

# ANURENDRA KUMAR

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## RESEARCH INTEREST

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Statistical Inference; Optimization; Machine Learning; Signal Processing; Computational Biology

## EDUCATION

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**Indian Institute of Technology, Kanpur**

M.Tech, *Electrical Engineering*

B.Tech, *Electrical Engineering*

Minors in *Artificial Intelligence, Linguistics*

*Jul '12 - May '17*

*GPA: 9.67/10*

*GPA: 8.0/10*

## RELEVANT COURSEWORK

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**Machine Learning and Algorithms:** Natural Language Processing\*; Probabilistic Machine Learning; Learning with Kernel; Computer Vision; Machine Learning; Data Structures and Algorithm; Principles of Computing

**Signal Processing:** Detection and Estimation Theory\*; Mathematical Methods in Signal Processing\*; Image Processing\*; Information Theory and Communication Systems; Topics in Signal and Image Processing; Digital Signal Processing

**Mathematics:** Convex Optimization\*; Probability and Statistics\*; Linear Algebra\* <sup>1</sup>

## RESEARCH EXPERIENCE

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**Dynamic Probabilistic Non-negative Matrix Factorization (DPNMF)** [\[Thesis\]](#)

*Jun'16 - May'17*

*Master's Thesis mentored by Prof. T. Guha, IIT Kanpur and Prof. P. Ghosh, IISc Bangalore*

The objective is to extend the existing NMF and *Probabilistic Latent Component Analysis* (PLCA) models used in acoustic modeling to exploit temporal dependence. Proposed a dynamic Dirichlet distribution as a prior distribution which is particularly suitable for non-negative data. Developed the solution with intuitive updates, which automatically reduces to the PLCA and NMF algorithms, when there is no temporal dependency. Proved the block-wise concavity of expected log-likelihood. Also, proposed the algorithm for source separation using the proposed DPNMF.

## PUBLICATION

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**A. Kumar**, T. Guha, P. Ghosh, 'A Dynamic Latent Variable Model for Source Separation', Int. Conf. on Acoustics, Speech and Signal Processing (ICASSP), Calgary, Apr 2018 . [\[Link\]](#)

L.Pandey, **A.Kumar**, V.Namboodiri, 'Monoaural audio source separation using variational autoencoders', Interspeech'18, Hyderabad, India . [\[Link\]](#)

**A.Kumar**, T.Guha, P.Ghosh, 'Dynamic Dirichlet Latent Variable Model', IEEE Trans. on speech and language processing (Minor revision). [\[Link\]](#)

## WORK EXPERIENCE

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**Research Associate** [\[Presentation\]](#)

*Aug'17 - Dec'17*

*Indian Institute of Technology Kanpur, India (Funding Agency; Indian Space and Research Organisation)*

Application-aware image quality evaluation aimed to develop a metric for quantifying the remote sensing image dynamics.

**Research Intern** [\[Presentation\]](#)

*Jun'17 - Aug'17*

*IBM research Bangalore, India (Cognitive Computing Platform & Infrastructure Division)*

Hierarchical sparse representation of Knowledge base(KB) – Developed an extension of translational embedding (TransE) model to learn the vector representation of entity and relations in KB. The proposed model could exploit the existing hierarchy in KB by imposing a tree structured hierarchy in latent dimensions. Proposed an iterative proximal gradient method which gave results similar to state of the art on 1 million entities from wikidata.

**Intern (Extreme Blue Internship Programme)** [\[Video\]](#)

*May'16 - Jul'16*

*IBM Bangalore, India*

Internet of Things (IOT) in Agriculture – Worked in a team to develop the prototype for precision agriculture in India. I took the charge of crop health monitoring from the *near infra red* (NIR) and RGB crop images and deployment of real sensors.

**Research Intern**

*May'15 - Jul'15*

*Samsung Research Institute, Delhi, India*

Latent variable models for object classification and annotation – Formulated the probabilistic framework for object classification and annotation. Learnt latent bases for each object as distribution of sparse SIFT features. Implemented the algorithm and achieved accuracy above 90% in classification.

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<sup>1</sup>\* denotes A grade

## TEACHING EXPERIENCE

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### Teaching Assistant, Convex Optimization, IIT Kanpur

Instructor: Prof. K. Rajawat

Jan'16 - Apr'16 & Jan'17 - Apr'17

### Teaching Assistant, Electronic Circuit Lab

Instructor : Prof. B. Mazhari

Aug'16 - Nov'16

## PROJECTS

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### Multiple Word Vector Embedding for polysemous words [\[Project Material\]](#)

Sep'15 - Nov'15

Natural Language Processing course project under Prof. A. Mukherjee, IIT Kanpur

- Extended word vector model to have multiple representations for polysemous words. Proposed two parametric and two non-parametric solutions. The solutions were evaluated on four evaluation metrics. Proposed solutions beat state-of-the-art in several specific cases.

### Automatic wheat grain quality estimation [\[Report\]](#)

Aug'16 - Nov'16

Best project in Image Processing course under Prof. T. Guha, IIT Kanpur

- Developed a proof-of-concept for quality estimation of grain from the image of a grain sample. Created a labeled data-set with the help of traders and farmers. Proposed a two-level segmentation method to segment overlapped grains which were further classified as grains/ impurities demonstrating the performance of proposed technique.

### Video segmentation [\[Project Material\]](#)

Jan'16 - Apr'16

Computer Vision course project under Prof. V. Nambodiri, IIT Kanpur

- Improved graph-based hierarchical segmentation in videos for both the online and offline segmentation. Proposed a preprocessing step which segments videos using shot transition detection. The proposed method performed better than state-of-the-art on all (four) evaluation metrics, for instance, *3D Undersegmentation Error*.

### Visual Odometry in Self-Driving Car [\[Project Material\]](#)

Sep'15 - Nov'15

Undergraduate project mentored by Prof. G. Pandey, IIT Kanpur

Developed and implemented visual odometry in self-driving car using opencv library in C++.

### Multiple Kernel Learning (MKL) [\[Project Material\]](#)

Sep'15 - Nov'15

Learning with Kernel course project under Prof. H. Karnick, IIT Kanpur

- Studied the theory behind multiple kernel learning and semi-infinite linear programming. Implemented and performed experiments to show that MKL automatically learns the efficient weighted distribution of multiple kernels and have the potential to handle data coming from heterogeneous sources.

### Diverse feature selection in Latent Variable models [\[Report\]](#)

Jan'16 - Apr'16

Probabilistic Machine Learning course project under Prof. P. Rai, IIT Kanpur

- To objective was to develop latent variable models to capture diverse topics/latent features. Reformulated maximum likelihood objective function of Probabilistic PCA and Matrix factorization as maximum a posteriori estimation. Used *determinantal point processes* and *mutual angular regularizer* as priors to incorporate diverse selection of latent features.

### Capacity maximization in Wideband Cognitive Radio Networks (CRN)

May'14 - Dec'14

Undergraduate project under Prof. K. Rajawat, IIT Kanpur

- Mathematically formulated the optimization problem for capacity maximization of *wideband* CRN inspired by the concept of *multiple input multiple output* (MIMO) beamforming. Majority of literature was dedicated to *narrowband* signals. Reformulated the non-convex problem as convex problem using convex optimization techniques and solved it.

### Unsupervised speaker diarization [\[Report\]](#)

Jan'16 - Apr'16

Selected Methods in Signal Processing course project under Prof. T. Guha, IIT Kanpur

- Implemented speaker diarization which solves the problem of speaker identification using speech data.

### Multi-objective Optimization and Pareto optimality [\[Report\]](#)

Sep'14 - Nov'14

Convex Optimization course project under Prof. K. Rajawat, IIT Kanpur

- Surveyed and implemented techniques to solve multi-objective optimization problems namely, *Method of Global Criterion* and *Normal Boundary Intersection*. Applied to cognitive radio networks in MIMO scenario.

## SCHOLASTIC ACHIEVEMENTS

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Best course project award in Image Processing.

Ranked in top 0.4% among 0.5 million candidates in IIT-Joint Entrance Exam 2012.

Received undergraduate scholarship (awarded on merit-cum-means basis) for three consecutive years at IIT Kanpur.

District rank 1, and among top 1% nationwide in Class XII (higher secondary) CBSE exam.