THE FUTURE OF CARDIOLOGY: FROM ARTIFICIAL INTELLIGENCE TO CARDIAC MONITORING

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Outline

• What is AI?
• Examples of how AI may be applied to medical data
• Role of AI in remote monitoring, wearables, and healthcare
AI and augmented vision

NEW NAVY DEVICE LEARNS BY DOING

Psychologist Shows Embryo of Computer Designed to Read and Grow Wiser

WASHINGTON, July 7 (UPI)

The Navy revealed the embryo of an electronic computer today that it expects will be able to walk, talk, see, write, reproduce itself and be conscious of its existence.

The embryo—the Weather Bureau's $2,000,000 "704" computer—learned to differentiate between right and left after fifty attempts in the Navy's demonstration for newspapers.

The service said it would use this principle to build the first of its Perceptron thinking machines that will be able to read and write. It is expected to be finished in about a year at a cost of $100,000.

Dr. Frank Rosenblatt, designer of the Perceptron, conducted the demonstration. He said the machine would be the first device to think as the human brain. As do human beings, Perceptron will make mistakes at first, but will grow wiser as it gains experience, he said.

Dr. Rosenblatt, a research psychologist at the Cornell Aeronautical Laboratory, Buffalo, said Perceptrons might be fired to the planets as mechanical space explorers.

Without Human Controls

The Navy said the perceptron would be the first non-living mechanism "capable of receiving, recognizing and identifying its surroundings without any human training or control."

The "brain" is designed to remember images and information it has perceived itself. Ordinary computers remember only what is fed into them on punch cards or magnetic tape.

Later Perceptrons will be able to recognize people and call out their names and instantly translate speech in one language to another. To do this, it would be possible to build brains that could reproduce themselves on an assembly line and which, would be conscious of their existence.

1958 New York Times...

In today's demonstration, the "704" was fed two cards, one with squares marked on the left side and the other with squares on the right side.

Learning by Doing

In the first fifty trials, the machine made no distinction between them. It then started registering a "Q" for the left squares and "O" for the right squares.

Dr. Rosenblatt said he could explain why the machine learned only in highly technical terms. But he said the computer had undergone a "self-induced change in the wiring diagram."

The first Perceptron will have about 1,000 electronic "association cells" receiving electrical impulses from an eye-like scanning device with 400 photo-cells. The human brain has 10,000,000,000 responsive cells, including 100,000,000 connections with the eyes.
Compute Power

- Transistor: The fastest supercomputer will equal the entire human race in 30 years.
- Integrated Circuits: Desktops will have human level speed by the middle of the 2020s, 12 years from now.
- Carbon Nanotubes: Today’s top SuperComputer is 10% of Human Brain, likely to match by 2012.

- Historically, desktop computing trails supercomputing by about 12 years, by a speed factor of 1000 to 25,000.
- Your cell phone may be smarter than you by 2030.
- In late 2009, new OS releases utilized GPUs as CPUs, generate up to one teraflop.
- Mobile devices trail Desktops by about 8 years, by a factor of 10 to 100.
• Machine intelligence + clinical intelligence = medical intelligence
Diagnosis of acute MI in the ED

Emergency Physicians
78%  85%

Neural Network
97%  96%

AI-enhanced ECG interpretation

Streamlining **human** capability
- First pass interpretation
- Triage work flow
- Scalability

Beyond **human** capability
- Seeing what a clinician cannot
- ‘value-added’ ECG read
- Moving beyond normal/abnormal
Low heart function
Risk of atrial fibrillation

- Sensitivity
- Specificity

Validation set (AUC = 0.93)
Testing Set (AUC = 0.93)

• Perfect test = 1.0
  - Detection of low EF = 0.93
  - Detection of risk of AF = 0.90

• Compares favorably with other medical tests:
  - Mammography for breast cancer = 0.85
  - Cervical cytology (Pap smear) = 0.70
  - PSA (prostate cancer) = 0.92
Can We Do It with a Smartphone?

Signal Acquisition

Processes ECG

Receiver Operating Characteristic

Secure cloud

Train Set

Test Set

Normalized Amp (Au)

Sensitivity

1 – Specificity

-0.3 -0.2 -0.1 0.0 0.1 0.2 0.3 0.4 0.5 0.6

0.0 0.2 0.4 0.6 0.8 1.0

0.0 0.2 0.4 0.6 0.8 1.0

-0.4 -0.2 0.0 0.2 0.4 0.6 0.8

Single Lead – Lead I (AUC=0.90)

12 Leads (AUC=0.93)
Is this enough?

How do we scale cost effective insights?

80% of Americans admit they are delaying or forgoing preventive care

[2015, Zocdoc]

22.5% of Americans don’t have a personal doctor

[2017, NPF]

4X

On average, an American visits the doctor four times a year, substantially less than in other countries. In Japan, people usually go to their doctor 13 times a year.

[2014, The Commonwealth Fund]
How do we traditionally achieve data?
The need to go beyond the office
Are physician-prescribed ambulatory recordings enough?

• Require engagement into a physician’s office
• Access issues to technology
• Appropriate data management and interpretation opportunities amongst treating practitioners
Delay in receipt of data

Arrocha, et al. PACE 2010
“The patient will see you now”

“There’s a growing expectation among patients and the general public for transparent and secure access to health data” – Khaldoun Tarakji
IOT Nation
Digital Health Summit HRS

“I call this the new symptom in cardiology – a high heart rate on a wearable device” – Nassir Marrouche, 2019

“It’s clearly the future – It’s obvious to us that this train has left the station and we can either try to catch up or we can lead.” – David Slotwiner, 2019
Apple Heart Study

- 400,000 patients enrolled in 8 months
- Pulse notification in 2,161 patients (0.52%)
  - 84% consistent with afib
- Afib identified in 34% with follow up patch monitoring
What is the best management for atrial fibrillation?

Get an iWatch?
Device Manufacturers

Physician

Patient

Opportunities
1. Supportive and widely used technologies (smart devices)
2. Patient engagement
3. Education
4. Potential for better and more affordable care

Obstacles / Challenges
1. Adoption by patients and physicians
2. Physician burden
3. Multiple and disconnected portals
4. Medical vocabulary and terminology
5. Regulatory concerns
How can elements work together

• Low cost physiologic monitors may inform implantable devices

• Scalable population health becomes more feasible the more we help annotate ambulatory data and engage AI

• The health of all versus the benefit of some
What are we truly scared of?
Is interpretation really that much better with current monitors?
How do we properly deal with the data influx?

• Work with industry
• Build rapidly modifiable, teachable systems
• Integrate across healthcare systems
Does it really have to be that bad?

“I have random dizzy spells”

“I have random dizzy spells … Here’s my rhythm strip”
Conclusions

• AI is an evolving tool to gain rapid insights from traditional medical diagnostics

• AI can allow for data to be rapidly analyzed at large scales rapidly

• Wearable monitors will facilitate the distribution of AI algorithms and AI will facilitate clinician management of monitoring data
Questions & Discussion