

Scientific support to Munition in the sea

The workshop addresses scientific gaps
and how research can bring
substantial contributions for
solutions and advances in knowledge

CNR-INM
National Research Council of Italy
Institute of Marine Engineering
Via di Vallerano, 139, 00128 Rome

December 6-7, 2018

Support to Decisions AI Technology, Knowledge-Based Systems, Agent-Based Modeling



Amedeo Cesta

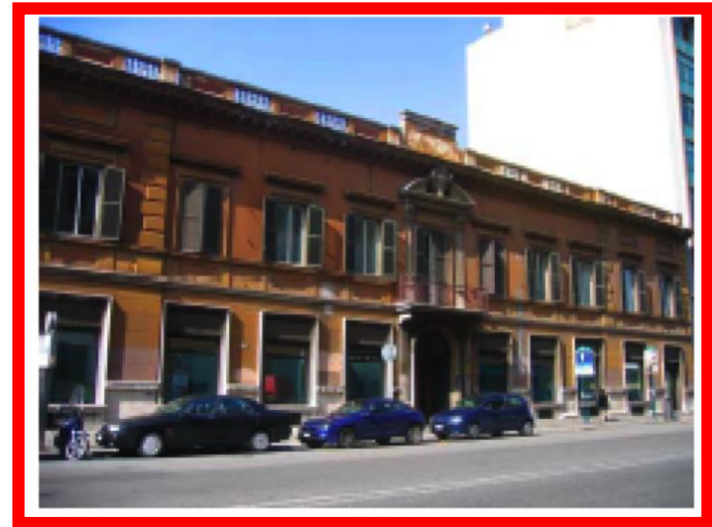
Consiglio Nazionale delle Ricerche

Institute for Cognitive Sciences and Technologies

<http://www.istc.cnr.it/group/pst>

ISTC-CNR: a CNR Institute

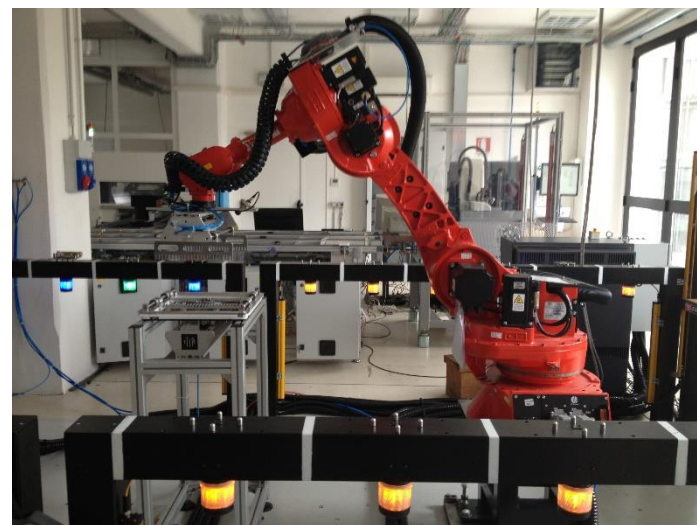
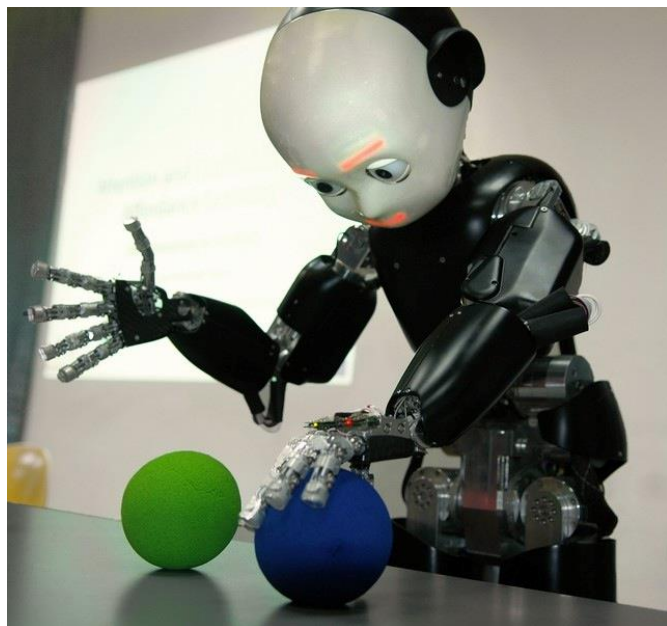
**Institute for
Cognitive Science
and Technology
@
CNR - National
Research Council of
Italy**



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Via S. Martino della Battaglia, 44
I-00185 Rome, Italy
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Robotics & AI @ CNR-ISTC

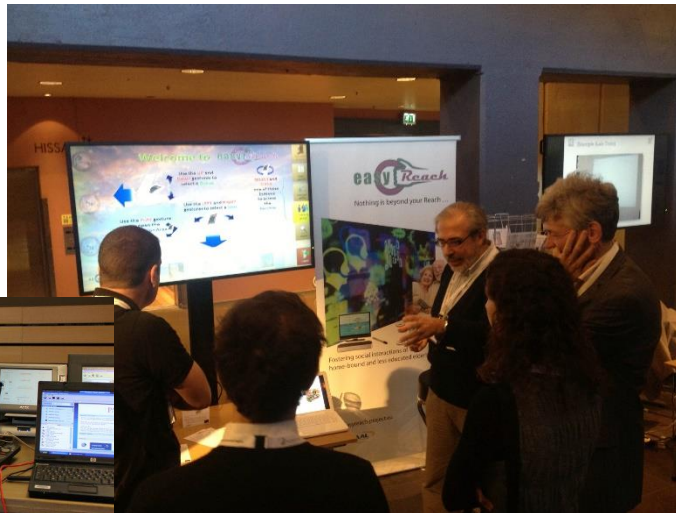
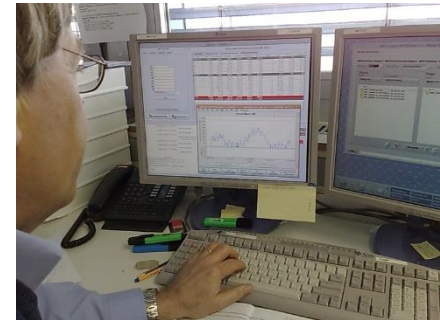


A set of my interests ...

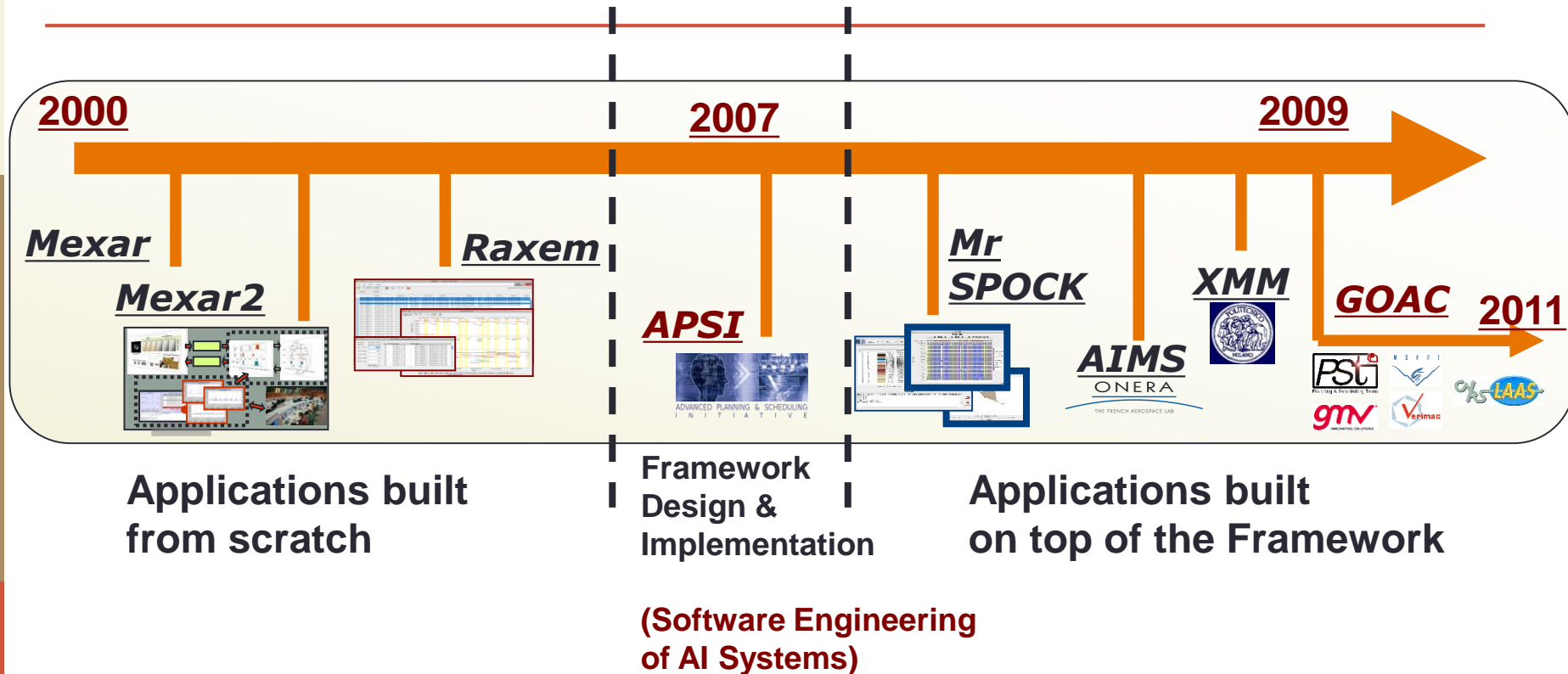


**Interactive
systems**

**Autonomous
systems**



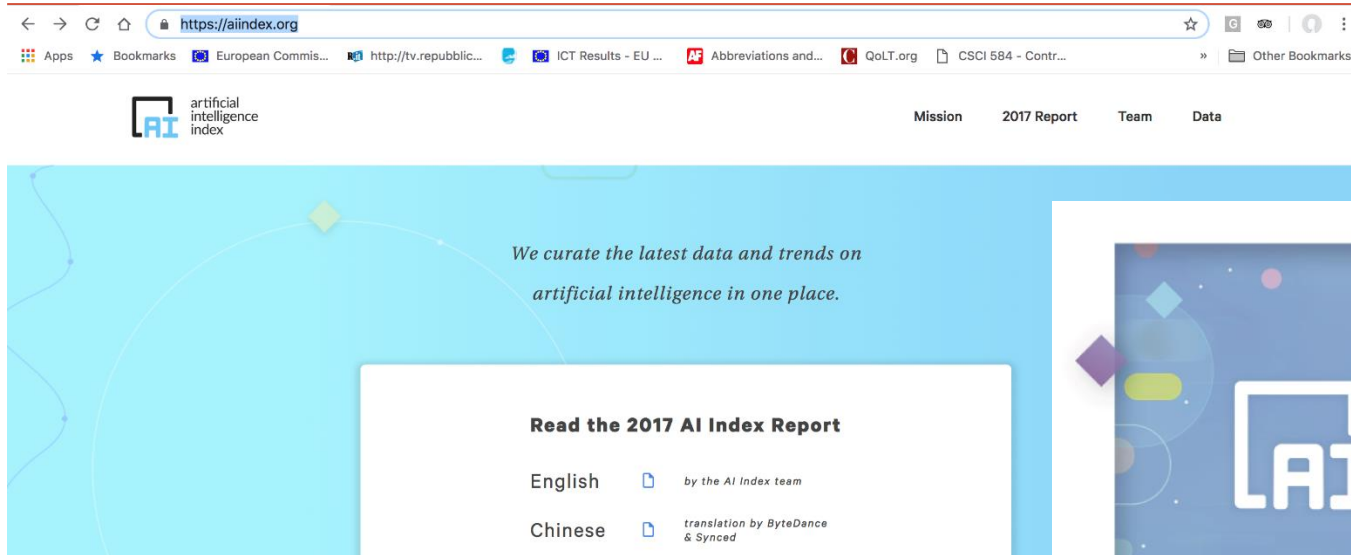
An example: the collaboration with ESA



International leadership in planning software for on-ground mission operations support



A report on AI performances (<http://aiindex.org>)



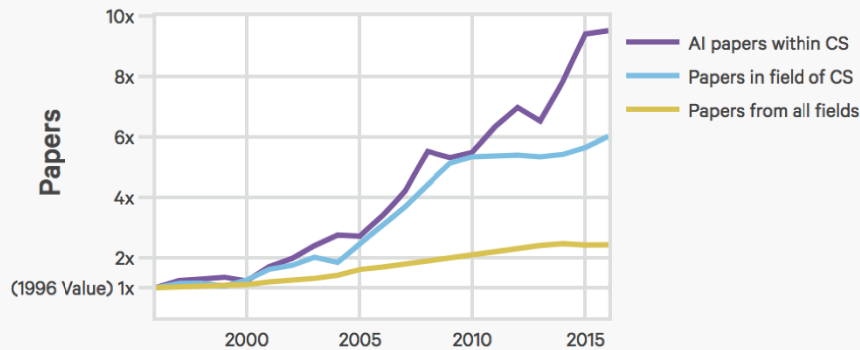
- ❑ A set of indicators gathered from top experts of the field
- ❑ The idea of having an evolving report on «the state of AI»

Download from the same link the 2018 edition !!



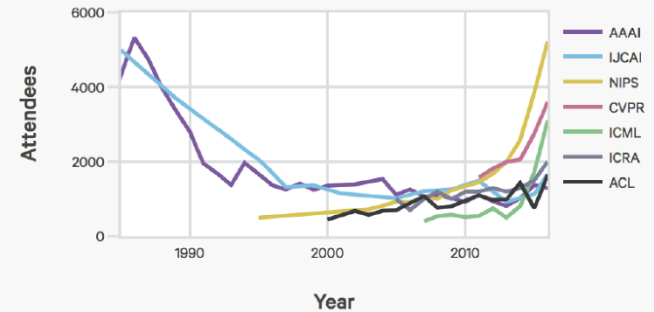
Some indicators of a healthy sector

Growth of Annually Published Papers



Year

Large Conference Attendance

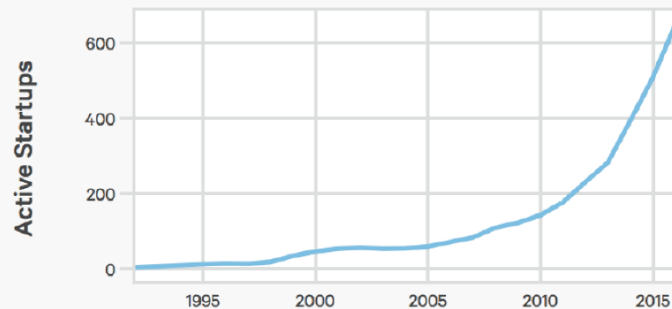


AIINDEX.ORG

Shifting Focus

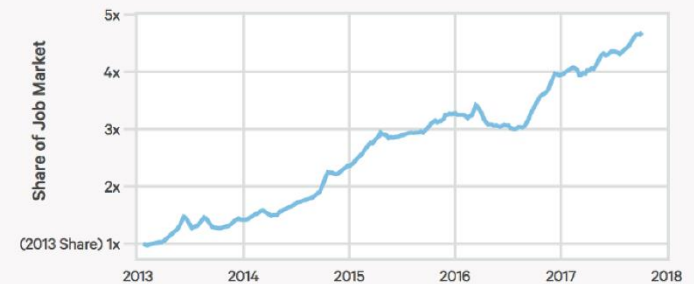
These attendance numbers show that research focus has shifted *from symbolic reasoning to machine learning and deep learning*.

Startups Developing AI Systems



Year

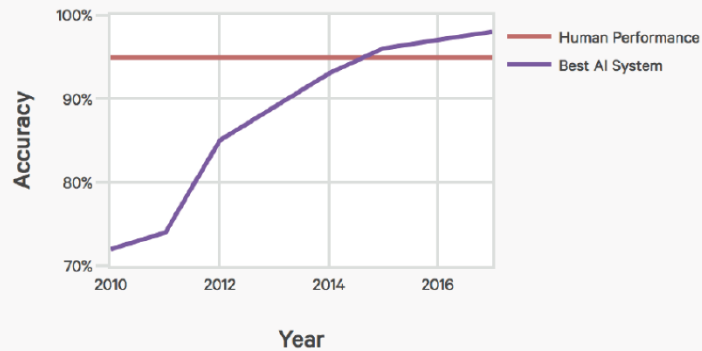
Share of US Jobs Requiring AI Skills (Indeed.com)



Date

Comparison with humans ...

Object Detection, LSVRC Competition

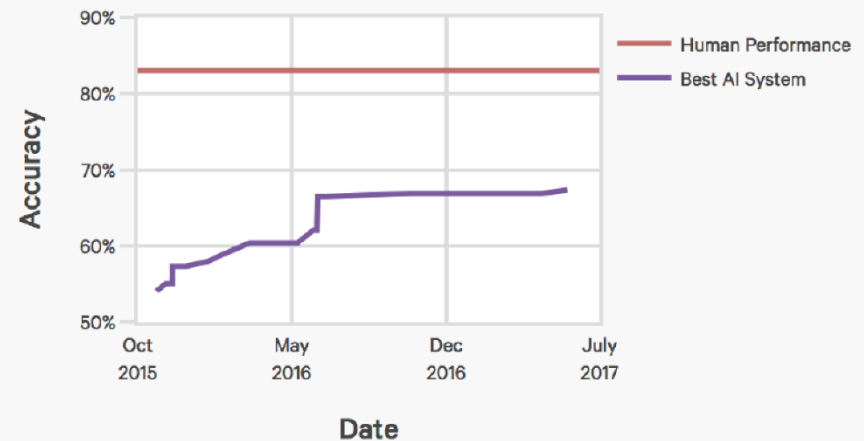


Source: image-net.org

AIINDEX.ORG

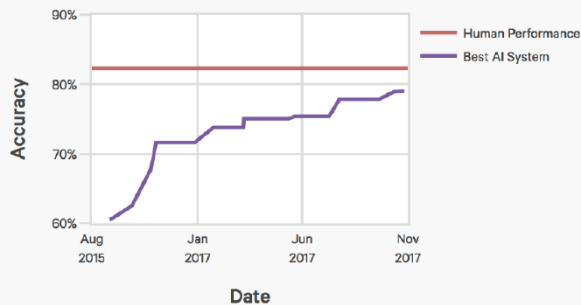


Visual Question Answering, VQA 1.0

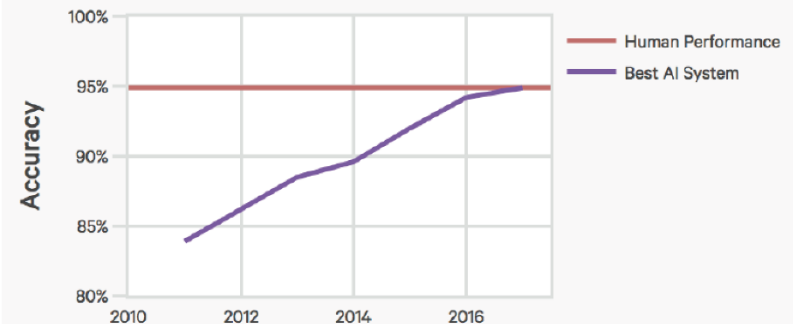


2.5% *Error rates for image labeling have fallen from 28.5% to below 2.5% since 2010.*

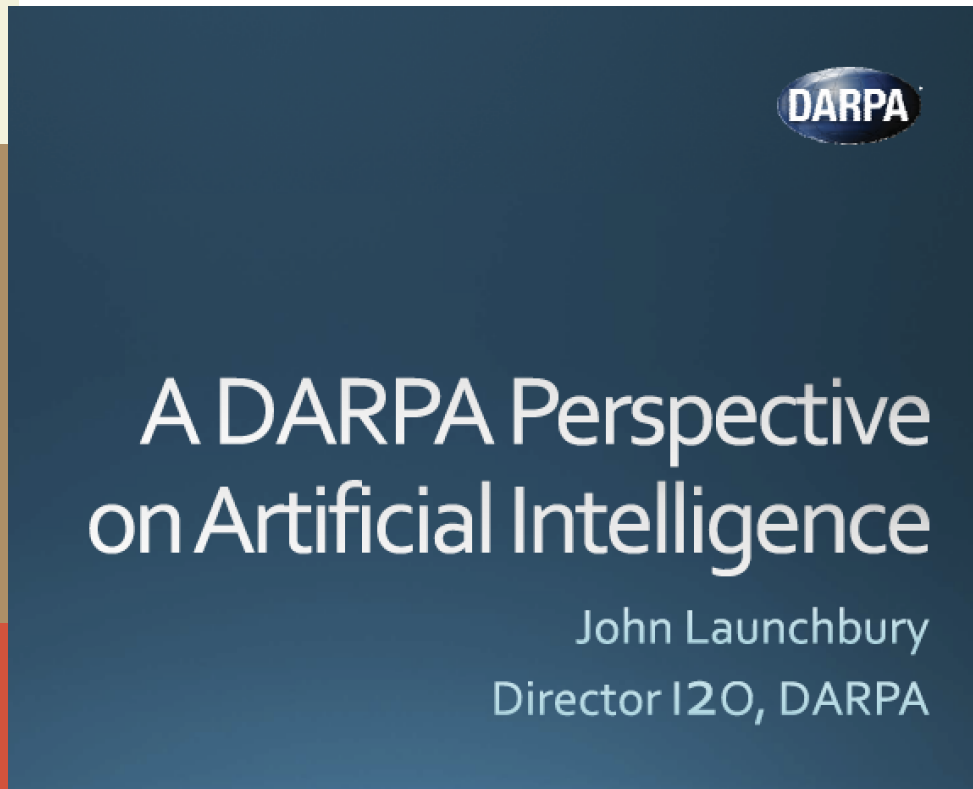
Question Answering, SQuAD v1.1



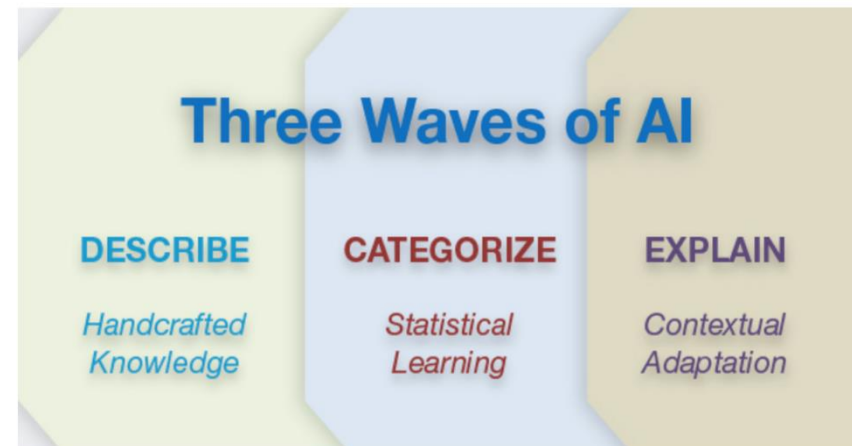
Speech Recognition, Switchboard HUB5'00



A very recent talk from DARPA

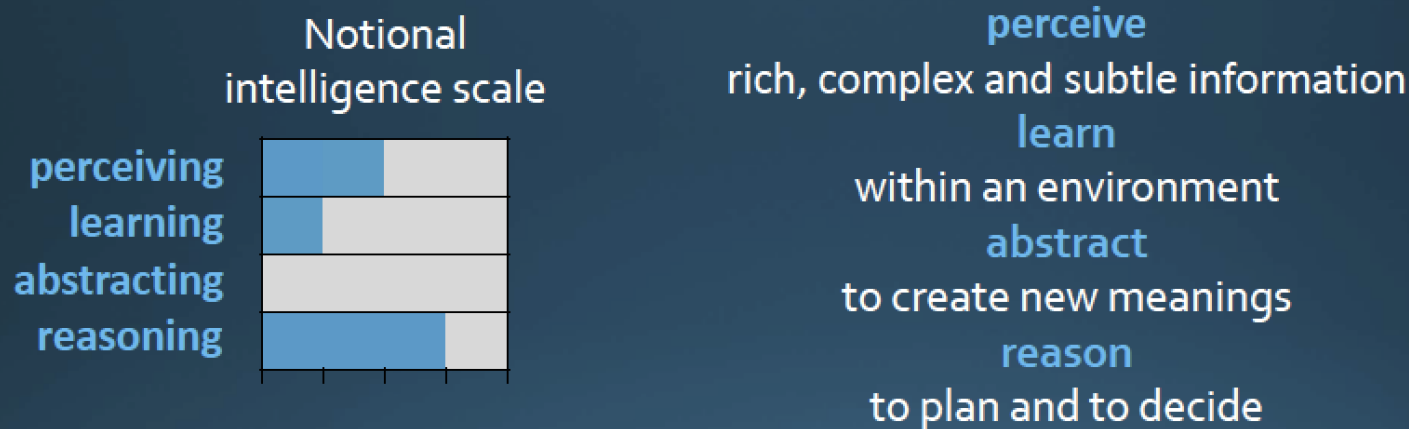


DARPA Perspective on AI



AI from key abilities

Ability to process information



Artificial intelligence is a programmed ability to process information

Reasoning-Based AI

The first wave of AI



Handcrafted Knowledge

Reasoning-Based AI (2)

The first wave of AI

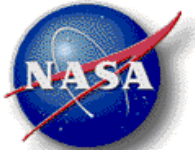


Engineers create sets of rules
to represent knowledge in
well-defined domains



The **structure** of the knowledge is defined by humans
The **specifics** are explored by the machine

DS1 Remote Agent Experiment (circa 1999)



- Remote Agent Experiment
 - May 17-21, 1999
 - 65 Million miles from Earth
 - During *Ballistic Cruise*
- Remote Agent on DS1 wins NASA's 1999 Software of the Year



Ground System

Real-Time Execution

Remote Agent

Mission Manager

Smart Executive

Planner/
Scheduler

Mode ID
and
Reconfig

RAX Manager

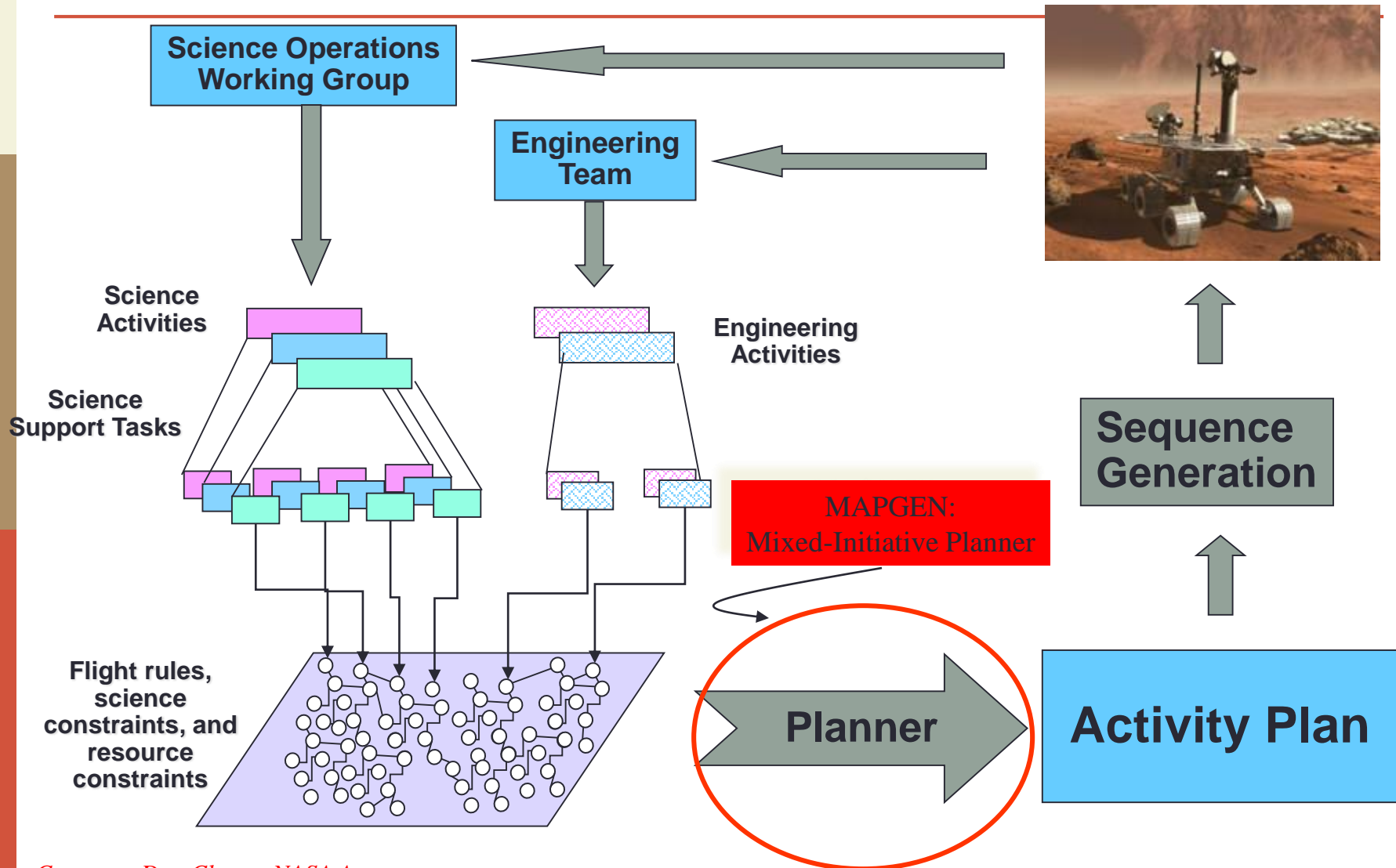
Planning Experts (incl.
Navigation)

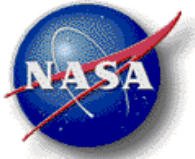
Fault
Monitors

Flight
H/W

**Courtesy:
Kanna Rajan 2005**

Abstracted Command Cycle for MER





MAPGEN in Surface Operations

- MAPGEN: First AI based System to control a spacecraft on the surface of another planet on January 15th 2004

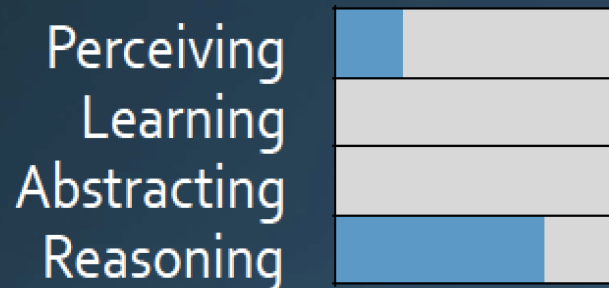
- Spirit:
 - Nominal science operations from Sol 15 to 18
 - All planned activities from 16/17 executed on board
 - Return to nominal science operations within 2-3 days
- Opportunity:
 - Informal use begins Sol 4/5
 - Commanded activities executed on board nominally
- Dual rover use of MAPGEN for the last 1000+ Sols!
 - Twice a day
 - Continued use for years ...



- Conservative Return on Investment (ROI) to NASA: 20% to 30% additional science returned per Sol, over a manual approach for plan synthesis

Emphasis on Reasoning Aspects

The first wave of AI



Enables reasoning over
narrowly defined problems

No learning capability
and poor handling of
uncertainty

Limitations: slow scale up

First wave stumbles



2004
completed: 0



Source: DARPA

2005
completed: 5

DARPA Autonomous Vehicle Grand Challenge
140 miles of dirt tracks in California and Nevada

Recent years in AI

The second wave of AI



Source: thrillist.com



Statistical Learning

Emphasis on statistical models

The second wave of AI



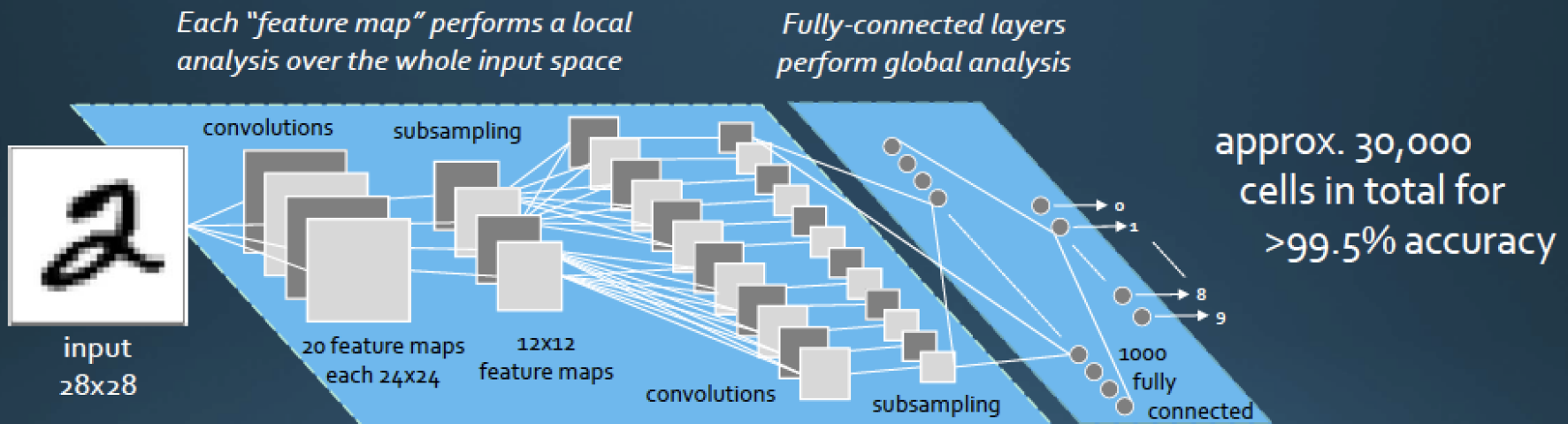
Engineers create statistical models
for specific problem domains and
train them on big data



Source: gobelluno.it

Main actors in data-science: the Machine-Learning «programmers» + the high-performance computing

Structured neural net



Machine-learning "programmers" design the network structure with experience and by trial and error

Great success for sure

AI technology is powerful

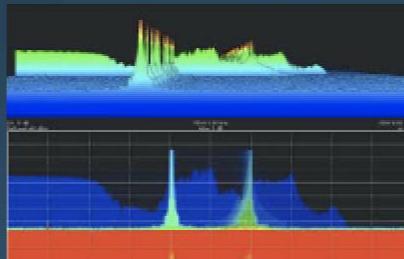


Code and network flows



Observe real-time
cyber attacks at scale

Electromagnetic spectrum



Overcome spectrum scarcity
to meet wireless data demand

Autonomous platforms



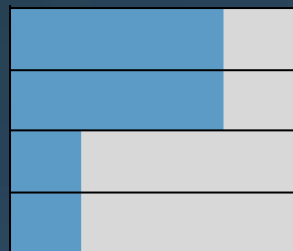
Reshape defense
missions

Assessment

The second wave of AI



Perceiving
Learning
Abstracting
Reasoning



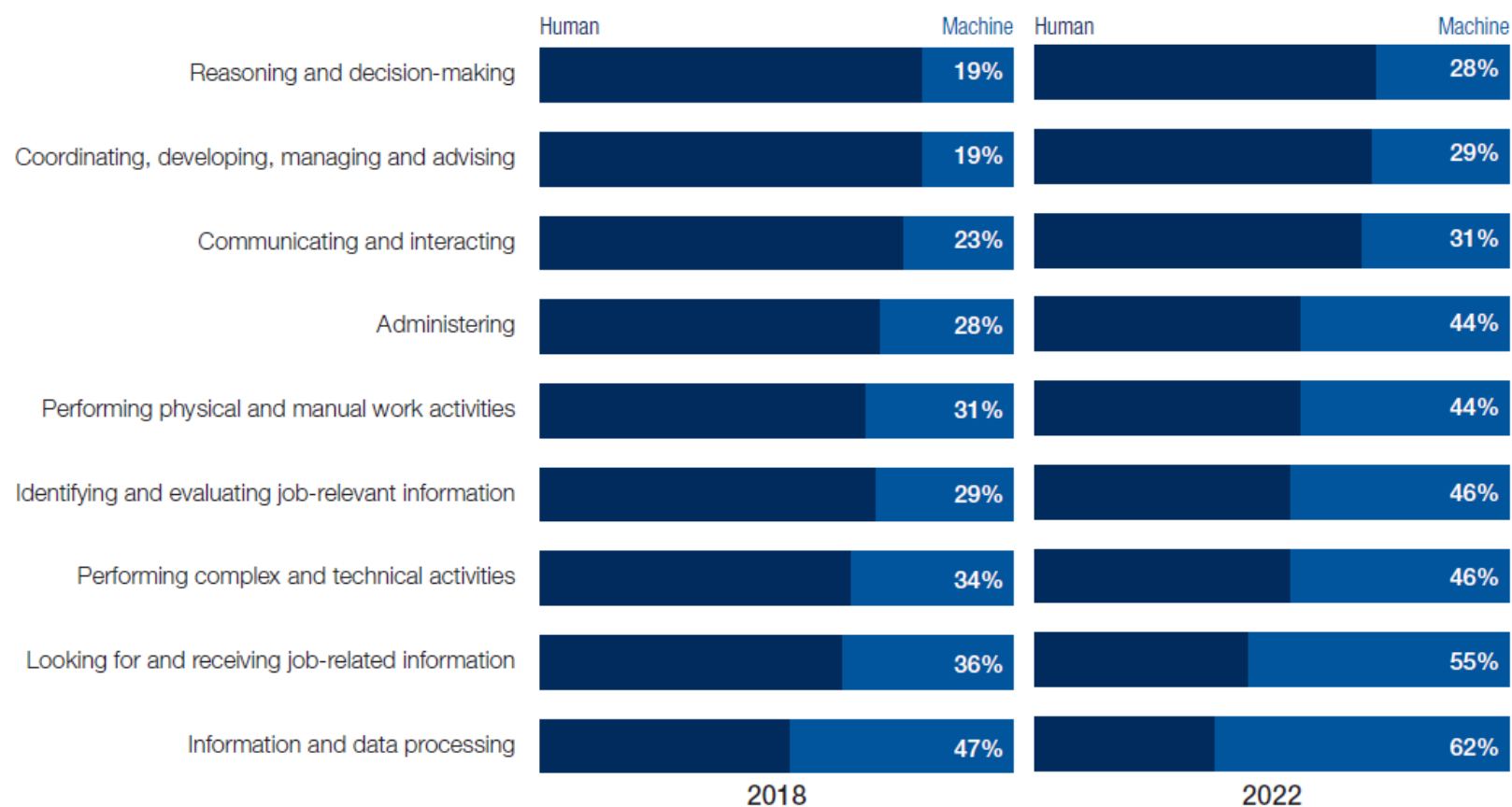
Nuanced classification and
prediction capabilities

No contextual capability and
minimal reasoning ability

The Future of Jobs (report WEF 2018)

The Future of Jobs Report 2018

Figure 5: Ratio of human-machine working hours, 2018 vs. 2022 (projected)



Source: Future of Jobs Survey 2018, World Economic Forum.

For this meeting purposes the current AI state-of-the-art can be of great help



- E.g., for the task of monitoring «status of things» current techniques may help a lot
- **Predictive models (agent-based simulations, big data knowledge discovery, use of other math-base models)** allow to derive several sophisticated new data
- Then you can decide better

But ...

Challenges with second wave



a young boy is holding
a baseball bat

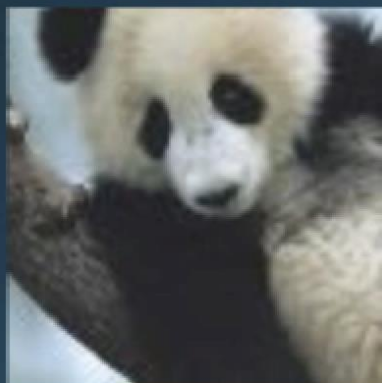
Statistically impressive,
but individually unreliable

But ...

Challenges with second wave



"Panda"



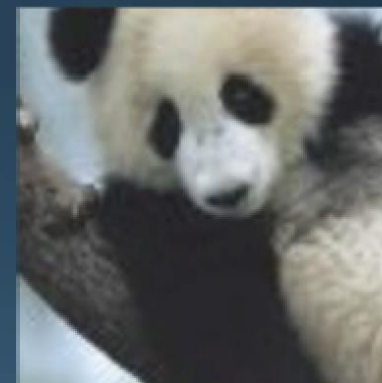
+

< 1%
targeted distortion



=

"Gibbon"
(99.3% confidence)



Inherent flaws can be exploited

... even worst !!

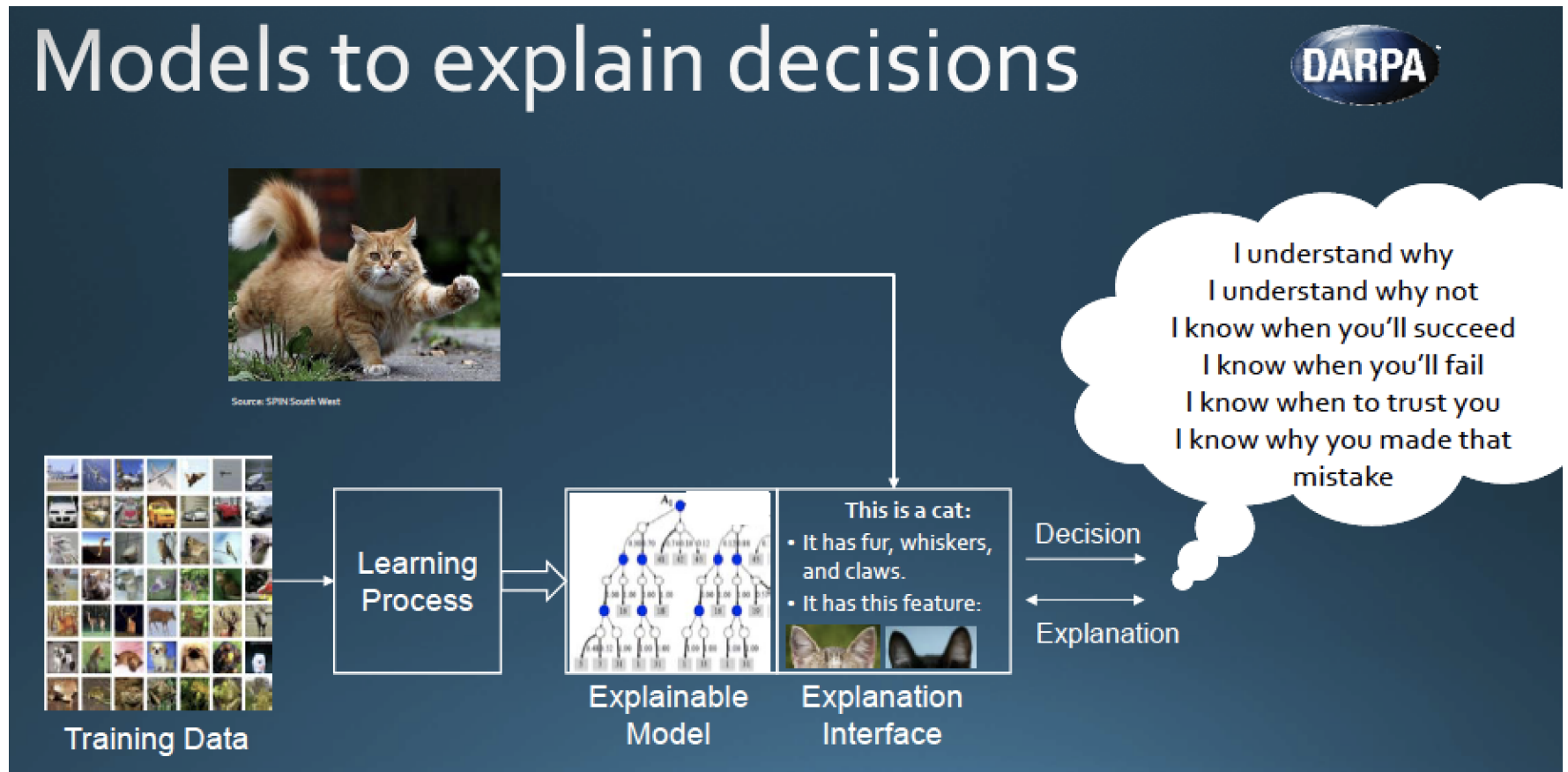
Challenges with second wave



Internet trolls cause
the AI bot, Tay,
to act offensively

Skewed training data creates maladaptation

One key problem ... «understand why(s)»



Their approach !!!!



DEFENSE ADVANCED
RESEARCH PROJECTS AGENCY

EXPLORE BY TAG

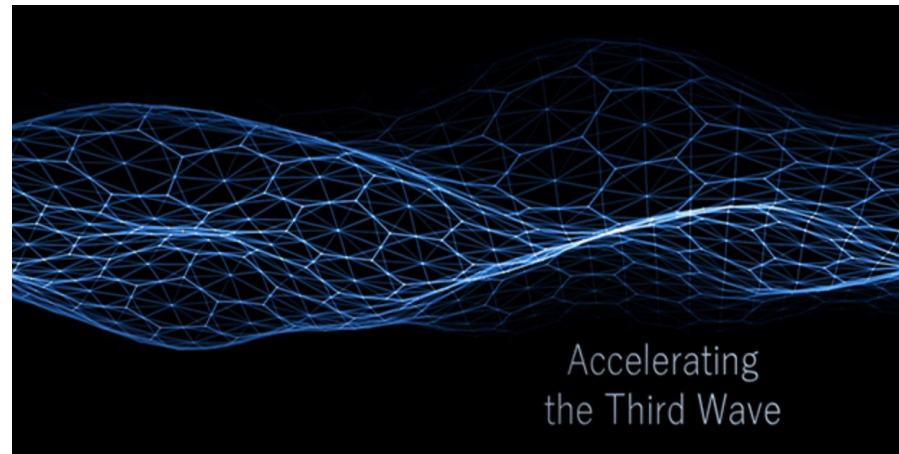
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Defense Advanced Research Projects Agency > News And Events

DARPA Announces \$2 Billion Campaign to Develop Next Wave of AI Technologies

DARPA's multi-year strategy seeks contextual reasoning in AI systems to create more trusting, collaborative partnerships between humans and machines

OUTREACH@DARPA.MIL
9/7/2018



Accelerating
the Third Wave

The third wave ... hopefully

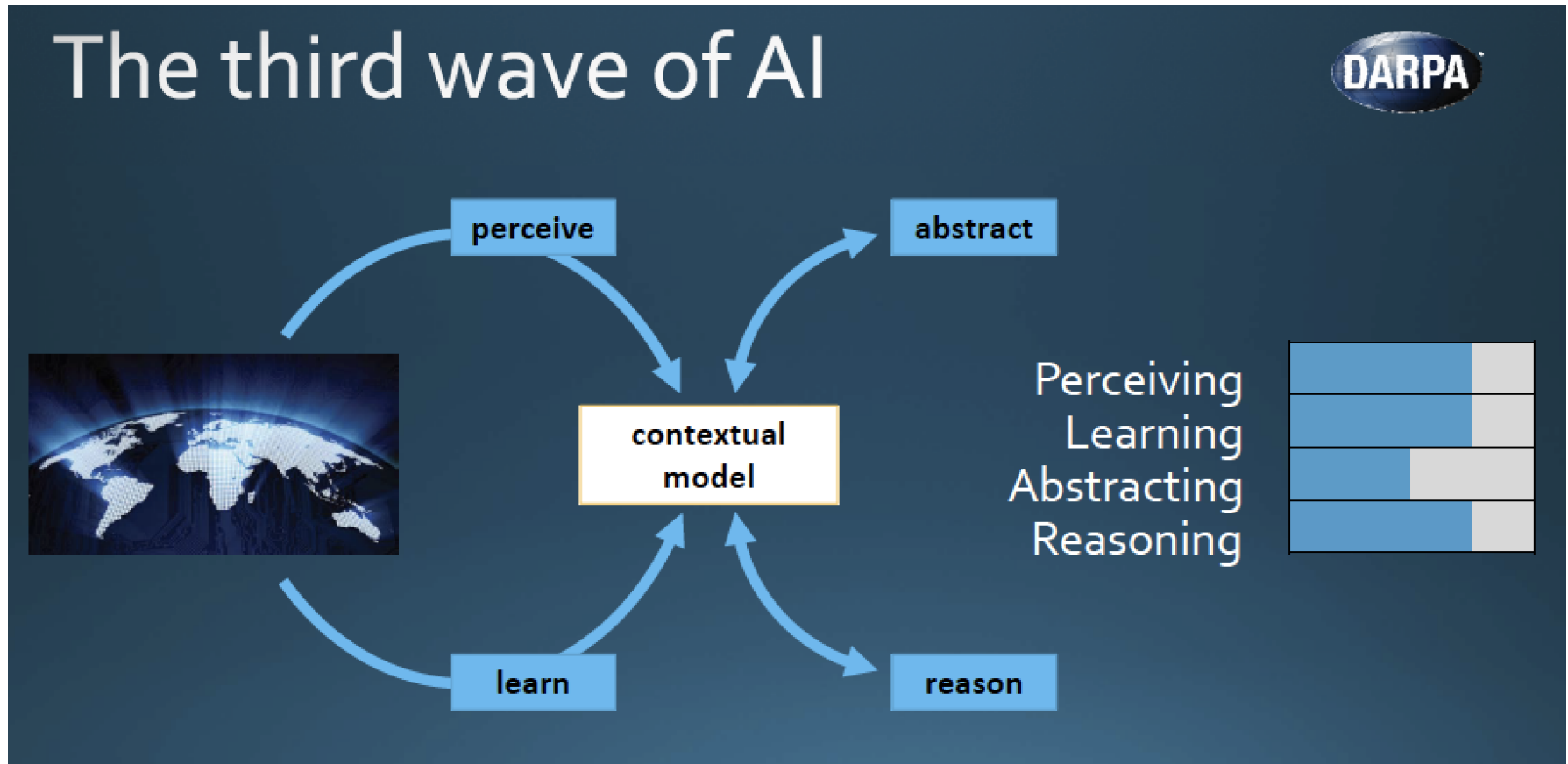
The (future) third wave of AI



Contextual adaptation

Systems construct contextual explanatory models
for classes of real world phenomena

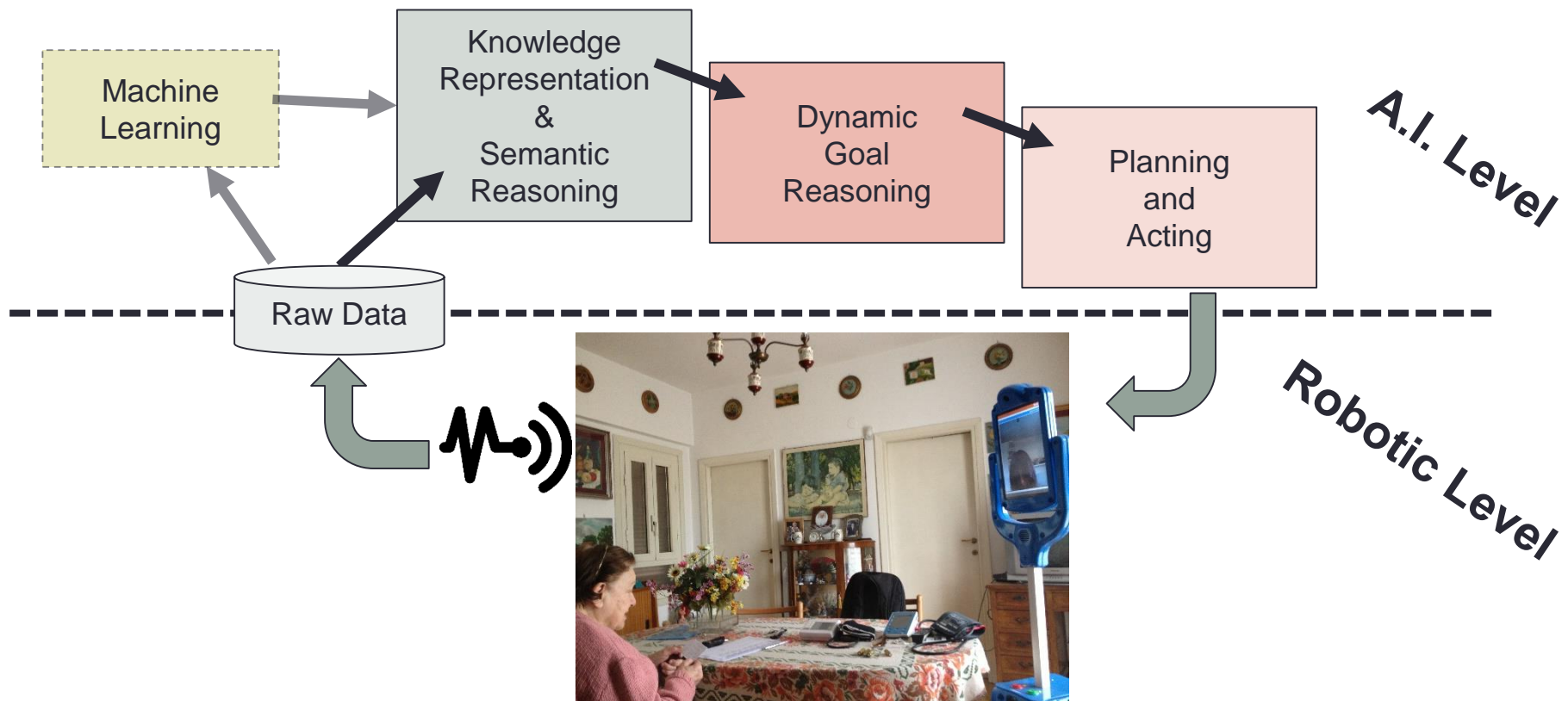
The third wave ... hopefully (2)



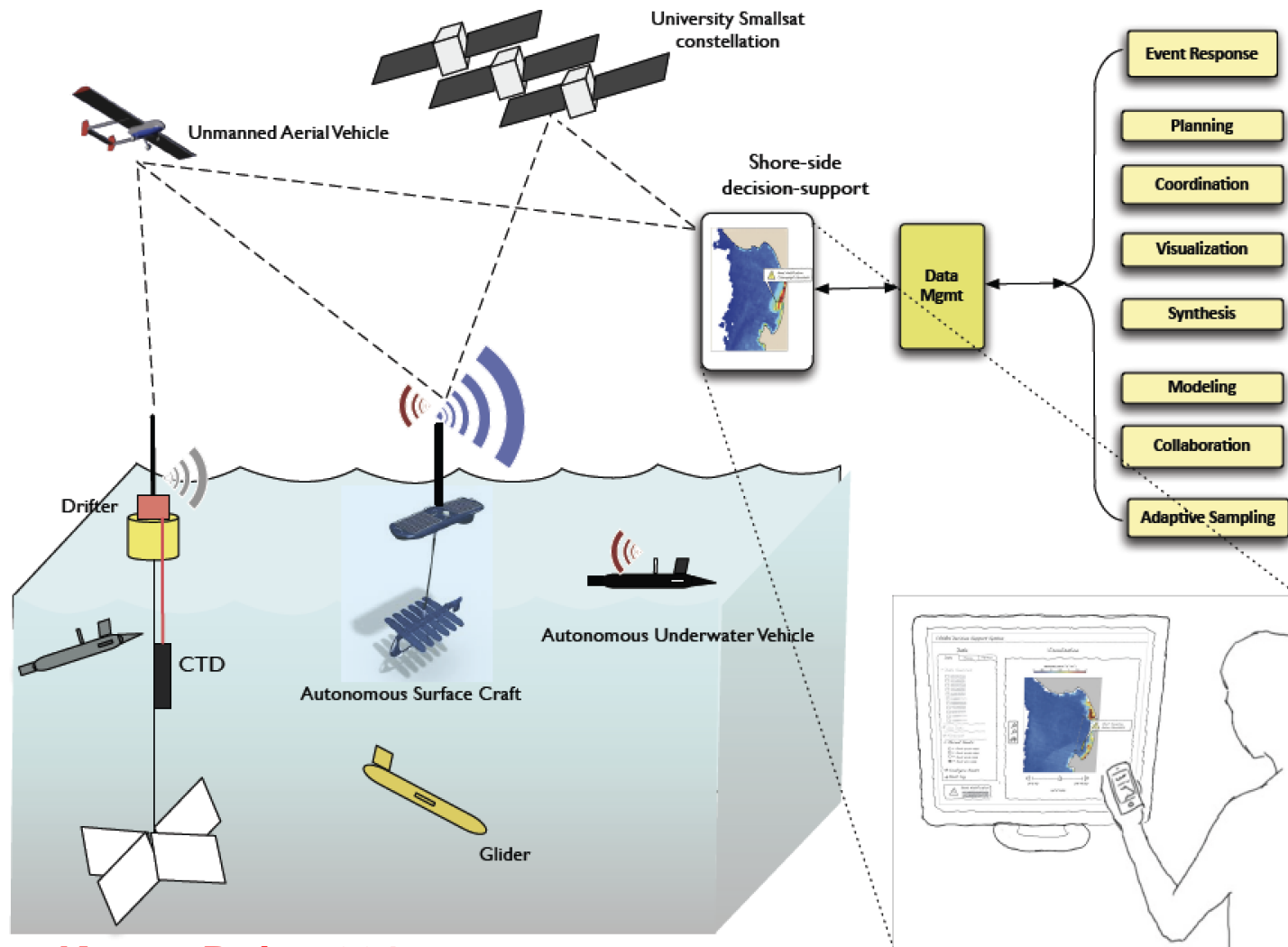
My current research goals ...

- Assistive Robotics domain poses a important challenges
 - **continuous operation over time**
 - **adaptable behaviors according to different user needs**
- We are investigating possible connections between robust ***Knowledge-Based AI*** and new ***Data Science AI*** techniques
- We are pursuing a foundational step towards a **Continuous Sense-Reason-Act loop** to be deployed on top of cutting-edge robotic solutions

The KoALA Approach



A more focused scenario ...



Courtesy: Kanna Rajan 2017

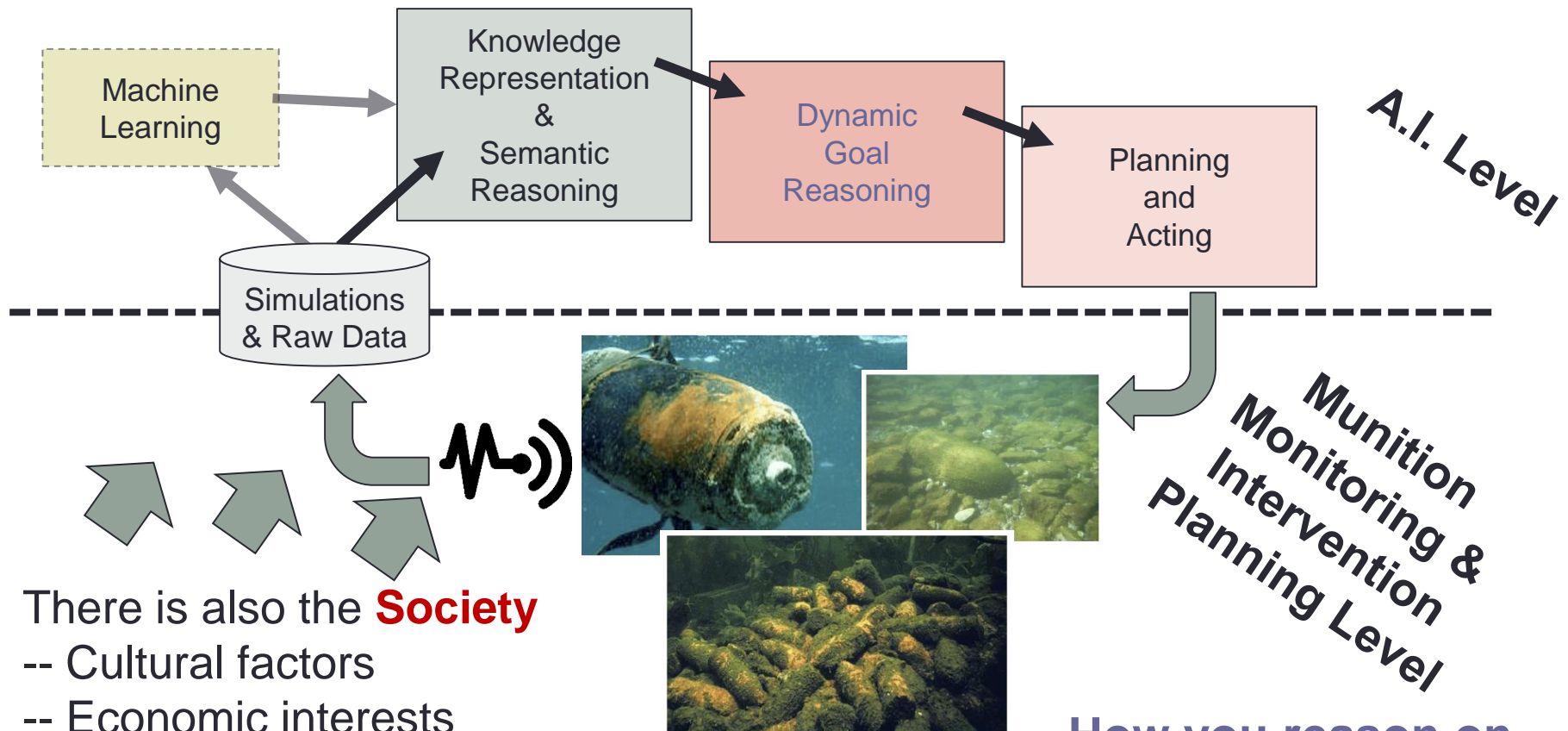
Support to better perform decision making

Key strengths of ABM (Agent Based Modeling)

- Society is not an aggregate of indistinguishable particles. Modeling society for what it is: agents are not particles!
- Agent Based Generative Social Simulation (ABGSS):
 - If you didn't grow it up, you're not explaining it
 - Rules out correlations
 - Extends on simple causation
 - But looking for the simplest generative mechanism leads to *ad hoc* models
 -
- Minds
 - Modeling not only the relation and social processes
 - But also the internal cognitive processes
 - Double modeling: simulations as the interaction between a model of the mind and a model of society



Possible uses of KoALA elsewhere ...



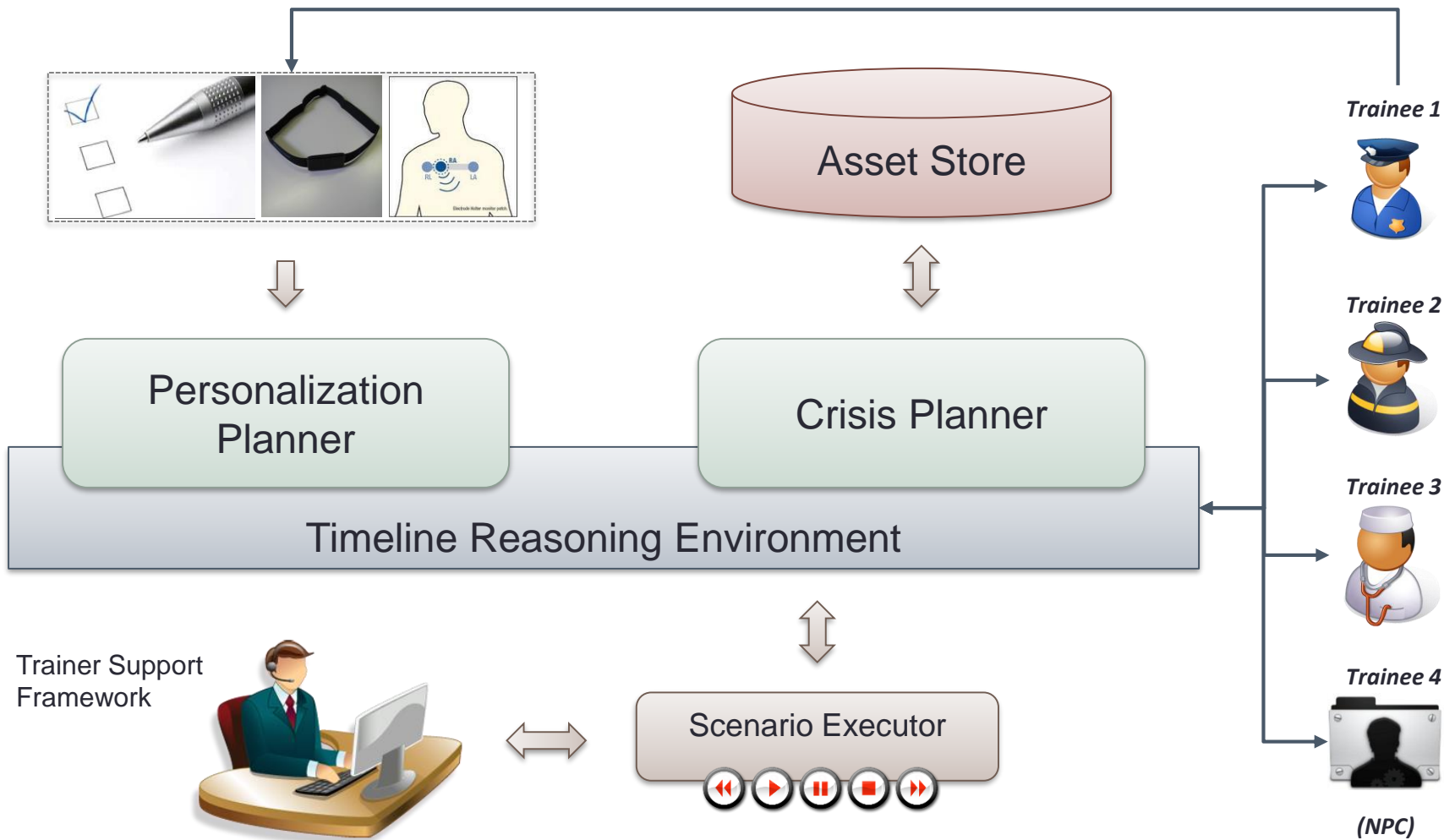
There is also the **Society**

- Cultural factors
- Economic interests
- Political priorities

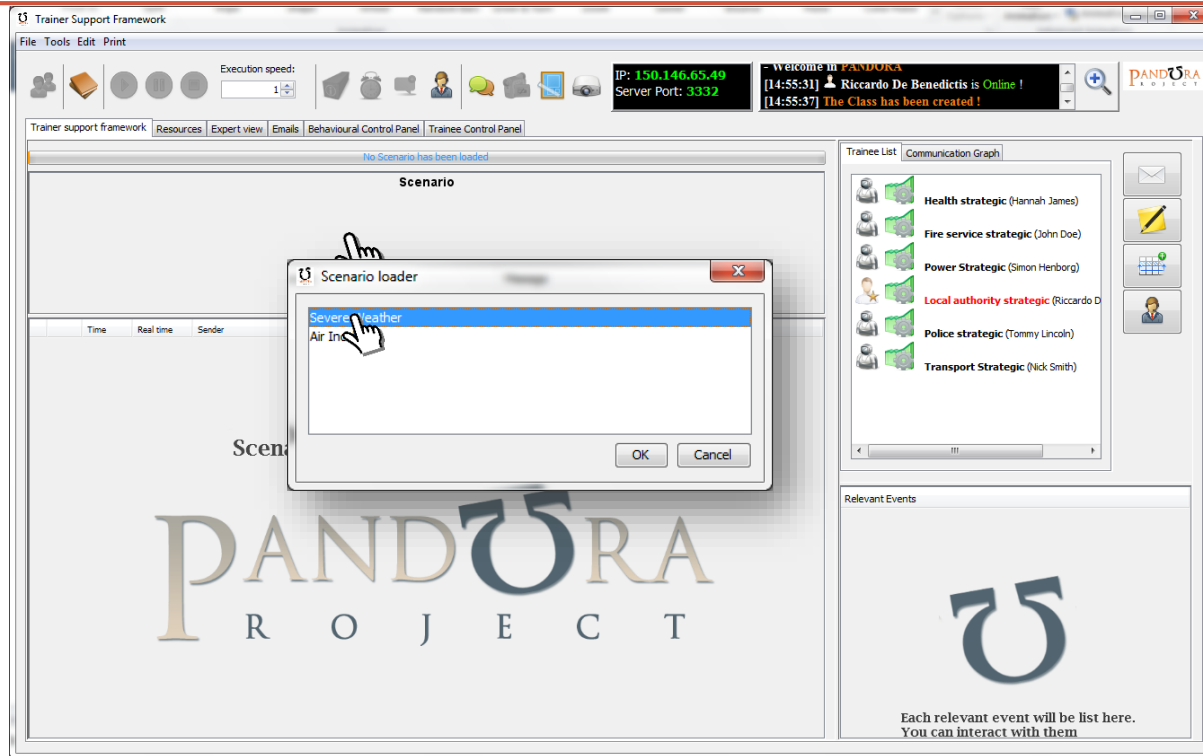
Key message: to take decisions you have to adapt to societal specificities

How you reason on data to help decision making
here is a key aspect

The PANDORA Training



Interactive Lessons as Plan Execution

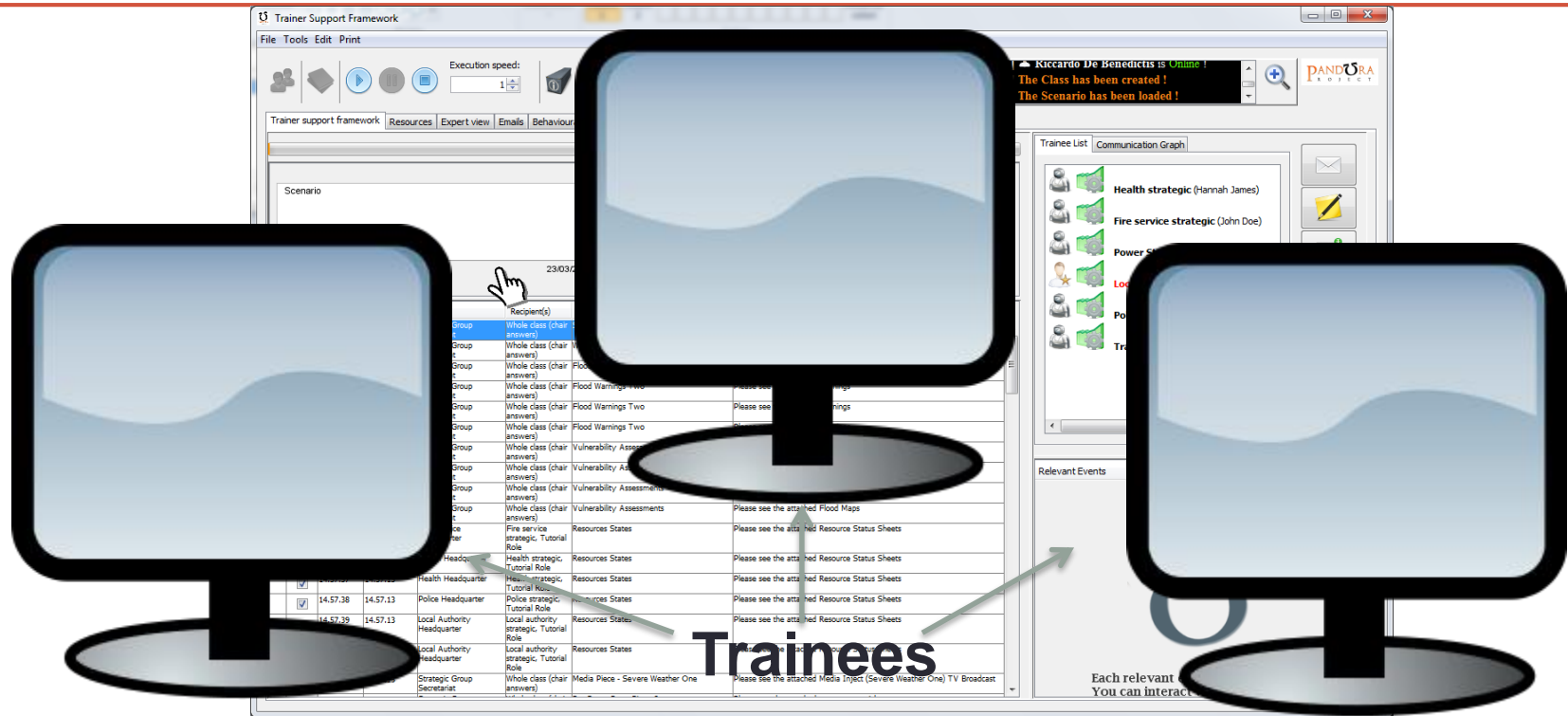


Maps

Videos

Documents

Interactive Lessons as Plan Execution

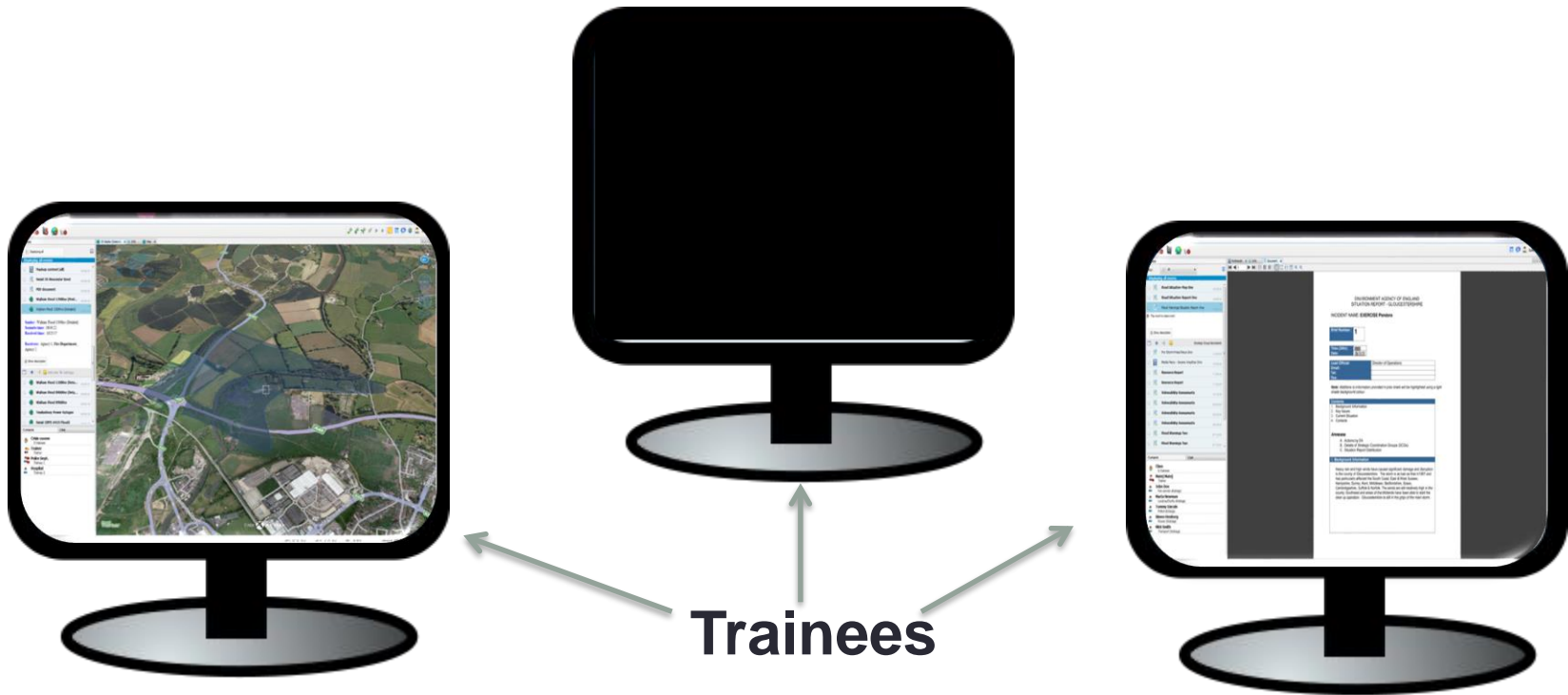


Maps

Videos

Documents

Interactive Lessons as Plan Execution



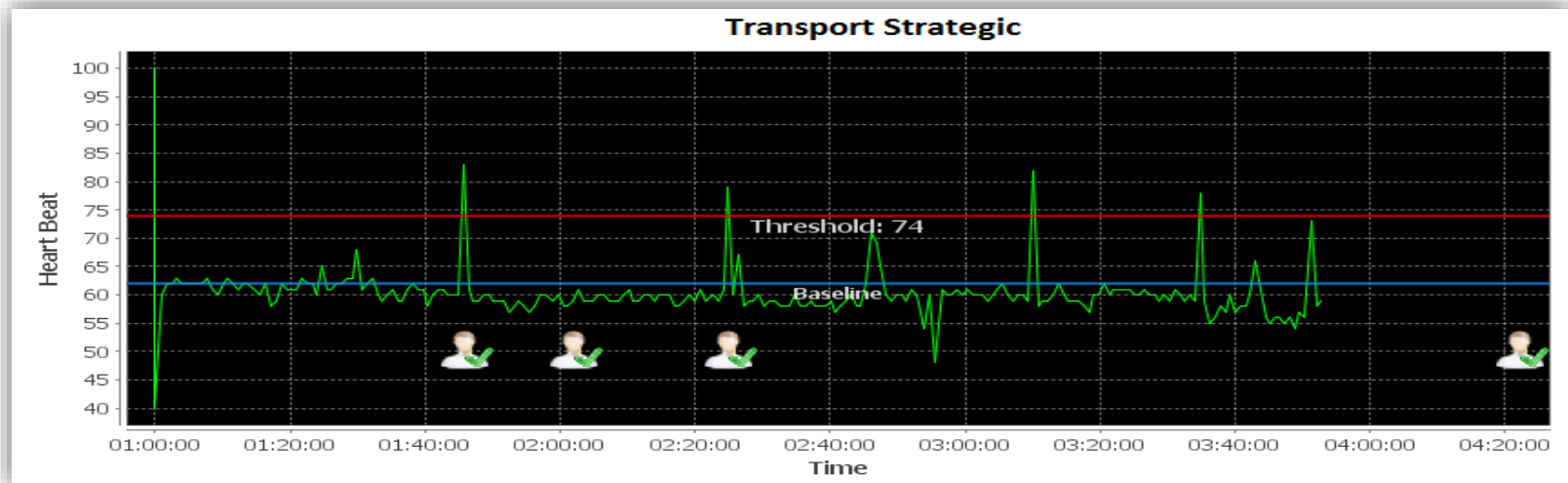
Maps

Videos

Documents

System Evaluation

(EPC - York, UK Cabinet Office Experts 2012-13)



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Thanks !!!!



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