UNIVERSITAS KRISTEN PETRA

Siana Halim <halim@petra.ac.id>

New Submission Received-Special Issue [ASTESJ]

3 messages

Prof. Wang Xiu Ying <w.x.ying@astesj.com> Wed, Jul 22, 2020 at 12:39 AM
To: halim@petra.ac.id, handojo@petra.ac.id, ivan.enricow16@gmail.com, felecia@petra.ac.id, tanti@petra.ac.id

Dear Siana Halim,

Thank you for submitting the following manuscript for publication in Advances in Science, Technology and Engineering Systems Journal

Track: Special Issue Paper
Special Issue/Section: Special Issue on Multidisciplinary Sciences and Engineering 2020-21
Title: Spatial Multi-Layer Perceptron Model for Predicting Dengue Fever Outbreaks in Surabaya
Author(s): Siana Halim, Andreas Handojo, Ivan Widodo, Felecia Felecia, Tanti Octavia
Corresponding Author: Siana Halim
Affiliation of Corresponding Author: Petra Christian University
Date of Manuscript Submission: 21-Jul-2020 (UTC)

Before we send your manuscript to reviewers to evaluate it, please confirm that you agree with the condition below by simply replying to this email.

Advances in Science, Technology and Engineering Systems Journal is an open-access journal. If your paper is accepted for publication, the following Article
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Journal APC: 500 USD
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I will send your manuscript to reviewers to evaluate it as soon as you confirm the above conditions. If accepted after peer-review, it will be published in the coming issue after copy-editing and professional production.

Please do not hesitate to contact us if you have any questions. We look forward to receiving your confirmation soon.

Best Regards
Prof. Wang Xiu Ying
Guest Editor-in-Chief
Advances in Science, Technology and Engineering Systems Journal (ASTESJ)

Siana Halim <halim@petra.ac.id> Wed, Jul 22, 2020 at 3:45 AM
To: "Prof. Wang Xiu Ying" <w.x.ying@astesj.com>
Cc: Andreas Handojo <handojo@petra.ac.id>, Ivan Enrico <ivan.enricow16@gmail.com>, felecia@petra.ac.id, tanti@petra.ac.id

Dear Prof. Wang,
Yes we are agree for the APC 360 usd

Regards
Siana
[Quoted text hidden]

Prof. Wang Xiu Ying <w.x.ying@astesj.com> Thu, Jul 23, 2020 at 2:29 AM
To: Siana Halim <halim@petra.ac.id>
Cc: Andreas Handojo <handojo@petra.ac.id>, Ivan Enrico <ivan.enricow16@gmail.com>, felecia@petra.ac.id, tanti@petra.ac.id

Dear Siana Halim,

Thank you for the confirmation. Your paper is now under review.

Best Regards
Prof. Wang Xiu Ying
Guest Editor-in-Chief
Advances in Science, Technology and Engineering Systems Journal (ASTESJ)

[Quoted text hidden]

> [Quoted text hidden]

UNIVERSITAS KRISTEN PETRA

Siana Halim <halim@petra.ac.id>

[ASTESJ, 20M-07-490] Review results of your manuscript

2 messages

ASTESJ <no-reply@manuscriptlink.com> Fri, Aug 28, 2020 at 10:47 AM
To: halim@petra.ac.id
Cc: w.x.ying@astesj.com

Dear Dr. Siana Halim,

We have completed our review process for the following manuscript submitted to the *Advances in Science, Technology and Engineering Systems Journal*.

Track: Special Issue Paper
Special Issue/Section: Special Issue on Multidisciplinary Sciences and Engineering 2020-21
Manuscript ID: 20M-07-490
Title: Spatial Multi-Layer Perceptron Model for Predicting Dengue Fever Outbreaks in Surabaya
Author(s): Siana Halim, Andreas Handojo, Ivan Widodo, Felecia Felecia, Tanti Octavia
Corresponding Author: Siana Halim
Affiliation of Corresponding Author: Petra Christian University
Date of Manuscript Submission: 21-Jul-2020 (UTC)

Overall review result: Major Revision Required

The second half of this email contains important review comments and you can also find them in the following online system.

* Online System URL: https://www.manuscriptlink.com/journals/astesj

You should revise your manuscript according to reviewers' comments and resubmit it to the above online system for reconsideration.

You should also write a reply letter giving a point-by-point response to the reviewers' comments. The reply letter should be uploaded as a seperate file in addition to your revised manuscript.

The deadline for submission of the revised manuscript and reply letter is 11-Sep-2020. If you have any question regarding the revised manuscript, please contact the journal manager.

Thank you for submitting your manuscript to the *Advances in Science, Technology and Engineering Systems Journal*.

Review Results

- Comments of Guest Editor-
The paper requires significant editing. Please make your contribution and the novelty of your work very clear to readers. The final decision regarding the publication will be based on your revised manuscript.

- Reviewer Review Scores and Comments -
Reviewer #1

Overall Judgement: Accept subject to revisions, as noted in comments

Comments
In the current study author/s have adopted Multi Linear Perceptron model and also constructed a web-design to manage the information and to predict the dengue fever outbreak in Surabaya. It is good thought and work done is nicely presented. However, there are a few corrections and the questions that need to be addressed.
Methodology
1. Briefly explain the hidden layer/s.
2. Two figures have been marked as Figure 3, Please change the figure/s number.
3. Kindly mention in the methodology, the software used to plot the Figures.

4. Also incorporate the statistical details.
Result and discussion
1. In the figure 6, Please mention the p value between Real and Predicted box plot. Also, mention the interquartile range of the prediction in the result and discussion section 3.2.
2. In the section 3.2, author/s mentioned “Some community health centers reported that there were no dengue fever cases in their area (the number of cases equal to zero), but in their surrounded areas reported highly dengue fever case. As the result, the real zero number cannot be captured as zero in the model”. Is this the limitation of your model? What are the consequences which can arise due to this in predicting the true picture of any area with the disease? How to troubleshoot this? Kindly comment on this in the discussion.
3. The source of figure number 8 has not been mentioned in the text. Please indicate where figure 8 belongs to.
4. In a few places Figure has been named as “Fig”. Please make it uniform as either “Figure” or “Fig” throughout the draft.
5. Is your model helpful in predicting other diseases in different areas of the country if the disease specific database is created?

Reviewer #2

Overall Judgement: Accept with minor changes

The authors have taken an important aspect into consideration when predicting the outbreak of the dengue fever using the multi-layer perceptron model and making it a spatial model. The outbreak definitely involves the spatial component of the neighborhood and it is important to include that when trying to predict the outbreak and the extent of the outbreak. Please address the below mentioned issues:

1. Explain why the multi-layer perceptron model was chosen to do this study compared to the recent papers that study the dengue outbreak using the GWS (Geographically Weighted Regression) model or other machine learning algorithms.
2. Discuss how this model might be applicable to other regions also to broaden the significance of the spatial model.
3. Minor typos in the text - including spelling of dengue in the abstract, spelling of disease and comparison in Fig. 9 and 10.

Reviewer #3

Overall Judgement: Accept subject to revisions, as noted in comments

I think this review paper is fine to accept in "*Advances in Science, Technology and Engineering Systems Journal*". However, there are some issues mentioned below. So I do recommend the revision before acceptance. Wish you best of luck.

Abstract must state aim of the study, main results and major conclusions.
Please add explanation of risk in this line “In the present decade, Ketharpal mentioned that dengue is endemic to 128 countries, mostly developing nations, posing a risk to approximately 3.97 billion people annually” i.e. risk of what?
Rephrase the following line and remove the authors’ name. Only use the number in text, don’t use both (author name and number). Bhatt et al. [2] and Brady et al. [3] estimated using cartographic approaches that 390 million dengue infections annually, out of which 96 million cases evident apparently. Change all references in text throughout the manuscript in same manner.
Indonesian Health ministry recorded that January-March 2020 there are 39.876 DF cases with 254 people died [6, 7, 8]. You can modify the sentence as “ 39.876 DF cases and 254 deaths were reported by Indonesian Health Ministry from January to March, 2020.”
Improved outbreak prediction and detection through coordinated surveillance will be able to reduce the spread and DF effected area. Spread and DF? Revise the statement and remove the confusion.
4th paragraph of introduction section have repetition of word dengue fever but you have already mentioned its abbreviation. Please replace them with DF.
The font used in the figures should be Times New Roman, normal, size 8.
There is some English issue. So I do recommend the Native English editing before acceptance. For example:-
In this model, we assumed that the spread of the diseases is in the first order contiguity level. That is, the number of cases in location s, is contagious to its north, east, south, and west neighborhoods. Some additional explanatory variables are also included in the model. They are, sex ratio, poverty percentage, population density. In this proposed model, the first layer equation can be written as follows:
Discussion explains the importance of results in context of existing literature. Please compare your results with others i.e. same or contradictory to their findings.
Please explain or remove “#” from #Rainy day (days/month) in table 3.
Replace Fig 5. and Figure 5. with Figure 5 under the heading 3.2. Data Training and Testing.
Spatial-MLP in Conclusion. Use full form or abbreviation.
Figure 1: ASTESJ Logo? before reference. Please remove it.
References need major revision. Please change your reference format according to the following example.
M. Uzunoglu, M. S. Alam, “Dynamic modeling, design, and simulation of a combined PEM fuel cell and ultracapacitor

system for stand-alone residential applications" IEEE Trans. Ener. Conv., 21(3), 767–775, 2006. https://doi.org/10.1109/TEC.2006.875468.
Modify the second reference. All authors should be included in reference lists unless there are 10 or more, in which case only the first 10 should be given, followed by 'et al.'.

Additional Review Results: https://www.manuscriptlink.com/journals/astesj/downloadPublicFile/71470
Reviewer #4

Overall Judgement: Accept subject to revisions, as noted in comments

DEAR AUTHOR
VERY GLAD TO PLAY A ROLE IN REVIEWING YOUR MANUSCRIPT.
AT THIS HOUR OF PANDEMIC SUCH TOPICS PLAY A VITAL ROLE.

I HAVE HIGHLIGHTED FEW GRAMMATICAL, SPELLING ERRORS IN THE DOCUMENT. KINDLY DO THE REVISIONS AS PER NEED.

I FURTHER ENCOURAGE YOU TO CARRY THIS MODEL TO THE NEXT LEVEL WHICH COULD ALSO HELP IN COMBATTING VARIOUS SUCH INFECTIOUS, CONTAGIOUS DISEASE.

THANK YOU.

Reviewer #5

Overall Judgement: Reject, with no resubmission

Dear Authors,

Thanks for your hard work and time given to the manuscript. Although, There is no any novelty in this manuscript as reference to the study of Herath (Srilanka), Jongmuenwai and Laureano Rosario (Thailand) and many other mentioned in the manuscript. The similar type of studies have been already done on the dengue fever. In views of above, The manuscript is unable to accept.

Prof. Wang Xiu Ying, Guest Editor
Advances in Science, Technology and Engineering Systems Journal
Email: w.x.ying@astesj.com
Homepage: https://www.astesj.com

==========[Note]==========
This email is only for the delivery service.
Please do not reply to this mail.

Siana Halim <halim@petra.ac.id> Fri, Aug 28, 2020 at 10:53 AM
To: Andreas Handojo <handojo@petra.ac.id>, Tanti Octavia <tanti@petra.ac.id>, Felecia Felecia <felecia@petra.ac.id>

Ini adalah hasil review untuk paper kita.... tanggapan reviewernya beragam... dari menolak hingga minor revision.
Keputusan editornya Revision...
Ya sudah kita kerjakan revisinya... Deadline 11 September 2020. (kok cuma 2 minggu ya :(...

shl
[Quoted text hidden]

Reviewer 1
Methodology
1. Briefly explain the hidden layer/s.
Thank you, we explain the hidden layer/s briefly.
2. Two figures have been marked as Figure 3, Please change the figure/s number.
Thank you, we changed all the figures numbers
3. Kindly mention in the methodology, the software used to plot the Figures.
Thank you, we used python to implement the model.
4. Also incorporate the statistical details.
Thank you, already include in the paper.

Result and discussion
1. In the figure 6, Please mention the p value between Real and Predicted box plot. Also, mention the interquartile range of the prediction in the result and discussion section 3.2.
Thank you, we added statistical summarize in Table 4, the p-value and the confidence interval for the mean difference.

2. In the section 3.2, author/s mentioned “Some community health centers reported that there were no dengue fever cases in their area (the number of cases equal to zero), but in their surrounded areas reported highly dengue fever case. As the result, the real zero number cannot be captured as zero in the model”. Is this the limitation of your model?

Yes

What are the consequences which can arise due to this in predicting the true picture of any area with the disease? How to troubleshoot this? Kindly comment on this in the discussion.

As the result the model will predict the number of infected in that area as the mean value of the neighbourhood. We think this is okay, since the number will give early warning to that region to prevent the outbreak in that area. Thank you for your comment, we add the explanation in the discussion.

3. The source of figure number 8 has not been mentioned in the text. Please indicate where figure 8 belongs to.

Thank you. We mentioned Fig. 8 in the text.

4. In a few places Figure has been named as “Fig”. Please make it uniform as either “Figure” or “Fig” throughout the draft.

Thank you. We made it uniform as Figure through all the manuscript.

5. Is your model helpful in predicting other diseases in different areas of the country if the disease specific database is created?

Yes. The model is implemented as a Python function.

Reviewer #2

Overall Judgement: Accept with minor changes

1. Explain why the multi-layer perceptron model was chosen to do this study compared to the recent papers that study the dengue outbreak using the GWS (Geographically Weighted Regression) model or other machine learning algorithms.

Thank you, we have explored the statistical learning including the GWS. The paper (Statistical learning for predicting dengue fever rate in Surabaya) is published in Jurnal Teknik Industri, http://jurnalindustri.petra.ac.id/index.php/ind/article/view/22511. We then explored the machine leaning algorithm, the ML that can be extended into spatial property easily is multi-layer perceptron. Therefore, in this paper we proposed the spatial MLP.

2. Discuss how this model might be applicable to other regions also to broaden the significance of the spatial model.

The model is implemented as Python functions, so that it can be implemented in other regions, as far as the dataset is provided.

3. Minor typos in the text - including spelling of dengue in the abstract, spelling of disease and comparison in Fig. 9 and 10.

Thank you

Reviewer #3

Abstract must state aim of the study, main results and major conclusions.

Thank you, we revised it

Please add explanation of risk in this line “In the present decade, Ketharpal mentioned that dengue is endemic to 128 countries, mostly developing nations, posing a risk to approximately 3.97 billion people annually” i.e. risk of what?

Thank you, we revised it

Rephrase the following line and remove the authors’ name. Only use the number in text, don’t use both (author name and number). Bhatt et al. [2] and Brady et al. [3] estimated using cartographic approaches that 390 million dengue infections annually, out of which 96 million cases evident apparently. Change all references in text throughout the manuscript in same manner.

Thank you, we revised it

Indonesian Health ministry recorded that January-March 2020 there are 39.876 DF cases with 254 people died [6, 7, 8]. You can modify the sentence as “ 39.876 DF cases and 254 deaths were reported by Indonesian Health Ministry from January to March, 2020.” Improved outbreak prediction and detection through coordinated surveillance will be able to

reduce the spread and DF effected area. Spread and DF? Revise the statement and remove the confusion.
4th paragraph of introduction section have repetition of word dengue fever but you have already mentioned its abbreviation. Please replace them with DF.
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There is some English issue. So I do recommend the Native English editing before acceptance. For example:-
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Thank you, we revised it

Discussion explains the importance of results in context of existing literature.
Please compare your results with others i.e. same or contradictory to their findings.

Thank you, we revised it

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Replace Fig 5. and Figure 5. with Figure 5 under the heading 3.2. Data Training and Testing.
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Figure 1: ASTESJ Logo? before reference. Please remove it.

References need major revision. Please change your reference format according to the following example.
M. Uzunoglu, M. S. Alam, "Dynamic modeling, design, and simulation of a combined PEM fuel cell and ultracapacitor system for stand-alone residential applications" IEEE Trans. Ener. Conv., 21(3), 767–775, 2006. https://doi.org/10.1109/TEC.2006.875468.
Modify the second reference. All authors should be included in reference lists unless there are 10 or more, in which case only the first 10 should be given, followed by 'et al.'.

Thank you, we revised it

Additional Review
Results: https://www.manuscriptlink.com/journals/astesj/downloadPublicFile/71470

Thank you, we revised it

Reviewer #4

Overall Judgement: Accept subject to revisions, as noted in comments

DEAR AUTHOR
VERY GLAD TO PLAY A ROLE IN REVIEWING YOUR MANUSCRIPT.
AT THIS HOUR OF PANDEMIC SUCH TOPICS PLAY A VITAL ROLE.

I HAVE HIGHLIGHTED FEW GRAMMATICAL, SPELLING ERRORS IN THE DOCUMENT.
KINDLY DO THE REVISIONS AS PER NEED.

I FURTHER ENCOURAGE YOU TO CARRY THIS MODEL TO THE NEXT LEVEL WHICH

COULD ALSO HELP IN COMBATTING VARIOUS SUCH INFECTIOUS, CONTAGIOUS DISEASE.

ASTES

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Spatial Multi-Layer Perceptron Model for Predicting Dengue Fever Outbreaks in Surabaya

Corresponding Author*, ABC[1], ABC[2], ABC[3] (Use this style, Time New Roman, Font 10, Normal) (Use complete Author's name not abbreviated)

[1]*Author's Affiliation, Department, Institute, ZIP Code, Country*

[2]*Author's Affiliation, Department, Institute, ZIP Code, Country*

[3]*Author's Affiliation, Department, Institute, ZIP Code, Country*

A R T I C L E I N F O

Article history:
Received:
Accepted:
Online:

Keywords:
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Spatial
Dengue Fever Outbreak

A B S T R A C T

Dengue fever (DF) is a tropical disease spread by mosquitoes of the Aedes type. Therefore, a DF outbreak needs to be predicted to minimize the spread and death caused by it. The spread of dengue fever is a spatial problem. In this paper, we adopted the Multi Linear Perceptron (MLP) to solve the spatial problem, and we called it a spatial multi-layer perceptron model (SMLP). In this proposed model, we consider two types of input neurons in the SMLP, a region and the neighbourhood of that region. The spatial inputs dynamically change to the region. Additionally, the neighbourhood numbers of a region are also varied. So, the spatial inputs are changed in terms of the number of inputs and the neighbourhoods. As a result, the proposed model is outperformed the traditional MLP since it can adapt to the neighbourhoods. We can conclude the SMLP model can manage the information and predict the dengue fever outbreak in Surabaya

1. Introduction *(Heading 1)*

Dengue Fever (DF) outbreak happened annually, but every year the number of victims is very high. In the present decade, Ketharpal mentioned that dengue is endemic to 128 countries, mostly developing nations, posing a risk of death to approximately 3.97 billion people annually [1]. Cartographic approaches estimated that 390 million dengue infections annually, out of which 96 million cases evident apparently [2,3]. World health organization (WHO) stated that more than 70% of the population at risk for dengue worldwide live in member states of the WHO South-East Asia Region and Western Pacific Region [4]. WHO categorized the variable endemicity of dengue fever into four categories. Indonesia is included in category A which means the endemic occurs due significant public health problem, a leading cause of hospitalization and death among children, hyperendemicity with all four serotypes circulating in urban areas, and spreading to rural areas [5].

Indonesian Health ministry recorded that January-March 2020, there are 39.876 DF cases with 254 people died [6, 7, 8]. For significant reduction of dengue mortality, the strategies for the prevention of dengue include prompt diagnosis of fever cases, providing appro-priate clinical management, and controlling vector, and personal protection methods. Therefore, severe cases can be managed with appropriate treatment, and health personnel at all level can be trained. Improved outbreak prediction and detection through coordinated surveillance will be able to reduce DF spread and effected area [9, 10].

Many types of research have been done in predicting the spread and DF affected area. A five years dataset from Sleman, a district in Central Java Indonesia are used for predicting the spread of the DF [11]. Mahdiana's model is based on vector autoregressive spatial autocorrelation (varsa). A four years dataset from Bandung stated that the incidence rate of dengue fever was not related to annual rainfall, population density, larva free index, and prevention Program [12]. The spreading of DF in Surabaya, Indonesia, is modelled using statistical learning [13,14]. Besides of statistical learning approach, many researchers also developed the model in the machine learning approach. Various machine learning algorithms are compared, such as naive Bayes, random forests, minimal sequential optimization [15]. They collected data from the health department, Karuna medical hospital, Kerala, and online sources. The authors stated random forests gives better accuracy for the early detection of dengue disease.

On the other hand, the use of neural networks as an algorithm for predicting disease has been widely used. For example, in skin cancer using MLP [16] and heart disease [17]. An artificial neural network is used to predict the DF outbreak in Srilanka [18], using similar approach [19,20] the DF outbreak in Thailand modelled and in the Northwest Coast of Yucatan, Mexico and San Juan, Puerto Rico, respectively. Most of the artificial neural network that has been used to develop the model is multi-layer perceptron, with the input as the population characteristics in each region and number of DF infected in the previous years for predicting the number of DF infected in the current or next year.

In this research, we proposed a spatial multi-layer perceptron model for predicting the DF outbreak. As a case study, we used DF data in Surabaya. The proposed model adopts the spatial approach in statistical learning as well as the multi-layer perceptron in the machine learning approach. This proposed model tries to accommodate the nature of DF disease spreading. Because DF is a type of disease that spreads through dengue mosquitoes, if DF infects a particular area, the surrounding areas will be vulnerable to the spread of the disease (spatially correlated). Therefore, disease prediction in a particular area is greatly influenced by the DF disease in the surrounding area. So, to predict the possibility of the spread of dengue fever in a particular area, we need to calculate the spread DF data from the surrounding areas. This data will be calculated separately for each region (spatial dependent). This proposed model will implement in Multi-Layer Perceptron Model (MLP) Neural Network. The MLP NN model does not accommodate the spatial dependency in the neural-network construction. This proposed model tries to build a spatial MLP model to accommodate the nature of DF decease spreading.

Additionally, we also present the model for predicting the DF web basely. Since currently, the data for DF victims is manually collected at community health centers, and it will be reported to the regional health department. Based on this DF data, the city and province will take a curative and preventive action to prevent DF outbreak in next year. Urgent measures also being taken by community health centers during outbreaks such as fogging or spreading abate powder in water collecting area. Without a sound information system on DF outbreak location and spreading, the government cannot control and minimize dengue mortality.

2. Research Methods

2.1. Multilayer Perceptron

Multilayer perceptron (MLP), also often called as feedforward neural networks consists of neurons that are ordered into layers (Figure 1). The first layer is called the input layer, and the last one is called as the output layer, the layers between are hidden layers [21].

The main goal of MLP is to approximate some function f; e.g. in a regression, $Y = \theta_0 + \theta_1 X_1 + \cdots + \theta_n X_n$; the function $Y = f(X)$ maps the input vector X into the a value Y. The feedforward

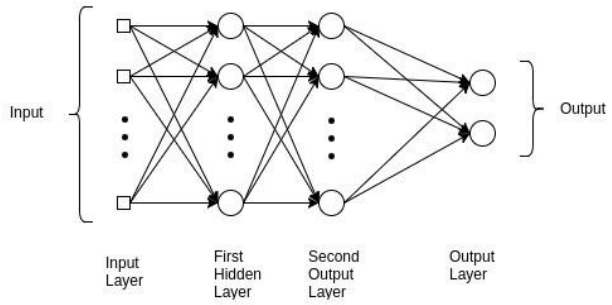


Figure 1. Multi-Layer Perceptron Neural Network

network defines a mapping $Y = f(X;\theta)$ and learns the value of the parameters θ that result in the best function approximation.

In the general MLP (Figure 1), we know that each layer can be modelled as a function of

$$Y = f(\theta X + b) \quad (1)$$

where f is the activation function, θ are weights in the layer, X is the input vector, which can also be the output of the previous layer, and b is the bias vector. The hidden layers, which are located in between the input and the output of a neural network, will perform nonlinear transformations of the input in the network. The number of the hidden layers are varied. It depends of the function of the neural network. Similarly, the number of the layers may vary. It depends on their associate weights [22].

The function f is called the transfer function. The transfer function used in this research is ReLu (Rectified Linear Unit) [23]. This function is defined as $y = \max(0, X)$. Visually it can be seen in Figure 2.

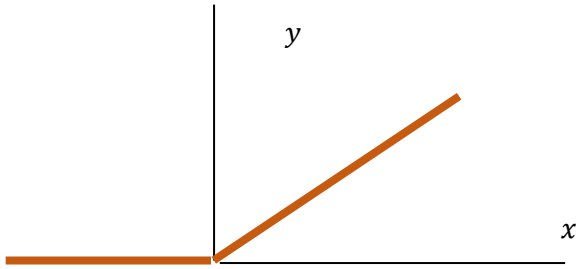


Figure 2. Rectified Linear Unit

2.2 Spatial Multilayer Perceptron

It is well known that the dengue fever happening most in tropical countries and considered as the fastest spreading mosquito-borne disease. It is transmitted by Aedes mosquito which infected with a dengue virus. The spreading of this diseases is spatially correlated [13]. The MLP model does not accommodate the spatial dependent in the neural-network construction. Therefore, in this paper we modified the Multilayer Perceptron Model (MLP), to accommodate the spatial nature of the disease.

In this model, we assumed that the spread of the diseases is in the first-order contiguity level. That is, the number of cases

in location s is contagious to its north, east, south, and west neighbourhoods. Some additional explanatory variables are also included in the model. They are sex ratio, poverty percen-tage, population density. In this proposed model, the first layer equation can be written as follows:

$$Y(s) = f\left(\sum_{j=1}^{N}\left(\sum_{i=1}^{M} w_{ij}^{1} X_i(s) + \sum_{k\in(nr,es,st,wt)} w_j^2(s_k) Y(s_k)\right) + \varepsilon\right) \quad (2)$$

Where:

$Y(s)$	:	Number of cases in the location s
w_{ij}^{1}	:	The jth neuron weight w.r.t explanatory variable i
$X_i(s)$	:	The explanatory variable i in the location s
$w_j^2(s_k)$	:	The j-th neuron weight w.r.t response variable Y in the location s_k
$Y(s_k)$	:	Number of dengue fever cases in the location s_k
s_k	:	The k (north, east, south, west) location of the location s
ε	:	Bias
M	:	Number of explanatory variables ($M = 3$)
N	:	Number of neurons
i, j, k	:	index

In this model the input of the MLP is changed depend on the location s. To give an illustration, let predicts the number of cases in sub-district Balongsari (Figure 3). This region shares borders to sub-district Asemrowo (north), sub-district Tanjungsari (east), sub-district Lontar (south) and sub-district Manukan Kulon (west).

	(A) Asemrowo	
(M) Manukan Kulon	(B) Balongsari	(T) Tanjungsari
	(L) Lontar	

Figure 3. Sub-district Balongsari surrounding area

So, the model can be written as

$$Y(B) = f\left(\sum_{j=1}^{N} w_{1j}^{1} X_1(B) + w_{2j}^{1} X_2(B) + w_{3j}^{1} X_3(B) + w_1^2(A)Y(A) + w_2^2(T)Y(T) + w_3^2(L)Y(L) + w_4^2(M)Y(M)\right)$$

Here $X_1(B)$ is the sex ratio in Balongsari, $X_2(B)$ is the poverty percentage in Balongsari, $X_3(B)$ is the population density in Balongsari. $Y(A), Y(T), Y(L)$ and $Y(M)$ are the number of DF case in Asemrowo, Tanjungsari, Lontar and Manukan Kulon respectively. The input neurons of the model adaptively changes with respect to the region s.

2.3 Design Spatial Multi-layer Perceptron Neural Network

The design uses seven neurons; three neurons represent sex ratio, percentage of poverty and population density of each region under health community center s recorded in 2018. The other four neurons are dynamic neurons. They represent the

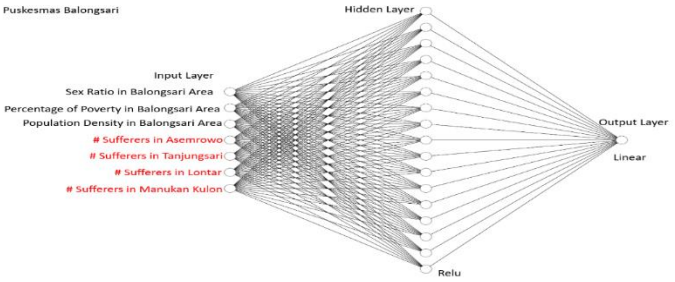


Figure 4. Ilustration for sub-district Balongsari

number of cases in the north, east, south, and west. These neurons depend on the location s (See Figure 4).

We used 252 data training (data from 2012-2015) and 126 (data from 2017-2018) data testing. The training process used 3500 epochs (Table 1), and mean squared error is used to measure the loss/error function and we used the stochastic gradient descent as the optimizer.

After some modeling the best design for this case used 1 hidden layer with 17 neurons and 1 output layer (Table 2). The activation function is rectified linear unit (Relu) on the hidden layer and linear on the output layer (Figure 5). This model is implemented as Python functions. It can be used to the other regions as far as the dataset is provided.

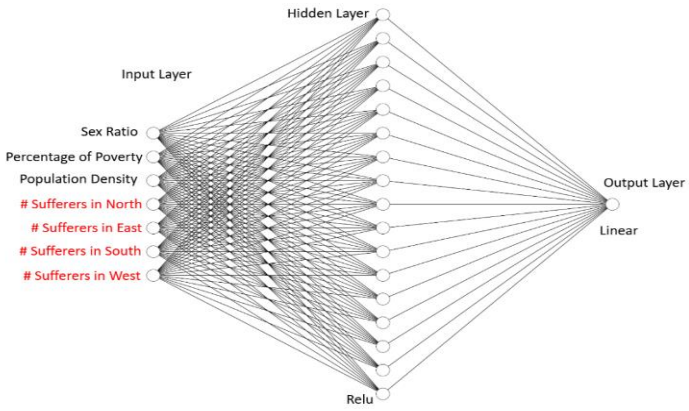


Figure 5. The design of Spatial MLP Model

Table 1. Setting the Number of Epochs and Neuron

Model	Epochs	Neuron	Loss on Data Training	Loss on Data Validation
1	1500	15	0.0198	0.0403
2		17	0.0187	0.0407
3		20	0.0196	0.039
4		22	0.0182	0.039
5	**3500**	15	0.0189	0.0304
6		**17**	**0.0176**	**0.0294**
7		20	0.0184	0.0383
8		22	0.0171	0.0399
9	4000	15	0.0184	0.0309
10		17	0.0171	0.0304
11		20	0.0181	0.0381
12		22	0.0169	0.0302

Table 2. Setting the Hidden Layer

Model	Layer	#Neuron Hidden Layer 1	# Neuron Hidden Layer 2	Loss on Data Training	Loss on Data Validation
1 hidden	1	17	-	0.0176	0.0294
2 hidden	2	17	7	0.0181	0.0297

3. Result and Discussion

3.1. Data Collection

Data we collected from Surabaya city consist of weather and population characteristic data. Weather data records the number of rainy days in a year, precipitation, maximum and minimum temperature, maximum and minimum humidity. The result shows that Surabaya weather is not significantly different, so it will not be used as the model's explanatory factor. Population characteristic data will be used in the model, and they are sex ratio, population density, and poverty percentage.

Table 3. Surabaya Statistics in 2018

	Min	Mean	Max
Population (thousand)	12541	45802	87561
Area (Km2)	0.915	2.001	14.400
Density (thousand/Km2)	2733	46992	541022
Sex Ratio (Men/Women)	91.5	99.27	110.93
Poverty percentage (%)	4.03	18.02	55.46
Rainy day (days/month)	9.83	13.99	16.00
Precipitation (mm/month)	129.9	164.6	194.9
Max Humidity per month	70	88.72	94.75
Min Humidity per month	46.08	53.14	57.83
Max Temperature	28.21	33.30	34.43
Min Temperature	23.11	26.29	28.73

3.2. Data Training and Testing

We use the recorded data from 2012-2015 as the training dataset and the data from 2016 to validate the model. The training dataset consists of 63x4 = 252 data. As usual, we normalized the data set in advanced. The mean square error of the training data is 0.0176. Figure 5 shows the fitting of the real data to the prediction one. The horizontal axe represents the community health center, the vertical axe represents the number of cases in each community health center, recorded from 2012-2015. Figure 6 shows that the prediction can follow the pattern of the real dataset. During 2012-2013 the number of cases was high, and it started to drop in 2014-2015. The box plot of the data training (Figure 7) shows that there are several outliers in the real dataset and those outliers cannot be captured by the proposed model. The median of the prediction is not significantly different from the real one, but the interquartile range of the prediction is smaller than the real dataset. The two-samples t-test for the training data set is summarized in Table 4 The one-sided p-value is 0.48, we can conclude that there is no mean difference between the real dataset and the predicted one. The mean difference is -0.06 and the 95% confidence interval of the mean difference is (-2.40, 2.29).

Table 4. Two-samples t-test for data training

	Real	*Predict*
Mean	18.86508	18.9246
Variance	262.0455	96.6676
Observations	252	252
Hypothesized Mean Difference	0	
df	414	
t Stat	-0.04989	
P(T<=t) one-tail	0.480117	
t Critical one-tail	1.648543	
P(T<=t) two-tail	0.960234	
t Critical two-tail	1.965711	

We use the recorded data from 2017-2018. There are 126 data. Applying the modelled, the loss value of the testing dataset is 0.052. Some of the prediction are lower/higher than the reality (see Figure 8). Some community health centers reported that there were no dengue fever cases in their area (the number of cases equal to zero), but in their surrounded areas reported highly dengue fever cases. As the result, the real zero number cannot be captured as zero in the model. The model will predict the number of infected in that area as the mean value of the neighborhood. This situation is acceptable, since the predicted number will give early warning to that region to prevent the outbreak in that area.

Figure. 6 The real and prediction line chart of data training from 2012-2015.

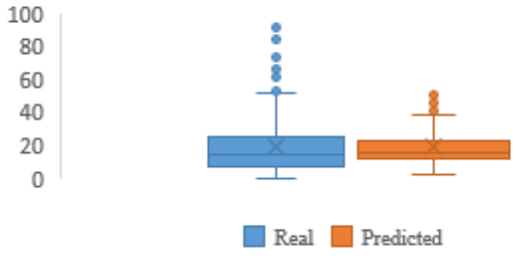


Figure. 7 The box plot of the training dataset

3.3 Discussion

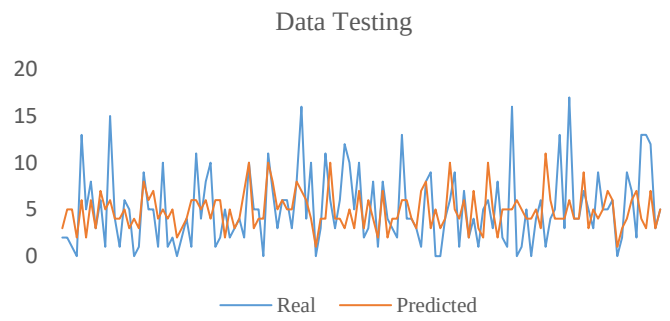


Figure. 8 The real and prediction line chart of data training from 2017-2018.

This modeled is implemented in a website base to help the "Dinas Kesehatan Surabaya" (The Surabaya Public Health Department) monitoring the dengue fever outbreak. From this website, users can see DF spreading data for each district in Surabaya in the selected year (Figure 9). Data on the number of victims in each sub-district will be displayed in red, yellow and green, with red representing the largest number of victims and green representing the smallest number of victims. Users can specify the upper limit of each color representative. The application will then automatically determine the color gradation based on the input, so that the user can see number of victims in each sub-district that representing in color information. The legend from this gradation color information will display next to the map. User also could choose and see detail information from each sub-district and number of DF victims.

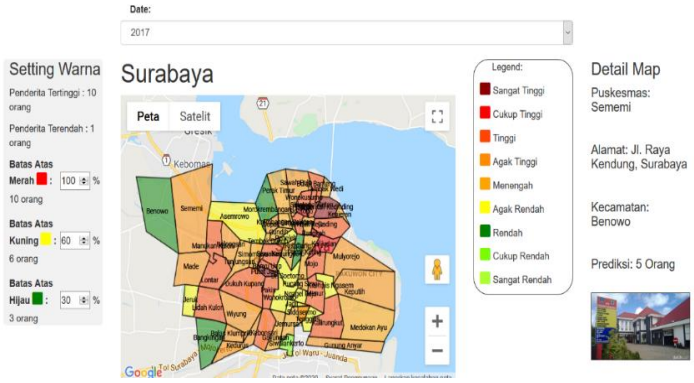
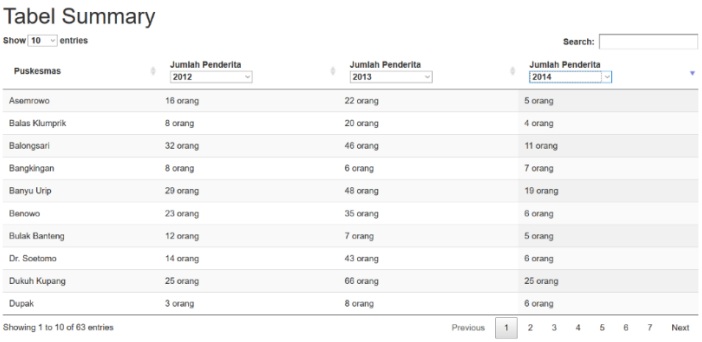


Figure 9. The web design for implemented model

Users can also see details of the number of patients in each sub-district and compare the movement of the number of patients in 3 years presented in tabular form (Figure 10). This data also can be viewed in graphical form (Figure 11).



Tabel Summary

Show 10 entries Search:

Puskesmas	Jumlah Penderita 2012	Jumlah Penderita 2013	Jumlah Penderita 2014
Asemrowo	18 orang	22 orang	5 orang
Balas Klumprik	8 orang	20 orang	4 orang
Balongsari	32 orang	46 orang	11 orang
Bangkingan	8 orang	6 orang	7 orang
Banyu Urip	29 orang	48 orang	19 orang
Benowo	23 orang	35 orang	6 orang
Bulak Banteng	12 orang	7 orang	5 orang
Dr. Soetomo	14 orang	43 orang	6 orang
Dukuh Kupang	25 orang	66 orang	25 orang
Dupak	3 orang	8 orang	6 orang

Showing 1 to 10 of 63 entries Previous 1 2 3 4 5 6 7 Next

Figure 10. Summarize comparizon spreading DF disease data for each sub-district in Surabaya

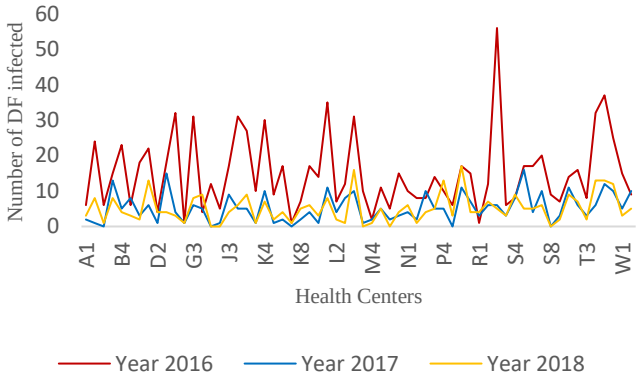


Figure 11. Summarize comparizon spreading DF disease data for each sub-district in Surabaya

This visual information will provide more informative information to help The Surabaya Public Health Department monitoring and prevent the dengue fever outbreak for each sub-district.

4. Conclusion

In this paper we proposed Spatial-MLP model for predicting dengue fever in Surabaya. The model can capture the data pattern. Additionally, the model is implemented in the web-based database. The Surabaya Public Health Department (Dinas Kesehatan Surabaya) can input the data and predict the outbreak online. However, right now in some regions the predictions are not performed well. In the next research, we will expand the model into spatial-temporal MLP model, which can capture data dependencies not only spatially, but also temporally.

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Author(s): Siana Halim, Andreas Handojo, Ivan Widodo, Felecia Felecia, Tanti Octavia
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