# Intelligent Reasoning Systems

**Machine Reasoning**

Virtual Box (creating a virtual machine)

Orange (Front-end ML toolkit)

Knowledge, Learning and Reasoning

Fuzzy Logic

**Reasoning Systems**

Neo4j

Protégé (Ontology Knowledge Representation/Management tool)

Or-Tools (Optimization tool)

Excel-Solver (Optimization using GA)

Recommendation Systems (Association Rules, Content-based and Collaborative Filtering)

Collaborative Filtering libraries (demolib, surprise, implicit)

**Cognitive Systems**

Google Dialogflow (Chat Development)

# Pattern Recognition Systems

**Problem Solving Using Pattern Recognition**

Model Evaluation – ROC Curve, Gains/Lift Chart

Dimensionality Reduction – Feature Selection (Filter, Wrapper, embedded), Feature Extraction (PCA, LDA)

Clustering

**Pattern Recognition and ML Systems**

Weka (Front-end ML toolkit)

RBFNN, GRNN, SOM neural networks (Neupy python library)

Keras Functional API

Residual connections (e.g. ResNet)

**Intelligent Systems and Sense Making (Signals)**

Nyquist-Shannon theorem for choosing sampling rate of a signal

Peak Finding

Baseline Correction

Check similarity b/w signals using Dynamic Time Warping (DTW)

Signal Decomposition/Feature Extraction - Fourier Transform and Wavelet Transform

Classification of extracted signal features/values (Supervised – Naïve Bayes, Unsupervised – Expectation Maximization (EM))

# Intelligent Sensing Systems

**Vision Systems (Image Processing)**

Thresholding Operations

Edge Detection

Connected Component Analysis (label components in binary image)

Image Enhancement (Contrast, brightness adjustment) – Point Transformations, Histogram Techniques.

Image Restoration/Noise Reduction – Image Averaging (take average of >1 noisy images), Blur (Mean, Gaussian, Median Filter)

Sharpening

Interpolation of Signals

Object Detection - Viola-Jones algorithm (Haar Cascade in OpenCV), YOLOv3

Image Segmentation – Threshold Segmentation, Edge Detection Segmentation, Morphological Snakes

Feature Extraction from Images -LBP, HOG

Face Verification – Traditional Algorithms (LBP, HOG), Pre-trained CNN, Siamese Network

**Spatial Reasoning from Sensor Data**

Distance b/w Camera and Object (Stereo Camera Setting)

Distance b/w 2 Objects (Homography Transformation)

Image to Image Matchin/Place Recognition/Visual Odometry – Feature Extraction (SIFT, SURF, GIST etc.), Feature Encoding (BOW, VLAD)

Types of 3D image representations (RGB-D, Point Cloud, Volumetric etc.)

Object Detection (RCNN, Fast RCNN, Faster RCNN)

Point Cloud Representation – Sensor Used (LiDAR), Capture View (Bird View, Front-view), Object Detection (PointNet, PointFusion, MV3D, Frustum PointNet)

Semantic Segmentation

**Real-time Audio-Visual Sensing and Sense Making**

Motion Feature Extraction from Video

Object Tracking

Action Recognition

Audio Classification

Object Detection SSD

Pose Estimation

# Practical Language Processing

**Text Analytics (TA)**

Text Preprocessing

Term Document Matrix (TDM) based Features Extraction – Binary, TF, TFIDF

English Grammar Revision

POS Tagging

Shallow Parsing

Deep Parsing

Document Grouping – KMeans Clustering, LDA Topic Modeling

NER – Rule based, ML based

Corpus Annotation Reliability - self-agreement rate, inter-annotator agreement rate (Cohen’s Kappa score)

Regex

WordNet Corpus

**New Media and Sentiment Mining (NMSM)**

Sentiment Analysis – Rule-based, ML based, Aspect based

Word Embedding for ML based SA – Term Document Matrix (TDM) based, Word2Vec (CBOW, Skip-gram), GloVe, Co-occurrence Matrix + SVD

Types of rules for Rule-based SA

**Text Processing Using Machine Learning (TPML)**

Word2Vec (CBOW, Skip-gram)

Ngram CNN

RNN

Bidirectional RNN

ELMo (Bidirectional LSTM)

Seq2Seq with Attention

Transformer (Encoder-decoder)

Paragraph To Vector (doc looks within itself to generate its vector) - PV-DM, PVDBOW

Sentence to Vector (doc looks at other docs to generate its vector) – Skip thoughts, Quick thoughts, SentenceBERT, BertScore

Transformers (BERT, GPT, Encoder-decoder)

Different Decoding Methods for classification layer (Selection of token using probability score) - Greedy search, Beam search, Top-k sampling, Top-p sampling

**Conversational UIs (CNI)**

Components and capabilities of a Conversational UI

Design Conversational UI – determine screenwriter, create screenplay, create persona (system, user)

Evaluation of Conversational UI – PARADISE, SASSI, SSA

Types of Chatbot (Task Oriented, QA Oriented)

Task Oriented Chatbot -

* Intent Detection – Contextual BiLSTM, Attention-Bi-LSTM
* Slots Filling (NER) – Markov Model, HMM, MEMM, CRF, BiLSTM + CRF, CNN + BiLSTM + CRF
* Dialog State Tracking – Word based RNN, Neural Belief Tracker
* Dialog Policy - ML based
* Response Generation – Seq2Seq

FAQ based Chatbot (given previous bot and user utterances, select answer for new user utterance/ question)– Pattern based, Retrieval/similarity based, ML based advanced retrieval

Machine Reading Comprehension Chatbot (given paragraph, select answer for user utterance/ question) – Memory Network, DrQA, BERT

Audio Processing basics

Speech Synthesis (TTS) – Spectrogram Prediction Network (e.g. Tacotron 2) + Vocoder Network (e.g. Parallel WaveNet, FloWaveNet)

* Tacotron 2 = Spectrogram Prediction Network = Encoder-Decoder architecture = Convert character sequence to mel spectrogram
* Modified WaveNet = Convert mel spectrogram to speech

Speech Recognition (STT) - End-to-End models = Connectionist Temporal Classification (CTC), Listen Attend and Spell (LAS), RNN Transducer (RNN-T)

Speaker Verification – GMM-UBM, SVM-based, iVector-based