
Subject: Faster alternative to MIN_CURVE_SURF in IDL contouring

Posted by [info](#) on Mon, 11 Oct 1993 22:13:34 GMT

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In response to complaints about the speed of MIN_CURVE_SURF when used with a large number of points, we have written a new User's Library function, TRI_SURF. TRI_SURF is a much more efficient method of interpolating a smooth surface over both regularly gridded and scattered points for larger datasets. This procedure is included at the end of this posting.

It uses the built-in routines TRIANGULATE and TRIGRID(/QUINTIC) to fit C1 smooth quintic polynomials to the surface. For example, TRI_SURF will interpolate a 25x25 matrix to 100x100 in about 4 seconds on a Sun IPX.

Cut Here

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; $Id: tri_surf.pro,v 1.1 1993/10/08 15:37:53 dave Exp $
```

```
FUNCTION TRI_SURF, z, x, y, REGULAR = regular, XGRID=xgrid, $  
  XVALUES = xvalues, YGRID = ygrid, YVALUES = yvalues, $  
  GS = gs, BOUNDS = bounds, NX = nx0, NY = ny0, $  
  MISSING = missing, EXTRAPOLATE = extrapolate
```

```
;  
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```
; NAME:  
; TRI_SURF
```

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;  
; PURPOSE:  
; This function Interpolates a regularly or irregularly gridded  
; set of points with a C1 smooth quintic surface.
```

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;  
; CATEGORY:  
; Mathematical functions, Interpolation, Surface Fitting
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;  
; CALLING SEQUENCE:  
; Result = TRI_SURF(Z [, X, Y])
```

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;  
; INPUTS:  
; X, Y, Z: arrays containing the X, Y, and Z coordinates of the  
; data points on the surface. Points need not be  
; regularly gridded. For regularly gridded input data,
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; X and Y are not used: the grid spacing is specified
; via the XGRID and YGRID (or XVALUES and YVALUES)
; keywords, and Z must be a two dimensional array.
; For irregular grids, all three parameters must be
; present and have the same number of elements.
;
; KEYWORD PARAMETERS:
; Input grid description:
; REGULAR: if set, the Z parameter is a two dimensional array
; of dimensions (N,M), containing measurements over a
; regular grid. If any of XGRID, YGRID, XVALUES, YVALUES
; are specified, REGULAR is implied. REGULAR is also
; implied if there is only one parameter, Z. If REGULAR is
; set, and no grid (_VALUE or _GRID) specifications are
; present, the respective grid is set to (0, 1, 2, ...).
; XGRID: contains a two element array, [xstart, xspacing],
; defining the input grid in the X direction. Do not
; specify both XGRID and XVALUES.
; XVALUES: if present, XVALUES(i) contains the X location
; of Z(i,j). XVALUES must be dimensioned with N elements.
; YGRID: contains a two element array, [ystart, yspacing],
; defining the input grid in the Y direction. Do not
; specify both YGRID and YVALUES.
; YVALUES: if present, YVALUES(i) contains the Y location
; of Z(i,j). YVALUES must be dimensioned with N elements.
;
; Output grid description:
; GS: If present, GS must be a two-element vector [XS, YS],
; where XS is the horizontal spacing between grid points
; and YS is the vertical spacing. The default is based on
; the extents of X and Y. If the grid starts at X value
; Xmin and ends at Xmax, then the default horizontal
; spacing is (Xmax - Xmin)/(NX-1). YS is computed in the
; same way. The default grid size, if neither NX or NY
; are specified, is 26 by 26.
; BOUNDS: If present, BOUNDS must be a four element array containing
; the grid limits in X and Y of the output grid:
; [Xmin, Ymin, Xmax, Ymax]. If not specified, the grid
; limits are set to the extent of X and Y.
; NX: The output grid size in the X direction. NX need not
; be specified if the size can be inferred from GS and
; BOUNDS. The default value is 26.
; NY: The output grid size in the Y direction. See NX.
;
; Others:
; EXTRAPOLATE: If set, extrapolate the surface to points outside
; the convex hull of input points. Has no effect if
; input points are regularly gridded.

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; MISSING: If set, points outside the convex hull of input points
; are set to this value. Default is 0. Has no effect
; if input points are regularly gridded.
;
; OUTPUTS:
; This function returns a two-dimensional floating point array
; containing the interpolated surface, sampled at the grid points.
;
; RESTRICTIONS:
; The output grid must enclose convex hull of the input points.
; PROCEDURE:
; This routine is similar to MIN_CURVE_SURF but the surface
; fitted is a smooth surface, not a minimum curvature surface. This
; routine has the advantage of being much more efficient
; for larger numbers of points.
;
; The built-in IDL routines TRIANGULATE and TRIGRID(/QUINTIC) are
; used.
;
; EXAMPLES:
; Example 1: Irregularly gridded cases
; Make a random set of points that lie on a gaussian:
; n = 15 ;# random points
; x = RANDOMU(seed, n)
; y = RANDOMU(seed, n)
; z = exp(-2 * ((x-.5)^2 + (y-.5)^2)) ;The gaussian
;
; get a 26 by 26 grid over the rectangle bounding x and y:
; r = TRI_SURF(z, x, y) ;Get the surface.
;
; Or: get a surface over the unit square, with spacing of 0.05:
; r = TRI_SURF(z, x, y, GS=[0.05, 0.05], BOUNDS=[0,0,1,1])
;
; Or: get a 10 by 10 surface over the rectangle bounding x and y:
; r = TRI_SURF(z, x, y, NX=10, NY=10)
;
; Example 2: Regularly gridded cases
; Make some random data
; z = randomu(seed, 5, 6)
;
; interpolate to a 26 x 26 grid:
; CONTOUR, TRI_SURF(z, /REGULAR)
;
; MODIFICATION HISTORY:
; DMS, RSI, October, 1993. Written.
;-

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ON_ERROR, 2
s = size(z) ;Assume 2D
nx = s(1)
ny = s(2)

reg = keyword_set(regular) or (n_params() eq 1)

if n_elements(xgrid) eq 2 then begin
  x = findgen(nx) * xgrid(1) + xgrid(0)
  reg = 1
endif else if n_elements(xvalues) gt 0 then begin
  if n_elements(xvalues) ne nx then $
    message,'Xvalues must have '+string(nx)+' elements.'
  x = xvalues
  reg = 1
endif

if n_elements(ygrid) eq 2 then begin
  y = findgen(ny) * ygrid(1) + ygrid(0)
  reg = 1
endif else if n_elements(yvalues) gt 0 then begin
  if n_elements(yvalues) ne ny then $
    message,'Yvalues must have '+string(ny)+' elements.'
  y = yvalues
  reg = 1
endif

if reg then begin
  if s(0) ne 2 then message,'Z array must be 2D for regular grids'
  if n_elements(x) ne nx then x = findgen(nx)
  if n_elements(y) ne ny then y = findgen(ny)
  x = x # replicate(1., ny) ;Expand to full arrays.
  y = replicate(1.,nx) # y
endif

n = n_elements(x)
if n ne n_elements(y) or n ne n_elements(z) then $
  message,'x, y, and z must have same number of elements.'

if n_elements(bounds) lt 4 then begin ;Bounds specified?
  xmin = min(x, max = xmax)
  ymin = min(y, max = ymax)
  bounds = [xmin, ymin, xmax, ymax]
endif

TRIANGULATE, x, y, tr, b

if n_elements(gs) lt 2 then begin ;GS specified? No.

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    if n_elements(nx0) le 0 then nx = 26 else nx = nx0 ;Defaults for nx and ny
    if n_elements(ny0) le 0 then ny = 26 else ny = ny0
    gs = [(bounds(2)-bounds(0))/(nx-1.), $
          (bounds(3)-bounds(1))/(ny-1.)]
endif else begin ;GS is specified?
    if n_elements(nx0) le 0 then $
nx = ceil((bounds(2)-bounds(0))/gs(0)) + 1 $
    else nx = nx0
    if n_elements(ny0) le 0 then $
ny = ceil((bounds(3)-bounds(1))/gs(1)) + 1 $
    else ny = ny0
endelse

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if N_ELEMENTS(missing) le 0 then missing = 0

```

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if KEYWORD_SET(extrapolate) then $
    return, TRIGRID(x,y,z, tr, /QUINTIC, gs, bounds, $
        MISSING=missing, EXTRAPOLATE=b)

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return, TRIGRID(x,y,z, tr, /QUINTIC, gs, bounds, MISSING=missing)
end

```
