North American Chinese Medical Physicists Association

Fall 2024
Volume 9 No. 2

NACMPA NEWSLETTER

Message from the President

Lu Wang, PhD
NACMPA President

Welcome to the Fall 2024 Edition of the NACMPA newsletter!

We had a very successful annual meeting in July. Thanks to the local organizing volunteers ZhiLei Shen, Sherry Liu, Chengyu Shi, and others who helped in selecting an ever nicer seafood restaurant with well selected menu. Many NACMPA members and their family attended the dinner. We carried out all the routine agenda of introduction, award, elections. In addition, this year, our program had been enriched. We added a scientific presentation section to attract more participants. We also added an entertaining section to energize the meeting atmosphere. An exciting period came when Chengyu Shi and ZhiLei Shen performed separately. Dr. Chengyu Shi performed a wonderful talk show, and attendees' atmosphere immediately changed and the cheers continued. Dr. Zhilei Shen invited her other two dance partners to perform ethnic dance, which was very beautiful and graceful, reflecting the customs of the south of the Yangtze River and the gentleness of women.

Of course, the success of the annual meeting was inseparable from our Excom members, our volunteers, and our sponsors. Thank you very much for our Excom and members' selfless dedication. We also very appreciated to our vendors' contributions! This year, we received the biggest financial support from our vendors in recent years!

We have been enhancing our communications. With the WeChat group reaching the maximum 500 limit, our president-elect Dr. Yi Rong started a group for mentees. If you are a student or a Postdoc fellow in the main NACMPA group, please quit there and join the NACMPA II Mentees group. Separately, we have migrated our official website hosting platform from a relatively outdated hosting platform to Wix. Thank you, Dr. Brian Wang and Dr. Yin Gao who had worked on this project diligently.

I will pass the president duty to Dr. Yi Rong in 2025 after my two-year term. It's true that I had taken earlier retirement since July, as I just wished to have more time for myself and my family, as well as my hobbies and my travel. I will miss my colleagues and friends in the field. I wish everyone the best in your career, your health, and your family life. Thank you everyone, especially volunteers and Excom officers for your trust and support of my work and our Association. I am quite sure that NACMPA will be stronger under the leadership of future.

Seeking Contributors 欢迎大家投稿

NACMPA NEWSLETTER is published by the North American Chinese Medical Physicists Association on a semiannually schedule. We welcome all readers to send us any suggestions or comments on any of the articles or new features to make this a more effective and engaging publi- cation and to enhance the overall reader- ship experience.

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From the NACMPA Officers

to all of You!

The Smart Assistant: Efficient Work in the Era of ChatGPT

Yunxiang Li, B.S.
Department of Radiation Oncology, UT Southwestern Medical Center

As a PhD student in the fields of medical physics and artificial intelligence, my daily life is packed with staying up-to-date on the latest research papers, conducting data analyses, and writing articles. Fortunately, ChatGPT has become a reliable assistant, helping me manage many of the tedious tasks in my work more efficiently. Here's how I've integrated ChatGPT into my daily workflow.

Since my research focuses on applying AI in medical physics, it's crucial for me to stay on the cutting edge of AI research. However, with the rapid developments in AI, new papers are published almost daily, making it impossible to keep up with all the latest work on my own. To address this challenge, I developed a tool that uses GPT's API to automatically read all new papers in the AI field every day, summarizing each paper into a short paragraph and categorizing them. This way, I can quickly scan relevant summaries by category, allowing me to choose the most interesting papers for an in-depth read. To make this tool accessible for others, I also created a website (see Figure 1), where users can subscribe to updates based on their research interests. Each morning, my server sends a personalized email to subscribed users with summaries on the topics they selected. Thanks to GPT's ability to quickly process and summarize the core content of each paper, I'm able to keep up with the latest advancements in AI research.

Furthermore, GPT now supports multimodal reading, making it more like a personal assistant in my daily life. Whenever I have a PDF filled with dense content, I simply upload it to GPT to extract the essential information I need. Additionally, GPT's ability to autonomously write and execute code is incredibly powerful—I can have GPT extract data from an Excel spreadsheet, a Word document, or even an image, and then automatically write code to analyze the data visually. Before GPT, this could have taken me several hours; now, it might only take a few seconds to get the results I want.

Beyond data analysis, GPT also powers some email management plugins that help me summarize the core content of each message. Especially every morning, when I open my inbox to find a massive stack of unread emails, it used to take a long time to read each one to ensure no important information was missed. Since using the GPT-based email summarization plugin, I can instantly grasp the essence of each email and quickly decide if it warrants a detailed read.

In summary, GPT is an all-encompassing assistant. Once you've experienced life with GPT, it's hard to imagine going back to life without it.

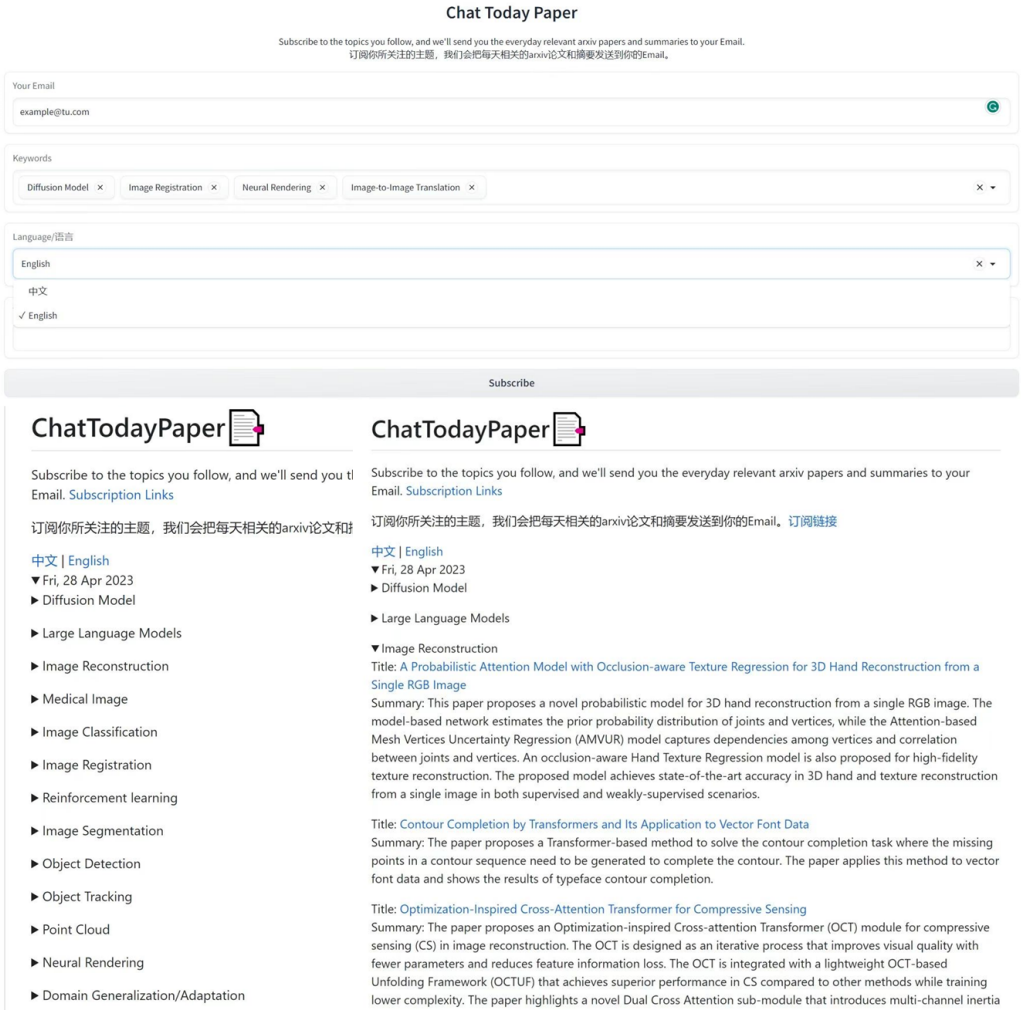


Figure 1. The Chat Today Paper website developed by Yunxiang Li.

你說ChatGPT也懂讀心術？！

Yen-Peng Liao, PhD.
Dpt. Radiation Oncology, UT Southwestern Medical Center, TX

ChatGPT是由OpenAI開發的一種基於自然語言處理（NLP）技術的生成式語言模型（Generative Language Model）。自從2022年11月公開測試以來，在全球引起了「奇異點」一般的科技旋風，社會上對於AI應用的正反意見至今仍未歇。作為一個生成式AI的重度使用者，今天想跟大家分享一些「不太正常的」使用經驗，以及我對AI的一些看法。

首先我們要了解「生成式語言模型」是什麼：『生成式語言模型的核心是**機率模型**，即它們通過對大量語言數據的學習來估計下一個詞的機率分佈，從而學會理解和模擬語言中的語法、語義和上下文，能夠生成有意義的句子或段落』（引用自ChatGPT的自我表白）。這樣的AI模型其實在做一個非常大膽的假設，認為只要我們能歸納全人類的語言習慣，就能夠理解對人類來說，怎樣的語言表達是「王道的」。

但如果我們從另一個角度來看，ChatGPT所產生的對話內容並不是基於邏輯推理，而是「一般人會這麼說的機率」，也就是說，對於ChatGPT而言，1+1之所以等於2，完全是因為地球上絕大部分的人都這麼說，所以答案應該就是2，與背後的定義與邏輯推論毫無關聯性，這也是為何早期版本它的基本四則運算能力非常糟糕的主因。話雖說如此，我們依舊可以用ChatGPT做一些可能沒什麼意義但是很有趣的事情。

我對ChatGPT進行的第一次「圖靈測試」，就是對它表演一個由知名魔術大師Max Maven所創作的魔術流程，大意是：讓觀眾想像魔術師手上有四張不同花色的Q，觀眾在演出的過程中從黑桃、紅心、方塊、梅花裡選擇一個花色，而觀眾選擇的那個花色，正是魔術師手上四張牌中，唯一張正面朝上的Q牌花色（這個魔術表演涉及許多心理學的技巧，未來有機會再和大家分享）。令人驚訝的是，在我的實驗中，ChatGPT確實無數次完美的猜中我手上那張牌的花色。這次的實驗，其實暗示著人類的語言表達極有可能並不如我們想像中的那麼依賴於邏輯分析，更多的是一種「慣性直覺」。雖然相較於人腦，語言模型仍然算是一個簡單的模型，但是這樣的模型已經體現出人們在做決策的時候容易受到引導的特質。

圖1 月費玩家可以建立客製化的GPT模型

如果有訂閱付費服務的朋友可能知道，ChatGPT也提供月費玩家開發自己的專屬模型。去年因為我們UTSW的死黨們忽然迷上了日式立直麻將，所以我花了一段時間研究了各種出牌的策略：包括「如何從起手牌的內容決定要往哪種牌型發展？」、「在打到某階段時要基於哪些條件選擇等牌還是棄牌？」，諸如此類的問題，這個「彥式立直麻將」GPT都會基於我本人的出牌理論與哲學給大家一個量身定做的答覆。

（有興趣的朋友可以用這個網址進入）
https://chatgpt.com/g/g-JPgieaxfB-yan-shi-li-zhi-ma-que

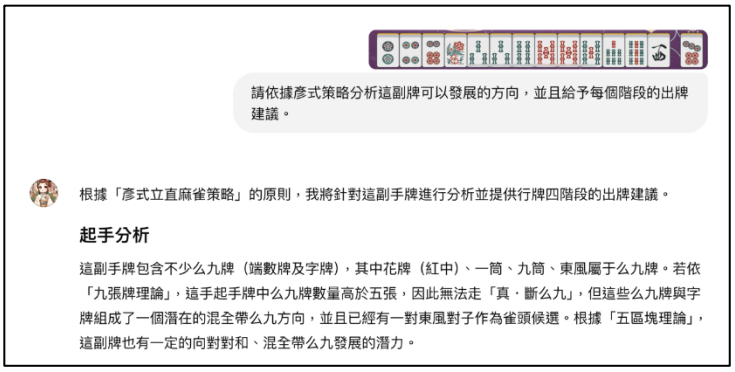


圖2 客製化GPT模型「彥式立直麻雀」的範例

除此之外，身邊朋友詢問度最高的必然是塔羅牌解讀的GPT。其實去年ChatGPT剛推出的時候，我對於這個主題是抱持否定的態度，主要是因為我認為塔羅解讀的好壞仰賴解讀者本身的人生歷練以及對於事物的洞察力，需要具備「能看見看不見的東西」的能力，這個基本假設與語言模型的機率模型架構是違背的。然而，當我今年體驗到由Google主導開發的NotebookLM，已經可以針對學術論文生成正反面討論的對話時，我想也許這個技術發展的從業人員們，也正在逐步解決這個問題當中。因此，我目前也正在開發「彥式塔羅解讀GPT」中，待開發完成再和大家分享。

AI在生活中的應用在近兩年真的是前所未有的爆炸式成長，我自己本身也玩音樂，我也曾經試著使用Suno來生成一些在表演時使用的特定曲風音樂。我對它的評價是「技術力滿點，但是缺乏新意」。這些經驗其實衍伸出我目前對AI（尤其是生成式AI）的一些看法。很多人在這一波AI革命中對自己行業的前途感到憂慮，不論我們願不願意接受，我們都難以否認許多過去被認為具有高度知識力與技術力的工作（例如：翻譯、平面設計師等）都受到了非常大的衝擊，甚至前陣子好萊屋的編劇、演員罷工也和AI發展有一定的關聯性。

我想最主要的原因，是由於當前多數行業是奠基於於後工業時代、資訊爆發時代所建構起的遊戲規則，我們從小所受的教育也更專注在單純的知識的養成。回想在我們成長的世代，總認為勞力是不值錢的，知識才是值錢的；但在AI爆炸的年代，知識也不值錢了，值錢的是想法、觀點。該怎麼應對這樣的轉變，是我們所有人當下最重要的課題，也許，十九世紀初次見到蒸汽機的農夫們，也和現在的我們一樣煩惱吧！

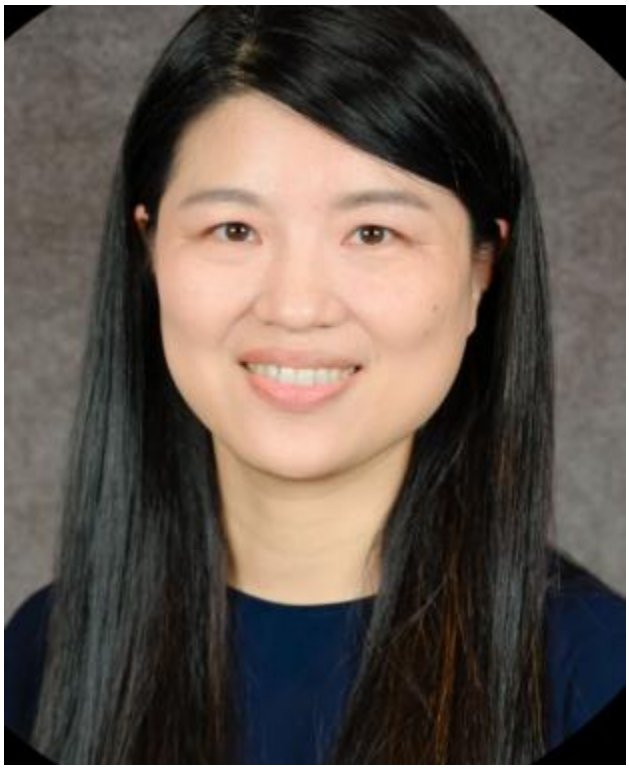
圖3 正在開發中的「彥式塔羅GPT」的訓練過程

Medical Physics Education in Taiwan: Development and Comparative Overview

Hui-Yu Cathy Tsai, PhD

Professor, Institute of Nuclear Engineering and Science

National Tsing Hua Universit



I. Introduction

Medical physics education in Taiwan has become increasingly important, driven by the growing demand for professionals skilled in radiation medicine and advanced imaging technologies. Three premier institutions—**National Yang Ming Chiao Tung University (NYCU)**, **Chang Gung University (CGU)**, and **National Tsing Hua University (NTHU)**—offer graduate-level programs that train students to excel in both clinical and research-oriented medical physics. These programs bridge the gap between theoretical physics and real-world applications, particularly in diagnostics, radiation therapy, and radiological safety, while adhering to global standards to ensure academic excellence and industry relevance.

II. Program Highlights

a. National Yang Ming Chiao Tung University (NYCU)

NYCU provides a well-rounded program balancing theoretical knowledge and practical experience. Core courses include diagnostic radiological physics, radiation therapy physics, and nuclear medicine physics, complemented by essential training in biostatistics, research ethics, and hands-on clinical internships. This holistic approach prepares students to address challenges in both clinical environments and academic research, making the program ideal for those seeking comprehensive professional development.

b. Chang Gung University (CGU)

CGU's program is rooted in practical, clinical applications, leveraging its close ties with Chang Gung Memorial Hospitals. Core subjects such as radiation dosimetry, medical imaging processing, and radiation therapy physics are paired with extensive clinical internships, providing students with firsthand exposure to clinical workflows. The program aligns with standards from international organizations like CAMPEP and AAPM, ensuring that graduates are fully equipped to meet the demands of modern healthcare.

c. National Tsing Hua University (NTHU)

NTHU provides a dynamic and research-focused program that combines foundational coursework, professional core training, and specialized advanced electives. The curriculum covers essential topics such as radiobiology, radiation therapy physics, medical imaging physics, Monte Carlo simulations, and AI-based imaging analysis. Aligned with the standards set by the IOMP (International Organization for Medical Physics), IAEA (International Atomic Energy Agency), and CAMPEP (Commission on Accreditation of Medical Physics Education Programs), the program emphasizes cutting-edge technologies and interdisciplinary collaboration. This approach equips students with the skills and knowledge needed to excel in innovative academic research and advanced clinical practice.

d. Curriculum Comparison

Institution	Core Curriculum	Electives	Unique Features
NYCU[1]	- Introduction to Biomedical Imaging and Radiological Sciences - Advanced Radiation Physics - Biostatistics - Research Ethics - - Clinical Internship	- Topics in Molecular Imaging - Statistical Analysis in Medical Imaging - Imaging Device Development	Balanced mix of theoretical and practical training, emphasizing academic research and clinical problem-solving
CGU[2]	- Radiation Dosimetry - Anatomy and Physiology - Medical Radiation Physics - - Physics of Radiotherapy - Radiobiology	- Molecular Imaging - Advanced Radiotherapy Physics - -Proton Therapy Techniques	Strong clinical focus, leveraging hospital affiliations for applied learning
NTHU[3]	- Radiation Dosimetry - Anatomy and Physiology - Radiobiology - Radiation Therapy Physics - Medical Imaging Physics (including diagnostic and nuclear medicine) - Health Physics - Research Ethics	- Monte Carlo Simulations - AI in Biomedical Imaging - Proton Therapy Applications - Molecular Imaging	Research-focused curriculum integrating advanced technologies and adhering to international standards (IAEA, CAMPEP)

III. Development, Objectives, and Achievements at NTHU

a. Program Design and Planning[4]

NTHU's Medical Physics Program is meticulously designed to address the diverse needs of both academic research and clinical training. Tailored for graduate students, the program requires 18 credit hours, with at least nine credits drawn from non-major-related subjects to foster interdisciplinary skills. Core courses such as radiation dosimetry, radiobiology, radiation therapy physics, medical imaging physics, and health physics establish a solid academic foundation. Advanced electives, including AI applications in medical imaging and Monte Carlo techniques, provide opportunities for specialization, allowing students to explore cutting-edge technologies in the field. The curriculum adheres to global education standards set by leading organizations such as IOMP, IAEA, and CAMPEP, ensuring alignment with international best practices.

To prepare undergraduates for a seamless transition into medical physics, NTHU also offers a robust and interdisciplinary undergraduate curriculum. This dual-track approach comprises a **primary specialization** and a **secondary specialization**. The primary specialization includes 20 credits of foundational courses, such as general physics, programming, engineering mathematics, and numerical analysis, which equip students with the analytical and technical skills needed for advanced study. The secondary specialization, designed for students from other disciplines, requires 32 credits, including 23 credits of core subjects like introduction to atomic science, electromagnetism I, modern physics I, probability and statistics, radiation safety, radiation measurements and laboratory, alongside 9 credits of electives such as quantum mechanics, medical instrumentation, and advanced radiation physics. This comprehensive framework not only prepares undergraduates for graduate programs but also provides them with the theoretical and practical expertise to meet the demands of a rapidly evolving field. By integrating foundational sciences with specialized medical physics training, NTHU fosters a pipeline of highly skilled professionals equipped to excel in both academic and clinical settings.

b. Goals and Vision

1. **Comprehensive Training**: Equip

[1] https://birs.nycu.edu.tw/%e7%a2%a9%e5%8d%9a%e7%8f%ad%e4%bf%ae%e8%aa%b2%e8%a6%8f%e5%ae%9a/

[2] https://mirs.cgu.edu.tw/p/412-1077-2573.php

[3] https://curricul.site.nthu.edu.tw/p/406-1208-182856,r8805.php?Lang=zh-tw

[4] https://nuclear.site.nthu.edu.tw/p/426-1071-34.php?Lang=zh-tw

students with the theoretical knowledge and practical expertise needed for clinical problem-solving and research innovation.

2. **Global Alignment**: Pursue international accreditation, ensuring graduates are prepared to compete on a global stage.
3. **Career Readiness**: Foster employability in clinical settings, research institutions, and the medical technology sector.
4. **Innovative Leadership**: Promote cutting-edge technologies such as AI, radiomics, and precision medicine in radiation therapy and imaging.

c. Achievements and Impact

- **Student Success**: Since its inception in 2019, the program has graduated 13 students who have secured academic and clinical positions.
- **Clinical Integration**: Partnerships with leading hospitals, including Chang Gung Memorial Hospitals, Taipei Veterans General Hospital, and National Taiwan University Cancer Center, provide students with invaluable real-world training.
- **Workforce Development**: The program addresses critical gaps in Taiwan's medical physics workforce, particularly in advanced modalities like particle therapy and radiomics.
- **Community Outreach**: Remote courses have been introduced for working professionals, benefiting over 120 participants and broadening access to medical physics education.
- **Innovation Leadership**: The program's interdisciplinary approach, blending physics, AI, and biomedical engineering, has established NTHU as a regional leader in medical physics education.

IV. Conclusion

The medical physics programs at NYCU, CGU, and NTHU exemplify Taiwan's dedication to cultivating highly skilled professionals in radiation medicine and imaging sciences. Each institution offers unique strengths: NYCU emphasizes a balanced foundation, CGU focuses on clinical readiness, and NTHU highlights research innovation and advanced technologies. Together, these programs not only meet international standards but also address global workforce needs, advancing the field of medical physics education. NTHU's progressive curriculum, strong hospital affiliations, and innovative research initiatives make it a valuable contributor to the international medical physics community.

Postscript

National Tsing Hua University (NTHU) is committed to providing its students with diverse clinical learning opportunities. We warmly invite esteemed medical institutions in North America to host our graduate students for an 8-week internship or observership during the summer. Should you be interested in collaborating, please reach out to **Professor Hui-Yu Tsai** at **huiyutsai@mx.nthu.edu.tw**. Your support in offering this invaluable training opportunity is greatly appreciated.

20. Wei S, Lin H, Shi C, Xiong W, Chen CC, Huang S, Press RH, Hasan S, Chhabra AM, Choi JI, Simone CB 2nd, Kang M. Use of single-energy proton pencil beam scanning Bragg peak for intensity-modulated proton therapy FLASH treatment planning in liver-hypofractionated radiation therapy. Med Phys. 2022 Oct;49(10):6560-6574.

Overlook of Adaptive Radiotherapy (ART) and potential roles of AI techniques

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Over the past decades, technological advancements have significantly enhanced the precision of radiation planning and delivery. Traditional radiotherapy (RT) approaches assume a stable patient anatomy over the whole course of treatment, using planning margins to account for minor anatomical or setup variations. In reality, daily anatomical changes—such as organ filling, changes in patient weight, and tumor size or shape—can often impact treatment accuracy. Recently, adaptive radiotherapy (ART) has emerged as a solution to accommodate these changes by adjusting treatment plans based on updated patient anatomy. As another important development in radiation oncology, the application of artificial intelligence (AI) has shown tremendous potential across various aspects of the field. The improvements in efficiency and consistency offered by AI are especially beneficial for the time- and resource-intensive ART workflows. However, some challenges remain for the clinical implementation of AI in ART. The purpose of this mini-review is to provide a concise overview of the current status of ART for general readers and to summarize the current and potential future applications of AI in ART.

1. ART: More precision, more personalization

Adaptive radiotherapy (ART) is revolutionizing cancer treatment by increasing both precision and personalization. By adjusting radiation doses to account for each patient's unique and changing anatomical or biological characteristics, ART strives to enhance the accuracy of tumor targeting while minimizing exposure to healthy tissue. Early clinical studies have shown promising results, with improved treatment outcomes and better sparing of normal tissue, leading to reduced toxicity for patients.

As outlined in Table 1, ART can be divided into four main categories, each focusing on different aspects of patient-specific adjustments and varying in frequency. **Offline ART** involves adjustments based on observed significant anatomical changes that could cause considerable deviations from the planned dose. This approach uses updated imaging between treatment sessions to make modifications for future treatments, compensating for the limitations of a one-plan-fits-all radiotherapy approach and adapting for the evolving anatomy. Typically, re-simulation images (re-CT) are acquired, and the entire planning process is repeated to align with the patient's current anatomy. While offline ART is relatively straightforward to implement and has lower technical requirements, it is limited in responding to daily anatomical changes**.**

In contrast, **online ART** involves performing the ART workflow within the same treatment session, using imaging acquired in real-time to adapt the plan based on the patient's current anatomy. Recently, advancements in imaging-integrated ART systems, such as MRI-Linac machines (Elekta Unity 1.5T, ViewRay 0.35T), CBCT-based systems like Varian Ethos, and PET-guided Reflexion systems, have enabled the clinical implementation of online ART. Unlike offline ART, which typically uses conventional radiotherapy software and workflows and takes hours to days for planning, online ART relies on specialized software and hardware platforms, allowing for replanning to be completed while the patient remains on the treatment table. By adapting to the "real" anatomy for each session, online ART often uses smaller margins and can deliver escalated doses to the tumor while minimizing toxicity to surrounding healthy tissues.

Biological Adaptive Radiotherapy (Biological ART) tailors treatment based on biological markers or functional imaging, such as PET scans or functional MRIs, to target specific subregions within the tumor, like hypoxic areas or regions with high SUV uptake. This approach enables "dose painting," delivering higher radiation doses to biologically active areas while sparing healthy tissue. Although it offers a high level of personalization and potential therapeutic benefits, it requires reliable biological markers and is a complex, labor-intensive, and costly procedure.

Intra-fractional ART adjusts treatment within a single session based on real-time imaging, responding to anatomical changes that occur during treatment. This approach accounts for shifts in anatomy, such as ongoing bladder filling or the movement and deformation of abdominal gas pockets and organs, which are not fully addressed by pre-session adaptations. While this method offers adaptability to rapid changes, it requires high-speed

imaging and real-time plan adaptation, presenting significant technical challenges. Currently, such technology is not yet available, but with advancements in radiotherapy planning and delivery software and hardware, real-time ART represents the next stage in achieving more precise and personalized radiotherapy.

Table 1 Main Categories of Adaptive Radiotherapy

Category of Adaptive RT	Description	Example	Advantages	Limitations
Offline ART	Adaptation based on prior treatment data, with adjustments made for future sessions	Periodical plan adaptation using re-sim images	Easier to implement; lower technical demand	Limited responsiveness to daily anatomical changes
Online ART	Plan adaptation performed during each treatment session based on daily imaging	MRI-Linac online adaptation system (e.g., Elekta Unity or ViewRay MRIdian), CBCT-guided adaptation systems (Varian Ethos)	Account for inter-fractional anatomy changes; reduced margin/improved precision with daily imaging; Highly responsive;	Time-intensive; requires sophisticated imaging/planning technology
Biological ART	Adjustments based on biological markers or functional imaging (e.g., PET)	Hypoxia-guided adaptation using PET or MRI to target hypoxic tumor regions	Tailors treatment to biological response; potential for high personalization	Complex and costly; needs reliable biological markers or imaging
Intra-fractional ART	Adjustments within the same treatment fraction (during the session) based on real-time imaging	Real-time tracking, respiratory gating	Accounts for rapid changes (e.g., organ motion)	Requires fast imaging and real-time computing; limited availability

2. Current Challenges for ART

Despite the promise of ART, especially the online ART, its clinical adoption has been limited due to the following major challenges. These barriers highlight the complexities and resource demands of integrating ART in clinical practice.

1) **Lack of standardized patient selection and screening system and clinical decision-support systems:** A comprehensive and consistent approach to patient screening is essential to identify individuals who are most likely to benefit from ART. There is also a need for a system that can better match patients to appropriate ART treatments and modalities, prioritizing those who are likely to achieve success with the intervention. Such a system could also help reduce the number of patients undergoing ART who may not benefit, thereby improving both cost-effectiveness and patient satisfaction.
2) **Low efficiency:** The ART process is time-consuming, requiring frequent human interventions while the patient waits on the treatment couch. On-couch time averages around 30 minutes for the Varian Ethos ART system and can extend to 60 minutes or more with the Unity MRI-linac, making it challenging for patients to tolerate and consuming valuable clinical resources.
3) **Need for a diverse team and significant resources:** Implementing ART is human-resource intensive, requiring specialists like physicians, physicists, dosimetrists, and therapists who work together to adjust treatments in real-time. Smaller clinics often lack these skilled personnel, limiting ART's availability outside well-resourced centers. Streamlined, automated adaptation systems are needed to expand access and enable more patients to benefit from this advanced technology.
4) **Lack of Standardized and Comprehensive QA Programs:** Over the years, many QA programs have been developed and integrated into the ART workflow, such as secondary dose verification and file integrity checks.

However, there are still several critical steps that heavily rely on manual checks, such as contour QA and plan quality QA, which are subjective and prone to human error. There is a need for more automated, robust, and standardized QA workflows for each step of ART.

5)

3. Role of AI for ART

In recent years, AI has demonstrated tremendous potential in the field of radiation oncology by automating time-consuming tasks, providing assistance and predictive capabilities, and improving the efficiency and consistency of the RT workflow. As AI technology evolves, its role in radiotherapy is expected to grow, especially with the emergence of new treatment techniques like ART. This evolution promises to deliver more refined and personalized treatment strategies, enhancing patient care quality, improving the effectiveness of radiotherapy, optimizing patient outcomes, and reducing side effects.

In Table 2, we summarize some representative examples of current AI applications in ART, along with reference papers. Due to the limited scope of this mini review, we will briefly summarize the major applications for the general reader and cannot guarantee that it fully covers all the novel applications of AI in ART. Current AI applications in RT span multiple stages of treatment, from initial visits to clinical workflow optimization. These advancements are particularly valuable in online ART settings, where timely adaptation is essential.

- **Initial Visit:** AI helps with trial screening, identifying patient eligibility for clinical trials, and provides treatment decision support for suitable treatment based on patient data and trial results.
- **Imaging Acquisition & Quality Improvement:** AI enhances fasting imaging by optimizing protocols[1], and enables synthetic imaging, converting among different imaging modalities (e.g., CBCT to CT[2], MRI to CT[3]).
- **Treatment Planning:** AI-driven image segmentation techniques help automate the delineation of tumors and surrounding healthy tissues, reducing manual workload while improving accuracy and consistency[4]. AI techniques can also assist in selecting optimal beam angles[5]. With deep learning-based dose prediction[6], a personalized directive can be derived to guide planners in creating optimal treatment plans[7]. Additionally, recent work has explored the use of LLM-based plan evaluation and auto-planning to generate and assess treatment plans.
- **Quality Assurance (QA):** AI has been used to verify treatment accuracy with fast second dose verification[8]. AI-based quality assurance tools evaluate and correct contours automatically, ensuring high contouring standards are maintained in ART workflow [9]. It can also monitor machine calibration, and analyzes log-based patient specific delivery monitoring [10].
- **Motion Management:** AI tracks and predicts for tumor and organ motion, ensuring more precise treatment delivery[11].
- **Radiomics & Outcome Monitoring:** AI predicts prognosis, monitors treatment response through imaging biomarkers, and estimates survival and recurrence. Machine learning in radiotherapy uses past patient data to identify patterns in tumor response, helping predict treatment success and side effects. This enables clinicians to make informed decisions and personalize treatment protocols, enhancing efficacy and managing side effects [12, 13].
- **Clinical Workflow Optimization:** AI automates routine tasks like scheduling and image annotation and helps with resource allocation and scheduling to optimize the clinical workflow [14, 15].
-
- **The future of AI in ART**

As AI models continue to learn from clinical data, they are expected to improve efficiency, reduce variability, and enhance the accuracy and robustness. The convergence of AI and ART is creating a new frontier in RT field. ART offers significant advantages by tailoring radiation doses to accommodate changes in a patient's anatomy over time. However, questions still persist about the optimal frequency of adaptations and the ideal radiation dose to apply in each case. The potential of AI in ART is immense, poised to reshape cancer treatment by improving precision, personalization, and overall efficiency. AI-powered tools are capable of automating complex tasks such as tumor contouring, dose optimization, and real-time treatment planning, reducing manual workload and minimizing delays in treatment. By analyzing vast datasets from patient anatomy and treatment outcomes, AI models can predict and adapt to changes in a patient's tumor/anatomy, allowing for more dynamic, individualized care. Furthermore, AI systems are being fine-tuned to personalize treatment plans based on each patient's unique

anatomical and biological traits, leading to better clinical outcomes and less side effects. As AI technology continues to advance, it will become an integral part of ART, making ART more accessible and reliable in routine clinical practice and offering significant benefits for both patients and clinicians.

Table 2 Representative examples of current AI applications in RT

Application Area	AI Applications
Initial Visit	**Trial Screening**: AI identifies patient eligibility for clinical trials[16].
	Treatment Decision Support: AI provides decision support based on patient data and trial results[17].
Imaging Acquisition & Quality Improvement	**Fasting Imaging**: AI optimizes accelerated imaging protocols [1]
	Synthetic Imaging (CBCT to CT, MRI to CT, etc.): AI converts imaging modalities to create synthetic images [2, 3].
Treatment Planning	**Automated Contouring of Tumors and Organs-at-Risk**: AI assists with accurate contour delineation [4, 18].
	Beam Angle Selection and Optimization: AI assists in beam angle selection for optimal dose distribution[5].
	Personalized Dose Prescription: AI tailors dose prescriptions to individual patient anatomy and tumor characteristics [7].
	Dose Prediction and Optimization: AI predicts dose distributions to optimize treatment plans [6].
	LLM-based Plan Evaluation and Auto-Planning: AI evaluates and generates treatment plans using language models.
Quality Assurance (QA)	**Second Dose Verification**: AI provides a second verification of planned vs. delivered doses[8].
	Contour Quality Check: AI evaluates contour accuracy and consistency[9].
	AI-driven Analysis of Machine Calibration: AI monitors treatment machine performance over time[19].
	Log-based Delivery Monitoring and QA: AI analyzes machine logs for accurate treatment delivery [10].
Motion Management	**Detection and prediction of Tumor and Organ Motion**: AI tracks and compensates for patient movement[11, 20].
Radiomics & Outcome Monitoring	**Tumor Characterization and Prognosis Prediction**: AI analyzes radiomics features to assess prognosis[12].
	Treatment Response Monitoring: AI monitors changes in imaging biomarkers to assess treatment response[21].
	Predicting Survival and Recurrence Probabilities: AI models predict patient survival and recurrence risks[13].
Clinical Workflow Optimization	**Automating Routine Tasks**: AI guide workflow optimization by identifying the key factors responsible for workflow outcomes [15].
	Optimizing Resource Allocation and Scheduling: AI assists in resource planning and treatment scheduling[14].

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国内重离子治疗的现状与发展方向

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中国是世界上第四个使用碳离子治疗的国家。重离子设备最早在中国的出现始于1988年，当时的中国科学院近代物理研究所（近物所）在兰州建成了国内第一台大型重离子研究装置（兰州重离子加速器），在之后也成为了国内第二家重离子中心——甘肃武威重离子中心的技术和设备基础。重离子治疗系统在中国大陆的正式临床应用始于2015年上海市质子重离子医院的开业，迄今即将进入第十年。最近十年中，重离子治疗在国内得到了快速的发展，这更多是体现在建设中及筹划中项目数量的快速增长之上。然而目前，大陆地区能够提供重离子治疗的机构仍只有上海、武威2家，台湾地区首套重离子治疗系统在2023年投入使用。

政策

重离子治疗系统在中国大陆接受中国国家卫生健康委员会（国家卫健委）的配置管理。2018-2020年期间，重离子设备被列为《大型医用设备配置许可管理目录》的甲类设备，但没有计划配置。不过，武威重离子中心在2019年完成46例患者的临床试验之后，单独获得了一份配置许可。2023年，第十四个五年计划（十四五）更新的《大型医用设备配置许可管理目录》将重离子系统和质子系统并列管理，并计划配置41台（套）。到2024年11月，在已发放的44台（套）质子重离子配置许可中，总计有9台（套）重离子系统获得配置许可，其中除2个已运营项目之外，还有4个项目在建设之中。至少有7家尚未获得重离子系统配置许可的医疗机构已开工建设重离子中心（重离子或者质子重离子一体机），这些机构也正努力获得十四五第二轮的配置许可。

我国大陆地区重离子项目进展（截止2024年11月15日）

序号	地区	中心/项目	状态	束流类型	治疗室	供应商	统计
1	甘肃省武威市（西北）	甘肃省武威肿瘤医院*^	运营	重离子	1个45°治疗室、1个90°治疗室、2个水平束治疗室	兰州泰基	已运营（2家）
2	上海市（华东）	上海市质子重离子医院*^	运营	重离子	1个45°旋转机架，3个水平束	西门子	
3	甘肃省武威市（西北）	兰州重离子医院^	在建	重离子	1个45°治疗室、1个90°治疗室、2个水平束治疗室	兰州泰基	在建（11家）
4	福建省莆田市（华东）	妈祖重离子医院^	在建	重离子	4间治疗室	兰州泰基	
5	湖北省武汉市（中南）	武汉大学重离子医学中心*^	在建	重离子	4间治疗室	兰州泰基	
6	浙江省杭州市（华东）	浙江省肿瘤医院	在建	重离子		兰州泰基	
7	山东省济南市（华东）	山东省肿瘤防治研究院*	在建	重离子		兰州泰基	
8	四川省成都市（西南）	四川大学华西医院*	在建	重离子		兰州泰基	
9	广东省广州市（中南）	中山大学肿瘤医院	在建	重离子			
10	江苏省徐州市（华东）	徐州质子重离子医院	在建	质子重离子		日立	
11	广东省佛山市（中南）	和祐医院	在建	质子重离子		日立	
12	广东省惠州市（中南）	惠州重离子医学中心	在建	重离子		近代物理所	
13	陕西省西安市（西北）	西安交通大学第一附属医院*	在建	重离子		西部超导	
14	吉林省长春市（东北）	吉林大学白求恩第一医院*	拟建	重离子		兰州泰基	拟建（6家）
15	江苏省南京市（华东）	南京重离子医院	拟建	重离子		兰州泰基	
16	湖南省长沙市（中南）	湘雅常德医院	拟建	重离子		兰州泰基	
17	福建省福州市（华东）	福建省肿瘤医院*	拟建	重离子			
18	贵州省贵阳市（西南）	贵州医科大学附属医院*	拟建	重离子			
19	北京市（华北）	北京协和医院	拟建	重离子			

注：分类规则如下：
运营：已正式运营并收治患者；
在建：已与设备供应商签署采购协议(或框架/战略协议)，基建已开工建设；
拟建：已与设备供应商签署采购协议(或框架/战略协议)，基建未开工建设。
*为已获得配置许可的设备，^为已获批注册的设备

为配合重离子走向临床应用，相关政府部门和行业协会共同努力，建立并完善行业标准

和规范。2017年2月17日，国家卫生计生委（现有国家卫健委前身）办公厅发布了《质子和重离子加速器放射治疗技术管理规范（2017版）》和《质子和重离子加速器放射治疗技术临床应用质量控制指标（2017年版）》。2018年，中国国家药品监督管理局（药监局）发布《质子碳离子治疗系统临床评价技术审查指导原则》，为医疗器械产品注册工作的规范性提供依据。这些规范指定重离子治疗系统在可用于临床治疗使用前需获得药监局的注册许可。对每一套设备在完成安装调试，临床验收，及由第三方有资质机构完成的设备型式检测（type testing）后需进行临床评价。设备与已获取药监局注册许可的设备具有技术特征和生物学特征等同性时可以使用等同性论证的方式申请设备注册，否则需要完成患者治疗临床试验后方可申请。患者治疗的临床试验要求顺利完成42例患有不同部位（头、颈部、胸，腹、脊柱，盆腔及四肢）肿瘤的放射治疗和为期3个月的随访，治疗结果满足安全性和有效性的指标后方可申请设备注册。在技术方面，2021年国家卫健委发布《放射治疗放射防护要求》，新增质子重离子放射治疗工作场所防护检测方法。在建设方面，2024年5月，《医疗机构质子重离子中心建设标准》正式发布。

临床应用

上海市质子重离子医院配备西门子的IONTRIS离子治疗系统，配置4间治疗室。截至2024年9月1日，上海质子重离子医院累计出院患者超过7,000例，其中使用重离子或重离子联合质子治疗的患者5,470例，约占总数的76%。预期2024年治疗患者总数超过1,100例。医院的七大病种（鼻咽癌、颅内颅底肿瘤、肺癌、肝癌、前列腺癌，胰腺癌、乳腺癌）患者数占总数的四分之三。上海质子重离子医院在原厂设备之外，还自主开发了眼科专用治疗椅。武威重离子中心配备国产重离子系统，配置4间治疗室，均为水平固定束。到2024年9月26日，武威重离子中心治疗患者超1,500例，并且在8月完成了其中两间治疗室的笔形束扫描技术升级，配置了45°和垂直固定束。

设备

提到兰州重离子加速器和武威重离子中心，就必然提到国产重离子设备。为推动医用重离子科技成果产业化，近物所成立了国科离子医疗科技和兰州科近泰基(兰州泰基)作为装备制造、运营维护服务等的提供方。国产重离子设备不断升级，兰州重离子中心作为第二套系统在2023年获得注册证，4个治疗室中增加45度和90度2个治疗室。第三套重离子设备安装在福建妈祖的福建医科大学附属协和医院妈祖院区，在今年4月获得了设备注册许可。9月底，安装在湖北省武汉人民医院的第四套重离子系统也获得了注册许可，升级还包括采用调制扫描模式及滑轨CT(计算机断层扫描)图像引导系统等。如前所述，国内对质子重离子系统的注册和其他国家不同，执行“一机一证”，每台设备需要完成临床评价。以前的设备都需要完成临床试验，再进行审批，耗时大约2年。但根据武汉经验，已经可以通过同类设备评价方式，缩短了获得注册许可的时间。根据报道，至少在杭州、长春、南京、济南还有4套设备正在积极建设中。在重离子设备升级方面，可提供单周期变能（Multi-Energy Extraction, MEE）及碳离子与质子每脉冲粒子数（particles per pulse, PPP）分别达3E9、3E10的新一代加速器；包括碳离子，质子及氦离子的多粒子治疗；设备小型化；旋转机架等不同思路在多个项目中初显身影。2024年5月，广东惠州重离子医学中心项目开工，其重离子系统由近物所签约提供。从审批信息来看，设计的新系统包括9间治疗室。

2024年6月PTCOG期间，国科离子展示了重离子质子一体机和治疗计划系统。11月9日，兰州泰基宣布其直线注入器调试出束。

日本日立获得了为数不多的重离子订单，在江苏徐州和广东佛山安装的两套日立系统均为质子重离子一体机（固定束重离子治疗室 + 旋转机架质子治疗室），目前均已进入安装调试阶段。2023年10月，西部超导领衔开发的超导重离子加速器项目在西安开工，可能弥补超导重离子设备的空白。目前看来，国产系统是国内重离子治疗的主要设备提供方。

未来进展

2019年，国家卫生健康委员会办公厅发布了《国家癌症区域医疗中心设置标准》，其中质子重离子放射治疗被纳入核心技术清单。为质子重离子放射治疗在国内的发展指出方向。从复旦版《2023年度中国医院专科剩余排行榜（肿瘤学）》来看，排名前十的肿瘤专科9家目前都规划了质子重离子治疗系统，其中重离子系统6套。期待它们的加入能够为重离子放疗提供更多的临床证据和共识与指南的制定，从而进一步推动重离子治疗的高质量发展。

医院/专科			质子重离子项目		
排名	名称	主院地点	粒子类型	项目状态	项目主体
1	中国医学科学院肿瘤医院	北京市	质子	建设中	河北医院
			质子	建设中	深圳医院
2	中山大学肿瘤防治中心	广东省广州市	重离子*	建设中	天河院区
3	复旦大学附属肿瘤医院	上海市	质子重离子	已运营	上海市质子重离子医院
4	北京大学肿瘤医院	北京市			
5	天津医科大学肿瘤医院	天津市	质子	规划中	
6	山东省肿瘤医院暨山东省肿瘤防治研究院	山东省济南市	质子	已运营	质子中心院区
			重离子	建设中	质子中心院区
			硼中子**	建设中	质子中心院区
7	中国科学院大学附属肿瘤医院（浙江省肿瘤医院）	浙江省杭州市	重离子*	建设中	本院
8	四川大学华西医院	四川省成都市	质子	建设中	华西国际肿瘤治疗中心
			重离子	建设中	华西国际肿瘤治疗中心
9	江苏省肿瘤医院	江苏省南京市	质子重离子*	规划中	江北院区
10	四川省肿瘤医院	四川省成都市	质子	建设中	天府院区

2024北美华人医学物理师协会（NACMPA）年会汇报

2024年7月24日晚，期待已久的北美华人物理师协会晚会在加州洛杉矶Rosemead的海珍大酒楼如期举行了。为什么期待呢？因为我们好久没有见面了。去开北美物理师年会，除了能够学习到最新的知识，见识到最新的工业产品，聆听到大师们的讲座，那就是同好友们相聚了，尤其是华人物理师的朋友们。大家忙忙碌碌，虽然平时在网络上联系打闹，但不如真正的见面来的亲切自然，从虚幻走向现实。

会议的日程很丰富，由NACMPA当选的主席王露和候选的主席戎懿两位教授主持。尤其是王露主席，今年也是她退休的年份，在周游世界的忙碌中，抽身回来支持北美华人物理师的聚会，非常感谢。会议如期在晚上6:30开始，由戎懿致辞开场，并由朱登嵩先生汇报协会的财务情况。接下来就是最期待的时刻了，评选出来的北美华人物理师奖项如下：

NACMPA服务奖，这个奖项一般给予服务过NACMPA的人员，今年是郑丹丹和杨凯两位

王露会长给郑丹丹教授颁奖

王露会长给杨凯先生颁奖

Yu Chen Excellence Community Service Award，这个奖项一般通过Yu Chen基金会的选举产生。今年是Zhenyu Shou博士（未出席）。

NACMPA最佳文章，这个奖项是通过推荐发表在去年不同高端杂志上，华人第一作者的文章，由评选委员会评选出

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IJMPCERO最佳文章，这个奖项是通过评选发表在IJMPCERO当年的文章，由评选委员会评选出的。

王露会长给 NACMPA 最佳文章颁奖

王露会长给 IJMPCERO 最佳文章颁奖

最激动人心的是NACMPA的荣誉墙，名人堂。这是通过评选委员会评选推荐的候选人评出的。一般候选人都是在学术上，在为人师表上，在为华人服务上作出巨大贡献的人。今年的获奖者是敬爱的Jackie Wu博士。

王露会长给 Jackie Wu 教授颁奖

Jackie Wu 教授发表心得

在颁奖结束以后，来到了更加激动人心的时刻，竞选环节。今年要选举出候选主席。由石成玉博士和林海波博士进行竞争。在竞争前，两位分别做了学术报告。石成玉博士报告的是心脏在放疗上的防护。林海波博士报告的是闪疗的最新发展。这个环节也是今年独有的，非常精彩，今后可能继续采纳。选举是在线通过手机投票，最后当选的是石成玉博士。

石成玉博士发表竞选演说


林海波博士发表竞选演说

另外一组竞选是Zhilei Shen和Mu-Han Lin两位优秀的教授。竞选财务。最后胜出的是Mu-Han Lin博士。其实以上四位竞选人都非常优秀，投票结果也是相差无几，非常接近。大家都非常愉快地接受了竞选结果，没有异议。

Zhilei Shen 教授发表竞选演说

Mu-Han Lin 教授发表竞选演说

后面更为精彩的环节到来了，石成玉和Zhilei Shen分别表演了节目。这也是今年不同往年的。石成玉博士表演了精彩的脱口秀，大家的气氛立马上来了，欢呼声不断。Zhilei Shen教授邀请她的另外两位舞伴表演了民族舞，非常好看，身形婀娜多姿，体现了江南的风情和女子的优柔，精彩绝伦。

石成玉博士的脱口秀

Zhilei Shen 团队舞蹈秀

Zhilei Shen 团队舞蹈秀

Zhilei Shen 团队舞蹈秀

Zhilei Shen 团队舞蹈秀

Zhilei Shen 团队舞蹈秀

接下来，大家觥筹交错，互相畅谈，并且有唱歌优美的物理师唱起了卡拉OK。气氛高潮迭起，令人难忘今宵。






这次华人聚会非常成功。当然，成功离不开我们的组织者，我们的志愿者，以及我们的赞助商。非常感谢他们无私的奉献。晚宴结束后，大家都非常期待明年在华盛顿DC的再次相聚。

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特别感谢以下志愿者的辛勤付出和无私奉献：

陈鑫儒，段炼，胡宗盛，张昊兆，卢明辉，石成玉，许启帆，彭军博，申刘芝蕾

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