CZ2003 Tutorial 6 (Electronic week). Possible solutions

Blobby shapes

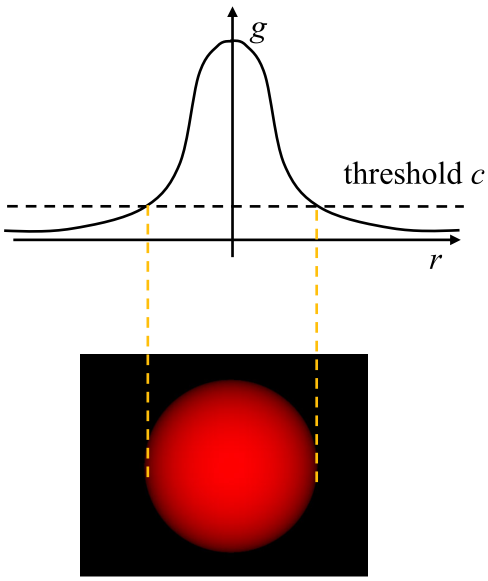
1. Using FVRML, experiment with blobby objects and understand what parameters in the blobby function affect the object size and shape.

The individual blobby function is given as

$$g = f(x, y, z) = ae^{-r}$$

where

$$r = (x - x_b)^2 + (y - y_b)^2 + (z - z_b)^2$$



This bell-shaped function is always positive. To be able to visualize it as an implicit function, we have to deduct from the function a certain threshold value *c* that will make the function equal to zero and less then zero:

$$g = f(x, y, z) = ae^{-r} - c$$

The three areas of the function values *g*, specifically those that >0, =0 and <0, will be define which points will be inside the shape, on its surface and outside the shape, respectively [*refer to blob1.wrl*]

Experiment with the value of *c* and notice that each time one individual blob will be rendered as a sphere but with different radius – function of the threshold value *c*.

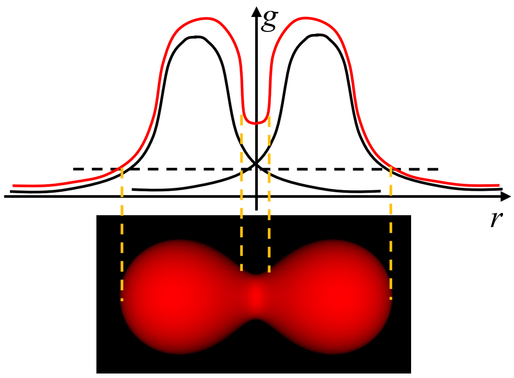
The radius of the individual blob can be also changed by the scaling coefficient *a* in front of the exponent function.

Given that several blobs can be added together, try to use the same threshold value while changing values *a* for each individual blob:

$$g = f(x, y, z) = a_1e^{-r} + a_2e^{-r} - c$$

Here, in each exponent function there should be a different function for r so that the centers of the blobs, defined by their coordinates (x_0, y_0, z_0), are different:

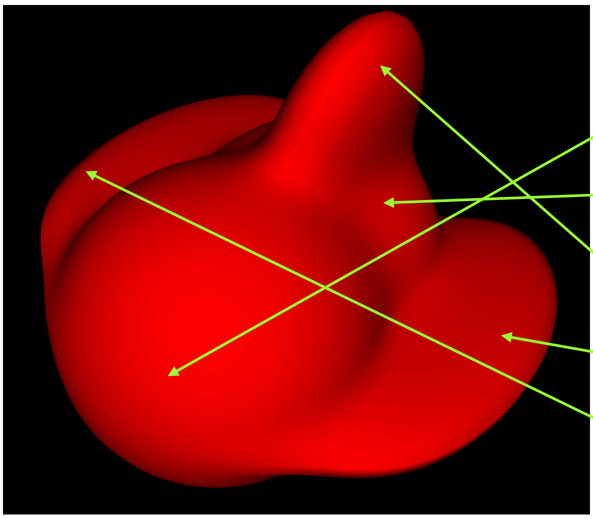
$$r = (x - x_b)^2 + (y - y_b)^2 + (z - z_b)^2$$



[*refer to blob2.wrl*]

Furthermore, each individual blob can be scaled by coefficients s_1, s_2, s_3 as follows:

$$r = s_1(x - x_b)^2 + s_2(y - y_b)^2 + s_3(z - z_b)^2$$



$$g = f(x,y,z) =$$
$$2e^{-\left((x+1)^2+y^2+z^2\right)}$$
$$+e^{-\left((x-1)^2+y^2+z^2\right)}$$
$$+0.3e^{-\left((x-1)^2+(y-2)^2+5z^2\right)}$$
$$+0.3e^{-\left((0.5(x-1))^2+(3y)^2+(z-2)^2\right)}$$
$$+0.3e^{-\left((0.5(x-1))^2+(3y)^2+(z+2)^2\right)}$$
$$-0.05 \ge 0$$

[*refer to blob3.wrl*]

2. Using FVRML, propose a function alternative to blobby object function but such that it does not use exponent function e^n that is quite heavy for calculations

$$g = f(x,y,z) = ae^{-r}$$

where

$$r = (x - x_b)^2 + (y - y_b)^2 + (z - z_b)^2$$

The proposed function must work in a similar way for making soft shapes that consist of several shapes, each defined by its individual function, while their algebraic sum defines the whole shape, as illustrated in Figure Q1.

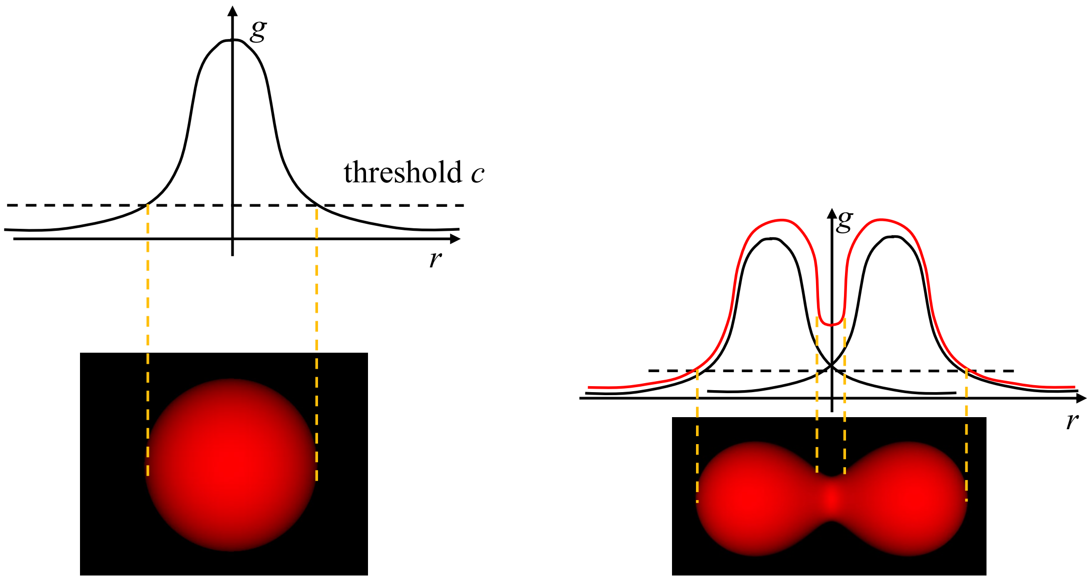


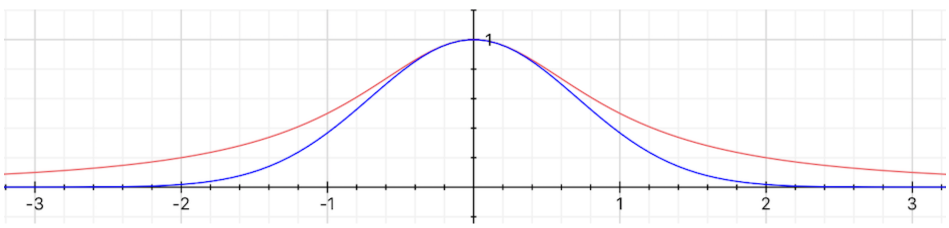
Figure Q1

[*refer to blob1.wrl*]   [*refer to blob2.wrl*]

We have to use one of many ways to define a bell-shaped function, as it is displayed in Figure 1. A possible and frequently used function for approximating it can be as follows:

$$g = f(x,y,z) = \frac{1}{r+1}$$

$$r = (x - x_b)^2 + (y - y_b)^2 + (z - z_b)^2$$



Addition of 1 is needed to avoid zero division when r=0 as well as scaling of the function above 1 when r=[0, 1]. This function will also require a certain threshold c but its value will be, of course, different from that used in the blobby function for defining two similar shapes. Hence, a close equivalent to the shape defined by exp(-(x^2+y^2+z^2))-0.01 will be then defined by 1/((x^2+y^2+z^2)+1)-0.18.
[*refer to blob5.wrl*]

Several individual functions can be added together to make a soft blended object. For example:
2/(((x+1)^2+y^2+z^2)+0.0001) + 1/(((x-1)^2+y^2+z^2)+0.0001) -1.4

defines a shape that look like the one define by the exponent-based functions
2*exp(-((x+1)^2+y^2+z^2)) + exp(((x-1)^2+y^2+z^2))-0.25

[*refer to blob6.wrl*]