COURSE SYLLABUS

1. COURSE TITLE
Introduction to Bioinformatics

2. COURSE CODE
AI3073

3. PRE-REQUISITE
Nil

4. CO-REQUISITE
Nil

5. NO. OF UNITS
3

6. CONTACT HOURS
42

7. MEDIUM OF INSTRUCTION (MOI)
English

8. OFFERING UNIT
Artificial Intelligence Programme, Faculty of Science and Technology

9. SYLLABUS PREPARED & REVIEWED BY
Prepared by Dr. Xiaoling Peng
Reviewed by Dr. Ping He

10. AIMS & OBJECTIVES
The course is designed to introduce the most important and basic concepts, methods, and tools used in Bioinformatics which includes an introduction to Bioinformatics, experience with select bioinformatics tools and databases currently utilized in the life sciences.

11. COURSE CONTENT
1. Introduction
    i. What is bioinformatics

ii. Examples on application of bioinformatics on daily research
iii. Major Research Directions of Bioinformatics

2. Genome, gene, RNA, protein and classic algorithms
   i. Understanding Gene and RNA
   ii. Genome and Sequencing
   iii. Sequence alignment
   iv. Protein and CRISPR
3. Bioinformatic data and tools
   i. Data Format
      a) Fasta, sam, pdb, gtf, vcf, RPKM/FPKM (Optional)
   ii. Database and tools
      a) National Center for Biotechnology Information (NCBI)
      b) Ensembl (EMBL-EBI/Sanger Institute)
      c) Protein Data Bank and other important data resources
      d) Gene Ontology and KEGG
4. Statistical analysis and machine learning in bioinformatics
   i. R and statistical model
      a) R basic and data preprocessing
      b) Differential expression
      c) Gene set enrichment
      d) Maximum likelihood estimation and phylogeny
   ii. Machine learning in bioinformatics
      a) Matrix factorization and imputation
      b) Biological network and clustering
      c) Regression and classification (Optional)
      d) Markov (Optional)
5. State-of-art technologies and case study (Optional)
   i. Spatial transcriptomics
   ii. Genome editing
   iii. Protein structure prediction, drug design and deep learning
   iv. Biological networks inference

12. COURSE INTENDED LEARNING OUTCOMES (CILOS) WITH MATCHING TO PILOS

For AI students:

Programme Intended Learning Outcomes (PILOs)

Programme Title: Bachelor of Science (Honours) in Artificial Intelligence	
PILO	**Upon successful completion of the Programme, students should be able to:**
PILO 1	Articulate and explain the principles, concepts and theories required across the field of artificial intelligence.
PILO 2	Develop appropriate artificial intelligence algorithms and systems, and enhance performance of them through comparisons and refinements of alternative approaches.
PILO 3	Identify problems solvable by artificial intelligence in real world applications and develop solutions using appropriate technology and systematic tools.
PILO 4	Collaborate and work effectively in teams using different communication formats in the context of AI technology.
PILO 5	Investigate contemporary issues in the field of artificial intelligence, and develop life-long effective learning skills.

CILOs-PILOs Mapping Matrix

Course Code & Title: AI3073 Introduction to Bioinformatics		
CILO	**Upon successful completion, students should be able to:**	**PILO(s) Addressed**
CILO 1	**Describe** basic concepts, models and algorithm in bioinformatics.	PILO 1
CILO 2	**Apply** the learned skills and techniques to solve real world problems.	PILO 3
CILO 3	**Analyze** real Bio-data with appropriate software	PILO 3
CILO 4	**Present** bioinformatics results in a professional manner in both oral and written forms	PILO 4

For CST students:

Programme Intended Learning Outcomes (PILOs)

Programme Title: Bachelor of Science (Honours) in Computer Science and Technology	
PILO	**Upon successful completion of the Programme, students should be able to:**
PILO 1	**Analyze** the basic principles of computer science and technology;
PILO 2	**Translate** real world problems into IT requirements;
PILO 3	**Design** and **develop** complex software;
PILO 4	**Apply** up-to-date technology to **solve** general problems in specific areas;
PILO 5	**Communicate** effectively and **collaborate** in a team.

CILOs-PILOs Mapping Matrix

Course Code & Title: AI3073 Introduction to Bioinformatics		
CILO	**Upon successful completion of the course, students should be able to:**	**PILO(s) to be addressed**
CILO 1	**Describe** basic concepts, models and algorithm in bioinformatics.	PILO 1
CILO 2	**Apply** the learned skills and techniques to solve real world problems.	PILO 4
CILO3	**Analyze** real Bio-data with appropriate software	PILO 4
CILO 4	**Present** bioinformatics results in a professional manner in both oral and written forms	PILO 5

13. TEACHING & LEARNING ACTIVITIES (TLAS)

CILO No.	**TLAs**
CILO 1	● **Lecture:** Three hours of lectures will be given per week. Instructor will share his experiences of biostatistics with students. During lectures, students will be asked to have group discussions and do group work on questions given by the teacher. ● **Tutorials:** One hour of tutorials will be given per week. Question and answer type assignments will be given to students to ensure that students fully understand the lecture materials for concepts and theories.

CILO No.	TLAs
CILO 2	• **Group discussion and case studies**: To enhance students' understanding of biostatistics, students will be required to discuss some real life problems by groups, and instructors will guide students to solve problems. • **Group Projects and oral presentation:** Students will be required to search information online, apply statistical knowledge in real life problems, and give oral presentations in English.
CILO 3-4	• **Group Projects and oral presentation:** Students will be required to search information online, use statistical method and software in real life problems, and give oral presentations in English.

14. ASSESSMENT METHODS (AMS)

Type of Assessment Methods	Weighting	CILOs Addressed	Description of Assessment Tasks
Assignment	20%	1,3	Written and programming assignments will measure the students' understanding of the theory and their ability to solve practical problems.
Quizes	30%	1-2	Quizes will test students' understanding of basic concepts and algorithms on bioinformatics.
Labs	20%	2,3	Lab practices will measure students' understanding of basic concepts and algorithms on bioinformatics, and make sure students are prepared for solving real-life bioinformatic problems.
Group project and essay writing	30%	2-4	Group project will test students' ability in selecting proper methods to explain, analyse and solve real-world problems.

15. TEXTBOOKS / RECOMMENDED READINGS

Textbook:

Marketa J. Zvelebil and Jeremy O. Baum, Understanding Bioinformatics. New York : Garland Science, 2007.

Recommended Readings:

1. Jean-Michel Claverie and Cedric Notredame, Bioinformatics For Dummies, 2nd Edition
2. Wiley, 2007.
3. Arthur Lesk, Introduction to Bioinformatics, 4th Edition, Oxford, 2014.
4. Jonathan Pevsner, Bioinformatics and Functional Genomics, second edition. Wiley-Blackwell, 2009.
5. Nello Cristianini and Matthew W. Hahn, Introduction to Computational Genomics: A Case Studies Approach, Cambridge University Press, 2007.
6. Buffalo, Bioinformatics Data Skills: Reproducible and Robust Research with Open Source Tools, O'Reilly, 2015.
7. James Tisdall, Beginning Perl for Bioinformatics, O'Reilly & Associates, 2001.
8. Eija Korpelainen and Jarno Tuimala, RNA-seq Data Analysis: A Practical Approach, Chapman & Hall/CRC, 2014.
9. Cedric Gondro, Primer to Analysis of Genomic Data Using R, Springer, 2015.
10. Martin Jones, Python for Biologists: A complete Programming course for beginners, CreateSpace, 2013.

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