

Suggested Teaching Guidelines for
Natural Language Processing & Computer Vision
PG-DAI February 2025

Duration: 40 Classroom hours and 60 Lab hours

Objective: To Introduce the students to Natural Language Processing & Computer Vision.

Prerequisites: Good knowledge of Python Programming and fundamentals of Artificial Intelligence.

Evaluation method: Theory exam–	40%
Lab Exam -	40%
Internal exam-	20%

List of Books / Other training material

Courseware:

Natural Language Processing, by Pushpak Bhattacharyya, Aditya Joshi / Wiley India, 2023

Reference Book:

1. The Big Book of NLP Techniques by Shlomo Vaknin
2. Theory and Practice of NLP Coaching: A Psychological Approach by Bruce Grimley

NLP (26 Hrs T + 44 Hrs L)

Session 1:

Lecture

Language in Cognitive Science

- Definitions of language
- Language as a rule-governed dynamic system
- Knowledge of language: Innateness of Grammar
- Language as a biological, social and psychological phenomenon
- Modes of language: spoken and written
- Language system as expression and content
- Language and symbolic systems: Artificial language (Logical language/programming Language) vs. Natural Language
- Linguistics as a scientific study

Session 2:

Lecture

Language Analysis and Computational Linguistics

Language Analysis:

- Paradigmatic and Syntagmatic relationship
- Form, Function and Meaning in Language Analysis
- Levels of Linguistic Analysis: Phonetics, Phonology, Morphology, Syntax,

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Semantics,

- Discourse, Pragmatics, Lexicology
- Artificial Intelligence (AI) and its sub disciplines
- Natural Language Understanding (NLU)
- Natural Language Generation (NLG)
- Natural Language Interaction (NLI)

Assignment: Difference between Semantics and Pragmatics

Session 3: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

Shallow Parsing and Tools for NLP

- Morphological Analysis
- Tokenization & PoS Tagging
- Chunking & Multi word expression (MWE)
- Named-Entity Recognition
- Lemmatizer & Stemming
- Morphological Synthesis
- Word Sense Disambiguation
- Universal Networking Language

Assignment: Apply tok , stemming , lemma, and POS tagging for following data
<https://www.kaggle.com/arushchillar/disneyland-reviews>

Session 4: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

Deep Parsing and Tools for NLP

- Syntactic Parsing Techniques and algorithms
- Semantic Parsing
- Information Extraction
- Automatic Summarization
- Anaphora Resolution, Pragmatics and Discourse analysis
- Ontology & Semantic Web

Session 5: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

Statistical Approaches

- Probability Theory & Models
- Discrete Time Models
- Markov Models, Entropy Models
- Statistical Parsing
- Text Categorization / Classification and Clustering
- Text Classification Using Support Vector Machine (SVM)
- Centroid based Classification

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Session 6: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

NLP with Machine Learning and Deep Learning

- Machine Learning & Deep Learning for NLP
- ML vs. DL along with respective algorithms names
- Linear Algebra Review
- ANN, RNN, CNN, DNN Long Short-Term Memory (LSTM)
- Gated Feedback Recurrent Neural Networks

Assignment: Difference between ANN, RNN and CNN

Session 7: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

Study of Important ML/DL Algorithms & Case Studies:

- Pre-processing
- Need of Pre-processing Data
- Introduction to NLTK, spaCy
- Using Python Scripts

Session 8: (2 Hrs of Theory + 4 Hrs of Lab)

- Introduction to gates, GRU and LSTM
- How LSTM and GRU resolves exploding and vanishing gradient problems

Assignment –Lab:

- Implement LSTM and GRU in python
- Sequence Modeling Lab
- Using Tensor Flow and python for music
- Generation using deep learning

Session 9: (2 Hrs of Theory + 4 Hrs of Lab)

- Sequence Modeling - Word representation
- word embedding matrix
- learning words and embedding's
- Sentiment classifications

Session 10: (2 Hrs of Theory + 4 Hrs of Lab)

Lecture

Word2Vec models (Skip-gram, CBOW, Glove, one hot Encoding)

- Sequence-to-sequence models (Seq2Seq) - GloVe: Global Vectors for Word representation
- Brief on Sequence-to-Sequence Models
- RNN based Sequence-to-Sequence Model
- Challenges
- Transformer in NLP

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- Understanding the Model Architecture
 - Getting Hang of Self- Attention
 - Calculation of Self-Attention
 - Limitations of the Transformer
- Transformer-XL oUsing Transformer for Language Modeling
- Using Transformer- XL for Language Modeling

Session 11: (2 Hrs of Theory + 4 Hrs of Lab)

- Bert in NLP
- Model Architecture
- BERT Pre-Training Tasks
- NLP Model Deployment Techniques using Flask

Session 12 & 13:

Speech Processing

- Articulatory Phonetics
- Speech Sounds and Phonetic Transcription
- Acoustic Phonetics
- Phonology
- Computational Phonology
- Digital Signal Processing Techniques
- Automatic Speech Recognition (ASR)
- Speech Recognition Approaches
- Text to Speech (TTS) system
- Speech Synthesis Approaches
- Language Models

Lab Session:

NLP Applications

- Lexicon, Dictionaries, thesaurus
- Transliteration, Spell Checker, Grammar Checker, Domain identification, Language identification
- Auto suggest/ Auto complete, Gender Prediction
- Machine Translation
- Neural machine translation
- Information extraction and Retrieval
- Question answering & dialogue agents
- Speech Technologies
- OCR, Hand Writing Recognition
- Indian Language Script Technology
- Language identification
- Auto suggest/ Auto complete, chat bots, Robotics

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Computer Vision (14 Hrs T + 16 Hrs L)

Session 14 & 15:

- Introduction to Computer Vision
- Computer Vision and Natural Language Processing
- The Three R's of Computer Vision
- Basics of Image Processing
- Vision Level – Low, Mid & High

Lab Assignments: Load any .jpeg image and process the image using Open CV

Session 16 & 17:

- Edge Detection, Interest Points and Corners
- Image Classification
- Recognition, Bag of Features, and Large-scale Instance Recognition
- Transfer Learning

Lab Assignments: Load any image and classify the image and implement the edge detection

Session 18: (2 Hrs of Theory and 4 Hrs of Lab)

- Alex Net,
- ResNet,
- Image Net

Lab Assignments: Implement AlexNet, ResNet and Image Net on the data sets.

Session 19 & 20:

Introduction to Object Detection Algorithms

- YoLo (High Level Overview)
- RCNN
- Fast RCNN
- Faster RCNN
- Mask RCNN

Lab Session

Applications of Computer Vision

- Gender Prediction
- Image Mapping
- Face / Object Recognition
- Image Recreation
- Image Matching