AI is big business
Corporate Valuations by Sector
Beginning to make an Impact in Health

**Breakthrough in AI technology to improve care for patients**

Two years ago, Moorfields Eye Hospital NHS Foundation Trust and DeepMind Health came together to announce a five-year partnership to explore whether artificial intelligence (AI) technology could help clinicians improve the care for their patients.

Researchers from Moorfields and the UCL Institute of Ophthalmology have had a recent breakthrough in this research, published on Nature Medicine’s website, which describes how machine learning technology has been successfully trained on thousands of historic de-personalised eye scans to identify signs of eye disease and recommend how patients should be referred for care.

The AI system can recommend the correct referral decision for over 50 eye diseases with 94% accuracy, matching world-leading eye experts. It hoped that the technology could revolutionise the way professionals carry out eye tests, allowing them to spot conditions earlier and prioritise patients with the most serious eye diseases before irreversible damage sets in.

**Dartford and Gravesham NHS Trust implements AI in radiology**

**BBH building better healthcare**

Dartford and Gravesham NHS Trust implements AI in radiology

14-Jun-2019

**Building and Design**
**Facilities**
**Patient Experience**
**Technology**
**Infection Care**

Trust partners with Bolobi.ai to support quicker diagnosis workflows

The new technology helps to immediately pinpoint abnormal radiographic scans.

**Densitas and Leeds Teaching Hospitals sign partnership to bring innovative, personalized breast screening technologies into their routine clinical workflow.**

HALIFAX, Nova Scotia, July 24, 2019 /PRNewswire/ --

Densitas, Inc., a breast imaging analytics innovator based in Halifax, Nova Scotia, announces a recently formalized partnership with the Leeds Teaching Hospitals NHS Trust in the UK. The partnership seeks to introduce innovative personalized breast screening technologies, including our **densitometry™** and **densitometry®** products, into routine clinical workflow. The goal is to ultimately enable population-level stratified breast screening and mammography quality improvement and clinical research in the area of breast health.

“Our partnership with Leeds Teaching Hospitals NHS Trust is the first of its kind in the UK and represents an alignment of vision that is intended to improve appropriate levels of care in breast cancer screening through innovation in technology and service delivery,” says Mohamed Abdellatif, CEO of Densitas. “We are excited to collaborate with Dr. Nisha Sharma, Director of Breast Screening, and her team at Leeds Teaching Hospital’s NHS Trust breast screening program to introduce our machine learning powered breast imaging analytics platform into a clinical care setting.”
NHS aims to be a world leader in artificial intelligence and machine learning within 5 years

5 June 2019

Digital  Innovation  Long Term Plan

NHS chief Simon Stevens today called on tech firms to help the health service become a world leader in the use of artificial intelligence (AI) and machine learning.

He also asked staff to work with us and share ideas on reforms to the payment systems that would help encourage and facilitate quicker adoption and expansion.

The technology can help speed up diagnosis of cancer and other diseases and deliver more convenient care by revolutionising outpatient services.

Speaking at the Reform Health Conference today, NHS chief executive Simon Stevens announced a global call for evidence from technologists for how the NHS can best incentivise the use of carefully targeted AI across the NHS from April 2020 and beyond.

The NHS boss challenged tech innovators to come forward with proposals for how the NHS can harness innovative solutions that can free up staff time and cut the time patients wait for results.

At the same time he pledged to consider reimbursement reforms to the NHS tariff and other payment systems to incentivise quick and safe adoption across the NHS.

Exploiting the boom in AI technology will help to meet the NHS Long Term Plan’s target of making up to 30 million outpatient appointments unnecessary, saving over £1 billion in what would have been increasing outpatient visits which can then be reinvested in front line care, saving patients unnecessary journeys to hospitals.
Artificial Intelligence
- When computers do tasks normally requiring human intelligence

Machine Learning
- Rapid automatic construction of algorithms from data

Neural Networks
- Powerful form of machine learning

Deep Learning
- Neural networks with many layers
Machine Learning Needs Lots of Data

Deep learning requires around 1000 positive examples and 1000 negative examples to learn – by contrast a human needs 3 examples.
Neural Networks simulate the way neural impulses are sent to the brain from human eyes.

- Contrast
- Size
- Shape
- Boundary
- Texture

What we see

What the computer sees
The diagram illustrates the performance of Deep Learning and Traditional Machine Learning Algorithms in relation to the amount of data.

- **Deep Learning**
  - Performance increases more rapidly with the amount of data.
  - The curve shows exponential growth.

- **Traditional Machine Learning Algorithms**
  - Performance increases at a slower rate compared to Deep Learning.
  - The curve shows a more linear progression.

The area in the middle represents the **Plateau in Performance** where both algorithms show limited progress with additional data.

The diagram also includes the text: "CODES OF INTEREST."
The Rapid Development of Machine Learning

ImageNet Visual Recognition Error Rates

- Human error rate

- 2010: 30%
- 2011: 25%
- 2012: 20%
- 2013: 15%
- 2014: 10%
- 2015, 2016, 2017: 5%
Machine Learning - Adversarial Training
Adversarial images from thisfacedoesnotexist.com
AI and Radiology

upstream

downstream
AI and Radiology

- Patient positioning
- Patient movement prediction
- Error correction
- Image processing & reconstruction
- Modality optimisation & predictive maintenance
AI and Radiology

downstream

- Regression
  - Developmental Question – Bone Age / Brain Age

- Classification
  - Tumour / No Tumour
  - Improvement or regression
  - Normal / abnormal
  - Fracture
  - Haemorrhage

- Segmentation
  - Volume of Tumour
  - Malignant / Benign
  - Organ Segmentation & Analysis
  - Predictive Analysis
AI and Radiology

- Intra Cranial Haemorrhage
  - Identification
  - Classification
  - Triage & Prioritisation
  - Review of EPR to appraise risk factors and develop treatment plan

Example from MaxQ AI
AI and Radiology

- Chest X-Ray
  - Pneumonia and more than 13 other common diseases
  - Identification
  - Classification
  - Triage / Prioritisation
  - AI Reading time <2 minutes compared with Radiologist
  - Reading time >4hrs

Example from Stanford University MLG – CheXnet (112,120 learning set)

In the U.K. there are an estimated 330,000 X-rays at any given time that have been waiting more than 30 days for a report – Warwick University
Breast Screening
- Upstream patient position
- Downstream Identification
- Classification
- Density Adjustment
- Automated Quality Assessment

According to the Royal College of Radiologists, two million breast screen’s are done each year in the UK, requiring a review by two radiologists. Consistency can vary with visual reporting being subjective, not reliably reproducible and not standardised.
AI and Radiology

- Vertebral Compression Fracture
  - Identification
  - Classification
  - Triage / Prioritisation

Example from Zebra Medical AI
AI and Radiology

Adversarial AI – Lower IV Contrast Media Dose

AI and Radiology

Adversarial AI – Reduce PET Radiation Dose

Chen KT et al. Radiology, 290, 2018
Challenges

• Peer reviewed papers – hard to come by
• Requirement for lots of data
• Rarer conditions harder to find training data
• Over-fitting – AI only learning the data set
• Potential for genetic or regional bias in the data
• GDPR
• Silo development - tailored for individual manufacturers or systems
• Common interface
• ICT infrastructure
Challenges

Finlayson SG, Kohane IS, Beam AL. Adversarial Attacks Against Medical Deep Learning Systems
Challenges

Radiology Example: Pneumothorax Detection

Finlayson SG, Kohane IS, Beam AL. Adversarial Attacks Against Medical Deep Learning Systems
Liability for decisions made about patient care almost exclusively rests with the healthcare practitioner.

AI models have large amounts of data, some of which are not perceptible to humans, will liability be shared between:

• The healthcare practitioner
• Hospital Management
• The company which developed the AI tool.

Could the radiologist be made liable for NOT having used AI or going against its analysis?
Guidance

Understanding artificial intelligence ethics and safety

Understand how to use artificial intelligence ethically and safely

Published 10 June 2019
From: Government Digital Service and Office for Artificial Intelligence

Introduction

Today we have some truly remarkable data-driven innovations, apps, clinical decision support tools supported by intelligent algorithms, and the widespread adoption of electronic health records. In parallel, we are seeing advancements in technology and, in particular, artificial intelligence (AI) techniques.

Combining these developments with data-sharing across the NHS has the potential to improve diagnosis, treatment, experience of care, efficiency of the system and overall outcomes for the people at the heart of the NHS, public health and the wider health and care system.

Innovators in this field come from sectors that are not necessarily familiar with medical ethics and research regulation, and who may utilise data sets and processing methods that sit outside existing NHS safeguards.

It is our duty as NHS England and central government to capitalise on these opportunities responsibly. People need to know that their data is being used for their own good and that their privacy and rights are safeguarded. They need to understand how and when data about them is shared, so that they can feel reassured that their data...
Positive Trend or Travesty?

• Within the next 2 to 5 years the majority of MRI, CT, X-Ray and Ultrasound will be segmented by AI in Acute Hospitals

• Optimise workflow and reduce demand on radiologists

• It will reduce the number of scans, improve prevention of disease and diagnosis, reduce radiation and harm, reduce clinical errors, improve patient outcomes and enable precision / tailored health

• Deep Learning Algorithms will identify anomalies humans cannot or have not previously recognised.

• Care pathways will be optimised with preventative screening and diagnosis happening more rapidly and in new locations

• Still many questions to answer
The Utopia – the digital twin
Machines will not replace humans in healthcare practice, but they will remove “machine tasks” from clinical workflow.

In Radiology AI will offer an army of highly trained radiologists with photographic memories and no need to eat or sleep.

Ultimately:

“Radiologists who use AI will replace those who don’t”