Formus Labs Ltd

Pre-interview Questions

Medical Imaging Research Engineer

Dear applicant,

Thank you for your interest in joining Formus Labs. This set of problems aim to assess your skills specific to the role of Medical Image Research Engineer. Question 1 is a coding problem composed of several parts that build on each other. Question 2 seeks a written answer about research planning.

Please email your solutions to your recruitment contact the day before your interview. For code solutions, please share your code via a Github or Bitbucket account. Provide clear documentation for building and running your code, and interpreting results when appropriate. You may use a programming language of your choice, but Python is preferred.

For written answer questions, please send as a PDF document.

Question 1: Image Segmentation

Extraction of 3D geometry from 3D medical images is a routine part of our workflow. We would like you to produce code to perform a series of operations on an example CT scan.

First download the example CT scan here. The zip file contains 200 slices of a CT scan, where each slice is in the standard DICOM format. The slices stacked together to form a 3D image volume. The metadata in each DICOM file contains information about (amongst others) image size, image position and size relative to the CT scanner, and scanner settings. **Hint:** you may find it useful to use a DICOM viewer application to inspect the scan.

a. Please write a program to read the scan and print out
    i. The maximum voxel intensity
    ii. The mean voxel intensity
    iii. The coordinates of the centre of the image volume, in the scanner coordinate system.

    Hint: in each slice, the spacing between pixels is 0.97 mm x 0.97 mm. The distance between each slice is 1.6 mm. You may also use the information in the DICOM header to help you calculate coordinates.
    Hint: If you are using Python, you may want to use the pydicom package to help with reading these files.
    Fallback: If you are not able to read DICOM files, you may use this set of .tiff files which have equivalent image information but is missing metadata.

b. Please write a program that reads the scan, segments the metal objects in the scan (treat all metal objects as 1 object), and write to file the segmentation as a series of binary image files (one for each slice of the scan).

c. Using the output binary image files, train a neural network of your choice to replicate the segmentation task in **step c**. Provide a metric to quantify the error between the segmentation produced by your neural network and your program in step b.

Question 2: Validation Study

Measuring the anatomy of the hip joint is a key part of planning for a hip replacement surgery. Key measurements such as the diameter of the hip socket (acetabulum) help surgeons decide the size and type of implants they will use.

There are various technologies and software for automatically measuring patient anatomy from 3D medical images. We would like to perform a validation study to assess the accuracy of one such technology against manual measurements by a clinician. Please come up with an outline of the study methodology (**bullet points, ½ - 1 page max**) that you may use to carry out this validation.

Note that this study is not about developing the technology, but validating its accuracy. Things you may consider are:

- Sample size
- Data collection protocol
- Appropriate statistical analysis