```
(defpackage :tiny (:use :cl))
(in-package :tiny)
(mapc #'load  '("lib/macros"     "lib/maths"   "lib/strings"  "lib/lists"
                "lib/settings"  "lib/structs"  "lib/egs" ))

(defvar my (settings "
 TINY: semi-supervised multi-objective explanation facility.
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 USAGE:  lisp eg.lisp [OPTIONS] [ARG]"
  '((far    "-F"  "how far is distant      " .95)
    (file   "-f"  "help file              " "../../data/auto93.lisp")
    (help   "-h"  "show help              " nil)
    (keep   "-K"  "items to keep          " 256)
    (k      "-k"  "nb low attributes classes" 1)
    (m      "-m"  "nb low frequency classes " 2)
    (p      "-p"  "distance coeffecient    " 2)
    (seed   "-s"  "random number seed      " 10019)
    (some   "-S"  "how many                " 512)
    (example "-e" "example to run          " "ls"))))

(mapc #'load '("col/sample" "col/sym" "col/num" "col/cols" "row/row" "row/rows"))

(defstruct+ cols
  "Factory for making nums or syms."
  names  ; list of column names
  all    ; all the generated columns
  x      ; just the independent columns
  y      ; just the dependent columns
  klass) ; just the klass col (if it exists)

(defun make-cols (lst)
  "Upper/lowercase words ==> nums/syms. Kept in 'all' and maybe elsewhere."
  (let (all x y kl (at -1))
    (dolist (str lst (%make-cols
                      :names lst :x x :y y :klass kl :all (reverse all)))
      (let* ((what (if (upper-case-p (char str 0)) #'make-num #'make-sym))
             (col  (funcall what str (incf at))))
        (push col all)
        (unless (eq #\~ (charn str))
          (if (member (charn str) '(#\! #\- #\+)) (push col y) (push col x))
          (if (eq #\! (charn str)) (setf kl col)))))))

(defstruct+ num
   "summarize numeric columns"
   (txt "")  ; column name
   (at 0)    ; column position
   (n 0)     ; #items seen
   (w 1)     ; (1,-1) = (maximize, minimize)
   (lo most-positive-fixnum) ; least seen
   (hi most-negative-fixnum) ; most seen
   (_kept (make-sample)))    ; items seen

(defun make-num (&optional (s "") (n 0))
  "Create."
  (%make-num :txt s :at n :w (if (eq #\- (charn s)) -1 1)))

(defmethod add ((i num) (lst cons))
  "Add a list of items."
  (dolist (x lst i) (add i x)))

(defmethod add ((i num) x)
  "Add one thing, skipping 'dont know', updating 'lo,hi' and 'kept'."
  (unless (eq x #\?)
    (with-slots (lo hi) i
      (incf (? i n))
      (add (? i _kept) x)
      (setf lo (min x (? i lo))
            hi (max x (? i hi))))))

(defmethod norm ((i num) x)
  "Map 'x' 0..1 (unless its unknown, unless gap too small."
  (with-slots (lo hi) i
    (cond ((eq x #\?)          x)
          ((< (- hi lo) 1E-9) 0)
          (t                  (/ (- x lo) (- hi lo))))))

(defmethod dist ((i num) x y)
  "Gap between things (0..1). For unknowns, assume max distance."
  (cond ((and (eq #\? x) (eq #\? y))
                         (return-from dist 1))
        ((eq #\? x)   (setf y (norm i y) x (if (< y .5) 1 0)))
        ((eq #\? y)   (setf x (norm i x) y (if (< x .5) 1 0)))
        (t            (setf x (norm i x) y (norm i y))))
  (abs (- x y)))

(defmethod mid ((i num))
  "Middle."
  (mid (? i _kept)))

(defmethod div ((i num))
  "Diversity"
  (div (? i _kept)))

(defmethod discretize ((i num) x &optional (bins (? my bins)))
  "Map 'x' to one of 'bins' integers."
  (with-slots (lo hi) i
    (let ((b (/ (- hi lo) bins)))
      (if (= hi lo) 1 (* b (floor (+ .5 (/ x b))))))))

(defstruct+ sample
```



```
  "Keep up to 'max' numbers (after which, replace any old with new)."
  (_kept ; where to keep
         (make-array 2 :fill-pointer 0 :adjustable t))
  (n 0)
  max    ; how many to keep
  ok)    ; nil if items added and list not resorted yet

(defun make-sample (&optional (max (! my keep)))
  "Create."
  (%make-sample :max max))

(defmethod add ((i sample) (x number))
  "Update."
  (incf (? i n))
  (let ((size (length (? i _kept))))
    (cond ((< size  (? i max))
           (setf (? i ok) nil)
           (vector-push-extend x (? i _kept)))
          ((< (randf) (/ (? i n) (? i max)))
           (setf (? i ok) nil)
           (setf (elt (? i _kept) (randi size)) x)))))

(defmethod per ((i sample) p)
  "Return the pth item from 'kept'."
  (let* ((all (sorted i))
         (n  (1- (length all))))
    (elt all (max 0 (min n (floor (* p n)))))))

(defmethod mid ((i sample))
  "Middle"
  (per i .5))

(defmethod div ((i sample))
  "Diversity"
  (/ (- (per i .9) (per i .1)) 2.58))

(defmethod sorted ((i sample))
  "Return 'kept', sorted."
  (unless (? i ok)
    (sort (? i _kept) #'<)
    (setf (? i ok) t))
  (? i _kept))

(defstruct+ sym
  "Summarize symbolic columns"
  (txt "")  ; column name
  (at 0)    ; column position
  (n 0)     ; #items seen
  kept)     ; symbol counts of the items

(defun make-sym (&optional s n)
  "Create."
  (%make-sym :txt s :at n))

(defmethod add ((i sym) (lst cons))
  "Add a list of items."
  (dolist (x lst i) (add i x)))

(defmethod add ((i sym) x)
  "Add one items, skipping 'dont know', update frequency counts."
  (unless (eq x #\?)
    (incf (? i n))
    (incf (geta x (? i kept)))))

(defmethod adds ((i sym) x inc)
  "Bulk add of a symbol 'x', 'inc' times."
  (incf (? i n) inc)
  (incf (geta x (? i kept)) inc))

(defmethod mid ((i sym))
  "Middle"
  (loop for (key . n) in (? i kept) maximizing n return key))

(defmethod div ((i sym))
  "Diversity (entropy)."
  (labels ((fun (p) (* -1 (* p (log p 2)))))
    (loop for (_ . n) in (? i kept) sum (fun (/ n (? i n))))))

(defmethod dist ((i sym) x y)
  "Gap between 2 items; if unknown, assume max. distance."
  (cond ((and (eq #\? x) (eq #\? y)) 1)
        ((equal x y)                 0)
        (t                           1)))
```

```
(defstruct+ row
  "Hold one record"
  cells    ; cells
  _parent  ; pointer to someone who can say what are (e.g.) lo,hi
  evaled)  ; have we used the y values

(defun make-row (rows lst)
  "Create."
  (%make-row :_parent rows :cells lst))

(defmethod better ((row1 row) (row2 row))
  "Row1 better than row2 if jumping away is better jumping to."
  (let* ((s1 0) (s2 0)
         (cols (? row1 _parent cols y))
         (n (length cols)))
    (setf (? row1 evaled) t
          (? row2 evaled) t)
    (dolist (col cols (< (/ s1 n) (/ s2 n)))
      (with-slots (at w) col
        (let ((x (norm col (elt (? row1 cells) at)))
              (y (norm col (elt (? row2 cells) at))))
          (decf s1 (exp (* w (/ (- x y) n))))
          (decf s2 (exp (* w (/ (- y x) n)))))))))

(defmethod around ((row1 row) allrows)
  "Sort 'allrows' by distance to 'row1'."
  (labels ((two (row2) (cons (dist (? row1 _parent cols)  row1 row2) row2)))
    (sort (mapcar 'two allrows) 'car<)))

(defmethod far ((i row) allrows)
  "Return something far away from 'i'. Avoid outliers by only going so 'far'."
  (cdr (elt (around i allrows)
            (floor (* (length allrows) (? my far))))))

(defstruct+ rows
            "Stores multiple rows, and their summaries."
            rows   ; all the rows
            cols)  ; summaries of all the columns

(defun make-rows (&optional src (i (%make-rows)))
  "Eat first row for the column header,  add the rest"
  (labels ((top.row.is.special  (x) (if (? i cols)
                                        (push (add i x) (? i rows))
                                        (setf (? i cols) (make-cols x)))))
    (if (stringp src)
      (with-lines src (lambda (line) (top.row.is.special (cells line))))
      (mapcar #'top.row.is.special src))
    i))

(defmethod clone ((i rows) &optional src)
  "Create a new table with same structure as 'i'."
  (make-rows (cons (? i cols names) src)))

(defmethod add ((i rows) (lst cons))
  "Row creation. Called in we try to add a simple list."
  (add i (make-row i lst)))

(defmethod add ((i rows) (row1 row))
  "For all the unskipped columns, update from 'row1'."
  (dolist (cols `(,(? i cols x) ,(? i cols y)) row1)
    (dolist (col cols)
      (add col (elt (? row1 cells) (? col at))))))

(defmethod dist ((i rows) (row1 row) (row2 row))
  "Gap between 'row1', 'row2'. At 'p'=2, this is Euclidean distance."
  (let ((d 0) (n 0) (p (! my p)))
    (dolist (col (? i cols x))
      (incf n)
      (incf d (expt (dist col (elt (? row1 cells) (? col at))
                              (elt (? row2 cells) (? col at)))
                    p)))
    (expt (/ d n) (/ 1 p))))

(defmethod half ((i rows) &optional all above)
  "Split rows in two by their distance to two remove points."
  (or all (? i rows))
  (print 1)
  (let (all some left right c tmp)
    (setf all  (or   all (? i rows)))
    (setf some  (many all (! my some)))
    (return-from half  (print (length some)))
    (setf left  (or   above (far (any some) some)))
    (setf right (far  left some))
    (setf c     (dist (? i _parent) left right))
    (setf tmp   (mapcar (lambda (row)
                          (print 2)
                          (let ((a (dist (? row _parent) row left))
                                (b (dist (? row _parent) row right)))
                            (cons (/ (+ (* a a) (* c c) (- (* b b))) (* 2 c)) row)))
                        all))
    (print 1)
    (let ((n 0) lefts rights)
      (dolist (one (sort tmp #'car<))
        (if (< (incf n) (/ (length tmp) 2))
          (push (cdr one) lefts)
          (push (cdr one) rights)))
      (values left right lefts rights c))))
```

```lisp
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||[_)/    [ | )(_](_.[   (_)_)

; Simple alist access
(defmacro ! (l x)
  "Get into association lists."
  `(cdr (assoc ',x ,l)))

(defmacro ? (s x &rest xs)
 "(? obj x y z) == (slot-value (slot-value (slot-value obj 'x) 'y) 'z)"
 (if (null xs) `(slot-value ,s ',x) `(? (slot-value ,s ',x) ,@xs)))

(defmacro geta (x lst &optional (init 0))
  "Endure lst has a slot for `x`. If missing, initialize it with `init`."
  `(cdr (or (assoc ,x ,lst :test #'equal)
            (car (setf ,lst (cons (cons ,x ,init) ,lst))))))
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|*|_  /   ._ _  _.-+-|_  __
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; round
(defun rnd (number &optional (digits 3))
  "Round to `digits` decimal places."
  (let* ((div (expt 10 digits))
         (tmp (/ (round (* number div)) div)))
    (if (zerop digits) (floor tmp) (float tmp))))

; Random number control (since reseeding in LISP is... strange).
(defvar *seed* 10013)

(defun randf (&optional (n 1.0))
  "Random float 0.. n")
  (setf *seed* (mod (* 16807.0d0 *seed*) 2147483647.0d0))
  (* n (- 1.0d0 (/ *seed* 2147483647.0d0))))

(defun randi (&optional (n 1))
  "Random int 0..n"
  (floor (* n (/ (randf 1000000000.0) 1000000000))))
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||[_)/    _)  | [  |[ )(_]_)
                       ._|
(defun charn (x)
  "Last thing from a string."
  (and (stringp x)
       (> (length x) 0)
       (char x (1- (length x)))))

(defun trim (x)
  "Kill leading tailing whitespace."
  (string-trim '(#\Space #\Tab #\Newline) x))

(defun thing (x &aux (y (trim x)))
  "Turn `x` into a number or string or `?`."
  (cond ((string= y "?") #\?)
        ((string= y "t") t)
        ((string= y "nil") nil)
        (t (let ((z (read-from-string y nil nil)))
             (if (numberp z) z y)))))

(defun splits (str &key (char #\,) (filter #'identity))
  "Divide `str` on `char`, filtering all items through `filter`."
  (loop for start = 0 then (1+ finish)
    for        finish = (position char str :start start)
    collecting (funcall filter (trim (subseq str start finish)))
    until      (null finish)))

; String to lines or cells of things
(defun lines (string) (splits string :char   #\Newline))
(defun cells (string &key (char #\,)) (splits string :char char :filter #'thing))

(defun with-lines (file fun)
  "Call `fun` for each line in `file`."
  (with-open-file (s file)
    (loop (funcall fun (or (read-line s nil) (return))))))
. .     /  .    ,
|*|_  /   |* __-+- __
||[_)/    ||_)  | _)

; sort predicates
(defun lt (x)     (lambda (a b) (< (slot-value a x) (slot-value b x))))
(defun gt (x)     (lambda (a b) (> (slot-value a x) (slot-value b x))))
(defun car< (a b) (< (car a) (car b)))
(defun car> (a b) (> (car a) (car b)))

; random sampling (with replacement).
(defmethod any ((i cons))   (any (coerce 'vector i)))
(defmethod any ((i vector)) (elt i (random (length i))))

(defmethod many ((i cons)   &optional (n 10)) (many (coerce i 'vector) n))
(defmethod many ((i vector) &optional (n 10)) (loop repeat n collect (any i)))
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||[_)/    _) (/, |  | |[ )(_]_)
                          ._|
; Update `default` from command line.  Boolean flags just flip defaults.
(defun cli (key.flag.help.default)
  "If `flag` exists on command line, update `key`."
  (destructuring-bind (key flag help default) key.flag.help.default
    (declare (ignore help))
    (let* ((args #+clisp ext:*args*
                 #+sbcl sb-ext:*posix-argv*)
           (it (member flag args :test 'equalp)))
      (cons key (cond ((not it)            default)
                      ((equal default t)   nil)
                      ((equal default nil) t)
                      (t                   (thing (second it))))))))

(defun settings (header options)
  "Update settings. If  `help` is set, print help."
  (let ((tmp (mapcar (lambda (x) (cli x)) options)))
    (when (! tmp help)
      (format t "~&~{~a~%~}~%OPTIONS:~%" (lines header))
      (dolist (one options)
        (destructuring-bind (flag help default) (cdr one)
          (format t "  ~a  ~a = ~a~%" flag help default))))
    tmp))
. .     /     ,          ,
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(defmacro defstruct+ (x doco &body body)
  "Creates %x for constructor, enables pretty print, hides slots with "_" prefix."
  (let* ((slots (mapcar    (lambda (x) (if (consp x) (car x) x))          body))
         (show  (remove-if (lambda (x) (eq #\_ (char (symbol-name x) 0))) slots)))
    `(progn
       (defstruct (,x (:constructor ,(intern (format nil "%MAKE-~a" x)))) ,@body)
       (defmethod print-object ((self ,x) str)
         (labels ((fun (y) (format nil ":~(~a~) ~a" y (slot-value self y))))
           (format str "~a" (cons ',x (mapcar #'fun ',show))))))))
. .     /
|*|_  /   _  _  __
||[_)/    (/,(_]_)
             ._|
; Define one demos.
(defvar *egs* nil)
(defmacro eg (what arg doc &rest src)
  "Create one example."
  `(push (list ',what ',doc (lambda ,arg ,@src)) *egs*))

(defun demos (settings all &optional one)
  "Run `one` (or `all`) the demos. Reset globals between each
 run.  Return to the operating systems the failure count (so
 fails=0 means `successs`)."
  (let ((fails 0)
        (resets (copy-list settings)))
    (dolist (trio all)
      (destructuring-bind (what doc fun) trio
        (setf what (format nil "~(~a~)" what))
        (when (member what (list 'all one) :test 'equalp)
          (loop for (key . value) in resets do
            (setf (cdr (assoc key settings)) value))
          (setf *seed* (or (cdr (assoc 'seed settings)) 10019))
          (unless (eq t (funcall fun ))
            (incf fails)
            (format t "~&FAIL [~a] ~a ~%" what doc)))))
    #+clisp (ext:exit fails)
    #+sbcl  (sb-ext:exit :code fails)))

 _  _
(/,(_]
   ._|
; test suite
(load "tiny")
(in-package :tiny)

(eg my () "show options" (pprint my) t)

(eg any () "any, many"
    (print (sort (loop repeat 20 collect (any #(10 20 30 40))) #'<))
    (print (sort (many #(10 20 30 40 50 60 70 80 90
                         100 110 120 130 140 150) 5) #'<))
    t)

(eg sym () "sym"
    (let ((s (add (make-sym) '(a a a a b b c))))
      (and (= 1.379 (rnd (div s))) (eq 'c (mid s)))))

(eg sample () "sample"
    (setf (! my keep) 64)
    (let ((s (make-sample)))
      (dotimes (i 100) (add s (1- i)))
      (and (= 32.170544 (div s)) (= 56 (mid s)))))

(eg num () "num nums"
    (setf (! my keep) 64)
    (let ((n  (make-num)))
      (dotimes (i 100) (add n (1- i)))
      (and (= 98 (? n hi)) (= 32.170544 (div n)) (= 56 (mid n)))))

(eg cols () "cols"
    (print (make-cols '("aa" "bb" "Height" "Weight-" "Age-")))
    t)

(eg lines () "lines"
    (with-lines "../../data/auto93.csv"
                (lambda (x) (print (cells x))))
    t)

(eg rows () "rows"
    (let ((rows (make-rows "../../data/auto93.csv")))
      (print (? (? rows cols) y)))
    t)

(eg dist () "dist"
    (let (all
           (r (make-rows "../../data/auto93.csv")))
      (dolist (two (cdr (? r rows)))
        (push (dist r (car (? r rows)) two) all))
      (format t "~{ ~,3f~}" (sort all #'<))
      t))

(eg half () "half"
    (let ((r (make-rows "../../data/auto93.csv")))
      (half r)
      t))
(demos my *egs* (! my example))
```