0035/2020/A

基於人工智能的新型冠狀病毒 SARS-CoV-2感染的診斷核心關鍵技術

Key techniques for diagnosing SARS-CoV-2 infection based on artificial intelligence

申請實體 Unit： 澳門科技大學
Macau University of Science and Technology
項目負責人 PI： 張 康 講座教授 Chair Prof. Kang, ZHANG
項目主要成員Members：霍文遜 院長 Dean, Manson, FOK
李志煥 博士 Dr. Zhihuan, LI

11th Feb, 2022

❖立論依據 Background

➢ 2019年12月起，新冠肺炎迅速蔓延 Rapid spread

- 該疾病潛伏期較長（最長達24天） Long incubation
- 潛伏期患者流動性大，早期較難診斷 hard in early diagnosis
- 擴散速度迅速，感染人數急劇增加 infection dramatically grows
- 給各地有限的醫療資源帶來巨大壓力 limited healthcare resource

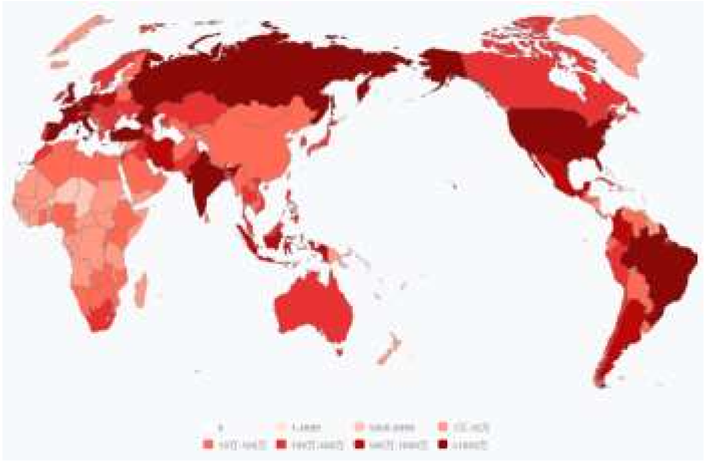
➢ 精準診療和互聯網醫療需要人工智能助力Precision + AI medicine

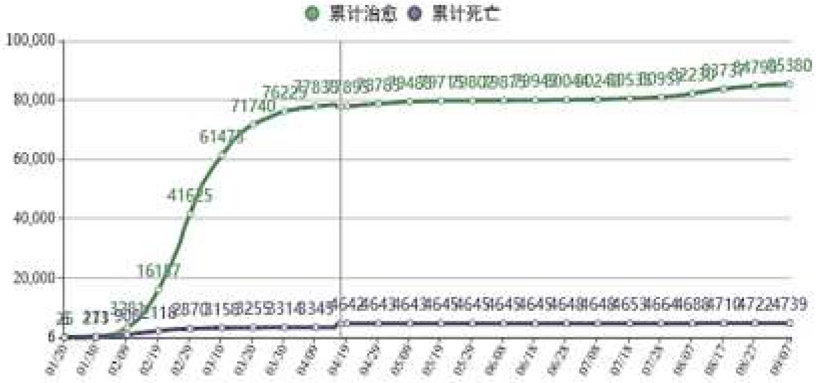
- 各地醫護人員和檢測設備等資源嚴重不足 Limited resource
- 各地醫療資源分佈不均衡 uneven resource distribution
- 無法快速並精準檢測和診斷病情 time consuming
- 急需人工智能賦能助力 AI assisted

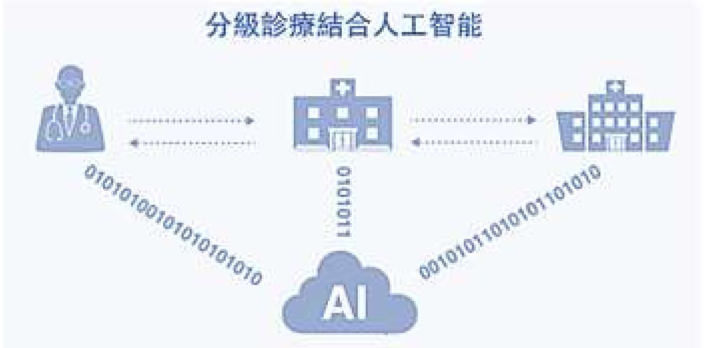
➢ 澳門作為國際重要港口，人口流動大，人口密度高，對疫情早期的快速檢測可有效控制疫情蔓延，故，人工智能檢測工具的研發可很大程度上緩解醫療壓力 Macau as an important international port with large population mobility and high population density, AI can greatly alleviate medical pressure

➢ 人工智能關鍵技術在醫學上的應用越來越成熟 Mature AI technology

- 深度學習 Deep learning
- 自然語言處理 NLP







❖ 研究內容與方法 Research content and Methodology

➢ 研究內容 Research content

工作內容
Content

1.

收集新冠患者的CT資料，建立臨床-影像學複合人工智能快速分選模型，区分出正常人与肺炎患者

CT data of COVID-19 patients were collected to establish a clinical-imaging composite AI classification model to distinguish normal people and pneumonia patients

2.

整合臨床其他信息，利用深度學習技術進一步開發了新冠肺炎AI診斷模型

Integrating CT and clinical information, to develop the AI diagnostic model using deep learning

3.

將模型通過網路雲平臺推廣、部署至科大醫院及其他地區，並在應用中進一步對模型進行反覆運算與優化。

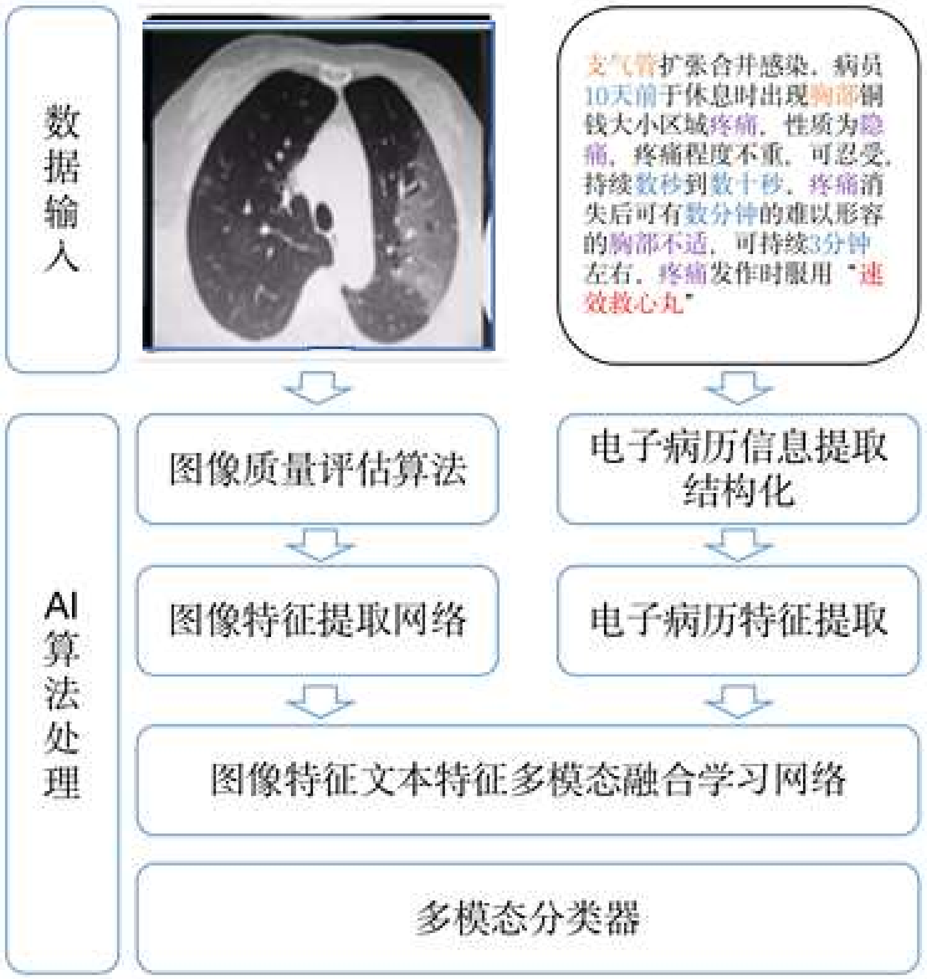
Promotion and deployment of this system in UH and optimization this model

*本項目內容未經許可禁止轉載，違者必究。項目組負責人對內容擁有最終解釋權。

➢研究方案 Research Method

- **整合CT影像信息和臨床其他數據，利用深度學習技術開發了新冠肺炎AI診斷模型** Integrating CT and clinical information, to develop the AI diagnostic model using deep learning
    - 系統接受胸部CT圖像以及電子病歷作為**聯合輸入**。利用深度學習和自然語言處理技術對CT圖像及電子病歷進行**特征提取**，經過多模態融合**診斷模型**，最後**輸出結果**。Inputting chest CT images and electronic medical records firstly, extract features using deep learning and NLP tehchnology, finally, results will be given from the AI diagnostic model.

- **涉及的關鍵技術與處理Key process：**
    - 圖像品質智能評估 Intelligent assessment of image quality
    - 圖像特徵提取網路 Image feature extraction network
    - 電子病歷信息（臨床表現相關資訊）提取結構化 Structured extraction of electronic medical record information (information related to clinical manifestations)
    - 多模態分類器 Multimode classifiers



数据输入

支气管扩张合并感染，病员10天前于休息时出现胸部铜钱大小区域疼痛，性质为隐痛，疼痛程度不重，可忍受，持续数秒到数十秒，疼痛消失后可有数分钟的难以形容的胸部不适，可持续3分钟左右，疼痛发作时服用"速效救心丸"

AI算法处理

图像质量评估算法

电子病历信息提取结构化

图像特征提取网络

电子病历特征提取

图像特征文本特征多模态融合学习网络

多模态分类器

技術方案架構圖

Technical solution architecture diagram

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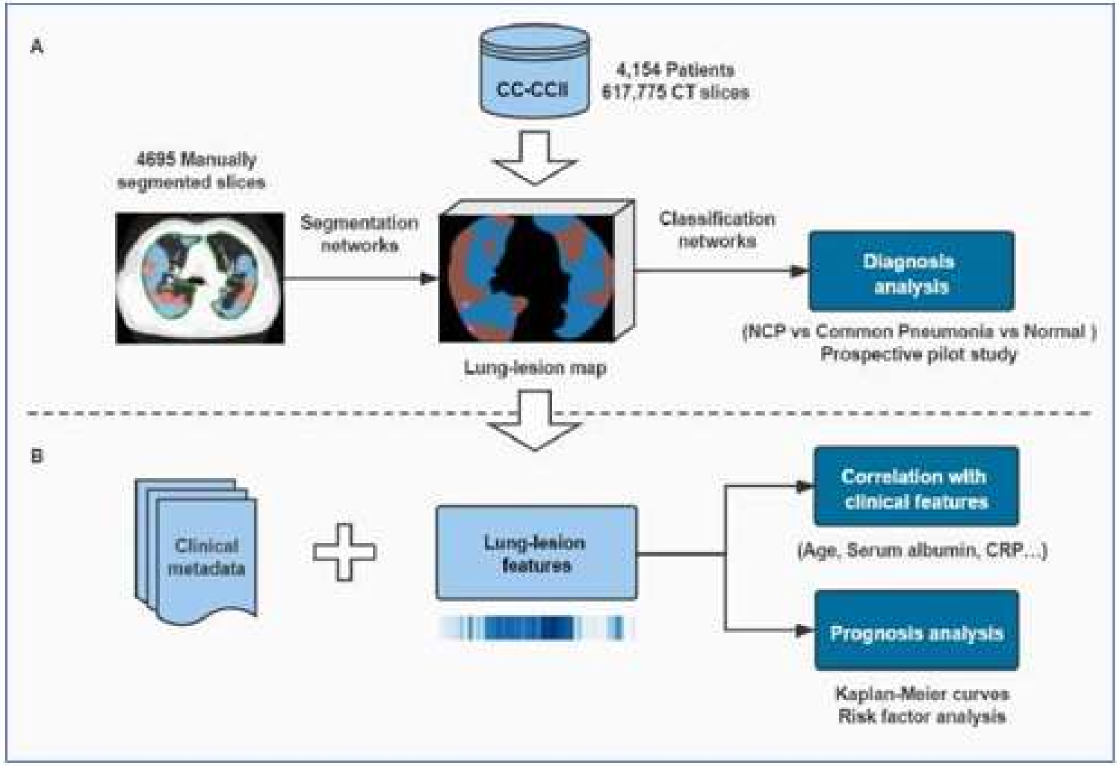
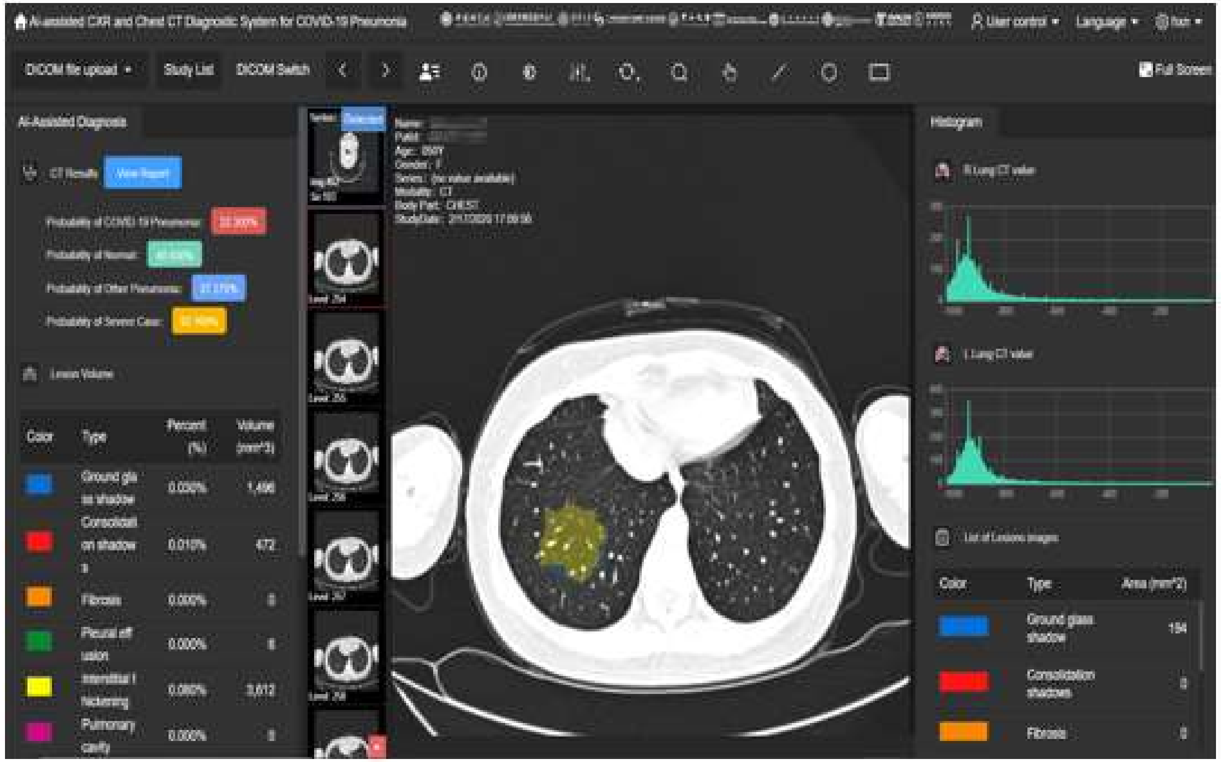
❖ 專案成果 Project outcomes

科學技術發展基金
F I D I O I T

➢ 項目產品 Product


A
CC-CCII
4,154 Patients
617,775 CT slices
4695 Manually segmented slices
Segmentation networks
Classification networks
Diagnosis analysis
(NCP vs Common Pneumonia vs Normal)
Prospective pilot study
Lung-lesion map
B
Clinical metadata
Lung-lesion features
Correlation with clinical features
(Age, Serum albumin, CRP...)
Prognosis analysis
Kaplan-Meier curves
Risk factor analysis


AI-assisted CXR and Chest CT Diagnostic System for COVID-19 Pneumonia
User control
Language
DICOM file upload
Study List
DICOM Switch
Full Screen
AI-Assisted Diagnosis
CT Results
View Report
Lesion Volume
Color
Type
Percent (%)
Volume (mm^3)
Ground glass shadow
Consolidation shadows
Fibrosis
Pleural effusion
Interstitial thickening
Pulmonary cavity
Histogram
List of Lesions images
Area (mm^2)

➢ 該系統可在**20秒內**高效區分新冠肺炎與其他病毒性肺炎並可預測危重等級，且**準確率高達90%以上**，相當於一個省級三甲醫院影像學副教授的診斷水準。The system can effectively distinguish COVID-19 from other viral pneumonitis within 20 seconds and predict the severity level with an accuracy rate of more than 90%, equivalent to the diagnostic level of an associate professor of imaging in a provincial third-grade A hospital.

➢ 項目總負責人 PI、協作/合作

張康 Kang, ZHANG：

澳門科技大學醫學院講座教授、生物醫學和創新中心主任、科大醫院醫生

研究方向Area： 醫學人工智能AI in Healthcare、幹細胞及再生醫學Stem Cells、
遺傳學Genetics、眼底病診療Fundus

研究成果： **國際頂級期刊*New Engl J Med, Nature, Science, Cell* 等發表文章200餘篇；國際及國內授權專利14項。** 《Science》2006年世界科學十大進展之一；《Nature Medicine》2016年生命科學七大領域的八大突破性進展；《Cell》2018 年度和2020年度最佳論文。

項目負責人： 對項目總設計和規劃；領導項目總體研究方向與把控進度等。整合算法模型與臨床應用平台，調整設計方案以符合臨床實際需求。

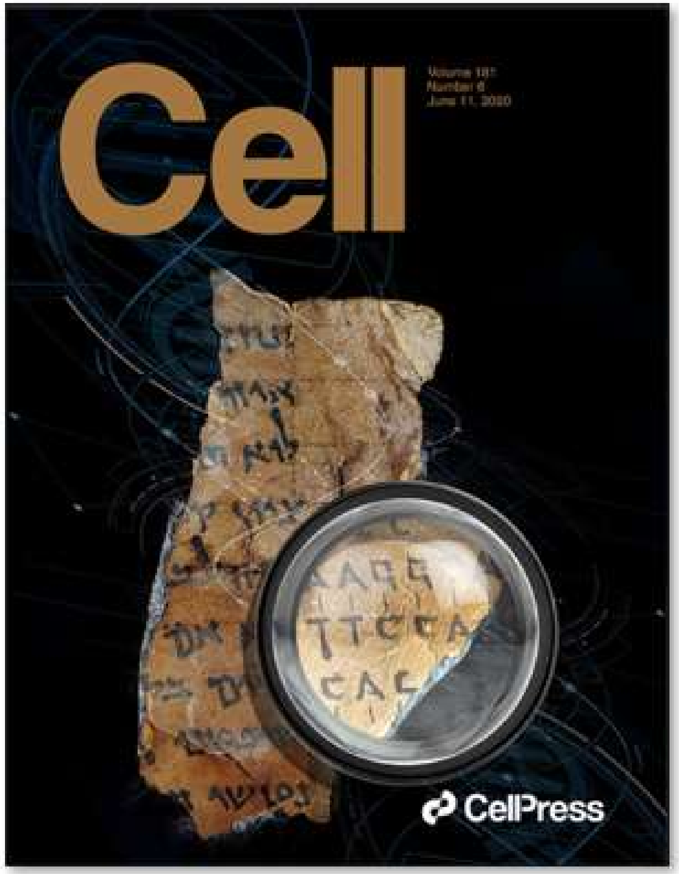
澳門科技大學： 擁有國際頂尖科學家，粵港澳及國際一流資源平台，以及生物醫學和創新中心和醫療人工智能實驗室，和科大醫院臨床支持系統。

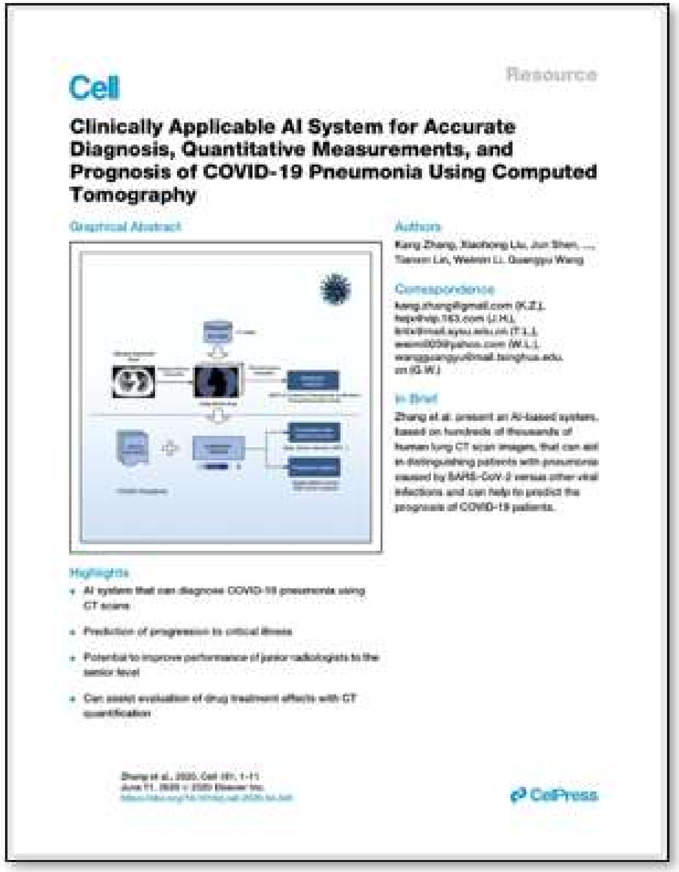
廣州實驗室（生物島實驗室）： 醫學人工智能工程技術研究中心，擁有強大的人工智能系統開發團
和經驗、生物醫學專家、經驗豐富的臨床醫生。國際一流水平的臨床應用基地、成果轉化及應用基

*本項目內容未經許可禁止轉載，違者必究。項目組負責人對內容擁有最終解釋權。

❖ 專案成果 Project outcomes

➢ 成果已發表 Publication





Cell

Resource

Clinically Applicable AI System for Accurate Diagnosis, Quantitative Measurements, and Prognosis of COVID-19 Pneumonia Using Computed Tomography

Graphical Abstract

Authors

Kang Zhang, Xiaohong Liu, Jun Shen, ..., Tianxin Lin, Weimin Li, Guangyu Wang

Correspondence

In Brief

Zhang et al. present an AI-based system, based on hundreds of thousands of human lung CT scan images, that can aid in distinguishing patients with pneumonia caused by SARS-CoV-2 versus other viral infections and can help to predict the prognosis of COVID-19 patients.

Highlights

- AI system that can diagnose COVID-19 pneumonia using CT scans
- Prediction of progression to critical illness
- Potential to improve performance of junior radiologists to the senior level
- Can assist evaluation of drug treatment effects with CT quantification

Zhang et al., 2020, Cell 181, 1–11
June 11, 2020 © 2020 Elsevier Inc.

CellPress

Zhang K, Liu XH, Shen J, Li ZH, et al., He JX, Lin TY, LI WM, Wang GY. (2020). Clinically Applicable AI System for Accurate Diagnosis, Quantitative Measurements and Prognosis of COVID-19 Pneumonia Using Computed Tomography. (2020). ***Cell***. DOI: 10.1016/j.cell.2020.04.045.

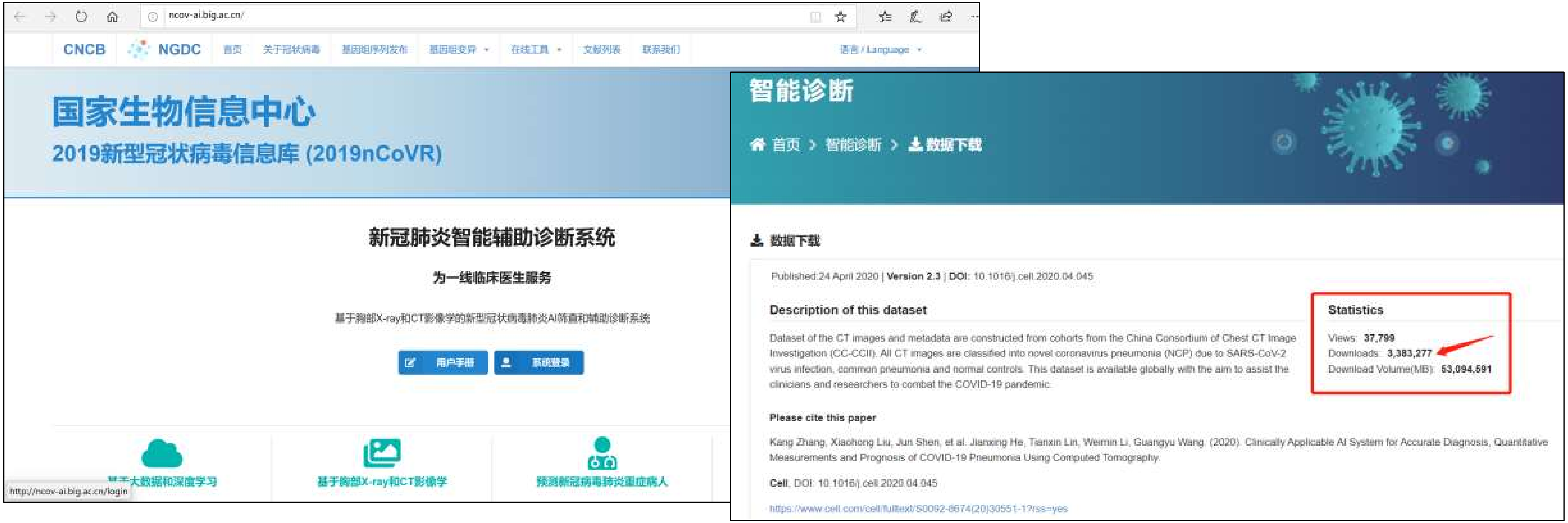
Corresponding and lead author.
主導第一作者兼通訊作者

Cell Press: 2020中国年度最佳论文奖

Published on 24th , April, 2020, *Cell*

❖ 專案成果 Project outcomes

➢ 系統和代碼以及數據集已開源 The system, code and datasets are open source



国家生物信息中心

2019新型冠状病毒信息库 (2019nCoVR)

新冠肺炎智能辅助诊断系统

为一线临床医生服务

基于胸部X-ray和CT影像学的新型冠状病毒肺炎AI筛查和辅助诊断系统

数据下载

Published:24 April 2020 | **Version 2.3** | **DOI:** 10.1016/j.cell.2020.04.045

Description of this dataset

Dataset of the CT images and metadata are constructed from cohorts from the China Consortium of Chest CT Image Investigation (CC-CCII). All CT images are classified into novel coronavirus pneumonia (NCP) due to SARS-CoV-2 virus infection, common pneumonia and normal controls. This dataset is available globally with the aim to assist the clinicians and researchers to combat the COVID-19 pandemic.

Statistics

Views: **37,799**
Downloads: **3,383,277**
Download Volume(MB): **53,094,591**

Please cite this paper

Kang Zhang, Xiaohong Liu, Jun Shen, et al. Jianxing He, Tianxin Lin, Weimin Li, Guangyu Wang. (2020). Clinically Applicable AI System for Accurate Diagnosis, Quantitative Measurements and Prognosis of COVID-19 Pneumonia Using Computed Tomography.

Cell. DOI: 10.1016/j.cell.2020.04.045

https://www.cell.com/cell/fulltext/S0092-8674(20)30551-1?rss=yes

- 該系統掛載於中國科學院國家生物信息中心，與此研究成果同步發佈的還有一個高品質、大規模的影像資料庫和專業技術演算法的代碼，與全世界分享，助力全球抗疫。 截至2022年2月11日統計，全球下載量已高達338多萬次，且還在持續攀升。 The system is mounted at the National Bioinformatics Center of the Chinese Academy of Sciences. Together with the research results, a high-quality, large-scale image database and code of professional technical algorithms are released to be Shared with the world to help fight the epidemic globally. As of Feb 11, the number of downloads worldwide has reached 3,383,277 and continues to climb.

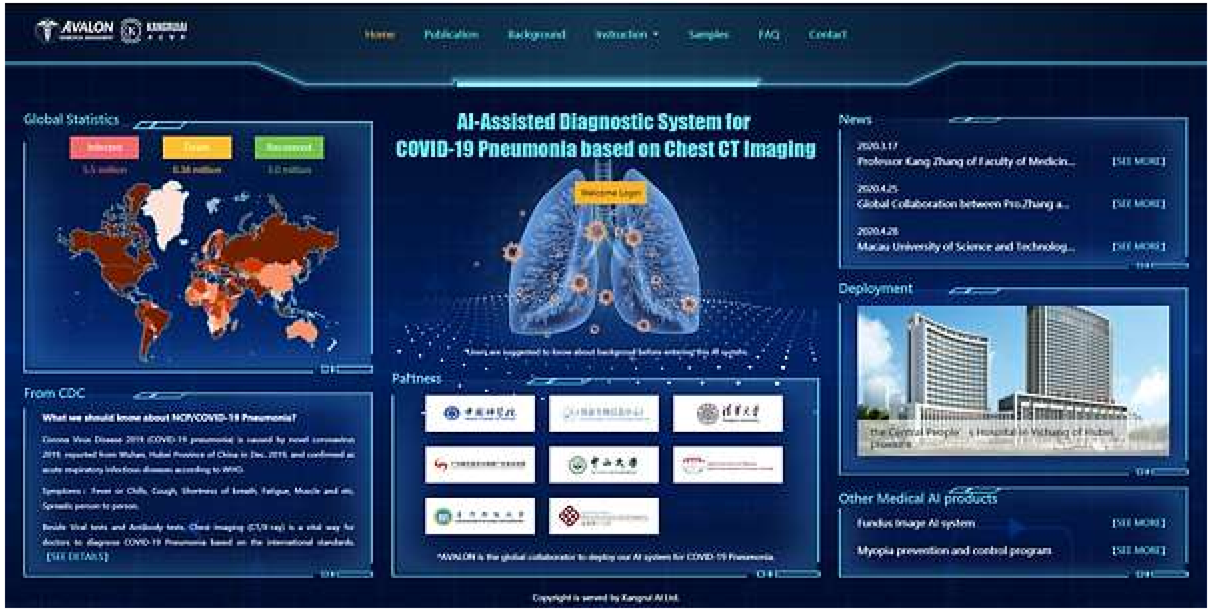
❖ 專案成果 Project outcomes

➢ 項目進度之國內、外部署 The deployment home and abroad

- ✓ **國內China：** 中山大學孫逸仙紀念醫院、武漢金銀潭醫院、湖北宜昌市中心人民醫院和澳門科大醫院等**11家醫院在使用；**
- ✓ **國外Overseas：** 伊拉克、巴西、美國、英國、韓國和厄瓜多爾等**數個國家已部署**Iraq, Brazil, THE United States, The United Kingdom, South Korea and Ecuador

獲得中國科學院以及聯合國和多國醫生們一致好評。 highly praised by the Chinese Academy of Sciences, the United Nations and doctors from many countries

接下來，為助力全球抗疫工作，提升該系統模型的泛化能力和精準度，繼續與國際合作平台接洽中。


AVALON
KANGRUI
Home
Publication
Background
Instruction
Samples
FAQ
Contact
Global Statistics
Welcome Login
Partners
Deployment
the Central People's Hospital in Yichang of Hubei Province

AI-Assisted Diagnostic System for COVID-19 Pneumonia based on Chest CT Imaging

From CDC

What we should know about NCP/COVID-19 Pneumonia?

Corona Virus Disease 2019 (COVID-19 pneumonia) is caused by novel coronavirus 2019, reported from Wuhan, Hubei Province of China in Dec. 2019, and confirmed as acute respiratory infectious diseases according to WHO.

Symptoms : Fever or Chills, Cough, Shortness of breath, Fatigue, Muscle and etc. Spreads person to person.

Beside Viral tests and Antibody tests, Chest imaging (CT/X-ray) is a vital way for doctors to diagnose COVID-19 Pneumonia based on the international standards. [SEE DETAILS]

*AVALON is the global collaborator to deploy our AI system for COVID-19 Pneumonia

News

2020.3.17
Professor Kang Zhang of Faculty of Medicin... [SEE MORE]

2020.4.25
Global Collaboration between Pro.Zhang a... [SEE MORE]

2020.4.28
Macau University of Science and Technolog... [SEE MORE]

Other Medical AI products

Fundus Image AI system [SEE MORE]

Myopia prevention and control program [SEE MORE]

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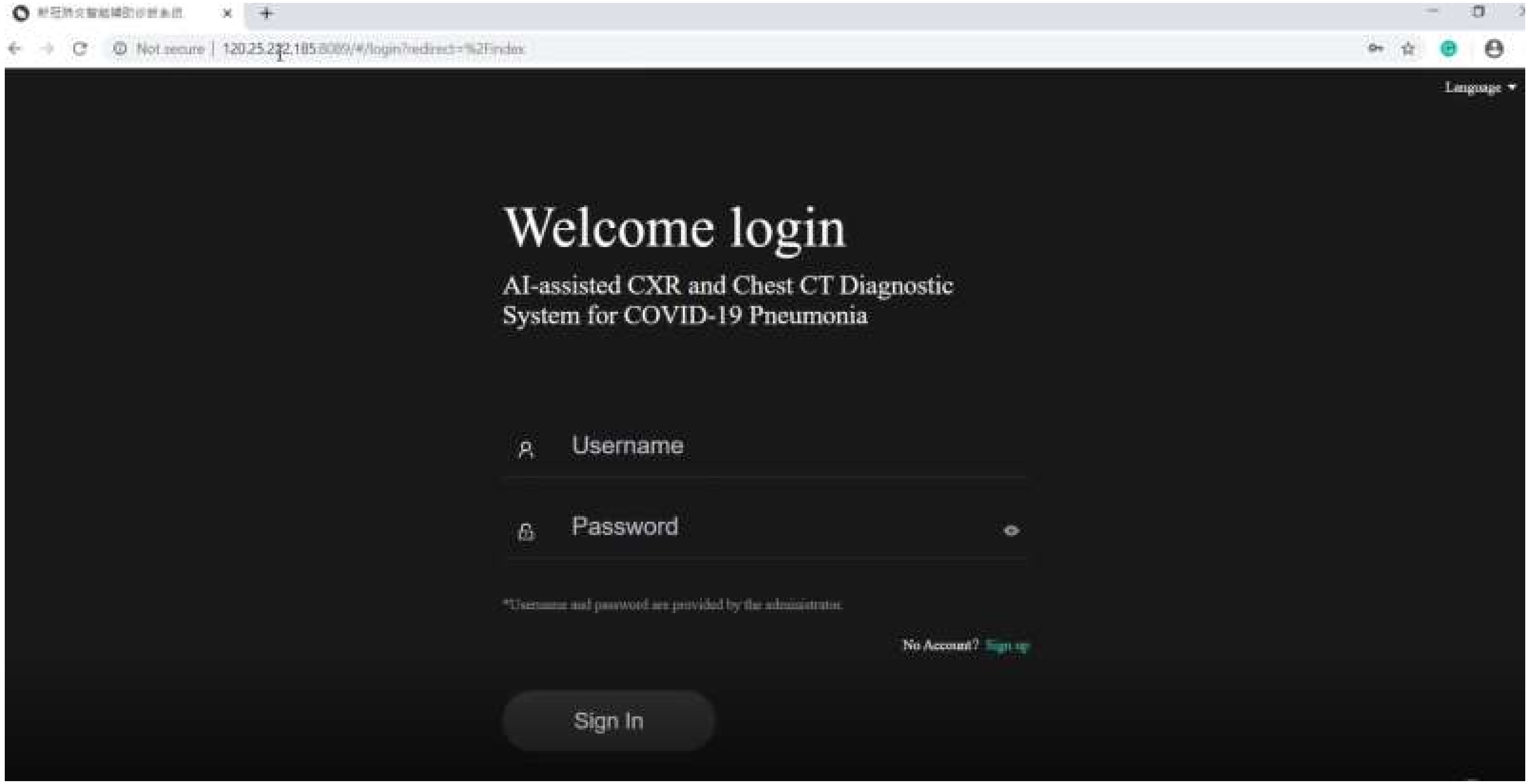
中山大学附属第二医院南院
澳門科技大學
鏡湖醫院
The United States
South Korea
Brazil
Ecuador
Iran
Iraq
United Kingdom

視頻演示 Video demo

- https://180.184.67.53:8091/static/covid_introduce.mp4


Not secure
Language
Username
Password
Sign In

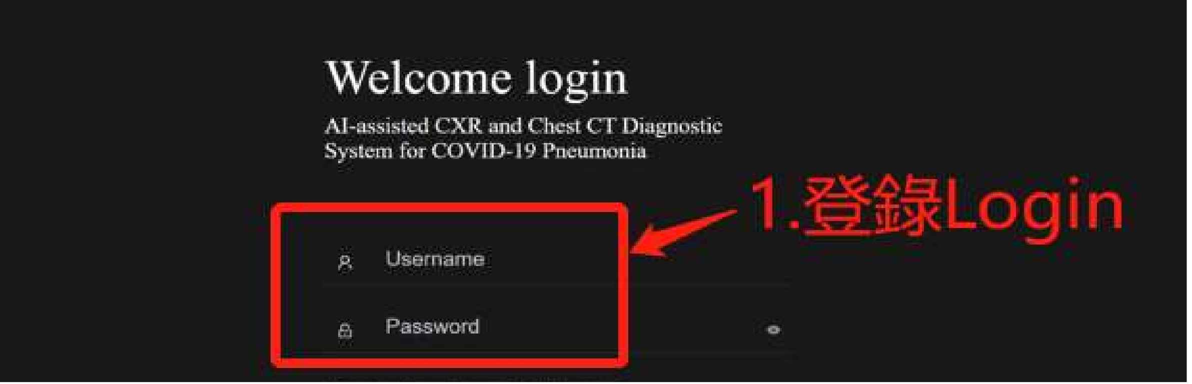
Welcome login

AI-assisted CXR and Chest CT Diagnostic System for COVID-19 Pneumonia

*Username and password are provided by the administrator.

No Account? Sign up

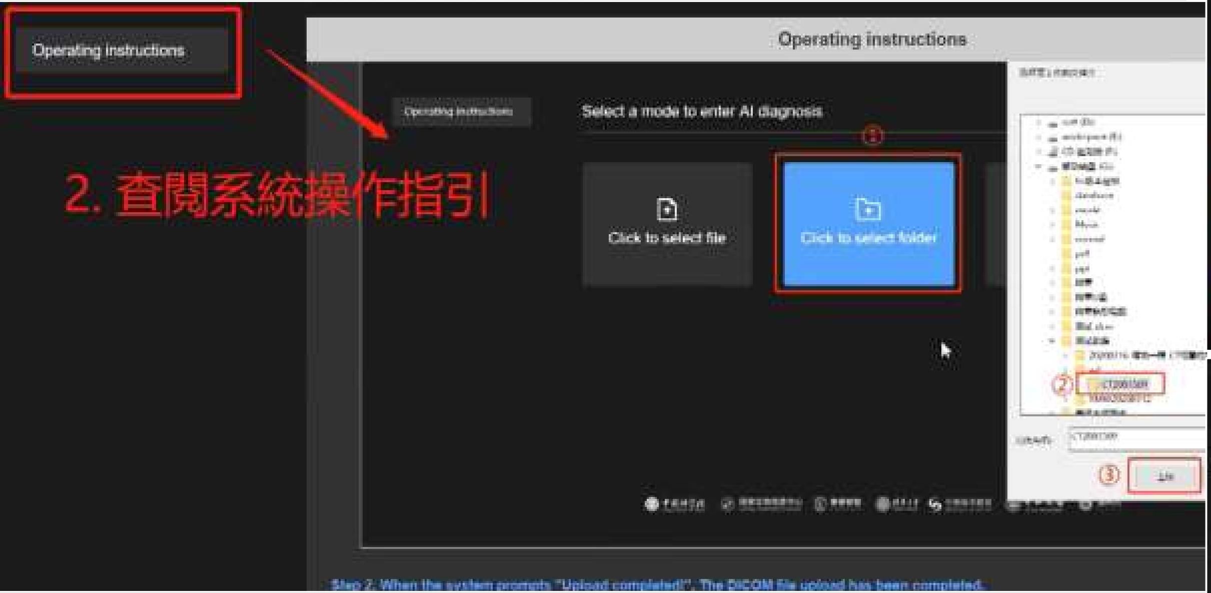
*本項目內容未經許可禁止轉載，違者必究。項目組負責人對內容擁有最終解釋權。


Welcome login

AI-assisted CXR and Chest CT Diagnostic System for COVID-19 Pneumonia

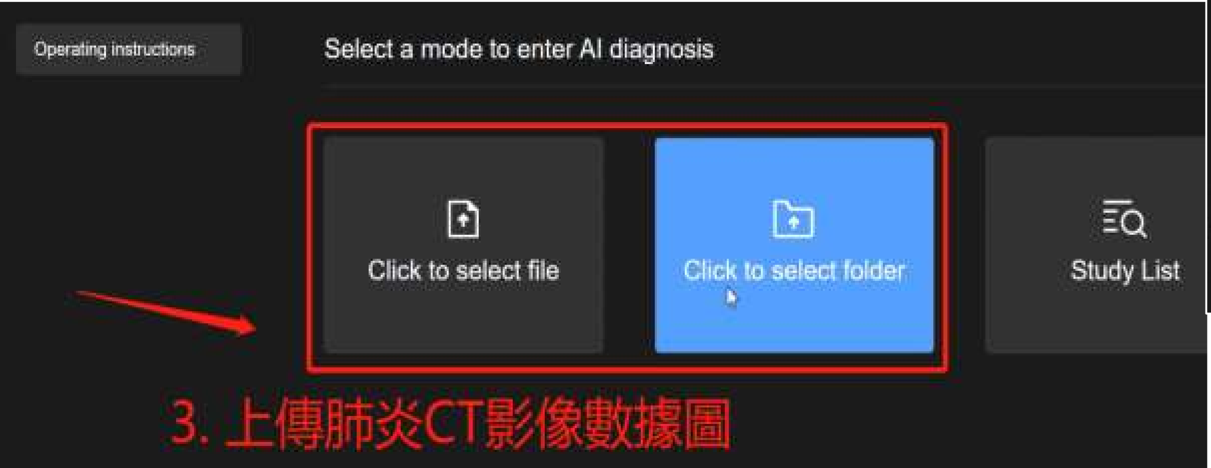
Username
Password

1.登錄Login

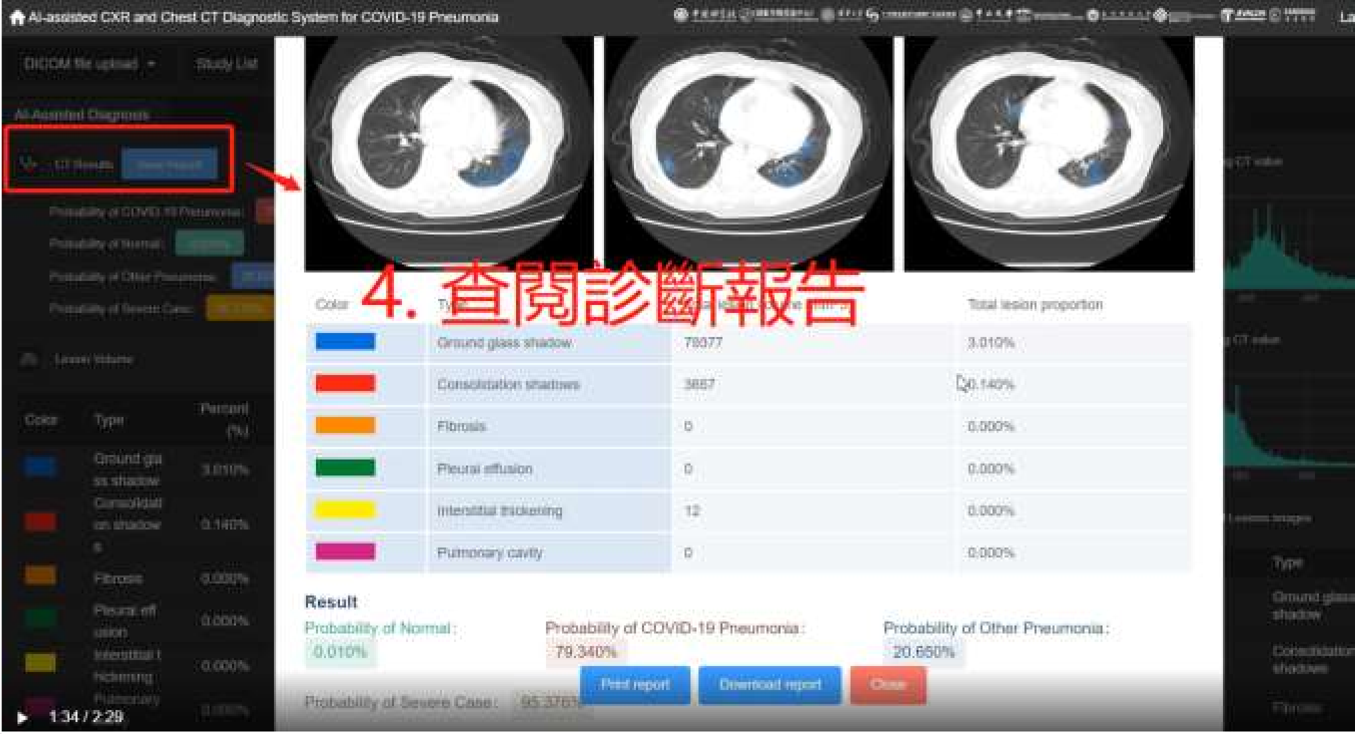

Operating instructions
Operating instructions
Operating instructions
Select a mode to enter AI diagnosis
Click to select file
Click to select folder
①
②
③

2. 查閱系統操作指引

Step 2. When the system prompts "Upload completed!", The DICOM file upload has been completed.


Operating instructions
Select a mode to enter AI diagnosis
Click to select file
Click to select folder
Study List

3. 上傳肺炎CT影像數據圖


AI-assisted CXR and Chest CT Diagnostic System for COVID-19 Pneumonia

DICOM file upload
Study List
AI-Assisted Diagnosis
CT Results
View Report
Lesion Volume
1:34 / 2:29

4. 查閱診斷報告

Color	Type		Total lesion proportion
🟦	Ground glass shadow	78077	3.010%
🟥	Consolidation shadows	3657	0.140%
🟧	Fibrosis	0	0.000%
🟩	Pleural effusion	0	0.000%
🟨	Interstitial thickening	12	0.000%
🟪	Pulmonary cavity	0	0.000%

Result

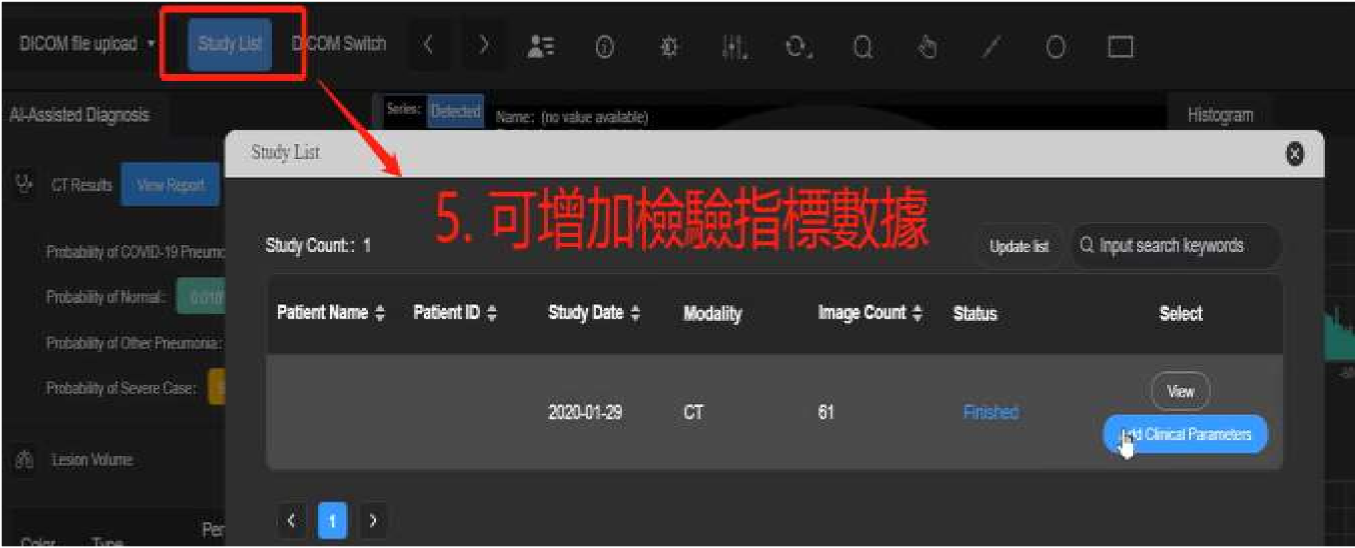
Probability of Normal: 0.010%

Probability of COVID-19 Pneumonia: 79.340%

Probability of Other Pneumonia: 20.650%

Probability of Severe Case: 95.376

Print report
Download report
Close


DICOM file upload
Study List
DICOM Switch
AI-Assisted Diagnosis
CT Results
View Report
Probability of COVID-19 Pneumonia
Probability of Normal:
Probability of Other Pneumonia:
Probability of Severe Case:
Lesion Volume
Histogram
Series: Detected
Name: (no value available)
Study List
Update list
Input search keywords

5. 可增加檢驗指標數據

Study Count: 1

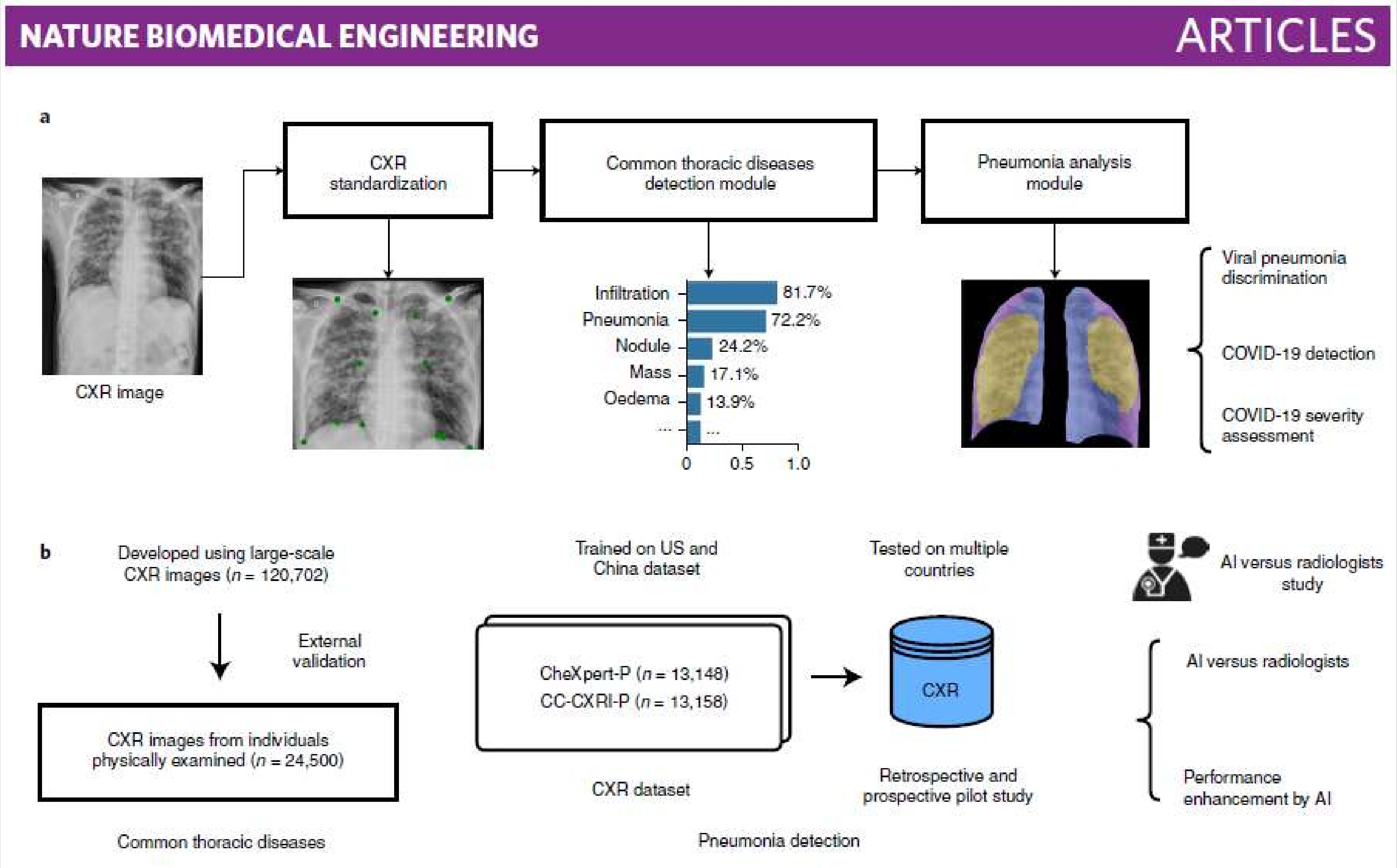
Patient Name	Patient ID	Study Date	Modality	Image Count	Status	Select
		2020-01-29	CT	61	Finished	View Add Clinical Parameters

新冠AI診斷五步曲

通过CXR影像诊断和鉴别病毒性、非病毒性和新冠肺炎的深度学习系统

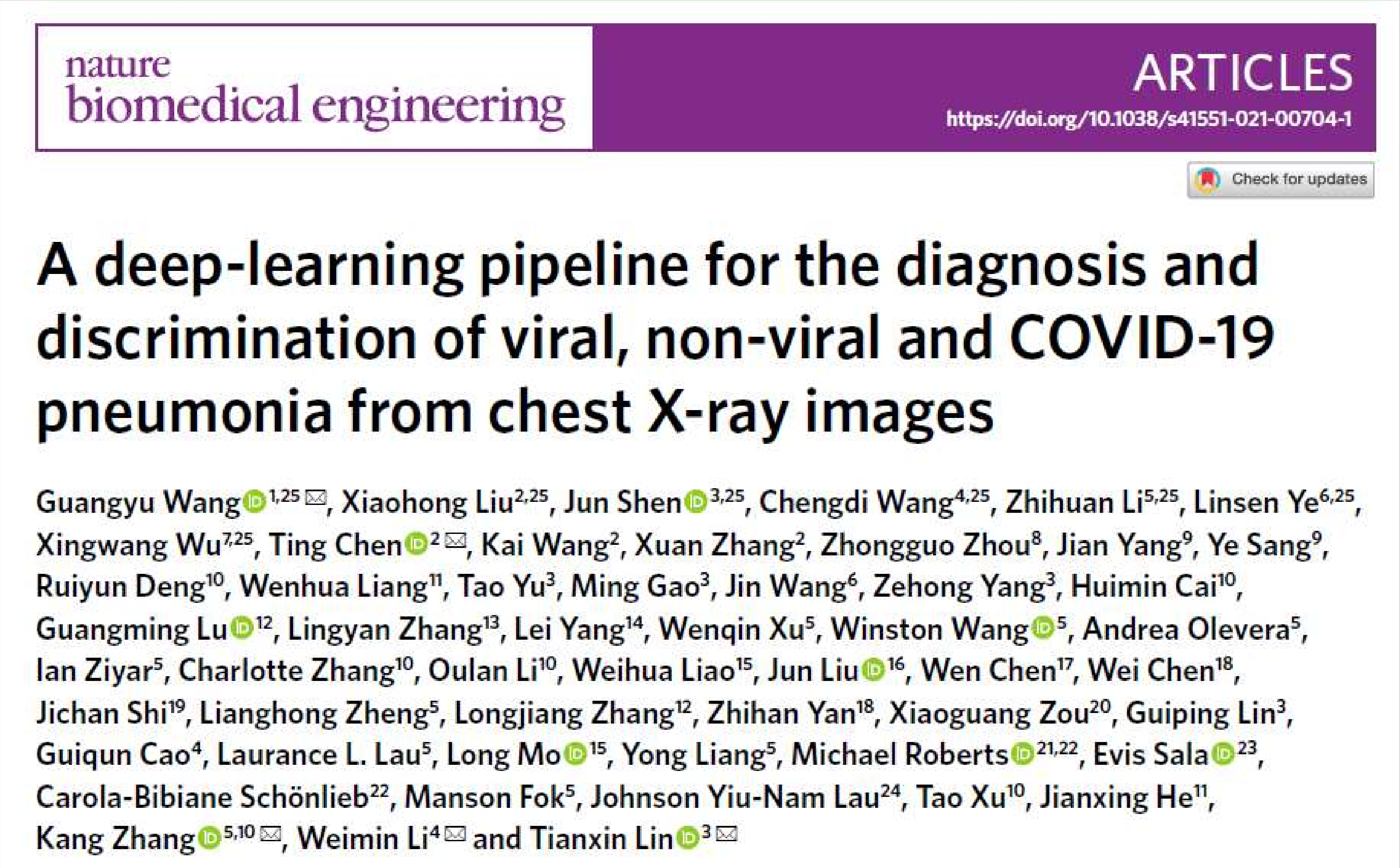
A deep-learning pipeline for the diagnosis and discrimination of viral, non-viral and COVID-19 pneumonia from chest X-ray images

基於12萬個患者的**145,000**張胸部x-ray圖像，團隊成功開發了一套準確的人工智能系統，該系統從病灶標記、檢測、配准、分割和診斷預測在內的模組化處理流程，提供了穩固且可解釋的結果，可以幫助放射科醫生準確、快速地區分新冠肺炎及其他類型肺炎， 其他常見肺部疾病及正常患者並評估其嚴重性，而且還能識別很難被放射科醫生發現的肺部彌漫性病變特徵等優勢。**尤其在偏遠和貧困地區**。


NATURE BIOMEDICAL ENGINEERING
ARTICLES
a
CXR image
CXR standardization
Common thoracic diseases detection module
Infiltration 81.7%
Pneumonia 72.2%
Nodule 24.2%
Mass 17.1%
Oedema 13.9%
... ...
0
0.5
1.0
Pneumonia analysis module
Viral pneumonia discrimination
COVID-19 detection
COVID-19 severity assessment
b
Developed using large-scale CXR images (n = 120,702)
External validation
CXR images from individuals physically examined (n = 24,500)
Common thoracic diseases
Trained on US and China dataset
CheXpert-P (n = 13,148)
CC-CXRI-P (n = 13,158)
CXR dataset
Tested on multiple countries
CXR
Retrospective and prospective pilot study
AI versus radiologists study
AI versus radiologists
Performance enhancement by AI
Pneumonia detection

通过CXR影像诊断和鉴别病毒性、非病毒性和新冠肺炎的深度学习系统

A deep-learning pipeline for the diagnosis and discrimination of viral, non-viral and COVID-19 pneumonia from chest X-ray images



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ARTICLES

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A deep-learning pipeline for the diagnosis and discrimination of viral, non-viral and COVID-19 pneumonia from chest X-ray images

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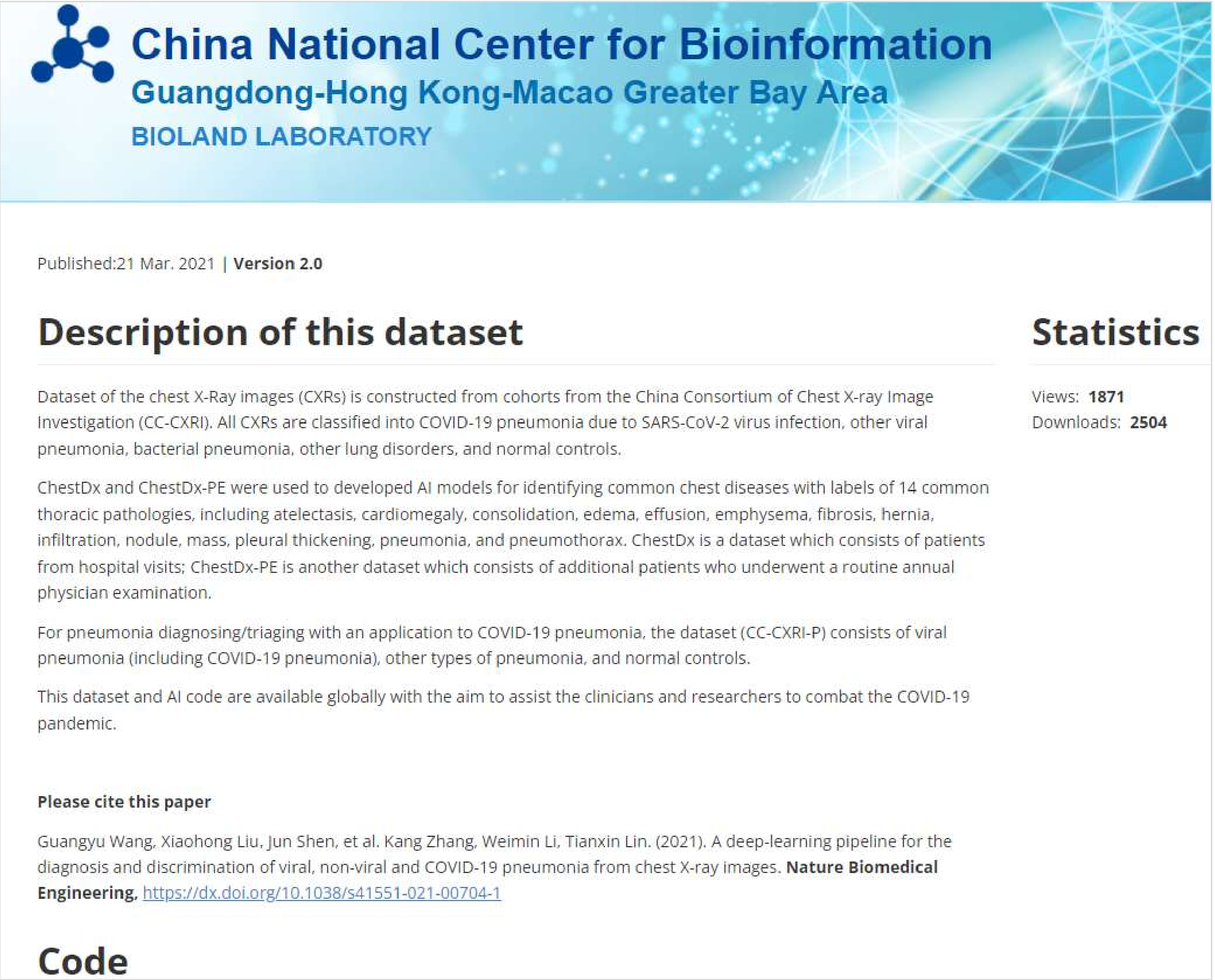

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Description of this dataset

Dataset of the chest X-Ray images (CXRs) is constructed from cohorts from the China Consortium of Chest X-ray Image Investigation (CC-CXRI). All CXRs are classified into COVID-19 pneumonia due to SARS-CoV-2 virus infection, other viral pneumonia, bacterial pneumonia, other lung disorders, and normal controls.

ChestDx and ChestDx-PE were used to developed AI models for identifying common chest diseases with labels of 14 common thoracic pathologies, including atelectasis, cardiomegaly, consolidation, edema, effusion, emphysema, fibrosis, hernia, infiltration, nodule, mass, pleural thickening, pneumonia, and pneumothorax. ChestDx is a dataset which consists of patients from hospital visits; ChestDx-PE is another dataset which consists of additional patients who underwent a routine annual physician examination.

For pneumonia diagnosing/triaging with an application to COVID-19 pneumonia, the dataset (CC-CXRI-P) consists of viral pneumonia (including COVID-19 pneumonia), other types of pneumonia, and normal controls.

This dataset and AI code are available globally with the aim to assist the clinicians and researchers to combat the COVID-19 pandemic.

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Code

Statistics

Views: **1871**
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該研究成果的數據庫和代碼掛載於國家生物信息中心粵港澳大湾区节点，與全世界分享，助力全球抗疫。 截至2022年2月17日統計，全球下載量已高達2500多次。

感謝各位的聆聽！

Thank you！

*本項目內容未經許可禁止轉載，違者必究。項目組負責人對內容擁有最終解釋權。