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PROCEEDING

**THE 3RD INTERNATIONAL CONFERENCE
ON MATHEMATICS AND STATISTICS**

BOGOR, 5 - 6 AUGUST 2008

*Mathematics and Statistics: bridge for academia, business,
and government in the entrepreneurial era*

3rd
ICOMS 2008
INTERNATIONAL CONFERENCE ON MATHEMATICS AND STATISTICS



Department of Applied
Mathematics
Faculty of Science
Universitas Indonesia



IKMPS
Indonesian Mathematical Society
P.O. Box 100000
Jakarta 10100



Indonesian Mathematical
Education Commission

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*Mathematics and Statistics: bridge for academia, business,
and government in the entrepreneurial era*

organized by



MSMSSEA (Moslems Statisticians and
Mathematicians Society in South East Asia)



Department of Statistics
Department of Mathematics
Institut Pertanian Bogor



Department of Mathematics
Universiti Malaysia Terengganu,
Malaysia

PREFACE

Assalaamu'alaikum warahmatullaahi wabarakaatuh

Welcome all participants of ICoMS 2008 to Bogor – Indonesia. This event is organized by MSMSSEA in collaboration with Institut Pertanian Bogor (Indonesia) and Universiti Malaysia Terenganu (Malaysia).

We, the organizing committee, are very glad having this international conference due to many reasons.

1. ICoMS is a good avenue for mathematicians, statisticians, and other scientist to communicate.
2. ICoMS 2008 has a theme related to entrepreneurial era which is very important for mathematicians and statisticians, and scientist in general.
3. The event is important venue for business group, government, and academia to communicate and share knowledge as well.
4. Bogor is beautiful place in Indonesia surrounded by many research centers, IPB, Botanical garden, an other point of interest related to research institution.

We are also happy that the Vice President of Republic of Indonesia, Ministry of National Education, Ministry of Energy and Mineral Resources, and Ministry of Communication and Information Technology are supporting to the ICoMS 2008.

This event held on two days, August 5-6, and consist of several parts. We invite 17 outstanding professors to share and discuss topics in mathematics and statistics, including application. As many as 170 paper and 30 posters presented during this two-day conference. We appreciate to all of contributor from various countries who are motivated to participate in this event.

High appreciation is also awarded to companies and agencies which facilitate so that the even could run well.

We really hope all participants can benefit many things from this international event. May God bless you.

Wa'alaikumsalam warahmatullaahi wabarakaatuh.

The Committee of ICoMS 2008

CONTENTS

Preface		ii
Contents		iii
Speech of Director General of Higher Education: Dr. Fasli Jalal		xiii
 SESSION A		
Vector-Borne Disease Transmission Model: The Case of Filariasis Transmission in Jati Sampurna	A.K. Supriatna a;ꣳ H. Serviana b E. Soewono	1
Optimization of Dining Table Placement in Restaurant Using Genetic Algorithm	Monika, Arnold Aribowo, Samuel Lukas	11
The Influence of Islamic Mathematics In The Malay World: A Study of Classical Astronomical Tables	Baharrudin Zainal and Mat Rofa Ismail	16
Problem-Based Learning Strategy To Improve Mathematics Skills Among Students	Ismail Abdullah	24
Linear Time Invariant Versus Linear Parameter Varying Reduced Order Controller Design For Aircraft Model	Widowati	31
Scientific Computing Research In The Faculty of Information Science And Technology Universiti Kebangsaan Malaysia	Mohammad Khatim Hasan, Muriati Mokhtar, Riza Sulaiman and Jumat Sulaiman	39
The Functions of Contextual Problems On A Mathematics Instruction Implementing The Realistic Approach	Rini Setianingsih	47
Further Results On The Ramsey Numbers For Star Union Cycle Versus Wheel On Seven Vertices	I Wayan Sudarsana, Edy Tri Baskoro, and Hilda Assiyatun	54
Characteristics of Lecturer That Influences Effective Teaching In Quality Education Based On Tqm Concepts	Khairul Anuar Mohd Ali, Zainol Mustafa, Fazli Idris & Siau Yee	58
Feynman Diagrams And The Tau Function	Zainal Abdul Aziz	66
An Evaluation Of The Efficiency Wage Model: Evidence From Bangladesh Food Industry	Masud Rana, Md. Azizul Baten and Mezbahur Rahman	74
Modeling Self-Potential (Sp) Distribution Groundwater Flow Using Boundary Element Method (BEM)	Muhammad Hamzah, S., Santoso, D., Parnadi, W.W., Sulistijo, B	83
Nonlinear Dynamic Plant Identification Of Waste Heat Boiler Unit Using Adaptive Wavelet - Neural Network (Wavenet) Method	Yuliati	91
A Group Mutual Exclusion Algorithm For Ad Hoc Mobile Networks	Armin Lawi	100
On The Measurement Of Credit Risk: A New Geometric Approach	Alireza Bahiraie, Noor Akma Ibrahim, Ismail bin Mohd, Azhar A.K.M	105

Slide By Slide Method In Solving General Global Optimization Problems	Goh Khang Wen, Ismail bin Mohd, and Yosza bin Dasril	111
The Infinite Divisibility Of Geometric Distribution	Dodi Devianto and Katsuo Takano	120
Tight Immersions And Transnormal Embeddings	B.A.Saleemi	126
Hydromagnetic Flow Over An Impermeable Linearly Stretching Sheet Immersed In A Non-Darcian Porous Medium	Noor Fadiya Mohd Noor and Ishak Hashim	131
Wavelet Analysis Of Solar Mass Ejection During Active And Quiet Sun	Saifuddin Ahmed Jilani and M.Ayub Khan YousfZai	138
Modeling A Determination Of Expected Commercial Value Of A Project In Producing Innovative Products In Smes	Nursafarizah Abd Aziz, Nor Ratna Masrom, Yosza Bin Dasril, and Adi Saptari	144
Modelling Nurse Rostering Using A 0-1 Goal Programming: A Case Study In Hukm	Ruzzakiah Jenal, Wan Rosmanira Ismail, Liong Choong Yeun And Masri Binti Ayob	151
SESSION B		
Enhancing Students' Mathematical Learning through Teacher Professional Development	Yaya S. Kusumah	159
Around Prime And Maximal Ideals Of A Skew Polynomial Ring Over A Dedekind Domain	A. K. Amir, P. Astuti, and I. Muchtadi-Alamsyah	169
The Fuzzy Version Of The Fundamental Theorem Of Semigroup Homomorphism	<u>Karyati</u> , Indah Emilia W, Sri Wahyuni, Budi Surodjo, Setiadji	173
Solving Fourth-Order Parabolic Equations By Red-Black Quarter-Sweep Sor Iterative Methods	J. Sulaiman, M. Othman, and M.K. Hasan	180
25 Years Development Of Knowledge Graph Theory: The Results And The Challenge	Sri Nurdiati and Cornelis Hoede	187
Eigenvalues And Eigenvectors Of Matrices Over Fuzzy Number Max-Plus Algebra	M. Andy Rudhito, Sri Wahyuni, Ari Suparwanto, and F. Susilo	195
The Partition Dimension Of Windmill Graph	Darmaji, Novian Syah, Saladin Uttungadewa, Edy Tri Baskoro	203
Sorting Process Of Two Sets Of Non-Quantitative Data: Mathematical Method And Analysis	Edi Cahyono, David Taniar, La Ode Saidi, Arman and Natalis Ransi	206
On The Metric Dimension Of $P_2[P_n]$	S. Widosaputro, E.T. Baskoro, A.N.M. Salman, and D. Suprijanto	215
IS-LM In Slow-Fast System	Joice Ruth Juliana, Endah Asmawati	219

A Four-Stage Fifth-Order Runge-Kutta-Nystrom Methods With Dispersion Of High Order	Norazak Senu, Mohamed Suleiman Fudziah Ismail, Mohamed Othman, and Norfifah Bachok@Lati	224
Logic In Recurrent Hopfield Network	Saratha Sathasivam	232
The Generalization Of Incidence Algebra	Ema Carnia, Sri Wahyuni, Irawati and Setiadji	238
Representation Of Sm-Operators On Product Spaces Of r –Lebesgue Spaces $L_p(E, \Sigma, \mu)$, $1 < p < \infty$	Muslim Ansori ,Soeparna Darmawijaya and Supama	242
Benard-Marangoni Instability In A Rotating Fluid Layer With Feedback Control Strategy	Zailan Siri and Ishak Hashim	252
Interior Point Methods For Solving Linear Programing	Iwan Tri Riyadi Yanto,Julan Hernadi, and Yudi Ari Adi	259
Endo-Prime N-Group	Indah Emilia Wijayanti	266
Modelling Of Budget Allocation For University Library	Engku Muhammad Nazri Bin Engku Abu Bakar, Syariza Abdul Rahman, Noorezatty Mohd Yusop	271
A Novel Natural Approach To Euclidean TSP	Nur Azman Abu, Shahrin Sahib And Nanna Suryana	278
R-Linear Independent Generalization	Suprpto, Sri Wahyuni, Indah Emilia W., Irawati	287
A Study For Hyperbolic Decline Exponent Bound	S. Wahyuningsih, S. Darwis, A.Y. Gunawan, and A.K. Permadi	291
The F -Coloring Of The Corona Product Of Complete Graph With Cycle Graph	Adiwijaya, A.N.M. Salman, E.T. Baskoro, and D. Suprijanto	298
A Modified Explicit Group Iterative Algorithm With Accelerated Over-Relaxation For Solving Poisson Equation	Shukhrat I. Rakhimov, Mohamed Othman	302
Asymptotic Behavior Of Linear Delay Differential Systems	Eti Dwi Wiraningsih, Widodo, Lina Aryati, Syamsuddin Toaha	307
On total vertex-irregular labellings of tP_n a forest constructed from a disjoint union of paths	Nurdin1, E.T. Baskoro, A.N.M. Salman, N.N. Gaos	311

SESSION C

The Effectiveness Of The Contextual Video As A Teaching Tool In The Teaching And Learning Statistics At The Universiti Tun Hussein Onn Malaysia (Uthm)	<u>Nafisah Kamariah Md Kamaruddin</u> , Zulkarnain Md Amin, Norfadzilah Ishak, Wan Mohd Rashid Wan Ahmad, And Maizam Alias	316
The Nonlinear Mechanism Of Tsunami Wave Generation	Nazeeruddin Yaacob And Zainal Abdul Aziz	323
Open Economy Macroeconomics: A Linear Rational Expectations Model	Iman Sugema and Toni Bakhtiar	332
The Range Of Mathematical Capability Of University Math Lecturers In Jakarta Indonesia	Ramir Santos Austria	340
An Application Wavelet Based Preconditioner For The Solution Of Ordinary Differential Equation	Ismail Bin Mohd and Farikhin	347
Research And Statistic Studying Model At Junior High School By Realistic Mathematics Education Application	Yani Ramdani	352
Using The Algebra Of Hypergraph For Reconstruction Phylogenetic Trees	Mulia Astuti, Irawati, Intan Mughtadi-Alamsyah, Ahmad Muchlis, Achirul Akbar Dan Muliana. A. Halim	366
Interval Linear Programming	Herry Suprajitno, Ismail Bin Mohd	374
What Happen With Numbers At Our Primary School?	Mohini Mohamed, Zulkifli, Jasmaniah	382
Determination Of GPS Signal Path Using The Runge-Kutta Method	Mardina Abdullah, Siti Sarah Nik Zulkifli, Mahamod Ismail, Ahmad Mahir Razali And Azami Zaharim	387
A Novel Linguistic Aggregation Method For Group Decision Making	Zamali Tarmudi, Mohd Lazim Abdullah And Abu Osman Md Tap	392
A Series Of Element Shape Functions For Infinite Elements	Sri Mardiyati	399
Promoting Creativity In Learning Mathematics Using Open-Ended Problems	Tatag Yuli Eko Siswono	406
Modeling Traffic Lights In Intersection Using Petri Nets	Dieky Adzkiya And Subiono	412
An Alternative Formulation For Electromagnetic Wave Propagations In Source Free Region	Noraini Md Nusi And Mohamed Othman	418
On The Number Of Families Of Branching Processes With Immigration With Family Sizes	Husna Hasan	424

Marangoni Convection In A Fluid Layer With Non-Uniform Temperature Gradient	Norihan Md. Arifin, Siti Suzilliana Putri Mohamed Isa, Roslinda Mohd Nazar, and Mohd Noor Saad	429
Dubrovin Valuation Rings Of Skew Ploynomial Rings	Intan Muchtadi Alamsyah	435
SESSION D		
The Roles Of Numerical Method And Optimal Control Theory In Cancer Immunotherapy	Ismail Bin Mohd, Arif Bin Mandangan	438
The Development of Applied Statistical Analysis	H. Ahmad Ansori Mattjik	450
Risk Factors For Water Fowl Infection With Avian Influenza H5n1, West Java Province, Indonesia	Etih Sudarnika, Asep Saefuddin, Abdul Zahid And Chaerul Basri	459
Trend Of The Import And Export Of Cocoa In Malaysia	H. J. Zainodin, G. Khuneswari & S.C. Albert Ling	463
Performance Analysis Of Reactive Mobile Ad Hoc Networks Routing Protocols Based On Taguchi Technique	Hazura Mohamed, Muhammad Hisyam Lee, Mazalan Sarahintu, Shaharuddin Salleh, And Bahrom Sanugi	472
Optimum Designs Of Multiresponse Surface Models For The First Order Lattice Simplex Designs	Ruslan , Susanti L, Purhadi, Sony S	479
Bayesian Approach For Choice-Conjoint Model In Consumer Preferences	Zulhanif, Ismail Bin Mohd, Noor Akma Ibrahim, Mustafa Bin Mamat	484
Simultan Equation Models Of Gross Domestic Product By Exchange Rate And Money Supply Scenario Analysis For Indonesian Economy	Bagus Sumargo	492
On Designing Algorithm For Sample Selection	L. Muhamad Safiih And Yaya Sudarya Triana	501
Generating Claim Data Of General Insurance Based On Collective Risk Model And Claim Process	Aceng K. Mutaqin, Dumaria R. Tampubolon, Sutawanir Darwis	506
An Application On Multiple-Correspondence Analysis On The Survey For Implementation Of The Profit-Loss Sharing Concept	Novriana Sumarti, Nurdinintya Athari S., And M. Rizka Fadhli	509
GIS Spatial Data Visualization Tools For Artificial Reefs Distribution	Mustafa Man, Md Yazid Mohd Saman, Noor Maizura M. Noor Khalid Samo And W.Aezwani W.A.Bakar	514

An Alternative Approach In Getting A Representative Model In A Mutiple Regression Analysis	G. Khuneswari, H. J. Zainodin, G. Darmesah & S. H. Sim	522
Wireless Internet Usage Among Students In Universiti Malaysia Sabah	Sathissan Ragavan, Darmesah Gabda, Amran Ahmed	531
An evaluation of a software for circular variables: ORIANA	Siti Fatimah Hassan, Abdul Ghapor Hussin and Yong Zulina Zubairi	539
Evaluation Of Some Methods For Estimating Parameters Of Regression Model With Various Zero Observations By Monte Carlo Simulation	Fitria Virgantari, Tjut Awaliyah, I Wayan Mangku, and Siswadi	545
Stability Model's By "Eberhart-Russel's" And Biplot Of Qpm (Quality Protein Maize) Under Central Maize In Indonesia	M Yasin Hg., Sigit Budi Santoso., And Sri Sunarti	553
Increasing Power Of Robust Test Through Pre-Testing In Multivariate Simple Regression Model	Rossita M. Yunus And Shahjahan Khan	559
Application Of Buhlmann-Straub Model On Tectonic Earthquake Insurance Problem	Hasih Pratiwi, Subanar, Danardono, And J.A.M. Van Der Weide	567
Evaluating The Cox-Aalen Model	Danardono	574
Estimation Of Distributed Lag Model With Adaptive Ekspectation And Partial Adjustment On The Distribution Of Fmcd-Based Robust Mahalanobis Distance	Aidawayati Rangkuti <u>Hazlina Hj Ali</u> , Maman A. Djauhari, and Sharipah S.S. Yahaya	579 587
Organizational Commitment Of Public Sector Employees In Pakistan: A Statistical Evidence	<u>Dr. M. Rashid Salahria</u> and Qasim Zafar	595
Carbon Based Material Processing Method Using Statistical Application Technique	N. Hashim, A.N. Zainal Abidin, M. Deraman, W. R. Wan Abdullah, A. Mohd Ramli, 6R.M. Yunus	600
SESSION E		
Continuous Time Model For Portfolio Problem Using Dynamic Programming Approach	Sugiyarto, Ismail Mohd., Mustafa Mamat And Yosza Dasril	607
A Comparison of MLE and GEE On Modeling Binary Panel Response	Jaka Nugraha, Suryo Guritno, Sri Haryatmi	612
Bayesian Scan Statistic For Spatial Cluster Detection	Setia Gunawan Wijaya, Dian Lestari, And Yekti Widyaningsih	619
Correlation Coefficient Estimation From Grouped Data	Teti Sofia Yanti	626
The Performance Of Exponential Weighted Moving Average (Ewma) Control Chart Between Classical, Robust And Bootstrap Method	Khalida Binti Oseman, Nazaruddin Omar And Habshah Midi	634

Inventory Model With Gamma Distribution	Hadi Sumadibrata, Ismail Bin Mohd	642
Accuracy Analysis Of Naive Bayesian Anti-Spam Filter	Ruslam, Armin Lawi, And Sri Astuti Thamrin	649
A New Method For Generating Fuzzy Rules From Training Data And Its Application In Financial Problems	Agus Maman Abadi, Subanar, Widodo, Samsubar Saleh	655
The Application Of Laws Of Large Numbers In Convergence Concept In Probability And Distribution	Georgina M. Tinungki	662
An Empirical Bayes Approach for Binary Response Data in Small Area Estimation	Dian Handayani, Noor Akma Ibrahim, Khairil A. Notodiputro, MOhd. Bakri Adam	669
Statistical Models For Small Area Estimation	Khairil A Notodiputro, Anang Kurnia, and Kusman Sadik	677
Maximum Likelihood Estimation For The Non-Separable Spatial Unilateral Autoregressive Model	Norhashidah Awang, Mahendran Shitan	685
Small Area Estimation Using Natural Exponential Families With Quadratic Variance Function (Nef-Qvf) For Binary Data	Kismiantini	691
Using An Extended And Ensemble Kalman Filter Algorithm For The Training Of Feedforward Neural Network In Time Series Forecasting	Zaقياتud Darojah, M. Isa Irawan, And Erna Apriliani	696
Estimation Of Outstanding Claims Liability And Sensitivity Analysis: Probabilistic Trend Family (PTF) Model	Arif Herlambang, Dumaria R Tampubolon	704
Expected Value Of Shot Noise Processes	Suyono	711
Modelling Malaysian Wind Speed Data Via Two Paramaters Weibull	Nur Arina Basilah Kamisan, Yong Zulina Zubairi, Abdul Ghapor Hussin, Mohd. Sahar Yahya	718
Application Of Latin Hypercube Sampling And Monte Carlo Simulation Methods: Case Study The Reliability Of Stress Intensity Factor And Energy Release Rate Of Indonesian Hardwoods	<u>Yosafat Aji Pranata</u> And Pricillia Sofyan Tanuwijaya	726
The Development Of Markov Chain Monte Carlo (Mcmc) Algorithm For Autologistic Regression Parameters Estimation	Suci Astutik, Rahma Fitriani, Umu Sa'adah, And Agustin Iskandar	734
A Note About Dh-Fever Estimation With ARIMAX Models	Elly Ana, Dwi Atmono Agus W	741
Evaluation Of Additive-Innovational Outlier Identification Procedure For Some Bilinear Models	¹ smail, M.I., Mohamed, I.B., Yahya, M.S.	745

Interval Estimation For Quantile On One Parameter Exponential Distribution Under Multiple Type-Ii Censoring On Complex Case	Akhmad Fauzy	754
A Detection Measure Of Influential Observation Based On Forward Search Approach For Cox-Regression	Mohamed, I. B., Noh, N. A. M., Taib, N. A. M.	760
Gee-Smoothing Spline For Longitudinal Data	Suliadi, Noor Akma Ibrahim, Isthrinayagy S. Krishnarajah, and Isa Daud	768
SESSION F		
On Some Theory And Applications Of Bayesian Hierarchical Modeling	Kamarulzaman Ibrahim	776
Simultaneous Estimation After Selection And Ranking And Other Procedures :	Suryo Guritno	782
The Negative Exponential Case		
Survival Probabilities Of Genes In Partial Selfing Populations	Muhamad Sabran	789
The Probability Difference Indices And Empirical Sampling Distribution For Dif Indices For Identifying Item Bias In Multidimensional Item Response Theory	Badrun Kartowagiran And Heri Retnawati	799
Volumetric Stem Biomass: A Comparitive Study Using Multiple Regression Models	Noraini Abdullah, Zainodin Hj. Jubok And Amran Ahmed	806
An Innovative Approach In Analysing Wind Data Via Graphical Display	Fakhrulrozi Hussain, Yong Zulina Zubairi, And Abdul Ghapor Hussin	815
Denoising Time Series Data Using Daubechies Wavelet Packet Transformation	Samsul Ariffin Abdul Karim, Mohd Tahir Ismail	823
Detection Of Outliers In Circular Regression Model Via Row Deletion Approach	Abuzaid, A. H., Mohamed, I. B., And Hussin, A.G.	828
Implementation Of Classification Predictive Association Rule (CPAR) Algorithm To Diabetes Diagnose	Herwanto, Imas S. Sitanggang	835
Bayesian Survival Analysis Of Acute Leukemia Patients Using Multivariate Adaptive Regression Spline Model	Nurhayati Ulath, Sri Astuti Thamrin, And Armin Lawi	842
Combining Individual Learning And Group Discussion In Calculus Course	Endah Asmawati, And Joice Ruth Juliana	847
PBSTAT: A Web-Based Statistical Analysis Software For Participatory Plant Breeding	Willy Bayuardi Suwarno, Sobir, Hajrial Aswidinnoor, And Muhamad Syukur	852
Reliability Of The Specific Gravity (Sg) Value Of Three Indonesian Hardwoods Using Experimental Test And Monte Carlo Simulation	Yosafat Aji Pranata And Pricillia Sofyan Tanuwijaya	859
Comparison Of Differencing Parameter Estimation From Arfima	Gungum Darmawan, Nur	866

Model By Spectral Regression Methods	Iriawan, Suhartono	
Application Of Cluster Analysis To Developing Core Collection In Plant Genetic Resources	Sutoro	875
Small Area Estimation With Time And Area Effects Using A Dynamic Linear Model	Kusman Sadik And Khairil Anwar Notodiputro	880
Statistical Analysis Of Wind Direction Data	Ahmad Mahir Razali, Arfah Ahmad, Azami Zaharim And Kamaruzzaman Sopian	886
Generalized Additive Mixed Models in Small Area Estimation	Anang Kurnia, Khairil A. Notodiputro, Asep Saefuddin, I Wayan Mangku	891
Kernel Principal Component Analysis In Data Visualization	Ismail Djakaria, Suryo Guritno, Sri Haryatmi	898
GARCH Models And The Simulations	Nelson Nainggolan, Budi Nurani Ruchjana And Sutawanir Darwis	906
Rainfall Prediction Using Bayesian Network	Hera Faizal Rachmat, Aji Hamim Wigena, and Erfiani	911
Identifying Item Bias Using The Simple Volume Indices And Multidimensional Item Response Theory Likelihood Ratio (Irt-Lr) Test	Heri Retnawati	916
Ordinary Kriging And Inverse Distance Weighting For Mapping Soil Phosphorus In Paddy Field	Mohammad Masjkur, Muhammad Nuraidi and Chichi Noviant	924
K-Means Clustering Visualization On Agriculture Potential Data For Villages In Bogor Using Mapserver	Imas S. Sitanggang, Henri Harianja, and Lailan Syaufina	932
Some Methods To Estimate The Number Of Components In A Mixture	M. A. Satyawan, A. H. Wigena, Erfiani	941
A Probabilistic Model For Finding A Repeat Triplet Region In DNA Sequence	Tigor Nauli	947
Application Of Spherical Harmonics In Determination Of Tec Using Gps Observable	Mardina Abdullah, Siti Aminah Bahari, Baharudin Yatim, Azami Zaharim, Ahmad Mahir Razali	954
Testing Structure Correlation Of Global Market By Statistic Vsv	Erna Tri Herdiani, and Maman A. Djauhari	961
Exploring the MAUP from a spatial perspective	Gandhi Pawitan	967
Estimation of RCA(1) Model using EF: A new procedure and its robustness	1Norli Anida Abdullah, 2Ibrahim Mohamed, 3Shelton Peiris	996
Second Order Linear Elliptic Operators In The Unit Square	Abdul Rouf Alghofari	1008

POSTER

Study Of Fractional Factorial Split-Plot Experiment	Sri Winarni, Budi Susetyo, and Bagus Sartono	1012
Improving Model Performance For Predicting Poverty Village Category Using Neighborhood Information In Bogor	Bagus Sartono, Bagus Sartono, and Zulhelmi Thaib	1019
Ammi Models On Count Data: Log-Bilinear Models	Alfian Futuhul Hadi H. Ahmad Ansori Mattjik I Made Sumertajaya Halimatus Sa'diyah	1026
Prediction Of Oil Production Using Non Linear Regression By Sdpro Software (Special Program Package)*)	Budi Nurani R , and Kartlos J. Kachiashvili	1038
An Implementation Of Spatial Data Mining Using Spatial Autoregressive (Sar) Model For Education Quality Mapping At West Java*)	Atje Setiawan A. , Retantyo Wardoyo , Sri Hartati , and Agus Harjoko	1045
Validation Of Training Model For Robust Tests Of Spread	Teh Sin Yin, and Abdul Rahman Othman	1056
Spectral Approach For Time Series Analysis	Kusman Sadik	1063
The ACE Algorithm for Optimal Transformations in Multiple Regression	Kusman Sadik	1066
The Relation Between The Students' Interaction And The Construction Of Mathematical Knowledge	Rini Setianingsih	1069
Application of Auto Logistic Regression Spatial Model using Variogram Based Weighting Matrix to Predict Poverty Village Category	Utami Dyah Syafitri, Bagus Sartono, Vinda Pratama	1075
Developing Data Mining System Using Fuzzy Association Rules	Imas S. Sitanggang, Arsha Mustika, Aziz Kustiyo	1082

**Speech of Director General of Higher Education at ICoMS 2008
At Novotel Corralia, Bogor, 5 August 2008**

Dr. Fasli Jalal

The Director General of Higher Education
Ministry of National Education, Republic of Indonesia

Bismillahirrahmanirrahim

Assalamu'alaikum Warrahmatullahiwabaraktuh

Good morning ladies and gentlemen

It is a great honor for me to provide a speech in this important scientific event, the Third International Conference on Mathematics and Statistics of MSMSSEA (Muslim Statistician and Mathematician Society in South East Asia). I can see from here that the audiences are of from various countries. So, let me welcome you to Indonesia, a country of great diversity in unity. I think it likes mathematics and statistics that we always find diversities and similarities. As far as I know that these two terms that make science and technology develop rapidly.

Someday a Germany great scientist, who found the Normal Distribution, Carl Fredric Gauss (1777-1855), had mentioned that mathematics, is the queen and servant of science. It is very reasonable statement, because mathematics plays an important role in developing science and technology and in the same time it must be reconed in all aspects of science production, preservation and dissemination. Hence, it is a servant of science. In the other hand, all scientists, irrespective their domains have to understand mathematics (including statistics) in order to analyze the problems properly. Thus, it is a queen of science. With its two functions, mathematics with its derivatives has narrowed the gap between the so called hard science and soft science. Hence, there is no exact distinctin between soft and hard sciences. Whatever the sciences, they need mathematics and statistics in order to clarify and simplify the issues. In mathematics and statistics, simplicity is the clarity of mind. However, mathematics and statistics can analyze complex issues. The modelling itself is the simplication of complicated real world.

Ladies and gentlemen

Let me talk about about sscience, mathematics and technology which are well-known as the tripod in an unknown area. All scientists who have achieved high standing positions in science reputation always have strong mathematical background. Hence, they can see the things that the other people can't see, also they can predict that the other people can't predict. Their deductive as well as inductive thinking are both adequate. These two ways of thinking are essential in research and science development. Deductive reasoning is considered mathematical way of thinking, while inductive is statistical way of thinking. Both type of reasoning are the key factors of scientific circle, without them the science development is stagnant. The Kuhnian model of scientific revolution occures when the deductive and inductive thinking are accomodated well in a society. Hence, education has to provide great room for student to flourish their reasoning. Their brain for deductive and inductive thinking can develop if the school gives enough space for student creativity. Hence, they can think freely and try to find facts, which are called data in the statistical term, to proof their ideas. A great Indonesian statistician, Prof. Nasoetion (1932-2002), someday mentioned 'In God we trust, all other bring data'.

The challenges are to find the ways in order to facilitate the students to love science and mathematics. After they love and understand the important of science and mathematics as well as stimulated by realities, finally they can develop technologies. Hence, the three point of the tripod are interconnected and progress well in a conducive ecosystem. Many technological problems influence the mathematical and science development, and at the end have made the society developed and their income increased. However, the conducive academic atmosphere is needed in order the tripod of science, mathematics, and technologies can develop well. For example, the problems of communication and information have made topology, number theory, and graph theory which are needed in developing information technology. This phenomenon has created big market for the mathematicians and statisticians. Finally, without strong mathematics (including statistics) the technologies as well as the economy are stuck. In other word, there is no great economy without great mathematics and science. Hence the economic development is termed as knowledge-based economy or K-economy. There is no K-economy in society with poor knowledge. In other words, K-economy can only develop well in the society, who understand knowledge. This society is called knowledge-based society or K-society. I am sure that all scientists in this room agree with me that the developing countries have to be the K-society in order to lead the world. Otherwise, we are only the followers.

Ladies and gentlemen.

I understand that one of the clusters in this conference is 'mathematics in education processes. I believe this is very important for scientist and professors of higher education to pay enough attention to the basic and secondary education, especially in cultivating the important of mathematics and science for emerging technologies. Students with poor comprehension of mathematics can be predicted will have difficulties in facing complex subjects. Therefore, the universities have obligations to make the basic and secondary education understand well the fundamental principles of mathematics including their mathematical skills. Since the pupils are the main sources of the future scientists and technologists, their foundation in basic science and mathematics is greatly important. Hence, interesting method of subject delivery is key factor for the pupils to comprehend mathematics. So, one of important services of higher education to society is to train the teacher of lower education in order to follow new frontier of science. They need to be up dated. This service has direct and indirect positive effect to the universities. The direct effect is to obtain high quality of student intake, while the indirect one is to share knowledge to the society.

I fully agree with the theme of the third ICoMS "mathematics and statistics as a bridge for academia, government and business in the entrepreneurial era". This theme implies some consequences, such as: mathematics and statistics are not just passive subject to be learned or memorized, they must be considered as active materials to be understand creatively and hence finally the scientists can produce mathematics and statistics. In other words, students have to learn mathematics and statistics actively including the basic theory and their application. It is understood that inside the airplane there exist complex mathematics and statistics. Without strong mathematics and statistics, the airplane cannot fly appropriately. This example can be extended into many areas of life and technologies, including medicine, social sciences, economy, business, politics, public health, biotechnology, manufacturing, civil engineering, energy, and so on. However, to produce mathematics and statistics needs entrepreneurial soul. Hence collaboration among stakeholder from various institutions is needed in approaching the complex issues in the entrepreneurial era.

For our fellows from the private sectors, one easy way to help mathematicians and statisticians is to provide education programs on CSR (Corporate Social Responsibility). For example we can build a

mathematics fellowship program, mathematics and statistics entrepreneurial award, entrepreneurial research competition, and many other things. For implementing these ideas, we are more than happy to collaborate with the private sectors.

Ladies and gentlemen

At the present time, almost all countries are shifting their concept of development from centralism to decentralism. The paradigm shift is also recognized by international bodies, like The World Bank. Hence, the role of scientists including mathematicians and statisticians are getting crucial. Why? Because regional development without strong human resource is difficult. The local governments certainly need knowledge for their regional planning. Mathematicians and statisticians can collaborate with the local government in creating and measuring some tangible indicators for government strategic planning and road mapping. Otherwise, the plan is too normative and uneasy to measure. As a result, the progress of development cannot be evaluated objectively. Number is not everything in lives, but lives without number is nothing. Hence, cooperative action among academia, government and business is 'a must'.

To optimize the opportunity, let me provide you some assignment to formulate what is the role of mathematicians and statisticians in the economic holistic development. While you are presenting your research papers, maximize your present here to have such discussion on mathematics related to regional development, entrepreneurship, environment, food and energy resources including the process of education and research. It looks simple but needs a well trained mathematicians and statistician like you all. I believe you can produce innovative approaches which are useful for the Indonesian government, universities, research centers, private sectors, and other community. Your thought is surely needed by other participants coming from various countries.

Finally, I envy my deep gratitude while hoping you enjoy this conference and other activities organized by MSMSSEA. I hope you are always fresh and health with full enthusiasm in participating the important event.

Selamat berkonferensi dan terima kasih.

Billahittaufiq wal hidayah

Wassalamu'alaikum warahmatullahi wabarakatuh

Dr. Fasli Jalal

PBSTAT: A WEB-BASED STATISTICAL ANALYSIS SOFTWARE FOR PARTICIPATORY PLANT BREEDING

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Abstract. Indonesian agriculture areas were dominated by variation in agro-ecological and socio-economic conditions implies that formal plant breeding (FPB) programs less effective compare to participatory plant breeding (PPB). However to improve genetic gain in PPB, should be supported by simple statistical program. PBSTAT was developed in order to meet the needs of simple statistical software for selection and trials in participatory breeding approach. This software is programmed using PHP scripting language, therefore can be utilized on web platform, and provides easy access for its users to do the statistical analysis. The user can use common spreadsheet software for data entry and web browser to run the analysis. The main feature of PBSTAT is analysis of variance (ANOVA) for analyzing variety trials in one location (using one factor RCBD), multi-locations, and multi-seasons-locations (combined analysis of several RCBD trials across seasons and locations). Mean differences can be compared using Tukey's HSD method. Other important feature of PBSTAT is stability analysis using Finlay-Wilkinson method. This feature is very useful for the breeder conducting several participatory trials to elucidate which genotypes are stable across environments, and which one are environment-specific.

Keywords: statistical software, combined ANOVA, broad-sense heritability, stability analysis

1. Introduction

Indonesian agriculture areas were dominated by variation in agro-ecological and socio-economic conditions implies that formal plant breeding (FPB) programs less effective compare to participatory plant breeding (PPB). PPB is defined as plant breeding program that involving researchers, farmers, and other stakeholders such as consumers, vendors, industries, extension and farmer groups (Sperling *et al.*, 2001).

One of the most important thing to consider in PPB trials is interaction of genotype and environment. The effect of the environment is therefore a distraction in the genetical analysis, and our aim will thus be to isolate it and set it on one side in the analysis rather than to make it subject of analysis in its own right, except of course where genotype and environment interact in producing their effects (Mather and Jinks, 1982). Genotypic main effects (i.e. differences in mean yield between genotypes) provide the only relevant information when genotype x environment (GE) interaction effects are absent or ignored (Annicchiarico, 2002).

In the data analysis point of view, there is many statistical analysis software existed to meet the needs of combined analysis. However to improve genetic gain in PPB, should be supported by simple statistical program. PBSTAT was developed in order to meet the needs of simple statistical software for selection and trials in participatory breeding approach. Utilizing the web technology, this software provides easy access to do PPB's combined analysis.

2. Software features

2.1 The platform

PBSTAT is using web platform. The reason is because we want this software to be available widely over the internet. It will make its users, especially plant breeders, can use it easily. They don't need to install this software in their PC. They just require a web browser to run PBSTAT. We have tested it with Microsoft® Internet Explorer 6 and Mozilla Firefox 3 web browser. Using web browser, just point to <http://web.ipb.ac.id/~agrohort/pbstat> to access this software.

We are using PHP: Hypertext Preprocessor, a famous web programming language to develop this software. The scripts are processed server-side, and the outputs are sent as HTML page. The software can be hosted over the internet, or distributed in CD using a packaged web server software embedded with PHP, such as Server2Go (Haber Kern, 2008).

2.2 The data file

Here we use a sample data set from rice yield evaluation trials conducted in four locations (Aswidinnor *et al.* 2007, with one location added). In each location, 20 genotypes are arranged in Randomized Complete Block Design (RCBD) with three replications. Yield observed at each experimental plot and then converted to ton/ha at 14% moisture content.

Field-collected data inputted in a Microsoft® Excel worksheet (Figure 1). The first row is used only for the name of factors or variables, and the following rows could be contain either labels or observation data. The name of factors or variable must be all in lowercase or uppercase, and without spacing. Note that PBSTAT is using some reserved letters or word to define the session, location, replication, and genotype factors, which is Y, L, REP, and G respectively. If we want to add another character, such as plant height and 100 g seed weight, simply input the data in the right column after YIELD.

The data file has to be saved in Microsoft® Excel 2000/XP/2003 format, with the “xls” extension. In this example, name of data file is “COMBINED RICE 4 LOC.xls”. The Excel data file can be directly imported by PBSTAT. Note that data file must be closed before imported.

	A	B	C	D
1	L	REP	G	YIELD
2	1	1	1	7.8
3	1	1	2	6.1
4	1	1	3	8.5
5	1	1	4	5.8
6	1	1	5	6.2
7	1	1	6	6.0
8	1	1	7	7.4
9	1	1	8	5.1
10	1	1	9	5.3
11	1	1	10	4.3
12	1	1	11	3.4
13	1	1	12	4.5
14	1	1	13	4.1
15	1	1	14	5.3
16	1	1	15	7.3
17	1	1	16	5.7
18	1	1	17	4.9
19	1	1	18	6.1
20	1	1	19	5.4
21	1	1	20	6.3
22	1	2	1	4.2
23	1	2	2	4.6
24	1	2	3	7.7
25	1	2	4	5.0

Figure 1. Yield data obtained from multi-locations trial

2.3 The interface

Because of its specialized feature, the first screen of PBSTAT 1.0 software directly shows a query form for PPB’s data analysis (Figure 2). In this form, we have to browse data file (in Microsoft® Excel format), choose type of trial, and define response variable(s) according to the data file’s column name(s). Those form elements are mandatory. Moreover, we can select further data analysis, those are estimation of broad sense heritability (h^2_{bs}) and Finlay-Wilkinson stability analysis. Finally, a click on “Show” button will run the program and outputs the result.

PBSTAT 1.0

Data Analysis for Participatory Plant Breeding

Data File (Excel): D:\COMBINED RICE 4 [Browse...]

Trial: Multilocations

Response: YIELD

Data Analysis:

- Estimation of Broad Sense Heritability (h^2_{bs})
- Finlay-Wilkinson Stability Analysis

Show

Figure 2. Data analysis query form

2.4 The output

Output of ANOVA presented in Figure 3. In this example, the dependent variable is YIELD. To make a “common” heritability estimation by using the Expected Mean Squares in combined analysis (Comstock and Moll, 1963; Darrah and Mukuru, 1977), G and L here are assumed as random factors. Therefore, G is tested to G*L and G*L is tested to Error (Annicchiarico, 2002). In SAS program, we have to do this way using “test h = ... e = ...” statement after MODEL in PROC ANOVA (SAS Institute, Inc., 2003). The summary of ANOVA table presented after the series of ANOVA tables. If there is more than one variable analyzed, the summary table will contains ANOVA’s summary of all variables.

ANOVA for YIELD

Source	df	SS	MS	Counted F	Tabulated F		P Value
					5%	1%	
L	3	176.87	58.96	41.50**	2.66	3.91	0.0000
REP*L	8	11.36	1.42	1.42 ^{ns}	2.00	2.63	0.1913
G	19	177.94	9.37	1.80**	1.66	2.03	0.0000
G*L	57	296.61	5.20	5.21**	1.41	1.63	0.0000
Error	152	151.82	1.00				
Corrected Total	239	814.60					

cv = 21.11%

Summary of ANOVA

Karakter	G	G*L	cv (%)
YIELD	**	**	21.11

* = significant at P < 0.05
** = significant at P < 0.01

Figure 3. Output of ANOVA

However, for precise result of combined analysis, it's suggested to do the ANOVA for each locations first, and then check the homogeneity of variance among locations using chi-square test. If the variances are homogeneous, we can use the pooled error mean square in combined analysis. (Gomez and Gomez, 1984; Koopmans, 1987). Unfortunately, the "automatic" ANOVA for each location using combined data set, as using "BY" statement in SAS's PROC ANOVA (SAS Institute, Inc., 2008), has not supported by PBSTAT yet.

Below the summary of ANOVA, PBSTAT also outputs GxL means (Figure 4). The means presented in two-way tables, with the mean of each G and L showed on the right and bottom, respectively. If there is a significant effect of G, L, or GxL factor the mean number is followed by HSD letter to show the differences between means. We limit the HSD comparisons to 20 sample means, which is the same as the maximum number of treatment means in q table (May in Steel and Torrie, 1980). Therefore, the letters doesn't appear in this example's GxL means (Figure 4).

G	L1	L2	L3	L4	Mean of G
G1	6.67	0.77	4.00	5.03	4.12 ^{def}
G2	5.37	5.33	4.27	5.43	5.10 ^{bcde}
G3	7.13	6.03	3.23	2.60	4.75 ^{bcdef}
G4	5.50	0.73	3.33	3.73	3.33 ^f
G5	6.47	6.87	4.73	6.77	6.21 ^{ab}
G6	7.00	4.07	2.70	4.63	4.60 ^{cdef}
G7	4.83	6.97	2.70	1.83	4.06 ^{def}
G8	4.97	2.33	3.77	4.10	3.79 ^{ef}
G9	6.13	5.57	4.03	2.70	4.61 ^{cdef}
G10	6.70	4.70	2.27	3.67	4.33 ^{def}
G11	5.70	5.50	3.20	3.77	4.54 ^{cdef}
G12	6.87	6.20	5.73	4.87	5.92 ^{abc}
G13	3.87	5.10	2.60	5.13	4.18 ^{def}
G14	4.20	6.87	2.23	1.80	3.78 ^{ef}
G15	8.00	7.87	4.47	6.60	6.73 ^a
G16	5.23	7.20	3.67	4.20	4.41 ^{bcde}

Figure 4. Output of GxL means and HSD test

The estimation of broad sense heritability is presented below the GxL tables, followed by the Finlay-Wilkinson stability analysis (Figure 5). The estimation of broad sense heritability showed genetic variance (V_G), interaction between genetic and location variance (V_{GxL}), phenotypic variance (V_P), and the broad sense heritability (h^2_{bs}) which is the ratio of V_G and V_P in percent (Darrah and Mukuru, 1977). For advanced breeding lines, the higher h^2_{bs} showed the better repeatability across environments.

The Finlay-Wilkinson stability analysis presented the genotype number, followed by its yield, b_i , and SDi. Finlay-Wilkinson proposed the regression coefficient for each genotype, b_i , as a stability parameter. The observed value are regressed on environmental indices defined as the difference between the marginal mean of the environments and over all mean. A genotype considered to be stable if its response to environment is parallel to the mean response of all genotypes in the trial (Lin *et al.*, 1985). Genotype has $b_i = 1.0$ considered dynamically stable. The b_i value greater than 1.0 expect the genotype is suitable for more favorable environments, otherwise the b_i value less than 1.0 expect the genotype is suitable for less favorable environments.

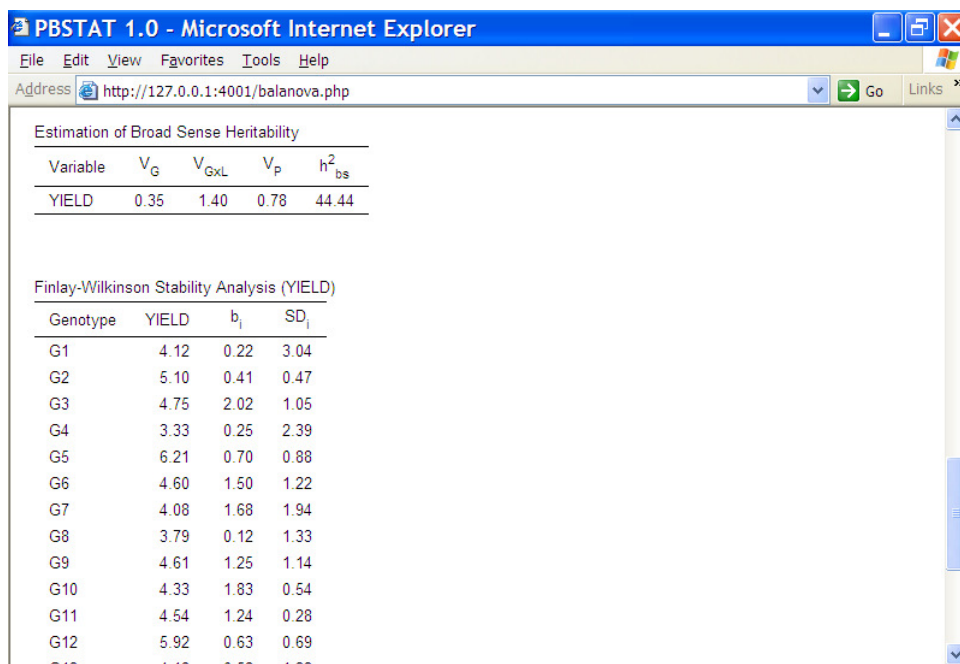


Figure 5. Output of Estimation of Broad Sense Heritability and Finlay-Wilkinson's Stability Analysis

3. PHP functions

3.1 Data reading and statistical tables

Excel data file are imported using PHP-ExcelReader utility (Tkachenko *et al.*, 2008). The F table and P-value are provided by PDL Library (Meagher *et al.*, 2008). The qtkey algorithm (Trujillo-Ortiz and Hernandez-Walls, 2003) is used to estimate the q studentized range critical value for HSD test.

PHP functions mostly used to store, read, and manipulate data are the array functions. For example, *foreach* statement is frequently used to do some calculation on array keys or values (Bakken *et al.*, 2008; Schwendiman, 2001).

3.2 Estimating broad sense heritability

PHP functions to estimate broad sense heritability for multi-locations trial is presented in Figure 6. We named it *heritability2*, where the *heritability1* and *heritability3* function will estimate heritability for single and multi-seasons-locations, respectively. The *heritability2* function simply required the number of replication and location, as well as G, G*L, and Error mean square. It will calculate the genetic variance (\$var_G), interaction between genetic and location variance (\$var_GL), phenotypic variance (\$var_P), and the broad sense heritability (\$h_bs). Finally, it will return those three values in one-dimensional array. We can access the array's values and present it in tabluar format like Figure 5 above.

```
function heritability2($r, $l, $ms_G, $ms_GL, $ms_E)
{
    $M1 = $ms_E; $M2 = $ms_GL; $M3 = $ms_G;
    $var_E = $M1; $var_G = ($M3-$M2)/($r*$l);
    $var_GL = ($M2-$M1)/$r;
    $var_P = $var_G + ($var_GL/$l) + ($var_E/($r*$l));
    $h_bs = ($var_G / $var_P) * 100;
    $ret = array($var_G, $var_GL, $var_P, $h_bs); return $ret;
}
```

Figure 6. PHP function for estimating broad sense heritability in multi-locations trial

3.3 Finlay-Wilkinson's stability analysis

We create PHP function `fw_stability` to do the Finlay-Wilkinson's stability analysis (Figure 7), based on its formula (Lin *et al.*, 1986). The function will require two parameters, `$G_value` and `$L_value`. Both of them are two-dimensional array. In `$G_value` array, `[G1][L1]` is the yield mean of Genotype 1 in Location 1. This value will be paired with the same element (`[G1][L1]`) in `$L_value` array, which contains the Location 1 mean over all genotypes. The `fw_stability` function will outputs `$fw_parameter`, which is an one-dimensional array. The array contains three values: genotype mean (`$G_mean`), b value (`$b`), and SDbi value (`$se`). Same as heritability functions, we can output those values in tabular format like Figure 5 above.

```
function fw_stability($G_value, $L_value)
{
    foreach($G_value as $key => $value)
    {
        $n = count($value);
        $G_mean[$key] = array_sum($value) / count($value);
    }

    foreach($L_value as $key => $value)
    {
        $L_mean[$key] = array_sum($value) / count($value);
    }

    foreach($G_value as $key => $value)
    {
        foreach ($value as $key2 => $value2)
        {
            $ypow[$key] += pow($value2 - $G_mean[$key], 2);
            $xpow[$key] += pow($L_value[$key][$key2] - $L_mean[$key], 2);
            $xy[$key] += ($value2 - $G_mean[$key]) * ($L_value[$key][$key2] -
            $L_mean[$key]);
        }

        $b[$key] = $xy[$key] / $xpow[$key];
        $se[$key] = sqrt((1/($n-2)) * ($ypow[$key] - (pow($xy[$key], 2)/$xpow[$key])));
    }

    $fw_parameter = array($G_mean, $b, $se);
    return $fw_parameter;
}
```

Figure 7. PHP function for Finlay-Wilkinson's stability analysis

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