AI IN ROBOTICS

(Are we there yet?)

Francesco <frag> Gadaleta   -   Eliseo <seldon> Ferrante

SPEAKERS

FRANCESCO GADALETA, PhD

Founder of Amethix
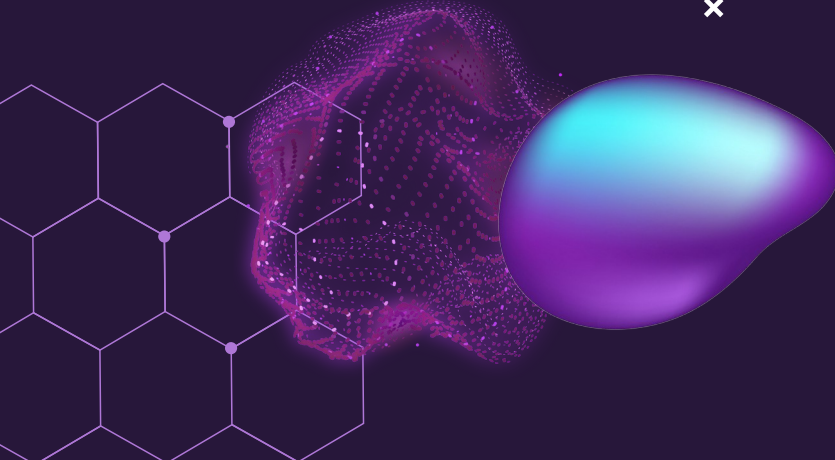Host of Data Science at Home podcast

ELISEO FERRANTE, PhD

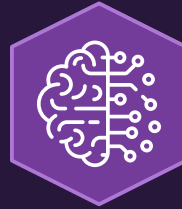Faculty at
Vrije Universiteit Amsterdam
Swarm Robotics Expert

WHAT ARE WE WORKING ON?

ENGINEERING

Amethix builds software engineering solutions for critical systems

AI/ML

Predictive algorithm design and data analytics (healthcare, energy)

ROBOTICS

Robotics applied to industrial, agriculture and defense sectors

IN THIS PRESENTATION

01 **SOME DEFINITIONS**

What do we mean when we talk about <robots/AI>

02 **SUCCESS STORIES**

Some success stories of AI in Robotics

03 **TECHNIQUES**

A non-exhaustive list of techniques of AI in Robotics
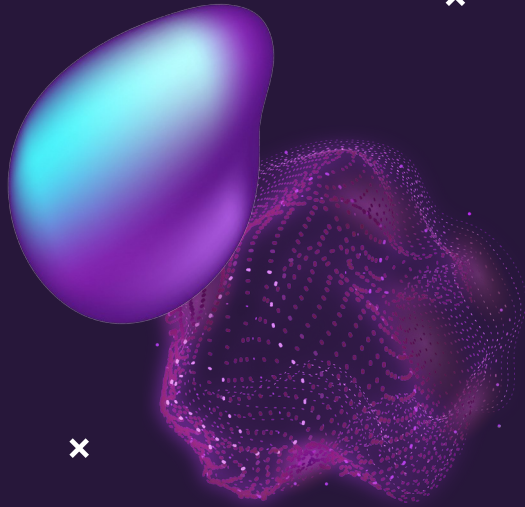
04 **GETTING STARTED**

This is cool! I want to work. What should I do?
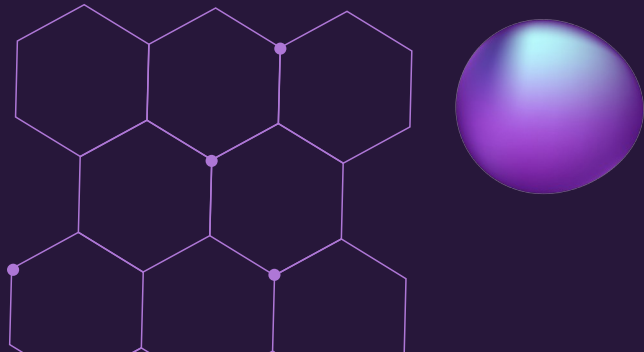
01

WHAT IS AI?

What do we talk about when we talk about AI

"I visualise a time when we will be to robots what dogs are to humans, and I'm rooting for the machines."

— **Claude Shannon**

ARTIFICIAL INTELLIGENCE

GENERAL

Complex traits of intelligence.
Not just combination but selection
of the "most appropriate" traits for
the task.

Eg. human like traits, conscience,
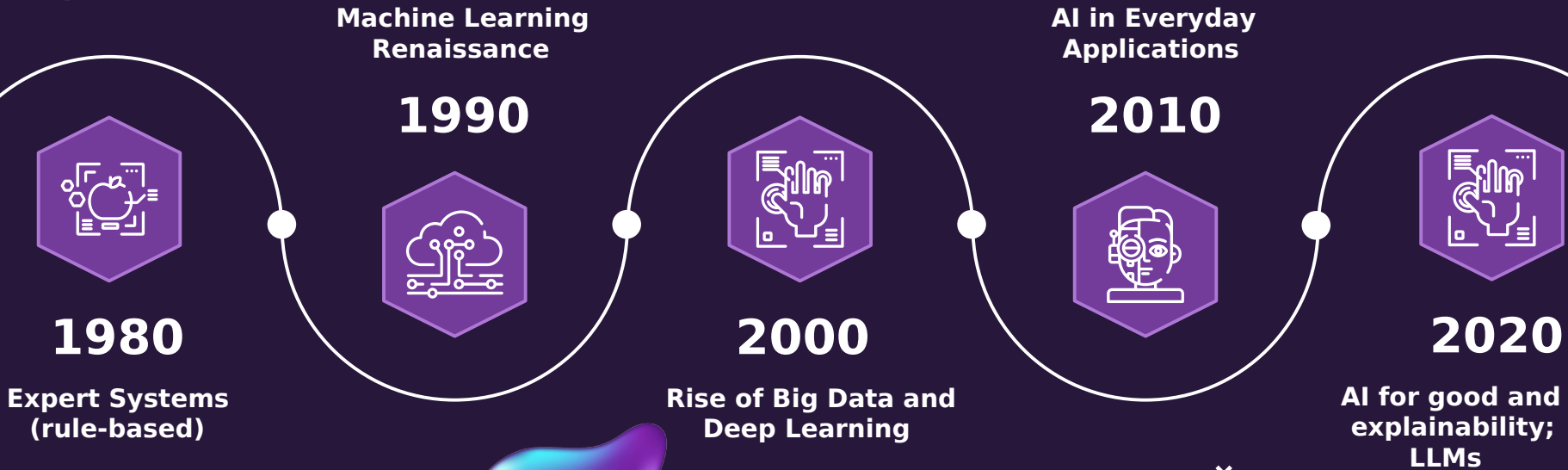awareness, fear, passion, etc.

SPECIALIZED

Single trait of intelligence.
A discipline that studies how to make
computers reproduce a specific trait of
intelligence (one at a time).

Eg. language, learning, planning,
perception, reasoning, data processing,
decision making, etc.

A BIT OF HISTORY

Machine Learning
Renaissance

1990

AI in Everyday
Applications

2010

1980

Expert Systems
(rule-based)

2000

Rise of Big Data and
Deep Learning

2020

AI for good and
explainability;
LLMs

AI/ROBOTICS SECTORS TODAY

SECTOR	ROLE OF AI	OPPORTUNITIES
Manufacturing and industrial	tasks such as assembly, welding, painting, and packaging AI does nothing	Maturity, personalization
Healthcare	tasks that require precision and delicate movements AI not used much	Reliability and risk; Personalization
Agri	tasks like planting, harvesting, and monitoring crop health Vision, localization, planning, decision making, mapping, perception, coordination	Scenario complexity
Logistics	material handling, sorting, and packaging Vision, localization, planning, decision making, mapping (not always "AI")	Personalization, efficiency
Defense	bomb disposal, surveillance, reconnaissance, and in unmanned aerial vehicles Vision, localization (not necessarily with GPS), planning, decision making, mapping, perception, coordination	Precision, efficiency, intelligence, safety

AI/ROBOTICS SECTORS TODAY

SECTOR	ROLE OF AI	OPPORTUNITIES
Education	teach students about programming, engineering, and problem-solving Special kind of robots (e.g. Nao) for teaching AI	Personalization, scalability
Entertainment	special effects, animatronics AI in video games, technologies of VR	Personalization, increased immersion
Social robotics	customer service, assistance for the elderly or people with disabilities (language, perception, assisting)	Personnel cost reduction
Space exploration	planetary exploration, satellite repair, and assembly of space structures All of the above, autonomous	Most challenging use case, performance, critical systems, extreme conditions, limited hardware

02

WHAT IS ROBOT(ICS)?

What do we talk about when we talk about robots
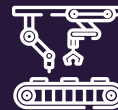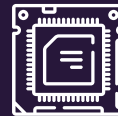
WHAT IS A ROBOT?

A **programmable machine** designed to perform tasks

- ◆ **autonomously** or
- ◆ with minimal human intervention.

It typically consists of

- ◆ **mechanical** components,
- ◆ **Sensors**
- ◆ computerized **control system**.

From **simple systems** (perform repetitive tasks)
to **advanced machines** (perform complex functions,
eg. problem-solving, learning, and interacting with their
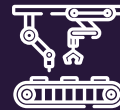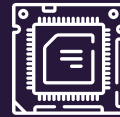environment).

WHAT IS A ROBOT? (continued)

Def. 2

A combination of

◆ software (soft and embedded),
◆ hardware (sensors and controllers),
◆ mechanics (joints, geometries, materials),
◆ electronics (boards, sensors, CPU/GPU),
◆ data flows (sensor data, events).

WHAT IS A ROBOT? (continued)

Def. 3

A piece of software that can learn, decide, control.

WHAT IS ROBOTICS?

A combination of disciplines among which

- ◆ AI
- ◆ software engineering
- ◆ mechatronic
- ◆ telecommunication
- ◆ control theory
- ◆ computer science
- ◆ data science
- ◆ decision making
- ◆ perception
- ◆ statistics
- ◆ probability theory
- ◆ game theory
- ◆ others?

ROBOTICS:
WHAT DO WE EXPECT?

ROBOTICS:
WHAT DO WE EXPECT?

AI TECHNIQUES IN ROBOTICS

◆ Locomotion (path planning)

◆ Decision making

◆ Perception (object recog, scene understanding, localization, sensor fusion)

◆ Manipulation and Intervention (human in the loop: haptics, compliance)

◆ Computer vision (target detection/avoidance)

◆ Task planning

◆ Collective intelligence (swarm)

SUCCESS STORIES IN AI

Boston dynamics: successful in building robots (no way average Joe Shmoe will be buying one anytime soon)

Softbank Robotics Nao robot: education

Aerofarms, Bustanica, InFarm: Vertical Farming, Growing Food in Urban Environments (drones, manipulators)

Farmwise: Precision Agriculture, Enhancing Efficiency and Sustainability

Multiway, Locus Robotics: Robotic Picking Systems

AstroBotic: Revolutionizing Space Exploration

SUCCESS STORIES IN A(gr)I

Automatic collection

Automatic/Precision spraying

SUCCESS STORIES IN AI

Analytics for efficient operations

Autonomous operations

COMMON MISCONCEPTIONS
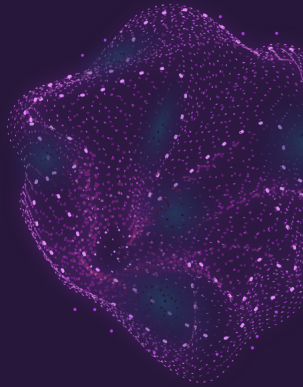
MYTH 1   AGI is here
(Human-like capabilities)
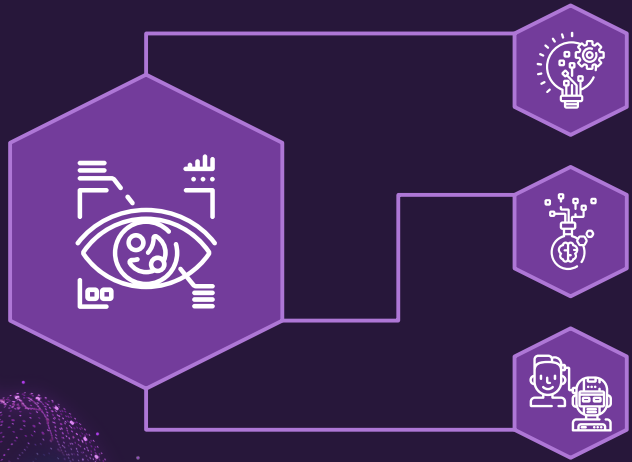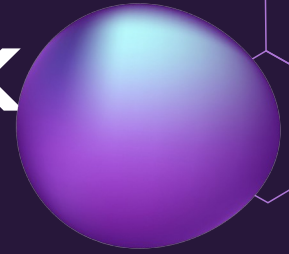
MYTH 2   Autonomous decision
making

MYTH 3   AI in Robotics is like
AI anywhere else

WHY ROBOTS STILL SxxK

COMPUTE PWR

Edge computing and battery lifetime (bottleneck)

FRAGMENTATION

HW and SW tooling fragmentation (no stds)

INTEGRATION

Complex stacks require huge integration effort

WORK IN AI & ROBOTICS

Programming: Rust, Python, C++. These languages are commonly used in robotics for tasks ranging from low-level control to high-level decision-making.

Mathematics and Algorithms: Be strong in linear algebra, calculus, and probability. Algorithms are essential for robotic perception, planning, and control.

Electronics and Control Systems: Familiarize with electronics, sensors, and control systems. Learn about PID controllers, feedback loops, and other control mechanisms that are fundamental to robotics.

Machine Learning and AI: (significant role in robotic perception, decision-making, and adaptability)

WORK IN AI & ROBOTICS (contd.)

Robotics Frameworks and Software: ROS Explore (Robot Operating System). Date but don't get married :)

Problem-Solving Skills: Cultivate strong problem-solving skills. Robotics involves dealing with complex challenges, and the ability to analyze problems and develop creative solutions is crucial.
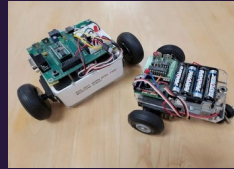
Continuous Learning and Adaptability: Remember! Robotics is a dynamic and heavily interdisciplinary field.

GETTING STARTED

OpenRR (Open Rust Robotics)
(programming)

Kits by Parallax, Clearpath Robotics
(programming & building)

Crazyflie Swarm bundle (nanodrones)

Robotics Flight (aerial)
https://www.coursera.org/learn/robotics-flight

Autonomous Robotics
https://developer.nvidia.com/blog/open-source-fleet-management-tools
-for-autonomous-mobile-robots/

THANKS!

GET IN TOUCH WITH US
francesco@amethix.com - e.ferrante@vu.nl

WORK WITH FRAG
amethix.com

PODCAST
datascienceathome.com