Armstrong Aboah, Ph.D.

Portfolio: https://aboah1994.github.io/
Github: github.com/aboah1994

Email: aboah1994@gmail.com
Mobile: +1-931-284-7657
Google Scholar Citation: 147

Education

- **University of Missouri** — Columbia, USA
  Doctor of Philosophy (Ph.D.) — *January 2020 - December 2022*
  Research Areas: *Naturalistic Driving, Transportation Safety, Anomaly Detection, Internet of Things, NLP, Autonomous Vehicle*
- **Tennessee Technological University** — Tennessee, USA
  Master of Science (MSc) — *August 2018 - December 2019*
  Research Areas: *Transportation Planning, Transportation Safety, Ridesharing, Demand Modelling*
- **Kwame Nkrumah University of Science and Technology** — Kumasi, Ghana
  Bachelor of Science (BSc.) — *September 2013 - July 2017*
  Research Areas: *Structure Health Monitoring, Structure Design and Failure, Earthquake Analysis, Self-Compacting Concrete*

Research Interest

- **Transportation Planning**:
- **Intelligent Transportation Systems**:
- **Autonomous and Connected Vehicles**:
- **Big Data Analytics in Transportation**:
- **Travel demand modeling and forecasting**:
- **Transportation and Traffic Safety Research**:
- **Machine Learning**:
- **Computer Vision**:
- **Digital Twins and Smart Cities**:
- **Operations Research**:

Teaching Interest (This is not an exhaustive list of areas I can contribute)

- **Transportation Planning**:
- **Advanced Research Methods**:
- **Statics**:
- **Travel Demand Modeling**:
- **Traffic Safety**:
- **Pavement Design**:

Skills Summary

- **Softwares**: VISSIM, Synchro, SimTraffic, AutoCAD, Microstation
- **Languages**: Python, ReactJs, R, SQL, Matlab
- **Frameworks**: Scikit, NLTK, SpaCy,Pytorch, TensorFlow, Keras, Django, Flask, NodeJS, LAMP
- **Tools**: Kubernetes, Docker, GIT, PostgreSQL, MySQL, SQLite
- **Platforms**: Linux, Web, Windows, Arduino, Raspberry, AWS, GCP
- **Soft Skills**: Leadership, Event Management, Writing, Public Speaking, Time Management

Academic and Teaching Experience

- ***Postdoctoral Researcher (01/2023-Present): Northwestern University***: Human-in-the-loop machine learning. Utilizing eye-tracking data to understand the decision-making of different professionals including radiologists, drivers, etc.
- ***Graduate Research Assistant (01/2020-12/2022): University of Missouri-Columbia***: Conducted research in Naturalistic Driving Studies - developed algorithms necessary to extract driving events from gyroscope readings; improving vehicle perception-developed object segmentations models to segment vehicles, pedestrians, roadway, trees, etc.; improving pavement maintenance - led a team in developing deep learning framework to predict road roughness index; pavement detection and quantification - led a team in designing a multi-task deep learning framework for detecting and quantifying pavement distress; Traffic monitoring - led a team in developing a deep learning frame for real-time anomaly detections of vehicles on the road
- ***Graduate Teaching Assistant (01/2020-12/2022): University of Missouri-Columbia***: Lectured in tutorial classes, demonstrated laboratory experiments, and marked assignment copies
- ***Graduate Research Assistant (08/2018-12/2019): Tennessee Technological University***: Conducted research in Transportation Network Companies (TNC)-undertook a descriptive analysis of TNC users using data collected in the most recent US National Household Travel Survey (NHTS) conducted in 2017 to develop a national profile of TNC users; investigated alternative statistical models in their ability to predict how often a person uses TNC Apps daily.
- ***Graduate Teaching Assistant (08/2018-12/2019): Tennessee Technological University***: Lectured in tutorial classes, demonstrated laboratory experiments, and marked assignment copies
- ***Graduate Teaching Assistant (08/2017-08/2018): Kwame Nkrumah University of Science and Technology***: Lectured in tutorial classes, demonstrated laboratory experiments, and marked assignment copies.

Industrial Work Experience

- **HDR Inc.** In-person
  Machine learning/ITS Intern (Internship) *May 2022 - August 2022*
  - **Grant Writing**: Helped with grant summary writing.
  - **Computer Vision Application**: Began a project of developing an automated pipeline for segmenting satellite images for the installation of fiber optics using UNET as my base architecture model
  - **Utility Pipes Project**: Developed a machine learning model to predict the state of a utility pipe- whether it is going to be dirty or not.
- **Felucca AI** Remote
  Research Scientist (Freelancer) *Dec 2021 - June 2022*
  - **Data Annotation**: Developed an end-to-end pipeline for data annotation.
  - **Problem Formulation**: Formulate research problems with regards to data collection for autonomous vehicles.
  - **Model Building**: Training state-of-art object detection models on custom datasets.

Research Projects

- **Traffic Anomaly Detection (Computer vision)**: In this project, we developed a framework for detecting traffic anomalies in video data. The proposed methodology relies on an augmented annotation pipeline that pre-annotates the training dataset using an object detection model trained on the COCO dataset. Annotations are subsequently used to build a vehicle detection model using the YOLOv5 network. Next, we estimate the background of each traffic video by computing the median of frames randomly sampled from a uniform distribution over a thirty-second period. Vehicle detections on extracted backgrounds are classified as anomaly candidates. Factors such as vehicle detection size, likelihood, and road feature masks were used to construct a decision tree to eliminate false anomalies. The start and end of an anomaly were computed by superimposing detections from anomaly candidates and their foreground detections.
- **Pavement Roughness Estimation-IRI (Deep Learning)**: The primary objective of this project was to develop a model to quickly and accurately determine the IRI values of road sections at a cheaper cost. In this project, I developed a smartphone app to collect road surface data at a cheaper cost. Also, I utilized other variables such as speed and gyroscope information in addition to the vertical acceleration information to increase the accuracy of determining IRI values of road sections.
- **Traffic Signal Performance Evaluation for Vulnerable Road Users (Machine Learning)**: This project has 2 main objectives: 1) to categorize pedestrians into subcategories in order to address their safety requirements at intersections; 2) to estimate the time required to cross an intersection and determine whether the pedestrian can safely cross within the pedestrian signal time allotted at intersections. The objectives were accomplished using data collected from three Ouster digital LiDAR sensors installed at an intersection in Chattanooga, Tennessee. The data was collected over a period of 3 hours. The datasets contain pedestrian and signal phase data. The LiDAR dataset included information about the physical characteristics of pedestrians such as their speeds, positions, directions, and size. The study defined heuristics to subclassify the pedestrian and evaluated the accuracy of the sub-classification using machine learning models. The study also carried analysis to determine if pedestrians were able to cross the intersection or not during the pedestrian allocated time.
- **Machine Learning Framework for Real-Time Assessment of Traffic Safety Utilizing Connected Vehicle Data (Machine Learning)**: the study proposes a framework that involves utilizing disaggregate vehicle trajectory data from connected vehicles deployed within the transportation network. This framework defines a process for extracting different variables from a high-resolution data source and exploring their potential application as useful signals for detecting potential safety-critical situations.
- **Artificial intelligence-enabled traffic monitoring system (Computer Vision)**: A novel approach to automatically monitor real-time traffic footage using deep convolutional neural networks and a stand-alone graphical user interface
- **Automated Retail Checkout (Deep Learning)**: In this project, we developed a framework specifically for automatic retail checkout. The proposed methodology relies on first building a robust object detection model using YOLOv5. Next, our pipeline identifies a region of interest (ROI) in every video by initially estimating the background of the video (i.e., computing the median of frames randomly sampled from a uniform distribution over the entire duration of the video), followed by ROI identification using adaptive thresholding. A selected ROI is then passed through a custom-trained YOLOv5 model for detection. The detections made within the ROI are further tracked using the DeepSORT algorithm. Finally, the time an object is first detected within the ROI is computed by finding the ratio of the frame number to the video frequency rate, thereby giving us precise time measurements of an object's first sighting within the ROI.
- **Vehicle Detection & Tracking (Computer Vision)**: In this project I developed a vehicle detection model using YOLO v5 and Deepsort for tracking. The tasked involved annotating 1000s of images and training the state-of-art single-stage object detection model yolov5 with the custom dataset. Tech: Python, Pytorch, Pandas
- **Anomaly Detection (Computer Vision)**: Developed a traffic anomaly detection model using deep learning-powered with a decision tree. Tech: Python, YOLO v5, Pytorch, & OpenCV.
- **Next Word Prediction (Natural Language Processing)**: The goal of this project is to use transformer models to predict the next word or a masked word in a sentence. The transformer model is a type of neural network architecture that has been shown to be highly effective in natural language processing tasks such as language translation and language understanding. In this project, the transformer model will be trained on a large corpus of text data using a technique called masked language modeling. In this technique, a portion of the words in the input sentence are randomly masked and the model is trained to predict the original word based on the context of the remaining words in the sentence. Tech: Python, Pytorch, Transformer.

- **Speech & Emotion Recognition (NLP, Computer Vision)**: The goal of this project is to develop a convolutional neural network (CNN) model to classify various speech files into different emotions. The model will be trained on a dataset of speech files that have been labeled with different emotions such as happy, sad, angry, neutral, etc. Tech: Python, Pytorch, CNN
- **CamVid Project(Computer Vision, Naturalistic Studies)**: The goal of the CamVid project is to develop a deep learning model for multiclass semantic segmentation using the Unet architecture. The CamVid project is a computer vision project that focuses on naturalistic studies, which aims to develop models that can understand the visual world in the same way that humans do. The project's goal is to develop a model that can segment an image into different classes of objects, such as cars, pedestrians, buildings, etc. Tech: Python, Pytorch, CNN, Unet
- **3D Image Reconstruction(Computer Vision)**: The goal of this project is to perform a 3D reconstruction of Google Street View images for direct distance measuring using computer vision techniques. 3D reconstruction is the process of creating a 3D model of an object or a scene from 2D images. In this project, the focus is on reconstructing 3D models of buildings and other structures from Google Street View images. Tech: Python, Pytorch
- **Bus Routing Problem**: The goal of this project is to use ArcGIS Pro and ArcPy to develop a bus routing system for St. Louis City. The bus routing problem is a problem of determining the most efficient routes for buses to take in order to serve the needs of the community. This problem is especially challenging for large cities like St. Louis where there are many different neighborhoods, destinations and routes to consider. Tech: ArcGIS, Arcpy
- **Covid-19 Sentiment Analysis (NLP)**: is a project that aims to understand and analyze the emotions and opinions expressed in text data related to the Covid-19 pandemic. This can be done by using various techniques such as text classification, sentiment analysis, and topic modeling.
- **Text Generation (NLP)**: Built a Markov chains function that creates a dictionary for text generation.
- **DeepInsight (NDS)**: the study develops an end-to-end pipeline for automatic, frame-by-frame labeling of NDS videos into various driving events by using vehicle telemetry data. To achieve this goal, we formulated the problem as a time series segmentation and classification problem. The segmentation task was achieved by developing a novel segmentation algorithm that utilizes the principle of energy-maximization to detect the start and end of any driving event.
- **Disease Classification (Computer vision)**: In this work, we propose GazeGNN, a novel gaze-guided graph neural network to do the disease classification in a unified representation graph that models both the image and gaze pattern information jointly. In the GazeGNN, the images are split into many patches which are viewed as nodes, then a graph is built by connecting the nearest neighbors. Raw gaze information of each patch is appended in each node. Our experiments on the chest X-ray dataset MIMIC-CXR show that our proposed method exhibits high efficiency and superior performance compared to existing methods.
- **GazeSAM (Computer vision)**: This study we investigated the potential of eye-tracking technology and the Segment Anything Model (SAM) to design a collaborative human-computer interaction system that automates medical image segmentation. We present the **GazeSAM** system to enable radiologists to collect segmentation masks by simply looking at the region of interest during image diagnosis. The proposed system tracks radiologists' eye movement and utilizes the eye-gaze data as the input prompt for SAM, which automatically generates the segmentation mask in real time. This study is the first work to leverage the power of eye-tracking technology and SAM to enhance the efficiency of daily clinical practice. Moreover, eye-gaze data coupled with image and corresponding segmentation labels can be easily recorded for further advanced eye-tracking research. .
- **Eye Detection (NDS and Computer Vision)**: Developed a deep learning model to detect the eye positioning of drivers while driving in a naturalistic driving environment using Yolov5 for detection and deepsort for tracking.
- **Weather Prediction**: Developed an LSTM model to perform a multiclass classification of weather.
- **Accident Analysis**: Developed a machine learning model to understand the various causes of vehicle crash.
- **Road Incident Detection**: Developed a deep learning model to detect various road incidents in Missouri

Refereed Publications

J-14. **Aboah, A.**, Adu-Gyamfi Yaw, Anuj Sharma et al. (2023): "Driver Maneuver Detection and Analysis using Time Series Segmentation and Classification", **ASCE Journal of Transportation Research Part A.**
Impact Factor: 2.19

J-13. **Aboah, A.**, & Adu-Gyamfi, Y. (2020). Smartphone-Based Pavement Roughness Estimation Using Deep Learning with Entity Embedding. **Advances in Data Science and Adaptive Analysis, 12(03n04), 2050007.**
Impact Factor: 0.8

J-12. **Aboah, Armstrong**, Michael Boeding, Yaw Adu-Gyamfi (2022). Mobile Sensing for Multipurpose Applications in Transportation. **Journal of Big Data Analytics in Transportation.**
Impact Factor: 1.23

J-11. **Aboah, Armstrong**, Michael Boeding, Yaw Adu-Gyamfi (2022). Mobile Sensing for Multipurpose Applications in Transportation. **Journal of Big Data Analytics in Transportation.**
Impact Factor: 1.23

J-10. Shoman, M., **Aboah, A.**, & Adu-Gyamfi, Y. (2020). Deep learning framework for predicting bus delays on multiple routes using heterogenous datasets. **Journal of Big Data Analytics in Transportation, 2(3), 275-290.**
Impact Factor: 1.23

J-9. **Aboah, Armstrong**, Daniel Badoe(2021). Factors Influencing the Use of Transportation Network Company Apps Based on US National Household Travel Survey Data. **Transportation Research Board. (TRB)**

J-8. **Aboah, Armstrong**, Elizabeth Arthur, Yaw Adu-Gyamfi (2021). A New Benchmark Dataset For Pavement Distress Detection And Severity Analysis. **Transportation Research Board. (TRB)**

J-7. Maged Shoman,**Aboah, Armstrong**, Yaw Adu-Gyamfi (2021). Evaluation of Connected Vehicles Data for Congestion and Incident Detection. **Transportation Research Board. (TRB)**

J-6. Maged Shoman,**Aboah, Armstrong**, Yaw Adu-Gyamfi (2021). Development and Visualization of Winter Severity Impact using Multisource Data. **Transportation Research Board. (TRB)**

J-5. **Aboah, Armstrong**, Bin Wang, Ulas Bagci, Yaw Adu-Gyamfi (2023). Real-time Multi-Class Helmet Violation Detection Using Few-Shot Data Sampling Technique and YOLOv8. **In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (CVPRw)**.
Impact Factor: 45.17

J-4. **Aboah, Armstrong**, Ulas Bagci, Yaw Adu-Gyamfi (2023). DeepSegmenter: Temporal Action Localization for Detecting Anomalies in Untrimmed Naturalistic Driving Videos. **In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (CVPRw)**.
Impact Factor: 45.17

J-3. **Aboah, A.**(2021): Vision-based system for traffic anomaly detection using deep learning and decision trees. **In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (pp. 4207-4212) (CVPRw)**.
Impact Factor: 45.17

J-2. **Aboah, A.**, Shoman, M., Morehead, A., Duan, Y., Daud, A., & Adu-Gyamfi, Y. (2022). A Region-Based Deep Learning Approach to Automated Retail Checkout. **In Proceedings of the IEEE/CVF Conference on Computer Vision and Pattern Recognition Workshop (pp. 3210-3215) (CVPRw)**.
Impact Factor: 45.17

J-1. Bin Wang, **Aboah, Armstrong**,Ulas Bagci. " GazeGNN: A Gaze-Guided Graph Neural Network for Disease Classification". **International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)**.

Conference Presentation

P-7. Pavement Distress Detection Using YOLOv5. (DSPS 2023)

P-6. Region-Based Deep Learning Approach to Automated Retail Checkout. (CVPR 2022)

P-5. Vision-based system for traffic anomaly detection using deep learning and decision trees. (CVPR 2021).

P-4. Factors Influencing the Use of Transportation Network Company Apps Based on US National Household Travel Survey Data (2021).

P-3. A New Benchmark Dataset For Pavement Distress Detection And Severity Analysis (TRB 2021)

P-2. Evaluation of Connected Vehicles Data for Congestion and Incident Detection(TRB 2021)

P-1. Development and Visualization of Winter Severity Impact using Multisource Data (TRB 2021)

Papers Under Review

R-4. Bin Wang, **Aboah, A.**, Zheyuan Zhang, Ulas Bagci (2023): "Gazesam: What you see is what you segment".arXiv preprint arXiv:2304.13844

R-3. Shoman, M., **Aboah, A.**, Daud, A., Adu-Gyamfi Yaw (2022): "GC-GRU-N for Traffic Prediction using Loop Detector Data", IEEE Transactions on Intelligent Transportation System.
Impact Factor: 6.49

R-2. **Aboah, Armstrong**, Michael Boeding, Yaw Adu-Gyamfi (2022). Mobile Sensing for Multipurpose Applications in Transportation. Journal of Big Data Analytics in Transportation.
Impact Factor: 1.23

R-1. Ashkan Behzadian, Tanner Wambui Muturi, **Aboah, Armstrong**, Yaw Adu-Gyamfi (2022). The 1st Data Science for Pavements Challenge.

Funded Research Grants

G-1. Sponsor: Federal Highway Administration
Title: "MIMIC – Multidisciplinary Initiative on Methods to Integrate and Create Artificial Realistic Data"
Amount:$1,073,255
Contribution: 2%
Duration: 2020 - 2022

Supervised Students

Undergraduate

G-1. Blessing Agyei Kyem (Co-advised with Russell Afrifa)

G-2. Eugene Denteh (Co-advised with Russell Afrifa)

G-3. Gideon Amedume (Co-advised with Russell Afrifa)

Masters

G-1. Daud Abdulateef (Co-advised with Adu-Gyamfi Yaw)

G-2. Neema Owor (Co-advised with Adu-Gyamfi Yaw)

Honors and Awards

- Outstanding PhD Student Award at the University of Missouri, 2022.
- Won first place in the ITS Heartland Annual Conference poster competition 2022 - January, 2022.
  Amount : $800.00
- Won first place in the ITS Heartland Annual Conference poster competition 2021 - November, 2021.
  Amount : $800.00
- Led a team that placed 4th in the 2022 AI city challenge organized by IEEE.
- Led a team that placed 5th in the 2021 AI city challenge organized by IEEE.
- Won second place in CMITE Students poster presentation.
- Best Teaching Assistant - Ghana Engineering Student Association Awards (2017/2018 Academic Year)
- Outstanding Departmental President - Ghana Engineering Student Association Awards (2016/2017 Academic Year)
- Excellent Student Award - College of Engineering Provost Award (2016/2017 Academic Year)
- Excellent Student Award - College of Engineering Provost Award (2015/2016 Academic Year).
- Excellent Student Award - College of Engineering Provost Award (2014/2015 Academic Year).

Volunteer Experience

- **Computer Vision Tutorials** — Columbia, USA
  Organized a free computer vision tutorials for everyone interested in the summer. — *Jun 2021 - August 2021*

- **Mentoring High School Students for National Science and Math Quiz** — Accra, Ghana
  Mentor, teach, and prepare High School Students for the National Math and Science Quiz — *Jun 2013 - Present*

Journal Reviews

- **TRB**: Artificial Intelligence Committee (10 reviews)
- **IET Image Processing**: Jan 2021 - Present (3 reviews)
- **ASCE Journal of Transportation Research Part: System**: Jan 2022 - Present (5 reviews)