



6th ANNUAL UC COURSE

Emerging personalized therapies for the
management of urothelial carcinomas

VI CURSO ANUAL DE UC

Terapias personalizadas emergentes
en el manejo del carcinoma urotelial

Aplicación de IA generativa en el cáncer de vejiga

Julio Mayol

Hospital Clínico San Carlos

Universidad Complutense de Madrid

Instituto de Investigación Sanitaria San Carlos



Correspondence



INTERNATIONAL JOURNAL OF SURGERY

OPEN

The potential impact of ChatGPT/GPT-4 on surgery: will it topple the profession of surgeons?

Kunming Cheng, MD^a, Zaijie Sun, MD^b, Yongbin He, MD^c, Shuqin Gu, PhD^{e,*}, Haiyang Wu, MD^{d,f,*}

Dear Editor,

With the rapid developments of artificial intelligence (AI), powerful AI-related technologies have entered many areas of life. Recently, ChatGPT (Generative Pre-trained Transformer), an AI-powered chatbot developed by OpenAI, has created a ruckus throughout the world and hits the international headlines frequently. ChatGPT is a natural language processing model and could generate human-like text, allowing users to obtain answers in an intuitive and conversational way^[1]. In the initial release version, ChatGPT is a fine-tuned application based on the GPT-3.5 engine. Over the past few months, multiple studies have demonstrated that ChatGPT/GPT-3.5 have great potential in medical applications, such as providing professional medical advice, identifying top research questions, as well as helping in academic writing^[2]. However, many scholars also pointed out that in many cases, the

HIGHLIGHTS

- This is the first study to summarize the potential applications of ChatGPT (Generative Pre-trained Transformer)/GPT-4 in the surgical field.
- ChatGPT/GPT-4 is capable of participating in multiple aspects of surgical work, including scientific writing, doctor-patient communication, diagnostic imaging, and patients' perioperative management.
- ChatGPT/GPT-4 could be a good assistant for surgeons, but it was not possible to topple the profession of surgeons.

pass a simulated bar exam with a score around the top 10% of test takers. Nevertheless, to our knowledge, there has been no



The answer is “Yes, it’s gonna replace us”, so sit back and relax



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M I N D

A QUARTERLY REVIEW

OF

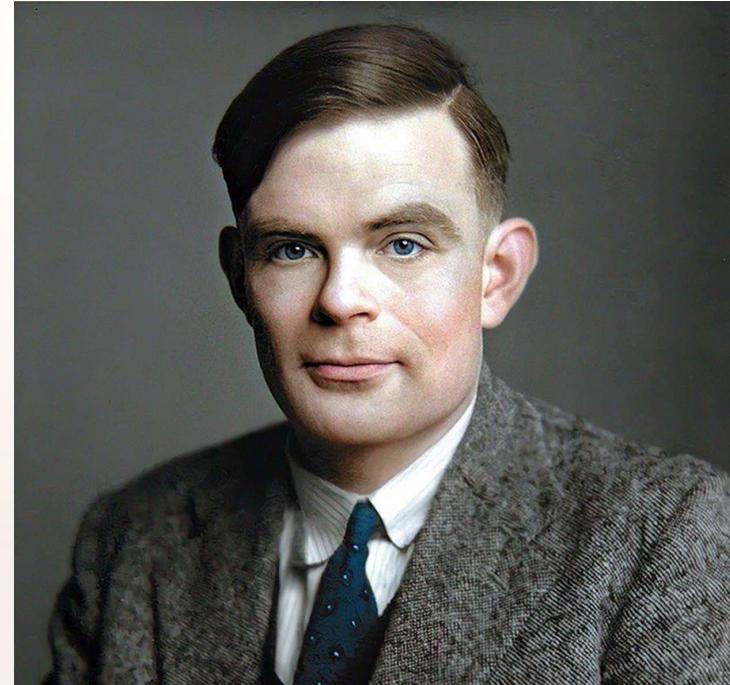
PSYCHOLOGY AND PHILOSOPHY

I.—COMPUTING MACHINERY AND INTELLIGENCE

BY A. M. TURING

1. *The Imitation Game.*

I PROPOSE to consider the question, ‘Can machines think?’ This should begin with definitions of the meaning of the terms ‘machine’ and ‘think’. The definitions might be framed so as to reflect so far as possible the normal use of the words, but this attitude is dangerous. If the meaning of the words ‘machine’ and ‘think’ are to be found by examining how they are commonly used it is difficult to escape the conclusion that the meaning and the answer to the question, ‘Can machines think?’ is to be sought in a statistical survey such as a Gallup poll. But this is absurd. Instead of attempting such a definition I shall replace the question by another, which is closely related to it and is expressed in relatively unambiguous words.





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A PROPOSAL FOR THE DARTMOUTH SUMMER RESEARCH PROJECT ON ARTIFICIAL INTELLIGENCE

J. McCarthy, Dartmouth College
M. L. Minsky, Harvard University
N. Rochester, I.B.M. Corporation
C.E. Shannon, Bell Telephone Laboratories

We propose that a 2 month, 10 man study of artificial intelligence be carried out during the summer of 1956 at Dartmouth College in Hanover, New Hampshire. The study is to proceed on the basis of the conjecture that every aspect of learning or any other feature of intelligence can in principle be so precisely described that a machine can be made to simulate it. An attempt will be made to find how to make machines use language, form abstractions and concepts, solve kinds of problems now reserved for humans, and improve themselves. We think that a significant advance can be made in one or more of these problems if a carefully selected group of scientists work on it together for a summer.

August 31, 1955





Tecnología: redes neuronales



Big data



Capacidad de procesamiento



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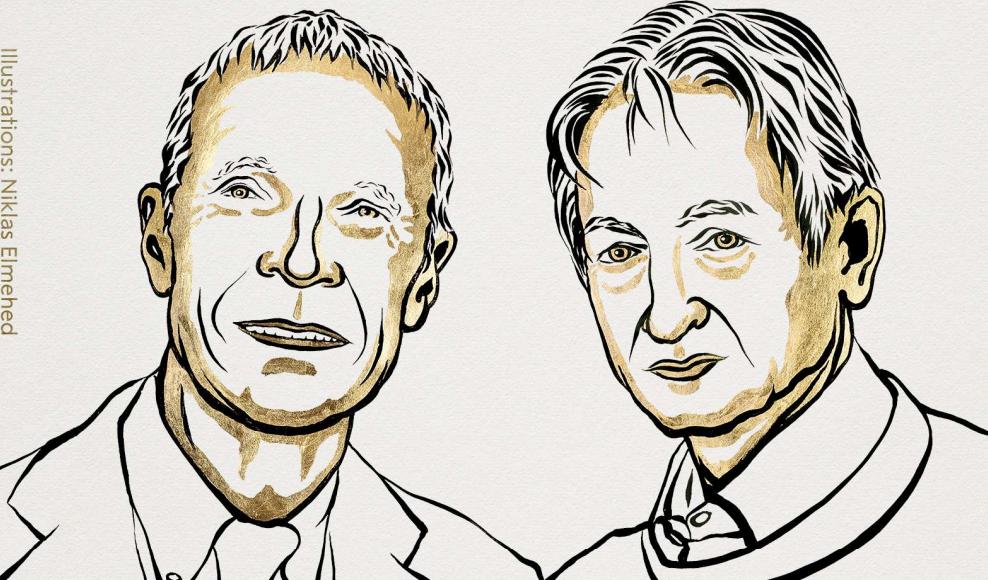
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THE NOBEL PRIZE
IN PHYSICS 2024

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John J. Hopfield Geoffrey E. Hinton

"for foundational discoveries and inventions
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THE ROYAL SWEDISH ACADEMY OF SCIENCES



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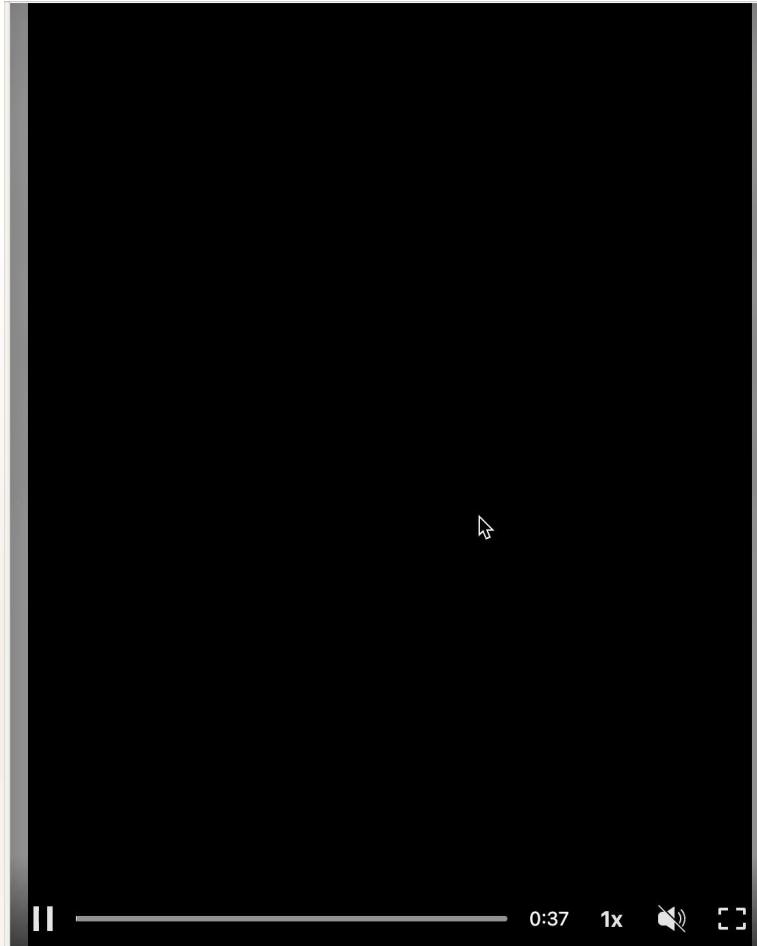
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Cómo funciona una red neuronal

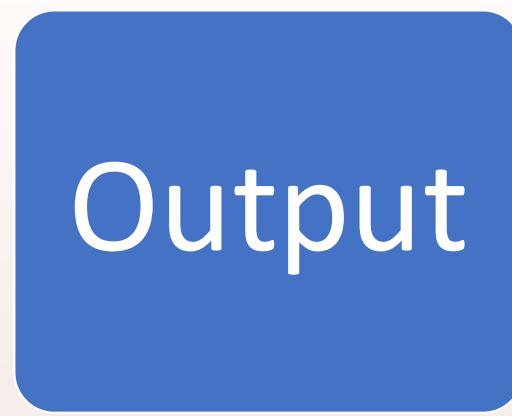
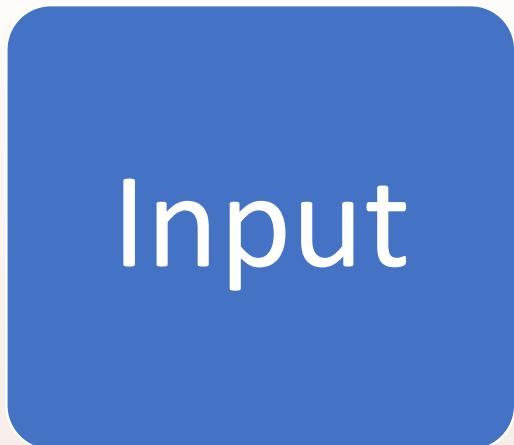




Cómo funciona

Prompt engineering

Pre-trained



RAG
Retrieval augmented generation

Generative Antagonistic Networks (GANs)
Recurrent Neural Networks(RNNs)
Transformers
Convolutional Neural Networks (CNNs)
Autoencoders Variacionales (VAEs)
Diffusion Models
NeRF (Neural Radiance Fields)



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Modelos entrenados en Oncología

OncoGPT: A Medical Conversational Model Tailored with Oncology Domain Expertise on a Large Language Model Meta-AI (LLaMA)

Fujian Jia^{1,*}, Xin Liu^{1,*§}, Lixi Deng^{1,*}, Jiwen Gu¹, Chunchao Pu¹, Tunan Bai¹,
Mengjiang Huang², Yuanzhi Lu^{3,§}, Kang Liu^{1,§}

1, Shenzhen Kanghua Juntai Biotech Co. Ltd., B 215, Unit No.7, Shahe Rd W,
Nanshan, Shenzhen, Guangdong Province 518063, China.

2, Department of Nutrition and Graduate Group in Nutritional Biology, University of
California, Davis, CA 95616, USA.

3, Department of Pathology, The First Affiliated Hospital of Jinan University, Tianhe
Qu, Guangzhou 510632, China.

A chalkboard with handwritten mathematical notes. At the top left, there is a diagram of a function $y = g(x)$ with a secant line drawn through it, labeled "Secant Lines". To the right, the derivative is defined as $f'(x) = \lim_{h \rightarrow 0} \frac{g(x+h) - g(x)}{h}$. Below this, the definition is expanded into two parts: $f(x) = \lim_{h \rightarrow 0} (x+h)^2 + 2$ and $= \lim_{h \rightarrow 0} \frac{x^2 + 2xh + h^2 + 2 - x^2 - 2}{h}$. Further down, the expression is simplified to $= \lim_{h \rightarrow 0} \frac{h(2x+h+2)}{h}$.

Matemática

- Rule-based: aritmética
- Machine learning: estadística
- LLM: álgebra lineal + estadística

Propósito





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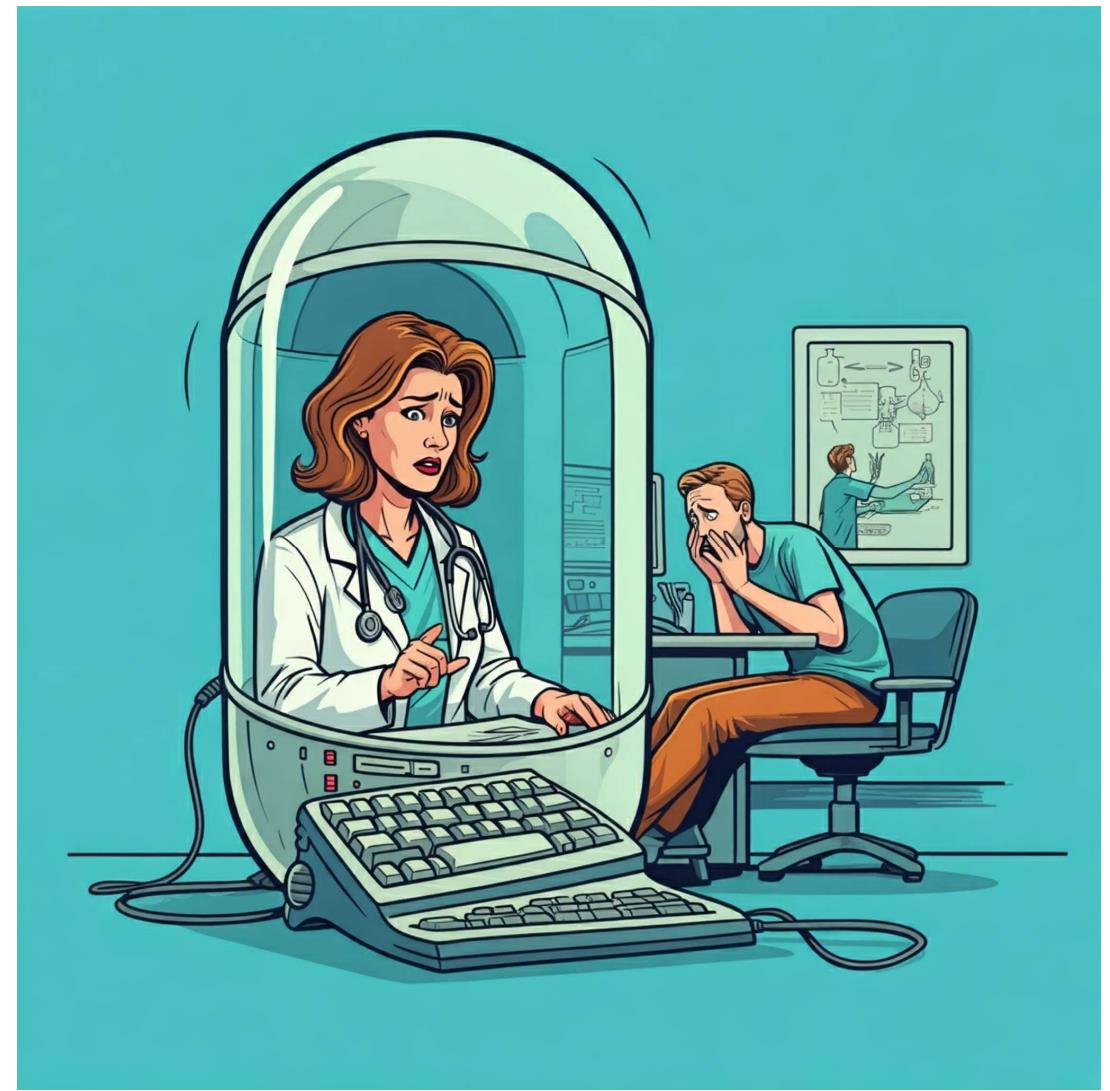


Valor en cáncer de vejiga

$(\text{Beneficio} - \text{daño}) \times (\text{PROMs} + \text{PREMs})$

Costes (€ + tiempo + CO2)

No era esto



Los humanos



Casos de uso



Nos fascina lo técnico pero la mayoría de nuestros problemas son cognitivos

Gen AI



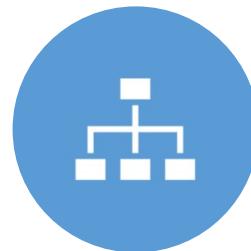
I+D+i



Educación y
entrenamiento



Práctica clínica



Gestión



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Eng. Sci., 2023, 26, 1003



Engineered Science

DOI: <https://dx.doi.org/10.30919/es1003>



Advancements in Bladder Cancer Management: A Comprehensive Review of Artificial Intelligence and Machine Learning Applications

Manu Sudhi,¹ Vinod Kumar Shukla,² Dasharathraj K Shetty,^{3,*} Vanshika Gupta,³ Aditi Sangram Desai,³ Nitlesh Naik⁴ and BM Zeeshan Hameed^{5,6}

Abstract

Artificial intelligence (AI) and machine learning (ML) have emerged as powerful tools in the diagnosis and treatment of bladder cancer, offering significant advancements in accuracy and speed. AI algorithms have enabled precise segmentation of the bladder wall and accurate detection of bladder tumors using non-invasive 3D image-based features from CT and MRI scans. Decision support systems based on AI have improved the assessment of treatment efficacy for muscle-invasive bladder cancer. AI-assisted cystoscopy has demonstrated higher sensitivity and specificity in identifying and categorizing bladder lesions, potentially outperforming human urologists. ML algorithms, including artificial neural networks, have shown superior predictive capabilities in prognosis and outcome prediction compared to conventional models. Radiomics and ML techniques have enhanced bladder cancer staging and treatment response assessment through accurate analysis of imaging data. AI-driven biomarker discovery, including metabolomics, has the potential to revolutionize non-invasive bladder cancer diagnosis and monitoring. Automated histologic grading and molecular typing facilitated by AI have led to faster and more precise diagnoses, enabling personalized treatment plans. The integration of AI and ML in bladder cancer diagnosis has the potential to improve patient outcomes significantly. By providing faster and more precise diagnoses, AI-driven approaches can enhance treatment planning and response evaluation. Additionally, AI-assisted cystoscopy and improved biomarkers can lead to less invasive and more effective diagnostic techniques. Furthermore, AI-driven prognostic models offer a more accurate prediction of patient outcomes, enabling personalized treatment strategies. These contributions collectively indicate a promising future for AI and ML in bladder cancer management, enhancing diagnostic accuracy, treatment efficacy, and patient care.

Keywords: Artificial Intelligence; Machine Learning; Bladder Cancer; Deep Learning; Neural Networks; Medical imaging.

Received: 17 October 2023; Revised: 29 October 2023; Accepted: 30 October 2023.

Article type: Review article.

Table 3. Advantages and limitations of AI in bladder cancer management.

Advantages	Limitation
1. Improved diagnostic accuracy	1. Data Dependence and Quality: AI models heavily rely on high-quality and diverse datasets for accurate predictions. Limited or biased data may lead to suboptimal results
2. Early detection and prognosis	2. Ethical Considerations: The use of AI in healthcare raises ethical concerns related to data privacy, patient consent, and potential biases in algorithmic decision-making.
3. Personalized treatment strategies	3. Interpretability and Transparency: Some AI models, particularly deep learning algorithms, are often considered "black boxes," making it challenging to interpret their decision-making process.
4. Improved treatment planning	4. Integration into Clinical Workflow: Incorporating AI into existing clinical workflows requires careful implementation and acceptance by healthcare professionals.
5. Reduced Healthcare costs	5. Expertise and Training: AI implementation demands skilled personnel with expertise in both medical and AI fields. Training healthcare professionals to use AI effectively can be time-consuming.
6. Empowering patients	6. Lack of Standardization: The lack of standardized AI algorithms and protocols may result in variations in diagnostic outcomes and treatment recommendations.
7. Advancement in Research	7. Regulatory and Legal Challenges: Regulatory approval and compliance with legal requirements can be complex and time-consuming for AI applications in healthcare.
	8. Data Security and Privacy: Storing and processing sensitive patient data requires robust security measures to prevent data breaches.



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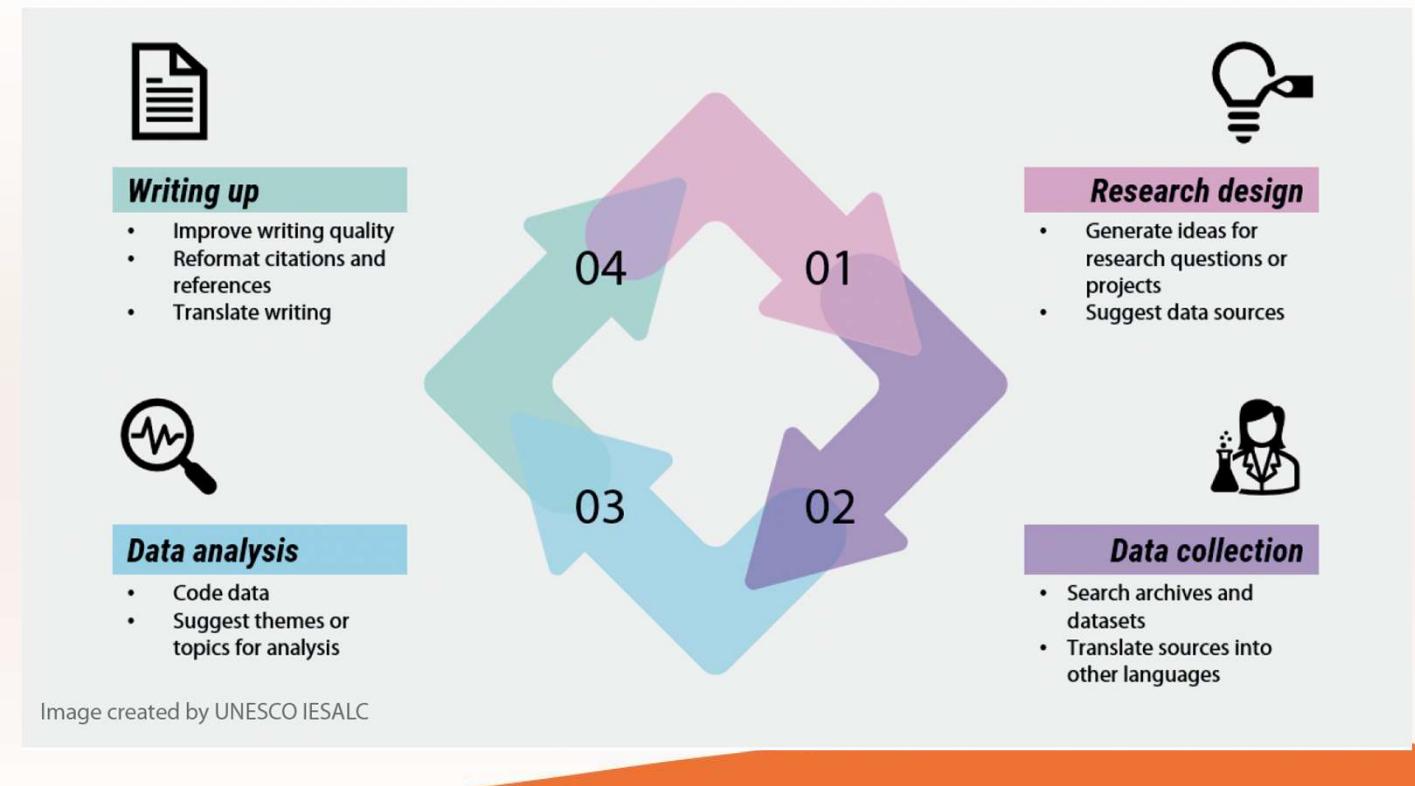
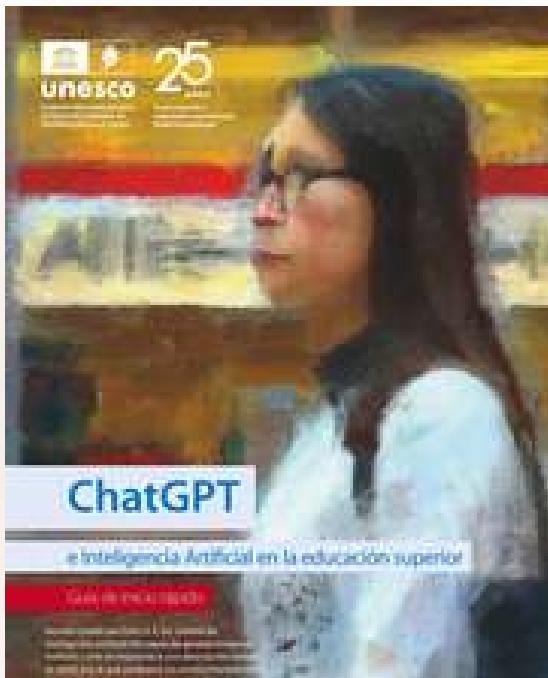
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Cómo usar ChatGPT (UNESCO)





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Simulador Reviewer #2 ▾



Simulador Reviewer #2

Por JULIO MAYOL ☺

Simulador severo y riguroso de Reviewer #2 en medicina basada en evidencia

Revisa
críticamente este
artículo quirúrgico:

Analiza este
ensayo clínico
en detalle:

¿Este estudio
justifica cambios
en la práctica...

Compara este
estudio con la
evidencia más...

Lee el artículo que te voy a subir, resúmelo y hazle una crítica rigurosa como si fueras reviewer #2



ChatGPT puede cometer errores. OpenAI no usa datos del área de trabajo de AI by JM para formar a sus modelos.





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Proyecto de investigación

ChatGPT o3 ▾

Temporal

¿En qué puedo ayudarte?

Quiero que de una manera rigurosa elabores una hipótesis de investigación novedosa en el tratamiento médico-quirúrgico del cáncer de vejiga, que aborde un gap en el conocimiento actual, y a partir de ella elabores un proyecto tipo FIS, que incluya lo primero una justificación, que además tenga objetivos bien definidos y abordados con la metodología rigurosa y bien fundamentada, con el análisis estadístico apropiado, que tenga en cuenta la perspectiva de género, el plan verde europeo, la política de gestión de datos, la estrategia de difusión y un presupuesto estimado pero riguroso, que incluya publicación de resultados en revistas open access (así como el equilibrio en roles y la distribución de tareas a tres años). El proyecto tiene que ser de vanguardia pero realista para tener éxito en la convocatoria.

+ Buscar Investigación en profundidad Crea una imagen ...

?

ChatGPT puede cometer errores. OpenAI no usa datos del área de trabajo de AI by JM para formar a sus modelos.

?



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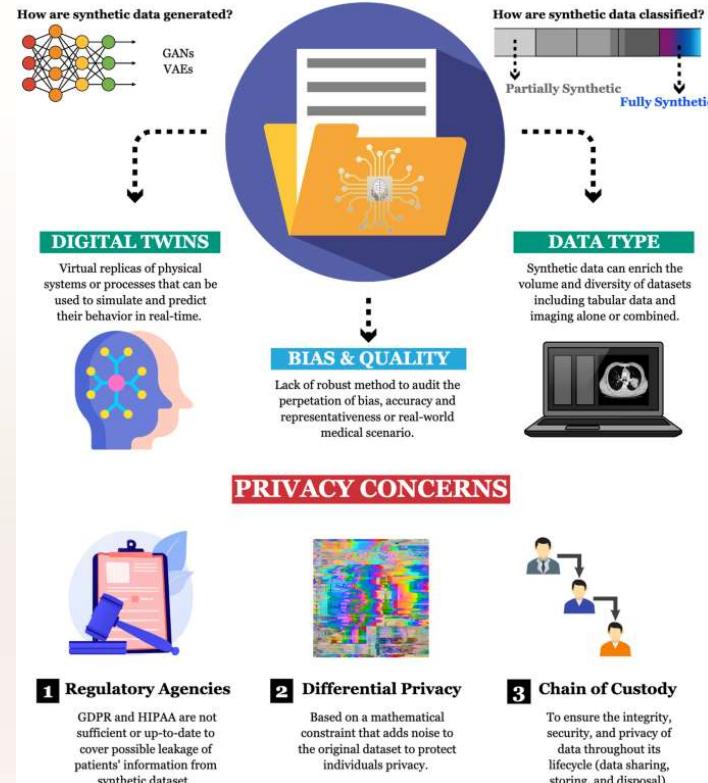
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Datos sintéticos

Synthetic Data

Definition (by the Royal Society and Alan Turing Institute): "data that has been generated using a purpose-built mathematical model or algorithm, with the aim of solving a (set of) data science task(s)".



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The screenshot shows the Julius AI platform interface. The left sidebar includes sections for Workspace (My Threads 90, My Workflows 3), My Files, and an active Inbox (5 notifications). Resources like Explore Workflows, Documentation, Community Forum, and Models Lab are also listed. A 'Julius for Teams' section offers team management and billing options. The main area features a central search bar with placeholder 'Add a file or start a conversation now and add files later...' and filters for Claude 3.7 Sonnet, No Theme, Advanced Reasoning (selected), Extended Memory, and Saved Prompts. Below this, a section titled 'What do you want to analyze today?' displays five workflow suggestions: Quick Visualization, Data Cleaner, Significance Testing, Time Series Analysis, and Extract Tables from PDF. Each suggestion includes a preview icon, title, description, and run count. The top right corner shows sharing and navigation icons, and the bottom right corner shows the Julius logo.

Julius

+ New

Workspace

My Threads (90)

My Workflows (3)

My Files

Inbox (5)

Resources

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Connecting

Share

Outline

Julius

A navigation bar at the top right.

What do you want to analyze today?

Add a file or start a conversation now and add files later...

Claude 3.7 Sonnet No Theme Advanced Reasoning (Selected) Extended Memory Saved Prompts

Or start from ready workflows

Search workflows...

Quick Visualization

Visually explore a spreadsheet... 44651 runs

Data Cleaner

Methodically clean your data... 11714 runs

Significance Testing

Run significance... 5897 runs

Time Series Analysis

Forecast time series data fo... 9103 runs

Extract Tables from PDF

Extract tables from a PDF!... 4704 runs

Julius' Workspace

60
MINUTES





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In collaboration with ZS



Intelligent Clinical Trials: Using Generative AI to Fast-Track Therapeutic Innovations

WHITE PAPER
DECEMBER 2024

Government

- Create standards for data collection and sharing
- Build centralized or federated data hubs
- Create incentives to drive networked data sharing
- Advocate for transparency in data usage

Regulators

- Drive policies enforcing data standards
- Establish regulatory sandboxes
- Promote adaptive trial designs
- Create AI-specific regulatory frameworks
- Balance innovation and compliance

Public-private consortia

- Establish shared AI innovation goals
- Implement advanced data security protocols
- Spearhead data-sharing initiatives

Clinical development leaders/pharma

- Use Gen AI to improve incomplete or low-quality datasets where possible
- Implement AI-driven adaptive trial designs
- Participate in data-sharing initiatives
- Combat innovation inertia
- Address workforce skills gaps

AI and technology leaders

- Develop AI solutions tailored for clinical settings
- Integrate diverse data sources

Healthcare providers

- Support data-sharing frameworks
- Promote data-driven innovation



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Revolutionizing surgical education: the AI and social media synergy



Julio Mayol PhD

Professor of Surgery Universidad Complutense de Madrid, Madrid, Spain

19 March 2025

General

Welcome to your new monthly SoMe update!

We're launching an initiative at BJS Academy to create and share educational content about social media and generative AI in surgery. All content is generated using AI tools, aiming to enhance learning experiences.



en español

Revolucionando la Educación Quirúrgica: Redes Sociales e IA

Lanzamos una iniciativa en BJS Academy para crear y compartir contenido educativo sobre redes sociales e inteligencia artificial generativa en cirugía. Todo el contenido es generado con herramientas de IA, buscando mejorar experiencias de aprendizaje.



Related articles





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+ Create



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EMPIRE: Urology Lecture Series



Max Kates
Assistant Professor
Director, Bladder Cancer Program
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0:04 / 57:34 • Intro >

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Educación

arXiv:2404.18416v1

(a) Video dialogue example

Hello, I am a medical student analyzing this surgical procedure video for my studies. Which surgical procedure is shown in this video?

Which specific surgical phase is shown in this video clip?

The specific surgical phase shown in this video clip is the dissection and isolation of the cystic duct and artery. This phase occurs after the surgeon has entered the abdominal cavity and visualized the gallbladder, which can be seen retracted superiorly by forceps, and before the clipping and dividing of the cystic duct and artery.

The surgeon is using a laparoscopic dissector to carefully separate the cystic duct and cystic artery from the surrounding tissue. This is a critical step as it allows the surgeon to clearly identify and isolate these structures before they are clipped and divided and can help to prevent injury to the common bile duct and hepatic artery.

The surgeon in this video clip is using two tools: **Laparoscopic Grasper**: A long, thin instrument with a handle on one end and a grasping mechanism on the other, which can be opened and closed to hold tissue and manipulate organs and other structures. **Hook Electrocautery**: A long, thin instrument with a handle on one end and a hook-shaped tip on the other. The hook shape allows the tool to dissect, cut and cauterize tissue. Cauterizing tissue helps prevent bleeding during surgery and seals off blood vessels and lymphatic ducts to minimize the risk of leaks.

Which tools and how many are being used by the surgeon?

Which steps should the surgeon take to avoid injuring those structures?

To prevent such injuries, the surgeon should consider the following:

- Critical View of Safety (CVS)**: This technique involves identifying the anatomical structures of the Calot's triangle to clearly visualize the cystic duct and artery independently before clipping or cutting to ensure that they are not mistaken for the common bile duct or hepatic artery.
- Intraoperative Cholangiogram (IOC)**: Although not frequently performed now, this procedure involves injecting a contrast dye into the cystic duct to visualize the biliary tree on X-ray. This can help the surgeon to confirm the anatomy of the bile ducts and identify any abnormal structures, ensuring the common bile duct is not clipped.
- Fluoroscopy**: By using fluoroscopy during the surgery to accurately identify the cystic duct and common bile duct using contrast.

Stay within Calot's triangle - The area bordered by the cystic duct, the common hepatic duct, and the cystic artery.

Do you want to learn more about the specific steps?

Which anatomical structures are visible?

The following anatomical structures are visible:

- Liver**: The large, reddish-brown organ in the upper right portion of the abdomen.
- Gallbladder**: The small, pear-shaped organ located below the liver. The gallbladder is grasped and retracted by forceps.
- Cystic duct**: The thin, tube-like structure that connects the gallbladder to the common bile duct.
- Common bile duct**: The larger duct visible below the cystic duct that carries bile from the liver and gallbladder to the small intestine.
- Cystic artery**: The small artery that supplies blood to the gallbladder; it is visible alongside the cystic duct.

(b) Feedback from surgeon

Pros <ul style="list-style-type: none"> "Impressive understanding of which surgical procedure is being performed, which specific phase in the procedure this video clip is taken from, which tools are being used, and which anatomical structures are visible." "Correctly identifies the risks in the current video clip, which is injuring the common bile duct, and correctly suggests taking the safety measures, highlighting the Critical View of Safety method first." 	Cons <ul style="list-style-type: none"> "The surgical procedure shown in this video is a laparoscopic cholecystectomy - the surgical removal of the gallbladder" -- this describes "cholecystectomy", but does not refer to the "laparoscopic" part - that the procedure is performed "keyhole". "Hook Electrocautery: The hook shape allows the tool to dissect, cut and cauterize tissue" -- this section does not explain what electrocautery itself actually is.
---	---

Figure 12 | Example of Med-Gemini-M 1.5's long-context capabilities on surgical video dialogue. Med-Gemini-M 1.5 analyzes a video clip from the Cholec80 dataset comprising footage from a laparoscopic cholecystectomy (a keyhole operation to remove the gallbladder). The model demonstrates its ability to analyse the video and conduct a realistic dialogue with a student learning about the procedure.



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Asistente Cáncer de Vejiga ▾



Asistente Cáncer de Vejiga

Por JULIO MAYOL ↗

Herramienta educativa de apoyo sobre cáncer de vejiga

Quiero que generes un paciente sintético que interaccione conmigo para evaluar, al final, mi grado de conocimiento (de matrícula de honor a suspenso - si mis conocimientos son deficientes o pongo el riesgo al paciente) y mi capacidad de comunicación





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Mejor que los expertos

JAMA
Network Open.



Original Investigation | Health Informatics

Large Language Model Influence on Diagnostic Reasoning

A Randomized Clinical Trial

Ethan Goh, MBBS, MS; Robert Gallo, MD; Jason Hom, MD; Eric Strong, MD; Yingjie Weng, MHS; Hannah Kerman, MD; Joséphine A. Cool, MD; Zahr Kanjee, MD, MPH; Andrew S. Parsons, MD, MPH; Neera Ahuja, MD; Eric Horvitz, MD, PhD; Daniel Yang, MD; Arnold Milstein, MD; Andrew P. J. Olson, MD; Adam Rodman, MD, MPH; Jonathan H. Chen, MD, PhD

Abstract

IMPORTANCE Large language models (LLMs) have shown promise in their performance on both multiple-choice and open-ended medical reasoning examinations, but it remains unknown whether the use of such tools improves physician diagnostic reasoning.

OBJECTIVE To assess the effect of an LLM on physicians' diagnostic reasoning compared with conventional resources.

DESIGN, SETTING, AND PARTICIPANTS A single-blind randomized clinical trial was conducted from November 29 to December 29, 2023. Using remote video conferencing and in-person participation across multiple academic medical institutions, physicians with training in family medicine, internal medicine, or emergency medicine were recruited.

INTERVENTION Participants were randomized to either access the LLM in addition to conventional diagnostic resources or conventional resources only, stratified by career stage. Participants were allocated 60 minutes to review up to 6 clinical vignettes.

MAIN OUTCOMES AND MEASURES The primary outcome was performance on a standardized rubric of diagnostic performance based on differential diagnosis accuracy, appropriateness of supporting and opposing factors, and next diagnostic evaluation steps, validated and graded via blinded expert consensus. Secondary outcomes included time spent per case (in seconds) and final diagnosis accuracy. All analyses followed the intention-to-treat principle. A secondary exploratory analysis evaluated the standalone performance of the LLM by comparing the primary outcomes between the LLM alone group and the conventional resource group.

RESULTS Fifty physicians (26 attendings, 24 residents; median years in practice, 3 [IQR, 2-8]) participated virtually as well as at 1 in-person site. The median diagnostic reasoning score per case was 76% (IQR, 66%-87%) for the LLM group and 74% (IQR, 63%-84%) for the conventional resources-only group, with an adjusted difference of 2 percentage points (95% CI, -4 to 8 percentage points; $P = .60$). The median time spent per case for the LLM group was 519 (IQR, 371-668) seconds, compared with 565 (IQR, 456-788) seconds for the conventional resources group, with a time difference of -82 (95% CI, -195 to 31; $P = .20$) seconds. The LLM alone scored 16 percentage points (95% CI, 2-30 percentage points; $P = .03$) higher than the conventional resources group.

CONCLUSIONS AND RELEVANCE In this trial, the availability of an LLM to physicians as a diagnostic aid did not significantly improve clinical reasoning compared with conventional resources. The LLM alone demonstrated higher performance than both physician groups, indicating the need for

Key Points

Question Does the use of a large language model (LLM) improve diagnostic reasoning performance among physicians in family medicine, internal medicine, or emergency medicine compared with conventional resources?

Findings In a randomized clinical trial including 50 physicians, the use of an LLM did not significantly enhance diagnostic reasoning performance compared with the availability of only conventional resources.

Meaning In this study, the use of an LLM did not necessarily enhance diagnostic reasoning of physicians beyond conventional resources; further development is needed to effectively integrate LLMs into clinical practice.

+ Visual Abstract

+ Invited Commentary

+ Supplemental content

Author affiliations and article information are listed at the end of this article.

(continued)

SUPR-GAN: SURgical PRediction GAN for Event Anticipation in Laparoscopic and Robotic Surgery

Yutong Ban^{1,2}, Guy Rosman^{1,2}, Jennifer A. Eckhoff², Thomas M. Ward², Daniel A. Hashimoto²
Taisei Kondo³, Hidekazu Iwaki³, Ozanan R. Meireles² and Daniela Rus¹

Abstract— Comprehension of surgical workflow is the foundation upon which artificial intelligence (AI) and machine learning (ML) holds the potential to assist intraoperative decision making and risk mitigation. In this work, we move beyond mere identification of past surgical phases, into prediction of future surgical steps and specification of the transitions between them. We use a novel Generative Adversarial Network (GAN) formulation to sample future surgical phases trajectories conditioned on past video frames from laparoscopic cholecystectomy (LC) videos and compare it to state-of-the-art approaches for surgical video analysis and alternative prediction methods. We demonstrate the GAN formulation’s effectiveness through inferring and predicting the progress of LC videos. We quantify the horizon-accuracy trade-off and explored average performance, as well as the performance on the more challenging, and clinically relevant transitions between phases. Furthermore, we conduct a survey, asking 16 surgeons of different specialties and educational levels to qualitatively evaluate predicted surgery phases.

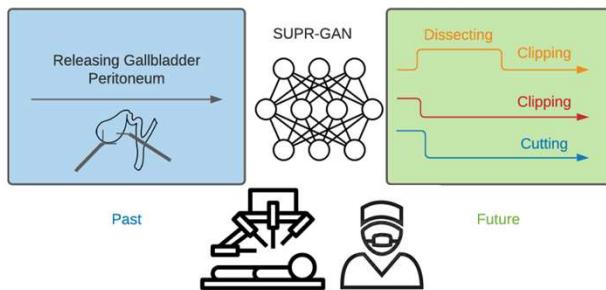


Fig. 1. Model overview: we predict a distribution of alternative future surgical phase sequences based on past surgical video frames.

surgery may in the far future translate the potential of advanced driving assistance systems to the operating room [16]. Phase prediction and early hazard detection promises



Clinical applications of artificial intelligence in robotic surgery

J. Everett Knudsen¹ · Umar Ghaffar² · Runzhuo Ma² · Andrew J. Hung²

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Abstract

Artificial intelligence (AI) is revolutionizing nearly every aspect of modern life. In the medical field, robotic surgery is the sector with some of the most innovative and impactful advancements. In this narrative review, we outline recent contributions of AI to the field of robotic surgery with a particular focus on intraoperative enhancement. AI modeling is allowing surgeons to have advanced intraoperative metrics such as force and tactile measurements, enhanced detection of positive surgical margins, and even allowing for the complete automation of certain steps in surgical procedures. AI is also revolutionizing the field of surgical education. AI modeling applied to intraoperative surgical video feeds and instrument kinematics data is allowing for the generation of automated skills assessments. AI also shows promise for the generation and delivery of highly specialized intraoperative surgical feedback for training surgeons. Although the adoption and integration of AI show promise in robotic surgery, it raises important, complex ethical questions. Frameworks for thinking through ethical dilemmas raised by AI are outlined in this review. AI enhancements in robotic surgery is some of the most groundbreaking research happening today, and the studies outlined in this review represent some of the most exciting innovations in recent years.

Keywords artificial intelligence · robotic surgery · robot-assisted surgery · intraoperative enhancement · clinical improvement · ethical considerations of AI

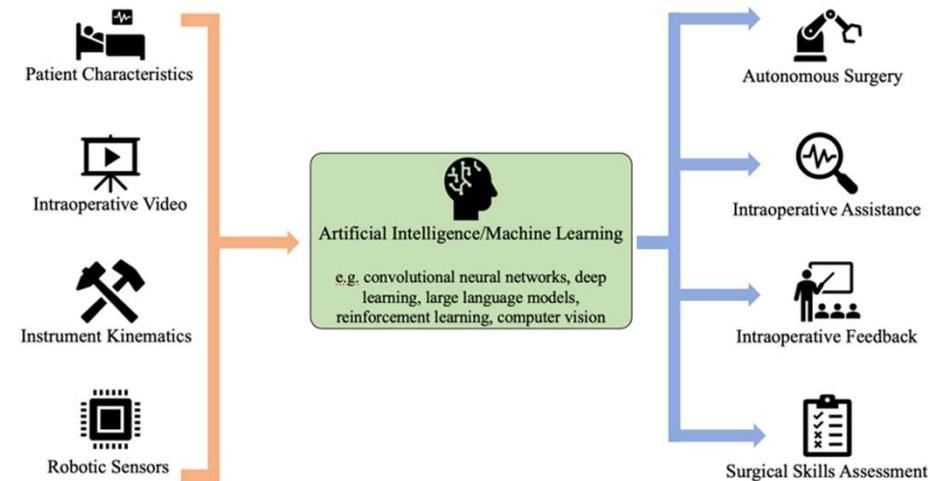


Fig. 1 Data inputs and outputs for the development of artificial intelligence/machine learning applications for the improvement of robotic surgery

Table 1

Levels of automation in robotic surgery. [3, 4]

Adapted from Panesar et al. and Attanasio et al.

Human vs. Autonomous Robotic Surgeon

Level 0 No Automation Traditional surgery: Human performs all surgical tasks; includes open, laparoscopic, and "master-slave" robotic surgical methods	Level 1 Some Assistance e.g. Intraoperative image guidance, augmented reality rendering; human surgeon still performs all surgical tasks	Level 2 Partial Automation Reduced required level of human input, but human surgeon still performs majority of surgical tasks
Level 3 Conditional Automation e.g. Automated bone drilling to prespecified depth with human setup; robot can perform certain procedural steps without human input	Level 4 High Automation e.g. Automated skin closure or lymph node dissection; Robot capable of performing most, if not all parts of a complex procedure with minimal human input	Level 5 Complete Automation e.g. Surgical robot that could perform an urgent cholecystectomy during a space flight; Robot is making all surgical decisions with no human input



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En consulta



LLAMALITICA

A group of diverse graduates in black caps and gowns are outdoors, looking up and smiling. The background shows green trees and a bright sky.

Retos éticos y legales

Escalado global



Artificial intelligence in surgery: a global balancing act

Divya Kewalramani^{1,*} Tyler J. Loftus², Julio Mayol³ and Mayur Narayan⁴

¹Department of Surgery, UPMC Children's Hospital of Pittsburgh, Pittsburgh, Pennsylvania, USA

²Department of Surgery, University of Florida, Gainesville, Florida, USA

³Department of Surgery, Hospital Clínico San Carlos, IdIISCS, Universidad Complutense de Madrid, Madrid, Spain

⁴Department of Surgery, Rutgers Robert Wood Johnson Medical School, New Brunswick, New Jersey, USA

*Correspondence to: Divya Kewalramani, Department of Surgery, Children's Hospital of Pittsburgh of UPMC, 4401 Penn Avenue, Pittsburgh, PA 15224, USA
(e-mail: kewalramanid@upmc.edu)

In the contemporary landscape of surgery, artificial intelligence (AI) plays markedly different roles across the global economic spectrum, offering solutions that range from reactive to predictive. In affluent nations, AI applications are predominantly predictive, proactively addressing potential health issues before they manifest. Conversely, in low- and middle-income countries (LMICs), as highlighted by Muir Gray, urgent challenges like unwarranted variability in surgical quality, harm, resource waste, inequity and lack of prevention prevail¹. These issues necessitate a strategic shift in AI application towards reactive solutions that directly address these immediate and critical surgical concerns. This dichotomy underscores the need for a strategic realignment of AI applications in surgery, moving beyond collaborative efforts to include major transformations in business models, surgical culture and technology. This article describes a comprehensive approach to aligning technology with the diverse needs of the global population, thus fostering a more balanced and responsive global surgical ecosystem.

processing tools could encourage responsible and round-the-clock care-seeking and primary symptom patient self-evaluation.

In LMICs, where surgical expertise may be limited or where patients often bear the burden of providing their own surgical supplies, AI-driven solutions could improve surgical outcomes and lead to more efficient resource management. Medikabazaar's approach, utilizing artificial neural networks for optimizing inventory logistics, exemplifies how AI can streamline the allocation of medical supplies and equipment, thereby easing patient stress and improving surgical experiences⁴. Moreover, the global vaccine distribution strategies employed by Moderna demonstrates AI's profound impact on supply chain management⁵. This success story offers valuable lessons on how AI can enhance surgical resource allocation worldwide.

The implementation of AI in administrative functions highlights the technology's versatility. For example, Globus AI in Norway has developed an AI-powered scheduling algorithm that significantly reduces administrative workload, thereby reducing physician

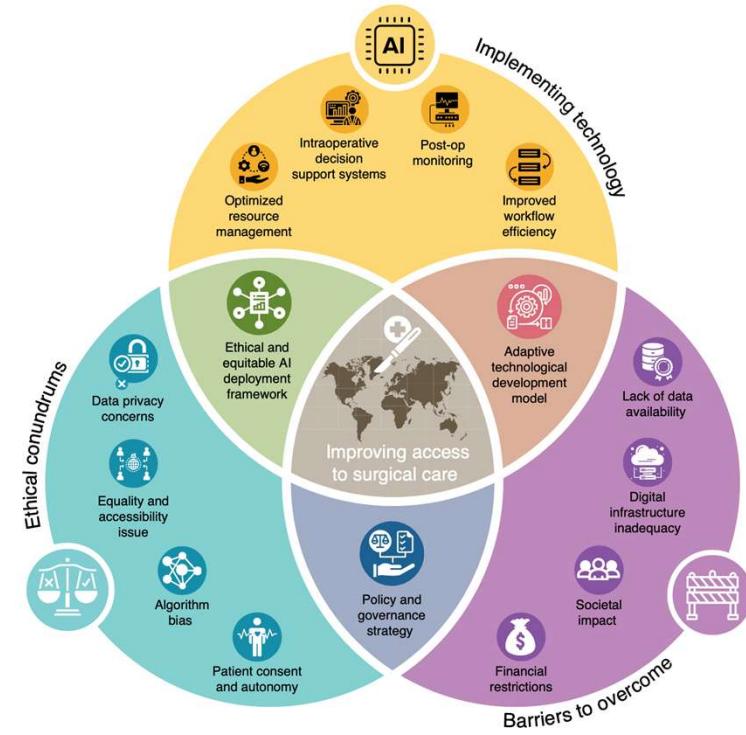


Fig. 1 Artificial intelligence in surgery



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Desarrollar una estrategia: por qué y para qué



Identificar los casos de uso que generan mejor valor



Invertir en innovación y en cambio cultural



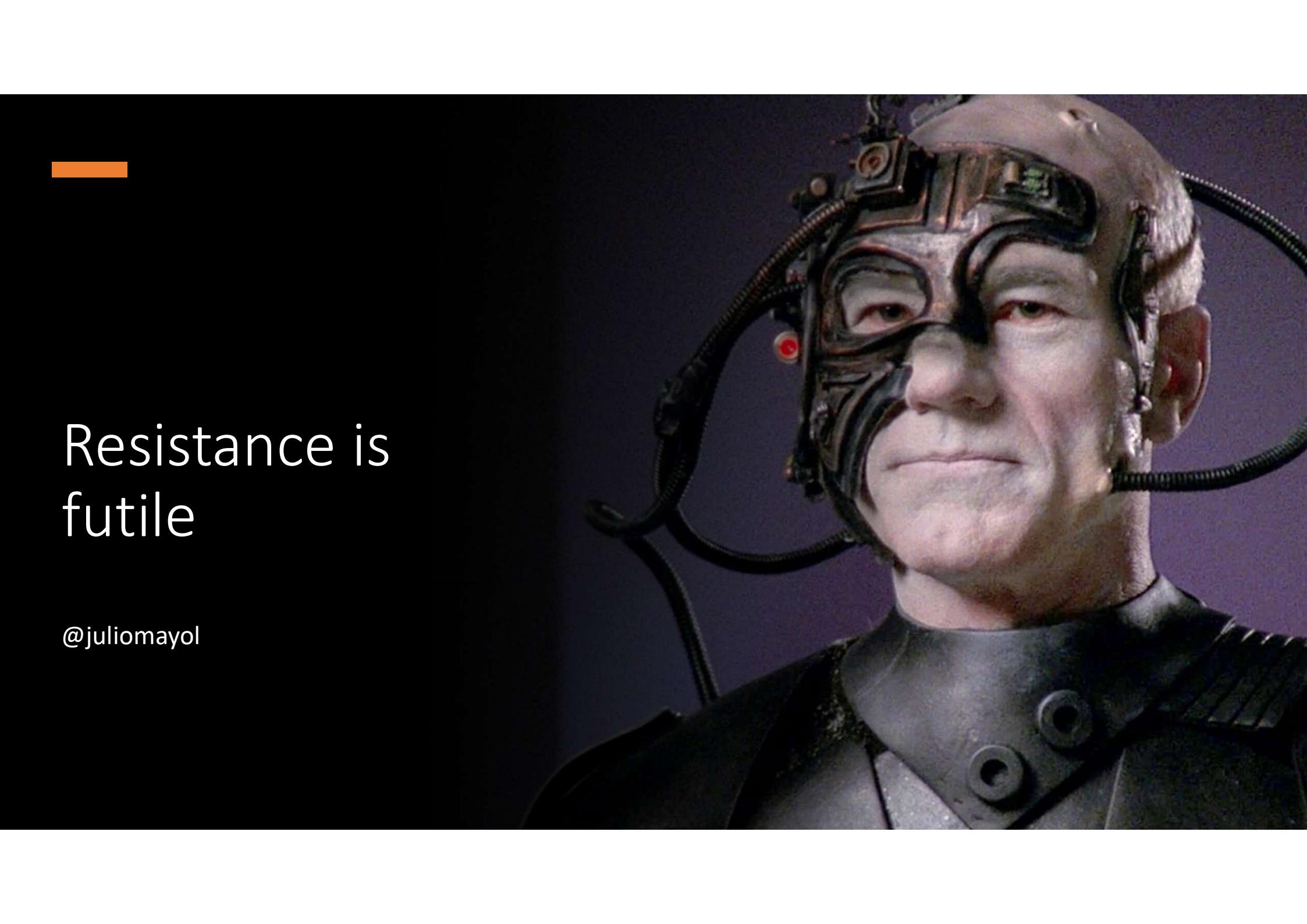
Formación: re-skilling y upskilling



Afrontar los problemas legales y éticos



- Pilotos de bajo riesgo con KPIs clínicos y de proceso
- Gobernanza de datos y cumplimiento EU AI Act (marzo 2025)
- Equipos multidisciplinares con formación en IA y ética
- Monitorizar sesgos y robustez; actualizar modelos
- Integrar IA en flujos de trabajo existentes



Resistance is
futile

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