FGAI4H-N-055-A06

E-meeting, 15-17 February 2022

Source:	WG-CO
Title:	Att.6 - Lessons learned from building AI models to address public health issues in India
Purpose:	Discussion

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Abstract:	This PPT contains a presentation from the "Catalysing Digital and AI Innovations for Health: Sharing Experiences from Africa and Asia" series.

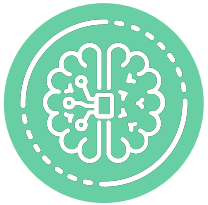
WADHWANI AI

AI for Social Impact

Alpan Raval

Wadhwani AI is an independent, nonprofit institute building AI-based solutions to achieve social impact at scale for the benefit of underserved communities across the developing world.

Our Work

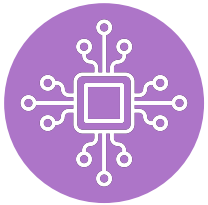


AI Readiness

CAPACITY BUILDING • ENABLING INNOVATION

We enable government ministries and civil society organizations to use AI/ML effectively, to enhance their programs and operations.

- Preparing data for AI solutions
- Discovering use cases
- Training staff
- Other capacity building measures
- Engagements: Ministry of Health and Family Welfare, Central TB Division, National Health Authority.



AI Solutions

BUILD • DEPLOY • CREATE IMPACT AT SCALE

We are currently developing 10+ solutions in the health and agriculture domains. Our goal is to grow rapidly and bring about sustainable and large-scale social impact through the use of AI.

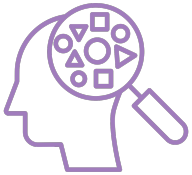
What is AI Readiness?

AI Readiness refers to an organization's **ability** to **create** and **use** AI to achieve greater **benefits** than traditional methods.

Effective solutions start with a systematic, long-term commitment to use AI for good.

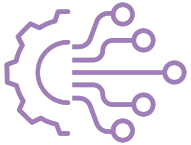
APPROACHING AI READINESS

- Apply a **maturity model** to become AI Ready
- Adopt a **methodology** for defining and solving technical problems where AI can achieve a greater impact than other methods.

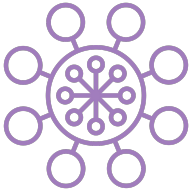


ABILITY
What is the organization's capacity to view and define problems through an AI lens and support AI solutions sustainably?

CREATE
What is required to build the necessary AI solutions?



USE
What is required to ensure the effective application of the AI solutions built?



BENEFITS
What is required to ensure that the anticipated benefits of the AI solution are in line with the benefits accrued once it is implemented?

Overview: AI Solutions in Public Health

TUBERCULOSIS (TB)

Line Probe Assay
AI-enabled test interpretation and transcription to remove errors and reduce time taken to initiate treatment for drug-resistant TB patients.

Loss to Follow-Up
AI-powered predictive models for early identification of TB patients likely to have treatment interrupted, to enable preventive measures.

TB Ultrasound
Classification algorithms for ultrasound scans that can be used to screen for pulmonary TB.

Cough Against TB
AI to detect TB using patient cough sounds for effective triaging, testing and treatment.

PANDEMIC RESPONSE AND PREVENTION

Cough Against COVID
AI to detect COVID-19 using patient cough sounds for effective triaging, testing, and treatment.

COVID Decision Support
Epidemiological models to track the spread of COVID and healthcare resources customized to local response strategies and provided to public administrators.

Event-Based Disease Surveillance
Natural Language Processing (NLP) model to scan media articles for reports of diseases, in two languages, for the timely identification of epidemic outbreaks.

MATERNAL, NEWBORN, AND CHILD HEALTH

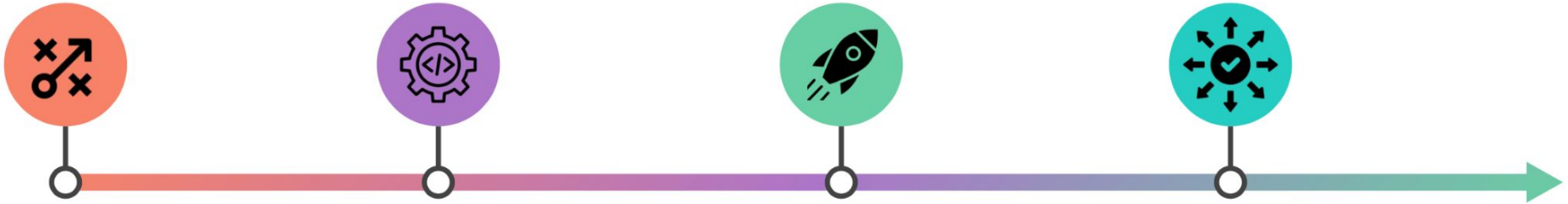
Newborn Anthropometry
AI-powered weighing scale to triage and deliver differentiated care to risk newborn babies, who are low-birth-weight.

Pregnancy Risk Stratification
AI-powered tool to predict maternal morbidity and mortality at various stages of pregnancy to reduce negative outcomes by triaging and access to differentiated care.

Class of Problems: AI for Social Impact

	Solution	Dataset	Delivery Mechanism	End User
Computer Vision	**Line Probe Assay:** AI-enabled test interpretation and transcription to remove errors and reduce time taken to initiate treatment for drug resistant TB patients.	Scanned copies of test sheets	A web-based application integrated into NIKSHAY and LIMS	Lab technicians at 64 drug and culture sensitivity labs in India
	Newborn Anthropometry: AI-powered weighing scale to triage and deliver differentiated care to risk newborn babies, who are low-birth weight.	Short videos of newborn babies	Smartphone application integrated into frontline healthcare programs	Frontline healthcare workers doing community visits
	Pest Management: AI-enabled pest advisory to improve farm-level decision-making by smallholder cotton farmers; reducing excess pesticide usage and protecting crops.	Images of pests on pest traps	Smartphone application integrated with Agri extension programs	Lead farmers and agriculture extension workers
	TB Ultrasound: Classification algorithms for ultrasound scans that can be used to screen for pulmonary TB.	Chest ultrasounds	Point of care diagnostic devices	Frontline healthcare workers and programs
	TB Skin Test: AI-powered tests for detecting latent TB in patients using C-Tb skin test results.	Image of patients skin where tested	Smartphone application integrated into the National TB Elimination Program	Frontline healthcare workers
Predictive	**COVID Decision Support**: Epidemiological models to track the spread of COVID and requirements of healthcare resources (capacity, equipment and personnel) customized to local response strategies and provided to public administrators.	COVID line list case data from cities/states	Presentations of model outputs in various scenarios made 1-2 per month	Public authorities managing the response and making decisions
	TB Loss to Follow-Up: AI-powered predictive models for early identification of TB patients likely to have treatment interrupted, so preventive actions can be taken.	NIKSHAY and Contextual data	Through the NIKSHAY (Govt of India TB patient platform)	Frontline TB healthcare workers
	Pregnancy Risk Stratification: AI-powered predictor of maternal morbidity and mortality at various stages of pregnancy to reduce negative outcomes by triaging and access to differentiated care.	Digitized antenatal care data	Through existing frontline health worker smartphone applications and platforms	Frontline healthcare workers and primary healthcare workers
NLP	**Event-Based Disease Surveillance:** Natural Language Processing algorithm to scan media articles for reports of diseases, in two languages, to identify outbreak of epidemics.	Media reports	Web-based app for the Integrated Disease Surveillance Program, Govt of India	Data entry operators who use it to compline daily reports
Speech / Sound Processing	**Cough Against COVID/ Cough Against TB:** AI to detect COVID and TB using patient cough sounds for effective triaging, testing, and treatment.	Cough sounds of people	Smartphone application	Primary healthcare centres and healthcare workers

Typical Roadmap: AI Solutions



PHASE 1

Assess & Plan

Conduct a formal assessment of the opportunity, plan, approach, resource allocation, timeline

Understand donor reporting

Create risk management baseline

PHASE 2

Develop & Test

Develop and test research and engineering solution

Conduct pilot(s) and field experiments

Augment risk management, mitigate external risks

PHASE 3

Deploy & Stabilize

Deploy inference engine

Improve performance, address errors, ensure accountability and explainability (where possible)

Engage to scale-up

Augment risk management

PHASE 4

Scale & Hand Over

Implement at scale

Create blueprint for long-term implementation

Hand over solution, make solution public

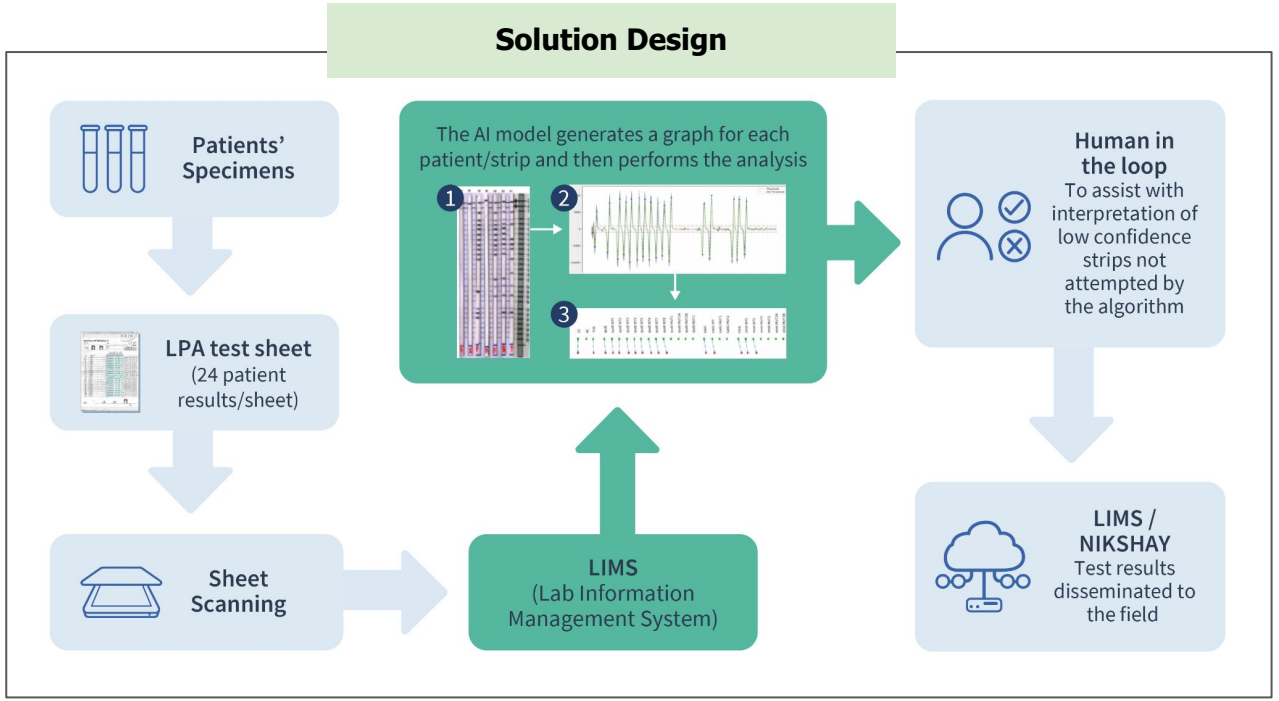
Provide consulting support when needed

Line Probe Assay: Automation Using Computer Vision

Problem: 64 Culture and Drug Sensitivity Labs (CDSL) conduct 400,000 LPA tests for Drug Resistant TB every year. Interpreting and transcribing is a tedious task, prone to errors (~30,000 tests/year) and take time (~5 hrs/day). This causes delays in treatment initiation and capacity constraints - annual need is estimated at 1,00,000 LPA tests.

Goal: Early diagnosis and appropriate treatment of DR-TB patients. Reduce errors to ~10,000, time taken to 1-2 minutes/batch and reduction of Lab TAT by 0.5 days per patient (at scale).

Solution: An AI/ML model to automate interpretation and transcription. 95% accuracy with human in the loop for First Line and Second Line. Solution piloted in 6 CDSL and integration with LIMS/NIKSHAY being discussed with NIC and CTD. Plan to implement in all 64 labs by H1 '22.

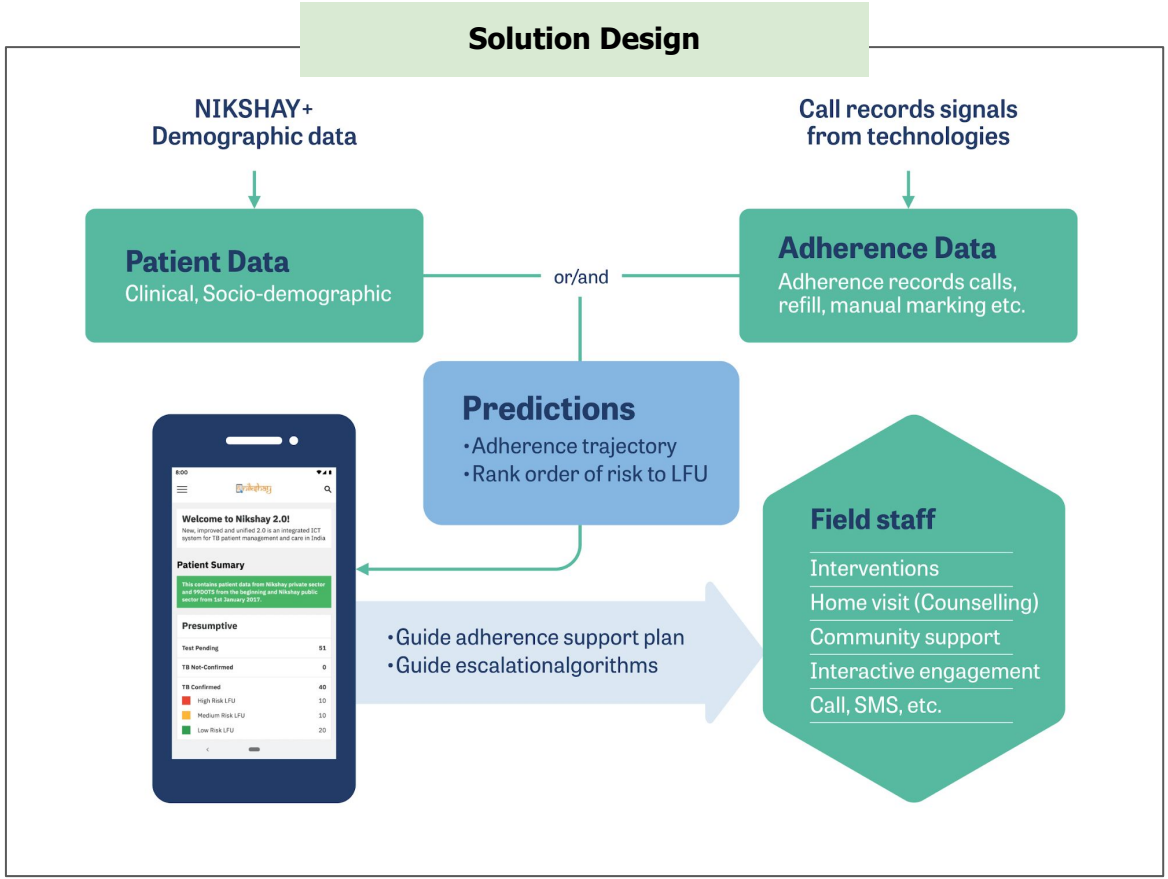


Loss to Follow-Up: AI-Based Risk Prediction

Problem: Treatment success of TB patients highly depends on the adherence to the treatment regimen. An extreme form of non-adherence is Lost to follow up (LFU), defined as a TB patient whose treatment was interrupted for one or more consecutive month(s). Around 1 lakh patients are lost to follow-up annually increasing the risk to individual and public health.

Goal: Early identification of patients at risk of LFU at the time of treatment initiation, in order to enable differentiated care. Aim to identify ~80,000 LFU patient at scaled deployment.

Current status: Prospective evaluation with 430K patients data completed. AI models outperformed rule based systems. Looking to add contextual data and pilot in several districts in Q1 22.

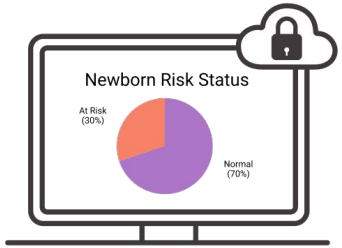


Newborn Anthropometry: Weight Estimation

The health worker takes a short video of the newborn using the Digital Tarazu app

The AI model estimates the newborn's weight and other measurements from the video

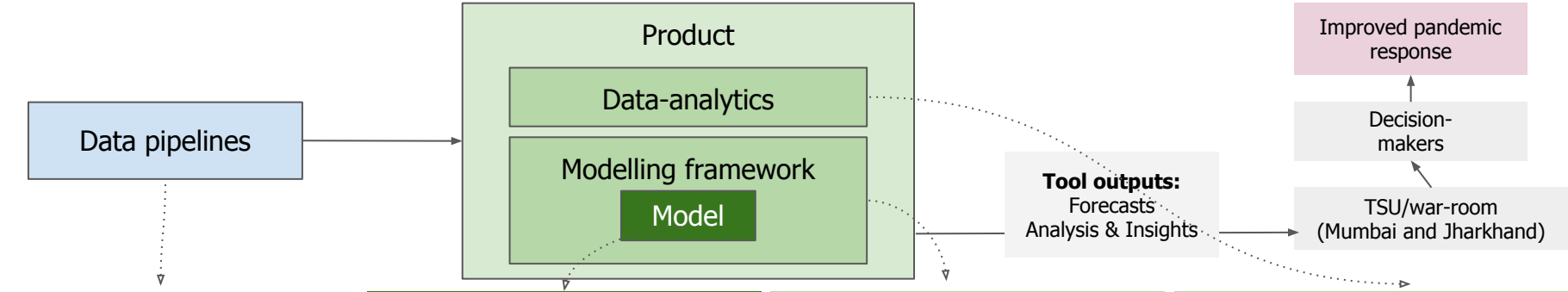
Health worker makes recommendation based on weight and other danger signs. Newborn gets appropriate care



Relevant databases updated in the backend.

Health system gets accurate, real-time, tamper-proof prevalence of low birthweight

COVID Decision Support: Rapid Development & Deployment



Data
- Case-counts, testing data as time-series
- Case & testing line lists

Infra
- Input through secured google sheets
- Secure S3 bucket for sensitive data & scripts to remove PII
- Data access through Athena user credentials

SEIR-type model
- Inputs: case-count as a time-series & a parameter search space
- Disease parameters learnt through ML (using hyperopt)
- Forecasts generated with uncertainty estimates
- What-if scenarios on r0 multiples & testing increases
- Output: Forecasts of case-counts by severity level as a time-series

Modelling framework
- Python notebook
- Model-agnostic framework
- Inputs: case-count as a time-series
- Generates forecasts & uncertainty estimates
- Produces artifacts for consumption (plots, CSVs, technical reports)

Analytics for decision-support
- Scripts to improve data quality of line-lists
- Dashboard with framework & key metrics
- Recommendations on under-tested groups
- Actionable reports to be shared with field officers

Influence on the pandemic response in Mumbai city and the Jharkhand State
- Recommendations led to key capacity increases of 2500+ ICU beds (in May), and +50k quarantine beds months in advance. Increased testing in under-tested wards by 27% in Mumbai
- Identified hotspots of spread in Ranchi
- Enabled key policy decisions, tracking of infection spread, planning of healthcare resources, and optimising strategies

Key Learnings

- **On-the-ground constraints drive innovation.**
  - Anthropometry: fixed-dimension reference object that is part of the ASHA toolkit.
  - LPA: Simple UI that enables human-in-the-loop AI.
  - Covid modeling: Model choice constrained by available data.

- **Data / Digitization challenges must be expected and addressed.**
  - Even where large datasets are available, they are noisy.
  - Where datasets need to be created (digitization + annotation), protocols need to be tight and protocol adherence closely monitored.
  - Make data collection / creation easy! (engg + UI)

- **AI Readiness needs training.**
  - Public health programs need to visualize problems through an AI lens and be able to interface with data scientists (lost in translation issues).
  - Appreciation of circumstances where AI works /is applicable and where it does not.

- **Privacy matters!**
  - Strong privacy concerns even in technologically challenged populations.

Thank you!

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