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APPLICATION OF MACHINE LEARNING IN ROBOTICS

Artificial Intelligence (AI) is set to disrupt practically every industry imaginable, and industrial robotics is no different. The powerful combination of robotics and AI or machine learning is opening the door to entirely new automation possibilities. In particular, deep learning methods have brought about significant improvements in a broad range of robot applications, including drones, mobile robots, robotics manipulators, bipedal robots, and self-driving cars.

There are several areas of robotic processes that AI and machine learning are impacting to make current applications more efficient and profitable. The scope of AI in robotics includes: computer vision, imitation learning, self-supervised learning, assistive and medical technologies and multi-agent learning.

An influx of big data, i.e. visual information available on the web (including annotated/labeled photos and videos), has propelled advances in computer vision, which in turn has helped further machine-learning based structured prediction learning techniques, leading to robot vision applications like identification and sorting of objects. One offshoot example of this is anomaly detection with unsupervised learning, such as building systems capable of finding and assessing faults in silicon wafers using convolutional neural networks.

Imitation learning is closely related to observational learning, a behavior exhibited by infants and toddlers. It is also an umbrella category for reinforcement learning, or the challenge of getting an agent to act in the world so as to maximize its rewards.

Imitation learning has become an integral part of field robotics, in which characteristics of mobility outside a factory setting in domains like domains like construction, agriculture, search and rescue, military, and others, make it challenging to manually program robotic solutions. Examples include inverse optimal control methods, or "programming by demonstration", which has been applied by Carnegie Mellon University and other organizations in the areas of humanoid robotics, legged locomotion, and off-road rough-terrain mobile navigators.

Self-supervised learning approaches enable robots to generate their own training examples in order to improve performance; this includes using a priori training and data captured close range to interpret "long-range ambiguous sensor data." It has been incorporated into robots and optical devices that can detect and reject objects (dust and snow, for example); identify vegetables and obstacles in rough terrain. Autonomous learning, which is a variant of self-supervised learning involving deep learning and unsupervised methods, has also been applied to robot and control tasks.

An assistive robot is a device that can sense, process sensory information, and perform actions that benefit people with disabilities and seniors (though smart assistive technologies also exist for the general population, such as driver assistance tools). Movement therapy robots provide a diagnostic or therapeutic benefit. Both of these are technologies that are largely (and unfortunately) still confined to the lab, as they're still cost-prohibitive for most hospitals in the U.S. and abroad.

Coordination and negotiation are key components of multi-agent learning, which involves machine learning-based robots that are able to adapt to a shifting landscape of other robots/agents and find "equilibrium strategies." Examples of multi-agent learning approaches include no-regret learning tools, which involve weighted algorithms that "boost" learning outcomes in multi-agent planning, and learning in market-based, distributed control systems.

Robots combined to build a better and more inclusive learning model than could be done with a single robot depending on the concept of exploring a building, its room layouts, and autonomously edifice a knowledge base. This type of machine learning approach enables robots to compare datasets or catalogs, reinforce mutual observations and correct omissions. It will undoubtedly play a near-future role in several robotic applications, including airborne vehicles and multiple autonomous lands.