

Labeled imagery used to train model for road surface detection, Carly Sutter, *UAlbany*

WINTER WEATHER CAMERA PROJECT

Winter weather causes extreme hazards on roadways that are challenging for meteorologists to predict and for federal departments to address. In New York, the topographical diversity of the state and severity of winter weather events create transportation issues that may not be anticipated until they're observed in real-time. Using road imagery provided by over 2,400 camera stations scattered across New York state, AI2ES researchers from University at Albany's Atmospheric Sciences Research Center (ASRC) and University of Oklahoma's School of Computer Science aim to predict road hazards caused by winter weather using AI. The two institutions work closely with the NY Department of Homeland Security and Emergency Services, as well as the NY Department of Transportation, to develop an operational AI model that can mitigate risks caused by roadway hazards through camera imagery detection.

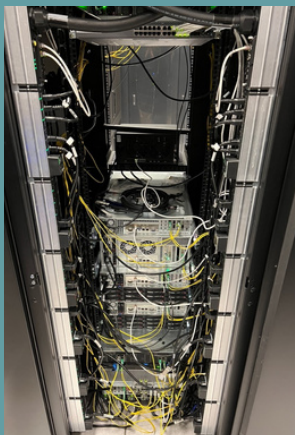
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MODEL DEVELOPMENT

UAlbany and OU's collaborative project began with collecting camera imagery from the Department of Transportation, specifically from the New York State Mesonet system. This network of 126 stations across the state collects atmospheric data for stakeholders such as UAlbany's ASRC. Dr. Kara Sulia, research associate at ASRC and Co-PI for the AI2ES Winter Weather project, notes that their experience working with the Department of Transportation on the Mesonet system provided a wealth of images for ASRC researchers to label based on road conditions. Currently, images are captured every 5 minutes, a speed made possible by UAlbany lead software engineer Arnoldas Krurbanovas; his establishment of a 100-terabyte image archive will allow researchers to "run machine learning models and edit at an extremely fast pace" once their models are operationalized. The task of "going through and manually labeling those images" is essential, according to UAlbany graduate student Carly Sutter, as the classification of roadway imagery informs how well the predictive model will eventually "generalize to unseen images." Images of New York roads are labeled as dry, wet, or snow-covered before training the project's CNN model for predictive accuracy.

Researchers from the OU School of Computer Science joined the Winter Weather project to help build and train a functional CNN model based on UAlbany's labeled images. Vincent Ferrera, an REU participant at OU, began training the institution's CNN model on the labeled imagery from UAlbany during Summer 2022. "The datasets we have all come from University at Albany," acknowledges Dr. Dimitris Diochnos, assistant professor at OU. OU's use of the data varies widely along different ML strategies to improve model accuracy and automation. Jay Rothenberger, a graduate student at OU School of Computer Science, describes how they are "working on lesser-used techniques of ML... to produce beneficial results" for problems such as the model's current reliance on labeled data. His goal in this collaborative project between OU and UAlbany is now to "train many models and compare their performances on data (they) haven't seen yet," particularly unlabeled and real-time data from the NYS Mesonet camera system.



Computer nodes and flash storage servers maintained by Arnoldas Kurbanovas,
UAlbany

RISK COMMUNICATION

While labeling the images used to train their current CNN model, researchers at UAlbany consulted with the Risk Communication team for clear guidance on accurate image labeling standards. Led by Carly Sutter, the interdisciplinary team worked together to refine a convergent approach to developing training data for supervised machine learning models. The interdisciplinary team working on the image labeling codebooks includes Sutter, Vanessa Przybylo, and Aaron Evans from UAlbany, as well as Christopher Wirz, Mariana Cains, and Jacob Radford from the National Center for Atmospheric Research (NCAR). “The general idea is that we’re using a method from communication research, which we call quantitative content analysis, to make hand labeling more consistent and transparent,” said Wirz, a postdoc on the risk communication team at NCAR. When discussing this process, Sutter emphasized the importance of “intercoder reliability”, so that all the coders on her team are labeling images consistently and reliably. The goal is to increase the accuracy of coding across the team and provide more transparency about the coding process, which helps in “building a fundamentally trustworthy dataset.” To achieve intercoder reliability, Sutter looked to codebooks crafted by the Risk Communication team for a different precipitation detection project led by Przybylo, which outlined carefully the rules for labeling images collected by the NY Department of Transportation camera system. UAlbany’s continued communication with the Risk Communication team allows Sutter and other researchers to test “(their) performance against each other” and “see how reliable (they) are in labeling their images.” These measures taken to provide intercoder

reliability between labeled images allows researchers at OU and UAlbany to train their predictive models with consistency and accuracy from their beginning stages. The next step in using unlabeled imagery is easier to achieve once the models can reliably detect roadway hazards based on Sutter and other’s labeled datasets. Wirz also added that “this approach also helps with the reproducibility and replicability of the machine learning model because it provides clear documentation and instructions for how the images were coded for training the model.”

COLLABORATION AND FUTURE PROGRESS

The efforts of both institutions towards this Winter Weather project is proving fruitful in both model accuracy and the benefits reaped by each team member from their collaboration across universities and research centers. Recently, OU was able to reach about 90% prediction accuracy after several rounds of training and adjustment to the current CNN model. Each institution boasts differing expertise, with UAlbany providing the meteorological knowledge necessary for image labeling, OU designing a progressive CNN model from their experience with machine learning projects, and the risk communication postdocs from NCAR bringing social science expertise. The combination of strengths from these fields allowed team members to learn from each other throughout the project’s development in the past two years. “I’ve been involved in a lot of collaborative projects,” Dr. Sulia recalls, “and by far, this is the most successful in terms of spending time and sharing knowledge.” The teams continue to confer in bi-weekly “Camera Work” meetings, where the next steps of the predictive model are planned. Though they are still in the testing phase of the model’s construction, Sutter and other researchers hope to one day apply their current work towards a model that is “as operational as possible across the U.S.” for improved safety against winter weather hazards.

RECENT AWARDS FOR AI2ES STUDENTS

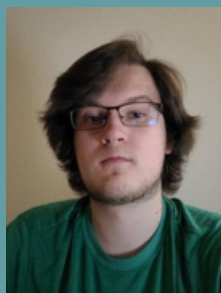
AI2ES students and associated researchers were very successful at AMS and AGU! We congratulate the award winners listed below as well as everyone who presented their research!

AMS Annual Meeting 2023



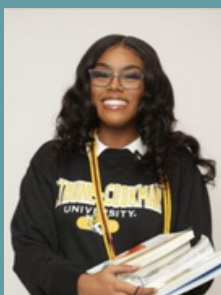
Bethany Earnest received second place in the AMS AI Student awards for her oral presentation: "Examining the Role of the Wildfire Triangle in Predicting Wildfire Occurrence for CONUS with the U-net3+ Model."

<https://ams.confex.com/ams/103ANUAL/meetingapp.cgi/Paper/419373>



Andrew Justin received first place in the AMS AI Student awards for his oral presentation: "Operational Analysis of Frontal Boundaries using U-Nets."

<https://ams.confex.com/ams/103ANUAL/meetingapp.cgi/Paper/420321>



Miranda White received first place in the AMS AI Student awards for her poster presentation: "AI Ensemble Predictions for Cold Stunning Events in the Shallow Laguna Madre."

<https://ams.confex.com/ams/103ANUAL/meetingapp.cgi/Paper/418860>

AGU Fall Meeting 2022



Marina Vicens-Miquel received an Outstanding Student Presentation Award (OSPA) for her presentation: "Generalized Model for Wet/Dry Shoreline Detection and Total Water Level Elevation Using Deep Learning."

<https://agu.confex.com/agu/fm22/meetingapp.cgi/Paper/1092757>

STUDENT SPOTLIGHT

The 2023 AMS AI conference elicited many phenomenal research presentations from AI2ES, three of which earned Student Awards in both oral and poster categories. For Miranda White, Coastal Marine System Science PhD student and CBI AI2ES graduate researcher attending Texas A&M University - Corpus Christi, the esteem of her first-place poster presentation is secondary to the purpose of her appearance at AMS. White credits her success to the practice of converging fields that she engages with daily as an AI2ES researcher. The presentation "AI Ensemble Predictions for Cold Stunning Events in the Shallow Laguna Madre" demonstrates the intersections of AI, environmental sciences, and risk communication that Miranda White champions while researching for the Cold-Stunning project at TAMU-CC. "I love to prepare for my presentations. I'm trying to make sure that I'm conveying and specifying what I really want my message to be," White enthuses, describing her process in preparing for a high-visibility event like the AMS AI conference. "Coming out of my poster, I knew that I had some really interesting results and a very interesting conceptual design," referencing the project's AI ensemble aimed to predict cold-stunning events in South Texas. To effectively demonstrate her research, Miranda White borrows from experiences with risk communication as an emerging tool within the AI community.

White did not immediately recognize risk communication as her field of interest upon entering a university setting. Graduating from Bethune–Cookman University with a B.S. and M.S. in Integrated Environmental Science, her experiences from implementing natural infrastructure in residential areas along the Indian River Lagoon coastline in Florida revealed that a lot of the skills she acquired from her prior research “were in parallel with risk communication.” White’s Master’s thesis required her to integrate several science practices to assess benefits of living shorelines, all while using social science methods to communicate her research with the local community. This process of creating useful and digestible studies now inspires White’s work with the AI2ES Cold-Stunning project. The 16 stakeholder groups involved in her research rely on both model accuracy and communicability of the model outputs to reduce harm to endangered sea turtles affected by cold-stunning events. While “the emphasis of our research is to provide accurate and reliable results,” White uses her interdisciplinary knowledge to present the research in an accessible manner for broader audiences. “Especially when predicting natural hazards and threats that can impact so many people,” it is crucial to ask, “How do I communicate with my stakeholders that this is happening and not just say ‘Well, the Mean Absolute Error of the model is this?’” White practices careful consideration for accessibility in most situations where research needs to be communicated, whether speaking to the Coast Guard or judges at the AMS AI conference. Her success this January is confirmation that she improves with each presentation!



Miranda
White
PhD Student/
Graduate
Researcher
TAMUCC
CBI AI2ES

NEWS AND OPPORTUNITIES

The 32nd Conference on Weather Analysis and Forecasting (WAF) and 28th Conference on Numerical Weather Prediction (NWP) will be held jointly with the 20th Conference on Mesoscale Processes during 17–21 July 2023 in Madison, WI. They are currently accepting abstracts for the conference until March 10, 2023. <https://tinyurl.com/yc4tezya>

Florida Tech is hosting the Statistical Models with Applications to Geoscience (SMAG) REU summer program from May 15 to July 8, 2023. Students from meteorology, math, environmental science, and computer science can apply until March 19, 2023.

<https://tinyurl.com/htj8c6n4>

The Coastal Bend Bays Foundation will host a Coastal Issues Forum on March 6, 2023, from 5:30–7:00 PM in the Del Mar Center for Economic Development, room 117. The theme “Graduate Students to Present About Cutting-Edge Coastal Environmental Research” features PhD students Miranda White and Marina Vicens–Miquel presenting their recent research. Tune in to the livestream at CBI AI2ES’s Facebook page: <https://tinyurl.com/2p83exnk>

Congratulations to Postdoctoral Researchers Randy Chase and Vanessa Przybylo as they venture away from AI2ES into their respective careers! We hope to see them again with many more successes to share.

Q&A

Test out the newest AI “Answers” tool for Google Sheets and explore other data sets below!

Google Sheet- <https://tinyurl.com/3p47j3db>

Tutorial- <https://tinyurl.com/2p9xhbaj>

For more discussion, visit the AI2ES Slack #newsletter channel!

Submit another question for a chance at appearing in next month’s newsletter.

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