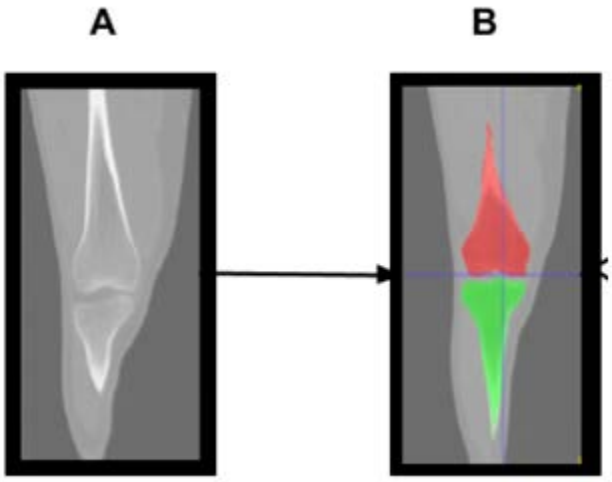
Overview of task 3.

Build pipeline for feature extraction and comparison from knee CT scan. Use the CT scan file provided in Task 1 for this exercise.

Pipeline Steps:

1. **Segmentation-Based Splitting:**
    a. Separate the 3D knee CT mask into three regions:
        i. Tibia region (green)
        ii. Femur region (red)
        iii. Background / non-bone region



2. **Convert 2D Pretrained Model to 3D:**
    a. Take a 2D pretrained DenseNet121 model from torchvision.

```
import torchvision.models as models
model_2d = models.densenet121(pretrained=True)
```

    b. Inflate all 2D convolutional layers to 3D:
        i. For each Conv2D layer with weights of shape (out_channels, in_channels, height, width), repeat the weights along a new depth dimension to obtain shape (out_channels, in_channels, depth, height, width).
        ii. Normalize the repeated weights by dividing them by the depth to maintain consistent scaling.
3. **Feature Extraction:**
    a. For each input 3D volume and region (Tibia, Femur, Background):
        i. Run through the converted 3D CNN.
        ii. Extract feature maps from:
            1. Last convolution layer
            2. Third-last convolution layer
            3. Fifth-last convolution layer

iii. Apply global average pooling (GAP) to each extracted feature map to produce a fixed N-dimensional feature vector.

4. **Feature Comparison:**
    a. For each pair of regions (Tibia ↔ Femur, Tibia ↔ Background, Femur ↔ Background):
        i. Compute cosine similarity between their extracted feature vectors.
        ii. Perform this comparison for features from the last, third-last, and fifth-last convolution layers.
5. **Result Organization:**
    a. Save all cosine similarity values into a single CSV file:
        i. Each row corresponds to one image (or image pair).
        ii. Each column corresponds to one of the 3 layers.
    b. Source code that reproduces your results should be submitted through GitHub.
    c. Zipped file of GitHub repo for this task. (You can navigate to <Code> button in green and use Download Zip function as described here.)

Links

- **Data:** **https://drive.google.com/file/d/1NR7OEboARP_fpseIZOY0Wy8Ir1NEYfL5/view?usp=drive_link**

- **Submission:** **https://forms.gle/q44gT5AqNyHwG3558**