PS01.09
APPLICATION OF INTELLIGENT MODELS FOR TUMOUR REGION SEGMENTATION IN PET/CT IMAGES

D. Santamaría Santamaría[1], D. García García[1], J. Sánchez Jiménez[2], L. M. Núñez Martínez[2], D. Lisei Coscia[3], C. Salvat Dávila[3], M. Nevares Herrero[3], G. Castillo Simón[3], J. J. Duque Gallo[3]

[1]Universidad de Burgos, Computer Engineering, Burgos, Spain
[2]Hospital Universitario de Burgos, Medical Physics Department, Burgos, Spain
[3]Hospital Universitario de Burgos, Nuclear Medicine Department, Burgos, Spain

Introduction: The objective of this study is the implementation and evaluation of a convolutional neural network (CNN) designed to segmentate tumour regions for three oncological pathologies: lung cancer, lymphoma, and melanoma.
Materials & Methods: We employed segmentation models based on a CNN previously trained on a dataset composed of 900 patients, validated in other centres. The dataset included patients who underwent FDG-18-PET-CT exams. Dataset included patients with histological diagnosis of malignant melanoma, lymphoma, or lung cancer and negative control patients. For the analysis, a sample of 15 patients aged between 20 and 55 years was used. The sample was representative of the variability in patient characteristics to ensure models robustness.
Results: The models achieve tumour region segmentation with high precision. Dice coefficients higher than 0.5 were observed, along with elevated values of sensitivity and specificity for each pathology studied. Specifically, for the BDAV segmentation type, a Dice coefficient of 0.514, sensitivity of 0.657, and specificity of 0.999 were obtained, while for the BlackBean segmentation type, a Dice coefficient of 0.526, sensitivity of 0.589, and specificity of 0.999 were recorded.
Summary: The implementation of intelligent models for tumour segmentation in PET-CT images promises a significant contribution to the task of identifying and delineating tumours. This tool can improve the efficiency of the diagnostic process by providing accurate and consistent segmentations, enabling better treatment planning and precise monitoring of the disease progression. The integration of intelligent models into clinical practice can enhance patient care and optimize resources in the field of oncology.
Appendix:

a) Segmentation Results Analysis

Type of segmentation	Dice coefficient	Sensitivity	Specificity
BDAV	0.514	0.657	0.999
BlackBean	0.526	0.589	0.999

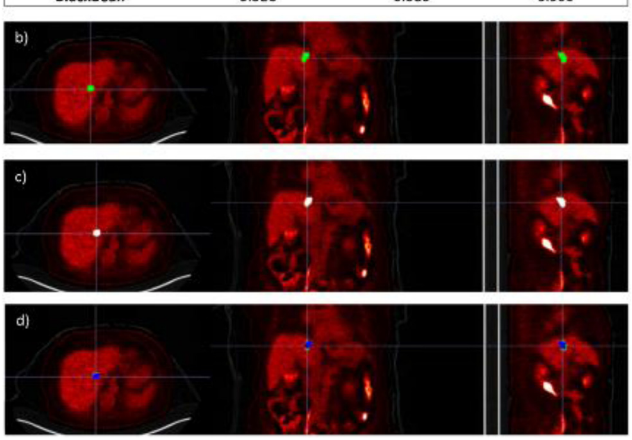

Figure 1: a) Results of both segmentation models. b) Manual segmentation of a patient. c) BlackBean segmentation (blue) over manual segmentation (green). d) BDAV segmentation (white) over manual segmentation (green).

European Journal of Medical Physics 125S1 (2024) 104011
doi:10.1016/j.ejmp.2024.104011

PS01.10
AUTOMATED DETERMINATION OF VERTEBRAL BONE QUALITY FROM T1-WEIGHTED MRI DATA USING CONVOLUTIONAL NEURAL NETWORK

K. Stojšić[1], S. Jurković[1,2]

[1]University Hospital Rijeka, Medical Physics and Radiation Protection Department, Rijeka, Croatia
[2]Faculty of Medicine, University of Rijeka, Department of Medical Physics and Biophysics, Rijeka, Croatia

Introduction: Studies have revealed a correlation between MRI-based vertebral bone quality (VBQ) score and bone mineral density (BMD) determined with dual-energy X-ray absorptiometry (DEXA). This investigation aims to automate VBQ determination using a convolutional neural network (CNN) to segment vertebrae and cerebral spinal fluid (CSF) using T1-weighted MRI data of the cervical and lumbar spine accurately and consistently. The merit of exclusion of bone islands in the VBQ score and determination of heterogeneity of vertebrae signal were also investigated.
Materials & Methods: T1-weighted MRI data used for training and validation was acquired by a 1.5 T MRI system. Preprocessing of image data for manual segmentation and labeling was accomplished with an in-house developed Python script. U-Net CNN architecture was chosen for model training. The trained models' performance was evaluated with a test set of image data.
For each clinical data, three calculations were performed: standard VBQ calculation, VBQ calculation with bone islands excluded and heterogeneity calculation for each individual vertebra. Bone islands were identified and segmented with an in-house developed Python script.
Results: CNN has achieved convergence after a large number of iterations. Test set of image data has shown that the loss functions have been minimized. Preliminary results of bone island exclusion and heterogeneity calculation are promising, but further investigation is required.
Summary: Automatic segmentation of vertebrae and CSF from T1-weighted MRI data was achieved by training a convolutional neural network. This segmentation method was used for VBQ measurement with and without bone islands and heterogeneity calculation.

European Journal of Medical Physics 125S1 (2024) 104012
doi:10.1016/j.ejmp.2024.104012

PS01.11
ANALYSIS OF BONE DENSITY OF THE EDENTULOUS JAWS USING CONE-BEAM COMPUTER TOMOGRAPHY IMAGES

T. Strohonova[1], S. Varzhapetian[1], A. Varzhapetian[1]

[1]Zaporizhzhia State Medical and Pharmaceutical University, Department of Medical Physics, Biophysics, and Further Mathematics, Zaporizhzhia, Ukraine

Aim: To study the existence of a relationship between the density of bone tissue and the length of the edentulous part of the tooth row.

Materials & Methods: Evaluation of the density of the spongy substance of the jaws by the maximum and average value of HU. The density of cancellous bone was evaluated only in the areas available for implant placement. The groups consisted of the localization and extent of the dentition defect. Statistical methods included the estimation of the arithmetic mean (M), standard deviation (sigma), error of the mean (m), confidence interval (95% CI), estimation of the median (Me) and interquartile range ([Q1; Q2]), Student's test (t criterion).
Results: Maximum and average indicators of cancellous bone density in defects of the upper (562.4 [347.1; 777.8] and 301.5 [163.0; 439.9], respectively (p = 0.84) and lower (1379.0 [1116.2; 1641.9] HU and 848.6 [630.6; 1066.6] HU, respectively, p = 0.96) jaws in the areas of molars and premolars with "large" defects are significantly different from the indicators "small" defects (299.7 [176.9; 422.4] and 642.6 [470.4; 814.9], 1061.1 [866.5; 1255.7] and 608.3 [440.5; 776.1, respectively). The average bone density of the alveolar process of the upper jaw is almost the same in defects of different lengths. The average density of the cancellous bone of the alveolar part of the lower jaw in "large" defects has significant differences from "average" ones (p = 0.02) and "small" (p = 0.005) defects.
To assess the relationship between the bone density at the site of edentia (future implantation), the number of pixels and number of Hounsfield units, image analysis was carried out. Multilayer perceptron (MLP) and radial-basis function (RBF) neural network models were used (Statistica 10).
Conclusions: The average density of cancellous bone of the alveolar part of the lower jaw in "large" defects has significant differences from "medium" (p = 0.02) and "small" (p = 0.005) defects, and regardless of the extent of the dentition defect corresponds to class D3 (350-850 HU) according to the Misch classification. The average density of cancellous bone of the alveolar process of the upper jaw in the areas of molars and premolars does not have significant differences depending on the extent of the dentition defect and corresponds to class D4 (150-350 HU) according to the Misch classification. Since one class includes a large range of values, the clinical classification of Misch does not allow taking into account individual bone density indicators that have statistically significant differences in different areas of the dentition. Both models MLP and RBF were showed a strong agreement between the predicted and experimental values.

European Journal of Medical Physics 125S1 (2024) 104013
doi:10.1016/j.ejmp.2024.104013

PS01.12
AUTOSEGMENTATION OF LYMPH NODE LEVELS IN RADIOTHERAPY OF PATIENTS WITH HEAD AND NECK TUMORS

F. Wagner[1], K. Dvornikovich[1], D. Neugebauer[1], F. Stritzke[1], S. Regnery[1], L. Bauer[1], P. Schröter[1], K. Weusthof[1], H. Franke[1], J. Debus[1], S. Klüter[1], T. Held[1]

[1]*Heidelberg University Hospital (UKHD), Radioonkologie, Heidelberg, Germany*

Introduction: Precise contouring of lymph node levels plays an important role in treatment planning for patients with head and neck tumors in order to achieve adequate tumor control on the one hand and to spare healthy tissue as much as possible on the other. However, contouring is time-consuming and subject to significant inter-individual variations. The aim of this project is therefore to evaluate two commercially available autosegmentation softwares with regard to the contouring of lymph node levels in the head and neck region.

Materials & Methods: Patients with head and neck tumors (n = 50) treated at Heidelberg University Hospital between 2022 and 2024 were retrospectively selected. The lymph node levels included in the expert CTV and resulting PTVs will then be compared with the contours created by the commercially available autosegmentation softwares using the Dice Coefficient Score and Hausdorff Distance; comparisons of the plans, which were planned on the manually drawn contours, are also under investigation.
Results: The analyses comparing the contours and the plans are currently being performed. Initial trials promise quick and easy application in the clinical workflow with contours similar to the ones manually drawn. For the initial trials, the impact on plan parameters by the clinically approved dose distribution, calculated for the autosegmented PTVs, are in a acceptable range.
Summary: Autosegmentation offers promising potential to increase efficiency and consistency. AI-based autosegmentation could contribute to a reduction in toxicity with improved functional preservation of the organs in the H&N region whilst saving valuable time for the physicians.

European Journal of Medical Physics 125S1 (2024) 104014
doi:10.1016/j.ejmp.2024.104014

PS01.13
UNCERTAINTY QUANTIFICATION OF MACHINE LEARNING MODELS FOR PATIENT-SPECIFIC QUALITY ASSURANCE PREDICTION

J. Japnanto[1], N. Lambri[2,3], P. Mancosu[3], A. Nisbet[1]

[1]*University College London (UCL), Department of Medical Physics and Biomedical Engineering, London, United Kingdom*
[2]*Humanitas University, Department of Biomedical Sciences, Milan, Italy*
[3]*IRCCS Humanitas Research Hospital, Radiotherapy and Radiosurgery Department, Milan, Italy*

Introduction: Volumetric modulated arc therapy (VMAT) plans must undergo patient-specific quality assurance (PSQA), acknowledged as a labour-intensive and time-consuming task. Machine learning (ML) algorithms offer promising solutions to alleviate the PSQA workload by correlating the complexity of a VMAT arc to the gamma passing rate (GPR). However, current literature lacks quantification of the models' uncertainty in these predictions. This study developed an ML regression model to predict GPRs using complexity metrics and quantified its uncertainty through the conformal prediction (CP) framework.
Material & Methods: A publicly accessible dataset of 12,473 VMAT arcs delivered from 2018 to 2022 was used, containing complexity metrics and PSQA analyses conducted with a 3%(global)/1 mm criterion. A LightGBM model was selected with cross-validation on the training set. Model calibration was performed with CP and conformalised quantile regression (CQR) to obtain prediction intervals (PI) under a confidence level of 10% (i.e., 90% coverage). The mean absolute error (MAE), mean interval width, and coverage of the models were assessed on the test set.
Results: The CP and CQR techniques achieved a MAE of 2.85% and 2.22% respectively on the test set. CP PIs yielded an effective coverage of 91.4% with a mean width of 9.3%. CQR PIs yielded a coverage of 90.4% with a mean width of 10.8%. These coverages were close to the target coverage of 90%.
Summary: CQR can form adaptive GPR PIs that reflect an ML model's confidence in its predictions. Uncertainty quantification can provide crucial information for implementing trustworthy virtual PSQA methods.