Health AI in Nepal: Excellence in Resource Constraints

Bishesh Khanal, PhD

bishesh.khanal@naamii.org.np

Founding Chairperson & Research Scientist,

NAAMII, Nepal

https://naamii.org

Advisor/Adjunct Faculty

Centre for Digital Technologies in Healthcare **(CDiTH) / IIIT Hyderabad, India**

12th National Summit of Health and Population Scientists in Nepal

National Health Research Council, Nepal

Kathmandu, Nepal

10 April 2026

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Other Engagements

Visiting Lecutures at Msc Public Health in University of Cambridge, UK

PhD Supervisions: Rochester Institute of Technology, USA; Duke University, USA; University of Barcelona, Spain; University of Tubingen, German.

Disclaimers, Conflict of Interests

- ***Terahs Technology (Co-founder; equity holding)***
- Tangible.careers (Co-founder; equity holding)
- Diyo.ai (Co-founder; equity holding)

Higher Education and Research

2004 – 2009
BE, Electronics Engineering

2010 – 2012
Msc: 1. Computer Vision (Robotics)
2. Computational Biology & Biomedicine

2012 – 2016
PhD, Computational Medicine

2017 – 2018
.Postdoc, Artificial Intelligence Healthcare

Co-founders of NAAMII

BE, Electronics Engineering

2004 200
9

Tribhuvan University
Institute of Engineering
Pulchowk campus

2010 201
2

Msc: 1. Computer Vision (Robotics)
2. Computational Biology & Biomedicine

POLYTECH NICE-SOPHIA
UNIVERSITÉ CÔTE D'AZUR

EPFL

PhD, Computational Medicine

2012 201
6

Inria
UNIVERSITÉ CÔTE D'AZUR

KING'S College LONDON
Imperial College London

2017 201
8

Postdoc, Artificial Intelligence for Fetal Ultrasound Imaging

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Established in 2018 as a company not-distributing profits

Building AI Excellence Ecosystems in the LMICs for an equitable world in the age of AI

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Building AI Excellence Ecosystems in the LMICs for an equitable world in the age of AI

Nepal's first multidisciplinary AI Center of Excellence

Vision

Improving Lives of People through scientific research and innovation

Building an Ecosystem: Through Three Pillars

Scientific Research

Education & Outreach

Industry & Innovation

Policy and Governance

Scientific Progress

Sectoral Impact

Global Equity

Advance Global AI Knowledge

Responsible AI & Global Reach

Build Capacity

Equitable Innovation

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Building an Ecosystem: Through Three Pillars

Scientific Research

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Global Equity

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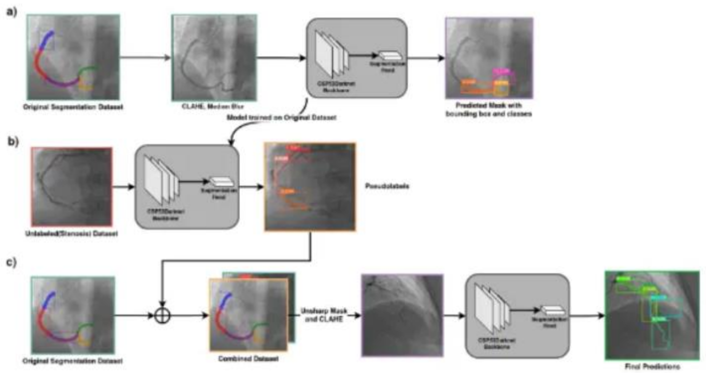
Scientific Research: Autonomous Research Groups

TOGAI (Transforming Global Health with AI)

TOGAI builds intelligent health technologies for low-resource settings. In a world where over 4.5 billion people lack access to essential healthcare, TOGAI tackles critical gaps in diagnostics, specialist access,…

Lead: Dr. Bishesh Khanal

+7

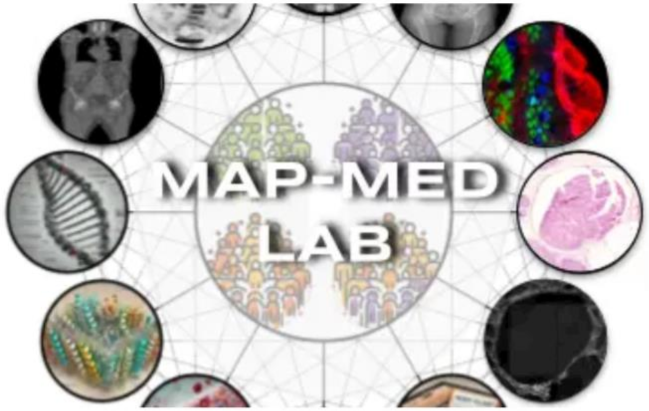


BBMMLL (B Bhattarai Multi-Modal Learning Lab)

The B Bhattarai MultiModal Learning Lab is at the forefront of developing robust and interpretable machine learning algorithms. Our mission is to pioneer algorithms that can reason across complex,…

Lead: Dr. Binod Bhattarai

RS RR PP +13



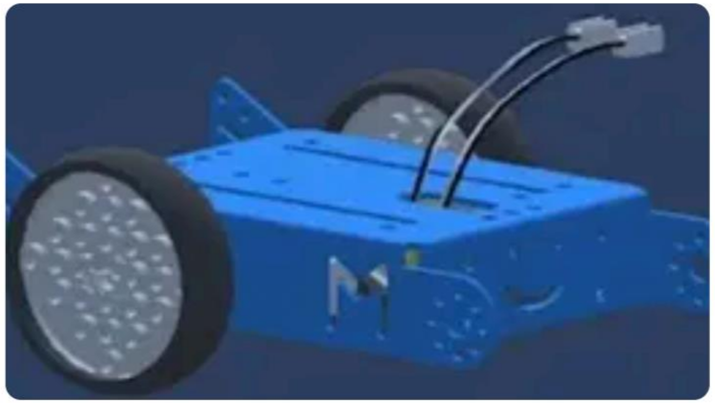
MAPMED (Multimodal Medical Data Analysis for Precision Medicine Lab)

MAPMED focuses on multimodal medical data analysis for decision support systems in radiomics and precision medicine. We specialize in analyzing multimodal medical imaging data, including PET, CT, MRI, and…

Lead: Dr. Taman Upadhaya | Dr. Suman Raj Bista

+6

Scientific Research: Autonomous Research Groups

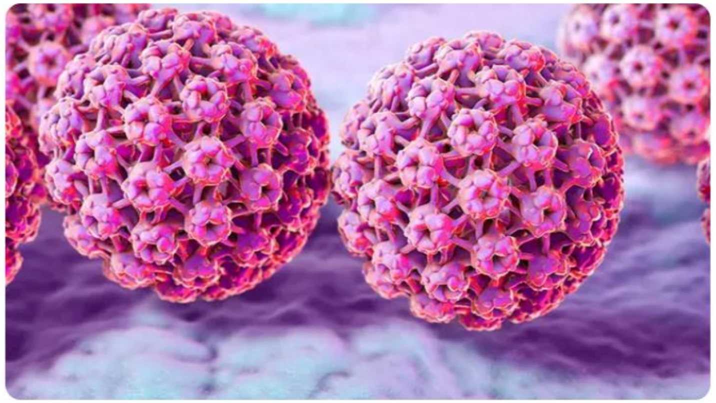


PUSHVIC (Providential Use of Spatial and Human Visual Computing)

PUSHVIC is at the forefront of research in Augmented Reality (AR), Robotics, and Computer Vision. We explore spatial computing and human visual perception to bridge the fundamental research to real-world…

Lead: Dr. François Rameau | Dr. Danda Pani Paudel

+6



CGL (Computational Genomics Lab)

CGL applies bioinformatics and machine learning to tackle pressing challenges in disease biology. Our research focuses on understanding the genomics of communicable and non-communicable diseases, wit…

Lead: Dr. Raunak Shrestha

SD

Agri AI (A²) Innovation Lab (AI for Conscious Living and Sustainable Agriculture)

A² Innovation Lab integrates cutting-edge technology with traditional farming wisdom to develop resilient, sustainable agricultural systems. Our mission centers on three foundational pillars: Climate-Smart Agricultur…

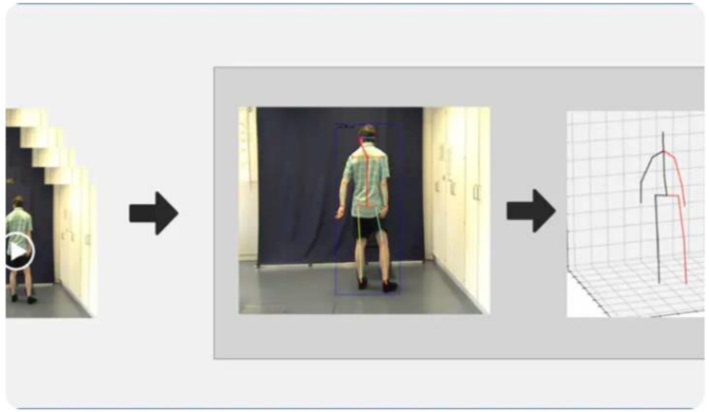
Lead: Dr. Bipendra Basnyat

Scientific Research: Autonomous Research Groups

TrAI (Translating Advances In Artificial Intelligence Into Health Services)

Our work translates the advances in artificial intelligence and digital health and the tools that it develops into health services, with a special focus on meeting the health needs of resource limited settings.…

Lead: Dr. Kiran Raj Pandey



RAIN (Research using Artificial Intelligence in Neuroscience)

The RAIN lab explores the intersection of AI and neuroscience, with emphasis on different neurological conditions and disorders.

Lead: Dr. Nabin Koirala

SB

AI & Society (Governance Lab)

The AI and Society group is committed to ensuring the responsible and ethical integration of AI into society. We develop tools and methods to enhance the public's understanding of AI and promote discussions about it…

Lead: Sandhya Sitoula

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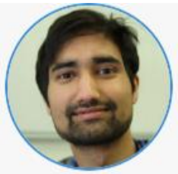
Research Groups Leb by: Adjunct Faculties (Borderless Groups)



Dr. Bishesh Khanal

Director / Research Scientist

Dr. Ajad Chhatkuli

Adj. Research Scientist

Dr. Binod Bhattarai

Adj. Research Scientist

Dr. Danda Pani Paudel

Adj. Research

Dr. Francois Rameau

Adj. Research Scientist

Dr. Nabin Koirala

Adj. Research Scientist

Dr. Prashnna K Gyawali

Adj. Research

Dr. Raunak Shrestha

Adj. Research Scientist

Prof. Dr. Sabita Maharjan

Adj. Principal Research

Dr. Sharib Ali

Adj. Research Scientist

Dr. Suman Raj Bista

Adj. Research Scientist

Dr. Taman Upadhaya

Adj. Research Scientist

Dr. Kiran Raj Pandey

Clinical Research Scientist

Dr. Bipendra Basnyat

Adj. Research Scientist

Dr. Buddhi Pathak

Adj. Research Scientist

ETH Zurich, Switzerland; INSAIT, Bulgaria; University of Aberdeen, UK;

University of Leeds, UK; University of Oxford, UK;

Imperial College London, UK; KAIST, Korea; Yale, USA; UCSF, USA;

University of Oslo, Norway; ...

NAAMII

Research Contributions

Published >75 research articles including Nature Digital Medicine, BMJ, MICCAI, CVPR, ECCV, NeuRIPS, MeDIA, TMI, …

Trained > 80 research staffs, supervised 5 Msc theses, PhD supervision (3, degrees from US;Spain;Germany), 2 Resident Doctor theses, 5 undergrad final year projects

Many top venues publications: **1st time from Nepal**

Won International Scientific Challenges competed by **top University labs globally**

Outline

Resource-Constrained Settings in Healthcare

Health AI in Resource-Constrained Settings with Examples from Nepal

Trustworthy AI in Healthcare

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Resource-Constrained Settings in Healthcare

Health AI in Resource-Constrained Settings with Examples from Nepal

Trustworthy AI in Healthcare

Resource-constrained Settings in Healthcare

Lack of experts

- Lack of medical doctors, radiologists in primary and community health care settings
- Overburdened Tertiary Health care centers (Big hospitals in urban centers)

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Other kinds of Resource-constraints?

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Lack of research and innovation

- Neglected Diseases
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- Emerging useful technology being inaccessible (e.g. chatbot due to language barrier)

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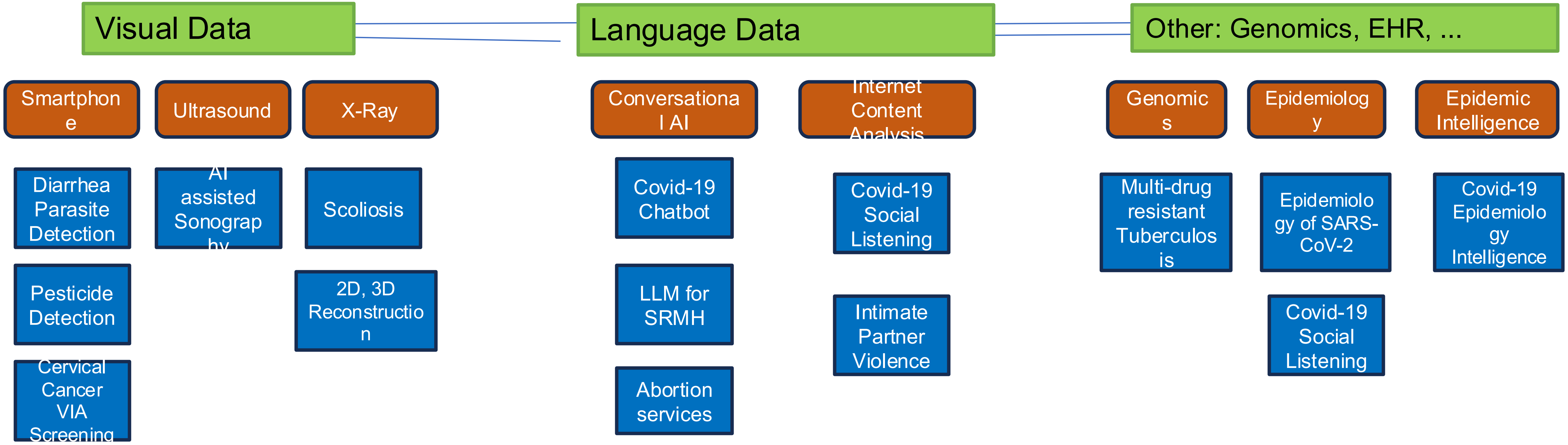
Resource-Constrained Settings in Healthcare

Health AI in Resource-Constrained Settings with Examples from Nepal

Trustworthy AI in Healthcare

TransfOrming Global health with AI (**TOGAI**)



Dental Hospital (with startup) OPG images auto-analysis
Telemedicine & AI integration in a hospital in Kathmandu:
- oral cancer
- otitis media
- Glaucoma and other eye diseases

TOGAI Themes

Empowering general-public for prevention and early detection

Broadening the scope of health services in primary and community health centers

Inventing new technology to enable health interventions previously not possible

Population-based studies to understand biology & for public health

Bringing access to information, quality health services, and rights to EVERYONE

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Pesticide Estimation with Low-cost Paper Device & AI App

Pesticides in Vegetables & Fruits

- Big problem in Nepal

What if:

- we go to pharmacy & buy a kit
- Grind vegetables
- See results of kit on Smartphone

Khanal, B., Pokhrel, P., **Khanal, B.**, & Giri, B. (2021). *Machine-Learning-Assisted Analysis of Colorimetric Assays on Paper Analytical Devices*. ACS omega, 6

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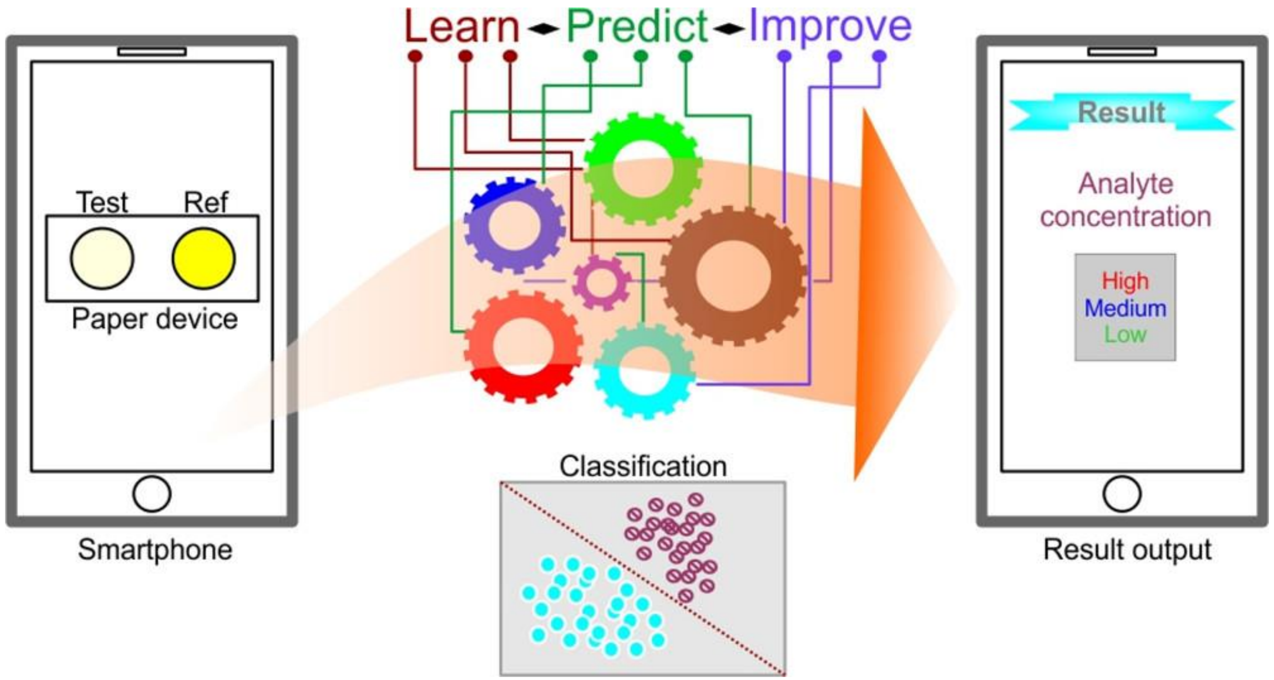

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Pesticide Estimation with Low-cost Paper Device & AI App

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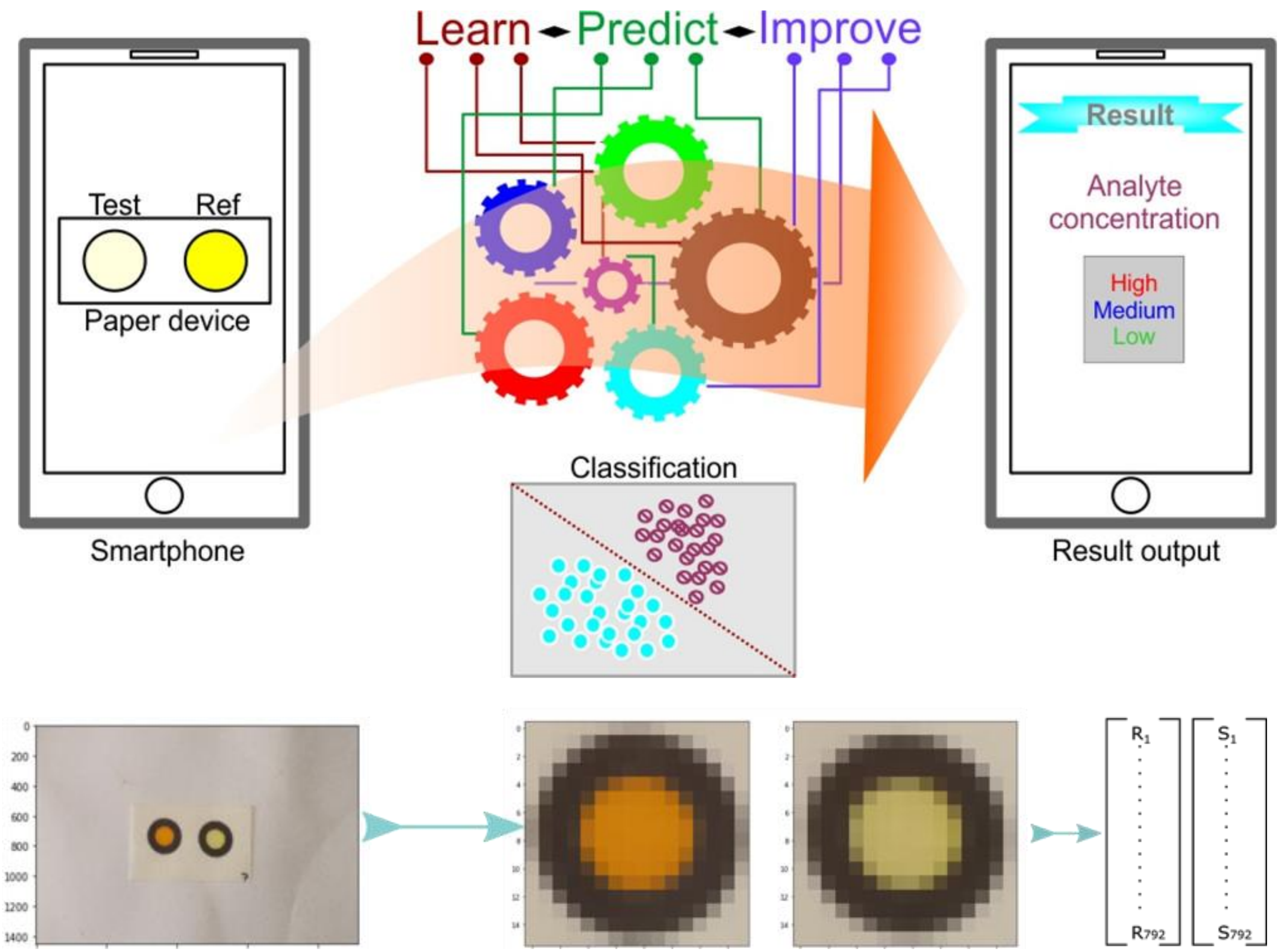
This could be possible for major family of pesticides!



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Kathmandu Institute of Applied Sciences

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AI-assisted Cervical Cancer Screening with Visual Inspection

Cervical Cancer

- Major type of cancer for women in Nepal (& many LMICs)
- Preventable if identified in pre-cancerous stage
- Can be cured if in early stage
- Visual Inspection with Acetic acid (VIA) most common screening in low-resource

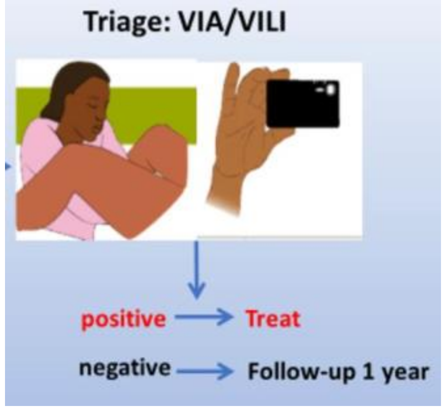
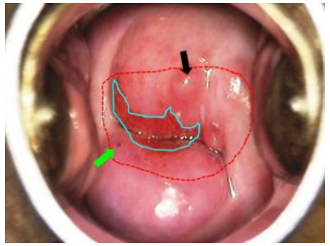


Image Source: Grohar D, et al. Scaling up community-based cervical cancer screening in Cameroon employing a single visit approach. IJGC 2020.

Problem

- Must screen large fraction of the women population but lack of experts



One Part of the Solution

- AI to assist non-experts (e.g. FCHVs, nurses) to do VIA more objectively & accurately

Poudel, K., Poudel, L., Shakya, P.R., Poudel, A., Shrestha, A. and **Khanal, B.**, 2024. *AI-Assisted Cervical Cancer Screening*. arXiv preprint arXiv:2403.11936.

Shrestha, A., Poudel, L., **Khanal, B.**, Poudel, K., Shakya, S., Timsina, P., Shakya, P., Shrestha, S. and Paneru, B., 2024. *Community-based Screening of Cervical Cancer in an Urban Setting in Nepal: A Cross-sectional Study*. Kathmandu Univ Med J, 88(4), pp.413-8.

Ultrasound (US) Imaging

https://becominghuman.ai/ultrasound-on-a-chip-supercharged-with-ai-the-most-disruptive-technology-in-radiology-b2684b0421aa

Advantages
- Portable
- Low-cost [Few Lakhs]
- High temporal resolution
- No radiation

Ultrasound (US) Imaging

Advantages
- Portable
- Low-cost [Few Lakhs]
- High temporal resolution
- No radiation

Challenges
- Limited Field of View
- Operator dependent
- High level expertise required

AI-Assisted Ultrasound (US) Imaging

- Consistency across operators
- Reliable, fast & easy diagnosis
- Enable Non-experts to do US imaging

US Imaging: Need to find right views -> detect -> measure, real-time

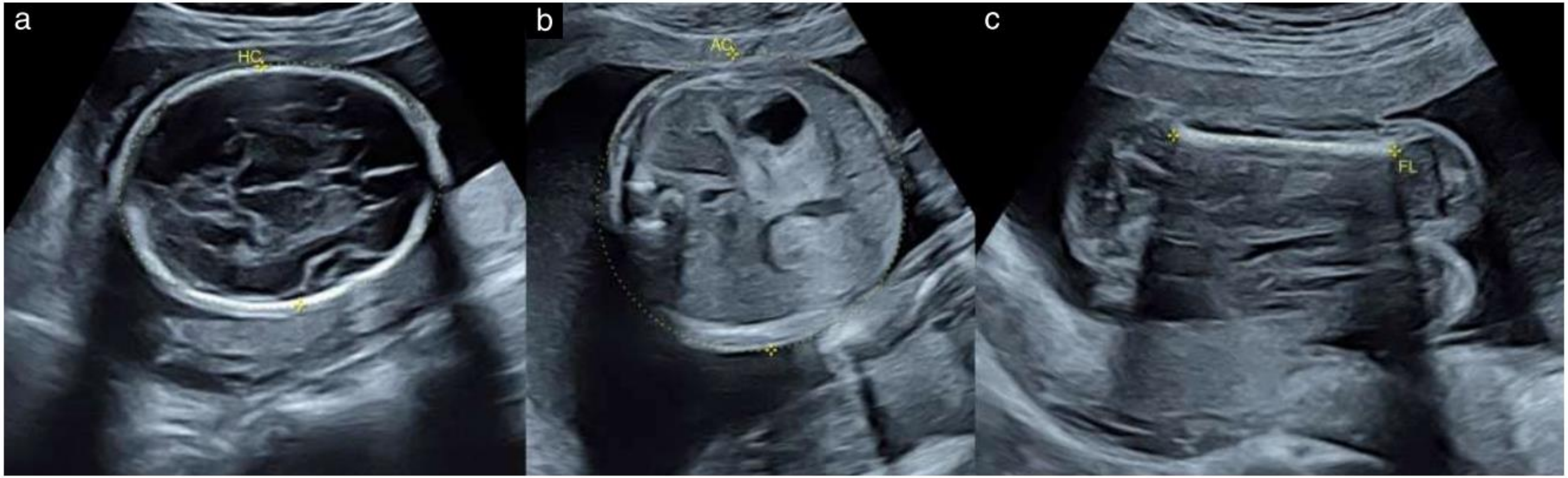


Figure 1 Standard fetal biometry. Sonographic measurements of: (a) head circumference (HC), (b) abdominal circumference (AC) and (c) femur length (FL).

Clinical Standards Committee. ISUOG Practice Guidelines (updated): performance of the routine mid-trimester fetal ultrasound scan. 2022.

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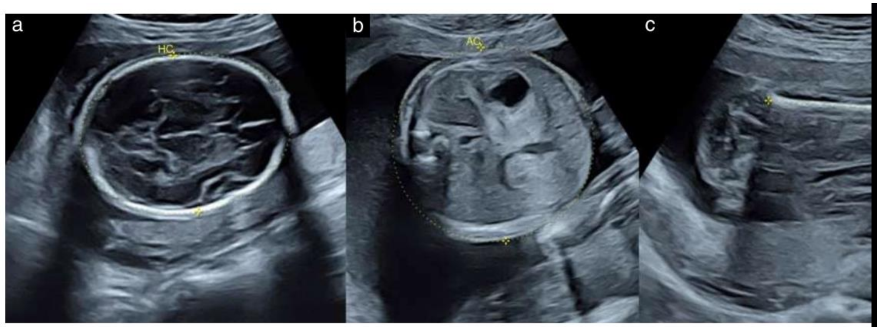

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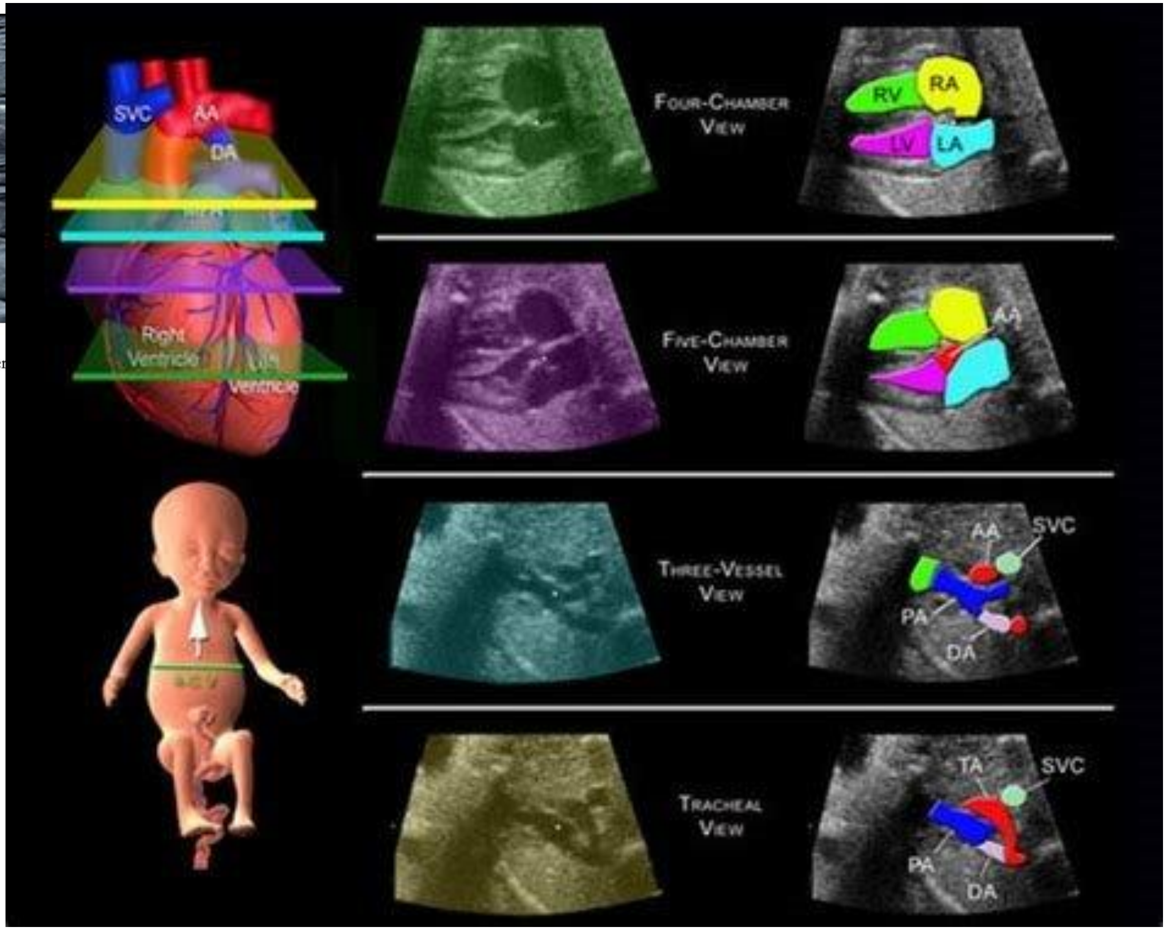

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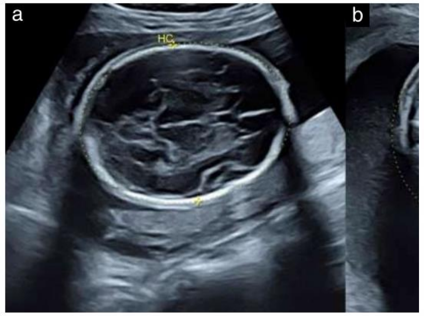

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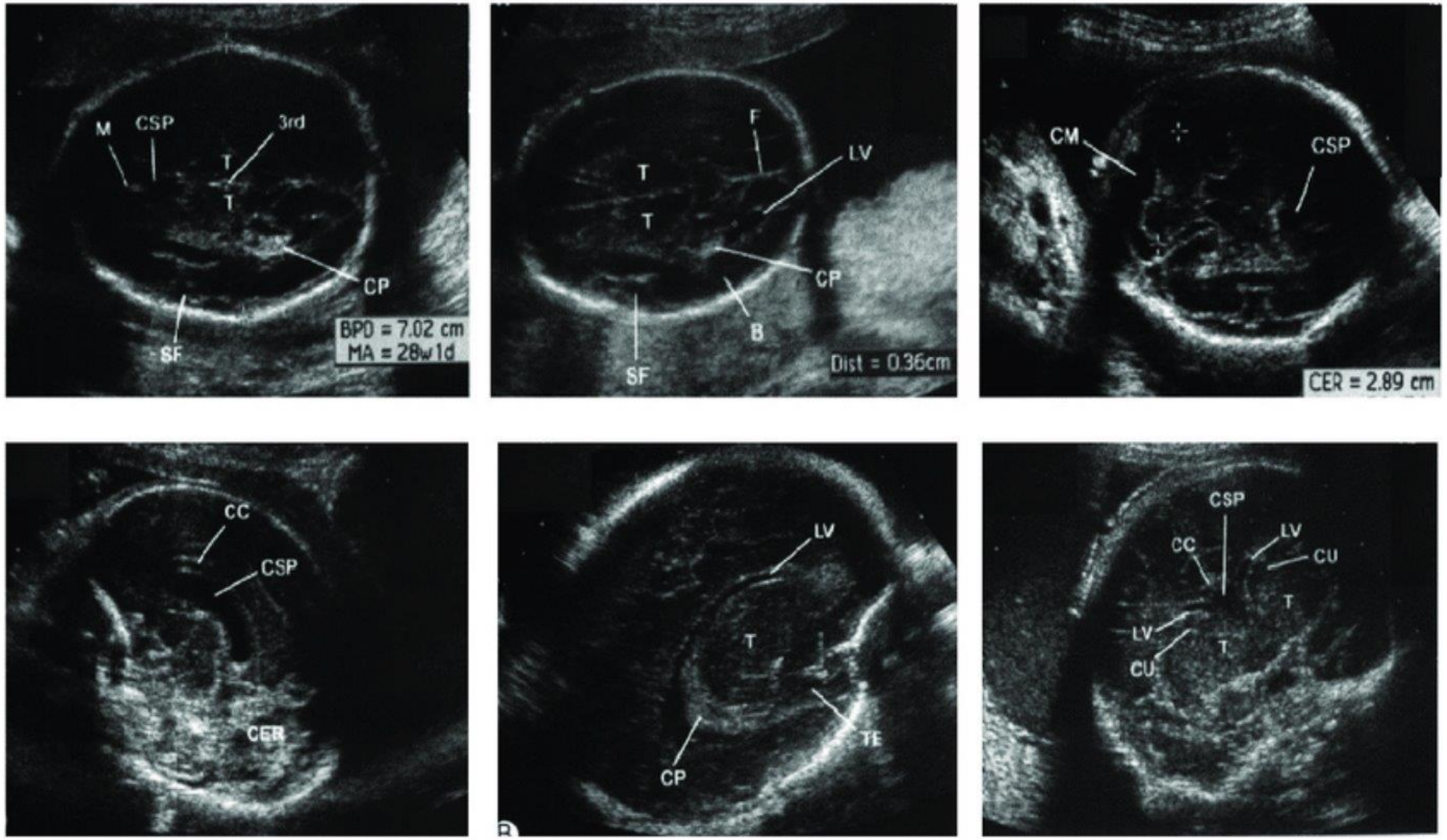


Samples of the six fetal brain standard planes.

Clinical Standards Committee. ISUOG Practice Guidelines (updated): performance of the routine mid-trimester fetal ultrasound scan. 2022.

How do we bring AI to the picture?

Automatic view classification and measurements: probe handling by experts

- **Most common and many models proposed for various anatomy and anamoly**

Guidance to non-expert users to find right views and aid (or auto) measurements

- **Relatively unsolved and many open problems**

How do we bring AI to the picture?

Automatic view classification and measurements: probe handling by experts

- **Most common and many models proposed for various anatomy and anamoly**

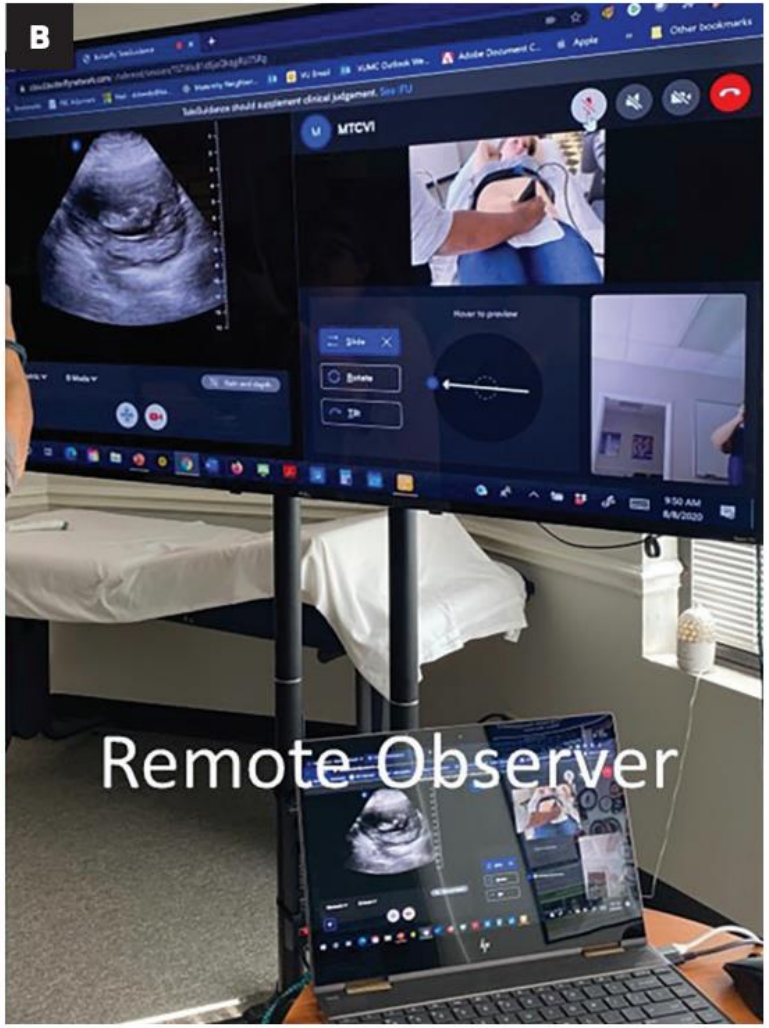
Guidance to non-expert users to find right views and aid (or auto) measurements

- **Relatively unsolved and many open problems**

Can we just take videos by sweeping the probes everywhere and then analyse?

Teleradiology Solution ?

Figure 1. Use of a handheld ultrasound unit by a local sonographer (A), while a remote instructor observes the sonographer via video and identical screen in real time. (B)



Diana L. Dowdy, and Robert D. Harris (2024). Global Health Imaging. Applied Radiology.

Teleradiology Solution ?

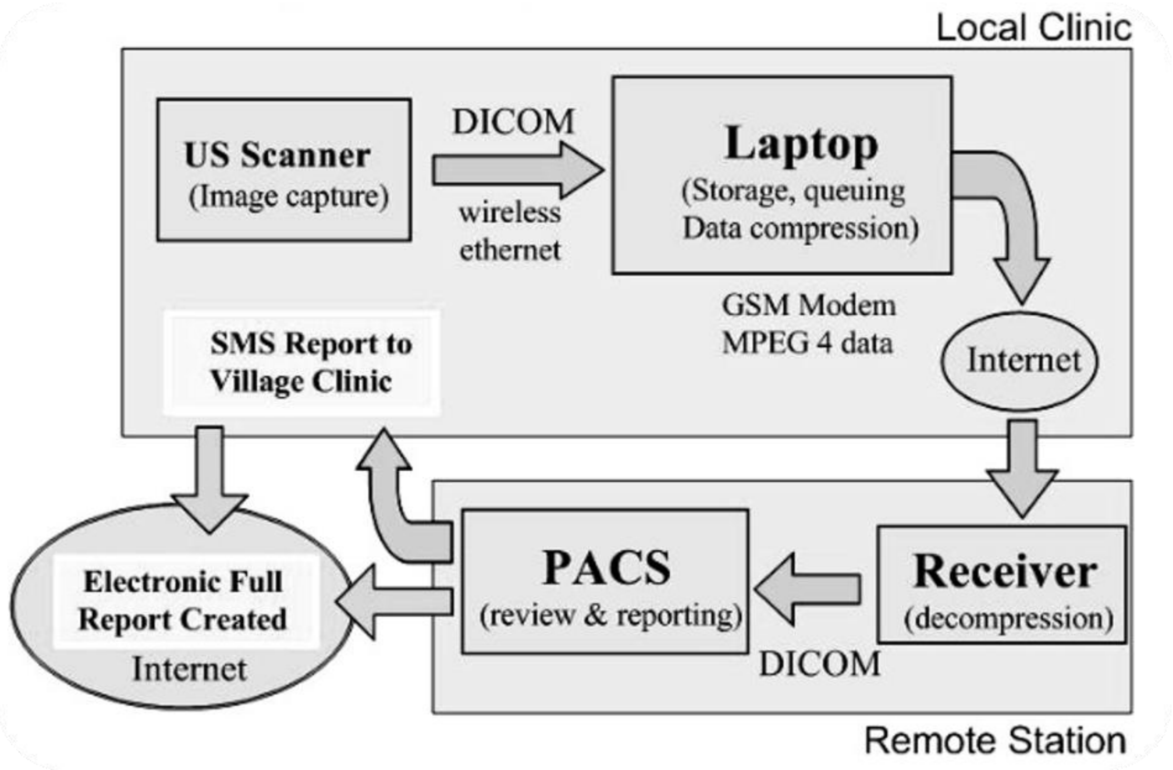
Hard to scale!

Good internet connection often not available (where this solution is required)

Need for experts to sync working hours with remote health workers for real-time feedback

Experts typically already burdened

Teleradiology Solution Explored in Early 2010s



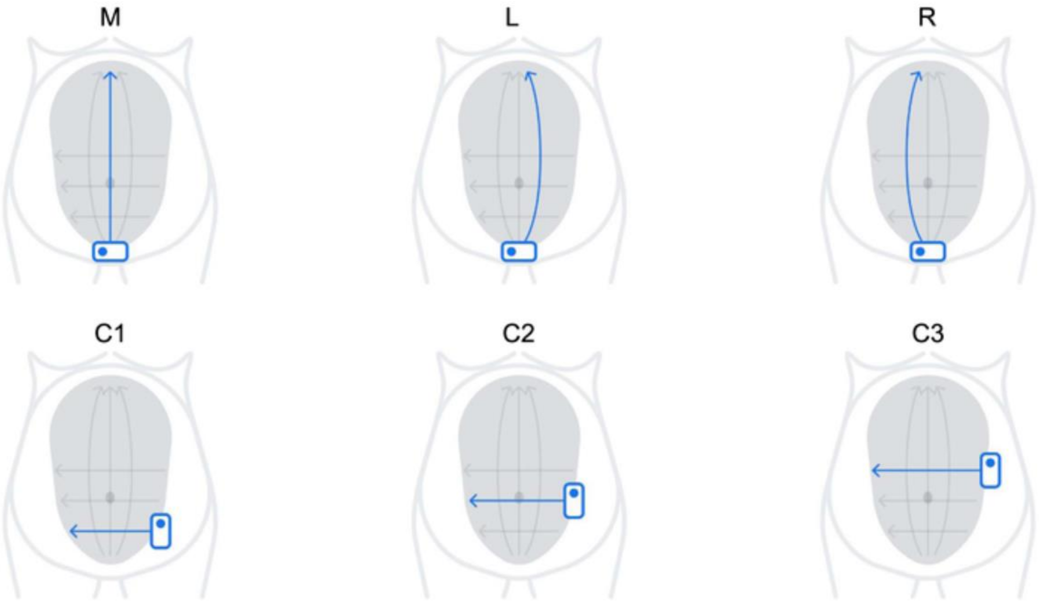
Destigter, Kristen *et al* (2011). Low-Cost Teleradiology for Rural Ultrasound. Proceedings - 2011 IEEE Global Humanitarian Technology Conference, GHTC 2011. https://www.philips.com/c-dam/corporate/about-philips/sustainability/healthy-people/fabric-of-africa/programs/Low-cost-teleradiology.pdf

Blind Sweep Videos; First Protocols by Imaging the World, 2011

Blind-sweep by non-experts using easy to follow protocol

Analysed later by experts

Transverse Center Pelvis
Midline (Pelvic Bone to Breast Bone)
Notch towards Patient's Right



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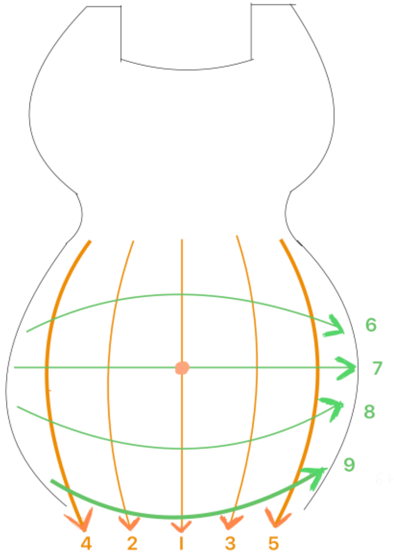
AI-Assisted Task-shifting for Rural Obstetrics Ultrasound

PI: Bishesh Khanal



Multi-country research

- Africa and South Asia
- AI-powered task shifting
- Funded by: Gates Foundation

Data Collection

- 2000 fetal Blind Sweep ultrasound videos
- Big teaching hospital in urban setting + community health center in a rural setting
- Data collection using 8 "blind sweeps"
- "blind" => following specific directions without considering fetal positions

AI-Assisted Task-shifting for Rural Obstetrics Ultrasound

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Gates Foundation

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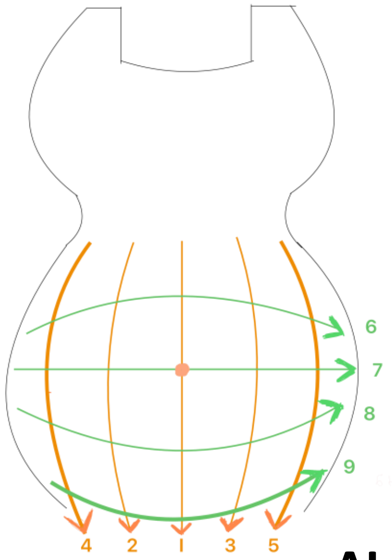

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- "blind" => following specific directions without considering fetal positions

AI-powered Quality Assessment for Blind Sweep

- Real-time high-quality acquisition of blind sweep

GE HealthCare

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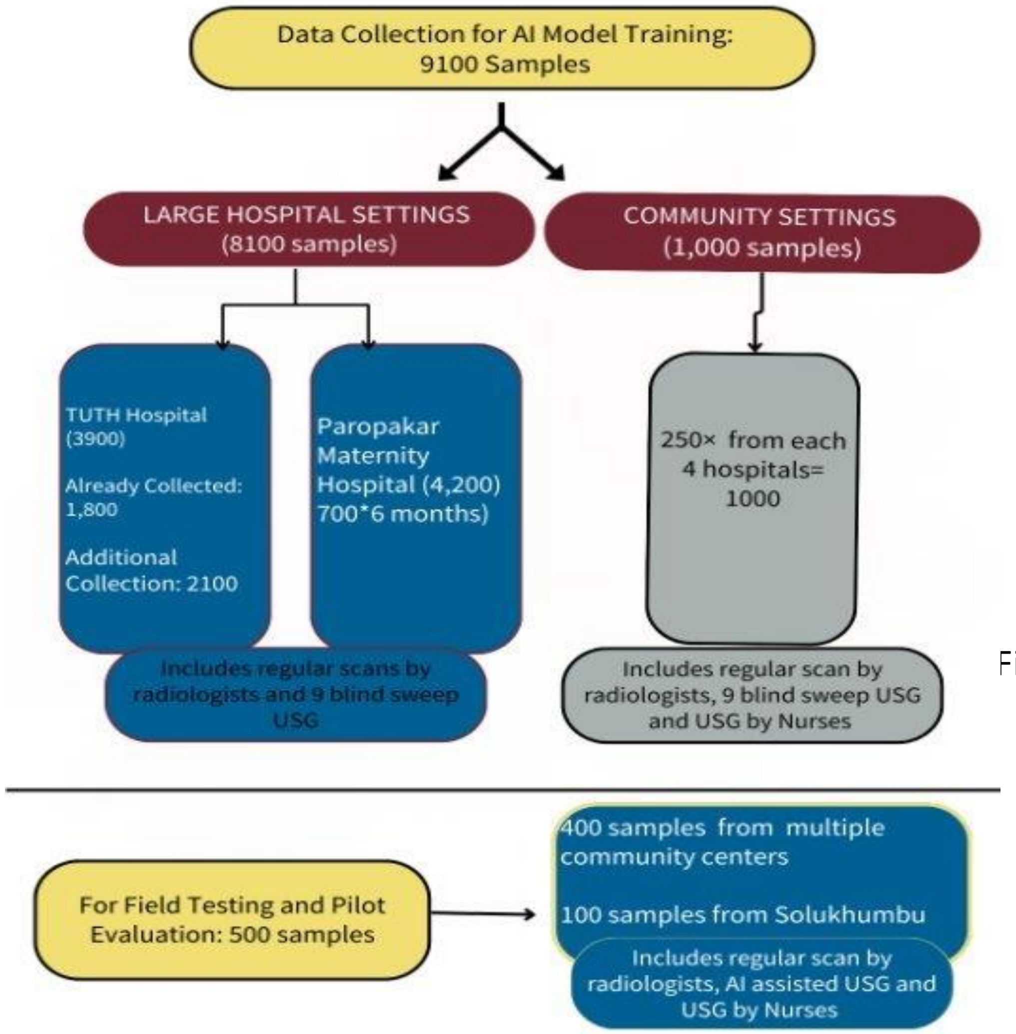
AI-Assisted Task-shifting for Rural Obstetrics Ultrasound

NAAMII
Maharajgunj Medical Campus
PI: Bishesh Khanal; Co-I: Pradeep Raj Regmi
IDRC · CRDI
International Development Research Centre
Centre de recherches pour le développement international
Canada
AI SAROSH



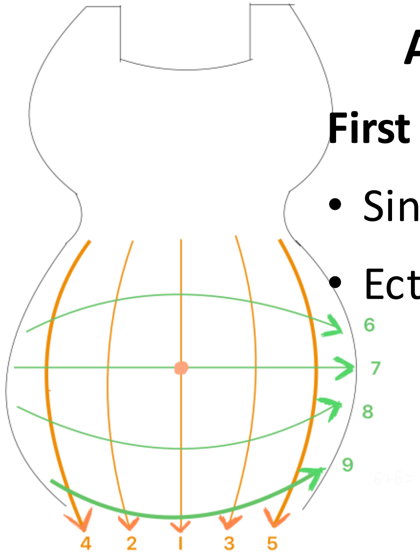


Fig 1. 9 sweep protocol

Abnormalities Selected and AI tasks

First trimester:

- Single vs multiple pregnancy
- Ectopic vs non-ectopic

Second trimester:

- Placental location
- Cervix Shape

Third trimester:

- Same as 2nd + Fetal orientation

Objective

- Improve FUS in primary and rural health centers
- AI-powered task shifting
- Automatically identify life-saving obs.emergencies

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Resource-Constrained Settings in Healthcare

Lack of experts

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- CT Scans and MRIs are expensive; more advanced expensive not available
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- Neglected Diseases
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Bi-planar X-ray to 3D reconstruction

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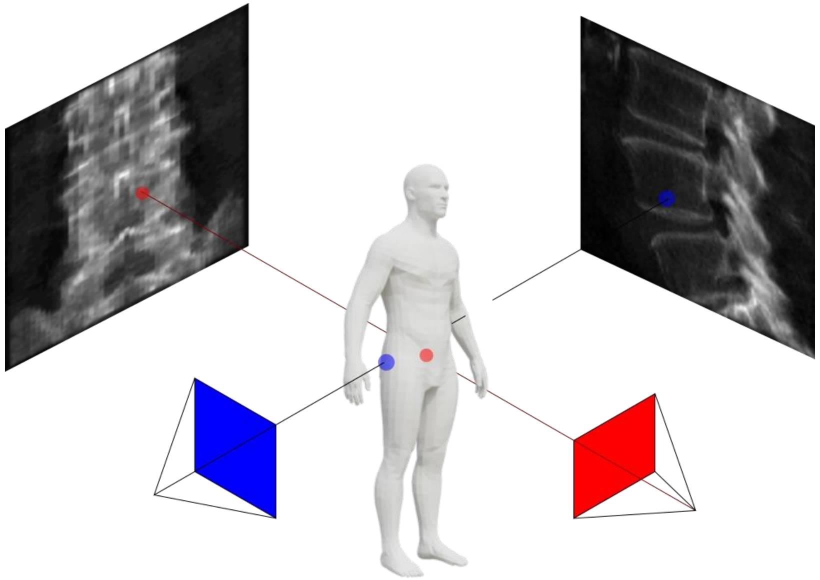


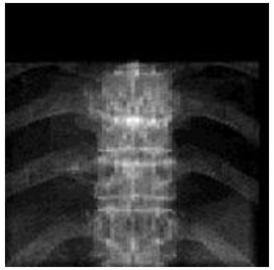
Biplanar X-ray

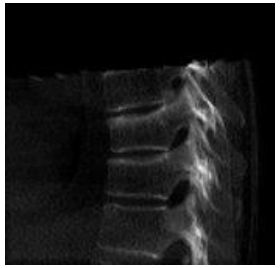
Reconstructed 3D Shape

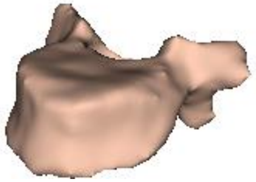
Augments low cost, low radiation X-ray device with CT-like 3D visualization

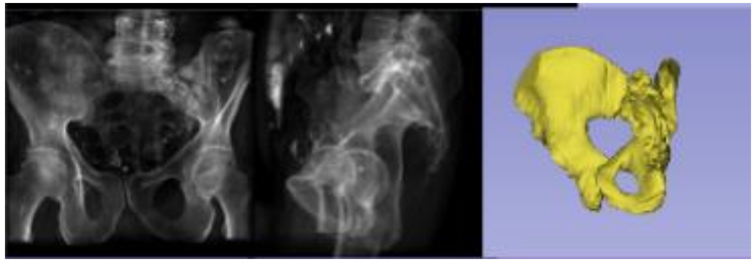
Improved diagnosis, surgery planning and navigation, better biomarkers

Alternate to Expensive/Unavailable CT-Scan?

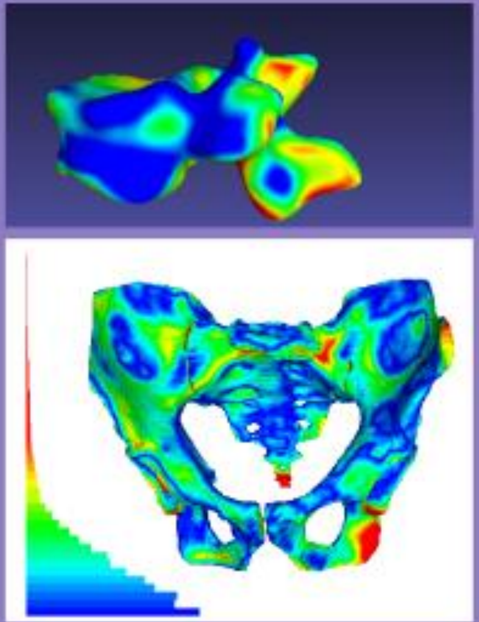








How do current state of the art perform in public dataset? (Not as well as reported.)



Error: Red, Green, Blue color denote positive, zero and negative distance to ground truth. Avg reconstruction error 2.5 mm Trained on the challenging public Vertebra Dataset (VerSe[1]).

Mahesh Shakya & **Bishesh Khanal**. Benchmarking X-ray 2D-3D reconstruction models and moving towards clinical translation. Neural Information Processing Systems (NeurIPS) Datasets and Benchmark Track, 2023..

Resource-Constrained Settings in Healthcare

Lack of experts

- Lack of medical doctors, radiologists in primary and community health care settings
- Overburdened Tertiary Health care centers (Big hospitals in urban centers)

Lack of devices, algorithms, or technologies

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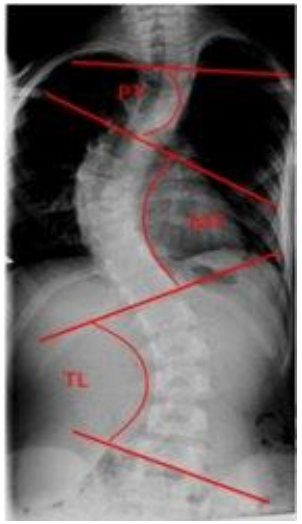
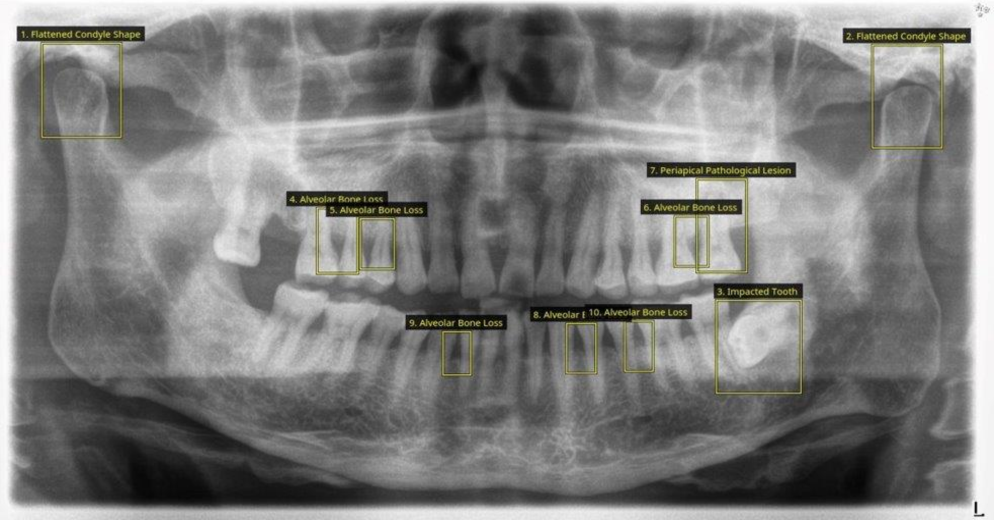
Lack of research and innovation

- Neglected Diseases
- Inability to solve problems quickly: Dengue is killing more & more people in Kathmandu
- Emerging useful technology being inaccessible (e.g. chatbot due to language barrier)

X-ray Imaging





Advantages

- Portable
- Low-cost
- Widely available

Challenges

- Under-reported

https://becominghuman.ai/ultrasound-on-a-chip-supercharged-with-ai-the-most-disruptive-technology-in-radiology-b2684b0421aa

विशेष रिपोर्टः बालबालिका हुर्काउँदा हुने त्रुटिले किशोरावस्थामै बाङ्गिन थाल्यो उनीहरूको हड्डी

- सबिना देवकोटा

| मंगलबार, भदौ १, २०७८

दुई वर्षअघिको कुरा हो । भक्तपुर, बालकोटकी १४ वर्षीया लिजा दाहालको शरीर एकाएक अस्वाभाविक देखिन थाल्यो । कताकता बाङ्गो भएर हिँडेजस्तो देखिने उनको शरीर बस्दा पनि कुप्रो परेर बसेजस्तो देखियो ।

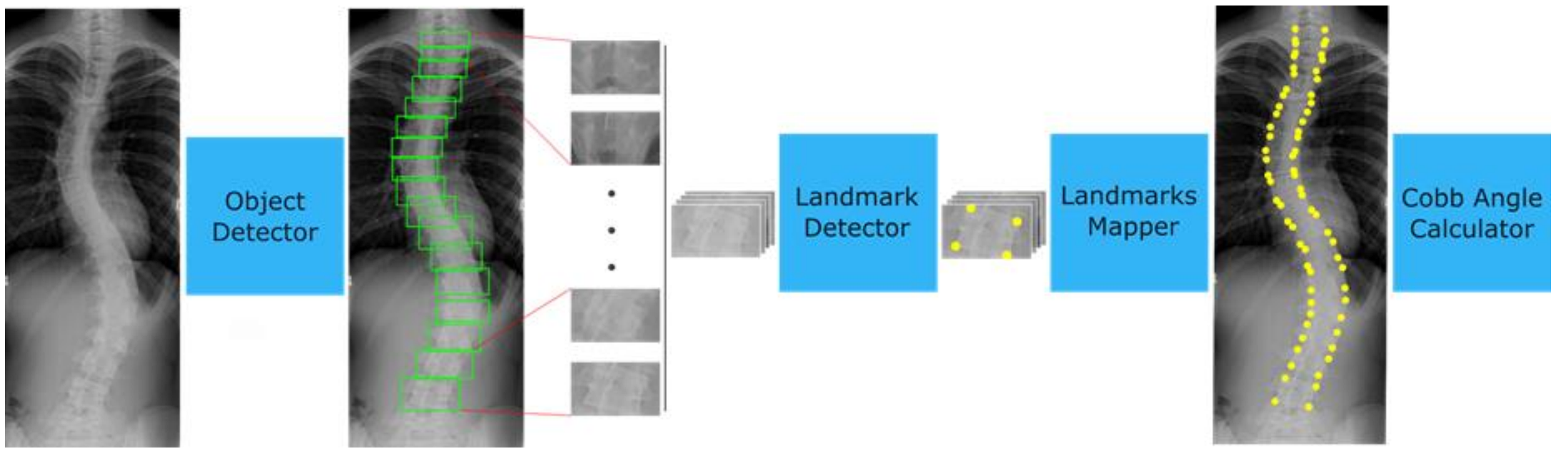
पौडेल भन्छन्, 'स्केरोसिस' जन्मजातै हड्डीमा हुने खराबीले निम्ताउने रोग हो ।' यद्यपि पछिल्लो समय यो रोग जन्मजात मात्रै नभएर लिजालाई झैं अव्यवस्थित जीवनशैली र खानपिनका कारण अधिकांश बालबालिका तथा किशोरावस्थामा देखिन थालेको पौडेल बताउँछन् ।

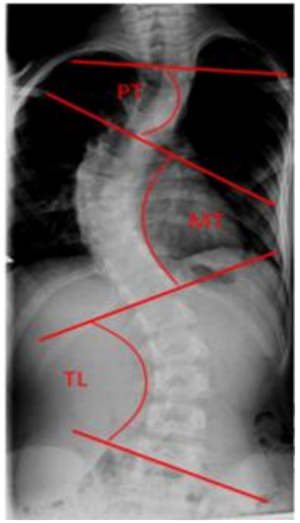
तिनैमध्येका अर्का एक हुन्, कालिमाटीका १३ वर्षीय सुप्रिम अधिकारी ।

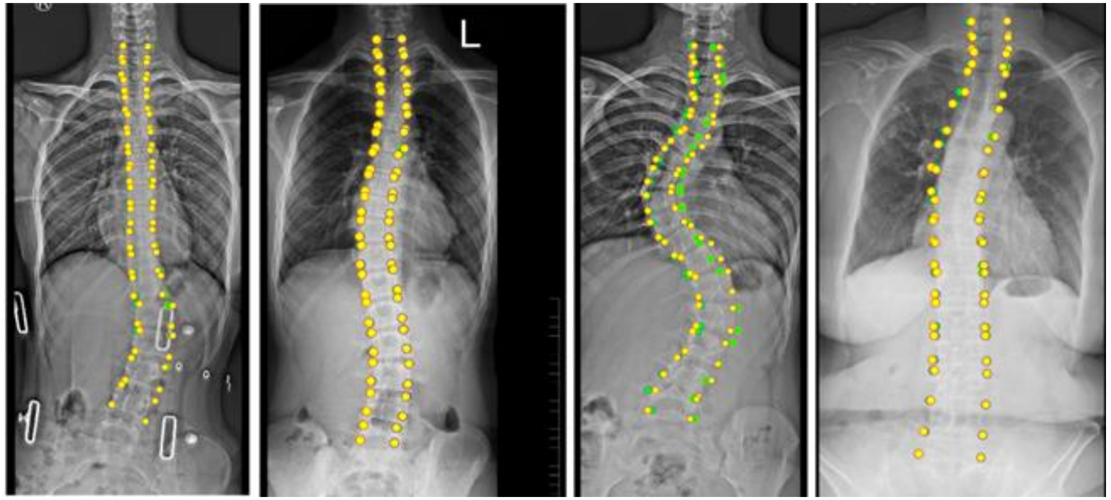
ग्रान्डी, टिचिङलगायत उपत्यकाका विभिन्न अस्पतालहरूमा दाहाल परिवार चहार्दै गर्दा (एक्स-रे, एमआरआई, सिटी स्क्यान) परीक्षण गरेपछि थाहा भयो, लिजाको मेरुदण्ड ४५ डिग्रीमा बाङ्गिसकेको रहेछ । चिकित्सकहरूले तत्काल

https://shilapatra.com/detail/64897

Scoliosis Management: Automatic Cobb-Angle Detection





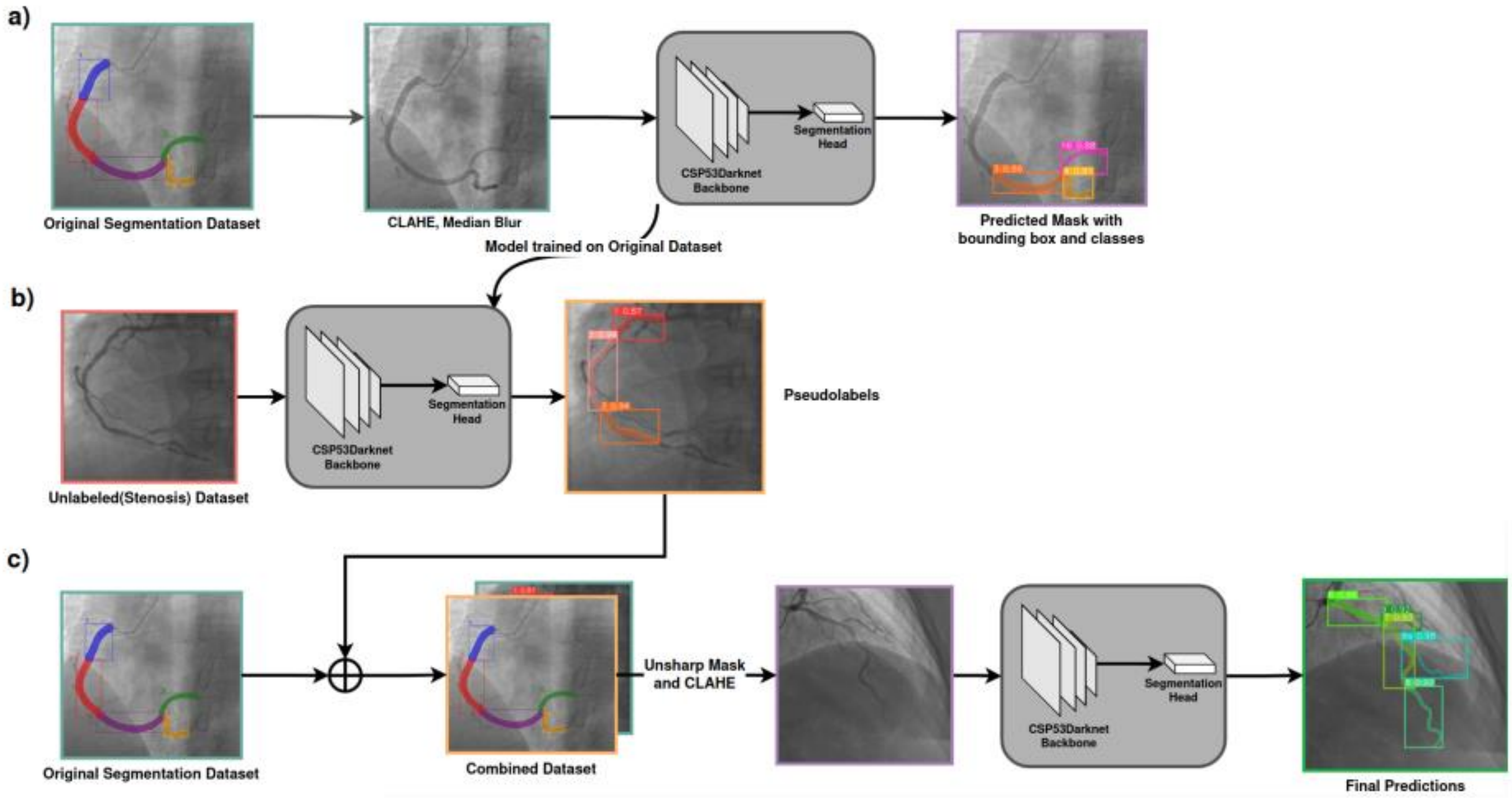


Scoliosis

- Common in adoloscents
- Permanent disability or fatal if untreated
- Cobb angle an important marker
  - Tedious to measure Cobb-angle
  - High inter-rater variability

Khanal, B., Dahal, L., Adhikari, P., & **Khanal, B**. Automatic Cobb Angle Detection using Vertebra Detector and Vertebra Corners Regression. *Workshop MICCAI 2019*.
Sheng, L., …, **Khanal, B.**, et al. Evaluation and comparison of accurate automated spinal curvature estimation algorithms with spinal anterior-posterior X-Ray images: The AASCE2019 challenge. *Medical Image Analysis 2021*.

Arterial Segmentation & Stenosis Detection in X-ray Angiography



Binod Bhattarai Lab @ NAAMII

Pokhrel, S., …, and **Bhattarai, B**. Cross-Task Data Augmentation by Pseudo-label Generation for Region Based Coronary Artery Instance Segmentation. Data Engineering in Medical Imaging (DEMI), MICCAI Workshop 2024.

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Low-cost Smartphone-sized Microscopes to Detect Parasites?

Easily Deployable

Automated and Scalable

Monitoring consistently across geoghraphies

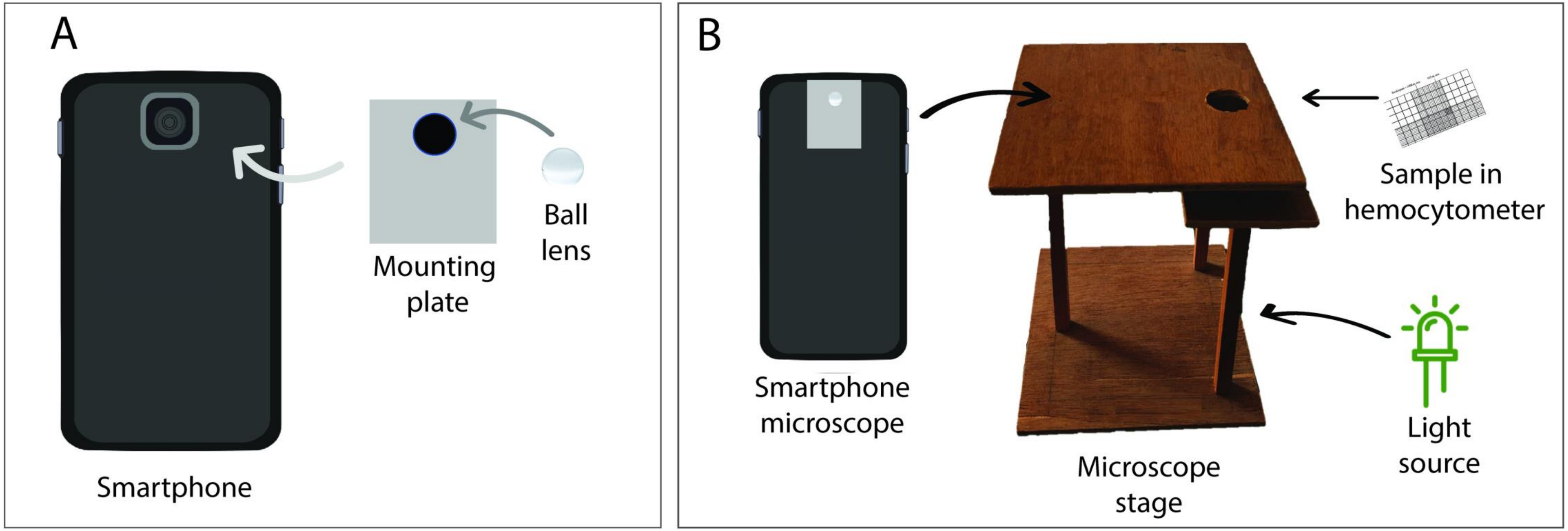
NAAMII

A smartphone microscopic method for simultaneous detection of (oo)cysts of *Cryptosporidium* and *Giardia*

Retina Shrestha, Rojina Duwal, Sajeev Wagle, Samiksha Pokhrel, Basant Giri, Bhanu Bhakta Neupane

PLOS Neglected Tropical Diseases

Published: September 8, 2020 • https://doi.org/10.1371/journal.pntd.0008560



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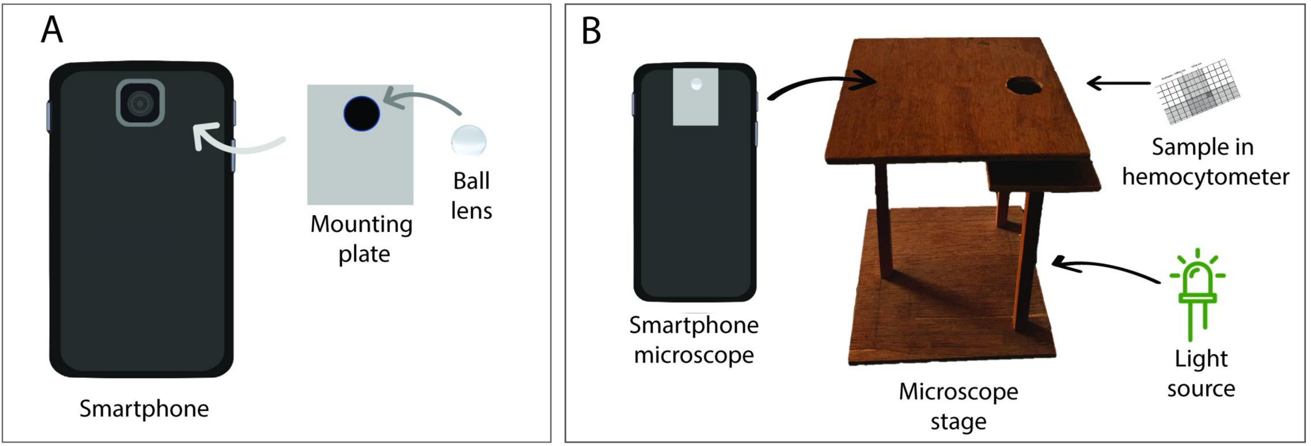
Smartphone Microscopy for Detecting cysts of Parasites



Diameter of ball lens (mm)	Clear field of view (µm)
0.5	114±6
1	203±6
2	490±10

https://doi.org/10.1371/journal.pntd.0008560.t001

Kathmandu Institute of Applied Sciences

A smartphone microscopic method for simultaneous detection of (oo)cysts of *Cryptosporidium* and *Giardia*

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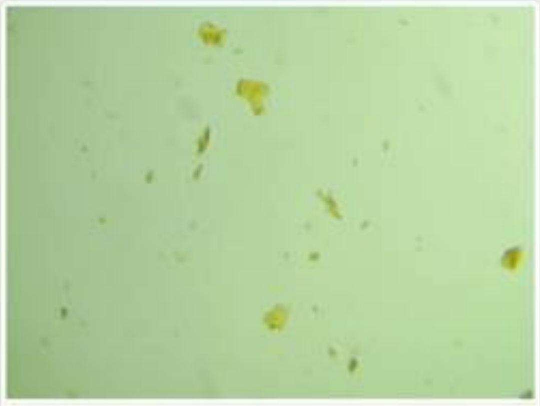
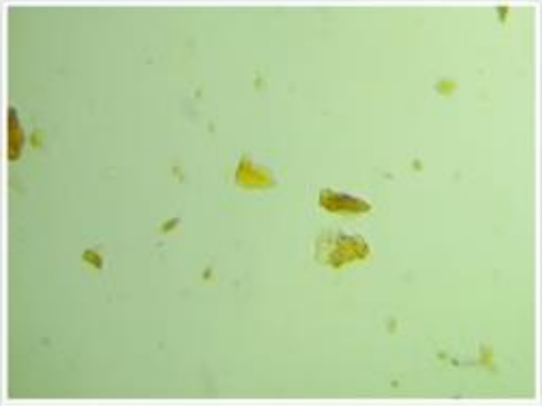
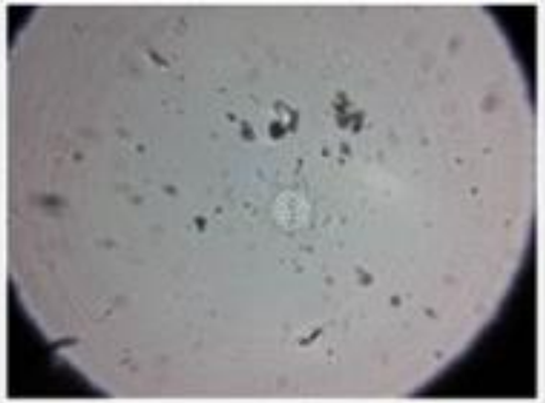
PLOS Neglected Tropical Diseases Published: September 8, 2020 • https://doi.org/10.1371/journal.pntd.0008560

Traditional Brightfield Microscope vs Smartphone Microscope







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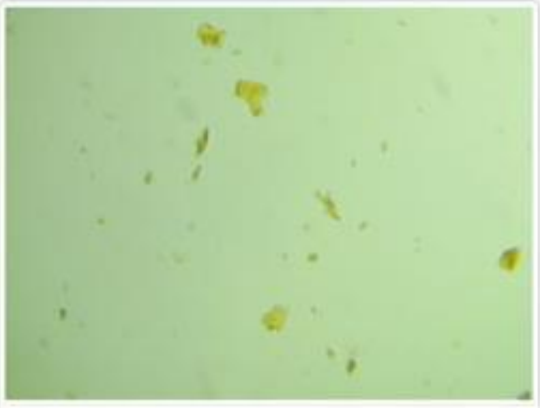
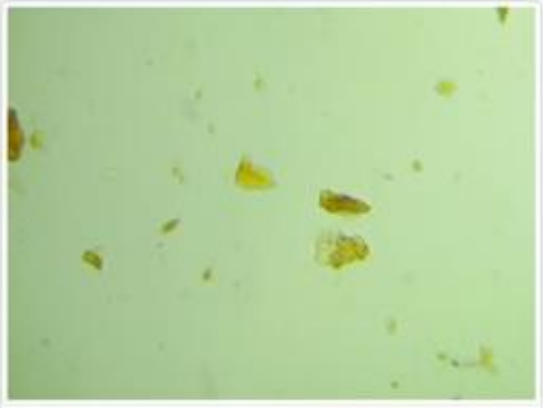
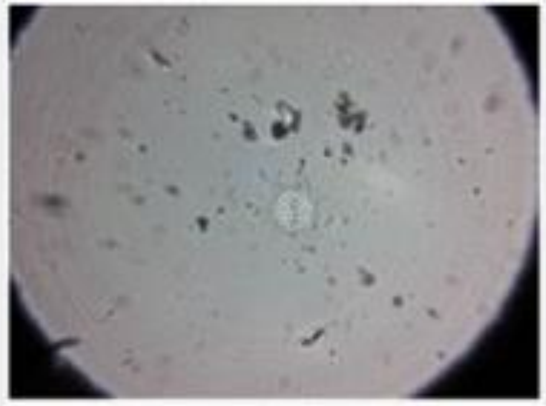
Microscopes can be Deployed, but Expertise to Detect Parasites?







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AI-powered Smartphone Microscopy

AI Models to Identify the Diarrhea Causing Parasites in Smartphone Microscope Images

AI-powered Smartphone Microscopy

AI Models to Identify the Diarrhea Causing Parasites in Smartphone Microscope Images

South – South Collaboration (+ in country collaboration) , not so common!

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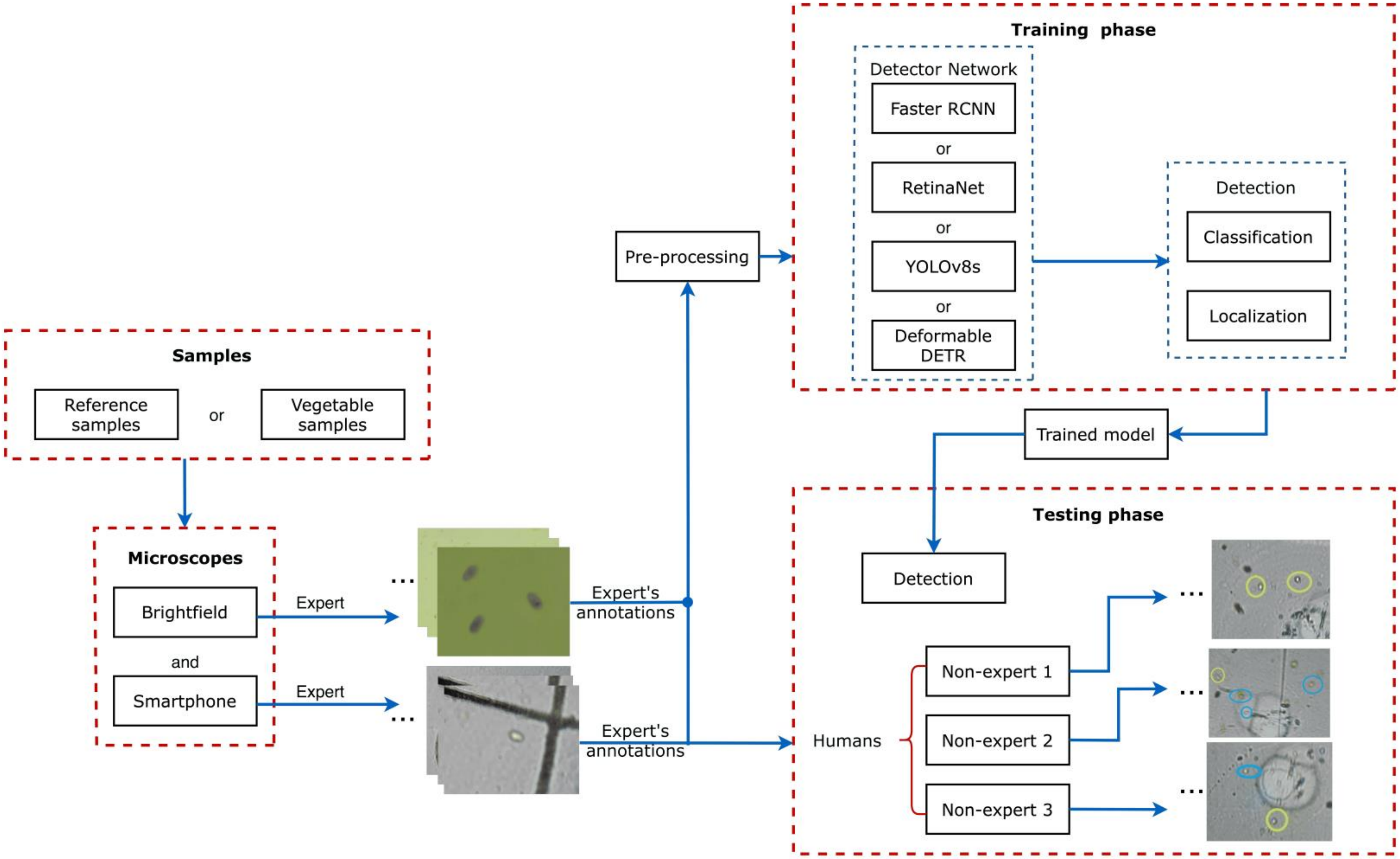
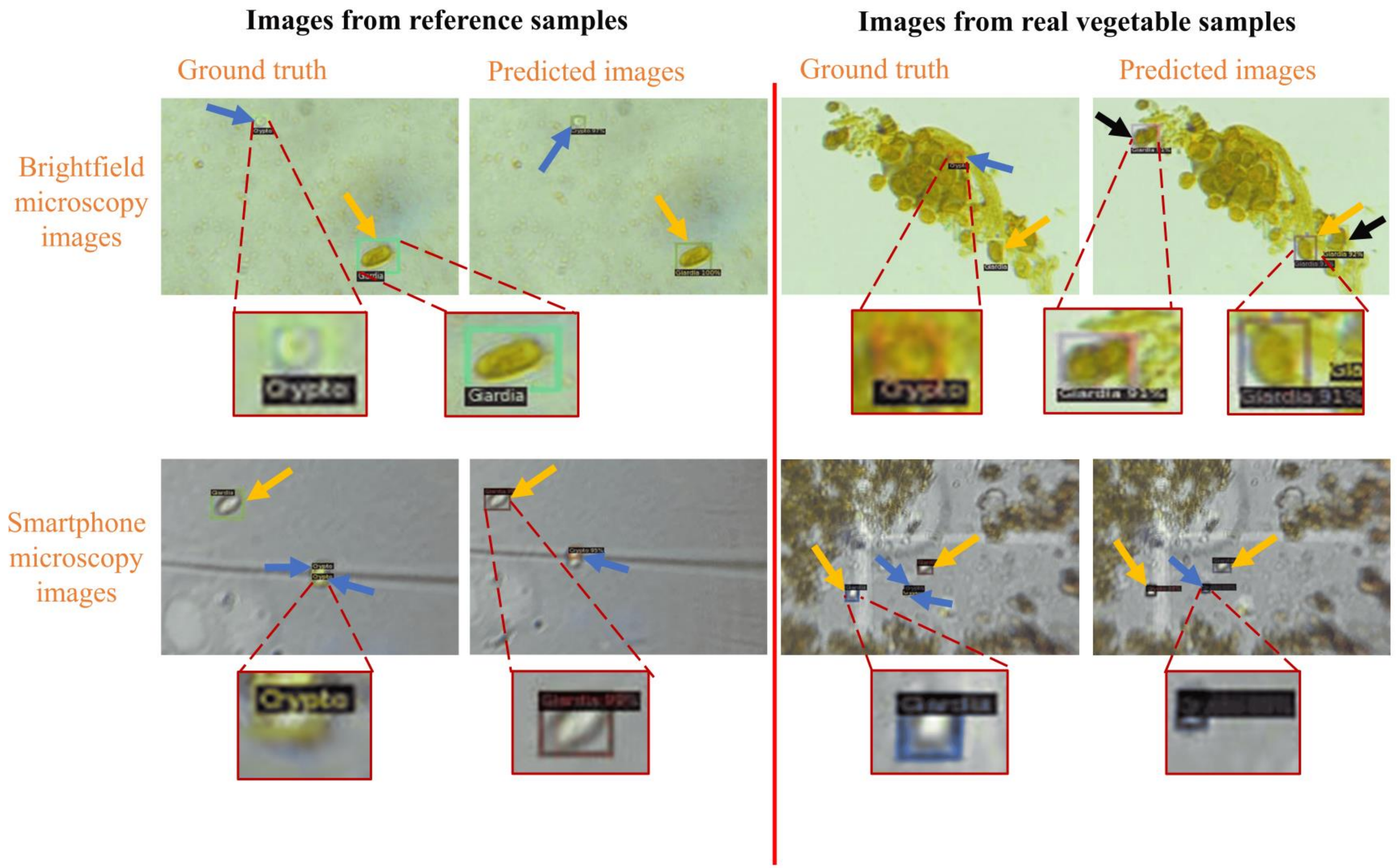
AI-powered Smartphone Microscopy



AI-powered Smartphone Microscopy



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AI-powered Smartphone Microscopy

Dataset	No. of images	Microscopes	Giardia's annotation	Cryptosporidium's annotation
Reference sample	830	Smartphone	839	534
		Brightfield	907	502
Vegetable sample	1005	Smartphone	439	796
		Brightfield	344	740
Test (vegetable sample)	193	Smartphone	165	137

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AI-powered Smartphone Microscopy

Dataset	**Models**	**Thresholds**	**Precision**	**Recall**	**F1-score**
		Giardia			
Reference Sample	Faster RCNN	$c = 0.7, i = 0.4$	**0.957** $\pm$ 0.014	0.968 $\pm$ 0.018	0.962 $\pm$ 0.007
	RetinaNet	$c = 0.5, i = 0.5$	0.917 $\pm$ 0.017	0.946 $\pm$ 0.013	0.931 $\pm$ 0.011
	YOLOv8s	$c = 0.4, i = 0.3$	0.954 $\pm$ 0.016	**0.975** $\pm$ 0.010	**0.965** $\pm$ 0.010
	Deformable DETR	$c = 0.4, i = 0.2$	0.864 $\pm$ 0.037	0.870 $\pm$ 0.014	0.867 $\pm$ 0.021
Vegetable Sample	Faster RCNN	$c = 0.8, i = 0.5$	0.783 $\pm$ 0.024	0.901$\pm$0.026	**0.837** $\pm$ 0.005
	RetinaNet	$c = 0.4, i = 0.4$	0.753 $\pm$ 0.029	**0.927** $\pm$ 0.035	0.830 $\pm$ 0.024
	YOLOv8s	$c = 0.4, i = 0.3$	**0.855** $\pm$ 0.037	0.811 $\pm$ 0.018	0.831 $\pm$ 0.018
	Deformable DETR	$c = 0.4, i = 0.2$	0.636 $\pm$ 0.042	0.782 $\pm$ 0.063	0.700 $\pm$ 0.042
		Cryptosporidium			
Reference Sample	Faster RCNN	$c = 0.7, i = 0.4$	0.880 $\pm$ 0.024	**0.915** $\pm$ 0.030	**0.897** $\pm$ 0.018
	RetinaNet	$c = 0.5, i = 0.5$	**0.917** $\pm$ 0.025	0.870 $\pm$ 0.031	0.893 $\pm$ 0.022
	YOLOv8s	$c = 0.4, i = 0.3$	0.890 $\pm$ 0.034	0.887 $\pm$ 0.031	0.888 $\pm$ 0.028
	Deformable DETR	$c = 0.4, i = 0.2$	0.768 $\pm$ 0.035	0.808 $\pm$ 0.012	0.787 $\pm$ 0.015
Vegetable Sample	Faster RCNN	$c = 0.8, i = 0.5$	0.845 $\pm$ 0.029	0.835 $\pm$ 0.045	**0.839** $\pm$0.024
	RetinaNet	$c = 0.4, i = 0.4$	0.801 $\pm$ 0.025	**0.851** $\pm$ 0.022	0.826 $\pm$ 0.023
	YOLOv8s	$c = 0.4, i = 0.3$	**0.879** $\pm$ 0.052	0.716 $\pm$ 0.065	0.788 $\pm$ 0.051
	Deformable DETR	$c = 0.4, i = 0.2$	0.642 $\pm$ 0.029	0.720 $\pm$ 0.054	0.678 $\pm$ 0.033

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Need for a Larger Dataset and Better Accuracy

Parasitoscope: AI-powered Smartphone Microscopy

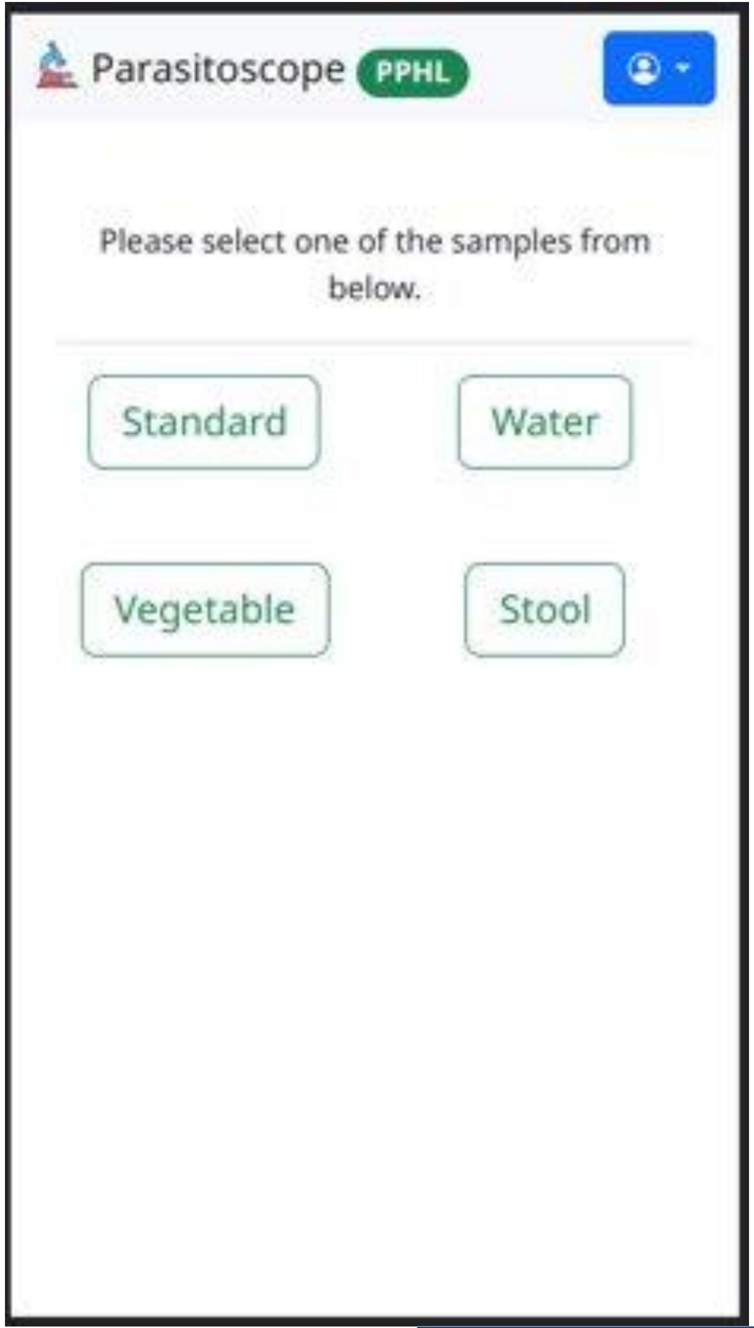
Lacuna Fund

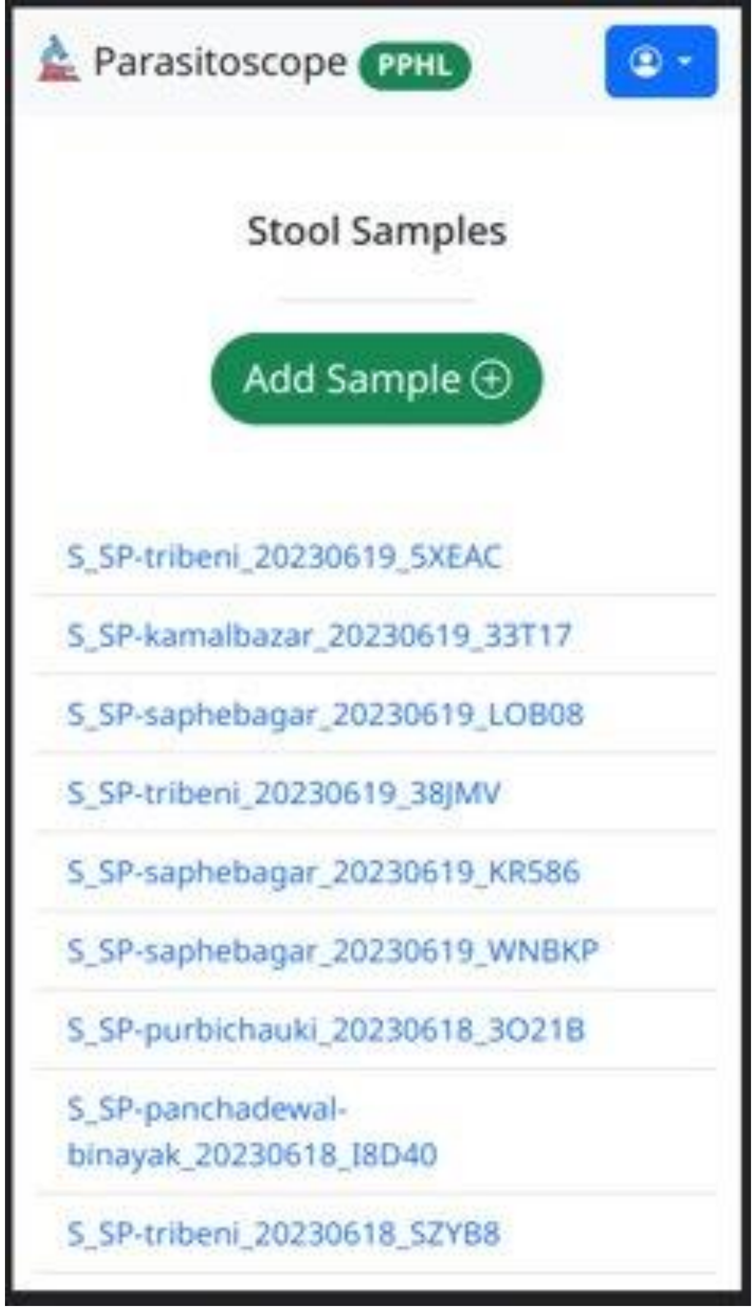
NAAMII

Kathmandu Institute of Applied Sciences

KIOCH

सामाजिक विकास मन्त्रालय
प्रदेश जनस्वास्थ्य प्रयोगशाला
मधेश प्रदेश, जनकपुरधाम





NAAMII Kathmandu Institute of Applied Sciences KIOCH प्रदेश जनस्वास्थ्य प्रयोगशाला Lacuna Fund

Parasitoscope PPHL

Add new stool sample

Province*

District*

Municipality/Gaunpalika*

Date of collection*

06/19/2023

Patient's Gender*

Patient's age*

Symptoms*

Stool texture*

Submit

Parasitoscope NAAMII

Waters / W_BP-kirtipur_20221129_F5K3W

W_BP-kirtipur_20221129_F5K3W

Date of collection	**Nov. 29, 2022**
Province	**Bagmati Pradesh**
District	**Kathmandu**
Municipality/GaunPalika	**Kirtipur**
Ward	**6**
Locality	**Jalbinayak temple**
Water Type	**River**
Water Use	**May be irrigation**
Latitude	**27.658300**
Longitude	**85.292000**
Site Image	

Slide 1

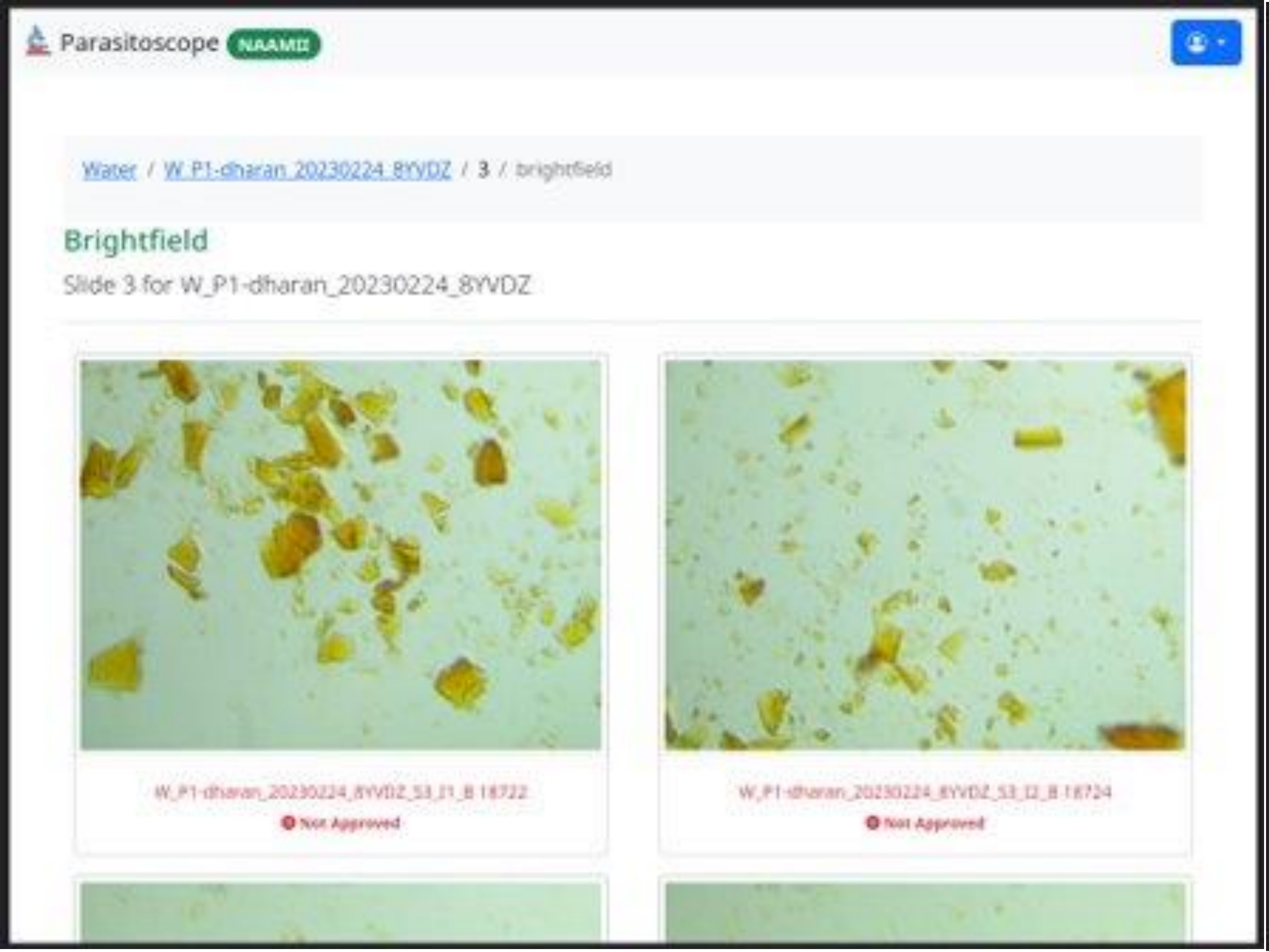
Parasitoscope NAAMII

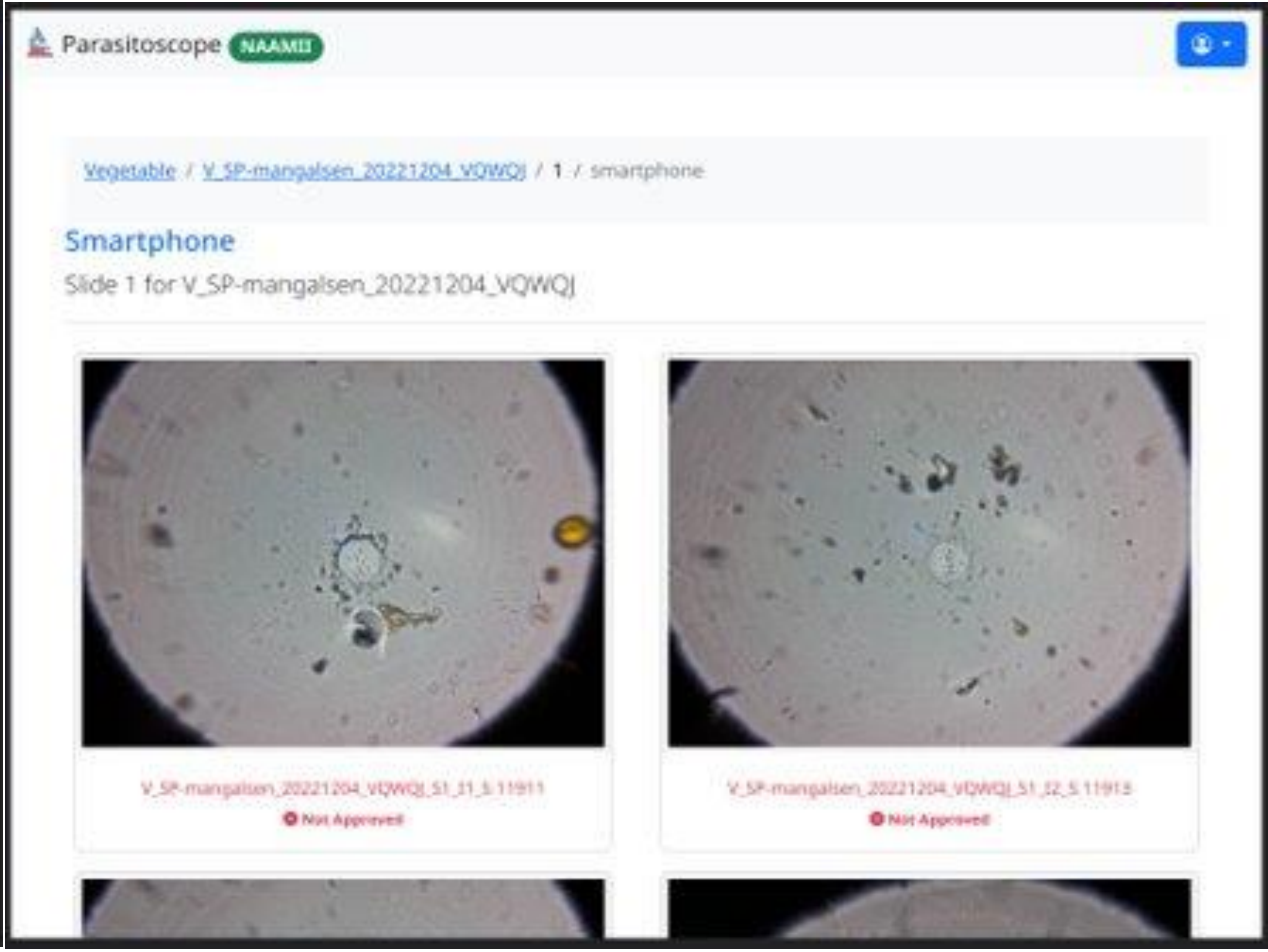
Vegetables / V_BP-kathmandu_20221201_036T9

V_BP-kathmandu_20221201_036T9

Date of collection	**Dec. 1, 2022**
Province	**Bagmati Pradesh**
District	**Kathmandu**
Municipality/GaunPalika	**Kathmandu**
Ward	**13**
Locality	**Kalimati tarkari bazzar**
Vegetable Name	**Carrot**
Vegetable Origin	**kaalimati bazzar**
Latitude	**27.698000**
Longitude	**85.299000**
Site Image	

NAAMII Kathmandu Institute of Applied Sciences KIOCH प्रदेश सरकार सामाजिक विकास मन्त्रालय प्रदेश जनस्वास्थ्य प्रयोगशाला Lacuna Fund

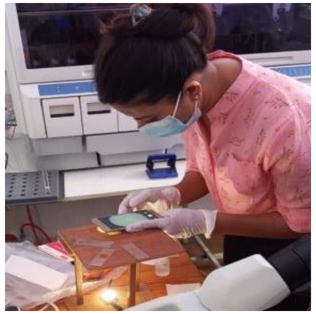


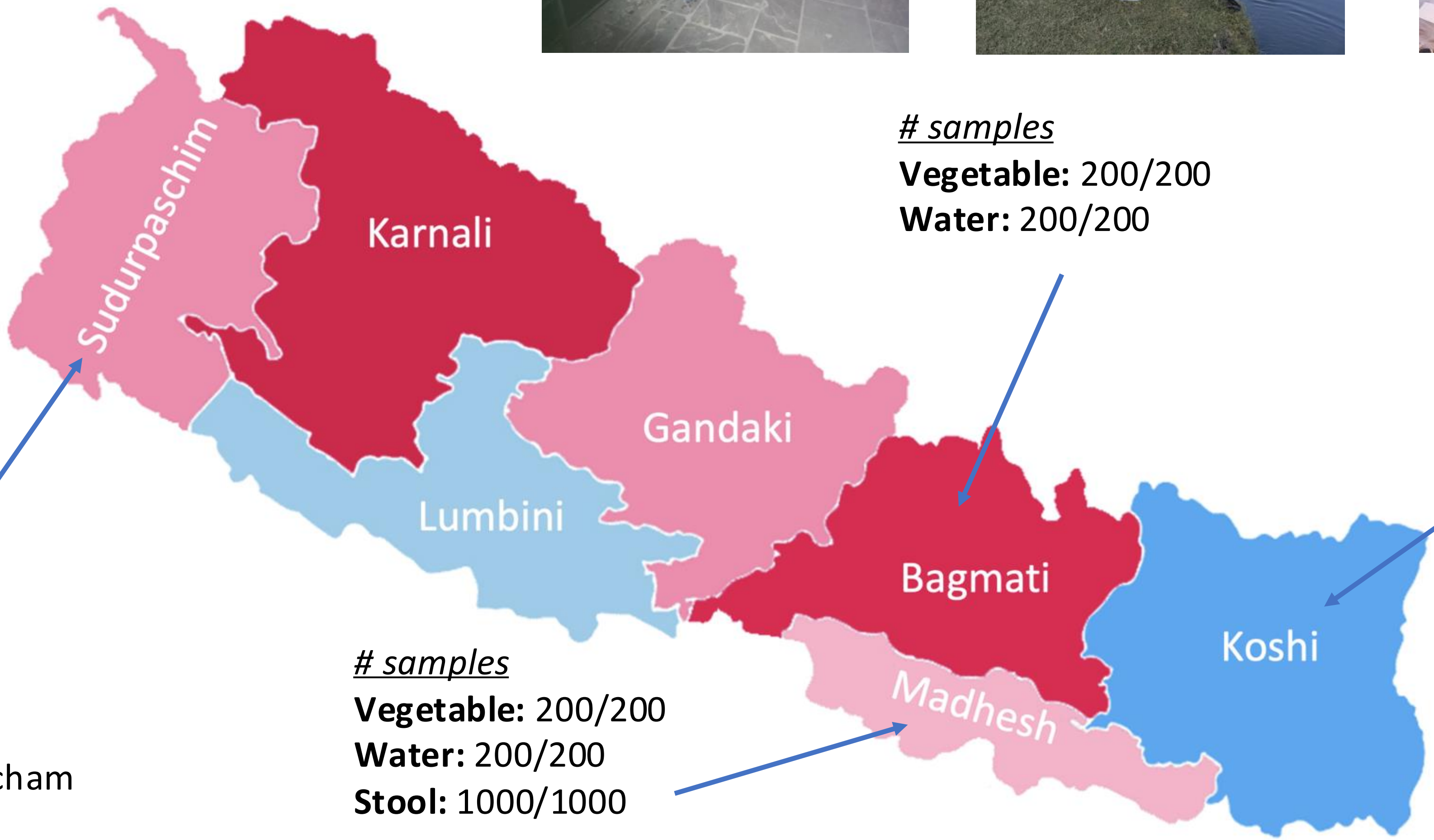


NAAMII Kathmandu Institute of Applied Sciences KIOCH प्रदेश जनस्वास्थ्य प्रयोगशाला Lacuna Fund

Sample Collection Stats

smartphone images uploaded: **194,775**
brightfield images uploaded: **193,020**





 # samples
Vegetable: 200/200
Water: 200/200
Stool: 1000/1000

Clinical Partner
Bayalpata Hospital, Accham

 # samples
Vegetable: 200/200
Water: 200/200

 # samples
Vegetable: 200/200
Water: 200/200
Stool: 1000/1000

Clinical Partner
PPHL, Dhanusha

 # samples
Vegetable: 200/200
Water: 200/200
Stool: 848/1000

Clinical Partner
KIOCH, Jhapa

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Image for Map of Nepal taken from [here]

Resource-Constrained Settings in Healthcare

Lack of experts

- Lack of medical doctors, radiologists in primary and community health care settings

Lack of devices, algorithms, or technologies

- CT Scans and MRIs are expensive; more advanced expensive not available
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Lack of research and innovation

- Neglected Diseases
- Inability to solve problems quickly: Dengue is killing more & more people in Kathmandu
- Emerging useful technology being inaccessible (e.g. chatbot due to language barrier)

Resource-Constrained Settings: Data Scarcity

Weakly Supervised

Weakly supervised localisation for fetal ultrasound images N Toussaint, B Khanal, M Sinclair, A Gomez, E Skelton, J Matthew, ... Deep Learning in Medical Image Analysis and Multimodal Learning for Clinical …	22	2018

Semi-Supervised, Unsupservised learning

Fixmatchseg: Fixing fixmatch for semi-supervised semantic segmentation P Upretee, B Khanal arXiv preprint arXiv:2208.00400	14	2022

Synthetic Data

Synthetic boost: Leveraging synthetic data for enhanced vision-language segmentation in echocardiography R Adhikari, M Dhakal, S Thapaliya, K Poudel, P Bhandari, B Khanal International Workshop on Advances in Simplifying Medical Ultrasound, 89-99	6	2023

Resource-Constrained Settings: Low Compute

Minimal to no Finetuning in VLMs an Foundation Models

MICCAI Brats Workshop 2024

- [ ] Parameter-efficient Fine-tuning for improved Convolutional Baseline for Brain Tumor Segmentation in Sub-Saharan Africa Adult Glioma Dataset — 2024
  B Adhikari, P Kulung, J Bohaju, LK Poudel, C Raymond, D Zhang, ...
  arXiv preprint arXiv:2412.14100

MICCAI 2024

- [ ] Vlsm-adapter: Finetuning vision-language segmentation efficiently with lightweight blocks — 1 — 2024
  M Dhakal, R Adhikari, S Thapaliya, B Khanal
  International Conference on Medical Image Computing and Computer-Assisted …

ACCV 2024

Rabin Adhikari, Safal Thapaliya, Manish Dhakal, Bishesh Khanal:
TuneVLSeg: Prompt Tuning Benchmark for Vision-Language Segmentation Models. ACCV (3) 2024: 44-62

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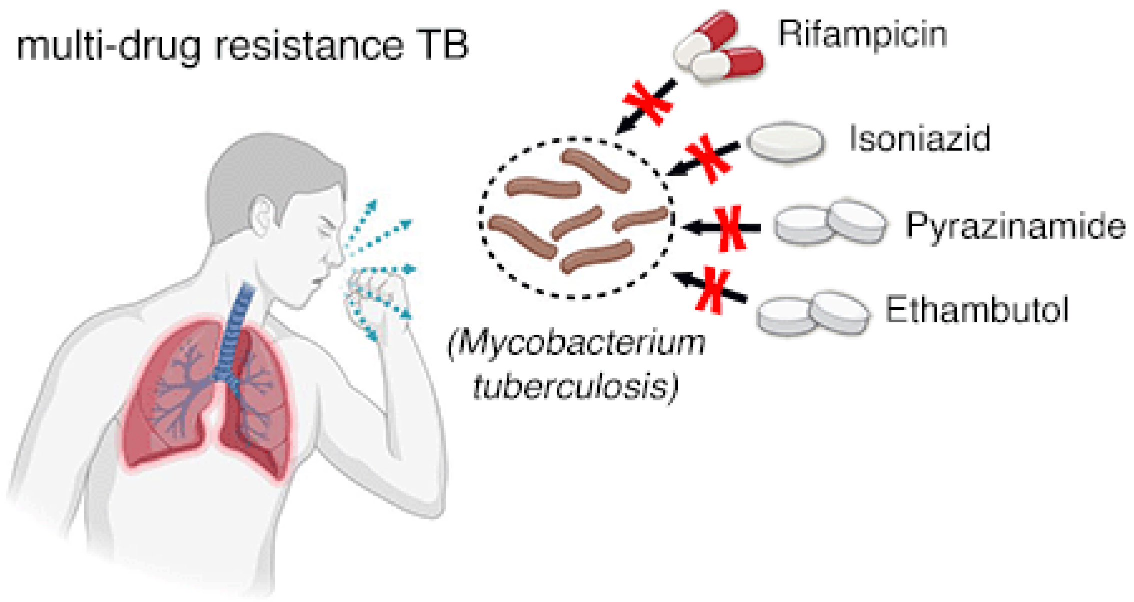
Tuberculosis: Still not a solved problem!



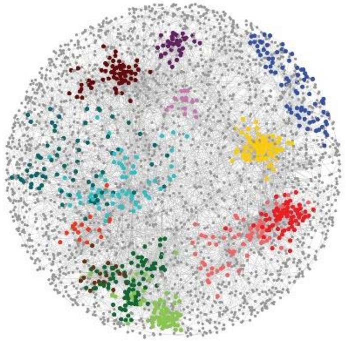
Lead: Dr. Raunak Shrestha
Computational Genomics Group @NAAMII

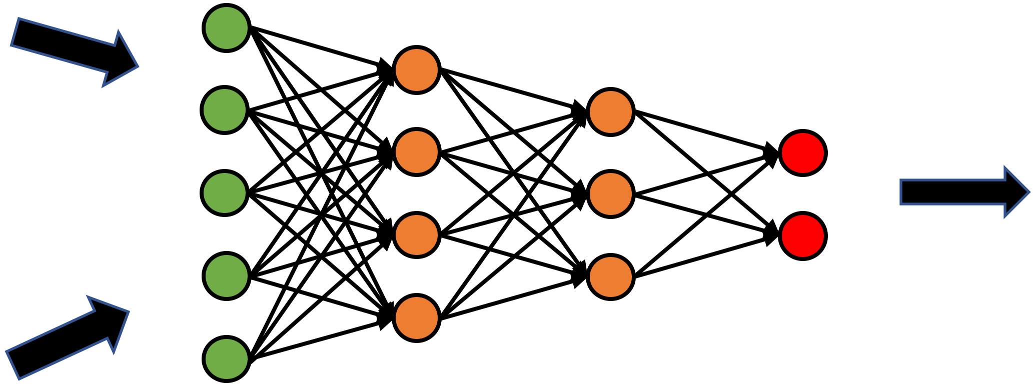
- Nepal has high TB burden
- TB bacteria are spread from person to person through the air
- Multi-drug resistant TB is biggest bottleneck in its eradication
- Gene mutations leading to multi-drug resistant TB are largely unknown

Predicting Multi-drug Resistant TB from Whole Genome Sequence

TB mutations

ACCTGCTACA**C**GCGGCAGGCAACTATGCCCAACGG
ATGACAGGACTGCT**G**GACGGC**A**AACGGATTCTG
GTTAGCGGAATCATCACCGACTC**G**TCGATCGCGTTTC
GGAGGTTCCATCGTCGGCA**T**GGACTTCGACCCGA**G**CCGGGCGAT
GTTAGCGGAATCATCACCGAC**T**CGTCGATCGCGTTTC





Predicting drug-resistant TB and drug-resistant mutations

Protein-Interaction Network

Lead: Dr. Raunak Shrestha
Computational Genomics
Group @NAAMII

(work under progress)

NAAMII   RSTMH   NIHR | National Institute for Health Research   UKaid

Resource-Constrained Settings in Healthcare

Lack of experts

- Lack of medical doctors, radiologists in primary and community health care settings

Lack of devices, algorithms, or technologies

- CT Scans and MRIs are expensive; more advanced expensive not available
- AI: Lack of Data/Internet/compute resources/financial resource

Lack of research and innovation

- Neglected Diseases
- Inability to solve problems quickly: Dengue is killing more & more people in Kathmandu
- Emerging useful technology being inaccessible (e.g. chatbot due to language barrier)

Evaluating Nepali Sexual, Reproductive and Maternal Health Chatbot with Large Language Models (LLMs)

SHARE THIS

Bishesh Khanal of the Nepal Applied Mathematics and Informatics Institute for Research in Nepal will assess LLMs for their ability to provide accurate information on sexual, reproductive, and maternal health (SRMH) topics in Nepali to the general public and female community health volunteers. In Nepal, limited access to

NAAMII DIYO.AI LOCALIZING AI Visible Impact psdnepal

INITIATIVE
Grand Challenges

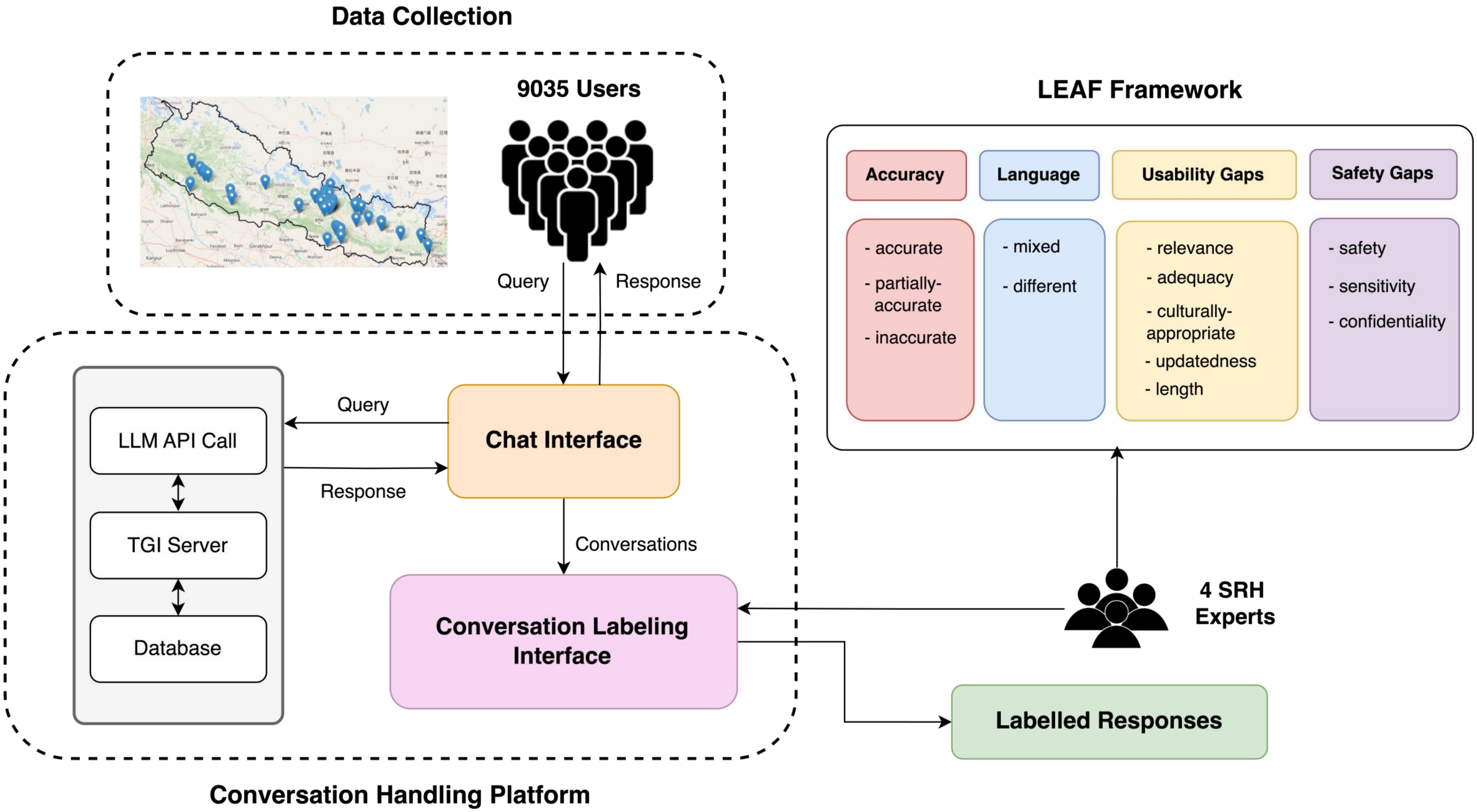
CHALLENGE
Artificial Intelligence

FUNDING DATE
Jul 9, 2023

PRINCIPAL INVESTIGATOR
Bishesh Khanal

ORGANIZATION
Nepal Applied Mathematics and Informatics Institute for Research

Sharma, M., …, & **Bishesh Khanal**. Evaluating Large Language Models' Responses to Sexual and Reproductive Health Queries in Nepali. *Under Review at Scientific Reports*



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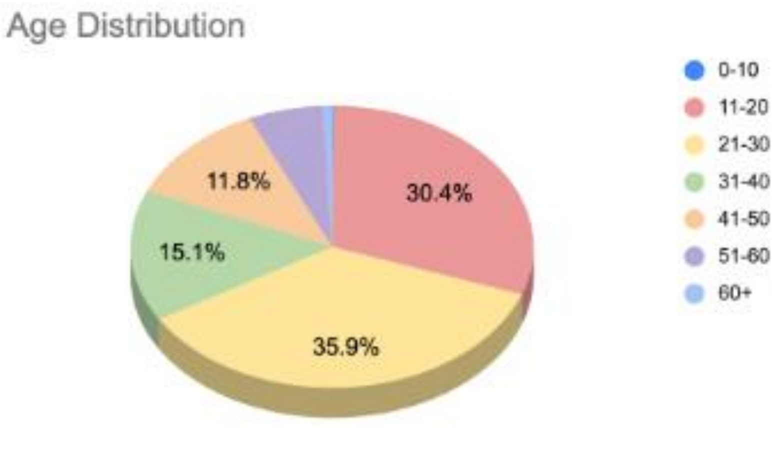
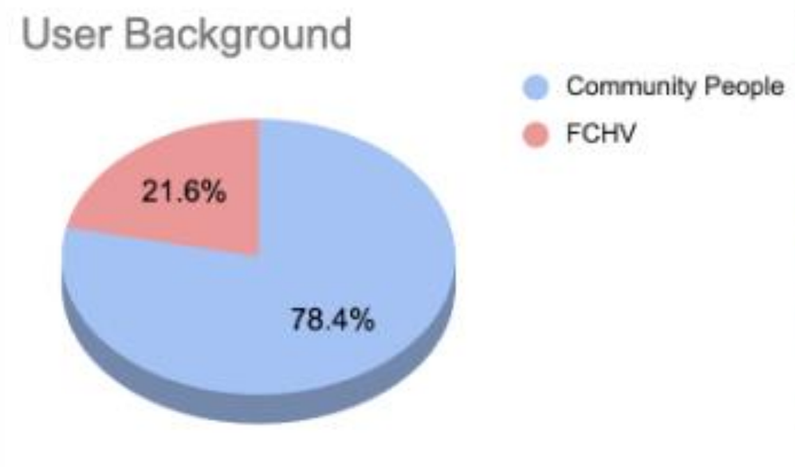
Dataset

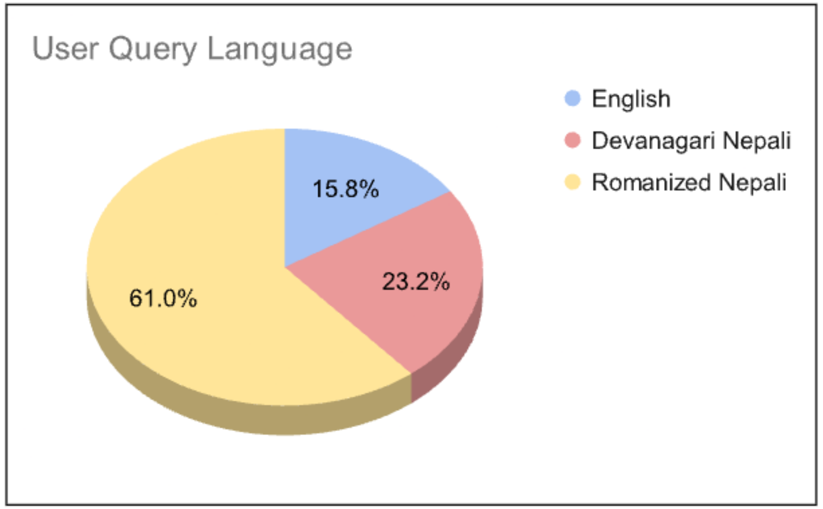


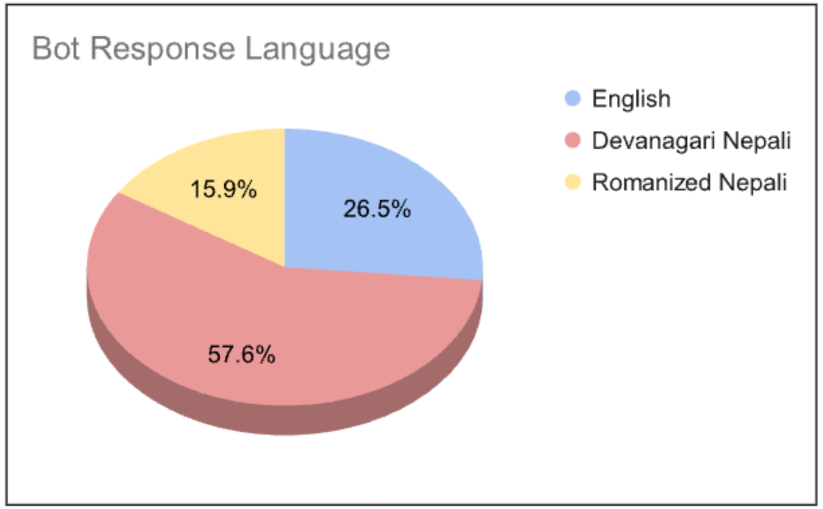


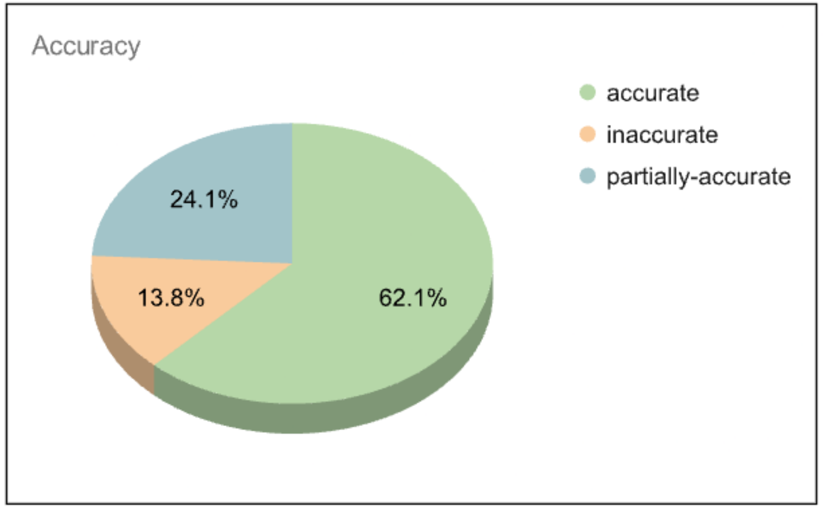
Location	Count	Percentage(%)
Bagmati Province	3458	38.27
Gandaki Province	685	7.58
Karnali Province	670	7.42
Koshi Province	1487	16.46
Lumbini Province	940	10.40
Madhesh Province	1088	12.04
Sudurpaschim Province	707	7.83

Sharma, M., …, & **Bishesh Khanal**. Evaluating Large Language Models' Responses to Sexual and Reproductive Health Queries in Nepali. *Under Review at Scientific Reports*

Dataset



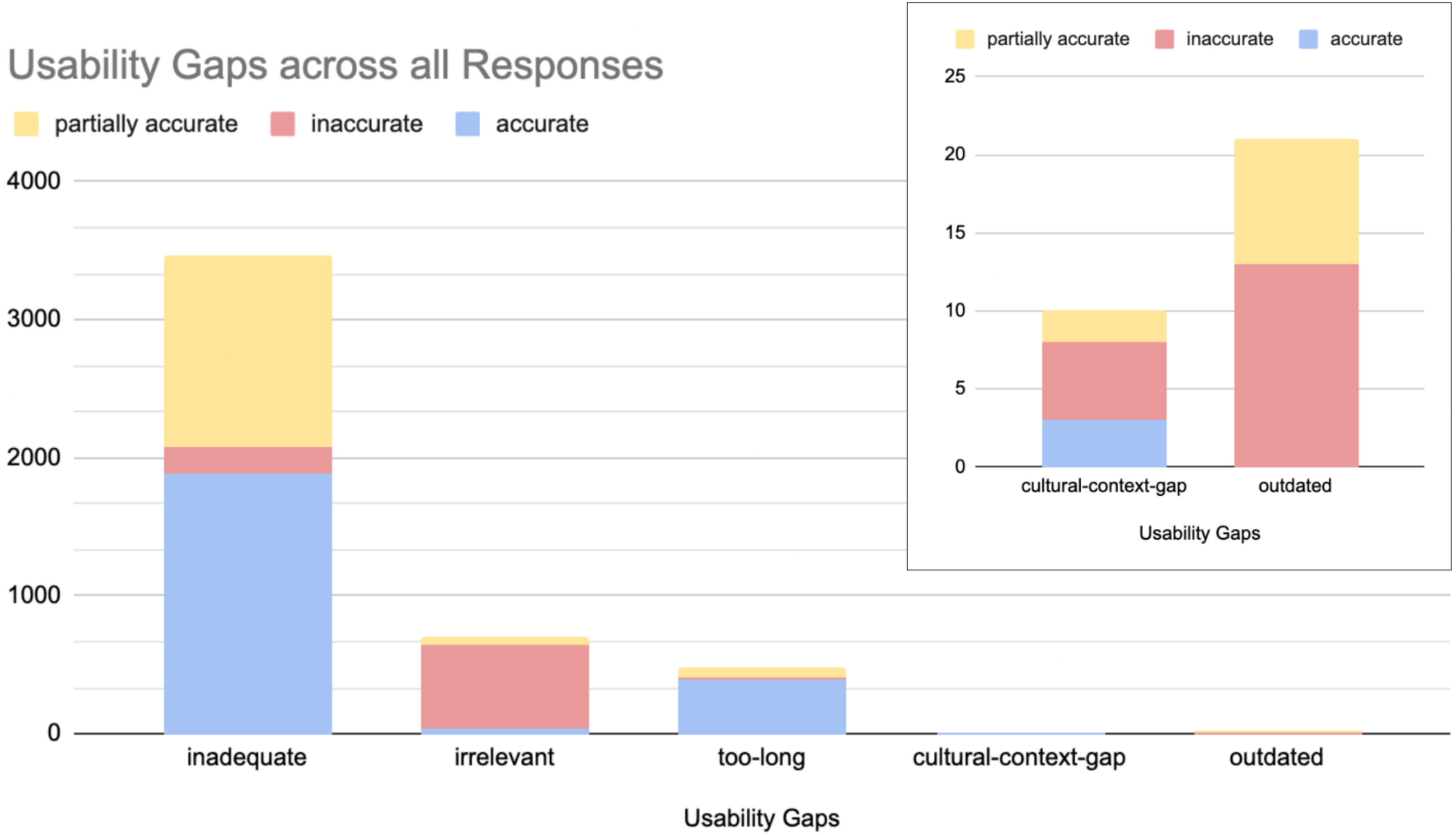




Safety Gap	Count	Percentage of Total Responses(%)
unsafe	98	0.74
insensitive/offensive	51	0.38
non-confidential	7	0.05

Sharma, M., ..., & **Bishesh Khanal**. Evaluating Large Language Models' Responses to Sexual and Reproductive Health Queries in Nepali. *Under Review at Scientific Reports*

Dataset



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Outline

Resource-Constrained Settings in Healthcare

Health AI in Resource-Constrained Settings with Examples from Nepal

Trustworthy AI in Healthcare

Trustworthy AI in Healthcare

Risks due to things going wrong very high

Stronger regulatory frameworks for deployment approval

Clinical translation of research and products: What's for AI compared to clinical trials?

Implementation Science & Public Health: Looking into Health Systems and Socio-Economics

FUTURE-AI: Best practices for trustworthy AI in medicine

FUTURE-AI is an international, multi-stakeholder initiative for defining and maintaining concrete guidelines that will facilitate the design, development, validation and deployment of trustworthy AI solutions in medicine and healthcare based on six guiding principles: Fairness, Universality, Traceability, Usability, Robustness and Explainability.

1
Fairness
The Fairness principle states that medical AI tools should maintain the same performance across individuals and groups of indiv...

Learn More ›

2
Universality
The Universality principle states that a medical AI tool should be generalisable outside the controlled environment where it wa...

Learn More ›

3
Traceability
The Traceability principle states that medical AI tools should be developed together with mechanisms for documenting and monito...

Learn More ›

4
Usability
The Usability principle states that the end-users should be able to use a medical AI tool to achieve a clinical goal efficientl...

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5
Robustness
The Robustness principle refers to the ability of a medical AI tool to maintain its performance and accuracy under expected or ...

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6
Explainability
The Explainability principle states that medical AI tools should provide clinically meaningful information about the logic behi...

Learn More ›

Lekadir, K., …, **Khanal, B.**, …, et al. FUTURE-AI: International consensus guideline for trustworthy and deployable artificial intelligence in healthcare. *Under review*

Guidelines for AI deployment in healthcare: Large collaborative

FUTURE-AI: International consensus guideline for trustworthy and deployable artificial intelligence in healthcare. Karim Lekadir et al. BMJ 2025.

Trustworthy AI: Human in the Loop and Language Inputs

Radiologists, Surgeons

- Most often the images are seen by medical professionals
- Medical Image Segmentation: a tedious time-consuming task
  - How about **language prompts** to interactively speed up segmentations while being inherently more interpretable?

Trustworthy AI: Human in the Loop and Language Inputs

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Vision Language Models

Exploring transfer learning in medical image segmentation using vision-language models K Poudel, M Dhakal, P Bhandari, R Adhikari, S Thapaliya, B Khanal MIDL, Paris, France 2024 (Medical Imaging with Deep Learning), arXiv …	13	2024

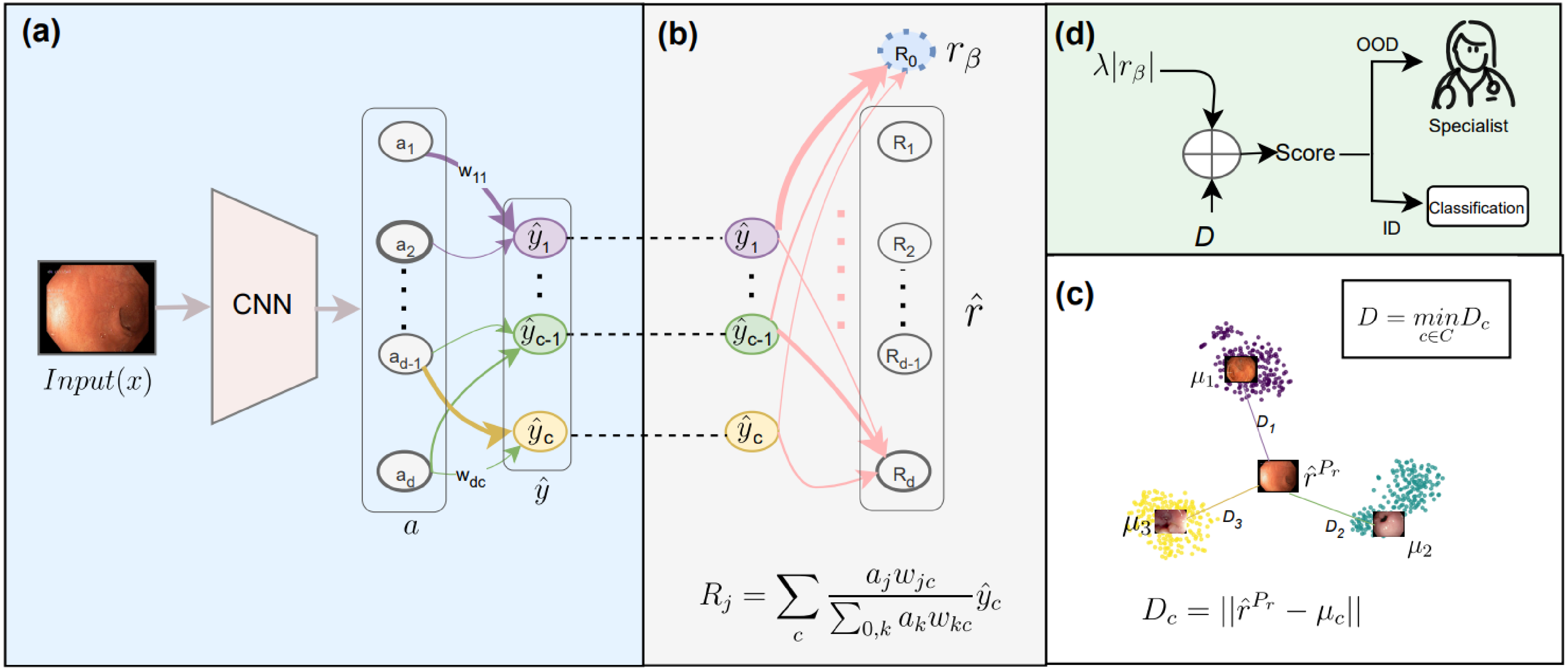
Trustworthy AI: Explainability

Trustworthy AI: Explainability

NERO: Explainable Out-of-Distribution Detection with Neuron-level Relevance

Authors Anju Chhetri, Jari Korhonen, Prashnna Gyawali, Binod Bhattarai

Publication date 2025/9



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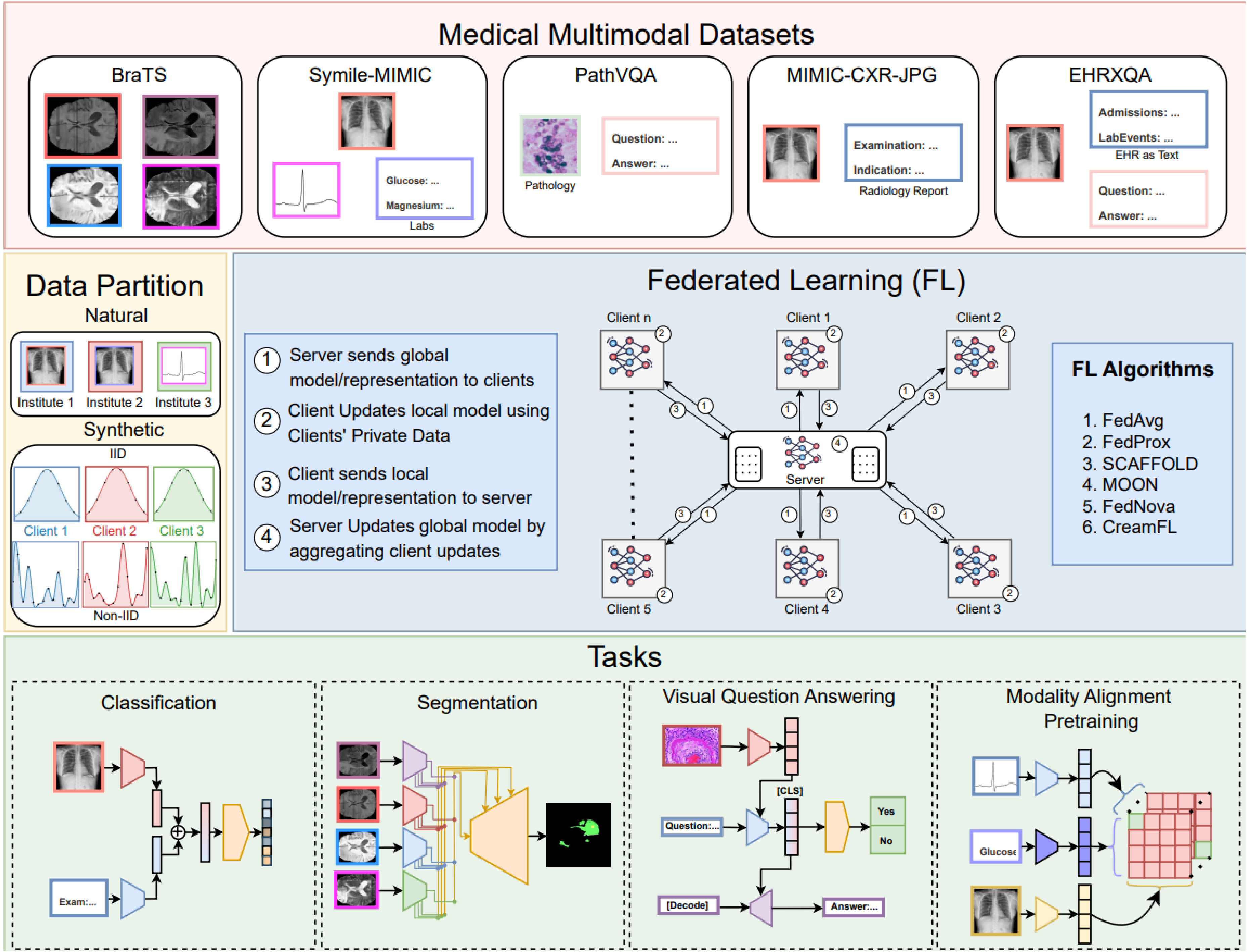
Trustworthy AI: Federated Learning

Med-MMFL: A Multimodal Federated Learning Benchmark in Healthcare

Authors Aavash Chhetri, Bibek Niroula, Pratik Shrestha, Yash Raj Shrestha, Lesley A Anderson, Prashnna K Gyawali, Loris Bazzani, Binod Bhattarai

Binod Bhattarai Lab @ NAAMII



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