Honors in Smart Computing | **T. Y. B.Tech.**

Program: B.Tech. CSE in IoT and Cyber Security with Blockchain Technology | **Semester: VI**

Course: Cognitive Computing (DJ19ICCHN1C2)

Course: Cognitive Computing Laboratory (DJ19ICCHN1L2)

Pre-requisite:

1. Artificial Intelligence
2. Smart technologies

Objectives:

1. To understand the key concepts and principles of Cognitive Computing.
2. To apply training and testing procedures for language models for cognitive computing applications.
3. To integrate computer vision techniques with other cognitive computing methodologies.
4. To work with popular Cognitive Computing frameworks.

Outcomes: On completion of the course, learner will be able to:

1. Understand the fundamentals of Cognitive Computing.
2. Demonstrate understanding of techniques for text-based processing of natural language with respect to morphology.
3. Perform POS tagging for a given natural language and select a suitable language modelling technique based on the structure of the language
4. Check the syntactic and semantic correctness of sentences using grammars and labelling
5. Apply computer vision techniques to image classification and object detection.
6. Explore Cognitive Computing frameworks and tools and build applications using cognitive services.

Detailed Syllabus: (unit wise)		
Unit	**Description**	**Duration**
1	**Introduction to Cognitive Computing** Overview of Cognitive Computing, Cognitive Computing - Cognitive Psychology - The Architecture of the Mind, The Nature of Cognitive	**6**

	Psychology, Cognitive architecture, Cognitive processes, The Cognitive Modeling Paradigms, Declarative / Logic based Computational cognitive modeling – connectionist models, Bayesian models. Introduction to Knowledge-Based AI, Human Cognition on AI, Cognitive Architectures	
2	**Introduction to Natural Language Processing (NLP)** **Introduction to NLP:** Basic Knowledge and Grammar in language processing, Stages in NLP, Ambiguities and its types in English and Indian Regional Languages, Challenges of NLP, Applications of NLP. **Word Level Analysis:** Morphology Analysis –Survey of English Morphology, Inflectional Morphology & Derivational Morphology, Lemmatization, Regular Expression, Finite Automata, Finite State Transducers (FST), Morphological Parsing with FST, Lexicon Free FST Porter Stemmer. N–Grams, Unigrams/Bigrams Language Models, Corpora, Computing the Probability of Word Sequence, Training and Testing	**8**
3	**Syntax Analysis** Part-Of-Speech Tagging (POS) - Open and Closed Words. Tag Set for English (Penn Treebank), Rule Based POS Tagging, Transformation Based Tagging, Stochastic POS Tagging and Issues –Multiple Tags & Words, Unknown Words. Hidden Markov Model (HMM), Maximum Entropy, And Conditional Random Field (CRF). CFG: Derivations, Constituency, Phrase Structure and Dependency Structure	**7**
4	**Semantic Analysis and Pragmatics:** Lexical Semantics, Attachment for Fragment of English- Sentences, Noun Phrases, Verb Phrases, Prepositional Phrases, Relations Among Lexemes & Their Senses – Homonymy, Polysemy, Synonymy, Hyponymy, WordNet, Robust Word Sense Disambiguation (WSD), Lexical Disambiguation, Resolving Lexical Ambiguity, Lexical Ambiguity Resolution **Pragmatics:** Discourse –Reference Resolution, Reference Phenomenon, Syntactic& Semantic Constraints on Co Reference	**8**
5	**Computer Vision in Cognitive Computing** **Introduction to Computer Vision**: Basics of computer vision, Image representation and feature extraction **Applications in Cognitive Computing**: Image Classification and Object Detection, Building image classification models, Implementing object detection algorithms, Real-world applications in healthcare and industry	**6**
6	**Cognitive Computing Frameworks and Tools** Overview of Cognitive Computing Frameworks, Introduction to popular frameworks: Exploring available APIs and services, IBM Watson, Microsoft Azure Cognitive Services, Comparative analysis of frameworks, Building simple applications using Cognitive Services, Ethical considerations in using pre-built services	**4**
	Total	**39**

List of Laboratory Experiments: (Minimum any eight experiments)	
Sr. No.	**Suggested Experiments**
1	Preprocessing steps in NLP Chunking using NLTK and SPACY
2	Apply various other text preprocessing techniques for any given text : Stop Word Removal, Lemmatization / Stemming.
3	Perform morphological analysis and word generation for any given text.
4	Implement N-Gram model for the given text input.
5	Build a POS tagger using HMM
6	Compare the accuracy of rule-based POS tagging, stochastic POS tagging, and transformation-based tagging. Use a common dataset for evaluation.
7	Compare the effectiveness of syntactic and semantic constraints on reference resolution in a pragmatic context. Evaluate their contribution to resolving reference phenomena.
8	Implement TF-IDF vectors in Natural Language Processing
9	Generate recursive set of sentences using Context Free Grammar Identify the word senses using "synset" in NLTK
10	Similarity Detection in NLP
11	Implement Named Entity Recognizer for the given text input.
12	Create a basic chatbot using a framework and program it to answer questions or perform simple tasks
13	Understand and implement different image representation techniques and feature extraction methods.
14	Implement basic image classification techniques and evaluate model performance.
15	Train a deep learning model for image classification, such as identifying objects in images or distinguishing between handwritten digits
16	Implement and compare different object detection algorithms.
17	Develop a cognitive computing system that can recognize and classify objects in real-time using computer vision techniques.

Any other experiment based on syllabus may be included, which would help the learner to understand topic/concept.

Books Recommended:

Text Books

1. Hurwitz, Kaufman, and Bowles, Cognitive Computing and Big Data Analytics, Wiley, First edition, 2015

2 Masood, Adnan, Hashmi, Adnan, “Cognitive Computing Recipes-Artificial, Intelligence

Solutions Using Microsoft Cognitive Services and TensorFlow, 2015

3. Speech and Language Processing, 2 nd Edition, Jurafsky and Martin, Prentice Hall, 2000, ISBN: 0130950696

Reference Books

1. Peter Fingar, Cognitive Computing: A Brief Guide for Game Changers, PHI Publication, 2015

2. Gerardus Blokdyk ,Cognitive Computing Complete Self-Assessment Guide, 2018

3. Rob High, Tanmay Bakshi, Cognitive Computing with IBM Watson: Build smart applications using Artificial Intelligence as a service, IBM Book Series, 2019

4. Ayyadevara V K., Reddy Y, "Modern Computer Vision with PyTorch: Explore deep learning concepts and implement over 50 realworld image applications", Pakt Publishing, Kindle edition available,2020.

5. Manning C., Schutze H. (latest reprint). Foundations of Statistical Natural Language Processing, The MIT Press, Kindle edition available.

6. James Allen. Natural Language Understanding. The Benajmins/Cummings Publishing Company Inc. 1994. ISBN 0-8053-0334-0.

7. Hagiwara M. (MEAP 2019 - estimated pbl Summer 2021). Real-World Natural Language Processing: Practical applications with deep learning, Manning Publications.

8. Kamath U., Liu J., Whitaker J, "Deep Learning for NLP and Speech Recognition", Springer, Kindle edition available,2019.

Web resources

1. https://www.python.org/

2. https://pytorch.org/

3. https://www.tensorflow.org/

Online Courses: NPTEL / Swayam

1. Natural Language Processing, By Prof. Pawan Goyal, IIT Kharagpur, **https://onlinecourses.nptel.ac.in/noc24_cs39/preview**

2. Natural Language Processing with Deep Learning in Python **https://www.udemy.com/course/natural-language-processing-with-deep-learning-in-python/**

3. Natural Language Processing (NLP) - Python & NLTK by Udemy **https://www.udemy.com/course/nlp-natural-language-processing-with-python/**

Evaluation Scheme:

Semester End Examination (A):

Theory:

1. Question paper will be based on the entire syllabus summing up to 75 marks.
2. Total duration allotted for writing the paper is 3 hrs.

Laboratory

Oral and Practical examinations will be based on the entire syllabus

Continuous Assessment (B):

Theory:

1. Two term tests of 25 marks each will be conducted during the semester out of which; one will be a compulsory term test (on minimum 02 Modules) and the other can either be a term test or an assignment on live problems or a course project.
2. Total duration allotted for writing each of the paper is 1 hr.
3. Average of the marks scored in both the two tests will be considered for final grading.

Laboratory: (Term work)

Laboratory work will be based on **DJ19ICCHN1L2** with a minimum of 08 experiments

The distribution of marks for term work shall be as follows:

i. Laboratory work (Performance of Experiments): 15 Marks
ii. Journal documentation (Write-up and/or Assignments): 5 marks
iii. Attendance (Theory + Practical):5 Marks

The final certification and acceptance of term work will be subject to satisfactory performance of laboratory work, and upon fulfilling minimum passing criteria in the term work.

Prepared by Checked by Head of the Department Principal