



Nombre Completo del Programa de Posgrado		Maestría en Ciencias en Ingeniería Eléctrica		
Nombre Completo del Curso		Tópicos selectos de matemáticas I / Introduction to Mathematics for Intelligent Systems		
Tipo de Curso		Electivo	Créditos	8
Número de horas		Teóricas:	60	Prácticas:
		Presenciales		No presenciales
Profesores que impartirán el curso				
Andrés Méndez Vázquez				
Objetivos del curso:	General	<p>The objective of this course is to teach four important areas in the Mathematics for Intelligent Systems:</p> <ul style="list-style-type: none"> • Theory and basic methods in Linear Algebra, • Introduction to statistics and probability methods, • Basic Methods in Optimization. 		
	Específicos			
Contenidos temáticos				
1. Linear Algebra [1, 2, 3]				
1.1. Linear Equations, Matrices and Gaussian Elimination				
1.1.1. (a) Linear Equations				
1.1.2. (b) The Geometry of Linear Equations				
1.1.3. (c) Matrix Notation and Matrix Multiplication				
1.1.4. (d) Triangular Factors and Row Exchanges				
1.1.5. (e) Inverses and Transposes				
1.1.6. (f) Solving the Regression Problem				
1.2. Vector Spaces				
1.2.1. (a) Space of Vectors and Subspaces				
1.2.2. (b) Solving Homogeneous and In-homogeneous Systems				
1.2.3. (c) Linear Independence, Basis and Dimensions				
1.2.4. (d) The Four Fundamental Subspaces				
1.2.5. (e) Graphs and Networks				
1.2.6. (f) Linear Transformations				
1.3. Orthogonality				
1.3.1. (a) Orthonormal Basis				
1.3.2. (b) Projections onto sub-spaces				
1.3.3. (c) The Regression Least Square				
1.3.4. (d) Gram-Schmidt				
1.4. Determinants				
1.4.1. (a) The Properties of the Determinants(d)				

1.4.2. (b) Permutations
1.4.3. (c) Cofactors
1.4.4. (d) Cramer's Rule
1.4.5. (e) Applications
1.5. The Eigenvectors and Eigenvalues
1.5.1. (a) The classic
1.5.2. (b) Diagonalization
1.5.3. (c) Difference Equations and Powers A^k
1.5.4. (d) Singular Value Decomposition
1.6. Derivatives of Matrices
1.6.1. (a) Generalizing the concept of derivatives
1.7. Applications
1.7.1. (a) Solving the Linear Regression Problem
1.7.2. (b) Application Principal Component Analysis
1.7.3. (c) Application for image processing EigenFaces
1.7.4. (d) Markov Matrices and the Google Matrix
1.7.5. (e) Linear Algebra in Probability and Statistics
2. Probability and Statistical Theory [4, 5]
2.1. Introduction
2.1.1. (a) Probability Definition
2.1.2. (b) The Sample Space
2.1.3. (c) Basic Set Operations
2.1.4. (d) Counting
2.1.4.1. i. How to produce probabilities?
2.2. Conditional Probability
2.2.1. (a) Definition and intuition
2.2.2. (b) Bayes' Rule
2.2.3. (c) Conditional Probabilities are probabilities
2.2.4. (d) Independence of events
2.2.5. (e) The use of conditioning to solve problems
2.3. Random Variables
2.3.1. (a) The basic intuition and definition
2.3.2. (b) Distributions
2.3.2.1. i. Continuous
2.3.2.2. ii. Discrete
2.3.3. (c) Cumulative distribution function
2.3.4. (d) Function of Random Variables
2.4. Expectation
2.4.1. (a) Define expectation as a weighted average
2.4.2. (b) Linearity of the expectation
2.4.3. (c) Examples, Geometric and Negative Binomial
2.4.4. (d) Indicator Random Variable and the Fundamental Bridge
2.4.5. (e) Variance
2.5. Moments
2.5.1. (a) Moments as summarizing a distribution
2.5.2. (b) How do we interpret moments?
2.5.3. (c) Sample moments
2.5.3.1. i. The Sample Mean
2.5.3.2. ii. The Sample Variance
2.5.4. (d) Moment generating functions
2.6. Joint distributions

2.6.1. (a) Joint, Marginal and Conditional
2.6.2. (b) Transformation of variables
2.6.3. (c) Covariance and Correlations
2.6.4. (d) Conditional Expectation
2.7. Inequalities and Limit Theorems
2.7.1. (a) Inequalities
2.7.2. (b) Law of Large Numbers
2.8. Applications
2.8.1. (a) Bayesian inference
2.8.2. (b) Generative Models vs. Discriminative Models
2.8.2.1. i. Models that learn from the data
2.8.3. (c) Markov Chains
2.8.4. (d) Markov Chain Monte Carlo
3. Optimization [6, 7]
3.1. Introduction
3.1.1. (a) Formulation
3.1.2. (b) Example: Least Squared Error
3.1.3. (c) Continuous versus Discrete Optimization
3.1.4. (d) Constrained and Unconstrained Optimization
3.2. The Basics
3.2.1. (a) What is a solution?
3.2.2. (b) How to recognize a minimum?
3.2.3. (c) Overview:
3.2.3.1. i. Linear Search
3.2.3.2. ii. Trust Region
3.3. Convex Functions
3.3.1. (a) Why Convex Functions?
3.3.2. (b) Differentiable Convex Functions
3.3.3. (c) Characterizing Convex Functions using differentiability
3.4. The Concept of an Algorithm
3.4.1. (a) Algorithms
3.4.2. (b) Convergence
3.4.3. (c) Comparison of Algorithms
3.5. Linear Search Methods
3.5.1. (a) Introduction
3.5.2. (b) Linear Search
3.5.3. (c) Search using Derivatives
3.5.3.1. i. Gradient Descent
3.5.3.2. ii. Newton's Method
3.5.4. (d) Applications in the Perceptron Algorithm and Logistic Regression
3.6. Trust-Region Methods
3.6.1. (a) Linear Search Vs Trust-Region
3.6.2. (b) The Basics for the Trust-Region
3.6.3. (c) Basic Algorithms
3.6.3.1. i. Levenberg-Marquardt algorithm
3.6.3.2. ii. Dogleg Method
3.7. Specific Methods:
3.7.1. (a) Conjugate Gradient Methods
3.7.2. (b) Quasi-Newton Methods
3.8. Optimality Conditions and Duality
3.8.1. (a) Lagrange Multipliers

3.8.2. (b) The Karush-Kuhn-Tucher Conditons

3.8.3. (c) Constraint Qualifications

3.8.4. (d) Lagrangian Dual Problems

3.8.5. (e) Formulating the Dual Problem

3.8.6. (f) Linear and Quadratic Programming

Bibliografía

1. G. Strang, Introduction to Linear Algebra. Wellesley, MA: Wellesley-Cambridge Press, fourth ed., 2009.
2. K. Hoffman and R. Kunze, Linear algebra. Prentice-Hall mathematics series, Prentice-Hall, 1971.
3. S. Lang, Algebra. Graduate Texts in Mathematics, Springer New York, 2005.
4. R. Ash, Basic Probability Theory. Dover Books on Mathematics Series, Dover Publications, Incorporated, 2012.
5. J. Blitzstein and J. Hwang, Introduction to Probability. Chapman & Hall/CRC Texts in Statistical Science, CRC Press, 2014.
6. J. Nocedal and S. J. Wright, Numerical Optimization, second edition. World Scientific, 2006.
7. M. S. Bazaraa, Nonlinear Programming: Theory and Algorithms. Wiley Publishing, 3rd ed., 2013.

Criterios de evaluación

Midterm 1	10%
Midterm 2	10%
Midterm 4	10%
Final	10%
8 Homework's	60%
Total	100%

Contribución del curso al perfil de egreso del programa

Conocimientos:

Habilidades:

Actitudes y valores: