愛心 · 品質 · 創新 · 當責
Compassion Quality Innovation Accountability

臺中榮民總醫院
Taichung Veterans General Hospital

2023 國際醫療衛生促進協會 – 智慧醫療研討會

臺中榮總智慧醫療介紹

陳昆輝 Kun-Hui Chen

智慧醫療委員會 執行長

臨床資訊委員會 執行長

骨科部　　主任

Aug. 11, 2023

Smart Hospital
from
Digital Transformation
數位轉型

3 stages of digital transformation

- Digitization (Digital Enablement) :
  - from nondigital to digital form of information
  - (ex. Paper to excel files)
- Digitalization (Digital Optimization, Doing More with Less) :
  - from nondigital to digital form of process and people
  - From snail mail, telephone calls to email, chat, social media) in work, business, social and leisure domains.
  - Automation is a major part of the digitalization story
  - Enterprise-wide, Buriness models still then same

3 stages of digital transformation

- Digital transformation (Exploring New Apporaches to Business) :
  - far beyond digitalization
  - Broader, Innovative and disruptive
  - Organizational/Culture change
  - Customer-driven strategic business transformation
  - New business model creation

From Harvard Business Review, Forbes, Binomia

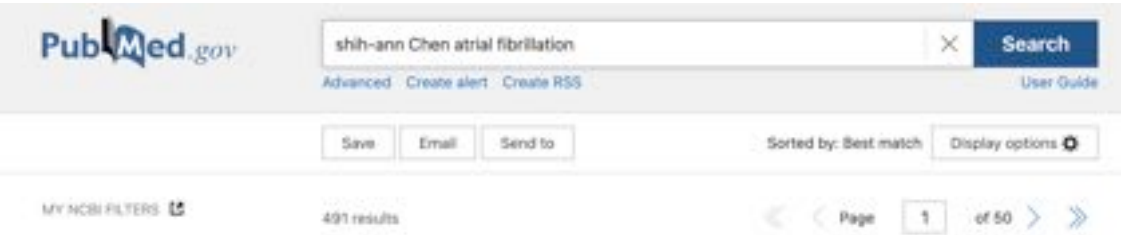
Support from High Table

John Wick

台中榮總智慧醫療的最重要推手

- Our superintendent, Prof. Shih-An Chen 陳適安院長, leads the team to achieve the most intelligent, cutting-edge, and precise medical care, build an excellent medical care environment, benefit our patients and employees, and create well-being and compassion.
- Taichung Veterans General Hospital has established itself as a world-class medical center to embody the spirit of "never stop growing" through clinical and research innovation.

Prof. Shih-An Chen
Superintendent, TCVGH



491 Af related articles

Taichung Veterans General Hospital -- Newsweek World's Best Smart Hospital 2023

TCVGH is the first and the only hospital in Taiwan
which was recognized as one of the world's best smart hospitals

254	Taichung Veterans General Hospital	Taichung
255	Bispebjerg Hospital	Bispebjerg
256	Sørlandet Sykehus Kristiansand	Kristiansand
257	Jeroen Bosch Ziekenhuis	s-Hertogenbosch

https://www.newsweek.com/rankings/worlds-best-smart-hospitals-2023

2020 成立推動核心: 臺中榮總AI工作室

2019.07.09

- 院長指示研擬規劃人工智慧核心服務小組

2020.03.01

- 績效獎金管理會核定：人工智慧大數據5年計畫經費 約3,000萬

2020.05.01

- 成立中榮AI工作室
- 任務：建置共通、共用、全院可使用的資料庫，以達人工智慧大數據資料分析與資料湖泊建構的目標

台中榮總 智慧醫療委員會 (2021)

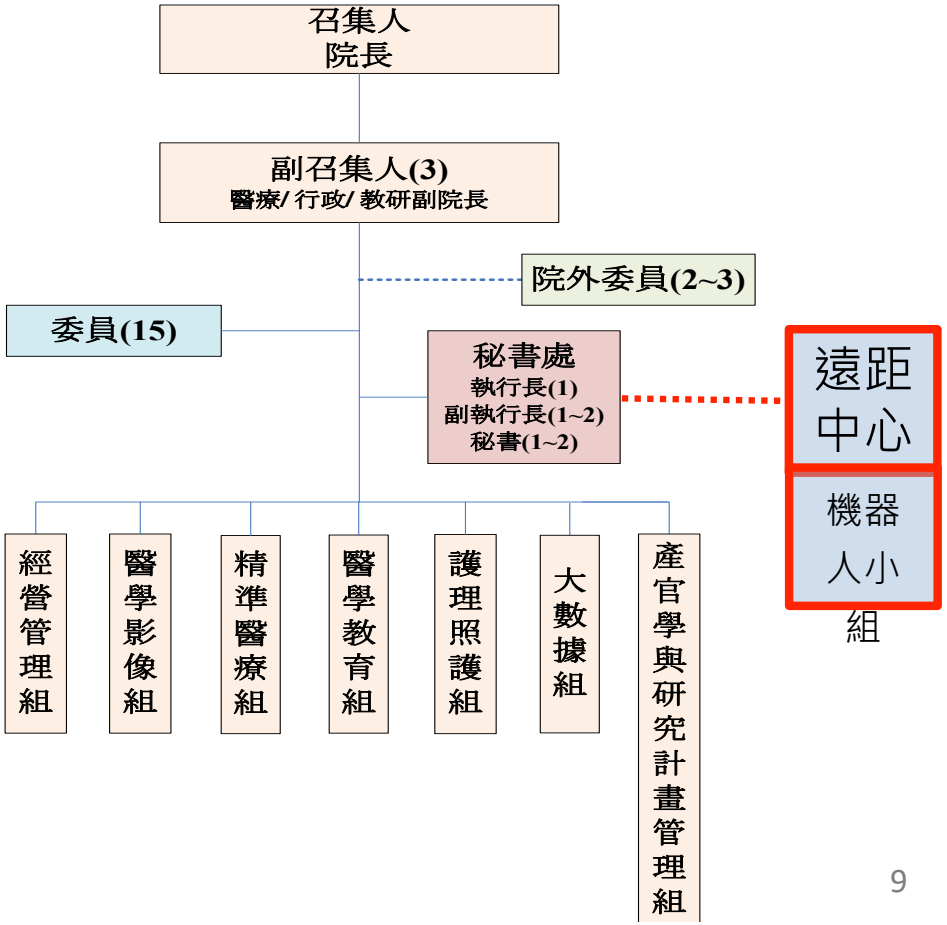
實踐願景“全人智慧、醫療典範”引領台灣智慧醫療發展

成立緣由

- AI 、IoT (AIoT)快速發展
- 智慧醫療是國家政策，全球快速發展
- 智慧醫療需要全院相關單位整合

成立的任務

- 推動與整合本院資訊軟硬體建置與應用
- 醫療、教學、研究、品質與經營管理等各領域的智慧應用與創新發展
- 管理應用大數據資料，進行人工智慧研究應用
- 推動人工智慧醫療產學合作與產品之產業化
- 推動精準健康醫療



112年醫研部院內AI計畫：21案(1/2)

進度追蹤(院部報告)

下次會議時間：112年2月14日(二) 14:00、2月17日(五)10:30
地點：行政大樓9樓院部會議室

項次	研究計畫名稱	研究單位	主持人	核定經額
1	使用IMU輔助幫助人工膝關節術後復健治療	骨科部	涂高暢	76,800
2	加護病房病人譫妄的發生率和危險因子分析之相關性研究	護理部	何淑芬	40,000
3	急性腎損傷即時預測系統於成人加護病房的外部驗證與臨床應用	重症醫學部	黃俊德	350,000
4	以人工智慧早期預測重症急性腎損傷需透析治療患者之腎功能恢復	重症醫學部	王彩融	250,000
5	研究對於心衰竭合併糖尿病患者，SGLT2抑制劑合併Valsartan/Sacubitril的臨床效果	心臟內科	王奇彥	200,000
6	癲癇病患之代謝性網路如何重塑?	教學部	董欣	200,000
7	深度學習自動預測基於有限元素法模擬之乳房攝影壓迫乳房的形變	放射線部	陳詩華	102,600
8	用深度學習方式去預測穿刺為非典型細胞的甲狀腺結節的良惡性	新陳代謝科	李宇璇	200,000
9	使用深度學習判斷頭頸癌症病患術前影像是否具筴膜外侵犯之預後分析 (II)	放射腫瘤部	劉怡君	200,000
10	人工智慧辨識CT影像局部侵犯性直腸癌	大腸直腸外科	林俊余	199,997
11	機器學習分析早產兒早期動作量表TIMP來預測未來發展軌跡	兒童醫學部	許雅淇	66,000
12	應用資料探勘法於放射線介入性栓塞肝臟腫瘤之治療決策分析	放射線部	張碧倚	100,000

112年醫研部院校AI計畫：9案

進度追蹤
(院部報告)

下次會議時間：112年2月14日(二) 14:00、2月17日(五)10:30
地點：行政大樓9樓院部會議室

項次	研究計畫名稱	研究單位	主持人	共同主持人單位	共同主持人	核定經額
1	以人工智能預測急診血行性感染病人臨床預後的表現	中榮急診部	胡松原	東海大學資管系/中榮急診部	姜自強/馬建文/林帛震	240,000
2	結合白斑症患部自動標記與處方資訊之治療評估系統	東海大學資工系	石志雄	中榮皮膚科	翁毓菁	180,000
3	使用機器學習和大數據分析建立住院老年人出院後非預期性再住院與死亡預測模組	中榮家庭醫學部	朱為民	東海大學數學系/資工系	陳宏銘/楊朝棟	160,000
4	探究組織架構與工作因子在不同部門護理人員的職場壓力與睡眠品質之影響-以某醫學中心為例	國立臺中科技大學資訊流通學院資訊管理系	陳大仁	中榮護理部/臺中科技大學中護健康學院護理科/美容科	徐莞雲/葉月珍/李雅婷	200,000
5	人工智慧用於未閉導管的血流動力學之測試與驗證	逢甲大學精密系統設計學士學位學程	蔡鈺鼎	中榮兒童醫學部	林明志	346,000
6	以影像辨識為基礎的物件比對應用研究-以疏導門、急診滯留人員為例	中臺科技大學人工智慧健康管理系	林俊榮	中榮醫務企管部	蔡鴻文	140,000
7	深度學習導引複雜型側流分析影像輔助判讀之研究-以雙通道糞便潛血之辨識為例	國立中興大學電機工程學系所	莊家峰	中榮胸腔內科	吳明峰	360,000
8	開發基於手機APP之職業性肌肉骨骼傷害檢測系統	靜宜大學資訊工程學系	陸子強	中榮急診部/靜宜大學資管系	詹毓哲/詹毓偉	180,000
9	開發以慣量量測單元為主之中風後病患步態數據採擷分析系統	國立聯合大學電機工程學系	吳有基	聯合大學資工系/中榮復健科/中榮醫學研究部	韓欽銓/程遠揚/陳享民	240,000

111年中榮與陽明交大智慧醫療合作計畫11案

執行期間	• 自111年11月1日起至112年7月31日止
經費來源	• 經費由雙方共同對等提供，共計500萬元
進度追蹤	• 第1次執行進度盤點會議【視訊會議】 • 會議時間：1月5日(w4)14:00-16:00 • 會議地點：行政大樓7樓會議室
預計規劃	• 3個月後再追蹤，4月18日辦理第2次進度盤點會議

時間	項目
14:00-14:10 (10分)	開場致詞
14:10-14:50 (40分)	計畫執行進度報告6案
14:50-15:20 (30分)	計畫執行進度報告5案
15:20-15:30 (10分)	團隊交流與意見回饋
15:30-15:50 (20分)	綜合討論

台中榮總 智慧醫療發展的合作夥伴(產官學)

台灣智慧醫療聯盟

- 國科會
- 臺中榮民總醫院
- 臺北榮民總醫院
- 國立台灣大學醫學院附屬醫院
- 三軍總醫院
- 台北醫學大學附屬醫院
- 台北馬偕紀念醫院
- 長庚醫療財團法人林口長庚紀念醫院
- 彰化基督教醫院
- 國立成功大學醫學院附設醫院
- 高雄醫學大學附設中和紀念醫院
- 佛教慈濟醫療財團法人花蓮慈濟醫院
- 中山醫學大學附設醫院
- 中國醫藥大學附設醫院
- 亞東紀念醫院
- 奇美醫療財團法人奇美醫院
- 長庚醫療財團法人高雄長庚紀念醫院
- 高雄榮民總醫院
- 國泰綜合醫院
- 新光吳火獅紀念醫院

院校合作

- 國立陽明交通大學
- 國立中興大學
- 東海大學
- 靜宜大學
- 國立臺北科技大學
- 國立勤益科技大學
- 逢甲大學
- .....

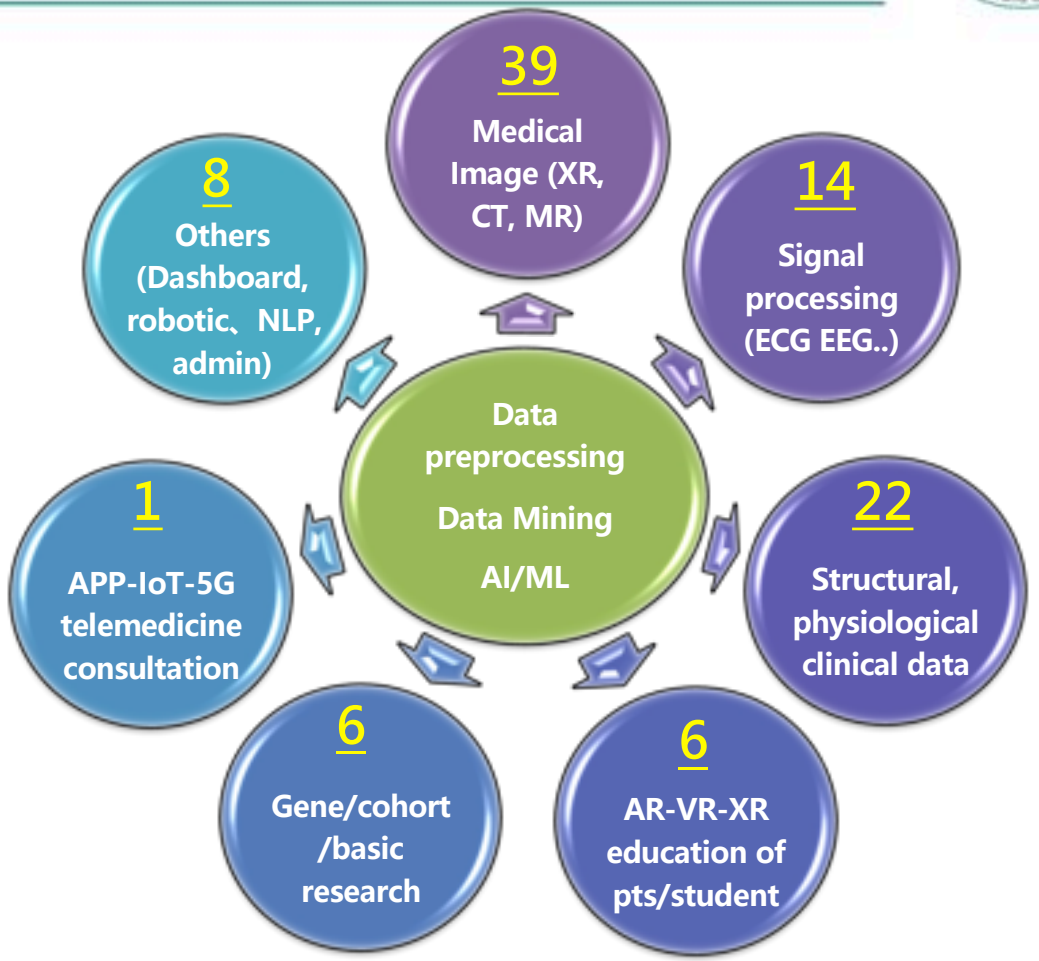
產業合作

- 廣達電腦
- 中華電信
- 飛利浦
- 台灣人工智慧實驗室
- 筑波醫電股份有限公司
- 緯創醫學科技股份有限公司
- 研華科技
- 宏碁智醫
- 中部科學園區(產學訓)
- .....

Digital Healthcare - AI Projects in 2022

Categories	Projects
In hospital big data program	11
In hospital AI program	37
VGHTC/NYCU smart health AI program	16
University collaboration AI program	32

Totally 96 projects



國科會 台灣智慧醫療聯盟計畫(TSHA)

成立跨機構聯盟 → 建置合作平台 → 完成AI模組跨院驗證 → 推動人工智慧醫療應用與產業接軌 → 籌募基金 → 永續經營

TSHA計畫總目標

- 建立醫學中心合作隊伍
- 建立多中心聯邦學習模式
- 以多中心國家隊伍的概念進行認證及商轉

TSHA 第1年 (110.09.01~111.06.30)

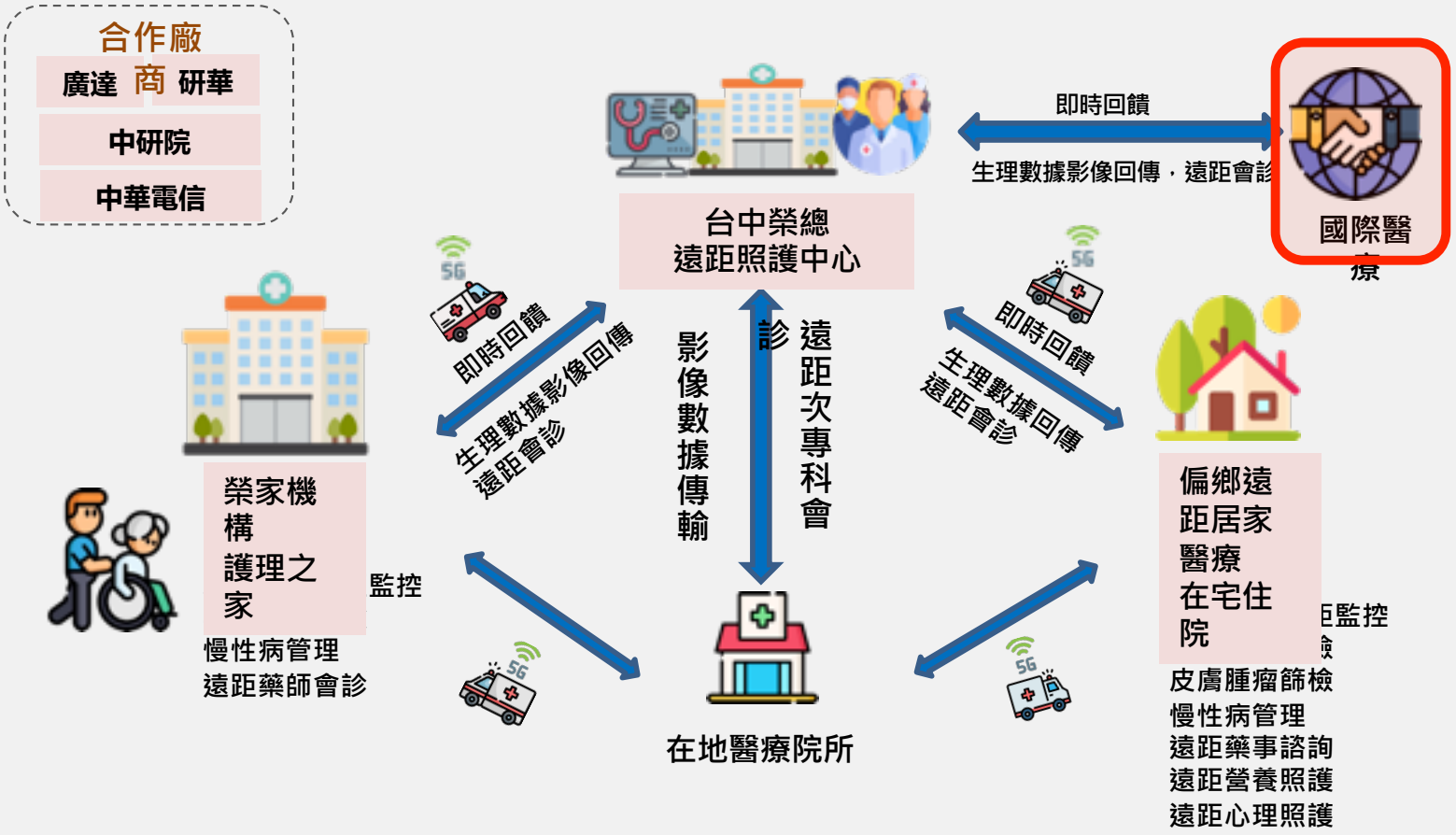
- 總經費19,987,000元
- 11家醫學中心合作
- 完成5專案主題AI跨院驗證目標

TSHA 第2年 (111.07.01~112.06.30)

- 總經費40,800,000元
- 19家醫學中心合作
- 5專案：醫材軟硬體整合規劃，執行國內與國際醫材認證
- 9專案：AI跨院驗證，並朝醫材認證邁進

第三期徵求案件中

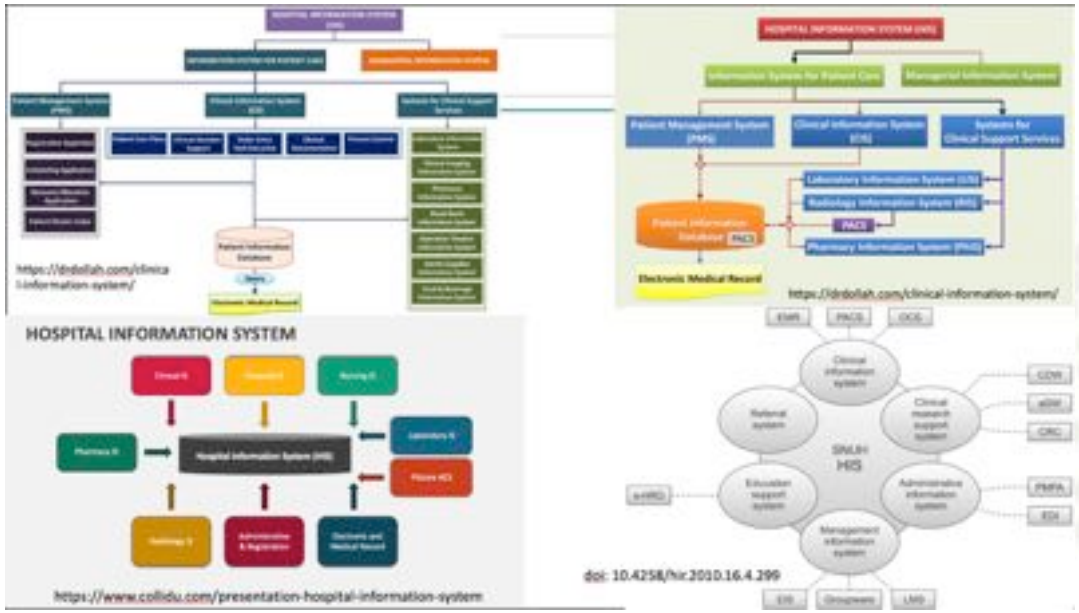
臺中榮總遠距照護中心願景



2022-2023 Goal in Smart Hospital Program

- Cloud Computing/Edge Computing in AI
- Structural EMR, Reports
- 5G AIoT data platform
- e-Telemedicine
- AI-OPD
- NLP in healthcare
- AI model deploy/Federal Learning
- International Smart Healthcare Summit

Support from IT Department



Hospital Information System Overview

- Hospital Portal System
- Outpatient Reservation System
- Patient APP
- Chatbot System
- Smart Services
- CRM Services System
- Telehealth care System

. . . . .

- Employee Portal System
- Hospital Management System (including Staff Management, Accounting Management, Purchasing Management, General Affairs Management, ...)
- Medical Device Management System and APP
- Patient Safety/ ADR/ Abnormal Event Reporting System
- Business Continuity Process and Programs

. . . . .

Patient Engagement
Enhance Patient Engagement

Health Team Collaboration
Enhance Health Team Performance

Data Integration & Analysis
Data-Driven Decision

Hospital Management
Enhance Support Team Performance

Teaching And Research
Enhance Teaching and Research Quality

- Data Warehouse System
- Hospital Management Information System (HMIS)
- Knowledge Management System
- Accredited Management System

. . . . .

- Integrated Outpatient/ Emergency/ Inpatient Systems
- TCM System
- E-Note Physician documentation System
- CPOE Medication order entry System
- Nursing Information System and APP
- PACS/Radiology information system
- Laboratory information system
- Pathology information system
- Abnormal Result management system
- Pharmacy information system
- OR Management System and APP
- Anesthesia Management System
- Health Checkup System
- Dietary Management System
- Clinical Exam. Scheduling System
- Case Management System
- Telehealth Care System
- Integration to National Health Insurance and EMR Exchange Center
- Billing Management System
- Referral System
- E-Sign System

. . . . .

- E-learning System
- E-Portfolio System
- Staff License Management System
- Research Management System
- Clinical Trial Management System

. . . . .

1987~2022 Mile stone to be a Digital HealthCare Hospital

Digitization → Digitalization → Digital Transformation

Film Free since 1993 → Paper Free → Equipment IoT → Integrate Cloud Information of NHI (Nat. Insurance) → Patient flow, Lean, Data IoT → AI/ML , TPMI precision medicine & care

1987

1989 Integrated OPD system

1991 Integrated ER system

1993 PACS system

2000

2001 e-Referral system

2003 e-Referral EMR-Exchange program

2008 Skype web-telephony System

2009 First Certified EMR Hospital

2010 Home care Telemedicine Consultation

2010

2012 Novel Voice Query of OPD status

2013 Wireless online of Ventilators

2014 Novel Elder-friendly Status Query of OPD

2015 National Smart Hospital Award

2015

2016 Medical Equipment Mx system

2016 National Service Award for 3C patient care

2018 OR Bigdata schedule system

2019 Early warning system & Blood sugar Mx. System

2020 Nat. Innovation Award : e-Labelling system

2019 Institutional National Smart Hospital Award

2019 Goverment Service Award

2020

2019~2020 AI training programs (/c Taiwan AI Academy, NTHU)

2020 AI Studio 1 AI per cell-unit

2022

AI OPD

96 proposals

National Science Council Program

1.Smart ICU Project(2020~)

2.Smart Healthcare Cross Domain Project toward 2030 (2021~)

3.TW Smart Healthcare Alliance(2021~)

World's First Hospital uses ePaper + UD Drug Cartridge (since 2018)

- Saving Labor and Time + Improve Safety + Love Earth
- Awards and Patents

eHIS 系統整合

監強的資訊實力當後盾

- 有彈性及開放的 eHIS 架構
- 系統整合良好

Hospital Information System (HIS)

- CIS (Clinical Information System)
- LIS (Laboratory Information Management System)
- RIS (Radiology Information System)
- NIS (Nursing Information System)
- PhIS (Pharmacy Information System)
- PACS (Picture Archiving and Communication System)
- CPOE (Computerized Provider/Physician Order Entry)
- CDS (Clinical Decision Support System)
- EMR (Electronic Medical Record)
- MIS (Management Information System)
- ……

Hospital Information System (HIS).2

- PMS (Patient Management System)
- PES (Physical Examination System)
- EIS (Executive Information System)
- Resource Management System
- Client Registration System
- CRM (Customer Relationship Management)
- PSI (Patient Safety Information)
- CMS (Case Management System)
- WTS (Ward-round Tablet System)
- EPS (EMR Portal System/Security)
- Research Information system
- Medical Education System
- Cellphone App

Specialized Database

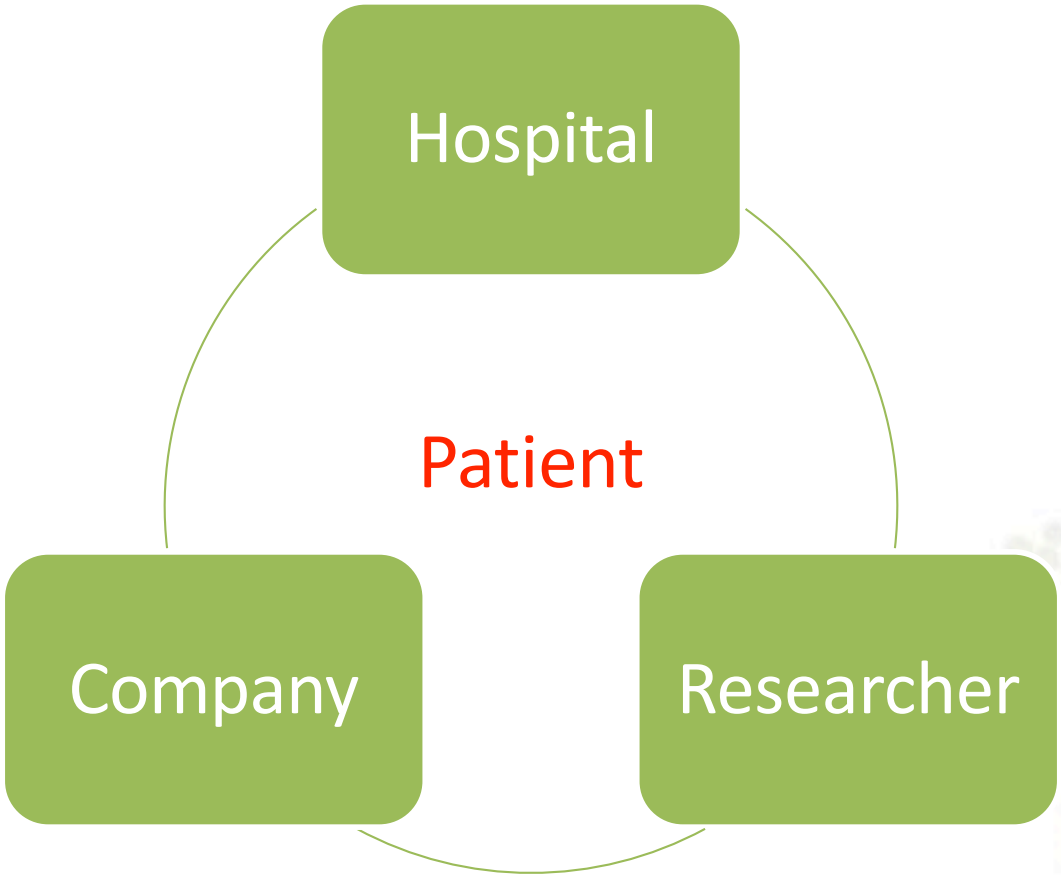
- CV-IS (CV information system)
- CPACS (Cardiovascular PACS)
- PIS (Pathology Information System)
- OR-IS
- ICU-IS
- ……

Standardization of System

- ISO-HL7 (Health Level Seven International) V3
- HL7-CDA (clinical Document Architecture)
- FHIR (Fast healthcare Interoperability Resources)
  - Based on HTTP RESTful protocol
  - HTML + CSS
  - Data by JSON or XML
- DICOM (Digital Imaging and Communications in Medicine)
- LOINC (Logical Observation Identifiers Names and Codes)
- SNOMED CT (Systematized Nomenclature of Medicine – Clinical Terms)
- CPT (Current Procedural Terminology)
- ICD-10-CM & PCS codes
- NHI-Code for payment (ex. 64280B, revisional posterior spinal fusion with inst.)
- VGHTC-code (80006439)

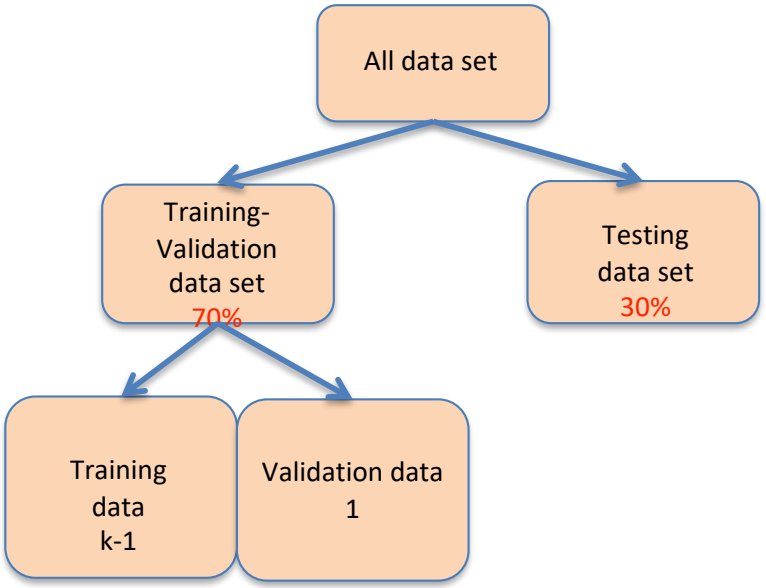
Support for Unmet need…

Culture for IT/AIoT technology enpower

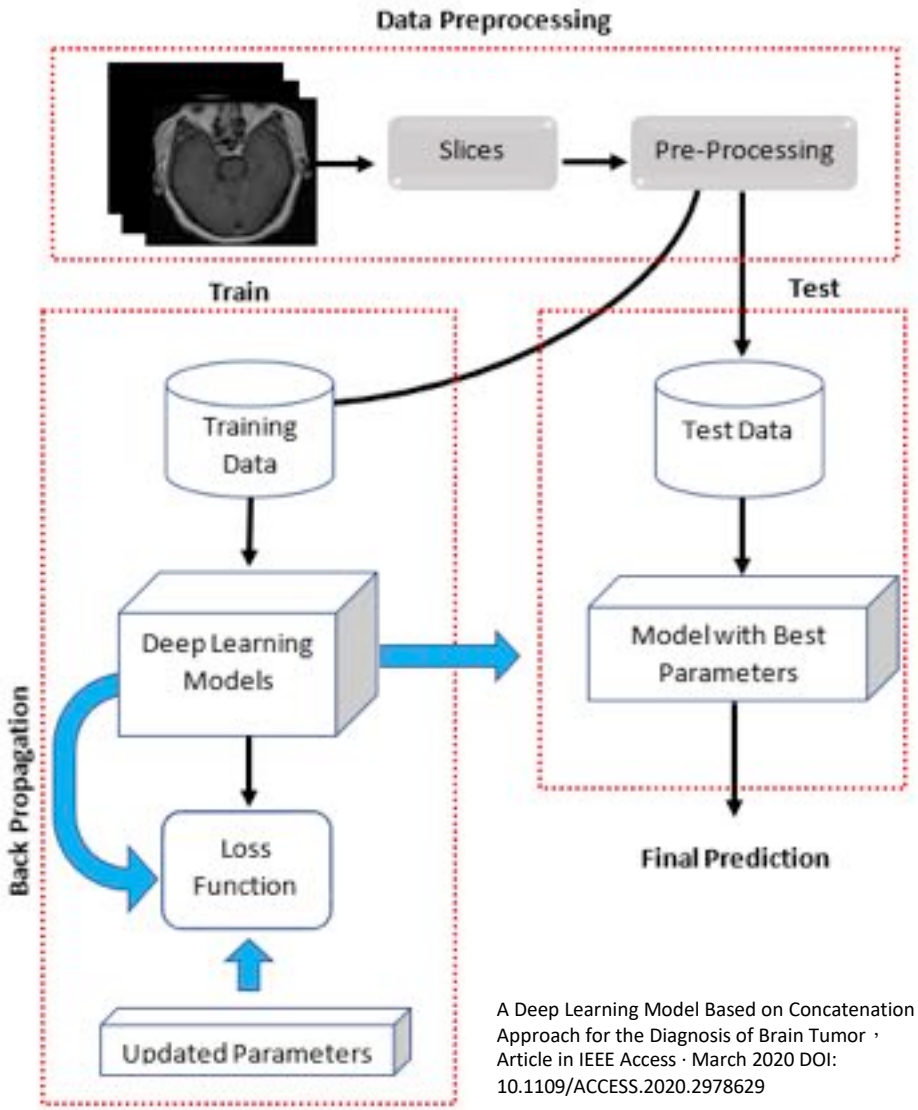


AI engagement

- Preprocessing handling
- Training-validation vs Testing
- Cross domain validation



K-fold cross-validation scheme
k=5



A Deep Learning Model Based on Concatenation Approach for the Diagnosis of Brain Tumor，Article in IEEE Access · March 2020 DOI: 10.1109/ACCESS.2020.2978629

Data everywhere

- Raw data for all image examination
  - CT/MRI,NM,pathology……
- Video
  - CV cath video
  - UGI/LGI scope…
  - Arthroscope
  - Laparoscope
  - Davinci’ s operation
  - Mazor/ROSA/Brainlab…
  - Surveillance
- Audio
  - Echocardiogram
  - Clinic conversation voice recording

Data everywhere

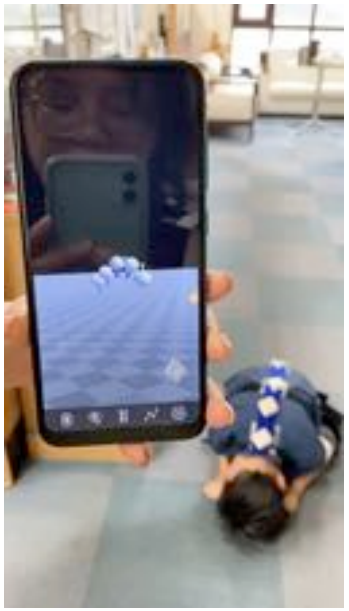
- Notes/Documents
  - Admission Note
  - Procedural Note
  - SOAP/POMR note
  - Operation Note
  - Discharging Note, Discharging diagnosis
  - NIS note
  - …
- Special chart / Database for specialists
  - CV Cath database
  - Osteoporosis database
  - Geriatric database
  - Diabetes mellitus database
  - Arthroplasty/Arthroscope database
  - …

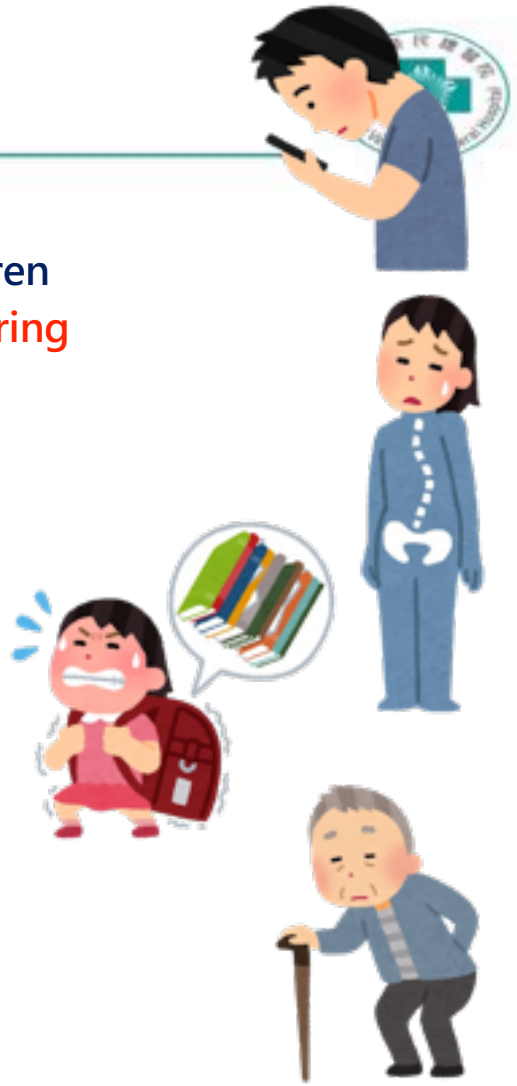
Data everywhere

- Data collected from different modality / new devices
  - Anesthesia Machine
  - IMU devices
  - EEG/EKG signals
  - Blood pressure signals
  - Davinci’ s operation
  - Mazor/ROSA/Brainlab…

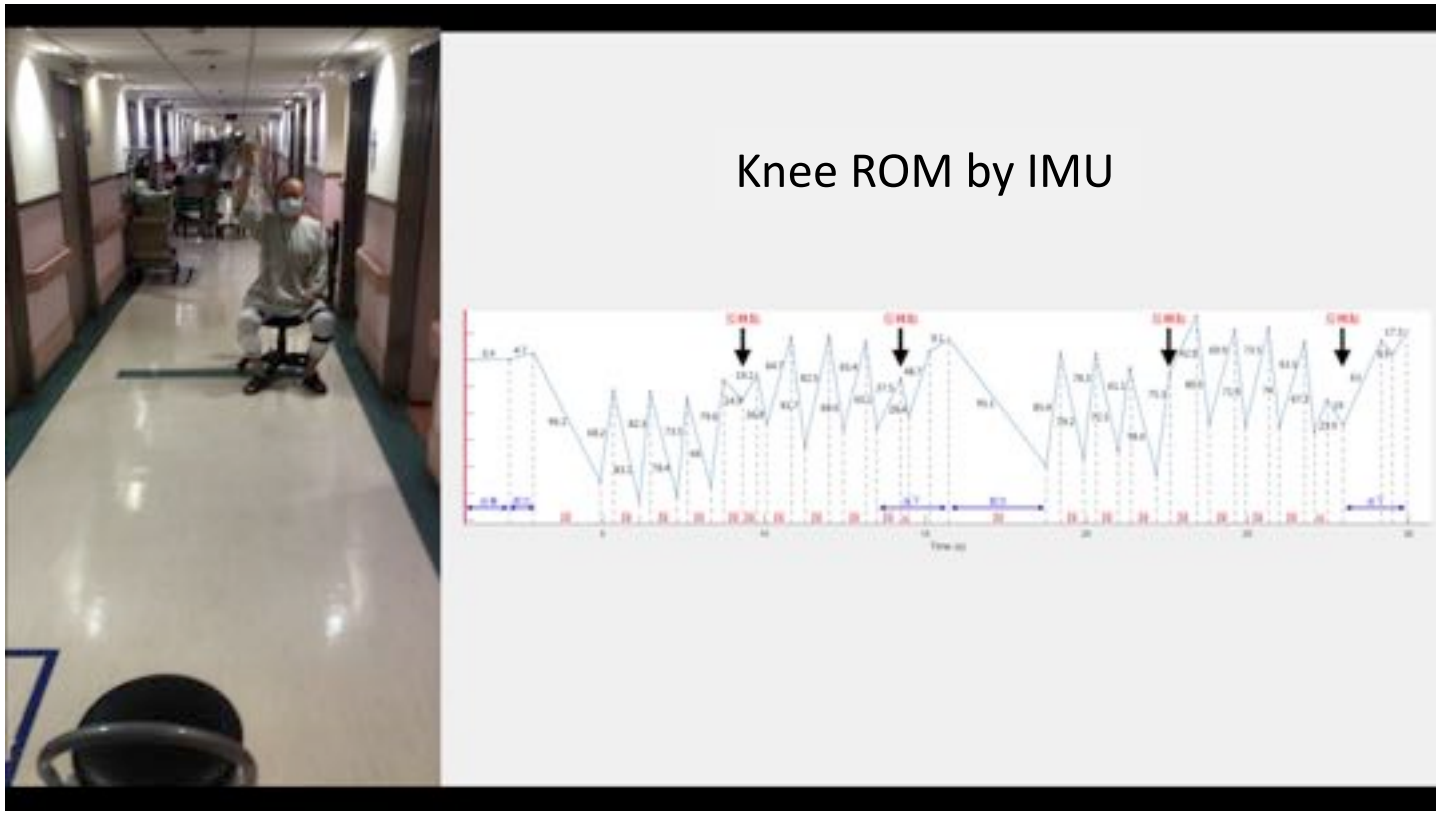
IMU application in spine disease

- More application scenarios
  - Kyphosis screening : Spinal surgery patients / Elderly / Children
  - Medical institution: Pre/post operative assessment / monitoring
  - For parents' use: Children's kyphosis warning system
  - Nursing homes / Home care: Elderly fall detection



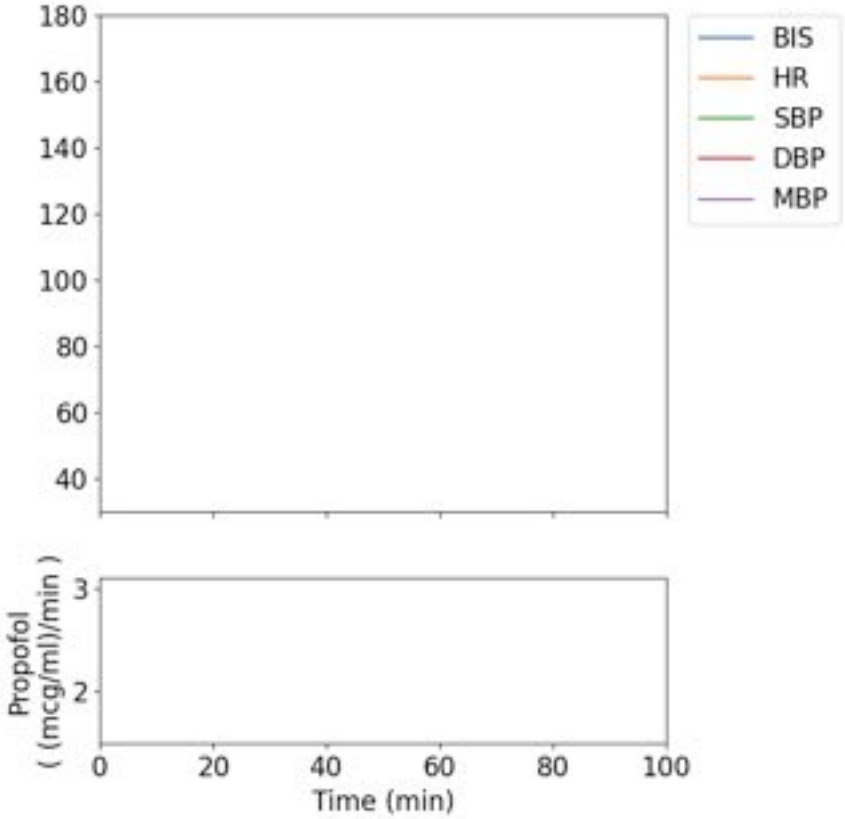


Knee ROM calculation by IMU

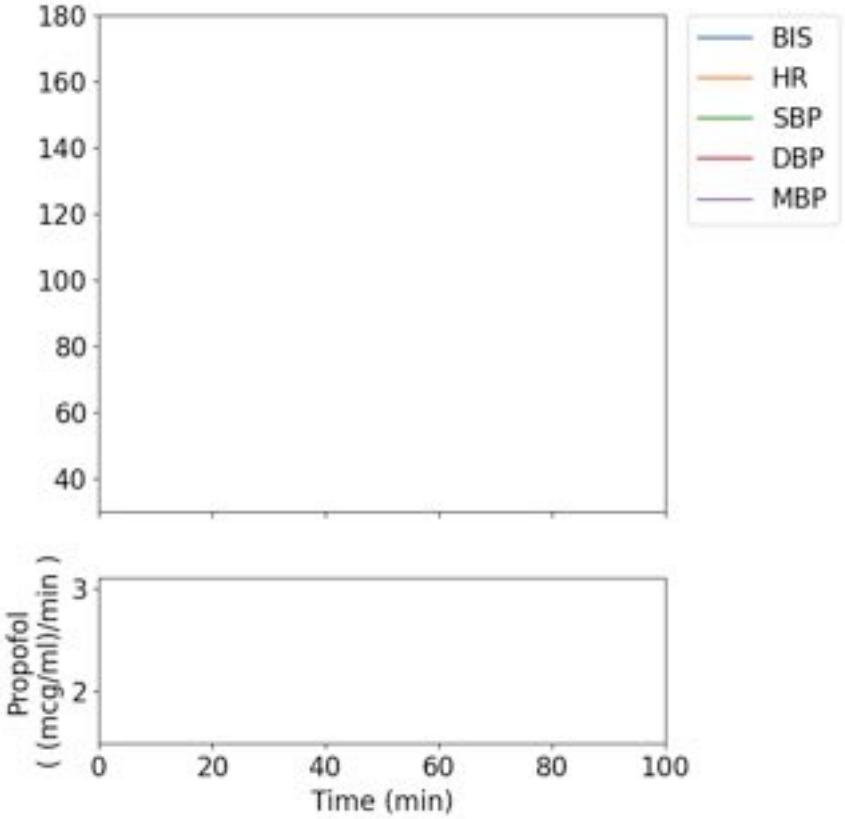


Anes. Simulation

Real Data



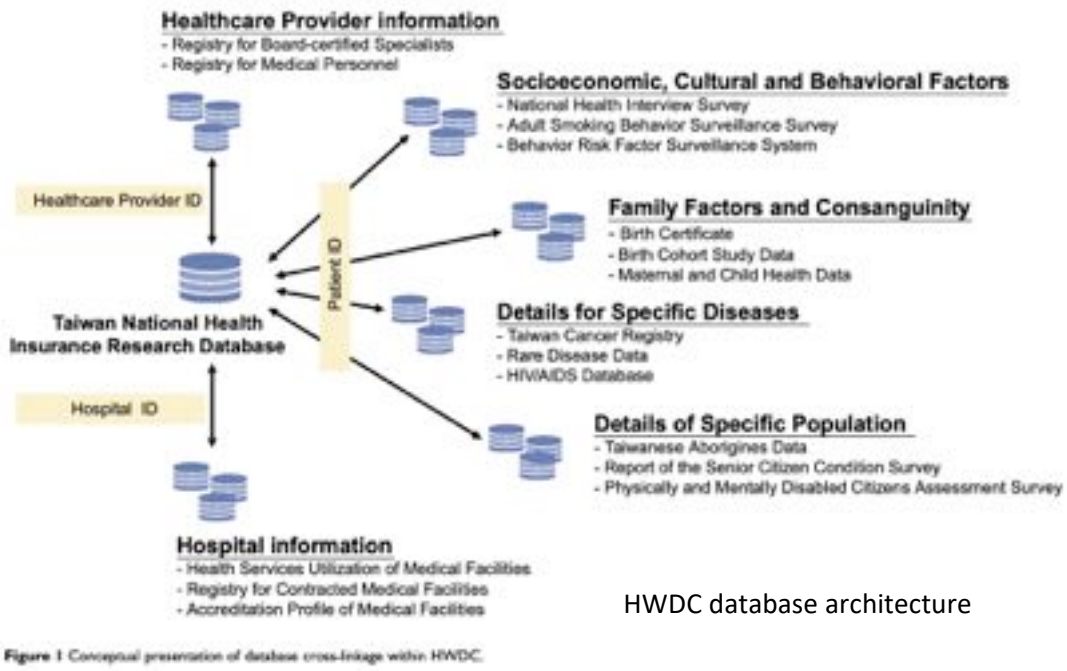
Simulation



Data everywhere

- National Health Research Institutes Biobank
- NHI Research Database (NHIRD)
- Health and Welfare Data Science Center (HWDC)
- Taiwan Government Open Data https://data.gov.tw

- TriNets Dataset
- Taiwan Cancer Registry Center
  - Lung Ca Database
- Arthroplasty Registry Center
- …



HWDC database architecture

Figure 1 Conceptual presentation of database cross-linkage within HWDC.

Influenza-like illness prediction using a long short-term memory deep learning model with multiple open data sources

Associations of PM2.5 and aspergillosis: ambient fine particulate air pollution and population-based big data linkage analyses

Po-Yu Liu, Yu-Tse Tsan, Yu-Wei Chan, Wei-Chen Chan, Zhi-Yuan Shi, Chao-Tung Yang & Ben-Shen Lou

Future Generation Computer Systems

journal homepage: www.elsevier.com/locate/fgcs

Using deep ensemble for influenza-like illness consultation rate prediction

Endah Kristiani, Yuan-An Chen, Chao-Tung Yang, Chin-Yin Huang, Yu-Tse Tsan, Wei-Cheng Chan

Future Generation Computer Systems

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The Implementation of a Real-time Monitoring and Prediction System of PM2.5 and Influenza-Like Illness Using Deep Learning

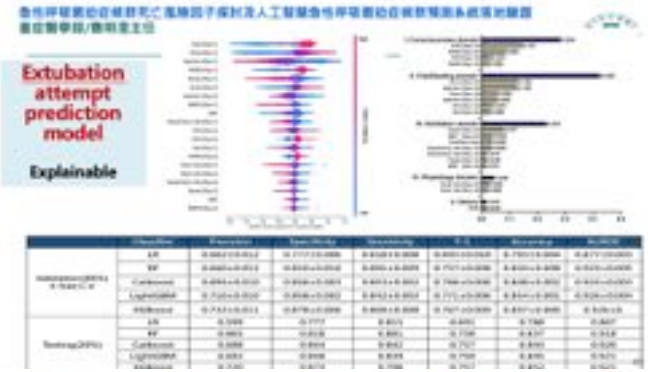
Computers in Human Behavior

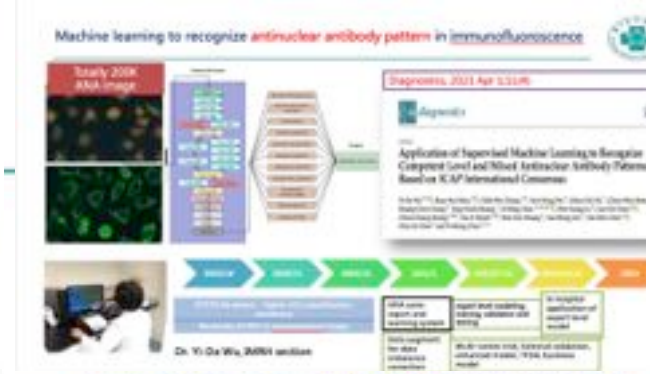
journal homepage: www.elsevier.com/locate/comphumbeh

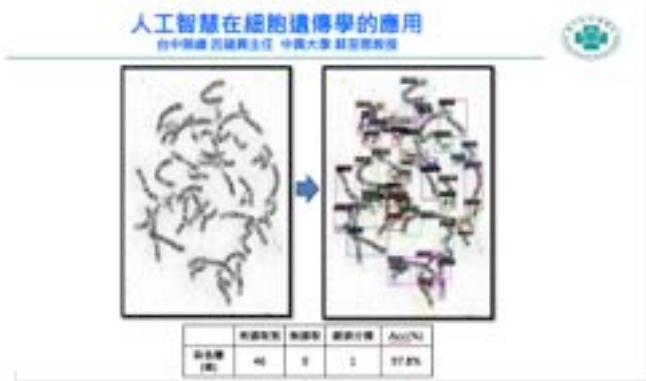
Full length article

An implementation of real-time air quality and influenza-like illness data storage and processing platform

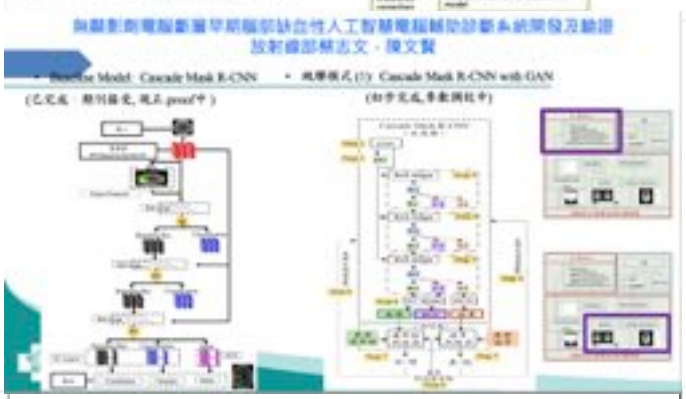
Chao-Tung Yang, Cai-Jin Chen, Yu-Tse Tsan, Po-Yu Liu, Yu-Wei Chan, Wei-Chen Chan


Extubation attempt prediction model
Explainable

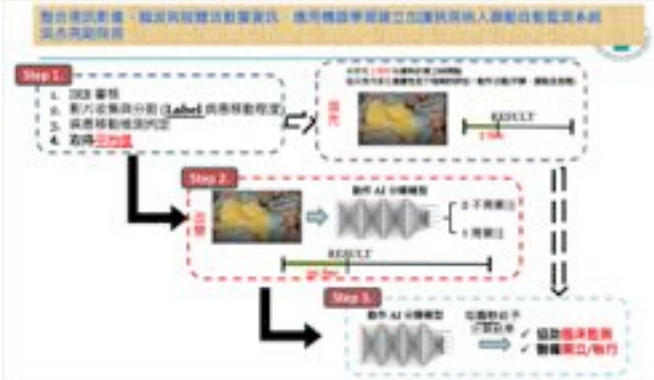

Machine learning to recognize antinuclear antibody pattern in immunofluorescence


人工智慧在細胞遺傳學的應用

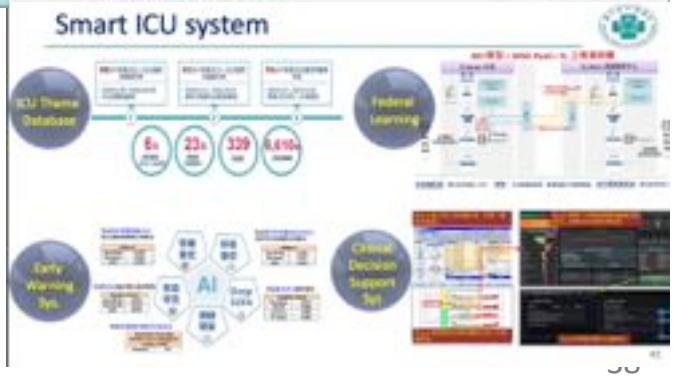

以AI自動判讀ANA間接免疫螢光染色之形態




Epiretinal Membrane Detection by Deep Learning on Optical Tomography
SCIENTIFIC REPORTS
Epiretinal Membrane Detection at the Ophthalmologist Level using Deep Learning of Optical Coherence Tomography




AI+HI智慧重症照護診療系統

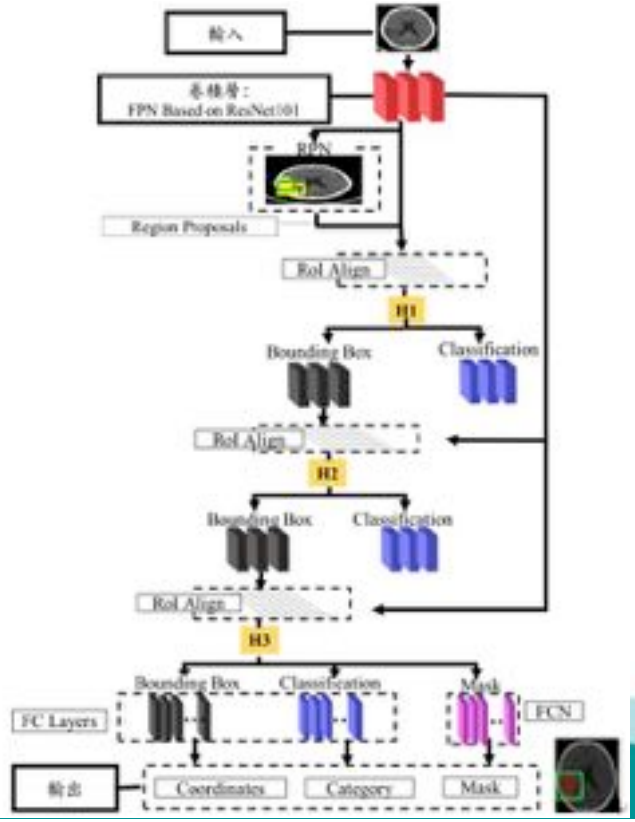

Smart ICU system

無顯影劑電腦斷層早期腦部缺血性人工智慧電腦輔助診斷系統開發及驗證

放射線部蔡志文，陳文賢

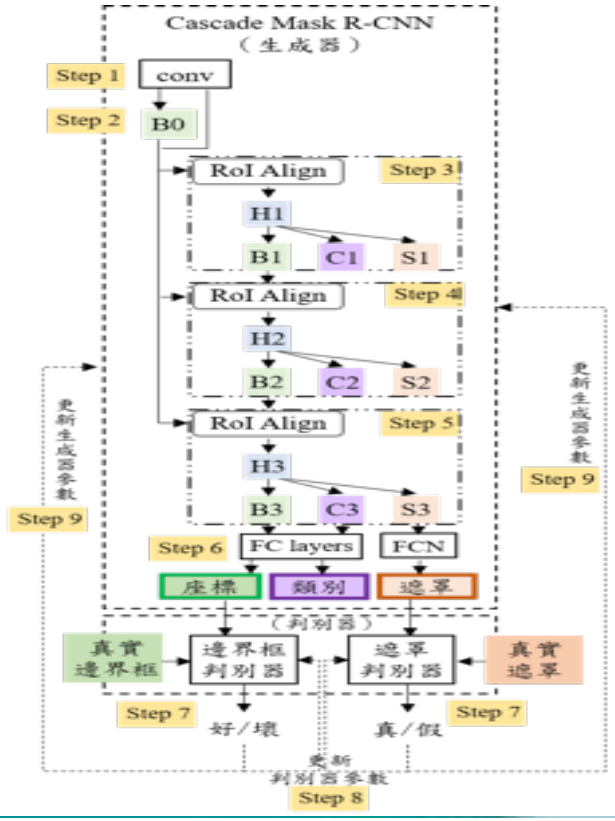
- Baseline Model: Cascade Mask R-CNN

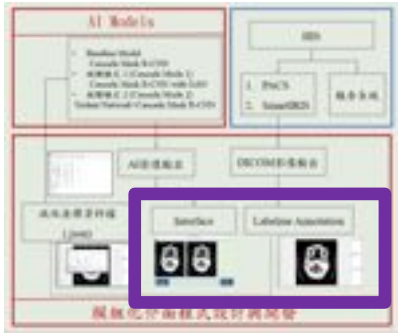
(已完成，期刊接受, 現正 proof中)



- 級聯模式 (1): Cascade Mask R-CNN with GAN

(初步完成,參數調校中)





建置資料自動清理模組與其在重症醫學之應用

臺中榮總 吳杰亮副院長/趙文震科主任。中興大學理學院 施因澤院長

INPUT：待清理檔案

XLS CSV …

自動化資料清理工具(軟體)

OUTPUT

1.清理後檔案

2.盒狀圖、點狀圖、分布圖、基本敘述統計等

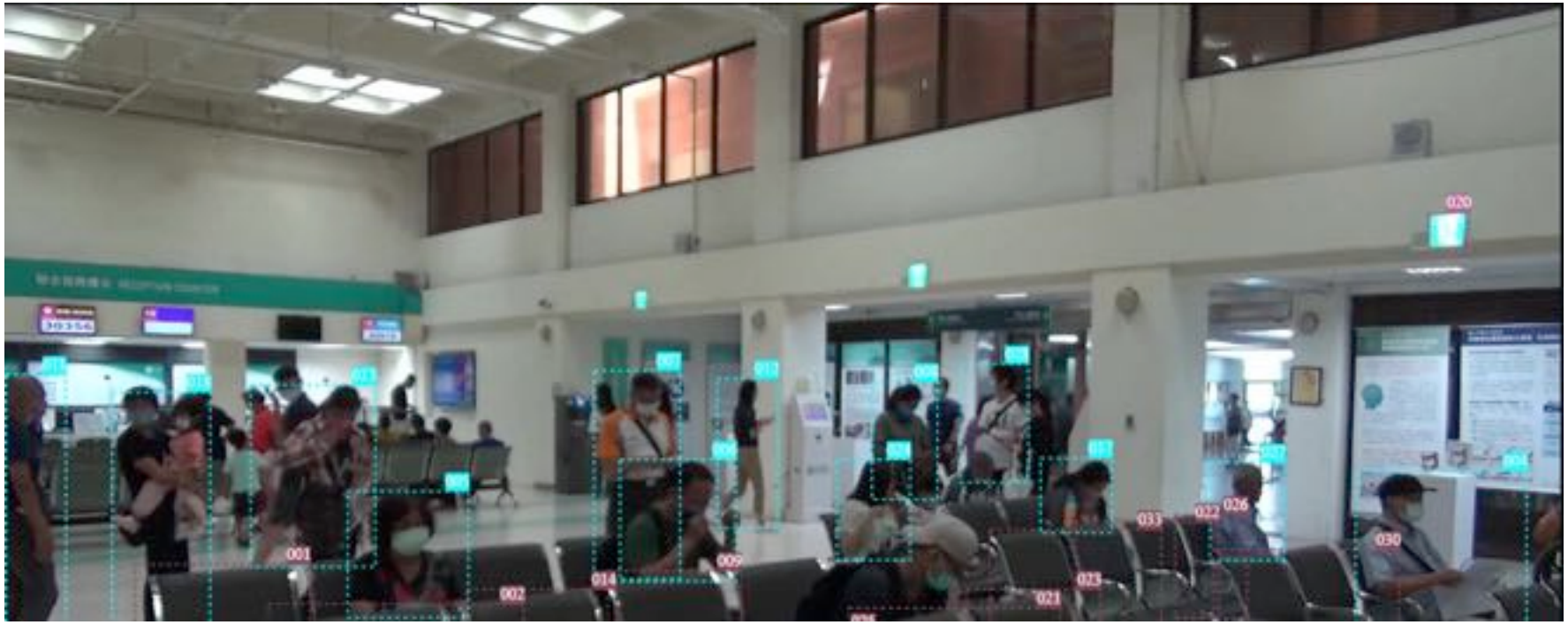
XLS CSV …

自動清理模組(UI、UX)設計

資料觀察	資料清理	資料補值	描述性統計
產出： 1. 每個欄位的資料觀察(盒狀圖、最大最小等) 可執行欄位： 1. 類別資料(直方圖) 2. 連續資料(盒狀圖、基本統計)	產出： 1. 清理過的檔案(csv.或excel) 2. 計算missing rate 可執行欄位： 1. Vital sign 7種 2. Ventilator 7種 3. 其他自訂 (可陸續擴增)	產出： 1. 補值後的csv、excel檔案	產出： 1. 平均數 2. 變異數 3. 統計檢定

以影像辨識為基礎的物件比對應用研究-
以疏導門、急診滯留人員為例

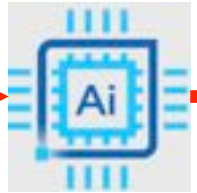
中臺科技大學 護理系林冠語 助理教授/臺中榮民總醫院醫務企管部 蔡鴻文 主任/國立勤益科技大學 資訊工程系 林俊榮 助理教授



藉由AI影像辨識技術，在不侵犯個資與隱私的基礎上，以不進行人臉辨識的方式，進行物件辨識與人數的計算。
適時的將訊息回饋給相關人員，提醒工作人員或民眾進行必要的調整與移動

Image AI Model Deploy

Source Image



AI Model Inference (Cloud or Edge)

Text

or

Labeled Image

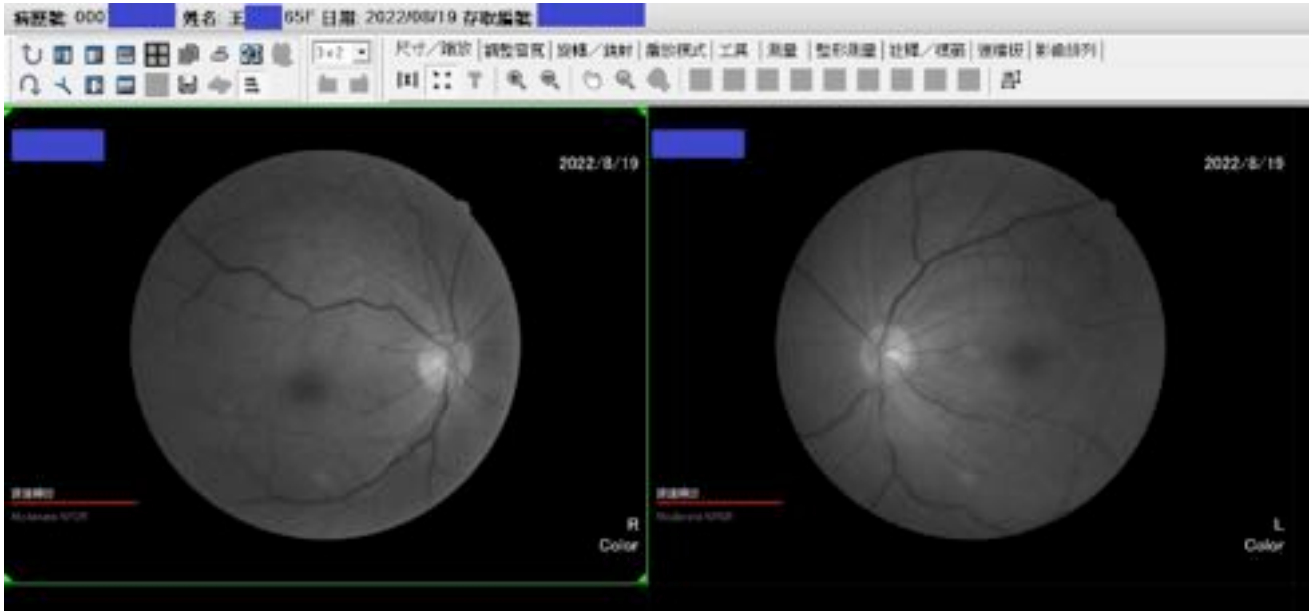
or

Labeled Image + Text

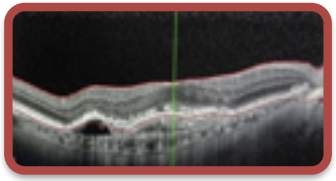
Inference Results

Labeled Image + Text

- eHIS system + AI inference suggestion



AI輔助門診 眼科部、新陳代謝科、皮膚科



眼科部：OCT

新陳代謝科：VeriSee

新陳代謝科：安克甲狀偵 AmCAD-UTe/x
(甲狀腺超音波電腦輔助偵測系統)

皮膚科：皮膚癌照片影像

Telehealth Call Center Service Model

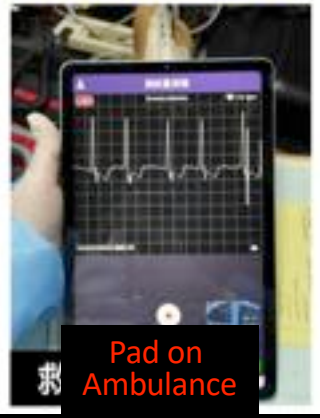
- **Our hospital has incorporate AIoT-5G technology to build the largest Telehealth command center in Taiwan, which provides comprehensive healthcare services in rural areas and international medical collaboration.**

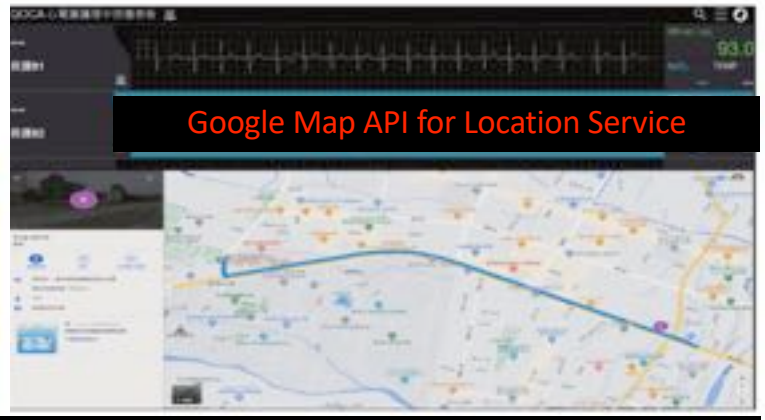
- "Telehealth Center" can provide
  - remote emergent patient consultation
  - home care call center
    - post-hospital home care
    - home physiological data monitoring
  - facilitate international medical service

  - improve the quality and efficiency of medical services

https://m.vghtc.gov.tw/telehealth-en

Real-time 5G tele-consultation of vital signs, ECG and video with position information of ambulance before arriving





台中榮總 醫療AI產業之路

台灣人工智慧學校

台中榮總 AI 工作室

東海、工業局 人工智慧專班

台中榮總 智慧醫療委員會

一部一科一室一AI

醫療資訊系統 → 大數據資料庫 → 人工智慧教育 → 形成機構文化 → 擬定研究主題 → 資料探勘清理 → 推論引擎建立 → 模型臨床驗證 → 模型落地應用 → 專利技術轉移 → 智慧醫材認證 → 產品商業模式 → 產品生命週期

智慧醫療全機構獎

落地應用、跨院聯邦

申請專利及SaMD

執行進度

發明專利 數據驅動人工智慧輔助多疾病模式決策即時回饋持續進化醫療照護系統

- 申請人撰寫及專利事務所初步審稿
- 院內產官學委員會審核
- 專利事務所撰寫文件
- 智慧財產局審理
- 智慧財產局核可

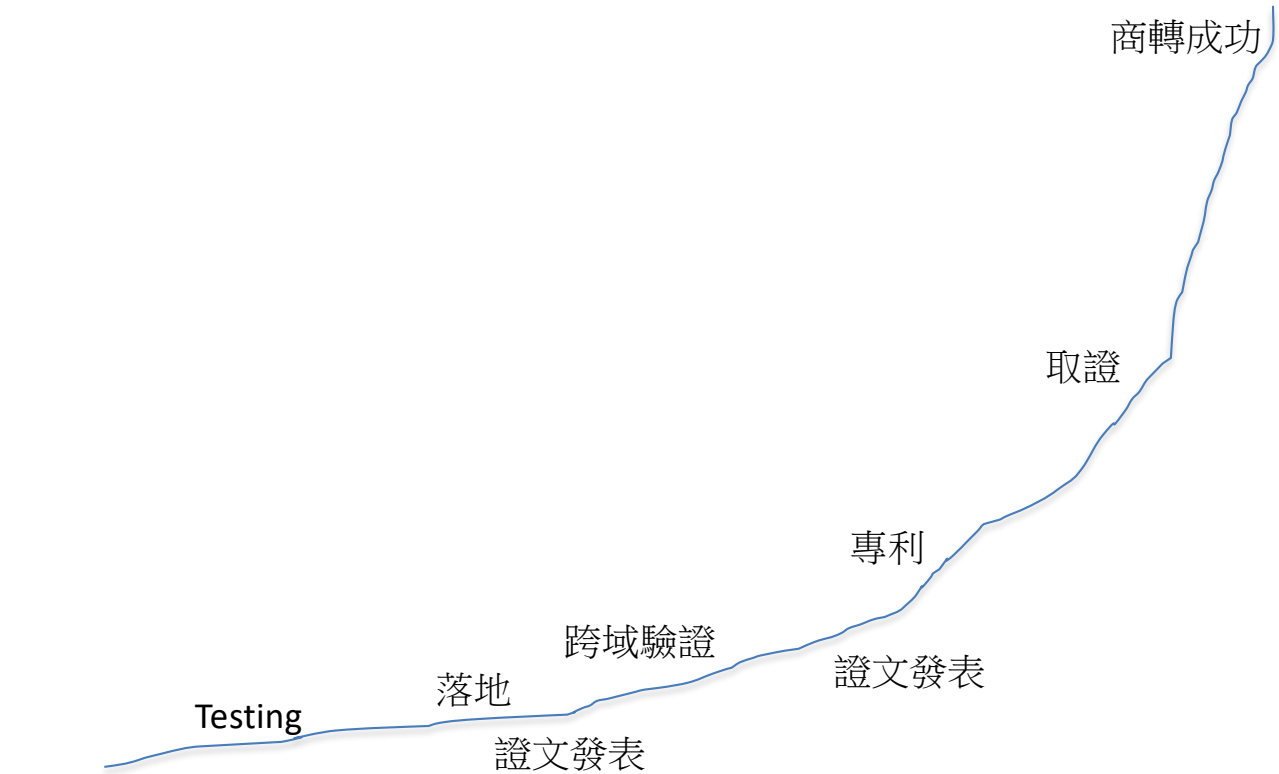
設計專利 加護病房疾病監測互動式儀表板

- 申請人撰寫及專利事務所初步審稿
- 院內產官學委員會審核
- 專利事務所撰寫文件
- 智慧財產局審理
- 智慧財產局核可

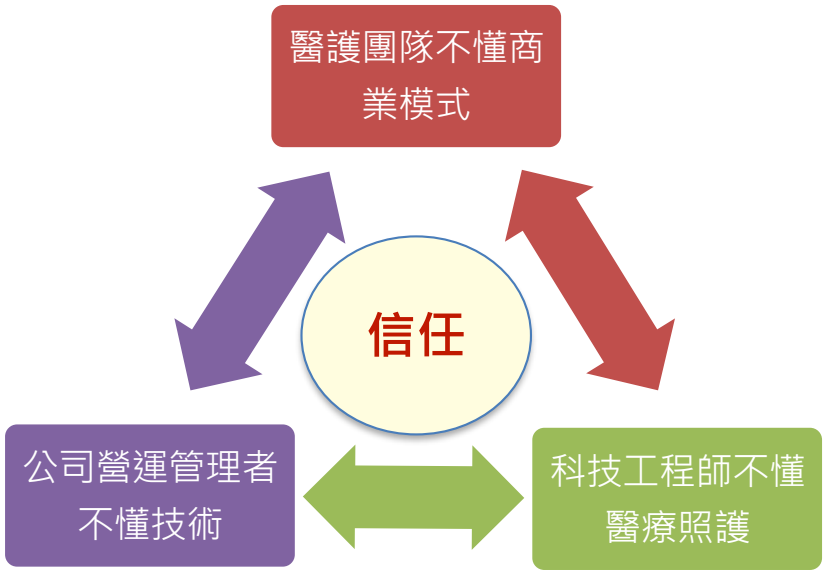
SaMD AI輔助ARDS分類器

- 申請需求確認
- 院內審核
- 顧問公司撰寫文件
- TFDA/美國FDA審理
- TFDA/美國FDA核可

AI 商品的成功之路



醫療AI 成果新創、商品化、產業化



MIT 2023 主題

- Generative AI
- Sustainable ML
- Robotics and Embodied Intelligence
- Visual Computing
- Future of Data, Trust and Privacy
- Edge AI
- Precision Wellness
- The Future of the Cloud
- Cybersecurity




From Data to Research to Patient

Data cleansing，AI modeling (Training, Validation, Testing) Deploy
Research papers, Deploy, Patent, Business Service Model

Form data to research to patient

- Image (X-ray, CT, MRI, photo, microscope, fluoro…)
- Voice ，TextReport (Lab, image, questionale, op note…)
- Video (scope, sono, 2D echocardiogram, surveillance)
- Documentation
- IMU，Robotic，Signals (wifi, BT, zigbee…)
- Specialized Database
- Renote Application : digital pathology, in-house monitoring
- Automation
  - Decision support (administration and clinical)
  - data cleaning/labeling
  - patient report outcome
- NLP, LLM (Large Language Model) : ChatGPT (OpenAI/MS), Bard (Google) and open models ex. BLOOM

driven by user, to fulfill unmet need is most important

Thanks for your attention !

Kun-Hui Chen
orthochen@gmail.com

Orthopedic Department
Smart Healthcare Committee
Clinical Informatics Committee