Global Association of Physicians of Indian Origin (GAPIO)

“Improving Health Worldwide”
Artificial Intelligence In Healthcare
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Future of Medicine
The First Task Watson Addressed was Winning on Jeopardy!
IBM Celebrates the 15th Anniversary of Deep Blue beating Garry Kasparov
NVIDIA Reveals New GPU, GeForce GTX 1080 is Faster than the Titan X
What is AI and ML?

Computers making decisions in real-world problems
Integration
Cleaning, transformations

Data Prep

Feature Engineering Cycle
• Generate features
• Select features

Feature Engineering Cycle

Modeling
• Choose algorithms
• Train the model/s

Modeling

Extract
• Extract R/Python file of the best model

Extract

Deploy
• Trained ML model as API or SHIP

Deploy
Machine Learning Phases

**Training Phase**
- Labels
- Images
- Feature Extractor
- Features
- Machine Learning Algorithm

**Prediction Phase**
- Images
- Feature Extractor
- Features
- Trained Classifier
- Label
AI | ML | DL Augments Human Decision-making in Healthcare

Medical imaging example of “AI Augmented” Decision Making

Traditional approach
- Take CT scan
- Data saved in a database
- Image read by a radiologist
- Radiologist highlights anomalies

Potential to apply AI
- Take CT scan
- Data saved in a database
- Image run through an AI trained model for diagnosis
- Anomaly report generated

Human involvement augmented by AI

Slide Source: Dell EMC Consulting
Image and Signal Processing in Medical Science?

- Bio-Imaging Research, Inc.
- Information about CT scans, ultrasound imaging, MRIs, and more
Big Data in Healthcare

- First time in history extremely Big Data is available
- The Big Data cannot be used by individual physician
- Big Data itself is meaningless, but processing it offers the promise of unlocking novel insights and accelerating breakthroughs in medicine which in turn has the potential to transform current clinical practice
- Explosion in knowledge is beyond use for any capacity
- It would be criminal not use latest processed data/protocol in management of patients
- Artificial Intelligence (AI) in the era of Big Data could assist physicians in shortening processing times and improving the quality of patient care in clinical practice
Limitations of Human Intelligence

• Only 20 percent of the knowledge physicians use to make diagnosis and treatment decisions today is evidence based

• The result? One in five diagnoses are incorrect or incomplete and

• 1.5 million medication errors are made in the US every year

• The amount of medical information available is doubling every five years and much of this data is unstructured – often in natural language

• And physicians simply don't have time to read every journal that can help them keep up to date with the latest advances

• 81 percent report that they spend five hours per month or less reading journals
### Why AI Getting Popular in Medical Science?

At the rate that technology changes and the rate our knowledge evolves… Enough time has passed to ensure that there is a necessity for a new review.

- Are Artificial Intelligence (AI) systems used and useful when applied to critical care?
- Community of computer scientists and healthcare professionals set a research program – Artificial Intelligence in Medicine (AIM) with the aim of revolutionize medicine
- AIM use ‘Machine Learning’ to use and create knowledge
- Machine learning – Computers that can learn from experience
- Use – Stored data used in diagnosis
- Creation – Analyse the relationship within the data to come up with new results
Data Remains to be the Heart of Machine Learning and AI: Data Availability at Biology of Human Systems

Data useful for the practice of precision medicine

- **Social Data**: Personal circumstances, such as living situation and income
- **Device Data**: Information collected from apps that measure fitness and sleeping, electronic inhalers etc
- **Metabolome**: Chemicals which are created, modified and broken down by bodily processes such as enzymatic reactions
- **Transcriptome**: Messages created from DNA to form the template (mRNA) of proteins
- **Genome**: Patient’s complete set of genes ‘written’ in DNA
- **Clinical Data**: Patient’s medical record
- **Exposome**: Impact of the external environment, such as pollution and tobacco smoke etc
- **Microbiome**: Collective name for 100 trillion microscopic bugs living inside us
- **Proteome**: System of proteins, including enzymes, which are the building blocks of the body
- **Epigenetic (Methylobome)**: The set of nucleic and methylation modifications in a human genome
- **Imaging**: Medical images, such as x-rays, scans, ultrasound
The Harvard and Australian studies into medical error remain the only studies that provide population level data on the rates of injuries to patients in hospitals and they identified a substantial amount of medical error.

In the United States, medical error results in 44,000 – 98,000 unnecessary deaths each year and 1,000,000 excess injuries.

The Harvard study of medical practice, Brennan et al. reviewed the medical charts of 30,121 patients admitted to 51 acute care hospitals in New York state in 1984.

They reported that adverse events – Injuries caused by medical management that prolonged admission or produced disability at the time of discharge – occurred in 3.7% of admissions.

A subsequent analysis of the same data “69% of injuries were caused by errors”
The quality of Australian health care, a population based study modelled on the Harvard study, investigators reviewed the medical records of 14,179 admissions to 28 hospitals in New South Wales and South Australia in 1995.

An adverse event occurred in 16.6% of admissions, resulting in permanent disability in 13.7% of patients and death in 4.9%; 51% of adverse events were considered to have been preventable.

Errors often occur when clinicians are inexperienced and new procedures are introduced. Extremes of age, complex care, urgent care, and a prolonged hospital stay are associated with more errors.
Transform the Entire Value Chain with Data and Exponentials

<table>
<thead>
<tr>
<th>The future of care delivery/surgery</th>
<th>The future of the patient</th>
<th>The future of healthcare operations</th>
<th>The future of research</th>
<th>The future of precision medicine</th>
<th>The future of medical education</th>
</tr>
</thead>
<tbody>
<tr>
<td>How might Artificial Intelligence, Machine Learning, and Big Data empower physicians, scientist and patients alike with the latest, most accurate clinical understanding in real time?</td>
<td>How can wearables, networks, sensors and virtual reality foster patient engagement and care coordination that transforms disease management?</td>
<td>How will additive Artificial Intelligence transform operations to optimize their supply chains, utilize just-in-time manufacturing, and increasingly automate their workforces to maximize efficiency?</td>
<td>How will natural language understanding transform the focus of research from discrete academic facilities to a global network of connected &amp; collaborating scientists?</td>
<td>How will genomics and precision medicine provide healthcare professionals with an expanded toolkit to interact directly with DNA and enable proactive management of risks and more precise treatments?</td>
<td>How can virtual/augmented reality revolutionize medical training and accelerate knowledge transfer?</td>
</tr>
</tbody>
</table>

Exponential technologies are radically transforming all aspects of the healthcare value chain
The Future of Care Delivery

Transforming the who, what, and where of care delivery

**Sample Use Cases**

**When Care is Delivered**

- **Retina Selfie** – Retina self-imaging allows patients to monitor for diseases such as multiple sclerosis and detect early warning signs.

**Where Care is Delivered**

- **Healogram** – Mobile platform that helps providers remotely monitor patients post-surgical procedure.

**Who Care is Delivered by**

- **iDAvatars** – Virtual avatar, Sophie, uses artificial intelligence and natural language processing to remotely monitor patients.

**Drivers of Disruption**

- Artificial Intelligence
- Robotics
- Augmented Reality
- Personalized Medicine
- Additive Manufacturing

**Sample Market Signals**

- Healogram
- PHILIPS
- organovo

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The Rise of Artificial Intelligence and the Uncertain Future for Physicians

- Physicians diagnose diseases based on personal medical histories, individual biomarkers, simple scores (e.g., CURB-65, MELD), and their physical examinations of individual patients.

- In contrast, AI can diagnose diseases based on a complex algorithm using hundreds of biomarkers, imaging results from millions of patients, aggregated published clinical research from PubMed, and thousands of physician's notes from Electronic Health Records (EHRs).

- While AI could assist physicians in many ways, it is unlikely to replace physicians in the foreseeable future.

- Let us look at the emerging uses of AI in medicine.
# The Future of Surgery

Transforming what surgeons see, know, and do

## Sample Use Cases

<table>
<thead>
<tr>
<th>What We See</th>
<th>What We Know</th>
<th>What We Do</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SNAP Surgical Theater</strong> – Augments surgeons’ reality with CT/MRI scans to see behind arteries and other critical structures.</td>
<td><strong>Oculus Rift</strong> – Improves training by allowing medical students to watch surgeries from the lead surgeon’s point of view.</td>
<td><strong>BoneWelding</strong> – Stronger bonds and improved osseo-integration enable new implant designs &amp; surgical methods.</td>
</tr>
</tbody>
</table>

## Drivers of Disruption

- ✓ Artificial Intelligence
- ✓ Augmented Reality
- ✓ Personalized Medicine
- ✓ Additive Manufacturing

## Sample Market Signals

- ✓ Networks & Sensors
- ✓ Nanotechnology
- ✓ Robotics

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The Future of the Patient

Transitioning from a passive role to an active role in health

Sample Use Cases

Tools for Self-service

**Tyto Care** – Handheld device that patients can use to self-examine their mouth, throat, eyes, heart, lungs, skin, and temperature.

New Ways to Engage

**Deloitte Cognitive Engagement** – Designed to boost patient involvement in care and expand the type of alerts and interactivity offered online.

The Quantified Self

**Ginger.io** – Aggregates cell phone data to monitor patient’s mental health and alert caregivers when symptoms are problematic.

Drivers of Disruption

- Networks & Sensors
- Wearables
- Artificial Intelligence
- Digital Medicine
- Robotics

Sample Market Signals

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The Future of Healthcare Operations

Automating labor and JIT manufacturing

Sample Use Cases

Efficient Administration
Care at Hand – Helps to prevent readmissions by deploying nursing staff skills to maximum efficiency.

Sample Market Signals

Drivers of Disruption
✓ Additive Manufacturing
✓ Robotics
✓ Artificial Intelligence
✓ Automation
✓ Nanotechnology

Improved Productivity
Aethon TUG Robots – Smart, autonomous robots substitute for the labor needed to haul and transport materials & clinical supplies.

Workforce Augmentation
Evena – Technician glasses provide high-definition, real-time images of vascular anatomy to enable fast, precise IV access.

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The Future of Research

Changing the how and who perform research

Sample Use Cases

Scientific Breakthroughs
- **Illumina** – Reached milestone of making it feasible to read someone’s genome for $1000, down from $95.3 Million in 2001.

New Collaboration Models
- **Foldit** – Predicts the structure of a protein by taking advantage of humans’ puzzle-solving intuitions through an online game.

Operational Efficiency
- **IBM and Mayo Clinic** – Using artificial intelligence to more accurately match patients with appropriate clinical trials.

Sample Market Signals

Drivers of Disruption
- ✓ Synthetic Biology
- ✓ Additive Manufacturing
- ✓ Genomics
- ✓ Personalized Medicine
- ✓ Nanotechnology

The future of care delivery/surgery  The future of the patient  The future of healthcare operations  The future of research  The future of precision medicine  The future of medical education

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The Future of Precision Medicine

Enabling proactive and precise treatments

<table>
<thead>
<tr>
<th>Preventative Measures</th>
<th>New Research/Treatment Methods</th>
<th>Increased Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Human Longevity Inc.</strong> – Building the world’s most comprehensive database on human genotypes.</td>
<td><strong>LiverChip</strong> – Dynamic 3-D cell culture platform can exactly mimic the architecture and physiology of the human liver.</td>
<td><strong>Wyss Institute</strong> – Harvard scientists built a nano-robot from designer DNA to deliver drug dosages to specific cell types.</td>
</tr>
</tbody>
</table>

**Sample Use Cases**

**Drivers of Disruption**
- Genomics
- Personalized Medicine
- Nanotechnology

**Sample Market Signals**

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The Future of Medical Education

Revolutionizing medical training

Sample Use Cases

Expanded Perspective

Dassault Systèmes – Augmented reality allows for enhanced visualizations and simulations.

New Learning Forums

Pop Up Labs – Creates in-house maker spaces to enable/accelerate medical professionals’ best practices and creation.

New Learning Forums

CrowdMed – Medical professionals across the globe collaborate on cases and learn of new treatment methods.

Drivers of Disruption

✓ Virtual/Augmented Reality
✓ Additive Manufacturing
✓ Maker Movement
✓ Crowdsourcing

Sample Market Signals

The future of care delivery/surgery
The future of the patient
The future of healthcare operations
The future of research
The future of precision medicine
The future of medical education

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The Data Types Considered in the Artificial Intelligence Artificial (AI) Literature


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Dermatologist-level Classification of Skin Cancer with Deep Neural Networks: Nature Article

- Andre Esteva\(^1 \text{n}1\), Brett Kuprel\(^1 \text{n}1\), Roberto A. Novoa\(^2, 3\), Justin Ko\(^2\)

- Deep convolutional Neural Networks (CNNs)\(^4, 5\) show potential for general and highly variable tasks across many fine-grained object categories

- Classification of skin lesions using a single CNN, trained end-to-end from images directly, using only pixels and disease labels as inputs

- We train a CNN using a dataset of 129,450 clinical images – two orders of magnitude larger than previous datasets consisting of 2,032 different diseases

- We test its performance against 21 board-certified dermatologists on biopsy-proven clinical images with two critical binary classification use cases: keratinocyte carcinomas versus benign seborrheic keratoses; and malignant melanomas versus benign nevi
Computer-aided Detection of Colorectal Polyps at CT Colonography: Prospective Clinical Performance and Third-Party Reimbursement

Ziemlewicz TJ\textsuperscript{1}, Kim DH\textsuperscript{1}, Hinshaw JL\textsuperscript{1}, Lubner MG

CAD in Medical imaging

- Detection of lung nodules on PA and lateral chest radiographs
- Detection of vertebral fractures on lateral chest radiograph
- Detection of intracranial aneurysms in MRA
- Detection of interval changes in successive whole-body bone scans
- Detection of breast cancer by use of mammograms
Case Studies:
IBM Watson In Action
The Science Behind Watson

- Watson understands natural language, breaking down the barrier between people and machines
- The system then generates hypotheses – recognizing that there are different probabilities of various outcomes
- See how Watson "learns," tracking feedback – learning from success and failure – to improve future responses
Watson enables processing of text, speech and images (...correlate to use cases in healthcare around understanding medical literature/patient records; interactions between caregivers and patients, etc.; analysis of images such as X-ray, MRI, simple cameras)

Watson can be trained on domain-specific and organization-specific content

Watson enables anytime-anywhere “augmented intelligence” via the cloud, so existing healthcare software can be enhanced without major re-writes

Watson enables intelligent interaction with devices (IoT) for enhanced care delivery in hospital, post-discharge care, clinical trials, etc.

Watson enables the use of predictive modeling which can be applied to disease progression, payer pricing models, medication adherence models, etc.
Problem/Opportunity

- A leading US hospital in US wanted to improve patient stays and reduce patient anxiety.
- Need to reduce doctor visits and automate status updates.

Solution: IBM Watson text-to-speech (and back)

- Smart Speaker near patient bed asks predefined questions.
- Speech-to-text API returns responses based on context.
- Response is sent to device using text-to-speech API in audio format.
- Patient controls appliances in room by voice command on Samsung SmartThings Hub and cloud platform.

Benefits

- Patient experience and satisfaction increased.
- Daily doctor visits decreased.
- Staff and housekeeping interactions improved.

Persistent Systems Toolkit

- IBM Bluemix, Samsung SmartThings Cloud platform, Node-Red.
- Conversation API, speech-to-text & text-to-speech APIs.
Problem/Opportunity
- Develop a dashboard showing different statistics for cancer patients
- Used information to treat and advise the patients in a more informed way based on the symptoms and other similar cases

Solution: IBM Watson text-to-speech (and back)
- Use Watson Analytics to crawl and analyze structured and unstructured oncology data
- Identify relationships among entities
- Deliver clear, understandable data visualizations for doctor & patient

Benefits
- Reduce patient fear, confusion and anxiety
- Provide actionable intelligence to caregivers to suggest possible treatments
- Deliver customized results based on patient demographics

Persistent Systems Toolkit
- IBM Watson Analytics
- Dash DB
Watson Tackles Cancer

- Watson was tested on 1,000 cancer diagnoses made by human experts. In 99% of them, Watson recommended the same treatment as the oncologists.

- In 30% of the cases, Watson also found a treatment option the human doctors missed.

- Some treatments were based on research papers that the doctors had not read — more than 160,000 cancer research papers are published a year.

- Other treatment options surfaced in new clinical trials the oncologists had not yet seen announced on the web.
Success Stories of AI Systems

Cancer:
- Somashekhar et al. demonstrated that the IBM Watson for oncology would be a reliable AI system for assisting the diagnosis of cancer through a double-blinded validation study.  
- Esteva et al. analysed clinical images to identify skin cancer subtypes.

Neurology:
- Bouton et al. developed an AI system to restore the control of movement in patients with quadriplegia.
- Farina et al. tested the power of an offline man/machine interface that uses the discharge timings of spinal motor neurons to control upper-limb prostheses.

Cardiology:
- Dilsizian and Siegel discussed the potential application of the AI system to diagnose the heart disease through cardiac images.
- Arterys recently received clearance from the US Food and Drug Administration (FDA) to market its Arterys Cardio DL application, which uses AI to provide automated, editable ventricle segmentations based on conventional cardiac MRI images.
Conclusion

- Real time knowledge is available first time in history
- Better than any guidelines.
- AI is expensive
- MD Anderson spent 65 million $ on IBM Watson platform and still to use
Artificial Intelligence for the Real World

Don’t start with moon shots.

by Thomas H. Davenport and Rajeev Ronanki

BY THOMAS H. DAVENPORT AND RAJEEV RONANKI
i-Doctor
Intelligent Drug Dispensing ATM Based on Symptom-based Algorithm
i-Doctor Introduction

i-Doctor, is an attempt to go beyond current telemedicine model and support Indian citizens to get affordable health care services within their vicinity.

Point of Care devices

Patient’s Interaction

Intelligent Diagnosis

Medicine Dispensing

Intelligent Systems in Action

The rise of the machines has already begun

100+ Medicines

Battery backed i-Doctor System
i-Doctor Methodology

Collect readings from easily configurable Point of care devices

Biometric Authentication

Weighing Scale

Thermometer

Camera

ECG

BP

Oeterxim

Patients Data

Intelligence System Questionnaire to Diagnose Clinical Condition

Battery backed i-Doctor System

Payment Gateway

Generate Prescription

Emergency Situation

Drug Dispensing Machine

Follow-up call

Call Doctor/Ambulance/Hospital
Future Of Medicine
i-Doctor Robot
SkinSense

Components used for prediction:

- **Multiple QSAR models** built using large publicly available data on sensitizers (of various potency classes) & non-sensitizers
- **Structural similarity** to known sensitizers and non-sensitizers
- Presence of **sub-structure(s)** associated with skin sensitization reaction mechanisms

- Integrated statistical & mechanistic approaches that helped achieve improved prediction performance & coverage

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RESEARCH ARTICLE

Integrated Computational Solution for Predicting Skin Sensitization Potential of Molecules

Konda Leela Sarath Kumar, Sujit R. Tangepadilwar, Aarti Desai, Vivek K. Singh, Aditya Jere

1. Persistent Systems Limited, Pune, Maharashtra, India. 2. Department of Pharmacoinformatics, National Institute of Pharmaceutical Education and Research (NIPER), Hyderbad, Telangana, India.
Key Features

- Predict skin sensitization potential of molecules
- Identify protein-reactive groups & skin sensitization mechanism of molecules
- Validated & compared against unbiased dataset with accuracy = 75.32%, CCR = 74.36%, sensitivity = 70% & specificity = 78.72%
- Accepts standard input formats (eg. SMILES, SDF) and allows drawing of structures
Definition of Health in Ayurveda

Components of Health

- Physical & Physiological
- Psychological
- Spiritual

Dosha – 3 (Vata, Pitta, Kapha)
Agni – 13 (Metabolic fire)
Dhatu – 7 (Body tissues)
Mala – 3 (Waste products)
Indriya – 5 (Sensory motor organs)
Manas – 1 (Mind)
Atma – (Soul)

One whose doshas, agni, functions of doshas and malas are in state of equilibrium, who has cheerful atman, mind, intellect and sense organs is designated as healthy.
The gist, as we can make out, is that individual body constitution analysis or ‘Prakriti’ analysis, as mentioned in Ayurveda, is very essential for positive health of mankind in times to come.

In today's era

Global Focus is on

PERSONALISED MEDICINE
Interventions from Samhita and Opinions of experts

- Samadosha
- Samagni
- Sama Dhatu
- Mala Kriya

Clusters of Ayurvedic Entity

Real-time Management of Patients

Interventions

Monitoring Parameter's

Modern Medicine Ayurveda

Outcome

Machine learning
Cognitive Domain Analysis of available interventions specific to clusters

- Clinical picture
- Radiology
- Receptor status
- Laboratory Data

Clusters of Disease with all data in Permutation

Interventions

Monitoring Parameter's

All Data that was used for cluster analysis

Outcome

Morbidity, Mortality, Survival, Quality of life

Real-time Management of Patients

Machine learning
Thank You!