Bone & Joint Open

Supplementary Material

10.1302/2633-1462.310.BJO-2022-0082.R1

Supplementary Methods

All images were first resized to 1,024 x 3,072 pixels and normalized (adaptive histogram equalization) to allow for contrast enhancement and better visualization of detail.[1] Images were excluded if they were not suitable for resizing due to padding. Furthermore, images were excluded from analysis if they were cropped, not centered, had obscured landmarks, the algorithm failed to correctly identify landmarks, or had overlapping talus and fibula segments. From the included patients, a sub-cohort of 250 patients were randomly selected for machine-learning model creation, and training and validation cohorts were split in an 8:2 ratio. Given the size limitation of CNNs, each image was split into six 512 × 1,024 segments for training and validation of the model, leading to a total of 1,500 (250 × 6) images used for training and validation.

A pre-trained deep-learning model for image analysis was chosen for the base network architecture (ResNet-34).[2] For model training, loss function, hyperparameter, and learning rate, the fastai (V2.3.0) deep-learning library was used.[3] Batch size was set to 2 for model training and the datasets were randomly split into training and validation sets in an 8:2 ratio (1,200:300 images). The training set data were also augmented by applying rotation, zoom, and wrap transforms. The neural network was trained for 75 epochs, and the optimal model was chosen based on the multiclass dice-coefficient. The models were trained with PyTorch on a 12 gigabyte NVIDIA Tesla K80 Graphics Processing Unit (GPU).

References

1. Pizer SM, Amburn EP, Austin JD, et al. Adaptive histogram equalization and its variations. *Computer Vision, Graphics, and Image Processing*. 1987;39(3):355-368.
2. He F, Liu T, Tao D. Why ResNet Works? Residuals Generalize. *IEEE Trans Neural Netw Learn Syst*. 2020;31(12):5349-5362.
3. Howard J, Gugger S. Fastai: A Layered API for Deep Learning. *Information*. 2020;11(2).

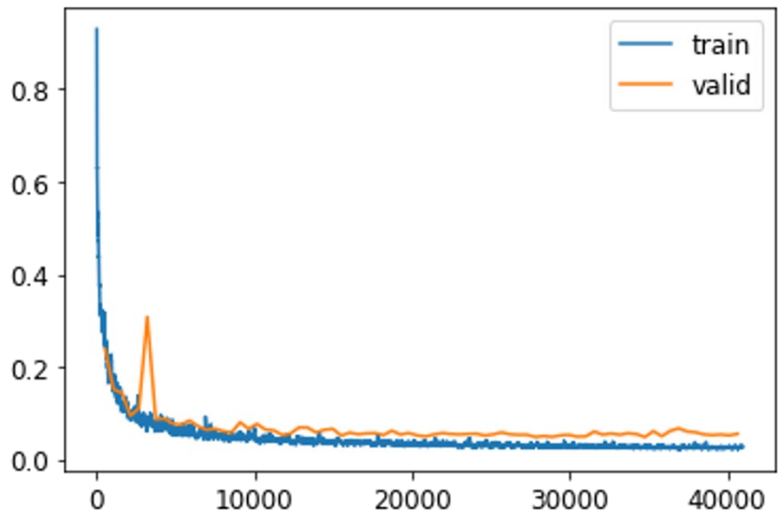

Fig. a. Loss over time for training and validation cohorts for soft-tissue deep-learning model.

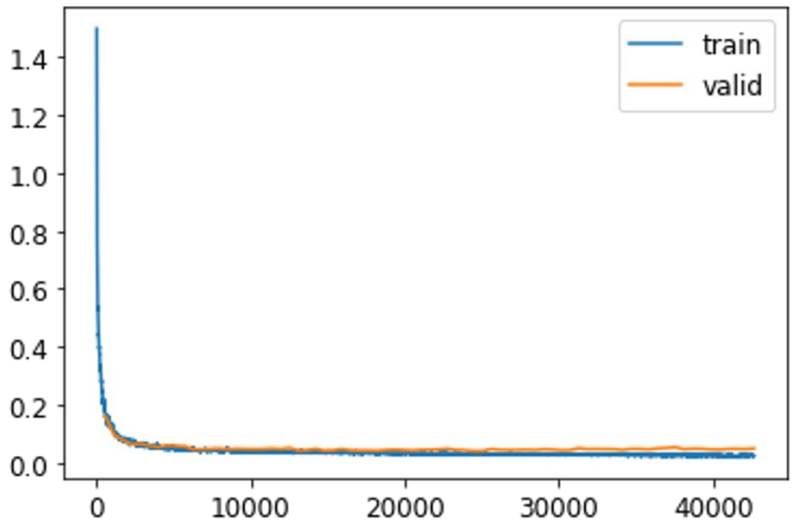

Fig. b. Loss over time for training and validation cohorts for bone landmark deep-learning model.

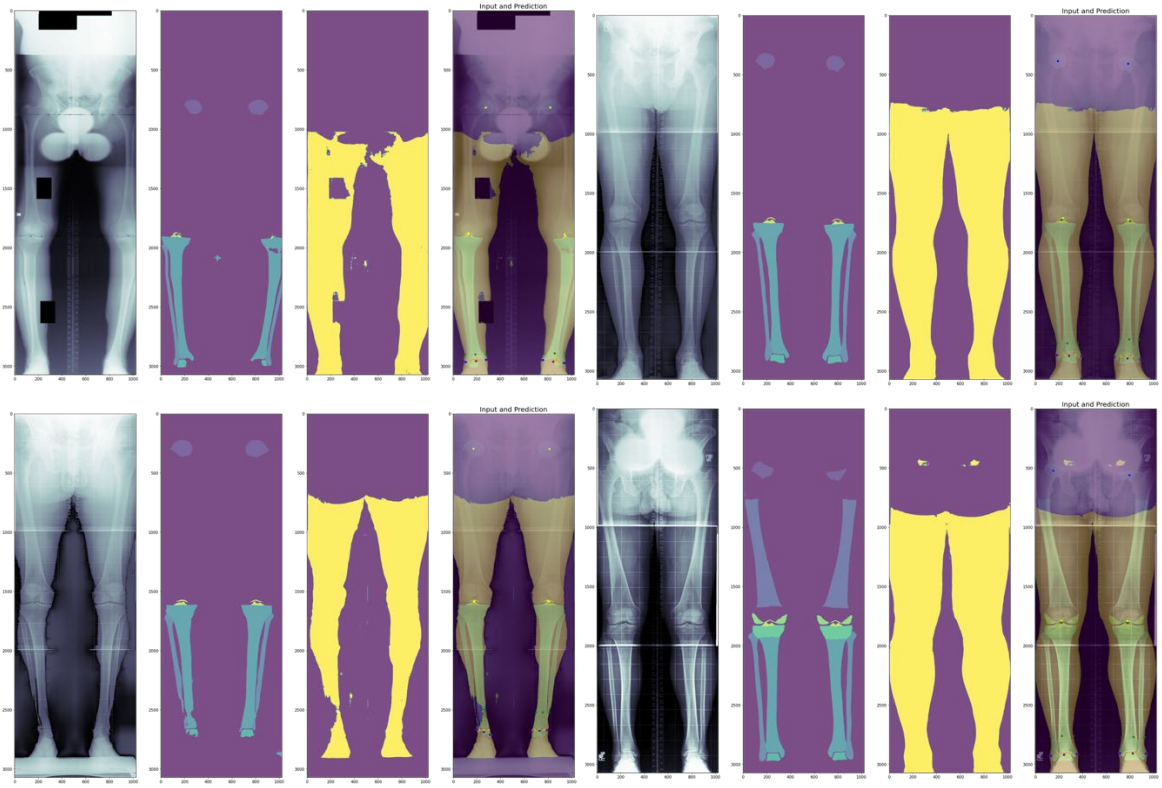

Fig. c. Excluded images for final analysis. Upper left = wrong talus prediction. Upper right = overlapping talus on image. Lower left = soft-tissue not visible. Lower right = occluded image (femoral head).