Artificial Intelligence in Disaster Preparedness, Response, and Recovery

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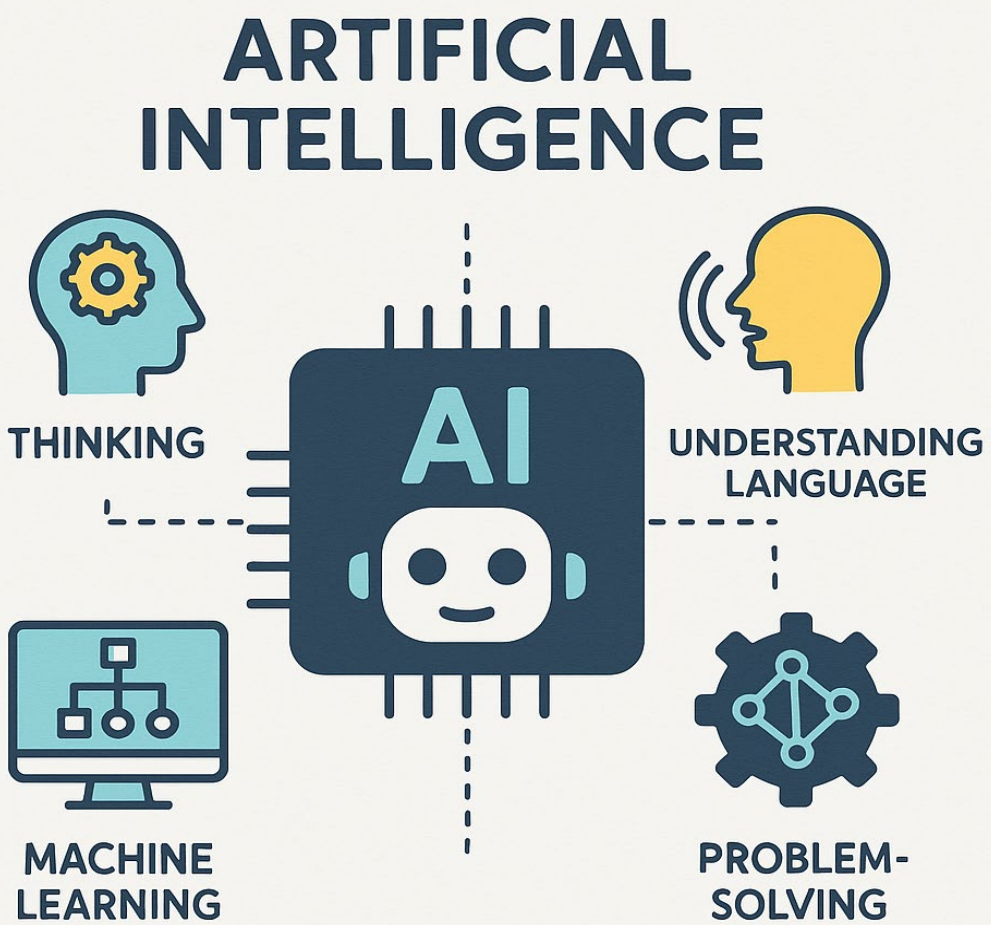
US EPA Office of Research and Development

What is AI?


ARTIFICIAL INTELLIGENCE
AI
THINKING
UNDERSTANDING LANGUAGE
MACHINE LEARNING
PROBLEM-SOLVING

Homeland Security Research Program – Leaning Forward

- The Current State of Artificial Intelligence in Disaster Recovery: Challenges, Opportunities, and Future Directions

- Artificial Intelligence Applications in Water Distribution Systems Cybersecurity: A Comprehensive Review

How can we speed up decision-making?

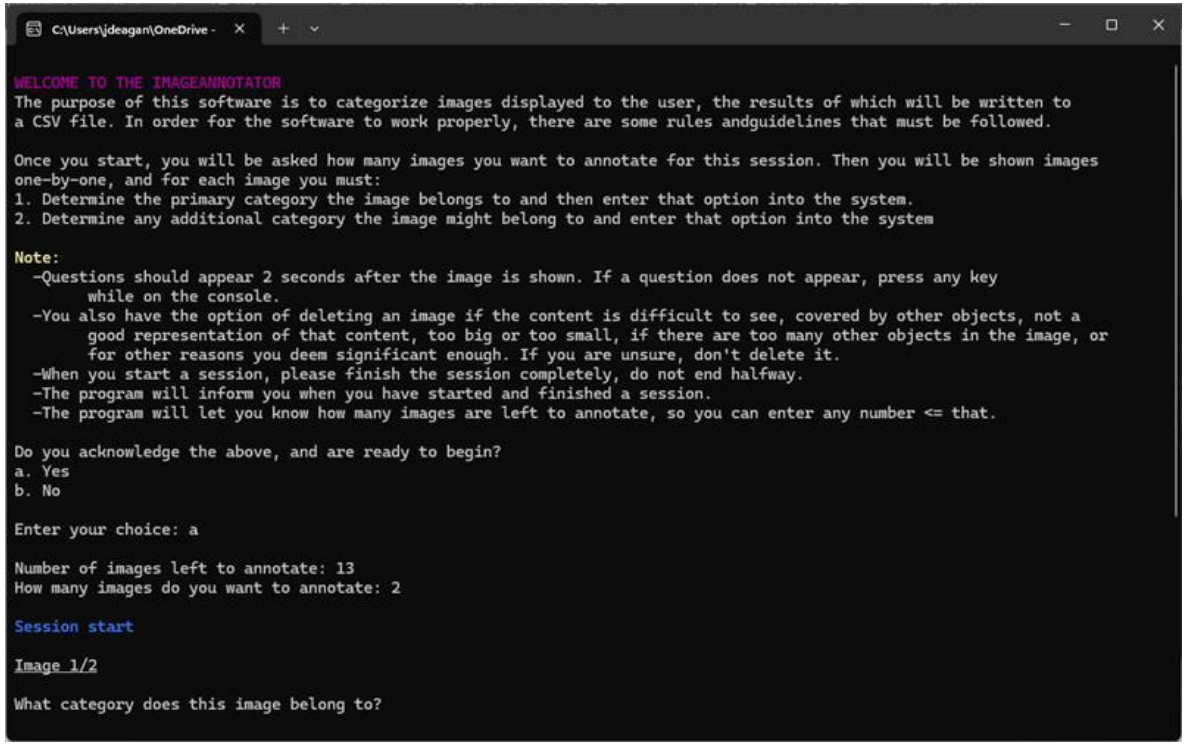
…Use AI to digest complex data and imagery

Analyzing Imagery Using AI

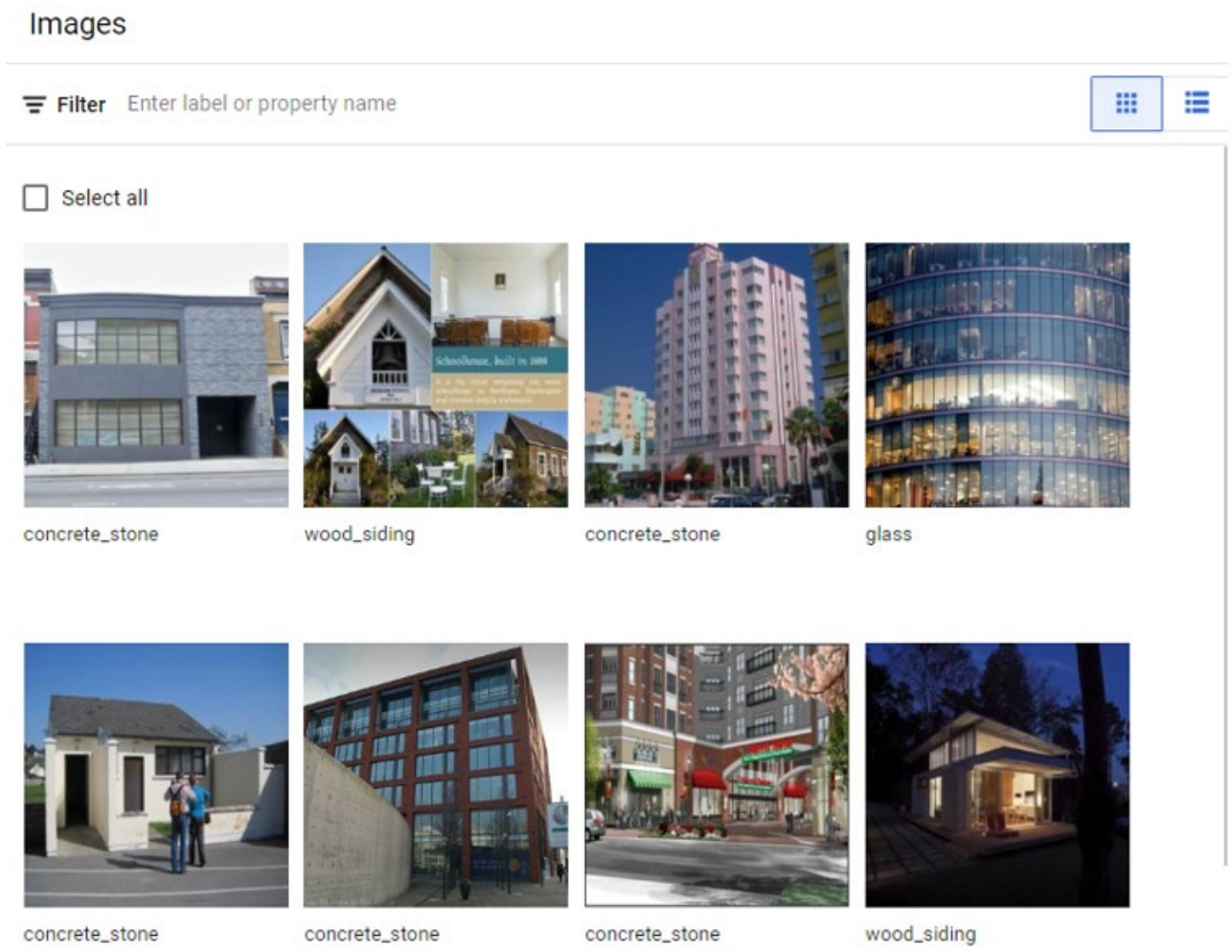
- **Why:** Improve rapid identification during emergency response and leverage AI for automated imagery analysis

- **How:** Google Vertex AI tested with two case studies:
  - Infrastructure
  - Microorganisms

- **What:** Successfully classified construction materials (~85% accuracy)
  - Promising results for microorganism detection; limited by data availability
  - Future: Expand datasets, enhance labeling, and evaluate advanced AI



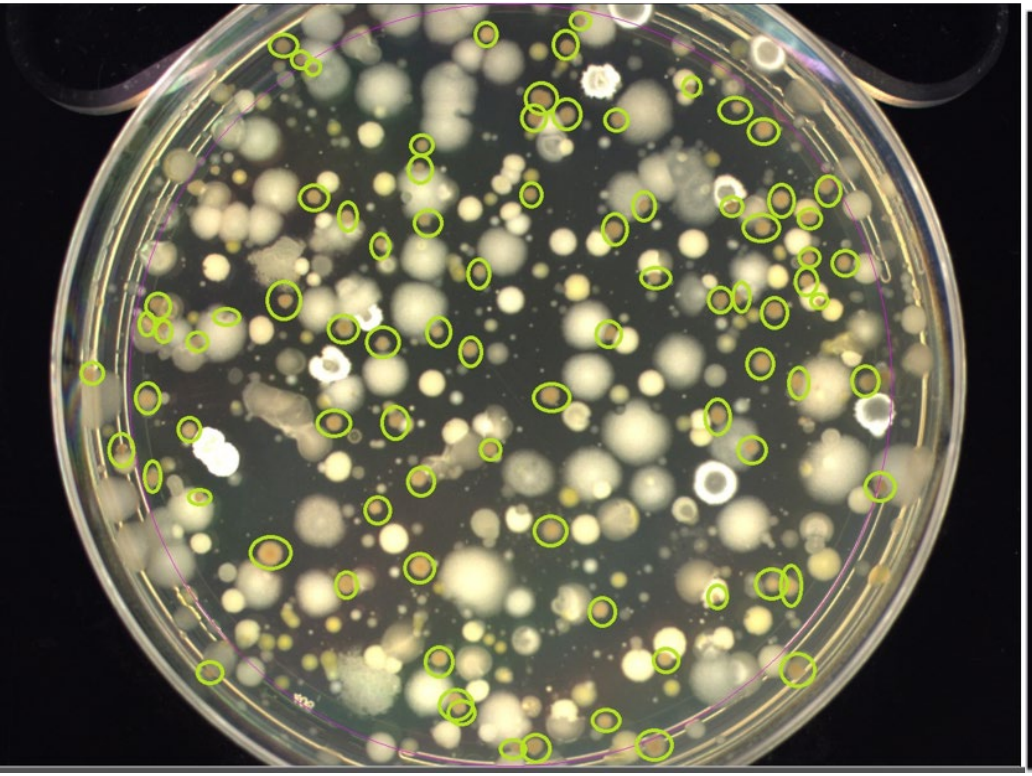
Analyzing Imagery Using AI - Infrastructure

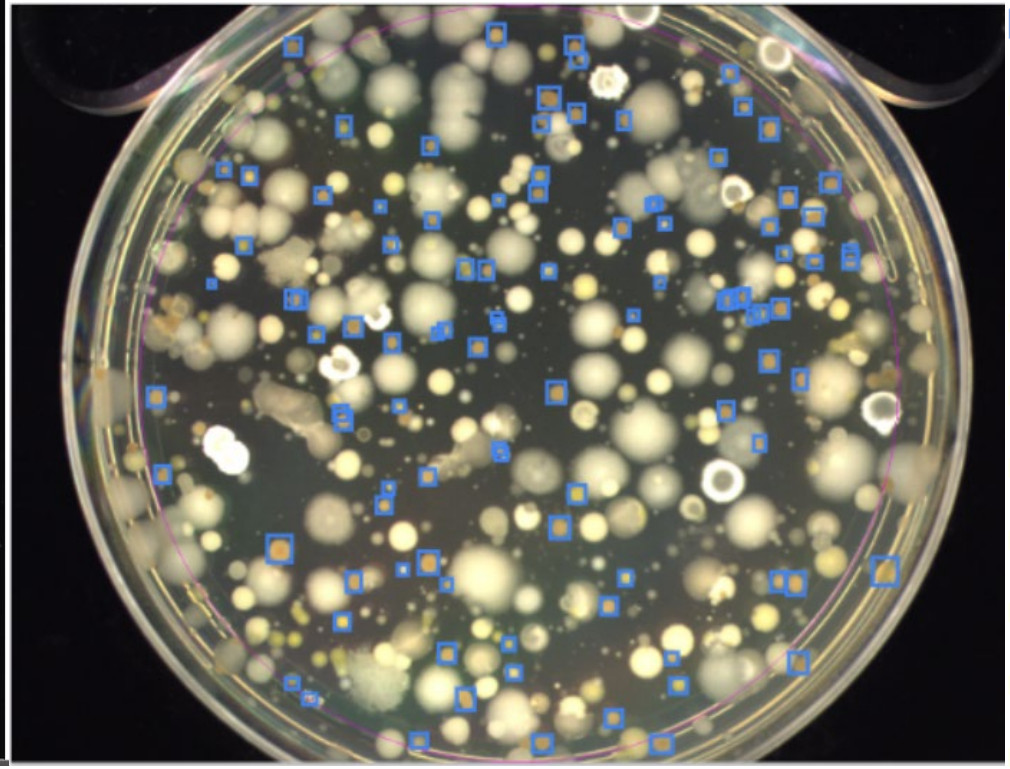


True label \ Predicted label	stone	steel	wood_siding	glass	concrete	brick
stone	0%	0%	9%	0%	0%	91%
steel	0%	53%	6%	25%	14%	3%
wood_siding	0%	0%	85%	1%	3%	10%
glass	0%	10%	0%	76%	14%	0%
concrete	0%	2%	10%	0%	46%	41%
brick	1%	2%	4%	1%	5%	88%

True label \ Predicted label	concrete_stone	wood_siding	glass_steel	brick
concrete_stone	80%	7%	2%	11%
wood_siding	13%	82%	0%	5%
glass_steel	52%	3%	44%	0%
brick	20%	5%	0%	75%

Analyzing Imagery Using AI - Microbiology





Filter Filter labels

BG (100)

BG 1	0.815
BG 2	0.711
BG 3	0.697
BG 4	0.652
BG 5	0.635
BG 6	0.598
BG 7	0.574
BG 8	0.560
BG 9	0.520
BG 10	0.519
BG 11	0.508
BG 12	0.495

How do we manage data efficiently during an incident?...

...Use AI to supplement planning and training efforts

Table-Top Exercise & Planning (Emergency Manager Level)

- **Why:** Tabletop exercises take a lot of time, money, and often reuse scenarios.

- **How:** Use AI to instantly create realistic, scenarios, including nearby infrastructure and possible threats.

- **What:** EmergencAI helps communities get better prepared for emergencies and build skills to make faster, smarter decisions.

Table-Top Exercise & Planning

Create New Scenario

Seed Source:	Random
Location:	Times Square
Scenario:	Biological
↳ Agent:	Anthrax
Plume Size:	Medium
Budget (Dollars):	0
Days:	0
Teams:	0
Team Size:	0
Hours per Shift:	0
Labs Available:	0

Values set to 0 above will be randomly sampled from a list.

Create New Scenario

Building Details

Building Area: 64,740㎡

Building Volume: 3,307,769.44 ㎥

Building Count: 4

Weather Conditions

Temperature: 67°F

Humidity: 66%

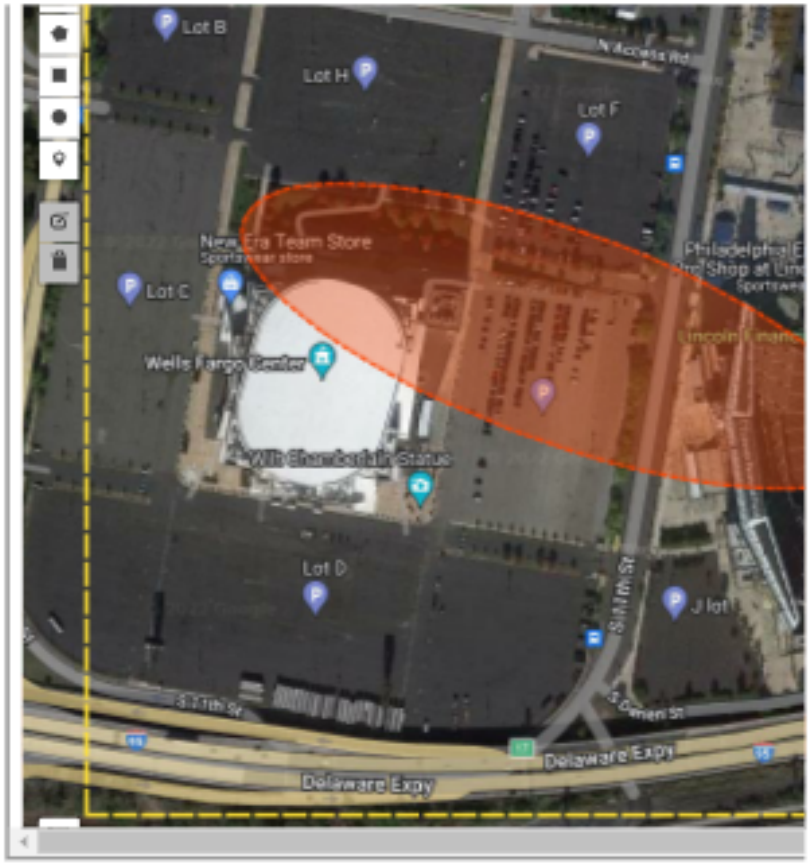
Wind Speed: 1.82 meters/sec

Wind Direction: 105 degrees (ESE)

Weather Description: scattered clouds

Land Use

Developed High Intensity:	45.08%
Developed, Medium Intensity:	24.28%
Grassland/Herbaceous:	19.60%
Developed, Low	7.01%



[EmergencAI Tool | Data Management Tabletop Exercise (Data TTX) Summary Report]

EPA United States Environmental Protection Agency

How do we optimize response activities in an incident?

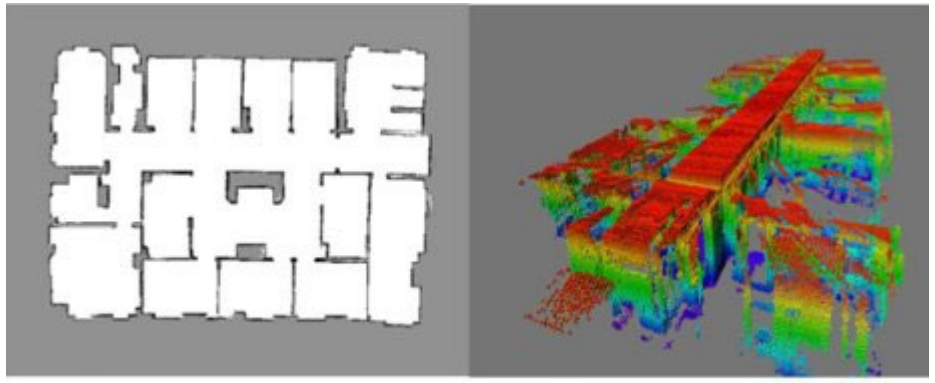
…Using AI to support situational awareness, navigation, and data collection

Disaster Site Navigation (Responder Level)

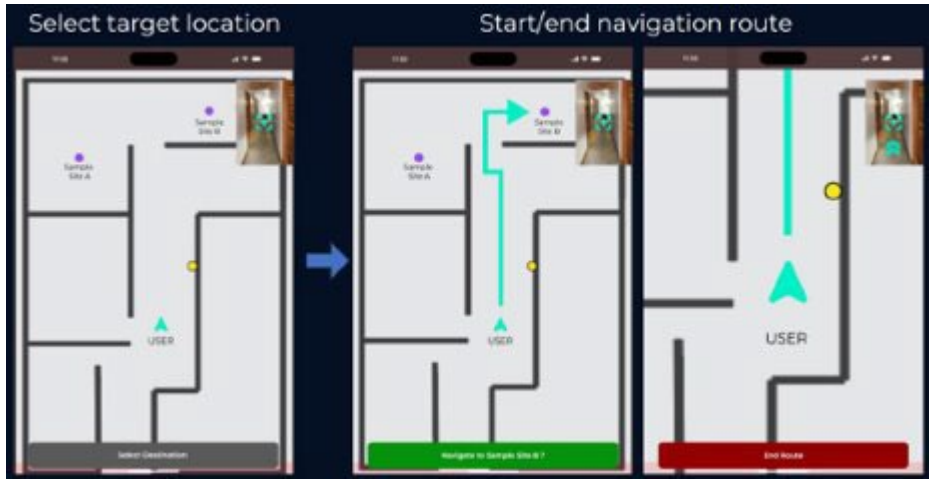
- **Why:** Need a low-cost, reliable way to navigate and recreate indoor and outdoor environments.

- **How:** Use small business grant to build an AI system that remembers where people go and helps guide them—no expensive gear needed.

- **What:** Commercial mapping tool for capturing and documenting indoor and outdoor spaces.

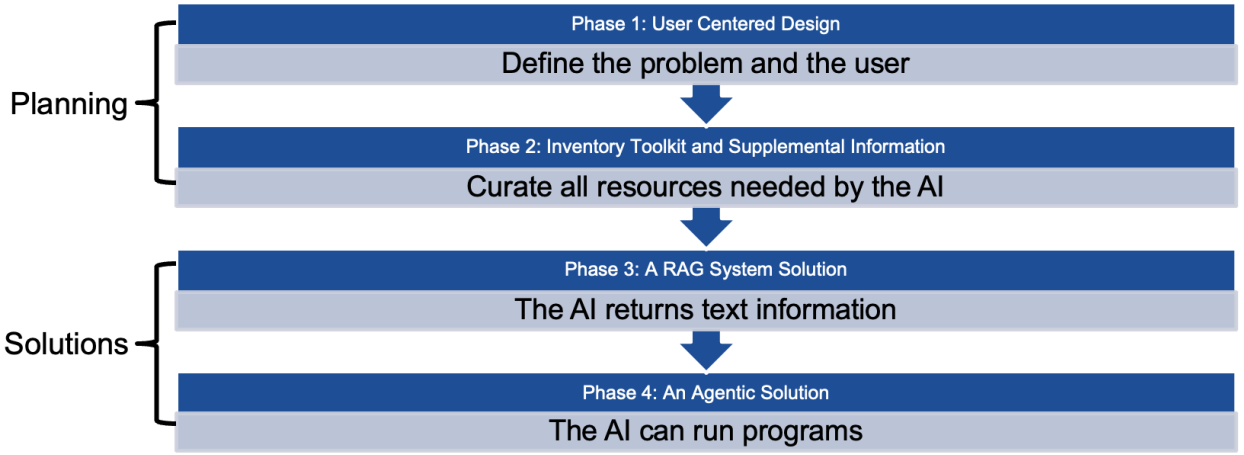


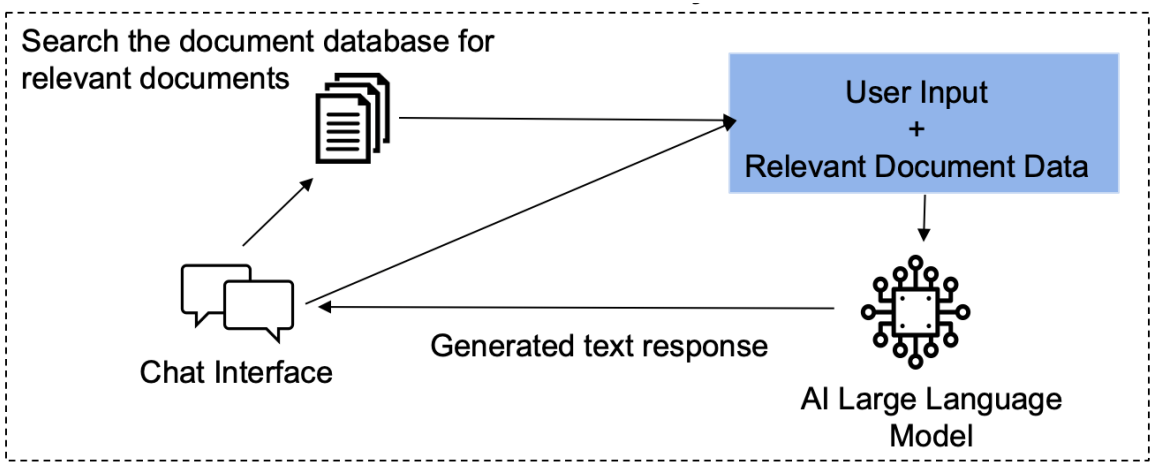
(a) 2D Occupancy Grid Map (b) 3D Occupancy Grid Map



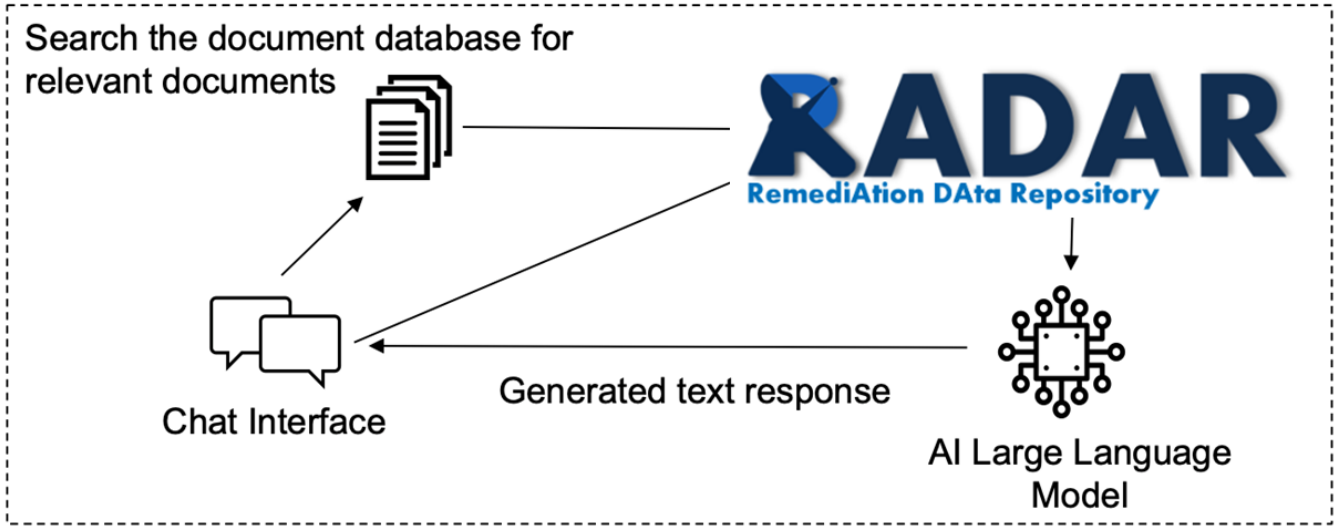
Industry Collaboration and R&D

- **Secured two small business grants** totaling $300K to advance AI research.
- **Partnered with Google** to align their disaster and damage assessment technologies with EPA's emergency response activities.
- **Curating resources necessary to train local models** and working towards a retrieval-augmented generation (RAG) solution.





R&D Cont.



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Biological Decontamination Compendium

A compendium of research and efficacy results on various materials to decontaminate a biological agent

Click More Info to view additional information about the dataset. More Info

Columns

Filter table Search

+ Select All − Deselect All

- SourceID
- Source Reference
- Decon Application Method
- Surface
- Loading
- Loading Units

SourceID	Source Reference	Decon Application Method	Surface	Loading	Loading Units	LPosRec	Coupon Area	Coupon Area Units	Decon Agent Dose Conc	Decon Agent Dose Conc Units	OriginalConcDose
97	Schnabel 2014 Inactivation of Vegetative Microorganisms and Bacillus atrophaeus	fumigation	Glass Bottle	40000	CFU/cm^3		250	cm^3	7700	J	7.7

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- Many any filters (OR)
- Match all filters (AND)

Incident Type +
Response Phase/Activity +
Task Type +
Information Topic +

Resource links open in a new tab and may be external to EPA.

Data Management for Wide-area Responses: Technology Evaluation and Operational Expert Feedback (Phase 1)

Type Report (PDF)
Year Published 2021

Aims to identify and recommend user-friendly tools that more easily facilitate the acquisition of field sampling data and subsequent management of sampling data following a wide-area incident to [...]

BIOLOGICAL SAMPLING

Expedient Approaches for the Management of Wastes generated from Biological Decontamination Operations in an Indoor Environment

Type Report (PDF)
Year Published 2016

The effectiveness of this decontamination approach was evaluated for high traffic commercial carpet tile, nitrile gloves (personal protective equipment [PPE]), books, and upholstered seat pans that are [...]

BIOLOGICAL DECONTAMINATION SAMPLING WASTE MANAGEMENT

Looking Forward…

More Information

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https://www.epa.gov/emergency-response-research

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