XXXIII CONGRESSO NAZIONALE AIRO

AIRO2023

BOLOGNA,
27-29 OTTOBRE 2023
PALAZZO DEI CONGRESSI

Radioterapia Oncologica: l'evoluzione al servizio dei pazienti

Intelligenza Artificiale, come cambierà il futuro delle nostre discipline: SIRM, AIMN, AIRO

Il punto di vista del radioterapista oncologo

Valerio Nardone

Dipartimento di Medicina di Precisione, AOU Vanvitelli, Napoli

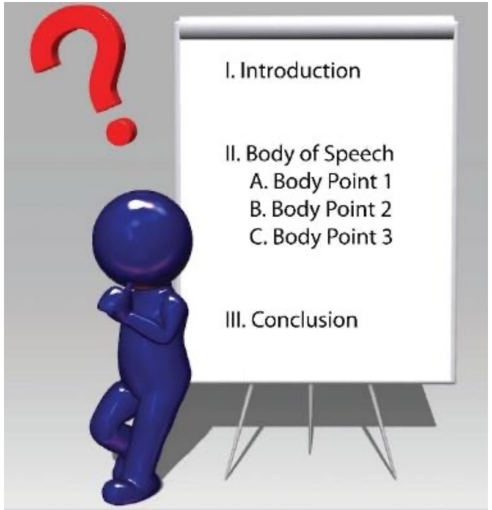
Associazione Italiana
Radioterapia e Oncologia clinica

Disclosures

Per quanto concerne tale presentazione, dichiaro di non avere avuto alcuna relazione rilevante (diretta od indiretta) di tipo finanziario con alcuna compagnia farmaceutica negli ultimi 24 mesi che possa essere considerato un **conflitto di interesse.**

Outline

- ***Definition;***
- ***Application in RadOnc;***
- ***New application (ESTRO, ASTRO);***
- ***Reaction of our community***
- ***Is there a future for #RadOnc with AI?***



In computer science, *artificial intelligence* (AI), is intelligence demonstrated by machines, in contrast to the *natural intelligence* displayed by humans and animals. The term AI is used to describe machines that mimic *cognitive* functions associated with human minds, such as *learning* and *problem solving*.

Other terms

- *Machine learning:* it is an application of AI that provides systems the ability to aumatically learn and improve from experience without explicit programmation;
- *Neural Networks: are computing systems inspired bu the biological neural networks and nodes called artificial neurons.*
- *Data mining:* is the practice of esaming large databases to generate new informations;

Automatic Recognition of Ripening Tomatoes by artificial intelligence

Artificial Intelligence in Factories

Japan ranked fourth in the world: In 2016, 303 robots were installed per 10,000 employees in the manufacturing industry.

AI in Health

Timeline of AI in health

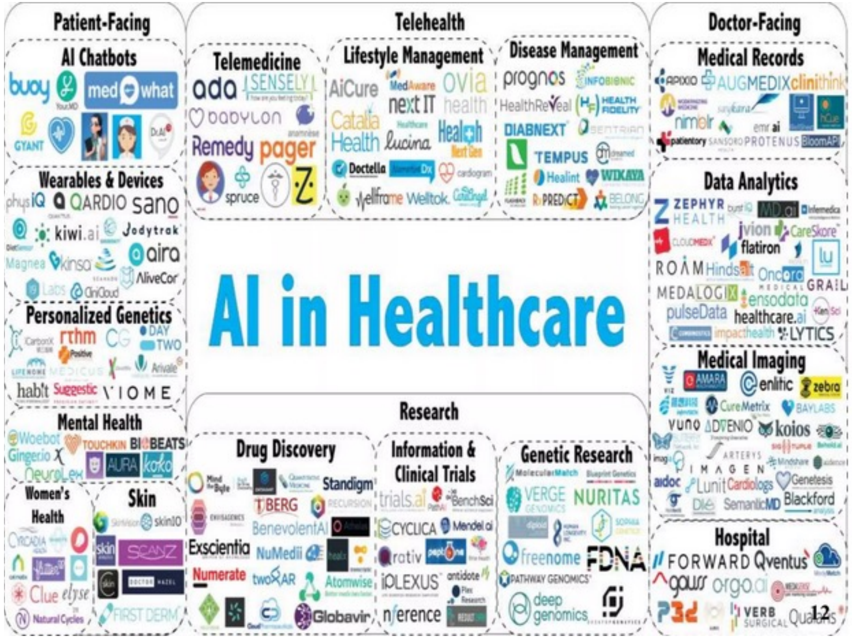
1955
Term coined by John McCarthy. Founded as an academic discipline in 1956 in US.

1960-1970
Produced first problem-solving program, or expert system, known as Dendral assisting to identifying bacteria and recommending antibiotics

1980s-1990s
Growth of microcomputer and new levels of network connectivity. AI systems in healthcare was designed to accommodate the absence of perfect data and build on the expertise of physicians.

2010-2019
- Genomic sequencing databases
- AI in electronic health record systems
- Natural language processing and computer vision,
- Robot-assisted surgery, etc

2019 & onwards
- •Discovery and development of drugs
- •Preclinical research
- •Personalized Health Care
- •And many more

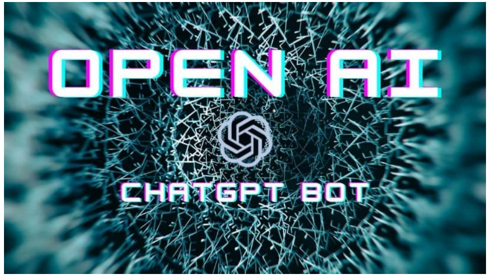


Special Reports > Exclusives

AI Passes U.S. Medical Licensing Exam

— Two papers show that large language models, including ChatGPT, can pass the USMLE

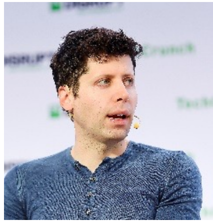
by Michael DePeau-Wilson, Enterprise & Investigative Writer, MedPage Today January 19, 2023



Meta AI

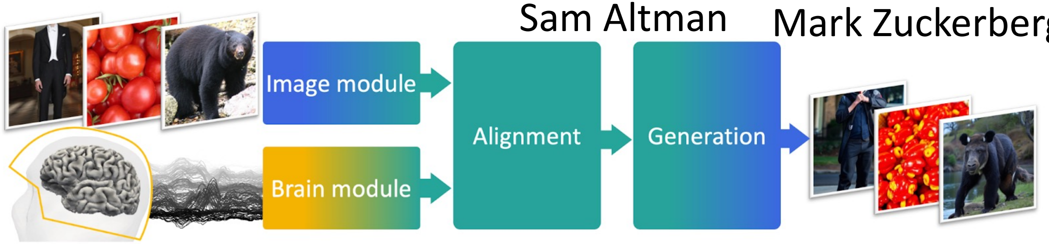
BRAIN DECODING: TOWARD REAL-TIME RECONSTRUCTION OF VISUAL PERCEPTION

Yohann Benchetrit[1,*], Hubert Banville[1,*], Jean-Rémi King[1,2]
[1]FAIR, Meta, [2] Laboratoire des Systèmes Perceptifs, École Normale Supérieure, PSL University
{ybenchetrit,hubertjb,jeanremi}@meta.com



Sam Altman

Mark Zuckerberg



Viewed Image   Predicted Image

Giuliano Amato

Jurist, politician, former minister now newly elected president of the AI algorithms commission, just wanted by the government. Among the objectives is the study of the applications of AI in the publishing world.

85 years old.

Sybil: A Validated Deep Learning Model to Predict Future Lung Cancer Risk From a Single Low-Dose Chest Computed Tomography

Journal of Clinical Oncology®
Volume 41, Issue 12 **2191**

Peter G. Mikhael, BSc[1,2]; Jeremy Wohlwend, ME[1,2]; Adam Yala, PhD[1,2]; Ludvig Karstens, MSc[1,2]; Justin Xiang, ME[1,2]; Angelo K. Takigami, MD[3,4]; Patrick P. Bourgouin, MD[3,4]; PuiYee Chan, PhD[5]; Sofiane Mrah, MSc[4]; Wael Amayri, BSc[4]; Yu-Hsiang Juan, MD[6,7]; Cheng-Ta Yang, MD[6,8]; Yung-Liang Wan, MD[6,7]; Gigin Lin, MD, PhD[6,7]; Lecia V. Sequist, MD, MPH[3,5]; Florian J. Fintelmann, MD[3,4]; and Regina Barzilay, PhD[1,2]

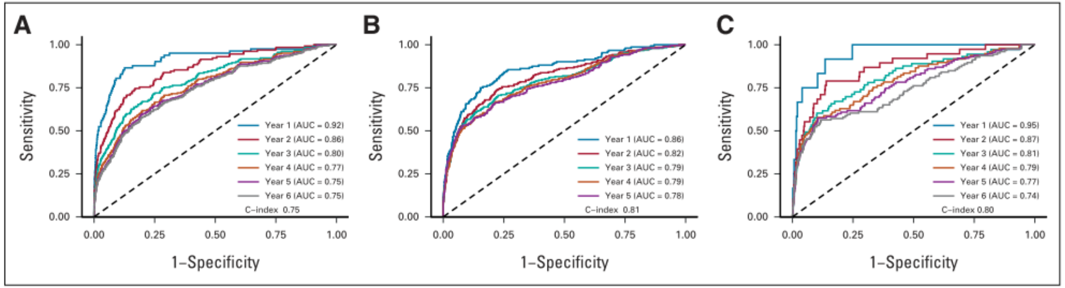


FIG 2. Receiver operating characteristic curves displaying Sybil’s ability to predict future lung cancer over 6 years following a single low-dose computed tomography from the (A) NLST, (B) MGH, and (C) CGMH test sets. CIs for each curve can be found in Table 1. AUC, area under the curve; C-index, concordance index; CGMH, Chang Gung Memorial Hospital; MGH, Massachusetts General Hospital; NLST, National Lung Screening Trial.

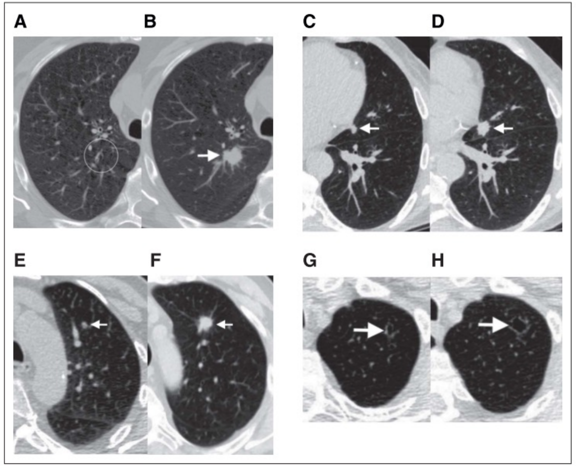


FIG 3. Examples of screening scans with negative clinical interpretations (Lung-RADS 1 or 2) and high Sybil risk scores, who subsequently developed lung cancer. Paired sets of images from four separate subjects from the National Lung Screening Trial and Massachusetts General Hospital cohorts illustrating Sybil’s potential in predicting future lung cancer. Clinical (preoperative) or pathologic (postoperative) stages are provided using

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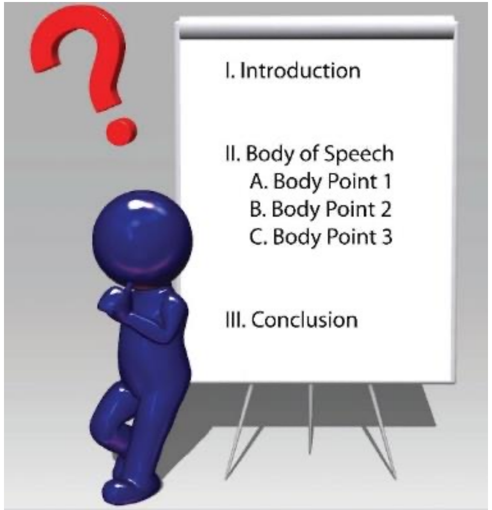
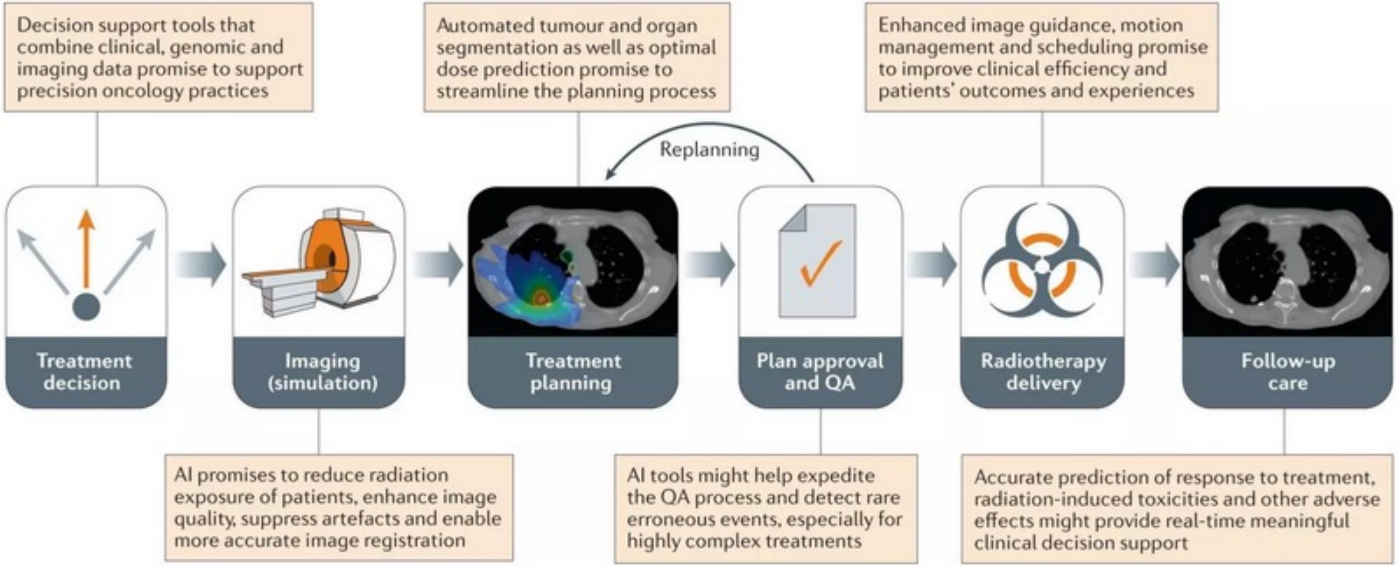
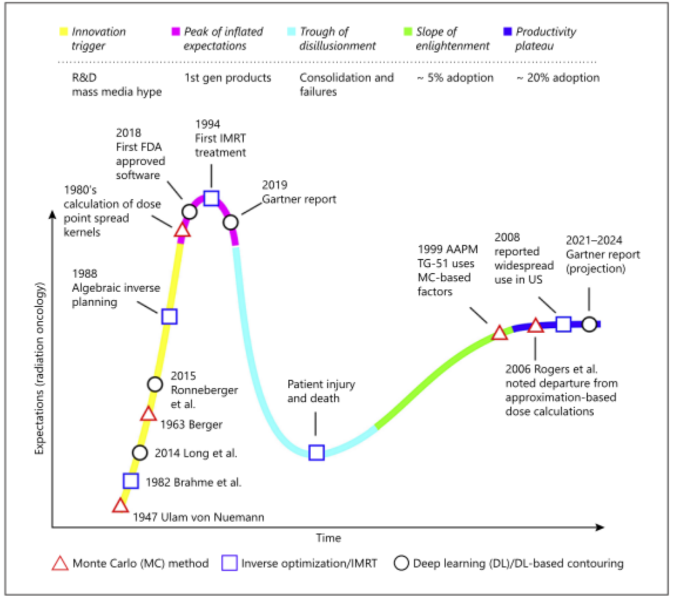


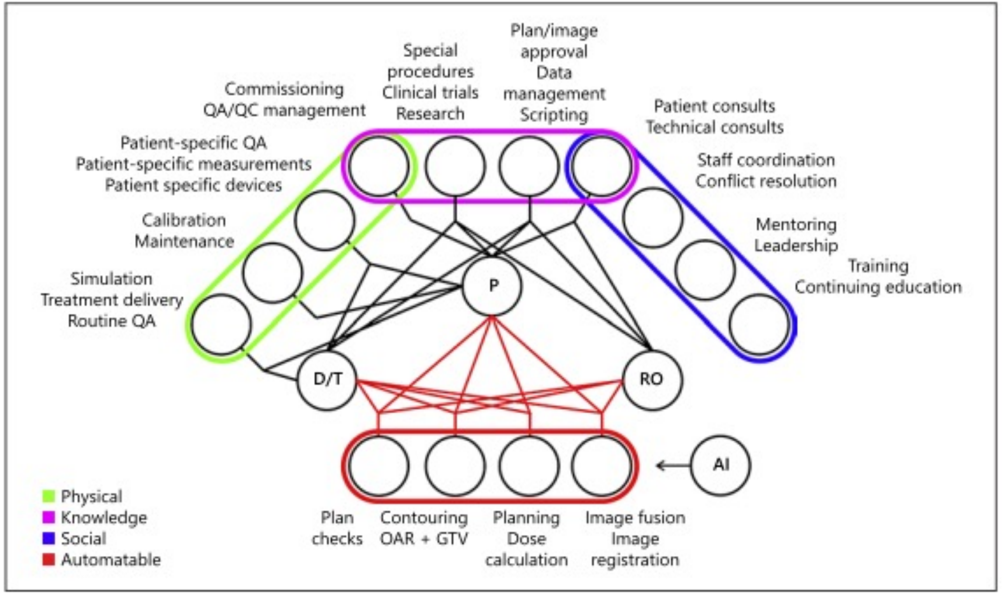
AI in Radiation Oncology



Huynh et al. Nat Rev Clin Oncol 2020

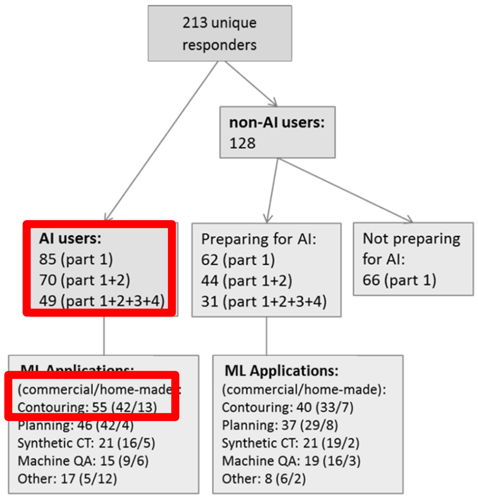
The Emergence of Artificial Intelligence within Radiation Oncology Treatment Planning, Tetherton et al. Oncology 2021

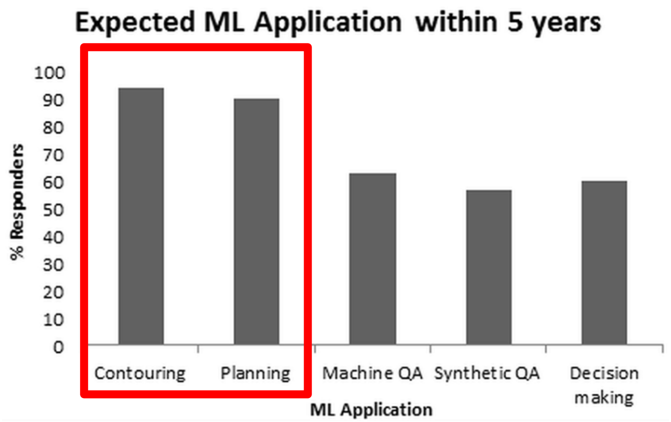


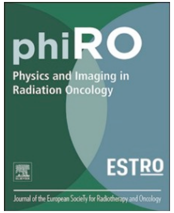


Hype cycle. This figure features a hype cycle curve for three major innovations in radiation oncology (triangle: Monte Carlo; square: Inverse optimization/IMRT; circle: deep learning-based contouring). The curve depicts expectations by the target audience (those in radiation oncology and medical physics) as a function of time. Yellow, magenta, cyan, green, and blue portions of the curve denote "innovation trigger," "peak of inflated expectations," "trough of disillusionment," "slope of enlightenment," and "productivity plateau" regions, respectively.

Use of AI in 2020







Supplemental Table 1. Number of Radiation Oncology Departments using or preparing to use machine learning applications in clinical practice per country

Radiation Oncology Departments and Machine Learning Applications	Clinical	Preparing
France	8	
Italy	7	5
Netherlands	8	3
Spain	7	2
Australia	5	4
Belgium	5	3
United Kingdom	4	3
Denmark	3	2
Switzerland	3	3
United States of Amerika	3	1
Germany	2	2
Norway	2	3

C.L. Brouwer et al. Physics and Imaging in Radiation Oncology 2020

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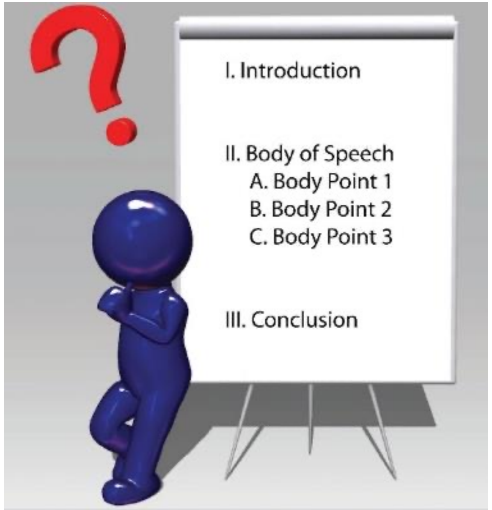


AI: friend or foe

AI is a friend

- Time reduction for the radiotherapist (contours, planning),
- Improve accuracy and precision in RT treatments,
- Predict toxicity,
- Cost reduction.

AI is a foe

- " I may take your job " ,
- Incorrect treatment decisions with incomplete or biased data,
- Manipulation of AI algorithms or steal patient data by hackers.

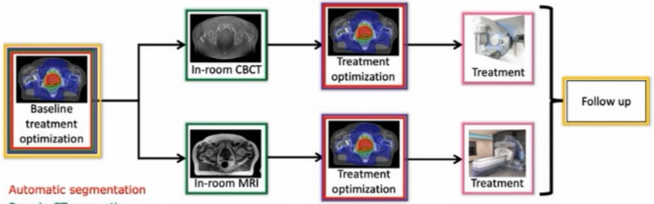
AI in the RT workflow

LMU KLINIKUM

Summary

Many roles for AI in the RT workflow

- AI algorithms are applicable to almost all aspects of the RT workflow
- Commercial solutions are now available
- Segmentation is one of the most visible applications
- Pseudo CT software is also making its way into the clinic
- Some aspects will naturally remain research topics



Automatic segmentation
Pseudo CT generation
Dose prediction and automatic planning
Motion tracking
Outcome prediction

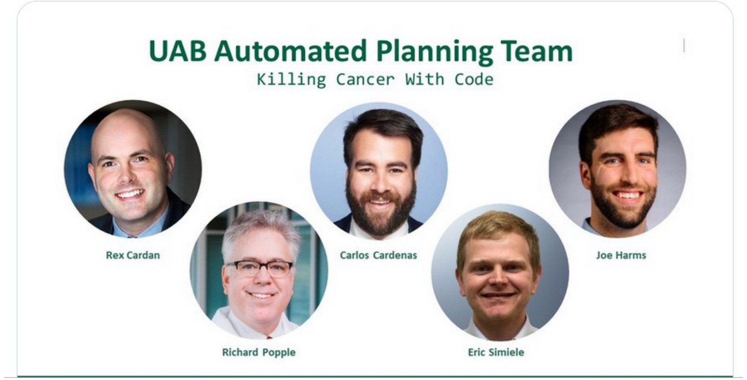
Guillaume LANDRY
(GERMANY)

ARTIFICIAL INTELLIGENCE → DEEP LEARNING → MACHINE LEARNING

UAB Radiation Oncology
@UABradonc

Congrats to our @UABmedphys #KillingCancerWithCode team who won 1st place at the @ESTRO_RT 2023 Auto-RTP Challenge. 13 international teams from academia and industry participated in the competition, all leveraging #AI and software tools to fully automate #RT treatment planning

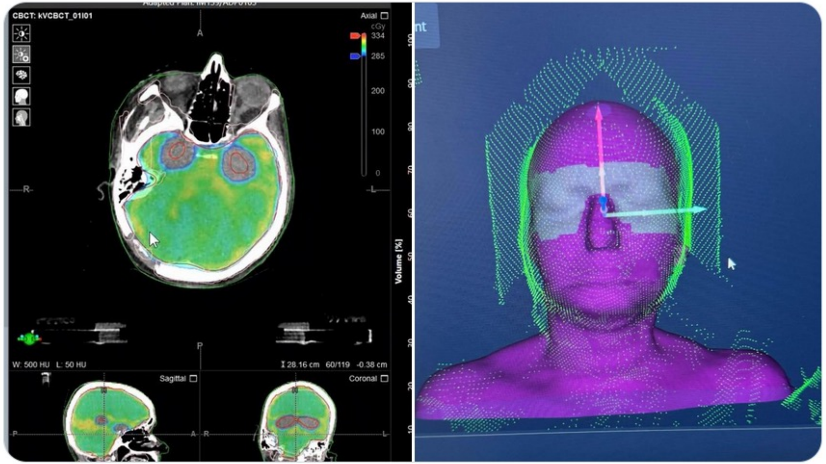
Traduci post



UTSW Radiation Oncology
@UTSW_RadOnc

This is made possible by AI-guided diagnostics MRI to synthetic CT generation, surface image guidance setup, and Ethos online adaptive therapy. This treatment is traditionally complicated and takes days to plan. Now with AI and Ethos, we can do day 0 immediate treatment!

Traduci post



O'Neil *et al. BMC Palliative Care* (2022) 21:220
https://doi.org/10.1186/s12904-022-01115-y
BMC Palliative Care

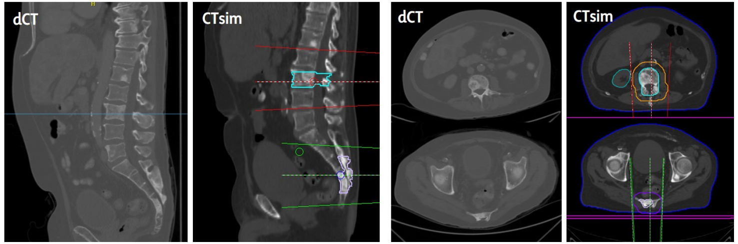
STUDY PROTOCOL **Open Access**

DART: diagnostic-CT-enabled planning: a randomized trial in palliative radiation therapy (study protocol)

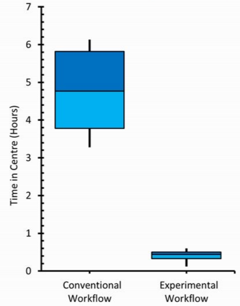
Melissa O'Neil, Timothy K. Nguyen, Joanna Laba, Robert Dinniwell, Andrew Warner and David A. Palma*

Diagnostic-CT-Enabled Planning: A Randomized Trial in Palliative Radiation Therapy

Palliative patients with bone/soft tissue/lung disease in thorax/abdo/pelvis who meet eligibility criteria and consent to participate n=33 → Randomization 1:2 →
- Arm 1: CT simulation planning (Conventional workflow)
- Arm 2: Diagnostic-CT-enabled planning (dCT) (Experimental workflow)



Results: Primary Endpoint (TIC)



Time in centre (hrs)	Arm 1	Arm 2
Median (IQR)	4.8 (3.8, 5.8)	0.4 (0.3, 0.5)
Mean ± SD	4.7 ± 1.1	0.4 ± 0.1

p<0.001

London Health Sciences Centre #ASTRO23

Melissa O'Neil MRT(T)
@Melissa_O_Neil

So excited to present 🎯DART RCT at the #ASTRO2023 late-breaking abstract and press sessions
👉Diagnostic CT-based planning ⬇️ pt time at cancer center from almost 5hrs to <0.5hrs w/out detriment to plan quality
👉Pts reported ⬇️ time burden
Do you 🎯? Join our Delphi study!

Impact of AI on Quality of Care, Clinical Practice and Training

- Variation in quality exists, but regionalization is NOT the solution;
- AI can reduce unrewarding tasks that consume time/cognitive burden;
- AI can also inform or facilitate strategies to enhance quality (simulation training for complex cases, patient selection for escalation of clinical care);

➢ **There will be pluses and minuses, but change is certain;**
➢ **Success will come through networking within us and across disciplines;**

Erin Gillespie

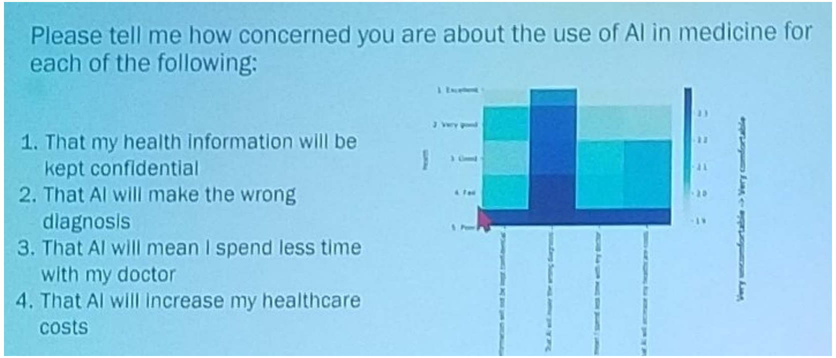
Deep learning in digital histopathology for prostate cancer

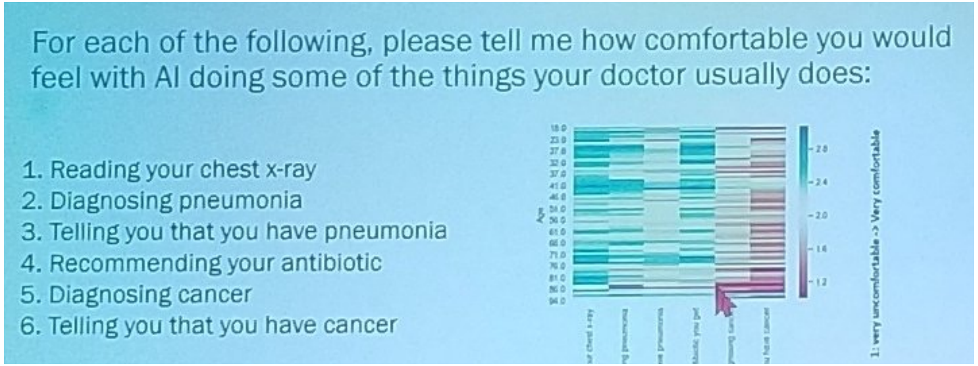
- AI derived prognostic biomarkers provide personalized risk estimates, that when grouped allows more streamlined communication;
- ArteraAI MMAI prognostic tool identifies 6-fold more low-risk patients than NCCN (safe omitting of ADT with RT, with a NNT>25);
- **Prognostic biomarkers help with shared-decision making to avoid futile treatment intensification;**

- **Use of AI tools leveraging digital pathology improves prognostication, enabling us to determine the optimal treatment plan for the single patient (precision medicine);**

Jonathan Tward

Current Progress of Machine Learning in Radiation Oncology





Sanjay Aneja

Radiography 29 (2023) S112–S116

Contents lists available at ScienceDirect

Radiography

journal homepage: www.elsevier.com/locate/radi

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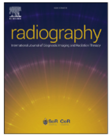


Check for updates

Patient views on the implementation of artificial intelligence in radiotherapy

S. Temple*, C. Rowbottom, J. Simpson

The Clatterbridge Cancer Centre NHS Foundation Trust, 65 Pembroke Place, Liverpool L7 8YA, UK

Overall, there was a moderately negative patient view towards the use of AI in radiotherapy.

Certain factors drew a more negative response than others, for example **patients desire significant personal interaction with healthcare professionals during the course of their treatment.**

No correlations with age and gender.

Exploring ethical challenges in RadOnc AI

- While waivers can be ethical and pragmatic solutions, patients have no idea that AI is being used in research or care involving them;
- **If for minimal risk for quality systems we can rely on good ML practice, for higher risk we necessitate prospective informed consent!**
- Umbrella consent needed to inform patients;
- **Additional disclosure duties: patient access to information about specific AI algorithms used in their care;**

Subha Perni

Conditions	Study Titles	NCT Numbers	Interventions
Lung Cancer	MIRA Clinical Learning Environment (MIRACLE): Lung	NCT05689437	Various machine learning models for ILD prediction, SGR prediction, and lung density monitoring
Early Stage Non-small Cell Lung Cancer, Non-small Cell Lung Cancer	Computed Tomography-Guided Stereotactic Adaptive Radiotherapy (CT-STAR) for the Treatment of Central and Ultra-Central Early-Stage Non-Small Cell Lung Cancer	NCT05785845	Computed tomography-guided stereotactic adaptive radiotherapy, ETHOS device
Various heart-related conditions	Stress Echo 2030: the Novel ABCDE-(FGLPR) Protocol to Define the Future of Imaging	NCT05081115	Various diagnostic tests related to stress echo
Breast Cancer, Axillary Lymph Node Dissection, Breast Cancer Related Lymphedema, Axillary Reverse Mapping	Nomogram to Predict Breast Cancer Related Lymphedema	NCT04665882	Axillary surgery based on lymphedema prediction nomogram
Esophageal Neoplasm	Response Prediction to Neoadjuvant Chemoradiation in Esophageal Cancer Using Artificial Intelligence & Machine Learning	NCT04489368	Neo-Adjuvant Radiotherapy, Neo-Adjuvant Chemotherapy, Esophagectomy
Metastasis to Liver, Colorectal Cancer	Comparison of Image Quality Between "Double Low Dose" Liver CT	NCT05790590	Double low dose CT, Standard dose CT
Various cancers (Prostate, Glioblastoma, Head and Neck, Kidney, Cervix)	MRI Guided Radiotherapy and Radiobiological Data: the ISRAR Database	NCT06041555	3 MRI sequences

Conditions	Study Titles	NCT Numbers	Interventions
Various Cancers (Arrhythmias, Cardiac, Breast, Prostate, Brain, Kidney, Head and Neck, Liver, Pancreatic, Spinal)	LEARN: Learning Environment for Artificial Intelligence in Radiotherapy New Technology	NCT05184790	-
Head and Neck Cancer	AI for Head Neck Cancer Treated With Adaptive RadioTherapy (RadiomicART)	NCT05081531	Adaptive Radiotherapy
Lung Carcinoma	Stereotactic Body Radiation Therapy Planning With Artificial Intelligence-Directed Dose Recommendation for Treatment of Primary or Metastatic Lung Tumors, RAD-AI Study	NCT05802186	Various imaging and radiation procedures
Lung Cancer	ARtificial Intelligence for Gross Tumour vOlume Segmentation	NCT05775068	Radiotherapy
Pelvic Cancer	Post Radiotherapy MRI Based AI System to Predict Radiation Proctitis for Pelvic Cancers	NCT04918992	Artificial Intelligence

43 studies found in ClinicalTrials.gov

PRO-React: Enhancing Cancer Patient Care

Study Design

Go to

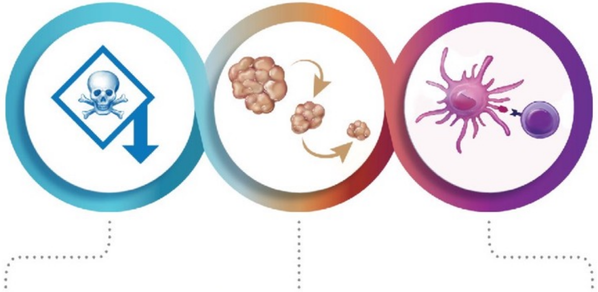
Study Type :	Observational [Patient Registry]
Estimated Enrollment :	166000 participants
Observational Model:	Cohort
Time Perspective:	Prospective
Target Follow-Up Duration:	6 Months
Official Title:	Development of an Artificial Intelligence-based Incident Prediction Algorithm to Improve Cancer Patient Care and Patient Safety
Actual Study Start Date :	August 3, 2022
Estimated Primary Completion Date :	December 2025
Estimated Study Completion Date :	December 2025

- **Early Incident Prediction**
  - PRO-React predicts incidents early, reducing risks.
- **Resource Optimization**
  - Identifying "low-risk" cases optimizes resource use.
- **OMCAT Register**
  - Combines PRO data for accurate predictions.
- **PRO Time Series Benefit**
  - High-frequency PRO data reduces delays.

Big Data Initiative: **Optimizing Data That is AI-Driven for Patient Treatments**

- AI mining of information from the patients through biopsies, blood examples, imaging;
- measuring biologoical prognostic changes along the way;
- exploring a mosaic of information;
- defining hypotheses in reaction to mechanistic understanding;

Three Attractions to PULSAR



SPLIT COURSE TREATMENTS ARE LESS TOXIC

Use in toxicity prone locations and re-treatments.

LONG INTERVALS BETWEEN PULSES FACILITATE ADAPTATION

Make big tumors small. Exploit dramatic changes in patient-derived biomarkers.

LONG INTERVALS BETWEEN PULSES MAY FOSTER ADAPTIVE IMMUNITY

Enhance systemic IO.

Illustration by Townsend Majors.

Robert Timmerman, M.D.
Professor and Department Chair

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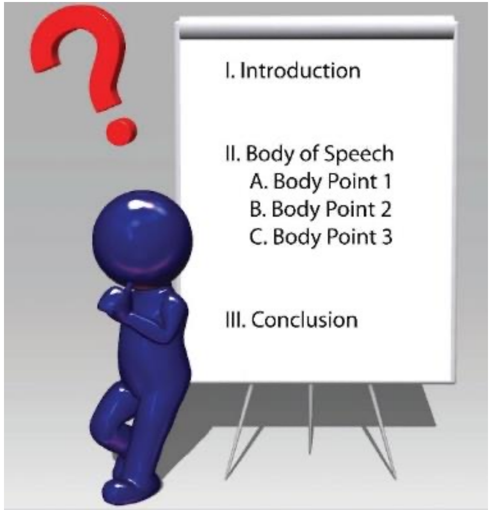
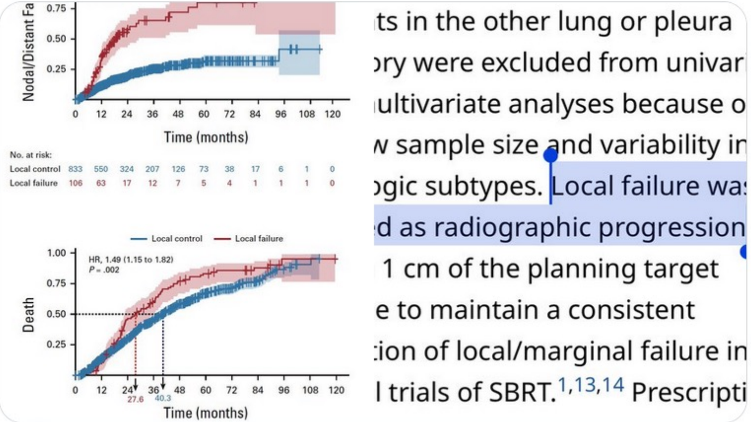


Genomic analysis in oncology with AI: the opportunity for RADONC

original reports

Drew Moghanaki @DrewMoghanaki · 16h
In risposta a @theabzlab
Congratulations on pushing us into the future.

I noticed a very high event rate in your cohort, suggesting these data will need to be validated in a healthier cohort to be applicable to operable pts.



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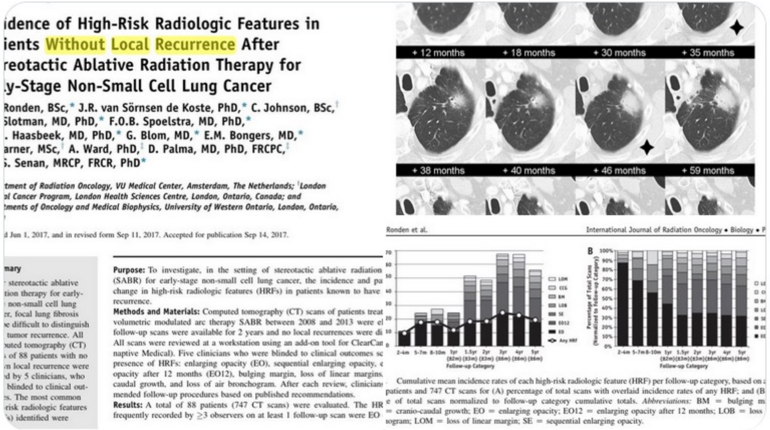
Drew Moghanaki @DrewMoghanaki · 16h
In risposta a @DrewMoghanaki e @theabzlab
This is a MUST READ paper for anyone coding local failures after SBRT. It shows how easy, but not how often, it is for coders to be fooled and overcall LF. doi.org/10.1016/j.ijro...



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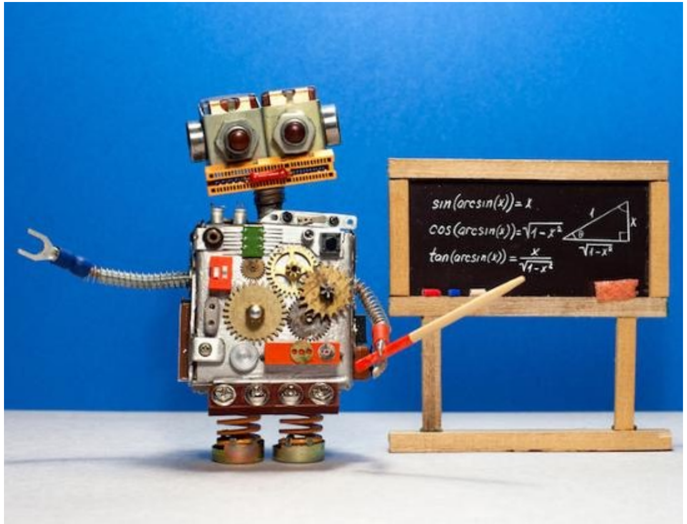
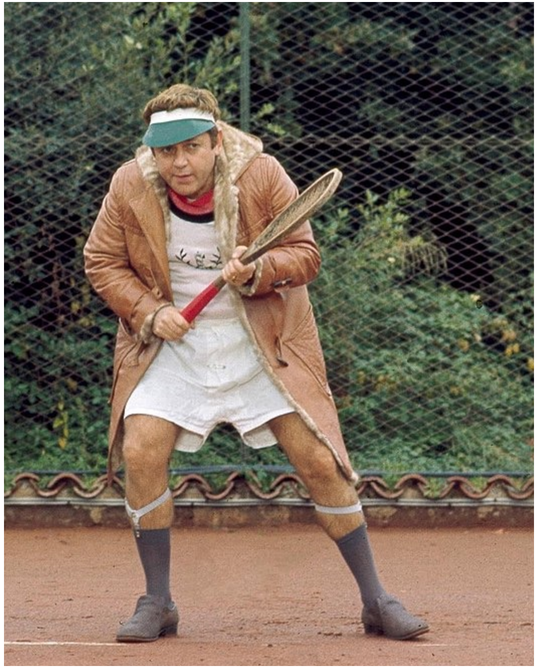
Things to remember: AI performance depends on the TRAINING





Don't try to get AI to replace the expert!

available at www.sciencedirect.com
journal homepage: euoncology.europeanurology.com

European Association of Urology

Digital Rectal Examination Is Not a Useful Screening Test for Prostate Cancer

Agne Krilaviciute [a,†], Nikolaus Becker [a,†], Jale Lakes [b], Jan Philipp Radtke [b], Markus Kuczyk [c], Inga Peters [c,‡], Nina N. Harke [c], Jürgen Debus [d,e], Stefan A. Koerber [d], Kathleen Herkommer [f], Jürgen E. Gschwend [f], Valentin H. Meissner [f], Axel Benner [g], Petra Seibold [a], Glen Kristiansen [h], Boris Hadaschik [i,j], Christian Arsov [b,§], Lars Schimmöller [k], Frederik Lars Giesel [l], Gerald Antoch [k], Marcus Makowski [m], Frank Wacker [n], Heinz-Peter Schlemmer [o], Rudolf Kaaks [p,||], Peter Albers [a,b,||,]*

Todd Scarbrough
@toddscarbrough

Blowing raspberries in radiologists'
replace a single iota of anything we
exams)

Radiotherapy and Oncology 186 (2023) 109747

Contents lists available at ScienceDirect

Radiotherapy and Oncology

journal homepage: www.thegreenjournal.com

Original Article

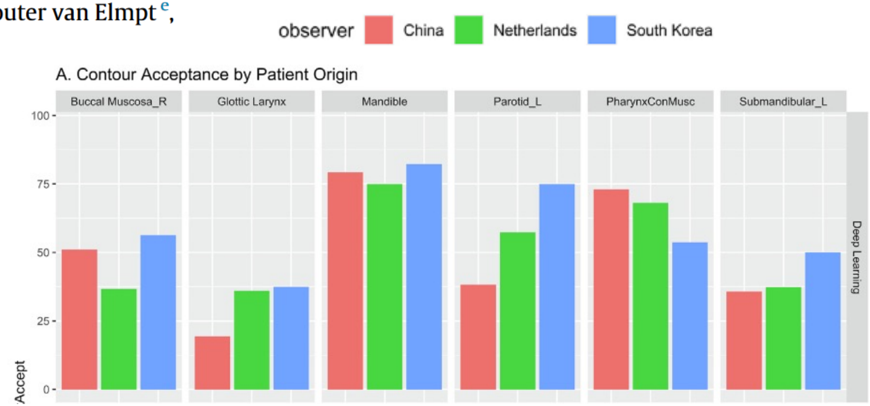
An investigation into the risk of population bias in deep learning autocontouring

Yasmin McQuinlan [a], Charlotte L. Brouwer [b,*], Zhixiong Lin [c], Yong Gan [c], Jin Sung Kim [d], Wouter van Elmpt [e], Mark J. Gooding [f,g]

Mark Gooding
@SciChief

Is your #AI #autocontouring for #RadOnc racist?

It might be reasonable to assume we are all the same on the inside, but could bias inherent in a training set from one demographic impact performance in another?



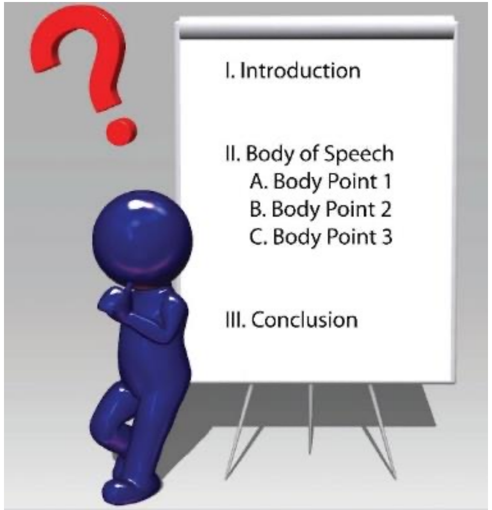
Two ways to look at AI:

Fear or Excitement?

1. I want my oncological modalities to be perfect, no failures, no toxicity;
2. I would like to have predictive models to educate patients as to their outcomes from specific therapies;
3. AI tools will only replace doctors who don'tuse them with doctors that do!

Outline

- ***Definition;***
- ***Application in RadOnc;***
- ***New application (ESTRO, ASTRO);***
- ***Reaction of our community***
- ➢ ***Is there a future for #RadOnc with AI?***



Where were we until 20 years ago?

3DRT

IMRT

VMAT

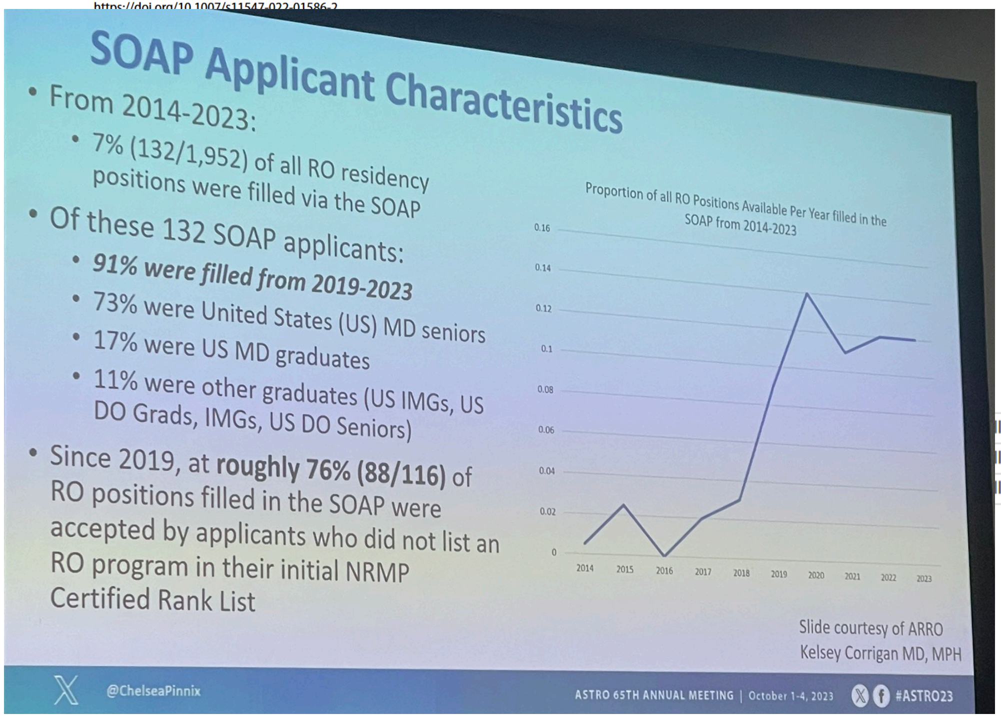
MRI-LINAC

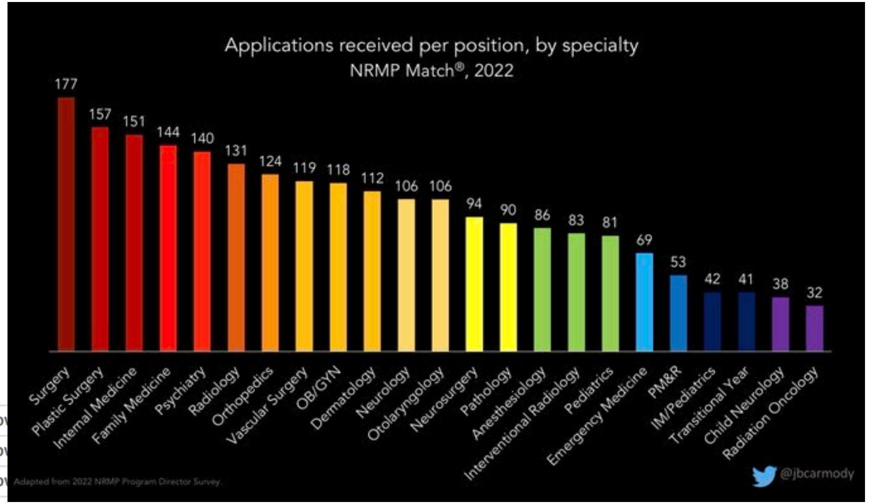
SRT

?

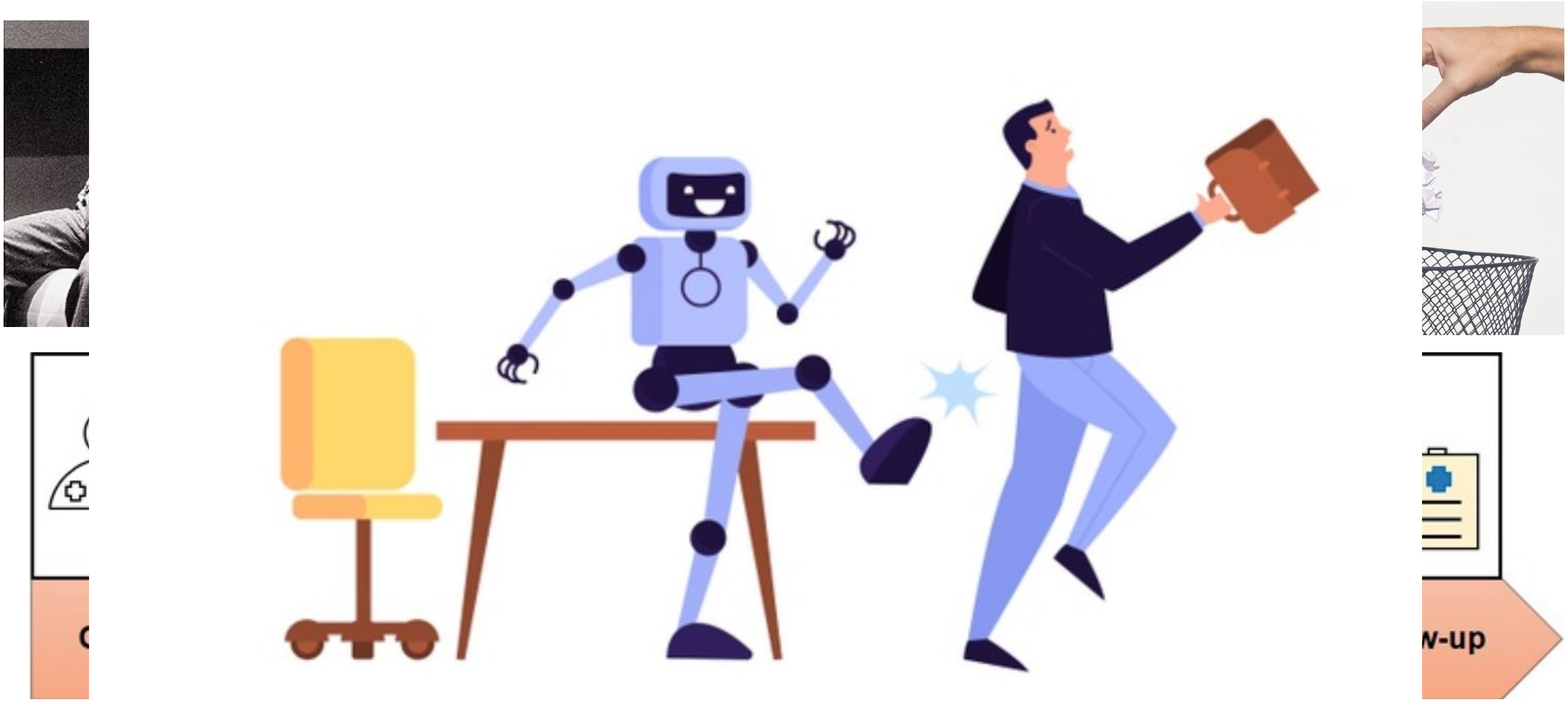
What is happening now?

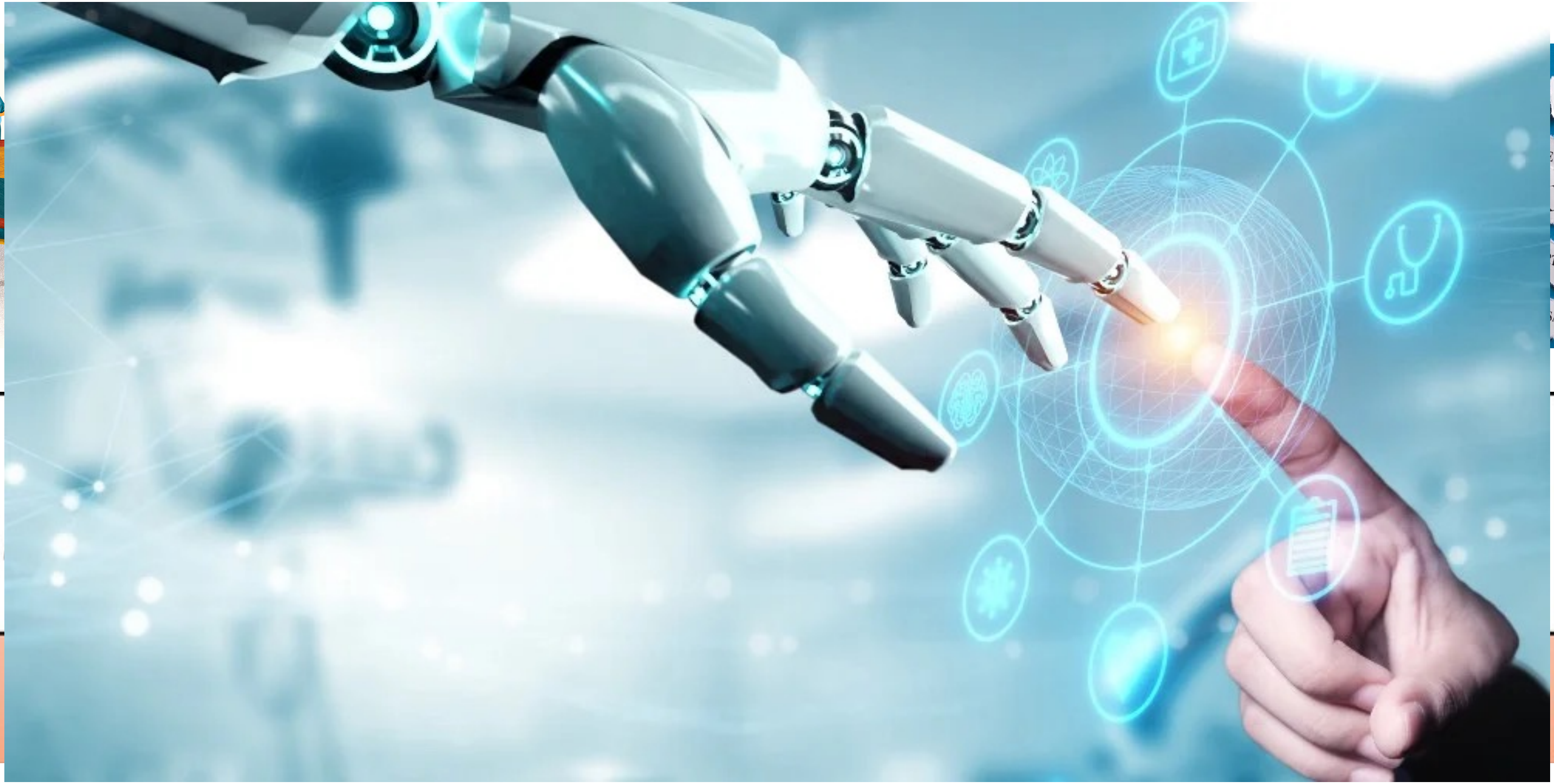
La radiologia medica (2023) 128:252–260
https://doi.org/10.1007/s11547-022-01586-2

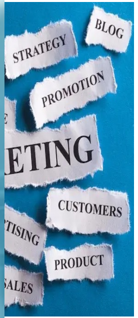




ASTRO 2023


w-up




STRATEGY
BLOG
PROMOTION
CUSTOMERS
PRODUCT

Where will we be in 10 years?

Conclusions

- In the next years we will see many different application of AI in RadOnc workflow;
- Current applications focus on contouring, planning, adaptive;
- Future development in other areas (genomic profiling, radiomics) could have an high impact on RadOnc;
- Ethical challenges need to be solved;
- A big effort of RadOnc community is needed to integrate AI and build a solid future for our community!

There is no SOUL in the MACHINE.
Only in front of it.

Without you, it's just DATA.

Thank you!


Roberta
Valerio
Roberto
Giuseppina
Rossella
Giusy
Luca
Federico
Vittorio
Dino
Paolo


Elekta
Levi's