cost schedule
gas
150
100
50
0
EXP_ARG1
KECCAK256_ARG1
URNDATACOPY_ARG2
MCOPY_ARG2
LOG0_ARG1
LOG1_ARG1
LOG2_ARG1
LOG3_ARG1
LOG4_ARG1
CREATE_ARG2
RETURN_ARG1
REVERT_ARG1



Calculate and plot the alternative gas cost schedule. The calculated values are:

- alternative_gas: the average of evms gas schedules, without any weights,
- alternative_gas_stderr: the standard deviation of evms gas schedules,
- alternative_gas_rel_diff: the relative difference between the current gas schedule and the alternative gas schedule, as a fraction,
- alternative_gas_rel_stderr: the relative standard deviation of evms gas schedules, relative to the alternative gas schedule, as a fraction.

```
gas_schedule_comparison[, c('opcode', 'constant_current_gas', 'alternative_gas', 'alternative_gas_stderr', 'alter
native_gas_rel_diff', 'alternative_gas_rel_stderr')]
```

```
##                 opcode constant_current_gas alternative_gas
## 1                  ADD            3.000e+00    2.224481e+00
## 2                  MUL            5.000e+00    5.148461e+00
## 3                  SUB            3.000e+00    2.681923e+00
## 4                  DIV            5.000e+00    4.034828e+00
## 5                 SDIV            5.000e+00    6.659054e+00
## 6                  MOD            5.000e+00    4.443201e+00
## 7                 SMOD            5.000e+00    7.059396e+00
## 8               ADDMOD            8.000e+00    8.116796e+00
## 9               MULMOD            8.000e+00    1.391602e+01
## 10                 EXP            1.000e+01    2.658449e+01
## 11          SIGNEXTEND            5.000e+00    5.246848e+00
## 12                  LT            3.000e+00    2.252492e+00
## 13                  GT            3.000e+00    2.610156e+00
## 14                 SLT            3.000e+00    3.000000e+00
## 15                 SGT            3.000e+00    3.148324e+00
## 16                  EQ            3.000e+00    2.625022e+00
## 17              ISZERO            3.000e+00    1.704212e+00
## 18                 AND            3.000e+00    2.461954e+00
## 19                  OR            3.000e+00    2.774879e+00
## 20                 XOR            3.000e+00    2.744515e+00
## 21                 NOT            3.000e+00    1.979485e+00
## 22                BYTE            3.000e+00    2.820659e+00
## 23                 SHL            3.000e+00    5.630425e+00
## 24                 SHR            3.000e+00    4.004473e+00
## 25                 SAR            3.000e+00    6.542702e+00
## 26             ADDRESS            2.000e+00    5.274908e+00
```

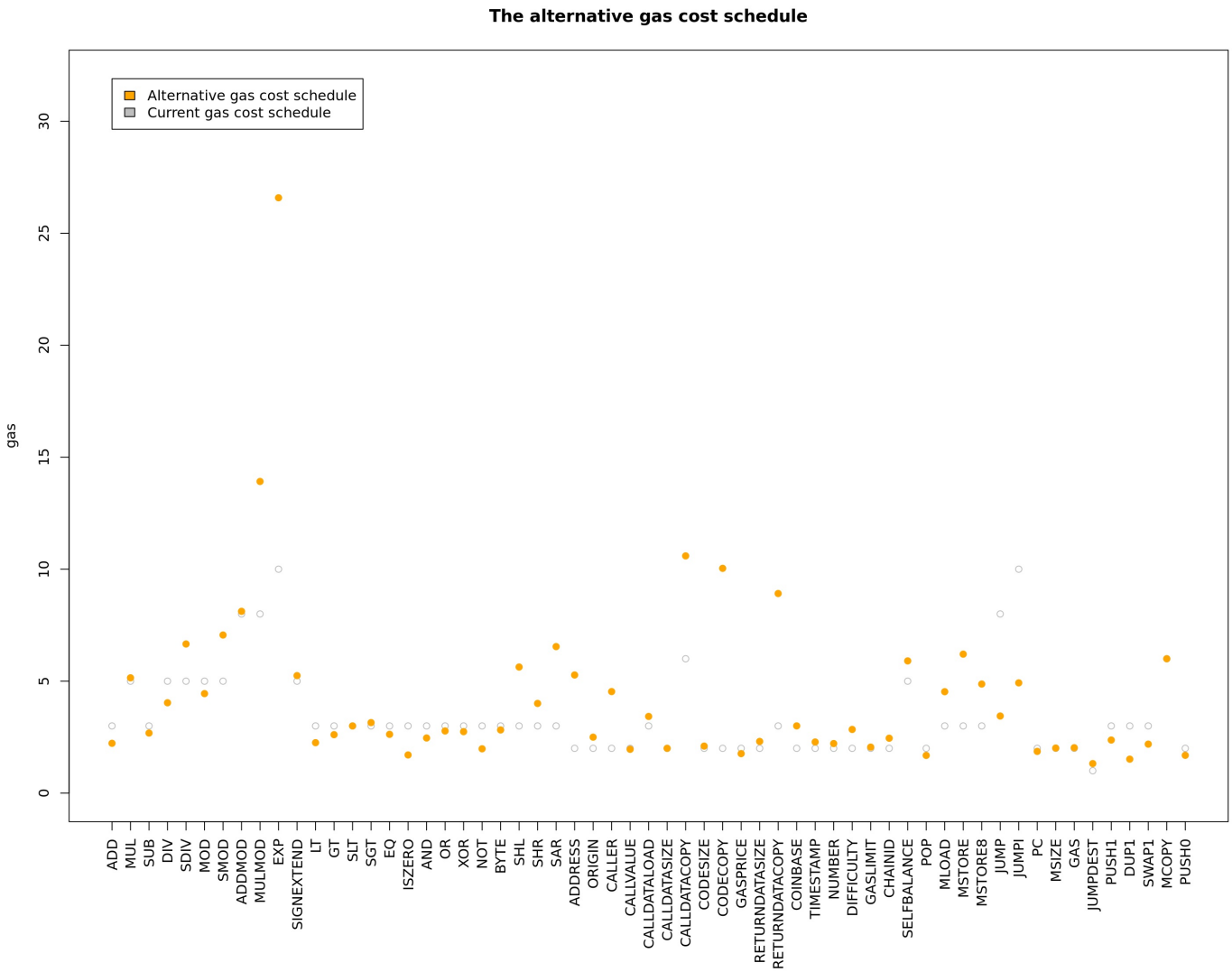
```
## 27              ORIGIN           2.000e+00    2.498470e+00
## 28              CALLER           2.000e+00    4.534461e+00
## 29           CALLVALUE           2.000e+00    1.956654e+00
## 30        CALLDATALOAD           3.000e+00    3.424028e+00
## 31        CALLDATASIZE           2.000e+00    2.000000e+00
## 32        CALLDATACOPY           6.000e+00    1.059284e+01
## 33            CODESIZE           2.000e+00    2.100414e+00
## 34            CODECOPY           2.000e+00    1.003680e+01
## 35            GASPRICE           2.000e+00    1.763490e+00
## 36      RETURNDATASIZE           2.000e+00    2.307849e+00
## 37      RETURNDATACOPY           3.000e+00    8.912552e+00
## 38            COINBASE           2.000e+00    3.002339e+00
## 39           TIMESTAMP           2.000e+00    2.282221e+00
## 40              NUMBER           2.000e+00    2.213386e+00
## 41          DIFFICULTY           2.000e+00    2.843432e+00
## 42            GASLIMIT           2.000e+00    2.054182e+00
## 43             CHAINID           2.000e+00    2.452061e+00
## 44         SELFBALANCE           5.000e+00    5.904110e+00
## 45                 POP           2.000e+00    1.683554e+00
## 46               MLOAD           3.000e+00    4.529077e+00
## 47              MSTORE           3.000e+00    6.205507e+00
## 48         MSTORE_COLD           3.000e+00    8.633141e+00
## 49             MSTORE8           3.000e+00    4.871218e+00
## 56                JUMP           8.000e+00    3.443185e+00
## 57               JUMPI           1.000e+01    4.923115e+00
## 58                  PC           2.000e+00    1.862876e+00
## 59               MSIZE           2.000e+00    2.012966e+00
## 60                 GAS           2.000e+00    2.027713e+00
## 61            JUMPDEST           1.000e+00    1.319073e+00
## 62               PUSH1           3.000e+00    2.370704e+00
## 63               PUSH2           3.000e+00    2.812686e+00
## 64               PUSH3           3.000e+00    2.873725e+00
## 65               PUSH4           3.000e+00    3.295925e+00
## 66               PUSH5           3.000e+00    3.608782e+00
## 67               PUSH6           3.000e+00    3.705978e+00
## 68               PUSH7           3.000e+00    3.836112e+00
## 69               PUSH8           3.000e+00    3.516063e+00
## 70               PUSH9           3.000e+00    3.601943e+00
## 71              PUSH10           3.000e+00    3.341602e+00
## 72              PUSH11           3.000e+00    3.119154e+00
## 73              PUSH12           3.000e+00    3.472017e+00
## 74              PUSH13           3.000e+00    3.419276e+00
## 75              PUSH14           3.000e+00    3.765758e+00
## 76              PUSH15           3.000e+00    3.645384e+00
## 77              PUSH16           3.000e+00    3.226922e+00
## 78              PUSH17           3.000e+00    3.919073e+00
## 79              PUSH18           3.000e+00    3.568524e+00
## 80              PUSH19           3.000e+00    3.894266e+00
## 81              PUSH20           3.000e+00    3.946374e+00
## 82              PUSH21           3.000e+00    4.037430e+00
## 83              PUSH22           3.000e+00    3.954860e+00
## 84              PUSH23           3.000e+00    3.989833e+00
## 85              PUSH24           3.000e+00    3.818219e+00
## 86              PUSH25           3.000e+00    3.429443e+00
## 87              PUSH26           3.000e+00    3.912973e+00
## 88              PUSH27           3.000e+00    3.731598e+00
## 89              PUSH28           3.000e+00    4.020333e+00
## 90              PUSH29           3.000e+00    4.067507e+00
## 91              PUSH30           3.000e+00    4.072794e+00
## 92              PUSH31           3.000e+00    4.432608e+00
## 93              PUSH32           3.000e+00    4.032534e+00
## 94                DUP1           3.000e+00    1.516703e+00
## 95                DUP2           3.000e+00    2.005198e+00
## 96                DUP3           3.000e+00    1.846935e+00
## 97                DUP4           3.000e+00    1.513715e+00
## 98                DUP5           3.000e+00    1.819687e+00
## 99                DUP6           3.000e+00    1.683373e+00
## 100               DUP7           3.000e+00    1.722994e+00
## 101               DUP8           3.000e+00    1.920081e+00
## 102               DUP9           3.000e+00    1.952591e+00
## 103              DUP10           3.000e+00    1.873349e+00
## 104              DUP11           3.000e+00    1.710803e+00
## 105              DUP12           3.000e+00    1.971893e+00
## 106              DUP13           3.000e+00    1.646604e+00
## 107              DUP14           3.000e+00    1.626271e+00
## 108              DUP15           3.000e+00    1.852015e+00
## 109              DUP16           3.000e+00    1.831697e+00
## 110              SWAP1           3.000e+00    2.187068e+00
## 111              SWAP2           3.000e+00    2.342822e+00
```

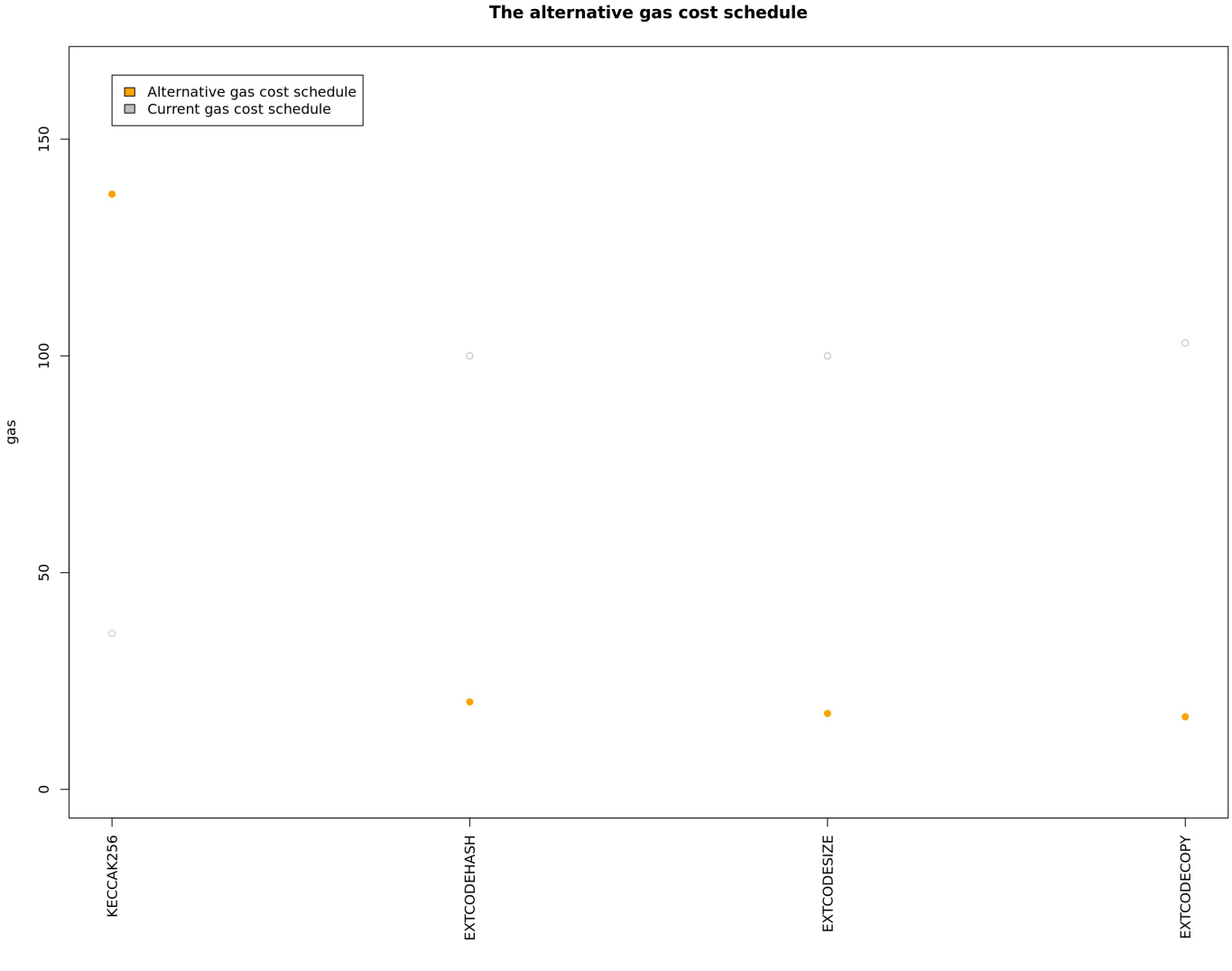
```
## 112              SWAP3           3.000e+00    2.366816e+00
## 113              SWAP4           3.000e+00    2.514030e+00
## 114              SWAP5           3.000e+00    2.186255e+00
## 115              SWAP6           3.000e+00    2.304481e+00
## 116              SWAP7           3.000e+00    2.587538e+00
## 117              SWAP8           3.000e+00    2.328595e+00
## 118              SWAP9           3.000e+00    2.531517e+00
## 119             SWAP10           3.000e+00    2.515408e+00
## 120             SWAP11           3.000e+00    2.024474e+00
## 121             SWAP12           3.000e+00    2.450183e+00
## 122             SWAP13           3.000e+00    2.611631e+00
## 123             SWAP14           3.000e+00    2.308800e+00
## 124             SWAP15           3.000e+00    2.384740e+00
## 125             SWAP16           3.000e+00    2.399594e+00
## 126              MCOPY           6.000e+00    6.000000e+00
## 127         MCOPY_COLD           6.000e+00    8.235015e+00
## 128              PUSH0           2.000e+00    1.688085e+00
## 129          KECCAK256           3.600e+01    1.373038e+02
## 130               LOG0           6.310e+02    3.512428e+01
## 131               LOG1           1.006e+03    5.779953e+01
## 132               LOG2           1.381e+03    5.977770e+01
## 133               LOG3           1.756e+03    6.671362e+01
## 134         EXTCODEHASH           1.000e+02    2.017753e+01
## 135         EXTCODESIZE           1.000e+02    1.752278e+01
## 136         EXTCODECOPY           1.030e+02    1.674984e+01
## 137             CREATE            3.202e+04    6.219212e+02
## 138               CALL            1.000e+02    1.755527e+02
## 139          STATICCALL           1.000e+02    1.525280e+02
## 140        DELEGATECALL           1.000e+02    1.337964e+02
## 141             RETURN            0.000e+00    5.768244e+00
## 142             REVERT            0.000e+00    2.496527e+01
## 143          ECRECOVER            3.100e+03    1.514192e+04
## 144            SHA2-256           1.720e+02    1.356653e+02
## 145          RIPEMD-160           8.200e+02    2.810513e+02
## 146            IDENTITY           1.180e+02    1.111582e+02
## 147              MODEXP           3.000e+02    3.264944e+02
## 148               ECADD           2.500e+02    3.239290e+03
## 149               ECMUL           6.100e+03    1.231746e+04
## 150      ECPAIRING79000           7.910e+04    7.281024e+04
## 151     ECPAIRING113000           1.131e+05    1.063866e+05
## 152     ECPAIRING181000           1.811e+05    1.735205e+05
## 153     ECPAIRING317000           3.171e+05    3.063528e+05
## 154             BLAKE2F           1.120e+02    1.725466e+02
## 155               TLOAD           1.000e+02    1.603469e+01
## 156           TLOAD_EXT           1.000e+02    1.869486e+01
## 157              TSTORE           1.000e+02    2.522515e+01
## 158             TSTORE0           1.000e+02    3.936878e+01
## 159          TSTORE_EXT           1.000e+02    4.371818e+01
## 160             EXP_ARG1          5.000e+01    3.783709e+01
## 161      KECCAK256_ARG1           6.000e+00    6.268706e-01
## 165 RETURNDATACOPY_ARG2           3.000e+00    5.191164e-03
## 166          MCOPY_ARG2           3.000e+00    1.301574e-01
## 167            LOG0_ARG1          8.000e+00    8.771081e-02
## 168            LOG1_ARG1          8.000e+00    8.640516e-02
## 169            LOG2_ARG1          8.000e+00    8.742280e-02
## 170            LOG3_ARG1          8.000e+00    8.677593e-02
## 171            LOG4_ARG1          8.000e+00    8.818493e-02
## 172         CREATE_ARG2           2.000e+00    5.069205e-01
## 173         RETURN_ARG1           0.000e+00    8.161624e-07
## 175         REVERT_ARG1           0.000e+00   -2.120710e-06
## 176     RIPEMD-160_ARG1           3.750e+00    1.220260e+00
## 177       SHA2-256_ARG1           3.750e-01    1.725744e-01
##     alternative_gas_stderr alternative_gas_rel_diff alternative_gas_rel_stderr
## 1             4.438226e+00             2.585062e-01                  1.9951733
## 2             2.780016e+00             2.969228e-02                  0.5399703
## 3             9.911581e-01             1.060257e-01                  0.3695699
## 4             1.947905e+00             1.930344e-01                  0.4827728
## 5             2.960854e+00             3.318108e-01                  0.4446359
## 6             3.649350e+00             1.113597e-01                  0.8213335
## 7             4.222129e+00             4.118792e-01                  0.5980864
## 8             7.344995e+00             1.459946e-02                  0.9049132
## 9             7.587887e+00             7.395022e-01                  0.5452628
## 10            1.146377e+01             1.658449e+00                  0.4312201
## 11            2.445107e+00             4.936966e-02                  0.4660143
## 12            4.813709e-01             2.491692e-01                  0.2137059
## 13            4.724804e-01             1.299481e-01                  0.1810162
## 14            8.906973e-01             4.440892e-16                  0.2968991
## 15            7.519345e-01             4.944125e-02                  0.2388365
## 16            5.238975e-01             1.249927e-01                  0.1995783
```

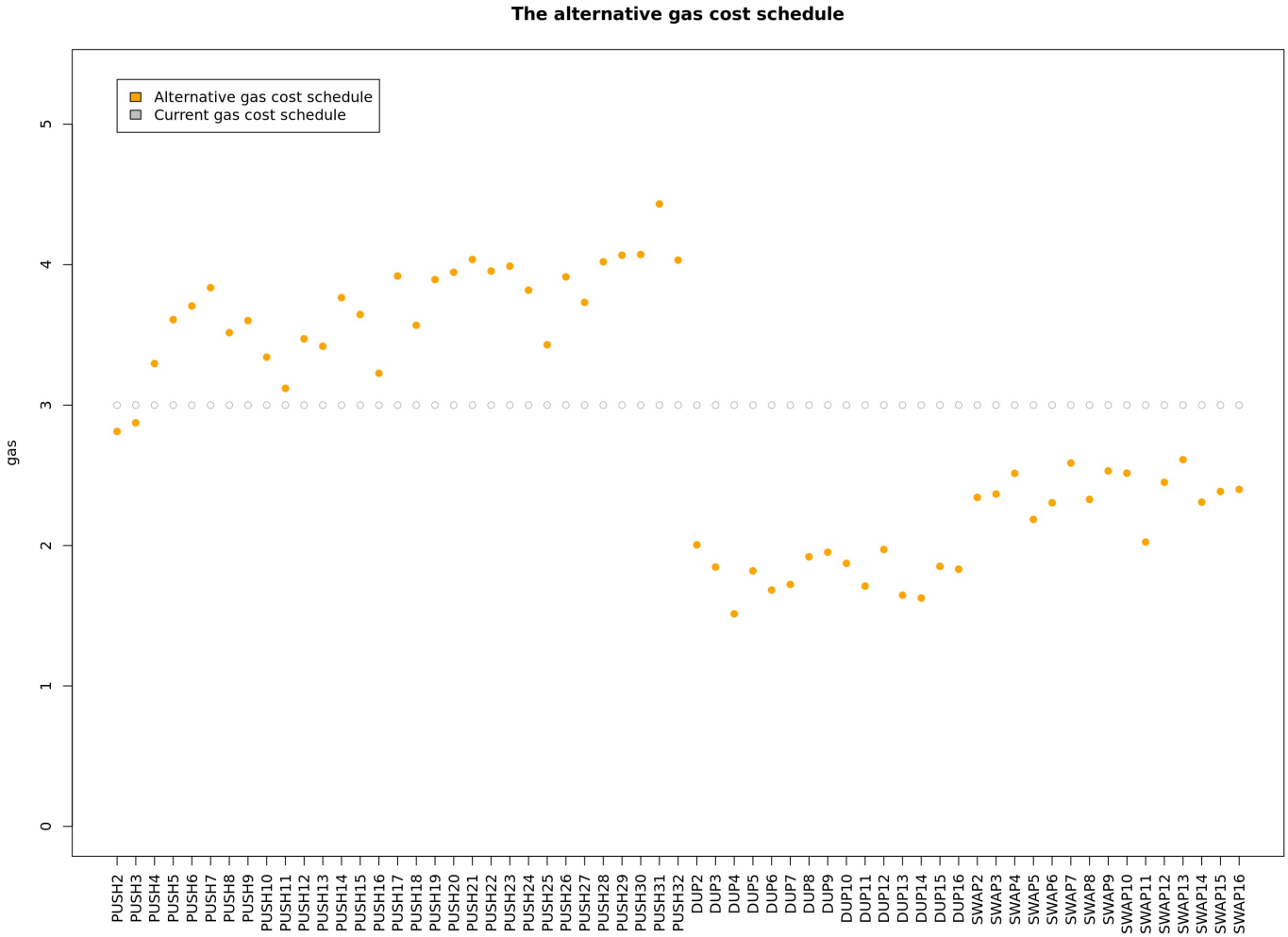
```
## 17          3.797938e-01          4.319293e-01          0.2228559
## 18          7.842015e-01          1.793485e-01          0.3185280
## 19          8.115675e-01          7.504049e-02          0.2924696
## 20          8.506686e-01          8.516168e-02          0.3099522
## 21          1.490732e+00          3.401716e-01          0.7530909
## 22          6.883226e-01          5.978040e-02          0.2440290
## 23          2.416604e+00          8.768084e-01          0.4292046
## 24          1.784386e+00          3.348245e-01          0.4455981
## 25          2.368550e+00          1.180901e+00          0.3620140
## 26          3.138926e+00          1.637454e+00          0.5950674
## 27          5.100041e+00          2.492352e-01          2.0412653
## 28          2.778531e+00          1.267231e+00          0.6127588
## 29          1.265265e+00          2.167288e-02          0.6466470
## 30          3.486013e+00          1.413426e-01          1.0181030
## 31          5.889085e-01          0.000000e+00          0.2944542
## 32          3.871877e+00          7.654737e-01          0.3655182
## 33          5.281308e-01          5.020695e-02          0.2514413
## 34          1.950757e+00          4.018402e+00          0.1943604
## 35          3.803433e+00          1.182548e-01          2.1567642
## 36          7.208731e-01          1.539244e-01          0.3123572
## 37          6.449839e+00          1.970851e+00          0.7236803
## 38          5.304848e+00          5.011697e-01          1.7669050
## 39          2.571696e+00          1.411103e-01          1.1268392
## 40          2.522832e+00          1.066929e-01          1.1398069
## 41          4.702278e+00          4.217161e-01          1.6537329
## 42          2.511810e+00          2.709109e-02          1.2227787
## 43          3.888510e+00          2.260306e-01          1.5858129
## 44          3.576233e+00          1.808221e-01          0.6057192
## 45          5.362589e-01          1.582231e-01          0.3185279
## 46          2.276769e+00          5.096923e-01          0.5027004
## 47          6.196184e+00          1.068502e+00          0.9984977
## 48          6.261671e+00          1.877714e+00          0.7253062
## 49          1.633809e+00          6.237393e-01          0.3354004
## 56          1.989195e+00          5.696018e-01          0.5777195
## 57          2.798728e+00          5.076885e-01          0.5684872
## 58          5.180672e-01          6.856217e-02          0.2781008
## 59          5.249018e-01          6.482984e-03          0.2607604
## 60          5.065157e-01          1.385640e-02          0.2497966
## 61          4.300288e-01          3.190727e-01          0.3260084
## 62          4.809724e-01          2.097655e-01          0.2028817
## 63          8.555448e-01          6.243806e-02          0.3041736
## 64          1.006930e+00          4.209176e-02          0.3503918
## 65          9.907886e-01          9.864164e-02          0.3006102
## 66          1.084704e+00          2.029272e-01          0.3005736
## 67          1.131450e+00          2.353260e-01          0.3053041
## 68          1.161625e+00          2.787041e-01          0.3028130
## 69          1.266160e+00          1.720211e-01          0.3601072
## 70          1.400120e+00          2.006478e-01          0.3887125
## 71          1.645887e+00          1.138674e-01          0.4925442
## 72          1.428994e+00          3.971804e-02          0.4581352
## 73          1.490783e+00          1.573391e-01          0.4293708
## 74          1.632878e+00          1.397587e-01          0.4775507
## 75          1.632747e+00          2.552528e-01          0.4335771
## 76          1.784079e+00          2.151281e-01          0.4894076
## 77          1.890061e+00          7.564050e-02          0.5857165
## 78          1.922578e+00          3.063576e-01          0.4905695
## 79          1.975380e+00          1.895079e-01          0.5535565
## 80          2.033268e+00          2.980887e-01          0.5221185
## 81          2.098064e+00          3.154580e-01          0.5316436
## 82          2.229737e+00          3.458101e-01          0.5522664
## 83          2.328253e+00          3.182866e-01          0.5887068
## 84          2.475462e+00          3.299444e-01          0.6204425
## 85          2.458614e+00          2.727396e-01          0.6439165
## 86          2.411502e+00          1.431476e-01          0.7031761
## 87          2.595201e+00          3.043243e-01          0.6632299
## 88          2.652861e+00          2.438661e-01          0.7109181
## 89          2.647790e+00          3.401112e-01          0.6585996
## 90          2.805627e+00          3.558357e-01          0.6897657
## 91          2.954046e+00          3.575979e-01          0.7253121
## 92          3.059576e+00          4.775358e-01          0.6902429
## 93          3.102472e+00          3.441779e-01          0.7693605
## 94          4.596531e-01          4.944325e-01          0.3030608
## 95          4.909007e-01          3.316006e-01          0.2448140
## 96          5.297911e-01          3.843549e-01          0.2868488
## 97          4.115375e-01          4.954284e-01          0.2718725
## 98          3.453239e-01          3.934377e-01          0.1897711
## 99          4.331139e-01          4.388757e-01          0.2572894
## 100         4.665318e-01          4.256688e-01          0.2707682
## 101         5.782839e-01          3.599729e-01          0.3011768
```

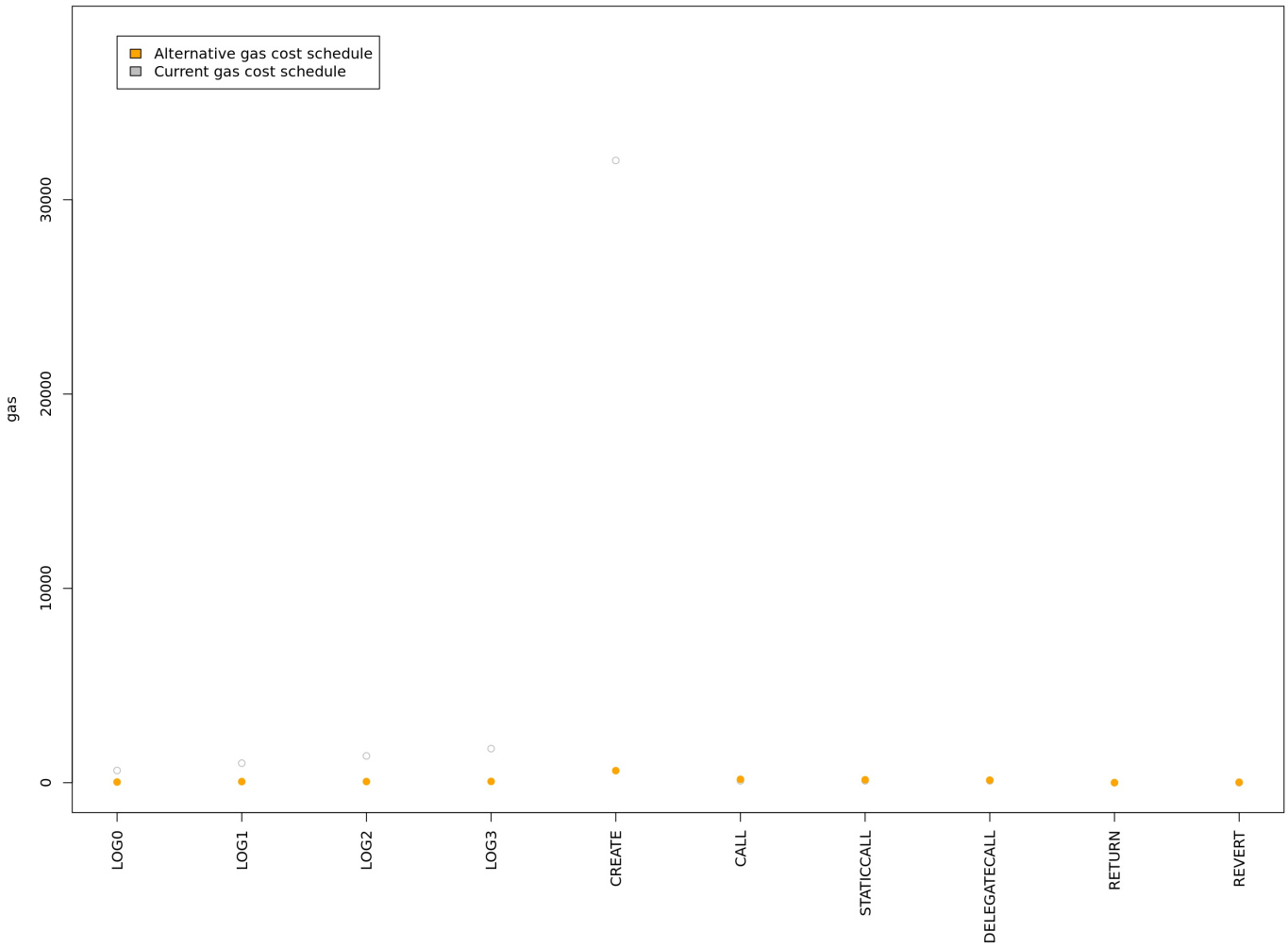
```
## 102          4.292470e-01            3.491365e-01                0.2198346
## 103          4.625303e-01            3.755503e-01                0.2469002
## 104          6.452133e-01            4.297325e-01                0.3771407
## 105          5.491609e-01            3.427023e-01                0.2784943
## 106          4.126665e-01            4.511319e-01                0.2506167
## 107          4.706231e-01            4.579097e-01                0.2893879
## 108          3.873034e-01            3.826617e-01                0.2091254
## 109          6.176864e-01            3.894345e-01                0.3372209
## 110          6.342883e-01            2.709774e-01                0.2900177
## 111          6.323145e-01            2.190592e-01                0.2698944
## 112          6.478657e-01            2.110614e-01                0.2737288
## 113          6.774500e-01            1.619900e-01                0.2694677
## 114          6.088169e-01            2.712485e-01                0.2784748
## 115          5.842775e-01            2.318397e-01                0.2535398
## 116          6.238938e-01            1.374873e-01                0.2411148
## 117          6.835751e-01            2.238018e-01                0.2935569
## 118          1.026649e+00            1.561610e-01                0.4055468
## 119          7.169560e-01            1.615306e-01                0.2850257
## 120          5.657590e-01            3.251755e-01                0.2794598
## 121          6.294918e-01            1.832723e-01                0.2569162
## 122          5.966196e-01            1.294564e-01                0.2284471
## 123          6.009470e-01            2.304001e-01                0.2602855
## 124          5.462245e-01            2.050867e-01                0.2290499
## 125          5.781257e-01            2.001355e-01                0.2409265
## 126          2.692929e+00            5.921189e-16                0.4488216
## 127          4.857376e+00            3.725025e-01                0.5898442
## 128          4.030664e-01            1.559577e-01                0.2387714
## 129          5.782185e+01            2.813994e+00                0.4211235
## 130          2.875273e+01            9.443355e-01                0.8186000
## 131          2.648605e+01            9.425452e-01                0.4582400
## 132          2.712447e+01            9.567142e-01                0.4537556
## 133          2.998001e+01            9.620082e-01                0.4493837
## 134          1.174308e+01            7.982247e-01                0.5819880
## 135          9.322896e+00            8.247722e-01                0.5320444
## 136          1.350800e+01            8.373802e-01                0.8064554
## 137          7.443757e+02            9.805771e-01                1.1968971
## 138          2.346030e+02            7.555266e-01                1.3363680
## 139          2.291871e+02            5.252795e-01                1.5025906
## 140          2.250690e+02            3.379636e-01                1.6821761
## 141          5.026065e+00                     Inf                0.8713337
## 142          1.296398e+01                     Inf                0.5192807
## 143          1.126091e+05            3.884489e+00                7.4369128
## 144          4.202497e+01            2.112482e-01                0.3097694
## 145          3.028587e+01            6.572545e-01                0.1077592
## 146          3.341887e+01            5.798140e-02                0.3006425
## 147          5.990022e+01            8.831459e-02                0.1834648
## 148          2.626063e+03            1.195716e+01                0.8106910
## 149          8.652193e+03            1.019256e+00                0.7024332
## 150          1.472731e+05            7.951656e-02                2.0226973
## 151          2.277651e+05            5.935849e-02                2.1409195
## 152          3.814110e+05            4.185235e-02                2.1980739
## 153          7.022989e+05            3.389215e-02                2.2924513
## 154          3.571478e+01            5.405943e-01                0.2069863
## 155          9.167728e+00            8.396531e-01                0.5717435
## 156          1.233069e+01            8.130514e-01                0.6595764
## 157          2.341475e+01            7.477485e-01                0.9282305
## 158          3.063310e+01            6.063122e-01                0.7781064
## 159          3.472374e+01            5.628182e-01                0.7942631
## 160          2.459600e+01            2.432582e-01                0.6500500
## 161          4.409025e-01            8.955216e-01                0.7033389
## 165          7.867593e-03            9.982696e-01                1.5155739
## 166          1.025982e-01            9.566142e-01                0.7882627
## 167          7.119975e-02            9.890361e-01                0.8117557
## 168          7.121568e-02            9.891994e-01                0.8242063
## 169          7.199854e-02            9.890722e-01                0.8235671
## 170          7.135755e-02            9.891530e-01                0.8223196
## 171          7.178543e-02            9.889769e-01                0.8140329
## 172          0.000000e+00            7.465398e-01                0.0000000
## 173          1.845349e-03                     Inf             2261.0069071
## 175          1.119434e-03                     Inf             -527.8582886
## 176          7.901901e-01            6.745974e-01                0.6475590
## 177          1.961828e-01            5.398017e-01                1.1368015
```

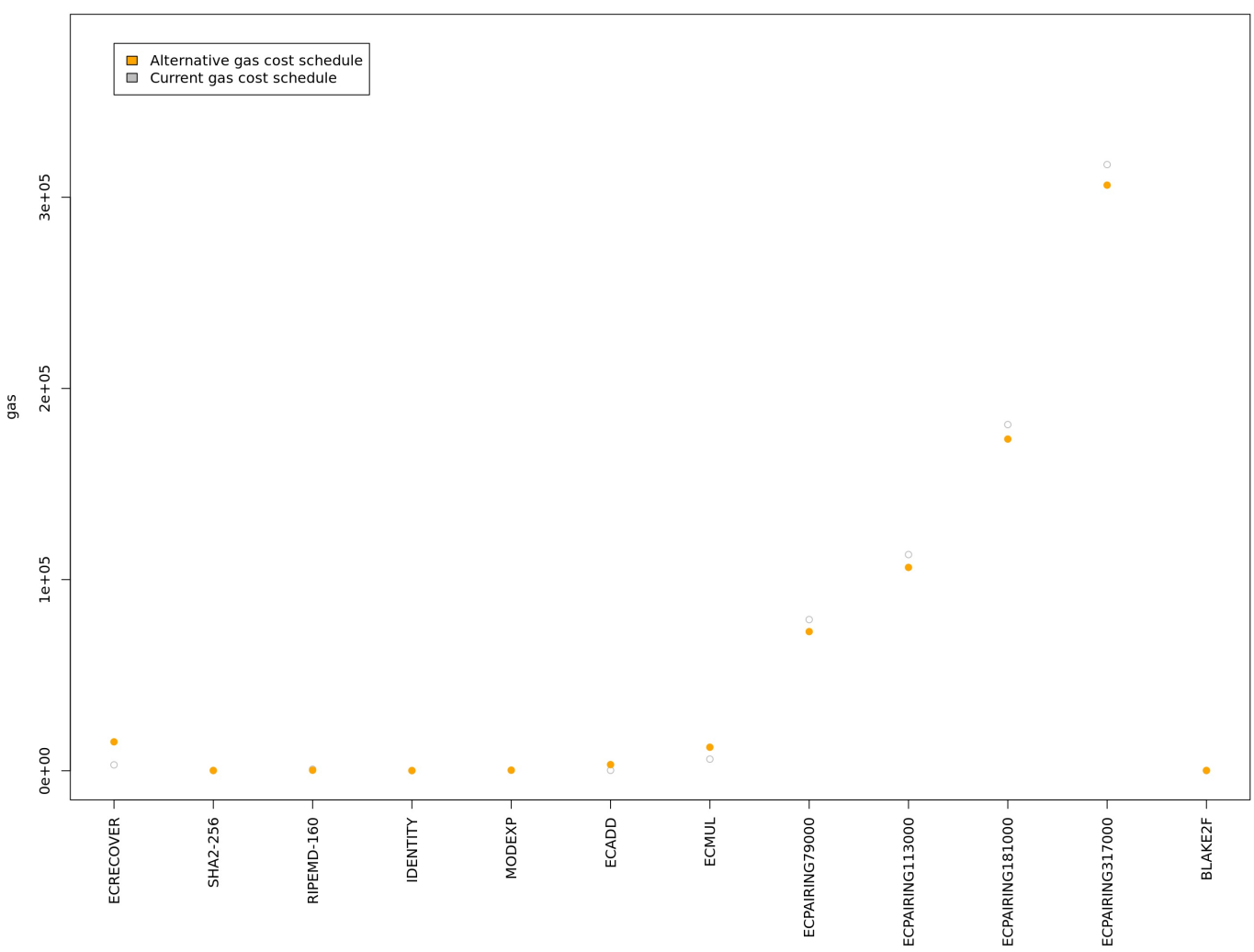
```
for (g in 0:max_groups) {
  groups_opcode <- current_gas_cost[which(current_gas_cost$groups == g), "opcode"]
  if (length(groups_opcode) == 0) {
    next
  }
  grups_gas_schedule_comparison <- gas_schedule_comparison[which(gas_schedule_comparison$opcode %in% groups_opcod
e), c("opcode", "constant_current_gas", "alternative_gas")]
  if (nrow(grups_gas_schedule_comparison) == 0) {
    next
  }
  maximum_gas_cost = max(grups_gas_schedule_comparison[, c("constant_current_gas", "alternative_gas")], na.rm=TRU
E)

  par(mar=c(10, 4, 4, 2) + 0.1) # default is c(5, 4, 4, 2) + 0.1
  plot(grups_gas_schedule_comparison$constant_current_gas, col='grey', xaxt='n', ylim=c(0,maximum_gas_cost * 1.2)
, xlab="", ylab="gas")
  axis(1, at=1:nrow(grups_gas_schedule_comparison), labels=grups_gas_schedule_comparison$opcode, las=2)
  points(grups_gas_schedule_comparison$alternative_gas, col='orange', bg='orange', xaxt='n', pch=21)
  title(main="The alternative gas cost schedule")
  legend(1, maximum_gas_cost * 1.2, c("Alternative gas cost schedule", "Current gas cost schedule"), fill=c('oran
ge', 'grey'), cex=1)
}
```


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
5
10
15
20
25
30
ADD
MUL
SUB
DIV
SDIV
MOD
SMOD
ADDMOD
MULMOD
EXP
SIGNEXTEND
LT
GT
SLT
SGT
EQ
ISZERO
AND
OR
XOR
NOT
BYTE
SHL
SHR
SAR
ADDRESS
ORIGIN
CALLER
CALLVALUE
CALLDATALOAD
CALLDATASIZE
CALLDATACOPY
CODESIZE
CODECOPY
GASPRICE
RETURNDATASIZE
RETURNDATACOPY
COINBASE
TIMESTAMP
NUMBER
DIFFICULTY
GASLIMIT
CHAINID
SELFBALANCE
POP
MLOAD
MSTORE
MSTORE8
JUMP
JUMPI
PC
MSIZE
GAS
JUMPDEST
PUSH1
DUP1
SWAP1
MCOPY
PUSH0

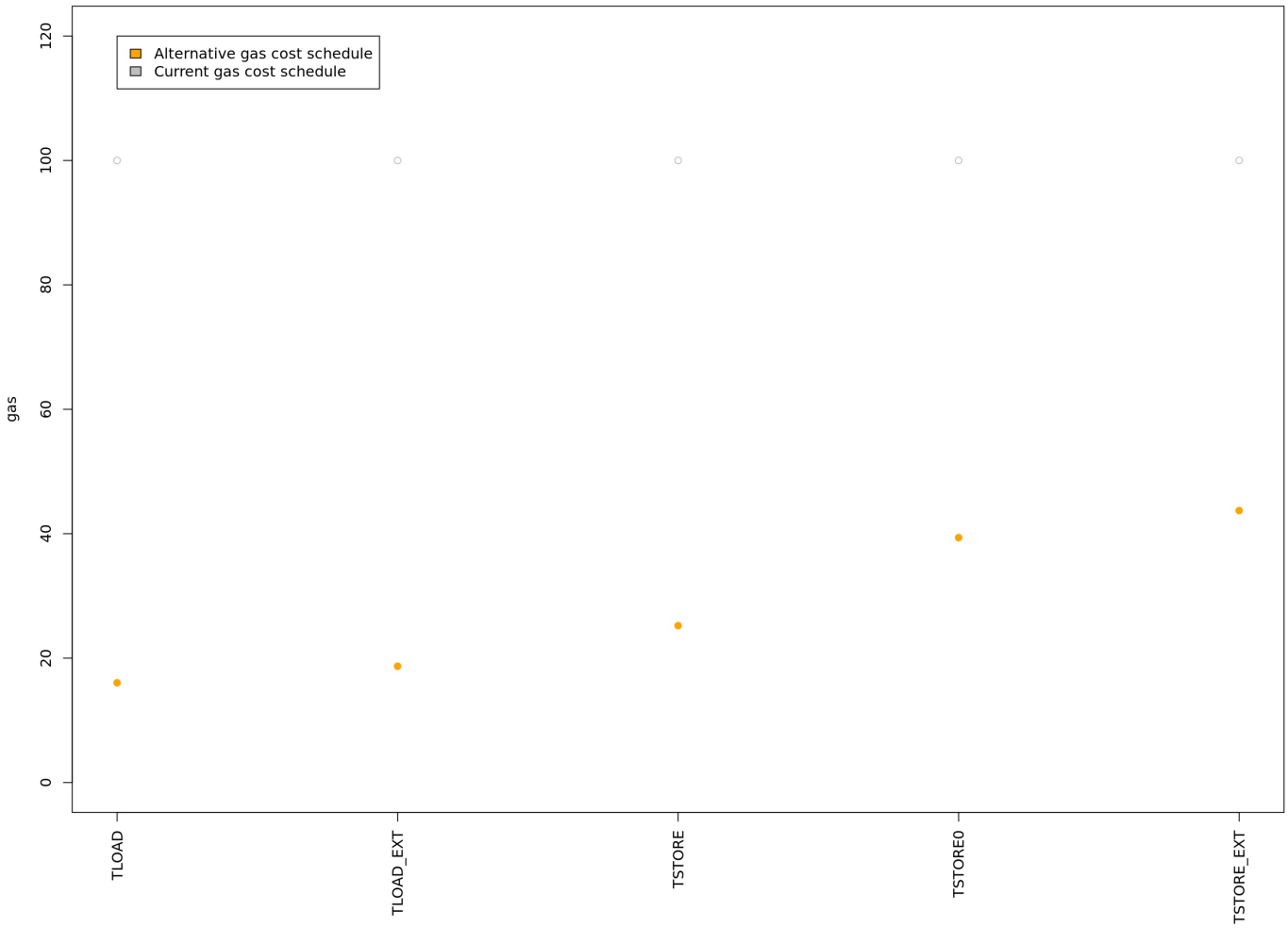

The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
50
100
150
KECCAK256
EXTCODEHASH
EXTCODESIZE
EXTCODECOPY

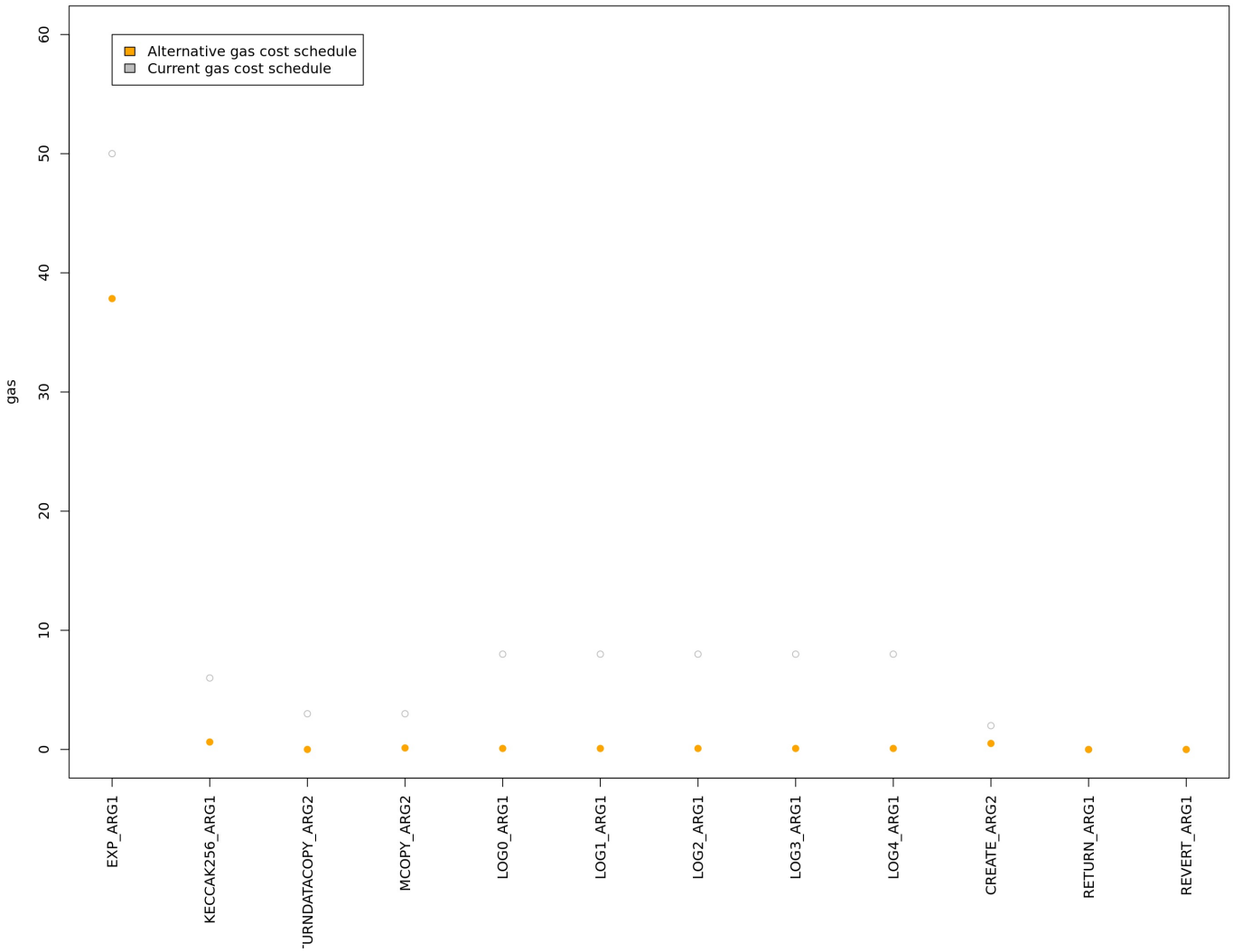

The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
1
2
3
4
5
PUSH2
PUSH3
PUSH4
PUSH5
PUSH6
PUSH7
PUSH8
PUSH9
PUSH10
PUSH11
PUSH12
PUSH13
PUSH14
PUSH15
PUSH16
PUSH17
PUSH18
PUSH19
PUSH20
PUSH21
PUSH22
PUSH23
PUSH24
PUSH25
PUSH26
PUSH27
PUSH28
PUSH29
PUSH30
PUSH31
PUSH32
DUP2
DUP3
DUP4
DUP5
DUP6
DUP7
DUP8
DUP9
DUP10
DUP11
DUP12
DUP13
DUP14
DUP15
DUP16
SWAP2
SWAP3
SWAP4
SWAP5
SWAP6
SWAP7
SWAP8
SWAP9
SWAP10
SWAP11
SWAP12
SWAP13
SWAP14
SWAP15
SWAP16

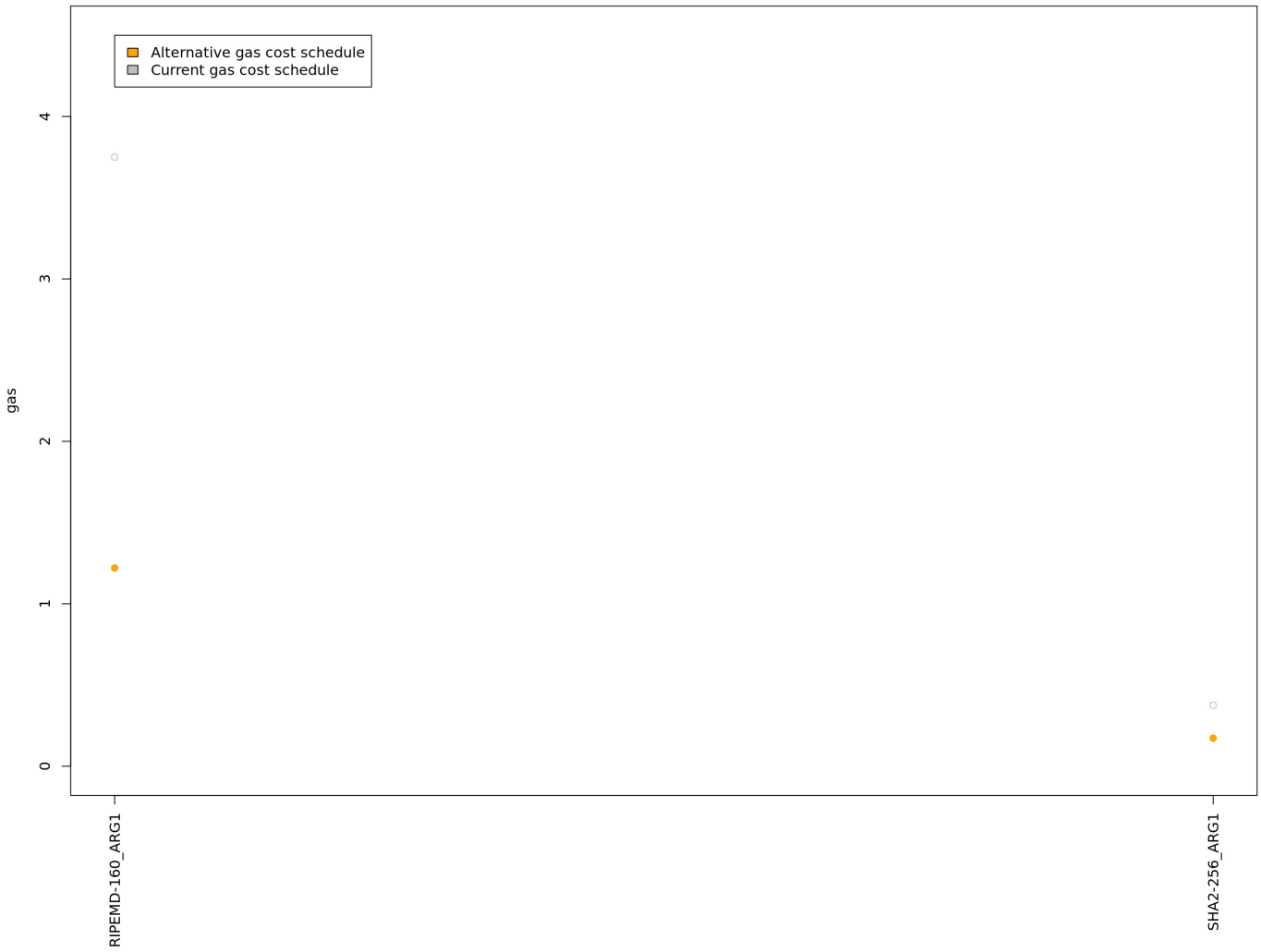

The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
10000
20000
30000
LOG0
LOG1
LOG2
LOG3
CREATE
CALL
STATICCALL
DELEGATECALL
RETURN
REVERT


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0e+00
1e+05
2e+05
3e+05
ECRECOVER
SHA2-256
RIPEMD-160
IDENTITY
MODEXP
ECADD
ECMUL
ECPAIRING79000
ECPAIRING113000
ECPAIRING181000
ECPAIRING317000
BLAKE2F


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
2
4
6
8
10
MSTORE_COLD
MCOPY_COLD


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
20
40
60
80
100
120
TLOAD
TLOAD_EXT
TSTORE
TSTORE0
TSTORE_EXT


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
10
20
30
40
50
60
EXP_ARG1
KECCAK256_ARG1
URNDATACOPY_ARG2
MCOPY_ARG2
LOG0_ARG1
LOG1_ARG1
LOG2_ARG1
LOG3_ARG1
LOG4_ARG1
CREATE_ARG2
RETURN_ARG1
REVERT_ARG1


The alternative gas cost schedule
Alternative gas cost schedule
Current gas cost schedule
gas
0
1
2
3
4
RIPEMD-160_ARG1
SHA2-256_ARG1