

GAI10SG194	Pattern Recognition and Anomaly Detection	L	T	P	C
Version 1.0		3	0	0	3
Pre-requisites/Exposure	Data Mining & Machine Learning				
Co-requisites	--				

Course Objectives

1. To understand fundamentals of pattern and its computational significance.
2. To study various approaches through which pattern recognition can be carried out

Course Outcomes

On completion of this course, the students will be able to

CO1. Explain the basic concepts of pattern and anomaly from information theory

CO2. Demonstrate the steps involved in extraction and detection of data patterns

CO3. Practice the various models used for pattern recognition using to solve real world problems approaches

Catalog Description

The course is aimed at specific problem, pattern recognition that is often encountered in data processing applications. The course details of pattern and anomaly as a distinguishable feature and specifications of them from information theory view point. Various methods that are available under statistical and learning approaches through which pattern analysis especially from recognition and detection purpose is addressed in this course.

Course Content

Unit 1. Pattern and Anomaly Detection Introduction

09 Lecture Hours

What is pattern? What is pattern recognition? Pattern recognition techniques, Training and learning in pattern recognition, Pattern recognition applications, Pattern recognition use cases, what is anomaly detection? What are some other practical uses for anomaly detection? How is anomaly detection calculated over time? Key point for AI and ML-anomaly detection, Tasks for artificial intelligence, AI system learning process, Test to geometric requirements for curves algebraic, Curves matched to data points, Case study: Anomaly detection with IBM Watson, Probability theory, Maximum likelihood theory and estimation, Model selection, Matrices of uncertainty (confusion matrices), Loss of logging (log-loss), Rate for F1 (F1 score), Metric selection, Hyperparameter selection, The problem with high dimensionality, Information theory.

Unit 2. Statistical Approaches for Pattern Recognition

09 Lecture Hours

Understanding statistics, T-test, Z-test, Z-test and t-test difference, P-value, Descriptive statistics, Type I error, Type II error, Differences between type I and type II errors, Null hypothesis, Statistical significance, Hypothesis testing, Four steps of hypothesis testing, Real-world example of hypothesis testing, Bonferroni test, Check of one-tailed, Probability distributions, Types of distributions, Regression models, Types of regression, How to select the best model for regression? Common questions, Linear models for classification, Example of positive linear regression.

Unit 3. Machine Learning Approaches for Pattern Recognition

09 Lecture Hours

Neural networks, how neural networks learn? Neural networks examples, Neural networks use cases, Kernel methods, Sparse kernel machines use cases, Graphical models, Mixture models and EM, Bayesian networks: Directed graphical models, Conditional probability distributions, Potential functions, Conditional independences, Sampling methods for pattern recognition, Continuous latent

variables, Combining models for pattern recognition, Markov chain Monte Carlo, The K-means algorithm, Applications of K-means.

Unit 4. Anomaly Detection & Anomaly Detection Approaches

09 Lecture Hours

What are anomalies? Applications of anomaly detection, Related use cases, Types of input data, Types of anomalies, Evaluation of an anomaly detector, Taxonomy of approaches, Classification based, Classification use cases, Supervised classification techniques, Nearest neighbour based techniques, Others model techniques, Information theory, Contextual anomaly based, Collective anomaly detection, On-line based model, Distributed anomaly detection, IDS analysis strategy.

Unit 5. Real-world problems

09 Lecture Hours

Network intrusion detection, Understanding of IDS core operation, How an IDS works? Types of intrusion detection systems, Fundamental concerns of intrusion detection systems, Intrusion detection vs. intrusion prevention, The future of IDS, Anomaly detection in big data, Key attributes of advanced anomaly detection, The real-world impact of anomaly detection, Anomaly detection on 5G: Possibilities and opportunities, Real time anomaly detection in docker, Hadoop cluster, Anomaly detection in IoT, Detection of deviations in deep learning time series results, Anomaly detection use cases, Anomaly detection with time series forecasting, What is time series analysis? Time series data models, how to find anomaly in time series data? Anomaly detection using machine learning, Anomaly detection using deep learning, Anomaly detection for an e-commerce pricing system, IBM's Watson AIOps automates IT anomaly detection and remediation.

Text Book - Pattern and Anomaly Detection (IBM ICE Publications)

Reference Materials

1. Richard O. Duda, Peter E. Hard, David G. Stork, Pattern Recognition, 2nd, Wiley, 2021.

Modes of Evaluation: Quiz/Assignment/ presentation/ extempore/ Written Examination

Examination Scheme:

Components	MSE	Presentation/Assignment/ etc	ESE
Weightage (%)	20 %	30 %	50 %

Course Outcomes	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
CO1	1														3
CO2	1				2										3
CO3					2										3
Average	1				2										3

1=weak

2= moderate

3=strong