



Connecting data
for future insights

Background



Francis Jeanson, PhD
CEO & Scientific Director

Head of Datadex, a data augmentation company

Former Manager at the Ontario Brain Institute

AI Software Engineering

PhD, MSc, BSc in Cognition, Adaptive Systems, AI

Member of the GA4GH

Startup and Academic Advisor in Data Science and AI

Diagnostic errors
occur in ~**10%** of
cases



18 Million
PRIMARY CARE ERRORS
PER YEAR IN THE US

Clinical trial success is
diminishing...
From 18% in the 90's to
9% in the 2000's

Trials costs are increasing



~11% increase per year...

Cost of healthcare
is increasing faster
than GDP

Healthcare: 3% per year

GDP: 2% per year

Solutions



Digitization of healthcare

Patient centered
preventative care

DATA: real-time, wearables, telemedicine ...

AI assisted
diagnosis/ prognosis

DATA: biomarkers, environment, ethical, ...

Short cycle
translational research

DATA: sharing, simulation, security, privacy

We are all eager to
harness the power
of AI

61%

of innovators are
using AI to identify
opportunities in data.

We are capturing
more data than ever
before but **insights**
remain elusive

LESS
THAN **5%**
of data are
leveraged by
organizations
on average

Your data Lake



No way to explore **sensitive data** before granting access

No governance over sensitive data means **increased risks**

No ability to link customer data without **violating privacy**

No way to **grant access** to just the data the analyst needs



PostgreSQL



teradata.

Our solution



Our solution



Automated
Data Indexing

Our solution



Automated
Data Indexing

Feature exploration
Data matching

Our solution



Automated
Data Indexing

Feature exploration
Data matching

Big data joins & unions
Private data linking

Our solution



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Access management
Fine grained sharing

Your insights



Automated
Data Indexing

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Healthcare insights with Datadex



“What is the likelihood of my patient being readmitted?”



DATADEx

EHR patient medical history database

LIMS blood data

Other clinic HL7 files

Wearable devices and mobile apps

Pharmacy medication database

Link Data Privately

Name	Age	Ph#
Susan Tao	23	+1 416 234-6343
Ethan Bim	45	234.543.2431
Pete Low	19	+1 647 994-5237

Name	Drug	Dosage	Height
Adas Ides	Lozepram	150 mg	6.3
Hani Ito	Aspirin	0.5 g	5.11
Susan Tao	Ibuprof.	250 ml	5.6

Name	Outcome	Score
Adas Ides	re-admitted	-3.4
Susan Tao	Cured	4.1
Leor Pasa	re-admitted	-2.8

Name
Susan Tao

Hash

Name	Age	Height	Drug	Dosage	Outcome	Score
76WX-RT23	23	5.6	Ibuprof.	250 ml	Cured	4.1

AI

Predictors

Outcomes

Fine Controlled Sharing

Assign digital access policies for governance compliance

Auditable access agreements

Fine control over fields for sharing

Secure cloud or direct data exchange

☐	☐	☒	☒
ID	Name	Income	Score
423	Adas Ides	89K	3.4
556	Suan Tao	143K	4.1
768	Leor Pasa	56K	2.8

Tangible Benefits

Standardized data

• *Improved statistics*

Increased sample sizes

• *Greater significance*

Increased entity features

• *Reveal new correlations*

Controlled data access

• *Stronger security*

Digital access policies

• *Future proof governance*

ROI for Users

Over 10 times

reduction in time to data access

Over 3 times

increase of data value

Creating New Opportunities Accelerate Innovation

Build your **innovations** from within and disseminate them

Make your data FAIR

- Findable
- Accessible
- Interoperable
- Reusable

Our Partners & Network





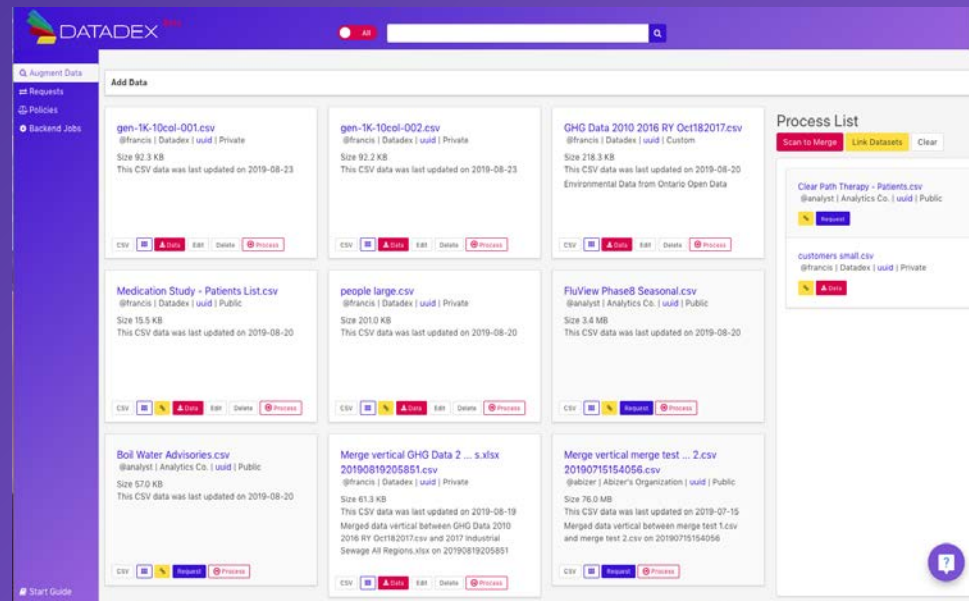
DATADEX

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The Era of Artificial Intelligence in Healthcare

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Faculty Affiliate – Vector Institute

Adjunct Senior Scientist – Institute for Clinical Evaluative Sciences

Professor – University of Toronto

October 2019

The AI 'Hype' in Healthcare

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Brain

Artificial Intelligence Will Redesign Healthcare

Artificial intelligence has an unimaginable potential. Within the next couple of years, it will revolutionize every area of our life, including medicine. I am fully convinced that it will redesign healthcare completely – and for the better. Let's take a look at the promising solutions it offers.

...patient's health. But—as even they will tell you—they're
...body. Heart attacks in particular are hard to anticipate.
...now, scientists have shown that computers capable of teaching themselves can perform even

What is Artificial Intelligence??

- Google dictionary
 - the theory and development of computer systems able to perform tasks that normally require human intelligence, such as visual perception, speech recognition, decision-making, and translation between languages

How do computers 'learn'??

Data... lots and lots of data



Unity Health Toronto: St. Michael's Hospital

- St. Michael's Hospital
 - Tertiary care teaching hospital in downtown Toronto
 - Established in 1892 with the founding goal of taking care of the sick and the poor of Toronto's inner city
 - 1 of two adult trauma centres in the GTA
 - 463 beds and numerous outpatient clinics
 - > 6,000 staff
 - > 900 physicians; > 1,600 nurses
 - Approximate annual patient volumes
 - > 75,000 ED visits
 - > 500,000 ambulatory visits
 - > 25,000 inpatient visits
 - Research: Li Ka Shing Knowledge Institute & Keenan Research Centre
 - > 200 investigators; > 800 staff
 - Fully affiliated with the University of Toronto
 - Part of the Toronto Academic Health Sciences Network (TAHSN)



'Advancing' Advanced Analytics in the Hospital



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Vision
Infrastructure
People & Culture
Process
Lessons

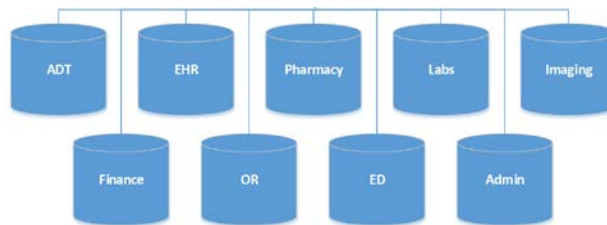
The Vision

- Vision – What Do We Want to See?
 - Make data and analytics an integral part of clinical and management decision-making to drive **better patient outcomes** and **improve hospital efficiency**
- Components of the Vision
 - Readily available, 'up to date', high quality data
 - Highly skilled data scientists
 - Software and hardware to enable advanced analytics
 - Data governance and access model that balances privacy with data accessibility
 - Engaged and 'data literate' hospital community

The Advanced Analytics Platform at the Network: Our Journey

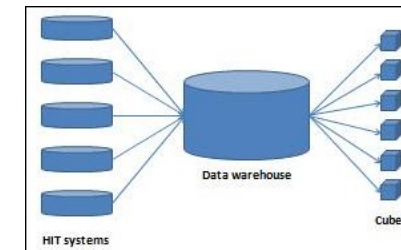
The Data Infrastructure

Siloed Datasets that are not 'analytics ready'



Phase 1 of data
warehouse completion:
March 2018

'Analytics ready' consolidated data warehouse



The People

Establishing a Data Science Unit

St. Michael's

Inspired Care.
Inspiring Science.

LKS-CHART

LKS-CHART Data Scientists

Computer Science: Machine Learning

Engineering: Simulation modeling and optimization

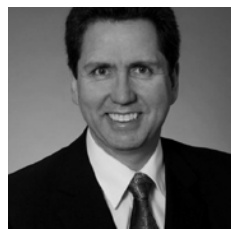
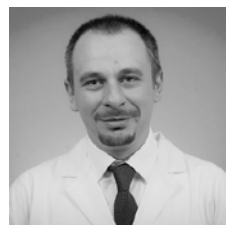
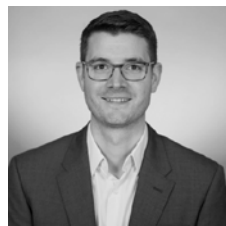
Statistics: Traditional biostatistics

DSS

The Analytical Tools

Analytical Tools Designed for Advanced Analytics / Artificial Intelligence





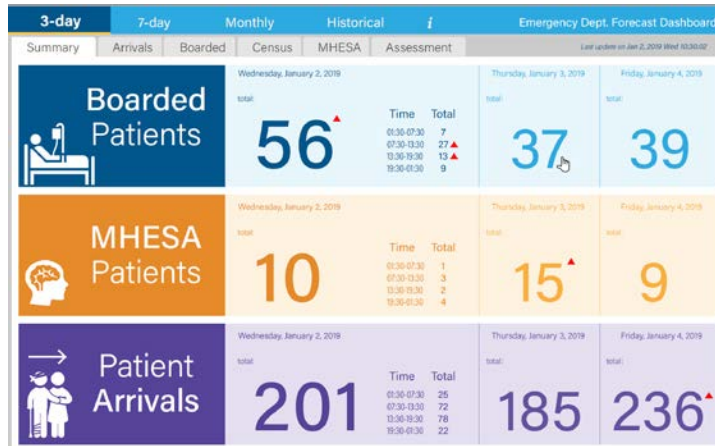
SHARED
PURPOSE

The Process

- Project ideas / questions come from end-users (management and clinical) NOT from the LKS-CHART
- Projects the LKS-CHART will work on (from highest to lowest priority):
 - Initiatives that have promise to improve **patient outcomes** AND reduce **costs**
 - Initiatives that have promise to improve **patient outcomes** at no additional **cost**
 - Initiatives that have promise to reduce **cost** but not adversely affect **patient outcomes**
 - All other initiatives that are prioritized by management and/or clinical leadership
- The majority of projects must have SMH leadership (management and/or clinical leadership) support to enact CHANGE
 - Where relevant, projects will have an evaluation component to assess impact and ROI
- Target project duration: 3-6 months
- Current Project Portfolio: 25+ projects at any time

AI at St. Michael's Hospital: Examples and Lessons

Emergency Department Wait Times



Forecasting patient volumes 3 days to 3 months in advance

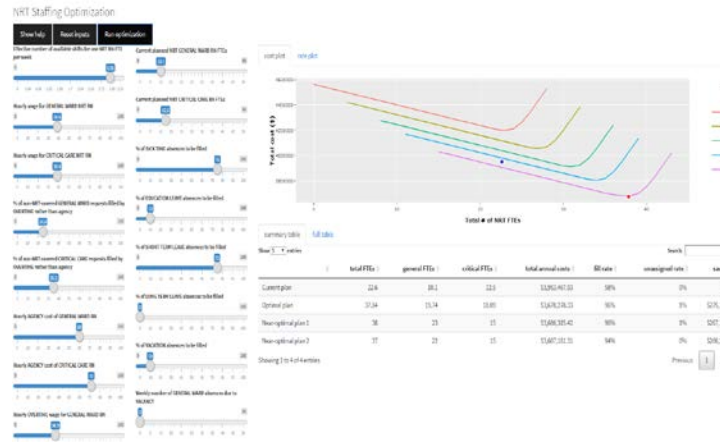
94-96% accuracy



↓ Wait Times
↑ Quality of Care

Key Lessons: Human Factors, Visualization, and Workflow

Optimizing Nurse Staffing



Optimize Nurse Resource Team Staffing at St. Michael's and St. Joseph's

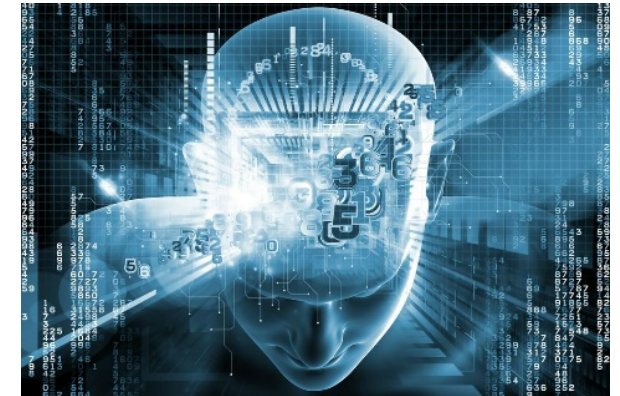
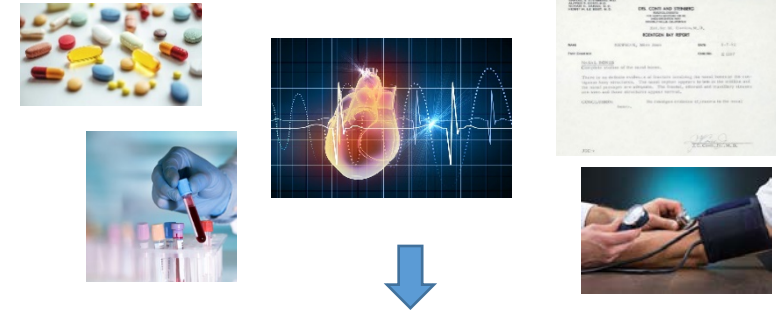
\$1 million cost reduction annually



↓ Cost
↑ Quality of Care

Key Lessons: End-User Needs and Customization

Predicting When Patients Do Poorly



Predict 24H in Advance: ICU Transfer or Death

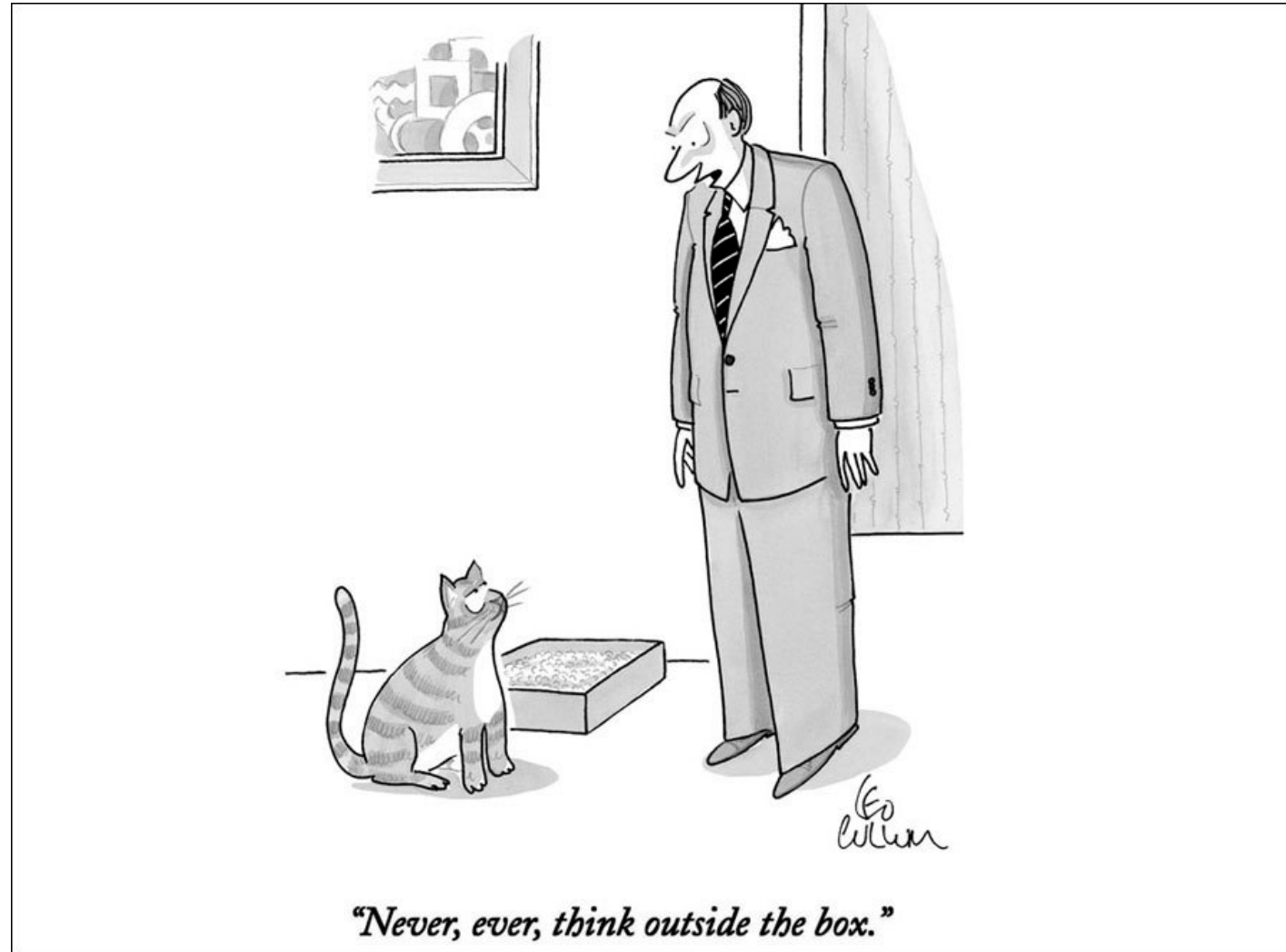
> 98% accuracy
↑ Patient Outcomes

Key Lessons: User Acceptance, Legal/Ethical, Implementation

Drug-Related Projects

- IV to Oral Antibiotic Conversion - implemented
 - Algorithm using structured data and natural language processing to assess clinical stability and absorption status of patients on IV antibiotics
 - Automated daily list of patients eligible for conversion to oral antibiotics to pharmacists
 - > 95% accuracy
- Oral Anticoagulation (OAC) - implemented
 - Algorithm using structured data and natural language processing to identify patients eligible for OAC but not receiving it
 - Automated daily list of patients eligible for OAC to cardiology team
 - > 90% accuracy
- Warfarin Dosing Algorithm – under development
 - Reinforcement learning algorithm that examines individual patient characteristics, lab values (including INR values), medications (including warfarin dose), orders (including diet orders), consults, vitals, and text notes every 6 hours to guide pharmacists on warfarin dosing

Discussion





The Era of Artificial Intelligence in Healthcare

— Medical Imaging

Marwan Sati

Development Executive, Cognitive Clinical Advisors

IBM Watson Health Imaging



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Data explosion and industry challenges: Creating opportunities for AI

Misdiagnoses entail huge costs for organizations

\$4 billion is spent on false-positive mammograms in the US each year

Administrative tasks take up significant time

64% of radiologists' time spent on non-interpretive tasks

More physicians are experiencing burnout

51% of physicians experienced at least one symptom of burnout in 2016, a 25% increase in the last four years

Imaging is generating a huge volume of data

60 billion medical images were generated in 2015 across the U.S.

Patient data is often unstructured

80% of patient data in organizations is unstructured, often lacking relevant context

The power of Watson

Human + machine = greater than the sum of its parts

Humans excel at:



Common Sense



Dilemmas



Morals



Compassion



Imagination



Dreaming



Abstraction



Generalization

AI systems excel at:



Natural Language



Pattern Identification



Locating Knowledge



Machine Learning

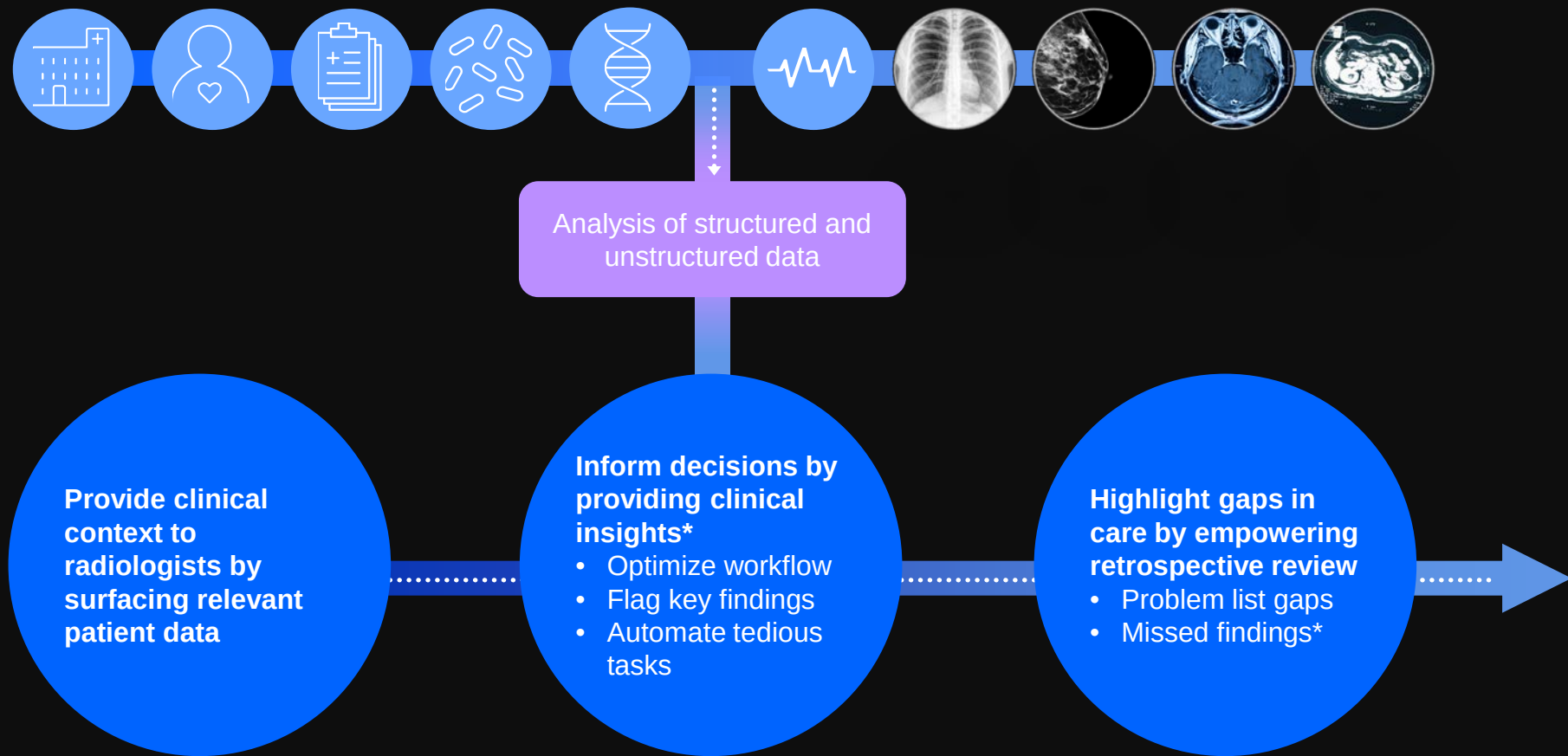


Eliminating Bias



Endless Capacity

AI in radiology workflow

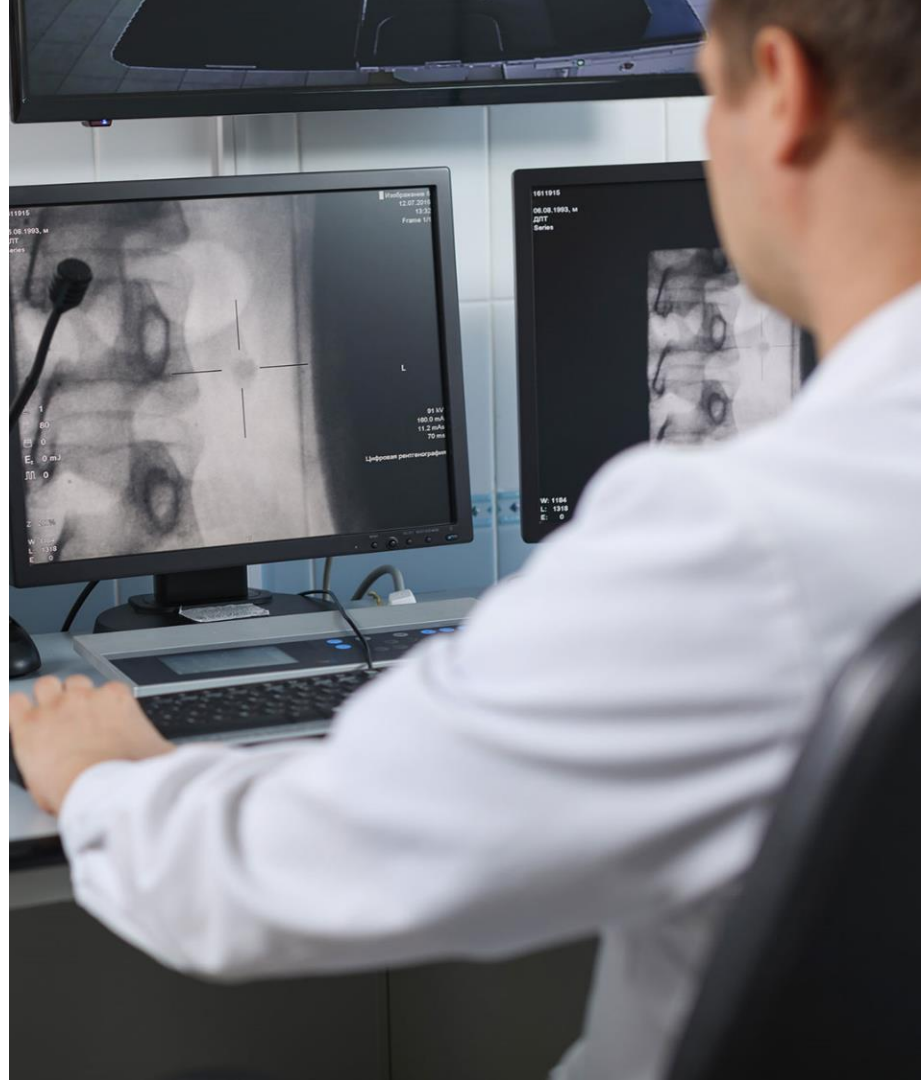




AI algorithms that work in clinical conditions

Designed for:

- Ease of use
- Efficient workflow
- Varied clinical histories
- Range of ages, genders, ethnicities
- Variety of PACS systems
- Diverse imaging protocols
- Multiple device manufacturers

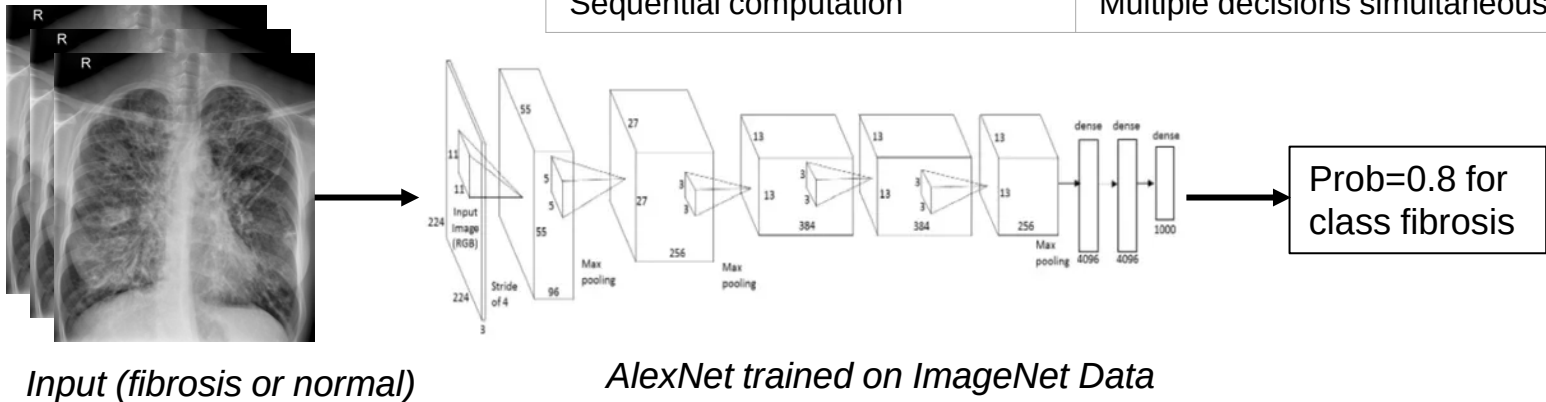




Deep learning on medical images

Deep learning is a branch of machine learning that makes use of multiple processing layers and hierarchical representations to drive the learning process.

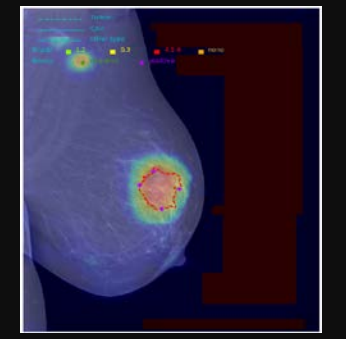
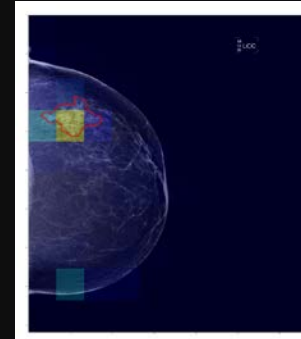
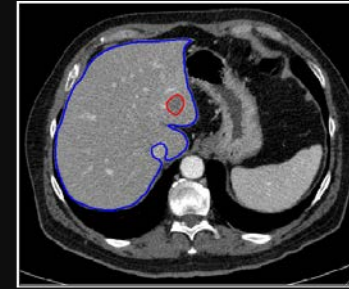
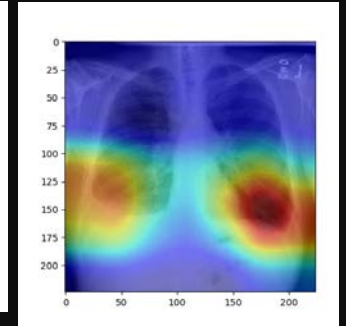
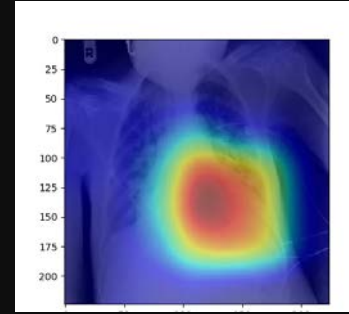
Traditional AI	Deep Learning
Flat hierarchy	Deep hierarchy with layers of abstraction
Manually defined features	Automatically learned features
More detailed local annotations	Less detailed global annotations
Sequential computation	Multiple decisions simultaneously



IBM Medical Imaging AI Development - Works in Progress -

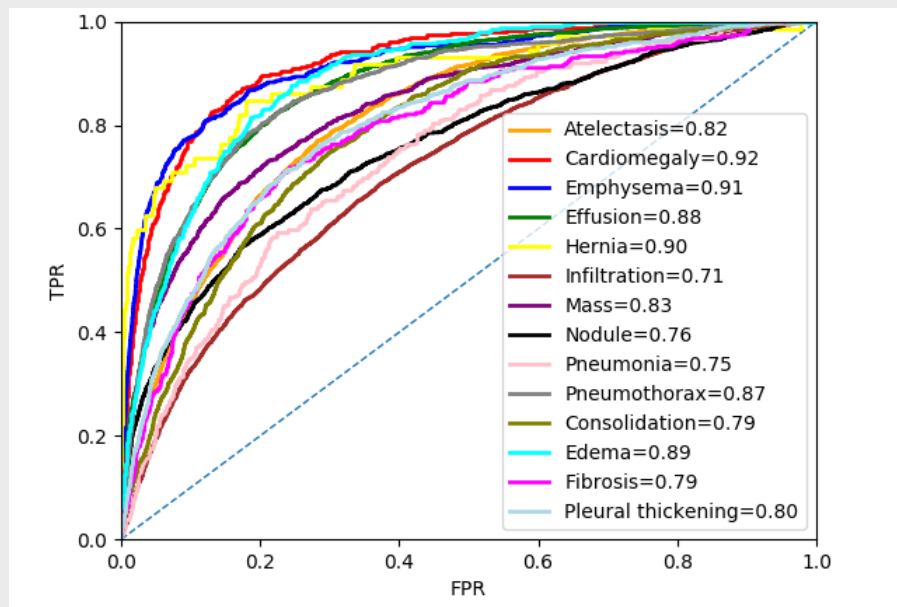
AI Development Activity Examples

- Diagnostic Discrepancy Detection
- Liver Cancer Detection
- Breast Cancer Screening
- Prostate Cancer Screening
- Etc.

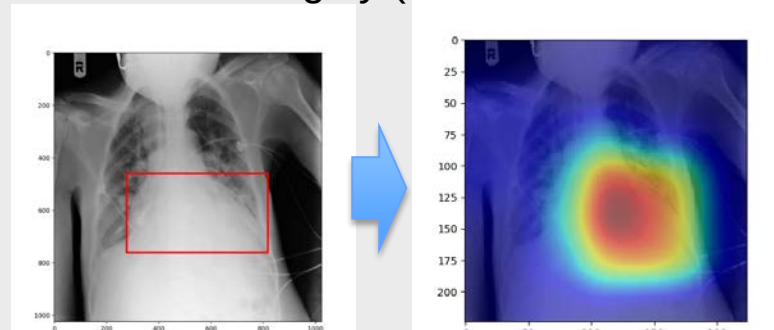


Automated analysis of chest x-rays * (*Works in Progress)

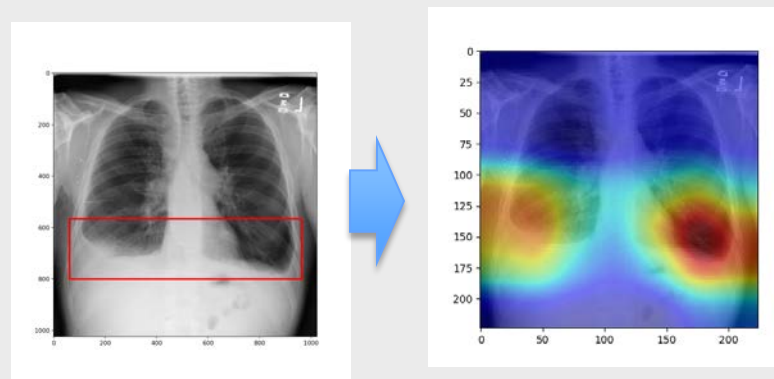
- Detection of 14 common diseases/conditions
- Achieved near state-of-the-art performance



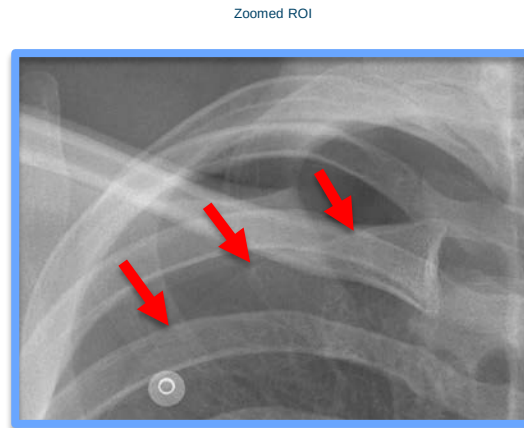
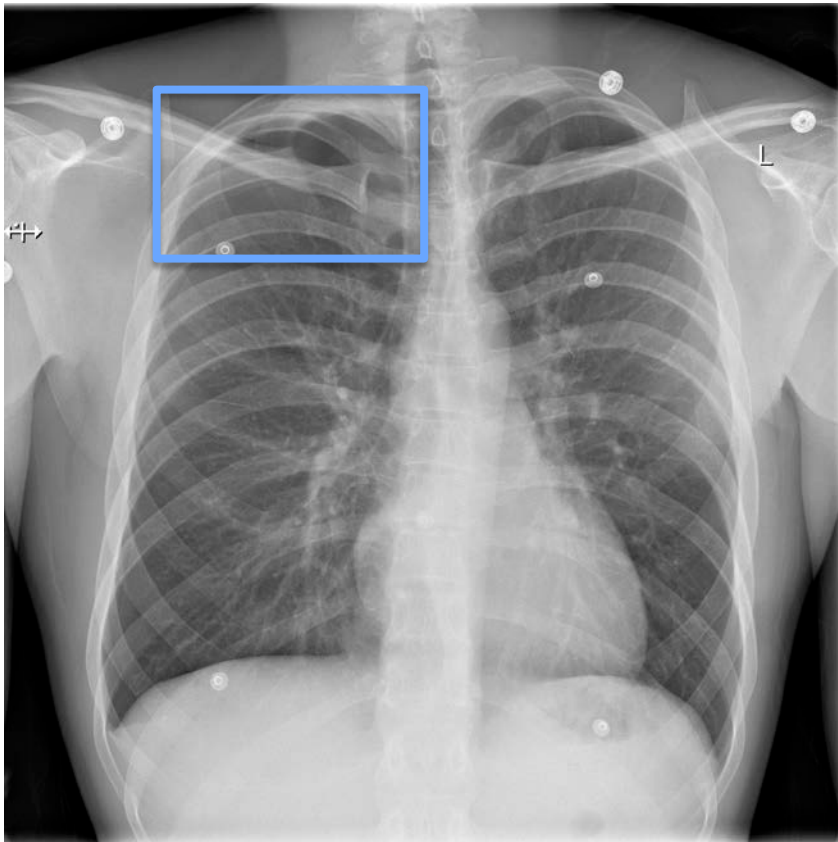
Cardiomegaly (enlarged heart)



Pleural effusion (fluid at base of lungs)

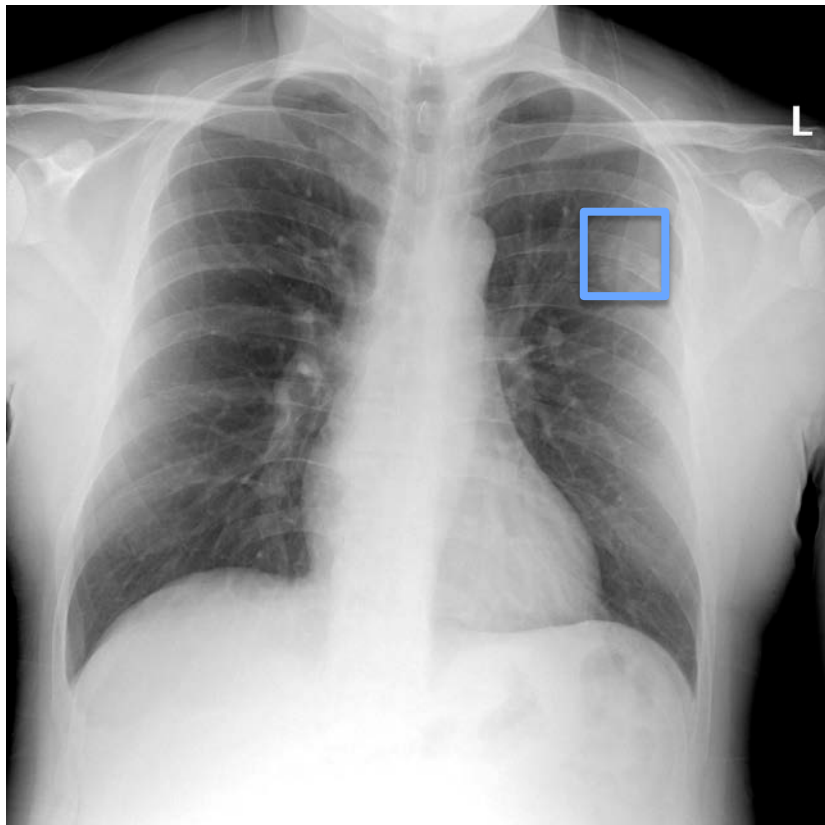


AI Application Example - Unreported pneumothorax

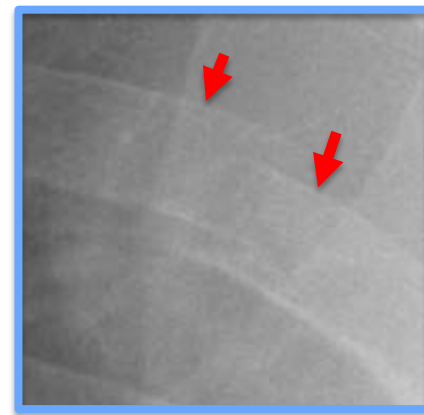


There is no lobar consolidation, pleural effusion, or pneumothorax. The cardiac silhouette is within normal limits. The bones are unremarkable. No acute cardiopulmonary disease. Signed Electronically By: Dr. [PERSONALNAME] - [ALPHANUMERICID] - [DATE]:54 PM

AI Imaging Example - Unreported rib fracture



Zoomed ROI



EXAM:
XR Chest, 1 View

EXAM DATE/TIME:
[PHI DATE]

CLINICAL HISTORY:
[PHI XXX YRS] old, male; Technotes: Chest pain: :

TECHNIQUE:
Imaging protocol: XR of the chest, 1 view.

COMPARISON:
No relevant prior studies available.

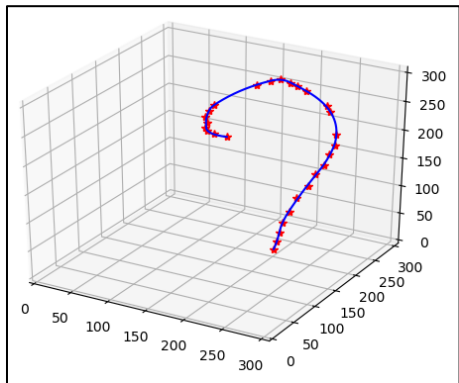
FINDINGS:
Lungs: Unremarkable. No consolidation.
Pleural space: Unremarkable. No pleural effusion. No pneumothorax.
Heart/Mediastinum: Unremarkable. No cardiomegaly.
Bones/joints: Unremarkable.

IMPRESSION:
No acute findings.

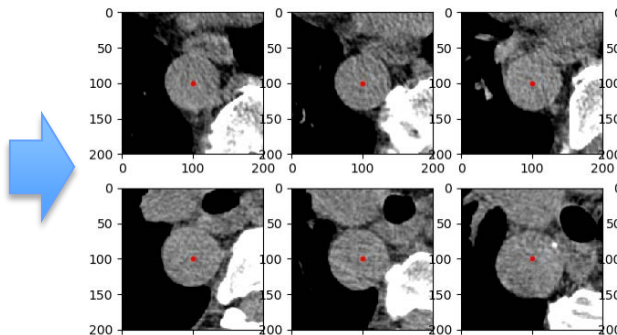
Automated assessment of aortic aneurysms in CT scans*

(*Works in Progress)

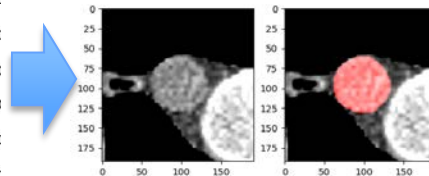
Detection of aorta
centerline in 3D



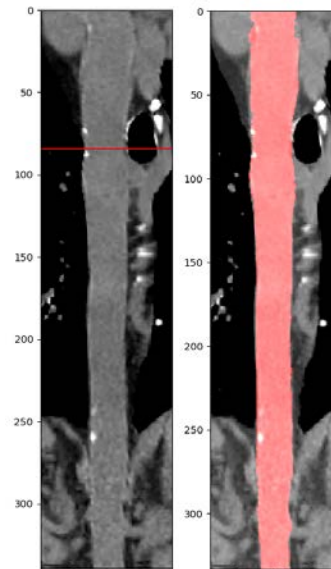
Extraction of 2D aorta
cross-sections



Aorta diameter
measurement



Aneurysm detection

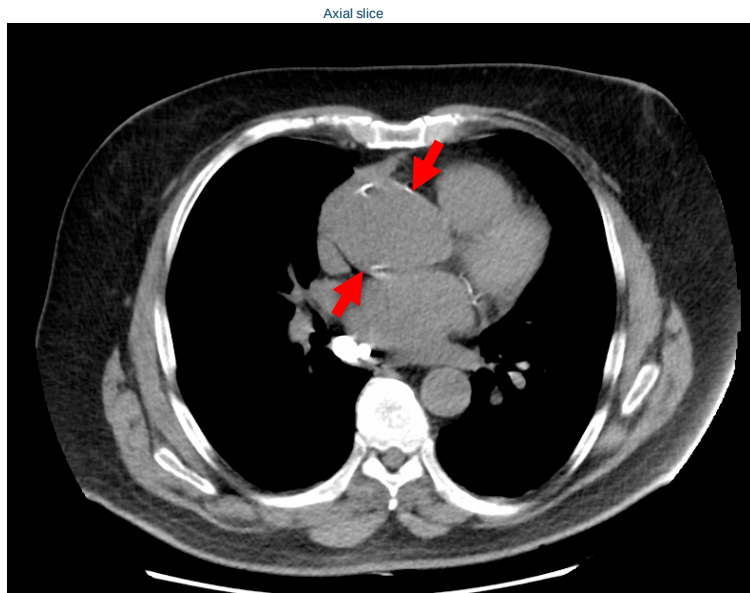


Aortic
aneurysm

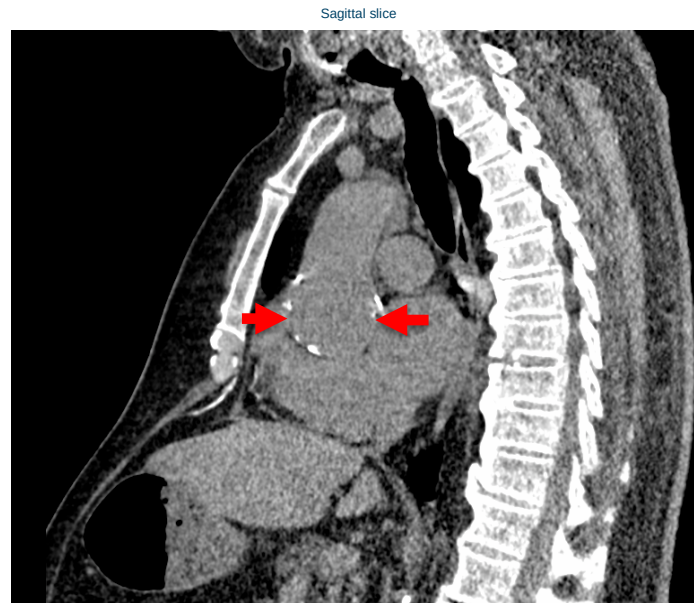
Aorta
Diameter
(cm)



AI Example - Unreported aortic dilatation



Unreported ascending thoracic aortic aneurysm measuring at least 5.6cm



FINDINGS:

Lungs: There is an azygous lobe. No lung mass or significant consolidation.

Pleural space: Normal. No pneumothorax. No pleural effusion.

Heart: Cardiomegaly is identified.

Mediastinum: There is subcarinal mediastinal calcification. There is also calcification in the right thoracic hilum.

Aorta: Normal. No aortic aneurysm.

Lymph nodes: Unremarkable. No enlarged lymph nodes.

Bones/joints: Degenerative change is identified in the spine. There is no evidence for acute fracture or malalignment.

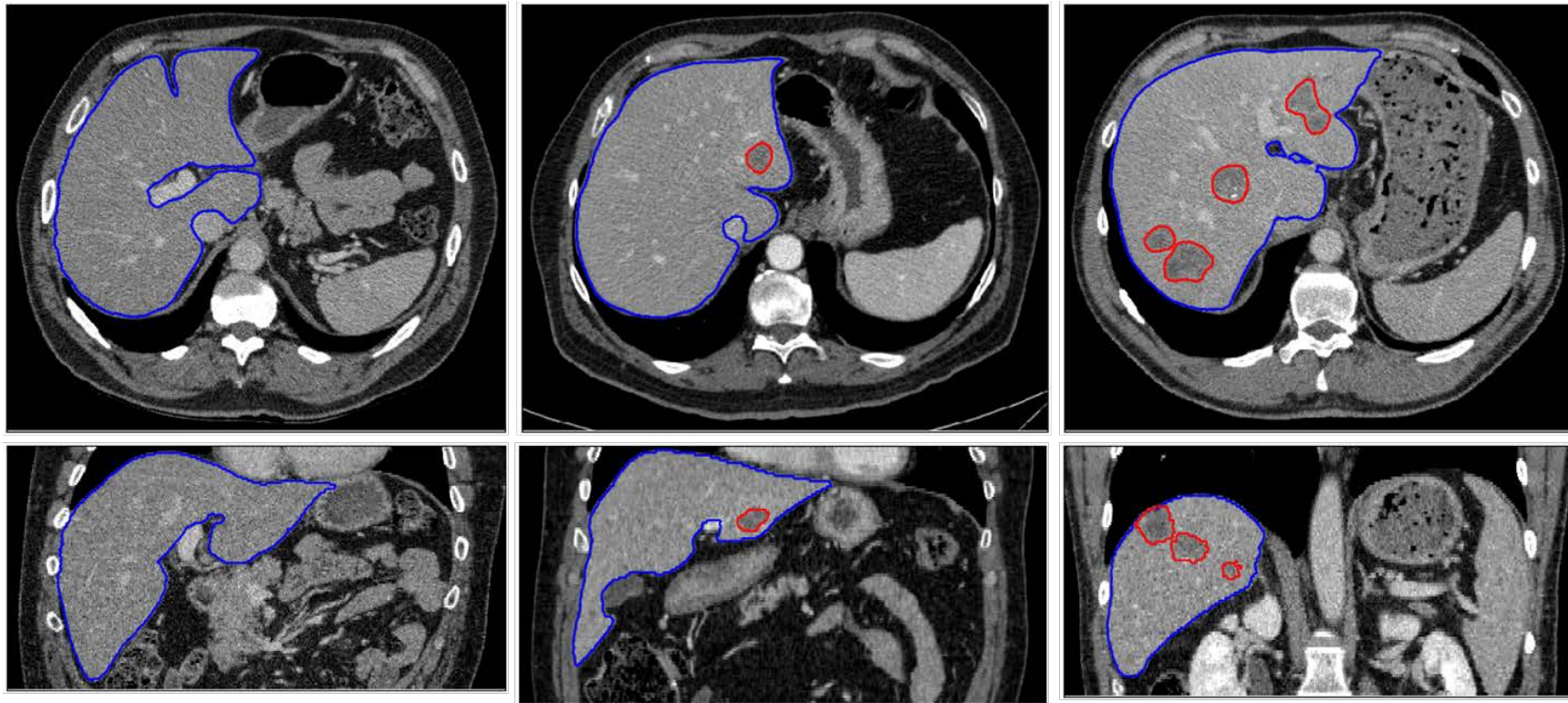
Soft tissues: Unremarkable.

IMPRESSION:

There are no acute concerning abnormalities.

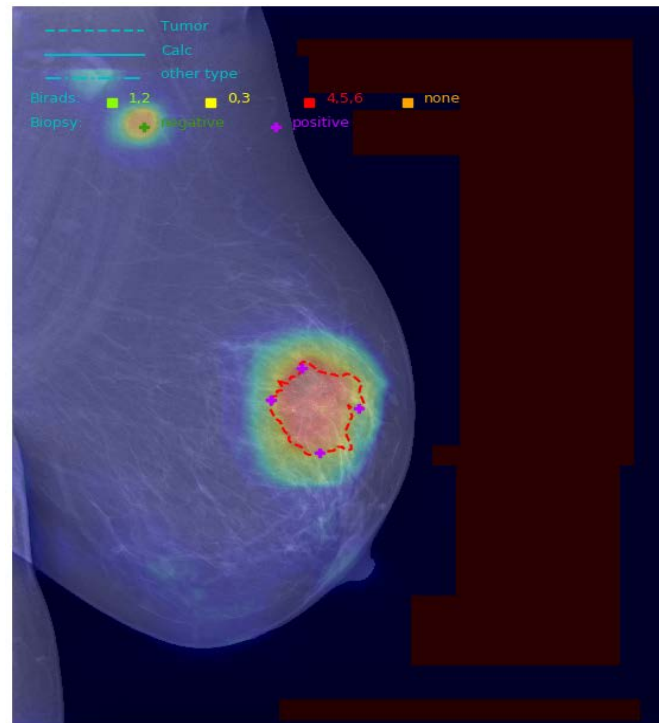
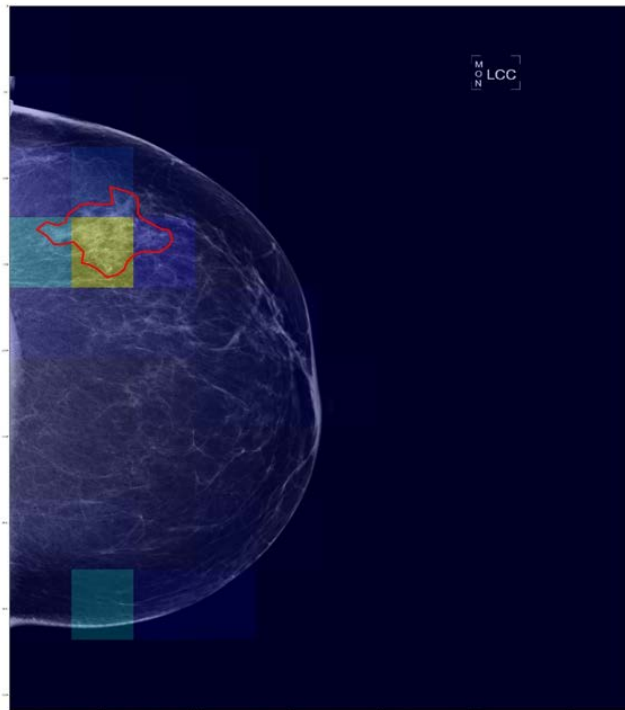


Liver Cancer Detection * (*Works in Progress)

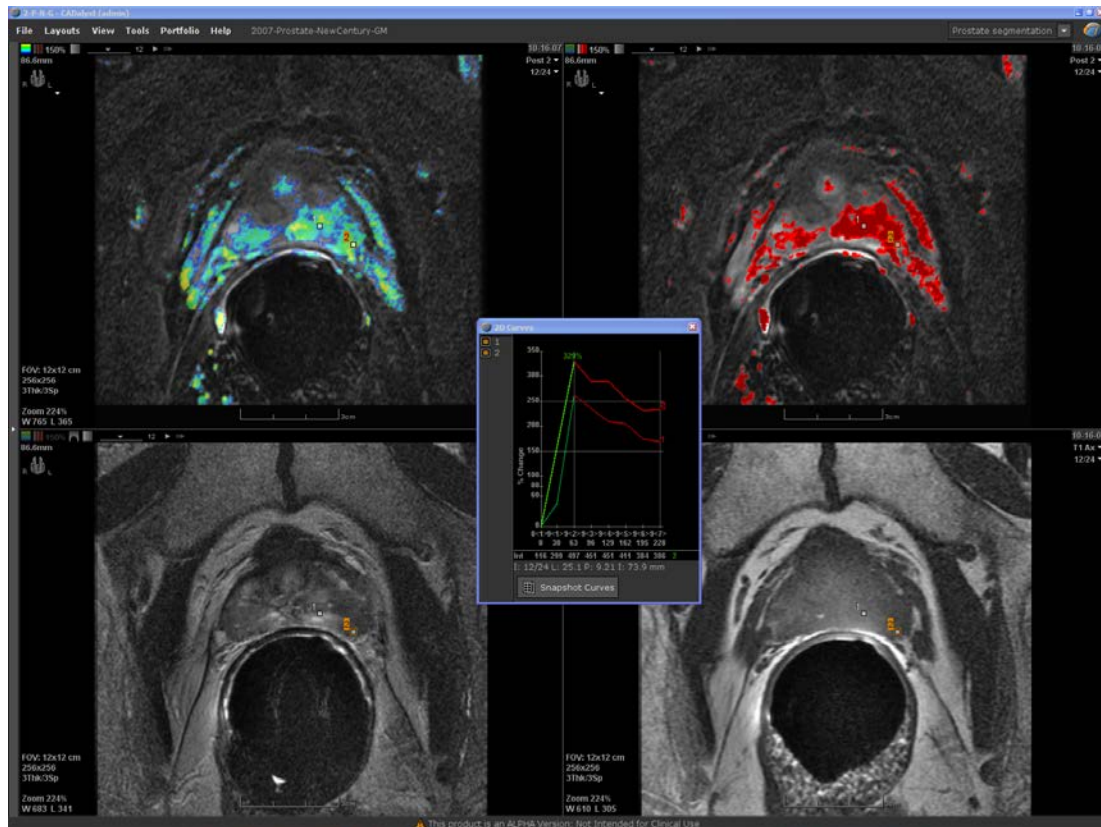




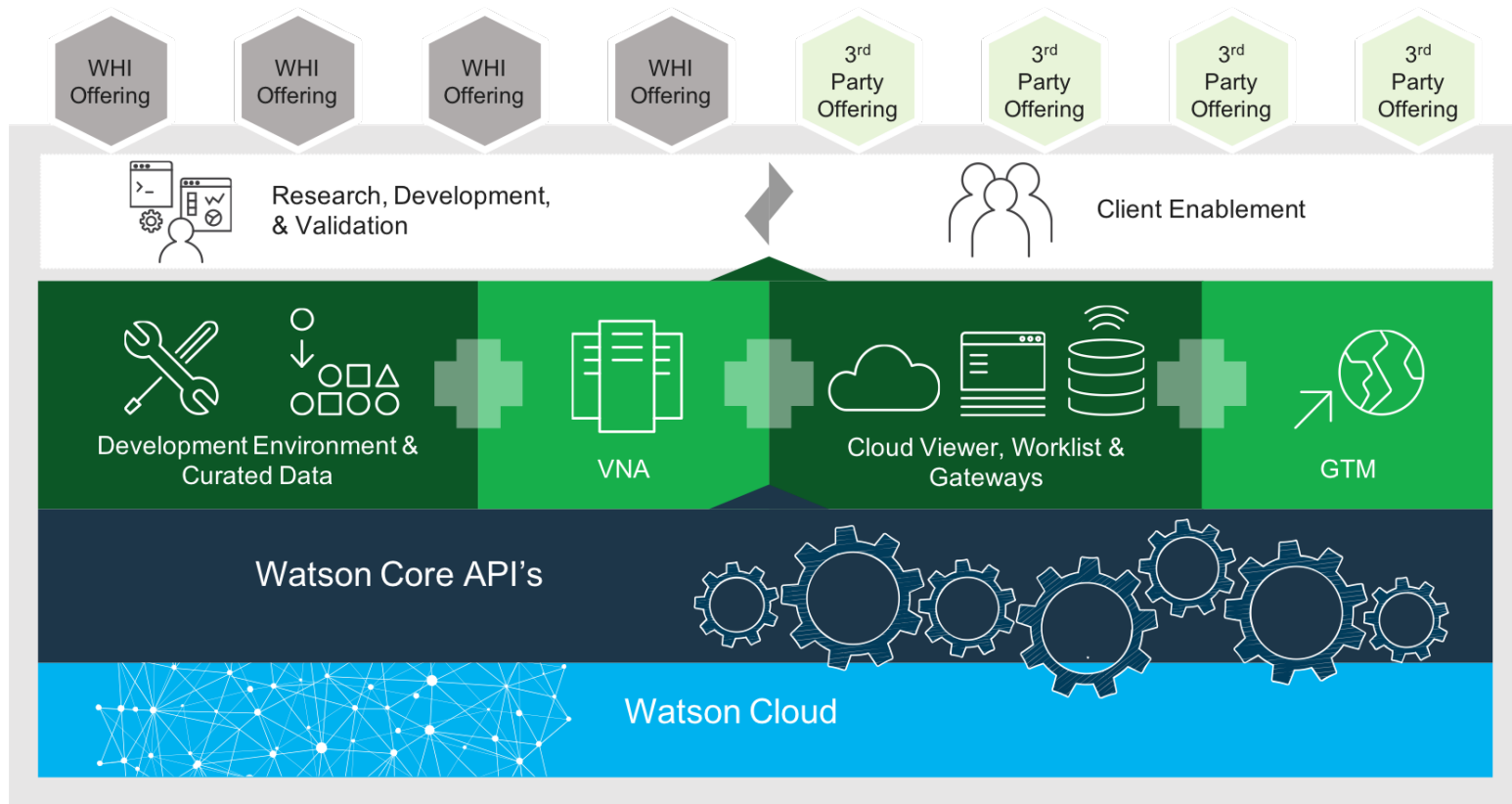
IBM Watson Imaging Care Advisor *for breast* * (work in progress)

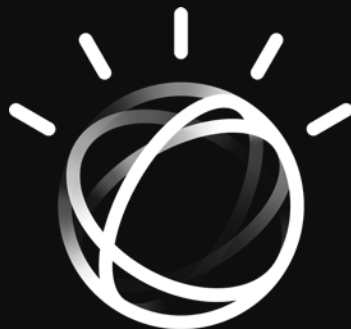


Detection and clustering of signature dynamic contrast patterns* (*Works in Progress)



Deploy AI algorithms at scale





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