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Trabecular Bone Model from µCT Data

This time, instead of creating a synthetic, parametric trabecular bone geometry, you will use µCT data to reconstruct the geometry of actual trabecular bone from a sheep tibia. You shall generate a FE model of a representative volume element (RVE) and investigate different mechanical properties of the microstructure of trabecular bone.

Tasks

1. Download the µCT data from the course's home page ("biopsy00").
2. Reconstruct the geometry of a RVE of the biopsy.
3. Determine the bone volume fraction, the RVE's apparent density, pore and trabecula size.
4. Create an FE model.
5. Determine apparent material properties (stiffness) in all directions.
6. Try to derive the most likely *in vivo* load direction (cf. van Rietbergen et al., 1996)
7. Compare your result to Carter and Hayes' density-stiffness relation.
8. Compare the results to your synthetic model.

Notes on 'Geometry Reconstruction'

- The visualization and image processing tool Avizo is installed on all MAC pool clients. There is a limited number of floating licenses available; please share them by working together in small groups.
- The provided µCT data is a bit unusual as it is a raw binary (instead of DICOM or a stack of PNG images). You'll need the following meta-data to accomplish your tasks:
    - Voxel count: 150×150×150
    - Isotropic resolution of 30 µm (→ 4.5 mm edge length)
    - Gray value resolution: 8 bit (unsigned)
    - Low X-ray absorption → bright, high X-ray absorption → dark
- The edge length of your RVE should be > 2.1 mm to get reliable results
- Important Avizo modules are:
    - "Edit new label field"
    - "Generate surface"
    - "Remesh surface"
    - "Generate tetra grid" (maybe)
- You can export generated data by selecting it in the project view and then File → Save data as …
- Surface meshes should be exported in STL format
- You may have to convert solid mesh data generated by Avizo using ANSYS Classic or ANSYS ICEM CFD, before being able to use it in ANSYS Workbench