

## act.lua

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1 #!/usr/bin/env lua
2 local help = [
3   act.lua : stochastic incremental XAI
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5
6 Options:
7   -h          Show help.
8   -b bins=7  Number of bins for discretization.
9   -e era=30   Update model every 'era' number of rows.
10  -r ruleMax=3 Max conditions in a rule.
11  -s seed=42  Random number seed.
12  -f file=..//lua/auto93.csv []
13
14 -- coerce(s) --> v ; Return int or float or bool or string from 's'.
15 local function coerce(s)
16   if s then return tonumber(s) or smatch("^s*(.-)%s*$") end end
17
18 local the(); for k,v in help:gmatch("(%)=(%)") do the[k] = coerce(v) end
19 math.randomseed(the.seed)
20
21 local DATA, NUM, SYM, COLS, clone, adds
22
23 --## Lib
24
25 local abs,exp,sqrt,log = math.abs, math.exp, math.sqrt, math.log
26 local max,rand,cos = math.max, math.random, math.cos
27
28 local sayio,write
29 local fm = string.format
30
31 -- sort(t,f) --> t ; Sort 't' using function 'f'.
32 local sort = function(t,f) table.sort(t,f); return t end
33 -- lt(f) --> f ; Return a function that sorts 'a' and 'b' on 'f'.
34 local lt = function(f) return function(a,b) f(a) < f(b) end end
35 -- cat(a) --> s ; Return a string representation of array 'a'.
36 local cat = function(a) return "... table.concat(a, \" \")" end
37
38 -- o(v) --> s ; Return a string representation of 'v'.
39 local function o(v, list,dict)
40   list = function(a, u)
41     for v in ipairs(a) do u[1+#u] = o(v) end; return cat(u) end
42   dict = function(a, u)
43     for k,v in pairs(a) do u[1+#u] = fmt("%s=%s", k, o(v)) end
44     return cat(sort(u)) end
45   end
46   return type(v) == "number" and fmt(v1=0 and "%0." or "%3.", v) or
47   type(v) == "table" and tostring(v) or (#>0 and list or dict)(v, {}) end
48
49 -- s2a(s) --> a ; Return array of words from string 's', split on ",".
50 local function s2a(s, a)
51   a={}; for s1 in smatch("([,]+)") do a[#a+1] = coerce(s1) end; return a end
52
53 -- csv(file) --> i ; Iterator that returns rows from 'file'.
54 local function csv(file, src)
55   src = assert(io.open(file))
56   return function()
57     s = src:read(); if s then return s2a(s) else src:close() end end end
58
59 -- shuffle(t) --> t ; Randomly shuffle the order of elements in 't'.
60 local shuffle = function(t, n)
61   for m=1,n do math.random(m); t[m],t[n]=t[n],t[m] end; return t end
62
63 -- cut(a,n,data) --> t,t; Split 'a' at 'n' (if 'data' exists,split that too).
64 local function cut(a,n, data)
65   local t1,a1,t2,a2 = {},{},{},{}
66   for j,i in ipairs(a) do if j <= n then a1[i+#a1]=v else a2[i+#a2]=v end end
67   return data and clone(data,a1),clone(data,a2) or a1,a2 end
68
69 -- mode(d) --> v ; Return the most frequent key in 'd'.
70 local function mode(d, v,n)
71   v,n = nil,0
72   for k,v in pairs(d) do if n>n then v,n=v1,n1 end end
73   return v end
74
75 -- box_muller(mu,sd) --> n ; Return a random number from a Gaussian 'mu','sd'.
76 function box_muller(mu,sd)
77   return mu + sd * sqrt(-2 * log(rand())) * cos(6.28 * rand()) end
78
79 --## Classes
80
81 -- DATA(src) --> DATA ; Create a new DATA, populated with 'src'.
82 function DATA( src) return adds(src, {n=0,rows={},cols=nil}) end
83
84 -- clone(i,src) --> DATA ; Return a new DATA with same structure as 'i'.
85 function clone(i, src) return adds(src, DATA(i.cols.names)) end
86
87 -- NUM(at,s) --> NUM ; Create a NUM object to summarize numbers.
88 function NUM(at,s)
89   return {at=at, of=s, n=0, mu=0, m2=0, sd=0,
90   best=(tostring(s) or ""):find"%s" and 1 or 0} end
91
92 -- SYM(at,s) --> SYM ; Create a SYM object to summarize symbols.
93 function SYM(at,s) return {at=at, of=s, n=0, has={}} end
94
95 -- COLS(row) --> COLS ; Create a COLS object from a list of column names.
96 function COLS(row, t,x,y,all,col)
97   x,y,all = {},{},{} for n,s in ipairs(row) do
98     col = (smatch("[%A-Z]" and NUM or SYM))(n,s)
99     all[n] = col
100    if not s:match"X*" then
101      t[#t+1] = s:find"%" and y or x
102      t[1+#t] = col end end
103  return {all=all, x=x, y=y, names=row} end

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104 --## Methods
105
106 -- add(i,v,inc) --> v ; Update 'i' with 'v' (incrementing by 'inc').
107 local function add(i,v, inc)
108   if v == "?" then return v end
109   i = inc or 1
110   i.m1 = i.m2 = i.mu = i.n = 0,0,0
111   if i.has then i.has[v] = inc + (i.has[v] or 0)
112   elseif i.mu then
113     if i.n < 0 and i.n < 2 then i.sd, i.m2, i.mu, i.n = 0,0,0,0 else
114       local d = v - i.mu
115       i.m1 = i.m2 + inc * d / i.n
116       i.m2 = i.m2 + inc * d * (v - i.mu)
117       i.sd = i.n*2 and 0 or sqrt((max(0,i.m2)/(i.n - 1))) end
118   elseif i.rows then
119     if not i.rows then i.cols = COLS(v) else
120       i.mid = nil
121       for _,v in pairs(i.cols.all) do add(col, v[col.at], inc) end
122       if i.n > 0 then i.rows[1+i.rows] = v end end end
123   return v end
124
125 -- sub(i,v) --> v ; Decrement 'v' from 'i'.
126 local function sub(i,v) return add(i,v,-1) end
127
128 -- adds(src,it) --> it ; Update 'it' with all items from 'src'.
129 function adds(src, it)
130   it = it or NUM()
131   if type(src) == "string" then
132     for row in csv(src) do add(it,row) end
133     else for _,row in pairs(src or {}) do add(it,row) end end
134   return it end
135
136 -- mid(i) --> v|row ; Return central tendency of 'i'.
137 local function mid(i)--> a | v; Expected value for 'i'.
138   if i.n == 0 then return i.mu end
139   elseif i.has then return mode(i.has)
140   elseif i.rows then
141     if not i._mid then
142       local t={} for _,col in pairs(i.cols.all) do t[1+#t] = mid(col) end
143       i._mid = t end
144   return i._mid end
145
146 -- norm(i,v) --> n ; Normalize 'v' 0..1 using 'i'.
147 local function norm(i,v)
148   return i.has[v=="?"] and v or 1/(1 + math.exp(-1.7 * (v - i.mu)/(i.sd + 1e-32))) end
149
150 -- ab(a,col,v1,v2) --> n ; Return distance between 'v1' and 'v2'.
151 local function ab(a,col,v1,v2)
152   if v1=="?" and v2=="?" then return 1 end
153   col.has then return v1:v2 and 0 or 1 end
154   v1,v2 = norm(v1),norm(v2),col.v1,v2
155   v1 = v1 ~= "?" and v1 or (v1 > 0.5 and 0 or 1)
156   v2 = v2 ~= "?" and v2 or (v1 > 0.5 and 0 or 1)
157   return abs(v1 - v2) end
158
159 -- distx(i, row1, row2) --> p ; Return distance 'row1' to 'row2' (using X cols).
160 local function distx(i, row1, row2, d)
161   d=0; for x in pairs(i.cols.x) do d=d + ab(x, row1[x],row2[x])^2 end
162   return sqrt(d/i.cols.x) end
163
164 -- disty(i, row) --> n ; Return distance of 'row' to best goal (using Y cols).
165 local function disty(i, row, d)
166   d=0; for y in pairs(i.cols.y) do d=d + (norm(y, row[y])) - y.best)^2 end
167   return sqrt(d/i.cols.y) end
168
169 -- distys(i,rows) --> rows ; Sort 'rows' by their distance to heaven.
170 local function distys(i, rows, y)
171   y = function(row) return disty(i, row) end
172   return sort(rows or i.rows, function(r1,r2) return y(r1) < y(r2) end) end
173
174 --## Think
175
176 -- two(data) --> t ; Incrementally cluster 'data' into 'best' and 'rest'.
177 local function two(data)
178   local train,test,seen,best,rest,d
179   shuffle(data.rows)
180   train,test = cut(data.rows, data.n/2)
181   start,todo = cut(train, 4)
182   seen = {} clone(data.start)
183   best,rest = setmetatable(seen,2,data)
184   done = function(row,what) return distx(seen, row, mid(what)) end
185   for n, row in pairs(todo) do
186     if n>256 then break end --say(".")
187     if d(row,best) < d(row,rest) then
188       add(best, row); --say(best..n)
189       if best.n >= (seen.n) then print("-")
190         add(rest, sub(best, table.remove(distys(best)))) end end end
191   distys(best)
192   return {best=best, rest=rest, seen=seen, test=test,
193   model = lt(function(row) return d(row,best) - d(row,rest) end)} end

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196 --## Demos
197
198 local egs={}
199
200 egs["-h"] = function(_) print("Un .help.. Un") end
201 egs["-m"] = function(n) math.randomseed(n); the.seed = n end
202 egs["-rbs"] = function(_) for row in csv(the.file) do print(o(row)) end end
203 egs["-csv"] = function(_) for row in csv(the.file) do print(o(row),40,50)) end
204 egs["-shuffle"] = function(_) print(o(shuffle(10,20,30,40,50))) end
205 egs["-mode"] = function(_) print(mode=d=2,f=10,g=1)) end
206
207 egs["-cut"] = function(_, b,c)
208   b,c=cut((10,20,30,40,50),2); print(o(b),(c))
209   for _=1,100 do b,c=cut((10,20,30,40,50),2) end end
210
211 egs["-num"] = function(_, num)
212   num=NUM()
213   for _=1,1000 do add(num, box_muller(10,5)) end
214   print(fmt("%.%M", num.mu, num.sd)) end
215
216 egs["-data"] = function_()
217   for n,col in pairs(DATA(the.file).cols.x) do
218     print(o(n,o(col))) end end
219
220 egs["-distx"] = function(_, data,t,u)
221   data = DATA(the.file)
222   t.rows = {}, shuffle(data.rows)
223   for n=2,#rows do t[1+#t] = distx(data.rows[n-1],rows[n]) end
224   print(o(t)) end
225
226 egs["-disty"] = function(_, data,num)
227   data,t = DATA(the.file), {}
228   distys(data)
229   for n, row in pairs(data.rows) do t[n]=disty(data, row) end
230   print(o(t)) end
231
232 egs["-inc"] = function(_, data,data2)
233   data = DATA(the.file)
234   print(o(mid(data1)))
235   data2 = clone(data)
236   for row in pairs(data2.rows) do
237     add(data2, row)
238     if data2.n==50 then print(o(mid(data2))) end end
239   while data2.rows do
240     sub(data2, table.remove(data2.rows))
241     if data2.n==50 then print(o(mid(data2)));break end end
242
243 egs["-wo"] = function(_, data,out,t)
244   t,data = {}, DATA(the.file)
245   for _=1,20 do
246     out = two(data)
247     t[1+#t] = (100*disty(out.seen, sort(out.test, out.model)[1]))/1 end
248   print(o(t)) end
249
250 -- cli(d,funs) --> nil ; Update 'd' with flags from command-line; run 'funs'.
251 local function cli(d,funs)
252   for i,s in pairs(arg) do
253     if s=="-h" then print("Un .help.. Un") end
254     then funs[s](coerce(arg[i+1]))
255     else for k,v in pairs(d) do
256       if k:sub(1,1)==s:sub(2) then d[k]=coerce(arg[i+1]) end end end end
257
258 if arg[0]:find"two.lua" then cli(the,egs) end

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