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Artificial intelligence and Healthcare

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ABSTRACT

It's not about option A vs. option B or treatment A vs. treatment B, it's about the sequences of decisions, understanding the way the world changes over time. It's being able to adapt to that in real time just like driving a car. We can compare different models and compare patterns that can tell us how patients change over time. This paper will introduce the use of AI (Artificial intelligence) in different healthcare areas and compare a few common AI algorithms that can be implemented using SAS procedures.

Using these algorithms we can push patterns to simple interfaces that can let patients and providers see what to expect in the future. Using the AI on with real patient's data, we can both improve the quality of healthcare and simultaneously reducing cost. In other words, we can make healthcare better and we can do it more cost effective at the same time.

INTRODUCTION

It's not about making better decisions; it's about having better information.

By letting the human do what they do well and letting the machines do what they do well, we may maximize the potential of both. In many pressing medical problems, the answers to knowing whom to treat, when to treat, and what to treat with, might already be in your data.

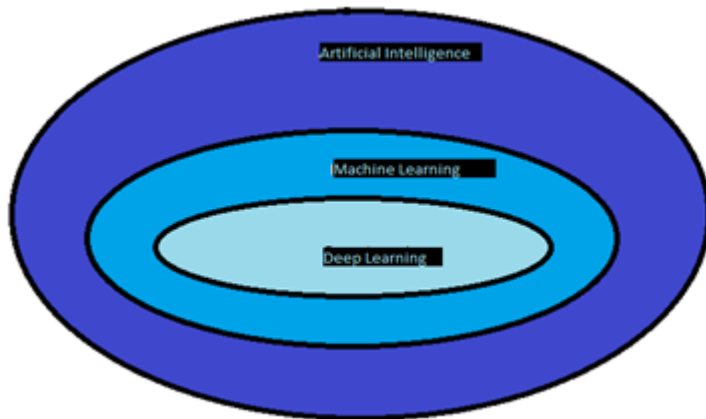
AI provides much of the basis for that evolution by powering predictive analytics and clinical decision support tools that lead providers into problems long before they might recognize the need to act.

Artificial intelligence can help support decisions around whether or not to continue care for critically ill patients, such as those who have entered a coma after heart arrest. AI can also provide earlier warnings for conditions like sepsis or seizures, which often require intensive analysis.

By having an AI algorithm with lots of relevant data from many sources, it's easier to pair up what you're seeing to a long-term pattern and maybe detect some improvements that would influence your decisions.

Clinical decision support, early insights, and risk scoring are some of the promising areas using artificial intelligence and machine learning. By utilizing new age tools and systems that make healthcare providers more aware of implication, more competent when delivering care, and more likely to get ahead of resolving issues, AI will revolutionize patient care and better clinical solutions.

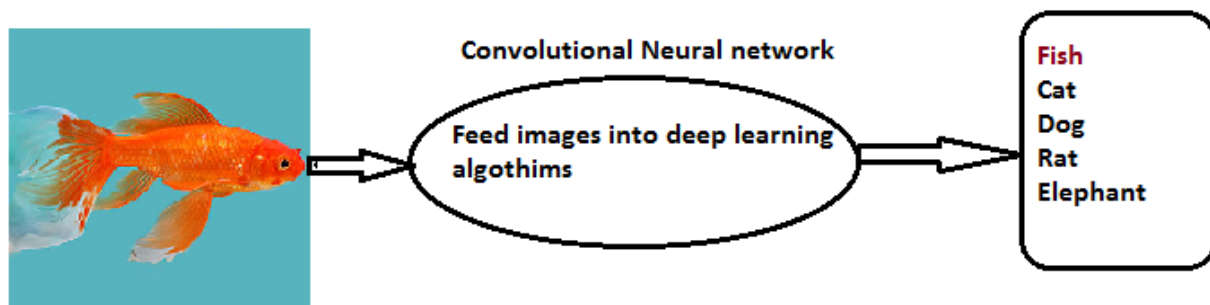
OVERVIEW ON DEEP LEARNING, MACHINE LEARNING AND AI



DEEP LEARNING

Deep Learning is a category of Machine learning that instructs a system to perform human-like tasks, such as recognizing speech, identifying images or making predictions.

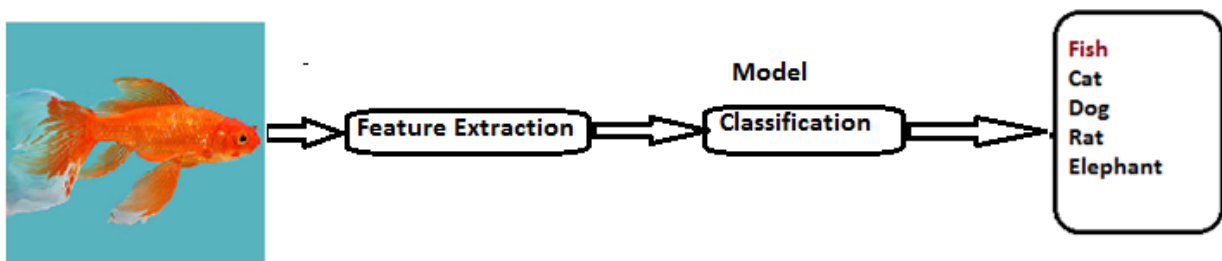
It structures algorithms in layers to create an artificial neural network that can learn and make intelligent decisions on its own.



In deep learning, we skip the manual step of extracting features from images instead we feed images directly to deep learning algorithms which then predict the object.

MACHINE LEARNING

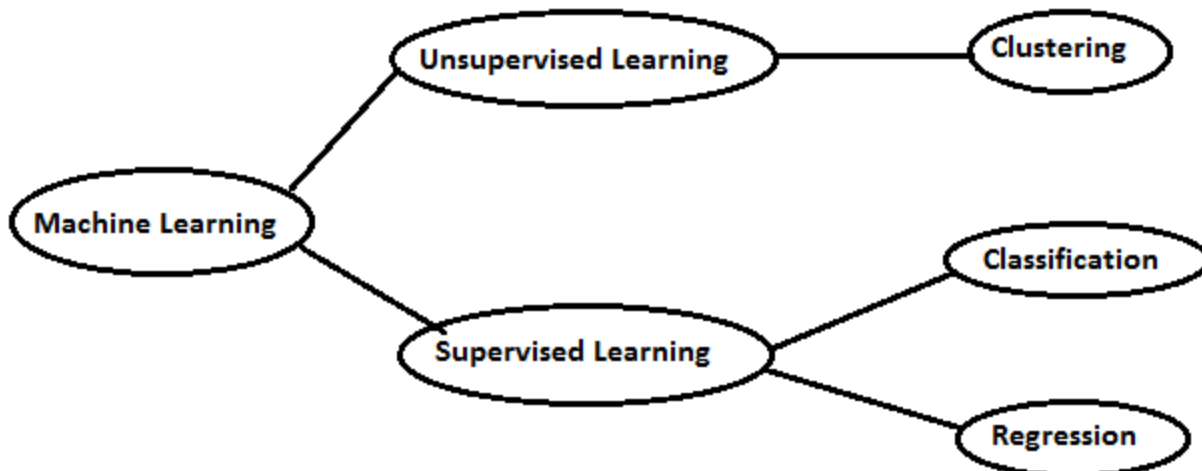
Machine Learning is the science of getting computers to learn and act like humans do, and improve their learning over time in an autonomous way, by supplying those data and information in the form of observations and real-world connections.



As in the figure above, we start with an image and extract relevant features from it. Then we create a model that describes and predicts an image.

Machine learning finds hidden insights in data without explicitly being told where to look or what to conclude. Machine learning today is a mathematically rigorous discipline that surrounds advanced modeling, optimization, and learning research; it has concrete applications in medicine, software, robotics etc. There is significant overlap among the fields of data science, data mining, and machine learning.

Machine learning can also be used to determine which treatments will be most effective for an individual patient based on their genetic makeup, demographic and psychographic characteristics.



Machine learning algorithms are divided into many categories, of which supervised and unsupervised learning techniques are most widely applied in other disciplines, particularly in data mining. Additional machine learning research areas include semi-supervised learning, transduction, reinforcement learning, and developmental learning.

In supervised learning the machine is taught by example. Examples of the desired inputs and outputs are provided. The algorithm uses this input to determine correlations and logic that can be used to predict the answer.

Semi-supervised learning is used to address similar problems as supervised learning. However, in semi-supervised learning the machine is provided some data with the answer labeled along with additional data that is not labeled with the answer.

In unsupervised learning, the machine studies data to identify patterns. In this case, there is no answer key. The machine determines correlations and relationships by parsing the available data.

Examples of Supervised and Unsupervised Machine Learning Algorithm

Supervised

- * Bayesian Statistics
- * Decision Trees
- * Forecasting
- * Neural Networks
- * Random Forests
- * Regression Analysis
- * Support Vector Machines (SVM)

Unsupervised

- * Affinity Analysis
- * Clustering
- * Clustering: K-Means
- * Nearest-Neighbor Mapping
- * Self-Organizing Maps
- * Singular Value
- * Decomposition

ARTIFICIAL INTELLIGENCE

Artificial intelligence is the science of training systems to model tasks through learning and automation.

Artificial intelligence : Core Areas

- * Machine learning
- * Natural language
- * Computer vision
- * Forecasting and optimization

Deep learning methods outperforms traditional queries by using Natural language processing to scan and analyze and summarize medical texts helping doctors in possible diagnosis in a fraction of the time. i.e. Deep learning models for detecting and classifying cancerous queries from CT/MRI scans.

The models of this kind are much faster and precise than traditional computer-aided models and continue to improve the detection and classification performance through machine learning.

After patients are prescribed medicine, sometimes they experience unexpected and dangerous side effects. AI can be leveraged to automatically recognize and interpret these adverse reactions across data sources dramatically improving the response time of health care leaders who can quickly stop the problem in its tracks.

AI is enhancing every aspect of the area we live in. AI could mean better care and lower costs.

From chronic diseases and cancer to radiology and risk assessment, there are nearly endless opportunities to leverage technology to deploy more precise, efficient, and impactful interventions at exactly the right moment in a patient's care.

For certain kinds of problems, machine learning methods can be much more accurate predictors than traditional methods for regression and classification.

In this paper, we present an example illustrating the application of machine learning method and interpretation of its results.



Classification trees are one of the earliest machine learning alternatives to logistic regression and remain popular because of ease of interpretation, natural segmentation of the space of the predictor variables, and accuracy in situations where there are complex interactions among the predictor variables.

REGRESSION AND CLASSIFICATION TREES USING PROC HPSPLIT (USING SAS)

The dependency of one dependent variable with other independent variables can be analyzed using the Regression and classification trees. PROC HPSPLIT is one of the procedures that can be used to identify the “best” split and creation of child nodes based on which we can analyze the dependency of variables. Once the primary dependencies variables are discerned using the PROC HPSPLIT decision trees, it can be applied to identify and predict the outcome variable for a new sample. In other words, this type of analysis helps with the prediction of outcomes based on understanding the factors of “interest” that most influences the results.

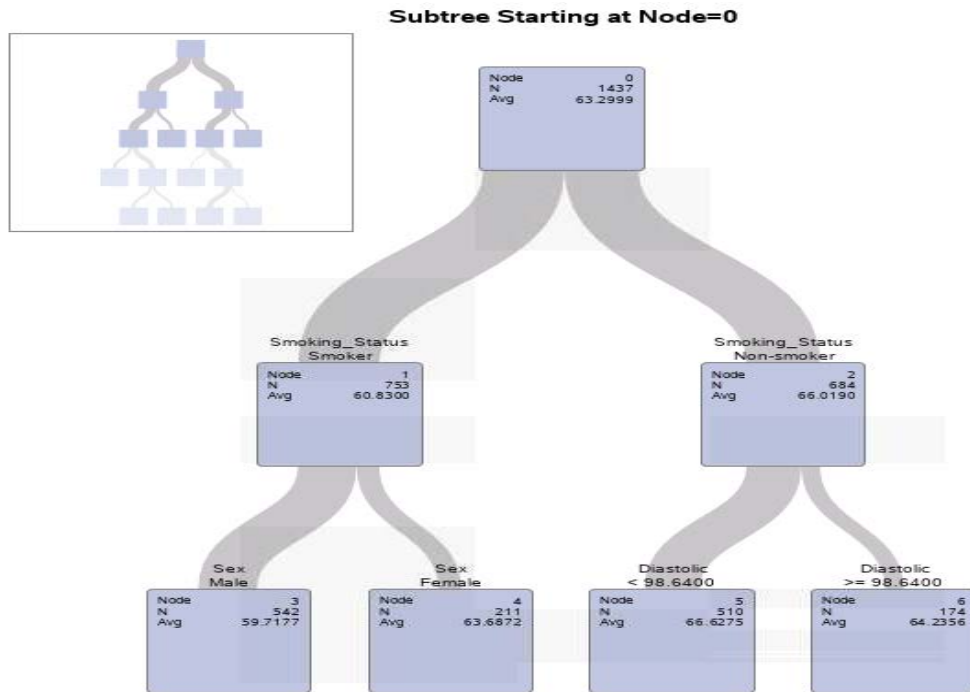
REGRESSION TREE EXAMPLE: CORONARY HEART DISEASE

Predicting the factors that influence the chances of CHD at an earlier age can help us to understand the influence of some risk factors that drive CHD in people. Below is the code that we use in this example to generate the tree using the proc hpsplit procedure as shown below

```
data heart;
set sashelp.heart;
  where AgeCHDdiag ne .;
if Smoking>0 then Smoking_Status='Smoker';
if Weight_Status ne 'Normal' then Weight_Status='Abnormal';
if Chol_Status ne ( 'High') then Chol_Status='Normal';

bmi=weight/(height)**2*703;
run;

proc hpsplit data=heart seed=123 plots = zoomedtree(nodes = ("0") depth = 2 fracprec
= 4
predictorprec = 4) nodes ;;
class sex Smoking_Status Weight_Status BP_Status Chol_Status ;
model AgeCHDdiag = sex bmi Smoking_Status Weight_Status BP_Status Chol_Status
Systolic Diastolic ;
output out=regout;
run;
```



Notice that the code uses plots = zoomed tree along with FRACPRED and PREDICTORPREC options in order to have a zoomed display at node 0.

At the top node we have 1437 observations and based on the tree the best split is the smoking factor. It can be predicted that smoking is a key factor for the earlier onset of CHD. Among the smokers, the factor that influences the earlier CHD is the sex, it is evident that Male gender is more susceptible to CHD than female subjects.

However, among the non-smokers, the key factor that drives the risk of earlier onset of CHD appears to be based on the Diastolic levels.

Based on these findings based on the risk factors associated with the patients we can categorize the subject's probability of developing the CHD and the output of HPSPLIT can be further analyzed to find the percentile of subjects falling under each node which in turn can assist with predicting the outcomes for a subject's probability of developing CHD.

Some other SAS High-performance procedures are as follows:

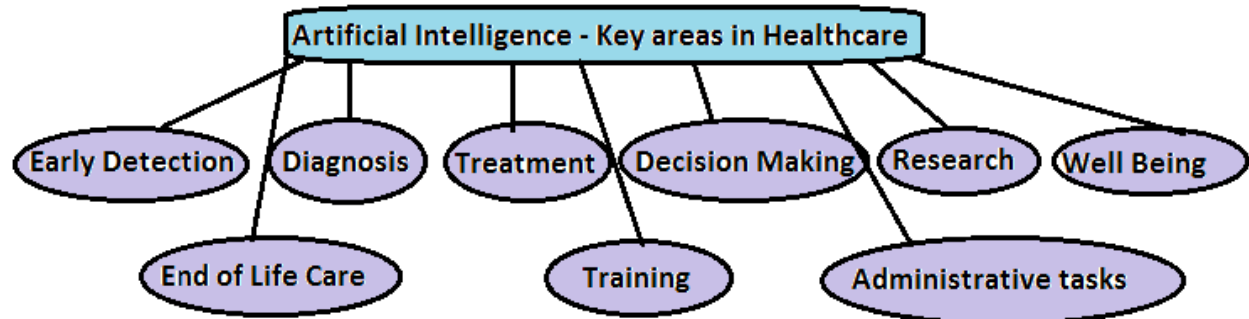
High-Performance Statistics

- HPLOGISTIC
- HPREG
- HPLMIXED
- HPNLMOD
- HPSPLIT
- HPGENSELECT
- HPFMM
- HPCANDISC
- HPPRINCOMP
- HPQUANTSELECT
- HPPLS

High-Performance Data Mining

- HPREDUCE
- HPNEURAL
- HPFOREST
- HP4SCORE
- HPDECIDE
- HPCLUS
- HPSVM
- HPBNET

SOME OF THE POTENTIAL AREAS FOR AI



Let's take a closer look at some of the key areas below with some examples:

RESEARCH - DRUG DEVELOPMENT

AI can scan through data at a super-fast rate which can revolutionize the development of new drugs.

The technology can analyze data drawn from various sources like clinical trials, patient health records and genetic records. It will help to predict how a drug might affect a person's cells and tissues and will lead to better clinical trials and bring drugs to market much faster.

DIAGNOSIS - MEDICAL IMAGING DIAGNOSTICS

X-rays, CT, scanners and MRI machines give partial view of the body's inner system, but they are not reliable because they are not always able to give an accurate diagnosis on their own.

But AI has removed the unreliability of the scanning machines by providing highly accurate inputs on the body. Using deep learning algorithms, it is now possible to differentiate between cancerous and non-cancerous cells in a much more precise manner.

The radiologists can now focus into the problem, and study accurately, and do something more than what the human eyes could do. By checking the affected area deeply, doctors can reach a better judgment on whether the treatment will affect the nearby areas or how deep the infection could go and discover the possibility of the disease.

Its capability in examining the affected area and going deeper into it helps the surgeons too while they are performing surgeries because they are now able to get better inputs on how to access the surgical area.

WELL BEING

✓ ELECTRONIC HEALTH RECORDS

Apart from information storage and retrieval, and identification of patterns, AI can handle other requests as well i.e. Overdue lab test reminder to patients, medicine refills, identifies emergencies and urgent attention etc.

✓ VIRTUAL HEALTH ASSISTANCE

Intelligent Virtual Assistant (IVA) and Medical Virtual Assistant (MVA) have taken the patient engagement to next level. The medical assistance has gone beyond wearables by urging patients to not just manage their goals, but also to actually help them look after their health like a real assistant would. There are health monitors and other devices that have AI incorporated in them. Here are some ways in which AI can help i.e. medication reminders, medical advice, diet suggestions for people with diet restrictions, prescription refills, doctor appointment reminders, virtual interaction with physicians etc.



Virtual nursing assistants are one of the examples. As virtual nurses are available round the clock, they can answer questions and monitor patients. Most applications of virtual nursing assistants today allow for more regular communication between patients and care providers between office visits to prevent hospital readmission or unnecessary hospital visits.

TREATMENT - ROBOTIC ASSISTANCE

The AI assistant can instantly provide information on the patient's past and present health and make suggestions that would help in the diagnosis. Surgeries have become minimally invasive techniques whereby hospital stay is considerably reduced. There are surgical bots that use computer vision to perform surgeries after calculating the measurements of the human body accurately.

AI can help with surgeries of various capacities, including procedures with varying levels of difficulties. And this can have huge implications on hospital stay, and thereby recovery of the patient. When a surgeon performs a complex surgery, AI provides him/her with real-time data to identify and reduce risk, and improve quality. Highly precise movements are made the robot hands so any tremors in the surgeon's hands will be neutralized completely, enabling the progress and success of microsurgeries.

Robot-assisted surgery is considered "minimally invasive" so patients won't need to heal from large incisions. With the help of artificial intelligence, robots can use data from past operations to inform new surgical techniques.

Example: First human test of robotic eye surgery a success

Source: <http://www.ox.ac.uk/news/2018-06-18-first-human-test-robotic-eye-surgery-success>

EARLY DETECTION - PROACTIVE MEDICAL CARE

In traditional medical treatment, the trend was to treat the patient after the disease is detected. For example, if a patient goes to a doctor with certain symptoms, the doctor might do certain tests, and then discover the patient has cancer. Treatment like radiation and chemotherapy are started afterward.

With Artificial Intelligence, there has been a shift in this trend because reactive medical care became proactive medical care. In this kind of care, the patient's complete medical history is studied and high-risk markers for various diseases are highlighted. At risk patients are then monitored for any change in their conditions, and if anything seems alarming enough, then the application can suggest medical intervention.

Similarly, there are condition-specific applications for AI like palliative care, congenital heart diseases and diabetes management.

DECISION MAKING AND DIAGNOSIS

Some of the areas where AI can help in decision making and diagnosis are as follows:

a. Detecting cancer i.e. skin and breast

AI can now diagnose skin cancer more accurately than doctors. The AI technology could reduce the number of false positives when symptoms are being analyzed this avoiding unnecessary treatment. It could also help reduce the overall wait times for patients who need urgent surgery.

Example 1: A Stanford University study tested an AI algorithm to detect skin cancers against dermatologists, and it performed at the level of the humans.

Source: <https://www.nature.com/articles/nature21056>

Example 2: Baidu Research recently announced that the results of early tests on its deep learning algorithm indicate that it can outperform humans when identifying breast cancer metastasis.

Source: <https://venturebeat.com/2018/06/18/baidu-researchs-breast-cancer-detection-algorithm-outperforms-human-pathologists/>

Example 3: Prime Minister Theresa May announced an AI revolution would help the National Health Service (NHS), the UK's healthcare system; predict those in an early stage of cancer to ultimately prevent thousands of cancer-



related deaths by 2033. The algorithms will examine medical records, habits and genetic information pooled from health charities, the NHS and AI.

Source: <https://www.independent.co.uk/news/uk/politics/nhs-artificial-intelligence-ai-cancer-deaths-2033-technology-promise-a8360451.html>

b. Eye health

Identifying eye problems early can significantly reduce the chance of sight loss.

Google DeepMind has teamed up with Moorfields Eye Hospital in London to work on diagnosing two major conditions that cause sight loss: diabetic retinopathy and age-related macular degeneration (AMD).

Example: Age-Related Macular Degeneration (AMD)

Source - <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6133903/>

c. Depression: AI could transform the way the illness is diagnosed, and provide technology-based treatments. There are many artificial intelligence based technologies available that can be used to help fight depression.

ADMINISTRATIVE TASKS AND TRAINING

Another way AI can impact healthcare is to automate administrative tasks. Technology such as voice-to-text transcriptions could help order tests, prescribe medications and write chart notes.

One example of using AI to support admin tasks is a partnership between the Cleveland Clinic and IBM that uses IBM's Watson to mine big data and help physicians provide a personalized and more efficient treatment experience.

END OF LIFE CARE

AI advances can help patients and physicians determine illness sooner to prepare for end-of-life costs and treatments before it's too late.

Failing to identify patients who need palliative care can have traumatic consequences. In case the patient's health suddenly deteriorates; they may spend their final days receiving aggressive and expensive medical treatments in hopes of extending their lives by a few weeks. It may allow patients to remain at home, instead of in the hospital, during their final days.

SOME CHALLENGES THAT NEED TO BE ADDRESSED

- Risks i.e. wrong predictions, safety, data security, new and exceptional cases
- Patient and doctors comfort level in using the AI systems
- Training and expertise to use AI systems
- Adherence to healthcare regulatory standards

CONCLUSION

It's not about making better decisions; it's about having better information. Artificial intelligence is changing healthcare. It is changing the role of the doctors and patients. It will change the overall healthcare in diagnosis, treatment, disease detection etc.

Incorporating AI in healthcare will benefit by providing better treatment methods i.e. robotic surgery, cell biology, stems therapy etc.; efficient and affordable healthcare, improve diagnosis and reduce diagnostic error, personalized care and predictive medical care.

Clinicians should be aware of the capabilities as well as current limitations of AI. Properly integrated AI will improve patient outcomes and health-care efficiency. Augmented intelligence at the point of care is likely to precede AI without human involvement.

The new generation of AI-related tools and systems will help healthcare providers provide efficient care and get ahead in diagnosing and preventing thus creating a new era of clinical quality and exciting breakthroughs in patient care.



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How Is AI Used In Healthcare - 5 Powerful Real-World Examples That Show the Latest Advances

<https://www.forbes.com/sites/bernardmarr/2018/07/27/how-is-ai-used-in-healthcare-5-powerful-real-world-examples-that-show-the-latest-advances/#7dc701845dfb>

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