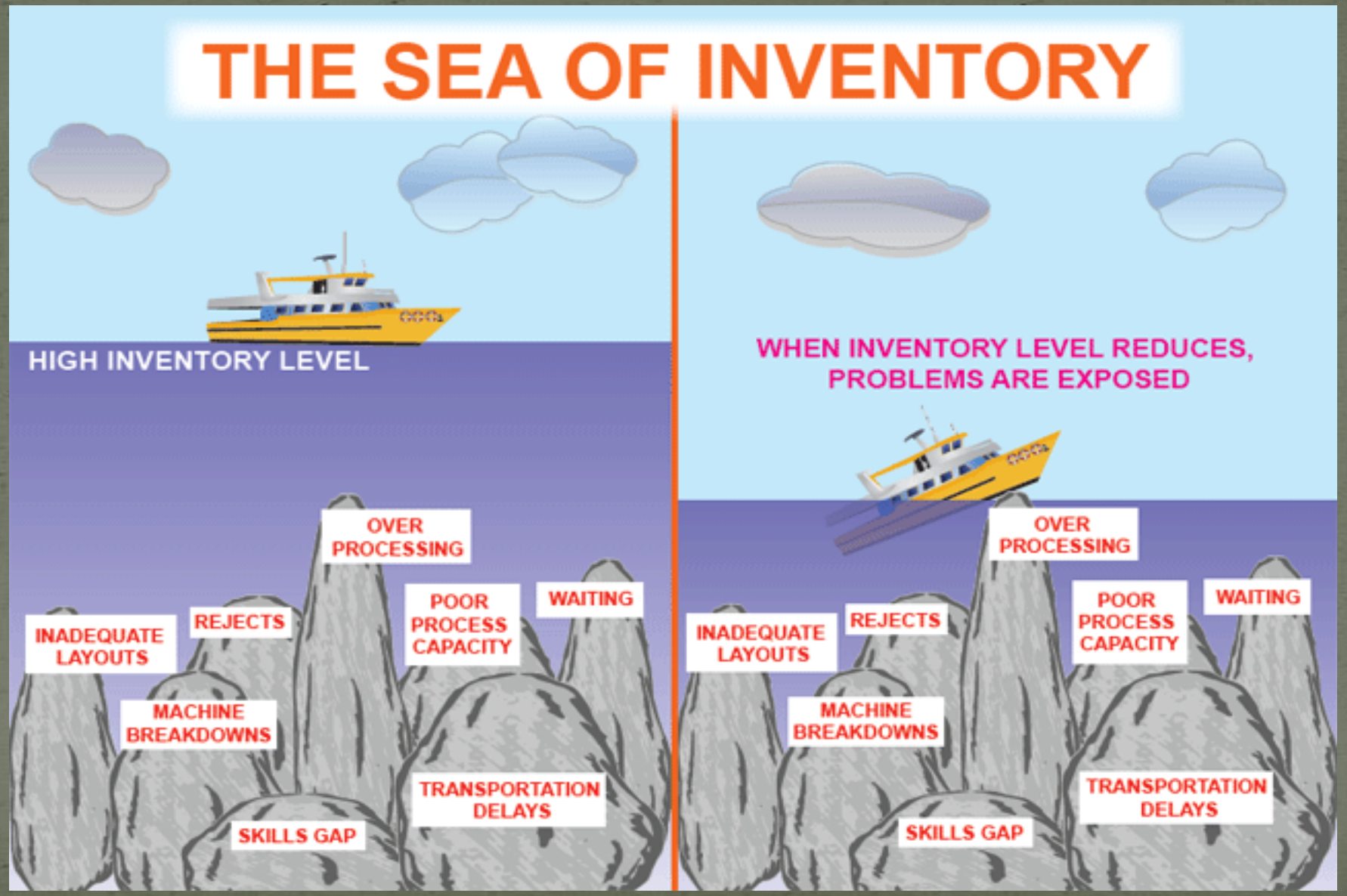
The changing face of healthcare post the COVID-19 pandemic

Subodha Kumar
Fox School of Business
Temple University

River & Boulder Analogy



Inventory

Inventory

Digital Innovations in Healthcare

BLOCKCHAIN IN
HEALTHCARE

101 Blockchains | BLOCKCHAIN FOR HEALTHCARE

The current blockchain trend is serving the healthcare industry in many ways – better supply chain, resolving drug counterfeit, improved data storage, and security

CHALLENGES OF THE CURRENT HEALTHCARE SYSTEM

- Drug counterfeit
- Data segmentation
- Poor management
- Healthcare security and data storage

HOW BLOCKCHAIN CAN SOLVE HEALTHCARE ISSUES

- Interoperability
- Security
- Maintenance cost
- Data integrity
- Universal access

BLOCKCHAIN TRANSFORMING HEALTHCARE

1 DRUG TRACEABILITY

Solves drug counterfeit by providing time-stamped and immutable transactions across the supply chain.

2 CLINICAL TRIALS

Improve clinical trial monitoring and effectiveness by removing frauds and data manipulation. This will further improve healthcare by a long shot.

3 PATIENT DATA MANAGEMENT

Blockchain can be used to manage and store patient data securely. This improves personalized and on-point treatments.

4 CLAIM AND BILLING

By removing intermediates, blockchain can improve both claim and billing aspects of the healthcare industry.

Blockchain in Pharmacy

How Blockchain Can Reduce Waste, Fraud in Pharmacy

safety and efficiency by decentralizing data. Nearly half of healthcare companies report that they are developing blockchain solutions,

says. “In this way, all of the members of the supply chain would be involved, and this then opens up possibilities for gaining access to data that was not previously possible.”

Using blockchain in the supply chain can also reduce the risk of fraudulent drugs infiltrating the supply chain. “Counterfeit pharmaceuticals are now considered to be the world’s largest fraud market. Blockchain technology could provide an answer,” Guenther says. “Packages have labels that are

How Blockchain is Changing Healthcare Supply Chains

- Cold Chain Monitoring
  - Food and pharmaceutical products often have specialized storage needs.
  - Sensors on sensitive products can record temperature, humidity, vibration, and other environmental conditions.
    - These readings can then be stored on a blockchain.
  - If a storage condition deviates from what is agreed, each member of the blockchain will see it.
  - A smart contract can trigger a response to correct the situation.
    - For instance, depending on the size of the deviation, the action may be to adjust the storage.
    - However, it could also extend to changing "use-by" dates, declaring products unfit, or applying penalties.

GLOBAL VIRTUAL REALITY IN HEALTHCARE MARKET SIZE, 2020-2027

$ 2.14 *Billion* in **2019**

$ 33.72 *Billion* by **2027**

Growing at a CAGR of

41.2%

GLOBAL VIRTUAL REALITY IN HEALTHCARE MARKET BY COMPONENT

Hardware | Software | Content

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5 USE CASES OF CHATBOTS IN HEALTHCARE

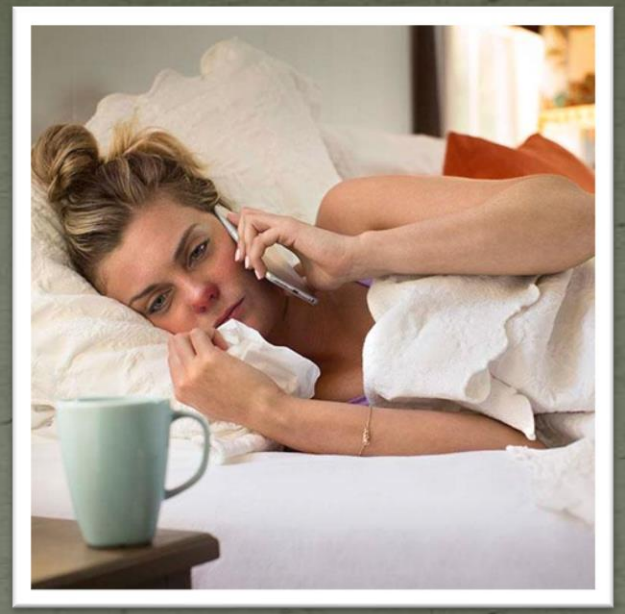
Providing informational support

Assistance in refilling

Scheduling appointments

Collecting patient information

Providing medical assistance



DISTANCE HEALING OR AGGRAVATING IN PANDEMIC:

An Empirical Investigation of the Impact of Covid-19 in Telemedicine Effectiveness

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Covid-19

- Individuals reluctant to go outside and get back to “normal”.
- Increased levels of anxiety due to staying inside.
- Elevated anxiety causing people to get assistance from public healthcare systems.

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In-Person Visits During Covid-19

- Untenable during Covid-19.
- Could potentially increase community transmission of the virus.
- Place an even greater burden on the healthcare system.

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Telemedicine in Covid-19

- Prior to Covid-19, telemedicine usage in numerous states heavily restrained by regulatory bodies.
- Several federal rules and regulations got relinquished to help physicians adopt telemedicine.
- A new act - Coronavirus Preparedness and Response Supplemental Appropriations Act, (signed in March, 2020) provided the new economic support needed for telemedicine.

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Telemedicine in Covid-19

- Significant rise in telemedicine usage.
- Spike in healthcare networks to include telemedicine facilities.
  - BCBS network to provide nurse-provided--staffed telemedicine services.
  - Spectrum Health to offers its consumers free virtual screening solutions.

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Telemedicine in Covid-19

- Surge in consumer adoption of telemedicine
  - 11% of US consumers used telehealth in 2019
  - 46% of consumers now using telehealth.
- Expected growth in US telehealth annual revenues
  - $3 billion - Pre-Covid-19
  - $250 billion - Post-Covid-19

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Telemedicine Adoption/Effectiveness in Covid-19

- Some consumers may feel comfortable using telemedicine tools for their health.
- Others may feel anxious and frustrated with sudden switch to using telehealth technology.

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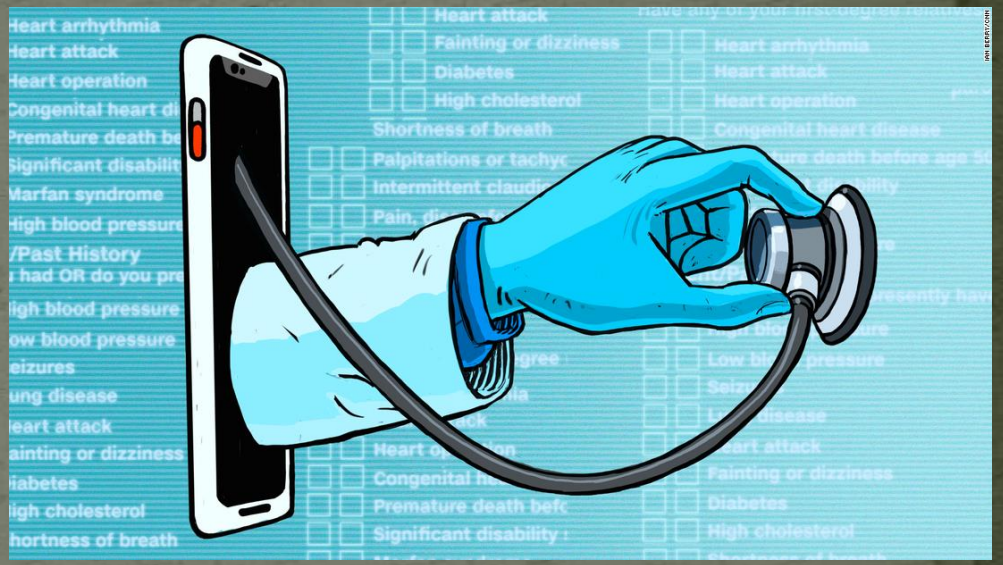
Impact of Covid-19 on the Telemedicine Effectiveness

Possible Scenarios:

- Telemedicine is more effective in Covid-19.
- Telemedicine is less effective in Covid-19.



Impact of Covid-19 on the Telemedicine Effectiveness

Scenario 1: Telemedicine more effective in Covid-19

- Rationale:
  - Low chance of acquiring Covid-19 due to clinic visits and social gathering.
  - No white coat anxiety.

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Impact of Covid-19 on the Telemedicine Effectiveness

Scenario 2: Telemedicine less effective in Covid-19

- Rationale:
  - Already high stress or anxiety at home and not being able to meet other people.
  - Patients with hypertension in elevated state of anxiety and at higher risk for COVID-19 infection.
  - Limitations in telehealth delivery where physical examinations or in-person visits are required

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Covid-19 and Quality of Telemedicine Appointments

- Covid-19 reduces the effectiveness of telemedicine appointments (relative to face-to-face appointments).

Why?

- Covid-19 causes high-risk patients (e.g., older patients) more likely to use telemedicine, and older patients are less familiar with technology.
- Therefore, COVID-19 reduces the effectiveness of telemedicine appointments.

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Covid-19 and Quality of Telemedicine Appointments

- Supporting Evidence:
  - Reduced effectiveness of telemedicine appointments for older patients during Covid-19.

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Recommendations

- No One-Size-Fits-All Strategy
  - Must be implemented differently for elderly patients during pandemic when anxiety level is already high.
- Deploy new digital telemedicine tools in elderly care—from monitoring their health, to helping them getting access to more convenient care, to giving them peace of mind.
- Train healthcare providers and build interpersonal relationships with patients in telemedicine settings.
- Develop simulated testing of telemedicine adoption with patients and providers.

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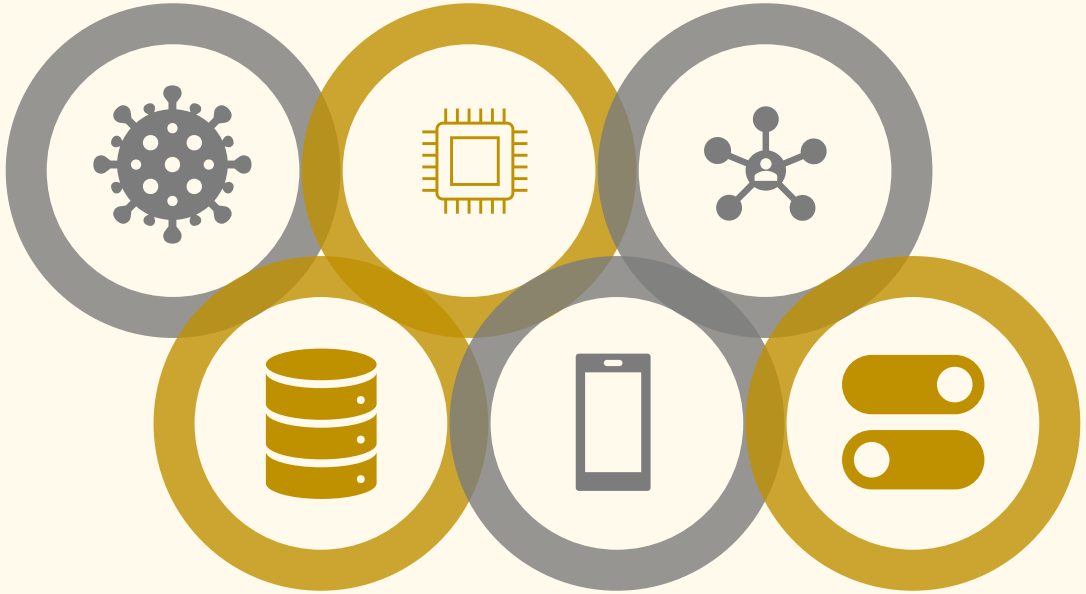
Indian Healthcare

Digital Healthcare in India

Renewed Interest due to the COVID-19 situation

Digitization and National Health ID

Convergence of key Industry players for platform creation

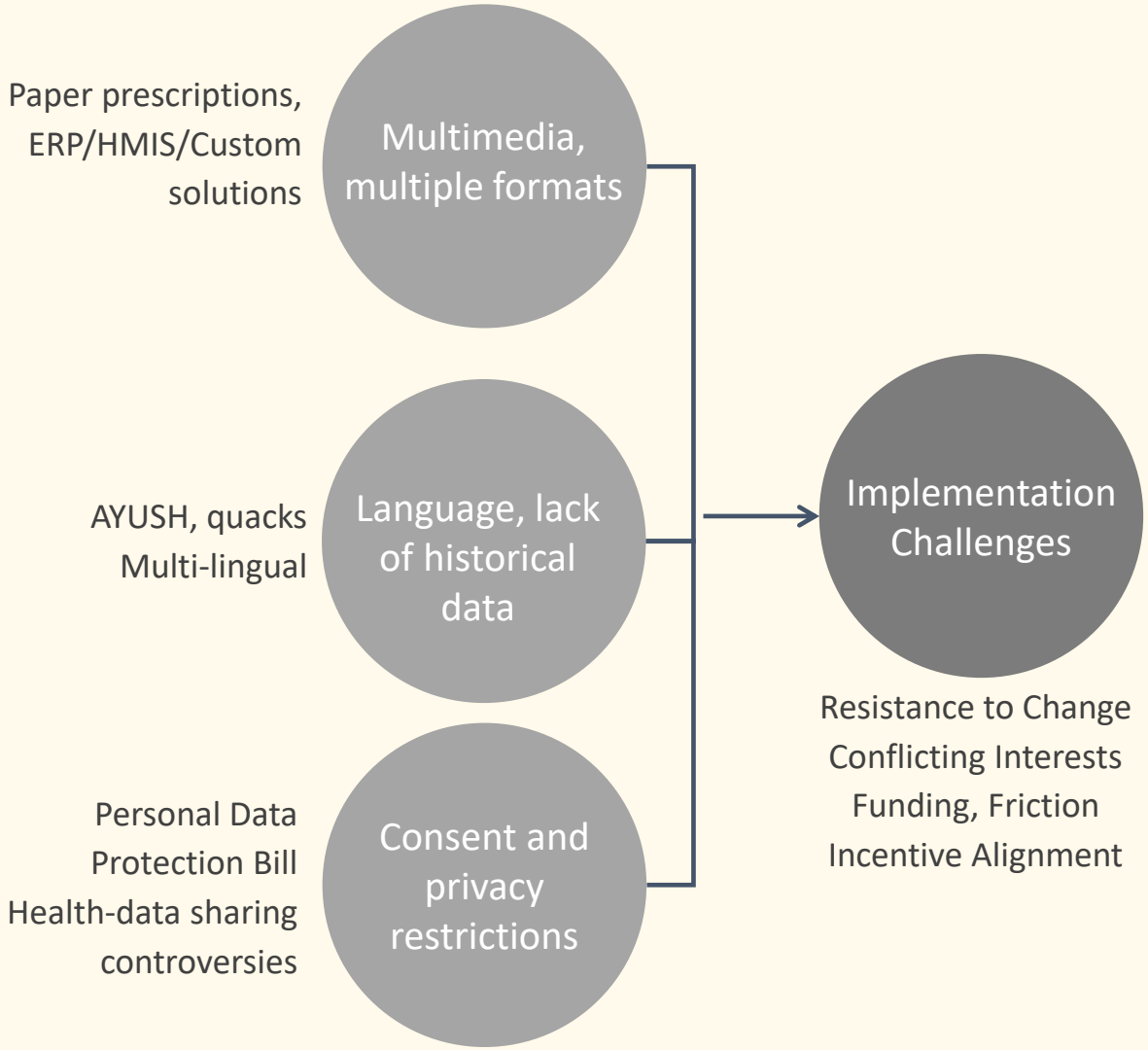


Standardization of Data Architecture

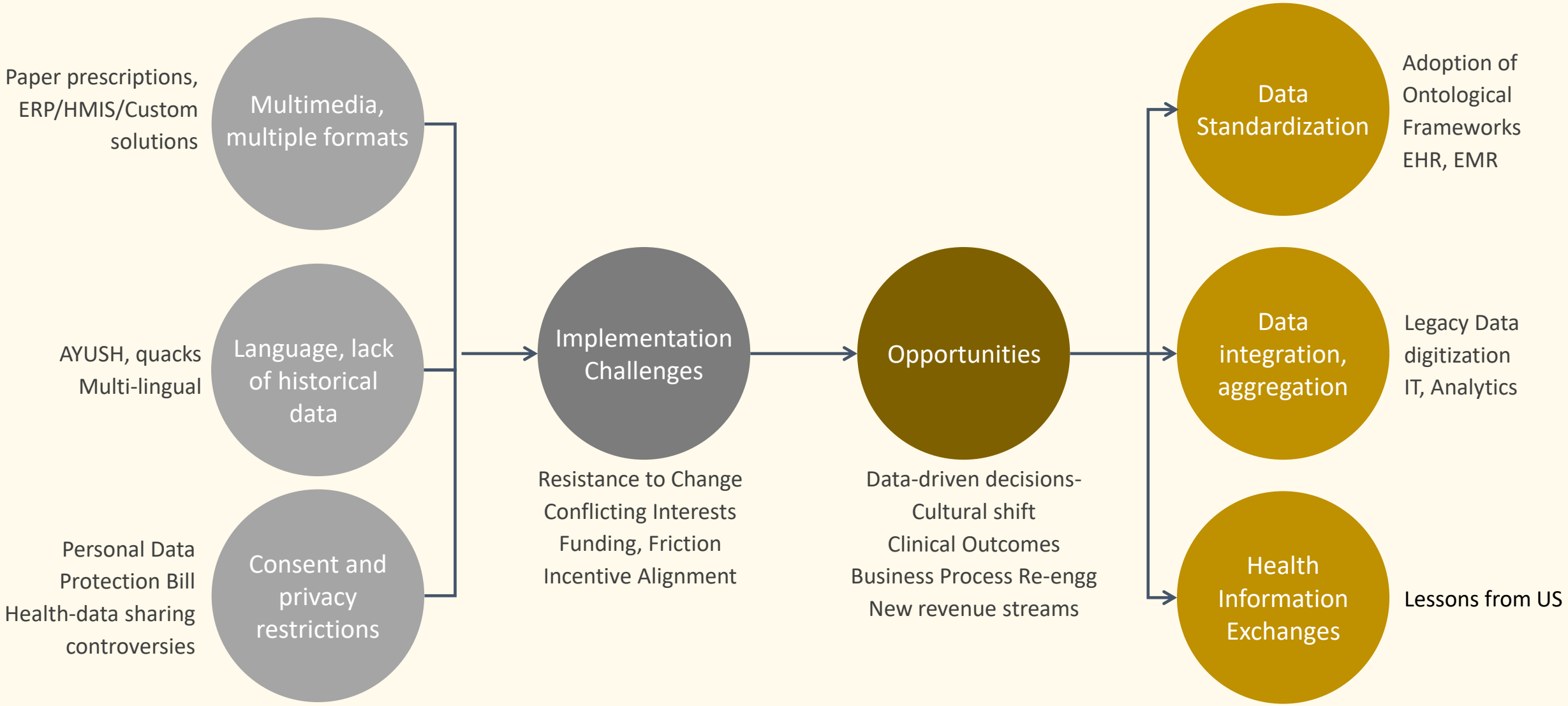
Governance, Data Privacy, Regulation

Diverse stakeholders- Incentive alignment

Challenges and Opportunities



Challenges and Opportunities



Co-opetition: Convergence of interest of Competitors

Applied AI in Healthcare

ISB Certified Business Analytics(CBA) Course- Capstone Projects

Industry-Research-Analytics connect

Industry and R&D Partners QuantLeap Consulting LLP

Successive Best Project Awards in 2018-19, 2019-20

1. Medical Image classification – Thermal Imaging
2. Pulse-wave analytics for Photoplethysmography (PPG)

Applied AI in Healthcare

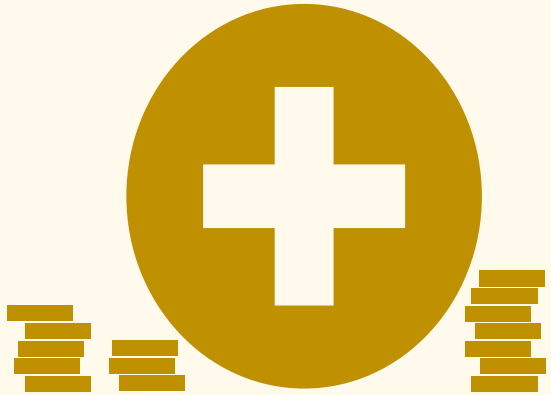
Capstone Project 1: Thermal Image Classification

Diabetic Foot Disease impacts everyone in the system…

Global Problem

23.5%

- *It is estimated that the number of people living with Peripheral Artery Disease increased by 23.5% in only a decade between 2000 and 2010.*
- *In 2010, 202 million people around the world were living with peripheral arterial disease.*



Direct Medical Cost

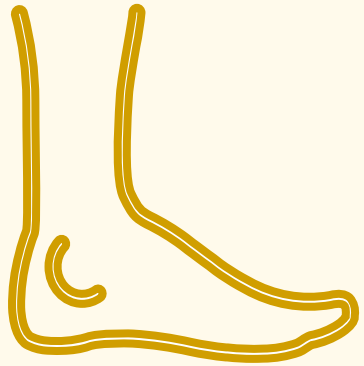
$107,900

- *In industrialized countries, the estimated direct medical costs $107,900 for an ulcer resulting in amputation.*
- *The costs associated with diabetic foot care is estimated to be $17 billion.*

Increased Amputation

2880/Day

- *Every 30 seconds someone, somewhere in the world is undergoing an amputation!*
  …According the American Diabetes Association.
- *In USA alone, there were approximately 80,000 amputations per year.*



Applied Analytics

Data Collection & Simulation

Data Mining

Automated Machine Learning

Azure ML

Statistical Analysis

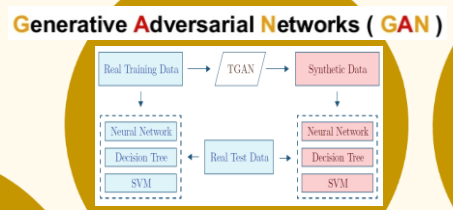
Deep learning & IOT

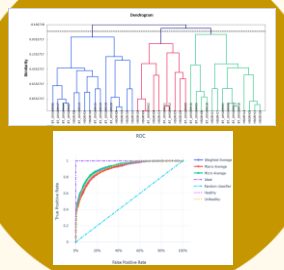
TensorFlow

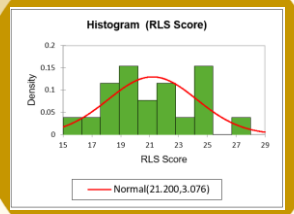
Python, Probability & Statistics

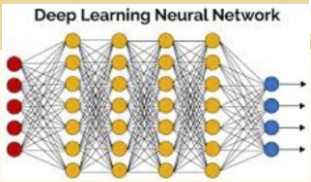
Power BI

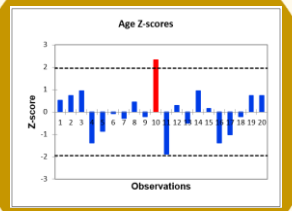
Data Visualization











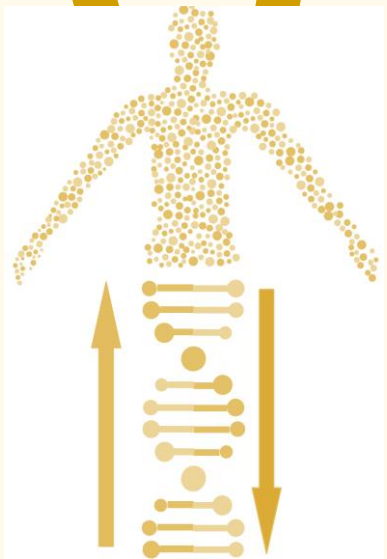
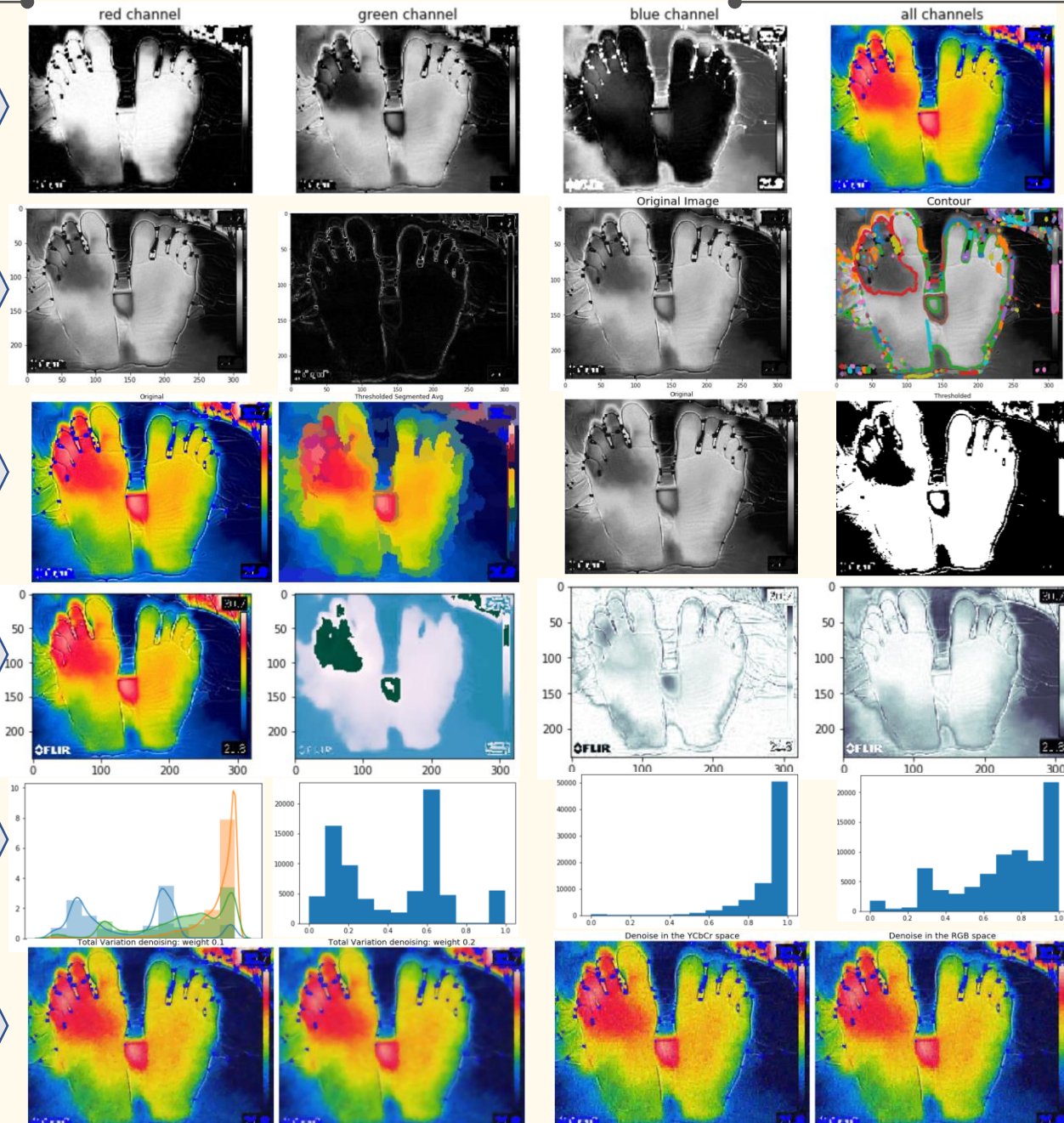
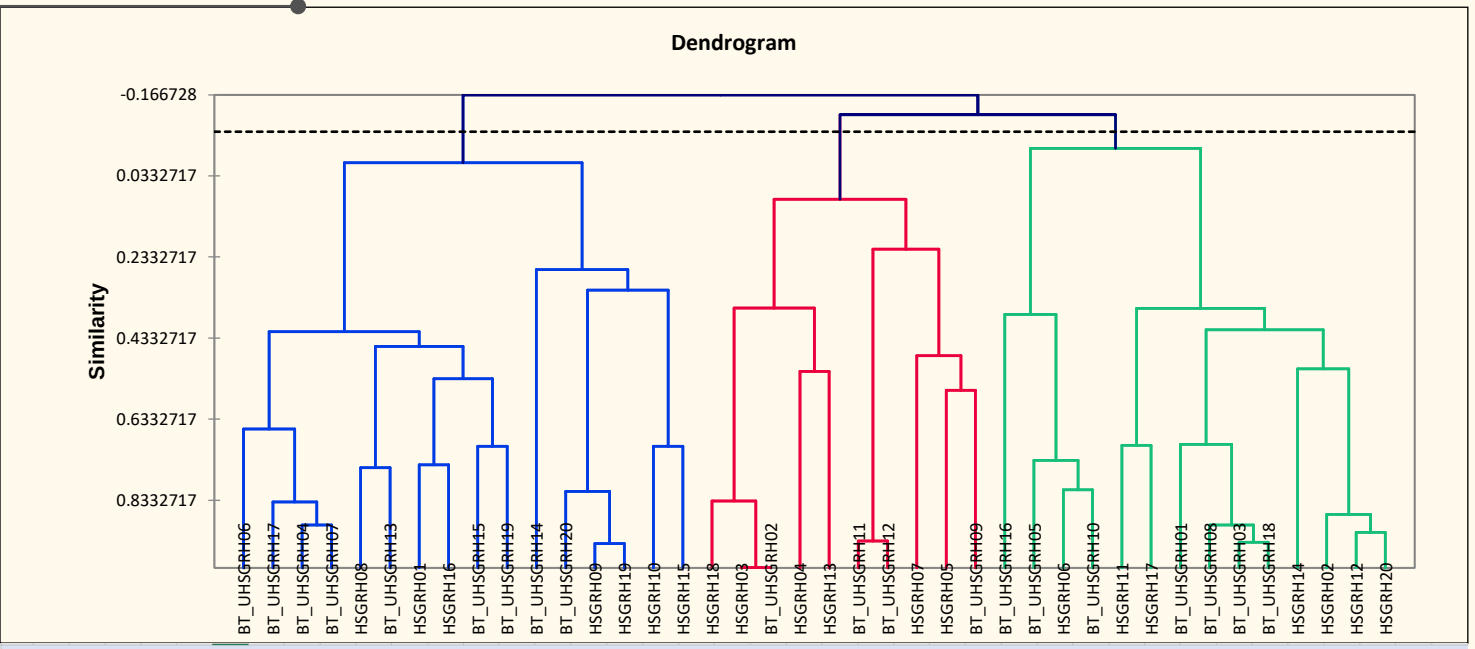


Image Analysis

- Image RGB Channels
- Edge & Contours
- Segmentation
- Hue, Saturation, Value
- HSV Pixel Histograms
- Denoising Filters



Algometric Hierarchical Clustering: Healthy & Unhealthy Patients

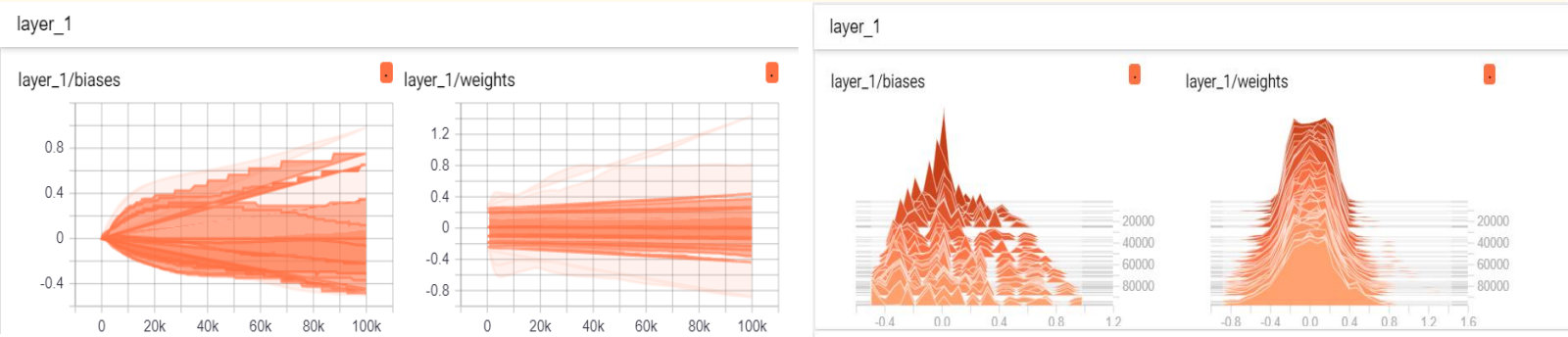


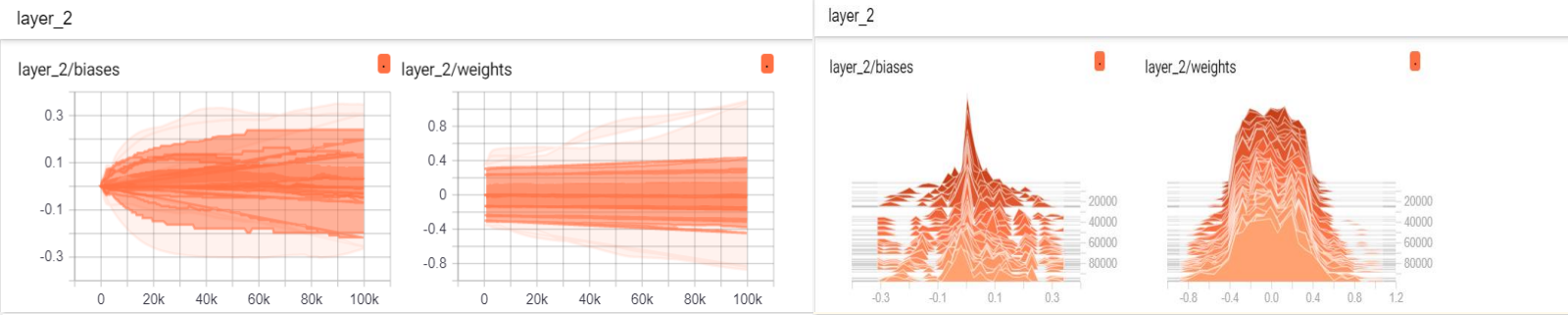
ID	H01	H02	H03	H04	H05	H06	H07	H08	H09	H10	H11	H12	H13	H14	H15	H16	H17	H18	H19	H20	UH01	UH02	UH03	UH04	UH05	UH06	UH07	UH08	UH09	UH10	UH11	UH12	UH13	UH14	UH15	UH16	UH17	UH18	UH19	UH20
H01	0.000	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.746	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.533	-0.167	0.418	-0.167	0.533	0.001
H02	-0.167	0.000	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.868	-0.118	0.509	-0.167	-0.167	0.360	-0.118	-0.167	0.868	0.413	-0.118	0.413	-0.167	-0.034	-0.167	-0.167	0.413	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.413	-0.167	-0.167
H03	-0.167	-0.118	0.000	0.359	0.091	-0.118	0.091	-0.167	-0.167	-0.167	-0.118	-0.118	0.359	-0.118	-0.167	-0.167	-0.118	0.835	-0.167	-0.118	-0.118	0.999	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.091	-0.118	0.091	0.091	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H04	-0.167	-0.118	0.359	0.000	0.091	-0.118	0.091	-0.167	-0.167	-0.167	-0.118	-0.118	0.516	-0.118	-0.167	-0.167	-0.118	0.359	-0.167	-0.118	-0.118	0.359	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.091	-0.118	0.091	0.091	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H05	-0.167	-0.118	0.091	0.091	0.000	-0.118	0.477	-0.167	-0.167	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.167	-0.118	0.091	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.562	-0.118	0.214	0.214	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H06	-0.167	-0.034	-0.118	-0.118	-0.118	0.000	-0.118	-0.167	-0.167	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	-0.167	-0.034	-0.118	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	0.735	-0.167	-0.167	-0.034	-0.118	0.807	-0.118	-0.118	-0.167	-0.167	-0.167	0.375	-0.167	-0.034	-0.167	-0.167
H07	-0.167	-0.118	0.091	0.091	0.477	-0.118	0.000	-0.167	-0.167	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.167	-0.118	0.091	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.477	-0.118	0.214	0.214	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H08	0.454	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.000	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.454	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.753	0.001	0.454	-0.167	0.418	-0.167	0.454	0.001
H09	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.000	0.315	-0.167	-0.167	-0.167	-0.167	0.315	0.001	-0.167	-0.167	0.940	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.001	-0.167	0.001	-0.167	0.001	0.812
H10	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.315	0.000	-0.167	-0.167	-0.167	-0.167	0.700	0.001	-0.167	-0.167	0.315	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.001	-0.167	0.001	-0.167	0.001	0.315
H11	-0.167	0.360	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.000	0.360	-0.118	0.360	-0.167	-0.167	0.698	-0.118	-0.167	0.360	0.360	-0.118	0.360	-0.167	-0.034	-0.167	-0.167	0.360	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.360	-0.167	-0.167
H12	-0.167	0.868	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.000	-0.118	0.509	-0.167	-0.167	0.360	-0.118	-0.167	0.913	0.413	-0.118	0.413	-0.167	-0.034	-0.167	-0.167	0.413	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.413	-0.167	-0.167
H13	-0.167	-0.118	0.359	0.516	0.091	-0.118	0.091	-0.167	-0.167	-0.167	-0.118	-0.118	0.000	-0.118	-0.167	-0.167	-0.118	0.359	-0.167	-0.118	-0.118	0.359	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.091	-0.118	0.091	0.091	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H14	-0.167	0.509	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.509	-0.118	0.000	-0.167	-0.167	0.360	-0.118	-0.167	0.509	0.413	-0.118	0.413	-0.167	-0.034	-0.167	-0.167	0.413	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.413	-0.167	-0.167
H15	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.315	0.700	-0.167	-0.167	-0.167	-0.167	0.000	0.001	-0.167	-0.167	0.315	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.001	-0.167	0.001	-0.167	0.001	0.315
H16	0.746	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.000	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.533	-0.167	0.418	-0.167	0.533	0.001
H17	-0.167	0.360	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.698	0.360	-0.118	0.360	-0.167	-0.167	0.000	-0.118	-0.167	0.360	0.360	-0.118	0.360	-0.167	-0.034	-0.167	-0.167	0.360	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.360	-0.167	-0.167
H18	-0.167	-0.118	0.835	0.359	0.091	-0.118	0.091	-0.167	-0.167	-0.167	-0.118	-0.118	0.359	-0.118	-0.167	-0.167	-0.118	0.000	-0.167	-0.118	-0.118	0.835	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.091	-0.118	0.091	0.091	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
H19	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.940	0.315	-0.167	-0.167	-0.167	-0.167	0.315	0.001	-0.167	-0.167	0.000	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.001	-0.167	0.001	-0.167	0.001	0.812
H20	-0.167	0.868	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.913	-0.118	0.509	-0.167	-0.167	0.360	-0.118	-0.167	0.000	0.413	-0.118	0.413	-0.167	-0.034	-0.167	-0.167	0.413	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.413	-0.167	-0.167
UH01	-0.167	0.413	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.413	-0.118	0.413	-0.167	-0.167	0.360	-0.118	-0.167	0.413	0.000	-0.118	0.695	-0.167	-0.034	-0.167	-0.167	0.695	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.695	-0.167	-0.167
UH02	-0.167	-0.118	0.999	0.359	0.091	-0.118	0.091	-0.167	-0.167	-0.167	-0.118	-0.118	0.359	-0.118	-0.167	-0.167	-0.118	0.835	-0.167	-0.118	-0.118	0.000	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.091	-0.118	0.091	0.091	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
UH03	-0.167	0.413	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.413	-0.118	0.413	-0.167	-0.167	0.360	-0.118	-0.167	0.413	0.695	-0.118	0.000	-0.167	-0.034	-0.167	-0.167	0.894	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.937	-0.167	-0.167
UH04	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.418	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.000	-0.167	0.658	0.894	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.418	-0.167	0.838	-0.167	0.418	0.001
UH05	-0.167	-0.034	-0.118	-0.118	-0.118	0.735	-0.118	-0.167	-0.167	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	-0.167	-0.034	-0.118	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	0.000	-0.167	-0.167	-0.034	-0.118	0.735	-0.118	-0.118	-0.167	-0.167	-0.167	0.375	-0.167	-0.034	-0.167	-0.167
UH06	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.418	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.658	-0.167	0.000	0.658	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.418	-0.167	0.658	-0.167	0.418	0.001
UH07	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.418	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.894	-0.167	0.658	0.000	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.418	-0.167	0.838	-0.167	0.418	0.001
UH08	-0.167	0.413	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.413	-0.118	0.413	-0.167	-0.167	0.360	-0.118	-0.167	0.413	0.695	-0.118	0.894	-0.167	-0.034	-0.167	-0.167	0.000	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.894	-0.167	-0.167
UH09	-0.167	-0.118	0.091	0.091	0.562	-0.118	0.477	-0.167	-0.167	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.167	-0.118	0.091	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.000	-0.118	0.214	0.214	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
UH10	-0.167	-0.034	-0.118	-0.118	-0.118	0.807	-0.118	-0.167	-0.167	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	-0.167	-0.034	-0.118	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	0.735	-0.167	-0.167	-0.034	-0.118	0.000	-0.118	-0.118	-0.167	-0.167	-0.167	0.375	-0.167	-0.034	-0.167	-0.167
UH11	-0.167	-0.118	0.091	0.091	0.214	-0.118	0.214	-0.167	-0.167	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.167	-0.118	0.091	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.214	-0.118	0.000	0.934	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
UH12	-0.167	-0.118	0.091	0.091	0.214	-0.118	0.214	-0.167	-0.167	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.167	-0.118	0.091	-0.167	-0.118	-0.118	0.091	-0.118	-0.167	-0.118	-0.167	-0.167	-0.118	0.214	-0.118	0.934	0.000	-0.167	-0.167	-0.167	-0.118	-0.167	-0.118	-0.167	-0.167
UH13	0.454	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.753	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.454	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.000	0.001	0.454	-0.167	0.418	-0.167	0.454	0.001
UH14	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.264	-0.167	-0.167	-0.167	-0.167	0.264	0.001	-0.167	-0.167	0.264	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.000	0.001	-0.167	0.001	-0.167	0.001	0.264
UH15	0.533	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.533	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.000	-0.167	0.418	-0.167	0.700	0.001
UH16	-0.167	-0.034	-0.118	-0.118	-0.118	0.375	-0.118	-0.167	-0.167	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	-0.167	-0.034	-0.118	-0.167	-0.034	-0.034	-0.118	-0.034	-0.167	0.375	-0.167	-0.167	-0.034	-0.118	0.375	-0.118	-0.118	-0.167	-0.167	-0.167	0.000	-0.167	-0.034	-0.167	-0.167
UH17	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.418	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.838	-0.167	0.658	0.838	-0.167	-0.167	-0.167	-0.167	-0.167	0.418	0.001	0.418	-0.167	0.000	-0.167	0.418	0.001
UH18	-0.167	0.413	-0.118	-0.118	-0.118	-0.034	-0.118	-0.167	-0.167	-0.167	0.360	0.413	-0.118	0.413	-0.167	-0.167	0.360	-0.118	-0.167	0.413	0.695	-0.118	0.937	-0.167	-0.034	-0.167	-0.167	0.894	-0.118	-0.034	-0.118	-0.118	-0.167	-0.167	-0.167	-0.034	-0.167	0.000	-0.167	-0.167
UH19	0.533	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.001	-0.167	-0.167	-0.167	-0.167	0.001	0.533	-0.167	-0.167	0.001	-0.167	-0.167	-0.167	-0.167	0.418	-0.167	0.418	0.418	-0.167	-0.167	-0.167	-0.167	-0.167	0.454	0.001	0.700	-0.167	0.418	-0.167	0.000	0.001
UH20	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.812	0.315	-0.167	-0.167	-0.167	-0.167	0.315	0.001	-0.167	-0.167	0.812	-0.167	-0.167	-0.167	-0.167	0.001	-0.167	0.001	0.001	-0.167	-0.167	-0.167	-0.167	-0.167	0.001	0.264	0.001	-0.167	0.001	-0.167	0.001	0.000

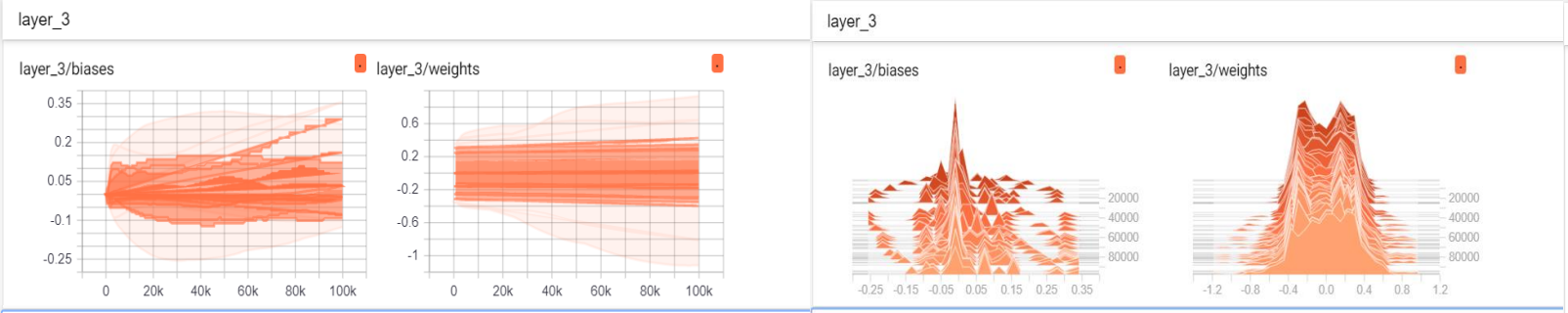
- Algometric Hierarchical Clustering shows the similarity between Healthy & Un-Healthy Patients.
- As seen in the clusters, few Healthy patients fall under Un-Healthy and vice-versa. This helped in correctly labelling the patient data.

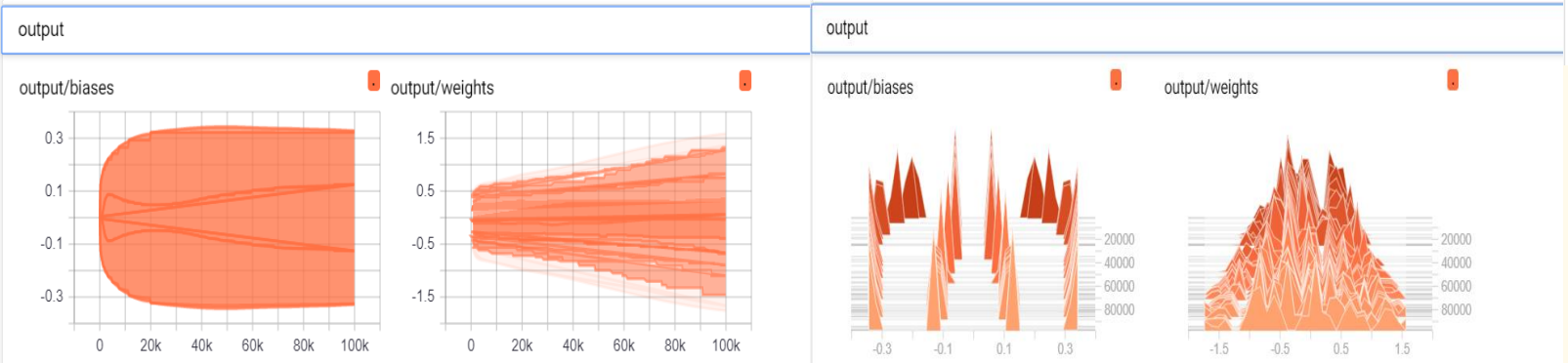
- Cophenetic distance matrix shows the distance between Healthy & Un-Healthy Patients.
- More the distance between two patients, greater is the difference in healthiness quotient.

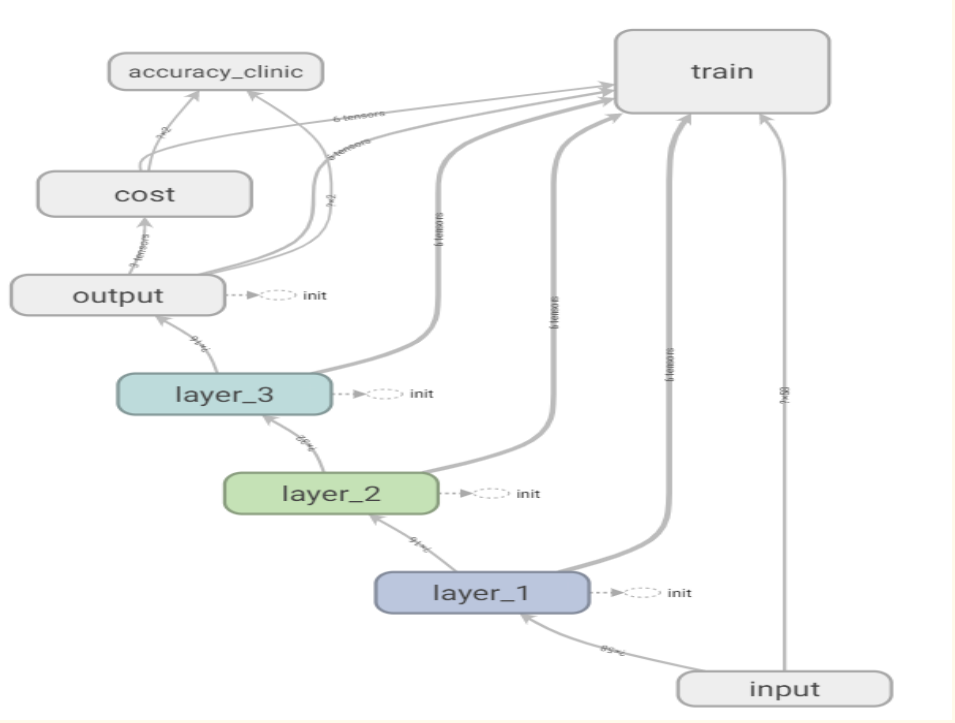
Deep Learning: Proactive Footcare Classification

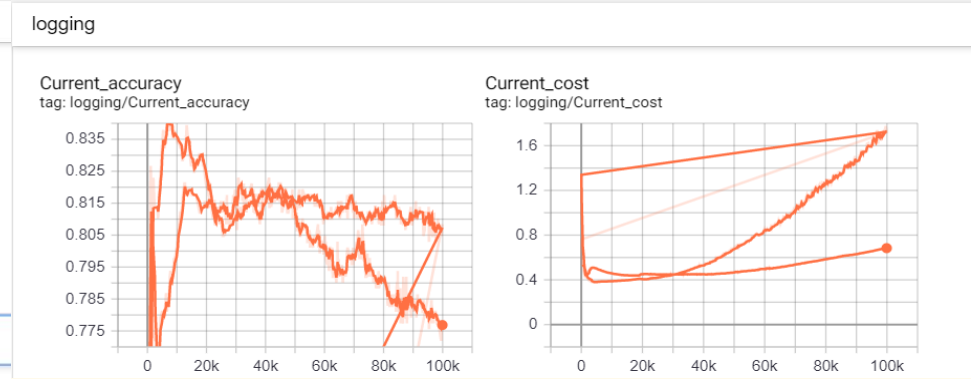










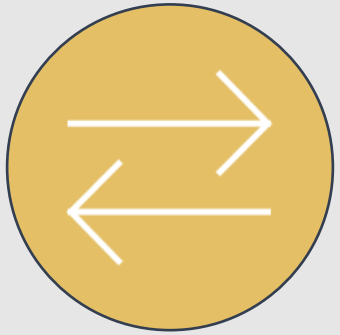


Deep Learning Neural Network Model with 3 hidden layers gave for Unhealthy patient response to treatment shows an accuracy of 0.92638

Key Outcomes and Insights

Patient Identification

Age, RLS Score, Dorsal_L_H2, Plantar_L_M1, Plantar_L_H2 came out to be significant features which needs further clinical interpretations.



Patient Assessment

Age, Dorsal_L_F1, Plantar_L_F2, Leg_L_6, Dorsal_R_H2 came out to be significant features which needs further clinical interpretations.

Proactive Footcare

Age, RLS Score, Plantar_L_H2, Dorsal_L_H2, Plantar_L_M1 came out to be significant features which needs further clinical interpretations.

Analytical Insights are meant for augmenting clinicians and not to replace them!

Applied AI in Healthcare

Capstone Project 2: Pulse Wave Analytics for Photoplethysmography (PPG)

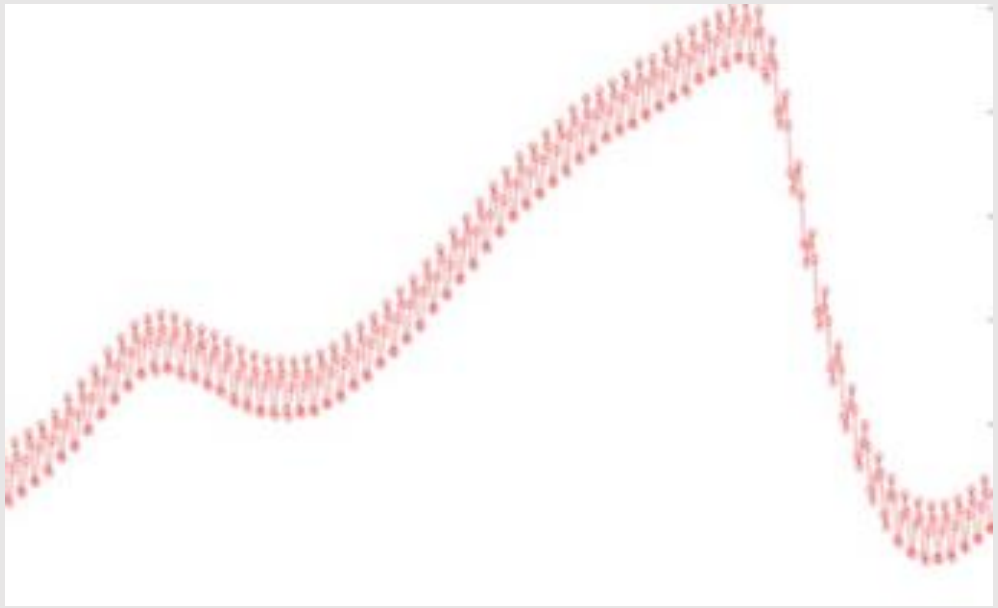
Business Context

Development in Pulse analysis

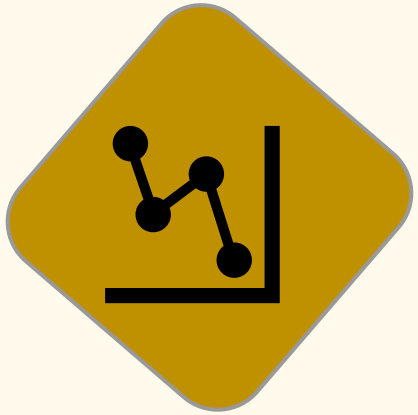
QuantLeap Consulting has developed a **proprietary device** with the ability to capture pulse at **high frequency**, providing high resolution pulse signal capturing

The **high sampling rate will lead to better input for predictive modelling**, which in turn can be used for early detection of deteriorating health conditions

QuantLeap Consulting



Analytical Techniques Used



Time Series Analysis

Detection of anomalies, forecasting, Waveform decomposition

Predictive Modelling

Predict Patient outcomes and disease conditions based on pattern mining of clinical parameters

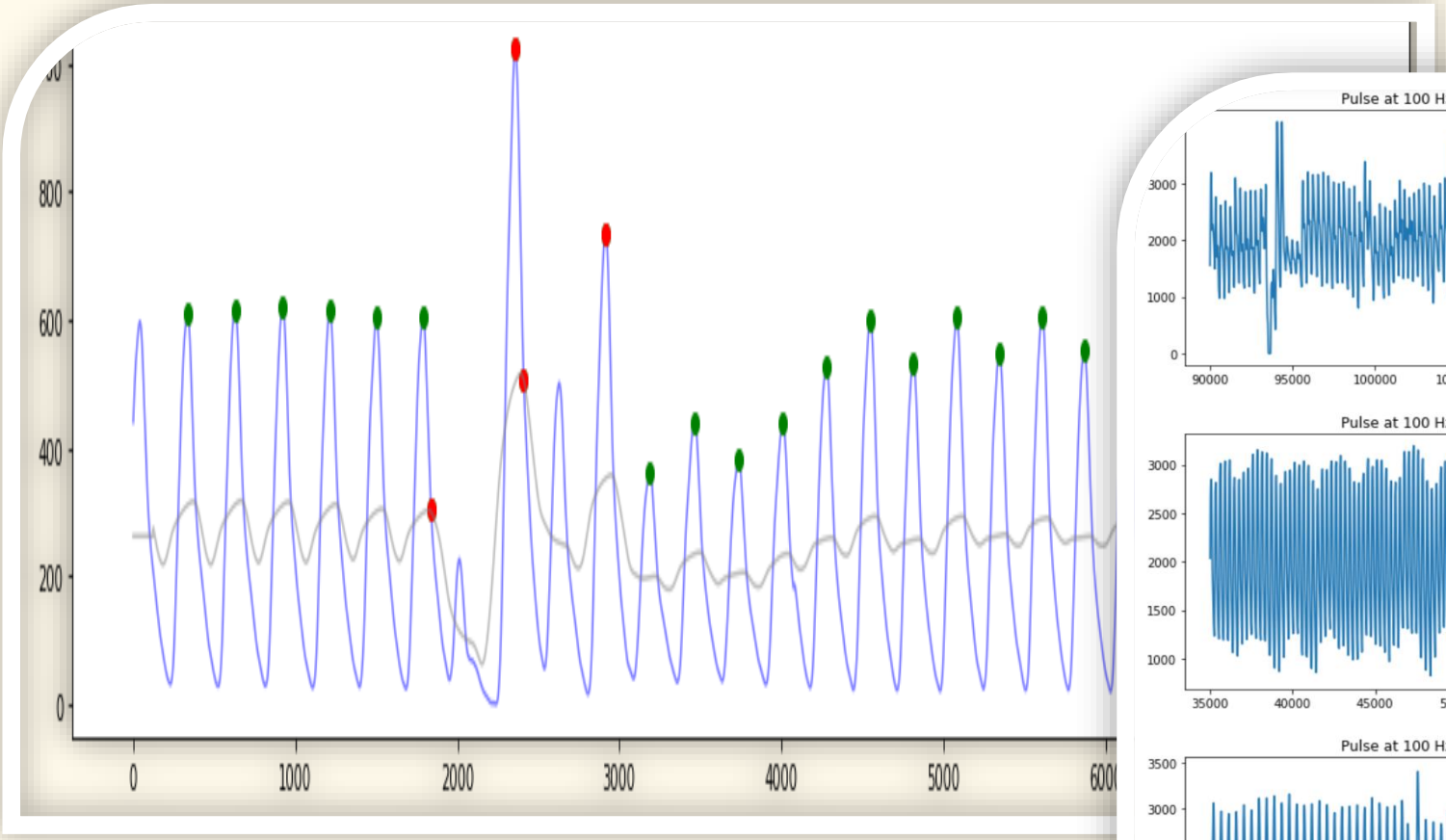
Applied ML

Classification algorithms

Statistical Analysis

Regression

Analysis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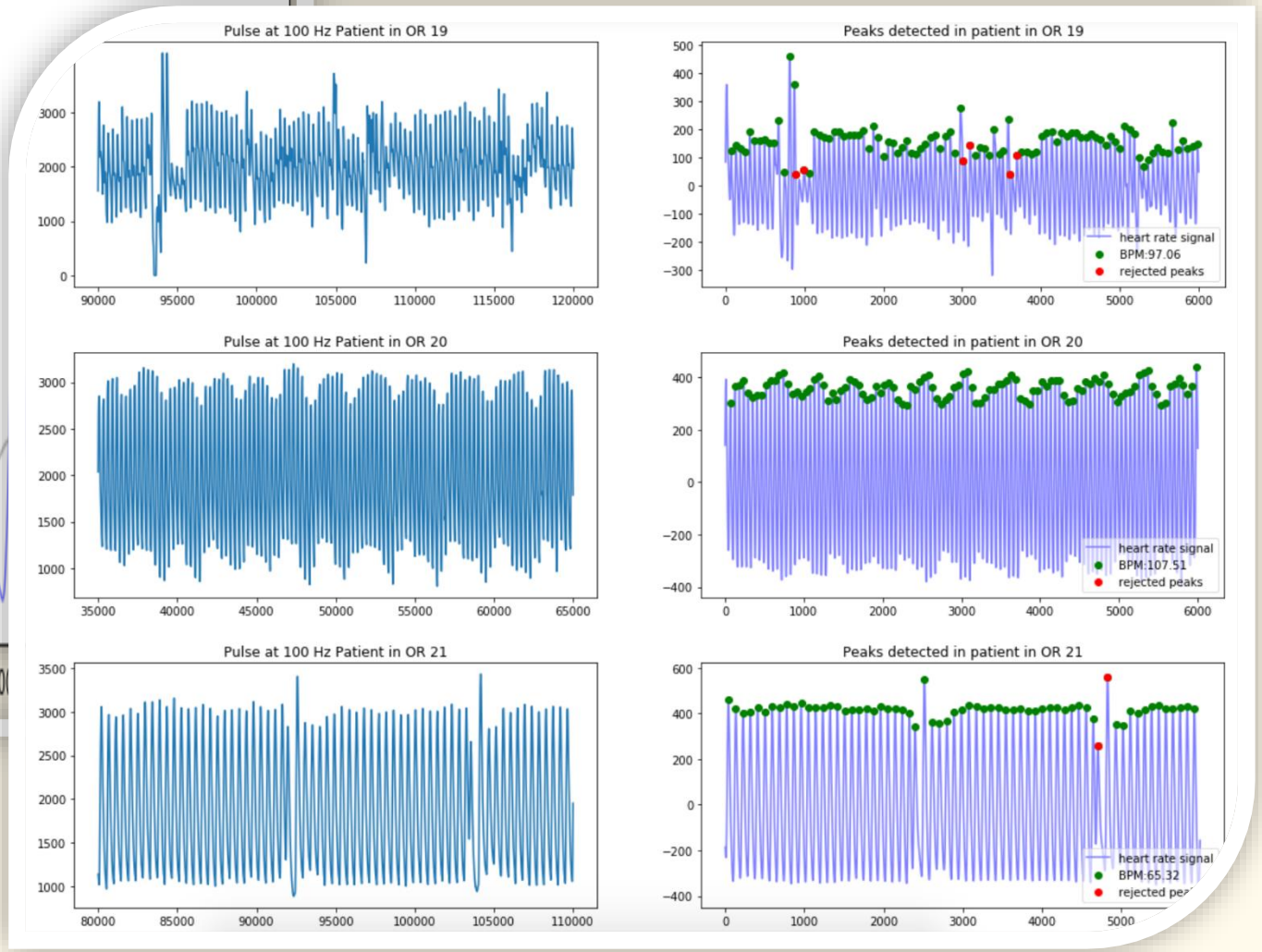

Pulse at 100 Hz Patient in OR 19
Peaks detected in patient in OR 19
heart rate signal
BPM:97.06
rejected peaks
Pulse at 100 Hz Patient in OR 20
Peaks detected in patient in OR 20
heart rate signal
BPM:107.51
rejected peaks
Pulse at 100 Hz Patient in OR 21
Peaks detected in patient in OR 21
heart rate signal
BPM:65.32

Business Impact

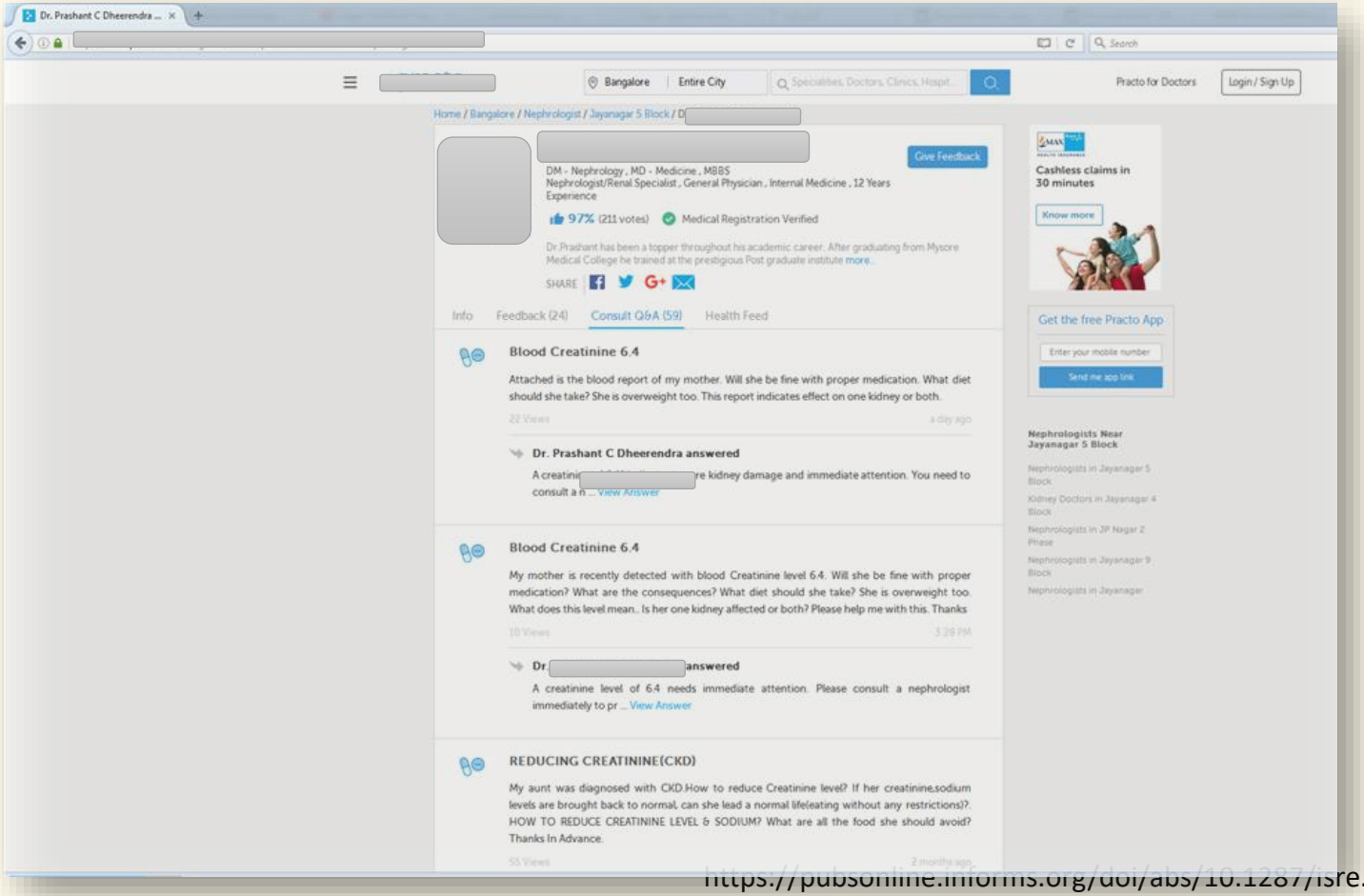
Validation of PPG signal for early prediction of diseases. Early detection of a deteriorating health condition, even in non-clinical setting, can be lifesaving.

The model only uses commonly known demographics information and features obtained from PPG, thus can be added as an extension to the devices

Potential applications in the early detection of a cardiopathy or improving the medical supervision of a cardiac patient.

Research: Online Healthcare Q&A Forums

When a Doctor Knows, It Shows: An Empirical Analysis of Doctors' Responses in a Q&A Forum of an Online Healthcare Portal



Healthcare Portals

Question-and-answer (Q&A) forums

Platform market model

User-Generated content

Peer Effect

User Recommendations

https://pubsonline.informs.org/doi/abs/10.1287/isre.2019.0836

Context

Leading Doctor Search and Appointment booking portal

Uber of doctor-patient market

47 cities
All specialties

~10% of registered doctors in urban India

~4 million appointment bookings every year at the time

Introduction of Q&A feature

Natural Experiment – Pre/Post-Introduction comparison

City-wise demographic data

- Demographic data collected from the India Census Bureau

Research Motivation

Positive reviews can help doctors improve their online reputation

- What is the impact of doctor responses on patient satisfaction?
- Causal Identification Using DID, Heckman-Type model, Matching:PSM

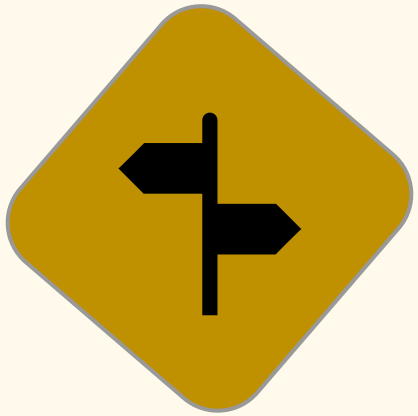
What is the spillover effect of focal doctor responses on nearby doctors' performance

- The count of doctors in the same city and specialty
- The number of doctors from the same city and specialty who are responding to user questions
- The number of questions answered by other doctors of the same city and specialty

Negative spillover effects: reduce the effectiveness of focal doctor responses

- Responding to user questions can be a competition tool

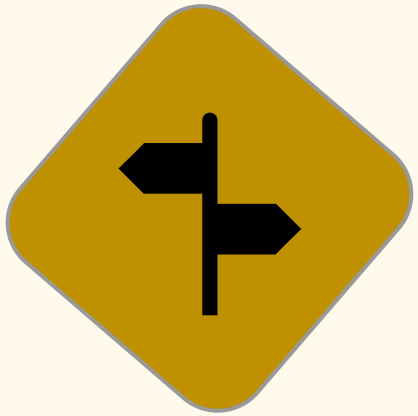
Insights and Managerial Implications



Signaling

The launch of the new doctor response feature benefits doctors

Insights and Managerial Implications



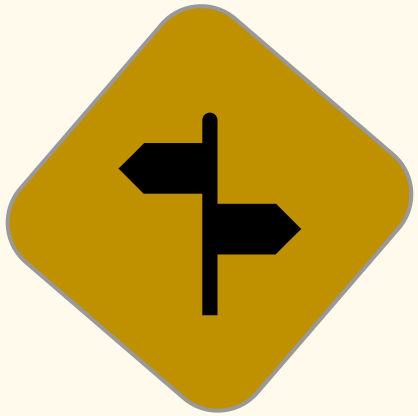
Signaling

The launch of the new doctor response feature benefits doctors

Spillover effect

Spillover effect of doctor responses

Insights and Managerial Implications



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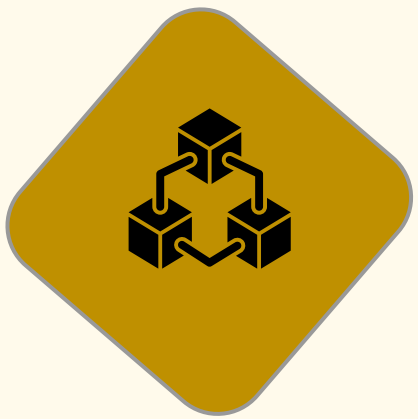
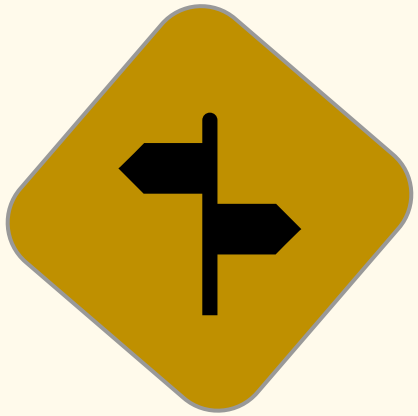
Spillover effect of doctor responses



Peer Effect

Without taking into account the online response strategies of nearby doctors a doctor's online response strategies may not be optimal

Insights and Managerial Implications

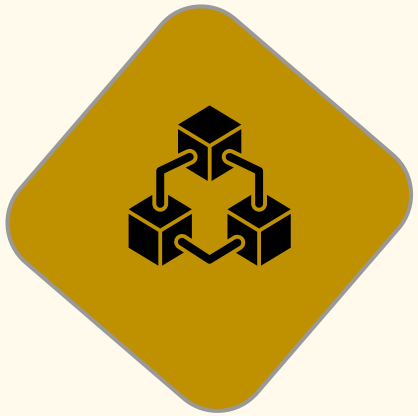


Signaling

The launch of the new doctor response feature benefits doctors

Spillover effect

Spillover effect of doctor responses



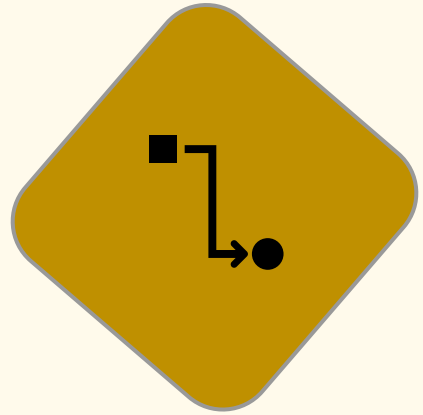
Peer Effect

Without taking into account the online response strategies of nearby doctors a doctor's online response strategies may not be optimal

Moderating factors

Moderating factors on the impact of doctor responses

doctors' specialty, experience, qualifications, appointment booking type, service fees, and response quality



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