



INSTITUT TEKNOLOGI SEPULUH NOPEMBER
FAKULTAS SAINS DAN ANALITIKA DATA
PROGRAM STUDI MAGISTER STATISTIKA
DEPARTEMEN STATISTIKA

Kode Dokumen

REV-1

RENCANA PEMBELAJARAN SEMESTER

MATA KULIAH (MK) / <i>Course</i>		KODE / <i>Code</i>	Rumpun MK / <i>Course Group</i>	BOBOT (sks) / <i>Weight (credit)</i>		SEMESTER / <i>Semester</i>	Tgl Penyusunan / <i>Drafting Date</i>
Pembelajaran Mesin Statistika Lanjut <i>Advanced Statistical Machine Learning</i>		SS255234	Analitika Data Ekonomi dan Finansial (AnDEF)	T=3	P=0	II	Agustus 2026
OTORISASI / <i>AUTHORIZATION</i>		Pengembang RPS / <i>RPS Developer</i>		Koordinator RMK / <i>Course Group Coordinator</i>		Ketua PRODI / <i>Head of Degree Program / Department</i>	
		Prof. Dr.rer.pol. Dedy Dwi Prastyo, S.Si, M.Si		Dr. Muhammad Sjahid Akbar, S.Si, M.Si		Irhamah, S.Si, M.Si, Ph.D	
Capaian Pembelajaran (CP)	CPL-PRODI yang dibebankan pada MK / <i>Program Learning Outcome (PLO)</i>						
<i>Learning Outcome (LO)</i>	CPL-2 <i>PLO-2</i>	Mampu mengembangkan dan memecahkan permasalahan ilmu pengetahuan dan teknologi dalam bidang Statistika melalui riset dengan pendekatan inter atau multidisiplin hingga menghasilkan karya inovatif dan teruji dalam bentuk tesis dan makalah yang telah diterima di jurnal ilmiah nasional terakreditasi atau diterima di seminar internasional bereputasi. <i>Able to develop and solve science and technology problems in Statistics through research with an inter or multidisciplinary approach to produce innovative and tested works in the form of theses and papers that have been accepted in accredited national journals or accepted at reputable international seminars.</i>					
	CPL-6 <i>PLO-6</i>	Mampu mengintegrasikan perangkat komputasi modern untuk mengembangkan solusi statistik yang efisien, dengan mengevaluasi keandalan dan ketepatan hasil komputasi. <i>Able to integrate modern computing tools to develop efficient statistical solutions, while assessing the reliability and accuracy of computational results.</i>					
	CPL-7 <i>PLO-7</i>	Mampu menganalisis dan mengevaluasi teknik komputasi statistik untuk memecahkan permasalahan statistika yang kompleks berbasis data. <i>Able to analyze and evaluate statistical computing techniques to solve complex data-based statistical problems.</i>					
	CPL-8 <i>PLO-8</i>	Mampu menganalisis dan mengevaluasi metode statistika untuk merumuskan solusi pada permasalahan teoritis dan riil dengan pendekatan multidisipliner <i>Able to analyze and evaluate statistical methodologies to formulate solutions for theoretical and real-world problems using a multidisciplinary approach.</i>					
	CPL-9 <i>PLO-9</i>	Mampu menganalisis dan mengevaluasi metode statistika berbasis komputasi atau analitik yang inovatif untuk mengatasi permasalahan riil di bidang bisnis, industri, ekonomi, finansial, sosial dan pembangunan berkelanjutan, lingkungan, kesehatan, serta mengevaluasi dampaknya terhadap pengambilan keputusan <i>Able to analyze and evaluate innovative computation- or analytics-based statistical methods to address real-world</i>					

		<i>problems in business, industry, economics and finance, social and sustainable development, environment, and health, and to assess their impact on decision-making.</i>
	Capaian Pembelajaran Mata Kuliah (CPMK) / Course Learning Outcome (CLO)	
	<p>CPMK-1. Mampu mengidentifikasi, memformulasi, dan menyelesaikan masalah statistika menggunakan machine learning <i>CLO-1. Able to identify, formulate, and solve statistical problems using machine learning</i></p> <p>CPMK-2. Mampu menganalisis penerapan konsep fungsi kernel pada metode dan pemodelan <i>CLO-2. Able to analyze the application of the kernel function in methods and modeling.</i></p> <p>CPMK-3. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang digunakan dalam Machine Learning untuk pengelompokan (clustering) <i>CLO-3. Able to apply computing techniques and to use modern computer tools/software used in machine learning for clustering.</i></p> <p>CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam Machine Learning untuk prediksi pada permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i></p> <p>CPMK-5. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam Machine Learning untuk peramalan deret waktu. <i>CLO-5. Able to apply computational techniques and to use modern computer tools/software used in machine learning for time series forecasting.</i></p> <p>CPMK-6. Mampu menyajikan hasil penelitian dalam bentuk laporan tertulis <i>CLO-6. Able to write a written report of the analysis obtained from the project.</i></p>	

		Matrik CPL – CPMK / <i>PLO – CLO Matrix</i>					
		CPMK	CPL-2	CPL-6	CPL-7	CPL-8	CPL-9
		CPMK-1				V	V
		CPMK-2		V	V		V
		CPMK-3		V	V		V
		CPMK-4		V	V		V
		CPMK-5	V				V
Deskripsi Singkat MK / <i>Course Description</i>	Mata kuliah Pembelajaran Mesin Statistika Lanjut (<i>Advanced Statistical Machine Learning</i>) membekali mahasiswa untuk menguasai secara mendalam tentang metode dan algoritma terkini yang digunakan untuk membuat komputer dapat melakukan pembelajaran dan berperilaku cerdas. Pada perkuliahan ini akan dibahas teori dan praktik metode dan algoritma terkini, dengan topik yang mencakup kernel-based density and modeling, serta metode/algoritma untuk <i>unsupervised learning</i> dan <i>supervised learning</i> untuk klasifikasi, regresi, dan peramalan deret waktu. <i>The Advanced Statistical Machine Learning course equips students to master the latest developing methods and algorithms used to make computers capable of learning and behaving intelligently. This lecture will discuss theory and practice for the latest methods and algorithms, with topics including kernel-based density and modeling, unsupervised learning, and supervised learning methods/algorithms for classification, regression, and time series forecasting.</i>						
Bahan Kajian: Materi Pembelajaran	Teknik Komputasi Modern, Perangkat Komputasi Modern, Metode dan Pemodelan, Aplikasi di Berbagai Bidang (Lab) <i>Modern Computing Techniques, Modern Computing Tools, Methods and Modeling, Applications in Various Fields (Lab)</i>						
Pustaka / <i>Course Material / References</i>	Utama / <i>Primary:</i>						
	1. James, G., Witten, D., Hastie, T., and Tibshirani, R., 2014, <i>An Introduction to Statistical Learning (with Applications in R)</i> , Springer						
	Pendukung / <i>Secondary:</i>						
	2. Hastie, T., Tibshirani, R., and Friedman, J., 2017, <i>The Elements of Statistical Learning: Data Mining, Inference, and Prediction</i> , Second Edition, Springer New York 3. Haykin, S., 1999, <i>Neural Networks</i> , 2 nd ed., Prentice Hall 4. Fausett, L., 1994, <i>Fundamentals of Neural Networks</i> , Prentice Hall 5. Limin Fu, 1994, <i>Neural Network in Computer Intelligence</i> , McGraw Hill 6. Sivanandam, S.N., Sumathi, S., and Deepa, S. N., 2006, <i>Introduction to Neural Networks using MATLAB 6</i> , McGraw-Hill 7. Cristianini, N. and Shawe-Taylor, J., 2000, <i>An Introduction to Support Vector Machines and Other Kernel-based Learning Methods</i> , 1st Edition, Cambridge University Press. 8. Goodfellow, I., Yoshua, B., and Courville, A., 2016. <i>Deep Learning</i> .						

	<p>9. Haerdle, W.K., Prastyo, D.D., Hafner, C.M. (2014). "Support vector machines with evolutionary model selection for default prediction." In: Racine, J., Su, L., Ullah, A. (eds.). <i>The Oxford Handbook of Applied Nonparametric and Semiparametric Econometrics and Statistics</i>, pp. 346–373. Oxford University Press, New York.</p> <p>10. Haerdle, W.K., Prastyo, D.D. (2014). Embedded predictor selection for default risk calculation: a Southeast Asian industry study. In: Chuen, D.L.K., Gregoriou, G.N. (eds.), <i>Handbook of Asian Finance: Financial Market and Sovereign Wealth Fund</i>, vol. 1, pp. 131–148. Academic Press, San Diego.</p> <p>11. Berry, M., Mohamed, A., Yap, B. (eds.). 2020. <i>Supervised and Unsupervised Learning for Data Science</i>. Springer.</p> <p>12. Prastyo, D. D., Savera, R. N., and Adiwibowo, D. H. (2023). Corporate Financial Distress Prediction Using Statistical Extreme Value-Based Modeling and Machine Learning. <i>Media Statistika</i>, 16(1), 1-12. https://doi.org/10.14710/medstat.16.1.1-12</p> <p>13. D. D. Prastyo, I. Yuniarti, Setiawan and S. P. Rahayu, "Interval Forecasting Using GEV Regression With Stochastic Search Variable Selection: A Simulation Study and Its Application to Forecast Imported Meat Price Range," in <i>IEEE Access</i>, vol. 13, pp. 113013-113027, 2025, https://doi.org/10.1109/ACCESS.2025.3579702</p> <p>14. F. I. Zayyan, D. D. Prastyo, M. S. Akbar, W. Karl Härdle and M. H. Lee, "GEVReg-MIDAS-SSVS for Mixed-Frequency Time Series Interval Forecasting," in <i>IEEE Access</i>, vol. 14, pp. 106287-106302, 2026, https://doi.org/10.1109/ACCESS.2026.3712031</p>
Dosen Pengampu / Lecturers	<p>Prof. Dr.rer.pol. Dedy Dwi Prastyo, S.Si., M.Si.</p> <p>Tintrim Dwi Ary Widhianingsih , S.Si, M.Stat, Ph.D.</p> <p>Dr. Dra. Kartika Fithriasari, M.Si</p>
Matakuliah syarat / Pre-requisite Course	

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	CPMK-1. Mampu mengidentifikasi, memformulasi, dan menyelesaikan masalah statistika menggunakan machine learning <i>CLO-1. Able to identify, formulate, and solve statistical problems using machine learning.</i>	1.1 Dapat menjelaskan dan memahami dasar <i>Machine Learning</i> 1.2 Dapat mengidentifikasi permasalahan yang cocok (<i>supervised and unsupervised</i>) untuk diselesaikan dengan <i>Machine Learning</i> 1.3 Perkembangan terkini metode Statistika untuk <i>Machine Learning</i> 1.1. Able to explain and understand the fundamentals of Machine Learning 1.2. Able to identify problems suitable (supervised and unsupervised) to be solved using Machine Learning 1.3. Recent developments in Statistical methods for Machine Learning	Tes lisan, observasi Aktivitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</i> <i>TM: 1 x 3 x 50” PT: 1 x 3 x 60” BM: 1 x 3 x 60”</i>		1. Konsep <i>Machine Learning</i> pada permasalahan <i>supervised and unsupervised learning</i> <i>1. The concept of Machine Learning in supervised and unsupervised learning problems</i>	5% / kum 5% <i>5% / Cumulative (5%)</i>
2	CPMK-2. Mampu	2.1 Konsep Fungsi Kernel	Tes lisan,	Ceramah		1. Konsep fungsi Kernel	10% / kum

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	menganalisis penerapan konsep fungsi kernel pada metode dan pemodelan <i>CLO-2. Able to analyze the application of the kernel function in methods and modeling.</i>	2.2 <i>Kernel Density Estimator (KDE)</i> 2.3 Penerapan fungsi Kernel pada berbagai metode dan pemodelan <i>2.1 Understanding the concept of the Kernel function</i> <i>2.2 Able to apply Kernel Density Estimator (KDE) and analyze it</i> <i>2.3 Able to analysis the application of Kernel function in methods and modeling</i>	observasi Aktifitas di kelas <i>Oral test, observation of in-class activities</i>	Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</i> <i>TM: 1 x 3 x 50”</i> <i>PT: 1 x 3 x 60”</i> <i>BM: 1 x 3 x 60”</i>		<i>1. The concept of Kernel function</i>	15% 10% / Cumulative (15%)
3	CPMK-3. Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk pengelompokan	3.1 Dapat memahami prinsip dasar algoritma pengelompokan tanpa pengawasan (<i>Unsupervised Clustering</i>). 3.2 Dapat mengimplementasikan dan menerapkan berbagai algoritma pengelompokan	Tes lisan, observasi Aktifitas di kelas <i>Oral test, observation of in-class</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive</i>		Metode pengelompokan (<i>clustering</i>) - Fuzzy C-mean Clustering - DBSCAN <i>Clustering Methods:</i>	5% / kum 20% 5% / Cumulative (20%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	(clustering) <i>CLO-3. Able to apply computing techniques and to use modern computer tools/software used in machine learning for clustering.</i>	<p>untuk mempartisi data ke dalam kelompok yang bermakna.</p> <p>3.3 Dapat mengevaluasi dan membandingkan kinerja pengelompokan menggunakan metrik yang sesuai.</p> <p>3.4 Dapat mengidentifikasi kekuatan, keterbatasan, dan aplikasi yang sesuai dari berbagai teknik pengelompokan.</p> <p>3.1 Able to understand the basic principles of unsupervised clustering algorithms</p> <p>3.2 Able to implement and apply various clustering algorithms to partition data into meaningful groups</p> <p>3.3 Able to evaluate and compare clustering performance using appropriate metrics</p> <p>3.4 Able to identify the strengths,</p>	activities	<p>Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</p> <p>TM: 1 x 3 x 50” PT: 1 x 3 x 60” BM: 1 x 3 x 60”</p>		<ul style="list-style-type: none"> Fuzzy C-Means Clustering DBSCAN 	

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		limitations, and suitable applications of various clustering techniques					
4	CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk prediksi pada permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and</i>	4.1 Mampu memahami prinsip dasar algoritma berbasis pohon (<i>Tree-based Algorithm</i>) dalam pembelajaran mesin. 4.2 Mampu mengimplementasikan dan menerapkan model berbasis pohon untuk tugas klasifikasi dan regresi. 4.3 Mampu mengevaluasi dan membandingkan berbagai algoritma berbasis pohon dalam hal kinerja dan interpretabilitas. 4.4 Mampu mengidentifikasi dan mengurangi masalah overfitting dan underfitting dalam model berbasis pohon. 4.1 Able to understand the basic principles of tree-based	Tes lisan, observasi Aktifitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif- Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</i> <i>TM: 1 x 3 x 50” PT: 1 x 3 x 60” BM: 1 x 3 x 60”</i>		Algoritma berbasis pohon - <i>Decision Tree</i> - <i>Bagging</i> - <i>Random Forest</i> <i>Tree Based Algorithm:</i> • <i>Decision Tree</i> • <i>Bagging</i> • <i>Random Forest</i>	10% / kum 30% <i>10% / Cumulative (30%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	algorithms in machine learning 4.2 Able to implement and apply tree-based models for classification and regression tasks 4.3 Able to evaluate and compare various tree-based algorithms in terms of performance and interpretability 4.4 Able to identify and mitigate overfitting and underfitting issues in tree-based models					
5	CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk	4.5 Dapat memahami konsep dasar Support Vector Machines (SVM) untuk klasifikasi dan regresi. 4.6 Dapat menjelaskan peran hyperplane, support vector, dan margin dalam batasan keputusan SVM. 4.7 Dapat membedakan antara SVM linear dan non-linear serta penggunaan fungsi kernel.	Tes lisan, observasi Aktifitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD),</i>		Algoritma SVM <i>SVM Algorithm</i>	10% / kum 40% <i>10% / Cumulative (10%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, <i>[Estimasi Waktu]</i> / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka]</i> / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	prediksi pada permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	<p>4.8 Dapat mengimplementasikan model SVM untuk berbagai tugas machine learning menggunakan Python.</p> <p>4.9 Dapat mengevaluasi dan menginterpretasikan kinerja model SVM menggunakan metrik yang sesuai.</p> <p>4.10 Dapat membandingkan SVM dengan model klasifikasi dan regresi lainnya, menganalisis kekuatan dan keterbatasannya.</p> <p>4.5 Able to understand the basic concept of Support Vector Machines (SVM) for classification and regression</p> <p>4.6 Able to explain the role of hyperplanes, support vectors, and margins in the decision boundaries of SVM</p> <p>4.7 Able to distinguish between linear and non-linear SVM, and understand the use of</p>		<p>Problem-Based Learning (PBL)</p> <p>TM: 1 x 3 x 50"</p> <p>PT: 1 x 3 x 60"</p> <p>BM: 1 x 3 x 60"</p>			

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, <i>[Estimasi Waktu] / Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka] / Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		kernel functions 4.8 Able to implement SVM models for various machine learning tasks using Python 4.9 Able to evaluate and interpret the performance of SVM models using appropriate metrics 4.10 Able to compare SVM with other classification and regression models, analyzing its strengths and limitations					
6-7	CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam Machine Learning untuk prediksi pada	4.11 Konsep multikolinearitas 4.12 Metode untuk mengatasi multikolinearitas 4.13 Variable and Feature selection 4.14 Handling imbalance classification problem <i>4.11 Multicollinearity concept</i> <i>4.12 Solving the multicollinearity problem</i> <i>4.13 Variable and feature selection</i>	Tes lisan, observasi Aktifitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based</i>		Algoritma SVM <i>SVM Algorithm</i>	10% / kum 50% <i>10% / Cumulative (50%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, <i>[Estimasi Waktu]</i> / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka]</i> / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	<i>4.14 Handling imbalance classification problem</i>		Learning (PBL) TM: 2 x 3 x 50" PT: 2 x 3 x 60" BM: 2 x 3 x 60"			
8	ETS/ <i>Midterm</i>						
9-10	CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat	4.15 Dapat mengidentifikasi permasalahan klasifikasi yang diselesaikan dengan Jaringan Saraf Tiruan (JST)	Tes lisan, observasi Aktifitas di kelas <i>Oral test,</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL)		1. Konsep dasar JST 2. Membangun arsitektur JST untuk klasifikasi dan Regresi	15% / kum 65% <i>15% / Cumulative (65%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, <i>[Estimasi Waktu]</i> / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka]</i> / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk prediksi pada permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	4.16 Dapat menyelesaikan kasus klasifikasi dengan menggunakan metode JST 4.15 Able to identify classification problems solved using Artificial Neural Networks (ANN) 4.16 Able to solve classification cases using ANN methods	observation of in-class activities	Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL) TM: 2 x 3 x 50” PT: 2 x 3 x 60” BM: 2 x 3 x 60”		3. <i>Single Layer Neural Network</i> 4. <i>Multilayer Neural Network</i> 1. Basic concepts of Artificial Neural Networks (ANN) 2. Building ANN architecture for Classification and Regression 3. Single Layer Neural Network 4. Multilayer Neural Network	

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		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
11-12	CPMK-4. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk prediksi pada permasalahan regresi dan klasifikasi <i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine</i>	4.17 Memahami karakteristik dan tantangan data tak terstruktur, khususnya data gambar. 4.18 Menjelaskan prinsip dasar dan arsitektur Jaringan Syaraf Tiruan Konvolusional (<i>Convolutional Neural Network - CNN</i>). 4.19 Memproses data gambar untuk tugas pembelajaran mesin. 4.20 Menerapkan model CNN untuk memecahkan masalah klasifikasi gambar. 4.21 Mengevaluasi kinerja CNN menggunakan metrik dan visualisasi yang sesuai. 4.22 Menganalisis keunggulan CNN dibandingkan model pembelajaran mesin tradisional untuk data gambar.	Tes lisan, observasi Aktivitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</i> <i>TM: 2 x 3 x 50” PT: 2 x 3 x 60” BM: 2 x 3 x 60”</i>		1. Pengantar Data Tak Terstruktur 2. Dasar-Dasar Data Gambar 3. Pengantar Jaringan Syaraf Tiruan untuk Data Gambar 4. Jaringan Syaraf Tiruan Konvolusional (CNN) <i>1. Introduction to Unstructured Data 2. Fundamentals of Image Data 3. Introduction to Neural Networks for Image Data 4. Convolutional Neural Networks (CNN)</i>	10% / kum 75% <i>10% / Cumulative (75%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<i>learning for predictions of regression and classification.</i>	characteristics and challenges of unstructured data, particularly image data 4.18 Explain the basic principles and architecture of Convolutional Neural Networks (CNN) 4.19 Process image data for machine learning tasks 4.20 Apply CNN models to solve image classification problems 4.21 Evaluate the performance of CNNs using appropriate metrics and visualizations 4.22 Analyze the advantages of CNNs compared to traditional machine learning models for image data					
13	CPMK-4. Mampu menerapkan teknik komputasi dan	4.23 Memahami karakteristik dan tantangan data teks tak terstruktur. 4.24 Menjelaskan konsep utama dalam representasi teks	Tes lisan, observasi Aktifitas di kelas	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based		1. Memahami Data Teks 2. Teknik Representasi Teks (Bag of Words, Term Frequency–	10% / kum 85% 10% / Cumulative

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		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	<p>menggunakan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk prediksi pada permasalahan regresi dan klasifikasi</p> <p><i>CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i></p>	<p>untuk pembelajaran mesin, termasuk tokenisasi, vektorisasi, dan penyisipan kata.</p> <p>4.25 Memahami arsitektur dan proses pembelajaran Jaringan Syaraf Tiruan Berulang (<i>recurrent neural network</i>-RNN) untuk data sekuensial.</p> <p>4.26 Menerapkan model berbasis RNN untuk menyelesaikan tugas pemrosesan bahasa alami (<i>Natural Language Processing</i>-NLP) dasar.</p> <p>4.27 Mengevaluasi dan menginterpretasikan kinerja RNN dalam klasifikasi teks atau tugas prediksi sekuens.</p> <p>4.23 Understand the characteristics and challenges of unstructured text data</p>	<p>Oral test, observation of in-class activities</p>	<p>learning (PBL)</p> <p>Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL)</p> <p>TM: 1 x 3 x 50" PT: 1 x 3 x 60" BM: 1 x 3 x 60"</p>		<p>Inverse Document Frequency - dan Word embeddings)</p> <p>3. Recurrent Neural Networks (RNN)</p> <p>1. Understanding Text Data</p> <p>2. Text Representation Techniques (Bag of Words, Term Frequency–Inverse Document Frequency, and Word Embeddings)</p> <p>3. Recurrent Neural Networks (RNN)</p>	(85%)

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		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		4.24 Explain key concepts in text representation for machine learning, including tokenization, vectorization, and word embedding 4.25 Understand the architecture and learning process of Recurrent Neural Networks (RNN) for sequential data 4.26 Apply RNN-based models to solve basic Natural Language Processing (NLP) tasks 4.27 Evaluate and interpret the performance of RNNs in text classification or sequence prediction tasks					
14-15	CPMK-5. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang	5.1 Memahami karakteristik dan tantangan data deret waktu dalam pembelajaran mesin. 5.2 Membedakan antara metode peramalan deret waktu tradisional dan pendekatan berbasis pembelajaran mesin. 5.3 Menerapkan model pembelajaran mesin yang	Tes lisan, observasi Aktifitas di kelas <i>Oral test, observation of in-class activities</i>	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL) <i>Interactive Lecture –</i>		1. Mengubah rangkaian waktu menjadi format pembelajaran terbimbing sliding windows, lag features) 2. Rekayasa fitur untuk data berbasis	15% / kum 100% <i>15% / Cumulative (100%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bantuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, [Estimasi Waktu] / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran [Pustaka] / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	diperlukan dalam Machine Learning untuk peramalan deret waktu. <i>CLO-5. Able to apply computational techniques and to use modern computer tools/software used in machine learning for time series forecasting.</i>	sesuai untuk tugas prediksi deret waktu. 5.4 Memproses data deret waktu terlebih dahulu untuk model pembelajaran terbimbing. 5.5 Mengevaluasi kinerja model deret waktu menggunakan metrik yang sesuai. 5.1 Understand the characteristics and challenges of time series data in machine learning 5.2 Differentiate between traditional time series forecasting methods and machine learning-based approaches 5.3 Apply appropriate machine learning models for time series prediction tasks 5.4 Preprocess time series data for supervised learning models		Exercise and Discussion (CILSD), Problem-Based Learning (PBL) TM: 2 x 3 x 50" PT: 2 x 3 x 60" BM: 2 x 3 x 60"		waktu 3. Menangani pemisahan pelatihan-pengujian berbasis waktu (validasi walk-forward) 4. Machine Learning Models for Time Series a. Linear Regression (with lag features) b. Decision Trees and Random Forest c. Gradient Boosting (e.g., XGBoost) d. Support Vector Regression (SVR) e. Introduction to Deep Learning models (optional: RNN, LSTM) 1. Convert time series	

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		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		5.5 Evaluate the performance of time series models using appropriate metrics				into supervised learning format (sliding windows, lag features) 2. Feature engineering for time-based data 3. Handle time-based train-test split (walk-forward validation) 4. Machine Learning Models for Time Series. a. Linear Regression (with lag features) b. Decision Trees and Random Forest c. Gradient Boosting (e.g., XGBoost) d. Support Vector Regression	

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / <i>Final capability for each learning step (LLO)</i>	Penilaian / <i>Evaluation</i>		Bentuk Pembelajaran, Metode Pembelajaran, Penugasan Mahasiswa, <i>[Estimasi Waktu]</i> / <i>Learning Format; Learning Methods; Assignment for Students; [Estimated Time]</i>		Materi Pembelajaran <i>[Pustaka]</i> / <i>Learning Materials [References]</i>	Bobot Penilaian (%) / <i>Evaluation Weight (%)</i>
		Indikator / <i>Indicator</i>	Kriteria & Bentuk / <i>Criteria and Format</i>	Luring / <i>Offline</i>	Daring / <i>Online</i>		
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
						(SVR) e. Introduction to Deep Learning models (optional: RNN, LSTM)	
16	EAS/ <i>Final Evaluation</i>						