OCCHIO CLINICO O AI?

I quasi cinquemila robot-chirurghi, che già lavorano nel mondo, diagnosticano ed eseguono operazioni meglio di alcuni colleghi in carne e ossa. Ed è solo l'inizio. Persino in campo psichiatrico, un algoritmo può risultare più accurato nella terapia e avere risultati equivalenti a un trattamento faccia a faccia

DI GILBERTO CORBELLINI
FOTOGRAFIE DI SEAN LOGAN

COME STAR WARS NELLA FOTO, IL BAMBINO AMERICANO JACOB TAGGART CON UNA PROTESI ROBOTICA IN STILE STORMTROOPER

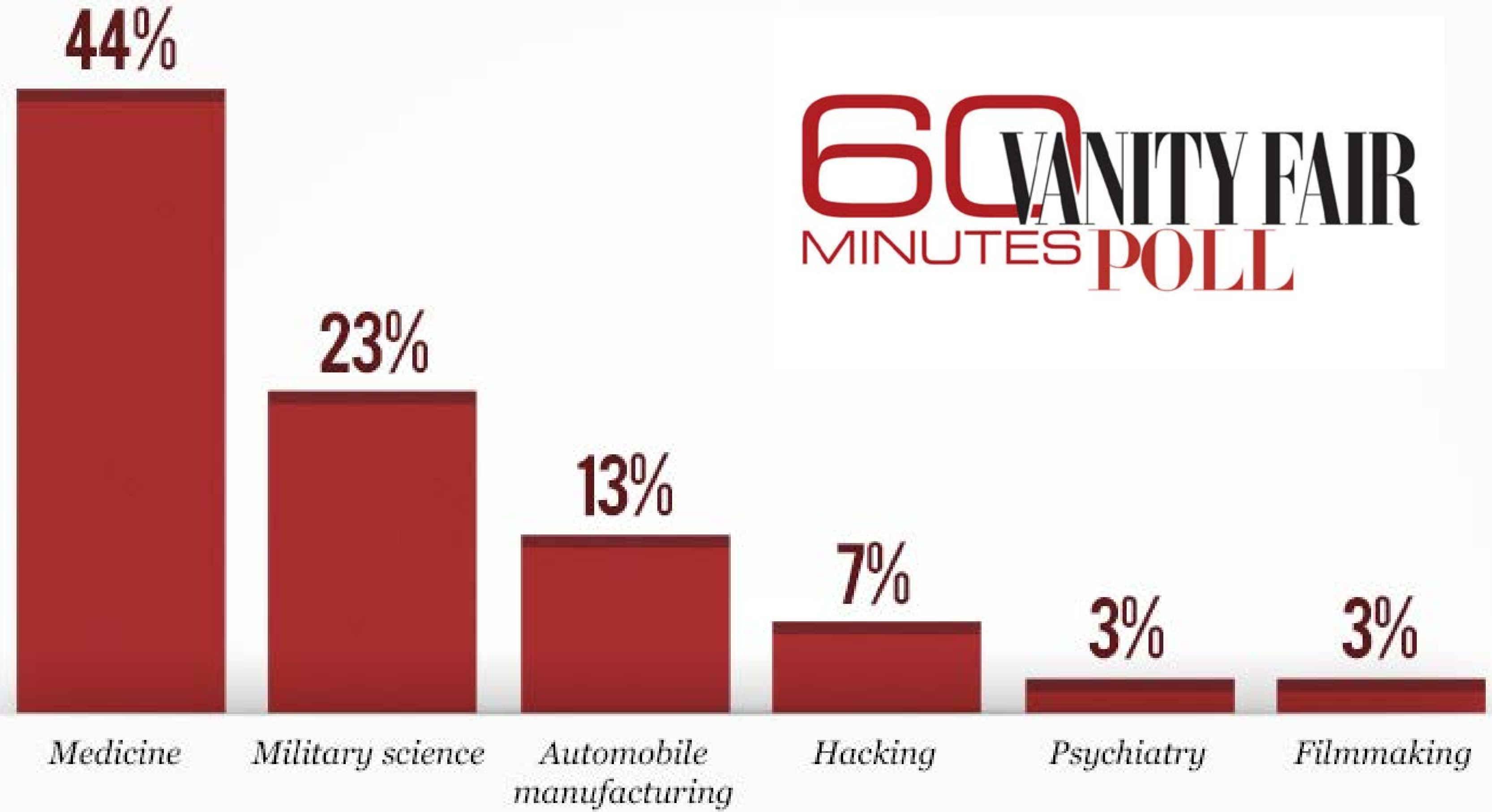
- Già oggi, per alcuni interventi chirurgici preferirei farmi operare da un robot assistito (nell'arco di 10 anni penso che lo preferirei in assoluto, anche se autonomo)

- L'AI supera le capacità diagnostiche umane già oggi in diversi ambiti clinici, e in futuro in tutti

- L'applicazione dell'AI in psichiatria produrrà benefici superiori a quelli immaginabili sulla base delle capacità di psichiatri e psicologi clinici

- I timori per l'AI e il suo impatto sul mondo umano sono frutto di fraintendimenti scientifici e bias cognitivi/emotivi.

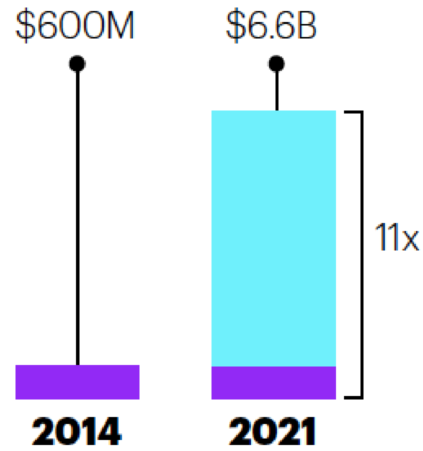
Which Field Will Benefit Most from Artificial Intelligence?



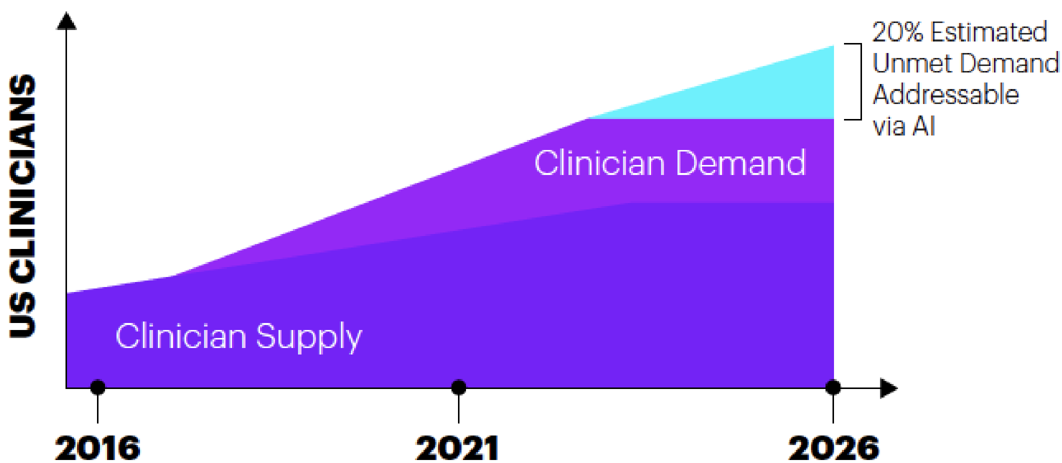
The AI health market is seeing explosive growth

HEALTH AI MARKET SIZE 2014-2021

Acquisitions of AI startups are rapidly increasing while the health AI market is set to register an explosive CAGR of 40% through 2021



AI can address unmet clinical demand



Top 10 AI Applications

APPLICATION	VALUE*
Robot-Assisted Surgery**	$40B
Virtual Nursing Assistants	$20B
Administrative Workflow Assistance	$18B
Fraud Detection	$17B
Dosage Error Reduction	$16B
Connected Machines	$14B
Clinical Trial Participant Identifier	$13B
Preliminary Diagnosis	$5B
Automated Image Diagnosis	$3B
Cybersecurity	$2B

TOTAL = ~$150B

STARTUPS MOBILE GADGETS

VINOD KHOSLA

Do We Need Doctors Or Algorithms?

Wired, 2012

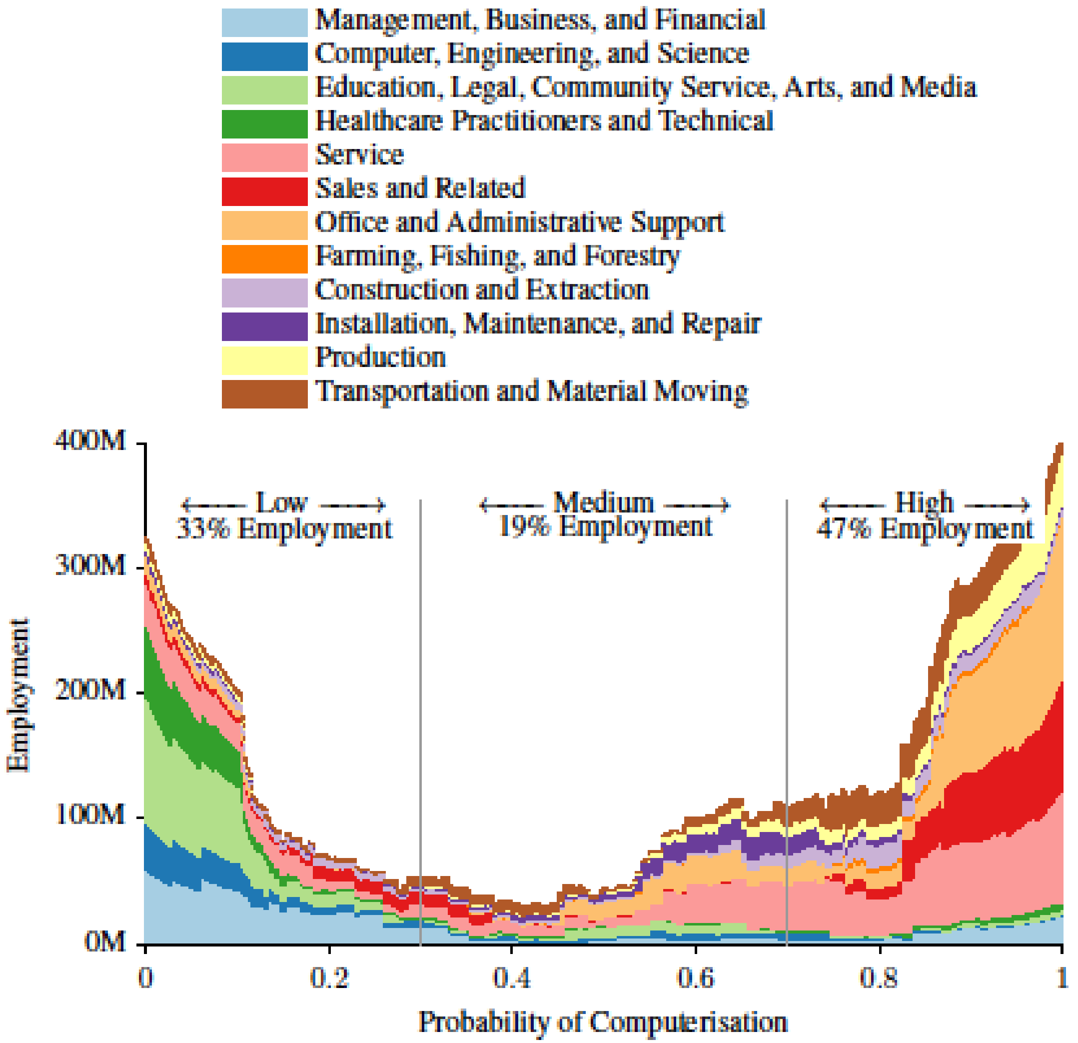
Eventually, we won’t need the average doctor and will have much better and cheaper care for 90-99% of our medical needs. We will still need to leverage the top 10 or 20% of doctors (at least for the next two decades) to help that bionic software get better at diagnosis. So a world mostly without doctors (at least average ones) is not only not reasonable, but also more likely than not. There will be exceptions, and plenty of stories around these exceptions, but what I am talking about will most likely be the rule and doctors may be the exception rather than the other way around.

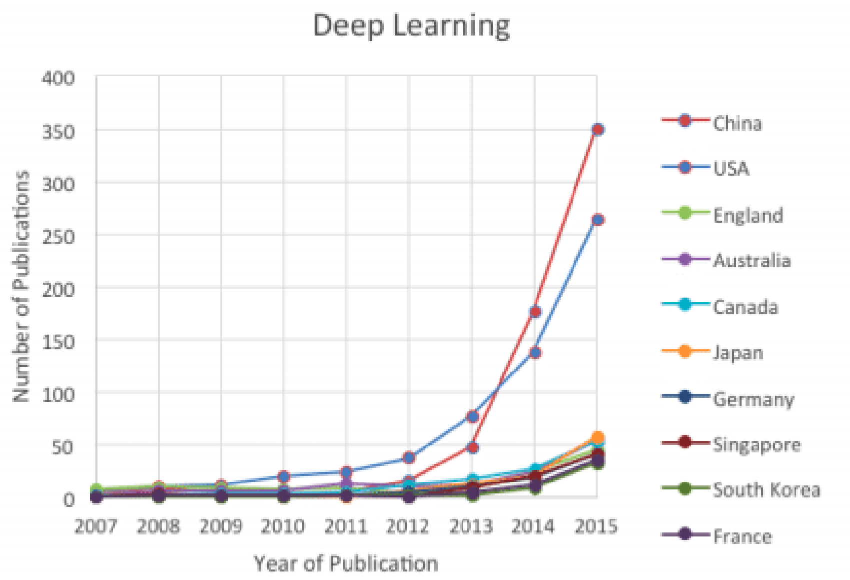
THE FUTURE OF EMPLOYMENT: HOW SUSCEPTIBLE ARE JOBS TO COMPUTERISATION?*

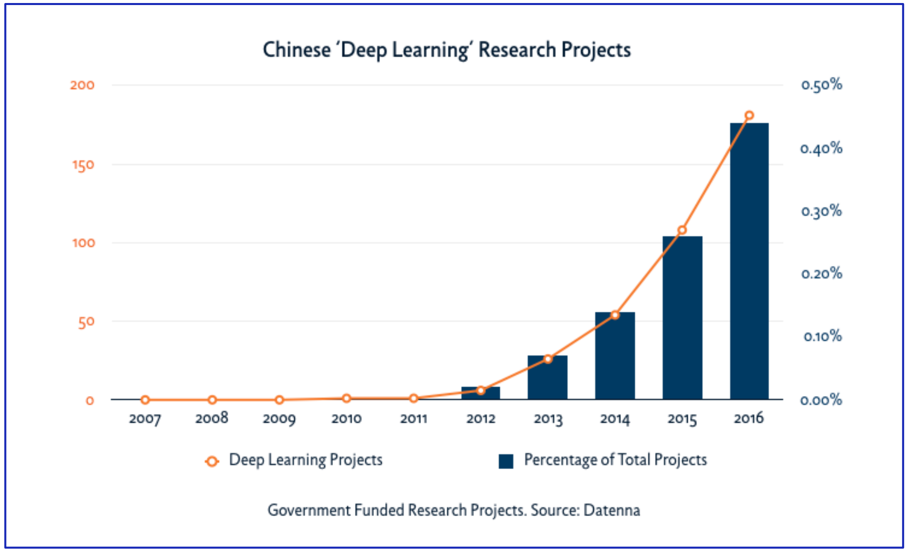
Carl Benedikt Frey† and Michael A. Osborne‡

September 17, 2013

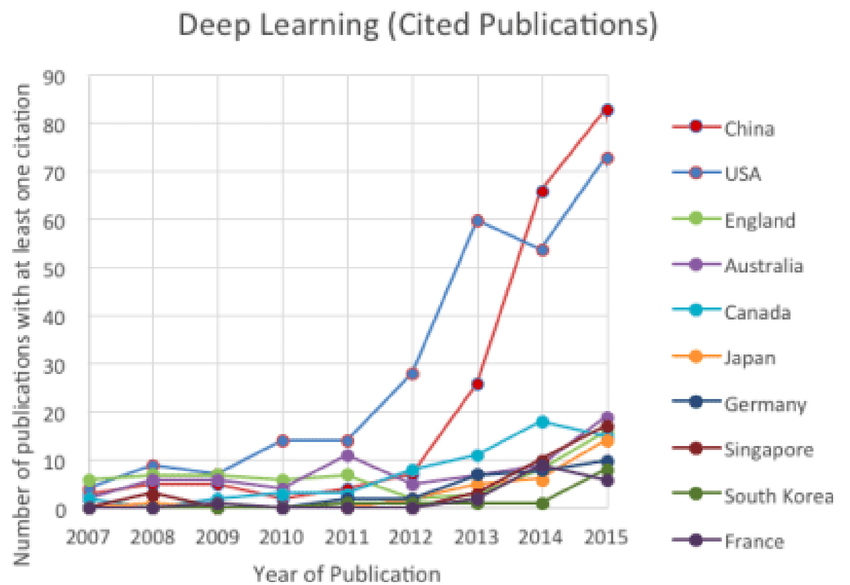
Computerisable				
Rank	Probability	Label	soc code	Occupation
1.	0.0028		29-1125	Recreational Therapists
2.	0.003		49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers
3.	0.003		11-9161	Emergency Management Directors
4.	0.0031		21-1023	Mental Health and Substance Abuse Social Workers
5.	0.0033		29-1181	Audiologists
6.	0.0035		29-1122	Occupational Therapists
7.	0.0035		29-2091	Orthotists and Prosthetists
8.	0.0035		21-1022	Healthcare Social Workers
9.	0.0036		29-1022	Oral and Maxillofacial Surgeons
10.	0.0036		33-1021	First-Line Supervisors of Fire Fighting and Prevention Workers
11.	0.0039		29-1031	Dietitians and Nutritionists
12.	0.0039		11-9081	Lodging Managers
13.	0.004		27-2032	Choreographers
14.	0.0041		41-9031	Sales Engineers
15.	0.0042	0	29-1060	Physicians and Surgeons
16.	0.0042		25-9031	Instructional Coordinators
17.	0.0043		19-3039	Psychologists, All Other
18.	0.0044		33-1012	First-Line Supervisors of Police and Detectives
19.	0.0044	0	29-1021	Dentists, General
20.	0.0044		25-2021	Elementary School Teachers, Except Special Education
21.	0.0045		19-1042	Medical Scientists, Except Epidemiologists
22.	0.0046		11-9032	Education Administrators, Elementary and Secondary School
23.	0.0046		29-1081	Podiatrists
24.	0.0047		19-3031	Clinical, Counseling, and School Psychologists
25.	0.0048		21-1014	Mental Health Counselors
26.	0.0049		51-6092	Fabric and Apparel Patternmakers
27.	0.0055		27-1027	Set and Exhibit Designers
28.	0.0055		11-3121	Human Resources Managers
29.	0.0061		39-9032	Recreation Workers
30.	0.0063		11-3131	Training and Development Managers
31.	0.0064		29-1127	Speech-Language Pathologists
32.	0.0065		15-1121	Computer Systems Analysts
33.	0.0067	0	11-9151	Social and Community Service Managers
34.	0.0068		25-4012	Curators
35.	0.0071		29-9091	Athletic Trainers
36.	0.0073		11-9111	Medical and Health Services Managers
37.	0.0074	0	25-2011	Preschool Teachers, Except Special Education
38.	0.0075		25-9021	Farm and Home Management Advisors
39.	0.0077		19-3091	Anthropologists and Archeologists

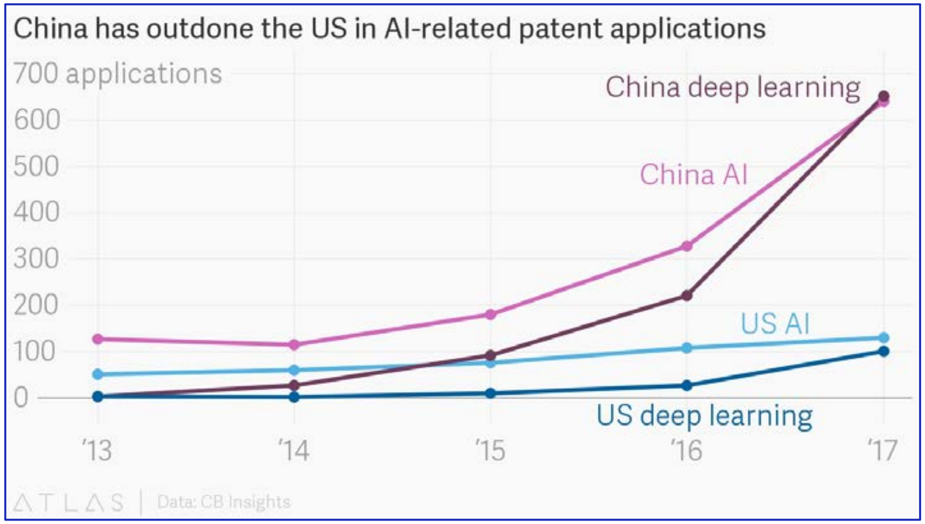






Journal **articles mentioning "deep learning" or "deep neural network"**, by nation.[62]





: Journal articles cited at least once, mentioning **"deep learning" or "deep neural network"**, by nation.[63]

- L’AI ridurrà gli errori medici. Il cervello umano dispone di pochi gigabyte di memoria operativa e la componente psicologico/emotiva, attivata da stress e autoinganni, può giocare negativamente nelle decisioni cliniche

- L’AI può aiutare a trovare soluzioni mediche per condizioni rare, attraverso reti che scambiano informazione (es. Modernizing Medicine)

- L’AI consentirà di sdrammatizzare molti scenari clinici (soprattutto in ambito chirurgico) e potenzierà le capacità di lavorare con sempre più precisione (usando dati, realtà aumentata, etc), sempre più sicurezza e più tranquillità per i pazienti

- L’AI consentirà di predire le malattie usando vasti repertori di dati e calandoli nel mondo reale (le esperienze dei pazienti)

- L’AI estinguerà la medicina difensiva abbattendo gli errori medici e le diagnosi sbagliate: stante che gli algoritmi sono più precisi ed efficienti sarà più difficile iù incolpare i medici per i danni

Deep Learning for Identifying Metastatic Breast Cancer

Dayong Wang Aditya Khosla* Rishab Gargeya Humayun Irshad Andrew H Beck
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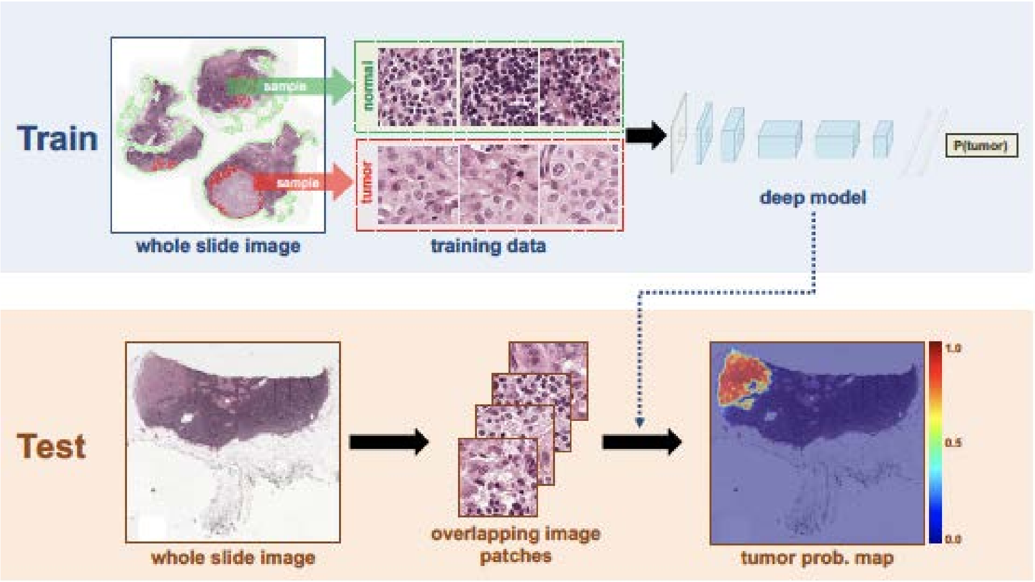
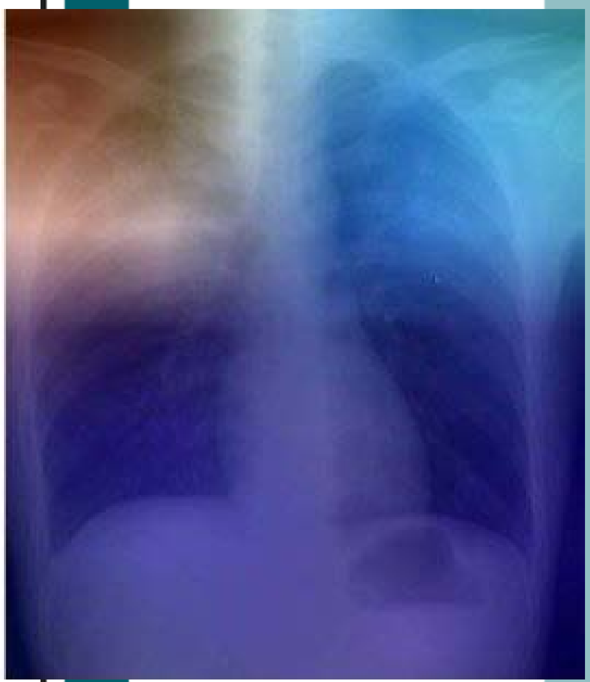
December 5, 2016

The International Symposium on Biomedical Imaging (ISBI) held a grand challenge to evaluate computational systems for the automated detection of metastatic breast cancer in whole slide images of sentinel lymph node biopsies. Our team won both competitions in the grand challenge, obtaining an area under the receiver operating curve (AUC) of 0.925 for the task of whole slide image classification and a score of 0.7051 for the tumor localization task. A pathologist independently reviewed the same images, obtaining a whole slide image classification AUC of 0.966 and a tumor localization score of 0.733. Combining our deep learning system's predictions with the human pathologist's diagnoses increased the pathologist's AUC to 0.995, representing an approximately 85 percent reduction in human error rate. These results demonstrate the power of using deep learning to produce significant improvements in the accuracy of pathological diagnoses.





Deep Learning at Chest Radiography: Automated Classification of Pulmonary Tuberculosis by Using Convolutional Neural Networks[1]

Paras Lakhani, MD
Baskaran Sundaram, MD

Purpose: To evaluate the efficacy of deep convolutional neural networks (DCNNs) for detecting tuberculosis (TB) on chest radiographs.

Materials and Methods: Four deidentified HIPAA-compliant datasets were used in this study that were exempted from review by the institutional review board, which consisted of 1007 posteroanterior chest radiographs. The datasets were split into training (68.0%), validation (17.1%), and test (14.9%). Two different DCNNs, AlexNet and GoogLeNet, were used to classify the images as having manifestations of pulmonary TB or as healthy. Both untrained and pretrained networks on ImageNet were used, and augmentation with multiple preprocessing techniques. Ensembles were performed on the best-performing algorithms. For cases where the classifiers were in disagreement, an independent board-certified cardiothoracic radiologist blindly interpreted the images to evaluate a potential radiologist-augmented workflow. Receiver operating characteristic curves and areas under the curve (AUCs) were used to assess model performance by using the DeLong method for statistical comparison of receiver operating characteristic curves.

Results: The best-performing classifier had an AUC of 0.99, which was an ensemble of the AlexNet and GoogLeNet DCNNs. The AUCs of the pretrained models were greater than that of the untrained models ($P < .001$). Augmenting the dataset further increased accuracy (P values for AlexNet and GoogLeNet were .03 and .02, respectively). The DCNNs had disagreement in 13 of the 150 test cases, which were blindly reviewed by a cardiothoracic radiologist, who correctly interpreted all 13 cases (100%). This radiologist-augmented approach resulted in a sensitivity of 97.3% and specificity 100%.

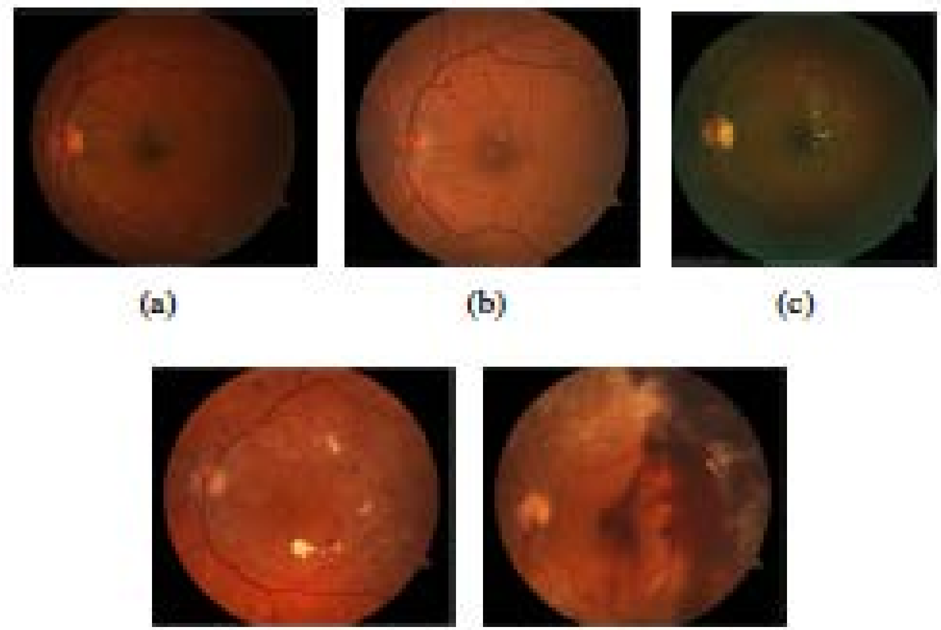
Conclusion: Deep learning with DCNNs can accurately classify TB at chest radiography with an AUC of 0.99. A radiologist-augmented approach for cases where there was disagreement among the classifiers further improved accuracy.

[1] From the Department of Radiology, Thomas Jefferson University Hospital, Sidney Kimmel Jefferson Medical College,

NEURAL NETWORKS WITH MANIFOLD LEARNING FOR DIABETIC RETINOPATHY DETECTION

Arjun Raj Rajanna, Kamelia Aryafar, Rajeev Ramchandran**, Christye Sisson, Ali Shokoufandeh* , Raymond Ptucha*
Rochester Institute of Technology, * Drexel University, **University of Rochester

Widespread surveillance programs using remote retinal imaging has proven to decrease the risk from diabetic retinopathy, the leading cause of blindness in the US. However, this process still requires manual verification of image quality and grading of images for level of disease by a trained human grader and will continue to be limited by the lack of such scarce resources. Computer-aided diagnosis of retinal images have recently gained increasing attention in the machine learning community. In this paper, we introduce a set of neural networks for diabetic retinopathy classification of fundus retinal images. We evaluate the efficiency of the proposed classifiers in combination with preprocessing and augmentation steps on a sample dataset. Our experimental results show that neural networks in combination with preprocessing on the images can boost the classification accuracy on this dataset. Moreover the proposed models are scalable and can be used in large scale datasets for diabetic retinopathy detection. The models introduced in this paper can be used to facilitate the diagnosis and speed up the detection process.



(a) (b) (c) (d) (e)

molecules

MDPI

Article

Deep Convolutional Neural Network-Based Early Automated Detection of Diabetic Retinopathy Using Fundus Image

Kele Xu [1], Dawei Feng [2,*] and Haibo Mi [2]

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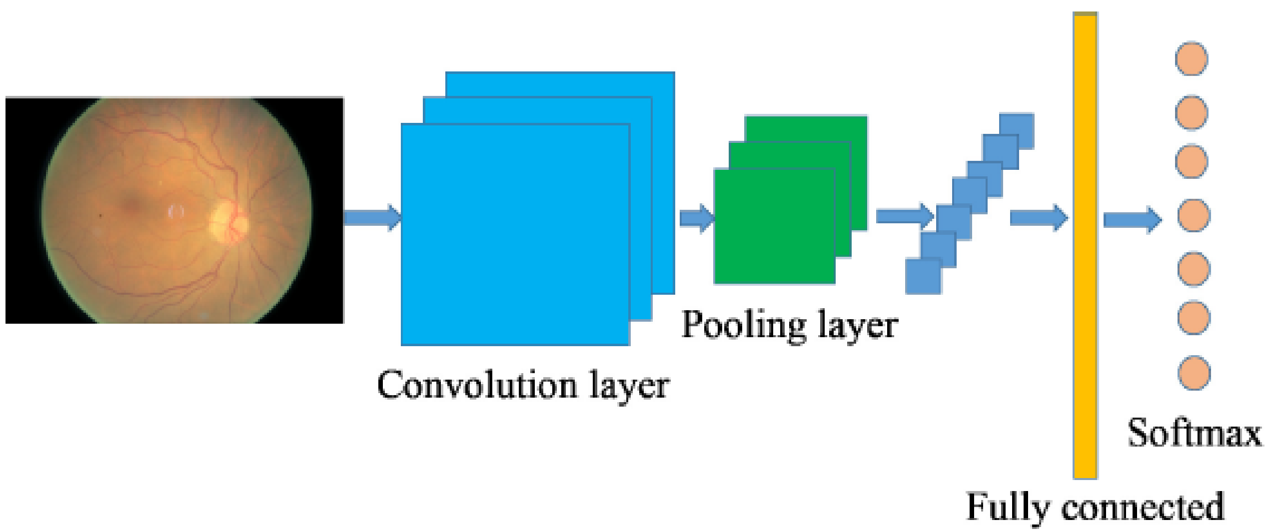
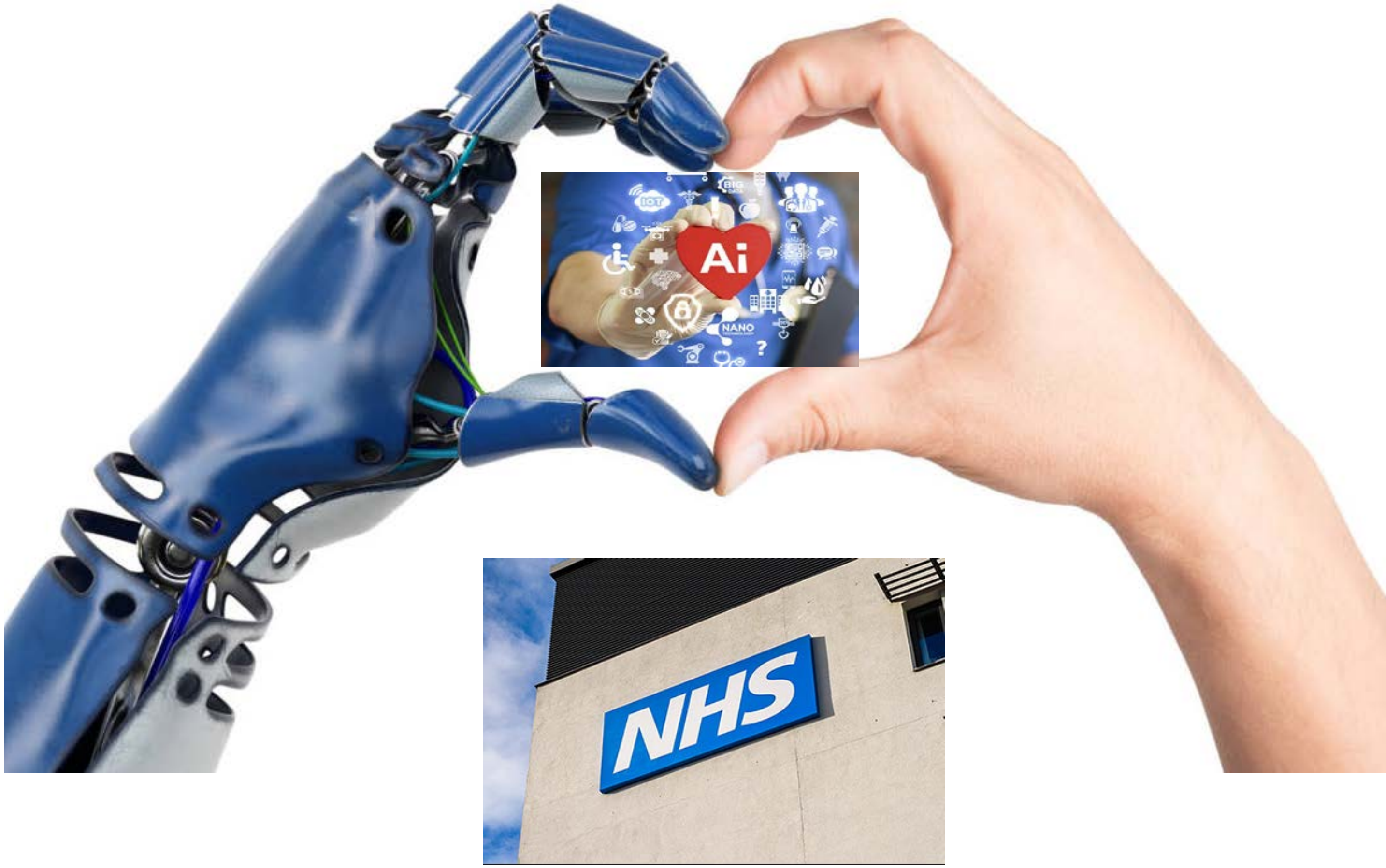
Abstract: The automatic detection of diabetic retinopathy is of vital importance, as it is the main cause of irreversible vision loss in the working-age population in the developed world. The early detection of diabetic retinopathy occurrence can be very helpful for clinical treatment; although several different feature extraction approaches have been proposed, the classification task for retinal images is still tedious even for those trained clinicians. Recently, deep convolutional neural networks have manifested superior performance in image classification compared to previous handcrafted feature-based image classification methods. Thus, in this paper, we explored the use of deep convolutional neural network methodology for the automatic classification of diabetic retinopathy using color fundus image, and obtained an accuracy of 94.5% on our dataset, outperforming the results obtained by using classical approaches.

Table 3. Performance comparison with different approaches.

Method	Accuracy
Hard exudates + GBM	89.4%
Red lesions + GBM	88.7%
Micro-aneurysms + GBM	86.2%
Blood vessel detection + GBM	79.1%
CNN without data augmentation	91.5%
CNN with data augmentation	94.5%





Thousands of people every year have an echocardiogram… Currently, 1 in 5 scans are misdiagnosed each year – the equivalent to 12,000 patients.

AI can detect 80,000 subtle changes in echocardiogram invisible to the naked eye, improving the accuracy of diagnosis to 90%. The machine learning system was trained using scans from previous patients, alongside data about whether they went on to have a heart attack.

The improved diagnostic accuracy will not only provide better care and outcomes, but save the NHS £300million a year in avoidable operations and treatment.

RESEARCH ARTICLE

Can machine-learning improve cardiovascular risk prediction using routine clinical data?

Stephen F. Weng[1,2☯*], **Jenna Reps**[3,4☯], **Joe Kai**[1,2‡], **Jonathan M. Garibaldi**[3,4‡], **Nadeem Qureshi**[1,2‡]

1 NIHR School for Primary Care Research, University of Nottingham, Nottingham, United Kingdom, **2** Division of Primary Care, School of Medicine, University of Nottingham, Nottingham, United Kingdom, **3** Advanced Data Analysis Centre, University of Nottingham, Nottingham, United Kingdom, **4** School of Computer Science, University of Nottingham, Nottingham, United Kingdom

Background

Current approaches to predict cardiovascular risk fail to identify many people who would benefit from preventive treatment, while others receive unnecessary intervention. Machine-learning offers opportunity to improve accuracy by exploiting complex interactions between risk factors. We assessed whether machine-learning can improve cardiovascular risk prediction.

Methods

Prospective cohort study using routine clinical data of 378,256 patients from UK family practices, free from cardiovascular disease at outset. Four machine-learning algorithms (random forest, logistic regression, gradient boosting machines, neural networks) were compared to an established algorithm (American College of Cardiology guidelines) to predict first cardiovascular event over 10-years. Predictive accuracy was assessed by area under the 'receiver operating curve' (AUC); and sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV) to predict 7.5% cardiovascular risk (threshold for initiating statins).

Findings

24,970 incident cardiovascular events (6.6%) occurred. Compared to the established risk prediction algorithm (AUC 0.728, 95% CI 0.723–0.735), machine-learning algorithms improved prediction: random forest +1.7% (AUC 0.745, 95% CI 0.739–0.750), logistic regression +3.2% (AUC 0.760, 95% CI 0.755–0.766), gradient boosting +3.3% (AUC 0.761, 95% CI 0.755–0.766), neural networks +3.6% (AUC 0.764, 95% CI 0.759–0.769). The highest achieving (neural networks) algorithm predicted 4,998/7,404 cases (sensitivity 67.5%, PPV 18.4%) and 53,458/75,585 non-cases (specificity 70.7%, NPV 95.7%), correctly predicting 355 (+7.6%) more patients who developed cardiovascular disease compared to the established algorithm.

Conclusions

Machine-learning significantly improves accuracy of cardiovascular risk prediction, increasing the number of patients identified who could benefit from preventive treatment, while avoiding unnecessary treatment of others.

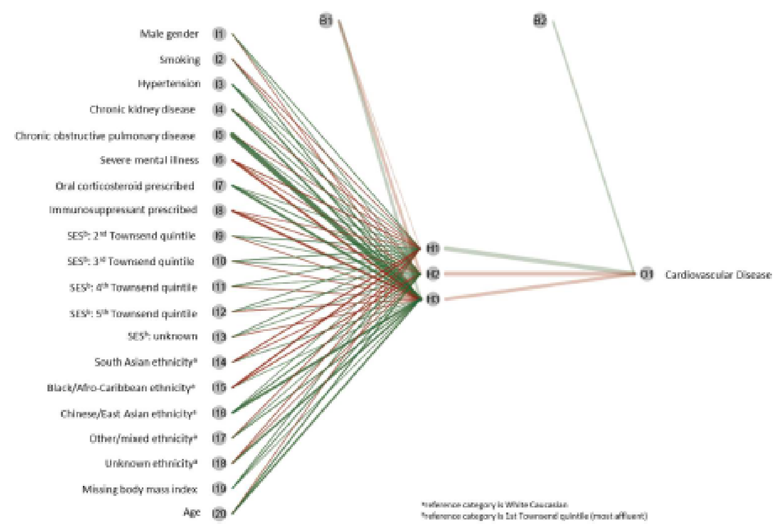


Fig 2. Illuminating "black-box" understanding of machine-learning neural networks: visualization of the risk factors and their association with cardiovascular disease developed from CPRD primary care study population. Green lines are positive predictors, red lines are negative predictors, and the thickness of the line represents the weight (importance) of the risk factor to the outcome.

Impact of an automated system for endocytoscopic diagnosis of small colorectal lesions: an international web-based study

Authors Yuichi Mori[1], Shin-ei Kudo[1], Philip Wai Yan Chiu[2], Rajvinder Singh[3], Masashi Misawa[1], Kunihiko Wakamura[1], Toyoki Kudo[1], Takemasa Hayashi[1], Atsushi Katagiri[1], Hideyuki Miyachi[1], Fumio Ishida[1], Yasuharu Maeda[1,4], Haruhiro Inoue[5], Yukitaka Nimura[6], Masahiro Oda[7], Kensaku Mori[8]

Institutions Institutions are listed at end of article.

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Bibliography
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Background and study aims: Optical diagnosis of colorectal polyps is expected to improve the cost-effectiveness of colonoscopy, but achieving a high accuracy is difficult for trainees. Computer-aided diagnosis (CAD) is therefore receiving attention as an attractive tool. This study aimed to validate the efficacy of the latest CAD model for endocytoscopy (380-fold ultra-magnifying endoscopy).

Patients and methods: This international web-based trial was conducted between August and November 2015. A web-based test comprising one white-light and one endocytoscopic image of 205 small colorectal polyps (≤10 mm) from 123 patients was undertaken by both CAD and by endoscopists (three experts and ten non-experts from three countries). Outcome measures were accuracy in identifying neoplastic change in diminutive (≤5 mm) and small (≤10 mm) polyps, and accuracy in predicting post-polypectomy surveillance intervals according to current guidelines for high confidence optical diagnoses of diminutive polyps.

Results: Of the 205 small polyps (147 neoplastic and 58 non-neoplastic), 139 were diminutive. CAD was accurate for 89% (95% confidence interval [CI] 83%–94%) of diminutive polyps and 89% (84%–93%) of small polyps, which was significantly greater than results for the non-experts (73% [71%–76%], $P<0.001$; and 76% [74%–78%], $P<0.001$, respectively) and comparable with the experts' results (90% [87%–93%], $P=0.703$; and 91% [89%–93%], $P=0.106$, respectively). The surveillance interval predicted by CAD provided 98% (93%–100%) and 96% (91%–99%) agreement with pathology-directed intervals of the European and American guidelines, respectively.

Conclusions: The use of CAD in endocytoscopy can be effective in the management of diminutive/small colorectal polyps.

UMIN Clinical Trial Registry: UMIN000018185.

Introduction

Optical diagnosis of small colorectal polyps is a promising tool for improving the cost-effectiveness of colonoscopy and reducing polypectomy-related complications. Both the European Society of Gastrointestinal Endoscopy (ESGE) [1] and the American Society of Gastrointestinal Endoscopy [2] suggest that optical diagnosis using advanced endoscopic modalities (e.g. narrow-band imaging [3] by Olympus Corp., Tokyo, Japan and chromoendoscopy [4]) for diminutive polyps can replace conventional histology under strictly controlled conditions. However, intensive, standardized training [5] or expertise is required to achieve a high accuracy in optical diagnosis and recent studies conducted in community-based hospitals have been disappointing [6,7]. The reported accuracies of endoscopy-directed surveillance intervals in these studies did not reach the 90% threshold of the Preservation and Incorporation of Valuable Endoscopic Innovations (PIVI) initiatives stated in the American Society of Gastrointestinal Endoscopy guidelines [2]; therefore, obtaining clinical benefit from optical diagnosis remains in the hands of experts.

Real-time computer-aided diagnosis (CAD) for endoscopic images has recently gained attention because of its potential to resolve the accuracy issue and reduce interobserver variability in optical diagnosis of colorectal lesions [8–11]. With CAD technology, non-expert endoscopists may more easily achieve sufficient accuracy to meet the threshold of the PIVI initiatives [12].

In 2015, we reported on a newly developed CAD system for endocytoscopy (EC-CAD) [13]. Endocytoscopy enables in vivo observation of cells and nuclei at 380-fold ultra-magnification under methylene blue staining [14–18], and EC-CAD

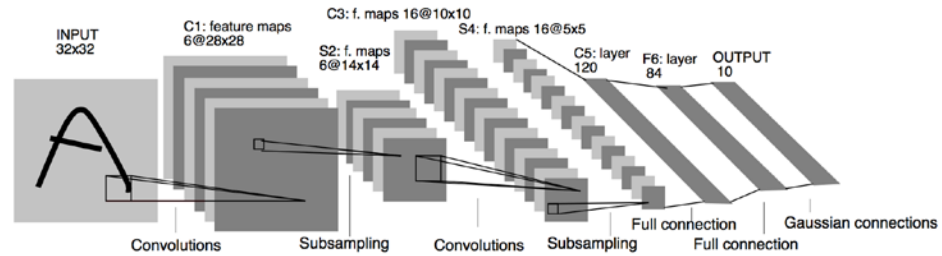
Scan this QR-Code to watch the video comment.

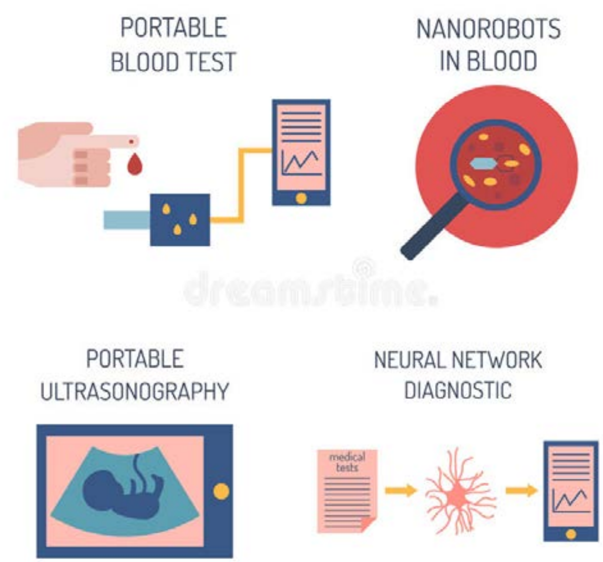
JCM Accepted Manuscript Posted Online 29 November 2017
J. Clin. Microbiol. doi:10.1128/JCM.01521-17

Automated Interpretation of Blood Culture Gram Stains using a Deep Convolutional Neural Network

Kenneth P. Smith†[a,b], Anthony D. Kang†[a, b, c], and James E. Kirby[a,b#]

Microscopic interpretation of stained smears is one of the most operator-dependent and time intensive activities in the clinical microbiology laboratory. Here, we investigated application of an automated image acquisition and convolutional neural network (CNN)-based approach for automated Gram stain classification. Using an automated microscopy platform, uncoverslipped slides were scanned with a 40x dry objective, generating images of sufficient resolution for interpretation. We collected 25,488 images from positive blood culture Gram stains prepared during routine clinical workup. These images were used to generate 100,213 crops containing Gram-positive cocci in clusters, Gram-positive cocci in chains/pairs, Gram-negative rods, or background (no cells). These categories were targeted for proof-of-concept development as they are associated with the majority of bloodstream infections. Our CNN model achieved classification accuracy of 94.9% on a test set of image crops. Receiver operating characteristic curve (ROC) analysis indicated a robust ability to differentiate between categories with area under the curve >0.98 for each. After training and validation, we applied the classification algorithm to new images collected from 189 whole slides without human intervention. Sensitivity/specificity was 98.4/75.0% for Gram-positive cocci in chains/pairs; 93.2/97.2% for Gram-positive cocci in clusters; and 96.3/98.1% for Gram-negative rods. Taken together, our data support proof-of-concept for a fully automated classification methodology for blood-culture Gram-stains. Importantly, the algorithm was highly adept at identifying image crops with organisms and could be used to present prescreened, classified crops to technologists to accelerate smear review. This concept could potentially be extended to all Gram stain interpretive activities in the clinical laboratory.





Comparing sequencing assays and human-machine analyses in actionable genomics for glioblastoma

OPEN

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Supplemental data at Neurology.org/ng

ABSTRACT

Objective: To analyze a glioblastoma tumor specimen with 3 different platforms and compare potentially actionable calls from each.

Methods: Tumor DNA was analyzed by a commercial targeted panel. In addition, tumor-normal DNA was analyzed by whole-genome sequencing (WGS) and tumor RNA was analyzed by RNA sequencing (RNA-seq). The WGS and RNA-seq data were analyzed by a team of bioinformaticians and cancer oncologists, and separately by IBM Watson Genomic Analytics (WGA), an automated system for prioritizing somatic variants and identifying drugs.

Results: More variants were identified by WGS/RNA analysis than by targeted panels. WGA completed a comparable analysis in a fraction of the time required by the human analysts.

Conclusions: The development of an effective human-machine interface in the analysis of deep cancer genomic datasets may provide potentially clinically actionable calls for individual patients in a more timely and efficient manner than currently possible.

ClinicalTrials.gov identifier: NCT02725684. *Neurol Genet* 2017;3:e164; doi: 10.1212/NXG.0000000000000164

GLOSSARY

CNV = copy number variant; **EGFR** = epidermal growth factor receptor; **GATK** = Genome Analysis Toolkit; **GBM** = glioblastoma; **IRB** = institutional review board; **NLP** = Natural Language Processing; **NYGC** = New York Genome Center; **RNA-seq** = RNA sequencing; **SNV** = single nucleotide variant; **SV** = structural variant; **TCGA** = The Cancer Genome Atlas; **TPM** = transcripts per million; **VCF** = variant call file; **VUS** = variants of uncertain significance; **WGA** = Watson Genomic Analytics; **WGS** = whole-genome sequencing.

The clinical application of next-generation sequencing technology to cancer diagnosis and treatment is in its early stages.[1–3] An initial implementation of this technology has been in targeted panels, where subsets of cancer-relevant and/or highly actionable genes are scrutinized for potentially actionable mutations. This approach has been widely adopted, offering high redundancy of sequence coverage for the small number of sites of known clinical utility at relatively low cost.

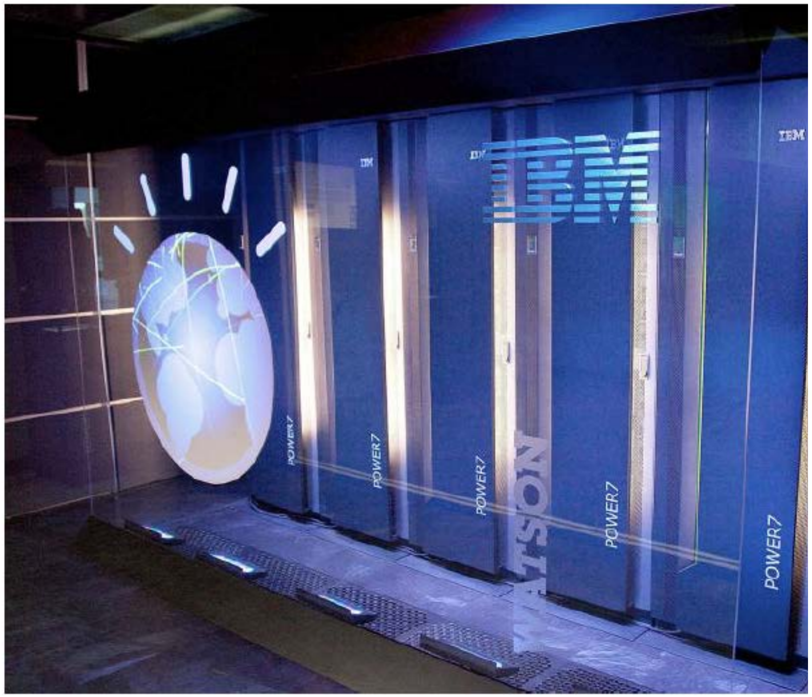
However, recent studies have shown that many more potentially clinically actionable mutations exist both in known cancer genes and in other genes not yet identified as cancer drivers.[4,5] Improvements in the efficiency of next-generation sequencing make it possible to consider whole-genome sequencing (WGS) as well as other omic assays such as RNA sequencing (RNA-seq) as clinical assays, but uncertainties remain about how much additional useful information is available from these assays.

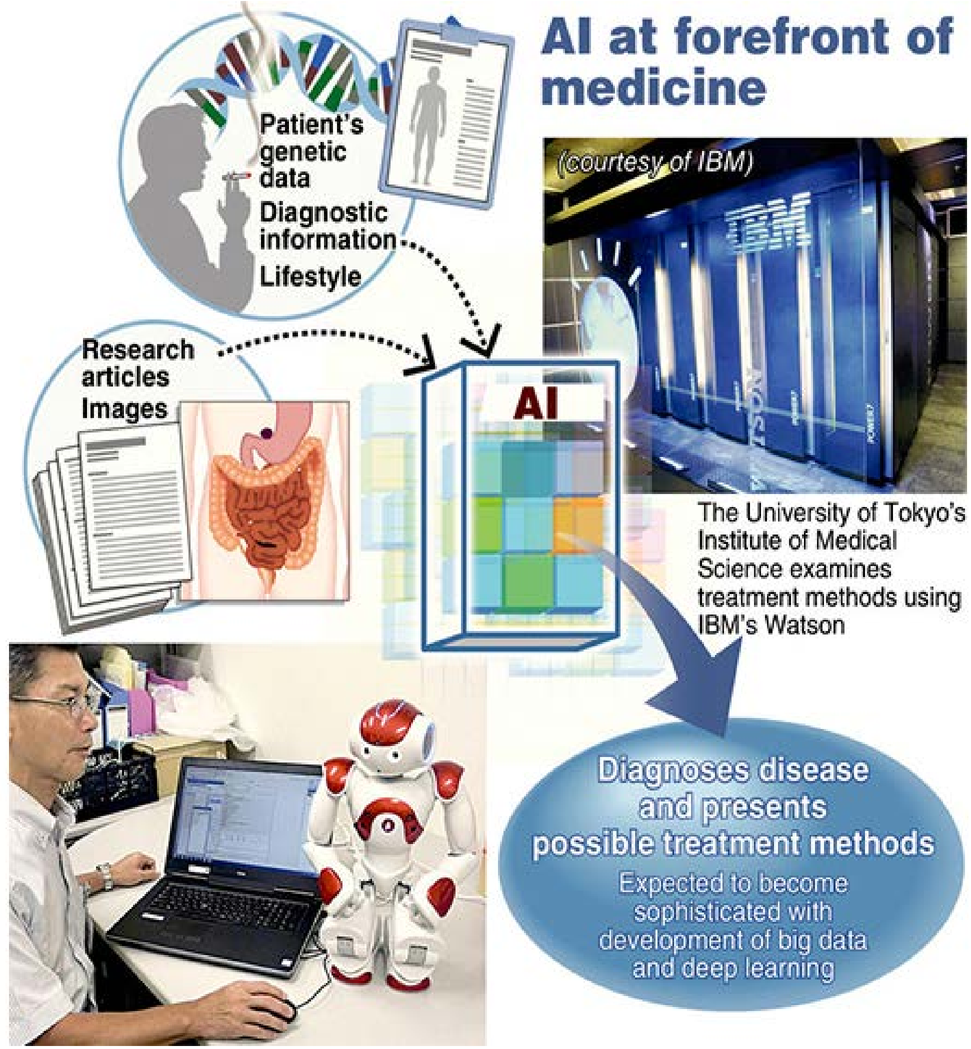
*These authors contributed equally to the manuscript.

From the New York Genome Center (K.O.W., M.O.F., N.R., A.-K.E., B.-J.C., K.A., M.S., V.V., E.A.B., J.L.M.V., M.C.Z., V.J., R.B.D.); IBM Thomas J. Watson Research Center (T.K., K.R., F.U., R.N., E.B., L.P., A.K.R.); Columbia University Medical Center (J.N.B., A.B.L., P.C., V.J.); Memorial Sloan-Kettering Cancer Center (C.G.), New York, NY; IBM Watson Health (S.H., V.V.M.), Boca Raton, FL; Laboratory of Molecular Neuro-Oncology (M.O.F., R.B.D.), and Howard Hughes Medical Institute (R.B.D.), The Rockefeller University, New York, NY. B.-J.C. is currently affiliated with Google, New York, NY. V.V. is currently affiliated with 23andMe, Inc., Mountain View, CA. E.A.B. is currently affiliated with Max Planck Institute of Immunobiology and Epigenetics, Freiburg, Germany.

Funding information and disclosures are provided at the end of the article. Go to Neurology.org/ng for full disclosure forms. The Article Processing Charge was funded by the authors.

the japan times August, 2016





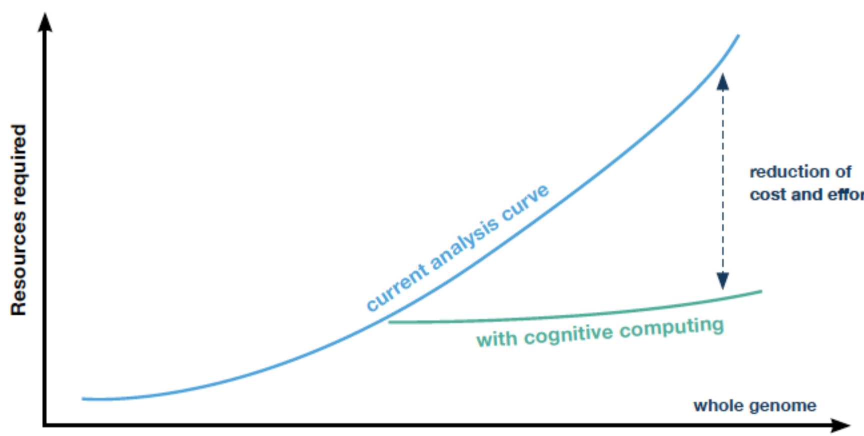
IBM big data used for rapid diagnosis of rare leukemia case in Japan

White Paper

Cancer genomics and cognitive computing — Bending the analysis curve

By Aditya Pai MSc, MS, MBA, CGC,

Figure 2: Potential shift of the analysis curve using Cognitive Computing



IBM Watson Health

npj Schizophrenia
www.nature.com/npjschz

ARTICLE OPEN

Automated analysis of free speech predicts psychosis onset in high-risk youths

Gillinder Bedi[1,2,9], Facundo Carrillo[3,9], Guillermo A Cecchi[4], Diego Fernández Slezak[3], Mariano Sigman[5], Natália B Mota[6], Sidarta Ribeiro[6], Daniel C Javitt[1,7], Mauro Copelli[8] and Cheryl M Corcoran[1,7]

BACKGROUND/OBJECTIVES: Psychiatry lacks the objective clinical tests routinely used in other specializations. Novel computerized methods to characterize complex behaviors such as speech could be used to identify and predict psychiatric illness in individuals.

AIMS: In this proof-of-principle study, our aim was to test automated speech analyses combined with Machine Learning to predict later psychosis onset in youths at clinical high-risk (CHR) for psychosis.

METHODS: Thirty-four CHR youths (11 females) had baseline interviews and were assessed quarterly for up to 2.5 years; five transitioned to psychosis. Using automated analysis, transcripts of interviews were evaluated for semantic and syntactic features predicting later psychosis onset. Speech features were fed into a convex hull classification algorithm with leave-one-subject-out cross-validation to assess their predictive value for psychosis outcome. The canonical correlation between the speech features and prodromal symptom ratings was computed.

RESULTS: Derived speech features included a Latent Semantic Analysis measure of semantic coherence and two syntactic markers of speech complexity: maximum phrase length and use of determiners (e.g., *which*). These speech features predicted later psychosis development with 100% accuracy, outperforming classification from clinical interviews. Speech features were significantly correlated with prodromal symptoms.

CONCLUSIONS: Findings support the utility of automated speech analysis to measure subtle, clinically relevant mental state changes in emergent psychosis. Recent developments in computer science, including natural language processing, could provide the foundation for future development of objective clinical tests for psychiatry.

npj Schizophrenia (2015) **1**, Article number: 15030; doi:10.1038/npjschz.2015.30; published online 26 August 2015

INTRODUCTION

The capacity of psychiatry to diagnose and treat serious mental illness has been hampered by the absence of objective clinical tests of the type routinely used in other fields of medicine. Although recent years have seen substantial advances in understanding of the neurobiology of mental illness,[1] these developments have yet to yield markers that reliably differentiate psychiatric health from illness at the level of the individual patient. Whereas clinical neuroscience has focused on the brain in mental illness, computer science has, in parallel, developed increasingly sophisticated automated approaches to characterize and predict human behavior. Such advances are now commonly utilized in industry (the private business sector): models combining demographic data and purchasing behavior are used to personalize advertising content[2] and automated language assessment is employed to screen job candidates and score essays.[3] The degree to which such technologies might also aid diagnosis and prognosis in psychiatry is only now beginning to be explored (e.g., see ref. 4).

Developments in automated natural language processing[5] present one promising avenue for psychiatry. Although speech may present a unique 'window into the mind' in a variety of altered states,[6] it is particularly relevant to psychosis. Thought disorder, a cardinal symptom of schizophrenia in which thought processes lose coherence, is typically diagnosed on the basis of clinical observation of disorganized speech.[7] As a complement to clinical observation, automated analysis methods have previously been used to assess speech correlates of thought disorder in schizophrenia.[8] For example, Latent Semantic Analysis (LSA), an automated high-dimensional associative analysis of semantic structure in speech, has been used to identify a reduction in semantic coherence in schizophrenia that correlates with clinical ratings and has comparable diagnostic accuracy.[3] LSA combined with structural speech analysis was also able to accurately differentiate between first-degree relatives of schizophrenia patients and unrelated healthy individuals, suggesting that subtle differences indicative of underlying genetic vulnerabilities to schizophrenia can be distinguished with computerized speech analysis.[9]

As yet, however, these methods have not been applied to the prediction of psychosis onset, even though clinically diagnosed subtle disorganization in speech has consistently been identified as predictive of psychosis (i.e., with classification accuracy of ~60%) among young people identified as at clinical high risk

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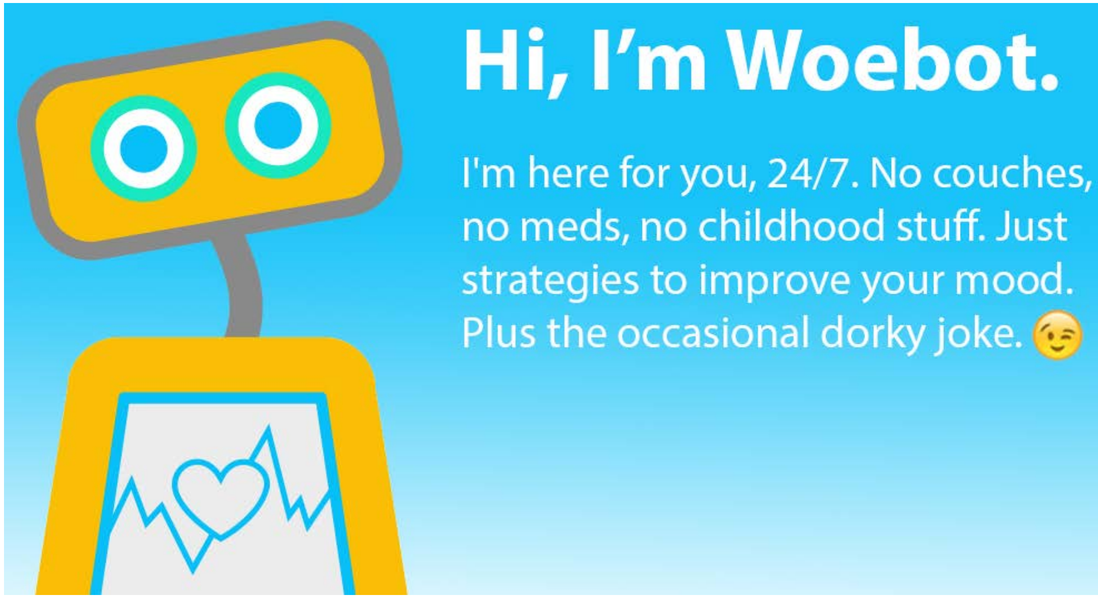
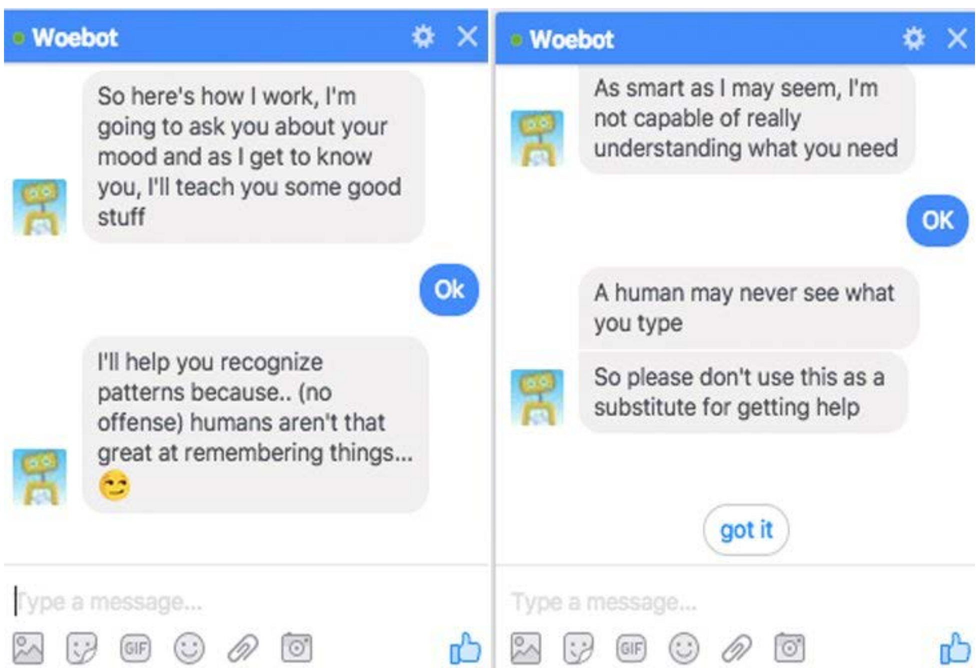
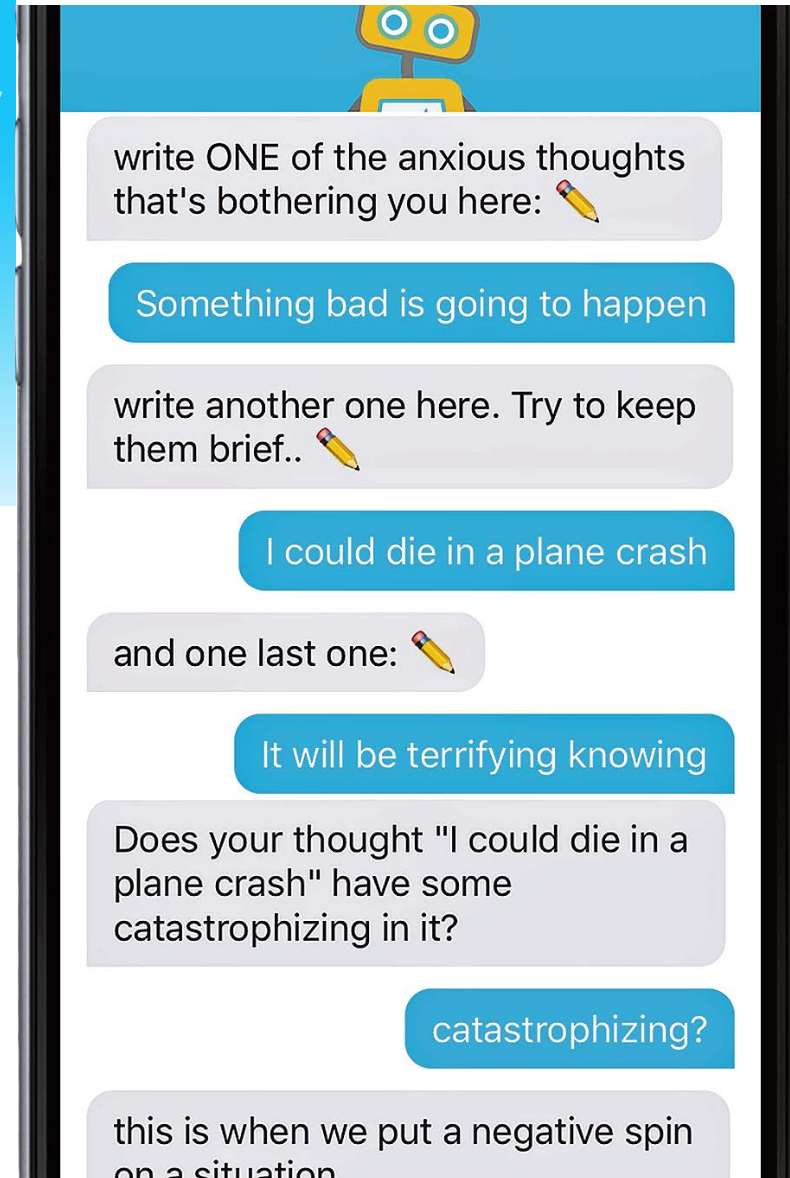
Correspondence: GA Cecchi or CM Corcoran (gcecchi@us.ibm.com or cc788@columbia.edu)
[9]These authors contributed equally to this work.
Received 13 May 2015; revised 19 June 2015; accepted 6 July 2015


Hi, I'm Woebot.
I'm here for you, 24/7. No couches, no meds, no childhood stuff. Just strategies to improve your mood. Plus the occasional dorky joke.


Woebot
So here's how I work, I'm going to ask you about your mood and as I get to know you, I'll teach you some good stuff
Ok
I'll help you recognize patterns because.. (no offense) humans aren't that great at remembering things...
Type a message...
Woebot
As smart as I may seem, I'm not capable of really understanding what you need
OK
A human may never see what you type
So please don't use this as a substitute for getting help
got it
Type a message...

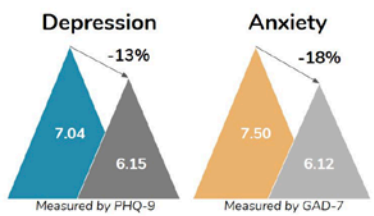

write ONE of the anxious thoughts that's bothering you here:
Something bad is going to happen
write another one here. Try to keep them brief..
I could die in a plane crash
and one last one:
It will be terrifying knowing
Does your thought "I could die in a plane crash" have some catastrophizing in it?
catastrophizing?
this is when we put a negative spin on a situation

Mental Health Chatbot

delivering on-demand, affordable, quality psychological support.

How it works

Built by clinical psychologists, Tess is a Mental Health Chatbot that coaches people through tough times to build resilience, by having text message conversations – in the same way a therapist would.



Evidence Based

Northwestern University conducted a randomized controlled trial that revealed interactions with Tess led to significantly reduced symptoms of depression (by 13%) and anxiety (by 18%).

On-Demand Support

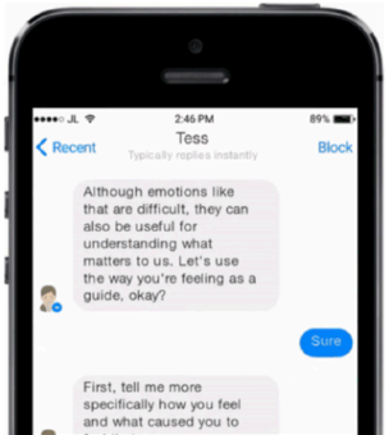
Tess is available 24/7 and accessible by any cell phone, from any location to deliver support using an integrative mental health approach, including: CBT, SFBT, Mindfulness and more.

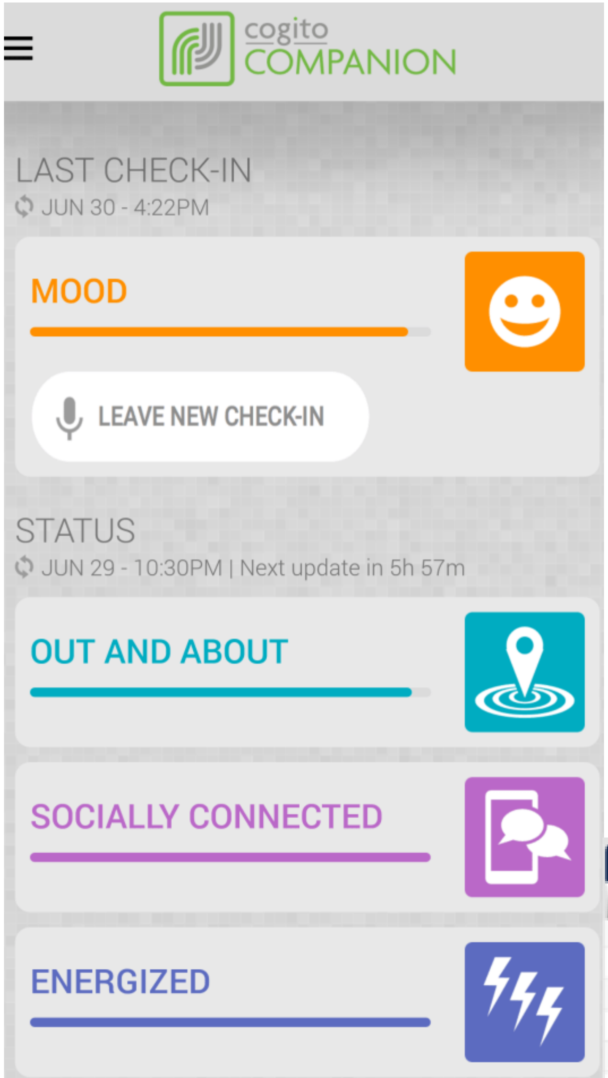
Customizable

Customize conversations, or use our defualt content. Start using our Electroninc Health Record (EHR) for a quick integration.

1. Psychological Artificial Intelligence

- Start a conversation with Tess by sending any message.
- Much like a therapist, Tess gives a brief introduction, and then works to understand your needs by simply asking, "how are





PATIENT	STABILITY		OUT AND ABOUT		SOCIALLY CONNECTED		ENERGIZED		MOOD		
Name	Score	Trend	Score	Trend	Score	Trend	Score	Trend	Score	Trend	Most Recent Entry
John	23		76		17		100				
Christine	38		40		0		100		56		5 Days ago
Alex	70		82								
Tony	71		95		99		50		100		9 Days ago
Brandy	79		3		96		100		100		124 Days ago
Samuel	80		80		12		100		45		78 Days ago
William	87		64						91		48 Days ago
Doug	87		96		100		66		0		86 Days ago
Albert	88		82		73		98		94		86 Days ago
Wendy	88		86		0		92		98		3 Days ago
Theo	94		96		100		88		34		23 Days ago
Steven	94		96		100		99		97		7 Days ago
Abbie	96		83		100		100		100		49 Days ago

Sensors

Miniaturized CGM

Working with **Dexcom** to reduce the barriers to use of continuous glucose monitors for people with diabetes.

READ MORE

Smart Lens Program

Partnering with **Alcon**, a subsidiary of Novartis, to build wireless sensing capability into ocular devices for applications including glucose sensing and accommodative vision correction.

READ MORE

Study Watch

Collecting physiological and environmental data from clinical studies for insight generation, using Verily-developed hardware and data platform.

READ MORE

Interventions

Debug

Stopping the spread of disease-carrying mosquitoes by rearing and releasing millions of sterile males.

READ MORE

Galvani Bioelectronics

Creating bioelectronic medicines to tackle a wide range of chronic diseases with **GlaxoSmithKline**.

READ MORE

Liftware

Helping people with hand tremor or limited hand and arm mobility to eat with confidence and independence.

READ MORE

Retinal Imaging

Working with **Nikon** (including its subsidiary Optos) and Google Research to develop machine learning-enabled solutions for diabetes related eye disease.

READ MORE

Verb Surgical

Advancing surgical robotics to benefit surgeons, patients, and hospitals, in partnership with **Ethicon**, a division of Johnson & Johnson.

READ MORE

Health Platforms & Population Health Tools

Healthcare performance measurement

Partnering with **3M Health Information Systems** to develop software tools to better analyze and report quality performance data across health care delivery systems and patient populations.

READ MORE

NHS Early Intervention Program

Developing risk-prediction models to drive innovation in chronic disease care with **NHS Heywood, Middleton and Rochdale Clinical Commissioning Group** and **Merck Sharp & Dohme Limited**.

READ MORE

Onduo

Developing comprehensive solutions for simple and intelligent diabetes management with **Sanofi**.

READ MORE

Precision medicine

Immunoscape

Working with **Gilead** to begin developing a comprehensive molecular map of inflammatory disease.

READ MORE

MS Observational Study

Working with **Biogen** and **Brigham and Women's Hospital** to research environmental, biological and other contributing factors to multiple sclerosis to determine early intervention options.

READ MORE

One Brave Idea

Pioneering an unprecedented research award with the **American Heart Association** and **AstraZeneca** focused on preventing or reversing coronary heart disease and ultimately improving cardiovascular health.

READ MORE

Personalized Parkinson's Project

Researching the course of Parkinson's disease with **Radboud UMC** and **ParkinsonNet** to identify biological and physiological markers and inform better treatments.

READ MORE

Precision Medicine Initiative

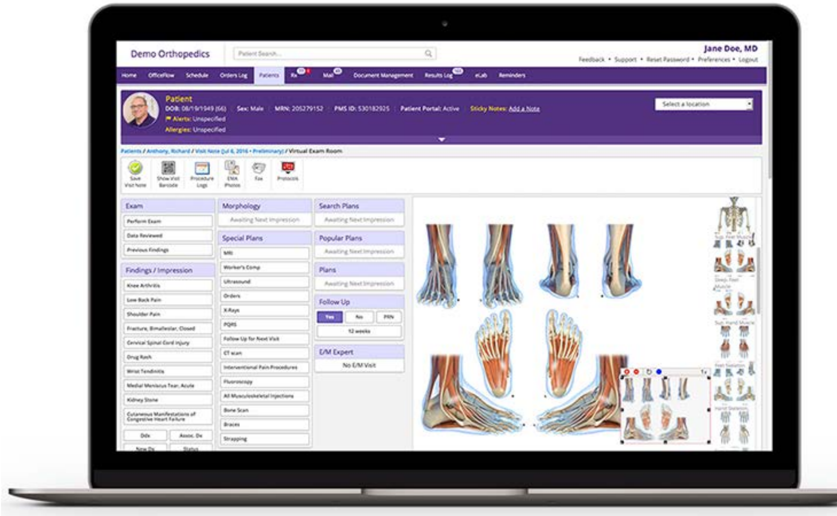
Supporting development of the Data and Research Support Center for the **NIH's** *All of Us* Research Program.

READ MORE

Project Baseline

Embarking on a landmark effort including a study with **Duke University** and **Stanford Medicine** to develop a rich dataset and research platform to better characterize transitions in health.

READ MORE



MODERNIZING MEDICINE

2017 MIPS SUCCESS

Estimated scores for EMA™ EHR users*

In the first year of CMS' Merit-Based Incentive Payment System (MIPS), thousands of EMA clients reported through Modernizing Medicine®'s Qualified Registry and achieved outstanding preliminary results.

HOW MANY SUBMITTED?

5,402 providers utilized our MIPS Registry

Submission typically took **1-5** minutes

WHAT'S AT STAKE?

- **4%** max payment adjustment for 2017
- For **$1M** billed in Medicare, that can mean up to a **$40K** bonus or penalty
- By 2022, adjustments rise to **9%** max

ON AVERAGE, HOW'D THEY DO?*

Quality 49.8 of 60 + Advancing Care Information 21.7 of 25 + Improvement Activities 10 of 15 = Overall Score 77.5 of 100

76% of submissions scored 70+*

70 pts = exceptional performer bonus

ACING IT

52% got perfect ACI scores*

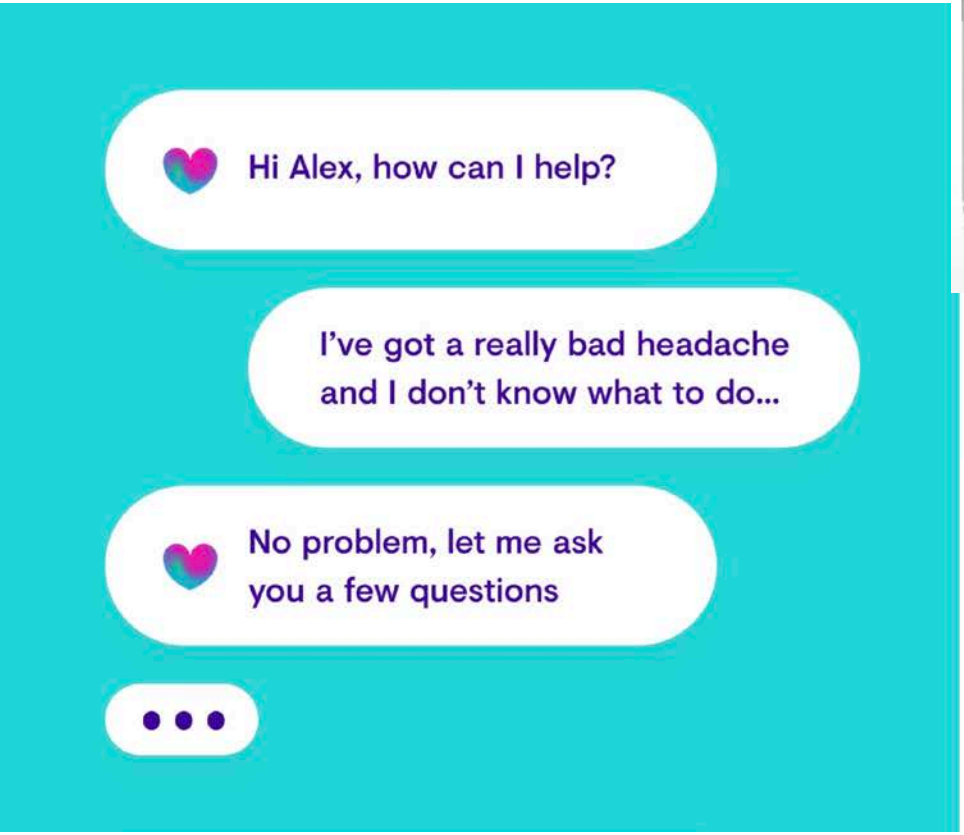
36% got perfect scores on both ACI & Quality*

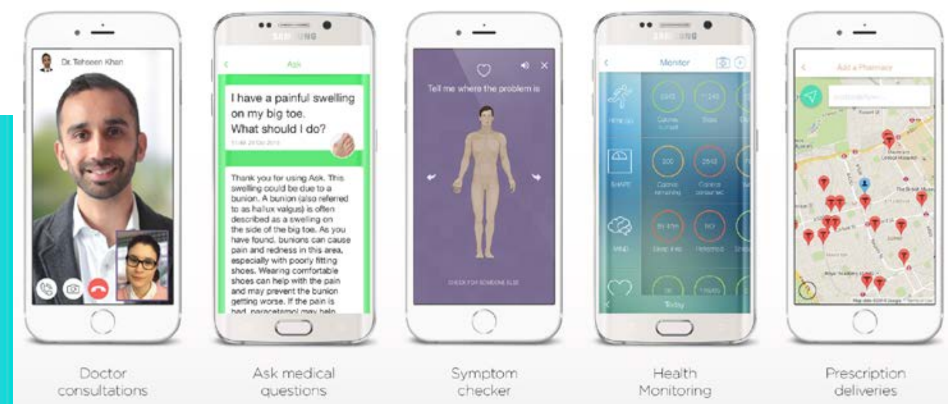
ON THE MONEY

99.9% OF MIPS ADVISING CLIENTS MET THEIR SCORE GOALS

To learn more about how EMA can help you succeed in MIPS, **visit modmed.com/mips**

*Scores are estimated based on MIPS scoring criteria published by the Centers for Medicare & Medicaid Services (CMS). CMS is scheduled to release final scores and feedback on July 1, 2018.





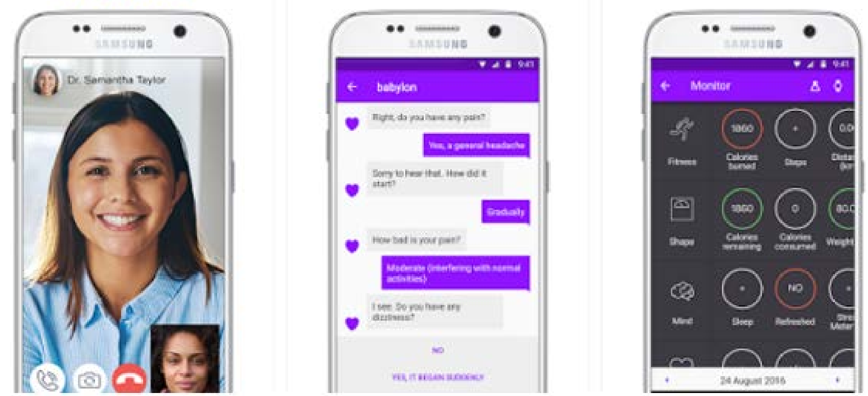
Babylon understands symptoms and directs you to the most appropriate service.

Babylon's AI system has been created by experienced doctors and scientists using the latest advances in deep learning. Much more than a searchable database, it assesses known symptoms and risk factors to provide informed, up-to-date medical information.

Live video appointments with qualified doctors 7 days a week

Chat to babylon 24/7 and get medical advice

Smart monitoring to keep track of your health



Our mission

Babylon believes it is possible to put an accessible and affordable health service in the hands of every person on earth.

How? By combining the ever-growing computing power of machines with the best medical expertise of humans to create a comprehensive, immediate and personalised health service and making it universally available.

Perché secondo i ‘conservatori’ le scienze della salute e della malattia avranno ancora bisogno di medici umani…

- Non si può rimpiazzare l’empatia (i pazienti non prenderebbe sul serio le raccomandazione di un chatboat e la fiducia richiederebbe un ascolto e risposte che implicano che si sia stati mentalmente capiti)
- I medici lavorano/ragionano in modi non lineari: in medicina sono richieste creatività e abilità nel problem solving, che algoritmi e robot non avranno mai
- La medicina è una tecnologia complessa fondata sulla scienza: nessun robot o algoritmo potrebbe chiaramente affrontare sfide cognitive e opertive e a più livelli, che implicano la mente umana. L’interpretazione sarà sempre un territorio umano
- Ci saranno sempre compiti che robot e algoritmi non sapranno compiere. Potranno sostituire i medici nella compilazione di pratiche amministrative, scrivere referti, recuperare ed elaborare dati, ma Watson non fa la manovra di Heimlich
- Non c’è un reale conflitto tra tecnologia e uomo, ma sempre e solo collaborazione. Non si potrà fermare l’irruzione delle tecnologie copmputazionali. Il caso dell’uso del deep learning per identificare il cancro metastasico del seno dimostra quando il sistema automatizzato coopera con i patologi è più potente, e l’errore umano si riduce dell’85%

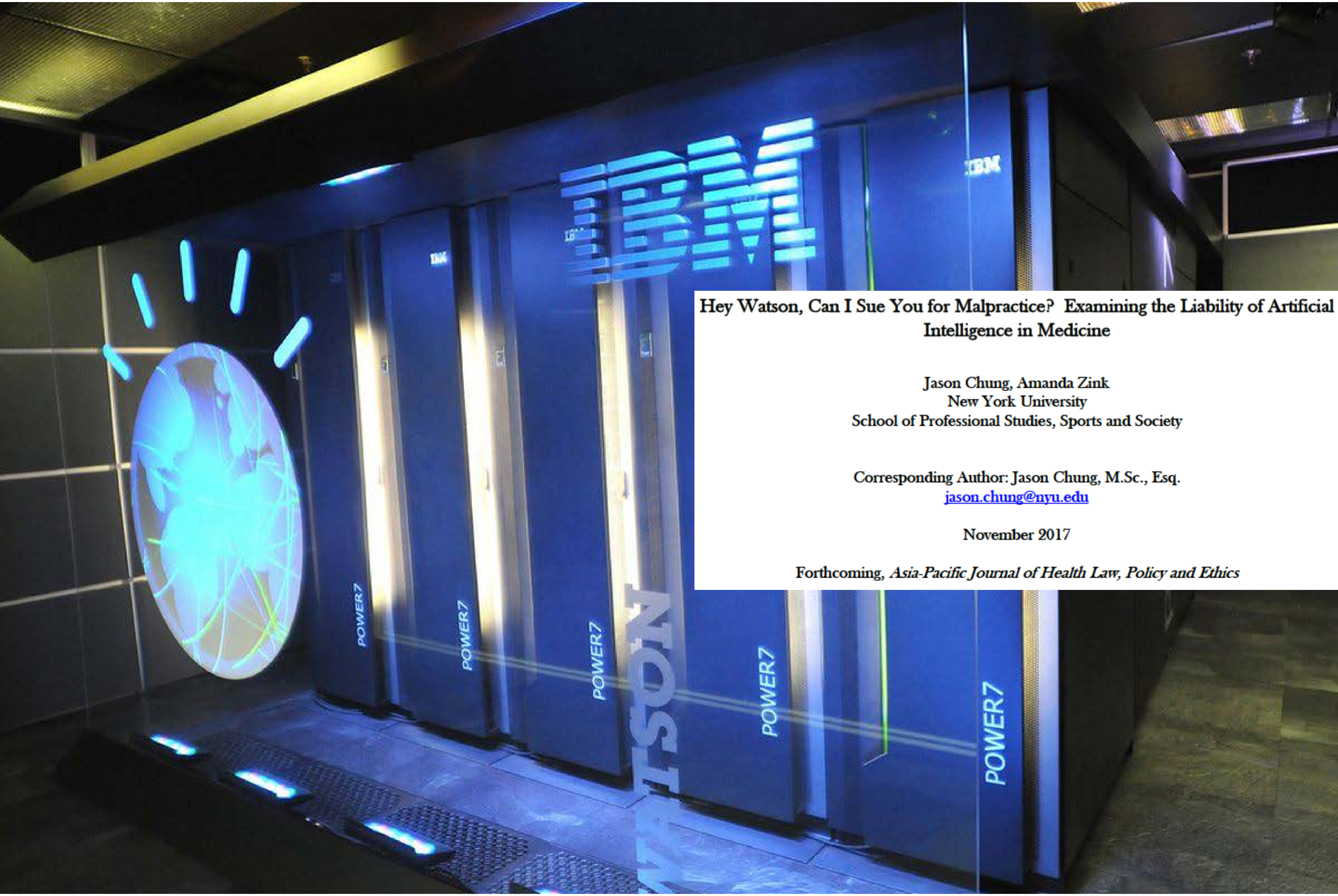
BIOETHICS BRIEFING NOTE

NUFFIELD COUNCIL ON BIOETHICS

Artificial intelligence (AI) in healthcare and research

OVERVIEW

- AI is being used or trialled for a range of healthcare and research purposes, including detection of disease, management of chronic conditions, delivery of health services, and drug discovery.
- AI has the potential to help address important health challenges, but might be limited by the quality of available health data, and by the inability of AI to display some human characteristics.
- The use of AI raises ethical issues, including: the potential for AI to make erroneous decisions; the question of who is responsible when AI is used to support decision-making; difficulties in validating the outputs of AI systems; inherent biases in the data used to train AI systems; ensuring the protection of potentially sensitive data; securing public trust in the development and use of AI technologies; effects on people's sense of dignity and social isolation in care situations; effects on the roles and skill-requirements of healthcare professionals; and the potential for AI to be used for malicious purposes.
- A key challenge will be ensuring that AI is developed and used in a way that is transparent and compatible with the public interest, whilst stimulating and driving innovation in the sector.



Hey Watson, Can I Sue You for Malpractice? Examining the Liability of Artificial Intelligence in Medicine

Jason Chung, Amanda Zink
New York University
School of Professional Studies, Sports and Society

Corresponding Author: Jason Chung, M.Sc., Esq.
jason.chung@nyu.edu

November 2017

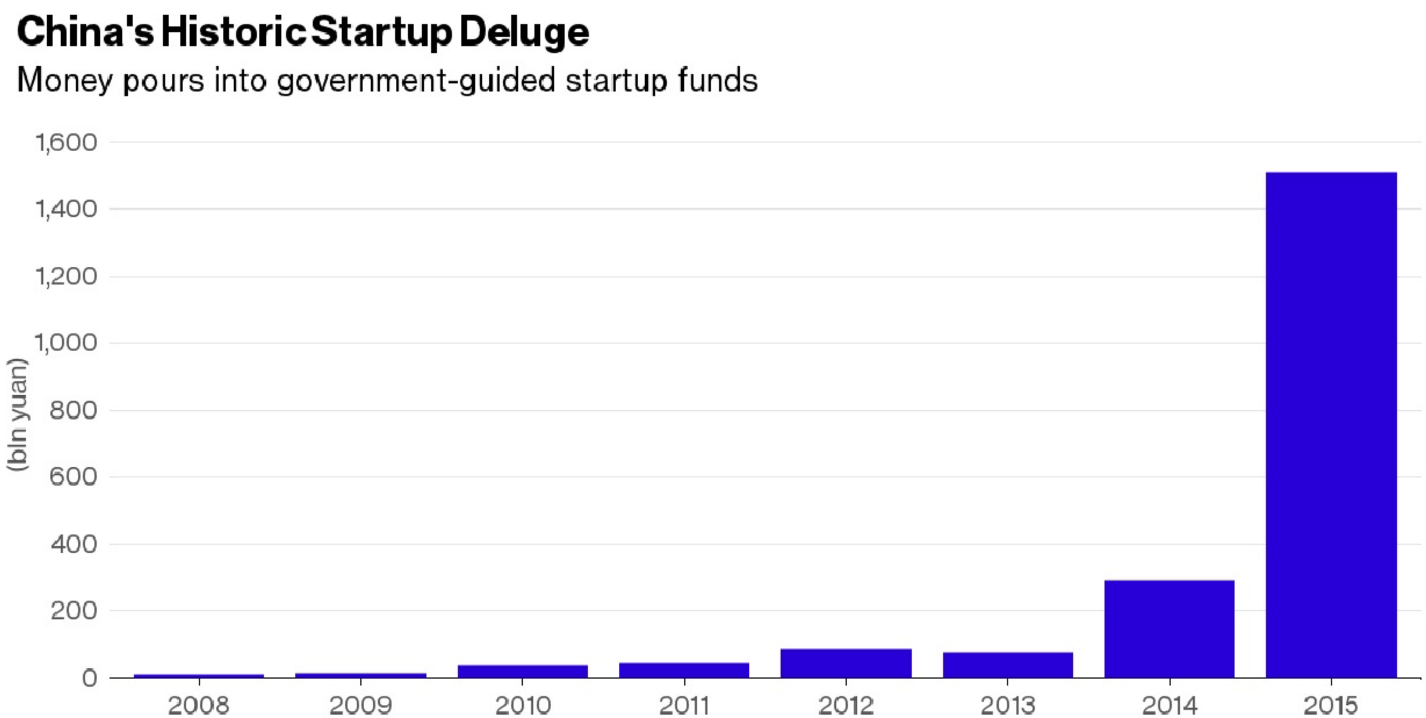
Forthcoming, *Asia-Pacific Journal of Health Law, Policy and Ethics*

I dati usati per creare gli algoritmi possono contenere bias, che si rifletteranno negli algoritmi e nelle raccomandazioni cliniche che generano. Altresì, gli algoritmi potrebbero essere progettati per distorcere i risultati, a secondo di chi li sviluppa e dai motivi dei programmatori, delle aziende e dei sistemi sanitari che li impiegano

I medici dovrebbero tener presente che gli algoritmi sono creati da uomini, valutare criticamente la fonte dei dati usati per costruire i modelli statistici progettati per fare previsioni, capire come i modelli funzionano e guardarsi dal diventare del tutto dipendenti da essi.

I dati raccolti sulla salute, le diagnosi e gli esisti clinici di un paziente diventano parte di una ‘conoscenza collettiva’, cioè della letteratura pubblicata e dell’informazione raccolta dai sistemi sanitari, per cui potrebbe essere usati senza attenzione per l’esperienza clinica e gli aspetti personali della cura di quel paziente

Le linee guida cliniche basate sul machine learning introdurranno introdurre un attore che è parte terza nel rapporto medico-paziente, sfidando attuali le dinamiche di responsabilità etica e legale implicate nella relazione e l’aspettativa di confidenzialità


China's Historic Startup Deluge
Money pours into government-guided startup funds
(bln yuan)
1,600
1,400
1,200
1,000
800
600
400
200
0
2008
2009
2010
2011
2012
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2015


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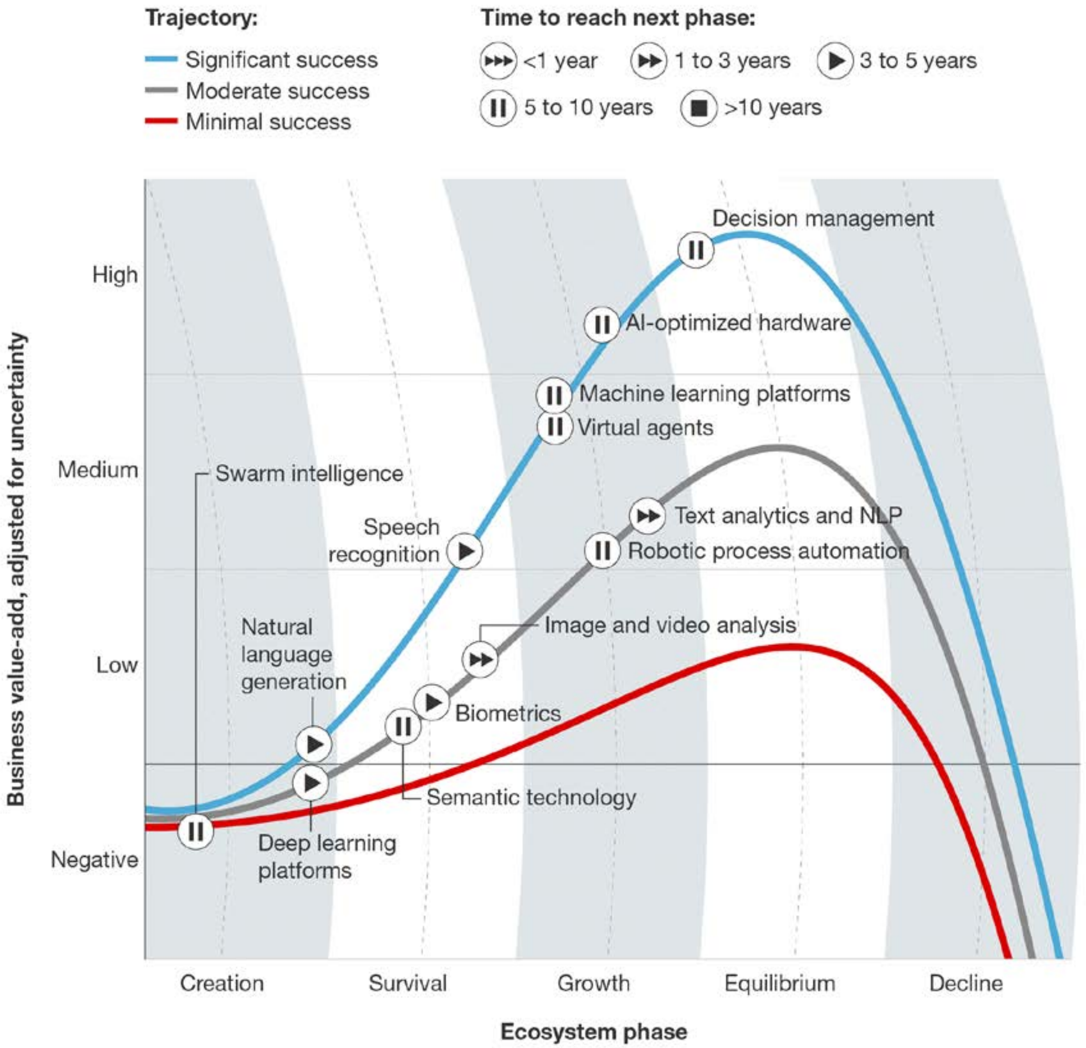


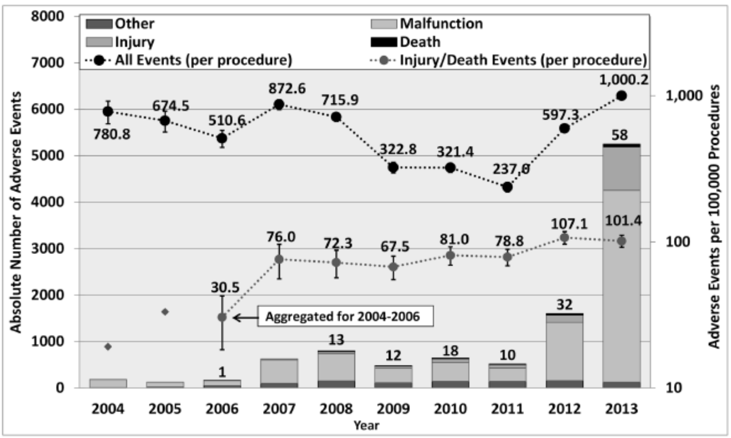
129161

RESEARCH ARTICLE

Adverse Events in Robotic Surgery: A Retrospective Study of 14 Years of FDA Data

Homa Alemzadeh[1]*, Jaishankar Raman[2], Nancy Leveson[3], Zbigniew Kalbarczyk[1], Ravishankar K. Iyer[1]

1 Coordinated Science Laboratory, University of Illinois at Urbana-Champaign, Urbana, Illinois, United States of America, **2** Department of Surgery, Rush University Medical Center, Chicago, Illinois, United States of America, **3** Department of Aeronautics and Astronautics, Massachusetts Institute of Technology, Cambridge, Massachusetts, United States of America



During the study period, 144 deaths (1.4% of the 10,624 reports), 1,391 patient injuries (13.1%), and 8,061 device malfunctions (75.9%) were reported. The numbers of injury and death events per procedure have stayed relatively constant (mean = 83.4, 95% confidence interval (CI), 74.2–92.7 per 100,000 procedures) over the years. **Surgical specialties** for which robots are extensively used, such as gynecology and urology, had lower numbers of injuries, deaths, and conversions per procedure than more complex surgeries, such as cardiothoracic and head and neck (106.3 vs. 232.9 per 100,000 procedures, Risk Ratio = 2.2, 95% CI, 1.9–2.6). **Device and instrument malfunctions,** such as falling of burnt/broken pieces of instruments into the patient (14.7%), electrical arcing of instruments (10.5%), unintended operation of instruments (8.6%), system errors (5%), and video/imaging problems (2.6%), constituted a major part of the reports. **Device malfunctions impacted patients** in terms of injuries or procedure interruptions. In 1,104 (10.4%) of all the events, the procedure was interrupted to restart the system (3.1%), to convert the procedure to non-robotic techniques (7.3%), or to reschedule it (2.5%).

JAMA | Original Investigation

Association of Robotic-Assisted vs Laparoscopic Radical Nephrectomy With Perioperative Outcomes and Health Care Costs, 2003 to 2015

In Gab Jeong, MD, PhD; Yash S. Khandwala, BS; Jae Heon Kim, MD, PhD; Deok Hyun Han, MD, PhD; Shufeng Li, MS; Ye Wang, PhD; Steven L. Chang, MD; Benjamin I. Chung, MD

IMPORTANCE Use of robotic surgery has increased in urological practice over the last decade. However, the use, outcomes, and costs of robotic nephrectomy are unknown.

OBJECTIVES To examine the trend in use of robotic-assisted operations for radical nephrectomy in the United States and to compare the perioperative outcomes and costs with laparoscopic radical nephrectomy.

DESIGN, SETTING, AND PARTICIPANTS This retrospective cohort study used the Premier Healthcare database to evaluate outcomes of patients who had undergone robotic-assisted or laparoscopic radical nephrectomy for renal mass at 416 US hospitals between January 2003 and September 2015. Multivariable regression modeling was used to assess outcomes.

EXPOSURES Robotic-assisted vs laparoscopic radical nephrectomy.

MAIN OUTCOMES AND MEASURES The primary outcome of the study was the trend in use of robotic-assisted radical nephrectomy. The secondary outcomes were perioperative complications, based on the Clavien classification system, and defined as any complication (Clavien grades 1-5) or major complications (Clavien grades 3-5, for which grade 5 results in death); resource use (operating time, blood transfusion, length of hospital stay); and direct hospital cost.

RESULTS Among 23 753 patients included in the study (mean age, 61.4 years; men, 13 792 [58.1%]), 18 573 underwent laparoscopic radical nephrectomy and 5180 underwent robotic-assisted radical nephrectomy. Use of robotic-assisted surgery increased from 1.5% (39 of 2676 radical nephrectomy procedures in 2003) to 27.0% (862 of 3194 radical nephrectomy procedures) in 2015 (*P* for trend <.001). In the weighted-adjusted analysis, there were no significant differences between robotic-assisted and laparoscopic radical nephrectomy in the incidence of any (Clavien grades 1-5) postoperative complications (adjusted rates, 22.2% vs 23.4%, difference, −1.2%; 95% CI, −5.4 to 3.0%) or major (Clavien grades 3-5) complications (adjusted rates, 3.5% vs 3.8%, difference, −0.3%; 95% CI, −1.0% to 0.5%). The rate of prolonged operating time (>4 hours) for patients undergoing the robotic-assisted procedure was higher than for patients receiving the laparoscopic procedure in the adjusted analysis (46.3% vs 25.8%; risk difference, 20.5%; 95% CI, 14.2% to 26.8%). Robotic-assisted radical nephrectomy was associated with higher mean 90-day direct hospital costs ($19 530 vs $16 851; difference, $2678; 95% CI, $838 to $4519), mainly accounted for operating room ($7217 vs $5378; difference, $1839; 95% CI, $1050 to $2628) and supply costs ($4876 vs $3891; difference, $985; 95% CI, $473 to $1498).

CONCLUSIONS AND RELEVANCE Among patients undergoing radical nephrectomy for renal mass between 2003 and 2015, the use of robotic-assisted surgery increased substantially. The use of robotic-assistance was not associated with increased risk of any or major complications but was associated with prolonged operating time and higher hospital costs compared with laparoscopic surgery.

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Editorial page 1545

Related article page 1569

Supplemental content

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