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Comparative Study of Recurrent Neural Network and Recurrent Neuro-Fuzzy Algorithm for Lung Cancer Detection

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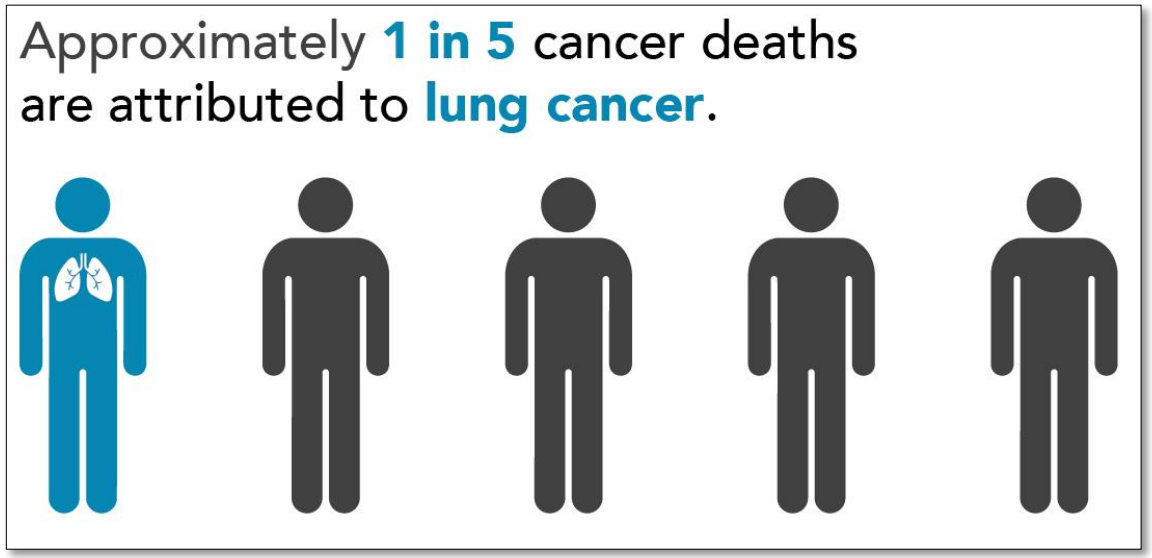
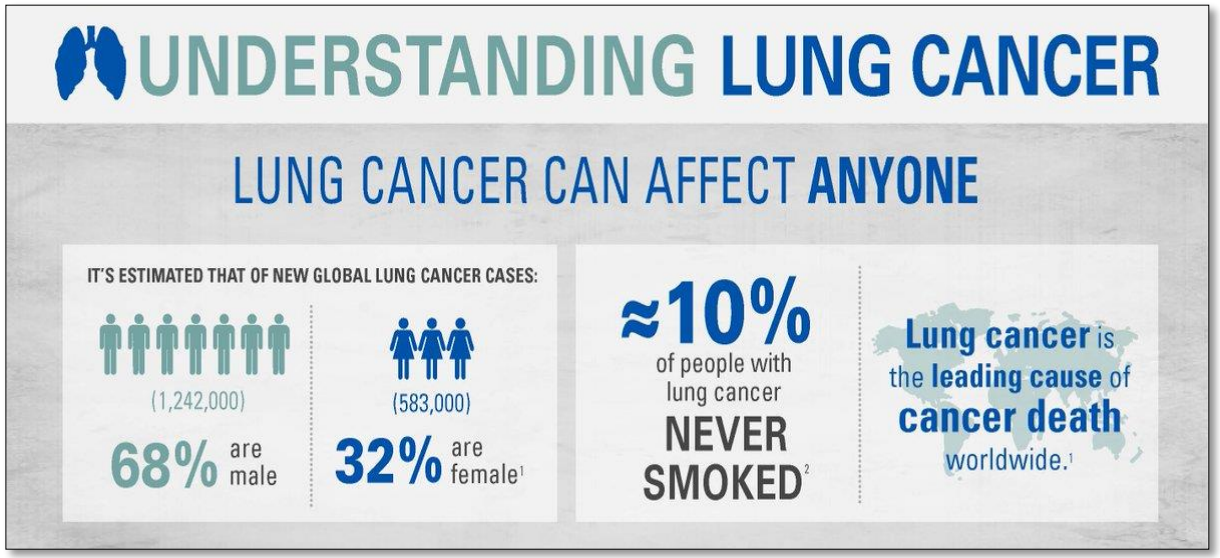
The Author(s) declare(s) that there is no conflict of interest.

Background

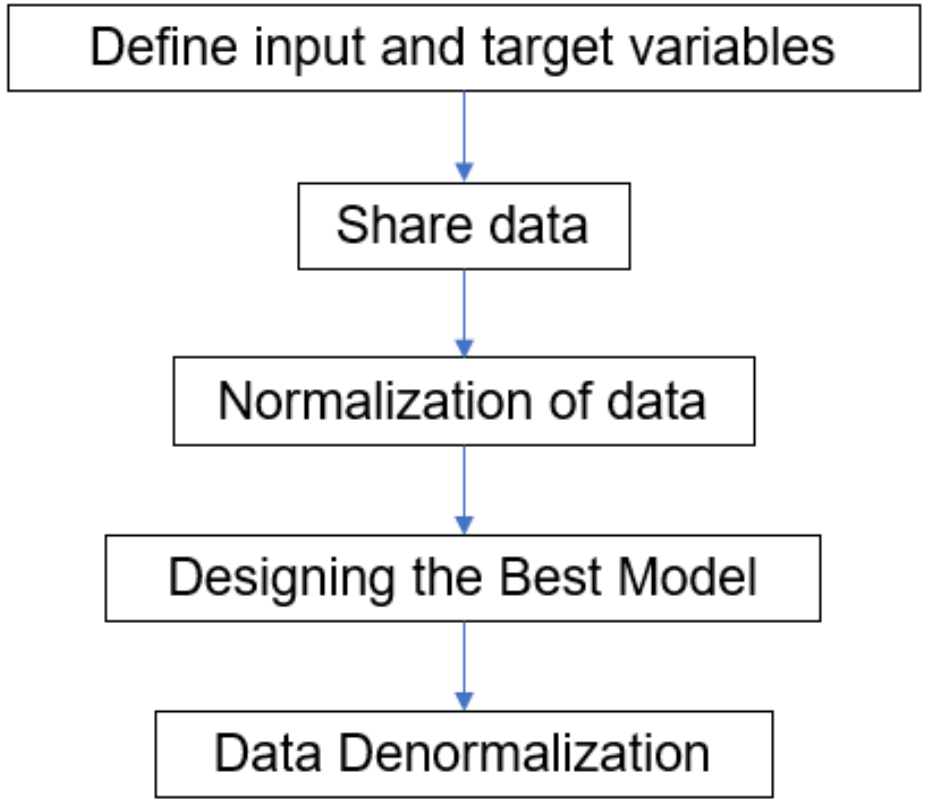




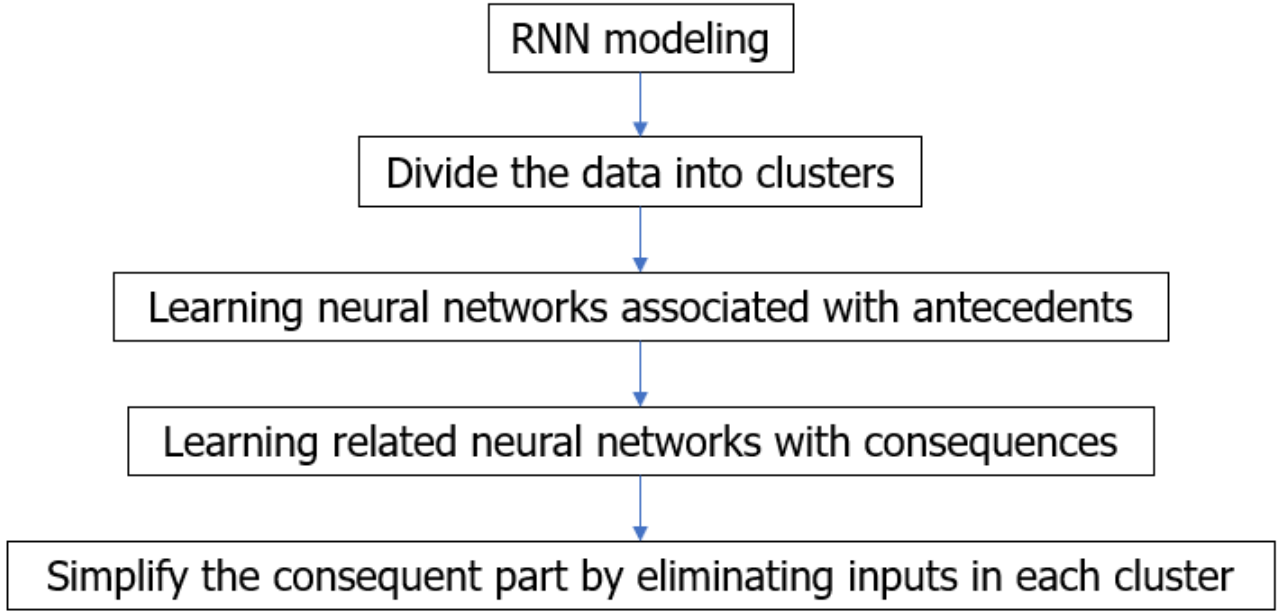
- Early detection using radiograph images of the lungs can significantly increase the patient's life expectancy.
- Nodule detection on lung X-ray images is very necessary because the detection results determine the next steps that must be taken in treating patients.
- Research to classify lung cancer is usually done by first extracting the lung image.
- The features extracted from the lung photo image are then classified by various models such as the neural network model (NN), the fuzzy model, and the neuro fuzzy (NF) model.
- This study aims to explain the procedure, application, and accuracy of Recurrent Neural Network modeling and Recurrent Neuro-Fuzzy modeling for lung cancer nodule classification from lung photo images.

Method

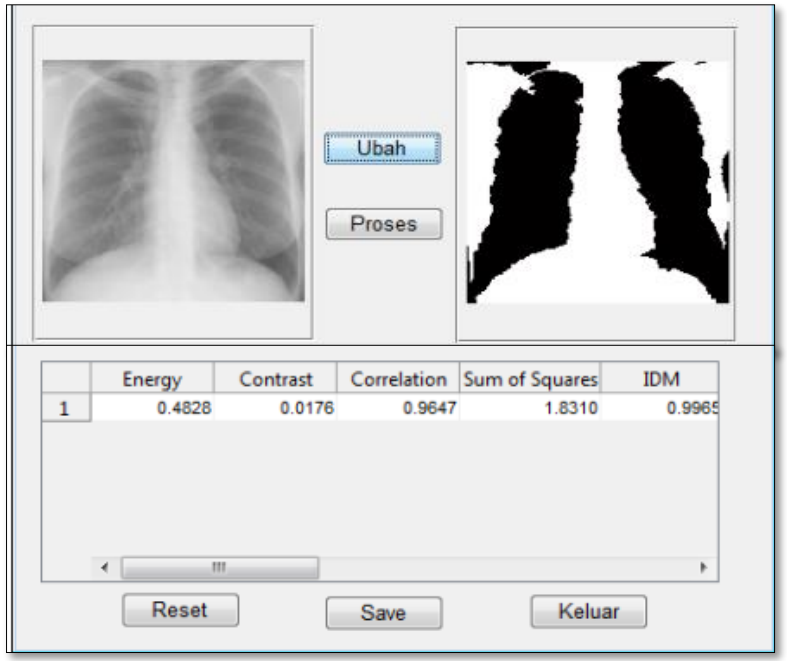
RNN Modeling Procedure



RNF Modeling Procedure



Method



GUI Display for Image Extraction

Data Sources

This study used 100 lung images (gray), consisting of 35 normal lung images, 33 benign lung tumor images, and 32 malignant lung tumor images.

Lung photo image data were obtained from the digital image database provided by the JSRT (*Japanese Society of Radiology Technology*).

Graphical Unit Interface (GUI)

The lung image is processed by extracting the image. The image extraction process can be done with the Gray Level Coocurrence Matrix (GLCM).
The statistical parameters were collected using MATLAB with an Image Processing Toolbox and a prototype system designed using a Graphical Unit Interface (GUI) to make it easier.

Method

The input variable consists of 14 statistical parameters from the extraction of images, namely:

1. Energy (X1)
2. contrast (X2)
3. correlation (X3)
4. sum of squares (X4)
5. inverse difference moment (X5)
6. sum average (X6)
7. sum variance (X7)
8. sum entropy (X8)
9. Entropy (X9)
10. difference variance (X10)
11. difference entropy (X11)
12. maximum probability (X12)
13. Homogeneity (X13)
14. Dissimilarity (X14)

Based on the results of image extraction, it is obtained three statistical parameters that produce the same value, namely X2, X10, and X14. This causes two statistical parameter to be eliminated, namely *X10* and *X14* so that the input variable becomes **12 variables.**

Method

How to determine classification?

The output variable of the model is the classification of lung cancer.

Determining the output of the model is to look at the highest degree of membership.

Expected outputs are class 1 for normal, class 2 for benign tumors and class 3 for malignant tumors.

There are several criteria in the classification of lung cancer, namely:

If the highest degree of membership is in class 1, the results of the classifications are normal.

If the highest degree of membership is in class 2, the results of the classifications are benign tumors.

If the highest degree of membership is in class 3, the results of the classifications are malignant tumors

Results

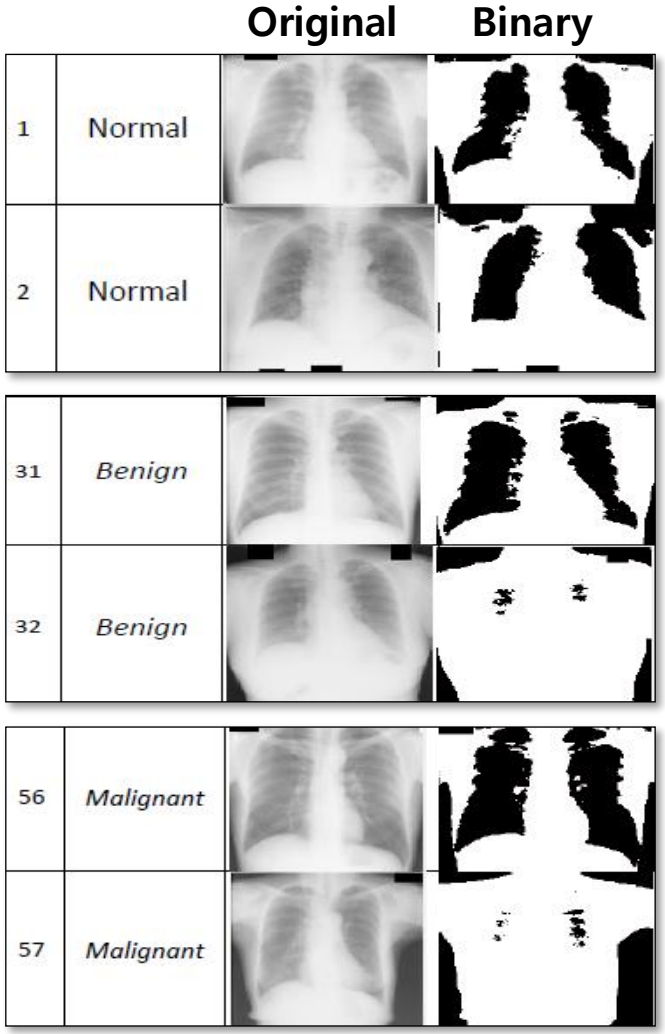
Comparison of the Accuracy of Classification of Lung Cancer Nodules Using the RNN Model and the RNF Model

Classification results must have errors and it is not uncommon to misidentify normal lung to be lung tumor or vice versa. Therefore, it is necessary to do an accuracy test which must first describe true positive (TP), false positive (FP), true negative (TN) and false negative (FN).

	Data Training			Data Testing		
	Sensitivity	Specificity	Accuracy	Sensitivity	Specificity	Accuracy
RNN	94%	56%	81,33%	80%	40%	64%
RNF	42%	68%	50,67%	40%	0%	24%

It can be seen that the RNN model provides better sensitivity, specificity, and accuracy than the RNF model for both training data and testing data by producing sensitivity, specificity, and accuracy values.

Some of the Thoracic Photo Image Data (Original and Binary)



Conclusions

The Recurrent Neural Network model is able to classify quite well compared to the Recurrent Neuro-Fuzzy model.

Although the RNN model provides better sensitivity, specificity, and accuracy values than the RNF model, this model is not yet maximally used as an indicator when the results are negative (normal lung) or positive results (lung tumor) because the accuracy is only 64%.


Thank you!