Pendeteksian Treatment Plan IMRT Suboptimal Menggunakan Machine Learning pada Fitur Radiomics Distribusi Dosis untuk Kanker Paru-Paru = Detection of Suboptimal IMRT Treatment Plan Using Machine Learning on Radiomics Features of Dose Distribution for Lung Cancers

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Abstrak

Penjaminan mutu dalam radioterapi adalah proses yang penting agar penggunaan radiasi memberikan manfaat yang maksimal. Saat ini sedang berkembang implementasi machine
learning (ML) dalam proses penjaminan mutu treatment planning. Pada penelitian ini, 34 treatment plan intensity-modulated radiation therapy (IMRT) optimal dan 10 treatment
plan IMRT suboptimal dari Rumah Sakit Siloam MRCCC Semanggi digunakan dalam
pemelajaran model ML berjenis autoencoder untuk pendeteksian anomali yang dikembangkan menggunakan PyTorch. Terdapat empat tahap dalam penelitian ini yaitu tahap persiapan, tahap pengembangan, tahap validasi, dan tahap evaluasi. Pada tahap pengembangan, data mentah disiapkan agar siap digunakan untuk pemelajaran model.
Pada tahap pengembangan, model dibuat menggunakan PyTorch dan dilakukan
optimisasi hyperparameter. Akurasi hasil pemelajaran model akan dianalisis pada tahap validasi. Terakhir, pada tahap evaluasi, kemampuan model dievaluasi dengan melakukan uji statistik Mann-Whitney U test pada parameter dose-volume histogram (DVH), fitur radiomics, dan metrik DVH (conformity index dan homogeneity index). Model menggunakan 161 fitur radiomics dengan konfigurasi paling optimal adalah epochs sebanyak 1.250 iterasi, konfigurasi hidden layers 150-50-17, dan learning rate sebesar
0,2. Hasilnya menunjukkan akurasi sebesar 30% dengan 7% fitur radiomics, 50% parameter DVH, dan homogeneity index berbeda secara signifikan. Setelah dilakukan pembersihan yaitu membuang data dengan nilai conformity index di bawah satu, didapat akurasi sebesar 17% dengan 12% fitur radiomics, 45% parameter DVH, dan kedua metrik
DVH berbeda secara signifikan. Jika hanya digunakan fitur radiomics yang berbeda secara signifikan, didapat akurasi naik menjadi 90%. Dari hasil ini, disimpulkan bahwa fitur radiomics kurang mampu mengkarakterisasi kualitas treatment plan. Selain itu, segmentasi planning target volume (PTV) beserta kelompok fitur radiomics firstorder adalah pembeda utama antara treatment plan optimal dengan suboptimal.
.....Quality assurance in radiotherapy is an important process so that the use of radiation provides maximum benefits. Currently, the implementation of machine learning in the quality assurance of treatment planning is growing. In this study, 34 optimal intensity- modulated radiation therapy (IMRT) treatment plans and 10 suboptimal IMRT treatment plans obtained from Siloam MRCCC Semanggi Hospital were used to train a machine
learning model called autoencoder for anomaly detection developed using PyTorch. There were four stages in this study, namely the preparation stage, development stage, validation stage, and evaluation stage. At the development stage, the raw data was
prepared so that it is ready to be used for training. At the development stage, the model was developed and

a hyperparameter optimization was performed. The accuracy of the model was analyzed at the validation stage. Finally, at the evaluation stage, the model performance was evaluated by performing Mann-Whitney U test on dose volume histogram (DVH) parameters, radiomics features, and DVH metrics (conformity index and homogeneity index). The model used 161 radiomics features with an epochs of 1,250 iterations, 150-50-17 hidden layers configuration, and a learning rate of 0.2 being the most optimal configuration. The results showed an accuracy of 30% with 7% of radiomics features, 50% of DVH parameters, and the homogeneity index being different significantly. After refinement, that is removing data with conformity index below one, the accuracy became 17% with 12% of radiomics features, 45% of DVH parameters, and both DVH metrics being different significantly. If the radiomics features used are those that were significantly different, the accuracy increased to 90%. From these results, it can be concluded that the radiomics features are unable to characterize the quality of the treatment plan. In addition, planning target volume (PTV) segment along with the firstorder radiomics feature group is the main differentiator between optimal and suboptimal treatment plans.