



BITS Pilani
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**BIRLA INSTITUTE OF
TECHNOLOGY & SCIENCE, PILANI
WORK INTEGRATED LEARNING PROGRAMMES**

COURSE HANDOUT

Part A: Content Design

Course Title	Natural Language Processing
Course No(s)	
Credit Units	3 units
Course Author	Prof. Vijayalakshmi and Dr. Chetana Gavankar
Version No	3.0
Date	6 th Jan 2020

Course Objectives

No	Course Objective
CO1	To learn the fundamental concepts and techniques of natural language processing (NLP)
CO2	To learn computational properties of natural languages and the commonly used algorithms for processing linguistic information
CO3	To apply NLP techniques in state of art applications
CO4	To learn implementation of NLP algorithms and techniques

Text Book(s)

T1	Speech and Language processing: An introduction to Natural Language Processing, Computational Linguistics and speech Recognition by Daniel Jurafsky and James H. Martin[3rd edition]
T2	Natural language understanding[2 nd edition] by James Allen

Reference Book(s) & other resources

R1	Handbook of Natural Language Processing, Second Edition—Nitin Indurkha, Fred J. Damerau, Fred J. Damerau
R2	Natural Language Processing with Python by Steven Bird, Ewan Klein, Edward Loper

Modular Content Structure**1. Introduction to Natural Language Understanding**

- 1.1 The Study of Language.
- 1.2 Applications of Natural Language Understanding.
- 1.3 Evaluating Language Understanding Systems.
- 1.4 The Different Levels of Language Analysis.
- 1.5 Representations and Understanding.
- 1.6 The Organization of Natural Language Understanding Systems.

2. N-gram Language Models

- 2.1 N-Grams
- 2.2 Evaluating Language Models
- 2.3 Generalization and Zeros
- 2.4 Smoothing
- 2.5 Kneser-Ney Smoothing
- 2.6 The Web and Stupid Backoff

3. Hidden Markov Models

- 3.1 Markov Chains
- 3.2 The Hidden Markov Model
- 3.3 Likelihood Computation: The Forward Algorithm
- 3.4 Decoding: The Viterbi Algorithm
- 3.5 HMM Training: The Forward-Backward Algorithm

4. Part-of-Speech Tagging

- 4.1 (Mostly) English Word Classes
- 4.2 The Penn Treebank Part-of-Speech Tag set
- 4.3 Part-of-Speech Tagging
- 4.4 HMM Part-of-Speech Tagging
- 4.5 Maximum Entropy Markov Models
- 4.6 Bidirectionality
- 4.7 Part-of-Speech Tagging for Morphologically Rich Languages

5. Grammars and Parsing.

- 5.1 Grammars and Sentence Structure.
- 5.2 What Makes a Good Grammar
- 5.3 A Top-Down Parser.
- 5.4 A Bottom-Up Chart Parser.
- 5.5 Top-Down Chart Parsing.
- 5.6 Finite State Models and Morphological Processing.
- 5.7 Grammars and Logic Programming.

5.8 Parsing

6. Statistical Constituency Parsing

- 6.1 Probabilistic Context-Free Grammars
- 6.2 Probabilistic CKY Parsing of PCFGs
- 6.3 Ways to Learn PCFG Rule Probabilities
- 6.4 Problems with PCFGs
- 6.5 Improving PCFGs by Splitting Non-Terminals
- 6.6 Probabilistic Lexicalized CFGs
- 6.7 Probabilistic CCG Parsing
- 6.8 Evaluating Parsers

7. Word sense and word net

- 7.1 Word Senses
- 7.2 Relations between Senses
- 7.3 WordNet: A Database of Lexical Relations
- 7.4 Word Sense Disambiguation
- 7.5 Alternate WSD algorithms and Tasks
- 7.6 Using Thesauruses to Improve Embeddings
- 7.7 Word Sense Induction

8. Dependency Parsing

- 8.1 Dependency Relations
- 8.2 Dependency Formalisms
- 8.3 Dependency Treebanks
- 8.4 Transition-Based Dependency Parsing
- 8.5 Graph-Based Dependency Parsing
- 8.6 Evaluation

9. Statistical Machine translation

- 9.1 Introduction
- 9.2 Approaches
- 9.3 Language Models
- 9.4 Parallel Corpora
- 9.5 Word Alignment
- 9.6 Phrase Library
- 9.7 Translation Models.
- 9.8 Search Strategies

10. Semantic web ontology

- 10.1 Introduction
- 10.2 Ontology and Ontologies
- 10.3 Ontology Engineering
- 10.4 Ontology Learning
- 10.5 State of the Art

11. Question Answering

- 11.1 IR-based Factoid Question answering
- 11.2 Knowledge-based Question Answering
- 11.3 Using multiple information sources: IBM's Watson
- 11.4 Evaluation of Factoid Answers

12 Dialogue Systems and Chatbots

- 12.1 Properties of Human Conversation
- 12.2 Chatbots
- 12.3 GUS: Simple Frame-based Dialogue Systems
- 12.4 The Dialogue-State Architecture
- 12.5 Evaluating Dialogue Systems
- 12.6 Dialogue System Design

13. Sentiment analysis

- 13.1 The Problem of Sentiment Analysis
- 13.2 Sentiment and Subjectivity Classification
- 13.3 Document-Level Sentiment Classification
- 13.4 Feature-Based Sentiment Analysis
- 13.5 Sentiment Analysis of Comparative Sentences

Learning Outcomes:

No	Learning Outcomes
LO1	Should have a good understanding of the field of natural language processing.
LO2	Should have an algorithms and techniques used in this field.
LO3	Should also understand the how natural language processing is used in Machine translation and Information extraction.

Part B: Contact Session Plan

Academic Term	
Course Title	Natural Language processing
Course No	
Lead Instructor	Dr. Chetana Gavankar

Course Contents

Contact session1	List of Topic Title (from content structure in Part A)	Topic # (from content structure in Part A)	Text/Ref Book/external resource
1	Introduction <ul style="list-style-type: none">• The Study of Language.• Applications of Natural Language Understanding.• Evaluating Language Understanding Systems.	Chapter1	T2

	<ul style="list-style-type: none"> • The Different Levels of Language Analysis. • Representations and Understanding. • The Organization of Natural Language Understanding Systems. 		
2	N-Grams Language models <ul style="list-style-type: none"> • Evaluating Language Models • Generalization and Zeros • Smoothing • Kneser-Ney Smoothing • The Web and Stupid Backoff 	Chapter 3	T1
4	Hidden Markov Models <ul style="list-style-type: none"> • Markov Chains • The Hidden Markov Model • Likelihood Computation: The Forward Algorithm • Decoding: The Viterbi Algorithm • HMM Training: The Forward-Backward Algorithm 	Appendix chapter A	T1
5	Part-of-Speech Tagging <ul style="list-style-type: none"> • (Mostly) English Word Classes • The Penn Treebank Part-of-Speech Tag set • Part-of-Speech Tagging • HMM Part-of-Speech Tagging • Maximum Entropy Markov Model • Bidirectionality • Part-of-Speech Tagging for Morphological Rich Languages 	Chapter8	T1
6	Grammars and Parsing <ul style="list-style-type: none"> • Grammars and Sentence Structure. • What Makes a Good Grammar • A Top-Down Parser. • A Bottom-Up Chart Parser. • Top-Down Chart Parsing. • Finite State Models and Morphological Processing. • Grammars and Logic Programming. • Parsing 	Chapter3	T2
7	Statistical Constituency Parsing <ul style="list-style-type: none"> • Probabilistic Context-Free Grammars 	Chapter 14	T1

	<ul style="list-style-type: none"> • Probabilistic CKY Parsing of PCFGs • Ways to Learn PCFG Rule Probabilities • Problems with PCFGs • Improving PCFGs by Splitting Non-Terminals • Probabilistic Lexicalized CFGs • Probabilistic CCG Parsing • Evaluating Parsers 		
8	Review of session 1 to session 7		
9	Dependency Parsing <ul style="list-style-type: none"> • Dependency Relations • Dependency Formalisms • Dependency Treebanks • Transition-Based Dependency Parsing • Graph-Based Dependency Parsing • Evaluation 	Chapter15	T1
10	Implementation using NLTK <ul style="list-style-type: none"> • Part of speech tagging • Build and draw parser tree • Implement parsing algorithm • Word sense disambiguation 		R2, Class Notes
11	Statistical Machine translation <ul style="list-style-type: none"> • Introduction • Approaches • Language Models • Parallel Corpora • Word Alignment • Phrase Library • Translation Models • Search Strategies 	Chapter 17	R1
12	Semantic web ontology <ul style="list-style-type: none"> • Introduction • Ontology and Ontologies • Ontology Engineering • Ontology Learning 	Chapter 24	R1 and class notes

	<ul style="list-style-type: none"> State of the Art 		
13	Question Answering <ul style="list-style-type: none"> IR-based Factoid Question answering Knowledge-based Question Answering Using multiple information sources: IBM's Watson Evaluation of Factoid Answers 	Chapter 25	T1
14	Dialogue Systems and Chatbots <ul style="list-style-type: none"> Properties of Human Conversation Chatbots GUS: Simple Frame-based Dialogue Systems The Dialogue-State Architecture Evaluating Dialogue Systems Dialogue System Design 	Chapter 26	T1
15	Sentiment analysis <ul style="list-style-type: none"> The Problem of Sentiment Analysis Sentiment and Subjectivity Classification Document-Level Sentiment Classification Feature-Based Sentiment Analysis Sentiment Analysis of Comparative Sentences 	Chapter 26	R1
16	Review of session 9 to session 15		

Evaluation Scheme

Evaluation Component	Name (Quiz, Lab, Project, Midterm exam, End semester exam, etc)	Type (Open book, Closed book, Online, etc.)	Weight	Duration	Day, Date, Session, Time
EC – 1	Assignment	Open book	20%		To be announced
EC – 2	Mid-term Exam	Closed book	30%	2 hours	To be announced
EC – 3	End Semester Exam	Open book	50%	2.5 hours	To be announced

Note - Evaluation components can be tailored depending on the proposed model.

Important Information

Syllabus for Mid-Semester Test (Closed Book): Topics in Weeks 1-8 (1-18 Hours)

Syllabus for Comprehensive Exam (Open Book): All topics given in plan of study

Evaluation Guidelines:

1. EC-1 consists of either two Assignments or three Quizzes. Announcements regarding the same will be made in a timely manner.
2. For Closed Book tests: No books or reference material of any kind will be permitted. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
3. For Open Book exams: Use of prescribed and reference text books, in original (not photocopies) is permitted. Class notes/slides as reference material in filed or bound form is permitted. However, loose sheets of paper will not be allowed. Use of calculators is permitted in all exams. Laptops/Mobiles of any kind are not allowed. Exchange of any material is not allowed.
4. If a student is unable to appear for the Regular Test/Exam due to genuine exigencies, the student should follow the procedure to apply for the Make-Up Test/Exam. The genuineness of the reason for absence in the Regular Exam shall be assessed prior to giving permission to appear for the Make-up Exam. Make-Up Test/Exam will be conducted only at selected exam centres on the dates to be announced later.

It shall be the responsibility of the individual student to be regular in maintaining the self-study schedule as given in the course handout, attend the lectures, and take all the prescribed evaluation components such as Assignment/Quiz, Mid-Semester Test and Comprehensive Exam according to the evaluation scheme provided in the handout.