

# Pengyu (Steven) Kan

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## CONTACT INFORMATION

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## EDUCATION

### Johns Hopkins University

Sep. 2021 - Current

*Doctor of Philosophy in Computer Science.*

### University of Wisconsin, Madison

Sep. 2016 - May 2020

*Bachelor of Science in Computer Science, Mathematics and Economics. Certificate in Physics.*

*GPA : 3.99/4.0*

My research interests focus on deep learning and computer vision. I care about enhancing the generality, reliability, and robustness of high-dimensional feature representation in deep learning. Additionally, I am working on effectively leveraging multi-modal inputs to enhance the understanding capabilities of neural networks. This includes combining textual and image information for applications in object detection tasks. My current research is related to object detection and adversarial robustness.

## PUBLICATIONS

- [1] [Towards Diffeomorphism Invariant Convolution Neural Networks](#)  
**Pengyu Kan**, Rudrasis Chakraborty, Vishnu Suresh Lokhande, Vikas Singh  
*Differential Geometry in Computer Vision and Machine Learning workshop*. 2021.
- [2] [A Guided Latent Dirichlet Allocation Approach to Investigate Real-time Latent Topics of Twitter Data during Hurricane Laura](#)  
Sulong Zhou, **Pengyu Kan**, Qunying Huang, Janet Silbernagel  
*Journal of Information Science*. 2021.
- [3] [Application of Image Segmentation in Surface Water Extraction of Freshwater Lakes using Radar Data](#)  
Sulong Zhou, **Pengyu Kan**, Janet Silbernagel, Jiefeng Jin  
*ISPRS Int. J. Geo-Inf.* 2020, 9, 424.
- [4] [Conditional Gradient Optimizer](#)  
**Pengyu Kan**, Vishnu Lokhande  
*Tensorflow Addons*

## RESEARCH EXPERIENCE

### Transformer-based Masked Adversarial Defenses to Patch Attacks Sep. 2021 - July. 2023

- Advisor : [Prof. René Vidal](#)
- Studied adversarial robustness of attention mechanism and transformer-based architectures in image classification and object detection tasks
- Compared with convolution-based models, including ResNet and Faster-RCNN
- Designed Masked Adversarial Defenses with randomness specifically targeting adversarial patch attacks
- Achieved comparable adversarial robustness to state-of-the-art defenses, in a more efficient training process
- Reached competitive results in DARPA GARD project on CARLA object detection tasks  
[\[Pre-print\]](#)

### Diffeomorphism Invariant Layer for Neural Network

Aug. 2020 - May. 2021

- Advisors : [Prof. Vikas Singh](#) and [Dr. Rudrasis Chakraborty](#)
- Designed and implemented equiconv and invariant layers for Neural Network to handle diffeomorphism deformation in input images
- Applied over ResNet and ConvNet and tested on Fashion MNIST, CIFAR10, SVHN, STL10 and CelebA datasets
- Compared with baseline models, including the Spatial Transformation model, CPAB Spatial Transformation model and Rotational Equivariance CNN model
- Test accuracy outperformed baseline models in cases of small scale affine and homography deformation by around 10% on CIFAR10 and around 20% on STL10  
[\[Accepted DiffCVML 2021\]](#)[\[Published Paper\]](#) [\[Presentation\]](#)

## **Latent Dirichlet Allocation (LDA) Method for Analyzing Twitter Data on Disaster Management**

Aug. 2020 - Dec. 2020

- Collaborator : Dr. Sulong Zhou
  - Applied Natural Language Processing (NLP) and the LDA method to extract topic and situational awareness (SA) information from Twitter data during the 2020 Hurricane Laura
  - Proposed general workflow to access SA information from Twitter with four main steps, including data collection, preprocessing, LDA with guided approach and latent topic clusters
  - Used the NLTK package for data preprocessing, including tokenizing, removing stop words and lemmatizing
  - Evaluated the selected latent topics with the Coherence Value model and PyLDAvis Visualization tool
  - Found 7 main topics among these tweets and their temporal trends during the 10-day period of the Hurricane Laura
- [\[Published Paper\]](#) [\[Code\]](#)

## **Adversarial Deep Metric Learning**

April 2020 - Jan. 2021

- Advisors : [Prof. Earlence Fernandes](#) and [Prof. Somesh Jha](#)
  - Formulated adversarial attack toward Deep Metric Learning (DML) model
  - Addressed the issue of data dependence for the distance-based loss function for DML model
  - Tested robustness of traditionally trained and adversarial trained DML model toward PGD, FGSW, and Carlini & Wagner's attack on ResNet over CUB200, CARS196 and SOP datasets
  - Applied attacks separately targeting on the positive anchor points, positive data points and negative datapoints in the triplet loss for the DML
  - Observed weak robustness of traditionally trained DML model and higher accuracy of adversarial trained model under these attacks
  - Applied high dimensional Gaussian samples with our proposed adversarial trained model and embedded them into 2d space to illustrate the effect of adversarial training
- [\[Pre-print\]](#)

## **Frank Wolfe Method for Area Under ROC (AUROC) Problem**

Feb. 2020 - Aug. 2020

- Advisors : [Prof. Vikas Singh](#) and [Prof. Sathya N. Ravi](#)
- Reformed AUROC problem based on the Riemann sum and as a constrained saddle point optimization problem, under 1 - norm constraint for the Lagrangian multiplier
- Compared performance of Frank Wolfe method with conventional SGD solution toward this saddle point optimization problem over MNIST, CIFAR10, CIFAR100 dataset on ResNet, Deep CNN and Kernel method
- Observed higher AUROC score over the validation set by 0.04 on CIFAR10 and ResNet with using Frank Wolfe method than conventional SGD solution for this constrained saddle point problem
- Applied Block Frank Wolfe method and added calibration loss term to reduce the convergence gap between our proposed method and the conventional SGD solution

## **The Otsu Method for Water Imaging Classification**

Dec. 2019 - May 2020

- Collaborator : Dr. Sulong Zhou
  - Applied the Otsu Method on radar reading and satellite images to classify water
  - Tested on the radar values of the Poyang Lake over years to classify the water regions, with an evaluation accuracy of 91%
  - Analyzed the changing pattern of the freshwater area of Poyang Lake over years to help for freshwater resource preservation
- [\[Published Paper\]](#)

## **Conditional Gradient (CG) Optimizer**

March 2019 - Jan. 2020

- Advisors : [Prof. Vikas Singh](#) and [Prof. Sathya N. Ravi](#)
  - Implemented and contributed CG Optimizer with Frobenius norm and Nuclear norm to TensorFlow Addons Package
  - Provided an alternative optimizer for constrained optimization problems and alternative approach of regularization for deep learning, through considering hard penalty of constraints
  - Wrote tutorial for CG Optimizer on MNIST Dataset and compared its performance with SGD
  - Took responsibility of maintenance and improvement of the CG Optimizer
- [\[Documentation\]](#) [\[Conditional Gradient Optimizer\]](#) [\[Tutorial\]](#)

TEACHING EXPERIENCE	<b>Teaching Assistant, Johns Hopkins University</b>	Sep. 2023 - Present
	Computer Vision (601.661) : Assisted on students learning for computer vision ; provided lectures on introduction to transformer <a href="#">[Slides]</a>	
	<b>Peer Mentor, University of Wisconsin - Madison</b>	Sep. 2018 - May 2020
	Algorithms (CS 577) : Held office hours and explained concepts of Algorithms to students ; provided feedback on students' homework	
	Artificial Intelligence (CS 540) : Held office hours to explain concepts and ideas related to machine learning and provided examples for better understanding	
	<b>Academic Mentor, Center of Academic Excellence</b>	Sep. 2017 - May 2019
	Helped first - year minority students get used to college study ; Tutored college students with Java and object-oriented programming ; Provided extra coding exercises and examples from real life to improve students' interest	
	<b>Volunteer Tutor, AmeriCorps</b>	Sep. 2016 - May 2017
	Tutored high school students in Geometry and Algebra ; Provided weekly feedback of students success and adjusted challenge level of exercise	
AWARDS	Phi Beta Kappa Honor Society	2019
	UW-Madison Juli Plant Grainger Scholarship in Economics	2019
	UW-Madison Undergraduate Scholarship for Summer Study	2018, 2019
	UW-Madison Meek Bishop Scholarship in Economics	2018
	Mathematical Contest in Modeling 2018 Honorable Mention	2018
	Dean's List	2016 - 2019
	College of Letters & Science General Scholarship	2017
SKILLS		
	<i>Programming languages</i> : Python, Java, C++, C	
	<i>Deep learning framework</i> : PyTorch, Tensorflow	
RELEVANT COURSEWORK	<i>Languages</i> : English, Chinese	
	Machine Learning, Deep Learning, Computer Vision, Vision as Bayesian Inference, Non-linear Optimizations, Matrix Analysis, Bayesian Statistics, Monte Carlo Methods, Linear Programming, Algorithms, Numerical Analysis, Analysis, Number Theory, Stochastic Process	