

MODULE HANDBOOK

STATISTICAL MACHINE LEARNING



**STATISTICS UNDERGRADUATE PROGRAM
DEPARTMENT OF STATISTICS
FACULTY OF SCIENCE AND DATA ANALYTICS
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
SURABAYA**

ENDORSEMENT PAGE

	MODULE HANDBOOK STATISTICAL MACHINE LEARNING STATISTICS UNDERGRADUATE PROGRAM DEPARTMENT OF STATISTICS INSTITUT TEKNOLOGI SEPULUH NOPEMBER
---	---

Proses <i>Process</i>	Penanggung Jawab <i>Person in Charge</i>			Tanggal <i>Date</i>
	Nama <i>Name</i>	Jabatan <i>Position</i>	Tanda tangan <i>Signature</i>	
Perumus <i>Preparation</i>	Dr.rer.pol. Dedy Dwi Prastyo, S.Si, M.Si	Dosen Lecturer		
Pemeriksa dan Pengendalian <i>Review and Control</i>	Dr.rer.pol. Dedy Dwi Prastyo, S.Si, M.Si; Dr. Kartika Fithriasari, M.Si	Tim kurikulum Curriculum team		
Persetujuan <i>Approval</i>	Dr. Ir. Setiawan, MS	Koordinator RMK Course Cluster Coordinator		
Penetapan <i>Determination</i>	Dr. Kartika Fithriasari, M.Si	Kepala Departemen Head of Department		

MODULE HANDBOOK

STATISTICAL MACHINE LEARNING

Module name	STATISTICAL MACHINE LEARNING	
Module level	Undergraduate	
Code	SS234526	
Course (if applicable)	STATISTICAL MACHINE LEARNING	
Semester	5	
Person responsible for the module	Dr.rer.pol. Dedy Dwi Prastyo, S.Si, M.Si	
Lecturer	Dr.rer pol. Dedy Dwi Prastyo, S.Si, M.Si Dr. Dra. Kartika Fithriasari, M.Si	
Language	Bahasa Indonesia and English	
Relation to curriculum	Undergraduate degree program, mandatory, 5th semester.	
Type of teaching, contact hours	Other SCL Methods (87.5%) Non-SCL Methods (12.5%)	
Workload	1. Lectures[L]: 2 x 50 = 100 minutes per week. 2. Practicum in Laboratory [P]: 1x170 = 170 minutes perweek 3. Exercises and Assignments [EA]: 3 x 60 = 180 minutes (3 hours)per week. 4. Independent learning [IL]: 3 x 60 = 180 minutes (3 hours) perweek.	
Credit points	3 credit points (SKS) Equivalent to 4.8 ECTS	
Requirements according to the examination regulations	A student must have attended at least 80% of the lectures to sit in the exams.	
Mandatory prerequisites	-	
Learning outcomes and their corresponding PLOs	CLO-1. Understand and able to explain the concept of supervised and unsupervised in machine learning and its application in various fields. CLO-2. Able to identify, formulate, and solve statistical problems using machine learning. CLO-3. Able to apply computing techniques and to use modern computer tools/software used in machine learning for clustering. CLO-4. Able to apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.	PLO-2 PLO-7 PLO-8 PLO-9 PLO-10

	CLO-5. Able to apply computational techniques and to use modern computer tools/software used in machine learning for time series forecasting. CLO-6. Able to write a written report of the analysis obtained from project.	
Content	The Statistical Machine Learning (SML) course equips students to master the latest developing methods and algorithms that are 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 unsupervised learning and supervised learning methods/algorithms for regression, classification, and time series forecasting.	
Assessment and its weight	Assignment 1 (20%) Project 1 – Midterm Exam (20%) Assignment 2 (20%) Project 2 – Final Exam (40%)	
Media employed	LCD, whiteboard, websites (myITS Classroom), zoom	
Reading list	1. 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 2. Haykin, S. 1999, <i>Neural Networks</i>, 2nd ., ed., Prentice Hall 3. Fausett, L., 1994, <i>Fundamental of Neural Networks</i>, Prentice Hall 4. Limin Fu, 1994, <i>Neural Network in Computer Intelligence</i>, McGraw Hill 5. Sivanandam, S.N., Sumathi, S., and Deepa, S. N., 2006, <i>Introduction to Neural Networks using MATLAB 6</i>, McGraw-Hill 6. James, G., Witten, D., Hastie, T., and Tibshirani, R., 2014, <i>An Introduction to Statistical Learning (with Application in R)</i>, Springer. 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>. 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. 10. Berry, M., Mohamed, A., Yap, B. (eds). 2020. <i>Supervised and Unsupervised Learning for Data Science</i>. Springer.	

		INSTITUT TEKNOLOGI SEPULUH NOPEMBER FAKULTAS SAINS DAN ANALITIKA DATA PROGRAM STUDI SARJANA STATISTIKA DEPARTEMEN STATISTIKA				Kode Dokumen	
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>
Statistical Machine Learning		KS1844749	AnDEF	T=3	P=3	V	11 January 2023
OTORISASI / <i>AUTHORIZATION</i>		Pengembang RPS / <i>RPS Developer</i>	Koordinator RMK / <i>Course Group Coordinator</i>			Ketua PRODI / <i>Head of Department</i>	
		Dr.rer.pol. Dedy Dwi Prastyo, S.Si, M.Si	Dr. Ir. Setiawan, M.S			Shofi Andari, S.Stat., 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 mengkaji dan memanfaatkan ilmu pengetahuan dan teknologi dalam rangka mengaplikasikannya pada bidang Statistika, serta mampu mengambil keputusan secara tepat dari hasil kerja sendiri maupun kerja kelompok dalam bentuk laporan tugas akhir atau bentuk kegiatan pembelajaran lain yang luarannya setara dengan Tugas Akhir melalui pemikiran logis, kritis, sistematis dan inovatif. <i>Able to study and utilize science and technology in order to apply it to the field of Statistics, and be able to make appropriate decisions from the results of their own work or group work in the form of final project reports or other forms of learning activities whose output is equivalent to the Final Project through logical, critical thinking, systematic and innovative.</i>					
	CPL-7 <i>PLO-7</i>	Mampu menggunakan perangkat komputasi modern untuk menyelesaikan permasalahan statistik. <i>Able to use modern computing devices to solve statistical problems.</i>					
	CPL-8 <i>PLO-8</i>	Mampu menggunakan teknik komputasi untuk menyelesaikan permasalahan statistik <i>Able to use computational techniques to solve statistical problems.</i>					
	CPL-9 <i>PLO-9</i>	Mampu menerapkan metode statistika untuk menganalisis permasalahan teoritis dan riil. <i>Able to apply statistical methods to analyze theoretical and real problems.</i>					
	CPL-10 <i>PLO-10</i>	Mampu menerapkan metode statistika Bisnis, Industri, Ekonomi, Sosial, Lingkungan atau Kesehatan pada permasalahan riil. <i>Able to apply business, industrial, economic, social, environmental or health statistical methods to real problems.</i>					
	Capaian Pembelajaran Mata Kuliah (CPMK) / <i>Course Learning Outcome (CLO)</i>						
CPMK-1. Mampu memahami konsep <i>supervised</i> dan <i>unsupervised</i> pada pembelajaran mesin (<i>Machine Learning</i>) dan aplikasinya di berbagai bidang. <i>CLO-1. Understand and able to explain the concept of supervised and unsupervised in machine learning and its application in various fields.</i> CPMK-2. Mampu mengidentifikasi, memformulasi, dan menyelesaikan masalah statistika menggunakan machine learning. <i>CLO-2. Able to identify, formulate, and solve statistical problems using machine learning.</i> CPMK-3. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang digunakan dalam <i>Machine Learning</i> untuk pengelompokan (<i>clustering</i>). <i>CLO-3. Able to apply computing techniques and to use modern computer tools/software used in machine learning for clustering.</i>							

	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 learning for predictions of regression and classification.</i> CPMK-5. Mampu menerapkan teknik komputasi dan menggunakan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> 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> 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>																																															
		Matrik CPL – CPMK / PLO – CLO Matrix <table><tr><th>CPMK</th><th>CPL-2</th><th>CPL-7</th><th>CPL-8</th><th>CPL-9</th><th>CPL-10</th></tr><tr><td>CPMK-1</td><td></td><td></td><td></td><td>V</td><td>V</td></tr><tr><td>CPMK-2</td><td></td><td></td><td></td><td>V</td><td>V</td></tr><tr><td>CPMK-3</td><td></td><td>V</td><td>V</td><td></td><td>V</td></tr><tr><td>CPMK-4</td><td></td><td>V</td><td>V</td><td></td><td>V</td></tr><tr><td>CPMK-5</td><td></td><td>V</td><td>V</td><td></td><td>V</td></tr><tr><td>CPMK-6</td><td>V</td><td></td><td></td><td></td><td></td></tr></table>					CPMK	CPL-2	CPL-7	CPL-8	CPL-9	CPL-10	CPMK-1				V	V	CPMK-2				V	V	CPMK-3		V	V		V	CPMK-4		V	V		V	CPMK-5		V	V		V	CPMK-6	V				
CPMK	CPL-2	CPL-7	CPL-8	CPL-9	CPL-10																																											
CPMK-1				V	V																																											
CPMK-2				V	V																																											
CPMK-3		V	V		V																																											
CPMK-4		V	V		V																																											
CPMK-5		V	V		V																																											
CPMK-6	V																																															
Deskripsi Singkat MK / <i>Course Description</i>	Mata kuliah Statistical Machine Learning (SML) membekali mahasiswa untuk menguasai metode dan algoritma yang berkembang terkini yang digunakan untuk membuat komputer dapat melakukan pembelajaran dan berperilaku cerdas. Pada perkuliahan ini akan dibahas teori dan praktik untuk metode dan algoritma terkini dengan topik mencakup metode/algoritma unsupervised learning dan supervised learning untuk regresi, klasifikasi, dan peramalan deret waktu. <i>The Statistical Machine Learning (SML) course equips students to master the latest developing methods and algorithms that are 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 unsupervised learning and supervised learning methods/algorithms for regression, classification, 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 / Primary :																																															
	1. James, G., Witten, D., Hastie, T., and Tibshirani, R., 2014, <i>An Introduction to Statistical Learning (with Application in R)</i> , Springer																																															
	Pendukung / Secondary:																																															

	- 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 - Haykin, S. 1999, <i>Neural Networks</i>, 2nd ., ed., Prentice Hall - Fausett, L., 1994, <i>Fundamental of Neural Networks</i>, Prentice Hall - Limin Fu, 1994, <i>Neural Network in Computer Intelligence</i>, McGraw Hill - Sivanandam, S.N., Sumathi, S., and Deepa, S. N., 2006, <i>Introduction to Neural Networks using MATLAB 6</i>, McGraw-Hill - 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. - Goodfellow, I., Yoshua, B., and Courville, A., 2016. <i>Deep Learning</i>. - 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. - Berry, M., Mohamed, A., Yap, B. (eds). 2020. <i>Supervised and Unsupervised Learning for Data Science</i>. Springer.
Dosen Pengampu / Lecturers	Dr. Dra. Kartika Fithriasari, M.Si; Santi Wulan Purnami, Ph.D.; Dr.rer pol. Dedy Dwi Prastyo, S.Si, M.Si; Novri Suhermi, Ph.D.; Dr. Muhammad Ahsan; Neni Alya Firdausanti, Ph.D.; Muhammad Syukron, M.Ai.; Rahmatin Nur Amalia, M.Si.
Matakuliah syarat / Pre-requisite Course	Analisis Deret Waktu, Analisis Multivariat Terapan

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	Penilaian / <i>Evaluation</i>		Bentuk 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 memahami konsep <i>supervised</i> dan	1.1 Dapat menjelaskan dan memahami dasar <i>Machine Learning</i>	Tes lisan, observasi Aktifitas di kelas	Ceramah Interaktif- Latihan Soal Diskusi		1. Konsep <i>Machine Learning</i> pada permasalahan <i>supervised</i>	5% / kum 5%

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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>unsupervised</i> pada pembelajaran mesin (<i>Machine Learning</i>) dan aplikasinya di berbagai bidang. <i>CLO-1. Understand and able to explain the concept of supervised and unsupervised in machine learning and its application in various fields.</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 (<i>supervised and unsupervised</i>) to be solved using Machine Learning 1.3. Recent developments in Statistical methods for Machine Learning	Oral test, observation of in-class activities	(CILSD), Problem-based learning (PBL) Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL) TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		<i>and unsupervised learning</i> 1. The concept of Machine Learning in supervised and unsupervised learning problems	5% / Cumulative (5%)
		1.4 Dapat mengidentifikasi permasalahan <i>supervised</i> dan <i>unsupervised</i> 1.5 Dapat mencari dan menggunakan <i>software</i> (terutama <i>library</i> di open source, misalkan di R) untuk	Observasi, Aktifitas di Lab Observation, Lab Activity	Praktikum Lab Activity P: 1 x 1 x 170"		2. Pre-processing data (mendeteksi missing value dan outlier, konsep imputasi data, transformasi data, seleksi variabel (<i>feature</i>) dengan 3. Seleksi variabel (<i>feature</i>) dengan	5% / kum 10% 5% / Cumulative (10%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		permasalahan <i>supervised</i> dan <i>unsupervised learning</i> 1.6 Dapat melakukan pre-processing data 1.7 Dapat melakukan pemilihan variabel dengan konsep <i>scatter plot</i> dan korelasi 1.4. <i>Able to identify supervised and unsupervised learning problems</i> 1.5. <i>Able to find and use software (especially open-source libraries, such as in R) for supervised and unsupervised learning problems</i> 1.6. <i>Able to perform data pre-processing</i> 1.7. <i>Able to perform variable selection using scatter plot and correlation concepts</i>				scatter plot dan metode korelasi 2. <i>Data pre-processing (detecting missing values and outliers, data imputation concepts, transformation)</i> 3. <i>Variable (feature) selection using scatter plots and correlation methods</i>	
2 - 3	CPMK-3. Mampu menggunakan teknik komputasi dan perangkat komputer modern yang diperlukan dalam <i>Machine Learning</i> untuk	2.1 Dapat memahami prinsip dasar algoritma pengelompokan tanpa pengawasan (<i>Unsupervised Clustering</i>). 2.2 Dapat mengimplementasikan dan menerapkan berbagai algoritma pengelompokan untuk mempartisi	Tes lisan, observasi Aktifitas di kelas	Ceramah Interaktif-Latihan Soal Diskusi (CILSD), Problem-based learning (PBL)		Metode pengelompokan (<i>clustering</i>) - Fuzzy C-mean Clustering - DBSCAN <i>Clustering Methods:</i>	7.5% / kum 17.5% 7.5% / Cumulative (17.5%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
	pengelompokan (clustering) <i>CLO-3. Able to apply computing techniques and to use modern computer tools/software used in machine learning for clustering.</i>	data ke dalam kelompok yang bermakna. 2.3 Dapat mengevaluasi dan membandingkan kinerja pengelompokan menggunakan metrik yang sesuai. 2.4 Dapat mengidentifikasi kekuatan, keterbatasan, dan aplikasi yang sesuai dari berbagai teknik pengelompokan. 2.1. Able to understand the basic principles of unsupervised clustering algorithms 2.2. Able to implement and apply various clustering algorithms to partition data into meaningful groups 2.3. Able to evaluate and compare clustering performance using appropriate metrics 2.4. Able to identify the strengths, limitations, and suitable applications of various clustering techniques	Oral test, observation of in-class activities	Interactive Lecture – Exercise and Discussion (CILSD), Problem-Based Learning (PBL) TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		- Fuzzy C-Means Clustering - DBSCAN	

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		2.5 Menerapkan berbagai algoritma pengelompokan menggunakan Python. 2.6 Menerapkan teknik pengelompokan pada kumpulan data dunia nyata dan menginterpretasikan hasilnya. 2.7 Mengevaluasi kinerja pengelompokan menggunakan metrik dan alat visualisasi yang sesuai. 2.8 Membandingkan berbagai algoritma pengelompokan dan menganalisis perilakunya dalam berbagai kondisi. untuk pengelompokan data 2.5. Apply various clustering algorithms using Python 2.6. Apply clustering techniques to real-world datasets and interpret the results 2.7. Evaluate clustering performance using appropriate metrics and visualization tools 2.8. Compare different clustering	Observasi, Aktifitas di Lab <i>Observation, Lab Activity</i>	Praktikum <i>Lab Activity</i> <i>P: 1 x 1 x 170"</i>		Praktik penerapan metode <i>clustering</i> pada data - Fuzzy C-mean Clustering - DBSCAN Implementation of Clustering Methods: - Fuzzy C-Means Clustering - DBSCAN	5% / kum 22.5% 5% / Cumulative (22.5%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		algorithms and analyze their behavior under various conditions for data clustering					
4 - 5	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</i>	3.1 Mampu memahami prinsip dasar algoritma berbasis pohon (<i>Tree-based Algorithm</i>) dalam pembelajaran mesin. 3.2 Mampu mengimplementasikan dan menerapkan model berbasis pohon untuk tugas klasifikasi dan regresi. 3.3 Mampu mengevaluasi dan membandingkan berbagai algoritma berbasis pohon dalam hal kinerja dan interpretabilitas. 3.4 Mampu mengidentifikasi dan mengurangi masalah overfitting dan underfitting dalam model berbasis pohon. 3.1. Able to understand the basic principles of tree-based algorithms in machine learning 3.2. Able to implement and apply tree-based models for classification and	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> TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		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>	7.5% / kum 30% <i>7.5% / Cumulative (30%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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>tools/software used in machine learning for predictions of regression and classification.</i>	regression tasks 3.3. Able to evaluate and compare various tree-based algorithms in terms of performance and interpretability 3.4. Able to identify and mitigate overfitting and underfitting issues in tree-based models					
		3.5 Menerapkan model pembelajaran mesin berbasis pohon menggunakan Python. 3.6 Menerapkan pohon keputusan dan metode ensemble ke kumpulan data dunia nyata. 3.7 Mengevaluasi dan menginterpretasikan kinerja model berbasis pohon. 3.8 Membandingkan berbagai algoritme berbasis pohon dan menganalisis efektivitasnya dalam berbagai skenario. 3.5. Apply tree-based machine learning models using Python 3.6. Apply decision trees and ensemble	Observasi, Aktifitas di Lab <i>Observation, Lab Activity</i>	Praktikum <i>Lab Activity</i> P: 1 x 1 x 170"		Praktik penerapan metode Algoritma berbasis pohon pada data menggunakan: - <i>Decision Tree</i> - <i>Bagging</i> - <i>Random Forest</i> <i>Implementation of Tree Based Algorithm:</i> - Decision Tree - Bagging - Random Forest	5% / kum 35% 5% / Cumulative (35%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		methods to real-world datasets 3.7. Evaluate and interpret the performance of tree-based models 3.8. Compare various tree-based algorithms and analyze their effectiveness in different scenarios					
6-7	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</i>	5.1 Dapat memahami konsep dasar Support Vector Machines (SVM) untuk klasifikasi dan regresi. 5.2 Dapat menjelaskan peran hyperplane, support vector, dan margin dalam batasan keputusan SVM. 5.3 Dapat membedakan antara SVM linear dan non-linear serta penggunaan fungsi kernel. 5.4 Dapat mengimplementasikan model SVM untuk berbagai tugas machine learning menggunakan Python. 5.5 Dapat mengevaluasi dan menginterpretasikan kinerja model SVM menggunakan metrik yang sesuai. 5.6 Dapat membandingkan SVM dengan model klasifikasi dan regresi lainnya,	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> TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		Algoritma SVM <i>SVM Algorithm</i>	7.5% / kum 42.5% <i>7.5% / Cumulative (42.5%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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] / Learning Materials [References]	Bobot Penilaian (%) / Evaluation Weight (%)
		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>use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	menganalisis kekuatan dan keterbatasannya. 5.1 Able to understand the basic concept of Support Vector Machines (SVM) for classification and regression 5.2 Able to explain the role of hyperplanes, support vectors, and margins in the decision boundaries of SVM 5.3 Able to distinguish between linear and non-linear SVM, and understand the use of kernel functions 5.4 Able to implement SVM models for various machine learning tasks using Python 5.5 Able to evaluate and interpret the performance of SVM models using appropriate metrics 5.6 Able to compare SVM with other classification and regression models, analyzing its strengths and limitations					

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		5.7 Menerapkan Support Vector Machines (SVM) untuk tugas klasifikasi dan regresi menggunakan Python. 5.8 Menerapkan SVM dengan berbagai fungsi kernel dan analisis dampaknya terhadap kinerja model. 5.9 Mengevaluasi kinerja model SVM menggunakan metrik dan teknik visualisasi yang sesuai. 5.10 Mengoptimalkan model SVM dengan menyetel hiperparameter dan menangani data yang tidak dapat dipisahkan secara linier. 5.7 Apply Support Vector Machines (SVM) for classification and regression tasks using Python 5.8 Apply SVM with various kernel functions and analyze their impact on model performance 5.9 Evaluate the performance of SVM models using appropriate metrics and visualization techniques	Observasi, Aktivitas di Lab <i>Observation, Lab Activity</i>	Praktikum <i>Lab Activity</i> P: 1 x 1 x 170"		Praktik penerapan metode Algoritma SVM pada data <i>Implementation of SVM Algorithm</i>	7.5% / kum 50% 7.5% / Cumulative (50%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	Penilaian / <i>Evaluation</i>		Bantuan 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)
		5.10 Optimize SVM models by tuning hyperparameters and handling non-linearly separable data					
8	ETS/Midterm						
9-10	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</i>	5.1 Dapat mengidentifikasi permasalahan klasifikasi yang diselesaikan dengan Jaringan Saraf Tiruan (JST) 5.2 Dapat menyelesaikan kasus klasifikasi dengan menggunakan metode JST 5.1. Able to identify classification problems solved using Artificial Neural Networks (ANN) 5.2. Able to solve classification cases using ANN methods	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> TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		1. Konsep dasar JST 2. Membangun arsitektur JST untuk klasifikasi dan Regresi 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	7.5% / kum 57.5% <i>7.5% / Cumulative (57.5%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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>tools/software used in machine learning for predictions of regression and classification.</i>						
		5.3 Dapat menggunakan <i>software</i> (terutama <i>library</i> di open source, misalkan di R atau <i>Python</i>) untuk klasifikasi dan regresi menggunakan JST 5.4 Menerapkan JST dengan berbagai Arsitektur dan analisis dampaknya terhadap kinerja model. 5.5 Mengevaluasi kinerja model JST menggunakan metrik dan teknik visualisasi yang sesuai. 5.6 Mengoptimalkan model JST dengan menyetel hiperparameter. 5.3. Able to use software (especially open-source libraries, such as in R or Python) for classification and	Observasi, Aktifitas di Lab <i>Observation, Lab Activity</i>	Praktikum <i>Lab Activity</i> P: 1 x 1 x 170"		Praktik menerapkan Jaringan Saraf Tiruan untuk Regresi dan Klasifikasi dengan: 1. <i>Single Layer Neural Network</i> 2. <i>Multilayer Neural Network</i> <i>Practice applying Artificial Neural Networks for Regression and Classification using:</i> 1. Single Layer Neural Network	5% / kum 62.5% 5% / Cumulative (62.5%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	Penilaian / <i>Evaluation</i>		Bantuan 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)
		regression using ANN 5.4. Apply ANN with various architectures and analyze their impact on model performance 5.5. Evaluate the performance of ANN models using appropriate metrics and visualization techniques 5.6. Optimize ANN models by tuning hyperparameters				2. Multilayer Neural Network	
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</i>	6.1 Memahami karakteristik dan tantangan data tak terstruktur, khususnya data gambar. 6.2 Menjelaskan prinsip dasar dan arsitektur Jaringan Syaraf Tiruan Konvolusional (<i>Convolutional Neural Network - CNN</i>). 6.3 Memproses data gambar untuk tugas pembelajaran mesin. 6.4 Menerapkan model CNN untuk memecahkan masalah klasifikasi gambar. 6.5 Mengevaluasi kinerja CNN menggunakan metrik dan visualisasi yang sesuai.	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> TM: 1 x 2 x 50" PT: 1 x 2 x 60" BM: 1 x 2 x 60"		1. Pengantar Data Tak Terstruktur 2. Dasar-Dasar Data Gambar 3. Pengantar Jaringan Syaraf Tiruan untuk Data Gambar 4. Jaringan Syaraf Tiruan Konvolusional (CNN) 1. <i>Introduction to Unstructured Data</i> 2. <i>Fundamentals of Image Data</i> 3. <i>Introduction to</i>	7.5% / kum 70% <i>7.5% / Cumulative (70%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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>apply computational techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	6.6 Menganalisis keunggulan CNN dibandingkan model pembelajaran mesin tradisional untuk data gambar. 6.1. Understand the characteristics and challenges of unstructured data, particularly image data 6.2. Explain the basic principles and architecture of Convolutional Neural Networks (CNN) 6.3. Process image data for machine learning tasks 6.4. Apply CNN models to solve image classification problems 6.5. Evaluate the performance of CNNs using appropriate metrics and visualizations 6.6. Analyze the advantages of CNNs compared to traditional machine learning models for image data				Neural Networks for Image Data 4. Convolutional Neural Networks (CNN)	
		6.1 Memproses data gambar sebelum digunakan dalam jaringan neural. 6.2 Menerapkan dan melatih arsitektur Convolutional Neural Network	Observasi, Aktifitas di Lab	Praktikum <i>Lab Activity</i>		Praktik menerapkan CNN untuk mengolah data gambar: 1. Praproses Data	5% / kum 75%

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		(CNN) dasar untuk tugas klasifikasi gambar. 6.3 Mengevaluasi dan menginterpretasikan kinerja model CNN menggunakan metrik dan visualisasi yang sesuai. 6.4 Menerapkan teknik untuk meningkatkan kinerja model CNN (misalnya, penambahan data, regularisasi). 6.5 Memvisualisasikan peta fitur CNN dan hasil pelatihan untuk mendapatkan wawasan tentang perilaku model. 6.1. Process image data before using it in neural networks 6.2. Implement and train basic Convolutional Neural Network (CNN) architectures for image classification tasks 6.3. Evaluate and interpret the performance of CNN models using appropriate metrics and	Observation, Lab Activity	P: 1 x 1 x 170"		Gambar (<i>Image Data Preprocessing</i>) 2. Implementasi Model CNN 3. Evaluasi dan Visualisasi Model Practice applying CNN to process image data: 1. Image Data Preprocessing 2. CNN Model Implementation 3. Model Evaluation and Visualization	5% / Cumulative (75%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		visualizations 6.4. Apply techniques to improve CNN model performance (e.g., data augmentation, regularization) 6.5. Visualize CNN feature maps and training results to gain insights into model behavior					
13-14	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</i>	7.1 Memahami karakteristik dan tantangan data teks tak terstruktur. 7.2 Menjelaskan konsep utama dalam representasi teks untuk pembelajaran mesin, termasuk tokenisasi, vektorisasi, dan penyisipan kata. 7.3 Memahami arsitektur dan proses pembelajaran Jaringan Syaraf Tiruan Berulang (<i>recurrent neural network-RNN</i>) untuk data sekuensial. 7.4 Menerapkan model berbasis RNN untuk menyelesaikan tugas pemrosesan bahasa alami (<i>Natural Language Processing-NLP</i>) dasar. 7.5 Mengevaluasi dan menginterpretasikan kinerja RNN	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> TM: 1 x 2 x 50” PT: 1 x 2 x 60” BM: 1 x 2 x 60”		1. Memahami Data Teks 2. Teknik Representasi Teks (Bag of Words, Term Frequency–Inverse Document Frequency - dan Word embeddings) 3. Recurrent Neural Networks (RNN) 1. <i>Understanding Text Data</i> 2. <i>Text Representation Techniques (Bag of Words, Term Frequency–Inverse Document</i>	7.5% / kum 82.5% <i>7.5% / Cumulative (82.5%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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>techniques and to use modern computer tools/software used in machine learning for predictions of regression and classification.</i>	dalam klasifikasi teks atau tugas prediksi sekuens. 7.1. Understand the characteristics and challenges of unstructured text data 7.2. Explain key concepts in text representation for machine learning, including tokenization, vectorization, and word embedding 7.3. Understand the architecture and learning process of Recurrent Neural Networks (RNN) for sequential data 7.4. Apply RNN-based models to solve basic Natural Language Processing (NLP) tasks 7.5. Evaluate and interpret the performance of RNNs in text classification or sequence prediction tasks				Frequency, and Word Embeddings) 3. Recurrent Neural Networks (RNN)	
		7.6 Memproses dan menyiapkan data teks mentah untuk model pembelajaran mesin.	Observasi, Aktifitas di Lab Observation, Lab Activity	Praktikum Lab Activity P: 1 x 1 x 170"		Praktik menerapkan RNN untuk mengolah data teks: 1. Basic Text Cleaning 2. Text to Sequence	5% / kum 87.5%

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		7.7 Menerapkan dan melatih model berbasis RNN (termasuk LSTM atau GRU) untuk tugas klasifikasi teks. 7.8 Menerapkan penyematan kata untuk merepresentasikan data tekstual secara efektif dalam model pembelajaran mendalam. 7.9 Mengevaluasi kinerja model RNN menggunakan metrik yang sesuai. 7.10 Menafsirkan dan memvisualisasikan hasil pelatihan untuk menganalisis perilaku model. 7.6. Process and prepare raw text data for machine learning models 7.7. Implement and train RNN-based models (including LSTM or GRU) for text classification tasks 7.8. Apply word embeddings to effectively represent textual data in deep learning models 7.9. Evaluate the performance of RNN models using appropriate metrics 7.10. Interpret and visualize training results to analyze model behavior				Conversion 3. Word Embeddings 4. Implementasi Model Berbasis RNN 5. Pelatihan & Evaluasi Model 6. Kumpulan Data untuk Praktik Practice applying RNN to process text data: 1. Basic Text Cleaning 2. Text-to-Sequence Conversion 3. Word Embeddings 4. RNN-Based Model Implementation 5. Model Training	5% / Cumulative (87.5%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
						& Evaluation 6. Datasets for Practice	
15	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>	8.1 Memahami karakteristik dan tantangan data deret waktu dalam pembelajaran mesin. 8.2 Membedakan antara metode peramalan deret waktu tradisional dan pendekatan berbasis pembelajaran mesin. 8.3 Menerapkan model pembelajaran mesin yang sesuai untuk tugas prediksi deret waktu. 8.4 Memproses data deret waktu terlebih dahulu untuk model pembelajaran terbimbing. 8.5 Mengevaluasi kinerja model deret waktu menggunakan metrik yang sesuai. 8.1. Understand the characteristics and challenges of time series data in machine learning 8.2. Differentiate between traditional	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> TM: 1 x 2 x 50” PT: 1 x 2 x 60” BM: 1 x 2 x 60”		1. Mengubah rangkaian waktu menjadi format pembelajaran terbimbing sliding windows, lag features) 2. Rekayasa fitur untuk data berbasis 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	7.5% / kum 95% <i>7.5% / Cumulative (95%)</i>

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		time series forecasting methods and machine learning-based approaches 8.3. Apply appropriate machine learning models for time series prediction tasks 8.4. Preprocess time series data for supervised learning models 8.5. Evaluate the performance of time series models using appropriate metrics				c. Gradient Boosting (e.g., XGBoost) d. Support Vector Regression (SVR) e. Introduction to Deep Learning models (optional: RNN, LSTM) 1. Convert time series 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)	

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
						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)	
		8.6 Memproses dan memvisualisasikan data deret waktu menggunakan Python. 8.7 Mengubah data deret waktu menjadi format pembelajaran terbimbing yang sesuai untuk model pembelajaran mesin. 8.8 Menerapkan model pembelajaran mesin untuk tugas peramalan deret waktu.	Observasi, Aktifitas di Lab <i>Observation, Lab Activity</i>	Praktikum <i>Lab Activity</i> P: 1 x 1 x 170"		Praktik menerapkan metode <i>machine learning</i> untuk mengolah data time series: 1. Praproses <i>Time Series</i> 2. Mengonversi <i>Time series</i> ke Format <i>Supervised</i> 3. Menerapkan Model	5% / kum 100% 5% / Cumulative (100%)

Mg Ke- / Week	Kemampuan akhir tiap tahapan belajar (Sub-CPMK) / Final capability for each learning step (LLO)	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)
		8.9 Mengevaluasi kinerja model menggunakan metrik deret waktu yang sesuai. 8.10 Membandingkan berbagai model pembelajaran mesin dan menganalisis kekuatan serta keterbatasannya untuk peramalan. 8.6. Process and visualize time series data using Python 8.7. Convert time series data into the appropriate supervised learning format for machine learning models 8.8. Apply machine learning models for time series forecasting tasks 8.9. Evaluate model performance using appropriate time series metrics 8.10. Compare various machine learning models and analyze their strengths and limitations for forecasting				<i>Machine Learning</i> 4. Pelatihan dan Evaluasi Model Practice applying machine learning methods to process time series data: 1. Time Series Preprocessing 2. Convert Time Series to Supervised Format 3. Apply Machine Learning Models 4. Model Training and Evaluation	
16	EAS/Final Evaluation						

	RENCANA ASESMEN & EVALUASI <i>Assesment and Evaluation Plan</i> Program Studi Sarjana Statistika / <i>Statistics Undergraduate Program</i> STATISTICAL MACHINE LEARNING / <i>STATISTICAL MACHINE LEARNING</i>		RA&E
			SLK-26
Kode MK: SS234526 <i>Course Code:</i> <i>SS234526</i>	Bobot sks (T/P): 3 <i>CREDITS : 3</i>	Rumpun MK: Analitika Data Ekonomi dan Finansial <i>Course cluster:</i> <i>Economic And Financial Data Analytics</i>	Smt: V <i>Semester V</i>
OTORISASI <i>AUTHORIZATION</i>	Penyusun <i>Author</i>	Koordinator RMK <i>Coordinator of course cluster</i>	Kaprodi <i>Head of Department</i> Dr.rer.pol. Dedy Dwi Prastyo

Mg ke (1)	Sub CP-MK (2)		Bentuk Asesmen (Penilaian) / <i>Evaluation Type</i> (3)	Bobot / <i>Scoring</i> (%) (4)
	No	Kemampuan akhir / <i>Final Capability</i>		
1		Tuliskan kemampuan akhir Sub CP-MK <i>Write down the final capability of Sub CP-MK</i>	Tuliskan bentuk asesmen <i>Write down the form of assessment</i>	
2				
3				
Total Bobot Penilaian				100%