Medical Intelligence: Big Data, Predictive Analytics, Machine Learning, and Artificial Intelligence

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Artificial Intelligence
EX_MACHINA

THERE IS NOTHING MORE HUMAN THAN THE WILL TO SURVIVE

COMING SOON
At last – a computer program that can beat a champion Go player PAGE 484

ALL SYSTEMS GO

Humankind vs Computer

人類と人工知能の叡智をかけた史上最強の五番勝負が始まる。

勝つのは、李世乭か？ Googleか？

賞金100万ドル

対局日程：3月9, 10, 12, 13, 15日／対局場：韓国ソウル
Artificial Intelligence

Artificial Intelligence in Medicine ("Medical Intelligence")
Missing Data

The Prevention and Treatment of Missing Data in Clinical Trials
Family meeting: parents okay with trach, PD and broviac implications, diuril started 4/10 Bumex gtt, Decadron 0.3mg; 11 wean TiVol. Incr Bumex drip. Wean meth. 4/12 wean DB. Feeds held (only got ~12cc). Huge leak around trach. Mg air leak, vent back to PRVC, mannitol 4/14. Febrile 38. 4/16 DC Bicitra, PEEP 5, clamp pigtail (=pneumo), DC next to scheduled. 4/18 CT to -10, start trophics 4/19 Cols. Diuril to PO. 4/23 Fever/cx/antibx 4/24 UGI nml. in decadron. Blood cx (both PICC and peripheral) positive respiratory acidosis with pH 7.1, CO 80-90 and ongoing age...
Excessive Data

By 2020, doctors will face 200x the amount of medical data and facts that a human could possibly process.¹

And it will get worse... The volume of medical data doubles every five years.²

81% of physicians can't even spare 5 hours per month to keep up.⁷
Future Data

New Health Sciences Data Sources

Drug Research
Social Media
Patient Records
Gene Sequencing
Test Results
Claims
Home Monitoring
Mobile Apps
Genomic Medicine: Next Generation
Precision Medicine:

PharmacoGenomics: Personalized Medicine
Internet of EveryThing Patient

THE HUMAN SIDE OF DATA
People go to hospitals to get well. Unfortunately, many will become even sicker because of exposure to bacteria and other germs.

They will be the unwilling recipients of Hospital-Acquired Infections known as HAIs.

1 IN 20 PATIENTS WILL GET AN HAI, 99,000 WILL DIE

Previous methods to track hand washing proved challenging for front providers.

HOWEVER, EMPOWERING PEOPLE WITH INFORMATION AND TOOLS MAKES A BIG DIFFERENCE.

GE’S AGILETRAC
is a core hand washing monitoring system that closes the gap between action and reality. Information sharing and data can lead to better outcomes.

1. SENSORS
2. COMPLIANCE TRACKING
3. REAL-TIME MEASUREMENT

WITH AWARENESS COMES ACTION
When people feel informed about their behavior they are more likely to react and change it.

A 20% sustained improvement in hand washing compliance was realized in the first eight weeks after implementing AgileTrac.

The automated system collects better data quality than traditional manual tracking systems.

THE RESULTS
Hand washing opportunities tracked per year.

Then 700
Now 1.8M

Safe hand-washing procedures have the potential to reduce the number of HAIs decrease risk to patients and caregivers.

DATA BECOMES A POWERFUL TOOL FOR COLLABORATION.
Little Information

Healthcare's Data Conundrum

From Disparate Data to Meaningful Information

We can empower healthcare organizations, providers and payers to unify the capture, analysis, and use of data to drive smarter care and business.

About 80% of patient information is unstructured, and in turn, unmineable.

Advancements in voice recognition and clinical language understanding are enabling the healthcare enterprise to capture information at the point of care, convert patient data into actionable information, and leverage that information for clinical, business, and patient good.

www.nuance.com/for-healthcare
Disparate Information

Knowledge and Intelligence Network

Disparate types of information are linked into multiscalar, multilateral, multidimensional relationships
The end of theory: The data deluge makes the scientific method (randomized controlled trials) 

*obsolete.*

Chris Anderson, *Wired*
Algorithms

```r
rm(list=ls())
library(dplyr)
library(gplots)
library(survival)
library(maxstat)
library(glmnet)
library(qvalue)

# source("https://bioconductor.org/biocLite.R")
# biocLite()
# biocLite(c("qvalue"))

# Setting the working directory here
setwd("~/HN2/")

# Reading in data
clinical<-read.table("~/HN2/clin.merged.txt",
                    sep="t",
                    fill=TRUE,
                    #
                    row.names=1,
                    colClasses="character")

# Setting up assigned variables
variables<-
c("patient.bcr_patient_barcode","patient.days_to_death","patient.days_to_last_followup","patient.vital_status")
clinical<-clinical[variables,]

# Transposing column and row
clinical<-t(clinical)
clinical<-data.frame(clinical,row.names=NULL,stringsAsFactors = FALSE)

# Converting to numeric
clinical$patient.days_to_death<-as.numeric(clinical$patient.days_to_death)
clinical$patient.days_to_last_followup<-as.numeric(clinical$patient.days_to_last_followup)
```
Big Data

Big Data: Expanding on 3 fronts at an increasing rate.

[Big] Data in Medicine

Next gen-seq, iPOP

Claims, EMR, Clinical notes

Number of samples

Small | Large

Small | Big
Computational Power

Exponential Growth of Computing

Computing Power / Per $1,000

- All Human Brains
- One Human Brain
- One Mouse Brain
- One Insect Brain

1900 1920 1940 1980 2000 2020 2040 2060
Cloud Computing

Application
- Monitoring
- Content
- Collaboration
- Communication
- Finance

Platform
- Object Storage
- Identity
- Runtime
- Queue
- Database

Infrastructure
- Compute
- Block Storage
- Network

Cloud Computing
Cognitive Computing:
Data Mining: New Knowledge from Big Data
Deep Learning: Machine Learning/Neural Networks
Do We Humans REALLY Need AI?
EME STREAMING ANALYTICS ARCHITECTURE

Patient Bedside Monitoring Network

- ICU Monitors
- Med Surg Monitors
- OR Monitors
- ED Monitors
- Telemetry System

Hospital Network

- Ancillary Monitoring Devices (vents, oximeters, video, etc)
- Hospital EMR and other data sources

- IBM Infosphere Streams

Various dashboards or notifications for clinicians & investigators

Excel Medical BedMasterEx & BedComm
The Artificial Intelligence Brain
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The Artificial Intelligence Brain

- Image Recognition
- Natural Language Processing
- Machine Learning
- Decision Support System
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- Image Recognition
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function newImg = myconv2(img, kernel)

    newImg = zeros(size(img));
    imgRow = size(img,1);
    imgCol = size(img,2);
    shift = (size(kernel,1)-1)/2; % maximum of how far we may go past border of img

    for row = 1:imgRow
        for col = 1:imgCol
            newImgVal = 0;
            for x = -shift:shift
                for y = -shift:shift
                    newRow = row - x;
                    if (newRow < 1)
                        continue;
                    elseif (newRow > imgRow)
                        continue;
                    end
                    newCol = col - y;
                    if (newCol < 1)
                        continue;
                    elseif (newCol > imgCol)
                        continue;
                    end
                    newImgVal = newImgVal + img(newRow, newCol)*kernel(x+shift+1,y+shift+1);
                end
            end
            newImg(row,col) = newImgVal;
        end
    end

    newImg(row,col) = newImgVal;
end
The Artificial Intelligence Brain
dens <- density(data, n = npts)
dx <- dens$x
dy <- dens$y
if(add == TRUE)
    plot(0, 0, main = xlab = ylab = if(orientation == 1)
dx2 <- (dx - min(dx))/max(dx) x[1]
dy2 <- (dy - min(dy))/max(dy) y[1]
    seqbelow <- rep(y[1], length(dx))
    if(Fill == T)
        confshade(dx2, seqbelow, dy2)
The Artificial Intelligence Brain

- Image Recognition
- Natural Language Processing
- Machine Learning
- Decision Support System
Cortical Infrastructure
Cortical Infrastructure
BioIntelligence Framework: A Living Expert Neural Network
Making the visible *invisible*
Making the invisible visible
HyperGraph Architecture
Intelligence-Based Medicine
Intelligence-Based Medicine
Intelligence-as-a-
Collective
SuperIntelligence
VERY SPECIAL THANKS TO:
Sharon Disney Lund Medical Intelligence and Innovation Institute (MI3)
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4 DAYS THAT WILL CHANGE THE WAY YOU THINK ABOUT THE FUTURE OF PEDIATRICS!

January 6-9, 2016
The Ritz-Carlton, Laguna Niguel | Dana Point, CA

International Society for Pediatric Innovation (iSPI)
peds2040.org