Adding the fourth variable to the surface algebraic equation

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The fourth variable

Some surface property:

- Temperature
- Rigidity
- Viscosity
- Pressure
- …

The values of the fourth variable will be represented with the colors.

x, y, z – geometry

c – coloration

Property – surface dependence examples

Functional dependence between shape and a property (the fourth variable) can be different:

$$c^2 - 5xc - 255c - 10x^2 - 10y^2 - 10z^2 + 500 = 0$$

$$\cos^2(c) - 5xSin(c) - 255c - 10x^2 - 10y^2 - 10z^2 + 500 = 0$$

Color equation

Color polynomial

Power (k)	Number of the variables (n)		
	2	3	4
1	3	4	5
2	6	10	15
3	10	20	35
4	15	35	70
5	21	56	126

The number of the coefficient for the polynomial =

$$\{N_{k,n}\} = \{N_{k-1,n}\} + c_{n+k-1}^{k} =$$

$$N_{i-1} + \frac{(n+k-1)!}{k!(n-1)!}$$

Visualization?

Visualization

I. Ways of solving the equation of the four variables

II. Color Equation roots and color correspondence
n → one color

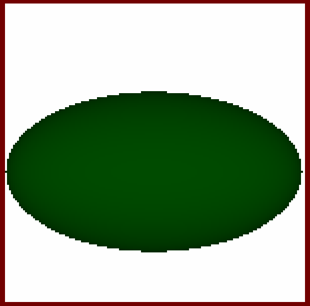
I. Two way of solving visualization problem of the four variable equations

1. The property is a constant value for the whole surface

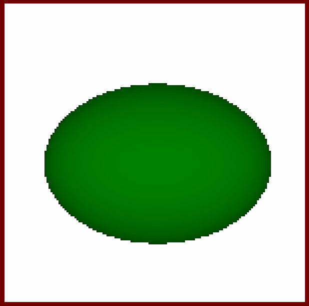
2. The property is irregularly spread on the surface

1. The property is a constant value for the whole surface

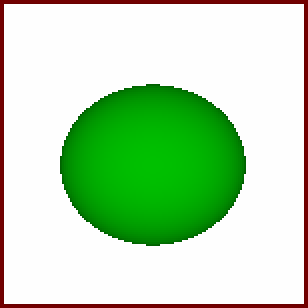
cx2 + 255y 2 + 255z 2 = 4000



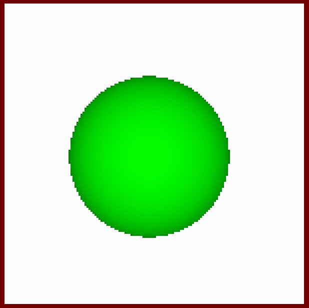
75G



128G



192G



255G

128x2 + 255y 2 + 255z 2 = 4000

192x2 + 255y 2 + 255z 2 = 4000

255x2 + 255y 2 + 255z 2 = 4000

2. The property is irregularly spread on the surface

1. Color equation F(x, y, z, c)

2. Surface equation
Set some value to C (0 or 1) in order to get surface equation.
$F(x, y, z, c) \rightarrow F(x, y, z)$

3. Property equation
Put calculated x, y, z values to the initial equation in order to get one variable equation.
$F(x, y, z, c) \rightarrow F(c)$

2. The property is irregularly spread on the surface

$F(x, y, z, c) \rightarrow F(x, y, z) + F(c)$

Coordinates systems may be different for these equations

Global for all

F(c) local coordinate system coincides with F(x, y, z) local coordinate system

Each equation has its own system

II. Color Equation roots and color correspondence

- Roots absence. Form disappears. Set some color for root absence.

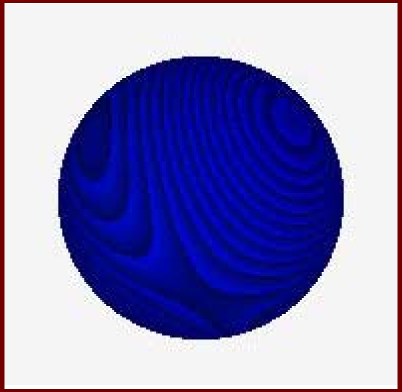
- One or more roots

$$C_j = \frac{\sum_{i=1}^{NumbeOfRoots} C_i}{NumberOfRoots}$$

$$C_j = F(c_i)$$

- Color maps. Value – Color.

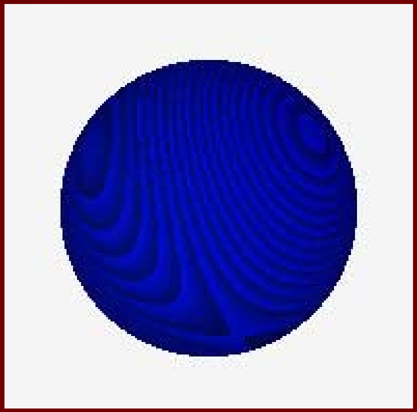
One or more roots

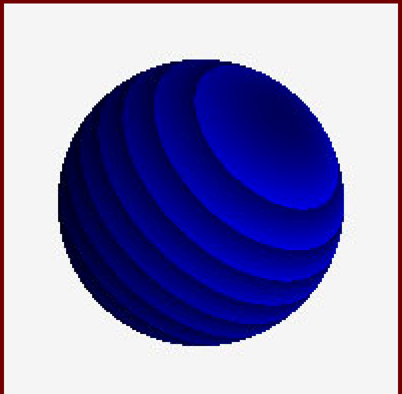


$$50xyc + 50xzc + 25yzc + c^2 - 255c \;\; - 10x^2 - 10y^2 - 10z^2 + 500 = 0$$

$$CC_j = C_j - Min(C_j)$$ $$Min(C_j) = -3280$$

Coefficients influence





$$100xc + 50xyc + 50xzc + c^2 - 255c - 10x^2 - 10y^2 - 10z^2 + 500 = 0$$

$$100xc + 100yc + 100zc + c^2 - 255c - 10x^2 - 10y^2 - 10z^2 + 500 = 0$$

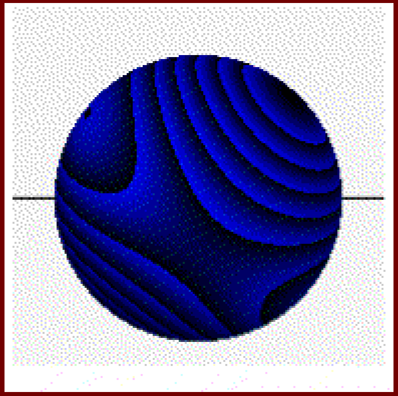
$$CC_j = C_j - Min(C_j)$$

$$Min(C_j) = -3280$$

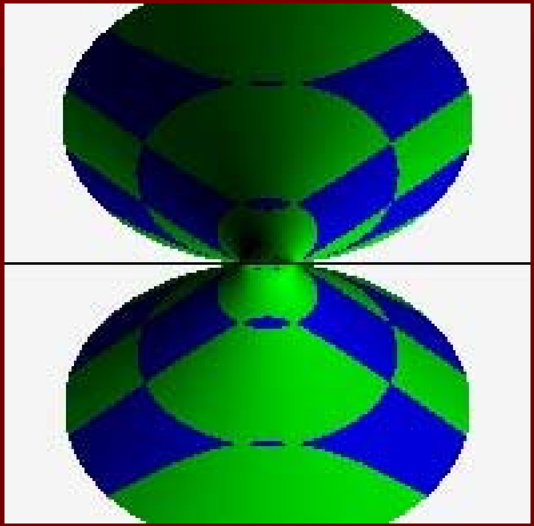
$$CC_j = C_j - Min(C_j)$$

$$Min(C_j) = -969$$

Coefficients influence



Color maps



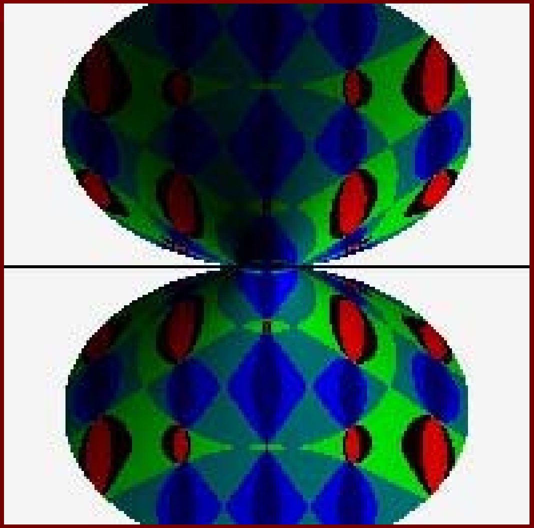
$$100Sin(x)Sin(x)c^2 + 100Cos(y)Cos(z)c - 10x^2 - 10y^2 + 10z^2 + 10 = 0$$

$(MeanRoot = 0)$ color = Red

$(MeanRoot < 0)$ color = Green

$(MeanRoot > 0)$ color = Blue

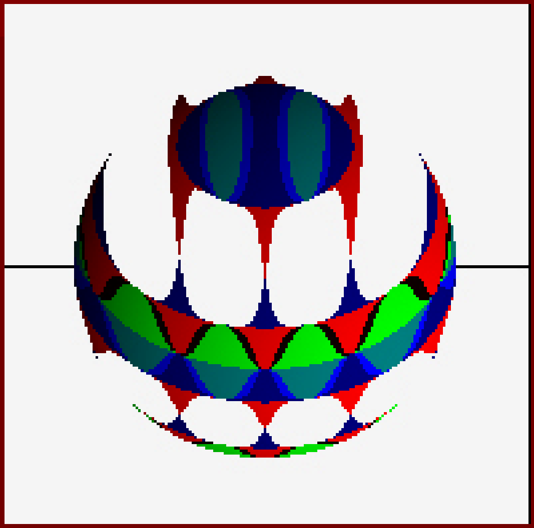
Color maps

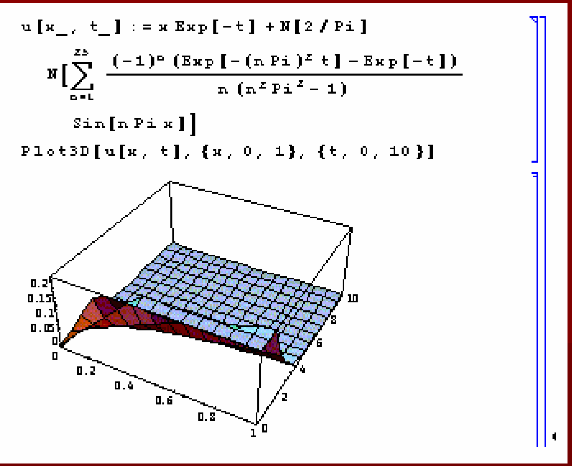


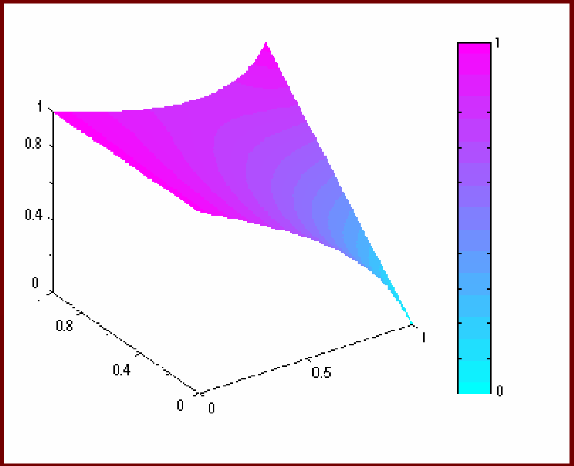
$$100 Sin(x) Sin(x) c^2 + 100 Cos(y) Cos(z) c - 10x^2 - 10y^2 + 10z^2 + 10 = 0$$

Color map is bigger then in previous example

Root absence



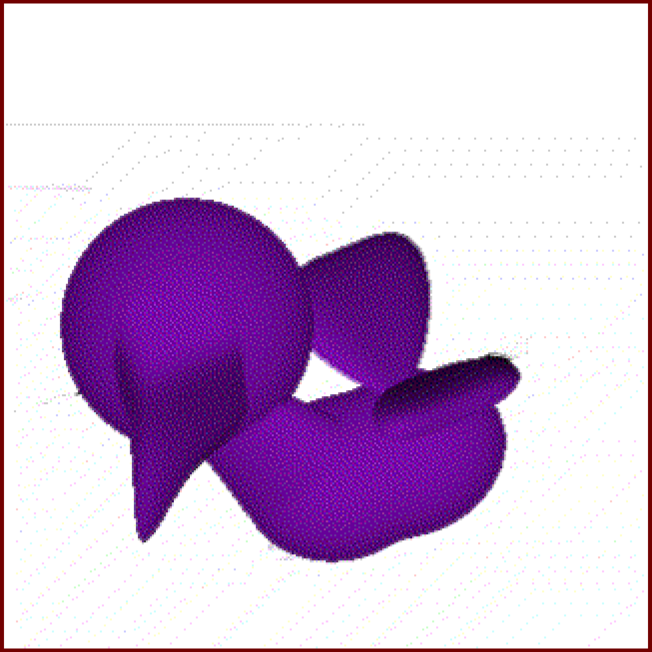




Conductivity and diffusion tasks in the athematica Packet

Mathematical physics tasks in the MATLAB

Color map of temperature spreading inside the car



Thanks!