National University of Engineering (UNI)
School of Computer Science
Syllabus 2027-I

1. COURSE

AI261. Probability and Statistics for AI (Elective)

2. GENERAL INFORMATION

2.1 Course	:	AI261. Probability and Statistics for AI
2.2 Cycle	:	CS300 Cycle.
2.3 Credits	:	4
2.4 Hours	:	2 HT; 4 HP;
2.5 Duration of the period	:	16 weeks
2.6 Type of course	:	Elective
2.7 Learning modality	:	Face to face
2.8 Prerrequisites	:	• BMA102. Differential Calculus. (1st Sem) • BMA101. Linear Algebra. (1st Sem) • STA251. Probability Calculation. (2nd Sem)

3. PROFESSORS

Meetings after coordination with the professor

4. INTRODUCTION TO THE COURSE

This course provides the essential probabilistic and statistical foundations for developing Artificial Intelligence systems. It covers key distributions, Bayesian inference, and statistical methods directly applied to machine learning problems, computer vision, and natural language processing.

5. GOALS

- Understand fundamental probability distributions in AI models
- Apply statistical inference methods in model training
- Implement probabilistic solutions using modern libraries (NumPy, SciPy)

6. COMPETENCES

AG-C07) Computing Knowledge: Applies knowledge of mathematics, science, and computing. (Usage)

7. TOPICS

Unit 1: Probabilistic Foundations (15 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Probability spaces and random variables • Key distributions: Normal, Poisson, Binomial, Multinomial • Bayes' Theorem and AI applications	• Calculate probabilities in discrete/continuous models [Usar] • Explain the role of distributions in ML algorithms [Familiarizarse]
Readings : [Bis06], [Mur12]	

Unit 2: Statistics for AI (15 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Parameter estimation (MLE, MAP) • Confidence intervals and hypothesis testing • Correlation analysis and linear regression	• Implement MLE/MAP in Python [Usar] • Evaluate statistical significance in model results [Evaluar]
Readings : [DS14], [Was04]	

Unit 3: Markov Chains and Stochastic Processes (15 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• Hidden Markov Models (HMMs) • Markov Chain Monte Carlo (MCMC) • Applications in NLP and computer vision	• Simulate basic stochastic processes [Usar] • Relate theory to neural network architectures [Familiarizarse]
Readings : [Ros19], [Bis06]	

Unit 4: Computational Tools (15 hours)	
Competences Expected: AG-C07	
Topics	**Learning Outcomes**
• NumPy for probabilistic operations • SciPy for statistical tests • Visualization with Matplotlib/Seaborn	• Program probabilistic simulations [Usar] • Generate statistical visualizations [Evaluar]
Readings : [Van16], [McK22]	

8. WORKPLAN

8.1 Methodology

Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

8.2 Theory Sessions

The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

8.3 Practical Sessions

The practical sessions are held in class where a series of exercises and/or practical concepts are developed through problem solving, problem solving, specific exercises and/or in application contexts.

9. EVALUATION SYSTEM

Theory Sessions:
The theory sessions are held in master classes with activities including active learning and roleplay to allow students to internalize the concepts.

Lab Sessions:
In order to verify their competences, several activities including active learning and roleplay will be developed during lab sessions.

Oral Presentations:
Individual and team participation is encouraged to present their ideas, motivating them with additional points in the different stages of the course evaluation.

Reading:
Throughout the course different readings are provided, which are evaluated. The average of the notes in the readings is

considered as the mark of a qualified practice. The use of our virtual campus allows each student to access the course information, and interact outside the classroom with the teacher and with the other students.

The final grade NF depends on the following grades:

- PE: Partial Exam.
- FE: Final Exam.
- P: Permanent Evaluation (Average of practical work and graded assignments).

The final grade NF is calculated as follows:

$$NF = \frac{PE + FE + P}{3}$$

10. BASIC BIBLIOGRAPHY

[Was04] Larry Wasserman. *All of Statistics: A Concise Course in Statistical Inference*. Aunque es de 2004, sigue siendo referencia estándar. Springer, 2004.

[Bis06] Christopher M. Bishop. *Pattern Recognition and Machine Learning*. Springer, 2006.

[Mur12] Kevin P. Murphy. *Machine Learning: A Probabilistic Perspective*. MIT Press, 2012.

[DS14] Morris H. DeGroot and Mark J. Schervish. *Probability and Statistics*. 4th. Pearson, 2014.

[Van16] Jake VanderPlas. *Python Data Science Handbook*. O'Reilly, 2016.

[Ros19] Sheldon M. Ross. *Introduction to Probability Models*. 12th. Academic Press, 2019.

[McK22] Wes McKinney. *Python for Data Analysis*. 3rd. O'Reilly, 2022.