CARNEGIE MELLON UNIVERSITY

24658/42640: Image-Based Computational Modeling and Analysis
Due Date: 12:00pm on October 31, 2022

Project 1 – Programming

All the students need to finish two problems, and submit a written report as well as source codes. There is no specific requirement on programming language, you can choose C/C++/Matlab/Python.

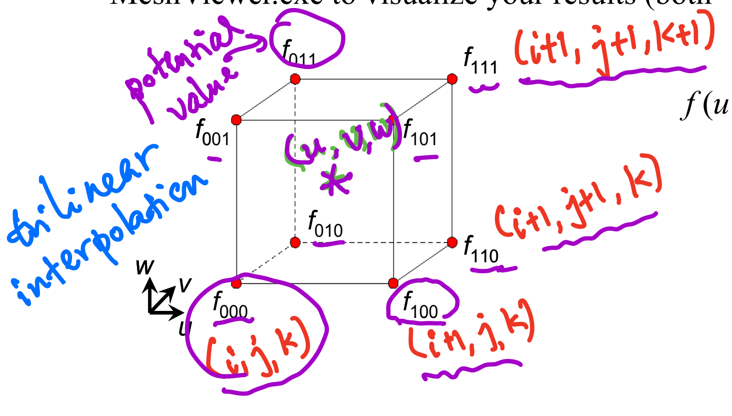
Problem 1 (10 points) Download the Project1.zip file from the Canvas, it includes

- VolumeRover_seg.exe – the VolRover executable file
- qt-mtedu333.dll – QT library file
- MSVCP60D.DLL and msvcrtd.dll – system files
- mri_dcm.rawiv – the input imaging data
- RoverManual_segmentation.pdf – a short manual for segmentation using VolRover + isocontouring
- RoverManul.pdf – the user manual of VolRover
- LittleBigEndian.pdf – a brief description of little endian and big endian.

Please use VolRover to segment the dog brain from mridcm.rawiv, then you will generate two new files called mri_dcm.rawiv_subunit_00.rawiv and mri_dcm.rawiv_subunit_01.rawiv. Take mri_dcm.rawiv_subunit_00.rawiv, write a small code to calculate the volume of the dog brain (unit: mm^3). The rawiv format is given in RoverManul.pdf. (Note: rawiv is in big endian. Big endian is the byte order on SUN, SGI, IBM architecture. Intel's byte order is little endian. In addition, VolRover requires nvidia graphics card on your computer.)

Problem 2 (20 points) Project1.zip also contains the accessibility data (2BG9_acc97129.rawiv) and the electron static potential (2BG9_pot97129.rawiv) of the protein 2BG9. Please use VolRover to generate an isosurface from the accessibility data (triangular mesh, save it in a *_tri.raw file), and calculate the electron static potential value for each vertex on the isosurface by constructing a trilinear function $f(u, v, w)$, where $0 \le u, v, w \le 1$. Print out the maximum, minimum, and mean value of the potential values (unit: dimensionless) on the solvent accessible surface, and write your triangular mesh in *_tri.rawc format. The color map is > 0.1 – blue, < -0.1 – red, [-0.1, 0.1] – white.

The description of raw and rawc formats is available in RoverManul.pdf. You can use MeshViewer.exe to visualize your results (both *_tri.raw and *_tri.rawc files).



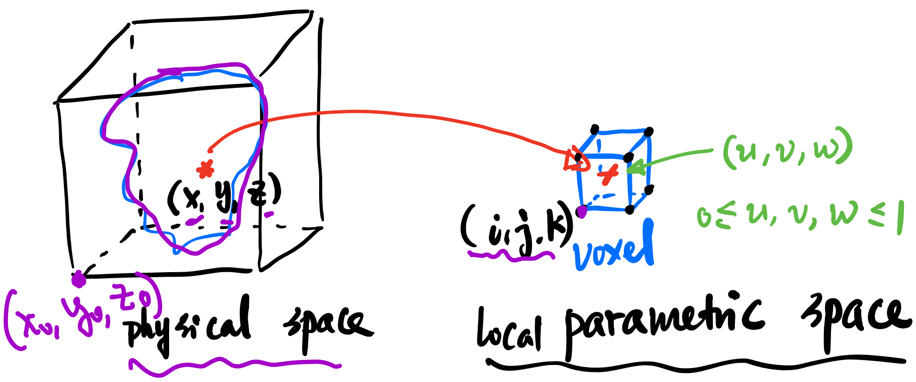
potential values

$$f(u,v,w) = f_{000}(1-u)(1-v)(1-w) + f_{011}(1-u)vw + f_{001}(1-u)(1-v)w + f_{101}u(1-v)w + f_{010}(1-u)v(1-w) + f_{110}uv(1-w) + f_{100}u(1-v)(1-w) + f_{111}uvw$$

Find out (i, j, k) and (u, v, w)

Project 1

Problem 2 :



*_tri.raw

rawiv header

$$x = x_0 + (\underset{\uparrow}{i}+\underset{\uparrow}{u}) * \Delta x \Rightarrow \begin{cases} i = \left[\dfrac{x-x_0}{\Delta x}\right] \\ u = \boxed{\dfrac{x-x_0}{\Delta x}} - i \end{cases}$$

unknowns

← take the integer part

$$y = y_0 + (j+v) * \Delta y \Rightarrow \begin{cases} j = \left[\dfrac{y-y_0}{\Delta y}\right] \\ v = \dfrac{y-y_0}{\Delta y} - j \end{cases}$$

$$z = z_0 + (k+w) * \Delta z \Rightarrow \begin{cases} k = \left[\dfrac{z-z_0}{\Delta z}\right] \\ w = \dfrac{z-z_0}{\Delta z} - k \end{cases}$$

*_tri.raw

#nverts #nelems

	x	y	z
0	⋮	⋮	⋮
#nverts	⋮		
nverts-1	⋮		

connectivity

0	1	2	← each tri
2	3	4	

*_tri.rawc

$0 \le r, g, b \le 1$

#nverts #nelems

#nverts

x	y	z	r	g	b	
⋮	⋮	⋮	0	0	1	← blue
⋮	⋮	⋮	1	0	0	← red
⋮	⋮	⋮	1	1	1	← white

connectivity the same