



SAGE
sagecontinuum.org

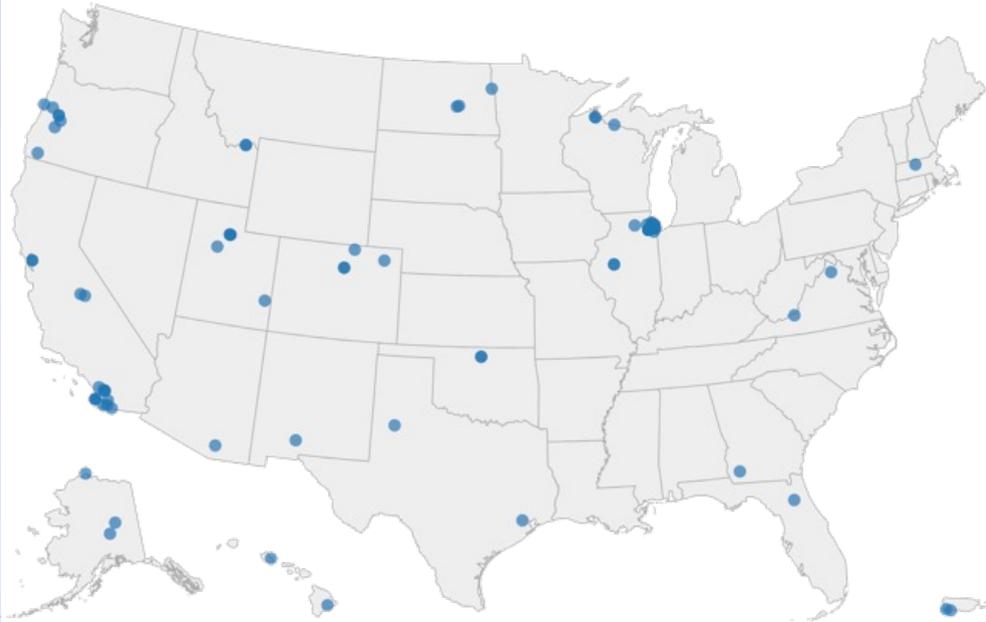


*Cyberinfrastructure for
AI@Edge Computing*

Sage: Scientific AI for the Edge Making Your Data Available for AI

Pete Beckman, Northwestern University

Sage Grande: An Open *Artificial Intelligence Testbed* Supporting Edge Computing and Intelligent Sensing



First generation Sage nodes deployed 2019-2024
(MSRI-1 #1935984 2019-2024)



Partnerships with American Companies

Embed AI with the Edge
Enable intelligent sensing



Goals

A NAIRR Pilot:

Providing academic community AI resources to:

- Develop new AI algorithms and technologies
- Advance techniques to enhance AI safety & privacy
- Explore *next-generation* AI-enabled infrastructure for real-time monitoring of wildfire, flooding, and drought to support early warning and mitigation for farms
- **Deploy 300 new state-of-the-art AI-enabled platforms across the USA, and in every state**
- Train students to use AI-enabled cyberinfrastructure with hackathons, workshops, and new curricula



Almost 10 years of experience

Building on NSF Array of Things (2016-2018)



Sage Grande
Award: #2436842
Start Date: 2/15/2025
\$25.6M over 5 years

Sage Leadership and Collaborators



Large, nationally distributed team:
Northwestern University, Univ of Hawaii,
Univ of CA San Diego, Univ of Chicago,
George Mason Univ, Univ of Utah, CO State,
Univ of Oregon, Argonne



AI Edge Computing

Run **YOUR** AI Code!

- Analyze ALL your data
- Provide real-time AI analysis
- Explore adaptive sampling
- Deploy **LLMs to the edge**
- **AI Agents** for autonomous control
- Build AI tools and skills



Put AI@Edge
HERE →



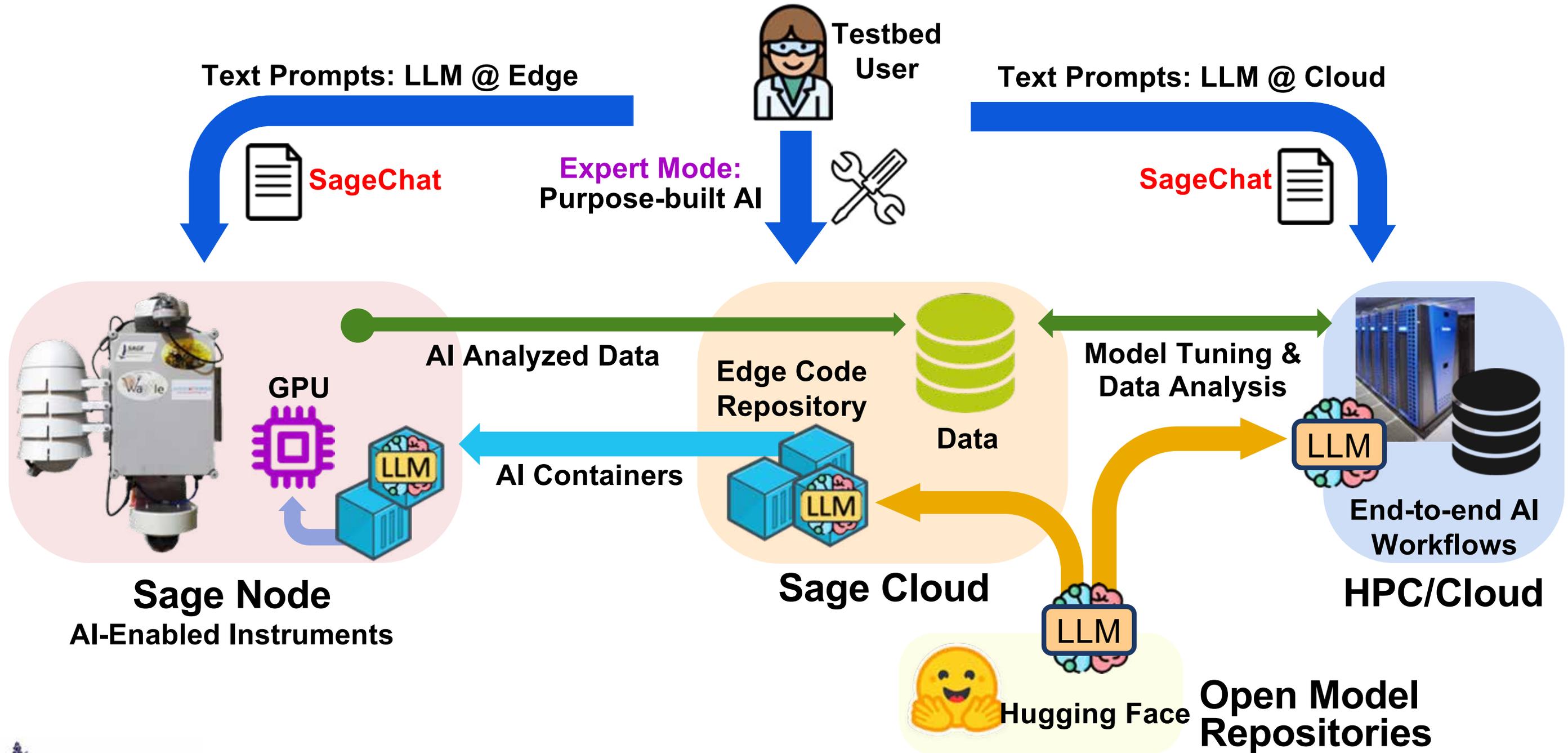
Put AI@Edge
HERE →



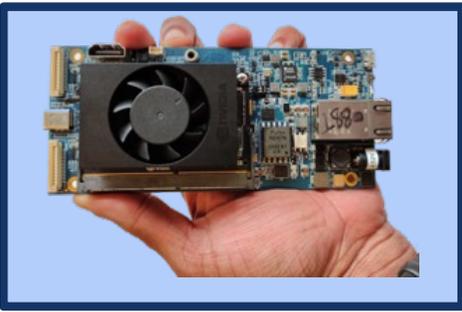
Put AI@Edge
HERE →



Sage Grande: Architecture Overview



Examples: Students and Postdocs



Wildfire Detection



Jakub Szumny

Biodiversity



Dario Dematties

Urban Safety



Anagha Tiwari

Volcanos!



Chris Lee

Digital Twins



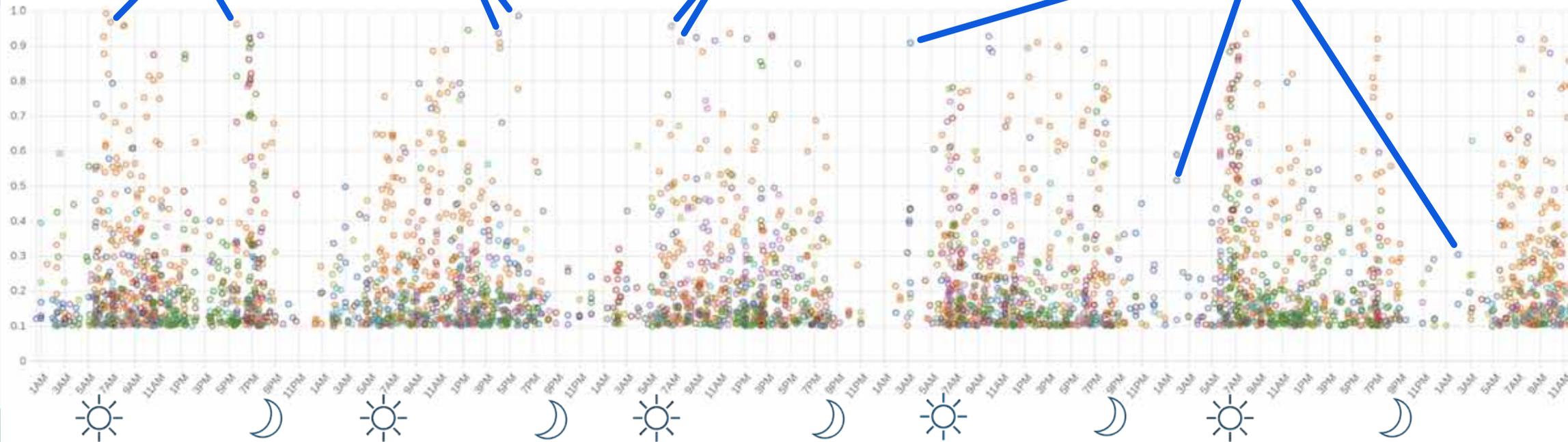
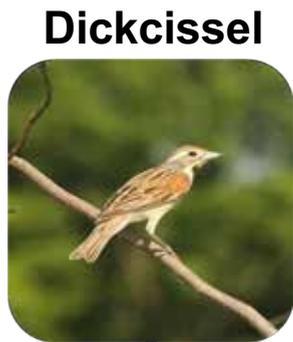
Bobby Jackson

Predict Flooding



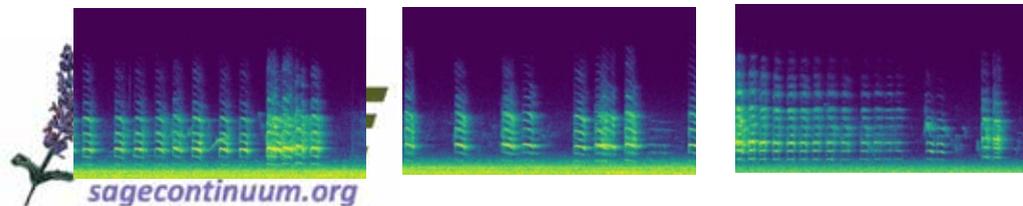
Seongha Park

AI to Monitor Biodiversity in Real Time

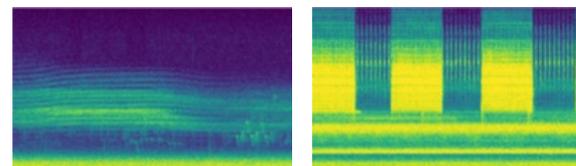


Emiquon National Wildlife Refuge, Illinois. (3/6-11/2024)

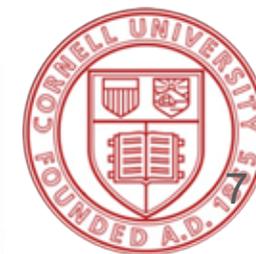
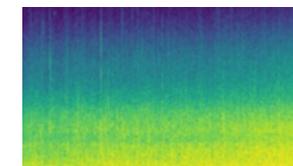
Blue Jay: 93.2%



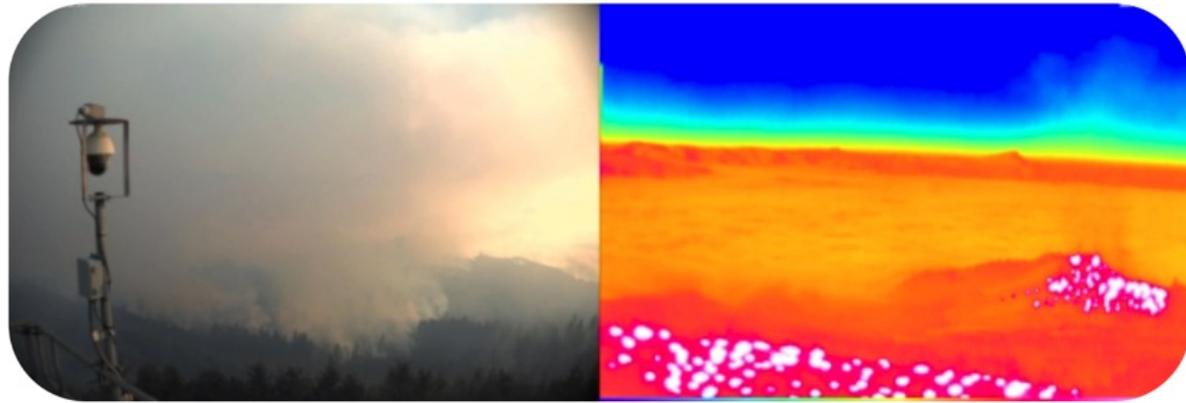
Future AI: Identify Insects



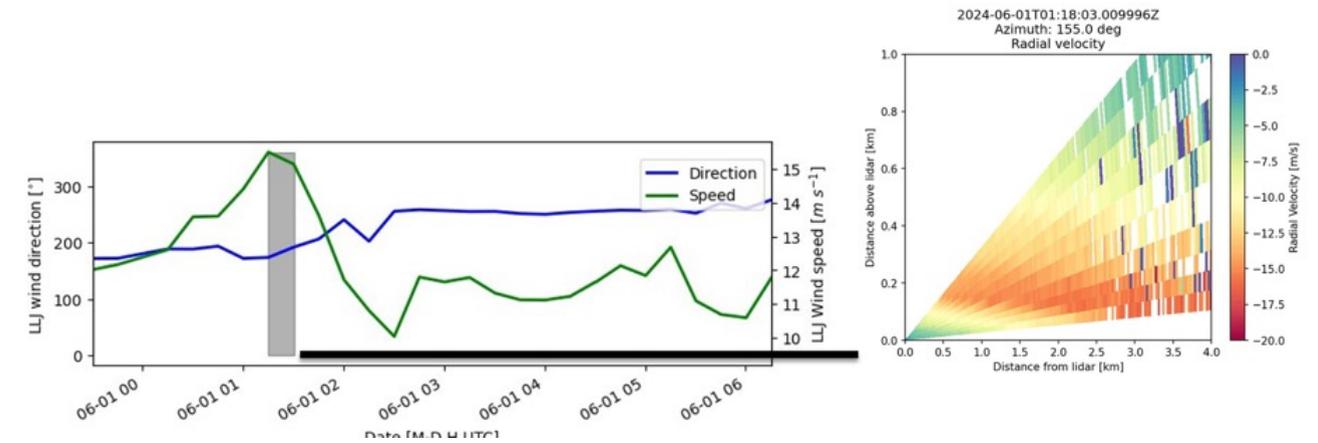
Rain



Sage Grande is an AI Testbed: What will you explore?



Infrared Camera in Oregon



LIDAR on Nantucket

National NSF Cyberinfrastructure to Support AI Research

Computer Science:

- AI inference & self-supervised learning
- LLM benchmarking and correctness at edge
- Cybersecurity, privacy, real-time data analysis
- Adaptive power management
- Programming model for continuum computing
- Resource management, streaming data

Domain Science:

- Developing next-gen AI-enabled instruments
- LLMs for in-situ data analysis
- Domain-specific tuned AI models for edge
- Understanding drought, wildfire, and flooding
- Real-time forecasts with edge-HPC models
- Adaptive steering of data collection

Volcano National Park October 2023



Thomas Giambelluca

- Apps
- Names
- Images
- Audio

App Filters

Apps
chrislee/moondr...

Nodes
W097

Names

cURL download
curl https://data.sageco...

```

import sage_data_client

df = sage_data_client.query(
  start="2025-02-16T18:00:
  end="2025-02-16T19:00:00
  filter={
    "plugin": "registry."
    "vsn": "W097"
  }
)

```

install client docs

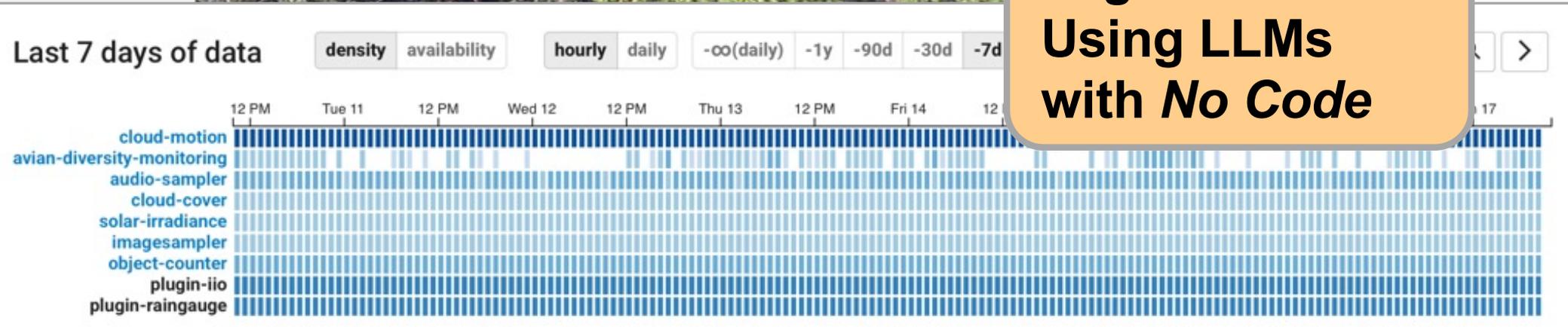
Node	Time	Name	Value
W097	1.8 days ago	caption	The image depicts a lush, verdant forest, with a variety of trees and shrubs in shades of green and brown. The forest is densely packed with deciduous and evergreen trees. The perspective is from a high vantage point, providing a bird's eye view of the forest. The sky is a light blue with wispy clouds. In the distance, a dark, possibly volcanic, landscape is visible, with a faint suggestion of a crater or vent. The image is taken from a distance, making it difficult to discern the exact location or scale of the forest and the distant landscape.
W097	1.8 days ago	points	[{"query": "smoke", "points": [{"x": 0.6015625, "y": 0.1728515625}], {"query": "fire", "points": []}, {"query": "hazard", "points": [{"x": 0.607421875, "y": 0.1728515625}]}]
W097	1.8 days ago	query	[{"query": "Is there a fire?", "response": "Yes, there is a fire visible in the image, located near the forest."}]



**Query: 'Is there a fire?',
response: 'Yes, there is a
fire visible in the image,
located near the forest.))**



**SageChat:
Using LLMs
with No Code**





[W097] Check-in:

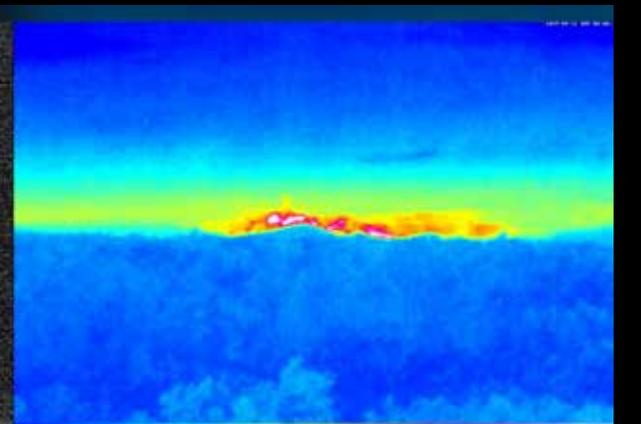
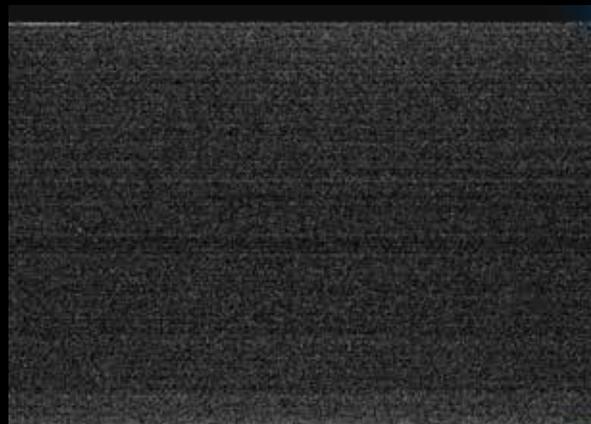
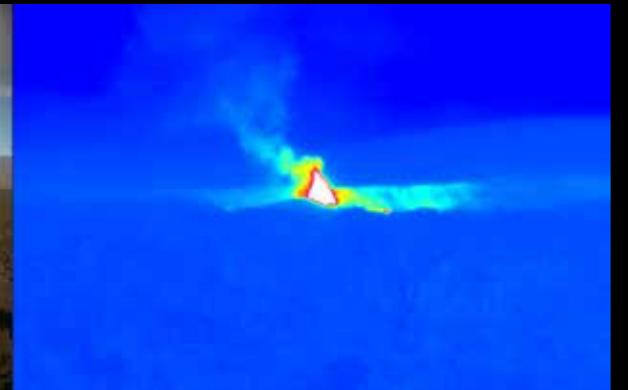
gpt-4o-mini-azure

- [2025-12-06 10:35:23HST] Is there a fire (fire that can cause damage) in this image? YES OR NO ANSWER ONLY!:
 - YES
- [2025-12-06 10:35:30HST] Is there a volcanic eruption in this image? YES OR NO ANSWER ONLY!:
 - YES
- [2025-12-06 10:35:40HST] Is there a natural disaster?:
 - Yes, the image you provided shows a volcanic eruption, which is considered a natural disaster. Volcanic eruptions can cause significant damage to the environment, affect air quality, and pose risks to nearby populations through lava flows, ashfall, and pyroclastic flows. If this photo is from a specific recent event, it's advisable to follow local news sources and official announcements for the latest safety information and updates.
- [2025-12-06 10:35:47HST] Detect signs of a hurricane from a live outdoor camera feed, including extreme winds, heavy rain, and low visibility. Answer strictly 'Yes' or 'No'.:
 - No
- [2025-12-06 10:35:54HST] Is there a hurricane currently happening in the image? YES OR NO ANSWER ONLY!:
 - No

You're Viewing Older Messages

Jump To Present

if a





comp



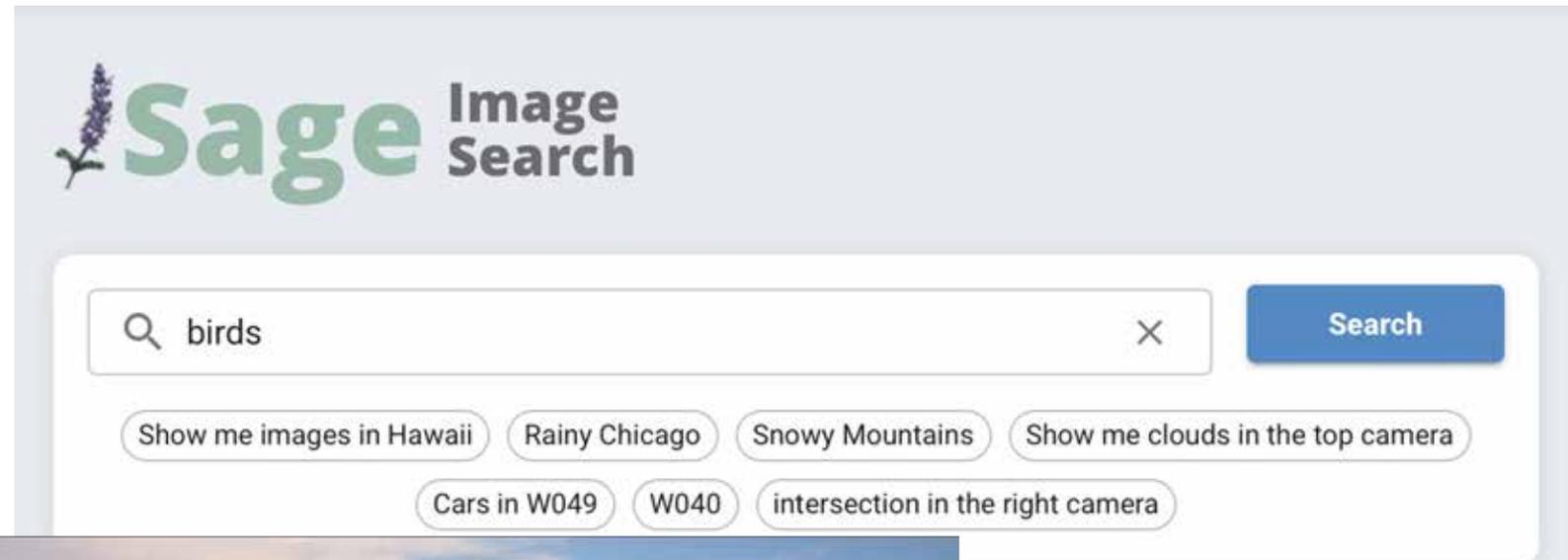


Agent-based Autonomous control for instruments: PTZ example



AI to Make Data Useful and Broadly Accessible to Scientific Communities

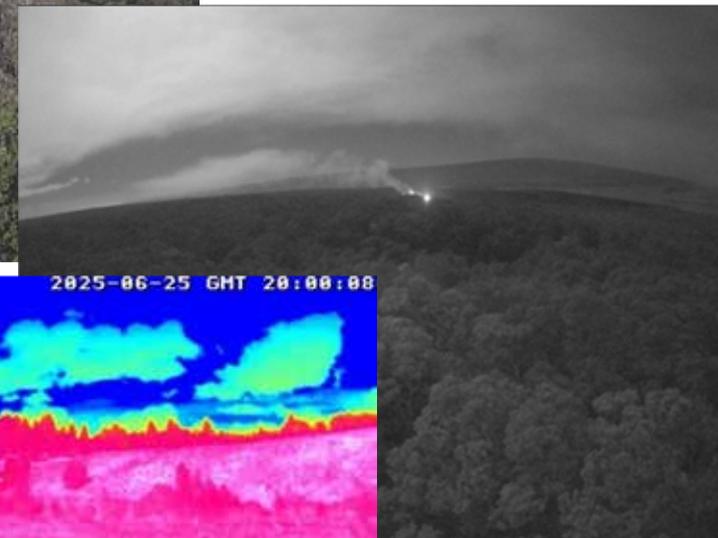
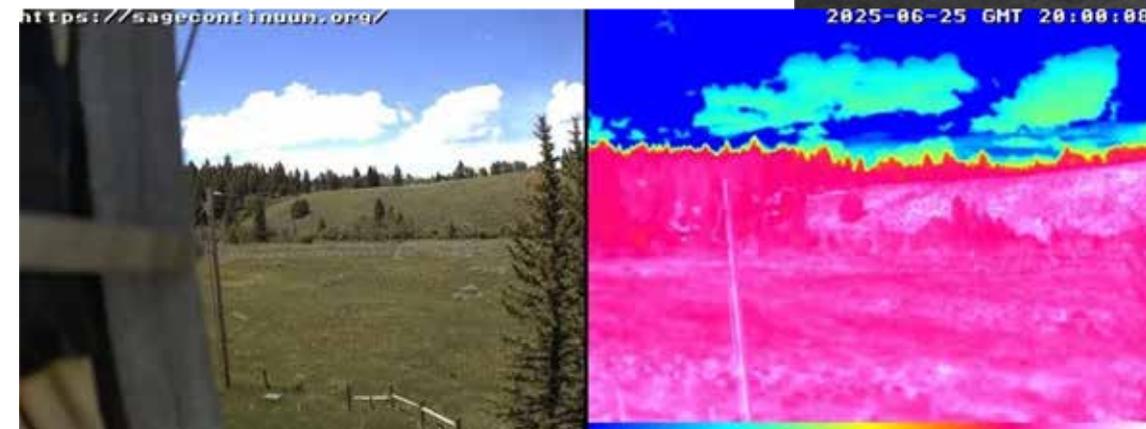
Early Prototype that shows the promise of AI for data insights



“Wildfire Smoke”

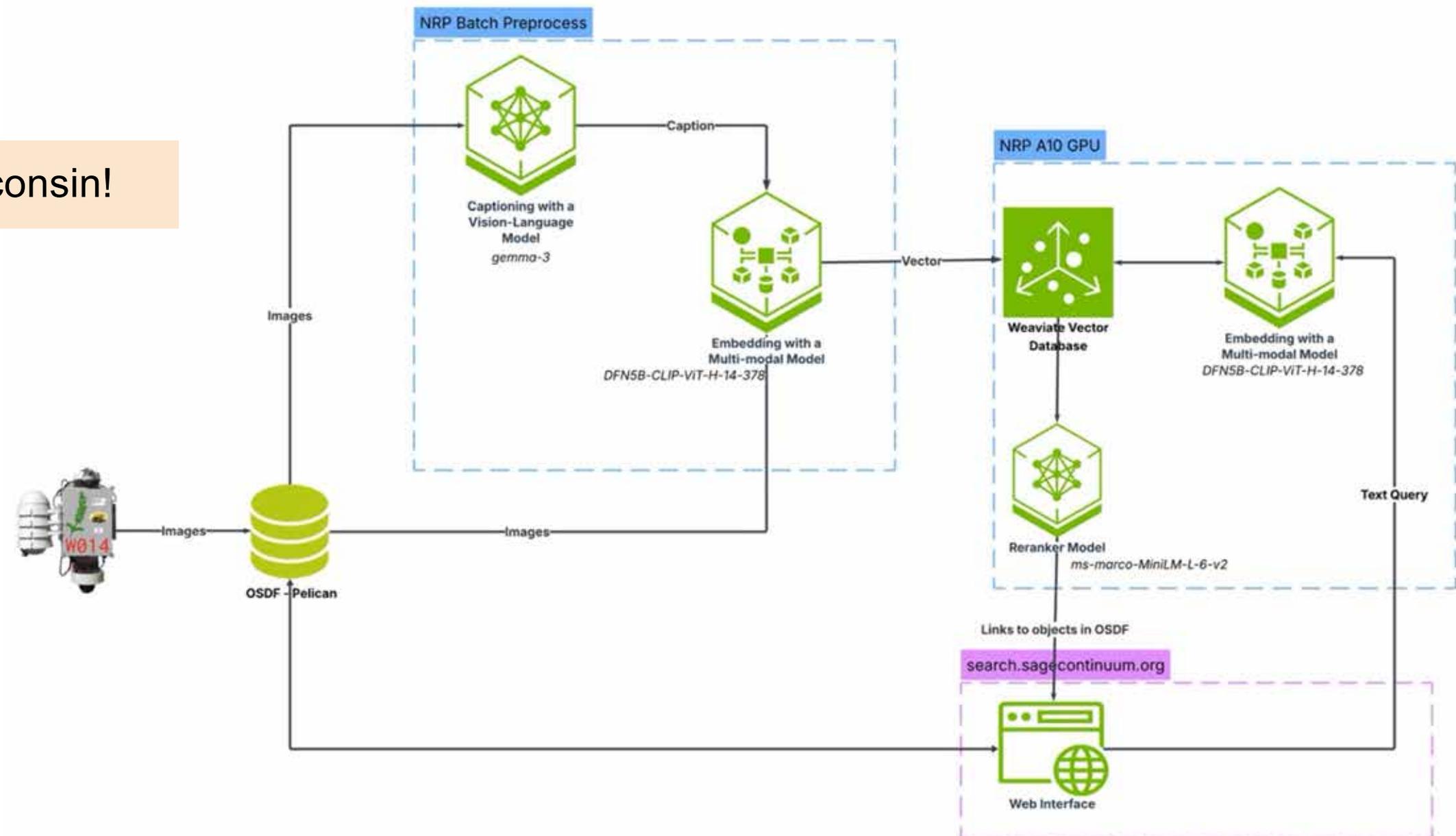


Soon: Agentic Data Analysis!



Integrating Sage Grande with other NSF Resources: NRP/NDP, Pelican/OSDF, PATH (HT Condor)

Thank you SDSC & U Wisconsin!



Sage Grande has a Prototype MCP (and “*Vibe Coding*”)

Sage MCP Server

A Model Context Protocol (MCP) server for interacting with the Sage Grande Testbed, cyberinfrastructure for AI@Edge. This server provides tools, resources, and prompts for querying sensor data, submitting jobs, and managing Sage nodes.

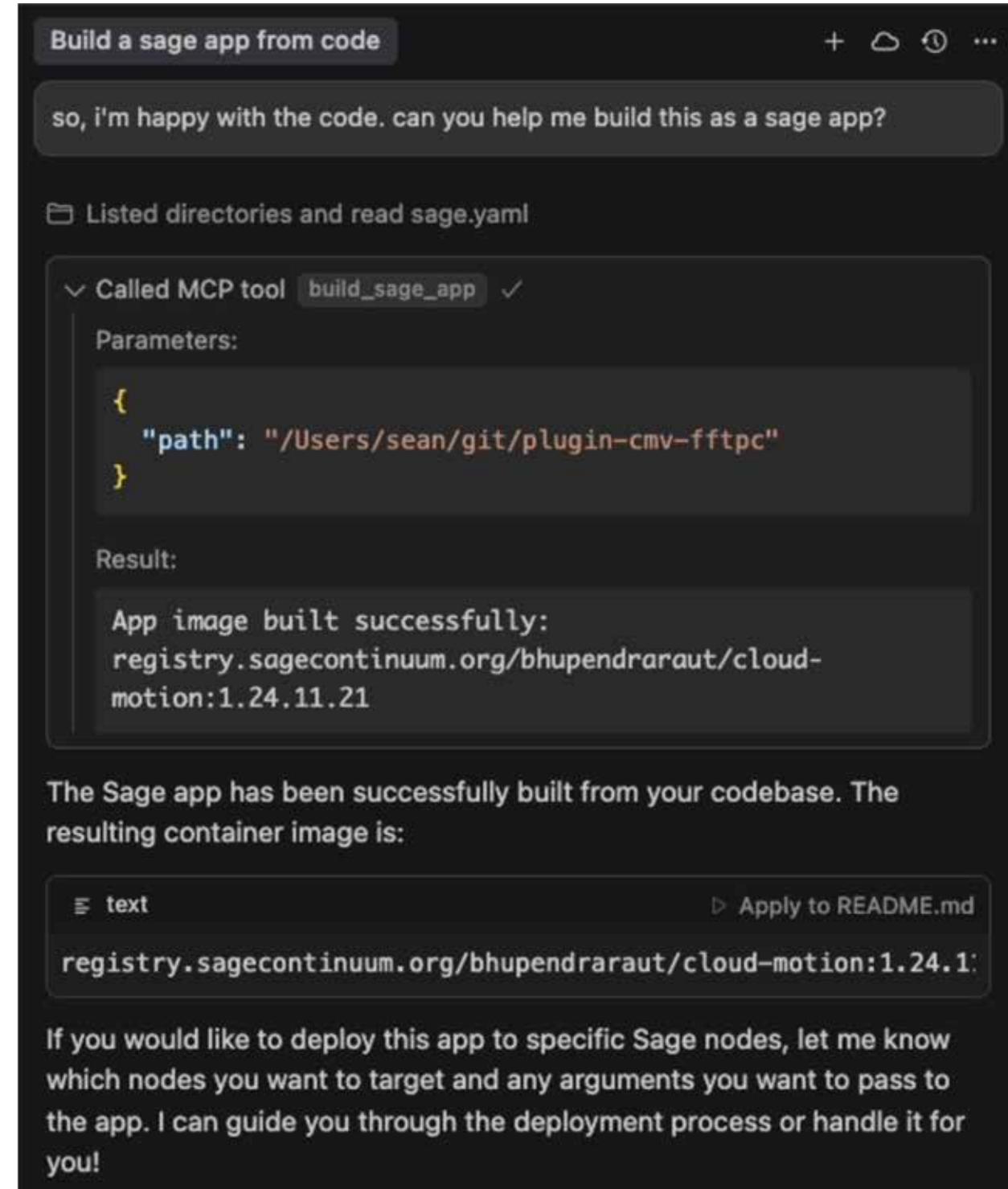
Quick Setup with Cursor IDE

The easiest way to use Sage MCP is through Cursor IDE with our hosted server:

1. Configure Cursor MCP

Add this to your Cursor MCP configuration file (`~/.cursor/mcp.json`):

```
{
  "mcpServers": {
    "sage": {
      "url": "https://mcp.sagecontinuum.org/mcp",
      "headers": {
        "Authorization": "Bearer {username}:{auth_token}"
      }
    }
  }
}
```



Build a sage app from code

so, i'm happy with the code. can you help me build this as a sage app?

Listed directories and read sage.yaml

Called MCP tool `build_sage_app` ✓

Parameters:

```
{
  "path": "/Users/sean/git/plugin-cmv-fftpc"
}
```

Result:

```
App image built successfully:
registry.sagecontinuum.org/bhupendraraut/cloud-motion:1.24.11.21
```

The Sage app has been successfully built from your codebase. The resulting container image is:

text Apply to README.md

```
registry.sagecontinuum.org/bhupendraraut/cloud-motion:1.24.11.21
```

If you would like to deploy this app to specific Sage nodes, let me know which nodes you want to target and any arguments you want to pass to the app. I can guide you through the deployment process or handle it for you!

What does the SGT MCP Provide Users?

A new way to write programs, **interact and find data**, and control Sage

Some Examples:

Core Capabilities

1. Sensor Data Exploration

Discover what's available:

```
"Show me all available Sage nodes and their sensors"
"What environmental data is available from the last hour?"
"List nodes in Chicago with temperature sensors"
```

Query specific data:

```
"Get temperature readings from node W06D"
"Show me rainfall data from all nodes"
"What's the current air quality in na"
```

3. Job Submission & Management

Submit jobs easily:

```
"Deploy a cloud cover detection job to n
"Run audio sampling on all nodes in Hawa
"Start a multi-plugin ML suite on prairi"
```

Monitor and manage:

```
"Check the status of job 12345"
"Show me recent data from my flowering p
"Remove job 67890 from the scheduler"
```

2. Plugin Discovery & Development

Find existing plugins:

```
"Find plugins for monitoring bird sounds"
"What computer vision plugins are available for plant detection?"
"Show me plugins that work with PTZ cameras"
```

Get development guidance:

```
"How do I create a custom Sage plugin for detecting flowers?"
"What's the best approach for real-time audio analysis on edge nodes?"
"Help me optimize a YOLO model for edge deployment"
```

Research & Data Analysis

Exploratory Data Analysis:

```
"I'm studying pollinator activity. What Sage data would be m
"Show me temperature trends across different ecosystems in t
"Find correlations between flowering patterns and weather da"
```

Hypothesis Testing:

```
"Compare bird activity between urban and rural nodes during
"Analyze the relationship between air quality and plant heal
"Test if rainfall patterns affect flowering timing in prairi"
```

Publication-Ready Analysis:

```
"Generate a statistical summary of biodiversity metrics from
"Create a comprehensive environmental report for node W06D o
"Export data in a format suitable for scientific publication"
```

68 Nodes | 8:29:36 AM

Status	Node	Focus	State	GPS	Sensors
✓	LCUF WBAA	Rural (LCOOU)	Wisconsin (WI)	45.95503902553785,-91.3649859195928	XNF-8010RV, XNV-8081Z, BME280, VK-162, BME680, RG-15, ML1-WS IP54, LoRaWAN Gateway, 15004
✓	HVNP W097	Rural (University of Hawaii)	Hawaii (HI)	19.415203653,-155.238319893	
✓	W08C	Rural (Neon)	Michigan (MI)	46.233870727,-89.537203252	

AI @ the Edge for Wildfire Detection

[Getting Started](#)

[Browse the Portal](#)

[Learn](#) [Contribute](#) [Run jobs](#)

[Browse](#)
Browse data from sensors and edge apps

[Analyze](#)
Use Sage APIs to fetch, analyze, or integrate data

November 2025 Sage Workshop (Virtual)

Join us for an virtual overview of the Sage platform, tentatively scheduled for **Wednesday, November 12th, 2025, from 2:00 PM to 5:00 PM CST** (subject to change).

This workshop will feature:

- An overview of Sage and its capabilities
- Step-by-step how-to sessions
- Highlights of recent student projects using Sage

Interested in attending? Please fill out our [registration form](#) so we can tailor the workshop to your interests.

Pre-Workshop Preparation (To be Determined)

To make the most of the session, we might suggest completing the following ahead of time:

- Read the [Getting Started Guide](#) to understand how Sage might connect to your work.
- Assemble your team members who plan to participate.

Summary:

- Sage Grande is a **Testbed**
 - **Run YOUR AI at the Edge**
 - **Use Sage data for your Science!**
- Explore running LLMs on the edge
- Explore AI Agents & autonomous control
- Explore AI for Data Analysis
- Develop new AI algorithms
- Develop new AI for scientific instruments
- Open for students, postdocs, and educators
- We have partnered with NEON, OHAZ, WiFire/HPWREN, and rural communities.
 - **We will deploy 300 nodes over the next 3 years!**
 - Do you want to be a **partner** and host a Sage node?



Slack

- #workshop
- #student-postdoc-research
- #help-desk
- @support

Email:

support@sagecontinuum.org

Office Hours Link

- www.sagecontinuum.org

[Getting Started ▶](#)

[Browse the Portal ▶](#)