Artificial Intelligence & Radiographer Reporting: Why it is important for radiographers to be at the discussion table?

Kevin Tucker
National Officer for Wales
What to cover today?

• What do we mean by Artificial Intelligence?
• How does it work?
• AI in Radiology
• Are radiographers at the table?
AI or just software?

• Smartphones: assistants such as Siri, adaptive battery, predictive actions, social media feeds, navigation and travel, advertising, music and media streaming services, face recognition
• Drones and smart cars which can make sense of their surroundings
• Smart homes, security and surveillance, image tagging and recognition
• Market research
• Banking and finance: stock market analysis and prediction, fraud detection
• Video games and ‘Go’
• Medicine
What is AI?

• The ability of a computer or robot to perform tasks commonly associated with intelligent beings. Examples:
  • Speech or handwriting recognition
  • Learning - computer search engines
  • Planning – supply chain applications
  • Problem solving – comparing ways of meeting an objective

• Humans are predictive – for machines to achieve this requires complex algorithms

• AI learns in response to changes in its environment and what is learned should take humans some effort to learn.

• Computers learn to perform tasks based on examples, rather than by relying on programming by a human.
Artificial Intelligence

Machine Learning

Deep Learning
Machine Learning

• Creating systems that can identify useful patterns from large data sets, and provide useful insights as a consequence.

• Artificial Neural Networks break up tasks and allow a network to learn and grow quickly

• They replicate the activities and connections of neurons which work together to process information and relay output
Deep Learning

• Based on artificial neural networks which attempt to mimic the way human brain works

• They utilise vast amounts of data in order to understand patterns within a data set

• Convolutional neural networks seem to be the dominant technique in image pattern recognition and are a major breakthrough in image recognition (self-driving cars, facial recognition systems and medical diagnostics)

• The field is moving fast!
Algorithms

• In simple terms it’s a procedure that tells your computer precisely what steps to take to solve a problem or reach a goal. The ingredients are called inputs, while the results are called the outputs.

• The internet is governed by algorithms that determine
  • what you see in your Facebook feed
  • what Netflix recommends to you
  • what ads you see in your browser

• When chained together, algorithms – like lines of code - are combined to build complex AI systems like neural networks.
Where computation is done
 Usually multi-layer

Each connection has a weighting

Input from environment  Where output is stored

Input  Hidden  Output
Sensory  Other  Motor

Where computation is done
 Usually multi-layer
Stanford launches huge dataset of chest x-rays for AI
By Erik L. Ridley, AuntMinnie staff writer

January 25, 2019 -- Researchers from Stanford University have released a massive dataset of more than 224,000 chest x-rays to be used for the development of artificial intelligence (AI) algorithms. The group has also launched a competition for developers of AI algorithms to test their models.
AI in Radiology:
Situation now

• The chase to develop algorithms
• Data availability across the NHS
• Local hospital arrangements with academic institutions
• Larger collaborations in the US with significant capital investment
• ACR has formed the Data Science Institute
  • Define appropriate medical imaging AI use cases;
  • Set standards for medical imaging AI interoperability;
  • Test and evaluate medical imaging AI algorithms; and
  • Address regulatory, legal and ethical issues that accompany medical imaging AI

• British Radiology Artificial Intelligence Network proposed to improve access to and govern curation of anonymised NHS data
There are over 120 start-ups and growth-phase companies developing machine learning solutions for medical imaging. 75 of these have entered the market since the start of 2015.

Total investment in 2018 was $580M, more than double the 2017 amount ($270M). HeartFlow accounted for $240M of the 2018 total.

In 2018, later-stage (Series B onwards) funding, excluding HeartFlow, more than doubled to a total of $237M, compared to 2017.

Early-stage (Angel, Seed and Series A) funding peaked in 2017 at 29 deals and slowed to 15 deals in 2018.

Only 1 of the ten most-funded companies is European. 5 are from the USA and 4 are from Asia.
Funding of Medical Imaging AI Companies (2009 to 2018)

*Excludes HeartFlow

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## The 5 Most Funded Medical Imaging AI Companies by Application

### Breast Imaging
- volparasolutions
- koios
- ScreenPoint Medical
- QView
- Cure Metrix

### Cardiovascular Imaging
- HeartFlow
- BAYLABS
- circle Imaging
- Dia Imaging Analysis
- Ultromics

### General Imaging
- VoxelCloud
- INTERVISION
- Nanosonic Medical
- Zebra Medical Vision
- Arterys

### Lung Imaging
- VIDA
- RADLogics
- Imbio
- Mindshare Medical
- EON

### Neurology Imaging
- viz.ai
- Brainomix
- maxQ
- QMENTA
- ICOMETRIX

* + 7 others
* + 6 others
* + 66 others
* + 4 others
* + 13 others
What could AI do in Radiology?
What could AI do in Radiology?

- Automatic Image Analysis
  - All studies from a certain modality or a certain exam type immediately sent for AI analysis: prioritisation; abnormal studies flagged
- Time-sensitive image interpretation (e.g. trauma)
- Enhancement of images
- Clinical decision support – what should I order?
- Patient management (scheduling, acquisition, positioning etc)
- Support the detection of lung tuberculosis on chest radiographs
- Improve detection of pulmonary nodules in CT
- Act as a second-reader
A computer-aided diagnosis system using artificial intelligence for the diagnosis and characterization of breast masses on ultrasound

Added value for the inexperienced breast radiologist

Park, Hee Jeong, MD; Kim, Sun Mi, MD; La Yun, Bo, MD; Jang, Mijung, MD; Kim, Bohyoung, PhD; Jang, Ja Yoon, MD; Lee, Jong Yoon, MD; Lee, Soo Hyun, MD
Automated Triaging of Adult Chest Radiographs with Deep Artificial Neural Networks


* M.A. and S.J.W. contributed equally to this work.
• AI can help to make medical equipment smarter, imaging and lab results faster, and examinations more precise.

• Expanding Precision Medicine through Integrated Decision Support

• This will by no means replace radiologists, but rather help to meet the rising demand for imaging examinations, prevent diagnostic errors, and enable sustained productivity increases
Deep-learning algorithm predicts Alzheimer's disease
By Erik L. Ridley, AuntMinnie staff writer

November 7, 2018 -- By learning to identify the metabolic patterns of Alzheimer's disease, a deep-learning algorithm for brain FDG-PET studies can accurately predict the onset of this devastating disease years before a clinical diagnosis can be made, according to new research published online in Radiology.
Robots could help detect cancer in less than a second, trials suggest
Deep learning in chest radiography: Detection of findings and presence of change


Published: October 4, 2018 • https://doi.org/10.1371/journal.pone.0204155

Abstract

Background

Deep learning (DL) based solutions have been proposed for interpretation of several imaging modalities including radiography, CT, and MR. For chest radiographs, DL algorithms have found success in the evaluation of abnormalities such as lung nodules, pulmonary tuberculosis, cystic fibrosis, pneumoconiosis, and location of peripherally inserted central catheters. Chest radiography represents the most commonly performed radiological test for a multitude of non-emergent and emergent clinical indications. This study aims to assess accuracy of deep learning (DL) algorithm for detection of abnormalities on routine frontal chest radiographs (CXR), and assessment of stability or change in findings over serial radiographs.
AI detects more malignant lung nodules on x-rays
By Erik L. Ridley, AuntMinnie staff writer

September 27, 2018 -- An artificial intelligence (AI) algorithm improved the performance of nonradiology physicians and even thoracic radiologists for detecting malignant pulmonary nodules on chest radiographs, according to research published online September 25 in Radiology.
... machine learning as an "ultimate threat" that could "end radiology as a thriving specialty."

"Who do you sue when a computer that replaced radiologists makes a mistake?"

"Radiology represents a completely different challenge, with much larger and more complex information,"

An intelligent assistant, not a replacement for radiologists

... there will be more radiologists in 20 years, not fewer, and that computers will be regarded as trusted friends, able to create preliminary reports, but not primary ones.

"Radiologists will have more time to spend with patients"
Artificial Intelligence, Real Radiology

The first issue of *Radiology: Artificial Intelligence* is here!

Start with the editorial by Charles E. Kahn, Jr., MD, MS, Editor.
Barriers to AI Adoption?

• Technical,
• Regulatory
• Financial
• Professional
• Public
Radiology consortium says it won’t pay for imaging system until supplier fixes issues

The East Midlands Radiology consortium (EMRAD) is reported to be withholding money from GE Healthcare until the supplier patches up problems with its beleaguered imaging system.
The NHS has a long way to go before AI can be effectively leveraged
Pros

• Effective clinical tool
  • Optimising workflow
  • Clinical decision support
  • Differential diagnosis
  • Analysis of ‘big data’

• Increases productivity
  • Faster report turnaround
  • Reporter more efficient / cost effective

• Reduces mistakes / litigation costs

• Earlier cancer detection / improved therapeutic treatments

• Reduce unnecessary interventions

• Predicting future disease before onset of symptoms (such as dementia)

• Improved patient outcomes
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Cons

• Adverse effect on careers
  • Reporting / radiology becomes a less attractive career option
  • Radiology is less attractive
  • Setback in radiography career pathway
  • Skill loss

• Machine errors replace human errors
  - who do I sue?

• Open to external manipulation

• Garbage in – garbage out

• Massive organisational change

• Not cost effective
• In the next five to 10 years, diagnostic imaging will be ‘revolutionised’ by machine learning
• The RCR believes that these techniques should be seen as a diagnostic tool rather than a workforce replacement
• AI has the potential, by ‘weeding out’ all normal X-rays, freeing up capacity to allow radiologists to work on the more complex studies.
• This technology is not yet developed enough to be an immediate solution.
Are radiographers at the table?

Pre-registration and postgraduate education
Informatics / Computing knowledge
Profile of the profession with start-ups
Engagement in research
'Whoever leads in AI will rule the world': Putin to Russian children on Knowledge Day