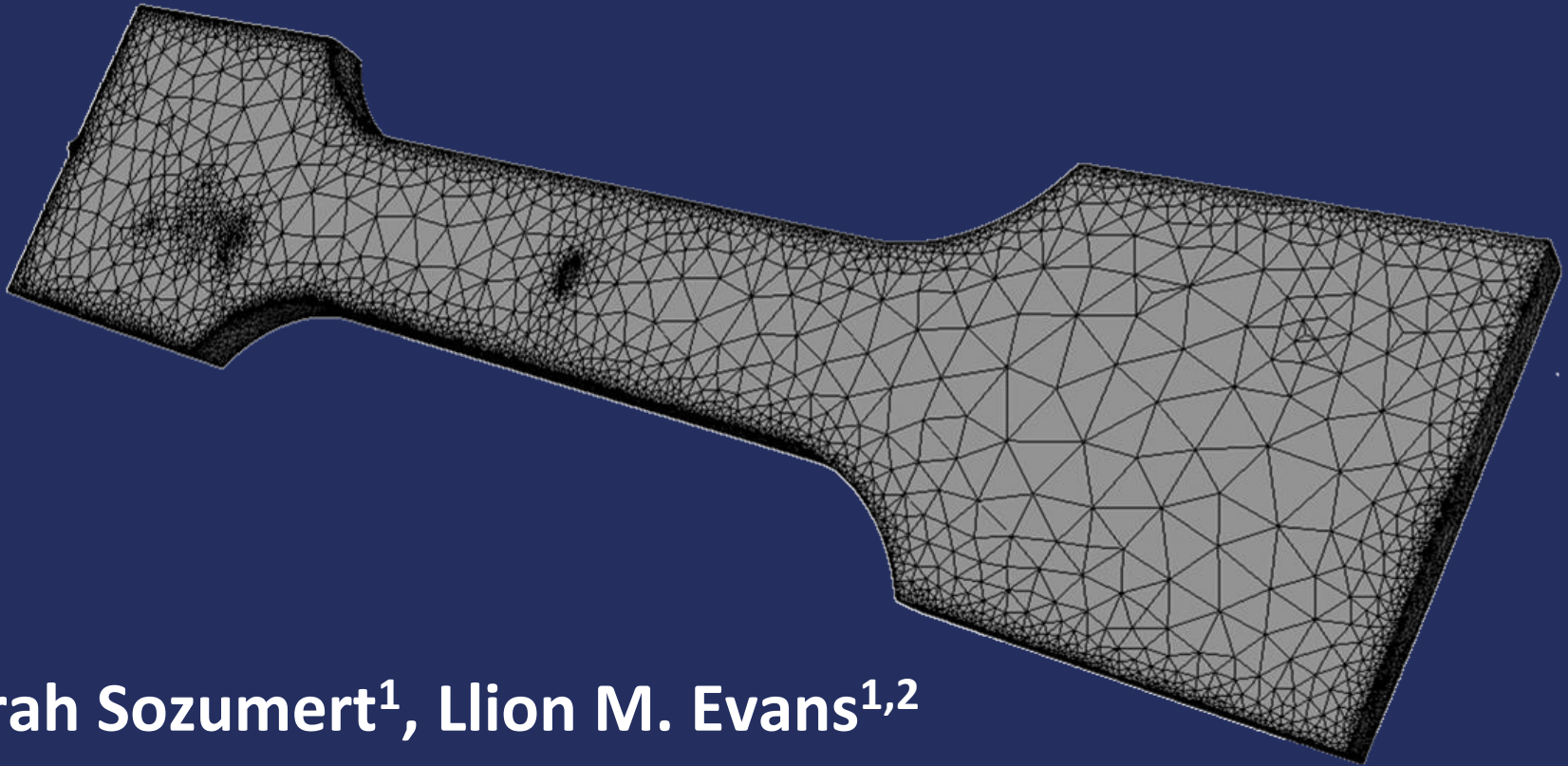


# IBSim-4i 2021: Training **ISO2MESH**



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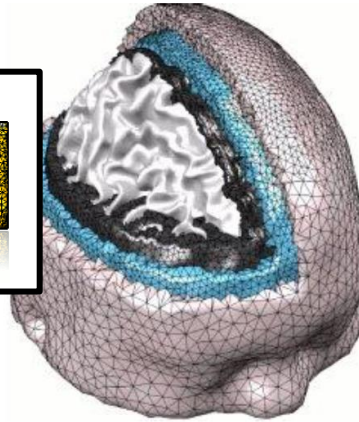
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<sup>2</sup>UK Atomic Energy Authority

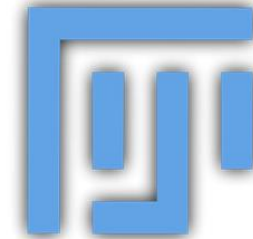
# ISO2MESH

- Hands-on session looking at mesh generation with **iso2mesh**.
- An open-source library of **Matlab/Octave**-based scripts.
- Tetrahedral or surface meshes from **surfaces, 3D binary & grayscale volumetric images**
- Developed by **Qianqian Fang**, Northeastern University, USA.
- Hundreds of research papers used and discussed iso2mesh
- Tutorials mostly based on examples from official iso2mesh website.
- Others developed by the **ZCCE IBSim group, Swansea University**.

## ISO2MESH

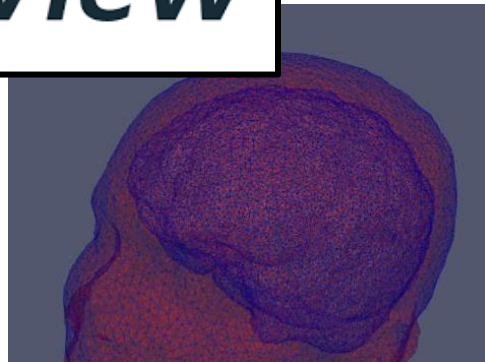


## ImageJ



## ParaView

Mesh visualization  
and quality check  
in ParaView.



## What can Fiji (ImageJ) do?

- Stitching
- Big Data
- Segmentation
- Tracking
- ..

# Virtual Machine (VM) and Octave

Turn on your VirtualLab 'Virtual Machine' from within VirtualBox.

Memory and processors

VM Properties

# Virtual Machine (VM) and Octave

Window size can be adjusted if necessary.

- Octave
- ImageJ
- ParaView

View	Input	Devices	Help
<input type="checkbox"/>	Full-screen Mode		Host+F
<input type="checkbox"/>	Seamless Mode		Host+L
<input type="checkbox"/>	Scaled Mode		Host+C
<input type="checkbox"/>	Adjust Window Size		Host+A
<input checked="" type="checkbox"/>	Auto-resize Guest Display		
<input type="checkbox"/>	Take Screenshot...		Host+E
<input type="checkbox"/>	Recording		
<input type="checkbox"/>	Menu Bar		▶
<input type="checkbox"/>	Status Bar		▶
<input type="checkbox"/>	Virtual Screen 1		▶



**Handouts** present the examples:

- Visualising volumetric data in ImageJ before meshing.
- Import and manipulate image data in Octave.
- Using key iso2mesh functions.
- Introducing key mesh parameters and their effects on resultant mesh.
- Testing surface smoothing methods.

**One script template and one/two solution script for each tutorial:**

*tutorial1\_surf2mesh\_ex1.m*    *tutorial1\_surf2mesh\_ex1\_sln.m*

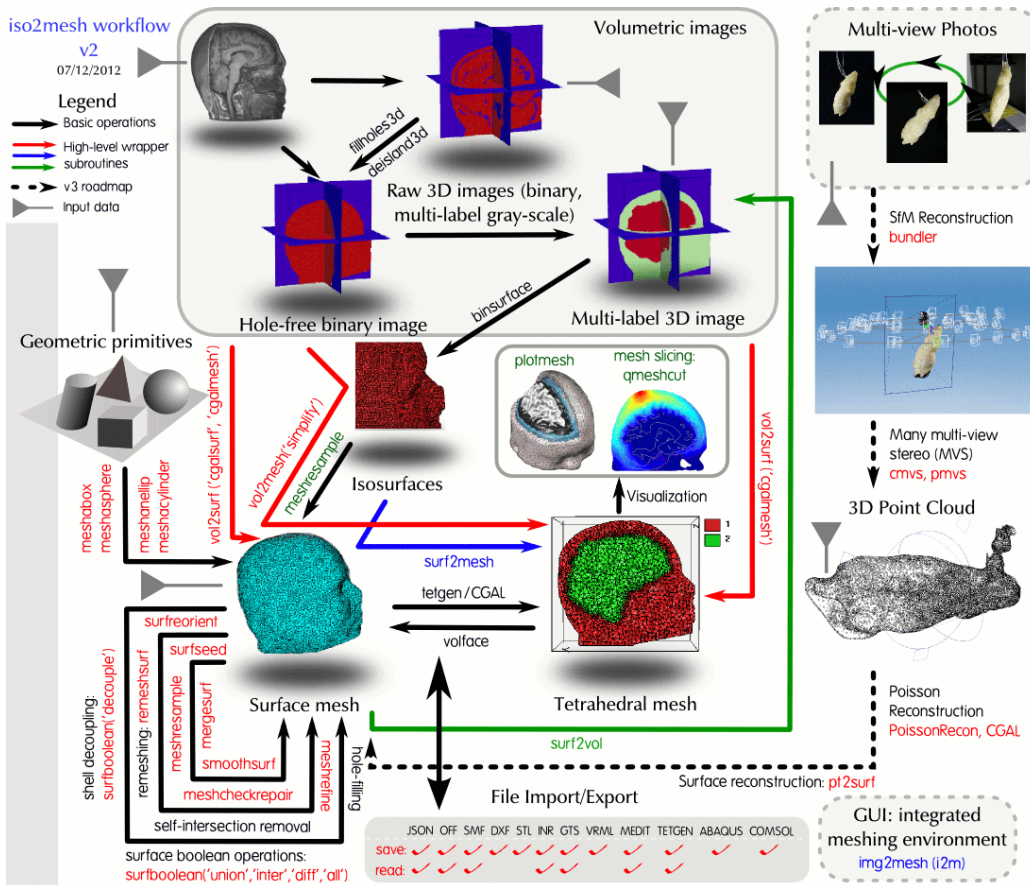
*tutorial2\_vol2mesh\_ex1.m*    *tutorial2\_vol2mesh\_ex1\_sln.m*

*tutorial3\_grayscale\_ex1.m*    *tutorial3\_grayscale\_ex1\_sln.m*

...

...

# iso2mesh Workflow



## Existing functions

## iso2mesh v1.0 function list

	core functions	surface processing	mesh repairing	graphing	binary image processing	mesh processing and inquiry
IO	vol2mesh/v2m	meshresample	meshcheckrepair	plotmesh	fillholes3d	
	vol2surf/v2s	remeshsurf	meshreorient	qmshcut	imedge3d	
	surf2mesh/s2m	smoothsurf/sms	removedupelem		smoothbinvol	
IO	surf2vol/s2v	surfseeds *	removedupnodes		thickenbinvol	
	binsurface	mergemesh *	removeisolatednode		thinbinvol	
			removeisolatedsurf			
IO						finddisconnsurf
						surfedge
						volface
IO						meshedge *
						extractloop
						meshcentroid
IO						nodevolume
						elemvolume
						neighborelem
IO						faceneighbors
						mesheuler
						surfplane *
IO						meshconn
						meshquality *
						raytrace *
IO						

File IO: ASC/OFF/SMF/Medit/INR/POLY/DXF/VRML formats

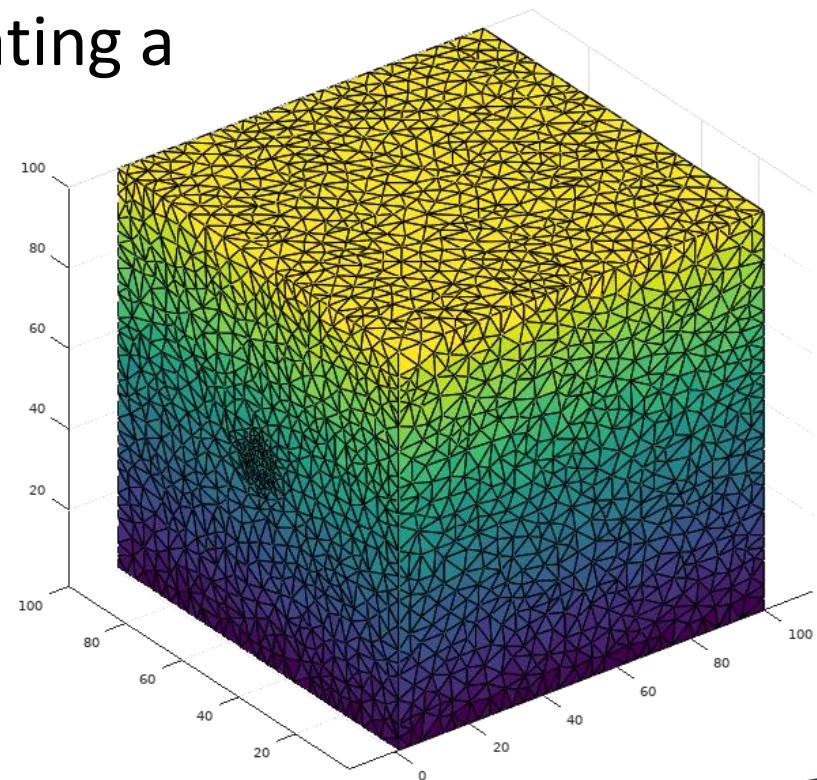
Images: <http://iso2mesh.sourceforge.net/>

## Learning Outcomes

- Getting used to Octave environment and iso2mesh scripts.
- Loading image data and creating a surface mesh.

## Script template(s)

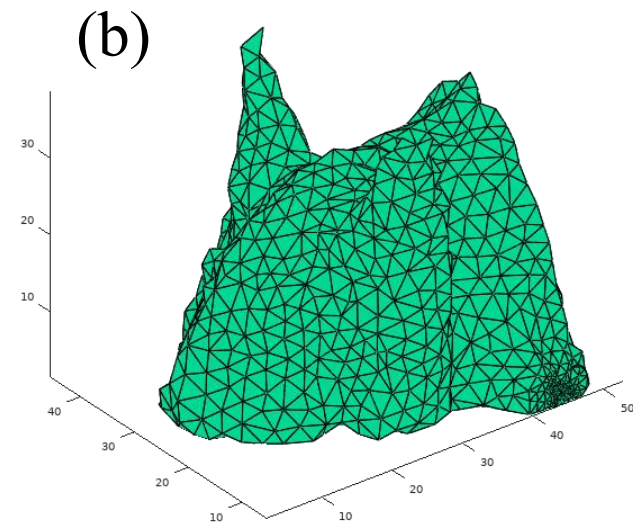
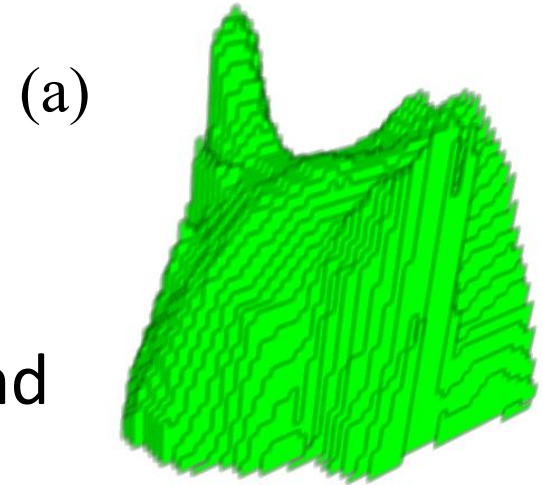
*tutorial1\_surf2mesh\_ex1.m*





## Learning Outcomes

- Generating meshed bodies from binarized volumetric images.
- Compare differences between v2m and vol2mesh functions.
- Comparing resultant meshes.

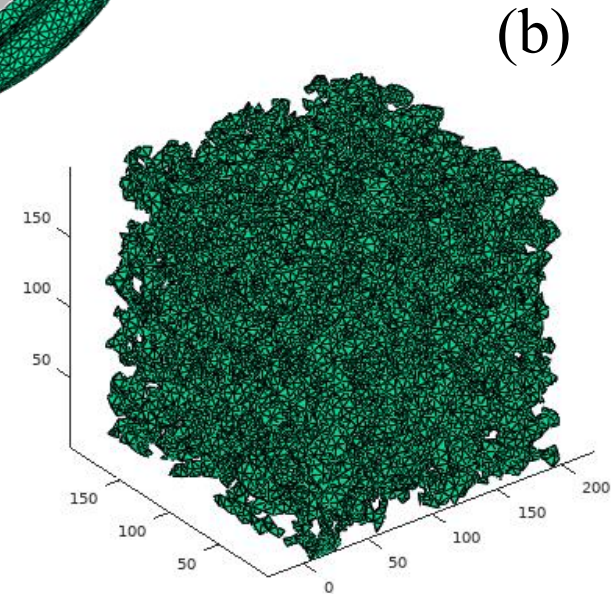
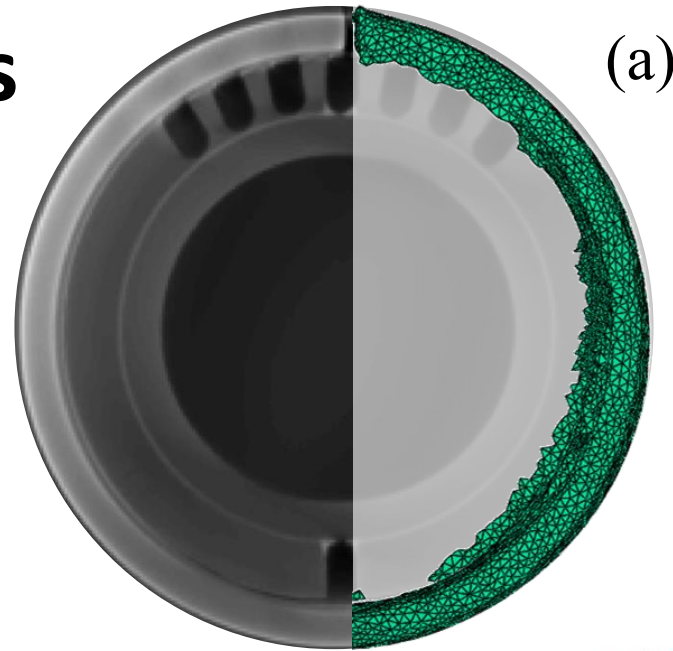


## Script template(s)

*tutorial2\_vol2mesh\_ex1.m*

## Learning Outcomes

- Generating meshes directly from real volumetric greyscale images, e.g. X-ray or MRI images.



## Script template(s)

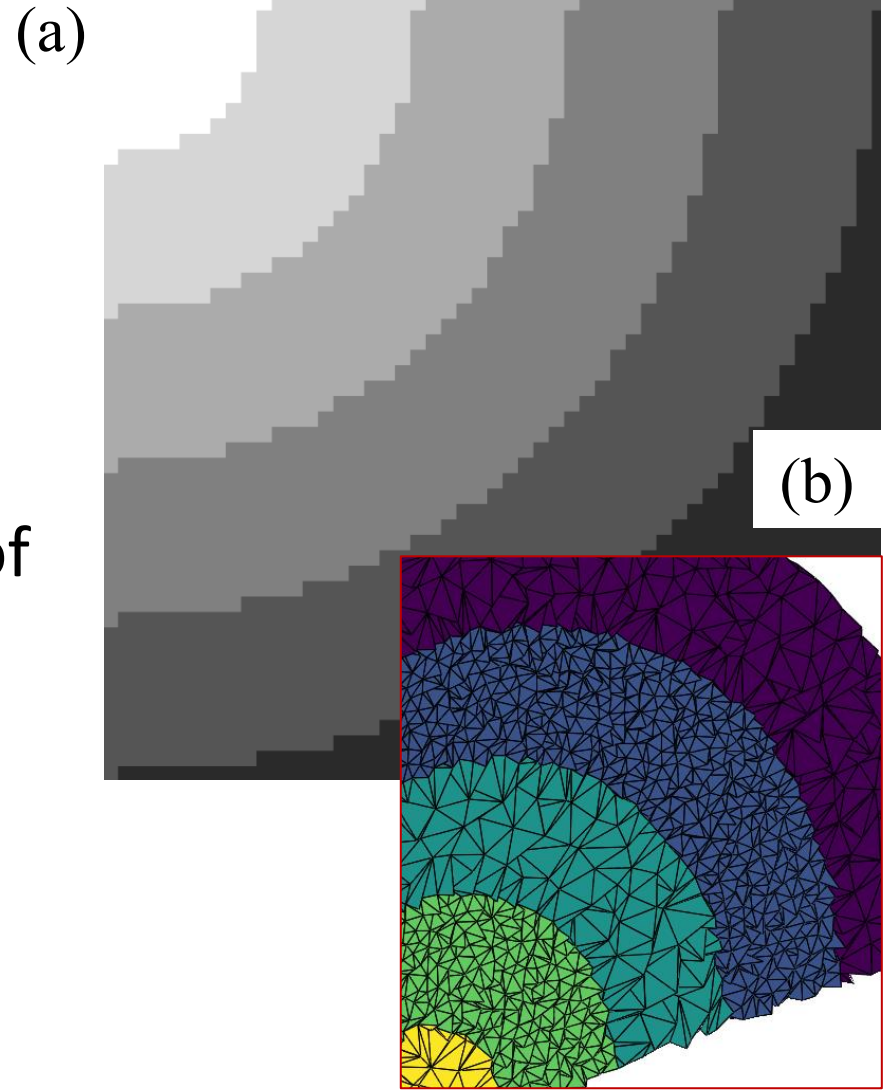
*tutorial3\_grayscale\_ex1.m*

## Learning Outcomes

- Visualising a multi-region body in ImageJ.
- Generating meshes with element sizing parameters unique to specific regions of volumetric data.

## Script template(s)

*tutorial4\_labelling\_ex1.m*



# Learning Outcomes

- Creating meshed bodies from single 2D images.
- Investigating the resultant meshes in ParaView.

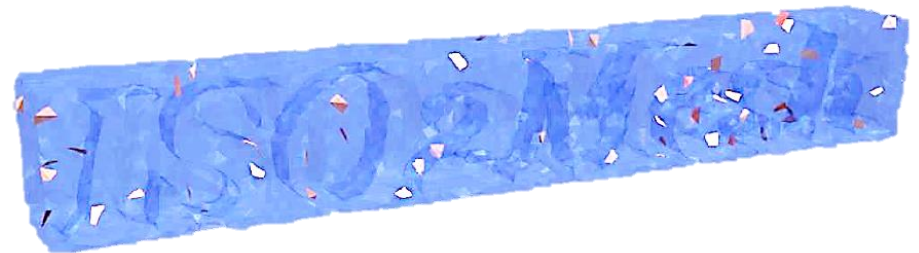
(a)



(b)

## Script template(s)

*tutorial5\_vol2mesh\_ex2.m*



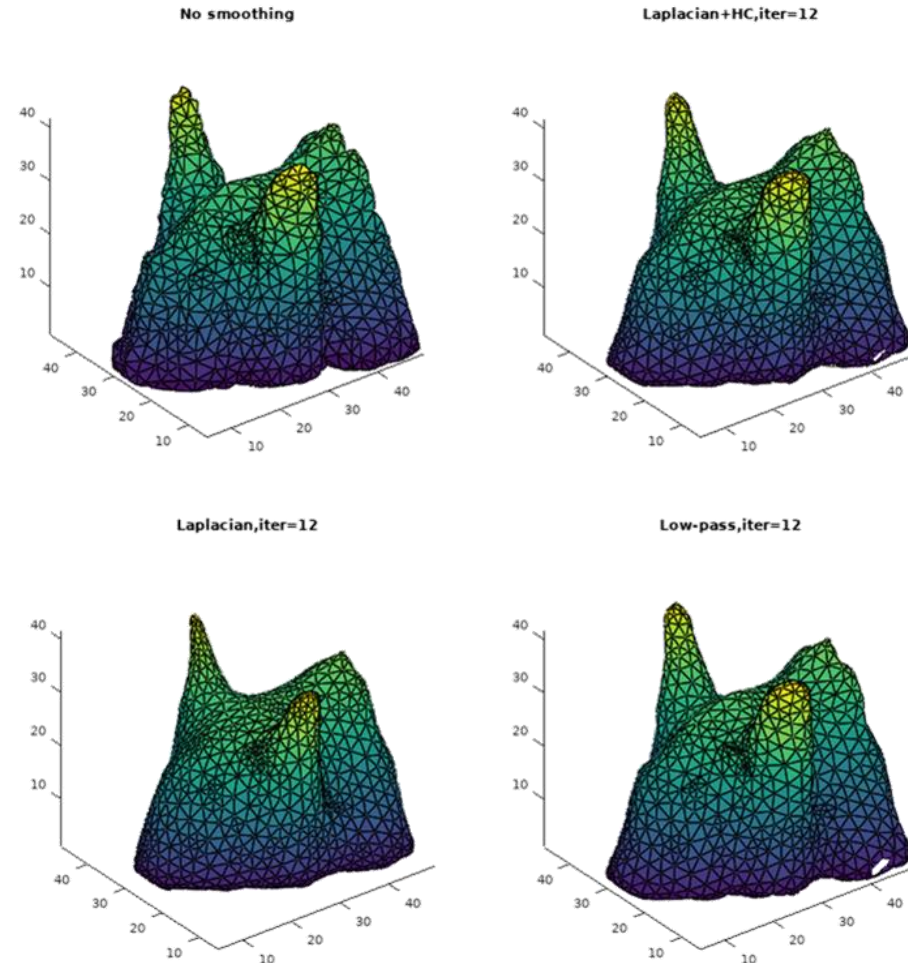


# Learning Outcomes

- Investigating the effects of the chosen smoothing techniques.
- Investigating the effect of different numbers of iterations during the smoothing process.

## Script template(s)

*tutorial6\_smoothing\_ex1.m*

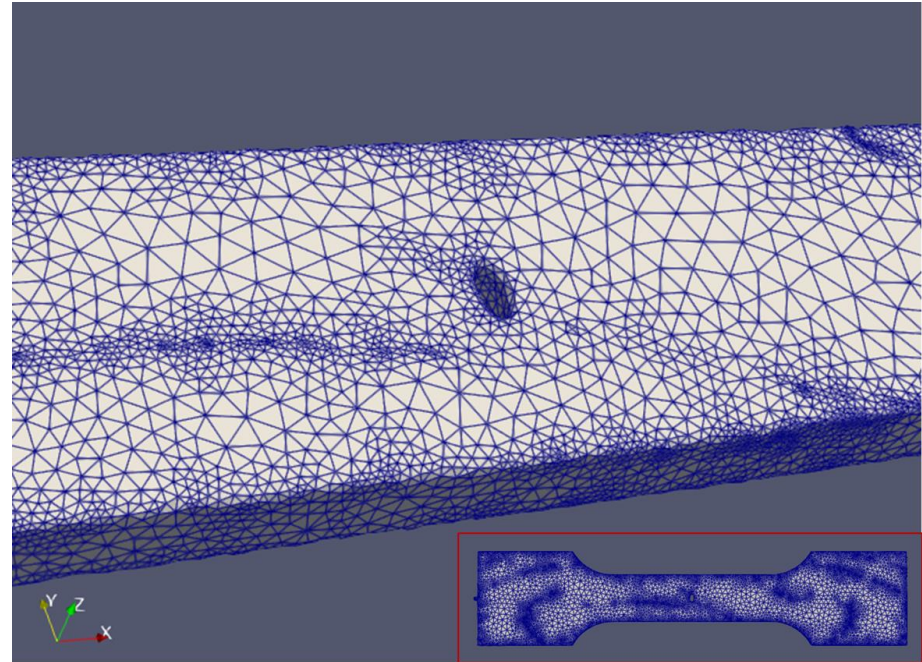


# Learning Outcomes

- Consolidate lessons learnt by putting into practice.
- Appreciation for a few aspects of preparing meshes to be 'simulation ready'.

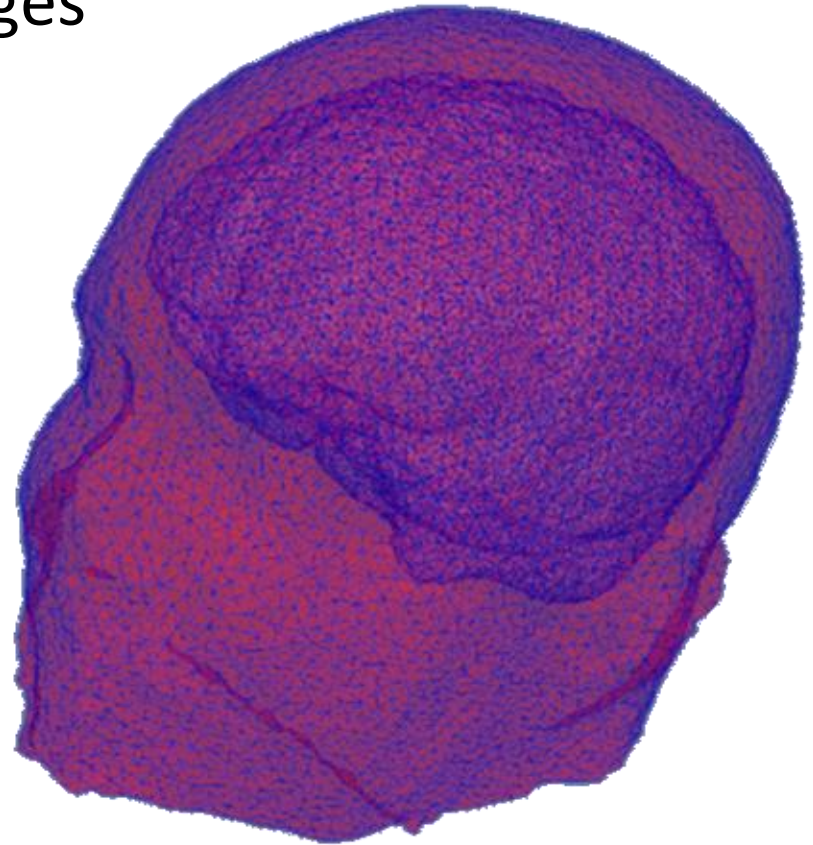
## Script template(s)

*tutorial7\_vol2mesh\_ex3\_sln.m*



# Learning Outcomes

- Appreciation of some challenges when combining images.
- Meshing multiple levelsets.
- Visualising multiple phases in ParaView.




## Script template(s)

*tutorial8\_vol2mesh\_ex4\_sln.m*

# Suggested Timetable

**Tue 19 Oct 2021**

9:00	Introduction
9:30	Tutorials 1-3
10:30	Coffee 
11:00	Tutorials 4-8
12:30	Lunch