Abhinav JAIN
Research Engineer

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💼 PROFESSIONAL EXPERIENCE

JUL 2020
JUL 2019

STAFF RESEARCH SOFTWARE ENGINEER | IBM RESEARCH LABS, INDIA
DATA FOR AI, SCALING & AUTOMATING AI
Project Manager : HIMA PATEL
Description : Assess the quality of data using intelligently designed quality metrics and provide insights on fixing the issues to data scientists for improving the performance of Machine Learning models. It included detecting issues such as bias from multiple but synonymous values of categorical variables, redundant features etc. Services provided as part of IBM's **Data Readiness Toolkit**.
> Developed a **Feature Selection** framework that utilises Mutual Information to determine features' relevancy and redundancy in predicting the target variable.
> Developed a **Programming-by-Example** system to programmatically transform data into user-intended homogeneous formats. The system learns a transformation routine from few input-output example pairs showcasing the required string transformation task.
> Designed and tested following PbE systems for synthesizing transformation programs on Flash-Fill dataset : hand-engineered symbolic system and Reinforcement Learning based statistical system.

Symbolic System for Program Synthesis | Neural Program Synthesis | Feature Selection | Automated AI | PyTorch

JUL 2019
JUL 2017

RESEARCH ENGINEER | IBM RESEARCH LABS, INDIA
PDF DATA EXTRACTION AND REPRESENTATION, WATSON COMPARE & COMPLY
Project Manager : DR. SAMEEP MEHTA, DR. ARUN KUMAR
Description : For reliable structured data extraction from scanned PDF documents, provided following added functionalities to the existing Watson service for PDF conversion :
> Deep Learning based Page Segmentation using U-Net to extract text lines.
> Multi-lingual support for data extraction when language of the text is changed.
> Hybrid PDF support for data extraction when documents contain scanned and programmatic content.
> Framework for detecting logos, bar-codes and signatures using connected component analysis.
> Framework for extraction of Tables, PDF Headers using Object Detection algorithm RetinaNet *(Link)*.
> Quality improvement of low resolution document images (72-100 DPI) using SuperResolution techniques like SRCNN, ESPCNN, EDSR, LapSRN and SRGAN.

Text Image Processing | Tesseract | Gradle | OpenCV | Java

AUG 2016
MAY 2016

INTERN | IBM RESEARCH LABS, INDIA
COHERENT VISUAL DESCRIPTION OF TEXTUAL INSTRUCTIONS
Project Manager : DR. SAMEEP MEHTA
Description : Developed a multi-stage framework to provide visual aid for a sequence of text-based instructions in the form of coherent images for better comprehension of the text.
> Mined visualisable phrases consisting of head action verbs and noun phrases for each instruction using standard practices like POS tagging, Dependency parsing and Co-reference resolution.
> Retrieved a set of images for each visualisable phrase from sources such as WikiHow, Flickr.
> Maintained coherency across instructions sharing common information in the form of latent/non-latent entities using a graph based matching method utilising Dijkstra's algorithm.
> Conducted a user study to validate improvement in understanding of text instructions when phrases and images together dictate the action being conducted in the instruction.
🜄 github.com/jabhinav/Coherent-Visual-Description-of-Textual-Instructions

textToImage | Content Mining | Graph Matching | Convolutional Neural Networks | Python

💻 RESEARCH PROJECTS

VIDEO REPRESENTATION LEARNING FOR FINE-GRAINED SCENE RECOGNITION AND RETRIEVAL　　　　2018-19

 github.com/jabhinav/Deep-Video-Understanding

Objective : Recognise critical scenes of a video that raise user anxiety and are finely embedded in some parent activity.
- › Proposed an *order-preserving similarity metric learning* framework that uses relative dissimilarity to distinguish such fine-grained activities from rest of the temporally overlapping video event.
- › Designed a **4-input Siamese Network** with CNN+LSTM architecture as backbone to learn the feature representations.
- › Formulated **Pentuplet Loss** [3] and later on, a more robust **Radial Loss** [4] to learn the required similarity metric.
- › Achieved F1 of **63.15%** in Critical Clip Recognition and F1 of **88%** in the known task of shot-boundary detection.
- › Demonstrated the effectiveness of the loss in learning a deep metric for measuring similarities by showing an improvement of **10%** in Quadlet Precision and **5%** in NDCG over state-of-the-art baselines in the task of fine-grained video retrieval.

Deep Metric Learning　Event Recognition　Content Based Retrieval or Ranking　Shot Boundary Detection　CNN-LSTM Siamese Nets　Loss Formulation

DEEP LEARNING FOR DOCUMENT IMAGE QUALITY ENHANCEMENT　　　　2017-19

 github.com/jabhinav/Super-Resolving-Documents

Objective : Extract text from low-quality scanned document images with high token fidelity.
- › Formulated a novel **Text Quality Improvement Loss** for the standard Super-Resolution Convolutional Neural Network (SRCNN) that simultaneously optimises perceptual quality of the image and the OCR performance of Tesseract.
- › Proposed framework identifies text regions from images and minimizes additional MSE between such localised regions on top of the standard MSE, enforced by Single Image Super Resolution frameworks.
- › Achieved **92.13%** OCR Cosine Accuracy and **87.27%** OCR String Matching Accuracy on the UNLV dataset.

SRCNN for SuperResolution　Loss Formulation　OCR Boosting　UNLV Documents Dataset　Caffe

EDUCATION ENRICHMENT　　　　2017-18

 github.com/jabhinav/EducationEnrichment

Objective : In the absence of domain knowledge, help the readers avail a complete semantic understanding of formal texts such as journal articles composed of complex terminologies intended to be understood by targeted demographic.
- › Proposed an **enrichment system** [2] that mitigates the problem of searching for required information through heaps of sources and augments given text with required concept definitions, applications and concept dependency graphs.
- › Identified key-concepts via a sequence of filtering stages - Linguistic Filtering, BBC Pruning and StackExchange Pruning.
- › Identified missing information for a concept based on user discretion by classifying associated text into its definition, application using a CNN-LSTM network with F1 score of **92.83%** and **85.31%** respectively.

NLP　AI for Education　Sentence Classification　Information Extraction　Dependency Parsing

EVOLVING AI　　　　2017-18

 github.com/jabhinav/Model-Learning

Objective : Train a pre-trained image classification model for a new class with limited training data ('n' to 'n+1' class learning).
- › Formulated the concept of **Deep Part Embeddings** [5] which are sub-networks of neuron activation extracted from a trained network identifying a visual and distinguishable element of a class.
- › Designed a framework that identifies visual elements intuitively constituting the new class and extracts the corresponding DPEs from the network pre-trained for the classes sharing the identified visual element.
- › Studied and produced results for DPE integration under two configurations : (i) sequential, when DPEs are sourced from different CNN architectures and (ii) shared ; when DPEs are sourced from the same CNN architecture.
- › Achieved **superior performance** and **faster convergence** with fewer training samples per class (25, 50) on the subset of Caltech dataset against simple fine-tuning and end-to-end training of the network.

Few-shot learning　Knowledge Transfer　Model Learning　Deep Part Embeddings　CNN Visualisation　CNN Activation Filtering

☰ SKILLS

Programming Languages	**Python** *(Proficient)*, Java, C++, HTML, CSS
Deep Learning Frameworks	**PyTorch** *(Proficient)*, Keras *(Intermediate)*, Caffe *(Intermediate)*
Python Libraries	Numpy, AllenNLP, OpenCV
Development Platforms	**PyCharm** *(Proficient)*, IntelliJ Idea, Eclipse
Operating Systems	Mac OS, Windows, Linux Ubuntu

🏆 Awards and Achievements

2019 | **RDA, IBM Research Labs**
IBM's Research Division Award (RDA) for "Document Conversion and Table Understanding"

2019 | **Certificate of Appreciation, IBM Research Labs**
Certificate was issued in honour of my contributions to IBM Watson Compare & Comply project which led to significant business and research impact

2016 | **Best Poster Award, IBM Research Labs**
Achieved recognition for the best project presentation

2014-15 | **Academic Excellence**
Awarded for exceptional performance in academics at I.I.T Kanpur

2013 | **Joint Entrance Examination**
Secured **All India Rank 655** (amongst 150,000 students) in JEE-Advanced 2013

2012-13 | **Best All Rounder Award**
Awarded Student of the year in the senior year of high school for all-round excellence

📘 Publications, Demos And Tutorials

Dec'17 | [1] S Mujumdar, N Gupta, <u>A Jain</u>, S Mehta, "Coherent Visual Description of Textual Instructions," in *IEEE International Symposium on Multimedia (ISM)*.

Aug'18 | [2] <u>A Jain</u>, N Gupta, S Mujumdar, S Mehta, R Madhok, "Content Driven Enrichment of Formal Text using Concept Definitions and Applications," in *Proceedings of the 29th on Hypertext and Social Media* (HT).

Aug'18 | [3] N Gupta, <u>A Jain</u>, P Agarwal ,S Mujumdar, S Mehta, "Pentuplet Loss for Simultaneous Shots and Critical Points Detection in a Video," in *International Conference on Pattern Recognition (ICPR)*.

Apr'19 | [4] <u>A Jain</u>, P Agarwal, S Mujumdar, N Gupta, S Mehta, C Chattopadhyay, "Radial Loss for Learning Fine-grained Video Similarity Metric," in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*.

Apr'19 | [5] N Gupta, S Mujumdar, P Agarwal , <u>A Jain</u>, S Mehta, "Learning Convolutional Neural Networks with Deep Part Embeddings," in *IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP)*.

Sep'19 | [6] S Mujumdar, N Gupta, <u>A Jain</u>, D. Burdick, "Simultaneous Optimisation of Image Quality Improvement and Text Content Extraction from Scanned Documents," in *IEEE nternational Conference on Document Analysis and Recognition (ICDAR)*.

Jun'20 | [7] Contributor, Demo on Data Quality Assessment and Improvement, ACM SIGMOD 2020

Aug'20 | [8] Tutor, Tutorial on Overview and Importance of Data Quality for Machine Learning Tasks, KDD 2020

[9] Paper on Muti-Stage Framework to Boost OCR performance on Low Quality Document Images (Manuscript submitted for publication)

[10] Paper on Programming-by-Example for Data Transformation using Reinforcement Learning (Manuscript submitted for publication)

📘 Patents

2018 | **System and Method to Generate Dynamic Personalized Infographics (Under Review)**
A system is proposed to automatically generate info-graphics from floating social media trends, personalised to user interests with the help of unstructured data available across different online platforms like Facebook, Twitter, News etc. The generated info-graphics are personalized by specifying the visual and non-visual elements specific to the user such as sketch or cariacture view for the former and personalisation elements such as viewer age-group, emotions, sentiment, sarcasm etc. for the latter.

🎓 EDUCATION

JUN 2017 JUL 2013	**INDIAN INSTITUTE OF TECHNOLOGY**, KANPUR, INDIA BACHELOR OF TECHNOLOGY (B.TECH) IN ELECTRICAL ENGINEERING Cumulative Performance Index, CPI : **9.0/10.0**
APR 2013 APR 2012	**JAWAHARLAL NEHRU SCHOOL**, BHOPAL, INDIA ALL INDIA SENIOR SCHOOL CERTIFICATE EXAMINATION, AISSCE, CLASS XII Percentage : **91.8%**

🏛 ACADEMIC PROJECTS

Nov'16
Aug'16
	TOPIC MODELLING
	Supervisor : Dr. Gaurav Pandey, Dr. Piyush Rai, I.I.T KANPUR
	Course : UNDER-GRADUATE PROJECT
	  › Use Topic Modeling to discover underlying latent themes (topics, meta-topics) of Newsgroup Corpora.
	  › Analyse algorithms - Poisson Factor analysis (PFA), PFA with Sigmoid Belief Networks, Deep PFA (DPFA) and Discriminative-DPFA based on their formulation, underlying assumptions, performance on document label classification and prepare survey report with pros-cons of each.
	Topic Modelling Document classification Gibbs Sampling Probabilistic Machine Learning

Jul'15
May'15
	VISION BASED SURVEILLANCE AND TRACKING SYSTEM FOR UAVs
	Supervisor : Dr. N.K. Verma, I.I.T KANPUR
	Course : SUMMER PROJECT
	  › Implementation of vision based object tracking algorithms like Optical Flow Approach, Background Subtraction, Interest Point Tracking and Real-Time Compressive Tracking.
	  › Extensive real-time testing and comparison of the algorithms' robustness against the following factors - pose variation, illumination, occlusion, and motion blur.
	  › Integrated the best performing, Real-Time Compressive Tracking with UAVs for live demonstration.
	Unsupervised Algorithms Object Recognition and Tracking Computer Vision

Dec'16
Aug'16
	BAYESIAN OPTIMIZATION FOR HYPER-PARAMETER TUNING
	Supervisor : Dr. Purushottam Kar, I.I.T KANPUR
	Course : OPTIMIZATION TECHNIQUES
	  › Studied and compared Bayesian Optimization frameworks - Gaussian Process based and Deep Network for Global Optimization, DNGO.
	  › Demonstrated improvements offered during hyper-parameter tuning by Bayesian optimization over random selection and grid-search in the task of MNIST digit classification using sparse auto-encoders stacked with soft-max classifier.
	Gaussian Process DNGO Spearmint Bayesian Optimisation Matlab Python

📇 FUTURE COURSEWORK

Logic And AI
Deep Reinforcement Learning
Learning based Methods in Computer Vision
Designing AI to cultivate Human Well-Being
Representation Learning in Computer Vision

📇 COMPLETED COURSEWORK - IIT KANPUR

Data Structures and Algorithms	Signals, Systems & Networks
Probabilistic Machine Learning	Probability and Statistics
Introduction to Stochastic Processes	Image Processing
Partial Differential Equation	Visual Recognition
Online Learning and Optimization	Linear Algebra