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NSF

A Software-Defined Sensor Network
Cyberinfrastructure for AI@Edge Computing

AI at the Edge

Pete Beckman: Co-Director Northwestern University / Argonne Inst. for Science and Engineering
Collaborators: Ilkay Altintas, Nicola Ferrier, Rajesh Sankaran, Charlie Catlett, Scott Collis,, Eugene Kelly, Jim Olds, Mike Papka, Dan Reed, Sean Shahkarami, Joe Swantek, Valerie Taylor, Doug Toomey, Frank Vernon, Rommel Zulueta, and many more….

Northwestern University
THE UNIVERSITY OF CHICAGO
Northern Illinois University
UIC UNIVERSITY OF ILLINOIS CHICAGO
Argonne NATIONAL LABORATORY
Colorado State University
UC San Diego
GEORGE MASON UNIVERSITY
THE UNIVERSITY OF UTAH
SAGE sagecontinuum.org
ARRAY of THINGS
ARM
neon National Ecological Observatory Network
HPWREN SDSC SAN DIEGO SUPERCOMPUTER CENTER
LINCOLN PARK ZOO FOR WILDLIFE. FOR ALL.
OHAZ

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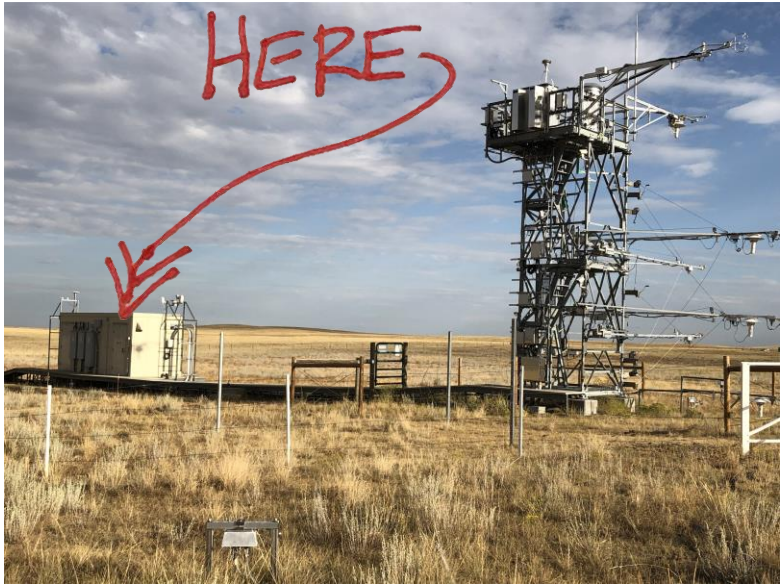
Sage: An AI@Edge Research Infrastructure

AI@Edge	Methodology	Sites
Motion Detector (V)	Background subtraction and Dense Optical Flow [C]	**U**
Motion Analysis (V)	Random Decision Forest [C]	**G**, **N**
Smoke and Fire Detection (I)	SmokeyNet DNN [F]	**N**, **R**
Solar Irradiance (I)	pvlib [D]	**U**, **G**, **O**
Cloud Cover (I)	U-Net [P]	**G**, **H**, **N**, **O**, **T**, **U**
Cloud Motion (V)	Phase Correlation [C]	**G**, **H**, **N**, **O**, **T**, **U**
Weather Classification (I)	Gradient Boosting Tree [X]	**M**
Traffic State (V)	YOLO V7 and Sort [P]	**U**
Object Counter (I)	YOLO V7 [P]	**G**, **H**, **N**, **O**, **T**, **U**
Water Depth Estimation (I)	U-Net [P]	**N**
Surface Water Detection (V)	DeepLab v2 and ResNet 101 [P]	**G**
Surface Water Classification (I)	ResNet50 [P]	**U**
Avian Diversity (A)	BirdNET DNN ResNet [F]	**G**, **H**, **N**, **O**, **T**, **U**
Sound Event (A)	VGG based YAMNet DNN [F]	**G**, **H**, **N**, **O**, **T**, **U**

Framework: [D]=Pandas, [K]=Keras, [C]=OpenCV, [P]=PyTorch, [F]=TensorFlow, [X]=XGBoost
Sites: **M**=ARM, **G**=GLIFWC, **H**=HPWREN, **N**=NEON, **O**=OHAZ, **R**=Rural, **T**=TNC, **U**=Urban
Data:(I)=Image, (A)=Audio, (V)=Video

Put AI@Edge HERE



Analyse full resolution data, find highest value data for the science

New kind of **National AI Cyberinfrastructure**
* High-quality, resilient, well-documented software
* Supports PyTorch, OpenCV, TensorFlow, Kubernetes, Docker, etc.

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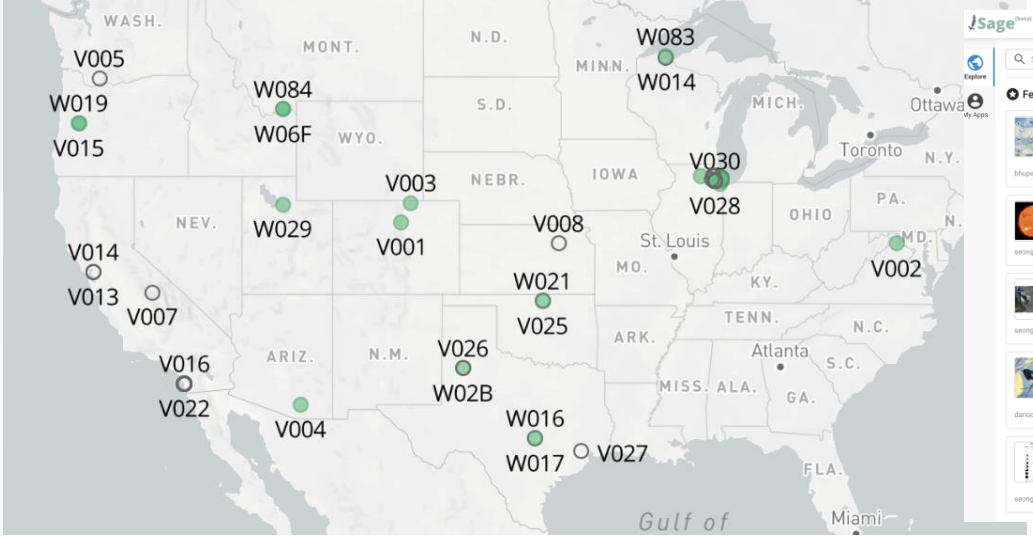
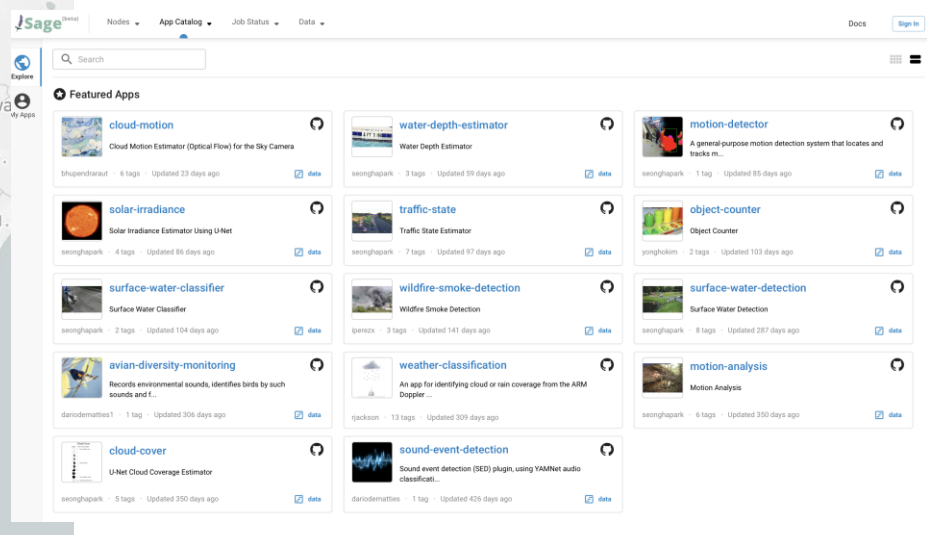
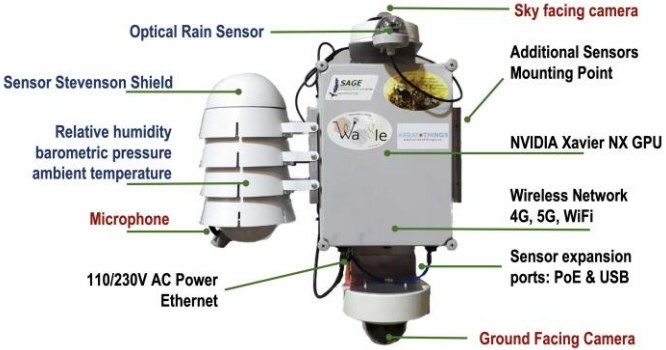
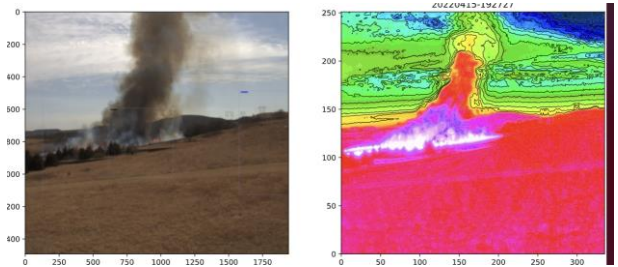




Sage Co-PI: Eugene Kelly, Colorado State
eugene.kelly@colostate.edu

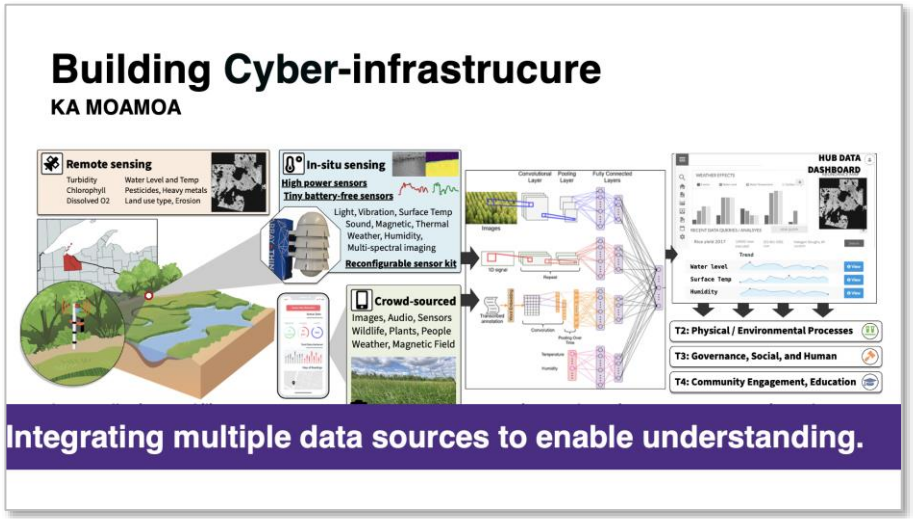
NEON Mobile Deployment Platform (MPD) with Sage Konza Prairie for controlled burn: April 2022.



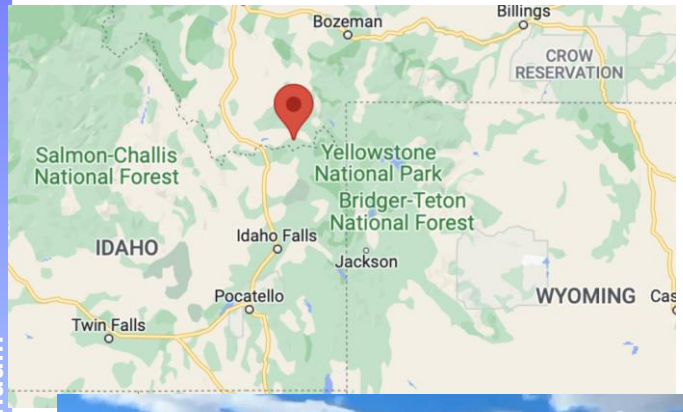


NSF Coastlines and People

Strengthening Resilience of Manoomin, the Sentinel Species of the Great Lakes, with Data-Science Supported Seventh Generation Stewardship
PI: Josiah Hester



Jonathan Gilbert, Biological Services Director, Great Lakes Indian Fish & Wildlife Commission (GLIFWC)



Wild Sage Node Deployment: University of Utah's Taft-Nicholson Center in Montana

Motivated by the success of the Konza burn, we are deploying more Sage towers.

Sensors: *Sage node with cameras, microphone, TPH, precipitation, dust and thermal camera.*

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Questions?

Join us!

- **Participate in next Hackathon**
- **Deploy nodes, write AI@Edge code**
- **Develop AI algorithms @ Edge!**

Getting started with Sage! - https://docs.sagecontinuum.org
Sage AI@Edge Apps - https://portal.sagecontinuum.org/apps/explore
Sage Data - https://portal.sagecontinuum.org/data
Sage Konza MDP Campaign - https://mdp.sagecontinuum.org
Overall Sage system status - https://admin.sagecontinuum.org/status
Waggle Github - https://github.com/waggle-sensor
Sage Continuum Github - https://github.com/waggle-sensor

Professors Aaron Packman and William Miller, Northwestern University
Gensburg-Markham Prairie, The Nature Conservancy
Photo Credits: Liliana Hernandez-Gonzalez, Northwestern University
Dec 2015

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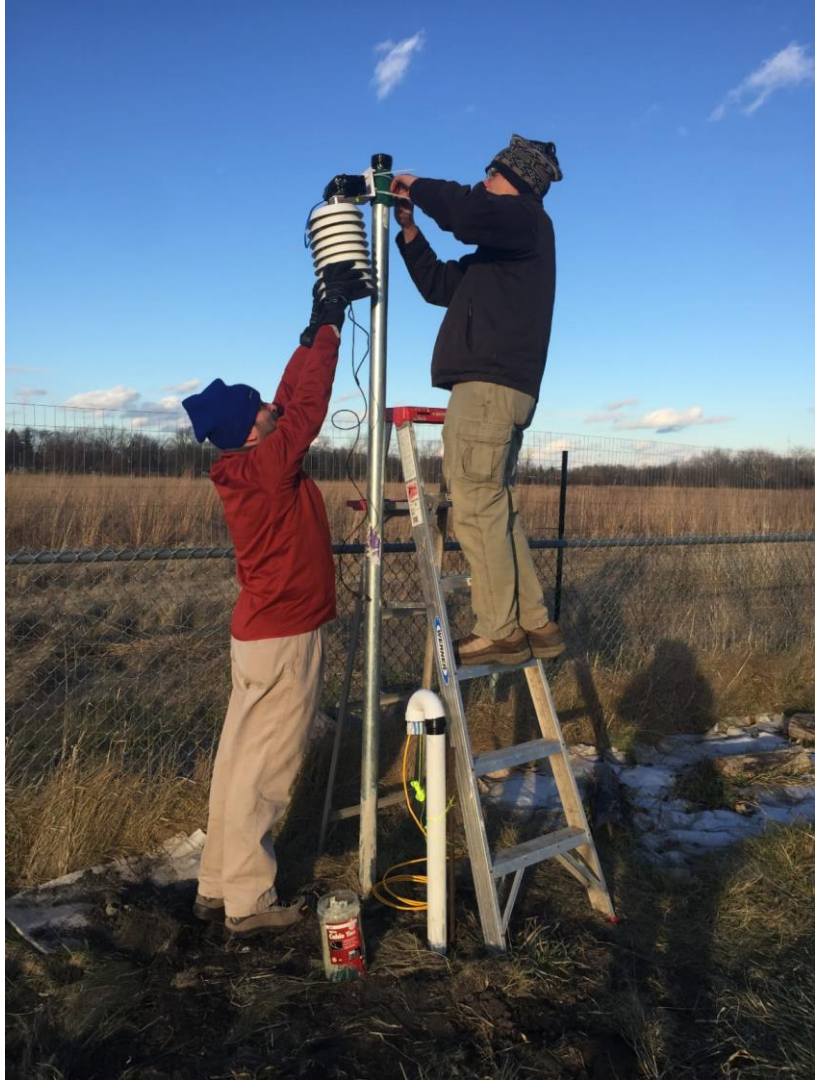

Backup Slide

AI Science for Students…

- Measuring river depth against graduated marker
- Auto-steering of PTZ cameras based on local AI
- Measuring snow depth against graduated marker
- Measuring vegetative states, growth rates
- Self-supervised learning: IR, LiDAR, audio, and RGB
- Vehicle types and flow speeds
- Quantify flower blooming (color, count)
- Outlying conditions from previous sensor data
- Calculating biodiversity based on audio
- Measuring surface water coverage
- Measuring lightning via RF (software defined radios)
- Measuring visibility across a field
- Measuring rime ice thickness
- Measuring ice coverage on a large body of water
- Measuring water flow speed
- Classifying wildlife behaviors
- Improved wildfire detection algorithms
- Wildlife tracking in open fields (speed, direction, count)
- Ultrasonic bat detection
- Measuring pedestrian movement dynamics
- Measuring land changes (riverbeds, plant coverage)
- Measuring water turbidity, debris movement, floating waste
- Measuring vehicle dynamics: identification of sliding, crashes, mishaps
- Measuring bike usage, bike lane dynamics
- Identifying urban "near misses"
- Measuring bird flocks and dynamics