Offset surface creation

An initial surface is given, given by the "createmesh" function, which forms a network with nodes. Dyou want to create an offset surface, offset by an amount h from the initial.The direction of displacement surface epends on the sign of h.

Sequence of calculation:
1.Restoring the normal from the nodal points of the initial surface and we get the nodal points of the displaced surface.
2.We connect the resulting node points

Notation:
initSur*-initial surface*
nodeInit , nodeOffset *-corner points of start and offset surfaces respectively*
unitNorm ,No *- unit normal and surface normal respectively*
meshOffset *- offset surface mesh*
±h *- offset distance*

The image is built on three-dimensional graphics and can be rotated with the mouse

pMesh

$$feval(f, x, y) := \text{str2num}(\text{concat}(\text{num2str}(f), "(", \text{num2str}(x), ",", \text{num2str}(y), ")"))$$

$$pRange(a, b, n) := \text{eval}\left(a + \frac{b - a}{n} \cdot [0..n]\right)$$

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pMesh(F) := | [ nu := rows(F) - 1   nv := cols(F) - 1 ]
            | [ np := 5   r_np := [1..np]   r_nv := [1..(nv - 1)] ]
            | [ M := matrix(0, 3)   c := [1..3] ]
            | for u ∈ [1..nu]
            |   for v ∈ [1..nv]
            |     | [ r := rows(M)   k := r + r_np ]
            |     | M_(k c) := F_([0 0 1 1 0]_(k-r) + u, [0 1 1 0 0]_(k-r) + v)_c
            |   [ r := rows(M)   j := r + r_nv ]
            |   M_(j c) := M_((u - 1)·(np·nv + nv - 1) + np·(nv - 1) - (j - r - 1)·np c)
            | M
```

PMesh returns a matrix suitable for 3D plots.

```
pMesh(f, X, Y) := | [ r := [1..length(X)]   c := [1..length(Y)]   F := 0 ]
                  | pMesh(F_(r c) := feval(f, X_r, Y_c))
```

Generate the unitary normal vectors to F arranged in the same way that pMesh

$$pNo(F, U, V) := \left| \begin{array}{l} \left[\text{Clear}(u, v, G) \;\; \Phi := feval(F, u, v) \right] \\ \left[g := \overrightarrow{\frac{d}{du}\Phi} \times \overrightarrow{\frac{d}{dv}\Phi} \;\; G(u, v) := \left| nznorm(g) \right. \right] \\ pMesh(\text{"G"}, U, V) \end{array} \right.$$

Returns a mesh matrix with the mesh in M and the unitary normals in N

$$pNoMesh(M, N, h) := \left| \begin{array}{l} A := [\, M \;\; M + h \cdot N \;\; M \,] \\ \left[r := [1 .. (3 \cdot \text{rows}(M))] \;\; c := [1 .. 3] \;\; No := 0 \right] \\ No_{r\,c} := \left(A_{1+\text{mod}(r-1,\,3)} \right)_{1+\text{trunc}\left(\frac{r-1}{3}\right)}^{\;c} \end{array} \right.$$

Shorthands

$$plot_1 := \left| \begin{cases} \text{""} \\ \text{""} \\ pNoMesh(M, N, h) \cdot \gamma \cdot zum \end{cases} \right. \qquad plot_2 := \left| \begin{cases} (M + h \cdot N) \cdot \gamma \cdot zum \\ (M - h \cdot N) \cdot \gamma \cdot zum \end{cases} \right.$$

$$zum := 1.7 \qquad \gamma := \begin{bmatrix} -0.8232 & -0.4194 & 0.3827 \\ 0.5677 & -0.6187 & 0.543 \\ 0.009 & 0.6643 & 0.7474 \end{bmatrix}$$

$$nznorm(x\#) := \left| \begin{array}{l} \text{try} \\ \quad \frac{x\#}{\text{norme}(x\#)} \\ \text{on error} \\ \quad x\# \end{array} \right.$$

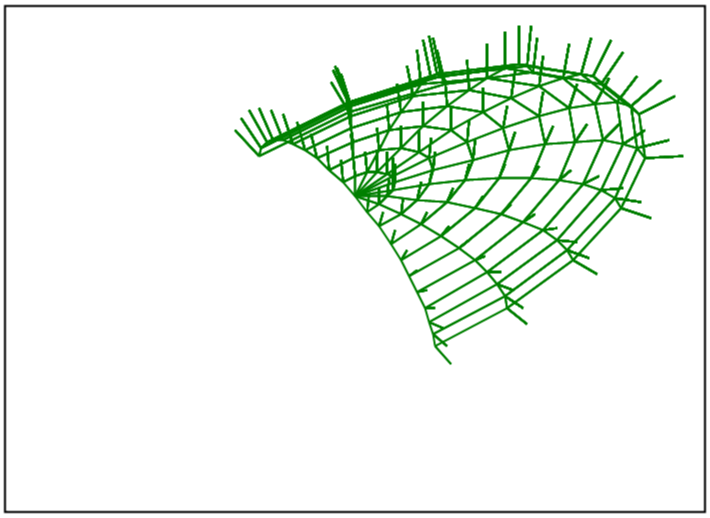
$$f(x) := \frac{(x_1)^2}{9^2} + \frac{(x_2)^2}{4.5^2} + \frac{(x_3)^2}{3^2} - 1$$

$$F(u, v) := \begin{bmatrix} 9 \cdot \sin(u) \cdot \cos(v) \\ 4.5 \cdot \sin(u) \cdot \sin(v) \\ 3 \cdot \cos(u) \end{bmatrix} \qquad U := pRange(0.5 \cdot \pi, 0, 10) \qquad V := pRange(1.5 \cdot \pi, 0.5 \cdot \pi, 10)$$

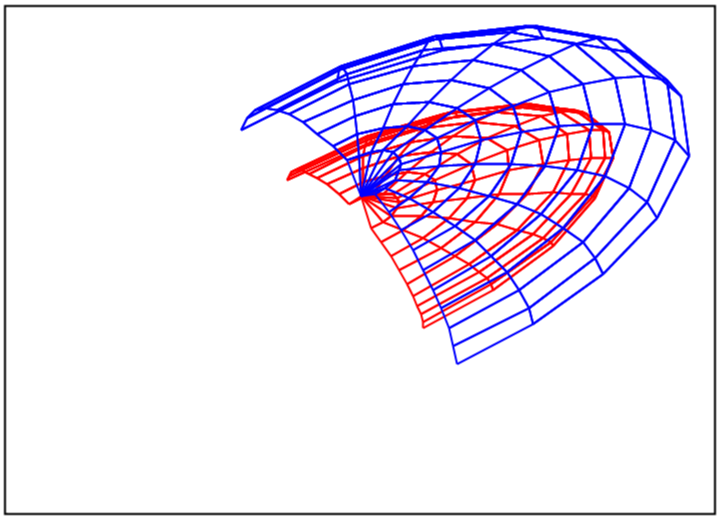
Issue at origin?

$$h := 1 \qquad M := pMesh(\text{"F"}, U, V) \qquad N := pNo(\text{"F"}, U, V) \qquad Ns := pNoMesh(M, N, h)$$

Normals from nodal points of initial surface



Offset surfaces on both sides of the initial surf.



$f(x) := 0.3 \cdot \sin(x_1) \cdot \cos(x_2) - x_3$

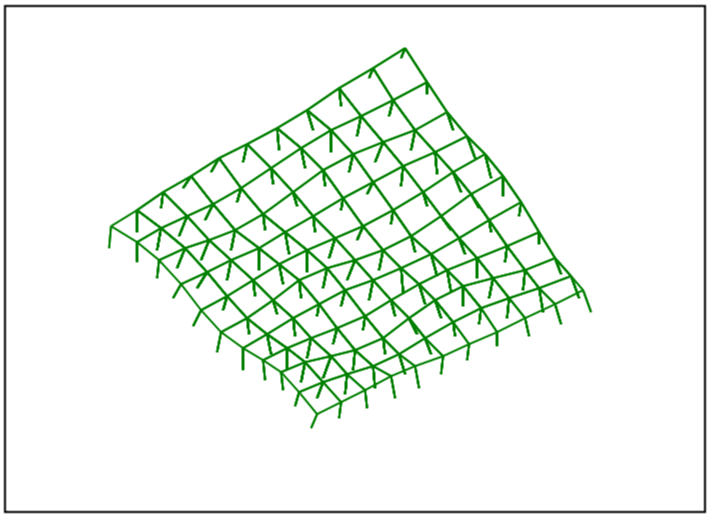
$$F(u, v) := \begin{bmatrix} u \\ v \\ 0.3 \cdot \sin(u) \cdot \cos(v) \end{bmatrix}$$

$U := pRange(-5, 5, 10)$

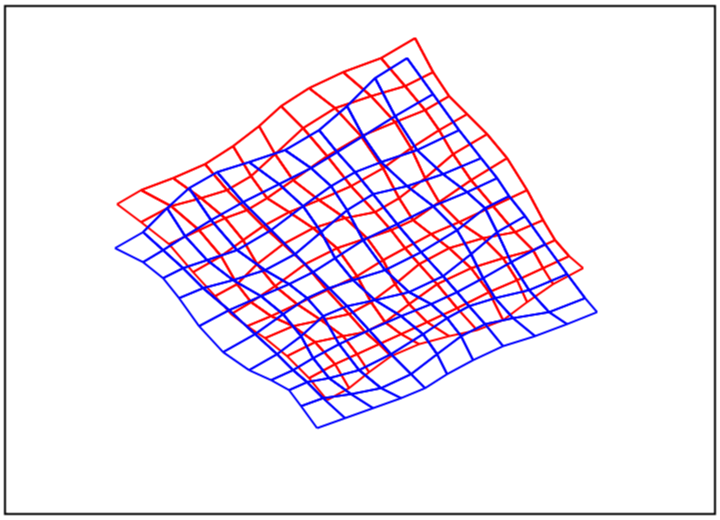
$V := pRange(-5, 5, 10)$

$h := -0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



Offset surfaces on both sides of the initial surf.



$f(x) := \sin(0.5 \cdot x_1 + 0.5 \cdot x_2) - x_3$

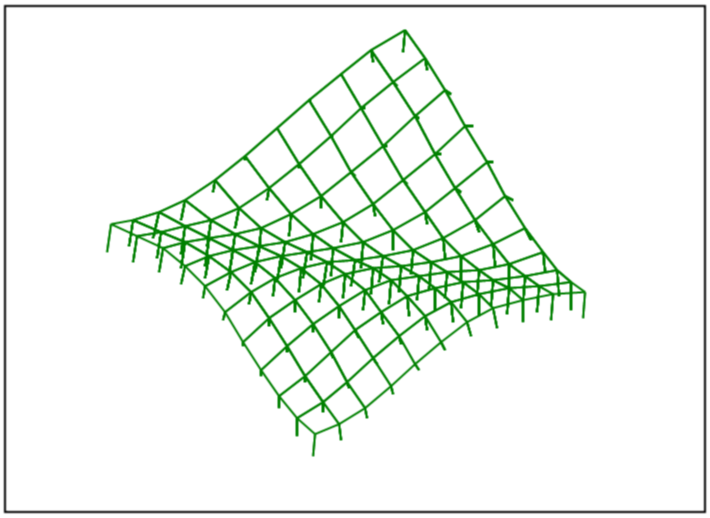
$$F(u, v) := \begin{bmatrix} u \\ v \\ \sin(0.5 \cdot u + 0.5 \cdot v) \end{bmatrix}$$

$U := pRange(-5, 5, 10)$

$V := pRange(-5, 5, 10)$

$h := -0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



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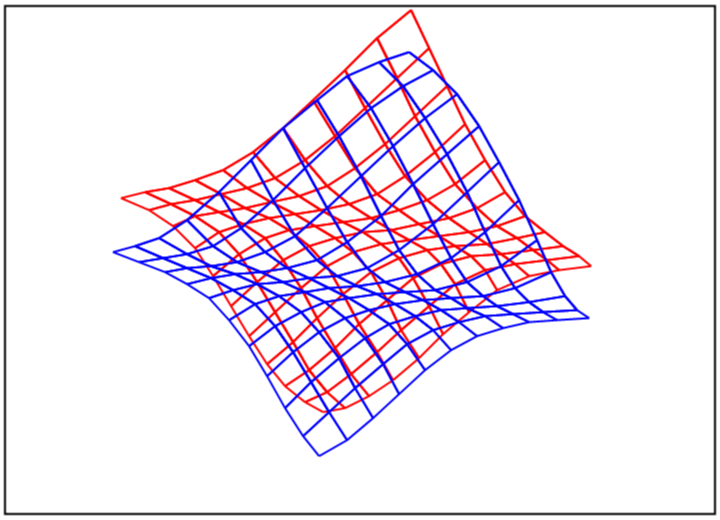


$f(x) := 0.2 \cdot \left(\sin\left(2 \cdot \pi x_1\right) + \sin\left(2 \cdot \pi x_2\right)\right) - x_3$ πx it's wrong.

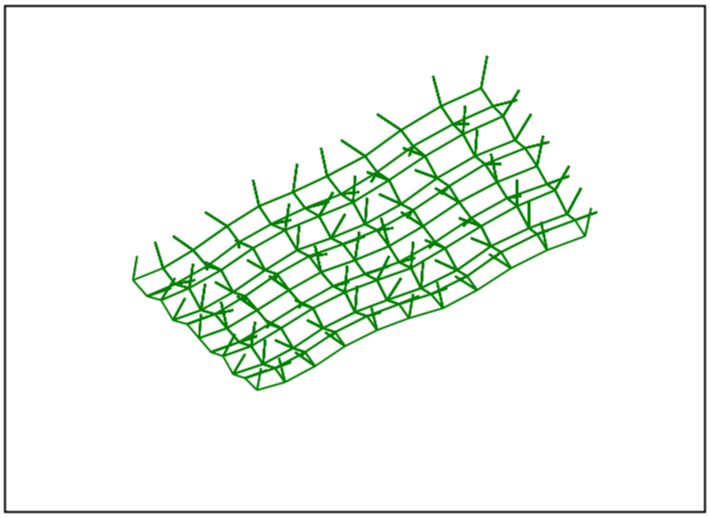
$$F(u, v) := \begin{bmatrix} u \\ v \\ 0.2 \cdot (\sin(2 \cdot \pi \cdot u) + \sin(2 \cdot \pi \cdot v)) \end{bmatrix}$$

$U := pRange(-6, 6, 10)$

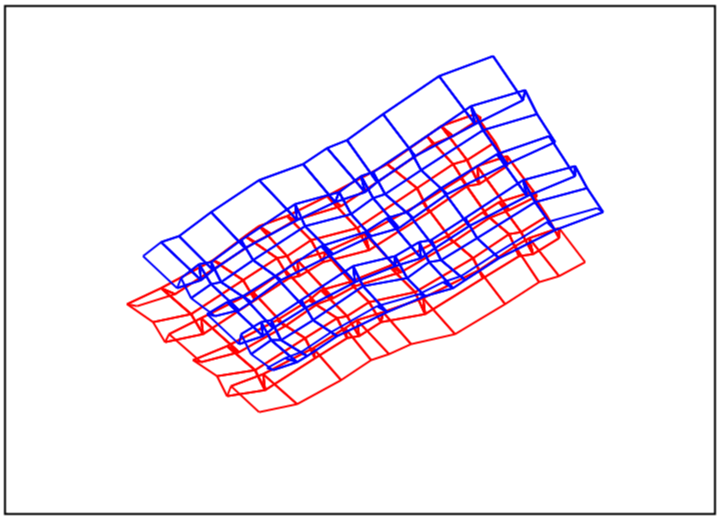
$V := pRange(-3, 3, 10)$

$h := 0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



Offset surfaces on both sides of the initial surf.



$$f(x) := \frac{(x_1)^2}{2^2} + \frac{(x_2)^2}{1^2} - x_3 + 5$$

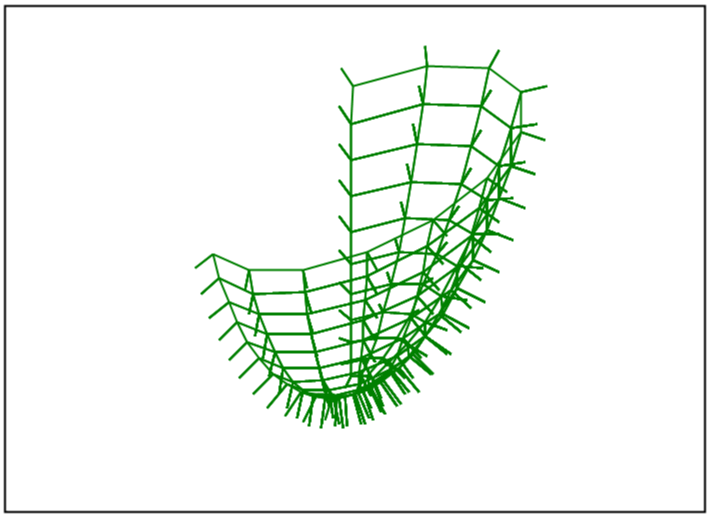
$$F(u, v) := \begin{bmatrix} 2 \cdot u \cdot \cos(v) \\ 1 \cdot u \cdot \sin(v) \\ u^2 - 5 \end{bmatrix}$$

$U := pRange(0.3, 3, 10)$

$V := pRange(1.4 \cdot \pi, 0, 10)$

$h := -0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



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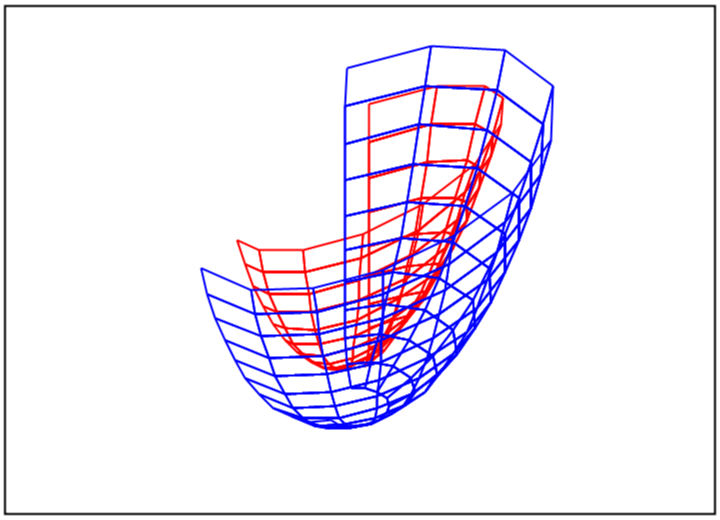


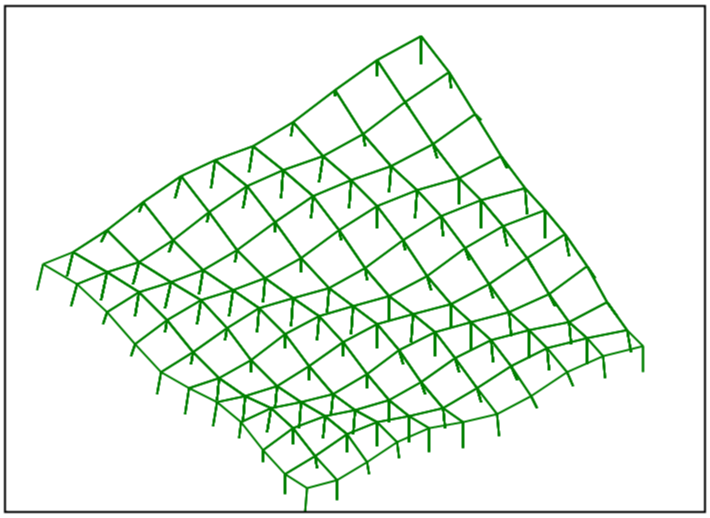
$$f(x) := 9 \cdot \frac{0.01 \cdot e^{x_1}}{0.094 + (x_1)^4 + (x_2)^4} - x_3$$

$$F(u,v) := \begin{bmatrix} u \\ v \\ 0.3 \cdot \sin(u+v) - 2 \end{bmatrix}$$

$U := pRange(-6, 6, 10)$ $V := pRange(-6, 6, 10)$

$h := -0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



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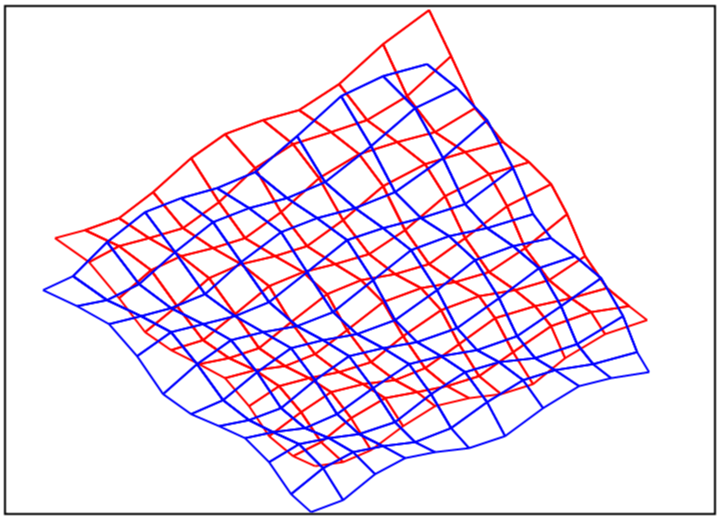


$$f(x) := 9 \cdot \frac{0.01 \cdot e^{x_1}}{0.094 + (x_1)^4 + (x_2)^4} - x_3$$

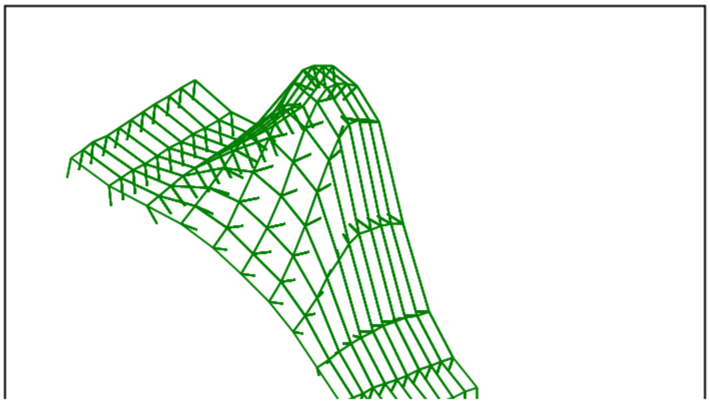
$$F(u,v) := \begin{bmatrix} 9 \cdot u \\ 9 \cdot v \\ 9 \cdot \frac{0.01 \cdot e^{u}}{0.0094 + (u)^4 + (v)^4} \end{bmatrix}$$

$U := pRange(0, 0.5, 10)$

$V := pRange(-0.8, 0.8, 10)$

$h := -0.8$ $M := pMesh("F", U, V)$ $N := pNo(F, U, V)$ $Ns := pNoMesh(M, N, h)$

Normals from nodal points of initial surface



Offset surfaces on both sides of the initial surf.