

人工智慧於臨床醫療的應用與未來趨勢

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簡廷因 主任



元智大學

Yuan Ze University

自我介紹

■ 簡廷因

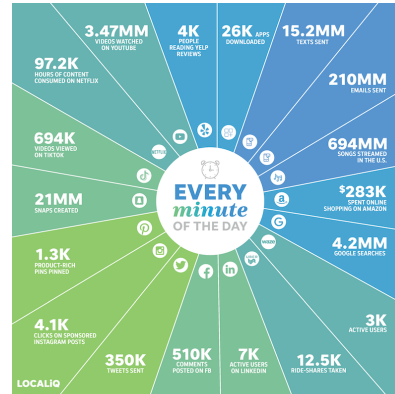
- 元智大學 資工系 主任
- 元智大學 大數據中心 主任
- 元智大學 生物與醫學資訊碩士學位學程 副教授
- 元智大學 資訊工程學系 副教授
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Data Are the King

- **Data-centric computing** will dominate the future!



- Now data are of:
 - High **volume**
 - High **velocity**
 - High **variety**



210M Emails sent
4.2M google searches
15.2M text sent
350K tweets sent
510K comment posted on FB

<http://image.slidesharecdn.com/bigdatabigrewards-chong-150502043013-conversion-gate01/95/big-data-big-rewards-4-638.jpg?cb=1430559062>; http://www.eweek.com/imagesvr_ce/4176/2013_ew_HubDataHP_01.jpg;
http://itlaw.wikia.com/wiki/Big_Data:_Seizing_Opportunities,_Preserving_Values; <https://www.smartinsights.com/internet-marketing-statistics/happens-online-60-seconds/>

大數據與人工智慧

■ AlphaGo的成功，AI又變得熱門

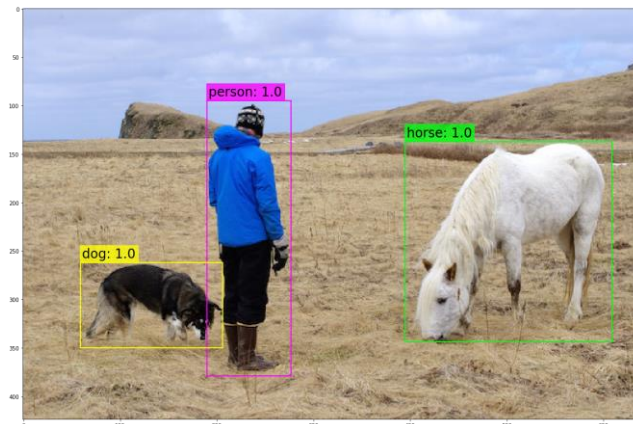
- 因硬體能夠處理大量資料
- 有大數據才有人工智慧



■ AI目的

- 希望機器可以跟人的頭腦一樣
 - 模式辨識
 - 物件辨識
 - 自我學習
 - 自動推理
 - 解決問題

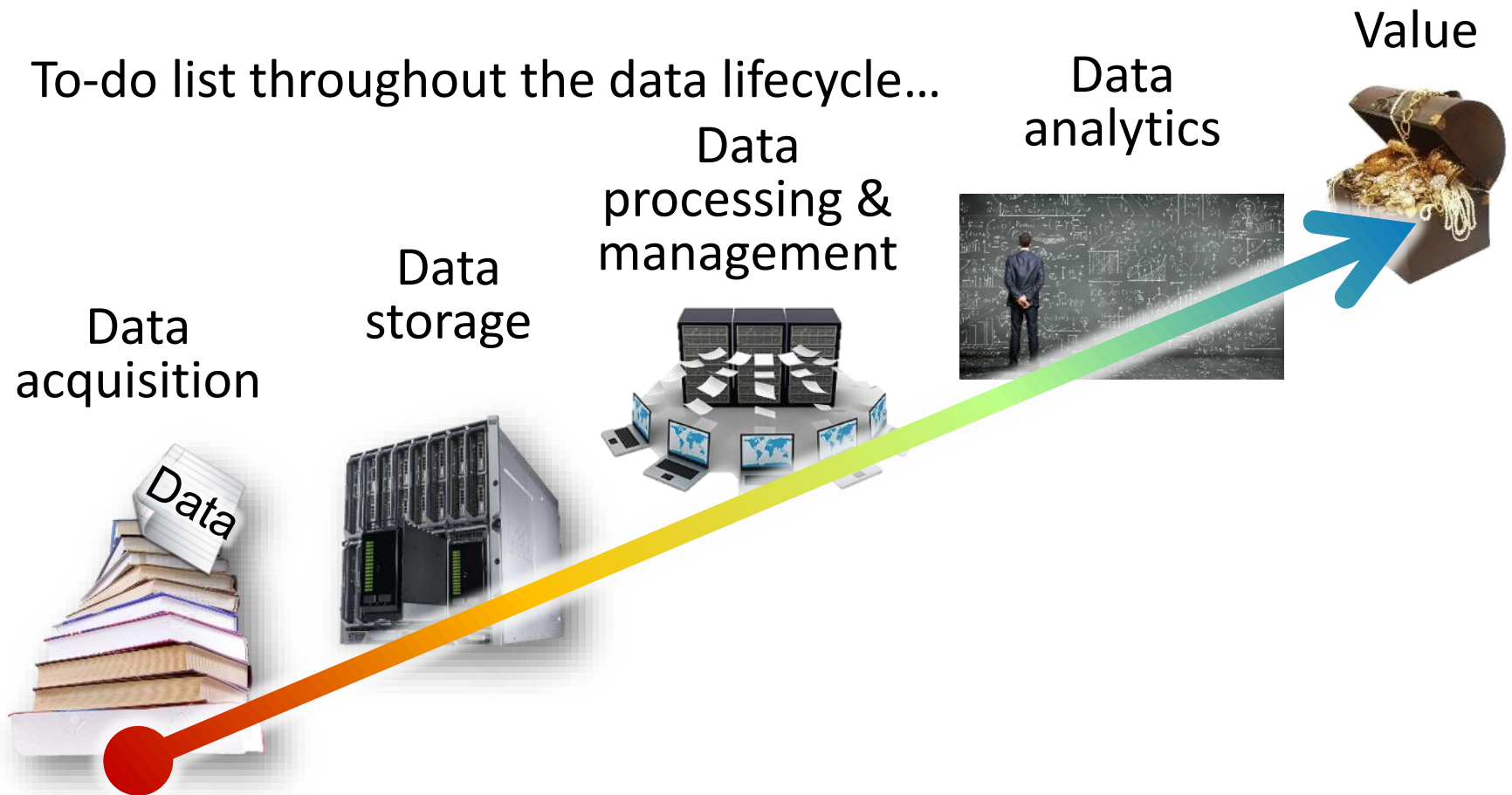
■ 在影像辨識領域，電腦已贏過人類



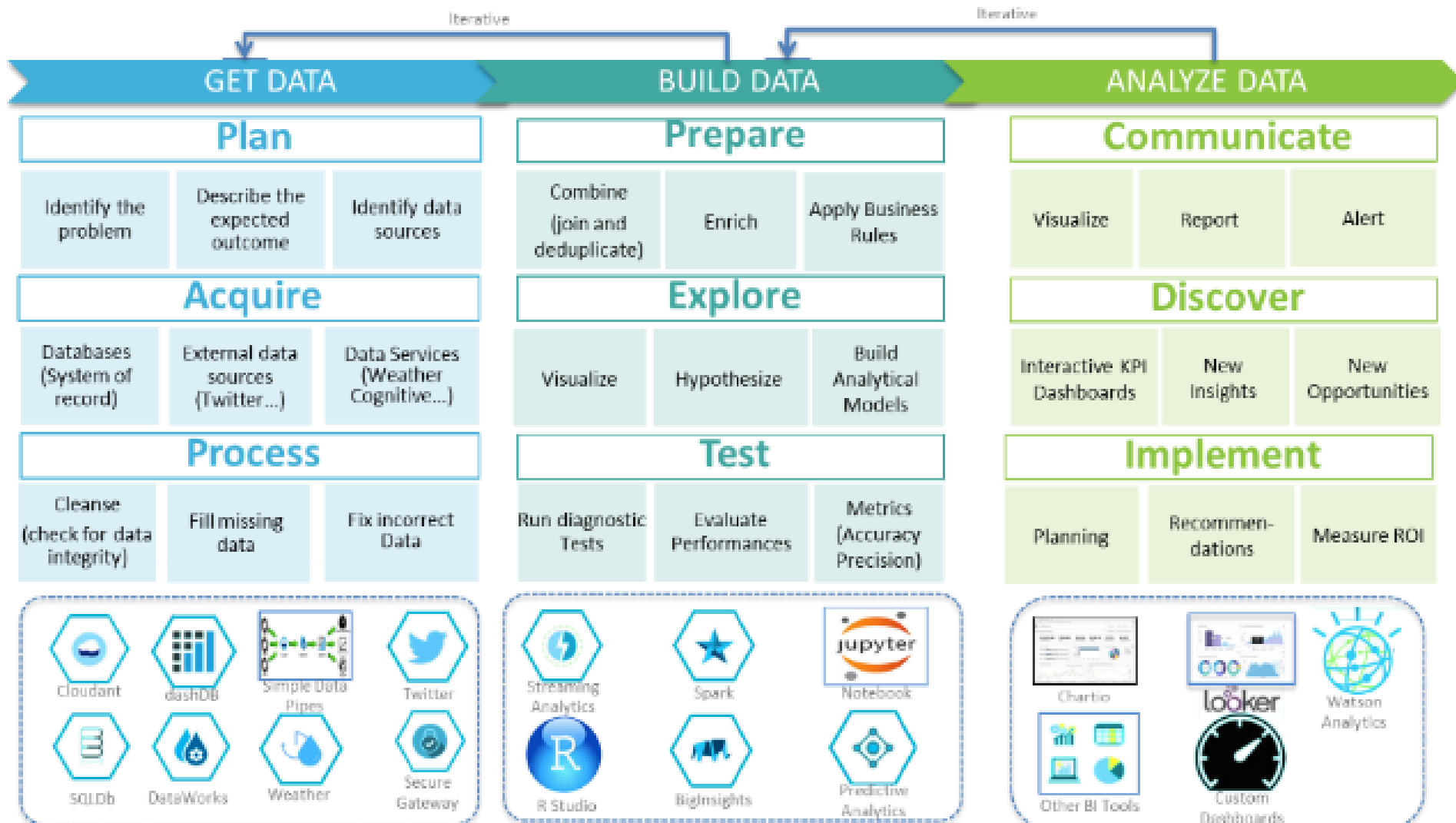
資料分析流程

■ Data-centric computing makes the computing system design a totally different story...

- To-do list throughout the data lifecycle...



資料分析流程



資料分析流程

■ Plan (定目標)

- 問題是什麼？
- 預期成果是什麼？
- 資料來源是什麼？

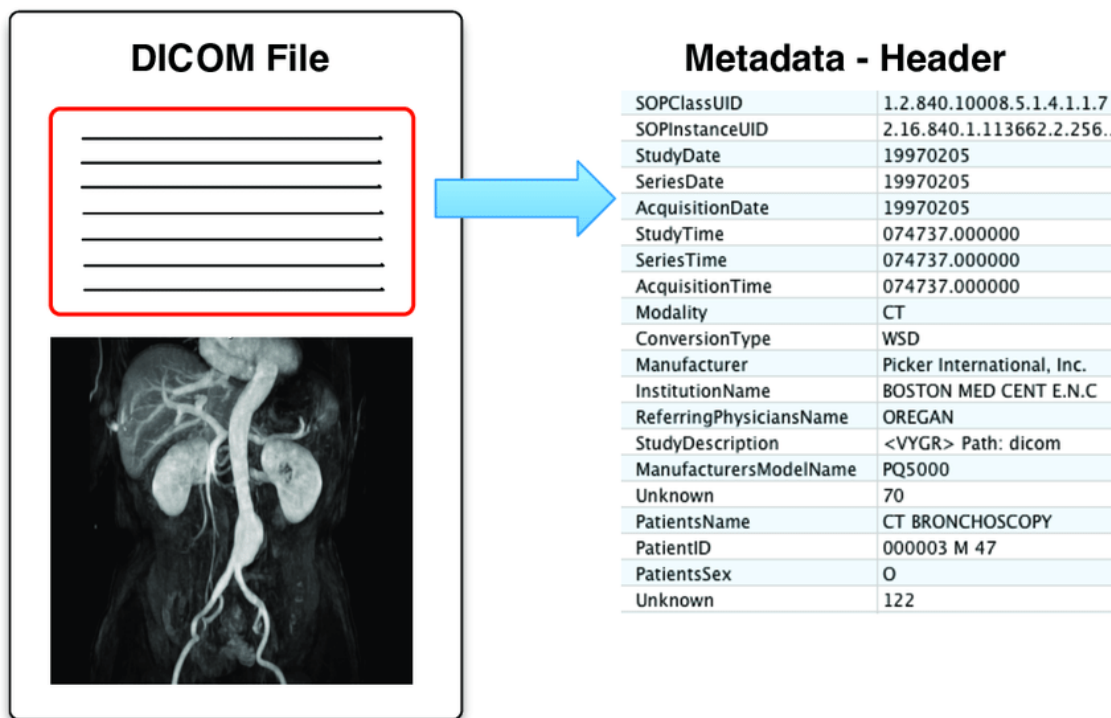
■ Acquire (資料取得)

- 資料庫有那些資料？
 - 已知關鍵因數資料一定要有
 - 預期成果相關資料一定要有
- 是否需要考慮外部資料？

醫療大數據

■ DICOM 格式

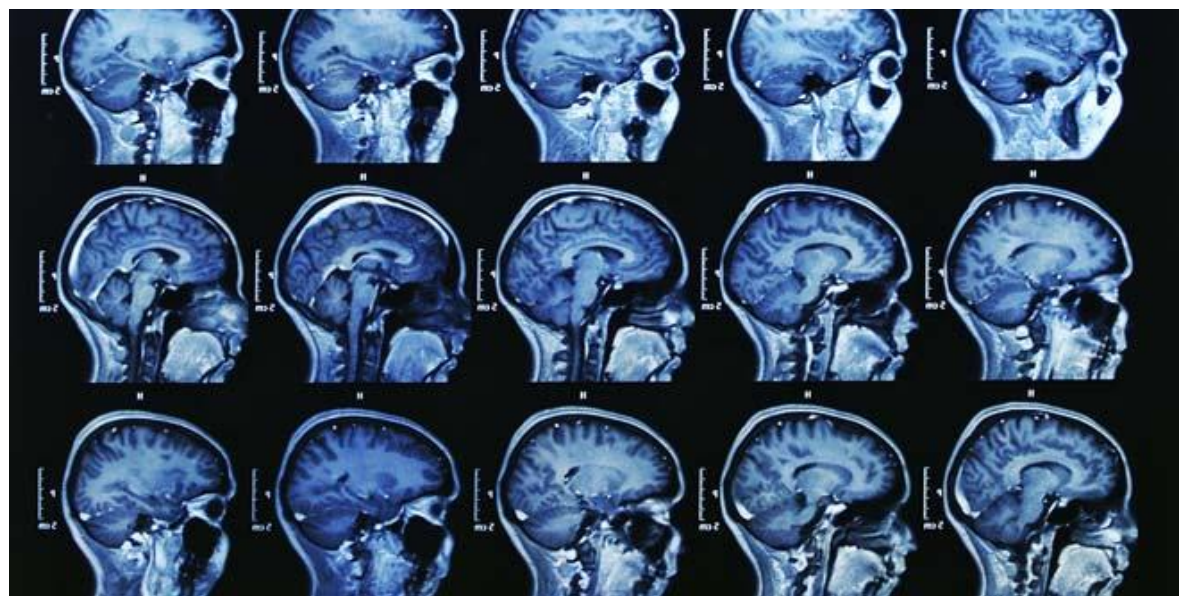
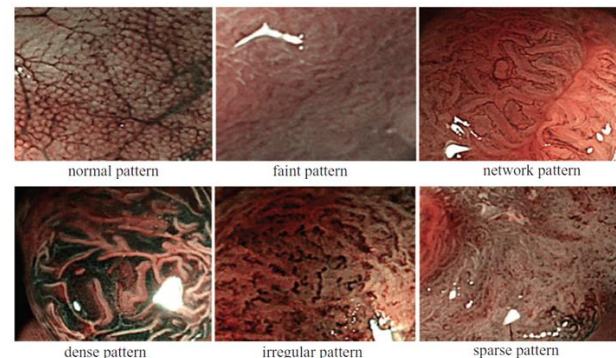
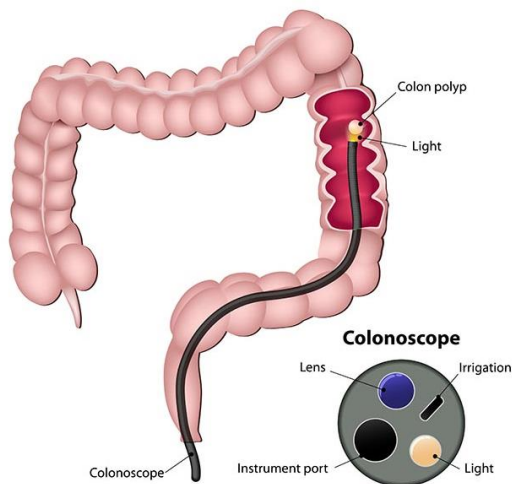
- 醫療數位影像傳輸協定（DICOM，Digital Imaging and Communications in Medicine）是一組通用的標準協定，在對於醫學影像的處理、儲存、列印、傳輸上。它包含了檔案格式的定義及網路通信協定



醫療大數據

■ 醫療數據資料集

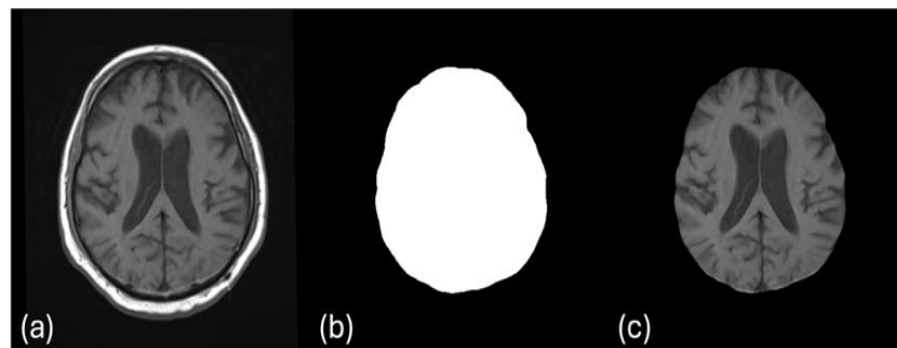
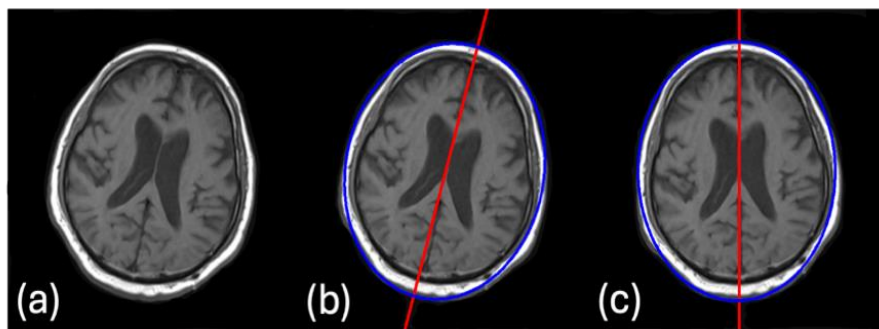
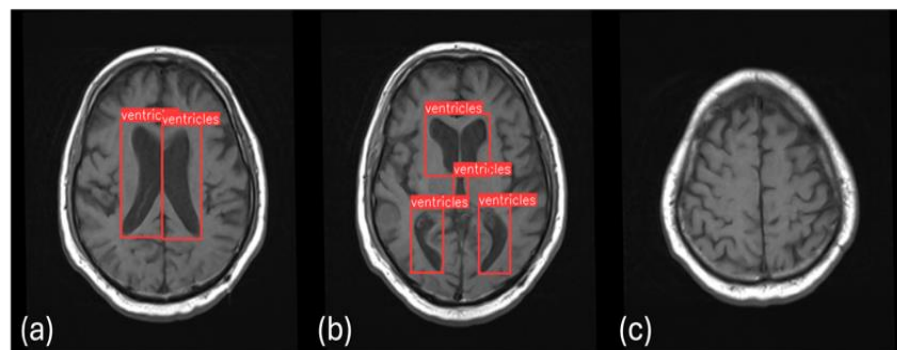
- 健保資料庫
- 病歷資料
- 醫療影像
 - 電腦斷層 (CT)
 - 核磁共振 (MRI)
 - 大腸鏡
 - 胃鏡
 - 心導管
 - 熱影像
 - ...
- 糞菌庫
- 穿戴式裝置資料



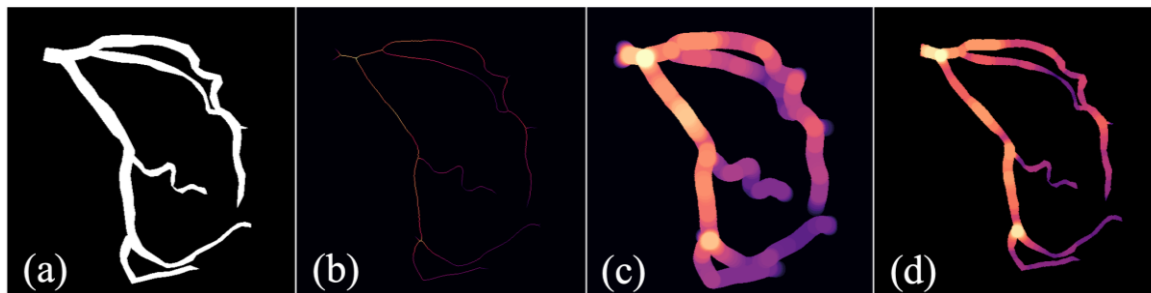
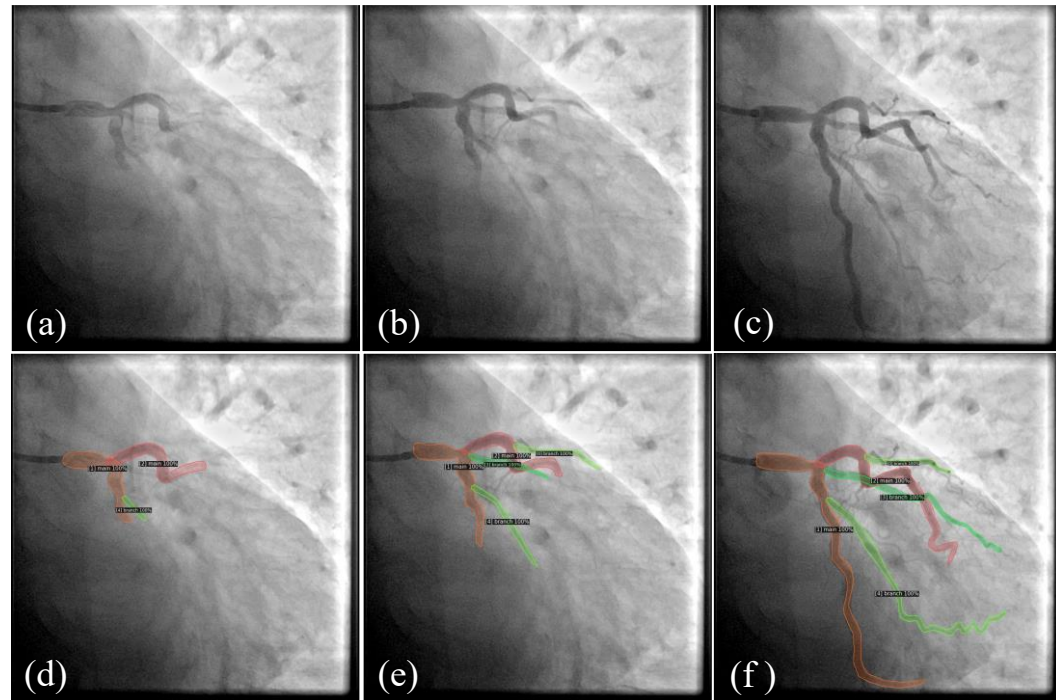
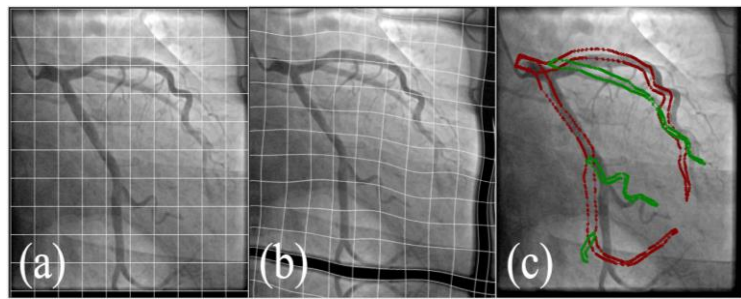
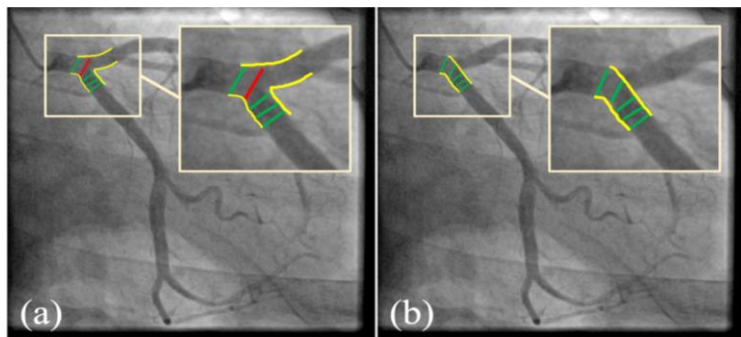
資料分析流程

■ Process (前處理)

- 數據品質好不好？
 - 遺漏值多不多？
 - 錯誤資料是否校正？
- 影像處理
- 擷取關鍵特徵



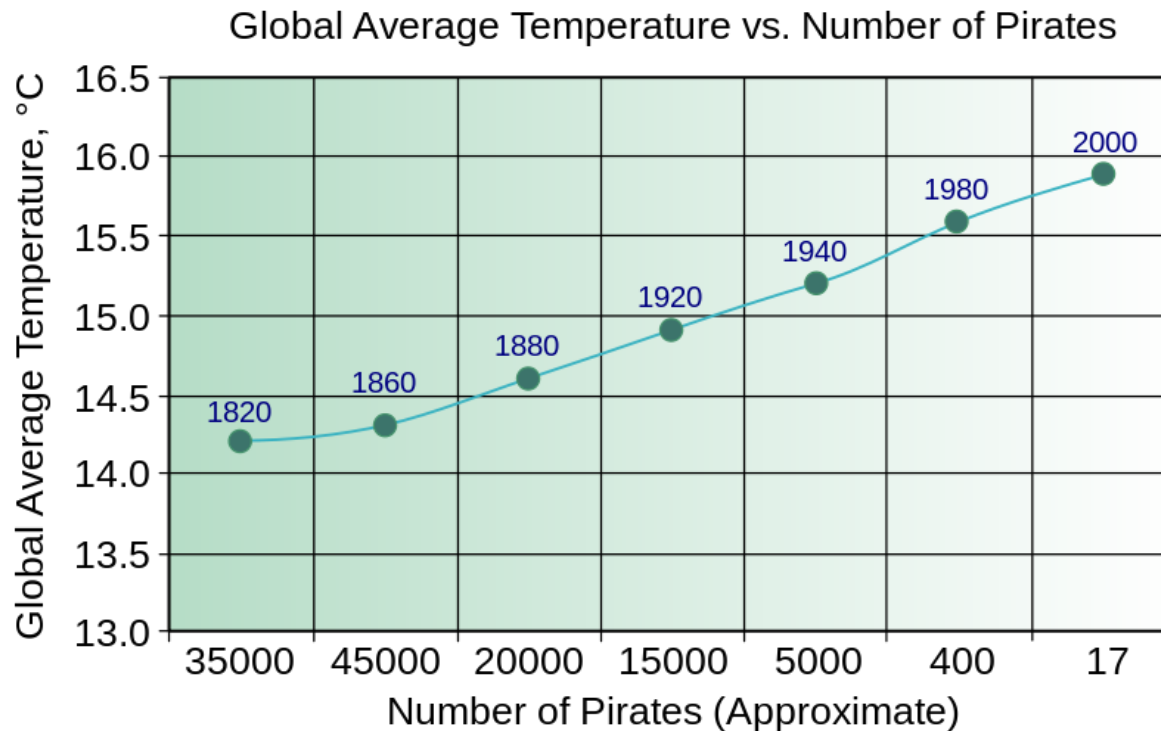
資料分析流程



資料分析流程

■ Analyze Data

- Value or Garbage?



健保資料庫釋憲案

- 憲法法庭認定個資法規定健保資料庫供公務或學術機關統計或研究合憲，但欠缺個資監督機制及當事人請求資料停止使用規定違憲。

健保資料庫釋憲案部分違憲 國發會：強化個資保護

2022/8/12 20:38 (8/12 22:13 更新)



憲法法庭12日決議，健保資料庫供學術研究合憲，但欠缺個資監督機制等有違憲之虞，要求相關機關3年內修法。(示意圖/中央社檔案照片)

<https://www.cna.com.tw/news/afe/202208120333.aspx>
<https://www.thenewslens.com/article/171564>

人工智慧在醫療 影像分析中的應用



元智大學

Yuan Ze University

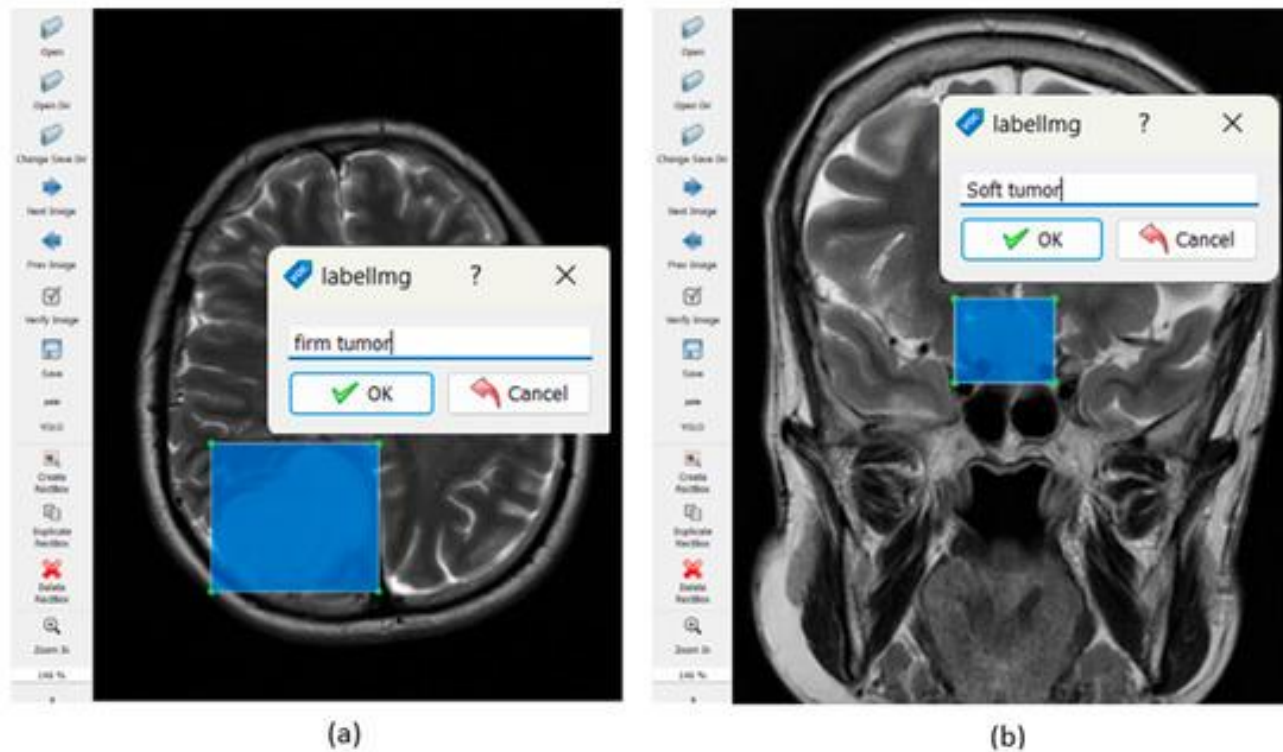
醫療與AI-醫療診斷

- 醫療主要聚焦在診斷 (diagnosis)、預後 (prognosis)、治療 (treatment)
- AI提供相當的協助
 - 偵測 (detection)
 - 分類 (classification)
 - 分割 (segmentation)
 - 預測 (prediction)
 - 建議 (recommendations)
 - 自然語言處理 (natural language processing)
 - 多模態處理 (multimodal processing)

醫療與AI

■ YOLO: Real-Time Object Detection

- 可自行建模



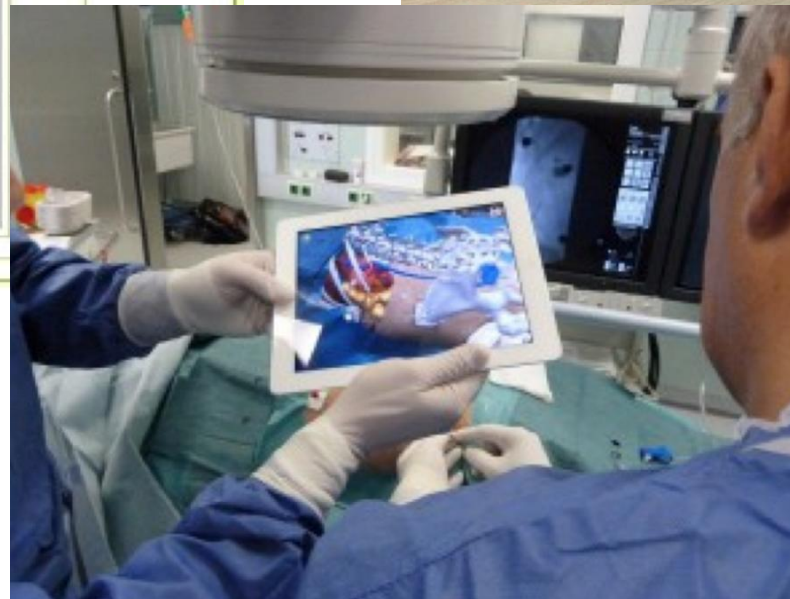
<https://www.mdpi.com/2079-3197/12/3/44>

醫療與AI-藥物辨識

■ 藥物外觀辨識

- 未來可結合AR(擴增實境)說明藥理

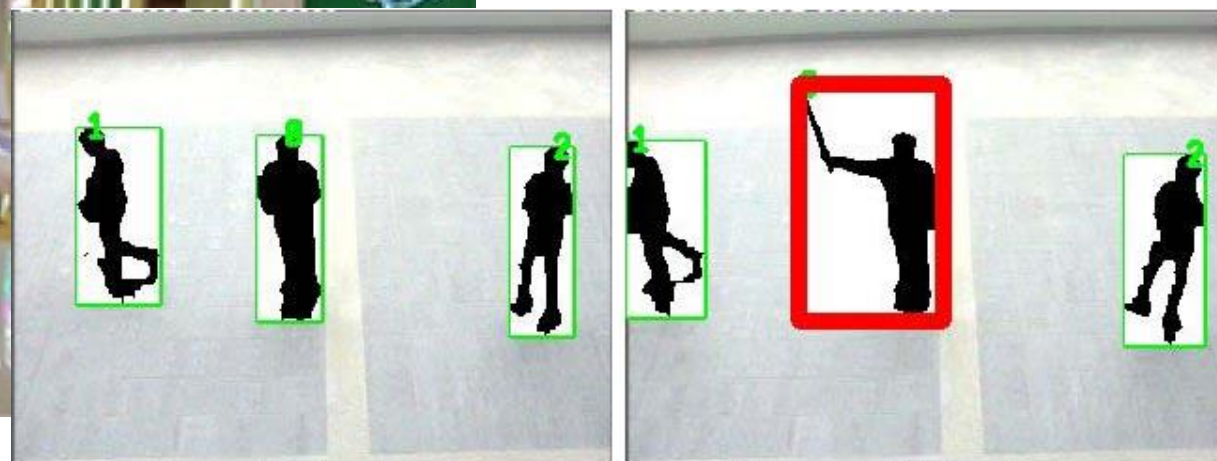
輸入藥品外觀--->查詢結果							
藥代	ACEM	藥品成份名	Acemet 60mg	單位	#	藥性	02
適應症	消炎止痛						
副作用	噁心、嘔吐、腹瀉、便秘、昏昏欲睡、眩暈、頭痛、疲倦						
用藥警語	血便、黑便、排厚圈膠狀疼痛、耳鳴、眼皮或臉浮腫						
藥物圖片							
其它用藥指示							
臨床用途	消炎止痛						



醫療與AI-肢體偵測

■ 員工/病患動作檢測

- 復健



Normal behavior

Abnormal behavior

<https://youtu.be/QWhHwglp8b4>

醫療與AI-生理資訊偵測

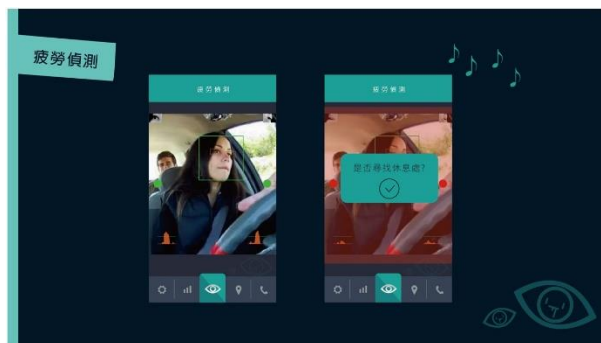
■ 中風偵測



<https://youtu.be/qkF9pwKDCm4>

醫療與AI-生理資訊偵測

■ 疲勞駕駛偵測



Android Studio

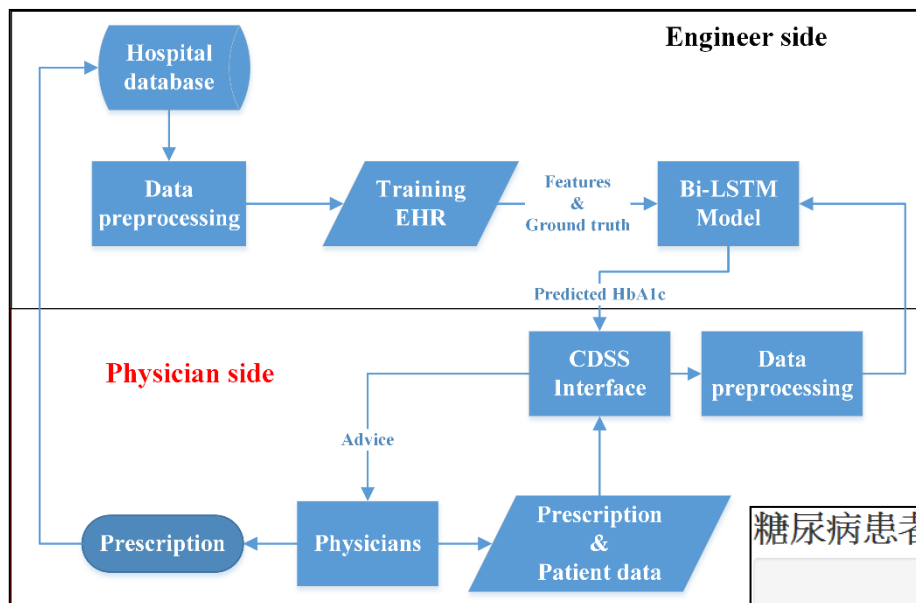


Open CV

<https://youtu.be/wAb38Ldgp0o>

醫療AI應用-醫療決策

■ 醫院用藥分析



糖尿病患者用藥之醫療決策系統

姓名	性別	年齡	身高	體重
王小明	男	30	170	75

藥名	劑量, Tab	頻率
UFORMIN * 500mg Tab	1	BID

HbA1c (%)
最近測量值
7.5
預測值
7.2

醫療與AI-生理資訊偵測

■ 體溫

- 熱影像
- RGB影像

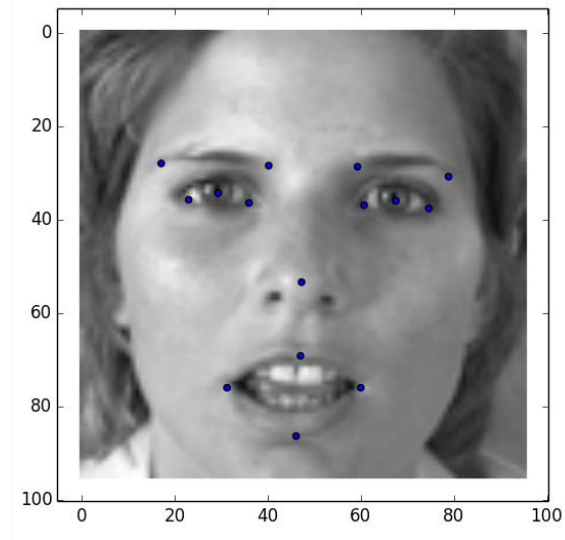
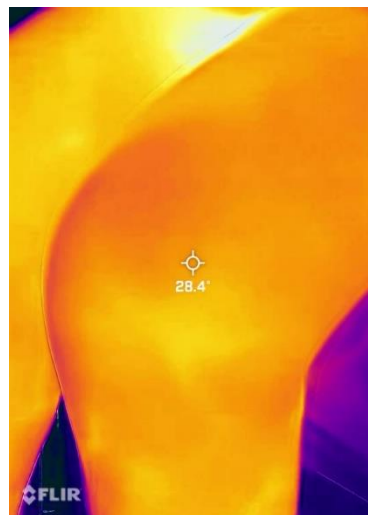
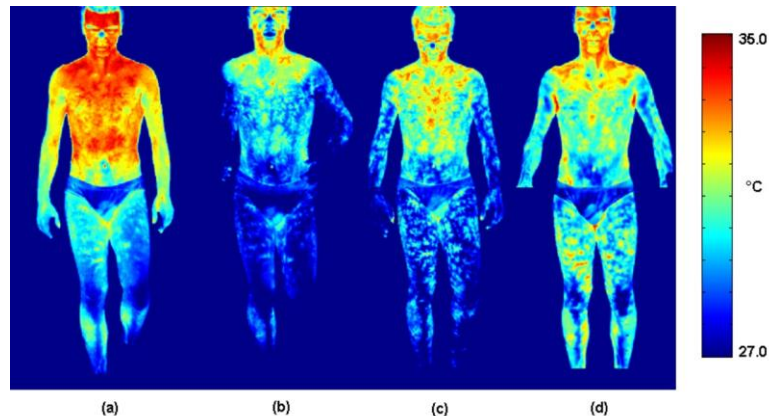
■ 呼吸率

- RGB影像
- Kinect

■ 臉部特徵

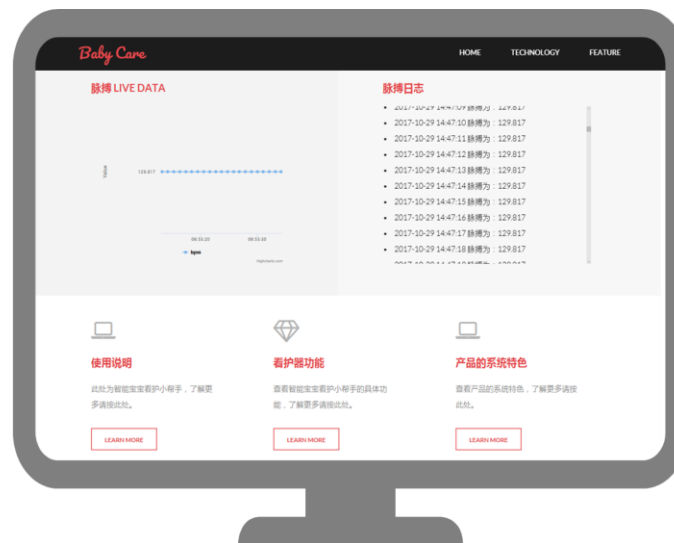
- RGB影像

■ 情緒分析



醫療與AI-智慧照護

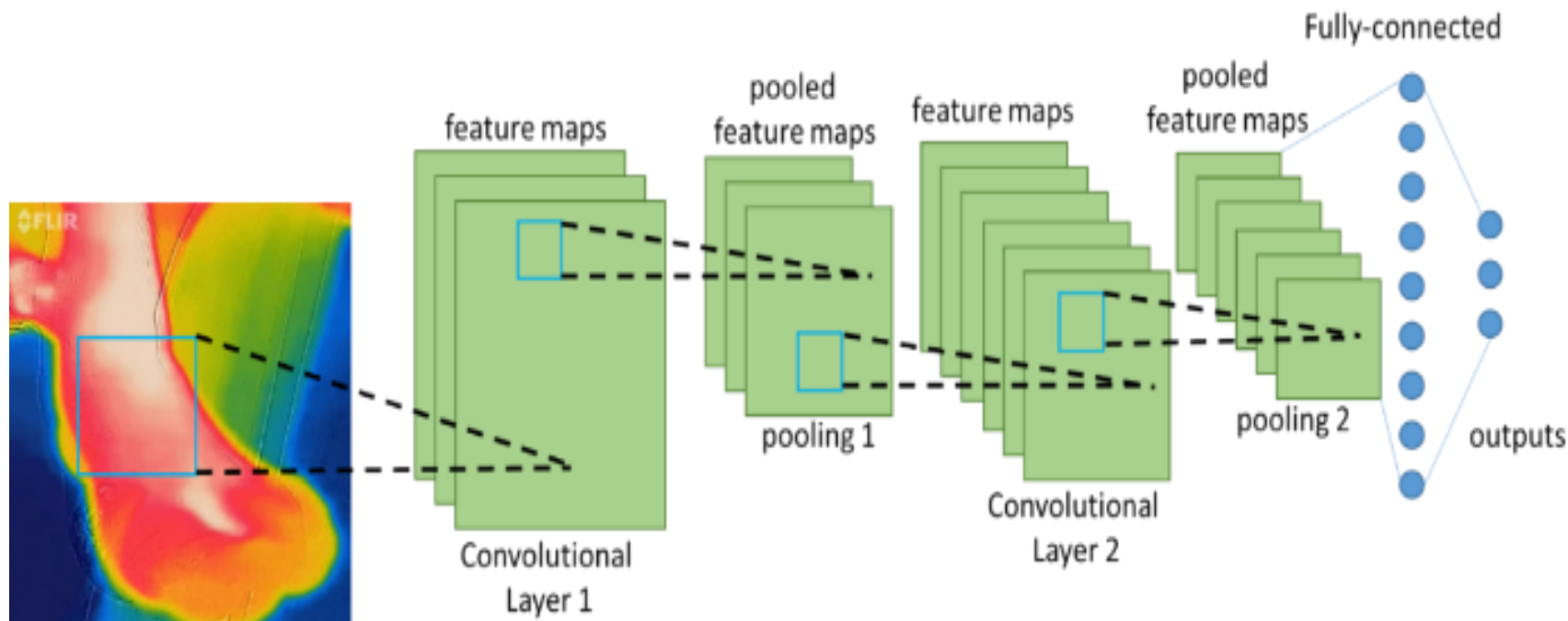
■ 嬰兒照護



醫療AI應用-醫療決策

■ 醫學影像分析

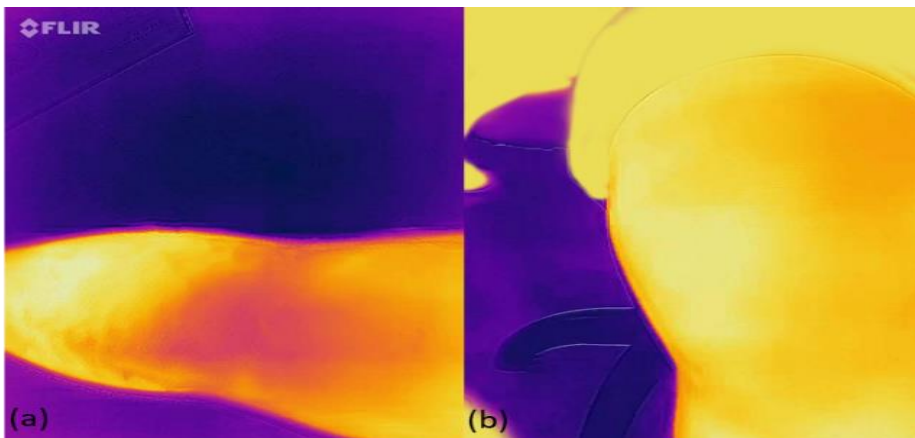
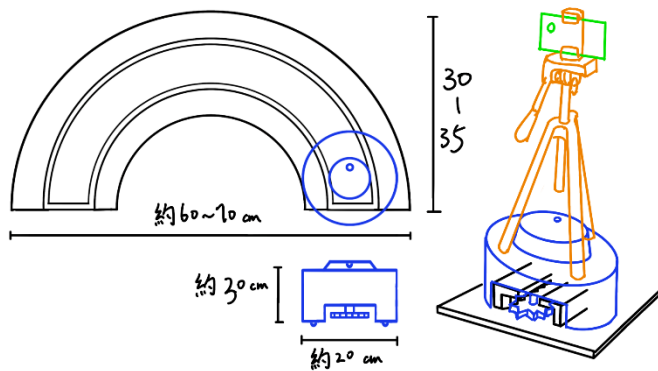
- 利用熱影像判定足底筋膜炎



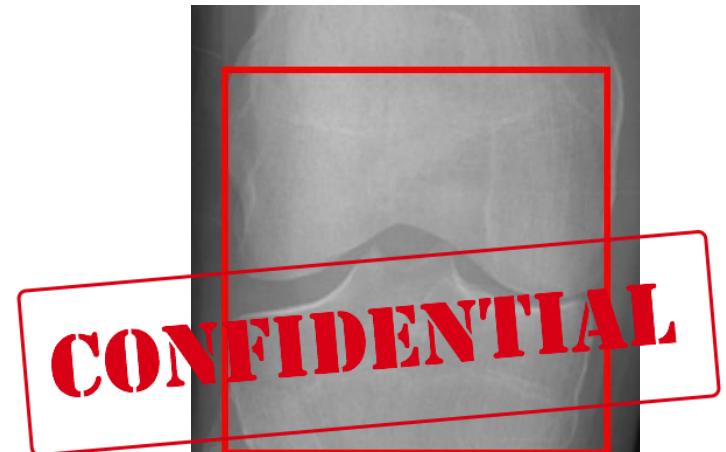
醫療AI應用-醫療決策

■ 醫學影像分析

- 利用熱影像判定退化性膝關節炎



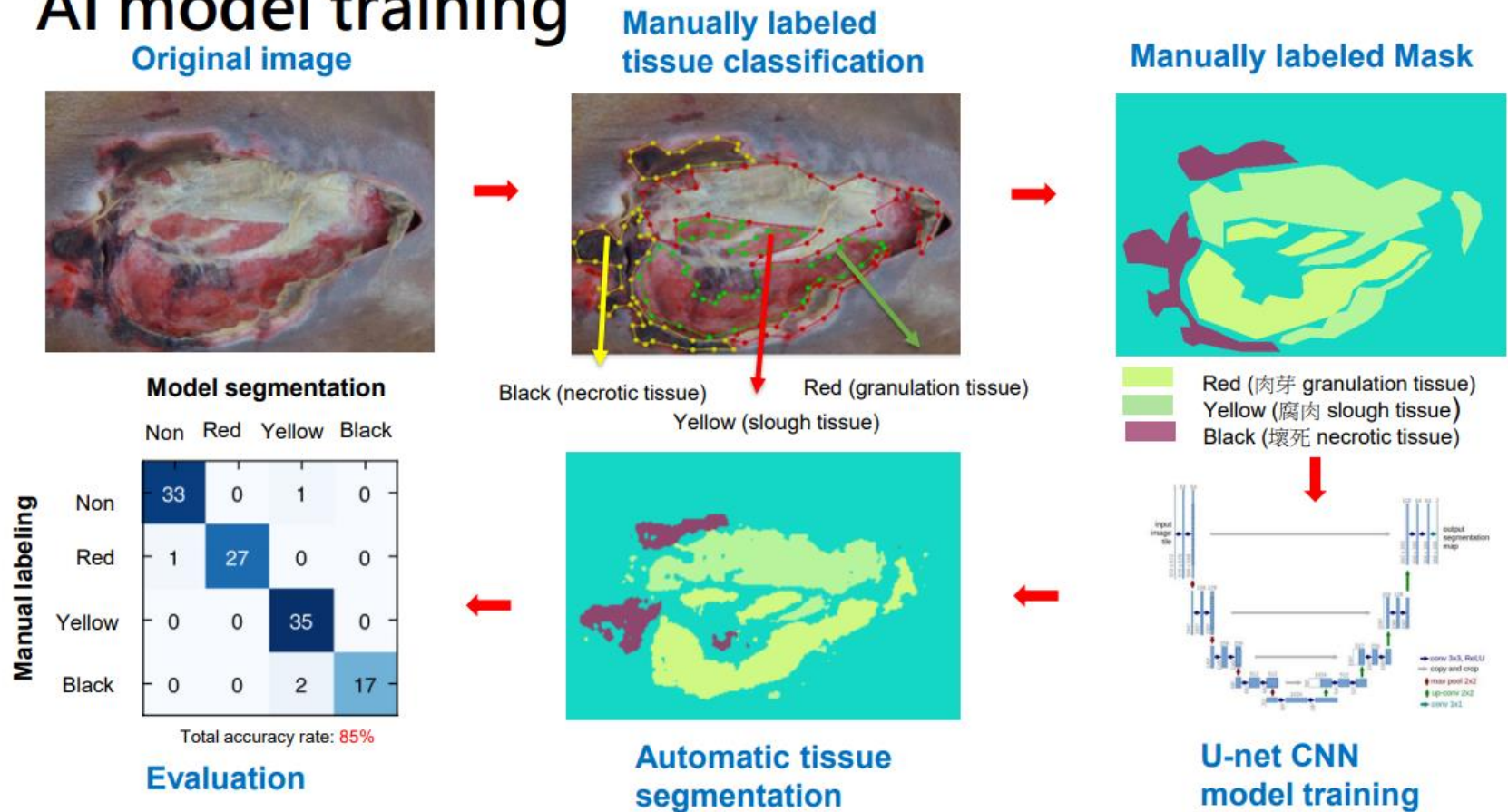
V.S



醫療AI應用-醫療決策

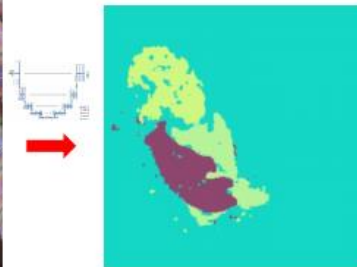
■ 褥瘡照護4.0

AI model training



醫療AI應用-醫療決策

■ 褥瘡照護4.0



紅色 (肉芽 33.65%)
黃色 (腐肉 28.55%)
黑色 (壞死 37.80%)

TABLE I
PHOTOGRAPHIC WOUND ASSESSMENT TOOL

Domain	Assessment
1. Edges	0 = Indistinct, diffuse, none clearly visible 1 = Distinct, well-defined clearly visible, attached, even with wound base 2 = Well-defined, not attached to wound base 3 = Well-defined, not attached to base, rolled under involved 4 = Well-defined, flange, curled or hypergranular
2. Necrotic Tissue Type	0 = None visible 1 = Withering necrotic tissue and/or surrounding yellow slough 2 = Locally adherent yellow slough 3 = Adherent, soft black eschar 4 = Freely adherent, hard black eschar
3. Necrotic Tissue Amount	0 = None visible 1 = < 25% of wound bed covered 2 = 25% to 50% of wound covered 3 = > 50% and < 75% of wound covered 4 = 75% to 100% of wound covered
4. Skin Color Surrounding Wound	0 = Pink or normal for skin group 1 = Bright red 2 = White or grey pallor or hypergranular 3 = Dark red or purple 4 = Black or hypergranular
5. Granulation Tissue	0 = No tissue or partial thickness exposed 1 = Bright, moist and 75% to 100% of wound bed and/or tissue overgrowth 2 = Bright, moist and < 75% and > 25% of wound bed 3 = Pink, moist and shiny red and/or fibrous & 10% of wound 4 = No granulation tissue present

傷口總分
(PWAT)計算



腐肉型傷口

傷口判定：傷口仍有大量的腐肉組織或壞死組織。

就醫建議：建議一至兩週內就醫，可能需清創。

換藥方式建議：可以使用清創或燙傷藥膏，並和鹽水紗布濕敷交替，達到物理性清創的目的。

換藥頻次：一天一次至一天兩次。

清創藥膏 燙傷藥膏

連結衛教資訊



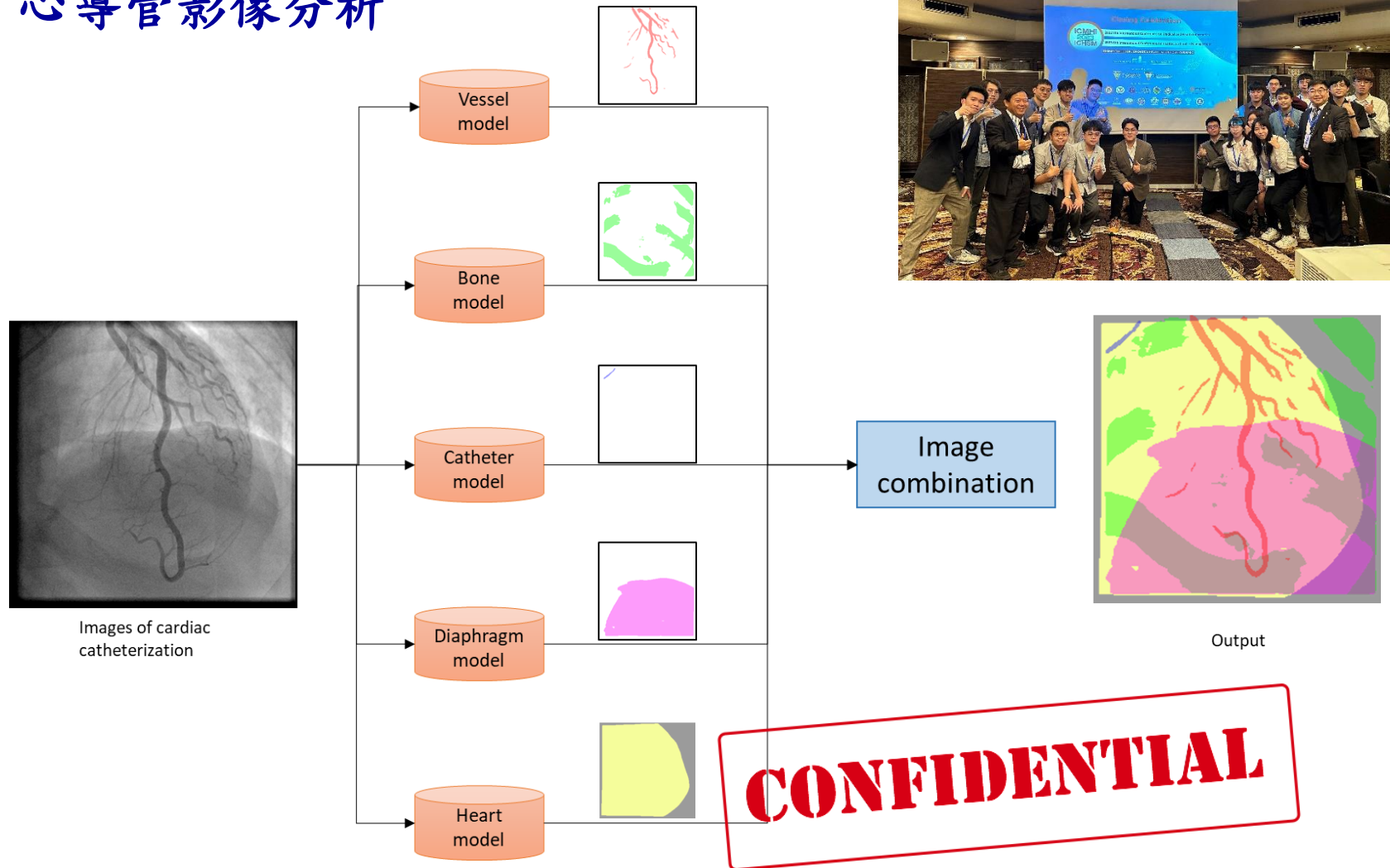
<https://youtu.be/7yoxWVAYTkI>

醫療AI應用-醫療決策



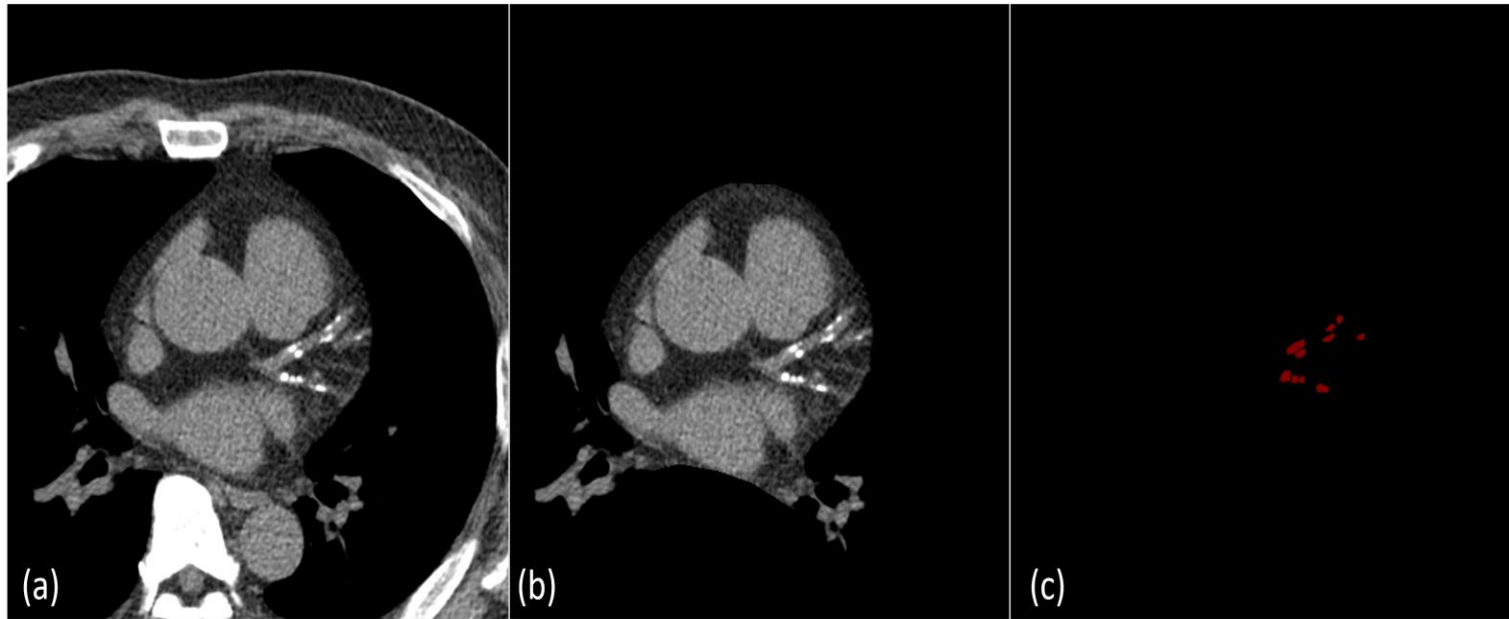
醫療AI應用-醫療決策

■ 心導管影像分析



醫療AI應用-醫療決策

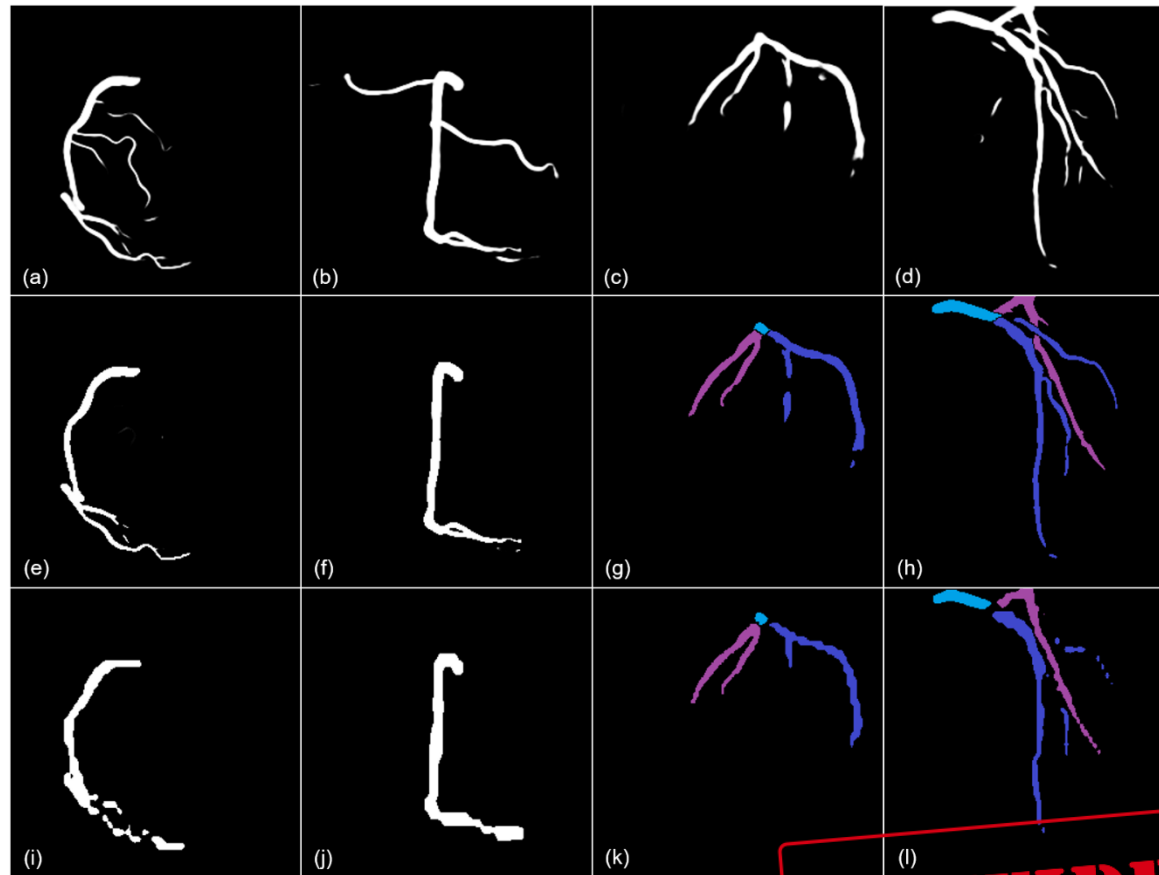
■ 冠狀動脈鈣化位置偵測



CONFIDENTIAL

醫療AI應用-醫療決策

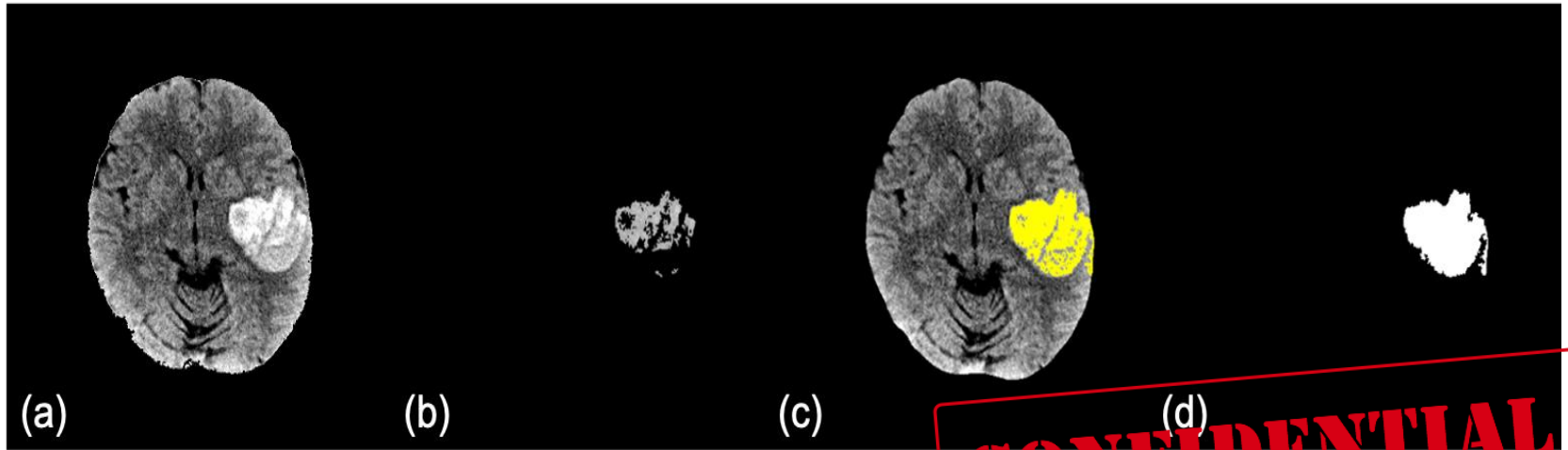
■ 心導管影像血管分段分析



CONFIDENTIAL

醫療AI應用-醫療決策

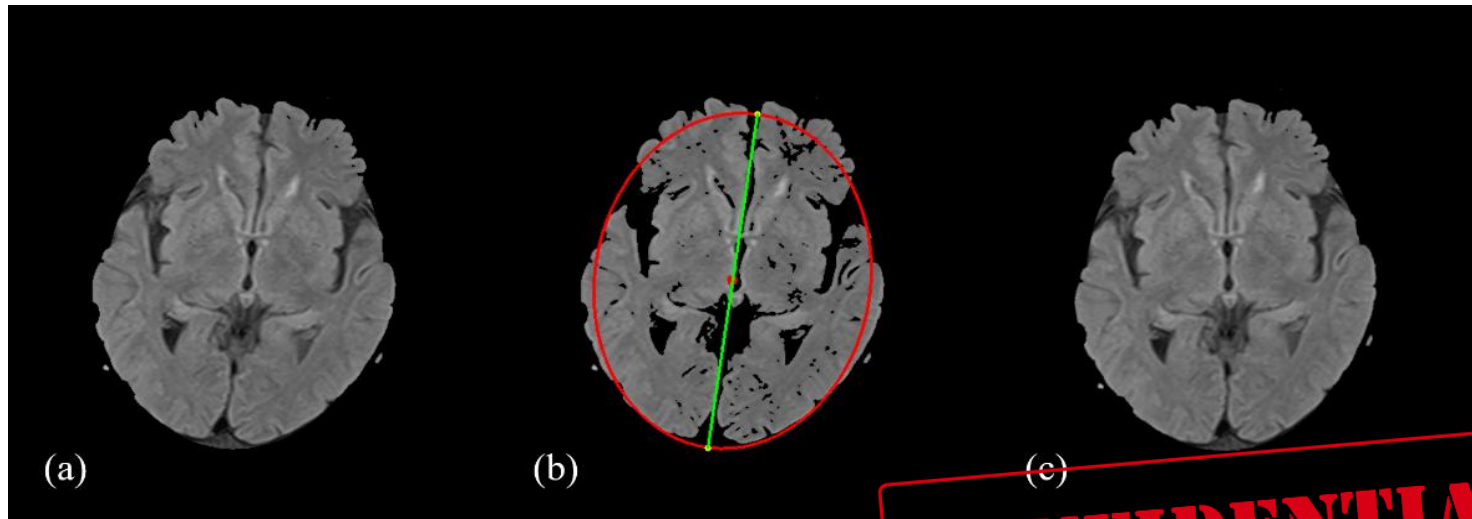
■ 腦部出血位置計算



CONFIDENTIAL

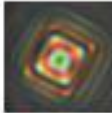
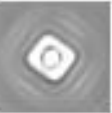
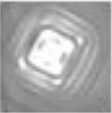
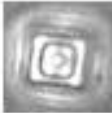
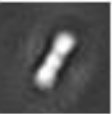
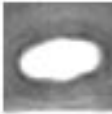
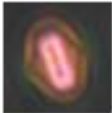
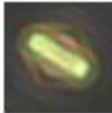
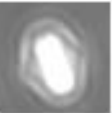
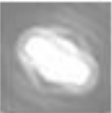
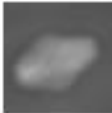
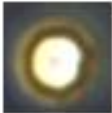
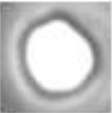
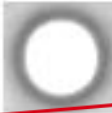
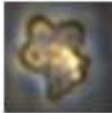
醫療AI應用-醫療決策

■ 腦白質病患偵測



CONFIDENTIAL

醫療AI應用-尿結晶計算

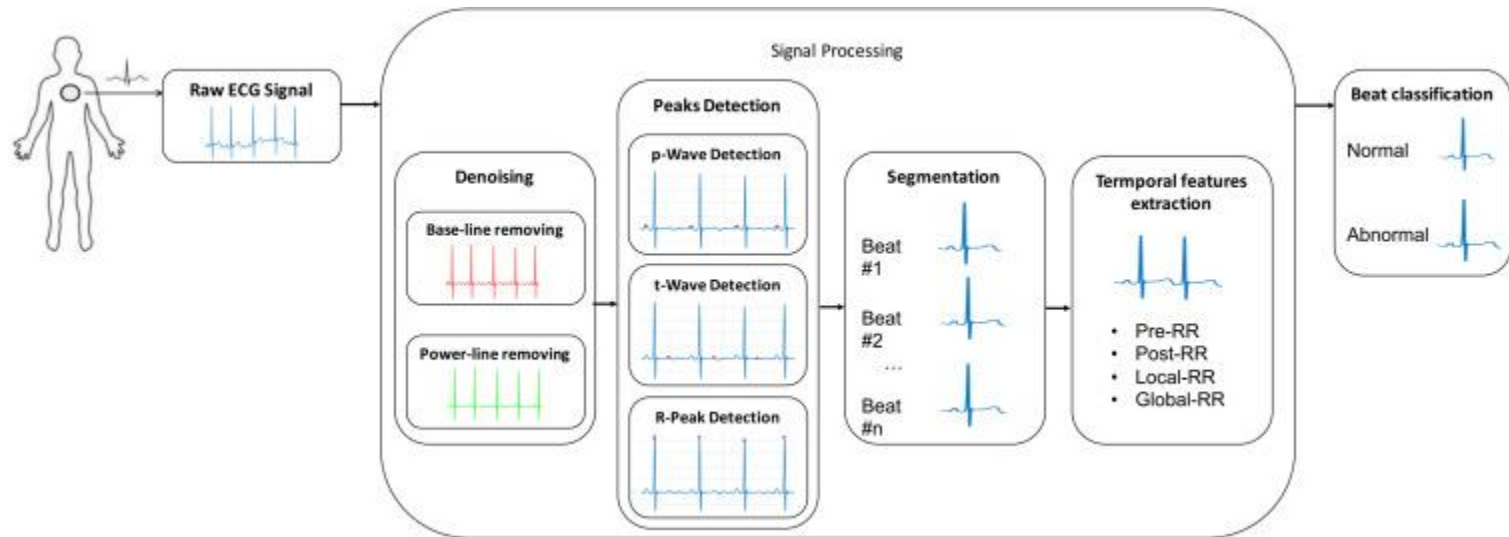
COD-OCT						
COM						
COD-DOD						
RBC						
Debris						

CONFIDENTIAL

醫療AI應用-疾病偵測

■ AI自動判定心律不整

- 可結合穿戴式裝置

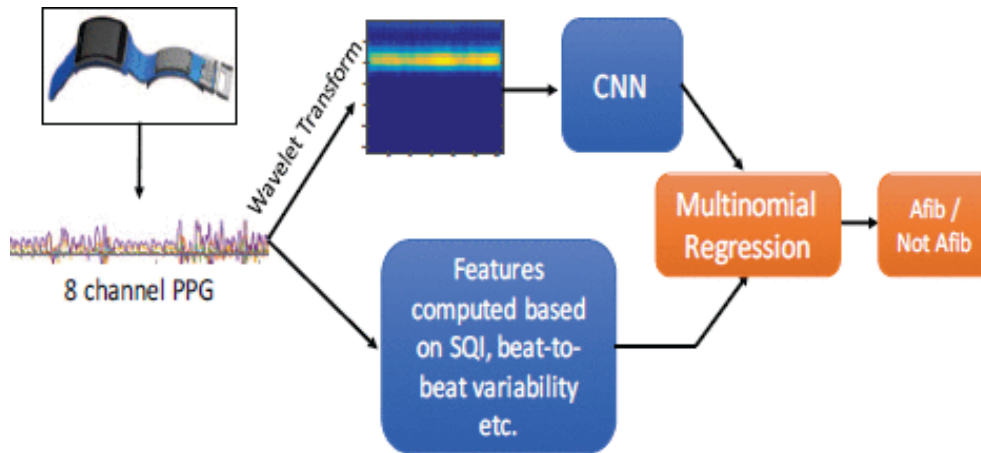


<https://www.sciencedirect.com/science/article/pii/S0167739X17324548>

Sannino, G., & De Pietro, G. (2018). A deep learning approach for ECG-based heartbeat classification for arrhythmia detection. *Future Generation Computer Systems*, 86, 446-455.

醫療AI應用-穿戴式裝置應用

■ 心房顫動偵測



<https://ieeexplore.ieee.org/abstract/document/7897225>

Shashikumar, S. P., Shah, A. J., Li, Q., Clifford, G. D., & Nemati, S. (2017, February). A deep learning approach to monitoring and detecting atrial fibrillation using wearable technology. In *2017 IEEE EMBS international conference on biomedical & health informatics (BHI)* (pp. 141-144). IEEE.

<https://www.jmir.org/2020/5/e16443/>

Kwon, S., Hong, J., Choi, E. K., Lee, B., Baik, C., Lee, E., ... & Yi, Y. (2020). Detection of atrial fibrillation using a ring-type wearable device (CardioTracker) and deep learning analysis of photoplethysmography signals: prospective observational proof-of-concept study. *Journal of Medical Internet Research*, 22(5), e16443.

人工智慧於臨床醫療未來趨勢

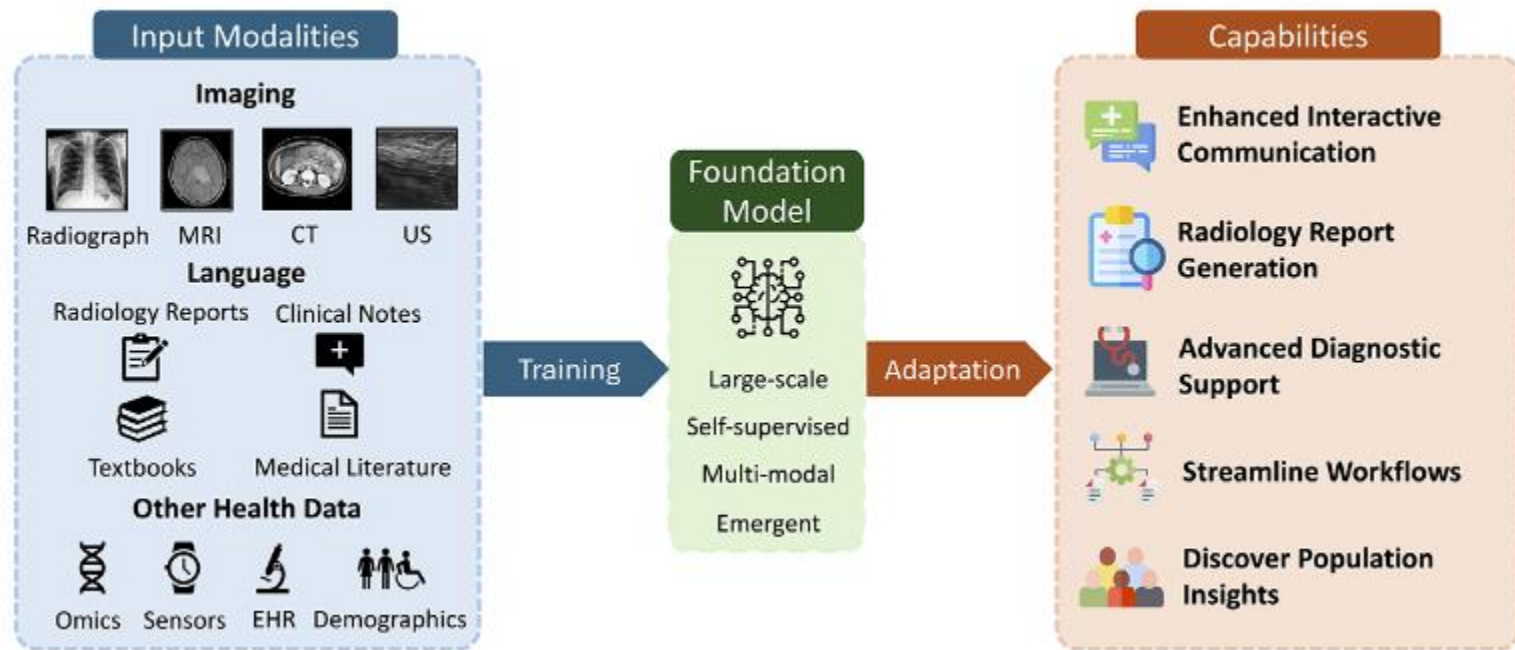


元智大學

Yuan Ze University

人工智慧於臨床醫療未來趨勢

■ 從單一疾病模型到通用性模型

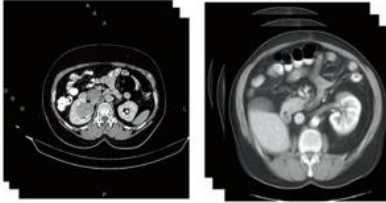


人工智慧於臨床醫療未來趨勢

■ 從單一影像到多模態模型

- 影像 + EHR + Lab + Clinical Text

A

Input image/prompt	Reference report	Generated report
	Injection of contrast via the orifice of purulent discharge showed opacification of the left perianal abscess. No evidence of obvious contrast extravasation into the anal canal or rectum.	Injection of contrast via the orifice of purulent discharge showed opacification of the perianal abscess. No evidence of obvious contrast extravasation into the anal canal or rectum is seen.
	A 43*36mm hetero-enhancing mass is noted at right renal sinus. There is no sign of local invasion to adjacent structures and no vascular extension. No regional lymphadenopathy is identified. Degenerative changes as osteophytosis are seen at the lumbar spine. Grade I spondylolisthesis of L5 on S1 is present with bilateral spondylolysis.	A 35 mm large exophytic mass is seen in the lower pole of the right kidney. The neoplasm has a similar density to normal renal parenchyma on non-enhanced CT scan. No regional lymphadenopathy is noted. After IV contrast media injection, the attenuation value didn't widened and the mass didn't enhance. Mild degenerative changes as osteophytosis are seen at the lumbar spine.

B

Input image	VQA Type	Example	Prediction
	Closed-ended	Q: Is there evidence of pleural effusion? A: Yes.	A: Yes
	Open-ended	Q: Which abnormalities can be detected in the right hilar region? A: Mild right-sided pleural effusion is noted.	A: Right pleural effusion is present, small in volume.
	Closed-ended	Q: What is the CT phase of the image? Choices: A. Non-contrast B. Contrast C. Arterial phase D. Portal venous phase A: C. Arterial phase	A: C. Arterial phase
	Open-ended	Q: Which contrast phase is shown in this CT image?	A: Arterial phase

人工智慧於臨床醫療未來趨勢

- 從醫療診斷到預測疾病未來發展
- 從醫療診斷到預防醫學

中文EN

Cancer Targeted Therapy Efficacy Prediction Toolkit Software

This software delineates both direct and indirect paradigms of imaging AI for predicting targeted-therapy response across multiple cancer types, explicitly distinguishing classical machine-learning from deep-learning approaches.



Indirect Prediction

Use imaging features to predict molecular alterations (e.g., EGFR, ALK, HER2) as surrogates for therapy selection.

Enter



Direct Prediction

End-to-end association between imaging representations and outcomes to predict benefit from a specific therapy.

Enter

人工智慧於臨床醫療未來趨勢

■ 從AI模型到AI代理人

A: Foundational LLMs

User

What are the latest ACR guidelines for incidental thyroid nodule follow-up?

Model

As my knowledge cutoff is October 2024, the most recent ACR white paper on management of incidental thyroid nodules that I'm aware of was published in 2017, with updates in 2021.

These guidelines stratify nodules by size, patient age, and risk factors, recommending follow-up ultrasound for nodules ≥ 1 cm in patients under 35 and for nodules ≥ 1.5 cm in older patients. If you need the most current guidelines, I'd recommend checking the ACR's official website or journal publications, or I could use a search function to find the updated information if you'd like.

B: Augmented LLMs

User

Is the patient currently taking any medications that may lead to lung fibrosis?

Model

Calling "EHR" tool: Getting patient current medications...

Result: Medication list includes: methotrexate (15mg weekly, started 4 years ago), leflunomide (20mg daily, started 2 years ago), hydroxychloroquine (200mg twice daily, started 6 years ago), folic acid (1mg daily), and omeprazole (20mg daily).

Calling "DrugBank" tool: Getting medication adverse events...

Result: Methotrexate: Known risk of pneumonitis (0.3-11.6% incidence) and pulmonary fibrosis with chronic use. Leflunomide: Associated with interstitial lung disease (0.5-1.2% incidence), higher risk when combined with methotrexate. Hydroxychloroquine: Rare reports of drug-induced respiratory disease (<0.1%). Omeprazole: No reports found. Folic acid: No reports found.

The patient is on methotrexate and leflunomide, both of which have an increased risk of pulmonary fibrosis. When used in combination, this risk is further elevated, necessitating careful evaluation of the CT pattern.

C: AI Agents

User

I'm reviewing this pediatric abdominal CT that shows an unusual cystic lesion in the pancreatic tail with calcifications. What's the differential diagnosis and appropriate next steps?



Model

I'll analyze this pediatric pancreatic tail lesion to determine the likely differential diagnosis and management recommendations. I will need to get the differential diagnosis first.

Step 1: First, I need to understand the differential for pancreatic tail cystic lesions with calcifications in pediatric patients.

Calling "STATdx" tool: Searching for "pediatric pancreatic cystic lesions with calcifications"...

Result: Differential includes: solid pseudopapillary neoplasm (SPN), pancreatoblastoma, pancreatic pseudocyst with calcifications, and mucinous cystic neoplasm. SPN is most common with this presentation in adolescents.

Hmm, I need more patient-specific information to refine this differential. Let me check the patient demographics. Given patient's demographic information (adolescent female) makes solid pseudopapillary neoplasm the leading diagnosis. However, I should check the clinical context to ensure we're not missing anything.

Step 2: Let me search for the clinical indication and history.

Calling "EHR" tool: Retrieving clinical history and indication for this study...

Result: Clinical indication: "Intermittent epigastric and LUQ pain for 3 months, palpable mass on physical exam." No documented history of pancreatitis or trauma.

The absence of pancreatitis or trauma makes pseudocyst less likely. Let me check the ACR recommendations for this scenario.

Step 3: Checking standard management recommendations.

Calling "ACR Appropriateness Criteria" tool: Searching guidelines for "pediatric pancreatic mass"...

Result: ACR recommends MRI with MRCP as the next imaging study of choice for further characterization of pediatric pancreatic masses. Endoscopic ultrasound with possible FNA may be appropriate depending on institutional expertise.

I should also check if there are any institutional protocols specific to our center.

Step 4: Checking for institution-specific protocols.

Calling "Institutional Protocols" tool: Searching for "pediatric pancreatic mass protocol"...

Result: Institution protocol recommends: (1) MRI with MRCP, (2) Pediatric surgical oncology consultation, (3) Consider tumor markers including beta-HCG, AFP, and CA 19-9.

Based on my systematic analysis, the most likely diagnosis for a cystic pancreatic tail lesion with calcifications in a 14-year-old female is Solid Pseudopapillary Neoplasm (SPN). This is supported by:

- Patient demographics (teen female) strongly match SPN's typical presentation
- The imaging features (cystic lesion with calcifications) are consistent with SPN
- The clinical presentation of vague symptoms over months is classic for SPN
- No history of pancreatitis or trauma makes pseudocyst less likely

Recommended next steps per institutional protocol:

1. Pancreatic protocol MRI with MRCP to better characterize the lesion
2. Pediatric surgical oncology consultation
3. Consider tumor marker panel (beta-HCG, AFP, CA 19-9)

Q&A



元智大學

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