Point/Counterpoint Live Debate:

AI Will Soon Change the Landscape of Medical Physics Research and Practice

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Disclosure

- Dr. Lei Xing has received speakers honoraria from Varian Medical Systems.
- Research grants supports from NIH, Varian, Google Inc., Huyihuiying Medical Co, Siemens.
- Scientific advisor for Huiyihuiying Med Tech Co.
- Founder of Luca Medical Systems.

WHY DO WE NEED AI?

WHAT AI CAN DO FOR US?

HOW WELL CAN AI DO OUR JOBS?

WHEN GENERAL AI WILL BE AVAILABLE?

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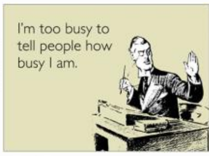
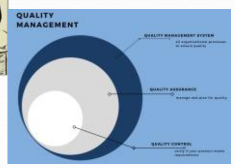
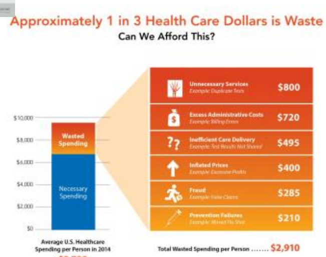
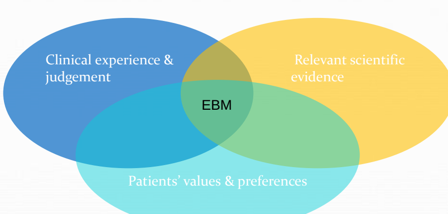
WHY DO WE NEED AI?







Current medical practice is evidence-based



Sakett et al, BMJ 312, 71-72, 1996

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Problems and concerns with current EBM

- Quality of the evidence
- Hypocognition
- Care provider dependent
- Efficiency & cost (not only the healthcare delivery process....)
- Lag between when the RCT is conducted and when its results are published/adopted
- Not individualized
- Human cognitive capacity???

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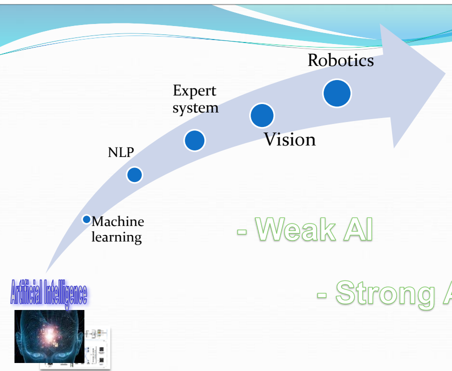
WHAT AI CAN DO FOR US?



- Weak AI
- Strong AI

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HOW WELL CAN AI DO OUR JOBS?

- Repetitive jobs
- Creative works

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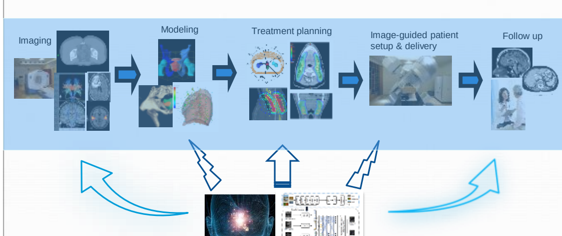
Radiation therapy workflow powered by AI
- high precision and automated patient management



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On-going AI related research at Stanford Radiation Oncology Department

- ✓ AI-aided image analysis, reconstruction, super-resolution imaging, and tumor target segmentation
- ✓ Autonomous treatment planning driven by deep learning
- ✓ RT delivery guided by multiple layers of neural network
- ✓ AI-aided clinical decision-making, toxicity and survival prediction
- ✓ AI-facilitated QA
- ✓ NLP auto-annotation and clinical notes transcription

JAMA | Original Investigation | INNOVATIONS IN HEALTH CARE DELIVERY

Development and Validation of a Deep Learning Algorithm for Detection of Diabetic Retinopathy in Retinal Fundus Photographs

Varun Gulshan, PhD; Lily Peng, MD, PhD; Marc Coram, PhD; Martin C. Stumpe, PhD; Derek Wu, BS; Arunachalam Narayanaswamy, PhD; Subhashini Venugopalan, MS; Kasumi Widner, MS; Tom Madams, MEng; Jorge Cuadros, OD, PhD; Ramasamy Kim, OD, DNB; Rajiv Raman, MS, DNB; Philip C. Nelson, BS; Jessica L. Mega, MD, MPH; Dale R. Webster, PhD

IMPORTANCE Deep learning is a family of computational methods that allow an algorithm to program itself by learning from a large set of examples that demonstrate the desired behavior, removing the need to specify rules explicitly. Application of these methods to medical imaging requires further assessment and validation.

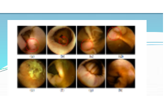
OBJECTIVE To apply deep learning to create an algorithm for automated detection of diabetic retinopathy and diabetic macular edema in retinal fundus photographs.

DESIGN AND SETTING A specific type of neural network optimized for image classification called a deep convolutional neural network was trained using a retrospective development data set of 128 175 retinal images, which were graded 3 to 7 times for diabetic retinopathy, diabetic macular edema, and image gradability by a panel of 54 US licensed ophthalmologists and ophthalmology senior residents between May and December 2015. The resultant algorithm was validated in January and February 2016 using 2 separate data sets, both graded by at least 7 US board-certified ophthalmologists with high intragrader consistency.

EXPOSURE Deep learning-trained algorithm.

Editorial pages 2366 and 2368

Supplemental content



Automatic Polyp Recognition by Densely Connected Neural Network with Unbalanced Discriminate and Category Sensitive Constraint

Yixuan Yuan, Wenjian Qin, Bin Han, Max, Q.-H. Meng, *Fellow, IEEE*, Lei Xing

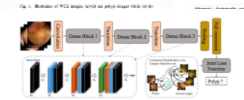
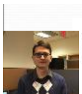


Fig. 2. Workflow of our proposed DS-DenseNet.

The best way to detect polyps is to visualize the gastrointestinal tract (GI) directly. The Colonoscopy, Wireless capsule endoscopy (WCE) [2] and Computed tomography (CT) are common tools for the visualization. Clinicians use these tools to collect GI images and make a diagnosis decision by checking these data frame by frame. Nevertheless, the manual inspection for polyp is usually time-consuming, error-prone and subjective [3]. An experienced clinician needs to spent more than 2 hours to analyze the collected 55,000 WCE images of one patient. It has been reported that the misdetection rate is as high as 25% [4]. Moreover, the characteristics of polyps show different shapes, textures, and sizes, and it is difficult for clinicians to recognize polyp images in all circumstances. Even well trained clinicians may produce varying diagnostic results. In this regard, automated detection

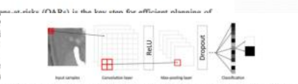


Segmentation of organs-at-risks in head and neck CT images using convolutional neural networks

Bulat Ibragimov[a] and Lei Xing
Department of Radiation Oncology, Stanford University School of Medicine, Stanford, California 94305, USA

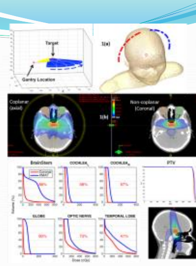
(Received 2 May 2016; revised 31 October 2016; accepted for publication 23 November 2016; published 13 February 2017)

Purpose: Accurate segmentation of organs-at-risks (OARs) is the key step for efficient planning of radiation therapy for head and neck (Ha… learning-based algorithm, for segmentati… mance against state-of-the-art automated … server variability.
Methods: Convolutional neural network… used to study consistent intensity patterns… in a previously unseen test CT image. For… tive intensity patches around voxels that b… ative intensity patches around voxels tha… passed through a sequence of CNN laye…

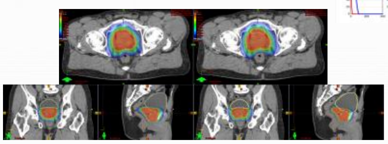


Medical Physics, 44 (2), February 2017

Autonomous treatment planning for RT

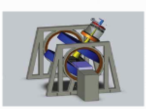


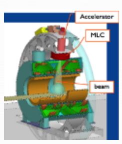
Kahn, Fahimian et al



M. Ma, Y. Yang et al

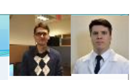
toward real-time volumetric MRI with deep learning





Courtesy of Jihong Wang

From population-average nomogram to deep learning-based toxicity prediction

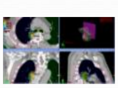


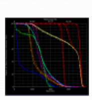
— B. Ibrimbrov, D. Toesca, D. Chang, A Koong, L Xing

Current approach:

(i) radiomics;

(ii) NTCP/TCP types of modeling





Predictive model

Machine learning-based toxicity/survival prediction

Deep dose analysis: combined

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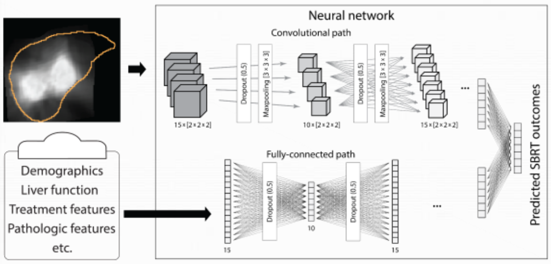
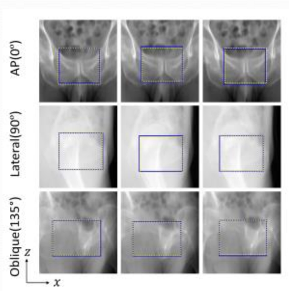
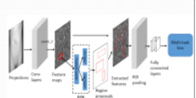
Multi-path network: 1) 3D CNN for dose plan; 2) fully-connected path for features



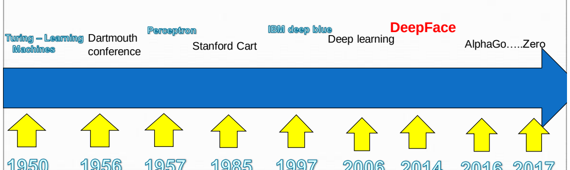
Visualizing the invisible soft tissue target





Zhao W, et al, RADIOLOGY, Submitted, 2018

WHEN GENERAL AI WILL BE IN THE CLINIC?



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SUMMARY

- APPLIED AI WILL SIGNIFICANTLY IMPROVE EFFICIENCY, QUALITY, AND REDUCE HEALTHCARE COST.

- WE ARE MARCHING INTO AN AGE OF GENERAL AI.

- MEDICAL PHYSICISTS SHOULD PLAY A MAJOR ROLE IN AI TECHNOLOGY.

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