Minutes of the 2nd Senate Meeting
22 February 2023 at 2 PM
IIIT Raichur

Section A: In the Presence of Student Representatives

Attendance is placed in Appendix 'A'.

A-2.1 Announcements:
The Director welcomed all the members to the Second Senate meeting of IIIT Raichur.

A-2.2 Confirmation of Minutes of 1st Senate Meeting held on 26 Dec 2022 at 2:30 PM
Senate Resolution on item A-2.1: ***Confirmed.***

A-2.3 Need for revised internship guidelines
As per the discussion in the previous senate meeting, the revised internship guidelines were presented during the current senate meeting. The major changes include the removal of NPTEL courses from the previous guidelines. Details are attached as ***Annexure-1.***
Senate Resolution on item A-2.2: ***Approved.***

A-2.4 Detention of students from promotion to a final year without clearing the backlogs

In the current scenario, the majority of the students are having backlogs even in their final year. Thus, to increase the ratio of the number of students placed to the total number of students, we should restrict backlog students to move to the final year.

The issue was discussed at length and the Senate members have suggested more detailed clarifications in all the subcategories for this agenda point.

Senate Resolution on item A-2.4: ***The Agenda point is to be brought up for discussion in the next Senate meeting.***

A-2.5 Need for guidelines for CGPA calculations and course conversion (honours to regular course)

Since we are offering honours and regular courses, there should be a guideline regarding the credit calculations for both honours and regular courses. In addition, guidelines are also needed for converting a honours course to a regular course in case a student failed to complete the required credits for the honours course. Details are attached as ***Annexure-2***.
Senate Resolution on item A-2.5: Approved subject to the following conditions:

a) **Approval is only for a specific category of electives.**
b) **Applicable for same or above-level courses.**
c) **Applicable for 2019 and 2020 batches for students even without an 8.0 CGPA**
d) **Applicable for the 2021 batch onwards with a minimum of 8 CGPA**

A-2.6 Starting of courses under ECE and Liberal Arts (LA)

The institute is going to float LA and ECE courses, previously taught by the faculty from IIT Hyderabad. This initiative would also expand the horizon of the expertise available within the institute for further introduction of the academic programs. Thus, approval is required to recruit faculty to teach these courses.
Senate Resolution on item A-2.6: ***Item not considered for Senate meeting since recruitment of Faculty does not fall within the purview of the Senate.***

A-2.7 List of experts for holding a panel for the selection of the faculty

The institute is in the process of frequent interviews in all streams (CSE/ECE/Maths/Liberal Arts), and the Senate is requested to suggest experienced faculty to meet this need.
Senate Resolution on item A-2.7: ***Approved. The Senate nominees may be nominated by the Chairman on a case-to-case basis.***

A-2.8 Need for revised Curriculum

Approval is needed for the following:-

(i) To introduce new courses and
(ii) To make changes to the existing curriculum

(a) Introduction to Data Structures (3 credits) and Data structures (3 credits) is being offered in the 2nd and 3rd semester, respectively. They need to be merged into a single course with 3 credits and it will be offered in the 3rd semester.

(b) Introduction of Object-oriented program course (3 credits) in the 2nd semester in place of introduction to data structures.

(c) Operating Systems 1 (1 credit) and Operating Systems 2 (3 credits) are being offered in the 3rd and 4th semesters, respectively. They need to be merged into a single course Operating Systems with 3 credits.

(d) The course Principles of Programming Language (CS231, 1 credit, 3rd semester) can be removed as Compilers and Programming language is being offered in the 4th semester. Introduction to Python programming (1 credit) can be introduced in place of CS231.

(e) Swapping of the courses Theory of Computation and Design and Analysis of Algorithms.

(f) Removal of OCs from the curriculum.

(g) Expanding a one-credit course "Introduction of Probability" to a three-credit course "Introduction of Probability, Statistics and Random Processes".

(h) The old and updated curriculum can be found in ***Annexure-3.***

Based on the suggestions received from the Senate members, the curriculum has been further revised. The revised curriculum is placed in ***Annexure-4.***

Senate Resolution on item A-2.8: ***Approved as per the revised curriculum.***

A-2.9 Approval for Ph.D. fee structure

Details are attached as ***Annexure-5.***

Senate Resolution on item A-2.9: ***Item not considered for Senate meeting since Fee structure does not fall within the purview of the Senate.***

A-2.10 (i) Approval of the new elective courses

a) *Introduction to Approximation Theory and Optimization* offered by Dr. Debmalya Sain

b) *Deep Learning with Graphs* offered by Dr. Priodyuti Pradhan
c) *Introduction to Quantum Machine Learning* offered by Dr. Priodyuti Pradhan
d) *Maths Tool for Machine learning and Data Science* offered by Dr. Alka

Senate Resolution on item A-2.9(i): *Approved. A standard template may be devised for seeking approval for all new courses.*

(ii) Approval for the new core course

Details are attached as ***Annexure-6.***

The online courses were approved by Prof. B. S. Murty on February 07, 2022

Multimedia Content Analysis was offered (by Prof. CKM, IITH) to 2019 batch students (in the 5th semester) in place of Foundations of Machine learning (CS311, 3 credits) due to a shortage of faculty.

Senate Resolution on item A-2.10(ii): *Ratified.*

A-2.11 Allowing students (including the 2019 batch) to do a major project in a company provided that the company doesn't have any objection to disclosing the work/internship done by the student. A faculty will be associated with the project/internship from the first day of joining.

A few companies are making it compulsory to do the internship in the 8th semester.

Senate Resolution on item A-2.11: Approved. Further to be approved by Senate-Chair on a case-to-case basis.

A-2.12 Giving a chance to reappear in exams: Only for 2019 batch students who have a backlog in various courses

The director Prof. HK Sardana and the faculty together took an initiative to conduct make-up exams for the 2019 batch. Without compromising the quality, a student can get a maximum score of 7 GPA. A chance is given to the backlog students (2019 batch) for the following reasons:

a) To improve the placement percentage statistics.
b) The 2019 batch is the first batch passing out and they start to carry IITR's legacy/brand to the world.
c) To give ample time to their major project.

Senate Resolution on item A-2.12: *Approved, subject to the condition that it is applicable only for the 2019 batch in view of the necessity to conduct online classes as a result of Covid-19.*

A-2.13 Any other item with the permission of the Chair

There being no other points, the meeting was concluded with the permission of the Chair.

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Appendix A

The following members were present during the senate meeting which was held on 22nd February 2023.

Senate Faculty Representatives

1. Prof. Harish Kumar Sardana, Director IIIT Raichur and Chairman Senate.
2. Prof. Bharat Bhooshan Panigrahi, IIT Hyderabad.
3. Prof. Saptarchi Majumdar, IIT Hyderabad.
4. Dr. Subrahmanyam Kalyanasundaram, IIT Hyderabad.
5. Dr. Viswanath Pulabaigari, IIIT Sri City.
6. Dr. Ramesh Jallu, IIIT Raichur.
7. Dr. Debasish Mukherjee, IIIT Raichur.
8. Dr. Suresh Chavhan, IIIT Raichur.
9. Dr. Nabin Kumar Meher, IIIT Raichur.
10. Dr. Priodyuti Pradhan, IIIT Raichur.
11. Dr. Alka Chaddha, IIIT Raichur.
12. Dr. Debmalya Sain, IIIT Raichur.
13. Dr. Neha Agarwal, IIIT Raichur.
14. Commodore Manohar Nambiar (Retd.), Registrar IIT Hyderabad.

Senate Student Representatives

1. Mr. Deepak Sai Perisetla.
2. Ms. Beerelly Srinitha.
3. Mr. Piyus Anand, Academic Secretary, IIIT Racihur.

ANNEXURE 1

Internship Guidelines - IIIT R

(Effective from 2020 Batch)

1. A student can enroll for an internship in either 6th or 7th or 8th semester.
2. A student has to score a minimum of 7.5 CGPA with no active backlogs in all previous semesters for availing the internship.
3. The duration of the internship is 6 months.
4. Only one internship is allowed in the entire BTech course.
5. A student has to complete the mandatory credits requirement before going to the internship.
6. A student opting for the internship has to inform his/her faculty adviser prior (at the beginning of a particular semester) along with the letter of approval from the industry/research institute he/she wants to get enrolled.
7. Upon successful completion, a student has to submit the internship report to the faculty adviser. A committee will be formed to conduct the viva for evaluation.
8. Below are the guidelines which has to be followed if a student opts for internship in a specific semester:

Sl. No.	Semester for enrolling	Guidelines
1.	6th Semester	It is mandatory for the student to complete the credit courses in either 7th or 8th semester.
		If no courses are offered during 8th semester, the student has to register with the 6th semester course (during 8th semester only) to complete the credit requirements.
		Since, only one internship is allowed, if a student completes the internship prior to placement, he/she will be allowed to appear for those companies whose mandatory requirement is not internship before PPO.

2.	7th Semester	It is mandatory for the student to complete the credit courses in either 6th or 8th semester.
		If no courses are offered during 8th semester, the student has to register with the 6th semester course (during 8th semester only) to complete the credit requirements.
		Since, only one internship is allowed, if a student completes the internship prior to placement, he/she will be allowed to appear for those companies whose mandatory requirement is not internship before PPO.
3.	8th Semester	A student has to complete the credit requirements before going for an internship.
		If a company offered mandatory internship, it is possible to convert the internship to external project provided all the details of the project will be made public and the student should be allowed to publish the thesis online.

ANNEXURE 2

CGPA and Course Conversion

Sl. No.	Agenda Points	Proposals for IIIT R
1	In case of additional courses, while calculating the final CGPA, do you consider the best of 120 credits (only for Elective courses).	Yes, only in terms of elective courses can be swapped and it will happen at the end of 7th sem. The additional courses will not be taken into account for CGPA calculations.
2	What is the requirement for an honors degree, is it just completing min 12 credits? Does it have any CGPA criteria at the end?	In order to earn an honors degree, a student has to earn a minimum of 12 extra credits in the student's major department. For CGPA calculations, we can mention in the transcript BTECH in CSE and BTECH in CSE with honors. For BTECH in CSE, the CGPA calculation will be on 120 credits whereas for BTECH in CSE with honors, the CGPA calculation will be on 132 (120+12) credits. Registration for honors: At the beginning of 5th sem. Credit conversion will be done by the end of 7th sem.
3	Are we allowed to convert honors courses to regular courses, as an elective, and vice versa?	If a student is registered for 12 credit course, the he is only allowed to convert two-third of total credit. If he/she is registered for less than two-third then he is allowed to convert only 3-credit. If he/she wants to drop the courses then all the honors course will be mentioned as additional course and no credit will be used for CGPA calculation.
4	If course conversion is allowed, then when should we convert the courses and what's its process?	A student has the option to convert a 3-credit course as mentioned in point no. 3. This conversion will happen only one time between 6 to 8 semesters.
5	Will honors grades be considered in regular CGPA calculation or honors grades are separate from regular CGPA?	There is two CGPA calculation in the transcript. One with BTECH in CSE and the other with BTECH in CSE with honors. One grade calculation is done on 120 credits and the other is done on 132 credits.

ANNEXURE-3

Revised Curriculum

	First Year						
	Semester - 1				Semester - 2		
Sl. No.	Course Name	Code	Credits		Course Name	Code	Credits
1	Maths I	MA101	3		Maths II	MA102	3
2	Introduction to Programming	ID110	3		Introduction to Life Sciences	BO121	1
3	Digital Fabrication	ID120	2		Hardware Description Language	EE121	2
4	Digital Logic Design	ID130	1		Discrete Structures	CS121	3
5	Digital Systems Design	ID131	1		Introduction to Object Oriented Programming	CS122	3
6	Introduction to AI	ID141	1		Independent Project	ID151	1
7	Introduction to Computer Science	CS101	2		Professional Communication Skills and Writing	ID161	2
8	LA/CA elective	LXXXX	2				
	Total credits		**15**		**Total credits**		**15**

	Second Year						
	Semester - 3				Semester - 4		
Sl. No	**Course Name**	**Code**	**Credits**		**Course Name**	Code	**Credits**
1	Introduction to Probability	MA201	1		Design and Analysis of Algorithms	CS251	3
2	Data Structures	CS201	3		Operating Systems	CS221	3
					Compiler and Programming Language	CS232	3
3	Theory of Computation	CS202	3		DBMS	CS261	3
4	Software Engineering	CS210	3		Engineering Elective	XXxxx	3
5	Computer Architecture	CS241	3		LA Electives	LAxxx	2
6	Introduction to Python Programming	CS231	2				
7	LA elective	LAXXX	3				
	Total credits		**18**		**Total credits**		**17**

Third Year

	Semester-5				Semester - 6					
					Without Internship			With Internship		
Sl.No	Course Name	Code	Credit		Course Name	Code	Credit	Course	Code	Credit
1	Computer Networks	CS301	4		Mini Project 1	CS391	3	Internship	CS	6
2	Foundations of Machine Learning	CS311	3		CS Elective 3	CSxxx	3			
3	CS Elective 1	CSxxx	3		CS Elective 4	CSxxx	3			
4	Free Elective 1	XXxxx	3		Free Elective 2	XXxxx	3			
5	CS Elective 2	CSxxx	3		Science Elective	XXxxx	1			
6	Personality Development/Pro Ethics	ID162/ID163	2							
Total			**18**				**13**			**6**

Fourth Year

	Semester - 7							Semester - 8					
	Without Internship			With Internship				Without Internship			With Internship		
Sl.no	Course	Type	Credit	Course	Type	Credit		Course	Type	Credit	course	Type	Credit
1	Mini Project 2 / CS Elective 5	CS491	3	Minor Project 1 / CS Elective 3	CSxxx	3		Major Project	CS	9	Major Project	CSxxx	9
2	CS Elective 6	CSxxx	3	CS Elective 4	CSxxx	3					Free Elective 3	XXxxx	3
3	CS Elective 7	CSxxx	3	CS Elective 5	CSxxx	3					CS Elective 7	CSxxx	3
4	Free Elective 3	XXxxx	3	CS Elective 6	CSxxx	3					Science Elective	XXxxx	1
5	Free Elective 4	XXxxx	3	Free Elective 2	XXxxx	3							
Total			**15**			**15**				**9**			**16**

Total Credit requirement = 120

	Without Internship		With Internship	
Sl. No	**Type**	**Credit**	**Type**	**Credit (wo/w)**
1	Basic science	9	Basic science	9
2	Basic Engg	17	Basic Engg	17
3	Dept Core	38	Dept Core	38
4	*Dept Electives	21 (-3)	*Dept Electives	21 (-3)
5	Free Electives	12	Free Electives	9
6	Life Skills	4	Life Skills	4
7	LA/CA	7	LA/CA	7
8	*Project	15 (+3)	*Internship+ project	12 (+3)
Total		**120**		**120**

*** One CS Elective is in option with a minor project**

Glossary of Terms:

1. **CS Elective:** A course of the student's choice, to be selected from the pool of electives offered by the CS department
2. **Free Elective:** A course of the student's choice, to be selected from any department (subject to meeting the prerequisites) or any online course
3. **LA/CA Elective:** A course of the student's choice, to be selected from the Liberal Arts and Creative Arts category
4. **Science Elective:** A course of the student's choice, to be selected from the Science stream

Credit Requirement: The minimum credit requirement for successful completion of the B.Tech course is 120 credits

Semester Internship:

1. Semester Internship is optional and can be undertaken from **January to June (i.e. in the 6th semester).**
2. Only students with **CGPA > 8.0** at the end of the 4th semester are eligible.
3. The duration of the semester internship must be of minimum six months and only with a single company. **It cannot be fractalized.**
4. Semester Interns can be recruited **only in Phase I (July to October i.e. in the 5th semester).**
5. It will be of 6 credits and evaluation will be done by the faculty committee at the end of the internship
6. Students need to submit Internship Report for grading by IITH Faculty
7. The students should complete the credits of the 6th semester missed out due to Semester Internship in any other semesters by end of the 8th semester for the award of B.Tech degree.
8. The students will not be allowed to register for any course credits during the semester internship irrespective of whether the internship is onsite or online.
9. The students should abide by the principle of making use of the semester completely to understand the industry environment and should exceed the expectations of the company offering semester internships. Students should use this opportunity to build professional networks in the industry.

B.Tech Honors

IIIT-Raichur has provision for an Honors program that is designed to challenge the brighter and more ambitious students, without burdening an average student. Some salient features are listed below:

- A student can opt for Honors after the completion of the second year.
- The student should have a CGPA >= 8.0 (without any backlog) at the end of the fourth semester.
- The student must complete an additional 12 discipline credits.
- Out of the 12 credits, a student may take up to 6 credits of Online Courses (OC) **(subject to approval from the authority concerned).**
- The student should have CGPA >= 8.0 (without any backlog) at the end of the eighth semester and should not have any backlog throughout the B.Tech course.

Probable list of CS Electives: Elective courses offered by the CSE department of IITH and following

1. Knowledge Representation and Reasoning
2. Machine Learning
3. Logic in Computer Science
4. Formal VerificationInformation Retrieval
5. Cyber Security
6. Cryptography (and Network security)
7. Big Data analysis and Applications
8. Introduction to Multi-Agent Modelling
9. Graphics and Multimedia
10. Data Mining and warehousing
11. Computational Geometry
12. Digital Image Processing
13. Soft Computing and evolutionary AI
14. Distributed Computing
15. High-performance computing
16. Cloud Computing
17. Human-Computer Interaction
18. VLSI System design
19. Wireless networks
20. Advanced Algorithms
21. Combinatorial Optimization

ANNEXURE-4

Revised Curriculum

	First Year						
	Semester-1				Semester-2		
Sl. No.	Course Name	Code	Credits		Course Name	Code	Credits
1	Maths I	MA101	3		Maths II	MA102	3
2	Introduction to Programming	ID110	3		Introduction to Life Sciences	BO121	1
3	Digital Fabrication	ID120	2		Hardware Description Language	EE121	2
4	Digital Logic Design	ID130	1		Discrete Structures	CS121	3
5	Digital Systems Design	ID131	1		Introduction to Object Oriented Programming	CS122	4
6	Introduction to AI	ID141	1		Independent Project	ID151	1
7	Introduction to Computer Science	CS101	2		Professional Communication Skills and Writing	ID161	2
8	LA/CA elective	LXXXX	2				
	Total credits		**15**		**Total credits**		**16**

	Second Year						
	Semester - 3				Semester - 4		
Sl. No	Course Name	Code	Credits		Course Name	Code	Credits
1	Introduction to Probability, Statistics and Random Process	MA201	3		Design and Analysis of Algorithms	CS251	3
2	Data Structures	CS201	4		Operating Systems	CS221	4
3	Theory of Computation	CS202	3		Compiler and Programming Language	CS232	3
4	Software Engineering	CS210	3		DBMS	CS261	3
5	Computer Architecture	CS241	3		Engineering Elective	XXxxx	3
6	Introduction to Python Programming	CS231	1		LA Electives	LAxxx	2
7	LA elective	LAXXX	3				
	Total credits		20		Total credits		18

Third Year

	Semester-5				Semester - 6					
					Without Internship			With Internship		
Sl.No	Course Name	Code	Credit		Course Name	Code	Credit	Course	Code	Credit
1	Computer Networks	CS301	4		Mini Project 1	CS391	3	Internship	CS	6
2	Foundations of Machine Learning	CS311	3		CS Elective 3	CSxxx	3			
3	CS Elective 1	CSxxx	3		CS Elective 4	CSxxx	3			
4	Free Elective 1	XXxxx	3		Free Elective 2	XXxxx	3			
5	CS Elective 2	CSxxx	3		Science Elective	XXxxx	1			
6	Personality Development/Pro Ethics	ID162/ID163	2							
Total			**18**				**13**			**6**

Fourth Year

	Semester - 7							Semester - 8					
	Without Internship			With Internship				Without Internship			With Internship		
Sl.no	Course	Type	Credit	Course	Type	Credit		Course	Type	Credit	course	Type	Credit
1	Mini Project 2 / CS Elective 5	CS491	3	Minor Project 1 / CS Elective 3	CSxxx	3		Major Project	CS	9	Major Project	CSxxx	9
2	CS Elective 6	CSxxx	3	CS Elective 4	CSxxx	3					Free Elective 3	XXxxx	3
3	CS Elective 7	CSxxx	3	CS Elective 5	CSxxx	3					CS Elective 7	CSxxx	3
4	Free Elective 3	XXxxx	3	CS Elective 6	CSxxx	3					Science Elective	XXxxx	1
5	Free Elective 4	XXxxx	3	Free Elective 2	XXxxx	3							
Total			**15**			**15**				**9**			**16**

Total Credit requirement = 124

	Without Internship		With Internship	
Sl. No	**Type**	**Credit**	**Type**	**Credit (wo/w)**
1	Basic science	11	Basic science	11
2	Basic Engg	14	Basic Engg	12
3	Dept Core	43	Dept Core	43
4	*Dept Electives	21 (-3)	*Dept Electives	21 (-3)
5	Free Electives	12	Free Electives	9
6	Life Skills	4	Life Skills	4
7	LA/CA	7	LA/CA	7
8	*Project	15 (+3)	*Internship+ project	12 (+3)
Total		**124**		**124**

*** One CS Elective is in option with a minor project**

Credit Courses Categorization:

Sl. No.	Course Type	List of courses
1.	Basic Sciences	MA101, MA102, BO121, MA201.
2.	Basic Engg	All Courses with code IDXXX expect ID161 and ID162/163.
2.	Dept Core	All Courses starting with CSXXX except CS Elective.
3.	Dept Elective	All CS Elective Courses.
4.	Free Electives	All Free Elective Courses.
5.	Life Skills	ID161 and ID162/163.
6.	LA/CA	All LA/CA Electives
7.	Project.	Minor Project 1, Minor Project 2 and Major Project.

Glossary of Terms:

1. **CS Elective:** A course of the student's choice, to be selected from the pool of electives offered by the CS department
2. **Free Elective:** A course of the student's choice, to be selected from any department (subject to meeting the prerequisites) or any online course
3. **LA/CA Elective:** A course of the student's choice, to be selected from the Liberal Arts and Creative Arts category
4. **Science Elective:** A course of the student's choice, to be selected from the Science stream

Credit Requirement: The minimum credit requirement for successful completion of the B.Tech course is 124 credits

Semester Internship:

Please see the revised guidelines of the internship.

B.Tech Honors

IIIT-Raichur has provision for an Honors program that is designed to challenge the brighter and more ambitious students, without burdening an average student. Some salient features are listed below:

- A student can opt for Honors after the completion of the second year.
- The student should have a CGPA >= 8.0 (without any backlog) at the end of the fourth semester.
- The student must complete an additional 12 discipline credits.
- The student should have CGPA >= 8.0 (without any backlog) at the end of the eighth semester and should not have any backlog throughout the B.Tech course.

Probable list of CS Electives: Elective courses offered by the CSE department of IITH and following

1. Knowledge Representation and Reasoning
2. Machine Learning
3. Logic in Computer Science
4. Formal VerificationInformation Retrieval
5. Cyber Security
6. Cryptography (and Network security)
7. Big Data analysis and Applications
8. Introduction to Multi-Agent Modelling
9. Graphics and Multimedia
10. Data Mining and warehousing
11. Computational Geometry
12. Digital Image Processing
13. Soft Computing and evolutionary AI
14. Distributed Computing
15. High-performance computing
16. Cloud Computing
17. Human-Computer Interaction
18. VLSI System design
19. Wireless networks
20. Advanced Algorithms
21. Combinatorial Optimization

ANNEXURE 6

a. An introduction to approximation theory and optimization (MA305)

Objectives: Approximation theory and optimization techniques are extremely important in tackling real world problems. This course is expected to familiarize the students with the basics of this field of study.To have a general understanding of approximations and optimization, with an emphasis on computational algorithms

Prerequisites: Basic knowledge on projections, inner products and norms

Course Contents: Basic concepts related to best approximation and best coapproximation (in R^n and possibly in other important mathematical structures including matrices), their relations with orthogonality, elementary geometric visualizations of these concepts and their applications to some relevant real world problems from the perspective of optimization, basic computations related to best (co)approximations, including the problem of existence and uniqueness.

References:

1. Introduction to optimization by Pablo Pedregal, Springer, 1st Edition, 2004.
2. Approximation Theory and Approximation Practises, SIAM, 1st Edition, 2017.

b. Deep Learning with Graphs [3 credits]

How does the disease spread nationwide? How can we predict traffic or weather? Answering these questions requires massive amounts of data. Complex data can be represented as a graph of object relationships and interactions. Graph data structures can be ingested by algorithms such as neural networks to perform classification, clustering, and regression tasks.

Objectives

1) Course explores the computational, algorithmic, and modeling challenges of analyzing massive graphs from network science and deep learning perspectives.

2) By studying underlying graph structures, we will master machine learning and network science techniques that can improve prediction and reveal insights into massive networks' structural and dynamic properties.

By the end of this course, students will be able to:

· Distinguish between traditional deep neural networks and deep neural networks with graphs

· Identify opportunities in solving real world problems using Graph neural networks

· Implementation of Graph Neural networks for real-world data sets using PyTorch

Prerequisites

Linear algebra, probability, calculus, differential equations, and Python programming is necessary.

Course contents

Section 1: Graph theory, Basic concepts and definitions; Diameter, Path length, Clustering, Centrality metrics; Structure of real networks, Degree distribution, Power-laws.

Section 2: Models of network formation; The Erdos-Renyi random model, Scale-free model; Clustered models; Models of network growth, Preferential attachment; Small-world networks, community detection, Diffusion, Percolation, epidemic process on networks, dynamical systems

Section 3: Deep Neural Networks basics, Convolution Neural Networks, node embedding, Knowledge Graph Embedding

Section 4: Traditional Methods for ML on Graphs, Graph neural networks, applications of graph neural networks, theory of Graph Neural Networks, Difference between deep neural networks and Graph neural networks, Deep Generative Models for Graphs,

Section 5: Implementation of Graph Neural networks using PyTorch

Section 6: Case study on epidemic spreading and stock market time series data sets.

Tools: Cytoscape, Gephi, NetworkX, PyTorch, PyG: The ultimate library for Graph Neural Networks

References

Together with several research papers, we will cover specific chapters from the following textbooks:

- A-L. Barabási, Network Science, available online, 2015.
- M.E.J. Newman, Networks - An introduction, Oxford Univ Press, 2010.
- A. Barrat, M. Barthelemy and A. Vespignani, Dynamical Processes on Complex Networks, Cambridge Univ Press, 2008.
- Aaron Courville, Ian Goodfellow, and Yoshua Bengio, Deep Learning
- CS224W: Machine Learning with Graphs, Stanford University

c. Introduction to Quantum Machine Learning [3 credits]

The pace of development in quantum computing mirrors the rapid advances made in machine learning and artificial intelligence. It is natural to ask whether quantum technologies could boost learning algorithms: this field of inquiry is called quantum-enhanced machine learning. This course aims to show what benefits current and future quantum technologies can provide to machine learning, focusing on algorithms that are challenging with classical digital computers. We strongly emphasize implementing the protocols using open-source frameworks in Qiskit on Real Quantum Computers.

Objectives:

1) Understand the notion of quantum states and their evolution in closed/open systems and quantum measurements as a form of sampling.

2) Contrast quantum computing paradigms and implementations. Recognize the limitations of current and near-future quantum technologies and the kind of tasks where they outperform or are expected to outperform classical computers. Explain variational circuits.

3) Describe and implement classical-quantum hybrid learning algorithms. Encode classical information in quantum systems. Perform discrete optimization in ensembles and unsupervised machine learning with different quantum computing paradigms.

4) Summarize quantum Fourier transformation, quantum phase estimation, and quantum matrix, and implement these algorithms using Qiskit

By the end of this course, students will be able to:

· Distinguish between quantum computing paradigms relevant to machine learning

· Identify opportunities in machine learning for using quantum resources

· Implement learning algorithms on real quantum computers using Qiskit.

Prerequisites:

Linear algebra, probability theory, complex numbers, Python, and basic knowledge of machine learning will be advantageous for this course.

Course contents

Section 1: Classical Probability, Linear algebra, concepts of Bra-Ket and matrix notations, unitary matrix, Basics of Quantum Mechanics: Axioms of quantum mechanics, Quantum States, Mixed states, Evolution in Closed Quantum Systems, Open Quantum Systems, Tensor products of Hilbert space, Observables, Measurements (Projective Measurements), Dynamics.

Section 2: The Qubits, Multiple Qubits (Geometric representation of Qubits-Bloch Sphere), Bipartite quantum systems, Entanglement, Quantum logic gates and Quantum Circuit diagrams, Quantum Fourior transformation, Quantum error correction. Models of quantum computing (Gate-Model, Adiabatic Quantum Computing, Quantum Annealing)

Section 3: Basics of Machine learning, Quantum Fourier transform, Quantum Phase estimation, The HHL Algorithm, Quantum Linear Regression and Classification, Variational quantum circuits for machine learning

Section 4: Qiskit/Pennylane (Optimization purposes), Quantum Walks, Parameterized Quantum Circuit, Quantum neural networks

Section 5: Quantum machine learning projects using Qiskit/Pennylane

References

[1] Michael A. Nielsen and Isaac L. Chuang, Quantum Computation and Quantum Information, (http://mmrc.amss.cas.cn/tlb/201702/W020170224608149940643.pdf)

[2] John Preskill Lecture notes, https://www.lorentz.leidenuniv.nl/quantumcomputers/literature/preskill_1_to_6.pdf

[3] Quantum Machine Learning using Qiskit, https://learn.qiskit.org/course/machine-learning/parameterized-quantum-circuits

[4] IBM Online notes on Qiskit, https://qiskit.org/textbook/ch-states/introduction.html

[5] Access IBM Quantum Computer, https://quantum-computing.ibm.com/

[6] Quantum Machine Learning using Pennylane, https://pennylane.ai/

(d) Math Tools for Data Science & Machine Learning(MA304)

Prerequisite: Calculus I and II; Linear Algebra; Vector Calculus, An introductory course in Probability and Statisics.

Objective of the course is to provides a rigorous introduction to mathematical tools for the data science drawn from linear algebra, harmonic analysis, probability theory and convex optimization. The main topics are the Singular-value-decomposition (SVD), application of dimensionality reduction, Markov Chains, Random process, Newton's method, Norms, Basis and orthogonal projections. The material is motivated by multiple data-analysis applications including dimensionality reduction, sound and image processing.

Course Contents: **Unit I: Linear Algebra & Vector Calculus**

Vectors and Matrices and Basic operations, Vector spaces, Eigenvalues and Eigenvectors, Singular value decomposition (SVD), and application to dimensionality reduction, Gradient of vector-valued functions, Gradients of matrices, Useful identities for computing Gradients.

Unit II: Probability and Statistics

Basic probability, conditional probability, Bayes' rule, random variables, random vectors, Probability bounds, Markov Chains, Application to web search algorithms, Introduction to Random processes, and Some important random processes.

Unit III: Foundation of Statistical Learning

Basics of statistical learning, models, Linear regression, the curse of dimensionality, overfitting etc., optimization and convexity, Gradient descent, Newton's method.

Unit IV: Analytic Geometry

Norms, Inner Products. Lengths and Distances, Angles and orthogonality, Orthogonal Basis, Orthogonal Complement, Inner Product of functions, Orthogonal Projections.

Unit V: Dimensionality Reduction with PCA

Problem Setting, Projection Perspective, Eigenvector Computation and Low-Rank Approximation, PCA in high Dimensions.

References:

Advanced Engineering Mathematics by Erwin Kreyszig

Introduction to Linear Algebra by Gilbert Strang

Element of Statistical Learning by T. Hastie, Robert Tibshirani and J. Friedman.

Linear Algebra and Optimization for Machine Learning by Charu C Aggarwal.

Machine Learning by Murphy

An introduction to Probability theory and its applications by William Feller.

First Course in Probability by S. Ross.

6 (G) Expansion of a one credit course "Intro. of Probability" to a three-credit course "Intro. of Probability, Statistics and Random Processes".

Proposed Changes: The proposed changes to the course will include the following:

1. Adding additional course materials, such as readings and assignments, to provide students with a more in-depth understanding of the subject matter.
2. Incorporating hands-on activities to provide students with practical experience in the subject matter.
3. Increasing the amount of time sent in class to allow for more in-depth discussions and group work.
4. Increasing the number of credits for the course from 1 to 3.

Benefits: The benefits of expanding the course to a 3 credit will include:

1. Providing students with a more comprehensive understanding of the subject matter.
2. Allowing students to gain practical experience in the subject matter through hands-on activities
3. Giving students more opportunities to engage in in-depth discussions and group work.

IOP(1 credit) course syllabus: Sample space and events, definitions of probability, properties of probability, conditional probability. Random variables: distribution functions, discrete and continuous random variables, moments of random variables, conditional expectation, Chebyshev inequality, and functions of random variables. Special Distributions: Bernoulli, Binomial, Geometric, Pascal, Poisson, Exponential, Uniform, Normal distributions, Limit Theorems: Law of the large number

IOP (3 credits) course syllabus

Basic concepts such as random experiments, probability axioms, conditional probability, and counting methods for Single and multiple random variables (discrete, continuous, and mixed), as well as moment-generating functions, characteristic functions, random vectors, and inequalities, Limit theorems and convergence Introduction to mathematical statistics, in particular, Bayesian and classical statistics Random processes including the processing of random signals, Poisson processes, discrete-time, and continuous-time Markov chains, and Brownian motion.

References:

1. An introduction to Probability theory and its applications by William Feller.
2. First Course in Probability by S. Ross.
3. Introduction to Probabilty by D. Bertsekas. J. Tsitsiklis
4. The signal and the Noise: Why most Predictions Fail but SOme Don't
5. Intoduction to Probability by Joseph K. Blitzstein and Jessica Hwang