NIASRA
NATIONAL INSTITUTE FOR APPLIED STATISTICS RESEARCH AUSTRALIA

UOW
AUSTRALIA

Certificate of Presentation

International Conference on Robust Statistics

3-7 July 2017

This is to certify that

Sifriyani sifriyani

Presented at the 2017 ICORS Conference

Prof Ray Chambers,
Chair, local organising committee,
2017 International Conference on Robust Statistics
University of Wollongong Australia

UNIVERSITY
OF WOLLONGONG
AUSTRALIA

School of Mathematics and Applied Statistics (SMAS)

National Institute for Applied Statistics Research Australia (NIASRA)

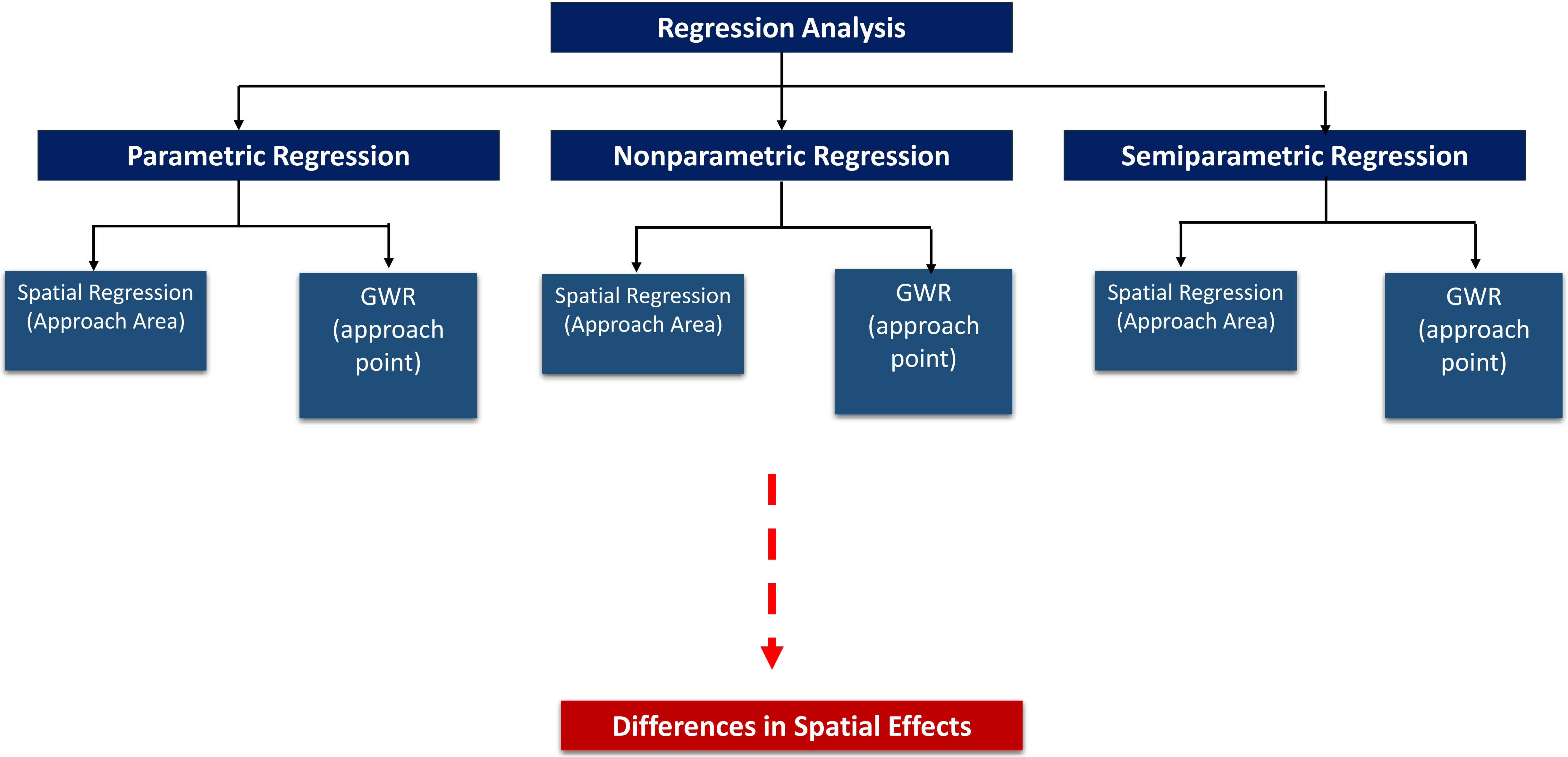
Statistical Modeling for Unemployment Rates using Nonparametric Geographically Weighted Regression with Truncated Spline Approach

Sifriyani, Sri Haryatmi Kartiko, I Nyoman Budiantara and Gunardi

Abstract

In this study we developed nonparametric geographically weighted regression models using truncated spline approach. This method is applied to the rate of unemployment data in East Java, as there are problems of high population growth impacting the high unemployment rate. This method was chosen due to the fact that the data used had an unknown regression curve and is influenced by the geographical element. Truncated spline approach is used because this approach has the function of a flexible mathematics and models that tend to look for the shape of the curve regression estimate objectively, without being influenced by the subjective factor of researchers. We first analysis was to find model estimators using truncated spline approach. Furthermore the selection of optimum knot points was done by selecting the minimum value of the Generalized Cross Validation (GCV). This study has been successfully mapped and modeled the unemployment rate with variables that affect it. The results using the nonparametric geographically weighted regression methods using truncated spline approach has the best statistical model and is satisfactory with 98.95% coefficient of determination and the MSE is equal to 0.0047.

Introduction

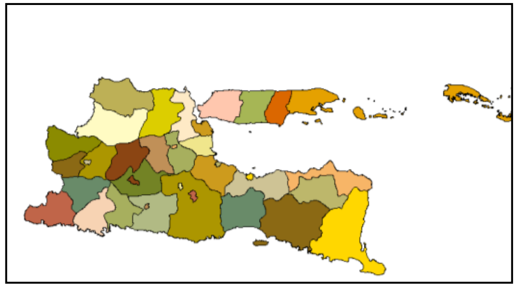


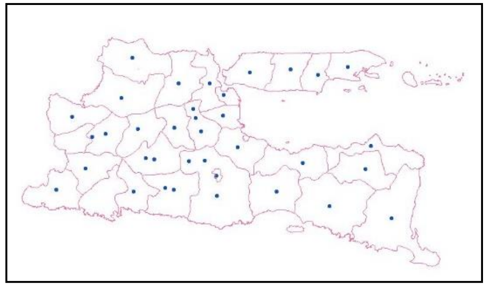
SPATIAL EFFECTS

Spatial Effects
(Anselin, Getis, 1992)

Spatial Dependence

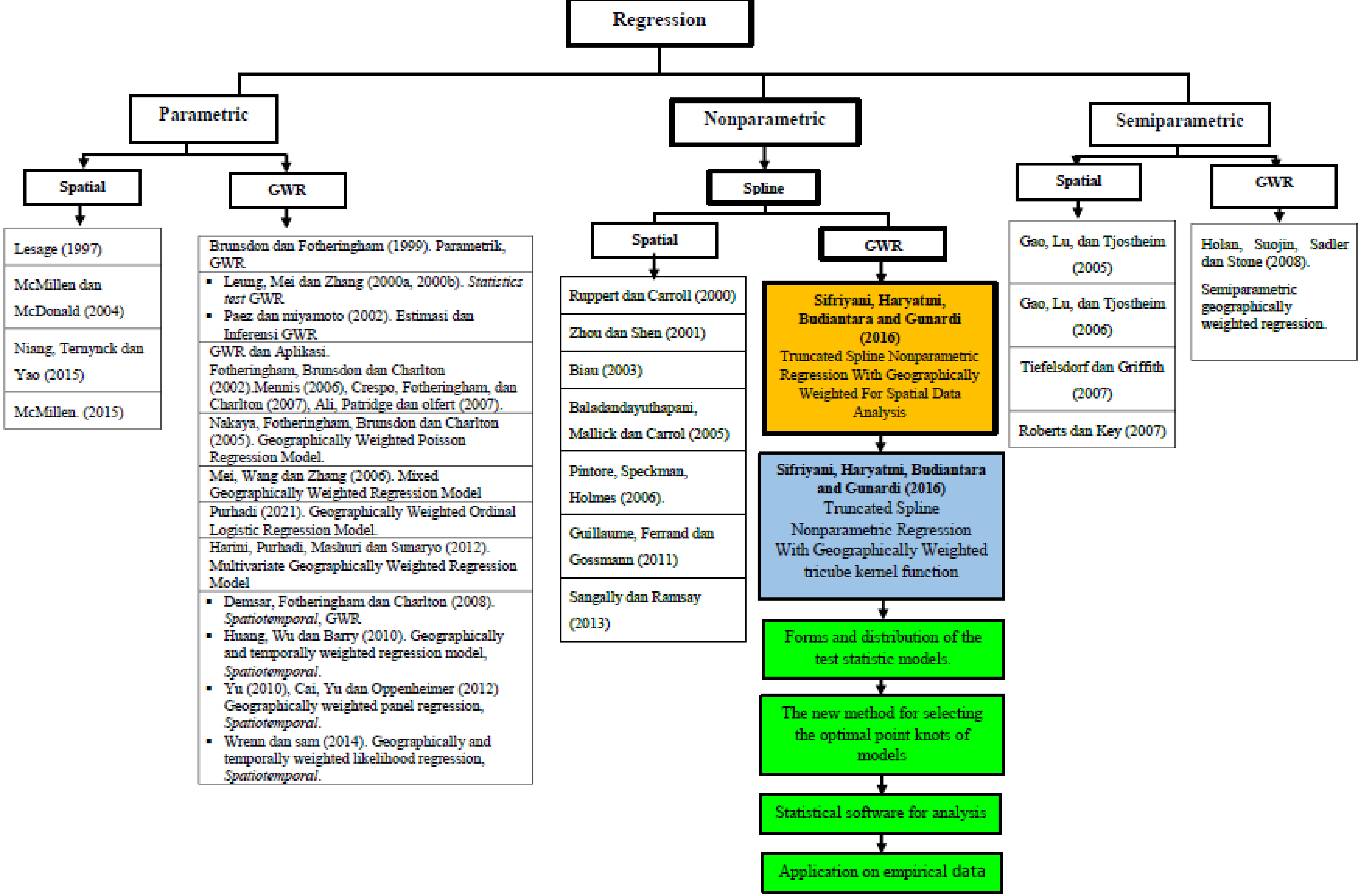
Functional relationships between events in an observation area with other events in the observation area.
Spatial Regression: *Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), General Spasial Model (GSM).*
Spatial regression using Approach Area



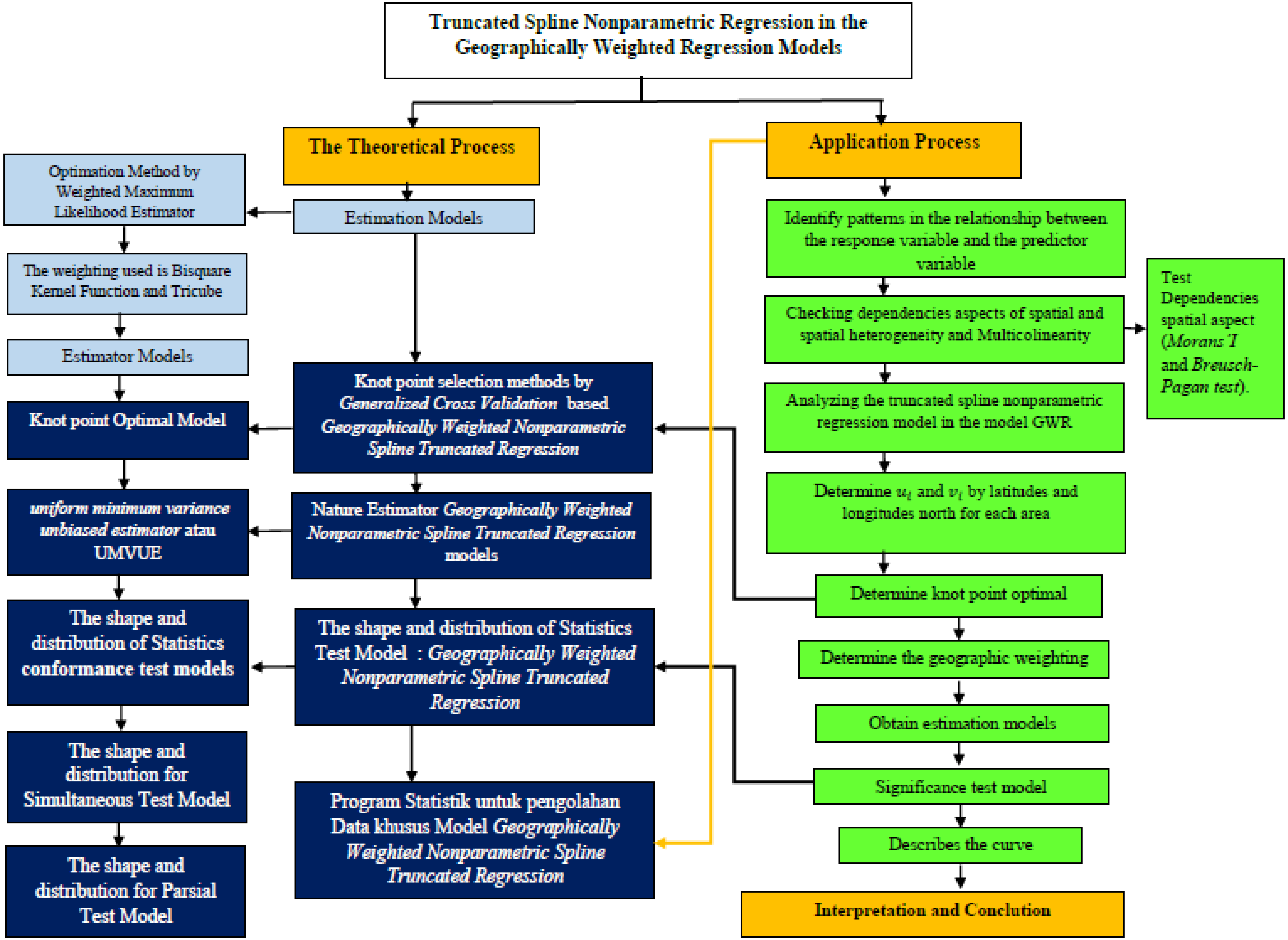


spatial variability

there are different influences on the predictor variable to respon variable from one region to another.
Geographically Weighted Regression Using Approach Point.



Regression
Parametric
Nonparametric
Semiparametric
Spatial
GWR
Spline
Spatial
GWR
Spatial
GWR
Lesage (1997)
McMillen dan McDonald (2004)
Niang, Ternynck dan Yao (2015)
McMillen. (2015)
Brunsdon dan Fotheringham (1999). Parametrik, GWR
Leung, Mei dan Zhang (2000a, 2000b). Statistics test GWR
Paez dan miyamoto (2002). Estimasi dan Inferensi GWR
GWR dan Aplikasi.
Fotheringham, Brunsdon dan Charlton (2002).Mennis (2006), Crespo, Fotheringham, dan Charlton (2007), Ali, Patridge dan olfert (2007).
Nakaya, Fotheringham, Brunsdon dan Charlton (2005). Geographically Weighted Poisson Regression Model.
Mei, Wang dan Zhang (2006). Mixed Geographically Weighted Regression Model
Purhadi (2021). Geographically Weighted Ordinal Logistic Regression Model.
Harini, Purhadi, Mashuri dan Sunaryo (2012). Multivariate Geographically Weighted Regression Model
Demsar, Fotheringham dan Charlton (2008). Spatiotemporal, GWR
Huang, Wu dan Barry (2010). Geographically and temporally weighted regression model, Spatiotemporal.
Yu (2010), Cai, Yu dan Oppenheimer (2012) Geographically weighted panel regression, Spatiotemporal.
Wrenn dan sam (2014). Geographically and temporally weighted likelihood regression, Spatiotemporal.
Ruppert dan Carroll (2000)
Zhou dan Shen (2001)
Biau (2003)
Baladandayuthapani, Mallick dan Carrol (2005)
Pintore, Speckman, Holmes (2006).
Guillaume, Ferrand dan Gossmann (2011)
Sangally dan Ramsay (2013)
Sifriyani, Haryatmi, Budiantara and Gunardi (2016)
Truncated Spline Nonparametric Regression With Geographically Weighted For Spatial Data Analysis
Sifriyani, Haryatmi, Budiantara and Gunardi (2016)
Truncated Spline Nonparametric Regression With Geographically Weighted tricube kernel function
Forms and distribution of the test statistic models.
The new method for selecting the optimal point knots of models
Statistical software for analysis
Application on empirical data
Gao, Lu, dan Tjostheim (2005)
Gao, Lu, dan Tjostheim (2006)
Tiefelsdorf dan Griffith (2007)
Roberts dan Key (2007)
Holan, Suojin, Sadler dan Stone (2008).
Semiparametric geographically weighted regression.


Truncated Spline Nonparametric Regression in the Geographically Weighted Regression Models
The Theoretical Process
Application Process
Optimation Method by Weighted Maximum Likelihood Estimator
Estimation Models
The weighting used is Bisquare Kernel Function and Tricube
Estimator Models
Knot point Optimal Model
Knot point selection methods by Generalized Cross Validation based Geographically Weighted Nonparametric Spline Truncated Regression
uniform minimum variance unbiased estimator atau UMVUE
Nature Estimator Geographically Weighted Nonparametric Spline Truncated Regression models
The shape and distribution of Statistics conformance test models
The shape and distribution of Statistics Test Model : Geographically Weighted Nonparametric Spline Truncated Regression
The shape and distribution for Simultaneous Test Model
Program Statistik untuk pengolahan Data khusus Model Geographically Weighted Nonparametric Spline Truncated Regression
The shape and distribution for Parsial Test Model
Identify patterns in the relationship between the response variable and the predictor variable
Checking dependencies aspects of spatial and spatial heterogeneity and Multicolinearity
Test Dependencies spatial aspect (Morans 'I and Breusch-Pagan test).
Analyzing the truncated spline nonparametric regression model in the model GWR
Determine u_i and v_i by latitudes and longitudes north for each area
Determine knot point optimal
Determine the geographic weighting
Obtain estimation models
Significance test model
Describes the curve
Interpretation and Conclution

Agricultural Sector
(Holan, Sadler, Stone, 2008).
Applications in agriculture with specific location (site-specific agriculture). The predictor variables is the provision of nitrogen and irrigation

Geographers Sector
(Mennis dan Jordan, 2005)
Air pollution in New Jersey, USA and var predictor is the population density, the number of industrial and environmental conditions

Geologi Sector
(Atkinson, German, Sear dan Clark, 2003)
Find a relationship between erosion occurring along the Avon River Dyfi in West Wales with variable geomorphology

If the pattern of the relationship between the response variable and the predictor variables have not identified a specific pattern

on spatial data, to overcome the unknown regression curve in GWR models can be completed with nonparametric regression.

Nonparametric Geographically Weighted Regression Models Using Truncated Spline Approach

Nonparametric Geographically Weighted Regression models using Truncated Spline approach is a nonparametric regression for the development of spatial data with parameter estimator which is local to each observation location. Truncated Spline approach is used to solve the problems of spatial analysis with its regression curve is unknown.

$$y_i = \sum_{p=1} f_p(x_{pi}) + \varepsilon_i$$

with $f_p(x_{pi})$ approximated by Truncated Spline functions for each location (u_i, v_i) which is defined as follows:

$$\begin{aligned} f_p(x_{pi}) = \beta_0(u_i, v_i) + \sum_{p=1}^{l} \sum_{k=1}^{m} \beta_{pk}(u_i, v_i) x_{pi}^k \\ \sum_{p=1}^{l} \sum_{k=1}^{m} \beta_{pm+h}(u_i, v_i)\,(x_{pi} - K_{ph})_+^m \end{aligned} \qquad (2)$$

Which further $f_p(x_{pi})$ will be called as f and by the equation f has the truncated function as follows:

$$(x_{pi} - K_{ph})_+^m = \begin{cases} (x_{pi} - K_{ph}), & x_{pi} \geq K_{ph} \\ 0, & x_{pi} \leq K_{ph} \end{cases}$$

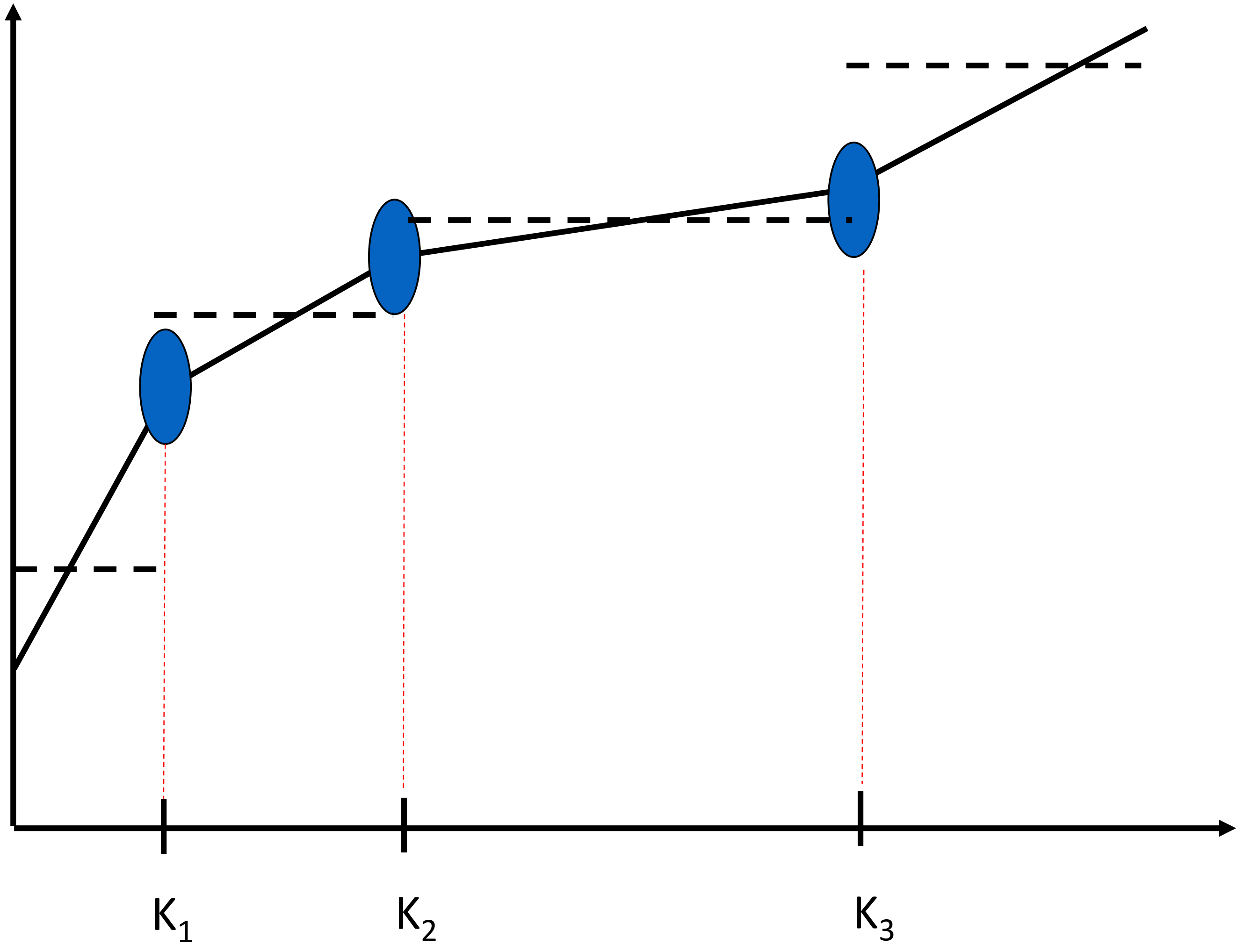
Truncated Spline

Truncated Spline of orde m with point knots $K_1, K_2, \ldots, K_r$ and $a < K_1 < \cdots < K_r < b$ is a function

$$f(x_i) = \sum_{k=0}^{m} \beta_k x_i^k + \sum_{h=1}^{r} \beta_{m+h}(x_i - K_h)_+^m$$

with β_k, β_{m+h} is real konstanta and $k = 0,1,2,\ldots,m$ and $h = 1,2,\ldots,r$ truncated function

$$(x_i - K_h)_+^m = \begin{cases} (x_i - K_h)^m, & x_i \geq K_h \\ 0, & x_i < K_h \end{cases}$$



Nonparametric Geographically Weighted Regression Models Using Truncated Spline Approach

Theorem 1 *If given regression model (3) with an error ϵ_i is Normal distribution with zero mean and variance $\sigma^2(u_i, v_i)$ then using Maximum Likelihood Estimator (MLE) obtained estimator $\hat{\tilde{\beta}}(u_i, v_i)$ and $\hat{\tilde{f}}$ is:*

$$\hat{\tilde{\beta}}(u_i, v_i) = (X^T W(u_i, v_i) X)^{-1} X^T W(u_i, v_i) \tilde{Y}$$

$$\hat{\tilde{f}} = X \hat{\tilde{\beta}}(u_i, v_i)$$

With:

$$W(u_i, v_i) = diag(w_1(u_i, v_i), w_2(u_i, v_i), \ldots, w_n(u_i, v_i))$$

Theorem 2 *If given the regression model (3) with an error is Normal distributed with mean zero and variance $\sigma^2(u_i, v_i)$ then by using Maximum Likelihood Estimator (MLE), estimator $\hat{\sigma}^2(u_i, v_i)$ is:*

$$\hat{\sigma}^2(u_i, v_i) = \frac{(\tilde{Y} - X\hat{\tilde{\beta}}(u_i, v_i))^T W(u_i, v_i)(\tilde{Y} - X\hat{\tilde{\beta}}(u_i, v_i))}{n}$$

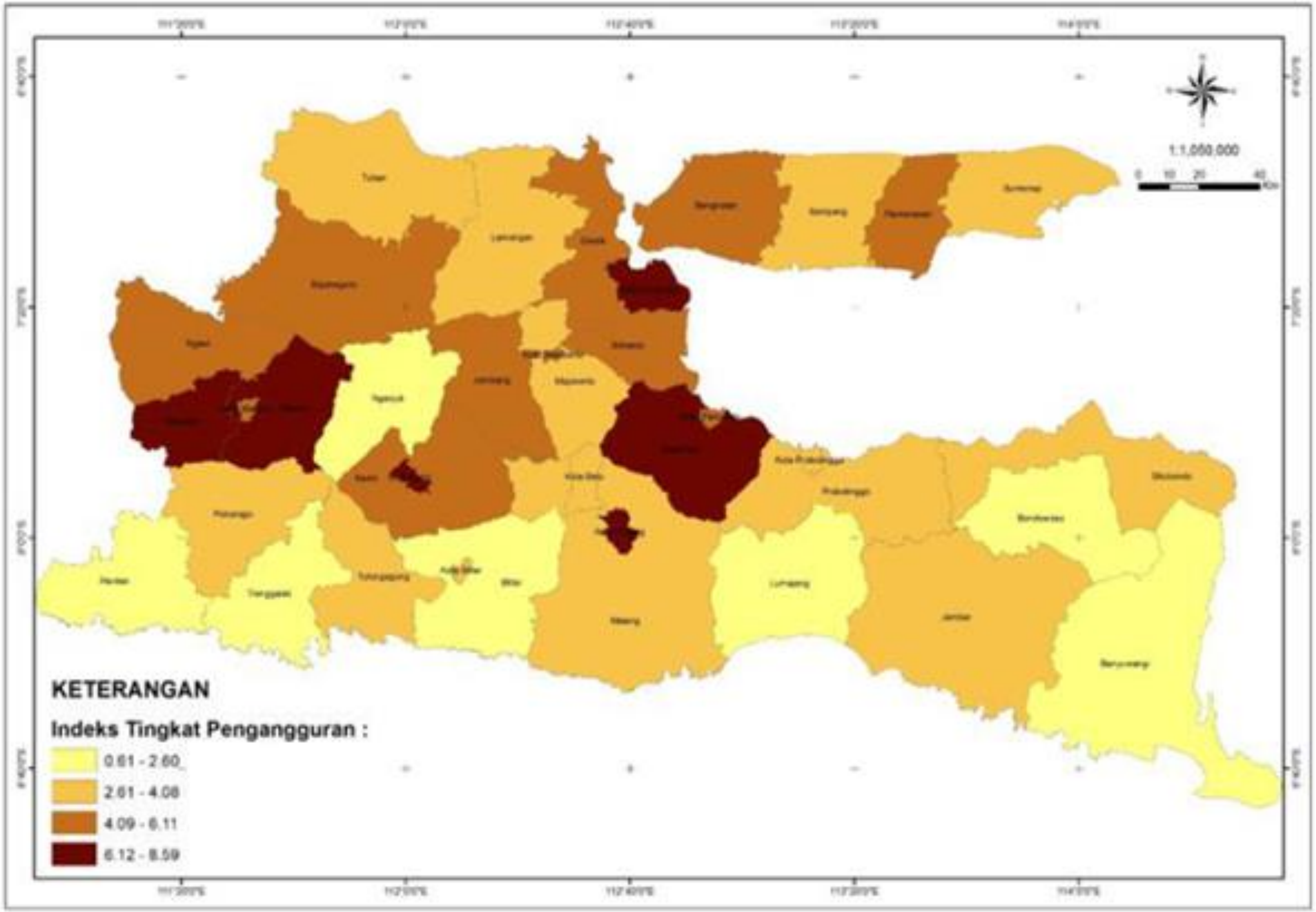
Research Methodology

Table 1 Reasearch variables

Variable	Explanation
y	The open unemployment rate which is the number of unemployment in the district/city divided by the total labor force in the district/city and multiplied by 100%.
x_1	Percentage of people whose education level is above high school in the district/city obtained from number of people aged 15 years old whose education level is above high school divided by the total population aged 15 and older multiplied by 100%.
x_2	The rate of economic growth obtained from the increase in Gross Regional Domestic Product (GDP) at constant prices.
x_4	The ratio of investment per total labor force measured from the amount of investment in the district/city divided by the total labor force.
x_5	Regional Minimum Wage (RMW) is a standard of minimum wage for an area designated by the local government to maintain the welfare of workers in the territory of each region which is different depending on the economic conditions.
x_6	The ratio of number of large and medium industries by total labor force.

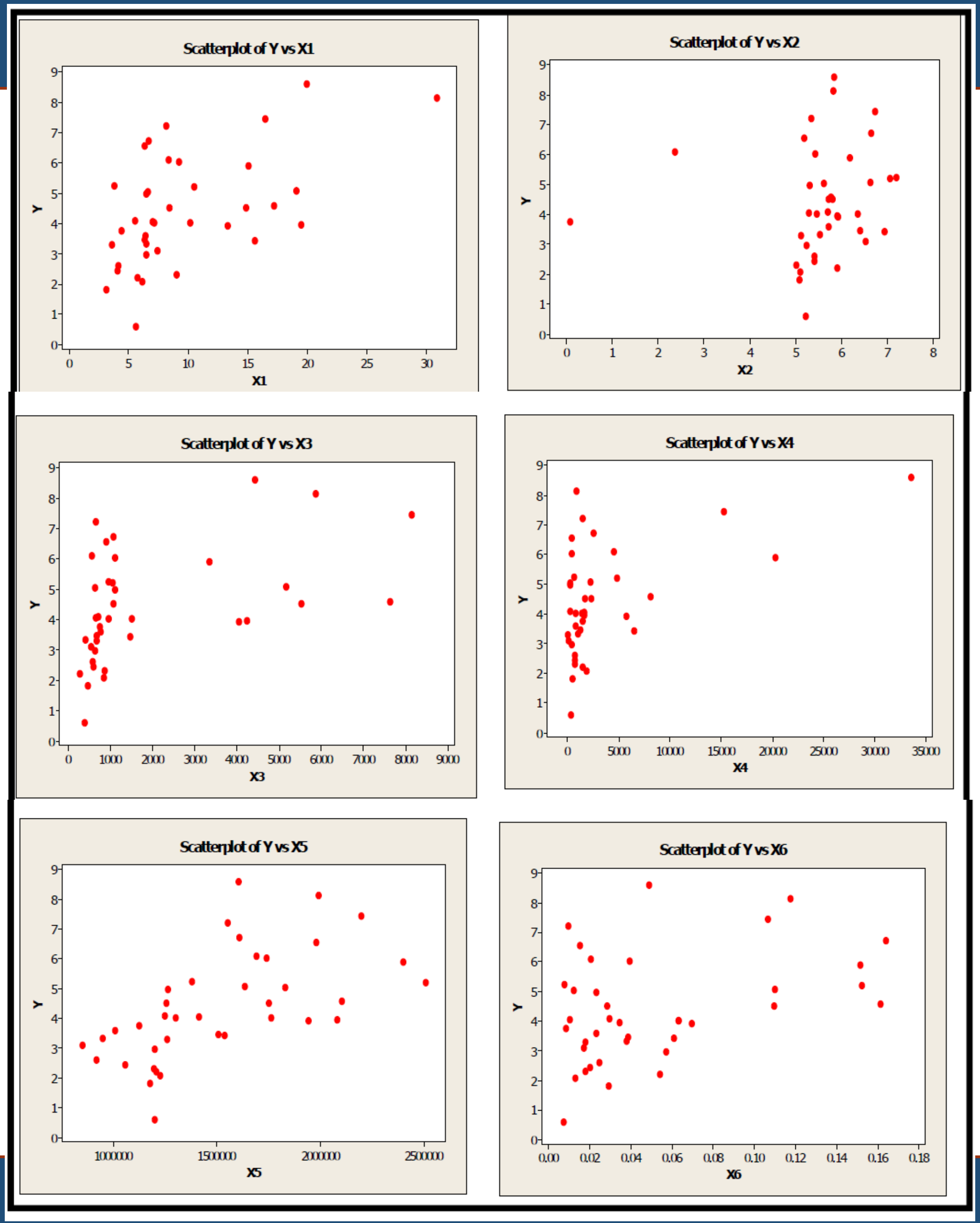
Source. BPS 2016

Research Methodology



Study Area

The total area of East Java province is 47,799.75 km^2 and consist of 38 districts/cities (BPS East Java, 2016a). Deployment of the percentage of unemployment rate is shown in Fig. 1. The percentage of unemployment rate was divided into four categories: Unemployment rate that is very high, high, medium and low. The category of a very high unemployment rate is contained in the region of Magetan, Madiun, Kediri, Malang, Pasuruan and Surabaya city.



Based on Fig, shown in the data patterns between the response variable and each of the predictor variables that form a particular pattern and it cannot be identified. For these reasons, the method to be used was the Nonparametric Spline Regression

Result and Discussion

4.1 Testing for Spatial Aspects

Each region has different characteristics, different parameters, also form different functions. Such/differences prove their spatial aspect. Testing for spatial aspects consists of testing for spatial dependence and spatial heterogeneity. Moran's I testing is used for spatial dependence in Table 4. Breusch-Pagan testing is used to see the spatial heterogeneity at each location in Table 3. The test results on spatial aspects of the unemployment rate data in East Java was contained spatial dependece and spatial heterogeneity. It required the analysis of data to use spatial analysis using point approach namely Geographically Weighted Regression.

Table 3 Breush-pagan for testing the spatial heterogenity

Breush-pagan test	df	P-value
10.605	24	0.00156

Table 4 Morans I for testing the spatial dependence

Morans I tests	Z	P-value
0.066171	226.15	0.000

Testing for Optimum Knot Point

Knot point is the point where the data patterns change. To obtain optimum knot point, the method used is Generalized Cross Validation (GCV). To choose the most optimum value of knots then used the minimum value of GCV.

The best Spline Nonparametric Regression models is obtained by the optimum knot points. According to Table 6 selection of Optimum Knot Points at Appendix, the minimum GCV value is 2.1275 on a combination of the first knot.

Table 6 Selection of Optimum Knot Points

Combi-nation	Knot Point	X_1	X_2	X_3	X_4	X_5	X_6	GCV
1	1	8.689902	1.494	1845.797	6737.82	1182792	0.03876	2.127547
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	9.798909	1.7788	2159.821	8078.364	1249034	0.045027	
2	1	8.689902	1.494	1845.797	6737.82	1182792	0.03876	2.194832
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	10.35341	1.9212	2316.832	8748.636	1282155	0.04816	
3	1	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	2.218992
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	10.35341	1.9212	2316.832	8748.636	1282155	0.04816	
4	1	5.917385	0.782	1060.738	3386.46	1017187	0.023094	2.226053
	2	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	
	3	15.34394	3.2028	3729.939	14781.08	1580244	0.076359	
5	1	8.689902	1.494	1845.797	6737.82	1182792	0.03876	2.226386
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	10.90792	2.0636	2473.844	9418.908	1315276	0.051293	
6	1	5.917385	0.782	1060.738	3386.46	1017187	0.023094	2.22695
	2	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	
	3	15.89845	3.3452	3886.951	15451.36	1613365	0.079492	
7	1	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	2.230465
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	11.46242	2.206	2630.856	10089.18	1348397	0.054426	
8	1	7.026392	1.0668	1374.761	4727.004	1083429	0.029361	2.238076
	2	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	
	3	15.34394	3.2028	3729.939	14781.08	1580244	0.076359	
9	1	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	2.239391
	2	9.244405	1.6364	2002.809	7408.092	1215913	0.041894	
	3	10.90792	2.0636	2473.844	9418.908	1315276	0.051293	
10	1	7.026392	1.0668	1374.761	4727.004	1083429	0.029361	2.218992
	2	8.135398	1.3516	1688.785	6067.548	1149671	0.035627	
	3	15.89845	3.3452	3886.951	15451.36	1613365	0.079492	

Result and Discussion

Table 8 Parameter significance test

Source of variation	SS	MS	F	P-value
Regression	121.73	3.9269	2.3079	0
Error	1.02	1.70	0	
Total	122.75			

Table 10 Goodness of fit test

R-Square	AIC	SSE
98.95%	49	0.0047

Table 11 Estimator $\hat{y}$ at each location

No	District/City	Value of Unemployment Rate in East Java in 2016 (y)	Prediction Value of Unemployment rate in East Java in 2016 ($\hat{y}$)
1.	Pacitan	0.61	1.562172
2.	Ponorogo	4.07	4.850104
3.	Trenggalek	2.45	2.185971
4.	Tulungagung	4.03	4.81887
5.	Blitar	2.3	2.347314
6.	Kediri	4.97	4.590934
7.	Malang	4.08	3.754664
8.	Lumajang	2.6	2.50648
9.	Jember	3.59	3.549956
10.	Banyuwangi	2.22	2.220445
11.	Bondowoso	1.82	2.246655
12.	Situbondo	3.34	2.93828
13.	Probolinggo	3.31	3.366552
14.	Pasuruan	6.71	4.529665
15.	Sidoarjo	5.91	5.563193
16.	Mojokerto	4.02	4.986041
17.	Jombang	6.04	5.526177
18.	Nganjuk	2.09	1.758886
19.	Madiun	7.23	5.251611
20.	Magetan	6.57	6.054003
21.	Ngawi	5.03	5.681623
22.	Bojonegoro	6.11	6.240686
23.	Tuban	2.98	2.512977
24.	Lamongan	3.45	4.852139
25.	Gresik	5.2	5.681464
26.	Bangkalan	5.24	4.539939
27.	Sampang	3.76	3.878978
28.	Pamekasan	4.53	4.642049
29.	Sumenep	3.09	3.37521
30.	Kota Kediri	8.59	8.836384
31.	Kota Blitar	3.95	4.999163
32.	Kota Malang	8.13	7.367727
33.	Kota Probolinggo	3.93	3.625871
34.	Kota Pasuruan	4.51	5.015693
35.	Kota Mojokerto	4.58	5.022481
36.	Kota Madiun	5.06	4.585661
37.	Kota Surabaya	7.45	7.123855
38.	Kota Batu	3.42	4.149134

Result and Discussion

District	Significant variable	Cluster
Banyuwangi	$x_1, x_2, x_3, x_4, x_5, x_6$	1
Probolinggo		
Sampang		
Pamekasan		
Lumajang		
Jember		
Blitar		
Bojonegoro		
Kota Kediri	x_2, x_3, x_4, x_5, x_6	2
Trenggalek		
Ngajuk		
Kediri		
Kota Madiun		
Jombang		
Situbondo	x_1, x_2, x_4, x_5, x_6	3
Sumenep		
Bondowoso		
Kota Probolinggo	x_1, x_3, x_4, x_5, x_6	4
Malang		
Bangkalan	x_1, x_3, x_4, x_6	5
Kota Surabaya	x_2, x_3, x_4, x_5	6
Magetan		
Tulungagung	x_1, x_2, x_3, x_5	7
Ponorogo	x_3, x_4, x_5	8
Kota Malang		
Kota Batu		
Sidoarjo		
Gresik		
Kota Mojokerto		
Kota Pasuruan		
Tuban		
Ngawi	x_4, x_5	9
Mojokerto		
Pacitan	x_5	10
Kota Blitar		
Lamongan		
Pasuruan	No significant variable	11
Madiun		

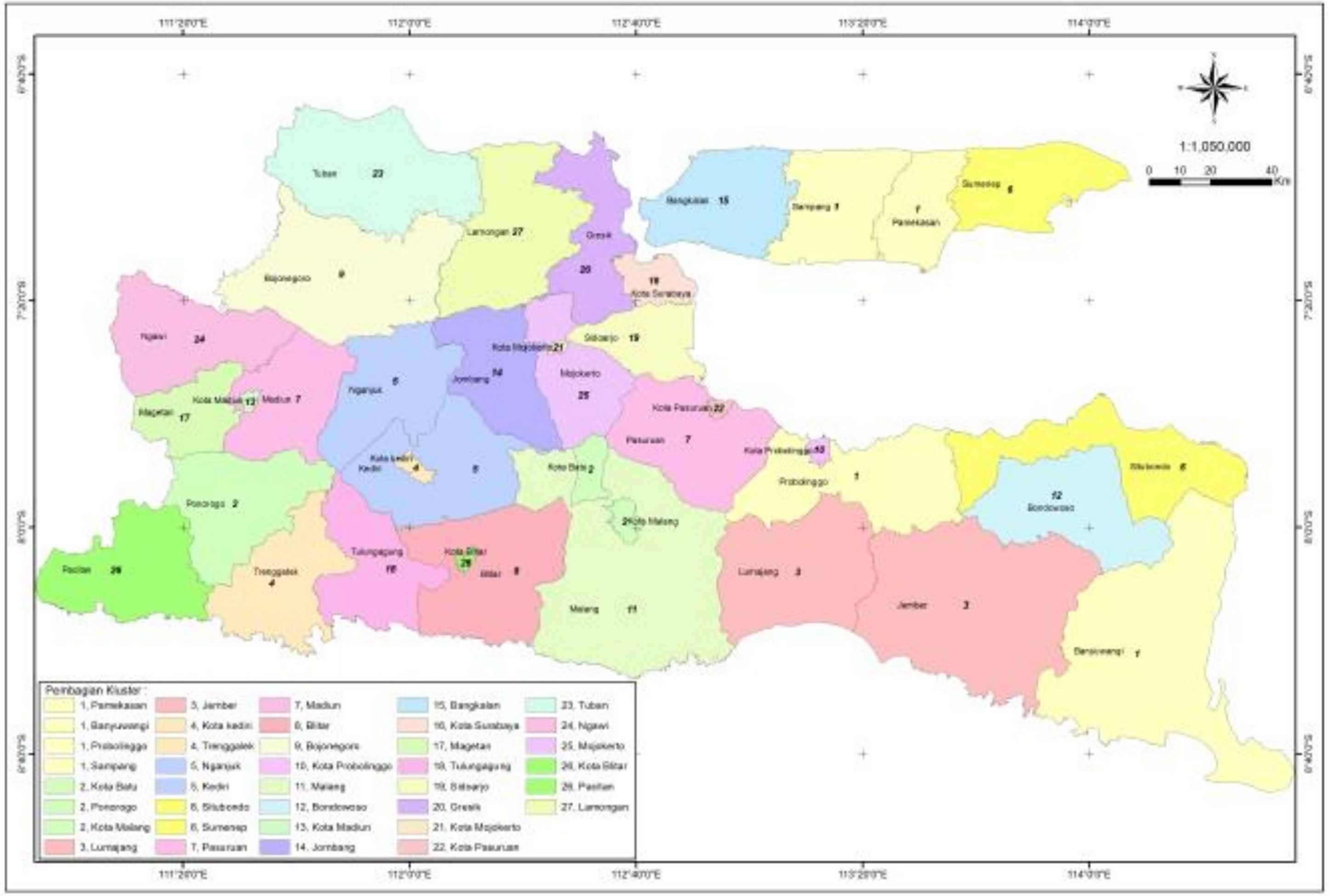


Fig. 3 Mapping the distribution of significant variables by district/city in East Java

Result and Discussion

only influenced by the Regional Minimum Wage (RMW). Furthermore, will be discussed statistical model based on the analysis that has been done. Nonparametric Geographically Weighted Regression models using Truncated Spline approach for the city of Surabaya is as follows:

$$\begin{aligned}\hat{y} =& \hat{\beta}_0 + \hat{\beta}_4 x_4 + \hat{\beta}_5 x_5 + \hat{\beta}(x_2 - K_1)_+ + \hat{\beta}_9(x_3 - K_1)_+ + \hat{\beta}_{11}(x_5 - K_1)_+ + \\ & \hat{\beta}_{14}(x_2 - K_1)_+ + \hat{\beta}_{15}(x_3 - K_2)_+ + \hat{\beta}_{16}(x_4 - K_2)_+ + \hat{\beta}_{81}(x_5 - K_2)_+ + \\ & \hat{\beta}_{20}(x_2 - K_3)_+ + \hat{\beta}_{21}(x_3 - K_3)_+ + \hat{\beta}_{22}(x_4 - K_3)_+ + \hat{\beta}_{23}(x_5 - K_3)_+\end{aligned} \quad (4)$$

Result and Discussion

Furthermore, substitute the parameter estimator β into Equation 4, it is obtained:

$$
\begin{aligned}
y = &- 0.00013 - 0.0002x_4 + 3.51x_5 - 0.01114(x_2 - K_1)_+ \\
&+ 0.000351(x_2 - K_2)_+ + 0.000172(x_2 - K_3)_+ - 0.00796(x_3 - K_1)_+ \\
&+ 0.011009(x_3 - K_2)_+ - 0.00011(x_3 - K_3)_+ - 0.00121(x_4 - K_2)_+ \\
&- 0.00102(x_4 - K_3)_+ - 0.10027(x_5 - K_1)_+ + 0.000161(x_5 - K_2)_+ \\
&- 0.001(x_5 - K_3)_+
\end{aligned} \tag{5}
$$

Substitute the optimum knot value given by Table 5 in Equation 5 in order to obtain truncated spline nonparametric regression model with the best three knot points:

$$
\begin{aligned}
y = &- 0.00013 - 0.0002x_4 + 3.51x_5 - 0.01114(x_2 - 1.494)_+ \\
&+ 0.000351(x_2 - 1.636)_+ + 0.000172(x_2 - 1.778)_+ \\
&- 0.00796(x_3 - 1845.797)_+ + 0.011009(x_3 - 2002.809)_+ \\
&- 0.00011(x_3 - 2159.821)_+ - 0.00121(x_4 - 7408.092)_+ \\
&- 0.00102(x_4 - 8078.364)_+ - 0.10027(x_3 - 1182792)_+ \\
&+ 0.000161(x_5 - 12159113)_+ - 0.001(x_5 - 1249034)_+
\end{aligned} \tag{6}
$$

Result and Discussion

If the variable x_3, x_4 and x_5 are considered constant, then the influence of economic growth on the unemployment rate in East Java is:

$$\hat{y} = -0.0114(x_2 - 1.494)_+ + 0.000351(x_2 - 1.636)_+ + 0.000172(x_2 - 1.778)_+$$

Truncated functions for variable x_2 are:

$$= \begin{cases} -0.01114x_2 + 0.016643 & 1.494 \leq x_2 < 1.636 \\ -0.01079x_2 + 0.016069 & 1.636 \leq x_2 < 1.778 \\ -0.01062x_2 + 0.015763 & 1.778 \leq x_2 \end{cases}$$

If the percentage of economic growth ranges between 1.494 to 1.636% and on that range if the percentage rate of economic growth increases 1% then the unemployment rate decreases 0.01114%. But if the percentage of economic growth ranges between 1.636 and 1.778%, on that range if the percentage of economic growth increases 1% then the unemployment rate decreases 0.01079%. If the percentage of economic growth is greater than or equal to 1.778% and on the range the percentage of economic growth increases 1% then the unemployment rate decreases 0.01062%. The influences of economic growth rate is inversely proportional to the unemployment rate in terms of increased economic growth can reduce the unemployment rate in the area of the city of Surabaya. If variable x_2, x_4 and x_5 are considered constant, then the influence of population density on the unemployment rate in East Java is:

$$\hat{y} = -0.00796(x_3 - 1845.797)_+ + 0.01109(x_3 - 2002.809)_+ + 0.00011(x_3 - 2159.821)_+$$

Truncated functions for variable x_3 are:

$$= \begin{cases} -0.00796x_3 + 14.69254 & 1845.797 \leq x_3 < 2002.809 \\ 0.00304x_3 - 7.35638 & 2002.809 \leq x_3 < 2159.821 \\ 0.002939x_3 - 7.1188 & 2159.821 \leq x_3 \end{cases}$$

5 Conclusion

Nonparametric Geographically Weighted Regression models using the best Truncated Spline approach is the model with the three knot points. This model has a minimum value of GCV i.e., 2.1275 with R-Square 98.95% and MSE 0.0047. Best geographical weighting used in the model is a Gaussian Kernel functions that has a smaller Cross Validation value than the Bisquare Kernel functions. This study is confined to three knot points and the use of the first order Truncated Spline Regression. Further research can be developed by using more than three knot points and the second or more order Truncated Spline Regression.

References

1. Adenan, R.R. and D.P. Indrijatmiko, Statistik Industri Besar dan Sedang Provinsi Jawa Timur 2014, Badan Pusat Statistika Provinsi Jawa Timur, Provinsi Jawa Timur (2016)
2. BPS East Java, Provinsi Jawa Timur Dalam Angka 2016, Provinsi Jawa Timur: Badan Pusat Statistika Provinsi Jawa Timur, Provinsi Jawa Timur (2016a)
3. BPS East Java, Produk Domestik Regional Bruto Kabupaten/Kota Menurut Lapangan Usaha 2010-2014, Provinsi Jawa Timur: Badan Pusat Statistika Provinsi Jawa Timur, Provinsi Jawa Timur (2015)
4. BPS East Java, Keadaan Angkatan Kerja di Jawa Timur Tahun 2015, Provinsi Jawa Timur: Badan Pusat Statistika Provinsi Jawa Timur, (2016b)
5. BPS Indonesia, Keadaan Angkatan Kerja di Indonesia 2016, Badan Pusat Statistika Indonesia, Jakarta (2016)
6. David, R. Bickel, Blending Bayesian and frequentist methods according to The precision of prior information with applications to hypothesis testing, Springer, **24**, 4, 523-546 (2015)
7. Demsar, U., A.S. Fotheringham and M. Charlton, Exploring the spatio-temporal dynamics of geographical processes with geographically weighted regression and geovisual analytics, Inference (DOI: 10.1057/palgrave.ivs.9500/87), **7**, 181-197 (2008)
8. Golan, A. and J.M. Perloff, Superior forecasts of the U.S. unemployment rate using a nonparametric method, Rev. Econom. Stat. (DOI: 10.1162/003465304774201860), **86**, 433-438 (2004)
9. Huang, B., B. Wu and M. Barry, Geographically and temporally weighted regression for modeling spatio-temporal variation in house prices, Int. J. Geograph. Inform. Sci. (DOI: 10.1080/13658810802672469), **24**, 383-401 (2010)

10. Mei, C.L., N. Wang and W.X. Zhang, Testing the importance of the explanatory variables in a mixed geographically weighted regression model, J. Environ. Plann. A (DOI: 10.1068/a3768), **38**, 587-598 (2006)
11. Miskolczi, M., J. Langhamrova and T. Fiala, Dependency between gross domestic product and unemployment in the Czech Republic, Res. J. Econom. Bus. ICT, 4, 47-51 (2011)
12. Nakaya, T., A.S. Fotheringham, C. Brunsdon and M. Charltron, Geographically Weighted Poisson Regression for disease association mapping, J. Stat. Med. (DOI: 10.1002/sim.2129), **24**, 2695-2717 (2005)
13. Proiette, T., Forecasting the U.S. unemployment rate, Dipartimento di Scienze Statistiche Universita di Udine (2001) This reasearch was supported by Cofin. MURST 2000 prot. MM13035581 003 as part of the project Linearity and Nonlinearty in Time Series Dynamics.
14. Pudprommarat, C., Statistical model for predicting unemployment rates in Thailand using generalized estimating equition. (2008)
15. Sari, R. and I.N. Budiantara, Pemodelan pengangguran terbuka di jawa timur dengan menggunakan pendekatan regesi spline multivariabel, J Sains Seni, **1**, 236-241 (2012)
16. Sifriyani, Haryatmi, I.N. Budiantara and Gunardi, Geographically weighted Regression with Sprune Approach, Far East Journal of Mathematical Sciences, **101**, **6**, 1183-1196 (2017)
17. Timothy, R. and M. Majid, On the L_p norms of kernel regression estimators for incomplete data with applications to classification, Journal Stastistical Methods and applications, Springer, **26**, **1**, 81-112 (2016)
18. Wrenn, D.H. and A.G. Sam, Geographically and temporally weighted likelihood regression: Exploring the spatiotemporal determinants of land use change, Regional Sci. Urban Econom (DOI: 10.1016/j.regsciurbeco.2013.10.005), **44**, 60-74, (2014)
19. Yang, L., Confidence band for additive regression model, J. Data Sci., **6**, 207- 217 (2008)
20. Yu, D., Exploring spatiotemporally varying regressed relationships: the geographically weighted panel regression analysis, Proceedings of the Joint International Conference on Theory, Data Handling and Modeling in GeoSpatial Information Science, (GSIS 10), 134-139 (2010)

Thanks For You Attention