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澳大新語

# UM Magazine



澳大成功研發全球首個智能中葡英翻譯平台

UM Develops the World's First Smart Chinese-Portuguese-English Translation Platform



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《澳大新語》為澳門大學官方刊物，每年出版  
兩期，旨在報導大學在教學、科研、服務等領域  
的最新發展動向。  
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on the latest development of the University  
in teaching, research and service.



## 編者的話 EDITOR'S WORDS

一項研究由研發、成果產出，再到推出市場應用，是一個非常不容易的歷程，背後更體現了研究人員鑽研學問、勇於探索和孜孜不倦的精神。

20年前，澳大的一班研究人員以人工智能技術研發出即時翻譯電子詞典「中葡通」，經過20年來歷屆學生持續的技術研發和改進，在多代翻譯系統的演變和升級的基礎上，今年年初推出全新的「在線中葡英輔助翻譯平台」(UM-CAT)。該產品利用全球領先的機器翻譯技術為翻譯人士及團隊度身訂造一站式應用平台，將有助企業和機構提升翻譯管理的效率和質量，為澳門作為中國與葡語國家商貿合作服務平台作出了積極的貢獻。研究團隊多年來的不懈努力，終於有了今天的豐碩成果，他們這種以研究成果服務大眾、貢獻社會的精神，值得我們讚揚和學習。

今期除了介紹UM-CAT外，「專題探討」欄目還有對先進材料、核醫學、中醫藥新平台的深度探討。此外，為配合社會發展的需要，澳大新增五個學士學位課程，為澳門各行各業培養跨學科、創新型人才。我們訪問了多位業界人士，分享他們對新課程的看法。

「人物專訪」欄目採訪了物聯網大數據專家賈維嘉教授、跨界藝術家梁藍波教授和語言學家陳海瑛教授，分享他們的人生經歷和學術成果。「學術研究」欄目介紹乳腺癌檢測以及數字醫療和生物信息學的最新研究成果。

The process of initiating a research project, producing research results, and commercialising those results is never easy. It requires the unrelenting effort of a group of dedicated researchers.

Two decades ago, a group of researchers at UM successfully developed PCT, the world's first talking Chinese-Portuguese electronic dictionary based on artificial intelligence technology. Over the past 20 years, they have continuously updated and improved the system. Early this year, the team launched UM-CAT, the latest Chinese-Portuguese-English machine translation system that can effectively assist professional translators in the translation, proofreading, and management of translation projects. This system thereby enhances translation quality and efficiency and supports Macao's role as a service platform for business and trade collaboration between China and Portuguese-speaking countries.

Apart from the UM-CAT system, other research-related topics that receive in-depth discussion in this issue include advanced materials, nuclear medicine, and Chinese medicine. On the teaching front, UM has launched five new bachelor's degree programmes, which are designed to nurture innovative, interdisciplinary professionals to support Macao's development. We interviewed some industry practitioners to hear their thoughts about the new programmes.

In the 'Exclusive Interview' column, big data expert Prof Weijia Jia, interdisciplinary artist Prof Lampo Leong, and linguist Prof Katherine Chen share their life experiences and academic achievements. The latest research breakthroughs in the prevention of breast cancer, in digital health, and in bioinformatics are also reported in the 'Academic Research' column.

張惠琴 Katrina Cheong

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# 澳大成功研發 全球首個智能中葡英翻譯平台

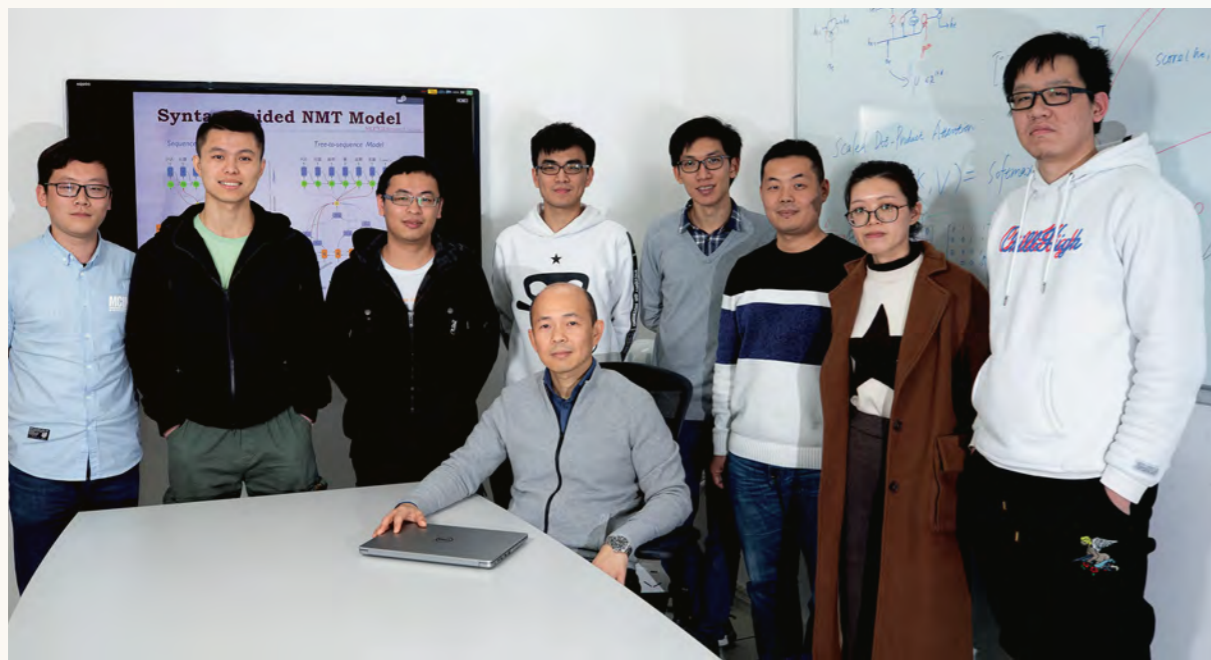
## UM Develops the World's First Smart Chinese-Portuguese-English Translation Platform

文 | 余偉業 · 圖 | 何杰平 (部分圖片由受訪者提供)

Chinese Text | Kelvin U · Photo | Jack Ho with some photos provided by the interviewee

在機器翻譯技術愈趨成熟和普及的今天，不同語言交流中的障礙有望進一步被突破。美國關注全球語言的組織 Globalization and Localization Association GALA 的研究數據顯示，2018年全球翻譯市場高達450億美元，並預計於2021年飆升至562億美元，其中中國市場將佔53.9億美元。面對世界翻譯市場不斷升溫，澳門大學研發的中葡英三語機器翻譯系統也不斷推陳出新，為多語翻譯在質與量上的需求提供更專業的服務。

Professor Wong Fai's research team | 黃輝教授的研究團隊



With the popularisation of increasingly sophisticated machine translation systems, language difference need not be the barrier that it used to be. According to statistics from the Globalization and Localization Association, the market size of the global language services industry reached USD 45 billion in 2018. By the year 2021, this figure is expected to rise to USD 56.2 billion, with the Chinese market claiming USD 5.39 billion. Seeing the growing demand for translation services worldwide, a team of researchers from the University of Macau (UM) has developed a Chinese-Portuguese-English machine translation system to assist translators and enhance the efficiency and quality of their work.

### 滿足企業翻譯需要

隨著人工智能和計算機技術的發展，澳大自然語言處理與中葡機器翻譯實驗室 (NLP<sup>2</sup>CT) 取得了重大的研究成果，機器翻譯已成為澳大的重點研發項目之一。其中，NLP<sup>2</sup>CT最新研發的「在線中葡英輔助翻譯平台」(UM-CAT)，能為中葡英雙語或三語互譯提供更專業的、準確性更高的全文智能翻譯，具體手法包括建立企業專屬的行業用語資料庫，清晰梳理大型翻譯項目的分工安排，有效追蹤翻譯流程及審核進度，以及智能識別參考用語等等。此翻譯平台適合個人、政府部門及企業處理大量多語翻譯項目，提升翻譯效率。UM-CAT自2018年12月推出至今，已有近百家國內外機構註冊使用。

據NLP<sup>2</sup>CT主任、科技學院副教授黃輝介紹，UM-CAT設計從兩大方面提升翻譯效率：首先，精明翻譯、善用參考。該平台不僅配備核心的智能翻譯功能，更引入翻譯記憶、術語管理、協同翻譯、AI輔助提示等多元設置。「UM-CAT能把不同翻譯員曾經使用或建議的、最終採用的譯文清晰顯示，以供參考，確保行文用語的一致性和準確性。」其次，協助翻譯團隊分工合作。UM-CAT採用「翻譯/審核/排版」的介面工作模式，靈活對不同的翻譯項目分工，

### Meeting the Needs of Translation Companies

With advancements in artificial intelligence and computer technology, machine translation has become one of the key areas of research at UM. In this respect, the Natural Language Processing & Portuguese-Chinese Machine Translation Laboratory (NLP<sup>2</sup>CT) has made tremendous progress over the past two decades, as is reflected in the various innovative translation systems it has developed, most notably UM-CAT, the latest online translation system that can effectively assist professional translators in the translation, proofreading, and management of translation projects. In addition to producing smart full-text translation with a high degree of accuracy, UM-CAT has various other functions, such as creating industry-specific terminology databases, enabling clear division of labour for large projects, effectively monitoring translation and review progress, and suggesting terms for reference. It is suitable for individuals, government departments and companies that need to handle a large amount of translation projects involving Chinese, English and Portuguese. Launched in December 2018, UM-CAT now has close to 100 registered institutional users, both at home and abroad.

Wong Fai, director of the NLP<sup>2</sup>CT and associate professor in the Faculty of Science and Technology (FST), explains that UM-CAT has two features that help enhance translation efficiency. First, the multiple built-in functions, such as smart translation, translation memory, glossary management, collaborative translation, and AI-based prompting, enable the system to show the

方便管理複雜多元的翻譯任務，同時有效追蹤翻譯進度及檢視最終翻譯結果，提高團隊協作效率。另外，NLP<sup>2</sup>CT透過澳大創新創業中心，針對企業和公司需要，可把UM-CAT個性化，為翻譯員提供完整的解決方案。

### 按地域性準確翻譯

對大眾而言，網上也有一些機器翻譯，如 Google Translate 就可以翻譯不同語種。但黃輝教授表示，網上翻譯系統一般是通用領域文本的翻譯，細節上未能根據地域上文化差異作出準確翻譯，「例如，澳門的『大三巴』，網上系統就不會把它翻譯得那麼準確地道；又譬如『筷子基』，就會譯成『筷子』餐具和『基本的意思』，而非我們所知道的街名『筷子基』。」他解釋說：「這些系統所翻譯的是大體意思，開發者一般不會關注個別性的或地域性的翻譯效果。相對而言，UM-CAT有很強的澳門本土語文化邏輯，在街道名稱、部門名字、法律語言、常用詞彙等方面的翻譯具有較高的準確度。」

另外，網上翻譯系統不會保留和管理用戶每一次使用後的翻譯知識，UM-CAT正好填補了這項功能。黃輝教授說：「例如著作翻譯，當你不滿意一個機器翻譯結果，對某一用語或句子作出調整，你會希望它以後按照你的修改，作同一表達。可惜，網上翻譯系統暫時沒有這種功能。而UM-CAT則可對你翻譯時的行文修改進行記憶儲存，方便日後重覆使用，以及給其他翻譯員參考。」黃輝教授認為，翻譯市場相當大，「大小企業都有自己不同程度的翻譯需求，往往需要有一個輔助翻譯管理系統去改善、加速翻譯工作，管理之前翻譯的文檔，而UM-CAT就可解決這方面的需求。」

translations that were produced, suggested, or adopted by different translators for the current user's reference, in order to ensure consistency and accuracy. Second, the user interface that integrates the various steps of a translation project, from translation to proofreading to typesetting, enables flexible division of labour for different projects, facilitates day-to-day management of complex projects, and allows users to effectively monitor translation progress and view the final product, thereby enhancing team efficiency. Moreover, the NLP<sup>2</sup>CT personalises UM-CAT through UM's Centre for Innovation and Entrepreneurship to better meet the needs of companies and provide the complete solution for translators.

### Tailor-made for the Local Market

You may wonder why anyone would need UM-CAT when there are already free online translation platforms such as Google Translate. Prof Wong explains that while Google Translate does a good job of translating generic terms, it falls short when it comes to culture-specific terms. For instance, if you type in the Chinese name of the Ruins of St Paul's Cathedral in Google Translate, it may not produce a satisfactory translation. Another example is 'Fai Chi Kei', a residential area in Macao. In Chinese, 'Fai Chi' means 'chopsticks', and 'Kei' means 'basics', so Google Translate is likely to translate this term into 'chopsticks basics'. It is an inevitable shortcoming with online translation platforms like Google Translate because developers tend to be geographically indiscriminate in the design process. But this is precisely where UM-CAT comes in. It can translate Macao's street names, government departments, legal terminology, and other terms commonly used in Macao, with a much higher degree of accuracy.

UM-CAT has another function that is lacking in online translation platforms like Google Translate—it enables the user to revise an unsatisfactory translation produced by the system and remembers the manually revised version for future reference. Prof Wong believes that UM-CAT has a role to play in the sizeable language service market. 'Big companies all need translation services to varying degrees, and a system like UM-CAT not only can help improve the speed and quality of translation; it can also assist in the management of old files,' he says.



黃輝教授的研究團隊獲首屆澳門科技獎技術進步獎

Prof Wong Fai's team receives the Science and Technology Progress Award at the first Macao Science and Technology Awards

### Will It Ever Replace Human Translators?

Whether or not you are a professional translator, it is natural to wonder if this type of technology will ever replace human translators? Prof Wong answers with a resounding 'No'. He explains that this misconception derives from a lack of understanding of machine translation. 'The intended function of machine translation is to realise automation of the process,' he says. 'In other words, the machine suggests a translation, but it is up to the translator to decide whether to accept or reject the suggestion based on his or her expertise.' According to Prof Wong, the translation produced by the machine is not always dependable, so a translator plays the essential role of a gatekeeper in order to prevent embarrassing mistakes. For instance, the machine is likely to translate '男士免進' into 'men's free entry', which is the exact opposite of the intended meaning ('no entry for men'). Also, as Prof Wong stresses, language is always changing, so too must machine translation systems, and for that to happen, we need humans to 'teach' the machine. For these reasons, it is unlikely that machine translation will completely replace human translators.

Prof Wong says, 'Over the past five years, the size of the machine translation market has nearly doubled, but on the other hand, the size of the human translation market also maintains an annual growth rate of 10 per cent. When mainland China and Macao reach the same degree of internationalisation as Europe and the United States, the demand for translation services will likely double. With competent human translators, the quality is guaranteed, but humans take longer time and have limitations as to the number of languages they can handle. Machine translation is the exact opposite. It is faster and can handle multilingual projects, but tends to produce inconsistent results. The inexorable progress of globalisation brings both opportunities and challenges for human translation and machine translation. Only by embracing the merits of both options can we achieve win-win results.'

### 機器翻譯並不取代人工翻譯

也許，有人會問，機器翻譯的出現，會令翻譯員失業嗎？黃輝教授認為，這樣的擔心是對機器翻譯的不瞭解，「這項科技的原意是讓翻譯邁向自動化，向人們提供翻譯的建議，至於是否採納，就要按你自身的專業作判斷。」他指出，機器翻譯的結果是不能盡信的，必須由翻譯員作質量上的把關，否則很容易釀成翻譯上的笑話，如母乳餵哺室的一則通告就把中文「男士免進」，翻譯成葡文「Entrada livre does homens」（男士免費進入）。另外，黃教授還強調，人類語言是不斷進化的，機器翻譯也需要不斷的更新，這方面就需要有人不斷地去「教」它，因此，機器翻譯不可能完全取代人工翻譯。

黃輝教授說：「過去五年，機器翻譯的量至少翻了兩倍；而人工翻譯的市場，每年也保持著10%的增長速度。如果內地、澳門的國際化程度達到歐美的水平，翻譯需求將會倍增。人工翻譯，有質量保證，但所需時間較長，且難以應付多種語言之間的翻譯；機器翻譯剛好相反，可以滿足這方面的需求，但翻譯質量難以保證。面對著不可逆轉的世界全球化進程，人工翻譯、機器翻譯，均面對著龐大的挑戰和機遇，兩者只有相互取長補短，才能走向雙贏。」

### 澳門機器翻譯第一人

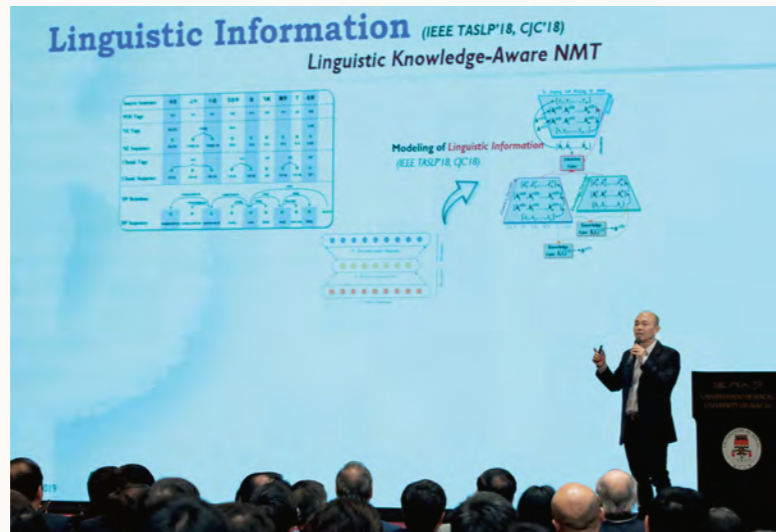
賦予機器翻譯技巧，等同於要機器「能理解、會思考」語言，掌握人類認知智慧，是人工智能技術中最難研發的課題之一，澳門回歸前沒有這方面的研究。1999年，全球首部中葡電子辭典誕生，令黃輝教授成為了澳門機器翻譯研究的第一人。當時，該辭典一推出，就有800多間政府部門及民間企業註冊使用。「回歸前，澳門有大量的官方文件有待翻譯，但卻沒有任何軟件、系統去輔助翻譯，因此有需要開展相關項目的研發。」2007年，時任葡萄牙總理若澤·蘇格拉德訪問澳大，讚揚澳大中葡雙語翻譯研究的成果，相信研究有助推動中葡友好合作。今天，澳大多項機器翻譯研發已大力推動了中葡翻譯工作，有助中葡經貿文化的交往。從無到有，一切都得來不易，黃輝教授說：「目前，澳大已構建起一個跨學科的研究平台，專注於自然語言處理、機器翻譯、機器學習及文本推斷等相關領域研究與系統開發。」

澳大和中國科學院自動化研究所舉辦的聯合研討會上，黃輝教授報告UM-CAT的最新研發成果。  
Prof Wong Fai presents the latest progress of UM-CAT at a joint seminar co-organised by UM and the Institute of Automation, Chinese Academy of Sciences.



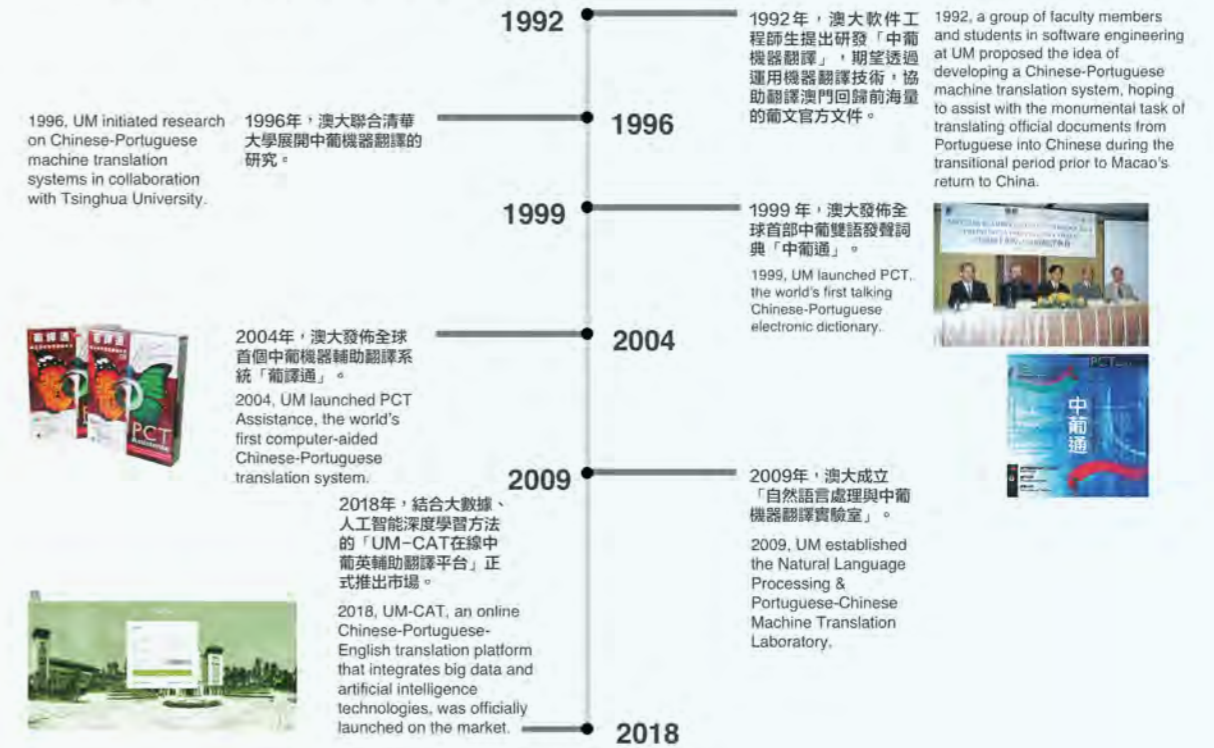
### The Pioneer of Machine Translation in Macao

Developing a machine translation system is in essence a process of teaching the machine to 'understand' and 'contemplate' language and acquire cognitive intelligence much like humans, which is one of the greatest challenges in the development of artificial intelligence technology. Before Macao's return to China, research in this area was virtually nonexistent. The gap was filled in 1999 when Prof Wong developed the world's first Chinese-Portuguese electronic dictionary, making him a pioneer in machine translation research in Macao. Soon after the launch of the e-dictionary, more than 800 government departments and private companies became registered users. 'Before the handover of Macao's sovereignty to China, a large number of official documents needed to be translated, but there was no software or system to aid the translation, so the development of the first e-dictionary was driven by a practical need,' he says. In 2007, during his visit to UM, then Portuguese President José Sócrates praised the university for its achievements in Chinese-Portuguese translation studies, which he believed would promote the friendship and collaboration between China and Portugal. His prediction has come true. The machine translation systems developed by UM over the years have indeed greatly facilitated Sino-Portuguese communication in business and cultural affairs. Prof Wong says, 'UM has established an interdisciplinary research platform, which is focused on the studies of natural language processing, machine translation, machine learning, and text inference, as well as the development of related systems.'



### 中葡機器翻譯歷程

#### MAJOR MILESTONES IN CHINESE-PORTUGUESE MACHINE TRANSLATION SYSTEMS



### 攻克語音翻譯領域的難關

2019年，適逢澳門回歸20周年，黃輝教授與NLP<sup>2</sup>CT團隊的下一個目標是攻克中葡語音翻譯領域，「作為機器翻譯的衍生研發，語音翻譯也被認為是未來五年內最具商業潛力的。」目前，NLP<sup>2</sup>CT正積極研發「會議智能翻譯系統」，預計可做到精準識別及翻譯，滿足多場景同傳交互體驗。黃輝教授透露，相關系統目前仍在測試階段，預計不久的將來可供大眾使用。

### Tackling the Challenge of Voice Translation

2019 marks the 20<sup>th</sup> anniversary of Macao's return to China. The next goal for Prof Wong and his team from the NLP<sup>2</sup>CT is to tackle the challenge of Chinese-Portuguese voice translation. 'As a spin-off of machine translation, voice translation is considered to be the most commercially promising area in the next five years,' he says. Currently, the NLP<sup>2</sup>CT is working on developing a smart conference translation system that can accurately identify and translate the languages used in a multilingual conference to enhance the efficiency of the conference process. The system is currently being tested and is expected to be launched for the mass market in the near future.



掃二維碼觀看訪談片段  
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# 翻譯平台UM-CAT研發團隊 分享研創歷程

## UM-CAT Development Team Shares Their Research Experiences

文 | 余偉業、校園記者錢詩雲 · 圖 | 何杰平 (部分圖片由受訪者提供)

Chinese Text | Kelvin U & UM Reporter Lyra Qian · Photo | Jack Ho with some photos provided by the interviewee

「在線中葡英輔助翻譯平台」(UM-CAT) 20年來能不斷的研發和推出新，迎合翻譯市場的需求，背後有賴一班現屆和歷屆參與研發的團隊緊密合作和日以繼夜的努力去完善和升級系統。

Over the past two decades, a team of researchers have worked tirelessly to continuously update and improve UM-CAT in order to meet the needs of the translation industry.

UM-CAT research team | UM-CAT系統研究團隊



UM-CAT Translation System | UM-CAT 翻譯系統界面

### 用戶為先

自然語言處理與中葡機器翻譯實驗室(NLP<sup>2</sup>CT)研究助理歐志雄，為研發UM-CAT的骨幹成員之一。他參與設計的「神經機器翻譯系統」，在2017年全國機器翻譯大賽(CWMT 2017)「英中機器翻譯評測」中突圍而出，與隊友一起包攬大賽的冠、亞、季軍；而該獲獎的系統，就是套用於現時UM-CAT機器翻譯的核心技術之一。目前，歐志雄擔當UM-CAT的「大管家」，負責UM-CAT系統架設和管理的工作，同時也兼顧為用戶提供良好的使用體驗。

歐志雄在澳大完成計算機科學學士和碩士學位後即加入實驗室當研究助理，快將近八年，他說：「經過多年的努力，最高興是見到UM-CAT項目能夠推出市場。UM-CAT著重中葡翻譯的品質，尤其針對澳門及葡語系國家慣用語，追求高準確度，且方便用戶使用，故具地區性的市場價值。甚至可以為翻譯公司設立專屬的管理模式，加速其工作流程和完善翻譯質量，這些服務對其他公司而言則較難做到。」

### Putting the Users First

Ao Chi Hong, a research assistant in the NLP<sup>2</sup>CT, is one of the core members of the team behind UM-CAT. The neural-based machine translation system, in which he was involved, won the top three awards at the 13<sup>th</sup> China Workshop on Machine Translation. The award-winning system is one of the core technologies used in developing UM-CAT. Currently, Ao is responsible for system setup and management of UM-CAT as well as ensuring good user experience.

Ao joined the NLP<sup>2</sup>CT as a research assistant after completing his bachelor's and master's degrees in computer sciences at UM. He has been working in the lab for nearly eight years. He says, 'After working on the system for so many years, I am most happy to see its launch into the market. We put great emphasis on the quality of Chinese-Portuguese translation and aim for a high degree of accuracy, especially with terms commonly used in Macao and Portuguese-speaking countries. We also make sure that it is easy to use. So it is a valuable product for our target markets. It can even create a tailor-made management mode for a translation company to streamline the work flow and improve the quality of translation. These functions are lacking in many other translation platforms currently available on the market.'

## 完善UM-CAT學習能力

另一參與研發UM-CAT的科技學院計算機科學博士研究生劉學博目前主要負責優化UM-CAT的機器學習演算法，進一步提升現有機器翻譯系統的翻譯品質，這也是他博士論文的研究方向。「目前，機器翻譯主要有兩個步驟：理解和生成，即理解待翻譯的語句，然後生成譯文；而我具體的研究，就是如何完善機器翻譯系統理解譯本的能力。」他解釋道：「只有提供準確度高、具參考價值的翻譯品質，才能真正輔助翻譯人員工作，這樣他們才會樂意使用。」

劉學博表示，UM-CAT與世界上絕大多數的機器翻譯系統一樣，都沿用2015年由加拿大蒙特利爾大學提出的一個框架；然而在2017年，Google公司推出新的框架，而且效果良好，顯著提升了譯文的品質，因此UM-CAT也需要與時俱進。「在優化演算法的領域上，只有不斷利用最新的框架和方法，才能確保機器翻譯的譯文質量得以提升，符合翻譯人員對準確度與流暢度的要求。」同年，黃輝教授率領NLP<sup>2</sup>CT研究團隊，赴清華大學作科研交流。劉學博為其中一員，他與清華研究員一起分析Google最新

## Improving UM-CAT's Machine Learning Algorithms

Liu Xuebo, a PhD student of computer sciences in FST, is also involved in the development of UM-CAT. He is mainly responsible for improving the translation quality of UM-CAT by improving its machine learning algorithms, which is also the subject of his PhD research. He explains, 'Machine translation includes two steps: understanding the source text and generating a translation. My work is to study how to improve the machine's ability to understand the text. Only by ensuring a high degree of accuracy will the system become a truly useful tool for the translators. And only then will they be happy to use it.'

According to Dr Liu, like the majority of machine translation systems in the world, UM-CAT is based on the architecture developed by the University of Montreal in 2015. However, in 2017, Google launched a new architecture, which greatly improved the quality of translation. So UM-CAT must be updated to keep pace with the changing technology. Liu says, 'In terms of improving the algorithms, only by using the latest architecture and method can we ensure that the quality of the translation meets translators' requirements for accuracy and readability.' In the same year, the team from the NLP<sup>2</sup>CT, led by Prof Wong, visited Tsinghua University. As a member of the team, Liu studied the latest architecture developed by Google

劉學博赴清華大學作科研交流

Liu Xuebo works with researchers at Tsinghua University



歐志雄與黃輝教授合影

Ao Chi Hong with Prof Wong Fai



NLP<sup>2</sup>CT孕育眾多機器翻譯人才

The NLP<sup>2</sup>CT has nurtured many machine translation researchers over the years

的框架，「最大的收穫就是把這個框架給研究透了。」

2018年11月，研究團隊回到澳門，並開始著手把最新的技術逐步套到UM-CAT系統上，以完善其機器深度學習的能力。劉學博說：「以前，機器翻譯系統的訓練，依賴於大規模的平行語料庫，即是幾百萬句中文譯本，與其相對應的葡文譯文，現在是不斷更新神經網路中每一神經元的參數。換言之，只要設計出更好的神經網路，那麼翻譯質量也會相應地顯著提高，可減少漏字的情況，或譯文語句變得更加流暢。」目前，澳大NLP<sup>2</sup>CT團隊有兩篇與清華合著的學術論文正向國際學術期刊投稿中，還有一項專利正待審批中。

with researchers from Tsinghua. 'The biggest gain for me was that we thoroughly studied and mastered the architecture,' he says.

In November 2018, the team returned to Macao and began to gradually integrate the latest technologies in UM-CAT to improve the system's ability for deep learning. Dr Liu explains: 'In the past, training machine translation systems relied heavily on parallel corpora. We are talking about millions of Chinese texts and corresponding Portuguese translations. But now, we constantly update the parameters of each neuron in the neural network. In other words, each time we develop a better neural network, the quality of the translation will greatly improve as a consequence, either by reducing the occurrence of overlooked words, or by improving the readability of the translation.' The team in the NLP<sup>2</sup>CT and their counterparts from Tsinghua University have submitted two jointly authored papers to international journals. A patent is also pending for approval.



## 翻譯機器的市場潛力

澳大NLP<sup>2</sup>CT研究團隊在2018年12月推出UM-CAT，現在已經著力為新一代（第四代）UM-CAT作準備。歷代參與該系統研發的校友，如今在不同領域綻放異彩。他們既推動澳門整體發展，亦投身大灣區，參與內地領先全球的企業，如阿里巴巴、百度、騰訊，有的甚至創業當CEO。這班校友見證系統的落地使用，心感興奮。

2012年電腦及資訊科學系碩士畢業生的田亮，畢業後在NLP<sup>2</sup>CT當了一年的研究助理，參與不同的機器翻譯研發。「在NLP<sup>2</sup>CT團隊裡，我學習到人工智能應用的巨大潛力。」2013年他離開實驗室創立一所在內地註冊的科技公司，主攻人工智能語音及圖像技術市場。UM-CAT作為「澳門製造」產品，他認為UM-CAT具有本土特色和優勢，更重要是服務葡語系國家的營商平台，優先解決葡萄牙語、英語、粵語、普通話等翻譯需要。」看到澳門未來翻譯的市場需求，田亮近年把業務紮根澳門，「現時正值機器翻譯迅速發展的時代，我希望把機器翻譯的相關技術和產品反哺澳門及葡語國家市場。另外，澳大是我的母校，希望透過高校和企業合作，促進UM-CAT在內地市場推出。」

## 人才輩出

另一位2012年電子商貿科學碩士畢業生曾曉東，在學期間也跨學系積極參與NLP<sup>2</sup>CT項目研發的工作，學習人工智能技術。2018年曾曉東躋身由《麻省理工科技評論》（MIT Technology Review）選出的「中國35歲以下科技創新青年35人」全球最權威的青年科技創新人才榜中，Google 聯合創始人 Larry Page 和 Sergey Brin、Facebook 創始人 Mark Zuckerberg 亦曾榜上有名。他說：「見到自己曾經參與研發的項目

## The Market Potential of Machine Translation Systems

The current version of UM-CAT was launched in December 2018, and the team is already working to develop a new generation of the system (G4). UM alumni who have been involved in the development of the system are shining in different professions, some in tech giants like Alibaba, Baidu, and Tencent, while others CEOs of their own businesses, contributing to the development of Macao and the Greater Bay Area. These alumni all feel excited to see the fruit of their labour being finally put to use.

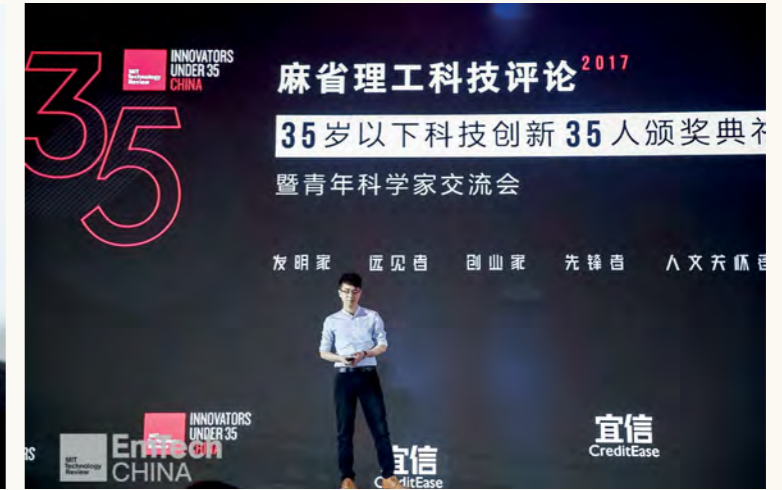
UM alumnus Tian Liang worked in the NLP<sup>2</sup>CT as a research assistant for one year after graduating from the master's degree programme in computer sciences in 2012. He was involved in the development of various machine translation systems. In the process, he learned the huge potential in the application of artificial intelligence. In 2013, he left the lab and registered a science and technology company in the mainland that is focused on developing AI voice and image technologies. He thinks that as a product made in Macao, UM-CAT has local characteristics and advantages. More importantly, it gives priority to the growing demand in Portuguese-speaking countries for translation services in Portuguese, English, Cantonese, and Mandarin. In recent years, Tian started to concentrate on the Macao market. 'This is a time when machine translation technology is developing rapidly, I hope to launch the related technologies and products in Macao and Portuguese-speaking countries. Also, UM is my alma mater, I hope to launch UM-CAT on the mainland market through collaboration with the university and companies.'

## A Breeding Ground for Tech Talent

UM alumnus Zeng Xiaodong, who graduated from the master's degree programme in e-commerce technology in 2012, was involved in some interdisciplinary projects in the NLP<sup>2</sup>CT while still studying at UM. In 2018, Zeng entered the 35 Innovators Under 35 China list released by *MIT Technology Review*. Former honorees on this list include Google co-founders Larry Page and Sergey



田亮希望促進UM-CAT在內地市場推出  
Tian Liang hopes to launch UM-CAT on the mainland market through collaboration



曾曉東成為被麻省理工看好的科技創新青年發明家  
Zeng Xiaodong was included in 35 Innovators Under 35 China list by MIT Technology Review

循序漸進落地，心情非常雀躍，UM-CAT可使語言不再是溝通的障礙。」

曾曉東形容他在NLP<sup>2</sup>CT學到的創新技術、到葡國當交換生的學習，為他畢業後創業打下強心針，令他明白到「要認真看待、尊重自己的興趣點，並加以發展」。目前，曾曉東在「螞蟻金服」技術實驗室，專注於物聯網與新零售跨領域結合的創新技術探索。他創造了中國首家無人店「淘咖啡」，實現「即走即付」新購物支付體驗的關鍵技術，開啟了內地無人值守的零售大門，成為被麻省理工看好的科技創新青年發明家。他感激澳大科技學院副教授黃輝和助理教授周沁的知識傳授，「澳大學習環境的開放，有機會接觸不同國家和地區的人，這樣的開放的環境能夠幫助鑄造綜合而開放的思維，而且每一位學生可獲得的教學資源可說是全國數一數二的。」

Brin, and Facebook founder Mark Zuckerberg. Zeng says, 'I'm very excited to see the project in which I was involved finally being put into use. UM-CAT removes language barriers in communication.'

Zeng notes that the innovative technologies he acquired in the NLP<sup>2</sup>CT and his experience as an exchange student in Portugal provided a powerful boost to his self-confidence when he later decided to start his own business after graduation. He learned from these experiences how important it is to honour one's passion and pursue a career following that passion. Currently, Zeng is working in Ant Financial's technology laboratory, where he devotes himself to exploring new technologies based on the Internet of Things that can transform the retail industry. He founded Tao Cafe, the first cashier-less shop in China, which enables customers to leave the shop with their items in hand without needing to head to a register, landing him on the *MIT Technology Review*'s list. Zeng is grateful to Prof Wong Fai and Dr Chao Sam from FST for their guidance. 'Studying at UM gave me the opportunity to meet people from different countries and regions. Such an open environment helps cultivate an open mind. In terms of educational resources accessible to every student, UM is arguably one of the best in China,' he says.

# 先進材料助解全球能源危機

## Developing Advanced Materials to Help Resolve Global Energy Crisis

文 | 余偉業、校園記者錢詩雲 · 圖 | 李向陽

Chinese Text | Kelvin U & UM Reporter Lyra Qian · Photo | Lei Heong leong

隨著全球能源危機和環境污染日益嚴重，綠色新能源的開發刻不容緩。2014年，澳門大學創建了「應用物理及材料工程研究所」(Institute of Applied Physics and Materials Engineering, IAPME)，為澳門目前唯一專門探索新能源、光電光轉換等應用物理學相關的材料和技術的研究所，協助解決全球能源危機。

With a growing global energy crisis and the proliferation of environmental pollution, it is increasingly urgent to develop new forms of green energy. In 2014, the University of Macau (UM) established the Institute of Applied Physics and Materials Engineering (IAPME), which is the only institute in Macao dedicated to exploring new forms of energy, electro-optical conversion, and advanced materials and technologies, with the aim of helping to resolve the global energy crisis.



### 年輕科研團隊

自成立以來，IAPME匯聚了一支創新意識強烈的年輕精英科研團隊，他們來自美國、歐洲、日本、新加坡、香港等世界知名大學和研究機構，具豐富的科研經歷、深厚的物理和材料專業背景，以及廣闊的國際化視野。其中，IAPME創所所長湯子康講座教授，更是國際知名的納米光電子材料領域領軍人物。在湯教授的帶領下，IAPME的研究實力、創新力在短短數年內迅速增長，獲國家自然科學基金重大集成項目、澳門科學技術發展基金、澳大科研基金等資助；開展70多個研究項目，發表SCI論文300多篇，國際學術影響力正穩步提升。

### 新能源材料研發

湯子康教授表示，IAPME以物理和化學為基礎，以材料為載體，從材料模擬設計出發，探索新材料、新工藝、新功能。以工程應用為導向，針對澳門及大灣區發展所需的科學技術，發展具澳門特色的新型應用物理及材料工程學科。目前，IAPME的研究重心放在太陽能、電能儲存（電池、氫存儲、燃料電池）及節能（高效光電子以及固體照明器件）等領域的關鍵材料製備和技術開發。

湯子康教授說：「材料是個廣泛的概念，不可能甚麼都做，而IAPME注重新能源材料以及光電光材料的開發和科技創新。結合納米科技，研發出高效的清潔能源以及光電光技術應用。這些研究將推動澳門新能源學科及相關產業的革新與發展，有望使之成為澳門未來的新科技支柱產業之一。」

左圖：湯子康教授(中)引領IAPME的研發取得多項突破  
Left Image: The IAPME, led by Prof Tang Zikang has achieved many breakthroughs

### A Young Research Team

Since its establishment, the IAPME has garnered a group of young, innovative researchers from world-renowned universities and research institutions in the United States, Europe, Japan, Singapore, and Hong Kong. Among them, Chair Professor Tang Zikang, director of the IAPME, is an internationally renowned leader in the field of nano-optoelectronic materials. Under his leadership, IAPME has rapidly progressed in research capacity and innovative power in just a few years, as evidenced by the research grants from the National Natural Science Foundation of China, Macao Science and Technology Development Fund, and the UM Research Fund. With more than 70 ongoing research projects and over 300 papers published in SCI-indexed journals, the institute's international academic influence is growing steadily.

### Developing New Forms of Energy & New Materials

According to Prof Tang, physics and chemistry are the foundation of what IAPME researchers do and materials are the vehicle for fulfilling their mission—developing new materials, new techniques, and new functions through materials simulation and design. With an application-oriented approach, the institute strives to develop innovative academic programmes in applied physics and materials engineering with local characteristics in order to nurture professionals who can develop new technologies needed by Macao and the Greater Bay Area. Currently, IAPME researchers focus on developing key materials and technologies for applications in the fields of solar energy, electrical energy storage (batteries, hydrogen storage, fuel cells) and energy conservation (high-efficiency optoelectronics and solid state lighting devices).

Prof Tang says: 'Materials engineering is a broad concept. We can't cover everything. Our current focus is on developing new forms of energy and new materials such as optoelectronic and electro-optic materials, as well as new technologies. We hope to develop new forms of efficient, clean energy using nanotechnology and explore the applications of optoelectronic and electro-optic technologies. These research studies will hopefully bring about a change in the existing academic programmes in new energy and promote the development of related

## 鈣鈦礦太陽能電池

綠色清潔能源的研究是IAPME的主導方向之一，其中，鈣鈦礦太陽能電池的研發備受國際矚目。

湯子康教授介紹，目前市場上的太陽能電池主要以多晶矽為原材料，提煉過程會造成高污染和高耗能，且技術昂貴。相反，目前 IAPME 主攻的鈣鈦礦太陽能器件，能用低溫印刷的方式大面積製備，成本低廉。主責鈣鈦礦太陽能電池研發的 IAPME 助理教授邢貴川表示，鈣鈦礦材料性能優異，同時具備了無機半導體的光電子特性和有機材料的溶液可加工性能，能高效地把太陽光能量轉換成電能，其最新報道的電光轉換效率高達23.7%，接近單晶矽的26.1%，遠高於染料敏化太陽能電池的11.9%和有機太陽能電池的12.6%。另外，邢教授說：「鈣鈦礦材料柔軟輕便，能用噴霧打印技術，印在背包或衣服上進行太陽能儲電，能大大提高效能。相信在未來建設智慧城市上，將有更多元化的應用。」

半導體膠體量子點  
Semiconductor colloidal quantum dots



industries in Macao. New energy has the potential to become a new pillar industry in Macao.'

## Perovskite Solar Cells

Developing new forms of green energy is one of the main research interests of the IAPME. In fact, the perovskite solar cells developed by the institute have already attracted considerable international attention.

Prof Tang explains that the solar cells currently available on the market are mostly made of polysilicon, whose manufacturing process is expensive, consumes much energy, and produces many pollutants. On the other hand, the perovskite solar cells which are developed by the institute can be mass-produced through low-temperature printing at a low cost. Xing Guichuan, an assistant professor in the IAPME, who is mainly in charge of the development of perovskite solar cells, says that perovskite solar cells have not only demonstrated excellent performance, but also have the optoelectronic properties of inorganic semiconductors and can be processed in solutions like organic materials. They can effectively convert solar energy into electrical power. According to the latest report, they can achieve a photoelectric conversion efficiency of 23.7%, comparable to that of single crystal silicon (26.1%) and far higher than that of dye-sensitised solar cells (11.9%) and organic solar cells (12.6%). Moreover, according to Prof Xing, perovskite materials are soft and light, so they can be printed on backpacks or clothes to store solar energy through spray painting technology, which can greatly improve efficiency. He believes that in the future perovskite materials will have more applications in the development of smart cities.

## Next-generation LED Technology

In addition to perovskite solar cells, Prof Xing is also in charge of the development of perovskite nanocrystalline light-emitting diodes (LEDs), which are hailed as 'the next-generation LED technology'. They are expected to bring low-cost, environmentally-friendly and highly-efficient LED displays and light sources into everyday life.

Indium, a raw material used to make gallium nitride LEDs, is a scarce metal with very small global reserves. Some

## 下一代LED技術

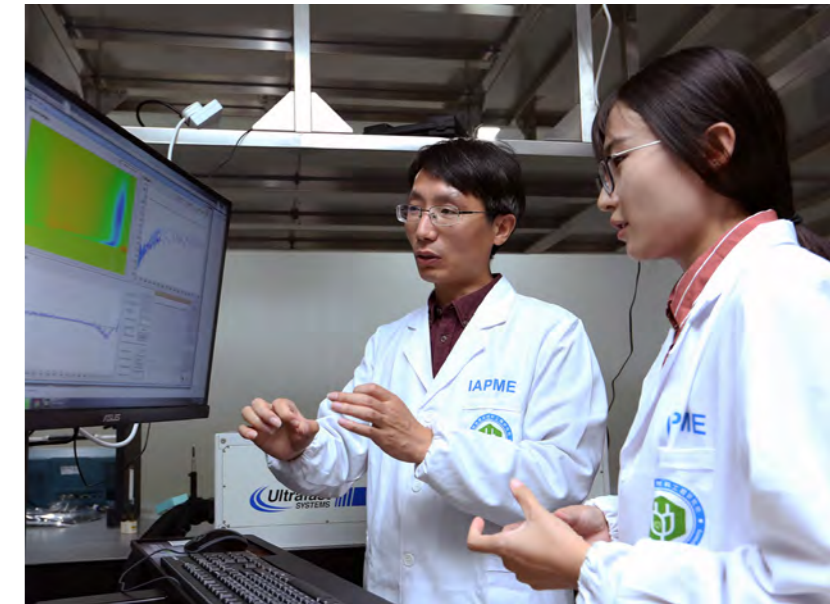
除了主力開發鈣鈦礦太陽能電池外，邢教授也兼顧研發鈣鈦礦納米晶發光二極管，該項目被譽為「下一代LED技術」，有望把低成本、環保高效的LED顯示屏和LED光源帶進日常生活中。

目前制造氮化鎵LED所需的原料「銦」，是全球儲量非常少的稀缺金屬資源，再過數十年有枯竭的風險，因此鈣鈦礦等量子點材料將會逐漸取代傳統LED材料。邢貴川教授是鈣鈦礦在發光研究領域的先驅者之一，他的研究進一步大幅提高鈣鈦礦型LED的發光效率。「全球約20%的電能是用來照明的，所以研發高效的照明技術對節約能源至關重要。鈣鈦礦溶液的製備過程既簡單又便宜，生產成本低，而且穩定性高，目前，鈣鈦礦的電光轉換效率已經超過20%，接近其它昂貴半導體的效率峰值，因此獲廣泛研究興趣。在不久的未來，這項技術將普及化、商業化，達到節能的目的。」

## 破多項世界紀錄

另一項IAPME引以自豪的科研成果是「新型超級水凝膠」，其吸附、溶脹、導電、機械性能大幅度提升，能廣泛應用於多個領域，滿足不同需求。負責該研發的IAPME助理教授孫國星介紹，澳大研發的水凝膠吸水倍數高達至13,600倍，即1克的材料吸水後會變成13,000克以上，其吸水溶脹性能是目前世界紀錄的3至4倍，因此可做成吸濕器、衛生巾、尿不濕、衣櫃除濕等民用產品，也可埋在土壤中用作農田保水、沙漠治理；同時，它對有機色素的吸附能力是目前世界紀錄的2倍，可放於污水中吸附其中的污染物，清潔水源。

孫教授表示，這款水凝膠採用價格低廉的普通水泥作為交聯劑，成本遠低於市面產品。另外，在力學性能方面，由於它比橡膠更軟、回復能力更強，具高彈性和減震功能，可用於電子、建築、機



邢貴川（左）是鈣鈦礦在發光研究領域的先驅者之一  
Xing Guichuan (left) is a pioneer in the development of perovskite solar cells

even argue that the earth might run out of indium in a few decades. This is why scientists are already exploring alternative materials to replace indium. Prof Xing is one such pioneer. If successful, his work will substantially improve the luminous efficiency of perovskite LEDs. 'About 20 per cent of electrical power in the world is used for lighting, so it is very important to develop efficient lighting technology to conserve energy,' he says. 'The process of making perovskite solution is simple, less expensive, and highly consistent. Because of the high photoelectric conversion efficiency of perovskite, which is over 20 per cent, close to the peak photoelectric conversion efficiency of other expensive semiconductors, it has become a subject of widespread study worldwide. I believe that the popularisation and commercialisation of this technology in the near future will help us achieve the goal of energy conservation.'

## Breaking Multiple World Records

Another proud brainchild of IAPME researchers is an innovative super hydrogel. This super hydrogel significantly outperforms regular hydrogel in water absorption, swelling ratio, electrical conductivity, and mechanical properties, and can be used in many fields to meet different needs. IAPME assistant professor

械等領域的緩衝墊材料；在電學性能方面，其表面電導率為目前世界紀錄的5倍，可作柔性電子器件，如柔性電機版、電容器隔膜等；最後，水凝膠和生物細胞具有良好的相容性，細胞可在其中完美舒展，舒適存活，因此有望可跨領域做成機械性能優異、生物相容性好的新一代生物醫學組織材料、人造器官等產品。目前，該技術正申請三項中國發明專利。

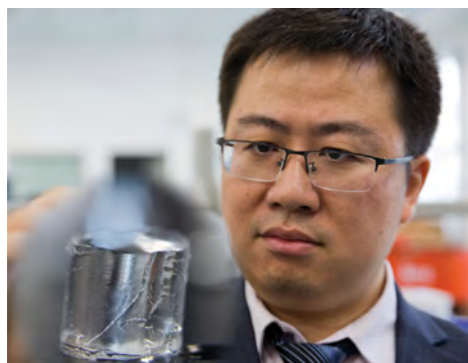
### 前沿科技增澳門競爭力

IAPME凝聚著不同領域的物理專家的智慧，走在科研的最前沿，也引領澳門在物理學和化學學科的發展。湯子康教授表示，透過開展多項材料工程研究，不僅為澳門培養科技人才，更有望為澳門的產業結構帶來新變化、注入新動力。目前，IAPME也主攻開發平板顯示材料與技術，積極研究如何將「半導體膠體量子點」（簡稱「量子點」，半導體納米晶材料之一）的性能發揮最大值，以最有效的方式把電變成光。

負責相關研究的助理教授王雙鵬表示，由於量子限域效應，僅通過調節量子點的微粒尺寸，就可以實現量子點的發光

孫國星研發的「新型超級水凝膠」正申請三項中國發明專利

Three China patents are pending for this new type of super hydrogel developed by Sun Guoxing



Sun Guoxing explains that this new hydrogel can absorb up to 13,600 times its own weight in water. In other words, one gram of this hydrogel can absorb over 13,000 grams of water, which is three to four times the water-absorption ability of the most water-absorbent hydrogel ever recorded. Because of its superior water absorption ability, it can be used to make everyday products such as moisture absorbers, sanitary napkins, and diapers; or buried in the soil to retain water for farmland or deserts. Moreover, it can absorb twice as much organic pigment as the current versions of hydrogel. So it can be used to absorb the pollutants in waste water in order to produce clean water.

According to Prof Sun, this hydrogel uses inexpensive cement as the cross-linking agent and therefore costs far less than the commercial products currently available on the market. In terms of mechanical properties, it is softer, more resilient, elastic, and shock-absorbent than rubber, which makes it an ideal material for cushions in many fields such as electronics, construction and machinery. In terms of electrical performance, its surface conductivity is five times greater than the highest surface conductivity ever recorded. It can be used to make flexible electronic devices, such as flexible printed circuits and capacitor diaphragms. Finally, hydrogels are highly compatible with biological cells and can provide a perfect environment for cells to live and grow. Therefore they can be used to make next-generation medical tissues or artificial organs, with the dual advantage of superior mechanical performance and high biological compatibility. Three China patents are pending for this technology.

### Enhancing Macao's Competitiveness Through Cutting-edge Technology

IAPME boasts a group of physicists and chemists who specialise in different fields. Together, they explore the frontiers of scientific research and promote the development of related disciplines in Macao. Prof Tang says that through initiating research studies in materials engineering, not only can the institute nurture science and technology professionals for Macao, but it will also hopefully bring about new changes to the industrial structure of Macao. Another focus of IAPME researchers' efforts is the development of materials and technologies



王雙鵬表示，新的顯示技術有可能帶動出一個新產業。  
Wang Shuangpeng thinks new display technologies have the potential to spawn a new industry

波長（顏色）從近紅外到藍紫光的連續可調。量子點發光的色彩純度極高，使得顯示畫面的色彩呈現更貼近人眼所見之真實世界。另外，量子點發光耗能低，成本低，是未來平板顯示技術的主流選擇之一。「可見，科技是第一生產力，新的顯示技術有可能帶動出一個新產業，有機會以核心技術佔領新市場，提高社會競爭力。」

### 革命性納米光熱生物材料

IAPME研發的納米材料在生物醫藥的應用方面也有令人欣喜的突破性進展。湯子康教授表示，通過量子點把光變熱的效應，不僅僅能有效殺死腫瘤，重要的是，腫瘤經納米光熱效應治愈後，體內會保持著長期的腫瘤免疫記憶。就是說治好過一次之後，再也不會復發。這是一種通過物理的方式激活動物體內腫瘤免疫系統的全新途徑。

目前，IAPME正和健康科學學院、中華醫藥研究院進行跨領域合作，小鼠動物實驗已經取得了非常好的效果。一旦腫瘤疫苗的研製取得成功，將會產生巨大的社會效應和商業價值，並在這領域引起革命性的迴響。

for flat panel displays. They are specifically exploring ways to maximise the performance of semiconductor colloidal quantum dots ('quantum dots' for short, one of the semiconductor nanocrystals) and turn electricity into light in the most effective way.

Wang Shuangpeng, an assistant professor in the institute who is in charge of related studies, says that because of the quantum confinement effect, the wavelength (colour) of quantum dots can be continuously adjusted from the wavelength of near-infrared light to that of blue-violet light by adjusting the particle size of quantum dots. The colour purity of quantum dots is extremely high, making the colour of the display closer to that of the real world seen through the human eye. In addition, quantum dots consume less luminous energy and therefore cost less, making them a sensible mainstream choice for future displays. 'Science and technology are the primary productive forces. New display technologies have the potential to spawn a new industry, or even help Macao to seize a new market and enhance its competitiveness,' says Prof Wang.

### Revolutionary Nanometre Photothermal Biomaterials

The IAPME has also achieved an encouraging breakthrough in the development of nanomaterials for biomedical applications. Prof Tang says that quantum dots can convert light into heat energy, which can not only kill cancer tumours, but also induce innate immune memory in the body. This means that once the cancer is cured through nano-photothermal therapy, it will never recur. It is a revolutionary non-invasive way to activate the body's immune system to cure cancer.

The IAPME is now involved in interdisciplinary, collaborative research projects with the UM Faculty of Health Sciences and Institute of Chinese Medical Sciences. Experiments on mice have produced excellent results. Once successful, the cancer vaccines will produce enormous social benefits and commercial value, as well as revolutionary repercussions in the field.



掃二維碼觀看訪談片段

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# 人工智能改良核醫學診治

## Applying AI in Nuclear Medicine to Improve Diagnosis and Treatment

文 | 葉浩男 · 圖 | 張愛華

Chinese Text | Davis Ip · Photo | Ella Cheong



莫昇萍教授的研究團隊主要研究核醫學儀器的開發、醫學影像的生成與後處理  
Prof Mok's research team focuses on the development of nuclear medical instrumentation, methods of medical imaging generation, and subsequent processing and analysis techniques.

網絡有云，有圖有真相，醫學影像也成為疾病診治不可或缺的一環。為了這個目標，澳門大學科技學院的生物醫學影像實驗室經過七年來不斷努力，近年初見成果，屢獲國際獎項。實驗室始創人莫昇萍教授說，希望深化運用人工智能等技術，進一步改良核醫學診斷和治療，改善市民健康。

A picture is worth a thousand words. This is clearly true in medical diagnosis. Indeed, medical imaging has become a powerful tool in the diagnosis and treatment of illness. Over the past seven years, the team in the Biomedical Imaging Laboratory, established by the Faculty of Science and Technology (FST), has worked relentlessly in this field, producing encouraging results that have garnered international recognition. Prof Greta Mok, founder of the laboratory, hopes to apply artificial intelligence (AI) and other related technologies in nuclear medicine to improve diagnosis and treatment of medical conditions for Macao residents.

莫昇萍是科技學院電機及電腦工程系副教授、健康科學學院兼任副教授，澳門首位土生土長的醫學影像學者。莫教授18歲離開澳門到台灣陽明大學升學，畢業後負笈到在醫學與公共衛生領域享譽全球的美國約翰·霍普金斯大學攻讀博士，是該學院首位來自澳門的博士畢業生。她之後曾在香港中文大學任教，2010年回流澳門加入澳大，2012年創立澳門首個生物醫學影像實驗室。

### 核子醫學影像

在核醫學診斷方面，病人會被注射或口服少量放射性藥物（同位素）。這些同位素會分佈在人體不同的部位，具特異性的積累到待診斷的器官或腫瘤，並放出伽馬射線到人體以外，被專門的伽馬照相機收集和生成影像。通過重建並分析這些影像，專家就能觀察器官的功能、腫瘤的位置、嚴重程度和有否轉移，並且評估治療效果等。莫教授說，器官移動（例如心跳或肺部充氣呼氣）有時會令醫學影像出現假影，影響診斷。

研究團隊主要研究核醫學儀器的開發、醫學影像生成的方法和後續的處理分析，讓醫學影像更加精準，涉及大腦、心臟、肝臟等多個器官，以及癌症的診斷和治療。莫教授說：「譬如說腦部，我們無法直接觀察腦部的功能，而帕金森症、失智症等不少病症發病前都沒有明顯症狀，最好的檢查方法，就是非侵入性的醫學影像掃描，而在此應用上，核醫學又比其他影像技術具有明顯優勢。」此外，偵測與定性腫瘤時，醫護人員通常會安排患者接受正電子掃描，先將有放射性氟標記的葡萄糖注射到體內。由於腫瘤會吸收很多葡萄糖，只要觀察不正常的「亮點」，就能得知腫瘤的位置和嚴重程度，以及有沒有潛在的轉移。

Prof Mok is an associate professor in the Department of Electrical and Computer Engineering and a joint associate professor in the Faculty of Health Sciences. She is the first native of Macao to become a medical imaging scholar in Macao. At age 18, she left Macao to pursue higher education at Yang-Ming University in Taiwan. After graduation, she was admitted by Johns Hopkins University in the United States, a universally acclaimed institution in the fields of medicine and public health. She is also the first Macao native to obtain a doctoral degree at JHU. She was later recruited by the Chinese University of Hong Kong as a junior faculty member before returning to Macao to join UM in 2010. Two years later, in 2012, she founded Macao's first Biomedical Imaging Laboratory.

### Nuclear Medicine Imaging

In nuclear medicine, patients are given small amounts of radioisotope-labelled drugs either orally or by injection. The radioisotopes then circulate through the body and are absorbed specifically by target organs or tumours under examination. The isotopes undergo radioactive decays and emit gamma rays from within the body, which are captured by a gamma camera to create images. By reconstructing and analysing these images, doctors can assess organ functions, tumour location, disease progression and staging, and effectiveness of the treatment. Prof Mok says that organ movements, such as the beating of the heart or the inflation and exhalation of the lungs, can sometimes lead to artifacts, which can degrade the interpretations of imaging results.

The research team currently focuses on the development of nuclear medical instrumentation, methods of medical image generation, and subsequent processing and analysis, with the aim of making medical images of the brain, heart, liver and other organs more accurate, in order to improve the medical diagnosis and treatment of cancers. 'Take the brain for example. We can't directly assess the brain functions from the physical examination,' says Prof Mok. 'There are a lot of diseases such as Parkinson's disease and dementia that don't have obvious symptoms before the onset of the diseases. So the best way to detect disease pre-emptively is to use non-invasive medical imaging techniques, and nuclear medicine has obvious advantages over other imaging technologies in this

### 三大研究項目

莫教授說，實驗室目前有三個主要的研究項目。「第一個是去除呼吸假影的呼吸控制器、相關影像採集及後期處理軟體的開發。病人接受掃描時，這個呼吸器可以主動地控制病人呼吸，然後採集影像，從而去除呼吸假影，提升對病灶的偵測能力和量化精度。」第二個項目則是設計和製造一台多用途的多針孔準值儀。該儀器比傳統的單針孔與平板準值儀採集到更多伽馬光子，增強掃描儀的靈敏度，繼而用以降低影像噪聲、減低輻射劑量或縮短掃描時間。實驗室已經委託荷蘭一家公司訂製該準值儀的原形，並安裝在實驗室的單光子電腦斷層掃描儀上再作評估。

實驗室有一台由澳門鏡湖醫院所贈的複合式單光子發射電腦斷層掃描

The lab has a SPECT/CT scanner, which was donated by Kiang Wu Hospital

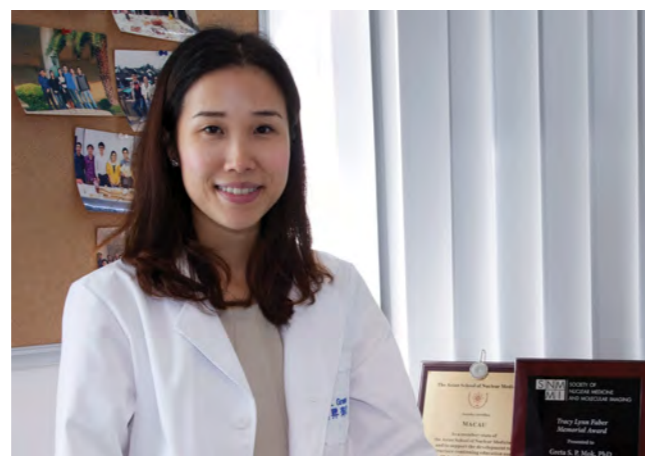


application.’ In the assessment of a tumour, the doctor can prescribe a positron emission tomography (PET) scan, where glucose labelled with radioactive fluorine is injected into the patient’s body. Since the malignant tumour usually absorbs more glucose than normal tissues, the doctor can pinpoint the location of the tumour and assess the severity of the condition by detecting and quantifying the unusually ‘bright spots’.

### Three Major Research Projects

According to Prof Mok, the lab currently has three major research projects. The first is the development of an active breathing controller to remove respiratory artefacts and related image acquisition and post-processing software. When the patient is scanned, this controller can suspend the patient’s breathing while collecting images, thereby removing respiratory artefacts, improving the quality of imaging, and enabling more accurate quantification of the lesions. The second project is to design and develop a multi-purpose, multi-pinhole collimator that can collect more gamma photons than traditional single-pinhole and parallel-hole collimators. This collimator can enhance the sensitivity of the scanner, which can in turn reduce image noise, radiation dose or scanning time. The lab has commissioned a Dutch company to customise a prototype of the collimator. The device has already been installed on the lab’s single-photon computed tomography (CT) scanner and is undergoing further evaluation.

莫昇萍教授和團隊的研究屢獲國際殊榮  
Prof Greta Mok’s team has won many international awards



除了診斷，放射性藥物也能用於治療，實驗室的第三個項目就能為接受標靶核素治療的病人計算藥物劑量，以及評估藥物對腫瘤的療效和各個器官帶來的放射劑量。「我們研發出一個三維核醫同位素治療劑量計算軟體，可供醫院或研究機構採用，優化劑量計算，令每個病人都有更準確、更個人化的注射劑量計算和輻射劑量評估。」

莫教授說，運用人工智能是醫學影像研究的一個趨勢。「人工智能可以提高影像質素，也能減少輻射劑量，我希望三個研究項目都能應用上人工智能技術。在去除呼吸假影的項目上，我們已經成功應用人工智能減低影像的噪聲。我們將來也會研究用人工智能，減少掃描所需的同位素劑量或生成影像的時間。」

### 發展潛力

在莫教授帶領下，實驗室培養了十多位來自澳門和內地的研究生，目前在世界各地及本澳的院校、業界和醫療機構發光發熱，其中在讀博士生張鐸和孫敬張看見醫學影像研究與人工智能結合的前發展前景。

過去數年，張鐸在莫教授指導下，發表了不少關於醫學影像校正的論文，包括涉及不同呼吸模式對醫學影像的影響。攻讀博士期間，張鐸獲莫教授推薦，到美國麻省大學醫學院和耶魯大學擔任訪問學者一年，參與前沿研究。「在耶魯工作的收穫很大，根據那邊導師的評價，我一個月做了別人一個學期才做完的工作。」由於表現出色和在澳大培養出的研究根基，耶魯大學的導師邀請張鐸到該校做博士後研究，但他認為畢業後留在粵港澳大灣區發展也是一個理想的選擇。「我們實驗室與大中華地區和歐美的科研機構聯繫密切，跟香港中文大學和中國科學院深圳先進技術研究院等大灣區院校也有合作，畢業後到大灣區其他大學任職發展潛力大，還方便以後跟莫教授在研究上保持緊密聯繫。」

In addition to diagnosis, radioactive drugs can also be used for treatment of cancers, which is exactly the focus of the lab’s third project. The lab has developed a piece of 3D computer software for internal dose calculation in targeted radionuclide therapy. It can be used to evaluate the radiation dose absorbed by the tumour and various organs, an important index for treatment efficacy and potential toxicity. Hospitals and research institutions can apply this software to optimise dose calculation for each individual patient, so that treatment planning could be more precise and personalised.

Prof Mok says that AI technology is increasingly used in medical imaging research. She says, ‘AI technology not only can help to improve the image quality, it can also reduce the radiation dose. I hope to apply AI technology in all three research projects. With our first project on respiratory artifact reduction, we have already successfully reduced image noise using AI technology. In the future, we will study the use of AI technology to reduce the radiation dose and image acquisition time to benefit the patients.’

### Enormous Potential

Under the leadership of Prof Mok, the lab has trained over a dozen postgraduate students from Macao and mainland China, who are now working at universities, industries, and medical institutions in Macao and other parts of the world. Among them, doctoral students Zhang Duo and Sun Jingzhang foresee enormous potential in applying AI technology to medical imaging research.

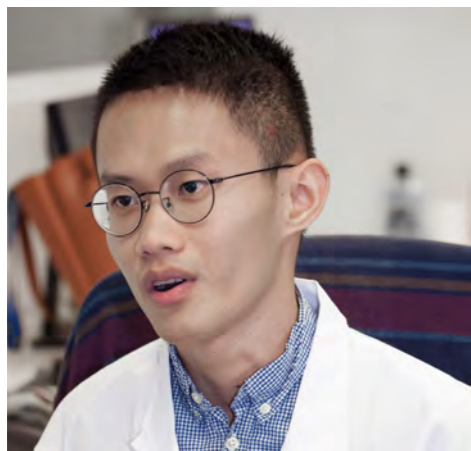
Over the past few years, under the guidance of Prof Mok, Zhang has published some papers on medical image correction, including one paper that examines the effects of different respiratory patterns on medical images. During his doctoral study, Zhang was recommended by Prof Mok to work as a visiting scholar for one year at the University of Massachusetts Medical School and Yale University in the US, where he participated in cutting-edge research. ‘I gained a lot from working at Yale. According to my supervisor at Yale, I did in one month what other students did in one semester,’ Zhang says. Because of his outstanding performance and the solid grounding in research he developed at UM, Yale’s supervisor invited him to be a postdoctoral research fellow at the university, but he had other plans. ‘Our lab is in close contact with research institutions in the

莫教授另一位博士生孫敬張的本科和碩士都是計算機科學。他在澳大的其中一項研究是運用人工神經網絡技術，降低醫學影像的噪聲。「首先我有計算機科學背景，之前也是做圖像處理。由於從事這方面研究的人也較少，所以我想嘗試探索更多。」孫敬張現在用深度學習技術，解決一些關於醫學影像質素的難題。



張鐸讀博期間獲薦到美國麻省大學醫學院和耶魯大學擔任訪問學者一年

During his doctoral study, Zhang Duo was recommended by Prof Mok to work as a visiting scholar for one year at the University of Massachusetts Medical School and Yale University in the USA.



孫敬張在莫昇萍教授指導下，利用人工神經網絡技術，降低醫學影像的噪聲。

Sun Jingzhang is working on the application of artificial neural networks to reduce noise in medical imaging under the guidance of Prof Mok.

Greater China region, Europe, and the US, and we also collaborate with institutions in the Greater Bay Area, such as the Chinese University of Hong Kong and Shenzhen Institutes of Advanced Technology of the Chinese Academy of Sciences. I plan to find a job at a university in the Greater Bay Area after graduation, because I see great potential for career development in this area. It would also be more convenient for me to keep in close research contact with Prof Mok.'

Sun Jingzhang, another of Prof Mok's PhD students, has both a bachelor's and master's degree in computer science. One of his research projects at UM involves using artificial neural networks to reduce noise in medical imaging. 'I have a background in computer science, and I used to study image processing. There aren't many people doing research in this area, so I want to explore more,' he says. Sun now uses deep learning techniques to try to tackle some challenging issues concerning medical image quality.

### International Recognition

The research results from the lab have been applied on more than 50 patients in Taiwan and the US to improve their medical diagnosis. The team has also won many awards at international conferences in recent years. At the Third Asian Nuclear Medicine Academic Forum in 2017, the team stood out among strong research groups from Asia and won the sole first prize in the Fourth Rising Nuclear Medicine Professional Challenge, the highest honour of the forum, for their work titled 'A Framework for Improved 3D Personalised Targeted Radionuclide Therapy Dosimetry Using Registration on Sequential ECT/CT'. It was the first time that a team from Macao had won this award. The same project later received the International Best Abstract Award and the third prize of the Computer and Instrumentation Council (CaIC) Young Investigator Award (YIA) at the 64<sup>th</sup> Annual Meeting of the Society of Nuclear Medicine and Molecular Imaging held in Denver, Colorado, US in the same year. It was the first time a research team from the Greater China region had been shortlisted for, much less received, an award in this YIA category. Two other notable teams shortlisted for this award were from Stanford University and MD Anderson Cancer Center.

### 國際肯定

實驗室的成果已在台灣和美國超過50個病人身上得到應用，提高了醫學影像的質素。團隊近年更在國際會議奪得多個獎項。在2017年的第三屆亞洲核醫學論壇上，團隊以研究課題「兼備圖像對位算法的三維個人化靶向核素治療劑量計算框架」，力壓一眾亞洲隊伍，榮獲論壇最高榮譽獎項「第四屆亞洲青年競賽」唯一一等獎，是首支來自澳門的獲獎隊伍。相關項目同年再下一城，在美國丹佛市舉行的北美核醫學與分子影像年會獲頒「國際最佳論文獎」和「青年研究家獎」第三名。其中在競逐「青年研究家獎」方面，實驗室是儀器與軟件類別首支來自大中華地區的入選團隊，力壓史丹福大學和德州安達森癌症中心的世界頂級強隊獲獎，讓澳門核醫研究在國際舞台上一鳴驚人。

在2018年北美核醫學與分子影像年會上，莫教授憑著針對治療肝臟腫瘤的研究再奪「國際最佳論文獎」。大會更向她頒發專門表揚傑出女科學家的「Tracy Lynn Faber Memorial Award」，表彰其對射線斷層成像與計算機斷層成像的設備、圖像重建和分析研究等的出色貢獻，令莫教授成為首名得獎的華人科學家。

莫教授說，這些國際肯定都是對研究團隊的莫大鼓舞。「要在澳門這個『同位素沙漠』從事核醫學研究異常艱鉅，同一項實驗要比其他地方付出多幾倍努力才能實現，臨床測試則大多要到外地進行。一眾國際獎項過去的得獎者都有醫學院的全力支持，澳大沒有醫院，而且難以取得同位素，但團隊也能排除萬難，得到國際認可，實在非常榮幸。」

The Year 2018 continued to be a fruitful year for Prof Mok's team. At the 65<sup>th</sup> Annual Meeting of the Society of Nuclear Medicine and Molecular Imaging (SNMMI) held in Philadelphia, Prof Mok received the International Best Abstract Award for the second consecutive year for her work titled 'Comparison of Different Tc-99m-MAA Imaging Protocols for Y-90 SIRT Treatment Planning', as well as the Tracy Lynn Faber Memorial Award, in recognition of her major contributions to high performance Emission Computed Tomography and Computed Tomography instrumentation, reconstruction, and analysis. She is the first Chinese scientist to ever receive this prestigious award.

'These international awards are certainly very encouraging for the research team,' says Prof Mok. 'In a "desert of isotopes" like Macao, it is exceedingly difficult to conduct research in nuclear medicine. For the same experiment, you need to work extra hard to make it happen. Most clinical trials have to be conducted outside of Macao. All the past winners of these international awards had the full support of their medical schools. UM doesn't have a medical school, and isotopes are just hard to obtain. But the team managed to overcome all the difficulties and won these international awards. We feel really honoured and thankful.'

It is not easy to build a lab from scratch. Prof Mok says, 'I am very grateful to my team and my students for their support. I am also grateful to the university for its trust and to the international and local societies for their recognition. Because of them, our hard work over the years has not been in vain. Everyone in the lab puts their hearts and souls into what they are doing. They are full of dreams and they are passionate about their research. I hope the fruits of our research can be applied in Macao as well. Hopefully we will increase collaborations with hospitals in Macao to let local patients be the first to benefit from our technology. Our goal is to bring real changes in the diagnosis and treatment of illnesses for local residents using medical imaging technologies.'



掃二維碼觀看訪談片段

Scan the QR code to watch the video interview

# 新增五個學士學位課程培養跨學科人才

## UM Launches Five New Undergraduate Programme to Nurture Interdisciplinary Professionals

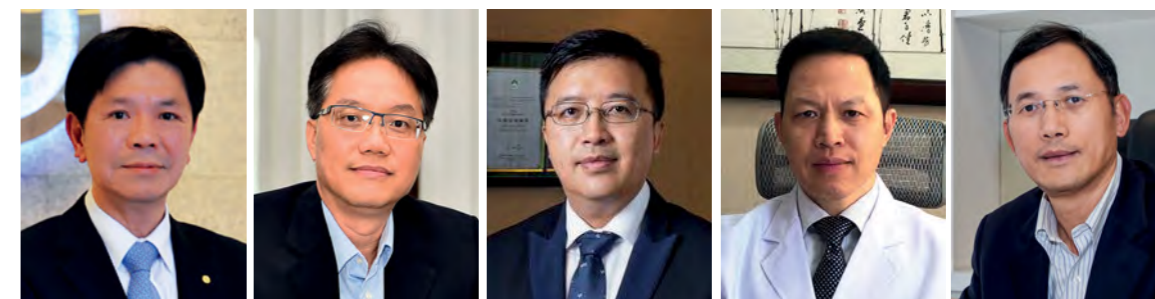
文 | 張愛華 · 圖 | 編輯部 (部分圖片由受訪者提供)

Chinese Text | Ella Cheong · Photo | Editorial Board with some photos provided by the interviewees



人才是引領社會進步的驅動力，澳門大學作為澳門特區最優秀的國際化、唯一一所綜合性公立大學，因應社會的發展和技術轉型的需要，於2019/2020學年推出五個全新的學士學位課程，為澳門各行各業培養創新和跨學科人才。本文訪問了多位業界人士，分享其對課程的看法。

Professional and skilled workers provide momentum for social progress. As the best, and the only public comprehensive, university in Macao, the University of Macau (UM) will launch five new bachelor's degree programmes in the 2019/2020 academic year to respond to the needs for social development and technological transformation. The programmes aim to nurture innovative and interdisciplinary professionals for various industries in Macao. In this article, we interview practitioners from different industries to solicit their views on the new programmes.



從左到右依次為：葉兆佳，高錦輝，馬志毅，鍾紅興，陳武

From left to right: Ip Sio Kai, Kou Kam Fai, Ma Chi Ngai, Chong Hong Heng, Chen Wu

### 新課程配合社會發展所需

2019年2月18日，國家公佈了《粵港澳大灣區發展規劃綱要》，鼓勵人才融入大灣區發展。澳門特區身處大灣區城市之一，而澳門大學作為特區公立大學，肩負為國家和澳門各行各業輸送高質素精英的重責。因應行業的轉型對跨學科人才的需求，澳大將於2019/2020學年推出五個全新學士學位課程，包括理學士學位（商業智能與數據分析）課程、教育學士學位（綜合科學）課程、理學士學位（應用物理及化學）課程、理學士學位（生物信息學）課程、理學士學位（數學－統計及數據科學）課程，培養教育、科學、精準醫療、大數據及商業智能領域的人才。畢業生通過課程所學以創新技術參與澳門和國家的發展大局，為推動社會發展發揮更大的作用。

### 澳門需 IT 及商業人才

理學士學位（商業智能與數據分析）課程旨在傳授商業管理、智能軟件應用、數據分析的知識及技巧，培養學生從跨學科角度發揮解難和應變的韌力，造就數據分析技能和商業知識兼備的人才，以迎接未來急劇變化的商業社會的各項挑戰，適合文理商科高中畢業生報讀。畢業生前景廣闊，容易融入商業、公共事業或政府部門需要。

### New Programmes Respond to Needs for Social Development

On 18 February 2019, the Chinese government released *The Outline of the Strategies for the Guangdong-Hong Kong-Macao Greater Bay Area*. According to the document, professional and skilled workers are encouraged to integrate themselves into the development of the Greater Bay Area. As Macao is one of the cities in this area, UM as a public university has the responsibility to nurture high-calibre professionals for various industries in China and Macao. To respond to the demand for interdisciplinary professionals prepared to contribute to technological transformation, in the 2019/2020 academic year UM will launch five new bachelor's degree programmes. They are: Bachelor of Science in Business Intelligence and Data Analytics Programme; Bachelor of Education in Integrated Science Programme; Bachelor of Science in Bioinformatics Programme; as well as Bachelor of Science in Applied Physics and Chemistry Programme and Bachelor of Science in Mathematics (Statistics and Data Science) Programme. The programmes aim to nurture professionals prepared to fulfill different needs of Macao and contribute to the development of China with the latest technologies.



中國銀行澳門分行副行長葉兆佳表示，當前智能銀行、無人銀行、虛擬銀行這些新業態、新模式不斷湧現，需要大量具備IT及商業知識的複合型人才，澳大開辦理學士學位（商業智能與數據分析）課程，可以與金融業深度合作，構建產學研體系。他說：「業界樂意為澳大學生提供廣闊的實踐及發展的平台。」

### 培養綜合科學人才

教育學士學位（綜合科學）課程以科學科目的培訓為總體框架，並整合物理、化學及生物等學科的學習範疇，課程設置以綜合科學基礎概念知識為本，學生可選擇以物理、化學或生物為專項學習領域，目標是培養本澳合資格的初中及高中教育階段的教師。學生畢業後除了當教師外還可以當學術研究員、技術人員、科學記者，以及從事與工程、製造業相關的職業，或在政府部門工作。

### Growing Demand for IT and Business Professionals in Macao

The Bachelor of Science in Business Intelligence and Data Analytics programme aims to nurture professionals who can take up challenges in a complex business environment with an interdisciplinary mindset and problem-solving skills. The programme is suitable for secondary school graduates from all streams (arts/science/commerce). Graduates of the programme will be equipped with knowledge in business management and skills in IT application and data analytics, and can pursue a career in the private or public sectors.

Ip Sio Kai, deputy general manager of the Bank of China Macau Branch, says that with the emergence of new business practices and models like smart banking, unmanned banking, and virtual reality banking, there is a huge demand for professionals with both IT and business knowledge. UM's Bachelor of Science in Business Intelligence and Data Analytics programme and the financial industry can jointly build a system for collaboration between industry, universities, and research institutes. 'The industry is happy to provide a platform for UM students to put their knowledge into practice and develop their careers,' says Ip.



澳門培正中學校長高錦輝表示，過往有意從事科技教育的高中畢業生，在鄰近地區就讀亦只能選擇單一科目如：物理、化學或生物等專業，未能真正得到綜合科學教師專業學位。他說：「澳大開設教育學士學位（綜合科學）課程，絕對能夠彌補這方面的不足」。高錦輝還提到，目前在澳門擔任老師，前景很不錯。根據經濟合作暨發展組織（OECD）提出的未來教育所需要的核心能力，應涵蓋知識、技能、特質與態度、後設學習等四大方向；以及內地教育已把AI放入高中課程，另教青局近年亦開設「學以致用」、「綜合應用技能教育」先導計劃等，這些方面更突顯了綜合科學教師的重要，加上澳門受惠於大灣區發展，此部分需求仍有很大空間。

### 科學檢測就業前景廣

理學士學位（應用物理及化學）課程提供物理及化學全面知識基礎的訓練及其跨學科領域的應用。學習範圍將涉及多元科學及工程學科（如材料科學、環境科學、生物醫藥學、電子、機械及製造工程等）及應用於面對如能源生產、健康、食品安全及自然資源使用等的全球性問題。畢業生可從事科學、工程、研究及教育等相關行業，於政府部門、公營機構、實驗室及化驗中心、醫院、微／光電子公司、石油及化工業、食品業、大學等機構工作。

澳門科技發展基金行政委員會主席馬志毅表示，澳門有很多環保營運的設施及各類型的檢測中心、製藥企業等都需要一些在外修讀該專業後回流的人才，甚至引入外地專才填補空缺，澳門的高等教育及科研基礎已在這領域積累不少經驗，下一步極有條件培育自己的專才。他非常歡迎澳大設立理學士學位（應用物理及化學）課程，認為可填補澳門在高等教育上的空缺，為澳門培育這方面領域的人才，畢業生將來不論是繼續進行基礎研究，或是投身這方面的專業服務，都有很大的發展空間。

### Nurturing Well-rounded Science Professionals

The Bachelor of Education in Integrated Science programme is structured to provide training in science education by integrating knowledge in the areas of physics, chemistry, and biology. Its foundation is centred on integrated science with specialisation in physics, chemistry or biology. The goal of the programme is to nurture qualified junior and senior secondary school teachers in Macao. Graduates of the programme will be qualified to become teachers, academic researchers, technicians, science journalists, or employees in the engineering and manufacturing industries, as well as government departments.

Kou Kam Fai, principal of Pui Ching Middle School (Macao), says that in the past secondary school graduates wishing to pursue a career in science education could only choose one subject from among physics, chemistry, and biology, at universities in neighbouring areas, and they were unable to pursue a degree that would prepare them to become well-rounded science teachers. 'UM's Bachelor of Education in Integrated Science programme will help to fill the gap,' says Kou. He contends that the career prospects of teachers in Macao are quite good. According to the Organisation for Economic Co-operation and Development, future education should aim to develop students' knowledge, skills, attitudes and values, and meta-learning. Many high schools in mainland China have included artificial intelligence into their curriculum. In addition, the Education and Youth Affairs Bureau has launched pilot programmes to promote the importance of applying knowledge and skills in a practical context. They demonstrate the importance of having well-rounded science teachers in Macao. Moreover, thanks to the development of the Guangdong-Hong Kong-Macao Greater Bay Area, there continues to be high levels of demand for well-rounded science teachers.

### Rosy Career Prospects in Professions Related to Scientific Testing

The Bachelor of Science in Applied Physics and Chemistry programme provides students with comprehensive training in the foundations of physics and chemistry, with a focus on interdisciplinary applications. The scope of study encompasses various scientific and engineering disciplines (materials science, environmental

## 生物信息學人才需求大

理學士學位（生物信息學）課程結合生物學、健康科學、信息和計算機科學等領域，旨在教育和培訓生物信息學領域的專業人才，這些人才將成為發展澳門作為智慧城市的重要組成部分。此課程的畢業生能完全勝任醫療領域相關的工作，可從事生物醫學、製藥和生物技術行業，如大學、科研院所、醫院和公司的研究人員，以及科學主任、監管人員、檢查員、行政人員等。

澳門精準醫學會會長鍾紅興醫生指出，隨著高通量測序技術的發展、生物醫學大數據的積累以及多學科的交叉，為生物信息學行業的發展帶來了新的機遇，並將會在生物醫學、人類健康、新藥研發、環境保護等領域取得重大成果。從有關生物信息學方面的就業前景研究、市場調查及招聘信息等數據來看，無論是學術界還是企業界，對於生物信息學人才需求的缺口是越來越大，世界各國對這一高層次人才的需求都非常迫切而強烈。對於澳大開設理學士學位（生物信息學）課程，鍾紅興表示極為讚賞，認為課程的開設必將推動澳門的科研、精準醫療等方面的發展。

課程造就數據分析技能和商業知識兼備的人才  
The programme nurtures professionals with data analytical skills and business knowledge



science, biomedical science and engineering, electronics, mechanical and manufacturing engineering) as well as content related to global challenges such as energy production, health and well-being, food safety, and the use of natural resources. Graduates can pursue a career in science, engineering, research, and education-related fields, such as in government departments, public institutions, laboratories and testing facilities, hospitals, microelectronics or optoelectronics companies, petroleum and chemical industries, food industry, and universities.

Ma Chi Ngai, president of the Administrative Committee of the Science and Technology Development Fund, says that environmental facilities, testing facilities, and pharmaceutical companies in Macao welcome those who have graduated from overseas universities with a degree in related fields, adding that they have hired professionals from outside Macao to fill this gap. Macao's higher education and research institutes have accumulated a lot of experience in this area and at this moment possess the right conditions to nurture their own professionals. He is pleased to see the launch of the Bachelor of Science in Applied Physics and Chemistry programme, adding that it can fill the gap in higher education in Macao and nurture professionals in this field. Graduates of the programme will have great scope for development, whether they decide to pursue basic research or work as industry practitioners.

## Huge Demand for Bioinformatics Professionals

The Bachelor of Science in Bioinformatics programme integrates the studies of biology, health sciences, information technology, and computer science, in order to nurture professionals in the area of bioinformatics. These professionals will become an important part of the smart city development of Macao. Graduates of the programme can pursue a career related to biomedical, pharmaceutical or biotechnological sciences in the medical sector. They can work as researchers at universities, research institutes, hospitals, or companies, or become directors of science departments, regulatory officials, inspectors, and administrators.

Chong Hong Heng, president of the Macau Association



課程結合統計分析及數據科學管理的專業訓練  
The programme provides training for professionals in statistical analysis and data science management

## 大數據迎接智慧未來

理學士學位（數學－統計及數據科學）課程全面涵蓋基礎數學、實用統計學、數據管理及數據分析等不同領域，以培養學生如何在具備紮實的數學知識基礎下，結合統計分析及數據科學管理的專業訓練，以迎接智慧未來的大數據人才的需求。學生畢業後可從事統計、數據科學或資訊科技範疇等相關行業，如數據及統計分析、決策分析、市場研究、金融業、資訊管理或商業分析、政府及服務範疇等。

隨著國家對科技創新的重視，加上大灣區帶動的發展，各行各業對大數據人才需求甚殷，中國電信澳門公司董事陳武指出，本澳電信企業對於數學、統計分析及數據科學管理知識兼備的人才有很大的需求，體現在一、電信企業運作產生了大量高價值數據；二、本澳電信企業對大數據的利用尚處於起步階段；三、在互聯網經濟時代，資料是新的生產要素，是基础性資源和戰略性資源，也是重要生產力，資料的收集、挖掘、連接、分析和運用，已成為國家綜合競爭力的新標誌。基於上述的情況，大數據應用在澳門具有非常廣闊的發展前景，需要大量的數據人才。

of Precision Medicine, says that with the development of high-throughput sequencing, the accumulation of big data in biomedical sciences, and the intersection of various academic disciplines, the bioinformatics industry has seen many new opportunities for development. This new environment will pave the way for new breakthroughs in biomedical sciences, human health, the development of new pharmaceutical products, and environmental protection. Studies of the career prospects of bioinformatics professionals, market surveys, and data from the recruitment process all show that there is a huge global demand for bioinformatics professionals in both academia and industry. Chong praises UM for launching the Bachelor of Science in Bioinformatics programme, adding that the programme will help to promote research and precision medicine development in Macao.

## Welcoming the Future of Big Data

The Bachelor of Science in Mathematics (Statistics and Data Science) programme will equip students with solid knowledge in mathematics and professional skills in statistical analysis and data science management, to meet the demand for talent in the field. Graduates can pursue a career in statistics, data science, or information technology, working as professionals of data science and statistical analysis, decision analysis, market research, finance, information management or business analysis, in government departments or service industries.

There is a great demand for big data professionals in various industries thanks to the increasing importance attached by China to technological advances and the development led by the Greater Bay Area. Chen Wu, chairman of China Telecom Macau, says that the company has a huge demand for professionals with knowledge of mathematics, statistical analysis, and data science and management, for several reasons. First, telecommunications companies in Macao have just begun to make use of big data. Second, in an era of internet economics, data are a new factor of production, as well as a basic and strategic resource. The ability to collect, dig, connect, analyse, and utilise data has become a criterion to evaluate the overall competitiveness of a country. Therefore, there is enormous potential for big data application in Macao and the city will need many big data professionals.

# 產學研結合建立中醫藥新平台

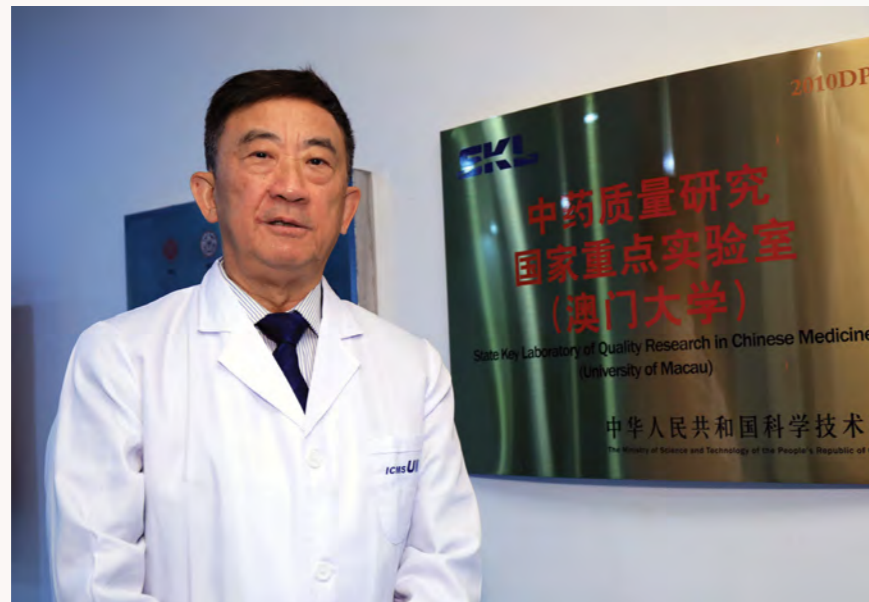
## Establishing a New Platform for Chinese Medicine

採訪 | 張愛華、陳拓 · 文 | 張愛華 · 圖 | 譚金榮、編輯部

Interview | Ella Cheong & Chad Chen · Chinese Text | Ella Cheong · Photo | Eric Tam & Editorial Board

國家於2019年2月18日正式公佈《粵港澳大灣區發展規劃綱要》（下稱綱要），提出打造高水準科技創新載體和平台，支援橫琴粵澳合作中醫藥科技產業園（下稱產業園）等重大創新載體建設，以及支援澳門中醫藥科技產業發展平台建設。中華醫藥是中華文明的瑰寶，國家主席習近平在《綱要》發佈前幾個月也專程去到產業園考察，反映國家對中醫藥的重視。

澳大中華醫藥研究院（下稱研究院）暨中藥質量研究國家重點實驗室（下稱實驗室）聯合北京大學天然藥物國家重點實驗室，以及產業園等產學研三方，共同建立「中華醫藥創新科技轉移平台」。該研究院院長兼實驗室主任王一濤教授表示，走進產業園只是研究院實現走國家所需、澳門所長、創新驅動發展之路其中一項工作目標，在現有成果基礎上，加上大灣區帶來的發展優勢，在人才培養和研究方面將會有更大的發展機遇和空間。



王一濤講座教授  
Chair Prof Wang Yitao

On 18 February 2019, the Chinese government released *The Outline of the Strategies for the Development of the Guangdong-Hong Kong-Macao Greater Bay Area* (the Outline). Some of the strategies mentioned in the document concern traditional Chinese medicine. For instance, establishing a high-quality platform for technology and innovation, providing support for the construction of a Traditional Chinese Medicine Science and Technology Industrial Park (the Industrial Park) and other major projects to facilitate innovation in Hengqin, and providing support for the establishment of a platform to promote the development of the Chinese medicine science and technology industry in Macao. Several months before the release of the Outline, President Xi Jinping inspected the Industrial Park, demonstrating the government's commitment to promoting the development of Chinese medicine.

The University of Macau's (UM) Institute of Chinese Medical Sciences (ICMS) and State Key Laboratory of Quality Research in Chinese Medicine (the Lab) have established a platform for the commercialisation of new technologies in Chinese medicine, in collaboration with Peking University's State Key Laboratory of Natural and Biomimetic Drugs and the Industrial Park in Hengqin. Prof Wang Yitao, director of both the ICMS and the Lab, says that establishing a presence in the Industrial Park is only one step the institute is taking to explore an innovation-driven path that aims to answer the nation's needs by tapping into Macao's advantages. With the progress the institute has already made, integration with the Greater Bay Area will provide greater scope for personnel training and research development.

### 創建中醫藥新平台

於2002年建立的研究院，以建設世界一流的中藥質量系統研究與創新中藥研發平台為願景，培育大批創新英才，科研成果驕人。2008年王一濤教授率領澳門中醫藥學者團隊，牽頭向國家科技部申報成立中藥質量研究國家重點實驗室，並於2010年12月獲國家科技部批准，全國第一個中醫藥領域的國家重點實驗室落戶澳門。自成立以來，實驗室接待了國家主席習近平、時任國務院總理溫家寶、時任國家副主席曾慶紅等國家領導

### Establishing a New Platform for Chinese Medicine

Founded in 2002, the ICMS hopes to establish a world-class platform for the study of Chinese medicine quality systems and the development of innovative Chinese medicines. Over the years, the institute has produced many Chinese medicine professionals and encouraging research results. In 2008, a group of Chinese medicine scholars in Macao, led by Prof Wang, applied to the Ministry of Science and Technology to establish a state key laboratory of quality research in Chinese medicine. In December 2010, the application was approved, leading to the establishment of China's first state key lab in the field of Chinese medicine. Since its founding, the Lab has received visits from various

人。2014年習主席到訪澳大，在聽取王一濤教授介紹由實驗室自主研發的全球首創「多態一體化膠囊」後，習主席鼓勵國家重點實驗室參與國家創新驅動發展戰略，為中醫藥發展做出更大貢獻。

王一濤教授說：「中醫藥是中華文明的瑰寶，受到全世界的重視。實驗室成立以來一直受到國家的重視和特區的支持，建設澳門中醫藥科技產業平台寫進粵港澳大灣區發展綱要，我們在科學研究、人才培養和成功轉化等方面將會有更大的發展機遇和空間。」在2018年，澳大已與廣州中醫藥大學、香港浸會大學共同構建「粵港澳大灣區中醫藥創新中心」，主要從事中醫藥創新研發和中藥國際品質標準研究。王教授補充道：「借助大灣區的創新環境和發展潛力，我們團隊將與大灣區的高校院所攜手合作，實現粵港澳三地資源優勢互補，為大灣區的中醫藥科技和產業發展做出更多的貢獻。」

### 產學研創新成果蜚聲海內外

王一濤教授是一位卓越的中醫藥研究專家，研究方向為中藥質量系統評價，創建中華醫藥研究院17年以來，一直秉持創新求實的科研精神與因材施教教育人理念，帶領研究院的學術人員和研究生屢獲殊榮，成就備受海內外同行與社會各界讚許。王教授與北京協和醫學院等單位共同完成的「中草藥DNA條形碼物種鑒定體系」，榮獲2016年國家科學技術進步獎二等獎，2011年榮獲澳門特區政府授予教育功績勳章，2018年榮獲澳門特區科技特別獎。

以研究院為主導的臨床醫學、藥理學和毒理學學科，連同澳大優勢學科工程學、計算機科學及社會科學總論進入全球基本科學指標資料庫（ESI）前1%。

王一濤教授表示，研究院和國家重點實驗室以建設世界一流的中藥質量系統研究與創新中藥研發平台為願景，已基本

state leaders, including President Xi, former State Council Premier Wen Jiabao, and former Vice President Zeng Qinghong. In 2014, President Xi visited UM. Upon learning of the multi-phase capsule developed by the lab, the first of its kind in the world, President Xi encouraged the lab to participate in China's innovation-driven growth strategy and make a more substantial contribution to Chinese medicine.

Prof Wang says, 'Chinese medicine is a gem of the Chinese civilisation, and it has received considerable attention worldwide. Ever since its founding, the lab has received a lot of support from the central and Macao SAR governments. In fact, the central government accords a very important status to the lab, so much so that establishing a platform for promoting the development of the Chinese medicine science and technology industry in Macao has been written into the Outline. This means we will have greater scope for further development in scientific research, personnel training, and commercialisation of research results.' In 2018, the Guangzhou University of Chinese Medicine, Hong Kong Baptist University, and UM jointly established a centre for innovations in Chinese medicine in the Greater Bay Area. The centre mainly focuses on the development of innovative Chinese medicines and the study of international quality standards for Chinese medicine. Prof Wang explains: 'The Greater Bay Area has great potential and provides an environment that is conducive to innovation. We want to join hands with other universities in the Greater Bay Area so we can combine our strengths and make greater contributions to the development of the Chinese medicine science and technology industry in the Greater Bay Area.'

### Widespread Recognition

Prof Wang is an eminent expert on Chinese medicine. His main research interest involves Chinese medicine quality system evaluation. As a researcher, he is innovative and rigorous. As an educator, he believes in tailoring his teaching methods to student aptitude. Under his leadership, the faculty members and postgraduate students in the institute have won numerous honours and widespread recognition from their peers both at home and abroad. A research project on using DNA barcoding for identifying the species of medicinal plants, jointly conducted by Prof



SKL製藥工程中心  
The pharmaceutical engineering centre

建成有效、安全、穩定、可控和臨床等五個研究中心。在澳門特區政府大力支持下，研究院／國家重點實驗室的靶標篩選中心和製藥工程中心將於2019年上半年投入使用。「各中心配備有國際領先的儀器設備，這些先進儀器應用於中藥複雜成分分離、成分分析、結構鑑定、代謝組學、蛋白組學、藥理活性、作用機制、創新劑型、新工藝和質量評價等研究領域，為國家重點實驗室的科學研究、成果轉化和產品開發提供了國際領先的條件保障。」

### 國際化創新人才培養

王一濤教授對人才培養十分嚴謹，他當年來到研究院後，就明確研究院教育理念，既要傳承中華醫藥精華、又要融匯生物醫藥前沿理論與方法，培養具有國際視野和創新能力的高端複合型人才。為澳門特區和國家培養發展中醫藥和生物醫藥科技產業發展急需的國際化科技和管理人才。研究院開創了澳門特區生物醫藥研究生培養體系，2002年創建中藥學和醫藥管理學碩士學位課程，培養

Wang's team and researchers at Peking Union Medical College and other institutions, received a second prize of the State Scientific and Technological Progress Award in 2016, a Medal of Merit-Education from the Macao SAR government in 2011, and a special award at the Macao Science and Technology Awards in 2018.

Two programmes offered by the institute, in the areas of Clinical Medicine, and Pharmacology & Toxicology, respectively, as well as three other programmes offered by UM, in Engineering, Computer Science, and Social Sciences, General, are ranked among the top 1% in Essential Sciences Indicators (ESI) rankings.

According to Prof Wang, there are currently five research centres under the institute, which are dedicated to studying the effectiveness, safety, stability, controllability, and clinical applications of Chinese medicines. With the support of the Macao SAR government, the target screening centre and pharmaceutical engineering centre became operational earlier this year. 'The centres are equipped with state-of-the-art devices, which are used in the separation and analysis of the ingredients of Chinese medicines; structure identification; studies of metabolomics, proteomics, pharmacological activity, and mechanism of action; development of new forms of drugs and new techniques; and quality evaluation. 'We hope to create world-class conditions to support the state key lab in its scientific research, commercialisation of research results, and product development,' says Prof Wang.

### Nurturing Innovative Professionals

Prof Wang adopts a meticulous approach to education. Soon after he joined the ICMS, he identified the mission of the institute: combining traditional Chinese medicine with advanced theories and methodologies in biomedical sciences to produce innovative, interdisciplinary Chinese medicine professionals with an international perspective. He believes there is an urgent need for such Chinese medicine professionals in Macao and China in order to promote the development of the Chinese medicine and the biomedical technology industry. In 2002, the institute launched Macao's first master's degree programmes in Chinese medical sciences and medicinal administration. A doctoral programme and a bachelor's degree programme in biomedical sciences were launched in 2004 and



實驗室自主研發的全球首創「多態一體化膠囊」

The world's first multi-phase capsule developed by the lab

了澳門第一批生物醫藥高端人才，2004年創辦生物醫藥博士學位課程，2011年創辦生物醫藥專業學士學位課程（2015年交與健康科學學院）。

至今，研究院已為國家、大灣區和澳門培養了500多位中華醫藥創新英才。其中不少畢業生成為了澳門醫藥衛生和相關行業的核心業務骨幹和高端管理英才，致力於深造的博士畢業後都如願赴哈佛、耶魯、芝加哥、劍橋和萊頓大學等世界著名學府深造，海外歸來後，在澳大，以及北京大學、清華大學、浙江大學等著名高校和國家「雙一流」學科擔任教授等高級職稱，成為澳門和內地中華醫藥創新發展和國際拓展的重要力量，還有不少畢業生成為世界500強醫藥企業的核心高管和研發科學家。

見到歷屆畢業生在中醫藥領域大放異彩，他難掩興奮地說：「我們研究院人才培養的三大特點是：國際化創新課程設計、全球視野英語教學、多學科交叉創新研究實踐、與國際著名學府的聯合培養，成為全球中華醫藥人才培養和科學研究引人矚目的亮點。」

2011 respectively, with the latter being included in the curriculum of the Faculty of Health Sciences in 2015.

Over the years, the ICMS has produced more than 500 graduates, many of whom are now key players or work in senior management positions in medicine, health, and other related industries in Macao. Those who graduated from PhD programmes and chose to pursue further education were accepted by world-renowned universities such as Harvard University, Yale University, the University of Chicago, the University of Cambridge, and Leiden University. After graduating from these universities, some became professors or were appointed to other senior academic positions at renowned universities in China such as Peking University, Tsinghua University, Zhejiang University, and UM play a key role in promoting the innovation and internationalisation of Chinese medicine in Macao and mainland China, while others were hired as senior management or research scientists at pharmaceutical companies ranked among the top 500 in the world.

Prof Wang is very excited about the achievements of the alumni. He says, 'In terms of academic programmes offered by our institute, it's worth mentioning a few things. First, we are innovative and meet international standards in our curriculum design. Second, English is our teaching language. Third, we are engaged in innovative, interdisciplinary research and launch joint programmes with renowned universities in the world. These three characteristics have made our institute the focus of attention in the international community.'

### Promoting Chinese Medicine in the Greater Bay Area

On 6 March 2011, with state leaders as witnesses, the governments of Guangdong province and the Macao SAR signed a framework collaboration agreement, signalling the official start of close cooperation between Guangdong and Macao. On 19 April of the same year, a groundbreaking ceremony was held for the Industrial Park, the first collaborative project between Guangdong and Macao. In 2010, the institute began to fully participate in the preparation and construction of the Industrial Park in Hengqin by providing support for the development and registration of new products, quality evaluation, pilot-scale production, personnel training, and the establishment

### 大灣區推動中醫藥發展

2011年3月6日，在國家領導人的見證下，廣東省人民政府與澳門特別行政區共同簽署了《粵澳合作框架協定》，正式拉開了粵澳兩地政府緊密合作的嶄新序幕。同年4月19日，「粵澳合作中醫藥科技產業園」在橫琴新區正式奠基，成為粵澳合作產業園區的首個落地專案。研究院一直積極服務澳門中醫藥科技產業發展，2010年開始全程參與粵澳合作中醫藥科技產業園的籌備和建設，配合粵澳合作中醫藥科技產業園在創新產品研發與註冊、品質評價、中試生產和人才培訓、共建北大-澳大中醫藥創新研究院等方面展開合作。2018年習主席在改革開放40週年廣東之行的第一站，就來到了橫琴產業園，視察了北大-澳大中醫藥創新研究院，與研究院畢業校友黎暢明、龔元香和倪靜雲等親切交談。

王一濤教授表示，研究院近十年來，先後完成粵澳中醫藥科技產業規劃、園區可行性研究、中藥大數據平台以及創新團隊建設等四個重大合作項目。研究院為實現澳門經濟適度多元發展，全力以赴地投身澳門中醫藥科技產業平台建設，協助粵澳中醫藥科技產業開展包括中醫藥國際培訓、質量檢測、劑型工藝、大數據平台等產業園軟件與硬體建設。與此同時，研究院還與產業園一道，將現代生物醫藥前沿理念與方法與傳統中華醫藥精髓和臨床經驗有機融合，面向「一帶一路」和葡語國家，培養創新型國際化應用性中華醫藥高端人才。

隨著澳門經濟的蓬勃發展和大灣區建設的深入，澳門對於中醫藥科技產業人才的需求將更為迫切，也為研究院帶來新的發展機遇和空間。王一濤教授表示研究院將繼續培養國家和澳門所急需的高水準人才，以創新驅動發展為動力，以中藥質量標準為先導，以中藥創新產品轉化為重點，建設澳門中醫藥科技產業平台，推進中華醫藥國際發展。

of a centre for innovations in Chinese medicine, a joint project between UM and Peking University. In 2018, on the first leg of his tour of Guangdong province in celebration of the 40<sup>th</sup> anniversary of China's reform and opening-up policy, President Xi visited the Industrial Park in Hengqin, where he made a special stop at the centre for innovations in Chinese medicine and talked to several alumni of the ICMS.

Over the past decade, the ICMS has completed four major collaborative projects, namely planning for the Chinese medicine science and technology industry in Guangdong and Macao, the feasibility study for the Industrial Park, the establishment of a big data platform for Chinese medicine, and the development of an innovative research team. The institute provides support in international training, quality control, the development of new forms of medicine, the establishment of a big data platform, and the construction of other software and hardware facilities, in order to support the Chinese medicine science and technology industry in Macao and Guangdong, and to promote economic diversification in Macao. It also collaborates with the Industrial Park to nurture Chinese medicine professionals for countries and regions covered by the Belt and Road Initiative as well as Portuguese-speaking countries.

With Macao's booming economy and the rapid development of the Greater Bay Area, the need for Chinese medicine professionals in Macao has never been greater. This brings new opportunities for the institute. Prof Wang says that the institute will continue to nurture the high-calibre professionals who are urgently needed by China and Macao, to follow the innovation-driven growth strategy, to prioritise the development of quality standards, to develop innovative Chinese medicine products, and to establish a platform to promote the development of the Chinese medicine science and technology industry in Macao as well as the internationalisation of Chinese medicine.



掃二維碼觀看訪談片段

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# 大數據專家賈維嘉在科技上的探索

## The Driving Force Behind Big Data Expert Weijia Jia's Scientific Inquiry

採訪 | 張愛華 · 文 | 葉浩男 · 圖 | 譚金榮

Interview | Ella Cheong · Chinese Text | Davis Ip · Photo | Eric Tam



1978年，全球定位系統首枚人造衛星發射升空，為網絡發展開啟無限可能。10多歲的賈維嘉那年放下挖地的鋤頭，離開貴州農村的家到湖南升大學，專業是計算機。他當時從未見過電腦、不知道網絡是甚麼、更想像不到將來會成為物聯網與大數據專家。經歷數十載後，他在2018年來到澳門，為協助構建智慧城市出力。這位澳門大學電腦及資訊科學系講座教授說：「網絡領域每日都有讓人興奮的新事物，對事物有好奇心，是一直推動我在電腦科學上不斷探索的力量。」

In 1978, the world's first GPS artificial satellite was launched, opening up endless new possibilities for network development. In the same year, the teenage Weijia Jia put down his hoe and left his home in rural Guizhou for a university in Hunan province, where he embarked on a new chapter of his life that would eventually launch him on a career studying big data and the Internet of Things (IoT). But at the time in 1978 when he started his college major in computer sciences, Jia had never seen a computer or heard of the internet, much less imagined that one day he would become an expert in big data and IoT. In 2018, he was invited to assist with the development of Macao into a smart city. Currently a chair professor in the Department of Computer and Information Science at the University of Macau (UM), Jia says, 'Exciting new things keep emerging in the field of the internet. A keen curiosity is what has been driving me in my exploration in computer sciences.'

### 研究之途始於嶽麓山下

賈教授同時是智慧城市物聯網國家重點實驗室（澳門大學）副主任、澳大數據科學中心主任。41年前，他是文化大革命結束、內地恢復高考後首批大學生中的一員。他說：「我父親走了幾十里山路，從縣城給我送來一張大學錄取通知書，當時整個縣城都轟動了。」

### A Journey that Starts at the Foot of Mount Yuelu

Prof Jia is also the deputy director of the State Key Laboratory of Internet of Things for Smart City (University of Macau) and director of the Centre for Data Science at UM. Forty-one years ago, he was among the first cohort of Chinese students to take the national college entrance examination after it was reinstated following the end of the Cultural Revolution. His father trudged miles of mountain road to deliver the admission letter to him and proudly told him how the news that he was accepted by a university had electrified the entire village.

左頁圖：智慧城市物聯網國家重點實驗室（澳門大學）主任宋永華教授（右）和賈維嘉教授（左）向到訪的國家科學技術部副部長張建國介紹實驗室  
Photo on left page: Prof Yonghua Song (right), Director of the State Key Laboratory of Internet of Things for Smart City (University of Macau), and Prof Weijia Jia (left), report the latest development of the lab to Zhang Jianguo, vice minister of science and technology of China.



好奇心驅使賈維嘉教授一直在電腦科學領域不斷探索  
A keen curiosity is what has been driving Prof Jia in his exploration in computer sciences

賈教授說，唐代詩人杜牧《山行》一詩的「停車坐愛楓林晚，霜葉紅於二月花」，指的是長沙嶽麓山的景色，而他就是二月份到嶽麓山下的中南礦冶學院（中南大學前身）報到，成為該院自動化系電子計算機專業的學生。「家人覺得計算機就像外星的東西一樣陌生，他們問我到底是甚麼，我說我也不懂，但我是個對事物有好奇心的人，應該是好奇心推動了我。」

在學院的第一年，賈維嘉雖然是計算機專業學生，但根本沒有機會接觸電腦。當時內地百廢待興，電腦技術與發達國家相差至少10多年，連他的老師也不太瞭解電腦。「他們跑去北京參觀電腦和參加培訓班，然後自己編寫教材。到我大二快大三時，學院才引進了一台DJS131型號國產計算機，要用穿孔紙帶來輸入和輸出指令，運算能力還比不上現在小朋友玩的遊戲機。」

他留校就讀碩士時，終於首次用到台式電腦。為了協助學院購買這台電腦，他還第一次坐飛機，從廣州回長沙。「那台電腦是意大利牌子，至少要五、六千美元。當時的火車從廣州到長沙也要24小時。領導怕路上出甚麼問題、電腦被偷走或搞壞，所以特批我們坐飛機。」

When the Tang dynasty poet Du Mu arrived at Mount Yuelu on an autumn evening more than 1,000 years ago, he paused and wrote the poem 'Mountain Trip', whose two famous lines, 'I stop my carriage for I love the maple trees in the twilight/The leaves after the early frost are as crimson as flowers in February', echoed beyond the mountain, down through the generations. On a February day, Prof Jia also arrived at the foot of Mount Yuelu, except that he was not there to admire the early spring flowers, but to become a student of computer sciences in the Department of Automation at the Central South Institute of Mining and Metallurgical Engineering (the predecessor of Central South University) located at the foot of the mountain. He recalls, 'The concept of a computer was completely alien to my family. They asked me what it was, and I said I didn't know either. But I've always been a curious person, and I guess it was this sense of curiosity that drove me to choose the major.'

But interestingly for a computer major, Jia did not get a chance to see a real computer during his first year in college. At the time, computer technology was clearly not at the top of the government's priority list. As a consequence, China lagged behind advanced countries in this area by at least ten years. Even Jia's professors hardly knew anything about computers. They went to Beijing to see what computers looked like, attended training courses there, and compiled teaching material after returning from the trip. It was not until Jia was about to start his third year of study that the faculty introduced a DJS-131 computer, a model that was made commercially in Shanghai (DJS is simply an acronym for the Chinese words for 'electronic computer'). That bulky machine used punched paper tape for data storage. In terms of computing power, it couldn't even compare to today's video game machines played by children.

The first time Jia saw a desktop computer was during his postgraduate years. He was asked to purchase a desktop computer for his faculty. So he and his colleagues took a train to Guangzhou and paid close to 6,000 US dollars for an Italian brand computer. The management of the faculty feared that the precious computer might be stolen or damaged during the 24-hour train ride, so they gave Jia and his colleagues special permission to complete the return trip by airplane. 'That was the first time I ever flew on an airplane,' says Jia with a smile.

After completing his master's degree in 1984, Jia

賈教授1984年碩士畢業後留校任教，數年後到加拿大渥太華大學任訪問學者一年，首次接觸人工智能，研究自然語言處理，卻正值人工智能的冬天。「人工智能那時產生不了價值，很大原因是當時機器計算能力不足。那時我突破不了自己，沒有成果，自己也覺得難為情。」在加拿大的最後幾個月，賈教授轉而研究面向對象程序設計。他坦言對這段經歷有點後悔，因為無論是人工智能還是面向對象程序設計，他在加拿大都沒有深入鑽研，自感學術積累不夠。他其後決定到比利時蒙斯理工學院攻讀博士，僅僅兩年半就畢業。

### 研究網絡通信數十載

1993年博士畢業後，賈教授留在歐洲，到波恩的德國國家信息科學中心從事博士後研究。「當時我的組長剛拿到一個歐盟項目，就是要做網絡通信，所以我又改到了網絡通信，後來就沒有改方向了，就一直做網絡。」他在1995年出任香港城市大學電腦科學系助理教授，後晉升為副教授、正教授，2014年到上海交通大學擔任全職致遠講席教授，2018年來澳大。回首這40年，他覺得網絡這個領域每日都有讓人興奮的新事物。「互聯網是我一直研究的方向，所以我肯定不會把互聯網棄掉，我現在的目標是結合人工智能、大數據和物聯網。」

賈教授的研究方向包括網絡空間實體對象傳感、人機物融合知識圖譜構建與大數據處理、下一代無線通信協議，以及物聯網。他目前有八個國家級科研項目，擁有兩項美國和五項中國內地專利，在頂級國際雜誌和學術會議上發表論文近500篇，獨著或合撰書籍14部。在賈教授的眾多研究成果中，最為人關注的是他在Anycast（選播）路由協議研究領域和網絡匹配方面的先驅性研究和領先成果。2017年，他憑「分佈式系統資源調度與管理的理論與方法」這項研究，獲國家教育部頒發高等學校科學研究優秀成果獎（科學技術）自然科學獎一等獎。

became a faculty member at his alma mater. Several years later, during his one-year stint at the University of Ottawa, Canada, as a visiting fellow, Jia learned about artificial intelligence and natural language processing for the first time. But back then, it was the winter of artificial intelligence. 'At the time, AI couldn't produce any value, mostly because early computers didn't have enough computing power. And I couldn't achieve any breakthrough, so I felt bad,' Prof Jia says. During his final months in Canada, Prof Jia changed the focus of his research to object-oriented programming. To this day, he still laments that he failed to make the most of his stay in Canada, because he didn't thoroughly study the two subjects. He later decided to study for a PhD degree at the University of Mons at Belgium and graduated in merely two and a half years.

### Decades of Research in Internet Communication

After obtaining his PhD degree in 1993, Jia stayed in Europe and became a post-doctoral research fellow at the German National Research Center for Information Technology. His team leader was just starting a project on network communication commissioned by the European Union, so he switched his research focus to this field and has never looked back. In 1995, he was appointed an assistant professor in the Department of Computer Science at the City University of Hong Kong. Later, he was successively promoted to associate professor and full professor. In 2014, he was appointed Zhiyuan Chair Professor at Shanghai Jiao Tong University. In 2018, he joined UM. Looking back on the past four decades, he feels that exciting new advances keep emerging in the field of internet. He says, 'The internet has always been my research interest, so this is an area I will continue to explore. My current goal is to combine AI, big data, and the Internet of Things.'

Prof Jia's main research interests include Entity Object Sensing through Cyberspace, Men-Machines-Things Knowledge Graph Completions and big data processing, next-generation wireless communication protocols, and the IoT. He is currently involved in eight national scientific research projects. He holds two patents from the United States and five patents from mainland China. He has published close to 500 papers in top-tier international journals and conferences. He is the author or co-author of 14 books. His research studies in Anycast rout-

## 協助澳門建設智慧城市

賈教授除了是智慧城市物聯網國家重點實驗室（澳門大學）副主任，也是該實驗室城市大數據與智能技術研究組的負責人，研究課題包括多層次、多模態智能感知信息標示理論與技術，以及大規模智慧城市異構數據的網絡存儲、傳輸和運算的理論方法。他指實驗室要為澳門服務，首先會在本地開展一些特色項目，計劃先與澳門的電信運營商合作，探討通信方面的大數據處理。「這也是澳門比較急需的，通信大數據可以解決幾個問題，包括人流管理、交通問題，還有優化未來基站的分布，因為我們的5G通信馬上就開始部署了。」

賈教授還正在籌備在今年9月開辦的碩士學位（數據科學）課程。該課程涵蓋人工智能、市場營銷、金融科技、精準醫學、智慧教育等方向，是澳門首個推出的跨學科大數據課程。他指課程旨在打破跨學科在應用大數據的壁壘，促進數據科學和大數據上的整合，針對性地為澳門培育大數據人才。

賈教授說，大數據與澳門成為智慧城市的願景密不可分。「我現在基本上就是在譜寫人、機、物三者的這個迴圈。我們每個人都在產生大數據，也在使用大數據，只是我們不知道，也沒有人對我們進行這個科普。」他指出，通過整合和分析日常生活產生的數據，就能推出更切合大眾與個人需求、更具智慧的服務。一個智慧城市裡，各種儀器和物件都能通過傳感器互相連接，而它們的移動、消耗和使用情況，都能產生大量數據。這些數據不但可以匯集起來，更能通過人工智能技術加以分析，協助人們找出龐大數據背後的意義。

「例如在我們的城市，對一些異常現象都有很多傳感器，資料都會傳送上去，經過人工智能處理，知道有異常現象的話，我們就能提前示警。」

ing protocol and matching networks have attracted widespread interest and attention. In 2017, his research project on theories and methodologies concerning resource allocation and management for distributed systems earned him a first prize in the Natural Science Award category from the Ministry of Education under an award programme in recognition of outstanding research achievements of scholars from higher education institutions.

## Assisting in the Development of a Smart City in Macao

Apart from being the deputy director of the State Key Laboratory of Internet of Things for Smart City (University of Macau), Prof Jia is also the head of the research team on urban big data and smart technologies in the lab. The team's main research interests include theory and technology for multi-level, multi-mode intelligent sensing identifications, as well as theories and methodologies concerning network storage, transmission, and computing of disparate data. Created to serve Macao, the lab's first priority is to initiate local projects with distinctive characteristics. The team plans to collaborate with telecommunications operators in Macao in big data processing. He says, 'Applying big data in telecommunications can address several urgent issues, including crowd control, traffic control, and optimisation of the allocation of base stations, because the establishment of 5G network infrastructure is under planning.'

In addition to research, Prof Jia is also preparing for the launch of a master's degree programme in data science in September of this year. The first interdisciplinary programme in big data in Macao, the programme will cover such areas as artificial intelligence, marketing, financial technology, precision medicine, and intelligent education, with the aim of promoting interdisciplinary application of big data and the integration of data science and big data applications.

According to Prof Jia, big data are inextricably linked to the development of a smart city in Macao. 'I am working on Men-Machines-Things Knowledge Graph Completions. Every one of us produces and uses big data every day, without realising it, because nobody has taught us anything about big data.' He points out that by integrating and analysing the big data produced



Prof Weijia Jia | 賈維嘉教授

## 培養應對時代挑戰的人才

人工智能和大數據的結合急劇改變我們的生活，也令不少人萌生投身資訊科技的念頭。培養了30多名博士的賈教授認為，今日的年輕人受惠於技術全球化，擁有很多難得的機會，但他們面對挑戰也比過去劇烈得多。「10年前我都不敢想像刷臉技術，今天內地的酒店都要刷臉。我有一些在上海交通大學帶的學生在內地做無人酒店項目，只要在手機程式看上一間房間，密碼鎖的密碼就會發過來，科技進步的速度可想而知。」

賈教授坦言，年輕人如果喜歡一個學科，必須花相當大的努力才能站穩陣腳，所以他對學生都是從嚴培養。「社會迫著你去進步，尤其是在資訊科技範疇，不進則退。所以我要求學生在國際一流的會議和期刊發表論文。我覺得這是對學生負責，如果不把他們培養到這樣的話，他們會後悔，我也會對不起我的良心。」

in everyday life, we will be able to provide services that are more intelligent and better meet the needs of individual customers. In a smart city, various kinds of instruments and things can be connected via sensors, and their movement, consumption and use will generate a large amount of data. These data can be collected and analysed with AI technology to help us find the meaning behind the data. He explains, 'For instance, we have sensors in our city to detect anomalies. By analysing such data with AI technology, we will be able to alert people pre-emptively.'

## Nurturing Big Data Professionals to Meet the Challenges of Our Time

The integration of AI technology and big data has radically changed every aspect of our lives, including the career choices we make. Indeed, more and more people are now contemplating a career in information science. Having supervised more than 30 PhD students, Prof Jia believes that the globalisation of technology has created unprecedented opportunities for young people. He says, 'A decade ago, face recognition was something I couldn't even imagine. But today, in some mainland hotels, it is already part of a standard check-in procedure. I have supervised some students at Shanghai Jiao Tong University who are now running staff-less hotels in China. Once a customer books a room using a mobile application, she will receive a passcode for the room. This shows you how fast the technology is advancing with each passing day.'

Prof Jia is a strict teacher. He always tells his students that it is not enough to merely like a subject; that they must work hard in order to stay competitive. He says, 'The fast-changing world forces you to keep upgrading your knowledge. This is especially true in the field of information science. If you don't move forward, you will fall behind. So I require my students to publish papers in top-tier international conferences and journals, because I think that's the responsible thing to do as a teacher. If I don't set high standards for them, one day they will regret, and I will also feel I have failed them.'



掃二維碼觀看訪談片段

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# 精於傳統 · 突破傳統： 梁藍波的跨界藝術設計理念

## From Tradition to Innovation: Lampo Leong's Interdisciplinary Approach to Art and Design

文 | 葉浩男 · 圖 | 何杰平 (部分圖片由受訪者提供)

Chinese Text | Davis Ip · Photo | Jack Ho with some photos provided by Interviewee

「藝術設計教育是對創造性的教育，創造性源自學生本身，學生到課堂來不應該僅僅是學到某種藝術設計的技能，不應該是老師把某種知識和方法教給學生，學生就按照著榜樣去做。最好的老師是要引導學生通過學習提昇眼光和品味，逐漸尋找到自己的特色、創造出自己獨特的表達方式和手法，因此，歸根到底，藝術設計教育是對學生創造性思維和能力的培養。」梁藍波教授站在他的《墨象》系列前解釋道。這輯當代水墨作品由中國傳統出發，結合西方現代藝術理念，展現了他對浩瀚宇宙的遐想以及對東、西方哲學的思考。精於中國傳統，博取西方所長，通過外力尋求對傳統的突破，繼而塑造出自己的獨特風格，可以說，這就是梁藍波數十年來的創作之路，也是他一貫的教育理念。

‘Art education is in essence education of creativity, which can only be cultivated from within,’ says Prof Lampo Leong, standing in front of his painting series *Inkscape*. ‘In an art class, it is not enough to spoon-feed students with knowledge, skills or techniques in art; instead, the best teachers are those who help students develop an aesthetic taste so that they can gradually and eventually originate their unique styles and expressions. Therefore, study of art is about cultivation of creativity, self-expression and critical thinking ability,’ explains Prof Leong.

A synthesis of traditional Chinese brushwork and modern Western art concepts, *Inkscape* represents Leong's fertile imagination of the vast universe, and his reflections on Eastern and Western philosophies. Sometimes cruising effortlessly within the familiar waters of Chinese tradition, other times intentionally veering off into fascinating foreign territory, Leong has developed his own unique style by simultaneously honouring Chinese tradition and breaking with it. This is not only how he has kept surpassing his own achievements in his pursuit of artistic expression over the past decades; it is also what he requires from his students.



左圖：梁藍波的狂草書法多次在「澳門視覺藝術聯展」中獲最佳創作獎，被澳門藝術博物館收藏。

Left: Prof Lampo Leong's calligraphy has won first prizes at the *Exposicao Colectiva dos Artistas de Macau* and collected by Macau Museum of Art.

右圖：梁藍波的《墨象》系列常見於國際藝術博覽會和佳士得、羅芙奧等現當代藝術拍賣。

Right: Prof Lampo Leong's paintings have been featured in famous auction houses such as Christie's and Ravenel, and in art expos, museums and galleries worldwide.

### 藝術設計的高度是一個社會的軟實力

梁藍波博士是澳門大學傳播系特聘教授、藝術設計中心主任和曹光彪書院副院長，也是國際著名的藝術家，在油畫、水墨畫、書法、攝影、設計、新媒體動畫影像和跨界表演藝術等領域均造詣精湛。他擁有數十年藝術設計教育的經驗，是美國哥倫比亞密蘇里大學的終身教授，藝術系前系主任。梁藍波獲美國加州美術學院碩士和中央美術學院博士，他是澳門特區政府「人才回澳考察計劃」的首批獲邀者之一，2018年通過全球招聘回澳大創建藝術設計中心。

澳門社會過去普遍對藝術設計認識不足，看待一件產品，主要看功能，至於外觀設計，那是非常次要的。但梁藍波指出，今時今日藝術設計在西方發達國家早已成為非常重要和熱門的領域，是一個國家、地區或機構體現軟實力的地方：「現在要推廣一件產品、一個理念，比拼的其實並不僅僅是技術，它的設計起到了關鍵性的作用，一個電腦跟另一個電腦的功能其實差別並不太大，它們賣的是設計、是品牌形

### Art and Design, Key Indicators of Soft Power in a Society

Prof Leong is a Distinguished Professor in the Department of Communication, Director of the Centre for Arts and Design, and Associate Master of Chao Kuang Piu College at UM. A world-renowned artist who traverses freely across oil painting, ink painting, calligraphy, photography, design, video animation and multimedia interdisciplinary performance. As a tenured professor at the University of Missouri-Columbia and a former art department chair, Leong has decades of experience in art and design education. He received a Master of Fine Arts degree from the California College of the Arts in the United States and a PhD degree from the Central Academy of Fine Arts in Beijing. He was also one of the first overseas Macao scholars to be courted by the Macao SAR government under a talent recruitment programme. In 2018, he joined UM through a global search and recruitment process and became the director of the Centre for Arts and Design.

Aesthetics used to be considered having little practical value in Macao. When developing a product, functionality tended to come first while the appearance was only of secondary importance, if it was to be considered at all. But according to Prof Leong, arts and design has been

象。例如，蘋果手機、電腦在設計上的簡潔、格調和品味就是它能風行全球的重要基礎。可以說，國際品牌的競爭在一定程度上是軟實力的競爭。」

### 精於傳統才能突破傳統

上世紀80年代初，梁藍波在廣州美術學院中國畫系畢業後赴美國留學，學習油畫。「我剛到美國時，我的教授跟我說：其實你畫得很好，不需要來學，你可以去開畫展、去賣畫。但他也說，你的畫沒有甚麼特色，如果你想要成為一位有建樹的藝術家，你就要創造出自己的獨特風格。」

梁教授指出，藝術上的創新就跟社會的革新一樣，往往需要借助外力的衝擊和推動，西方的教育推動了他去尋找自己的獨特面貌，而且還讓他懂得，東方的藝術需要借鑑西方的理念來發展，而東方的哲學其實也是一個東方藝術家得以在西方藝壇立足的關鍵要素。因此，博取眾長的學習以及挖掘和發揚自身的基因特質，這兩方面的修養和把控其實都非常重要，深刻影響著他往後的藝術探索。過去三十年，梁教授曾在世界各地的畫廊和博物館舉辦個人作品展70多次，獲選國際性或全國性的重要聯展300多個，70多次獲獎。他的作品常見於國際藝術博覽會，以及佳士得、羅芙奧等國際現當代藝術拍賣，得到世界十多個博物館的收藏。舊金山市政府公告將1999年11月19日定為「梁藍波日」。

創造性與個人的文化背景密不可分。無論是油畫、水墨畫還是多媒體創作，梁藍波的作品都隱藏著中國狂草書法和水墨藝術的元素，他的《墨象》、《動勢》、《聚合大系》等系列作品雖然是在西方抽象表現主義和後現代的框架上呈現，但骨子裡面的東方意味十分明顯。梁教授相信，精於傳統才能突破傳統。「我是科班出身和訓練的中國畫家和書法家，就算在西方多年，我的DNA裡的中國傳統元素仍然根深蒂固。如果

regarded as a key element of soft power in the West for a long time. He says, 'Today, when we try to sell a product or an idea, we are not just selling the technology. The design or the packaging is just as, if not more, important. One computer is actually not much different from another computer in functionality; what differentiates them are design and brand image. For instance, iPhone and Apple computers are so popular around the world because of their minimalistic and elegant design. It would be no exaggeration to say that the competition now between different brands is to some extent a competition in soft power.'

### From a Tradition Inheritor to a Cultural Innovator

When Leong graduated from the Department of Chinese Brush Painting at the Guangzhou Academy of Fine Arts in the early 1980s, he went to the United States to study oil painting. When he first entered the California College of the Arts, his professor told him: 'Actually your paintings are very good. You don't need to come here to study. You can just exhibit and sell your works.' The professor continued, 'However, your paintings are not much different from the paintings of other Chinese artists, so if you want to become a successful artist, you will have to develop your own unique style.'

Prof Leong points out that artistic innovations, like other social innovations, need to be challenged by external forces. Prof Leong was inspired by Western education through which he searched for his unique voice and understood that Chinese art could sail further on the wind of Western concepts. As a Chinese artist in the Western art world, Prof Leong realized that Chinese philosophies are the keys to the success. Therefore, he humbly learned from other cultures while at the same time explored his own unique cultural identity, which were critically important to his success.

Over the past several decades, his works have been featured at international auctions held by famous auction houses such as Christie's and Ravel, and selected for more than 70 solo and over 300 juried/curated national and international group exhibitions in art expos, museums and galleries worldwide, earning him more than 70 prestigious awards. His works have been collected by more than ten museums around the world such as Cantor Center for Visual Arts at Stanford University and

一個藝術家連自己的傳統都認識不足，如何談創造？不過，我們既要講究傳統，也要明確我們希望突破傳統的是甚麼，希望超越的又是甚麼？學好傳統是必要的起點，但不是最終的目的，創造性才是我們終身的追求。」

### 孕育澳門本土的藝術設計創造力

梁教授說，西方幾乎所有的大學都有藝術課程，藝術更是所有本科生的必修科目。藝術培育審美意識，但由於過去大家對藝術和審美教育的不重視，在中國內地和澳門，「科盲」也許已經不多，但「美盲」比比皆是。「例如，就算打一封信用這麼簡單的工作，我們的審美教育都遠遠沒有達到西方的中學水平，用哪種字體？行距要多大，段距要多大？這些都取決於一個人的審美能力。那麼，審美能力從哪來？就是通過學習視覺藝術而來。」在當今的國際競爭環境中，一個人的專業能力只是最基本的要求，真正令人脫穎而出的是他們在標準答案之上的表現、修養和創造力。

梁教授表示，近年來澳門出現了不少優秀的設計，如雜誌、品牌、產品、建築等，但這些設計雖然位於澳門、用於澳門，然而大多並非澳門人的創造，而是直接來自西方或者是我們的鄰居香港。

「一個社會要在某方面尋求發展，在那方面的教育就要先行，單靠引進和消費外來的藝術設計，澳門永遠無法生長出自己的設計能力和高度，永遠無法建立起自己應有的軟實力。由於地域狹小，人口不多，澳門在很多領域的競爭力都是相對有限的，但藝術設計和新媒體領域因為投資較少、見效較快、而且澳門本身就有大量的市場需求，是一個很有潛力的領域，亟待發展。但要孕育出屬於澳門的創造力，澳門必須首先在大學裡建立起國際水平的藝術設計孵化平台和機制。而只有將自己的文化、哲學融入到藝術設計，才有可能做出特色、做出水平，一直學別人的，永遠只能跟在別人後面。」

the Minneapolis Institute of Arts. The city of San Francisco proclaimed 19 November 1999 to be 'Lampo Leong Day.'

Cultivating creativity needs nourishment from one's cultural background. Whatever the medium, be it oil painting, ink painting, or multimedia art, Leong's works have subtle yet unmistakable elements of Chinese cursive calligraphy and ink painting. Influenced by Western abstract expressionism and postmodernism, his painting series *Inkscape*, *Moving Marks*, and *Contemplation • Forces* are embedded with a palpable Eastern quality. Prof Leong believes that only by thoroughly understanding the tradition can one achieve an innovative breakthrough. He says, 'I received formal training in Chinese painting and calligraphy, so even though I lived in the West for many years, Chinese traditions are in my DNA. If one doesn't even understand his or her own cultural traditions, how can one create something new? That said, we should also be clear about which part of the tradition we want to keep and which part should break with or surpass. Remember, mastering the tradition is just the starting point and the learning process, not the destination. The ultimate goal for an artist and designer is innovation.'

### Developing Macao's Own Soft Power in Art, Design and New Media

Prof Leong says almost all universities in the West offer art courses. Indeed, art is a compulsory subject for all undergraduates, as art education is considered to be an effective vehicle for cultivating aesthetic consciousness and creative ability. 'Scientific illiteracy' may be rare in mainland China and Macao now, but 'aesthetic illiteracy' is very common because of the neglect of art education in the past. 'Let's say a simple task like typing a letter, for example, it is obviously that our tertiary education in aesthetics are not on a par with that in the high schools in the West,' says Prof Leong. 'Which font should be used? What is the appropriate line spacing? What is the appropriate paragraph spacing? These questions may appear technical but they are really a test of one's aesthetic sense. In a highly competitive world, professional expertise is considered as basic requirement. What truly makes one stand out is one's personal qualities, knowledge in arts and culture and creativity.'

## 培養跨界的藝術設計和創意媒體人才

梁教授表示，澳大藝術設計中心目前已經在培養藝術設計的博士生，明年更會開設藝術設計的碩士課程，希望為澳門孕育卓越的藝術設計和創意媒體人才。

「我們講求跨領域合作和發展，課程設置必須有彈性和適合學生的發展。如果我們將研究生的課程內容定得太死，就會變成技術培訓班，與藝術設計教育理念相悖。至於學生是要設計海報、拍攝影片、專攻書法、創意繪畫、還是做多媒體的演出，這要根據每個學生的特點來決定。」梁教授補充道，「藝術設計中心啟導學生深入發掘自己的特長和研究方向，結合他們的背景進行創作。」

在梁教授的帶領下，中心去年十月主辦了「光·域：一場動畫影像與舞蹈融合的視聽盛宴」的跨界大型演出，展現出新媒體與藝術設計和舞蹈結合的新的可能性，這是數碼時代藝術設計領域最前沿的研究方向，得到了業界的高度關注和肯定，其中一些作品還在意大利獲得了國際著名的「A設計獎」。澳大的師生、澳門相關領域的藝術家和設計師，以及本地的中學生都通過對這次多媒體演出實實在在的參與，獲得了從研究能力、新媒體技術到審美的提昇。

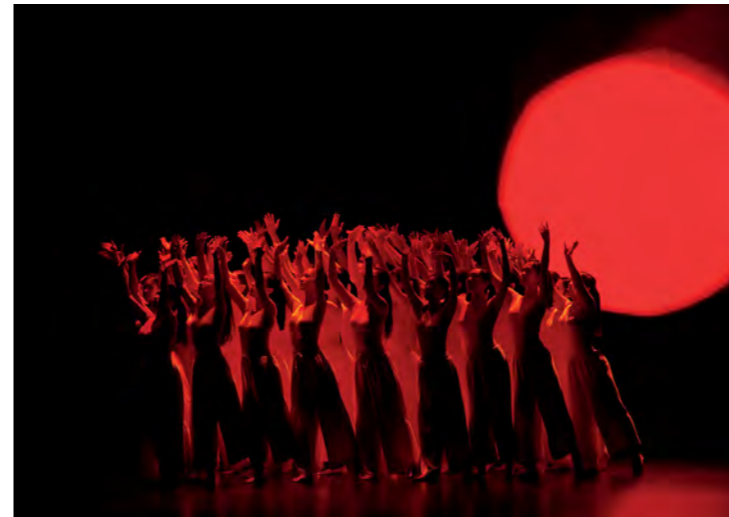
藝術設計中心與澳大傳播系、教育學院和人文學院等院系合作，為校內本科藝術設計和創意媒體教育提供專業的支援。作為「澳門中小學生人文社科教育基地」的一部分，中心與澳門教育局合作，通過講座、工作坊、展演等方式為澳門的中小學藝術設計師資培訓作出積極的貢獻。而作為「粵港澳大灣區美術與設計教育發展聯盟」的副理事長，梁教授表示，中心致力與澳門各高校的合作，並努力推進粵港澳大灣區美術與設計教育領域的交流與合作，同時大力推動澳門本地的文化創意產業的發展，以項目、展覽、講座、研發、出版等多種形式惠及澳門社會。

Prof Leong sees that there was an increasing number of outstanding examples of design in Macao in recent years, including magazines, luxury brands, products, architectures, hotels, etc. Yet quite a few of these were designed by Macao local. In fact, they were imported from Western countries or neighbouring Hong Kong. 'Education always comes first when a society wishes to be competitive in a new industry. If Macao continues to be merely an importer and consumer of foreign art and design, we will never be able to develop our own soft power in this area. Due to the small city's size and population, Macao's competitiveness is rather limited. Art and design is an area that doesn't require heavy investment and yet produces results fairly fast, which, when combined with the huge demand in the market, makes it an area with enormous potential. In order for Macao to become a city with creative designs, a world-class incubation platform and mechanism for art and design is a must. Only by integrating our own cultural elements with the arts and design will we be able to produce outstanding works with distinctive characteristics. By playing the role as imitator, we will forever be a follower,' he says.

## Nourishment of Interdisciplinary Art, Design and New Media Talents

According to Prof Leong, the Centre for Arts and Design currently offers doctoral programme in arts and design. Next year, a master's degree programme will be launched. With an emphasis on interdisciplinary collaboration, the programmes offered will be flexible to suit students' needs. He explains, 'For instance, if we are too rigid about the content of the postgraduate programmes, we run the risk of turning the centre into a technical school, which would be at odds with our purpose of creative education. Specializing in graphic design, photography, calligraphy, painting, animation, video, or multimedia art would depend on the students' talents and preferences.' Prof Leong adds that the centre hopes to help students discover their strengths so they can find a specialisation that best suits them.

In October 2018, the centre organised a multimedia interdisciplinary performance entitled 'Lightscape: A Synthesis of Video Animation and Dance', exploring how new media, artistic design, and dance can be fused together to create exciting new aesthetic possibilities, which represent the latest trend in art and design in a



梁藍波教授與李自豪教授的跨界合作作品「趨光」由澳門大學舞蹈團演出，在意大利獲國際上極負盛名的「A設計獎」（演出劇照由鄒甜甜拍攝）。

Lampo Leong's *Near Light*, collaborated with Research Fellow Yves Etienne Sonolet and Prof Michael Zihao Li of FED and performed by UM Dance Troupe, won the prestigious A'Design Award in Italy (Photo by Tiantian Huan).

通過大家的努力，希望能夠加深澳大、澳門社會和澳門政府對藝術設計和創意媒體的重要性的認識和重視。梁教授說：「在澳大創立一個專業的藝術設計課程對於澳門很重要，但為澳大師生創造一個有藝術品味的學習和工作環境同樣重要，因為，藝術修養不僅要通過學習來獲得，還要通過『薰陶』來培養。也就是說，我們每天生活的環境，每天所看到的東西的造型、用色等設計細節都會對學生的全人教育、品味和審美的發展起到潛移默化的影響。澳大有責任為下一代營造優質的藝術設計環境和學術氛圍，『軟實力』的提昇正是澳門社會能否成功地促進經濟的多元化發展並轉型為一個有深厚文化底蘊的世界級休閒旅遊中心的關鍵性因素。」



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觀看訪談片段  
Scan the QR code to watch  
the video interview

digital era. The show received considerable attention and recognition from the local industry and attracted many people, including UM faculty and students, artists and designers in related fields, and high school students from Macao. Some of the pieces received the prestigious A'Design Award in Italy. Participants reported that the performance greatly enhanced their research capacity, new media techniques, and aesthetic sensibilities.

The centre works closely with other departments and faculties at UM, such as the Dept. of Communication, Faculty of Education, and Faculty of Arts and Humanities, to support undergraduate education in art, design and creative media at UM. Prof Leong says, 'As part of the Macao Base for Primary & Secondary Education in Humanities & Social Sciences, the centre collaborates with the Education and Youth Affairs Bureau to make an active contribution in the training of Macao's primary and secondary schools teachers in the fields of arts, design and calligraphy through lectures and workshops.' As the Associate Director of the *Fine Arts and Design Education Development Alliance of the Guangdong-Hong Kong-Macao Greater Bay Area*, Prof Leong says that the centre is dedicated to collaborating with higher education institutions in Macao, promoting exchange and collaboration in arts and design education in the Greater Bay Area, and contributing to the development of the cultural and creative industries in Macao via various forms and channels, such as design projects, workshops, lectures, exhibitions, performances and publications.

Through joint efforts and collaborations, Leong hopes to enhance the public recognition and that the university, society and the government could value the importance of education in arts, design and creative media. He says, 'It is important for Macao to build a professional arts and design program at UM, and it is equally important to create an artistic learning and working environment for teachers and students. Arts is acquired not merely through formal training, but also by everyday engagement. In other words, the environment in which we live, the things we see every day, their designs, colours, and details...these all contribute to our aesthetic sense. It is the responsibility of UM to create a quality academic and artistic environment that is conducive to students' well-rounded education and personal development. Soft power is key in Macao's endeavour to diversify its economy and transform into a world-class tourism and leisure centre with rich cultural heritage.'

# 語言學家陳海瑛的有效學習法

## Linguist Katherine Chen on Effective Learning

文 | 余偉業 · 圖 | 譚金榮 (部分圖片由受訪者提供)

Chinese & English Text | Kelvin U · Photo | Eric Tam with some photos provided by the interviewee

「語言是理解人類社會關係的窗口。」擅長研究語言人類學的澳門大學英語中心 (ELC) 主任兼人文學院副教授陳海瑛，期望在教學研究上更上一層樓，並與ELC導師同心協力，有創意地因材施教，提高澳大學生學習英語的成效。

Prof Katherine Chen is the director of the English Language Centre (ELC) and associate professor of applied linguistics in the Faculty of Arts and Humanities (FAH), University of Macau (UM). As a specialist in linguistic anthropology and sociolinguistics, she sees language as a window into understanding human social relationships. Prof Chen not only teaches and conducts research, but also works with ELC instructors to facilitate effective English and academic learning at UM.

### 坦然地認清挑戰

澳大近年學士收生呈上升趨勢，面對眾多新生，如何協助提升學生的整體英語水平，以達至學術要求？陳教授坦言：「學術英語有別於一般日常英語，且新生英語程度各異，有的離基礎大學英語程度有一段距離，需要很大教學投入。須知道，每一語言級別的提升 (IELTS 級別) 起碼需要 200 小時正式課堂教學，學生需要有歐洲共同語言參考標準 C1 級別 (即 IELTS 6.5 級)，才達到在英語大學需要的基礎語言程度及技能，這涉及到大量的教學工作。目前 ELC 導師人手較為緊張，我希望為 ELC 爭取更多資源投入到

### The Challenges Ahead

In recent years, the number of students enrolled at UM has grown and they arrive with varying proficiencies in English. It is a challenge to bridge the gap between students' existing English knowledge and the needs of an English-language university environment. 'English for university use is different from everyday English. Using the International English Language Testing System (IELTS) as a reference, each English level takes 200 hours of formal classroom teaching. In order to meet the basic proficiency and academic skills training needed for studying in an English-language university, students need to reach IELTS 6.5 (equivalent to lower C1 level in the Common European Framework). We are eager to meet this challenge and I am requesting additional resources from the university to enhance ELC's provision.'



重要和核心的教學領域上。」

陳教授曾先後於美國密歇根大學培訓國際研究生成為美國大學導師，及在香港大學任教英語語言學和社會語言學，2011年獲頒「香港大學人文學院教學卓越獎」。陳教授看到澳大近年國際聲譽有顯著攀升，是一所具發展潛力的年輕大學，因此她在2018年6月來到澳大展開新的學術旅程。

記者問她未來將為ELC帶來怎樣的改變，陳教授說：「『改變』這一字眼，好像在說ELC之前工作有所不足，現在需要作出彌補似的。ELC的每一位導師一直都克盡己任，以專業的教學模式，令學生英語水平得以提升，我對他們一直以來的工作給予充份肯定。」她表示，成功的教學課程是不斷與時俱進，陳教授與ELC導師目前著手收集學生的數據，就語言學習的需要及動機進行深入研究，從而對症下藥，調整教學手段。「學習英語，某程度上都離不開個人的成長經歷、學習興趣，甚至連理想都有關。我們會透過分析和介入，從而使學生儘快適應澳大的全英教學環境。」

### 英語應視為二語或外語？

就英語學習的成果上，不少教師和家長都較常把港澳兩地的學生作對比，香港長大的陳教授認為這樣比較並不公平，並反問「比較的基準是甚麼？」她說：「講一口流利英語的香港學生（歐洲共同語言參考標準C1頂級或C2級別），大多數來自英文授課中學（EMI）中的頂尖中學，他們把英語視為第二語言；同時，香港也有許多學生跟澳門和內地的一樣，在中文授課中學（CMI）上學，視英語為外國語言，他們接觸英語的機會相對較少。當離開課室後，在飯堂、小賣部，基本上都不會用英語，兩者學習步伐自然不一。」

在澳大，也有不少來自CMI的學生，他

Prior to joining UM, Prof Chen had experience training international PhD students to be English-medium instructors at the University of Michigan, as well as teaching English linguistics and sociolinguistics at the University of Hong Kong (HKU). She received a Teaching Excellence Award from HKU's Faculty of Arts in 2011. Considering that UM has emerged as one of the best young universities with a burgeoning global reputation over the past few years, Prof Chen decided to embark on a new chapter of her academic career at UM in June 2018.

When asked what changes she will make to the ELC, Prof Chen said, 'I wouldn't call it changes because it's like saying that what my colleagues have been done before is not good enough. What I have noticed is that every ELC instructor is dedicated and professional. I'm impressed with the work they are doing. At the same time, any successful curriculum requires constant modification to improve learning outcomes. My colleagues and I are proposing to conduct a student-need analysis to further develop and modify the English language curriculum. The analysis will tell us how to help our students perform more effectively in UM classrooms that use English as the medium of instruction.'

### English: Second Language or Foreign Tongue

Teachers and parents tend to compare the English competency of students from Macao with Hong Kong (HK), but Prof Chen, who grew up in HK, points out that the comparison is not fair. 'Which group of HK students are you comparing with? Those who get to the top universities in HK have attained to top C1 or C2 level in the Common European Framework and many of them are from a group of elite English as Medium of Instruction (EMI) schools. They use English as a second language. Yet three quarters of HK students are from Chinese as Medium of Instruction (CMI) schools, like students in Macao and China, and they regard English as a foreign language. They don't really use English that much outside of the classroom. Chinese is their medium in the playground and cafeteria. Such students' exposure to English is, therefore, very different, and these environments are clearly less conducive to English learning,' says Prof Chen.

們也會跟EMI學生一起修讀英語，在這學習環境下，如何確保兩者的學習得到滿足？陳教授說：「這確是一大挑戰。把不同程度的學生共冶一爐，導師難以用同一教材教學，需要靈活變通，有創意地因材施教。」

課堂上，陳教授刻意分組，組內每位學生的英語程度各有參差，並大力鼓勵英語水平較佳的學生幫助能力較差的，從而學得更多。她常向學生分享她在密歇根大學讀書的故事，「在某些學科上，我的成績未如理想，而我的同學願意在週六日幫我補習，一起鑽研課題，這樣大家反而對知識有更透徹的理解。我也曾帶頭去幫其他同學補習。每一位學生各有所長，一定可以有所貢獻。」

### 對英語的擁有權

無論在世界哪一個角落，英文似乎都滲進生活中，尤其是港澳地區。人們在社交媒體如Line、WhatsApp、微信都有「打英文」的習慣，哪怕文法未必完全正確，這就如陳教授所言，人們在認知上已覺得「打英文」是每日慣例，是溝通的一門技能，然而要達至駕輕就熟的境界，就視乎對英語的擁有權有多重

陳海瑛教授曾於美國密歇根大學任教  
Prof Katherine Chen at the University of Michigan



At UM, a significant number of students come from CMI schools. They are required to take English classes with students from EMI schools. 'A considerable challenge for us at the ELC is to address the needs of every learner,' says Prof Chen. 'There are pros and cons of putting mixed level students together in the same classroom. It brings particular challenges to teachers. It's not possible to teach with the same material; we cannot adopt a one-size-fits-all approach. The instructor has to be very creative and dynamic and be able to spot what each learner needs and gives them the right material and tools at the appropriate time.'

One strategy used to optimise mixed-level learning environments is to get students to work in groups. Prof Chen often encourages academically-strong students to help their classmates in such group work as she believes it brings benefits to both. Learning how to guide others is a great way for stronger students to deepen existing knowledge. Weaker students also benefit as they now receive both teacher and peer support. Prof Chen experienced this herself when completing her PhD at the University of Michigan. 'I was so bad at Theoretical Syntax, but my classmates were willing to teach me and help me after class. In exchange I taught them Experimental Phonetics, which I was good at; the result was that we all excelled in both subjects. When teaching at the ELC I explain to my students that they are unique, have different learning styles, and skills that could benefit the group.'

### Be an 'Owner' of English

English is a global language and a 'lingua franca' among non-native English speakers. It is inevitable that people use English no matter where they are, especially in HK and Macao, and even in cyber social spaces (such as Line, WhatsApp and WeChat). Although most people do not view English as their own language, it is nonetheless part of their linguistic repertoire, notes Prof Chen. We asked Prof Chen how to reach a proficient level of English, and she answered that 'it depends on how much you want to take ownership of English. There are people who think English is not our language. They think that as a Chinese, using Chinese is enough, but it is better to be open-minded in this globalised world. I really hope that the new generation will embrace a multilingual identity. I consider myself multilingual and am grateful that I am

視。「有人會把英文視為外國語言，不屬於我的，我是中國人，用中文就夠。」陳教授主張新生代更應擁抱「多語用家」的身分，「我自己都是一位多語使用者，廣東話、普通話、英語也流利。多學一種語言，會令你多瞭解不同地方的文化，把你的世界觀打開得更寬闊。」

即使是CMI學生，也不需要氣餒，哪怕英文水平有別，仍有從後趕上的可能。陳教授指出，動力是關鍵，成年人也有語言學習的優勢，就是有較高的認知能力，能較快掌握語言的規律、文法變化，可惜很多人缺的是學習的動力。

「英語水平的提升，視乎學生自身的目光有多遠大，而ELC的教材設計，以激發學生學習興趣為依歸，增強他們擁有英文的慾望。」

### 鷹架式正面教學

澳門學生大多從幼稚園起就開始接觸英文，報讀大學前已累積了十多年的學習時間，但據陳教授的觀察，當中有不少學生的英語水平卻停滯不前。她指出，正面的學習體驗是必需的，「讀初中時，英語老師徐惠婷挑選了我去參加校際詩歌朗誦比賽。我肯定不是班上最醒目的，而且成績還很一般。」陳教授笑說：「老師選我，不是因為我英文突出，而是因為我對學習有一份衝勁，加上我的聲線不錯。當時我心裡很緊張，我連會話都未算太好，但老師她相信我做得到，她讓我建立自信心。」

當年，陳教授朗誦的詩歌，是由美國詩人Theodore Roethke所寫的「The Sloth」。老師逐字逐句教我發音，再如何投入情感。這是鷹架式教學，即像過河一樣，幫我鋪設所需的墊腳石，逐步走向終點。」那次雖然沒有獲獎，但得到了評判的正面評語。「老師沒有失望，反而讚我做得很好。我好感動，這就是正面學習。我在教學中也努力使學生有這樣的體會。」

fluent in Cantonese, Putonghua, and English. It gives you a broader worldview when you have more than one language at your command.'

'For students from CMI schools, it is always possible to catch up,' says Prof Chen; 'motivation is the key.' She explained that adults have higher cognitive abilities and are able to learn grammar rules and sentence structures more quickly than children, yet what most people lack are motivation and consistent practice. 'Which level students can achieve very much depends on their goal-setting. When the ELC designs teaching materials, we give top priority to piquing student interest and provoking the desire to "own" English.'

### Scaffolding and Positive Learning

Almost all students in Macao have been exposed to English since kindergarten. In other words, they have more than 12 years of experience in English learning before going to university. Prof Chen has observed, with concern, that many suffer from learning stagnation. In her opinion, a positive learning experience is key to helping students develop, and teachers can play a central role in facilitating this. 'I remember when I was in Form 3, I went for a solo verse speaking competition. At that time I was not the best one in my class; I was in the lower half. My teacher, Ms Tsui Wai Ting, picked me because she thought I had a good voice and I was quite energetic in class,' Prof Chen said. 'I was extremely nervous and my English was not that good, but my teacher saw something in me and she gave me faith, so I worked really hard because of her.'

The poem Prof Chen recited was The Sloth by the American poet Theodore Roethke. "In the beginning, I couldn't pronounce the words correctly, so my teacher patiently taught me the correct form. Later, I began to understand rhythm, how to emphasise and bring out emotion. My teacher gave me enough scaffolding that I needed to become confident so I knew I could do it. Though I didn't win I was the first in my school who received a Certificate of Merit and very positive comments from the judges. My teacher was very pleased. Since then I have had the confidence to develop my English language knowledge. I would like to instil this confidence in my students."

陳海瑛教授：「成功的教學課程應該不斷與時俱進。」  
Prof Chen believes any successful curriculum requires constant modification to improve learning outcomes



### 自主學習的覺醒

ELC期望透過對學生的求學需要作深入分析，從而定位及追蹤學生的學習情況，同時也給予導師更大的自主度。陳教授指出，語言學習是沒有捷徑的，「這個世界亦都不會有一粒藥丸，服用後翌日就會講英文。正如學游泳，你認為在電視機前，看著奧運會金牌得主游泳，看幾小時就會游泳嗎？你不下水，永遠不會學曉游泳。同樣道理，學英文就要多聽多講，例如你喜歡看英文電視劇，那就看吧，但只看英文字幕，強迫自己堅持下去，看一次不明，就多看幾次，慢慢你就會進步。」

陳教授說：「每一位ELC導師都很努力，每一步的調整都從有利學生學習角度出發。去年ELC老師們分享自己為甚麼當老師時，資深導師Alice Lee博士分享她做老師是希望『Pay it forward』：向曾教過她的、正面地改變了她的好老師致敬，把自己所學到的好經驗傳給學生。這也是ELC老師們的共同理念，我十分認同及欣賞。在ELC，我們的目的就是要正面地影響學生的英語學習，幫助學生的人生成長。」

### The Key to Learning

In response to the question of whether there are any special tips for students, Prof. Chen remarked: 'Just remember there are no shortcuts in learning any language. You can't just take a 'language pill' and know the language the next day when you wake up.' Prof Chen prefers the metaphor of learning to swim. 'Can you learn the skills by just watching other people swim? You can sit and watch Olympic medalists swim for hours but you would never be able to swim by just watching. You have to get into the water and do it. Learning English is the same, you need to use it, and you can do it by finding something in English that you love. For instance, if you like English TV or movies, go watch them with or without English subtitles (but not with Chinese subtitles!). Force yourself to go through with it. With time, you'll be able to understand the language, and you won't think of it as something that requires hard work.'

'Each ELC instructor works very hard. Every step we take aims to motivate our students to learn and to grow,' says Prof Chen. 'I would like to quote a colleague of mine, Dr Alice Lee, one of the ELC's Senior Instructors. Last year in a retreat we shared our motivations for teaching. Dr Lee said she teaches to "pay it forward". She had been taught by wonderful and inspiring teachers who made such a positive difference to her life, and she wants to be such an influence to her own students. It summed up the approach of all of us at the ELC; we aim to be an inspiring and positive influence on our students' university learning, indeed their whole life.'



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# 檢測基因突變預防遺傳性乳腺癌

## Preventing Hereditary Breast Cancer via Gene Testing

文 | 王山鳴 · 圖 | 何杰平 (部分圖片由作者提供)

Chinese & English Text | Wang Shanming · Photo | Jack Ho with some photos provided by the author

乳腺癌是世界各地女性最常見的癌症，平均每八位女性的一生中就有一位會得乳腺癌，乳腺癌也是澳門女性所有癌症類型中最常發生的癌症。醫學研究可以如何協助預防女性乳腺癌的發生？

One in eight women will develop breast cancer over the course of a lifetime. Breast cancer is the most common cancer in women worldwide, as well as the most commonly-occurring cancer in women in Macao. In view of this alarming trend, how can medical research prevent breast cancer?

### 乳腺癌的威脅

乳腺癌對女性健康是一個重大威脅。在2018年，全世界有超過200萬人，在中國有超過25萬人被診斷為乳腺癌。大約10-15%的乳腺癌病例是由按照孟德爾規律傳播的遺傳性基因突變引起的，大多數突變位於對維持基因組穩定性所必需的BRCA1和BRCA2基因（BRCA）上。攜帶BRCA1致病突變的女性患乳腺癌的終生風險高達80%。BRCA基因的突變也大大增加了患卵巢癌、前列腺癌和胰腺癌的風險。

### 有效的預防手段

在癌症發生之前鑑定BRCA突變攜帶者是預防突變攜帶者發生癌症的最有效預防手段，因為據此可以通過早期監測，靶向藥物預防，預防性手術和體外受精從而中斷突變向下一代的傳播來達到預防癌症

### The Threat of Breast Cancer

Breast cancer is a significant threat to women's health. In 2018, over 2 million women worldwide, and over 250,000 in China, were diagnosed with breast cancer. Around 10 to 15 per cent of breast cancer cases are caused by hereditary genetic mutations transmitted following Mendelian genetics. The majority of the mutations are located in BRCA1 and BRCA2 genes (BRCA), which are the essential genes for maintaining genome stability. Women carrying pathogenic mutations in BRCA1 have up to 80 per cent of lifetime risk of developing breast cancer. Mutations in BRCA genes also increase the risk of developing other types of cancer, including ovarian, prostate, and pancreatic cancers.

### Effective Prevention Method

Identification of BRCA mutation carriers before cancer occurrence is the most effective way to prevent mutation carriers from cancer, as it allows early cancer surveillance, targeted drug prevention, preventive surgery, and interrupts

的目的。具有已知的病因，可用於確定病因的方法，以及多種有效的預防和治療措施，BRCA突變引起的癌症是人類所有癌症中最可以預防的癌症。美國女演員安吉麗娜·朱莉的故事為BRCA突變與乳腺癌預防之間的關係提供了一個生動的例子。

### BRCA基因突變的研究

新近的研究表明，人類的BRCA基因突變具有高度的種族特異性，即不同種族人群在BRCA基因的突變非常不同。例如，拉丁美洲人群的BRCA突變高度異質，亞洲人群的BRCA突變與高加索人的BRCA突變顯著不同。種族特異性突變之所以非常重要，是因為它反映了不同種族人群中發生癌症的遺傳基礎，並且提供了特定的突變目標用於鑑定突變攜帶者，從而達到對特定種族群體精確預防、診斷和治療的目的。然而，目前廣泛用於臨床的BRCA突變數據主要來自於僅佔人口一小部分的歐洲和北美洲的高加索人群，而來自於佔世界人口80%的非高加索人人群的數據卻很少。

### BRCA突變數據庫

我們對中國人群進行了全面系統的分析以瞭解中國人群中BRCA突變狀況。我們從源自30,000多名中國癌症患者中收集到超過1,000個所報導的BRCA突變。這是目前源自中國人群最全面的，也是來自非高加索人群最大的BRCA數據。我們並將此數據開發為一個開放數據庫，中國人群BRCA突變數據庫，供公眾使用（<https://dbBRCA-Chinese.fhs.umac.mo>）。通過與非中國人群BRCA突變數據的全面比較，我們確定40%的中國人群BRCA突變僅存在於中國人群中。

mutation transmission to the next generation through in vitro fertilisation. With the known cause of genetic mutation, available methods to identify the genetic mutation, and multiple effective prevention and treatment options, BRCA mutation-caused cancers are the most preventable cancers among all cancer types in humans. The story of the American actress Angelina Jolie provides a vivid example of the relationship between BRCA mutation and breast cancer prevention.

### Studies of BRCA Mutations

Recent studies have revealed that BRCA mutation in humans is highly ethnic-specific, that is, different ethnicities have very different mutations in BRCA genes. For example, BRCA mutations in Latin Americans are highly heterogeneous, whereas BRCA mutations in Asians differ substantially from those in Caucasians. Ethnic-specific BRCA mutation is important, as it reflects the genetic basis for the cancer occurring in different ethnic populations, and provides specific mutation targets for precise identification of the mutation carriers for prevention, diagnosis and treatment of the cancer in given ethnic populations. However, the BRCA mutation data widely used in clinical applications are mostly derived from Caucasian populations in Europe and North America, which account for only a small portion of the total human population, whereas the data from non-Caucasian ethnicities, which account for 80 per cent of world population, are rare.

### BRCA Mutation Database

Our laboratory has been studying BRCA mutations in the Chinese population. Through comprehensive data analysis, we have collected over 1,000 BRCA mutations from over 30,000 Chinese cancer patients. This is the most comprehensive BRCA mutation data that originated from the Chinese population, and one of the largest from a non-Caucasian population. We have developed an open-access database, Chinese BRCA mutation database, for public use (<https://dbBRCA-Chinese.fhs.umac.mo>). Through comprehensive comparison with BRCA mutation data from non-Chinese populations around the world, we have determined that 40 per cent of the Chinese BRCA mutations are only present in the Chinese population but not in non-Chinese populations.

## 澳門人群BRCA突變狀況

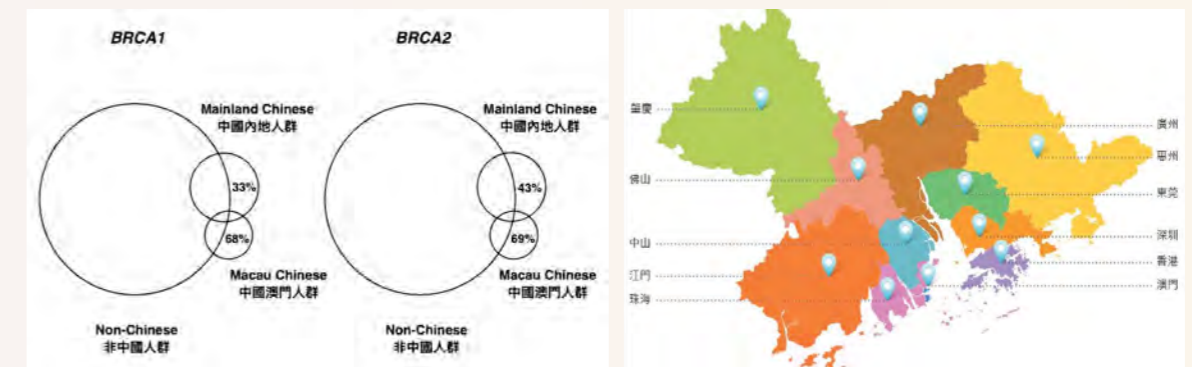
澳門有60多萬人口，50%以上是女性，95%是以廣東人為主的中國人。乳腺癌是澳門女性所有癌症類型中最常發生的癌症，在2003年至2013年間澳門共診斷出1,353例乳腺癌病例。我們對澳門人群進行了研究以瞭解澳門人群中BRCA基因的突變狀況。通過對2,000名澳門個體的分析，我們觀察到澳門人群中BRCA突變頻率明顯高於其他人群，這提示BRCA突變對澳門女性乳腺癌的作用可能高於其他人群（圖一）。

來自澳門人群BRCA突變數據的一個重要性在於它可直接應用於包括廣東，香港和澳門地區在內的粵港澳大灣區1億人群的癌症預防中。大灣區人群屬於嶺南人群，是中國人群的一個分支，其遺傳背景與中國內地人群有很大不同。由於澳門人群與粵港澳大灣區的人群遺傳背景的一致性，澳門人群為研究粵港澳大灣區人群的BRCA突變提供了一個良好的模版，而澳門人群中發現的種族特異性BRCA突變可以直接用於整個粵港澳大灣區的癌症預防和治療。我們正在朝這個方向努力中，包括擴大對澳門人群到檢測範圍，並在廣東人群中進行大規模驗證工作，為進一步在粵港澳大灣區

## BRCA Mutations in Macao

We further analysed BRCA mutations in Macao. Macao has a population of over 600,000, in which over 50 per cent are female, and 95 per cent are of Chinese ethnicity and predominantly Cantonese. Breast cancer is the most commonly occurring cancer of all cancer types in females in Macao, with 1,353 breast cancer cases diagnosed between 2003 and 2013. Through analysing 2,000 individuals in Macao, we observed a higher frequency of BRCA mutations in the Macao population than in other populations. This suggests that BRCA mutations can play a more significant role in breast cancer in the Macao population than in other populations (Fig. 1).

A significance of studying the population in Macao is that the data can be readily applicable to the population in the Greater Bay Area, including Guangdong, Hong Kong, and Macao. The population in the Greater Bay Area is a subgroup of the Chinese population known as Lingnan, whose genetic background is known to be substantially different from that of the inland Chinese population. As Macao's population is genetically the same as people in the Greater Bay Area, the ethnic-specific BRCA mutation identified in the Macao population should be the same as the population in the Greater Bay Area. Therefore, Macao's population provides a perfect model to study BRCA mutation in the population of the Greater Bay Area, and the BRCA mutations identified in the Macao population are readily applicable for cancer



圖一 · 澳門人群BRCA數據的特點及其對大灣區人群的意義：左圖為非中國人群、中國人群和中國澳門人群之間BRCA突變數據的比較，結果清楚表明在不同人群中BRCA突變存在顯著的差異，而且澳門人群具有其特異性；右圖為大灣區地圖，由於大灣區人群具有類似的遺傳背景，澳門人群可以作為大灣區人群癌症預防、診斷和治療研究的理想模版（大灣區地圖源自網絡）。

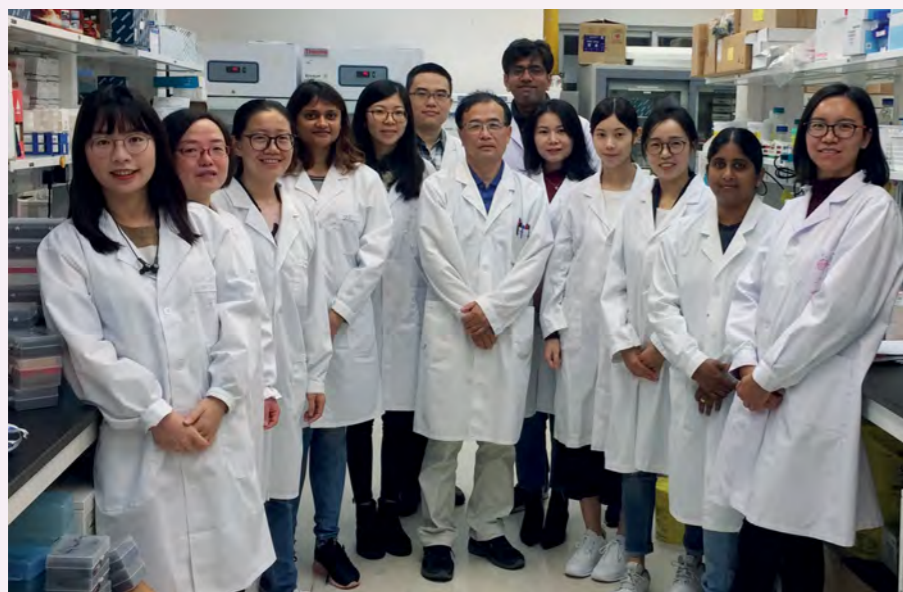
Figure 1 · The characteristics of the BRCA data on the Macao population and the implications for the Greater Bay Area: Diagram on the left is a comparison of BRCA data on non-Chinese populations, Chinese population, and Macao population. It clearly shows that BRCA mutations in humans are highly ethnic-specific and differ significantly across different populations. Diagram on the right is a map of the Greater Bay Area (Internet photo). As the Macao population is genetically the same as the population in the Greater Bay Area, Macao provides a perfect model to study BRCA mutation in the population of the Greater Bay Area, and the BRCA mutations identified in the Macao population are readily applicable for cancer prevention and treatment in the entire region.

推廣通過大規模人群BRCA基因突變篩查進行癌症預防奠定一個堅實的基礎。

註：本數據庫為第一個大規模、公益性、開放共享的中國人群BRCA變異數據庫，囊括了幾乎所有目前已知的來自於中國人群的BRCA變異數據。本數據庫也是來自非高加索人群單一國家的最大BRCA變異數據庫之一。健康科學學院希望本數據庫的建立和開放將促進中國人群BRCA相關癌症的研究和臨床應用，並推動國內和國際間在此領域的合作。

prevention and treatment in the entire area inhabited by a population of over 100 million, in which systematic investigations into BRCA mutations have been very limited. We are working hard in this direction, including expanding the coverage of testing in the Macao population and conducting large-scale verification work in the Guangdong population. Our work should lay a solid foundation for cancer prevention through promoting BRCA gene mutation screening for the population in the Greater Bay Area.

Note: This is the first large open-access Chinese BRCA mutation database, which contains data on almost all known BRCA mutations found in the Chinese population. This is also one of the largest non-Caucasian single-country BRCA mutation databases. It is the hope of the Faculty of Health Sciences that this database will promote the study of BRCA-related cancers in the Chinese population and the clinical applications of the research results, and enhance domestic and international collaboration in the field.



王山鳴教授的研究團隊  
The research team of  
Prof Wang Shanming



王山鳴，澳門大學健康科學學院教授，目前研究重點為運用醫學遺傳學、基因組學和生物資訊學的方法理解遺傳因素在癌症發生上的作用，和發展在群體層面預防遺傳突變所致癌症的策略。Wang Shanming is a professor in the Faculty of Health Sciences, University of Macau. His current research focuses on the use of medical genetics, genomics, and bioinformatics methods to understand the role of genetic factors in cancer development, and the development of strategies to prevent cancer caused by genetic mutations at the population level.



# 大數據背景下的數字醫療與生物信息

## Digital Health and Bioinformatics in the Era of Big Data

文 | 張曉華、金俞 · 翻譯 | 王丹丹、李軍焯 · 圖 | 何杰平 (部分圖片由作者提供)

Chinese Text | Douglas Zhang & Jin Yu · Translation | Wang Dandan & Lei Kuan Cheok

Photo | Jack Ho with some photos provided by the author

你是否曾關注 Google AlphaGo 與圍棋世界冠軍柯潔的對戰？你是否聽說過機器人醫生沃森赴華「出診」，10秒為癌症患者提供診療方案的新聞？你是否看到過人工智慧診斷乳腺癌的表現甚至超過了專業的病理學家的報道？近年來，隨著大數據與人工智慧的快速發展，以及我國大力推進健康醫療行業及醫療人工智慧的變革，數字醫療將成為一個不可避免的趨勢。利用人工智慧等技術，政府將可以節省費用更加有效地用於醫療供應，提供疾病和護理管理。

The research group led by Prof Douglas Zhang | 張曉華教授帶領的研究團隊



Have you followed the Go contest between Google AlphaGo and the world champion Ke Jie, or heard the news that the medical robot Watson travelled to China and issued a diagnosis and prescription for cancer patients in only ten seconds? What about the ability of artificial intelligence to outperform professional pathologists on recognising breast cancer?

In recent years, with the rapid development of big data and artificial intelligence, and the encouragement from the Chinese government of the advances in the healthcare industry and medical artificial intelligence (AI), it is perhaps inevitable that digital medicine will become the new norm. Utilising AI technology, the government may save more budget in order to more effectively fund medical supplies for disease management and nursing services.

### 兩大研究方向

除了數字醫療方面，隨著先進的生物分析技術的不斷推出和更新，生物醫學數據迅速積累，基於此類大數據一些以往不能解決的問題將有望解決。生物信息學相關的大數據技術和相關應用主要包括：基於高通量測序的個性化基因組、轉錄組和蛋白組研究，單細胞水平基因型和表型研究，人類健康相關微生物群落研究，生物醫學圖像研究等。利用生命系統本身的規律和知識，建立合理的假設和數學模型，對數據進行分析和解釋，是利用生物信息學大數據的根本目標與追求。

張曉華教授實驗室自2016年創建以來，一直專注於研究這兩方面的內容：一、利用可穿戴設備對人體生理動態參數進行連續監測，進而探討相關疾病與生理動態系統的關係，例如糖尿病、呼吸病和心臟病；二、通過高通量測序的個性化基因組、轉錄組和蛋白組研究，探究精準醫療與相關疾病的相關性。目前這些研究都得到了澳門政府、澳門科技基金會、澳門大學和健康科學學院的大力支持，各項目也在持續進行中。

### Two Major Research Directions

Aside from digital medicine, as novel and better techniques for biological analysis emerge, the quantity of medical data grows tremendously. Using big data, we can solve problems that were formerly unsolvable. Big data technologies and applications in bioinformatics include personal genome sequencing using high-throughput sequencing, transcriptomic and proteomic research, genotypic and phenotypic studies at single-cell level, metagenomics in human health, and medical image processing. Deriving hypotheses and mathematical models from the knowledge and observed patterns of biological systems to analyse and interpret data is the fundamental initiative and goal of using big data in bioinformatics.

Established in 2016, Prof Douglas Zhang's laboratory at the University of Macau (UM) focuses on two areas: 1) Continuous monitoring of human physiological signals with wearable devices, which in turn provides data for studying the relationship between physiological dynamics and diseases such as diabetes, respiratory and cardiac disorders; and 2) Genomic, transcriptomic and proteomic studies using high-throughput sequencing, from which the correlation between precision medicine and related diseases can be investigated. This research has been actively supported by the government of Macao, the Science and Technology Development Fund (FDCT), UM, and the Faculty of Health Sciences (FHS).

## 數字醫療

糖尿病是一種慢性代謝異常疾病，主要是由於體內胰腺不能分泌足夠的胰島素或體內細胞不能正常利用分泌的胰島素。最終導致血糖上升並長時間維持在高血糖狀態。中國是全球糖尿病患者人數最多的國家，根據已發表的全國性調查，過去30年來，中國糖尿病患病率急劇增加。老年人、男性、城市居民、經濟發達地區居民、超重和肥胖者的糖尿病患病率更高。如何對血糖數據進行方便快捷的監測？如何預防糖尿病的發生，在患者確診為糖尿病之前，提前進行干預治療，恢復健康狀態？如何從連續監測的海量血糖數據中，分析處理這些數據並挖掘出有用資訊？這些問題正是張曉華教授實驗室在進行的研究。

目前，在醫院與家庭中，患者是通過扎手指方式進行日常水準監測。通常糖尿病患者每天都要測試四次或以上血糖，使用一根細針刺破他們的手指。這對許多人來說是痛苦且不方便的，這可能導致檢測頻率降低，從而影響血糖水準的控制。對於糖尿病前期患者，如果通過連續監測血糖，就可以在確診為糖尿病之前提前干預治療，恢復到健康狀態。在與廣州醫科大學第一附屬醫院內分泌

## Digital Health

Diabetes is a group of chronic metabolic disorders. It occurs mainly due to the pancreas not producing enough insulin or the cells of the body not responding properly to the insulin produced. Finally, the body's blood glucose rises to a high level. China has the world's largest number of patients with diabetes. According to national surveys, the incidence of diabetes in China has increased dramatically over the past 30 years. Older people, men, residents of cities or economically developed areas, and overweight or obese people have a higher prevalence of diabetes. How can we monitor glucose in a convenient and quick way? How might we prevent the occurrence of diabetes? How is it possible to analyse and process the continuously monitored data and explore information from the massive data? These are the problems that Prof Zhang's laboratory studies.

Currently, patients with diabetes monitor their blood glucose by pricking their fingers in the hospital or at home. Generally, they need to prick their fingers with a small needle no more than four times to test the blood glucose levels. The testing method is painful and inconvenient, which may cause low frequency of glucose monitoring and even poor glucose control. For those patients in a pre-diabetes state, the continuous monitoring of glucose can guide the provision of advance interventions and help to restore health. In a cooperative project with the Department of Endocrinology in the First Affiliated

科合作專案中，被試者使用微創連續監測血糖設備(圖一)，研究團隊以此探究1型糖尿病、2型糖尿病、糖尿病前期和健康人的血糖動態複雜度和分形性的特點，並開發了R套裝軟體和相關函數，比較各種類型糖尿病患者血糖動態複雜度和分形性的不同。

在該實驗專案中，我們研發的R套裝軟體名為CGManalyzer，並發現糖尿病一型、二型患者，糖尿病前期和健康人之間，血糖數值的複雜度參數有顯著差異(圖二)，進而考慮可以通過複雜度參數的變異性，來評估糖尿病前期患者的身體狀況，從而對糖尿病前期患者進行干預治療、生活方式、飲食結構和運動情況的調節，將血糖調整到健康人的狀態。開發的R套裝軟體包含了多種用於分析連續監測血糖數據的函數，提供了廣泛而全面的數據分析方法，包括如何讀取一系列數據集，如何得到血糖的匯總統計數據，如何畫圖、轉換時間戳記格式、修正缺失值，如何評估每日差異的平均值以及連續重疊的淨血糖作用，如何計算多尺度樣本熵，進行成對比較，如何繪製各種反映血糖參數資訊的圖表。該套裝軟體發表在Bioinformatics 34: 1609-1611, 2018。該套裝軟體極大地促進了各種連續監測血糖數據的分析，並說明相關研究者對糖尿病的進一步探究。

除了與醫院合作，實驗室還曾在澳門範圍內開展過一項實驗，探究運動、心率、睡眠和飲食結構，對健康人與糖尿病患者的影響。本次實驗利用Fitbit charge 2設備連續監測被試者的心率、睡眠品質與運動情況，使用Freestyle血糖檢測儀連續監測被試者血糖波動情況，通過被試者每天拍照和文字記錄飲食情況。該研究項目吸引了眾多參與者進行實驗，該專案在數據分析處理中。

除糖尿病之外，實驗室還利用可穿戴設備對慢性阻塞性肺病、哮喘、過敏性鼻炎等呼吸病，心臟病進行研究，各項實驗都在進行中。

Hospital of Guangzhou Medical University, Prof Zhang explored the complexity and fractality of glucose dynamics in patients with type-1 diabetes, type-2 diabetes, pre-diabetes, and normal health. The subjects applied minimally invasive wearable devices (see Figure 1) to continuously monitor the blood glucose. Prof Zhang also developed a R package and related functions to analyse and compare the complexity and fractality.

In this project, Prof Zhang developed an R package CGManalyzer and he found that there was differentiation of complexity and fractality among type-1 diabetes, type-2 diabetes, prediabetes and health subjects (Figure 2). These results prompted Prof Zhang to conduct research to explore the use of complexity and fractality to assess the conditions of patients with prediabetes and then help doctors to treat the patients and adjust their life style, diet, and exercise. The developed R package contains functions for analysing data from a CGM study. It covers a wide and comprehensive range of data analysis methods including reading a series of datasets, obtaining summary statistics of glucose levels, plotting data, transforming the time stamp format, fixing missing values, evaluating the mean of daily difference and continuous overlapping net glycaemic action, calculating multiscale sample entropy, conducting pairwise comparison, and displaying results using various plots. This package is published in the journal *Bioinformatics*. This package has greatly facilitated the analysis of various CGM studies and helped scientists conduct research about diabetes.

In addition to cooperation with hospitals, Prof Zhang's laboratory has conducted an experiment in Macao to explore the effects of exercise, heart rate, sleep and diet on healthy people and diabetics. In the experiment, they used Fitbit charge 2 device to monitor the heart rate, sleep quality and exercise status, while the glucose fluctuations were continuously monitored by using the Freestyle blood glucose meter, and the diet was recorded and photographed by the subjects themselves. The research attracted many participants. The project is currently in the process of data analysis.

Prof Zhang also uses wearable medical devices to conduct studies on cardiovascular diseases and respiratory diseases such as chronic obstructive pulmonary disease, asthma and allergic rhinitis.



圖一 · Dexcom G4 PLATINUM 連續血糖檢測儀，已被美國FDA批准，可以連續監測血糖7天。

Figure 1 • Dexcom G4 PLATINUM CGM System, approved by US FDA can monitor the glucose continuously for seven days.

## 生物信息學

在生物信息學方面，實驗室也開展了許多研究項目。在基於第二代測序技術對變應性支氣管肺黴菌病（ABPA）病人轉錄組的綜合性研究挖掘其深層機制專案中，運用第二代測序研究與呼吸道疾病相關的非編碼RNA，如長鏈非編碼RNA（lncRNA）、環RNA（circRNA）。與廣州醫科大學附屬醫院及呼吸道疾病研究所合作，通過對正常人和病人的轉錄組比較研究，挖掘與該疾病發病相關的非編碼RNA，從而為該疾病的分子診斷及治療靶點的設計提供新的線索和思路。此外，與副校長（研究）、健康科學學院葛偉教授的實驗室合作，通過對不同處理的（如：利用Crispr技術對YX-1基因進行敲除）斑馬魚轉錄組研究來挖掘與該基因相關的長鏈非編碼RNA，為斑馬魚的生長發育研究提供新的分子理論基礎。

通過與健康科學學院院長鄧初夏教授的實驗室合作，我們在新的高通量RNA測序技術Drop-seq的基礎上，使用大鼠模型研究乳腺腫瘤細胞的分類和分化。鄧教授的實驗室負責生物測定和RNA測序以提供Drop-seq數據，我們的實驗室主要側重於數據分析，以探索大鼠

## Bioinformatics

Prof Zhang's laboratory has also initiated several research projects on bioinformatics. In the integrative transcriptomic analysis on the in-depth exploration of the mechanisms of allergic bronchopulmonary aspergillosis (ABPA), we utilise next-generation sequencing to study respiratory disease-related non-coding RNA, such as long non-coding RNA (lncRNA) and circular RNA (circRNA). We have collaborated with Guangzhou Medical University First Affiliated Hospital and Guangzhou Respiratory Tract Disease Research Centre. Through comparative transcriptomic studies between healthy individuals and patients, we discover disease-related non-coding RNA, which acts as candidates of biomarkers for molecular diagnosis as well as targets in drug design. Moreover, collaborating with Prof Ge Wei in the FHS, employing zebrafish with different mutations (eg YX-1 gene knockout with CRISPR/Cas9), we perform transcriptomic analysis to explore gene-related lncRNA, which helps clarify the regulation of the gene and thus provides the molecular mechanism of the specific gene during zebrafish development.

Through collaboration with Prof Chuxia Deng in the FHS, we investigate the classification and differentiation of breast tumour cells with rats as model using the new high-throughput RNA sequencing technique, Drop-seq. Deng's laboratory carries out the bioassays and RNA sequencing to obtain Drop-seq dataset, and our

乳腺腫瘤細胞分類和分化潛在的分子機制，包括表達量化、聚類分析，標記基因鑒定等。

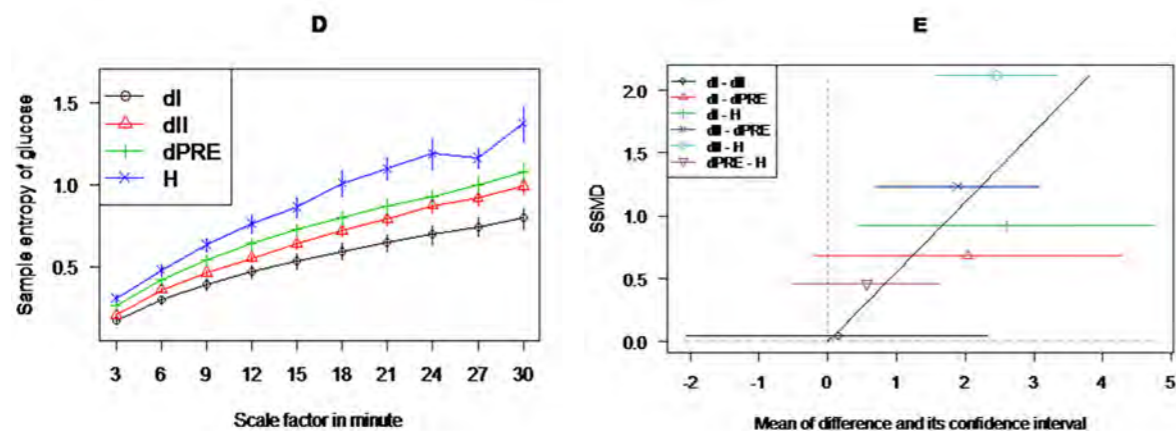
在基於CRISPR/Cas9技術全基因文庫的建立及大規模篩選分析技術開發專案中，實驗室與廣州銳博生物有限公司進行合作，得到了廣州市科技創新發展專項資金支持。專案聚焦CRISPR/Cas9技術基因編輯應用開發，開發便捷化學合成RNA用於CRISPR/Cas9的創新方法，逐步建立世界首個化學合成CRISPR/Cas9人類全基因組文庫，形成科學、可靠的CRISPR/Cas9技術大規模篩選數據分析系統。實驗室負責建立適應CRISPR/cas9高通量篩選的數據分析系統。課題組應用和改進前期建立的siRNA文庫高通量篩選體系，建立CRISPR/Cas9體系目標物庫設計、對照組設定、多孔板選擇、樣本量確定分析數理模型；同時，將數據質控的思想引入實驗設計源頭，解決和校正系統實驗偏差。

laboratory performs data analysis, including expression quantification, cluster analysis, and marker gene identification, to explore the classification and possible molecular mechanisms underlying differentiation of breast tumour cells of rats.

In the project of library construction of whole genome and high-throughput screening based on CRISPR/Cas9, Zhang's laboratory and RiboBio Co., Guangzhou began cooperation which is supported by a Science Innovation and Development Grant of the Guangzhou government. The project focuses on the development of application using CRISPR/Cas9 gene editing and accessible synthetic chemistry for RNA synthesis in CRISPR/Cas9 editing, so that it progressively builds the world's first human genome library which constitutes a scientific and reliable system of CRISPR/Cas9 high-throughput screening analysis, to support the mass application and industrialisation of CRISPR/Cas9 technology. Zhang's laboratory is responsible for developing data analysis platform for high-throughput screening with CRISPR/Cas9 editing. More specifically, our laboratory employs and improves the early high-throughput screening system with siRNA library, and designs mathematical models for target library, reference setup, microplate selection and sample quantification compliant with CRISPR/Cas9 editing. Also, we introduce quality control on data in experimental design to reduce systemic errors.

圖二 · 發表在 *Bioinformatics* 雜誌上的分析結果

Figure 2 • Results published in the *Bioinformatics*



張曉華，健康科學學院教授、博士生導師，美國統計協會會士和國際統計學會成員，研究領域涵蓋醫療人工智慧、高通量篩選、基因表型、精準醫療、數字醫療、高通量基因測序、臨床生物大數據醫用人工智慧開發等多個領域。

Douglas Zhang is a professor in the Faculty of Health Sciences, University of Macau. He is a fellow of the American Statistical Association and a member of the International Statistical Institute. His research interests include medical artificial intelligence, high-throughput screening, phenomics, precision medicine, digital medicine, high-throughput sequencing, and big data and artificial intelligence in clinical medicine.



金俞，張曉華教授的博士生，現主要負責臨床醫學大數據分析處理，專攻方向為連續監測生理數據在呼吸病中的應用與研究，探究機器學習與非線性方法對疾病的預測與診斷。

Jin Yu is a third-year PhD student at the University of Macau supervised by Prof Douglas Zhang. She is responsible for the analysis and processing of big data in clinical medicine. Her specialisation is the application and studies of continuous monitoring of physiological data in respiratory diseases, as well as the prediction and diagnosis of diseases by machine learning and nonlinear methods.



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