

A fundamental question

Charles P. Friedman

OR:

$$(\text{Brain} + \text{Computer}) > \text{Brain}$$

Friedman CP. JAMIA 2009;16(2):169-170

Menu

1. What is Artificial Intelligence?
2. History of AI in Medicine
3. Machine Learning
4. Where are we now?

SCIENCE

3 July 1959, Volume 130, Number 3366

Reasoning Foundations of Medical Diagnosis

Robert S. Ledley and Lee B. Lusted

The purpose of this article is to analyze the complicated reasoning processes inherent in medical diagnosis. The importance of this problem has received recent emphasis by the increasing interest in the use of electronic computers as an aid to medical diagnostic processes (1, 2). Before computers can be used effectively for such purposes, however, we need to know more about how the physician makes a medical diagnosis. If a physician is asked, "How do you make a medical diagnosis?" his explanation of the process might be as follows: "First, I obtain the case facts from the patient's history, physical examination, and laboratory tests. Second, I evaluate the relative importance of the different signs and responses. Some of the data fitted into a definite disease category, or that it may be one of several possible diseases, so that the exact nature cannot be determined." This, obviously, is a greatly simplified explanation of the process of diagnosis, for the physician might also comment that after seeing a patient he often has a "feeling about the case." This "feeling," although hard to explain, may be a summation of his experience concerning the way the data seem to fit together, the patient's reliability, general appearance, facial expression, and so forth, and the physician might add that such "feelings" influence the considered diagnosis. No one can doubt that complex reasoning processes are involved in making a medical diagnosis. The diagnosis is important because

most are the ones who do remember and consider the most possibilities." Computers are especially suited to help the physician collect and process clinical information and routine lines of diagnosis which he may have overlooked. In many cases computer may be as simple as a set of hand-drawn cards, whereas in other cases the use of a logical-digital electronic computer may be indicated. There are other ways in which computers may serve the physician, and some of these are suggested in this paper. For example, medical students might find the computer an important aid in learning the methods of differential diagnosis. But to use the computer that we must understand how the physician makes a medical diagnosis. This, then, brings us to the subject of our investigation: the reasoning foundations of medical diagnosis and treatment.

Medical diagnosis involves processes that can be systematically analyzed, as well as those characterized as "intangible." For instance, the reasoning foundation of medical diagnostic procedures are precisely analyzable and can be separated from certain considered intangible judgments and value decisions. Such a separation has several important advantages. First, systematization of the reasoning process enables the physician to define more clearly the intangible involved and therefore enables him to concentrate full attention on the most difficult judgments. Second, since the reasoning processes are susceptible to precise analysis, error from this source

Towards the Simulation of Clinical Cognition

Taking a Present Illness by Computer

STREIBER G. (MUNICH, GERM.)
 ALEXANDER G. (MUNICH, GERM.)
 ALEXANDER G. (MUNICH, GERM.)
 WILHELM E. (MUNICH, GERM.)
 BUCKER W. (MUNICH, GERM.)

Remarkably little is known about the way employed in the routine of clinical information is probably accounted for neither analysis, based on the study of cases, that we report on in this paper, nor the use of electronic computers.

Our experimental approach has been to use a computer to simulate the way in which a physician develops a complete present illness of a patient with whom he has a series of hypothetical cases, and to see if the computer were capable of doing this in the same way as the physician does. Our results in this program, and the program results in our group, are presented in this paper.

The intention to computerize medical diagnosis is to simulate the physician's diagnostic process. The program is designed to simulate the physician's diagnostic process, and to see if the computer were capable of doing this in the same way as the physician does. Our results in this program, and the program results in our group, are presented in this paper.

For the first time, a computerized program has been developed which simulates the physician's diagnostic process. The program is designed to simulate the physician's diagnostic process, and to see if the computer were capable of doing this in the same way as the physician does. Our results in this program, and the program results in our group, are presented in this paper.

June 1974 The American Journal

<p>NAME: NEPHROTIC SYNDROME</p> <p>IS-A-TYPEOF: CLINICAL STATE</p> <p>FINDING: LOW SERUM ALBUMIN CONCENTRATION</p> <p>FINDING: HEAVY PROTEINURIA</p> <p>FINDING: HIGH SERUM CHOLESTEROL CONCENTRATION</p> <p>FINDING: EITHER FACIAL OR PERI-ORBITAL AND SYMMETRICAL EDEMA</p> <p>FINDING: URINE LIPIDS PRESENT</p> <p>MUST NOT HAVE: PROTEINURIA ABSENT</p> <p>IS-SUFFICIENT: BOTH MASSIVE EDEMA AND >8GRAMS/24HRS PROTEINURIA</p> <p>MAJOR-SCORING: SERUM ALBUMIN CONCENTRATION</p> <p>LOW: -1.0</p> <p>HIGH: +1.0</p> <p>PROTEINURIA: >8GRAMS/24HRS: 1.0</p> <p>HEAVY: >3</p> <p>EDEN: EITHER ABSENT OR LIGHT: -1.0</p> <p>MASSIVE AND SYMMETRICAL: 1.0</p> <p>NOT MASSIVE BUT SYMMETRICAL: 0.5</p> <p>ASYMMETRICAL: 0.2</p> <p>ASYMMETRICAL: -0.5</p> <p>ABSENT: -1.0</p> <p>MINOR-SCORING:</p> <p>SERUM CHOLESTEROL CONCENTRATION:</p> <p>HIGH: +1.0</p> <p>NOT HIGH: -1.0</p> <p>URINE LIPIDS:</p>	<p>STATUS RULE: STABLE HEMODYNAMICS</p> <p>IF</p> <p>HEART RATE is ACCEPTABLE</p> <p>PULSE RATE does NOT CHANGE by 20 beats/min. in 15 min.</p> <p>MEAN ART BL PRESS is ACCEPTABLE</p> <p>MEAN ART BL PRESS does NOT CHANGE by 15 torr in 15 min.</p> <p>SVT BL PRESS is ACCEPTABLE</p> <p>THEN</p> <p>the HEMODYNAMICS are STABLE</p>
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Rule-based expert systems

STATUS RULE: STABLE HEMODYNAMICS

IF

HEART RATE is ACCEPTABLE

PULSE RATE does NOT CHANGE by 20 beats/min. in 15 min.

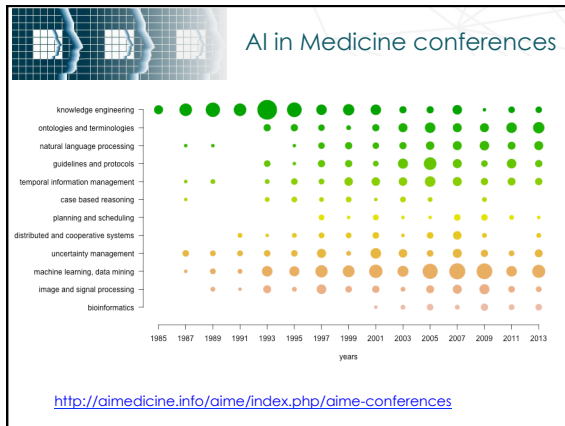
MEAN ART BL PRESS is ACCEPTABLE

MEAN ART BL PRESS does NOT CHANGE by 15 torr in 15 min.

SVT BL PRESS is ACCEPTABLE

THEN

the HEMODYNAMICS are STABLE



Menu

1. What is Artificial Intelligence?
2. History of AI in Medicine
3. Machine Learning
4. Where are we now?

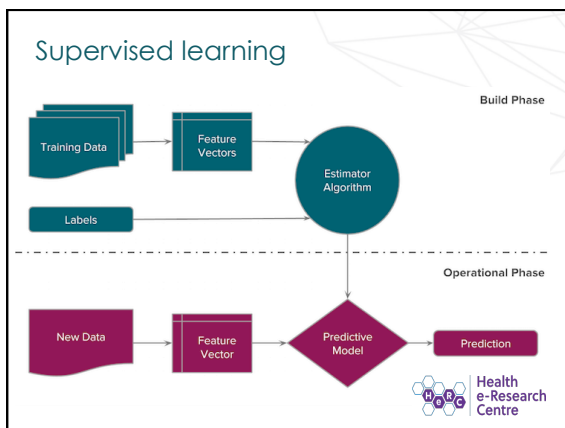
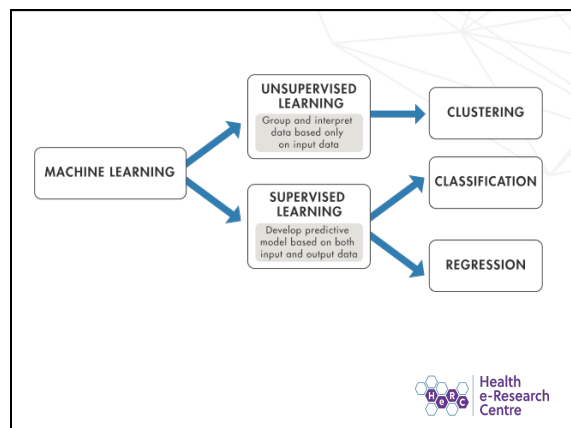
Machine Learning

A field of computer science that gives computers the ability to learn without being explicitly programmed

It can be easier to train a system by showing it examples of desired input-output behaviour than to program it manually

Recent progress in machine learning has been driven by

- development of new learning theory and algorithms
- the ongoing explosion in availability of data
- low-cost computation



Machine Learning	Statistics
network, graphs	model
focus on prediction	focus on inference
weights	parameters
learning	fitting
generalization	test set performance
supervised learning	regression/classification
unsupervised learning	density estimation, clustering
large grant = \$1,000,000	large grant = \$50,000
nice place to have a meeting: Snowbird, Utah, French Alps	nice place to have a meeting: Las Vegas in August

<http://statweb.stanford.edu/~tibs/stat315a/>

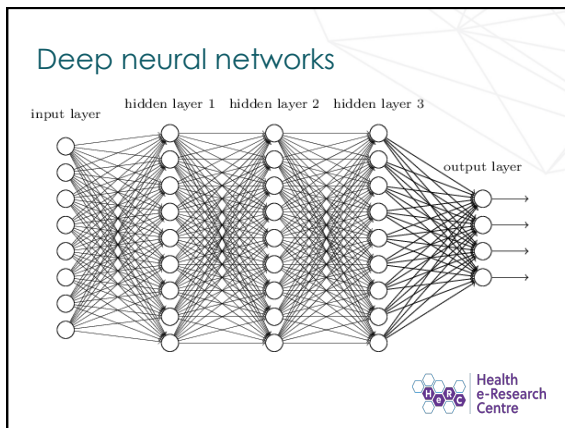
Statistics ← **Machine Learning**

T-Test
 Logistic Regression
 Elastic Net
 Gradient Boosting
 Deep Learning

From a presentation by Tom Liprot

The artificial neuron

Valentin, 1836 McCulloch & Pitts, 1943



Deep learning history

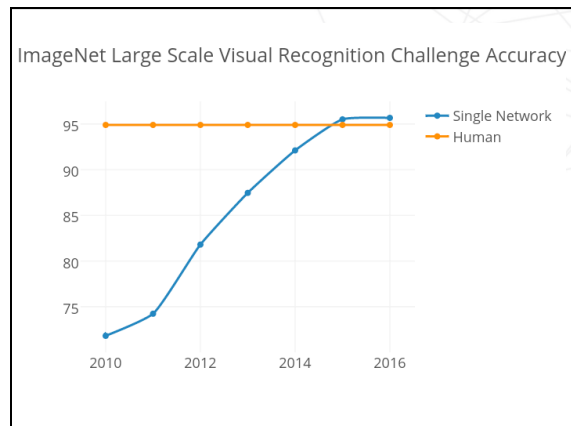
Year	Milestone
1940	Electronic Brain
1943	McCulloch & Pitts
1957	Perceptron
1958	ADALINE
1960	Golden Age
1969	XOR Problem
1970	Dark Age ("AI Winter")
1986	Multi-layered Perceptron (Backpropagation)
1995	SVM
2000	Deep Neural Network (Pretraining)
2006	Deep Neural Network (Pretraining)

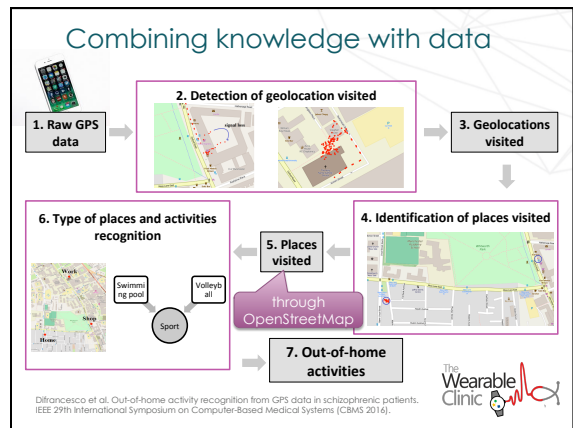
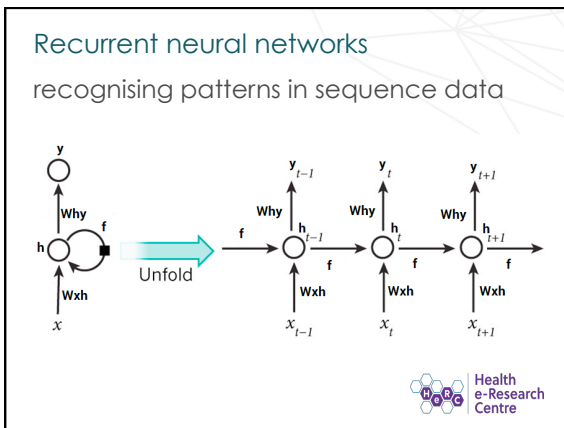
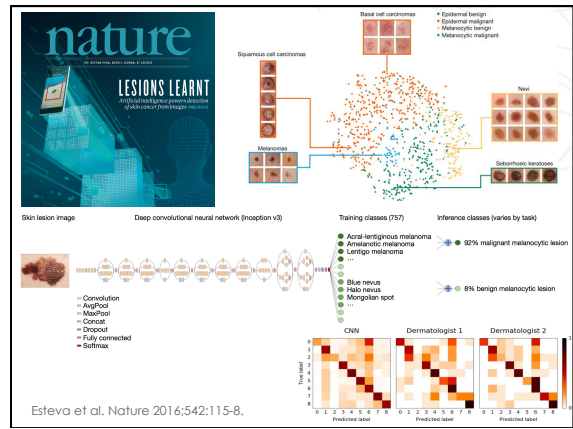
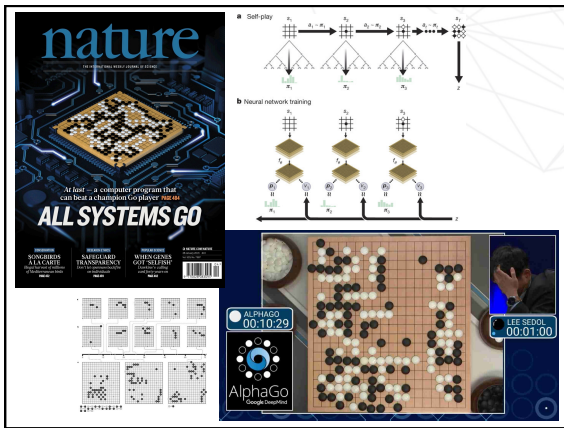
https://beandrew.github.io/deeplearning/2017/02/23/deep_learning_101_part1.html

ImageNet Large Scale Visual Recognition Challenge

person
 car
 helmet
 motorcycle

Fair





The slide is titled "Menu" and contains a list of four topics: "1. What is Artificial Intelligence?", "2. History of AI in Medicine", "3. Machine Learning", and "4. Where are we now?". The bottom half of the slide features a photograph of a human hand holding a prosthetic robotic hand.



The Lancet, Vol. 390, Dec 2017

Editorial


Artificial intelligence in health care: within touching distance

Replacing the doctor with an intelligent medical robot is a tempting prospect in a world where the idea of the industrialized medical advice from digital assistants that know the right questions to ask and understand complex data no longer seems implausible. It is a world in which medical information gathered at the point of care, and analysed using sophisticated machine algorithms, would be able to provide real-time actionable advice to the patient. The notion of an intelligent medical assistant, or even a fully autonomous medical robot, is a tantalizing prospect. The notion of an intelligent medical assistant, or even a fully autonomous medical robot, is a tantalizing prospect. The notion of an intelligent medical assistant, or even a fully autonomous medical robot, is a tantalizing prospect.

A scenario in which medical information, gathered at the point of care, is analyzed using sophisticated machine algorithms to provide real-time actionable analytics seems to be within touching distance

Very few AI technologies are already in clinical use. Translating technical success to meaningful clinical impact is the next great challenge


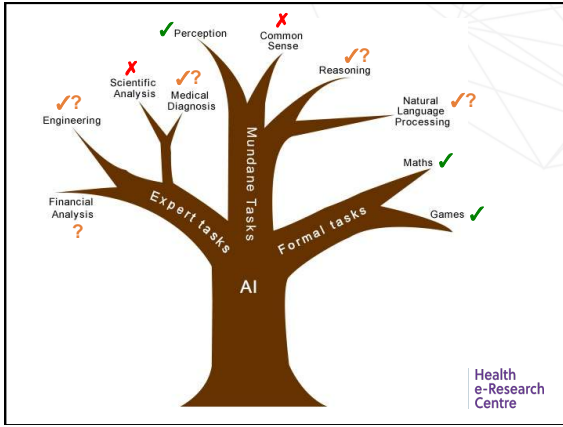
First and last mile problems




Enrico Coiera


The "first mile" problem
Without data and expert humans to train Machine Learning models, we have a production bottleneck that limits the rate of expansion of AI systems.

The "last mile" problem
An algorithm doesn't do anything on its own. Connecting it to the real world (e.g. delivering health care) is harder than building it in the first place.

Summary

- There is a long history of AI in medicine
- Recurring question is relationship between human and machine 
- Few AI systems are in clinical use
- Important breakthroughs in machine learning during the last decade
- Extreme reliance on data unlikely to work
- First and last mile problems often overlooked



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Thank you



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