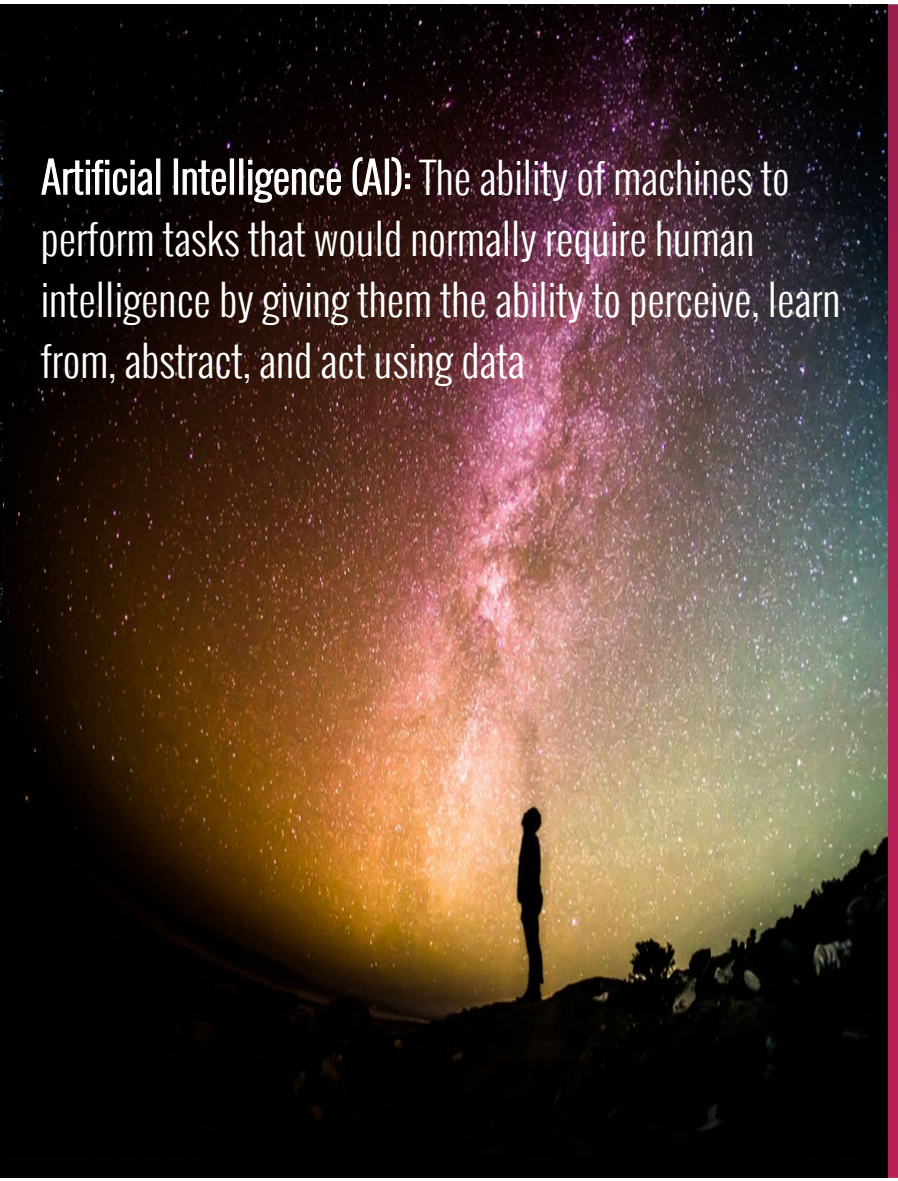


Artificial Intelligence (AI): The ability of machines to perform tasks that would normally require human intelligence by giving them the ability to perceive, learn from, abstract, and act using data

ARTIFICIAL INTELLIGENCE IN HEALTHCARE

LAUREN NEAL, PHD
PRINCIPAL/DIRECTOR
BOOZ ALLEN HAMILTON

eHealth Initiative
March 2019

CAN MACHINES PERFORM AS WELL AS HUMAN DOCTORS

A RECENT NATURE ARTICLE DESCRIBED HOW AI SYSTEMS CAN HELP DOCTORS DIAGNOSE DISEASE. HOW TO DISTINGUISH HYPE VS. REALITY?


nature medicine

Letter | Published: 11 February 2019

Evaluation and accurate diagnoses of pediatric diseases using artificial intelligence

Huiying Liang, Brian Y. Tsui, [...] Huimin Xia

Nature Medicine **25**, 433–438 (2019) | Download Citation


The New York Times

A.I. Shows Promise Assisting Physicians

Doctors competed against A.I. computers to recognize illnesses on magnetic resonance images of a human brain during a competition in Beijing last year. The human doctors lost. Mark Schiefelbein/Associated Press

By Cade Metz

Feb. 11, 2019


WIRED

ARIJIT SENGUPTA OPINION 03.06.19 08:00 AM

THE LIFE-THREATENING CONSEQUENCES OF OVERHYPING AI

A BRIEF HISTORY OF AI

AI HAS EXISTED SINCE THE 1950S, BUT PROGRESS HAS RECENTLY ACCELERATED

Eras of Machine Intelligence

Yesterday

Simple Task Execution

Machines perform simple, deterministic tasks in static environments using human knowledge codified as explicit sets of rules and programmed into them.

Today

Pattern Recognition

Machines recognize and act on patterns in data in static environments using sophisticated machine learning techniques.

Tomorrow

Contextual Reasoning

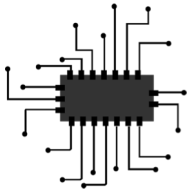
Machines understand context and use it to make decisions in dynamic environments using sophisticated machine learning techniques.

1950 1960 1970 1980 1990 2000 2010 2020 2030 2040

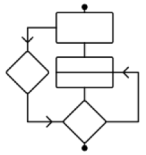
Accelerating Events of the 2010s

1. **Proliferation of Digital Data**

2. **Advances in Computing Power**



3. **New Machine Learning Research**



Source: Booz Allen analysis, Michael Copeland for Nvidia;

HOW MACHINES LEARN

THE FIVE "TRIBES" OF MACHINE LEARNING

1. Fill in gaps in existing knowledge
2. Emulate the human brain
3. Simulate evolution over generations
4. Systematically reduce uncertainty
5. Find similarities between old and new

Five approaches to structuring machine learning algorithms

"Tribe"	Origins	Motivation	Technical Approach
Symbolists	Logic, Philosophy	Automate the scientific method	Inverse Deduction
Connectionists	Neuroscience	Reverse engineer the human brain via math model of neurons	Backpropagation
Evolutionaries	Evolutionary Biology	Replicate the evolution of the human brain over generations	Genetic Programming
Bayesians	Statistics	Test hypotheses to determine the certainty of knowledge	Probabilistic Inference
Analogizers	Psychology	Use previous problems / solutions and extrapolate into new context	Kernel Machines

Source: The Master Algorithm by Pedro Domingos

WHAT YOU CAN (AND CAN'T) DO IN THE WORLD OF AI

AI IS GOOD AT AUTOMATING SIMPLE TASKS & FINDING/ACTING ON PATTERNS

Today, machines can outpace humans on some complex tasks, while a three-year old child can intuitively understand a scenario that even the most advanced AI cannot comprehend.

Intelligent Machines ***Can***…

- Respond to human commands
- Drive down a major highway
- Select the best treatments for disease
- Write poems, music, and artwork
- Learn human tastes, preferences
- Outperform humans at strategy games
- Learn to perform narrow tasks better than humans

Cannot…

- Speak conversationally about any topic you choose
- Drive in dense cities or bad weather
- Create art that is better than humans'
- Understand human emotion, humor
- Invent new games to play
- Teach itself new skills independently

Doctors rely on more than just data for medical decision making

Computer scientists find that physicians' "gut feelings" influence how many tests they order for patients.

Anne Trafton | MIT News Office
July 20, 2018

MIT News

AI TECHNOLOGIES

NON-EXHAUSTIVE

AI INVESTMENT HAS GIVEN RISE TO EXPANSIVE AI CAPABILITIES

AI Era	Resulting technologies	Use Cases	Example Application
Simple task execution *Fully Deployed*	**Robotic Process Automation (RPA)**	• Routine task automation • Process improvement	*A software "bot" transposes data from patient records into an online database*
Pattern recognition *Emerging Deployment/ Pilots*	**Core machine learning software**	• Cognitive automation • Anomaly detection & response	*Software scans patient data to identify new indicators of disease*
	Computer Vision	• Image/video tagging • Biometrics • Sentiment analysis • Facial recognition • Scene analysis	*A x-ray machine automatically identifies anomalies in patient scans*
	Natural Language Processing and Generation	• Virtual assistants • Chatbots • Machine translation • Speech recognition • Language detection • Sentiment analysis • Text analysis • Report generation	*Virtual assistants engage with patients to ask about symptoms and route them to the correct care provider*
	Cognitive Robotics	• Co-bots • Smart manufacturing • Smart logistics	*A robotic surgeon performs surgery, automatically responding to changes in a patient's condition in real time*
Contextual Reasoning *In the lab*	**Semantic or "Cognitive" computing**	• Fully autonomous vehicles	*A vehicle drives down a crowded city road, responding to bad weather and obstacles in traffic*

Source: Booz Allen Analysis

AI APPLICATIONS IN HEALTHCARE

NON-EXHAUSTIVE

AI SHOWS PROMISE IN TACKLING HEALTHCARE CHALLENGES

AI can provide solutions that reduce the clerical burden of EHR documentation and augment diagnoses with medical imaging supercomputers. With $30 billion a year flowing into AI research and development, new applications for patient monitoring and disease prediction have the potential to transform patient care.

Imaging & Diagnostics

AI is already being integrated into medical imaging analytics platforms to automate volumetric segmentation of lung nodules, detect cardiac function, identify suspected large vessel occlusions, and analyze CT perfusion images of the brain using deep learning.

Speech-enabled EHR Platforms

Platforms that provide speech-enabled data entry are being integrated with EHRs to improve physician-patient interactions. Digital scribes automatically enter information into the EHR system and virtual AI assistants analyze conversations between doctors and patients.

Clinical Text Processing

Natural language processing (NLP) extracts relevant medical information trapped in EHR clinical notes and supports terminology mapping.

Patient monitoring

Today, chatbots serve as the first line of support for mental health patients, checking in with individuals suffering from depression, monitoring moods, and sharing videos and tools. In the future, artificial emotional intelligence (AEI) will be used to analyze verbal and non-verbal cues to determine a person's emotional or psychological state and guide treatment.

Disease Prediction

Today, physicians can predict cardiovascular disease based on combined results from blood tests, an EKG and a CT scan. In the future, noninvasive scans of the back of the eye will be used to predict the risk of suffering a heart attack or stroke. Beyond heart disease, deep learning will be used to predict Alzheimer's Disease progression and detect the location, duration and types of events in EEG time series to diagnose sleep disorders.

CHALLENGES FOR AI APPLICATIONS IN HEALTHCARE

DATA INTENSIVENESS IS A BARRIER FOR ORGANIZATIONS GETTING STARTED WITH AI

Lack of organized, labeled data

Data is expensive to gather and process, and it is often created for billing purposes and not for diagnosis. Data sets also need to be very large, labeled and representative in order to train machine learning algorithms.

Ideas to consider: Use partnerships and structure infrastructure to capture the data you will need. Consider collecting new data to power your AI efforts.

Maintaining fairness

Machine learning algorithms may work really well for one patient group, but results may not be appropriate for others. Without data that is representative of diverse patient groups, fairness will continue to be a major challenge.

Ideas to consider: Solicit input from a range of colleagues to ensure a diversity of perspectives are incorporated into model building efforts. Make an effort to gather data from diverse patient groups.

Lack of talent assets

AI talent is scarce, and the battle for experts is fierce. Even the most prominent organizations can rarely hold talent for more than a year or two. In healthcare, the issue is even more pronounced because AI experts don't always understand clinical challenges.

Ideas to consider: Balance between borrowing, buying and building AI talent. For example, partner with academic organizations to borrow world-class talent and invest in programs to upskill in-house staff.

Managing risk

It's important to remember that AI systems are still nascent and no AI product or platform is truly "off-the-shelf." All but the most basic applications of AI come with a certain level of risk. This is even more critical when considering healthcare applications.

Ideas to consider: Start small, then scale. For example, robotic process automation (RPA) can be applied relatively easily and quickly to many administrative tasks and the cost is also generally low.

Source: Artificial Intelligence Primer

WHAT AI MEANS FOR BUSINESS

AI WILL ENHANCE HEALTHCARE ORGANIZATIONS' PERFORMANCE AND CREATE NEW NEEDS

New Organizational Capability Needs

- Evaluate the emerging landscape of AI technologies, algorithms, and data sources
- Evaluate the economics of AI solutions
- Understand and plan for impacts to staff
- Mitigate culture shock and change fatigue
- Guard against mistakes, algorithmic bias, and unintended consequences
- Identify and mitigate safety, security, and privacy risks
- Navigate political, legal, and regulatory hurdles

Emerging Opportunities through AI

- **Cost reduction** by automating repetitive work
- **Re-task employees** towards business issues that are not suited to a technology solution (e.g., customer service, complex problem analysis)
- **Build a more flexible workforce**; as commodity skillsets are increasingly automated, employees will get to work in interesting, diverse roles
- **Take on tougher problems** (e.g., medical drug discovery) that were previously too expensive to perform with humans

For more information, see The Artificial Intelligence Primer:
https://www.boozallen.com/s/insight/thought-leadership/the-artificial-intelligence-primer.html