COURSE CONTENTS

1- AN OVERVIEW OF BIOINFORMATICS
- What is Bioinformatics, and why is it important?
- Primer on molecular biology and genetics
- DNA, RNA, genes, gene expression genetic
- What is System Biology?
- A brief history of Bioinformatics
- What areas in Mathematics and Computer Science are involved
- Biologically inspired computing

2 - SEQUENCE ALIGNMENTS
- Introduction to Dynamic Programming
- The Smith-Waterman algorithm
- Database searches
- Alignment scores and statistical significance of database searches;
- Multiple sequence alignment

3 - CLUSTERING AND VISUALIZATION
- Unsupervised Clustering Methods
- Dimensionality and Data Reduction
- Application Examples in Metagenomics: Species
- Separation with Clustering
- Micro Array Data Analysis

4 - PHYLOGENETICS
- Introduction to phylogenetics (distance based and character based)
- Phylogenetic trees
- Distance matrix methods
- Maximum likelihood approaches
- Parsimony and ancestral sequences
- Comparison of phylogenetic methods

5 - USE OF MARKOV MODELS
- Markov Models in Bioinformatics
- Hidden Markov models: Viterbi, forward,backward algorithms
- Application Examples

6 - PATTERN DISCOVERY AND RECOGNITION
- Gene finding
- Motif Search and discovery
- Gene structure, open reading frames and gene expression
- Alternative Splicing
- Microarrays

7 - PROTEOMICS AND REGULATORY NETWORKS
- Introduction to proteomics - protein structure; protein classification
- Protein and RNA structure prediction
- Protein folding
- An introduction to Regulatory Networks

8- METABOLOMICS
- An introduction in the context of Agriculture
- Algorithmic challenges involved and opportunities for research
- Case Studies on Drought Tolerant Plants

9- METAGENOMICS
- An introduction describing why this area is different
- Key applications using pattern discovery
- Use of Metagenomics in Drug Discovery

10 - SELECTED EXAMPLES OF CURRENT RESEARCH
- Splice Site Detection with Markov models and Neural Networks
- Who has the best wheat?
- Semi-supervised Learning applied to Bioinformatics
- Locating CRISPR Sequences