陽明交大曾新穆教授團隊：數據驅動的救命技術

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近年來，全球疫情的爆發加速了智慧醫療的發展。根據 Grand View Research 的報告，2022 年全球智慧健康照護市場規模已達到 1494 億美元，預計到 2030 年將增長至 3852 億美元，年複合成長率達 12.8%。在這樣的背景下，急重症照護的需求日益迫切，尤其是心律不整、敗血症、心跳驟停等病症的早期預警和預測。

曾新穆教授團隊的突破性技術

曾新穆教授團隊開發的多目標時間序列早期預測技術及急重症預警應用系統，能夠有效地預測急重症的發生，並及時提供預警，這項技術不僅在學術界獲得認可，獲得了 2023 未來科技獎，更在實際醫療場域中展現了其價值。這項技術結合了人工智慧、醫學和資料科學的專業知識，透過深度強化學習和多目標優化演算法，利用心電圖等生理訊號資料，建立了高精準度的預測模型。

曾新穆教授團隊發展出多目標時間序列早期預測技術及急重症預警應用系統，包含一系列基於深度強化學習及多目標優化等技術之創新性早期預測演算法，其突破性特色包含曾新穆教授團隊所設計之片段政策網路 (Snippet Policy Network)、膝引導神經進化演算法 (Knee-Guided Neuroevolution Algorithm, KGNA)、控制代理人模組 (Co ntrolling Agent) 及鑑別器 (Discriminator)，能由所輸入之各類生理訊號所對應之時間序列中萃取出時序片段 (Snippet) 細微特徵，結合深度學習網路技術建構出具高精準度之預測模型，並運用智慧型代理人 (Intelligent Agent) 控制決策流程，及多目標優化技術於及早時間輸出兼顧準確性與及早性之最佳預測結果；同時，透過約束性 KGNA 並可讓使用者依各種應用場域之需求，對重要預測目標進行個別化優先度設定。基於技術之特性以及各項突出之效能驗證結果，此系統除了可運用於急重症領域之早期預警，未來將也可拓展至其它智慧醫療與智慧感測領域之異常預測。

關於 Benchmark 量化說明，曾新穆教授團隊提出技術所建立之早期預測模型以準確度 (Accuracy)、及早性 (Earliness)、召回率 (Recall)、精確度 (Precision)、F1-score、調和平均 (Harmonic Mean)、AUC(A rea Under ROC Curve) 等指標進行評估。其中調和平均為同時考慮到準確度與及 早性之指標。透過在多個公開大型心電圖資料集之測試，分別針對心律不整和敗血症早期預測之平均準確度可達 0.82 和 0.90 以上，並具最佳之及早性，顯示此技術於多項指標中皆遠優於其它最前沿之技術。

技術的實際應用與未來展望

團隊與聯新國際醫院進行產學合作，通過臨床試驗證明了其在實際醫療場域中的可行性，其中 AUC 達到 0.914。曾新穆教授團隊證明這項技術不僅能夠提升醫療照護品質，降低醫護人員的工作負擔，還能提高急重症患者的生存率和康復率，減輕患者和家庭的身心及經濟壓力。此外，這項技術的應用範圍非常廣泛，不僅限於醫療院所，還可以結合 AIoT 技術，如智慧病房，以及擴展到製造業等其他時間序列相關領域，進行早期異常預測和預警。

曾新穆教授團隊的技術在智慧醫療領域的應用，為急重症照護帶來了革命性的改變。隨著技術的不斷發展和應用，本院期待它能夠為全球醫療健康產業帶來更多的創新和進步。這不僅是一項科技成就，更是對人類健康和福祉的重大貢獻。隨著這項技術的進一步推廣和應用，我們有理由相信，智慧醫療將為未來的醫療照護開啟新的篇章。

NYCU Dr. Tseng's Data Intelligence Lab: Data-Driven Life-Saving Technology

In recent years, the global outbreak of the pandemic led to the growth of smart healthcare. According to a report by Grand View Research, the global smart healthcare market reached $149.4 billion in 2022 and is projected to grow to $385.2 billion by 2030, with a compound annual growth rate of 12.8%. In this context, the demand for critical care is increasingly urgent, particularly in the early warning and prediction of medical conditions such as arrhythmias, sepsis, and cardiac arrest.

The breakthrough technology developed by Professor Tseng's team

Professor Vincent S. Tseng's team has developed "Multi-Objective Series Early Prediction Technologies and the Alarm System for Critical Care" that can predict the onset of critical illnesses and issue timely warnings. Combining expertise in artificial intelligence, medicine, and data science, this technology utilizes deep reinforcement learning and multi-objective optimization algorithms and physiological signal datasets such as electrocardiograms to establish a highly accurate prediction model for critical illnesses. It has not only gained recognition in academia but also won the 2023 Future Technology Award, demonstrating its value in practical medical settings.

Professor Tseng and his team have developed the "Multi-Objective Series Early Prediction Technologies and Alarm System for Critical Care," which utilizes advanced early prediction algorithms based on deep reinforcement learning and multi-objective optimization. The system comprises several innovative components, including the Snippet Policy Network, Knee-Guided Neuro-evolution Algorithm (KGNA), Controlling Agent, and Discriminator, which can extract snippet features from various physiological signals corresponding to the input time series and fuse deep learning technologies to construct highly accurate predictive models. This system utilizes intelligent agents to control decision-making processes and multi-objective optimization techniques to achieve the best prediction results that maintain a balance between accuracy and timeliness in early output. Additionally, the constrained KGNA enables users to prioritize specific prediction targets based on their application requirements. The system has undergone extensive performance validation. It serves not only as a reliable early warning tool for critical illnesses but also has the potential to expand into other areas, such as smart healthcare and abnormal prediction in smart sensing across various domains.

Professor Vincent S. Tseng's team provides a quantitative explanation regarding Benchmarking, wherein the early prediction models established by their technology are evaluated using metrics such as Accuracy, Earliness, Recall, Precision, F1-score, Harmonic Mean, and AUC (Area Under ROC Curve). The harmonic mean, in particular, serves as an indicator that simultaneously considers accuracy and earliness. Through tests on various large publicly available electrocardiography datasets, the average accuracy in predicting arrhythmia and early sepsis surpasses 0.82 and 0.90, respectively, achieving optimal earliness. The result illustrates that this technique significantly outperforms other cutting-edge methods across multiple metrics.

Applications and Future Prospects of the Technology

The industry-academia collaboration between Professor Tseng's team and Landseed International Hospital demonstrates the feasibility of their application in actual medical environments, validated through clinical trials with an AUC of 0.914. The team's technology not only enhances the quality of medical care and reduces staff workload but also improves survival and recovery rates of critically ill patients, thus alleviating the physical, mental, and financial burdens on patients and their families. Moreover, the application of their technology can extend far beyond medical facilities to integrate AIoT technologies like smart wards and branch out into other time-series-related sectors such as manufacturing for early anomaly prediction and warning.

The technology developed by Professor Tseng's team has sparked a revolution in smart healthcare, substantially improving emergency and critical care. As this technology continues to evolve and be applied, our college anticipates its capacity to catalyze further innovation and advancement within the global healthcare sector. This achievement is not only a technological feat but also a profound contribution to human health and welfare. With the ongoing promotion and utilization of this technology, we are confident that smart healthcare will usher in a new era of medical care.