JOHNS HOPKINS
APPLIED PHYSICS LABORATORY

Intelligent Systems at JHU/APL

NASA AI Workshop : 27 November 2018

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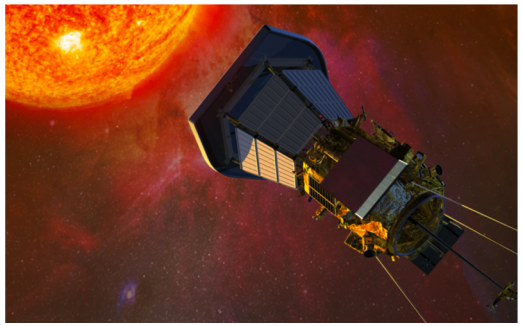
75 Years of Service to the Nation

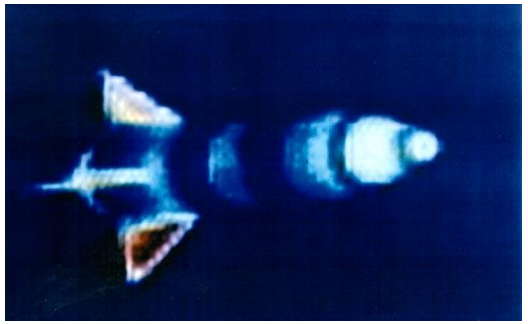
Transformative Innovation and Trusted Technical Leadership

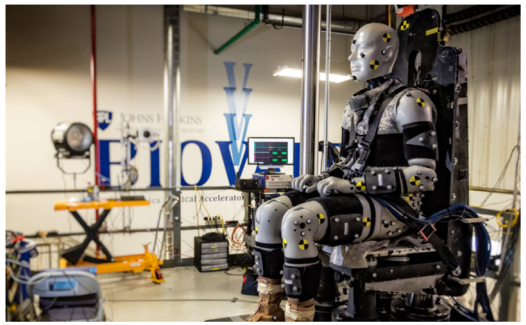
JHU/APL Organization

- Space Exploration
- Air & Missile Defense
- Force Projection
- Asymmetric Operations

- National Security Analysis
- Research & Exploratory Development



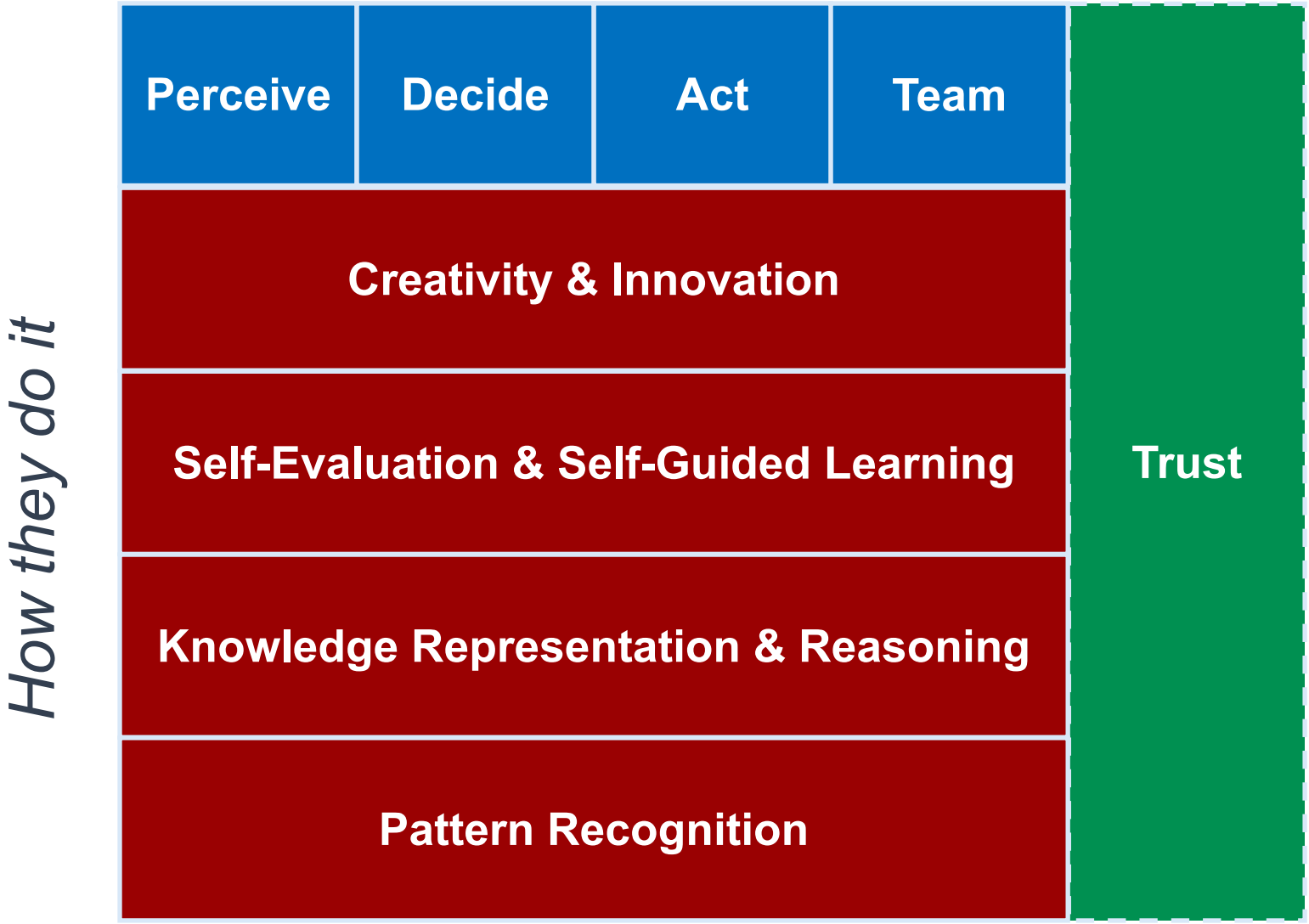




Cross Enterprise Multidisciplinary Team

- Artificial Intelligence
- Applied Neuroscience
- Robotics
- Autonomous Systems

What intelligent systems do



What intelligent systems do

Perceive	Decide	Act	Team	Trust

What intelligent systems do

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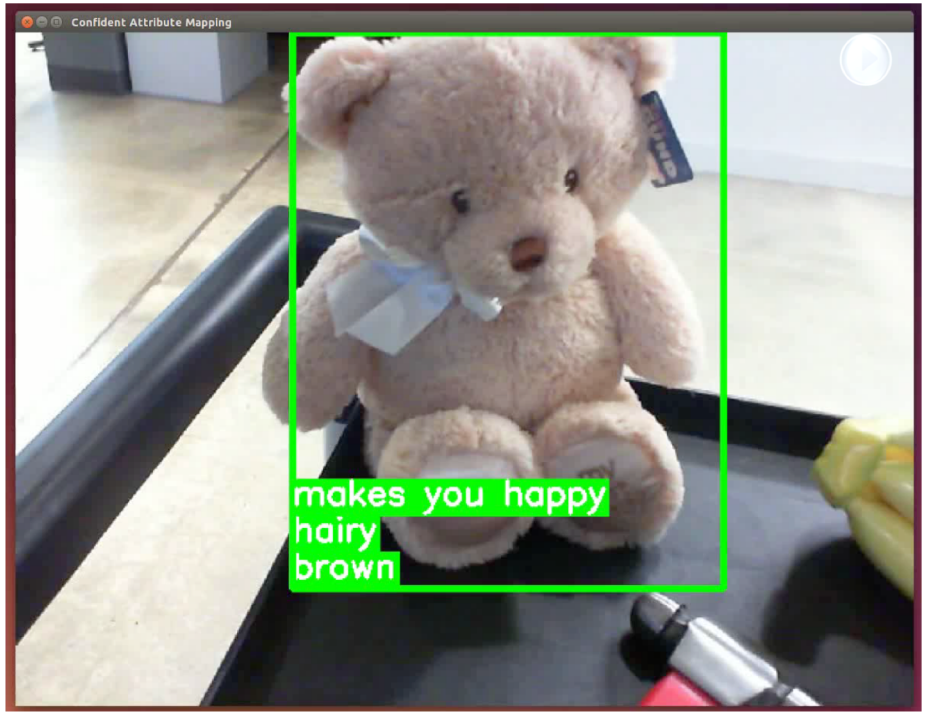
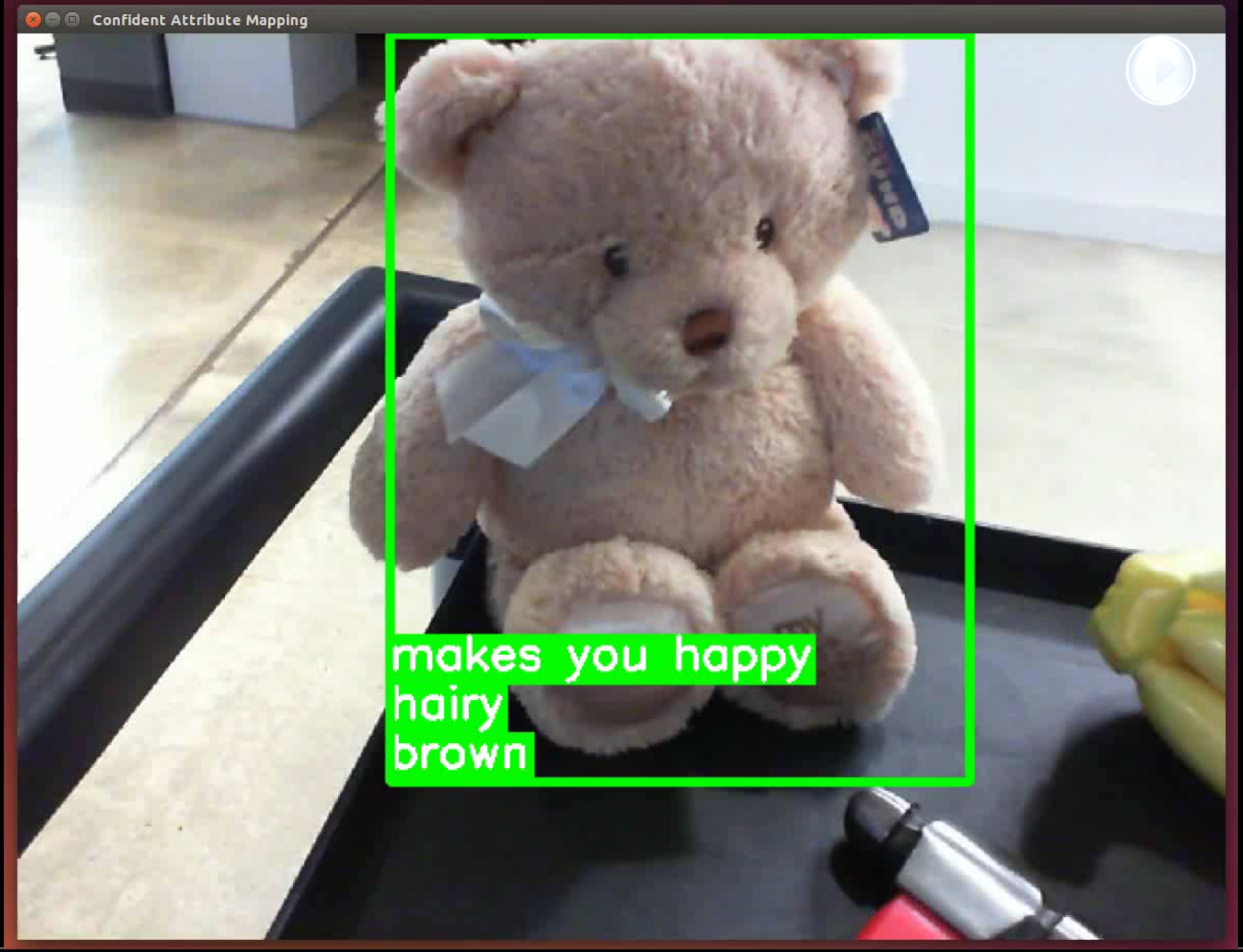
AI Research Challenge: Classification of Novel Objects

What intelligent systems do

Perceive	Decide	Act	Team	Trust



APL Research Example: Zero Shot Learning


Confident Attribute Mapping
makes you happy
hairy
brown

What intelligent systems do

Perceive	**Decide**	Act	Team	Trust

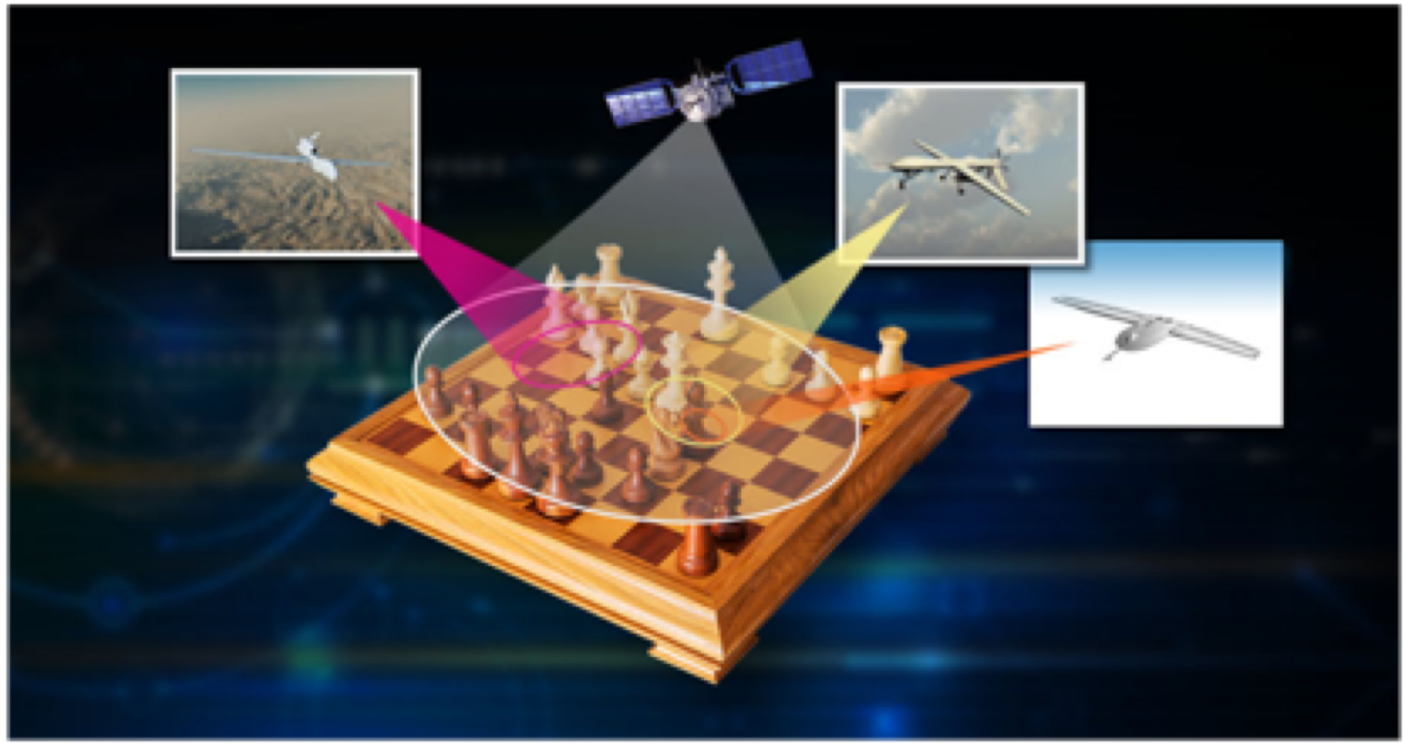
What intelligent systems do

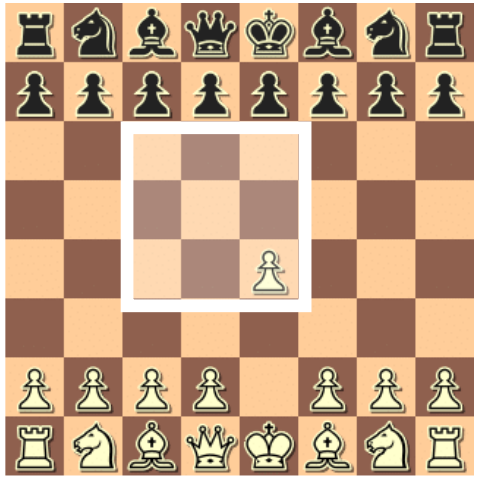
Perceive	**Decide**	Act	Team	Trust

AI Research Challenge: Translating advancements in gaming environments to real-world applications

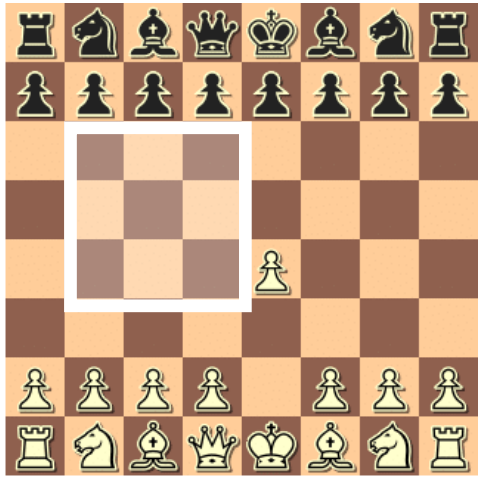
What intelligent systems do

Perceive	**Decide**	Act	Team	Trust





1 possible board state



20 possible board states

APL Research Example: Reconnaissance Blind Chess

What intelligent systems do

Perceive	Decide	**Act**	Team	Trust

What intelligent systems do

Perceive	Decide	**Act**	Team	Trust

AI Research Challenge: Generalizing to previously unseen, dynamic environments

What intelligent systems do

Perceive	Decide	**Act**	Team	Trust

APL Research Example: Flying Fish – Adapting to Dynamics Environments

10 FEET DEEP

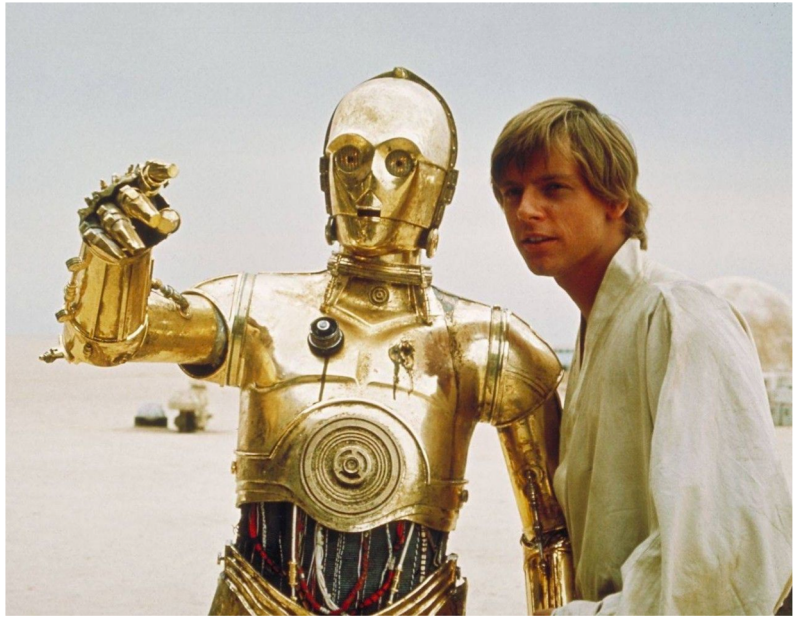
What intelligent systems do

Perceive	Decide	Act	Team	Trust

What intelligent systems do

Perceive	Decide	Act	**Team**	Trust

Collaboration



Fusion

<u>AI Research Challenge</u>: Joint task allocation & planning

What intelligent systems do

Perceive	Decide	Act	**Team**	Trust

APL Research Example: Autonomous Marsupial Robot Teams

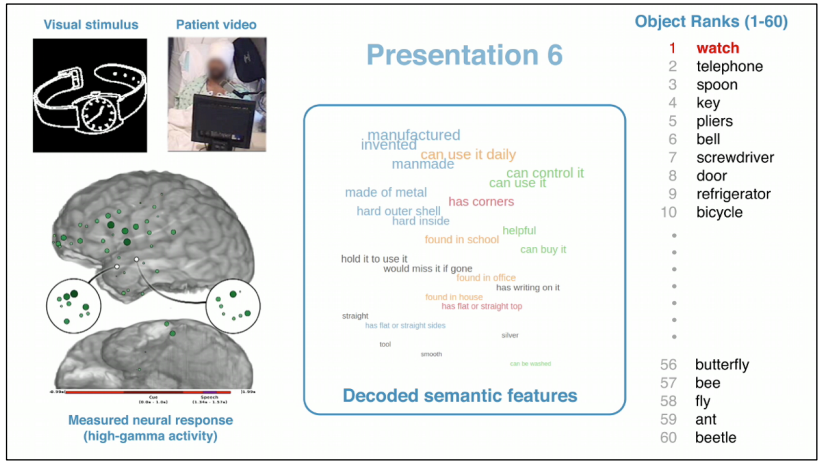
ROBO-SALLY APPROACHES A POTENTIALLY CONTAMINATED
SHIPPING CONTAINER IN A GPS DENIED AREA

What intelligent systems do

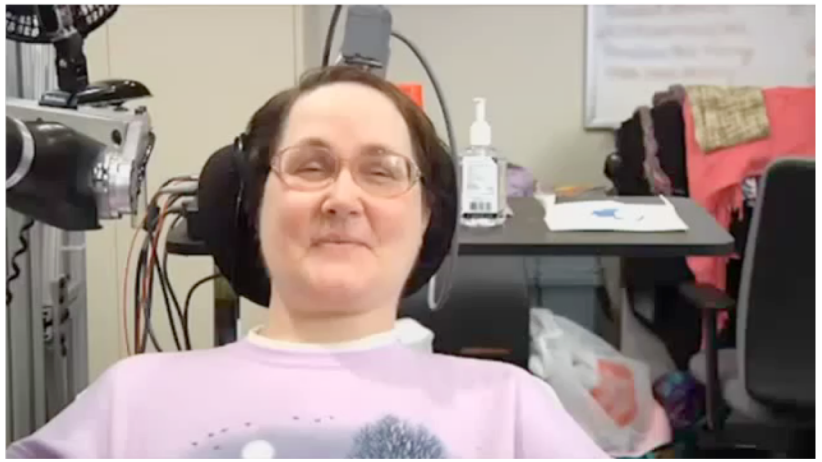
Perceive	Decide	Act	**Team**	Trust

Retinal Prosthetics

Brain Computer Interface Semantic Decoding



Brain Computer Interface Motor Control



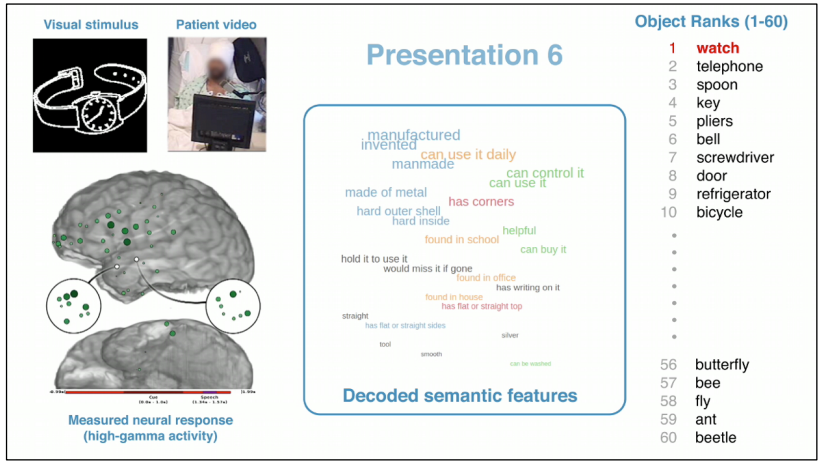
APL Research Examples: Human-Machine Fusion

What intelligent systems do

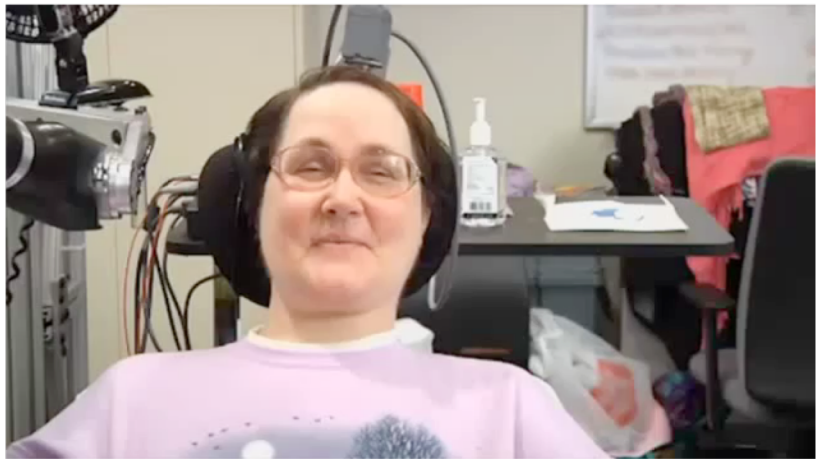
Perceive	Decide	Act	**Team**	Trust

Retinal Prosthetics

Brain Computer Interface Semantic Decoding



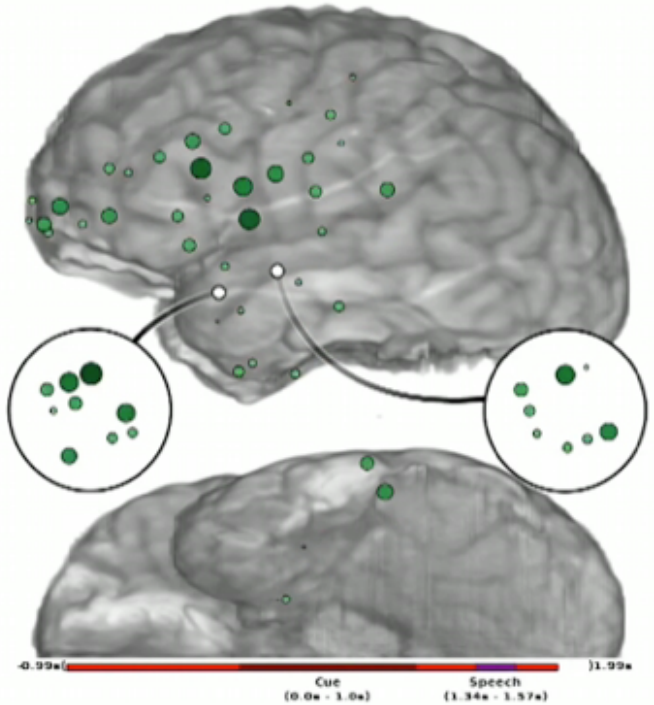
Brain Computer Interface Motor Control



APL Research Examples: Human-Machine Fusion

Visual stimulus

Patient video



Measured neural response
(high-gamma activity)

Presentation 6

Decoded semantic features

Object Ranks (1-60)

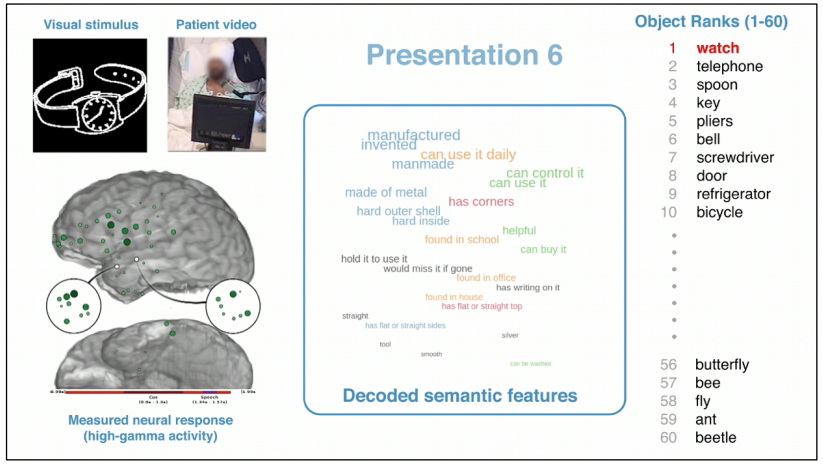
1 watch
2 telephone
3 spoon
4 key
5 pliers
6 bell
7 screwdriver
8 door
9 refrigerator
10 bicycle
•
•
•
•
•
•
•
56 butterfly
57 bee
58 fly
59 ant
60 beetle

What intelligent systems do

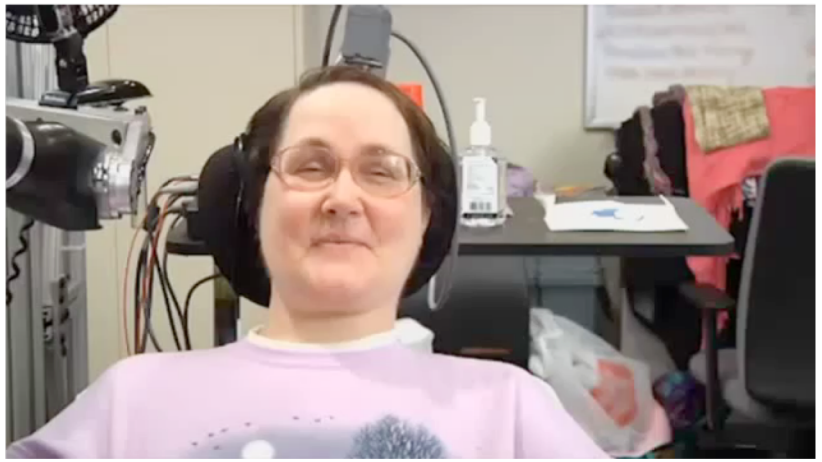
Perceive	Decide	Act	**Team**	Trust

Retinal Prosthetics

Brain Computer Interface Semantic Decoding



Brain Computer Interface Motor Control



APL Research Examples: Human-Machine Fusion

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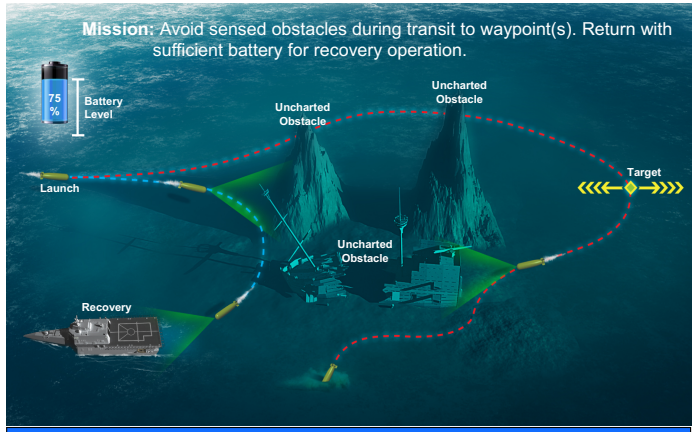
AI Research Challenge: Test & evaluation of intelligent systems

What intelligent systems do

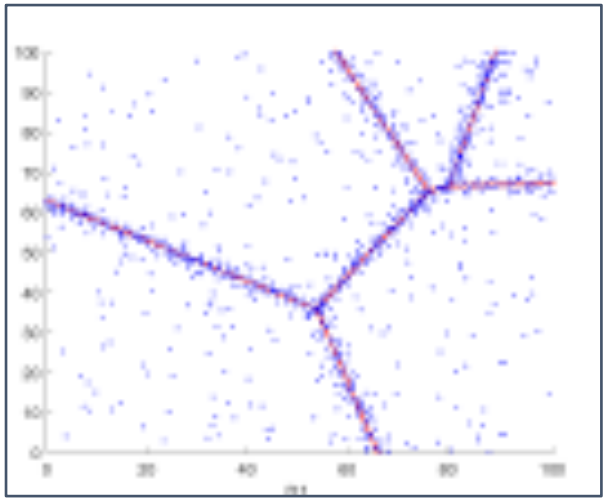
Perceive	Decide	Act	Team	Trust

Black Box System Imitation

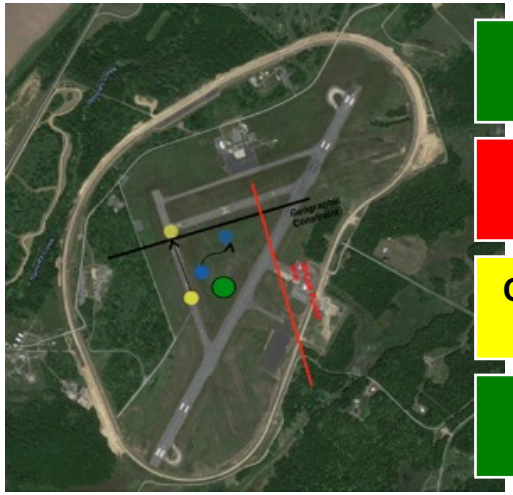


Mission Failure – UUV aborted mission due to insufficient battery
Safety Failure – UUV does not make it to recovery point

Black Box System Characterization



Black Box System Assessment



WATCHDOG NOMINAL

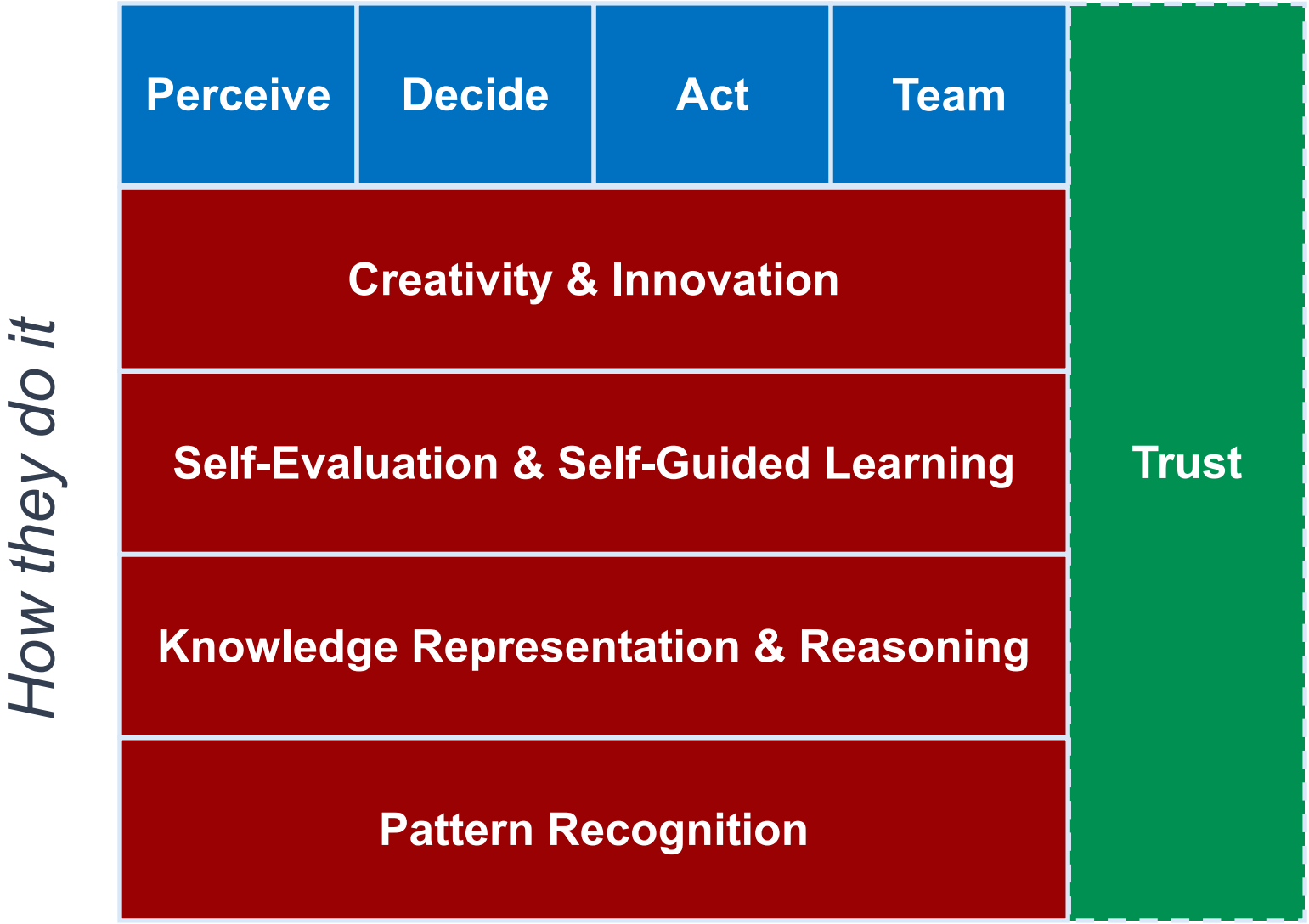
WATCHDOG ASSERT

CONSTRAINT VIOLATION

WATCHDOG NOMINAL

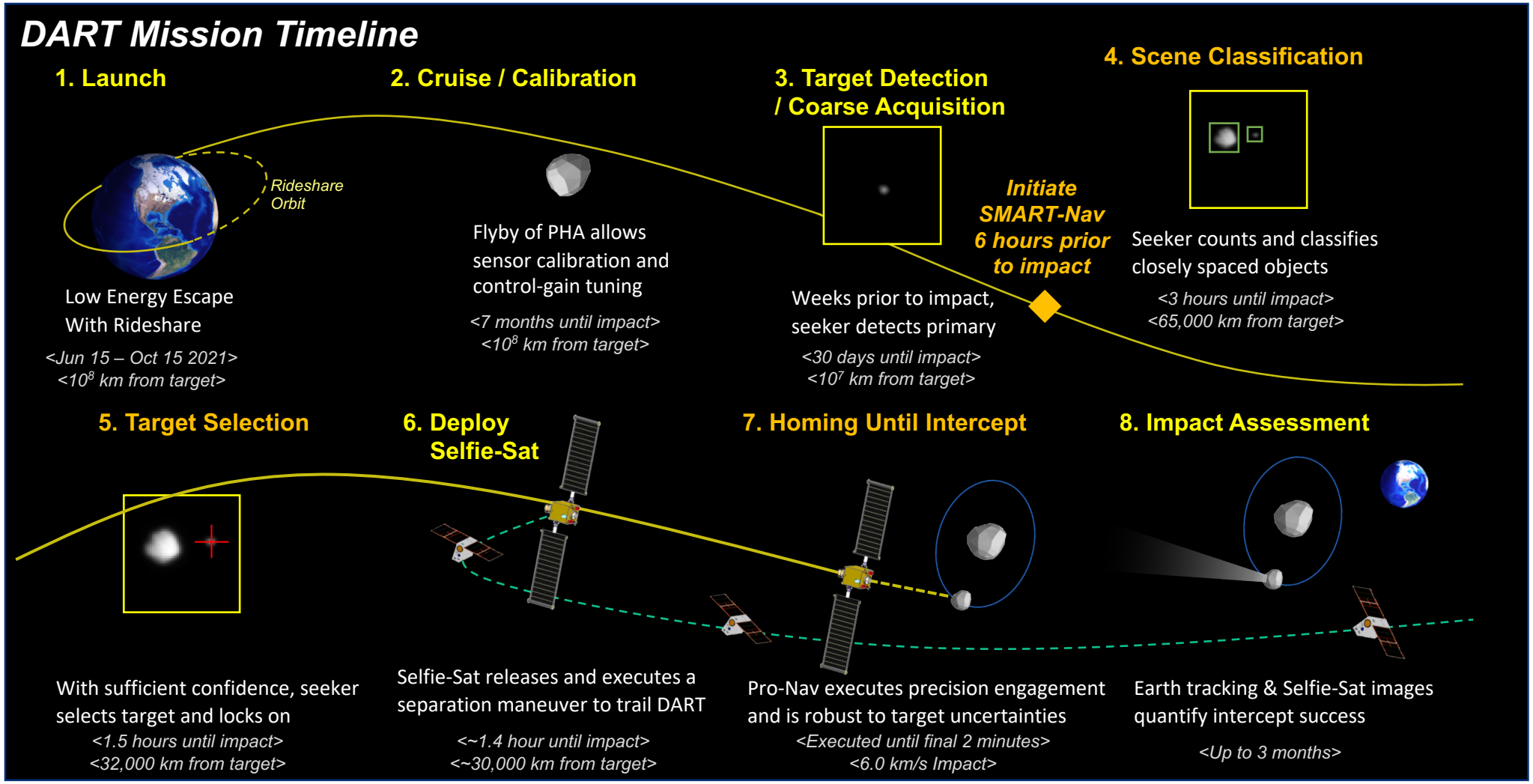
APL Research Examples: T&E for Intelligent Systems

What intelligent systems do



Double Asteroid Redirection Test (DART) Mission

Small-body maneuvering Autonomous Real-time Navigation (SMART Nav)



Time to Impact: 00:03:20
10x Realtime

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