



CDAO

ARTIFICIAL INTELLIGENCE AND ITS USES IN THE DOD

*TRANSFORMING
THE DEPARTMENT OF DEFENSE
THROUGH AI*



U.S. Department of Defense

ai.mil

OSD CDAO Education & Training
osd.pentagon.cdado.mbx.human-capital-team@mail.mil



TABLE OF CONTENTS

INTRODUCTION

1

WHAT IS AI?

2

TYPES OF AI

3-7

AI USE CASES

8-13

RESOURCES

14

INTRODUCTION

Curious to learn more about AI? This use case book provides tangible examples of how AI is deployed and can be used in work roles within the DoD.

WHY AI?

Artificial Intelligence (AI) is often spoken of as THE next big thing in technology and data driven outcomes. It's described as a transformative, disruptive technology that we, the Defense Department, absolutely must master to maintain a competitive edge in a great power competition. The Secretary of Defense has directed AI adoption, and most DoD personnel are ready to embrace AI...but what does that mean, exactly?

People who don't have a background in computer science or mathematics may have misconceptions about what AI looks like, and what it's capable (and not capable) of doing. We may have heard that technology we use every day incorporates AI, but don't really understand how or why. Even if we accept that AI is important, we may still wonder, "How can technology that drives tools like Spotify or Google Translate be useful for DoD applications?"

This booklet was created to explain AI concepts in simple terms. It identifies places where AI is already being used in the DoD, how it is being applied, and who it benefits. We hope that it will inspire you to think creatively about how the same ideas demonstrated within this booklet might be applied to your own work.

We also provide contact information to the Chief Digital Artificial Intelligence Office (CDAO) so that when you want to explore AI implementation in your organization, you can locate skilled practitioners to help you get your project going.

WHAT IS AI?

Before diving into the use cases that demonstrate how we can use AI across the Department of Defense, it is important to understand what AI is and the various technologies it encompasses.

At its simplest, AI is a field that combines computer science and robust datasets to enable problem-solving. It also encompasses sub-fields of machine learning and deep learning, which are frequently mentioned in conjunction with AI. These disciplines are composed of AI algorithms that create expert systems that make predictions or classifications based on input data.

While several definitions of AI have surfaced over the last few decades, DoD offers the following definition in their 2018 Artificial Intelligence Strategy, " AI refers to the ability of machines to perform tasks that normally require human intelligence - for example, recognizing patterns, learning from experience, drawing conclusions, making predictions, or taking action - whether digitally or as the smart software behind autonomous physical systems.¹" This definition encompasses a wide range of technologies and processes, but for simplicity's sake, in modern applications, AI can be subdivided into five fields of AI with different capabilities: Computer Vision, Robotic Process Automation, Deep Learning, Reinforcement Learning, and Natural Language Processing. We'll discuss each discipline and their various uses in the next section.

¹ Summary of the 2018 Department of Defense Artificial Intelligence Strategy, p.5

COMPUTER VISION

Computer vision is a field of AI that enables computers and systems to derive meaningful information from digital images, videos, and other visual inputs to take actions or make recommendations based on that information. If AI enables computers to think, computer vision enables them to see, observe and understand.²

GENERALIZED USES

- Image classification
- Image segmentation
- Image generation
- Object detection
- Object segmentation
- Edge detection
- Face recognition
- Face detection
- Optical character recognition
- Pattern detection
- Feature matching

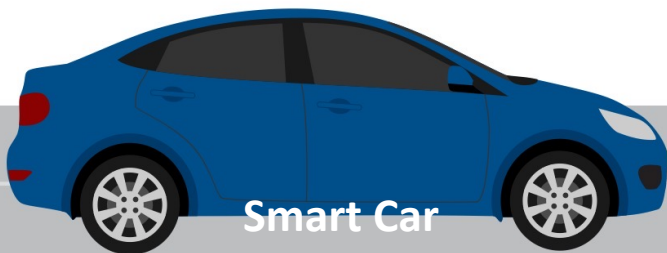


Computer Vision in Action

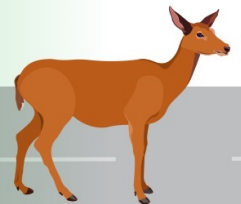
Smart cars use computer vision to analyze the road ahead of them to make autonomous decisions for the driver, like braking when there's danger ahead.



AI: *"Hmm, obstacle in the road. I'll stop to avoid a collision."*



Smart Car



²<https://www.ibm.com/topics/computer-vision>

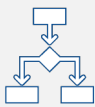
ROBOTIC PROCESS AUTOMATION

Robotic process automation (RPA), also known as software robotics, uses automation technologies to mimic back-office tasks of human workers, such as extracting data, filling in forms, moving files, et cetera. It combines application programming interfaces (APIs) and user interface (UI) interactions to integrate and perform repetitive tasks between enterprise and productivity applications.

By deploying scripts which emulate human processes, RPA tools complete autonomous execution of various activities and transactions across unrelated software systems.³

Generalized Uses

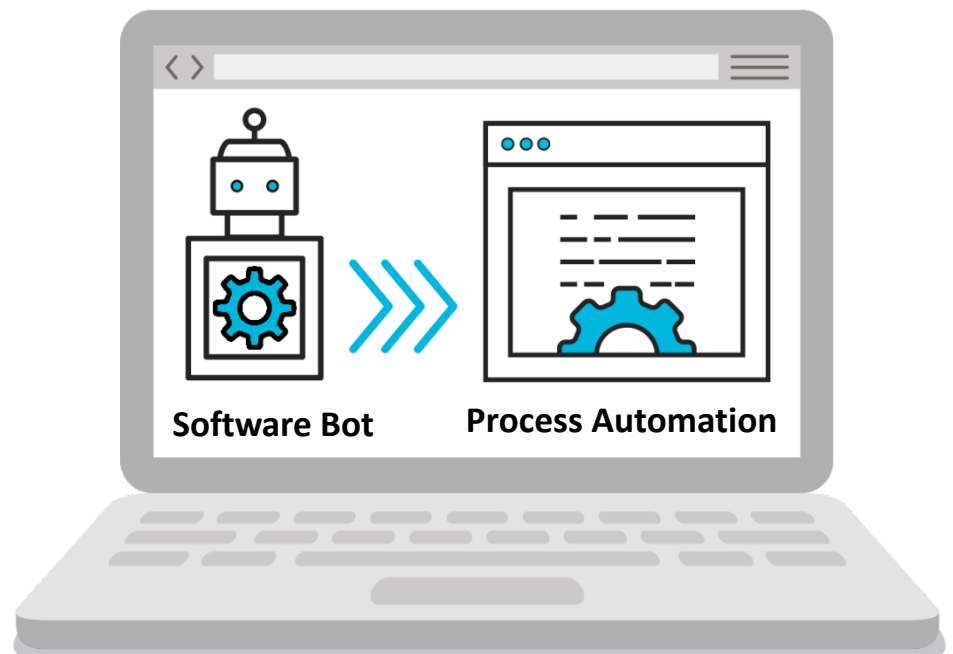
- Partially or fully automating human activities
- Accessing legacy system data
- Filling in forms
- Copying data between systems



RPA In Action

Do your workdays ever get bogged down in monotonous and repetitive tasks? RPA to the rescue!

RPA software can be leveraged to automate those repetitive tasks and save you time.



³<https://www.ibm.com/cloud/learn/rpa>

REINFORCEMENT LEARNING

Reinforcement Learning is a type of machine learning that enables an agent (e.g., application or tool) to learn in an interactive environment by trial and error, using feedback from its own actions and experiences. Unlike supervised learning, where feedback provided to the agent is the correct set of actions for performing a task, reinforcement learning uses rewards and punishment as signals for positive and negative behavior. In reinforcement learning, the goal is to find a suitable action model that would maximize the total cumulative reward of the agent.⁴

Generalized Uses

- Tasks and Objectives
- Optimization
- Wargames
- Robotics



Reinforcement Learning In Action

Ever play a video game against a computer player? The computer is trained to how to play and becomes more competitive through repeating actions in various scenarios until it learns how to play smart and efficiently.



⁴ <https://www.kdnuggets.com/2018/03/5-things-reinforcement-learning.html>

MACHINE LEARNING/ DEEP LEARNING

Since deep learning and machine learning are often used interchangeably (and without distinction) it's worth noting the nuances between the two. Machine learning, neural networks, and deep learning are all sub-fields of artificial intelligence whose algorithms enable advanced analytic capabilities. Classical machine learning algorithms and "non-deep" neural networks are generally more dependent on human intervention to encourage learning. This requires human experts to determine the set of features (i.e., variables or attributes) to understand the differences between data inputs and outputs, usually requiring more data preparation and structure to achieve the desired model performance.⁵ Deep learning, however, is considered a sub-field of machine learning, leveraging "deep" (i.e., multi-layered) neural networks to model relationships within a dataset. The way in which deep learning differs from classical machine learning is rooted in the structure of their underlying algorithms. An advantage of deep learning is its ability to automate much of the feature extraction process necessary for machine learning, eliminating some of the human intervention required and enabling the use of larger data sets. This allows technology to uncover patterns and make predictions beyond human abilities. You can think of deep learning as "scalable machine learning."

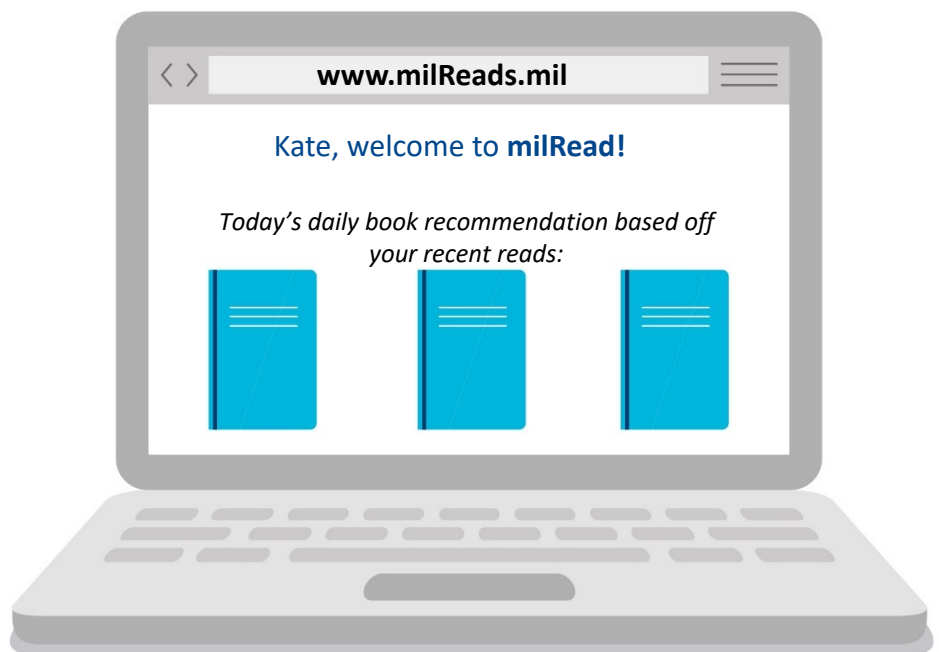
Generalized Uses

- Classification
- Prediction
- Identification
- Recommendation



ML In Action

Machine learning analyzes the frequency of data inputs to make predictions and give recommendations based on previous preferences.



⁵<https://www.ibm.com/cloud/learn/machine-learning>

NATURAL LANGUAGE PROCESSING

Natural language processing (NLP) refers to the branch of computer science—and more specifically, the branch of AI—concerned with giving computers the ability to understand text and spoken words in much the same way human beings can. NLP drives computer programs that translate text from one language to another, respond to spoken commands, and summarize large volumes of text rapidly—even in real time. There's a good chance you've interacted with NLP in the form of voice-operated GPS systems, digital assistants, speech-to-text dictation software, customer service chatbots, and other consumer conveniences. But NLP also plays a growing role in enterprise solutions that help streamline business operations, increase employee productivity, and simplify mission-critical business processes.⁶

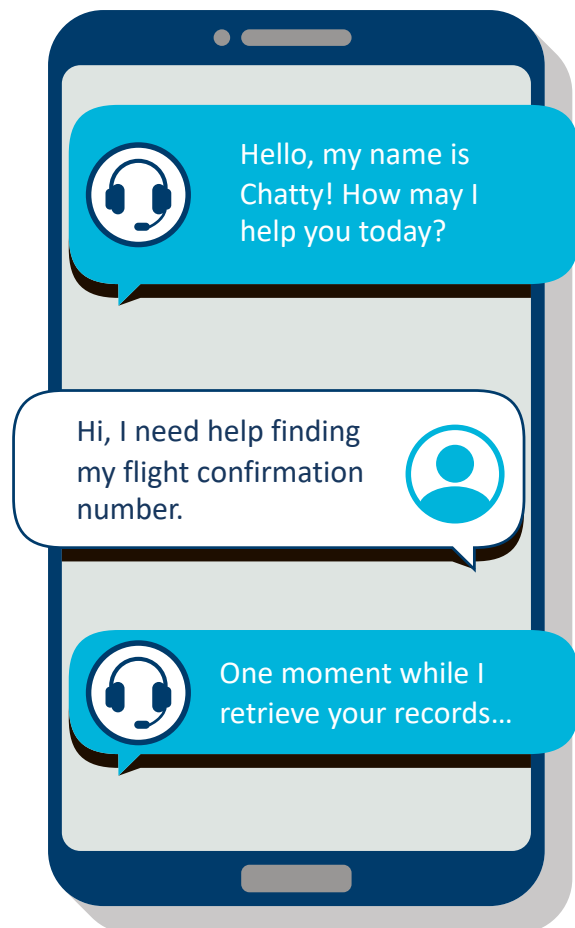
Generalized Uses

- Sentiment analysis
- Searching/summarizing
- Speech recognition
- Autocompletion/spell checking
- Chatbots
- Translation
- Fraud detection



NLP In Action

Customer service chat services on companies' websites commonly use NLP to create chatbots that interface with customers.



⁶<https://www.ibm.com/cloud/learn/natural-language-processing>



DEPARTMENT OF DEFENSE ARTIFICIAL INTELLIGENCE USE CASES

USE CASES: AI FOR JOINT WARFIGHTING

“Leveraging AI applications for systems, sensors, and targeting solutions to transform the character of warfare.”⁷

Imagine a world where AI-integrated sensors locate, identify, and track targets, then relay the information to warfighters in the field and commanders at HQ; these are just a few examples of the power of AI for warfighters. The AI can prioritize information sent to commanders, either by parameters set by humans, or by those the AI has learned over days of wargaming simulations done in the span of a few minutes or hours.

A skilled sensor operator can find a target in a displayed image or video feed using tools and training developed over years and at great cost. An AI can notice a few pixels out of place, or a stray heat signature, and identify potential targets with great precision, at great speed, and at a fraction of the cost. Or perhaps you can imagine an intelligence analyst who no longer must pore over hundreds of images to identify changes or areas of interest. That work is now done by AI in seconds, alerting humans to relevant changes, leaving the analyst to spend their time conducting analysis and determining the relevance of the information provided.

This is the power of AI for warfighters. For more information on how the Army is implementing this concept, read this [Blog - 01 24 20 - Aided Detection on the Future Battlefield](https://www.ai.mil/blog_01_24_20-aided-detection-on-the-future-battlefield-aitf.html) (https://www.ai.mil/blog_01_24_20-aided-detection-on-the-future-battlefield-aitf.html).

AI for Joint Warfighting in Action

The Joint Warfighting MI is working with several Combatant Commands (COCOMs) to build, test, and expand its Smart Sensor, a video processing AI prototype that rides on unmanned aerial vehicles and is trained to identify threats and immediately transmit the video of those threats back to manned computer stations for real-time analysis.⁸

Types of AI used:

Computer Vision | Deep Learning

⁷https://www.ai.mil/mi_joint_warfighting_operations.html

⁸https://www.ai.mil/blog_06_03_20-the_jcf_and_the_combatant_commands_a_symbiotic_relationship.html

⁹https://www.ai.mil/blog_01_24_20-aided-detection-on-the-future-battlefield-aitf.html

USE CASES: AI FOR JOINT LOGISTICS

“Improving fleet readiness through AI-driven diagnostics, training, process improvements, forecasting, and supply chain optimization.”¹⁰

Have you ever needed to maintain your unit’s gear but couldn’t bring something to full mission capable status because you were waiting on a part to ship from Guam? This is the type of situation almost anyone involved in DoD maintenance has experienced at some point in their careers. AI using neural networks can be used to predict maintenance needs in advance, connecting units to depots and depots to suppliers, so that parts are ordered, shipped automatically, and on the shelves BEFORE they’re needed. AI, using computer vision combined with a neural network, is being used to identify wear and tear on equipment and predict breakage or failure based on parameters human maintainers might not even consider. Is there a correlation between wear on widget A, lack of lubrication on sprocket B, and total equipment failure? The neural network can identify these patterns well before humans can. The AI could then flag that equipment for human attention and maintenance, mitigating a potential loss in mission capability.

If you’re a military aviator, you spend a lot of time in a simulator. A simulator can be a powerful way to replicate the cockpit environment at low cost, but it’s not always the best tool to replicate a battlefield environment. Programmed adversaries have capabilities limited by their coding and the capabilities of the simulator operators “driving” them. What if there was a way to replicate skilled adversary pilots, flying exact replicas of their actual aircraft, and whose skills would scale up or down with the skill of the U.S. trainee pilot, so that the training was always challenging, but never overwhelming? AI, using reinforcement learning, can fly millions of simulated engagements, using either known adversary tactics or developing their own.

AI for Joint Logistics in Action

Deep learning algorithms can be used as maintenance diagnostic and planning tools for complex equipment. The algorithm can identify potential failures based on data, rather than a set maintenance schedule, and can alert humans when action or parts might be required or order necessary parts automatically¹¹.

Types of AI Used: Deep Learning | Robotic Process Automation

¹⁰https://www.ai.mil/mi_joint_logistics.html

¹¹<https://peltarion.com/blog/applied-ai/the-value-add-of-deep-learning-in-predictive-maintenance>

USE CASES: AI FOR BUSINESS PROCESS TRANSFORMATION

“Transforming DoD business processes through AI that help unleash the strategic power of information, increase productivity, and reduce cost.”¹²

Is there anyone in your organization who spends a significant portion of their time reviewing documents for compliance with a certain set of rules or regulations? Does someone spend their days auditing forms for errors that, though mundane, could cost your organization time and money if not fixed? AI can utilize tools like optical character recognition and natural language processing (NLP) to automate and complete these tasks in a fraction of the time. This capability not only saves your organization time and money, but it also frees up your people to spend more time innovating, strategizing, or completing more challenging work.

One ever-present facet of military life is the continual personnel changes happening at any given time. Moves, promotions, marriages, changes in disability status, these things can all affect a member and need to be addressed quickly and accurately to ensure the member receives their correct entitlements and pay. Although many of these changes are simple and routine, many changes are happening at once. Wait times can grow long as workers struggle to clear the backlog. Many of these simple tasks could be (and are) offloaded to a robotic process automation AI, so that administrative personnel can focus on the more complex and challenging cases. Is there an administrative burden in your organization that you would be happy to let an AI complete for you?

AI for Business Process Transformation in Action

The US Air Force uses Machine Learning algorithms to Automate through logic-based expert system template and grammar rules in Air Force correspondence guidance, reduce time spent on correspondence by 50 percent.¹³

Types of AI Used:

NLP | Computer Vision | Robotic Process Automation

¹²https://www.ai.mil/mi_business_process_transformation.html

¹³https://www.ai.mil/blog_05_14_20-mi_business_process_transformation_mission.html

USE CASES: AI FOR JOINT INFORMATION WARFARE

“Delivering AI-enabled information capabilities that provide an information advantage to DoD and the Joint Force.”¹⁴

Cyberspace operations, information warfare, and electronic warfare are critical components of any potential future battlefield. Our adversaries are improving their capabilities to launch cyberattacks and are using AI to do so¹⁵. The best way to counter an AI-enabled adversary is to use AI to defend our systems as well.

An AI can detect patterns that correspond to a network intrusion and deploy countermeasures much faster than a human. The AI can then learn subtle changes in adversary tactics and redeploy its defensive systems to counter them. The same pattern recognition capability that can protect against cyberattacks can also identify and track specific cyber actors based on their behaviors.

AI for Joint Information Warfare in Action

An AI can learn from existing images or videos what illegal or suspicious behavior looks like, then warn humans when it observes precursor events like those that have led to adversary activities.¹⁶

Types of AI Used: Deep Learning | Computer Vision

¹⁴https://www.ai.mil/mi_joint_information_warfare.html

¹⁵<https://www.nscai.gov/2021-final-report/>

¹⁶<https://idstch.com/cyber/opportunities-and-challenges-of-applying-ai-ml-deep-learning-technologies-in-military-and-cyber-security/>

USE CASES: AI FOR JOINT FORCE PROTECTION

The DoD is using AI to rapidly provide first responders accurate information that is critical to saving lives and protecting property.¹⁷

When disaster strikes, rapid access to accurate information quickly can save lives. AI-enabled sensors can identify fire lines, flooded areas, people in need of rescue, and other critical pieces of information that can be sent automatically to a map accessible both to commanders at HQ and first responders in the field via mobile devices. Do you need a new route for emergency vehicles that takes new hazards caused by the disaster into account? AI can provide one. Do you need to allocate resources to fighting fires not only where they are now, but also to where they will be in the future? AI can make those projections and resourcing recommendations.

AI can be used in the Counter Weapons of Mass Destruction (WMD) field as well. Natural language processing can scrape social media for suspicious posts. Neural networks can identify patterns in behavior that lead to terrorist activity. Computer vision can track movement of people or materials observed on a variety of sensors all over the world. All of these capabilities can combine to help prevent proliferation of WMDs throughout the world.

AI for Joint Force Protection in Action

Unmanned aircraft equipped with Full Motion Video sensors can be flown over wildfire regions. The CDAO's AI computer vision algorithm automatically analyzes the video data, detects regions with active wildfires and provides near real-time fire location updates to a CDAO-developed digital map application on first responders' mobile devices. Faster and more accurate information allows for more rapid and better-informed decision-making.¹⁸

Types of AI Used: Computer Vision | Deep Learning

¹⁷https://www.ai.mil/mi_joint_force_protection.html

¹⁸https://www.ai.mil/blog_09_16_19.html

USE CASES: AI FOR WAR FIGHTER HEALTH

Artificial intelligence in medicine is changing the game. AI can be used to tailor treatments to individual patients. AI can also be used to identify potential problems in imaging (such as CAT scans, X-rays, or MRIs) faster than humans, leading to earlier interventions.

In 2018, the American Medical Association reported on a study concluded that 32% of doctors surveyed spent 20 hours or more per week just on paperwork and administrative tasks.¹⁹ AI can simplify and speed up the processing of medical paperwork and records, leaving more time for doctors, nurses, and other practitioners to spend with their patients.

Medical sensors and wearables that are combined with neural networks tell medical practitioners and individuals more about their health than ever before. Using data from these devices, AI can monitor the health status of DoD personnel, giving leadership an idea of the overall health of the force. It can signal to the individual or their doctor that they should investigate early warning signs of trouble and potentially get treated for medical conditions earlier than ever before.

AI for War Fighter Health in Action

The Warfighter Health team is advancing an initiative to digitize more than 55 million pathology slides for medical research to create algorithms that help identify different types of diseases.²⁰

Types of AI Used:

Computer Vision | Deep Learning

¹⁹ <https://www.ama-assn.org/practice-management/sustainability/do-you-spend-more-time-administrative-tasks-your-peers>

²⁰ https://www.ai.mil/blog_04_15_20-JAIC_mi_warfighter_health.html

Resources

Open-Source Resources

DoD Resources

Understanding AI Technology: A guide for DoD Leaders	https://www.ai.mil/docs/Understanding%20AI%20Technology.pdf
2020 DoD AI Training & Education Strategy	https://www.ai.mil/docs/2020 DoD AI Training and Education Strategy and Infographic 10 27 20.pdf
CDAO AI Explainer- Explaining Artificial Intelligence and Machine Learning	https://youtu.be/y_rY0Zln5L4
A DARPA Perspective on Artificial Intelligence	https://www.youtube.com/watch?v=-O01G3tSYpU

Industry Resources

How to Choose Your First AI Project	https://hbr.org/2019/02/how-to-choose-your-first-ai-project
-------------------------------------	---

The Chief Digital and Artificial Intelligence Office (CDAO) Talent and Workforce division develops, directs, and coordinates digital, data analytics, and artificial intelligence training opportunities across the Department.

osd.pentagon.cdao.mbx.human-capital-team@mail.mil



CDAO

ARTIFICIAL INTELLIGENCE AND ITS USES IN THE DOD

***TRANSFORMING THE DEPARTMENT OF DEFENSE
THROUGH AI***



U.S. Department of Defense

ai.mil

OSD CDAO Education & Training
osd.pentagon.cdado.mbx.human-capital-team@mail.mil