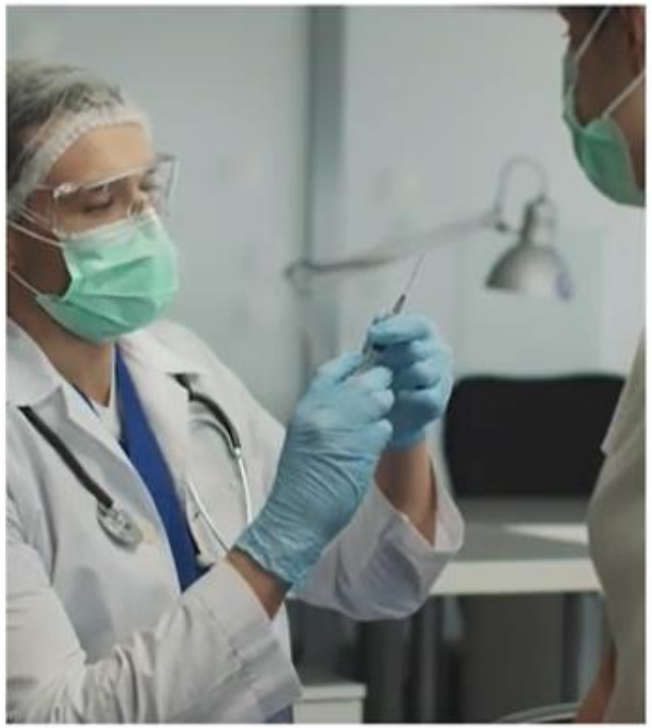
AI and Public Health

Climate change



Public health

Disaster management

AI for Good framework

Explore

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

Design

1. Prototype your solution
2. Ensure data privacy
3. Design the user experience

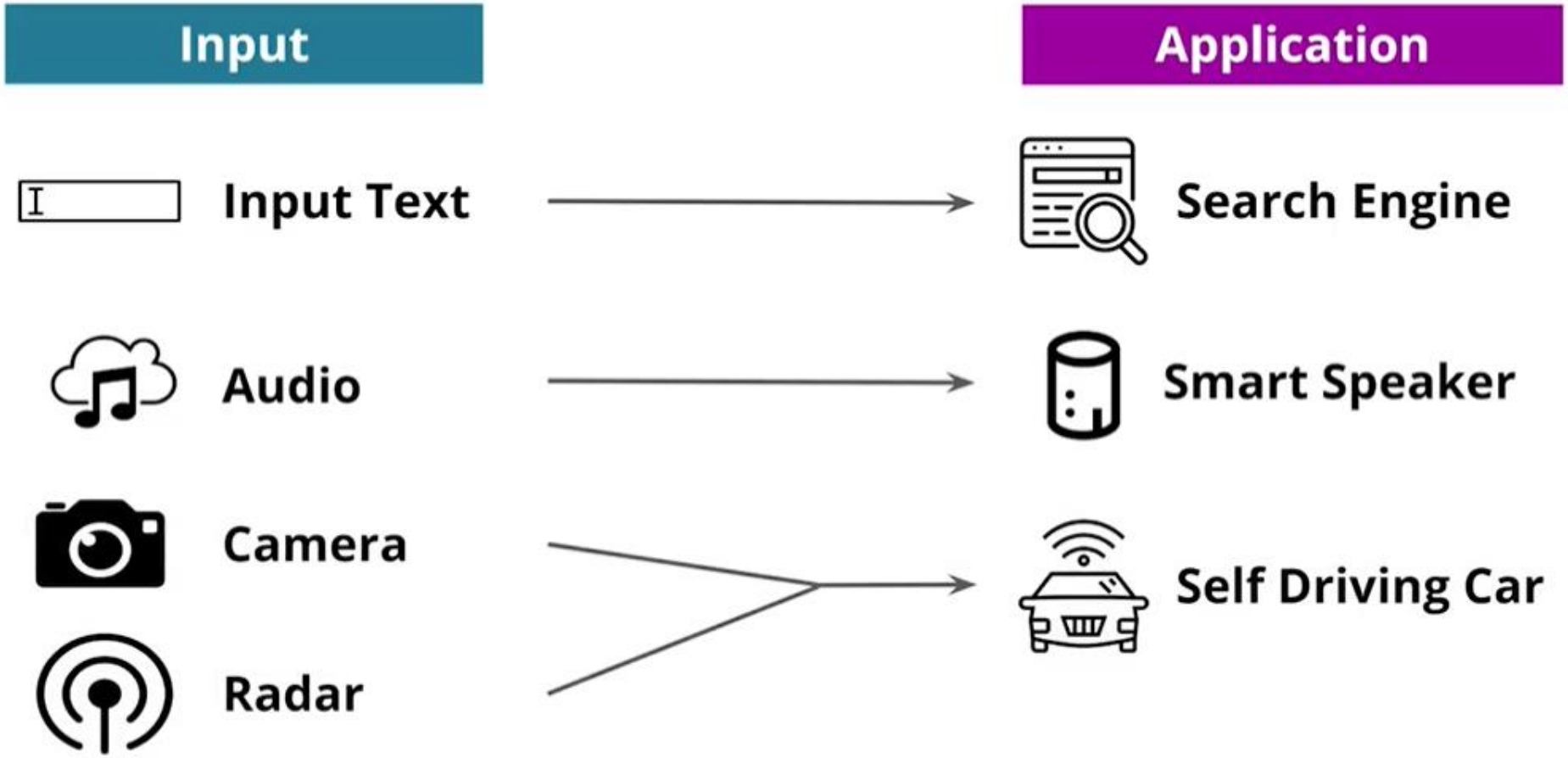
Implement

1. Productionize AI models
2. Integrate the user experience
3. Test with end users

Evaluate

1. Measure project impact
2. Communicate results
3. Determine next steps

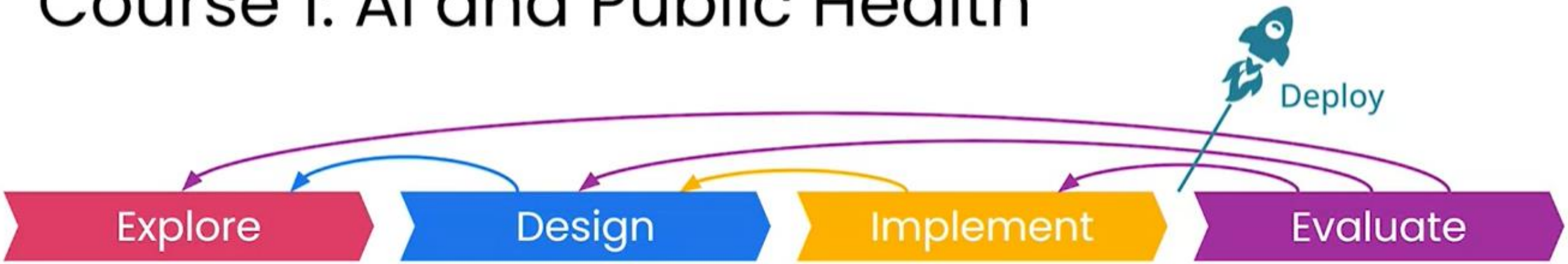
AI applications make decisions based on data




Environment
Health
Justice
Humanitarian action

UN Sustainable Development Goals

Course 1: AI and Public Health



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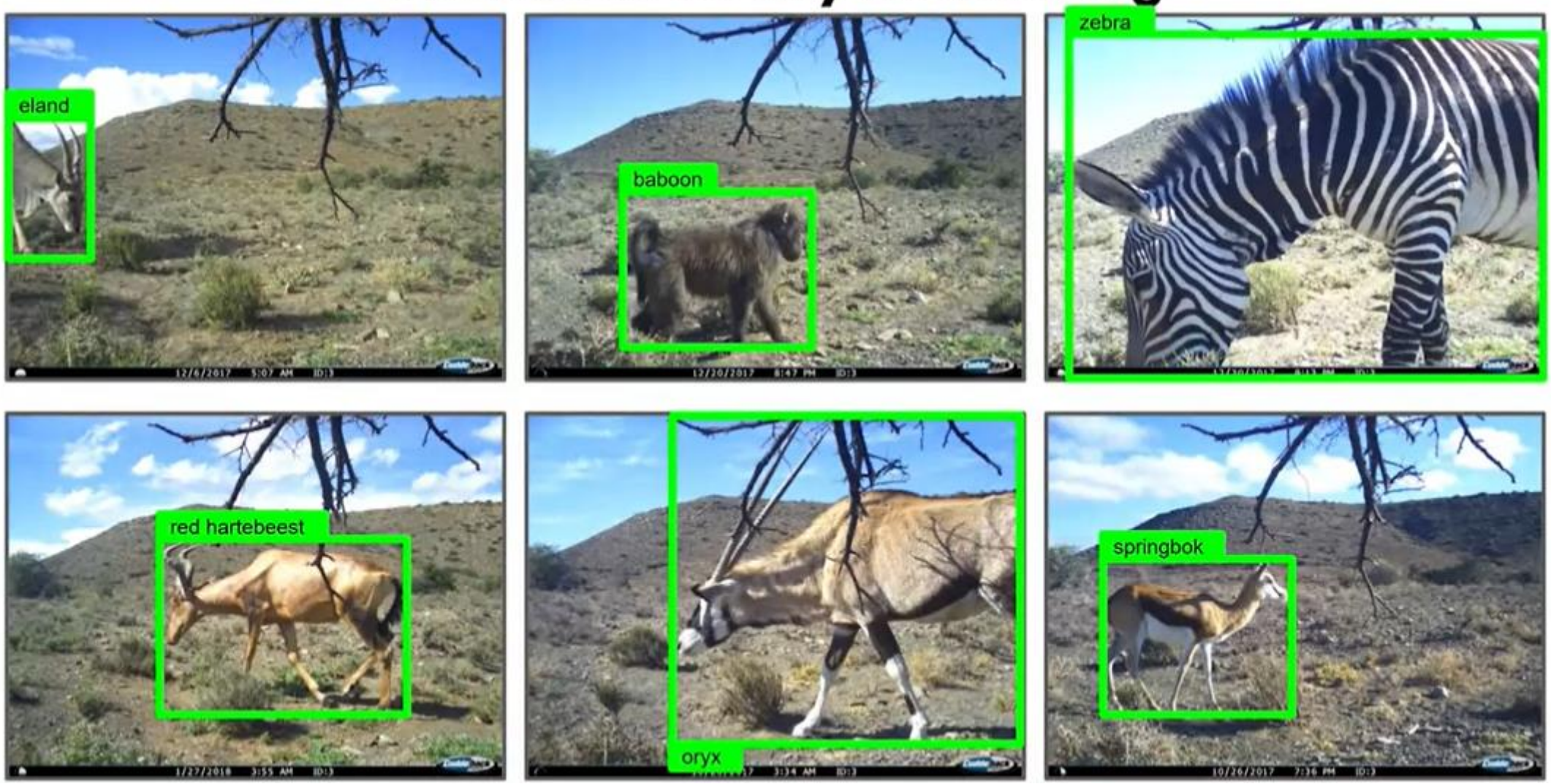
Course 2: AI and Climate Change

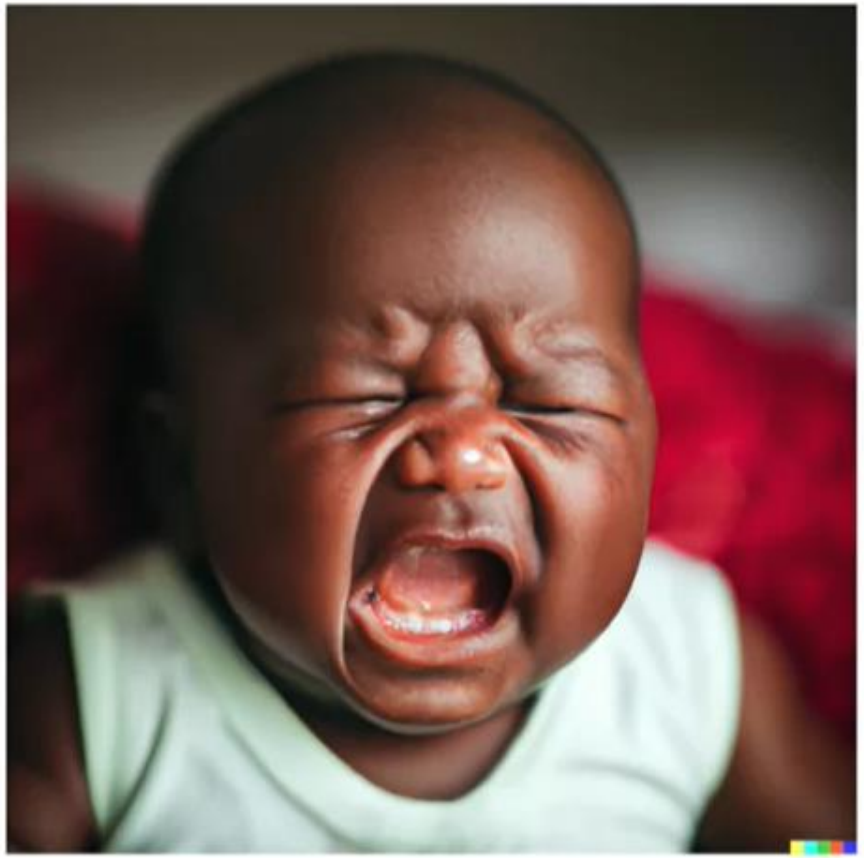
AI in biodiversity monitoring



Neonatal asphyxia

- Top causes of **sudden death and disabilities**
- Newborn is unable to sustain spontaneous breathing
- Brain cells do not get enough oxygen
- Could result in **irreversible brain damage**

Neonatal asphyxia: Yearly casualties



> 1 million babies die

> 1.2 million babies develop medical conditions

Image generated with DALL-E

Ubenwa solution

Detect early signs of neurological anomalies using a recording of the babies cry

Key advantages

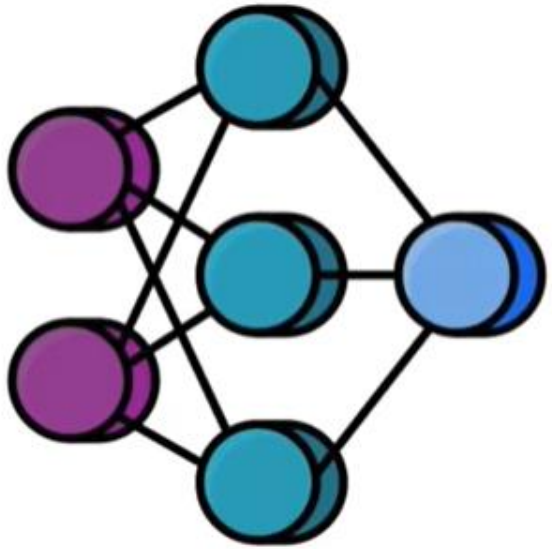
- Fast
- Cost-effective
- Non-invasive

Use of machine learning

Input

Cry recordings

Model



Neural network

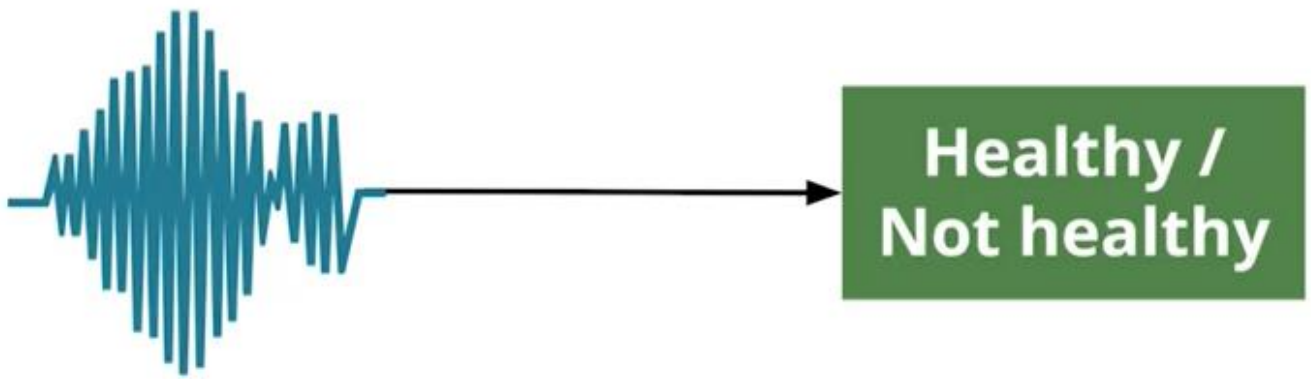
Output

Healthy / not healthy

Classification

Supervised learning

Input A	Output B	Application
Animal image	Type of animal	Image recognition
Text in Haitian Kreyol	Text in English	Machine translation
Cry recordings	Medical diagnosis	Speech recognition



Supervised learning

Input A	Output B	Application
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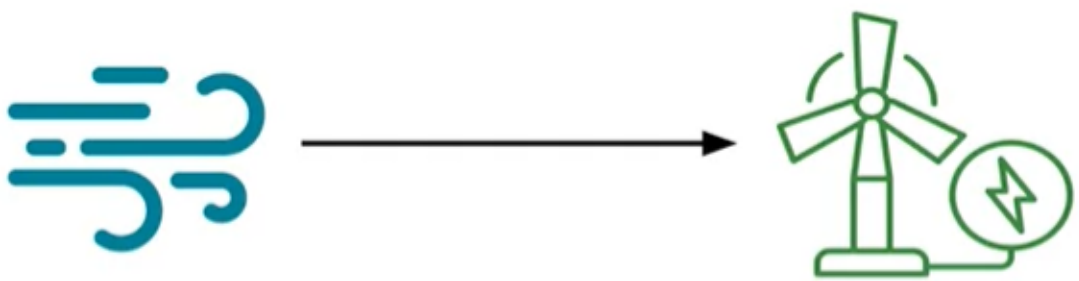
Cry recordings	Medical diagnosis	Speech recognition
Wind speed / sensor data	Energy generation	Prediction



Illegal mining detection

No illegal mining

No illegal mining

No illegal mining

Illegal mining

Illegal mining

Illegal mining

Possible illegal gold mining. Puerto Maldonado, Peru.

Supervised learning summary

Input A	Output B	Application
Road image	Cyclist / not cyclist	Image recognition
Satellite image	Mining/ no mining	Image recognition
Cry recordings	Healthy / not healthy	Speech recognition
Wind speed / sensor data	Energy generation	Prediction

AI first mindset

Supply chain logistic

Fitness plan

Medical diagnosis

Content creation

Disaster response

Global warming

Customer support

Public health

Personally identifiable information (PII)

any piece of information that can be used to identify an individual

Name

Phone Number

Address

Biometric Identifiers

Birth date

Credit Card Number

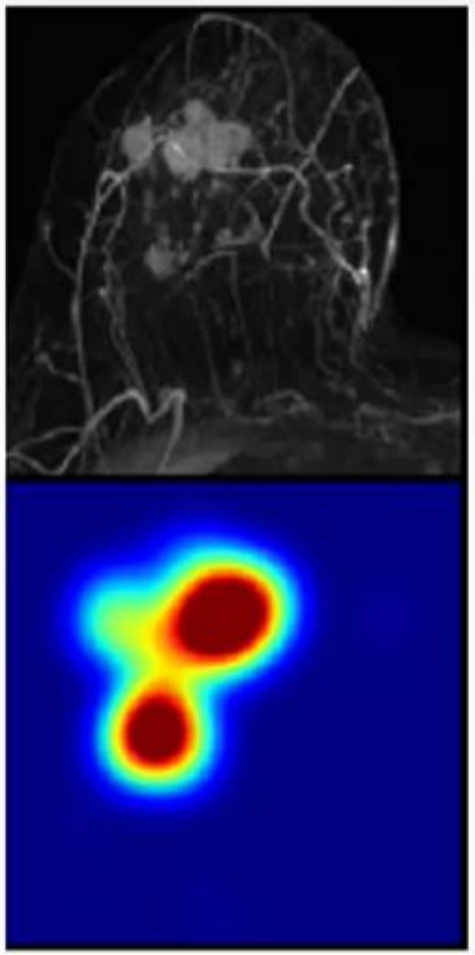
Microsoft

UNIVERSITY of WASHINGTON

AI for Health

FRED HUTCH
CURES START HERE™

AI for anomaly detection in breast cancer imaging



Felipe Oviedo, Y Xu, P. Liznerski, R. Vandermeulen, AS Kazerouni, M Hirano, E Blum, CI Lee, CI Li, J Lavista, H Rahbar, SC Partridge

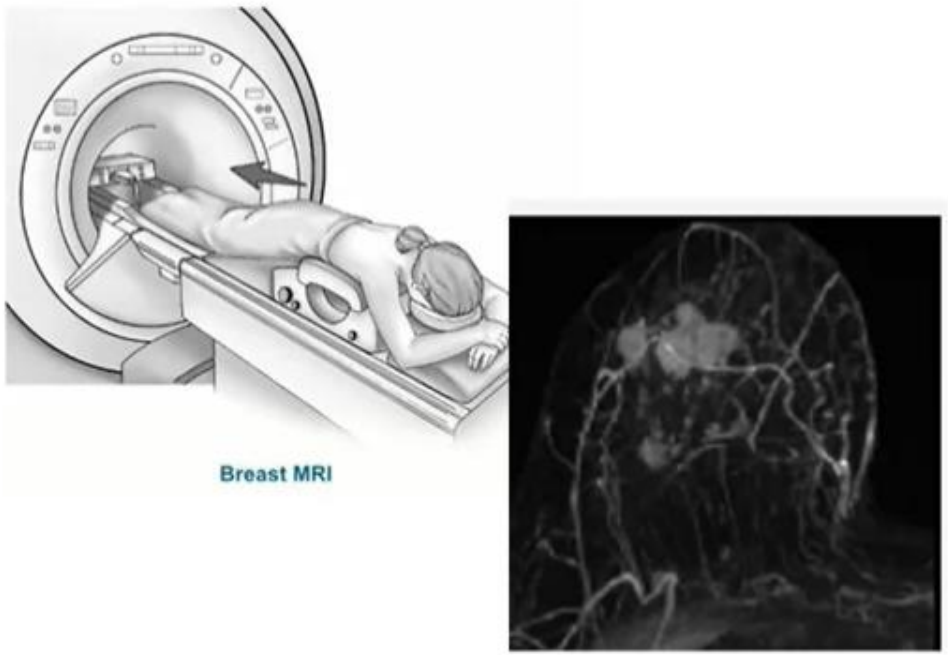
AI for Good Lab

Breast cancer, MRI and the role of machine learning

- Breast cancer is one the **most common types of cancer** worldwide.
- In the US only, **~300K new diagnosis** per year and **~40K deaths** per year.
- Magnetic Resonance Imaging (**MRI**) is used for cancer screening and early detection in **high-risk women.**
- **Project Goal:** Develop a machine learning model **to assist** radiologists in **early detection** of breast cancer from MRIs.

What's is not normal? A common problem in radiology

Breast MRI



Common Questions by Radiologist

Is the **breast normal or abnormal?**

Where are the abnormalities in the image?

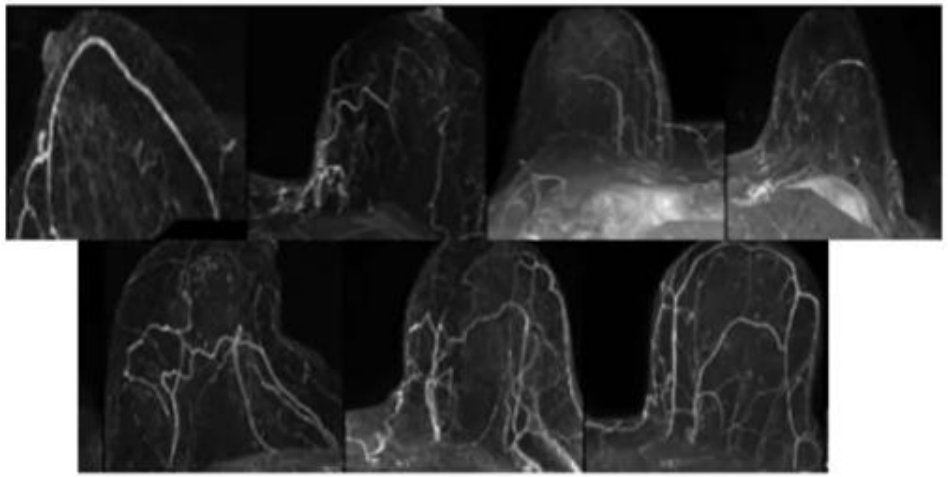
If there are abnormalities, can we make cancer **diagnoses or risk predictions**?

Challenges for applying machine learning

Problem: Machine learning from **few positive cases** is difficult

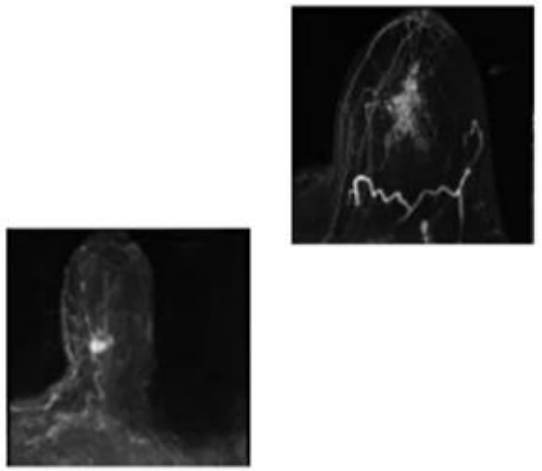
Negative cases (No Cancer or Low-Risk)

- **Abundant** (thousands of exams)



Positive cases (Cancer or High-Risk)

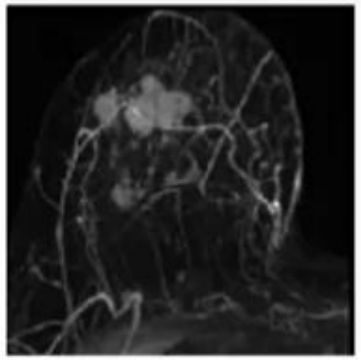
- **Scarce** (dozens / hundreds)



Our approach: Explainable deep anomaly detection model

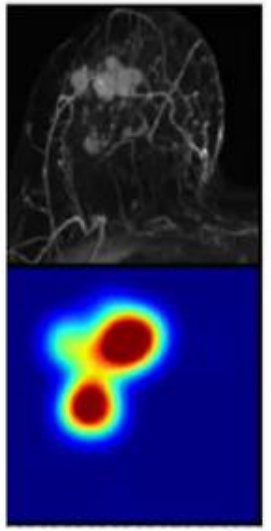
- Customized loss that learns to find **anomalies**
- 4000 patients, over 10,000 breast MRI exams

Breast MRI



Deep Anomaly Detection Model

Is it normal?
Yes / No



Learned **anomaly map & score**

Advantages

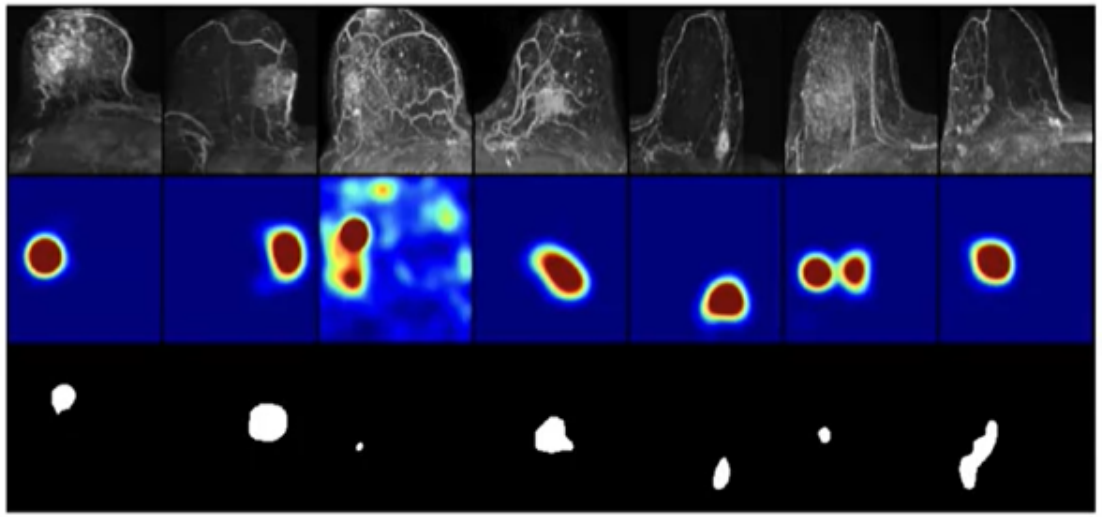
Learns what is a **normal** breast using **abundant negative data.**

Ranks abnormality with **anomaly score**

Provides abnormal areas in form of **anomaly map**

Results and future work

- Good **performance** for detecting existing cancer (Accuracy > 90%, AUC: 0.811) and predicting 5-year risk (Accuracy > 80%, AUC: 0.669) of developing cancer
- Reduces **exam time** by over 80%.
- Provides **explanations** for anomalous areas that match those made by a radiologist.
- **Next steps:** clinical use to reduce workload and prioritize difficult cases.



AI for Good framework

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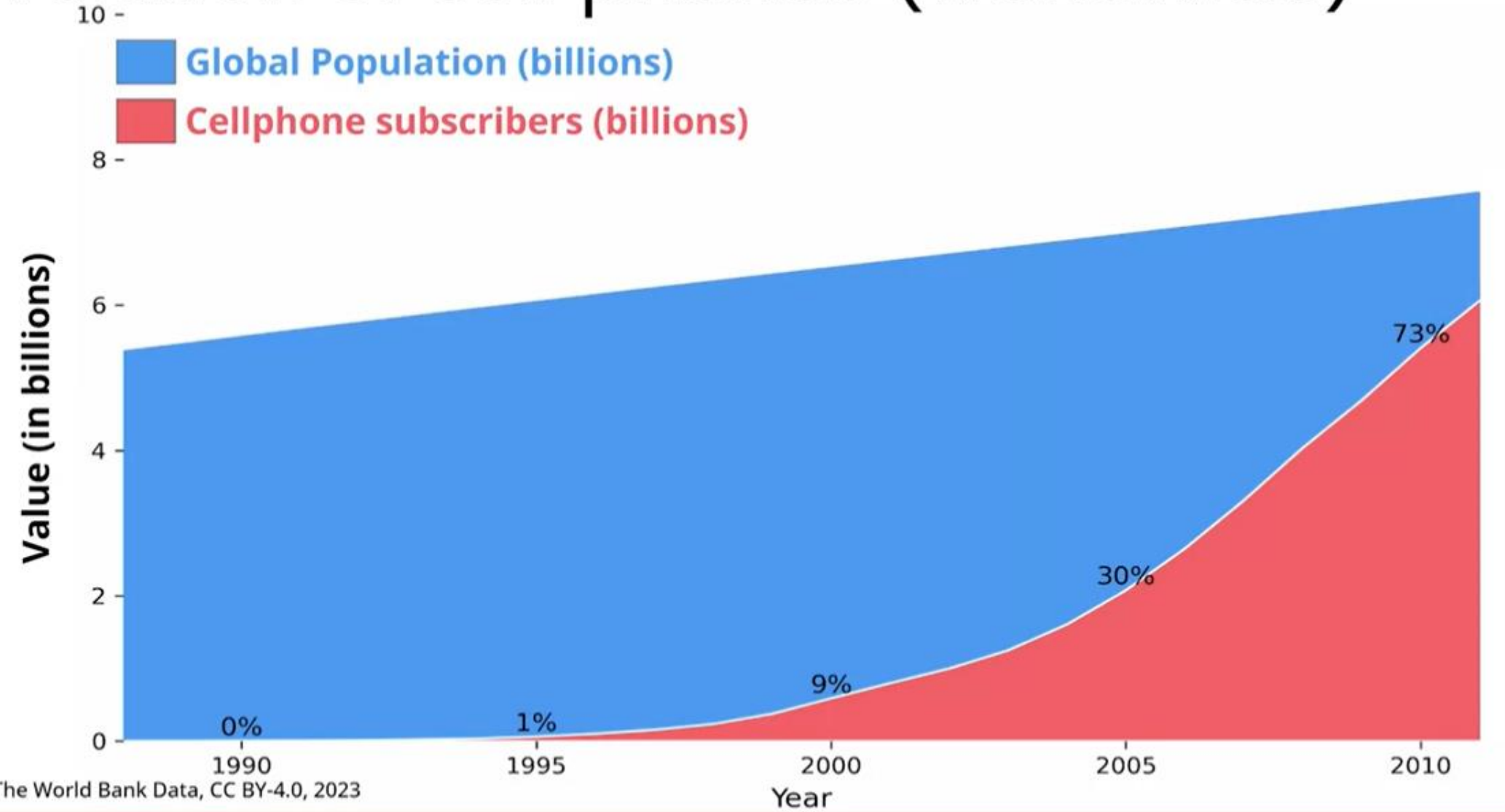
Evolution of cell phones (worldwide)



Data from The World Bank Data, CC BY-4.0, 2023

Malawi

Malawi clinic

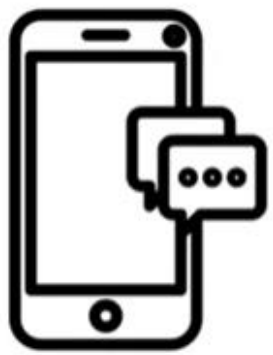
1
physician

>100,000
residents

People communicated through text messages

Text message classification

Input → **Output**



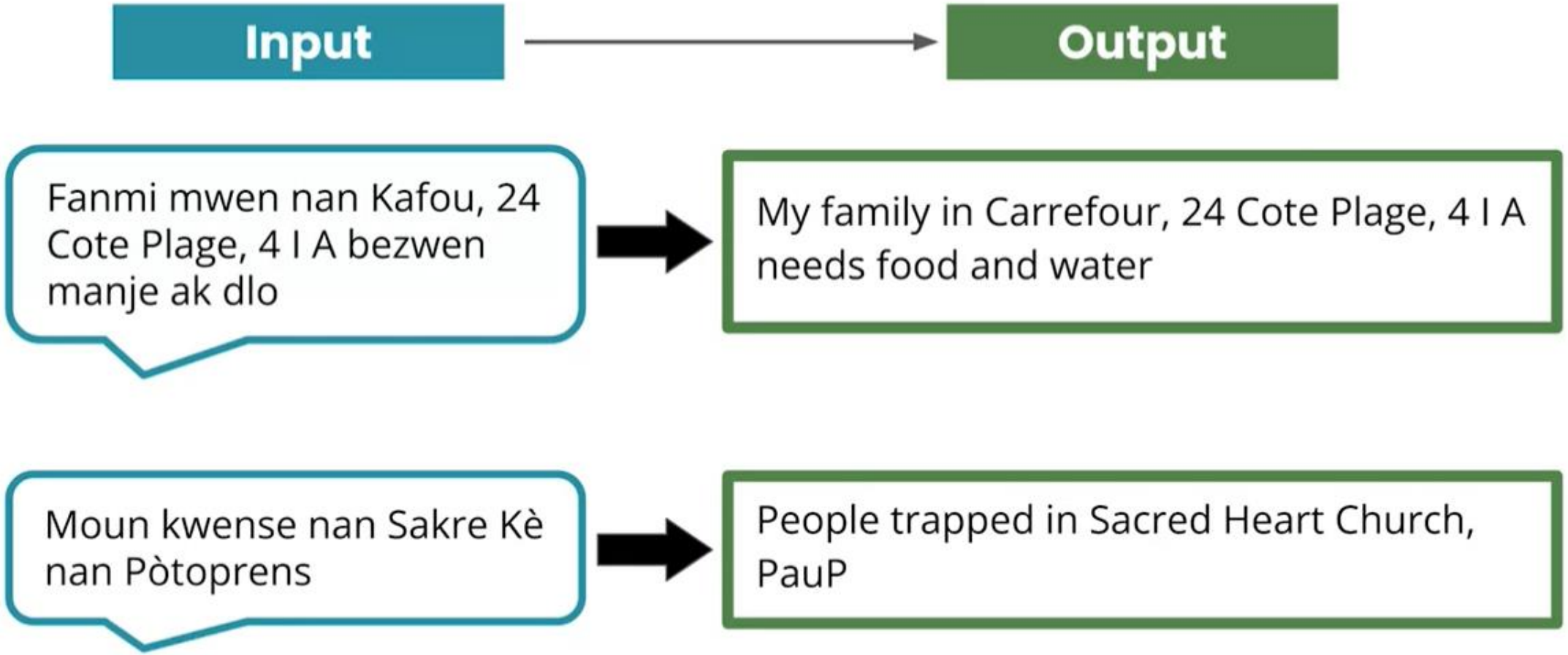
Text Messages

Administrative
related to
the clinic
→
1. Patient-related
2. Clinic-admin
3. Technological

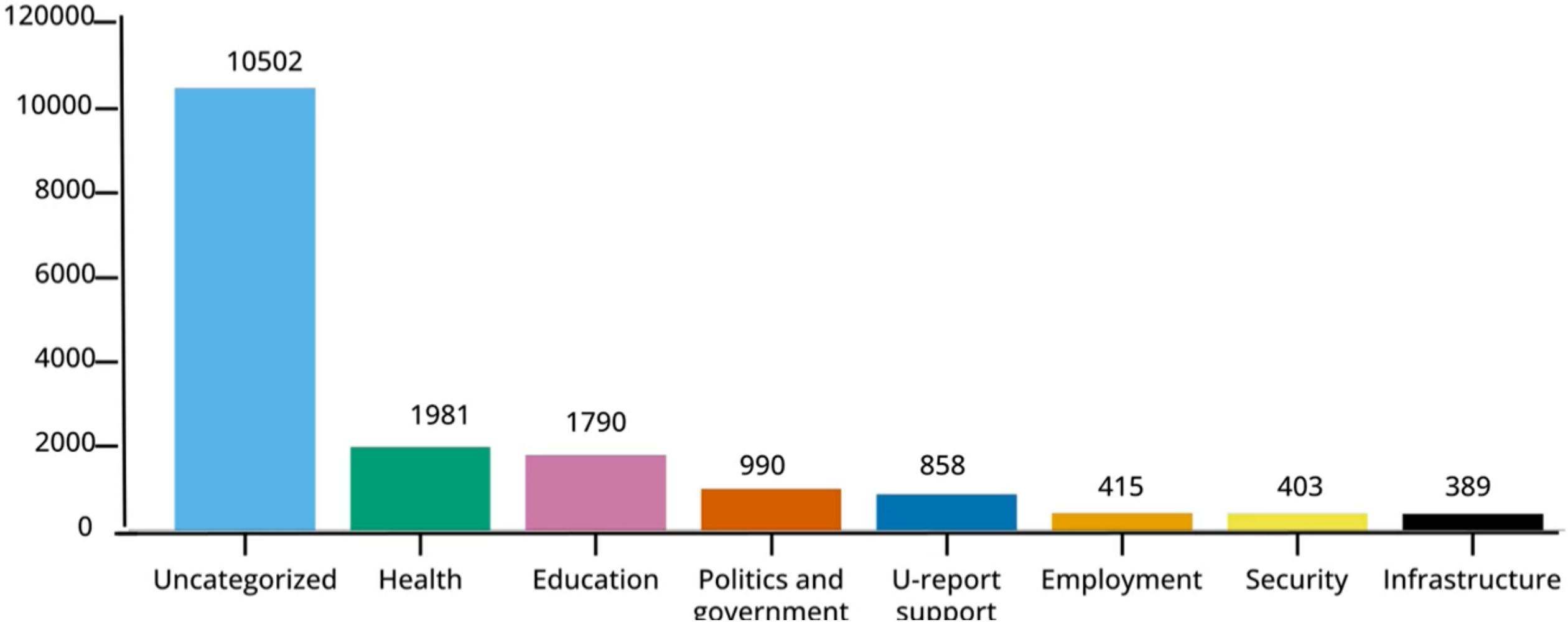
Requests
from Community
Health Workers
→
1. Response
2. Request for doctor
3. Medical advice

Illness
monitoring bodies
→
1. TB
2. HIV
3. Death

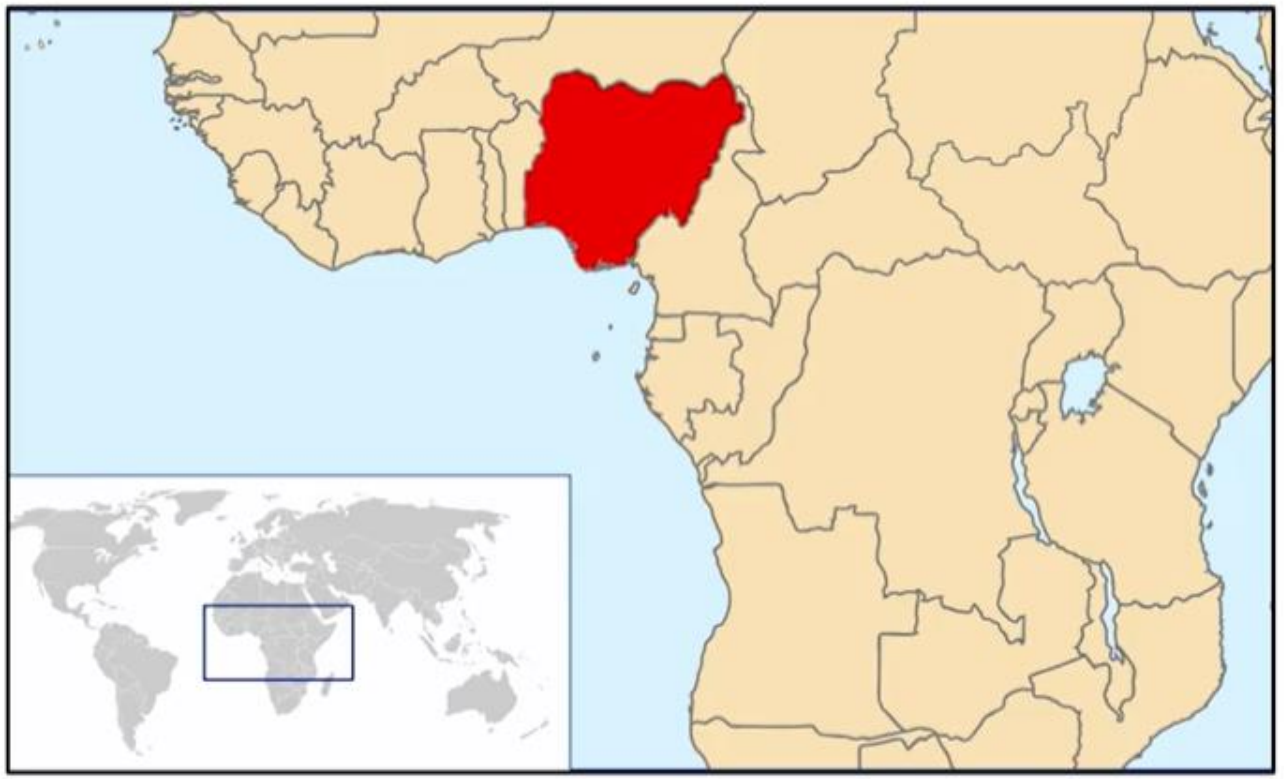
People were requesting help, mainly in Haitian Kreyol



Frequency of text messages to U-Report in Nigeria



1,000 days project



[Wikimedia Commons, 2006. Nigeria location]

1,000 DAYS

Nutrition and Healthcare for mothers

Pregnancy

2 years old

AI4G Framework: Explore Phase

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

AI4G Framework: Explore Phase

Deploy

Explore

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

A good problem statement should:

1. Define the problem you are hoping to address.
2. Identify key stakeholders.
3. Give an idea of what success looks like.
4. Not mention the specific technology you aim to deploy.

Explore: Define the problem

"It's hard to process large amounts of text messages in different languages."

Explore

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

"**Healthcare providers need to communicate directly with mothers in the community** to monitor their health and the health of their babies, and they are faced with the challenge of processing large volumes of text messages in multiple languages."

"Healthcare providers need to communicate directly with mothers in the community via surveys to monitor their health and the health of their babies. To do this, they need to be able to **quickly process a large volume of incoming text messages in multiple languages** including survey responses and other unrelated messages from the community."

Explore: Define the problem

A good problem statement should:

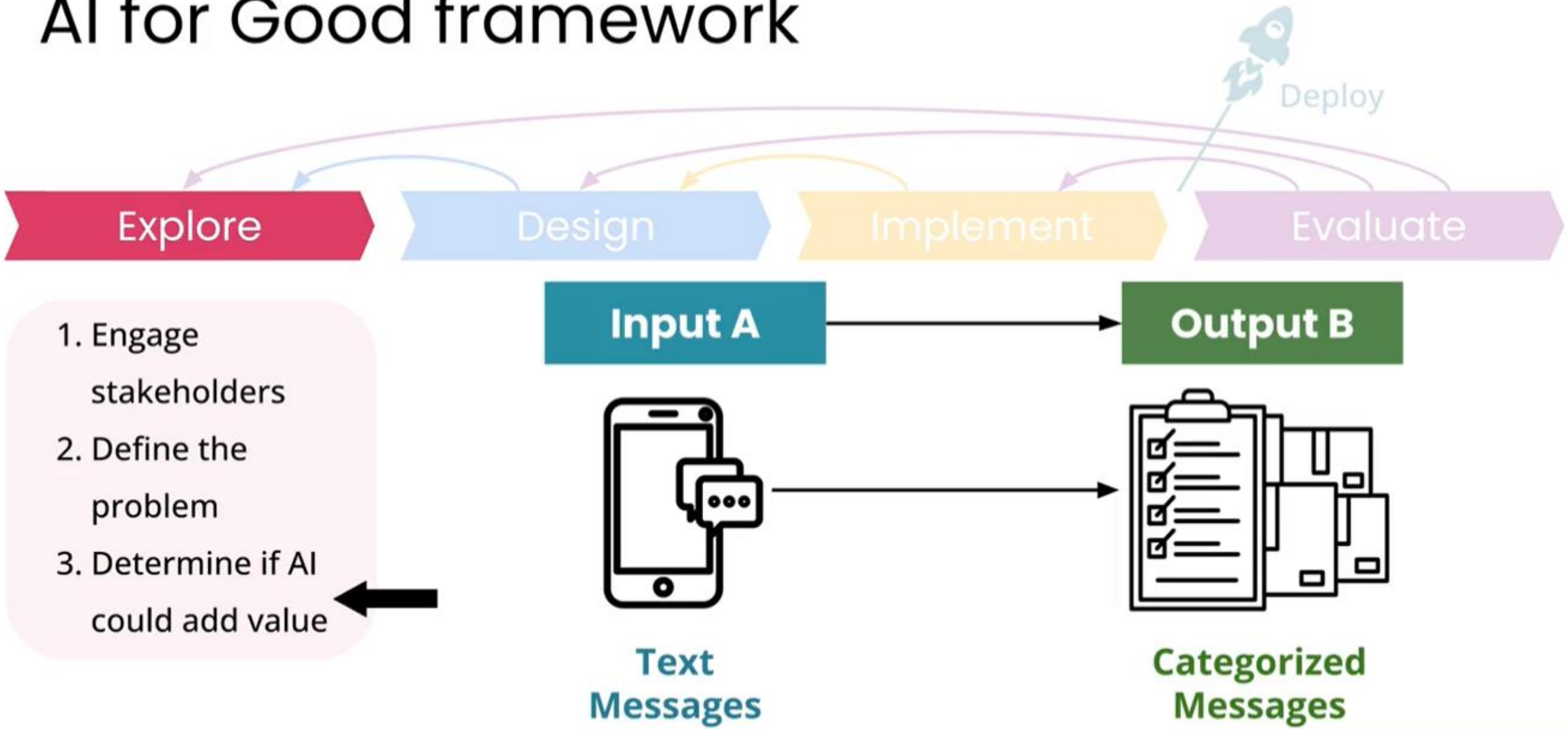
1. Be clear, concise, and specific.
2. Identify key stakeholders.
3. Give an idea of what success looks like.
4. Not mention the specific technology you aim to deploy.

Explore

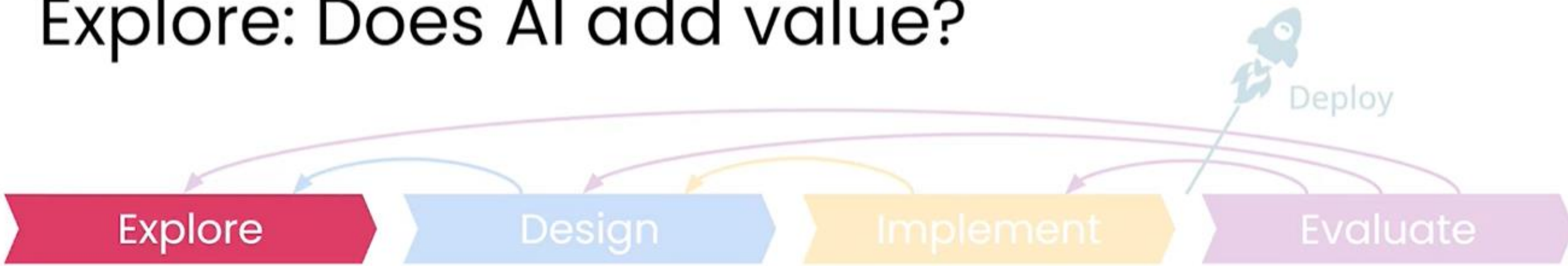
1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

"Healthcare providers need to communicate directly with mothers in the community via surveys to monitor their health and the health of their babies. To do this, they need to be able to **quickly process a large volume of incoming text messages in multiple languages** including survey responses and other unrelated messages from the community."

AI for Good framework



Explore: Does AI add value?

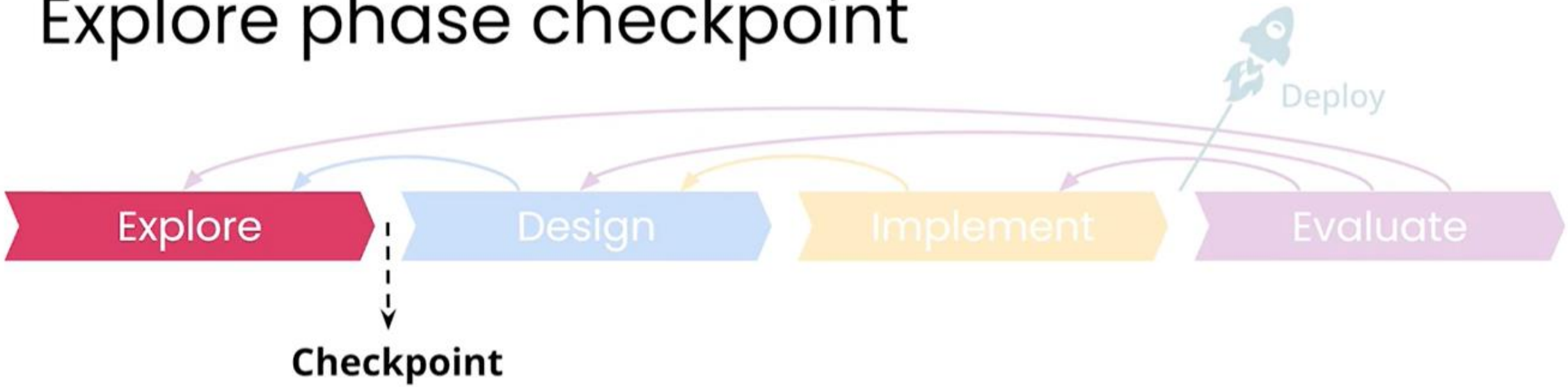


1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

Do no harm

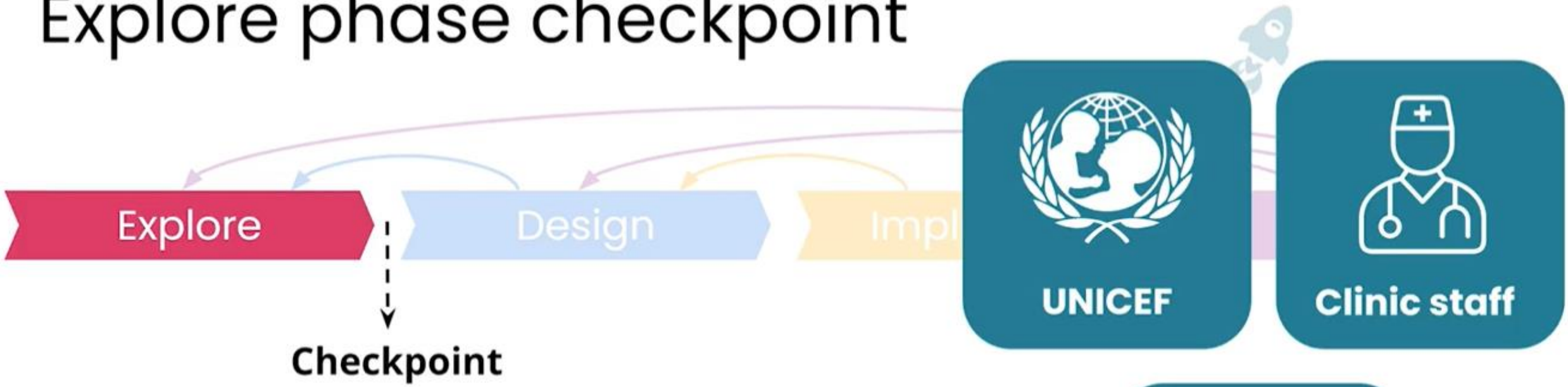
1. Message contain personally identifiable information that should be kept **private and secure**

Explore phase checkpoint



- What is the specific problem you are addressing?
- Who are the stakeholders?
- Do you have access to or can you collect the necessary data?
- Could AI add value? Where and how specifically?
- How does the “do no harm” principle come into play?

Explore phase checkpoint



Checkpoint

- What is the specific problem you are addressing? ✓
- Who are the stakeholders? ✓
- Do you have access to or can you collect the necessary data?
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Explore phase checkpoint

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Explore phase checkpoint

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- What is the specific problem you are addressing? ✓
- Who are the stakeholders? ✓
- Do you have access to or can you collect the necessary data? ✓
- Could AI add value? Where and how specifically? ✓
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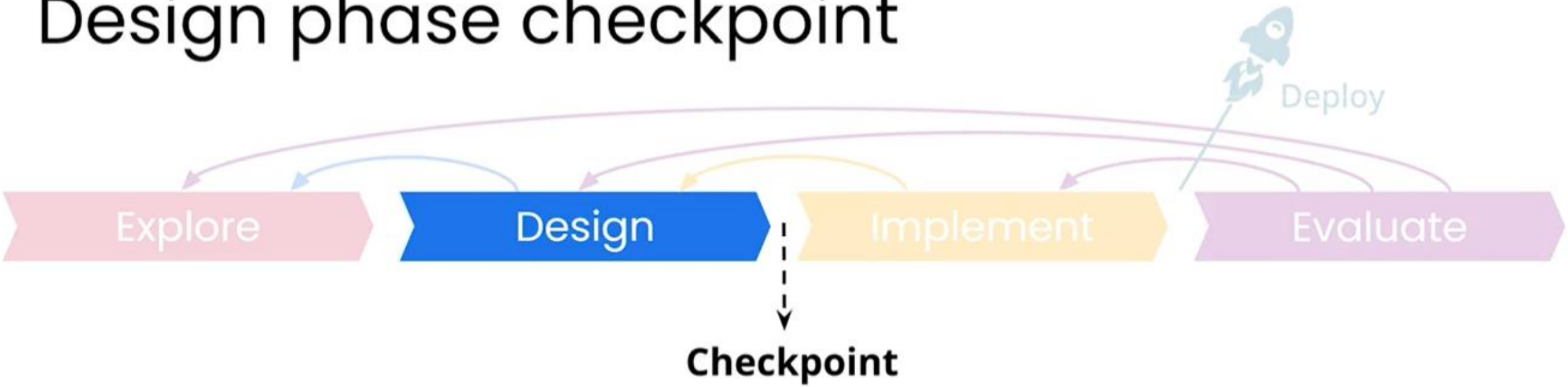
Design phase

1. Prototype your solution
2. Ensure data privacy
3. Design the user experience

Medical information contained PII

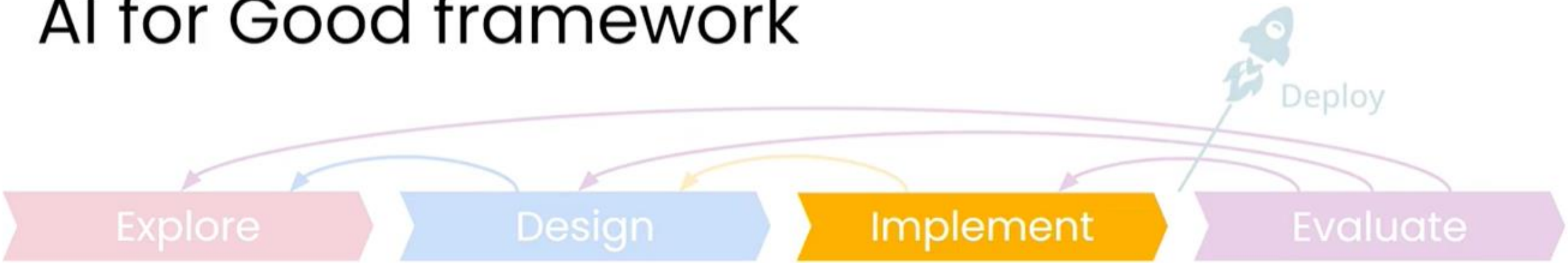
- Access to messages was limited
- Messages were not downloaded or stored

Design phase checkpoint



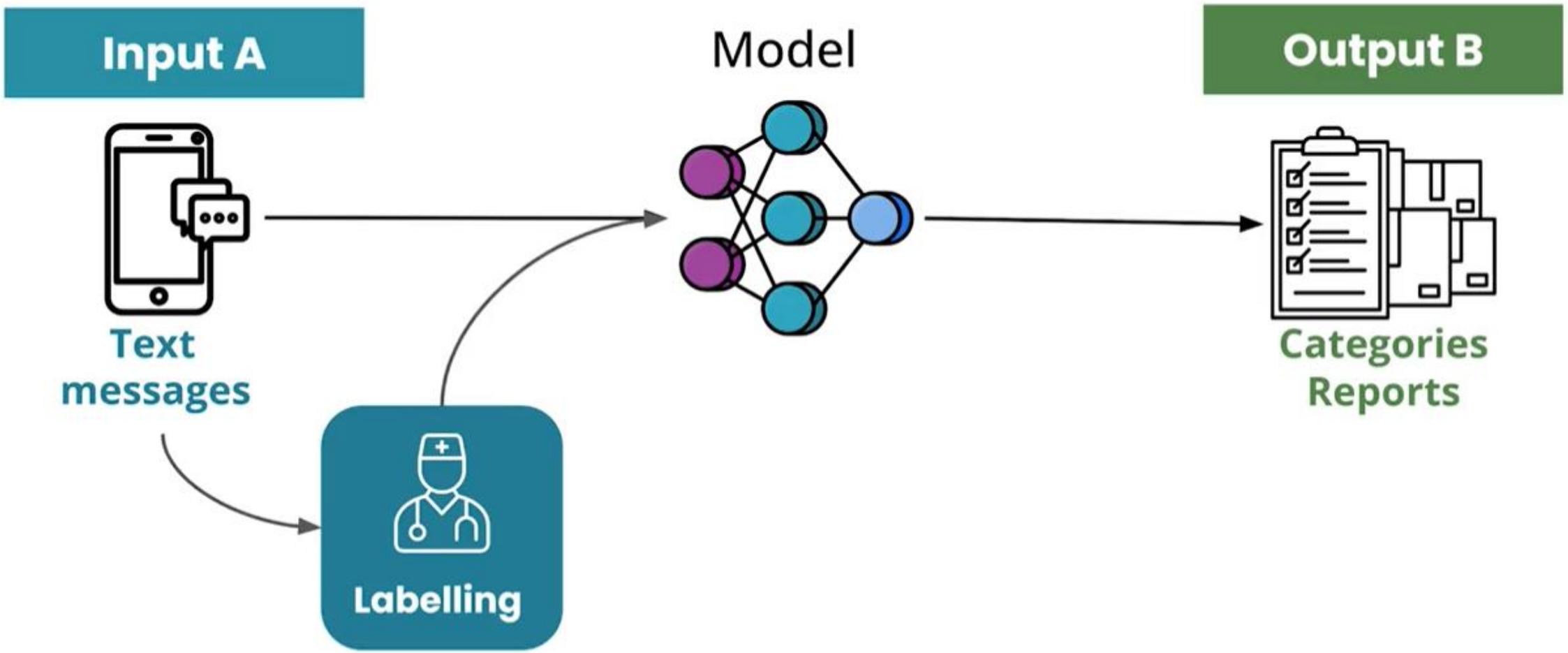
- How will you address issues with imbalances, biases, privacy, or other concerns with your data?
- What kind of model will you implement, and how will you measure its performance?
- How will your design address the problem you set out to work on?
- How will the end user interact with your system?

AI for Good framework

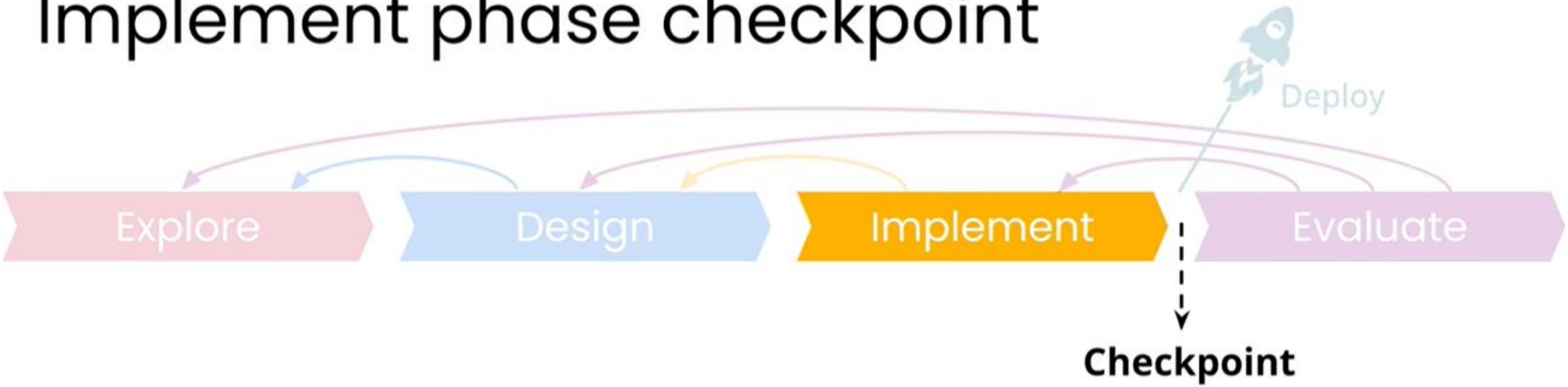


1. Productionize AI models
2. Integrate the user experience
3. Test with end users

Maternal & infant health classification



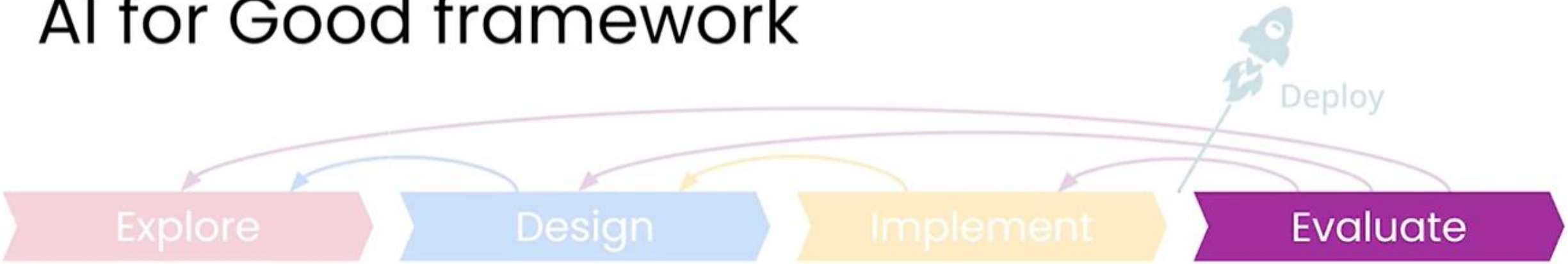
Implement phase checkpoint



Checkpoint

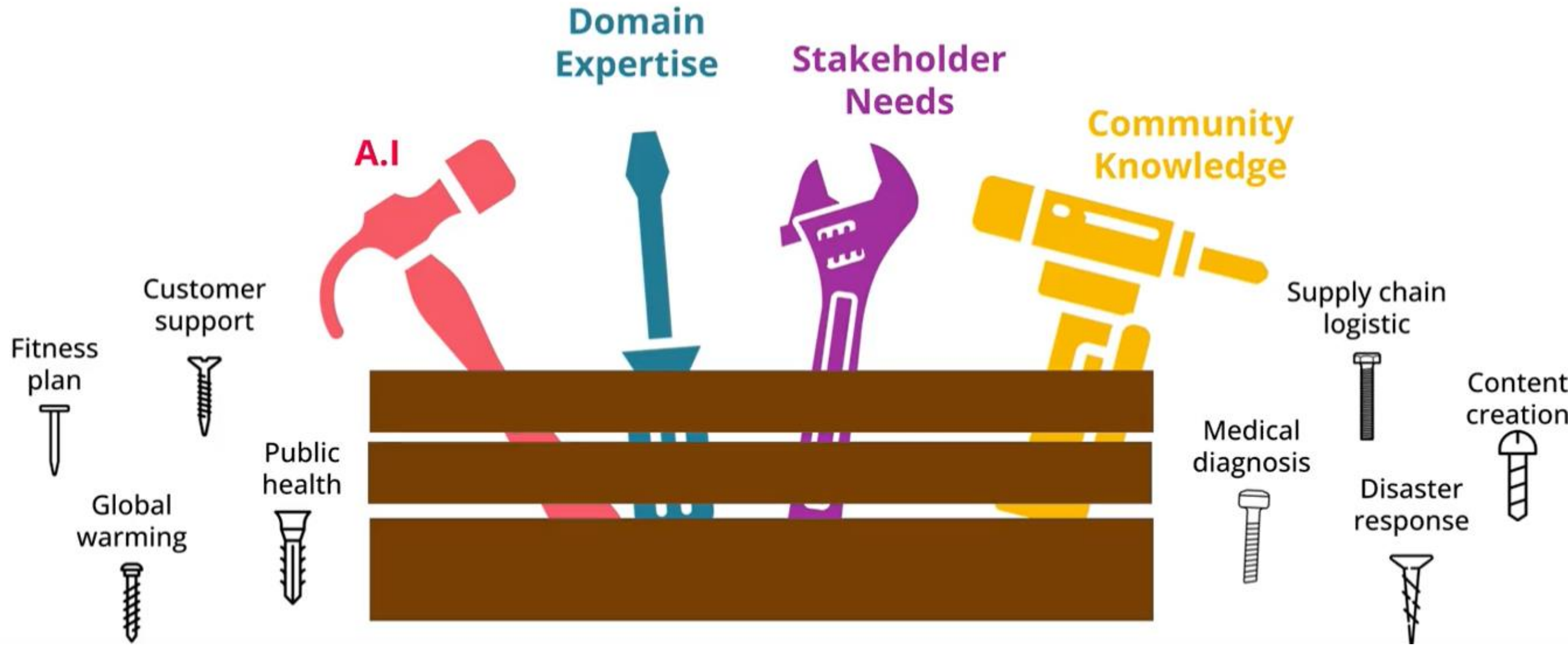
- Is your model performance acceptable?
- Are end users able to successfully use your system?

AI for Good framework



1. Measure project impact
2. Communicate results
3. Determine next steps

AI is only one part of any potential solution



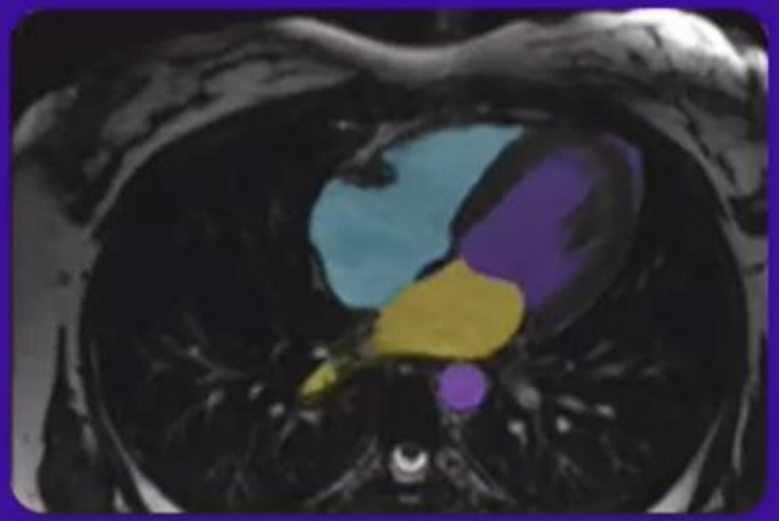
Report VOICE MATTERS

Translators without Borders

As of 2023, U-Report is active in 68 countries, serving over 11 million users worldwide

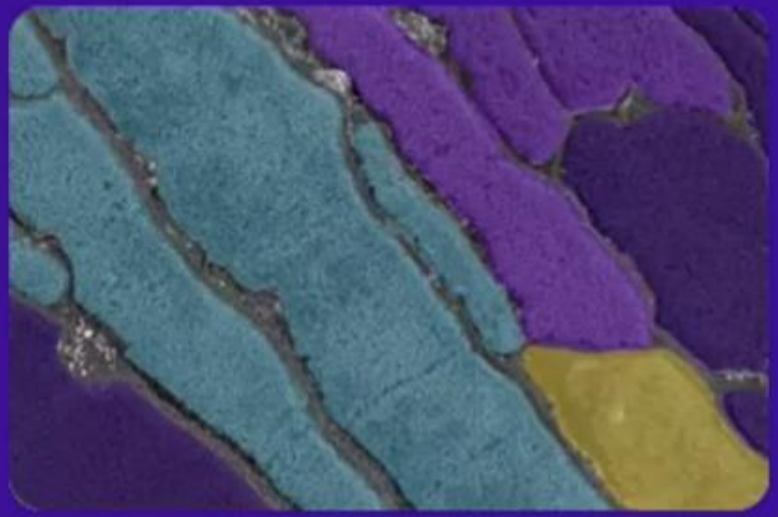
Geospatial

Automotive



Medical

Industrial



Agricultural

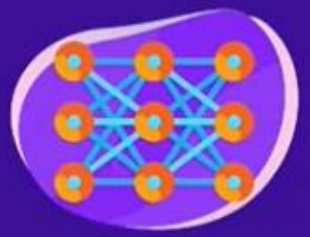
Retail

Trash and litter analysis

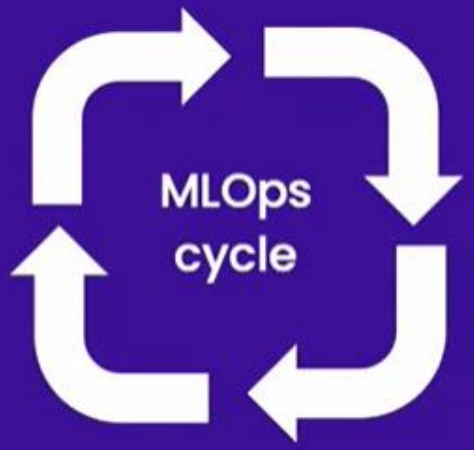
Damage detection

Our role

humans collect, generate and annotate the training data



1st stage: model training



2nd stage: model testing

humans give feedback for reinforcement learning

humans review the errors and provide insights as an AI audit

4th stage: model auditing

3rd stage: model deployment

humans monitor the AI model and edge cases in real time

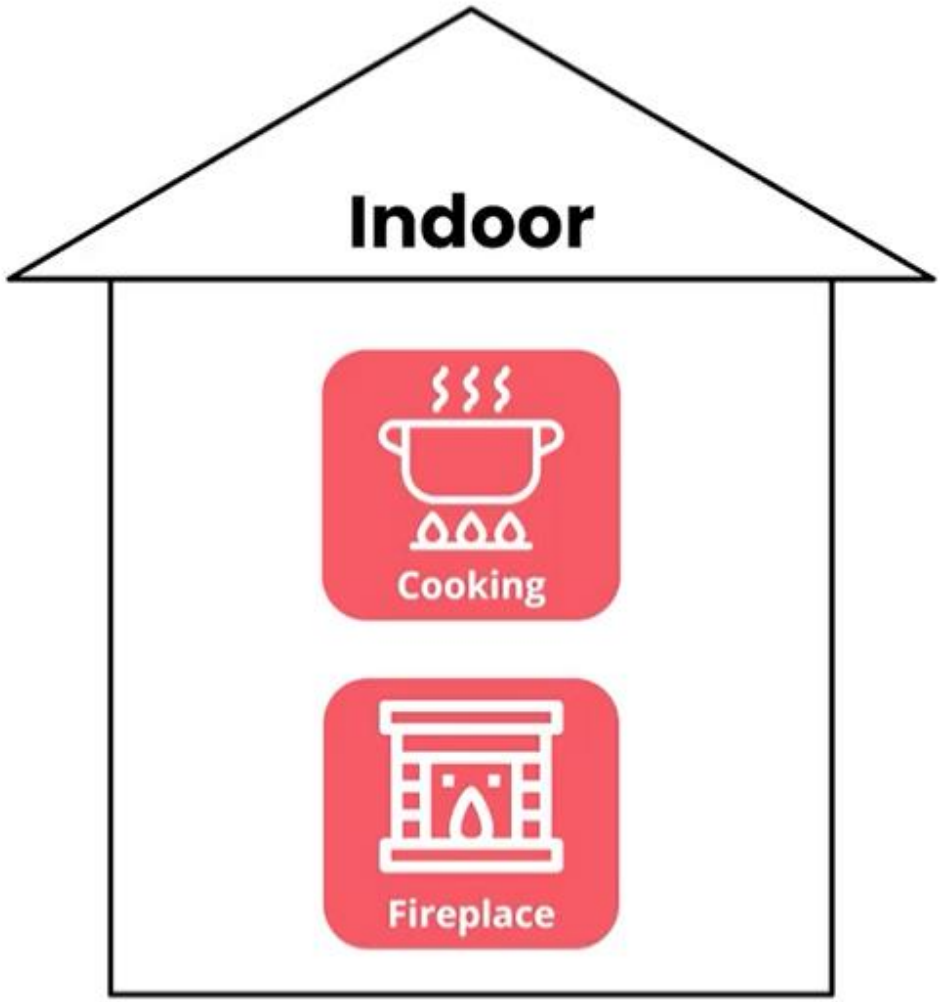
1. Are you incorporating **human feedback and input** at the different stages of your model training and deployment cycle?

2. Are you using a **diverse group of humans** to provide this input?

3. Are you making sure they are **compensated in a dignified way** for their work?

Air quality and public health

Air pollution



Outdoor

Modern ambient air pollution

Most common air pollutants

- Particulate matter (PM)
- Ozone
- Lead
- Oxides of nitrogen, sulfur, carbon

Particulate matter 2.5 ($PM_{2.5}$)

Human hair

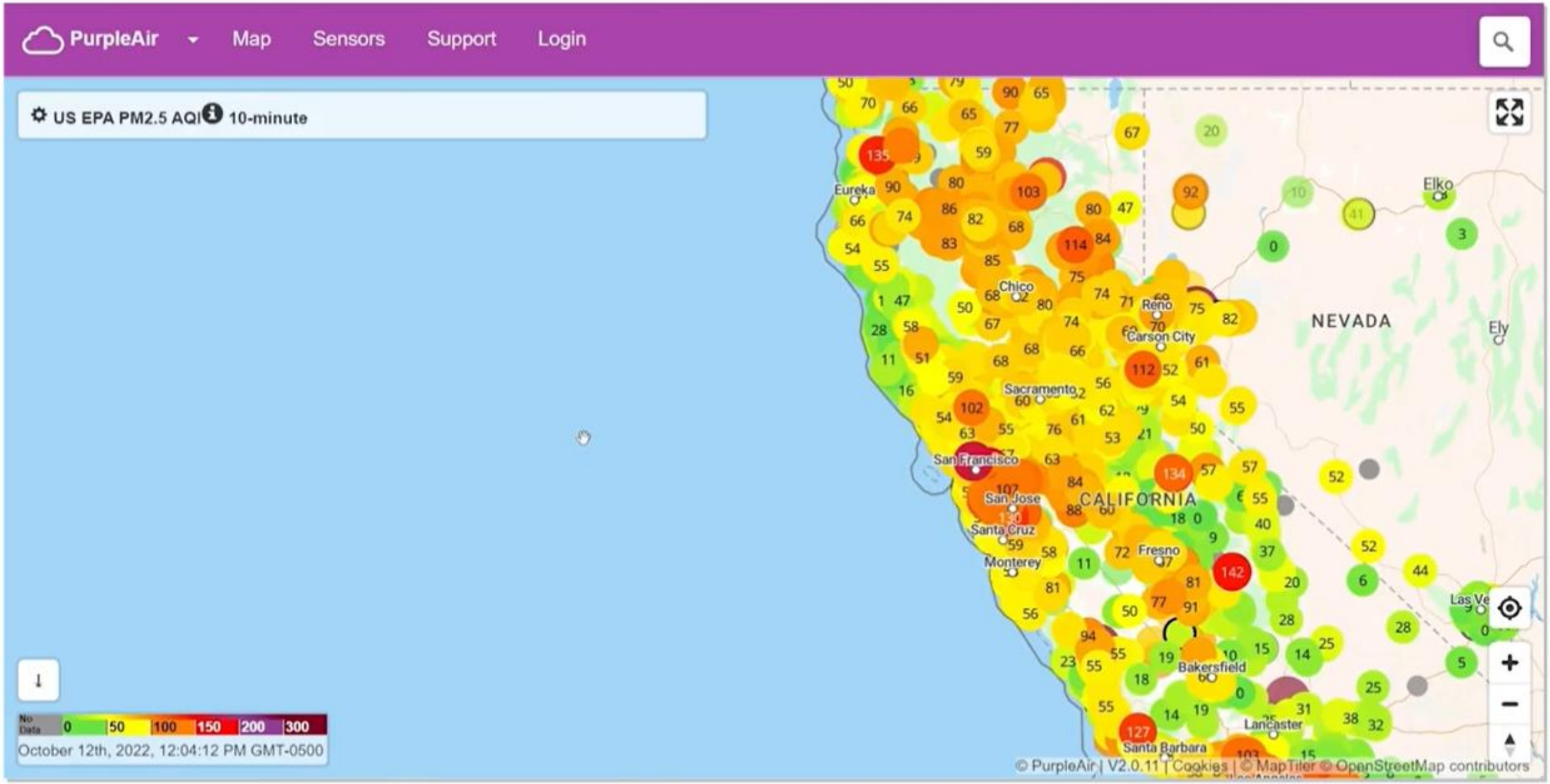
50-70μm
(microns)

PM 2.5

2.5μm
(microns)

20-30 PM2.5 particles span the width of one human hair!

- Chronic lung problems
- Lung cancer
- Cardiovascular diseases


PurpleAir
Map
Sensors
Support
Login
US EPA PM2.5 AQI
10-minute
No Data
0
50
100
150
200
300
October 12th, 2022, 12:04:12 PM GMT-0500
NEVADA
CALIFORNIA
Reno
Carson City
Elko
Ely
Chico
Sacramento
San Francisco
San Jose
Santa Cruz
Monterey
Fresno
Bakersfield
Lancaster
Santa Barbara
Eureka
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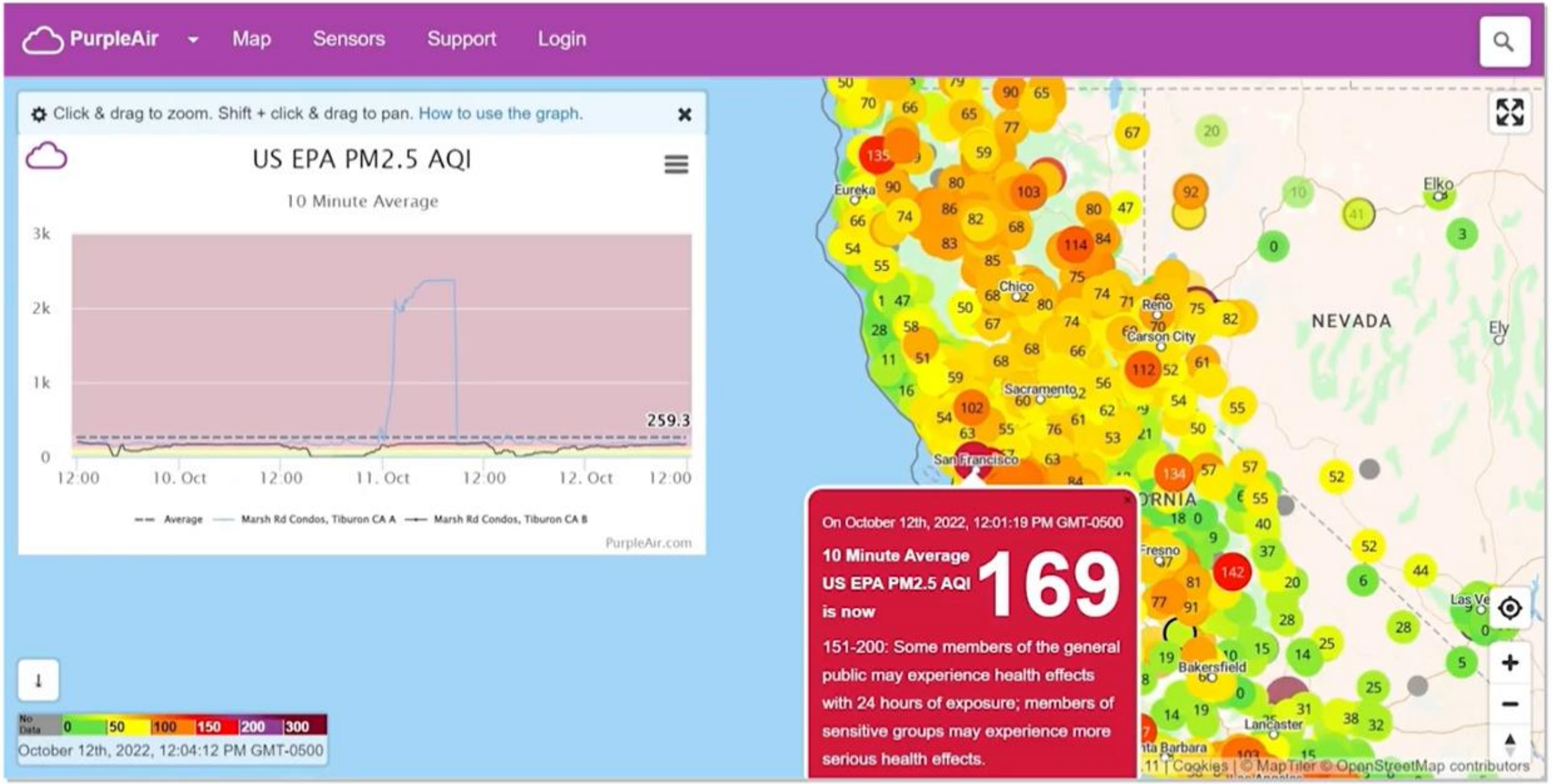
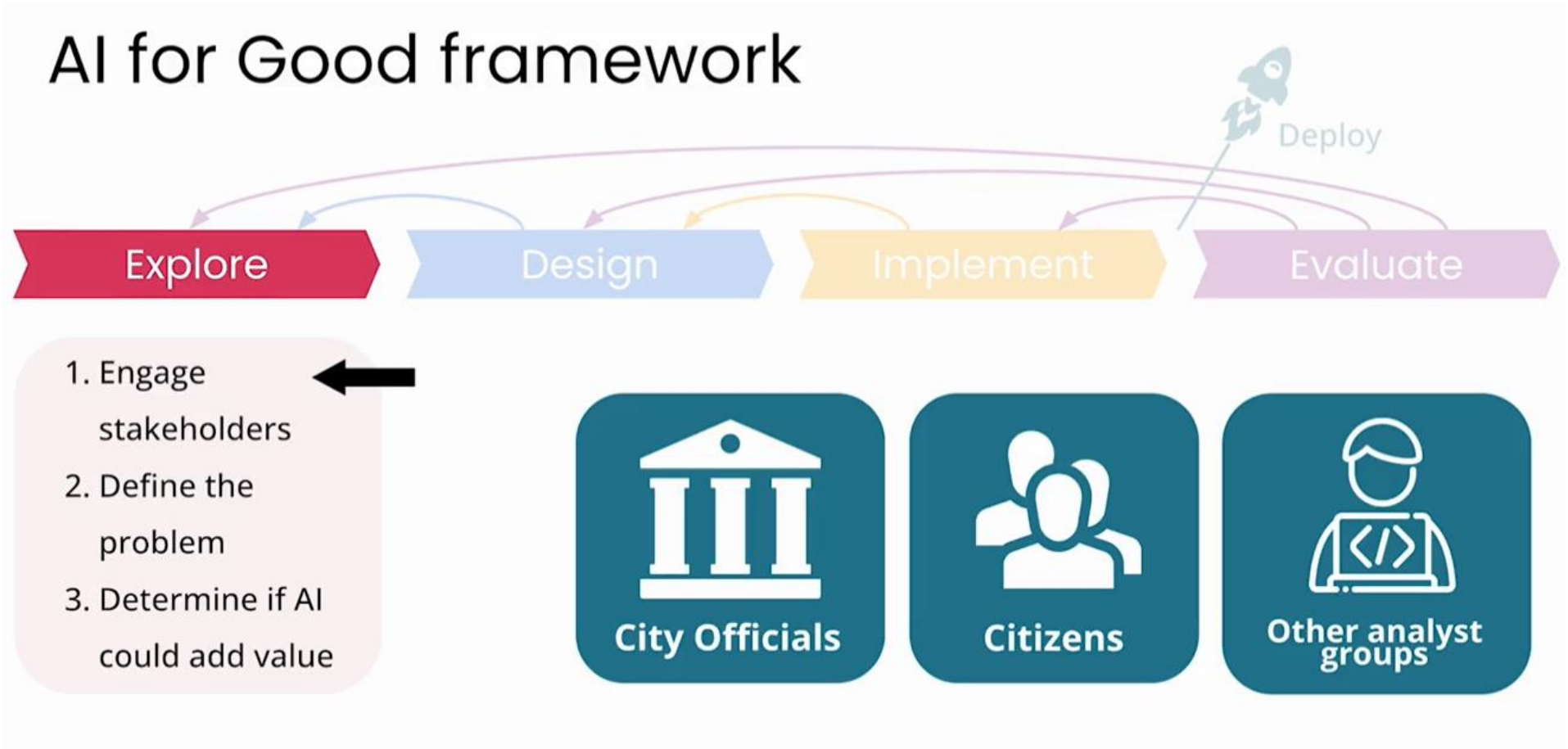

PurpleAir
Map
Sensors
Support
Login
Click & drag to zoom. Shift + click & drag to pan. How to use the graph.
US EPA PM2.5 AQI
10 Minute Average
3k
2k
1k
0
259.3
12:00
10. Oct
12:00
11. Oct
12:00
12. Oct
12:00
Average
Marsh Rd Condos, Tiburon CA A
Marsh Rd Condos, Tiburon CA B
PurpleAir.com
No Data
0
50
100
150
200
300
October 12th, 2022, 12:04:12 PM GMT-0500
NEVADA
Elko
Ely
Reno
Carson City
Chico
Sacramento
San Francisco
Fresno
Bakersfield
Lancaster
Las Ve
On October 12th, 2022, 12:01:19 PM GMT-0500
10 Minute Average
US EPA PM2.5 AQI
is now
169
151-200: Some members of the general public may experience health effects with 24 hours of exposure; members of sensitive groups may experience more serious health effects.
.11 | Cookies | © MapTiler © OpenStreetMap contributors

Bogotá Air Quality Monitoring Network

Measures Pollutants

- Particulate Matter
- Ozone
- Sulfur Oxide
- Nitrogen Oxide
- Carbon Oxide
- Atmospheric Conditions

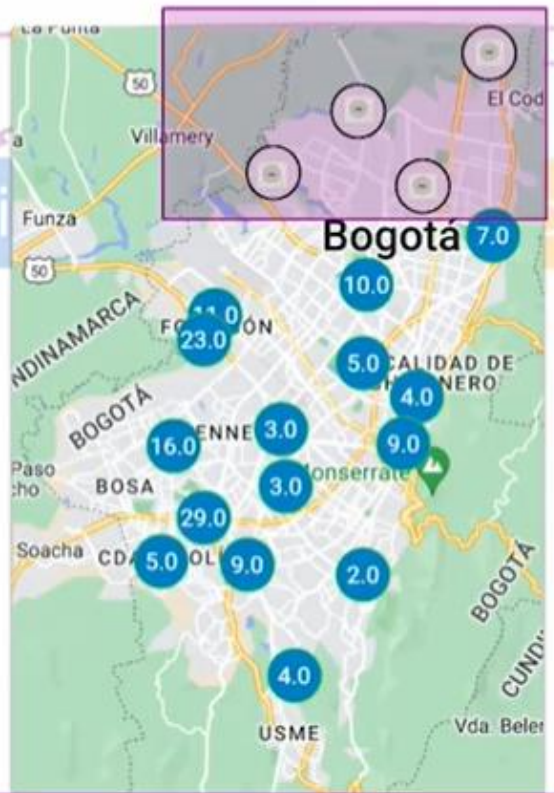
Air Quality - Explore Phase



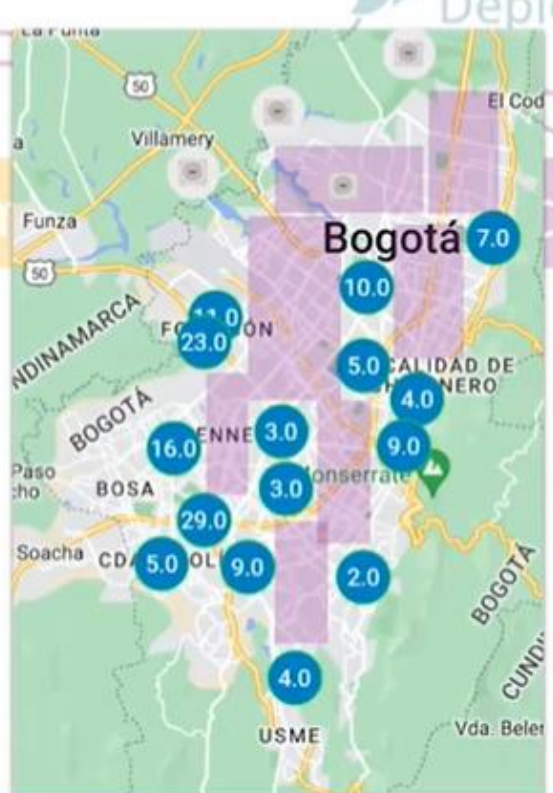
AI for Good framework

Explore

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value



No data available for these sensors



No data in-between the sensors

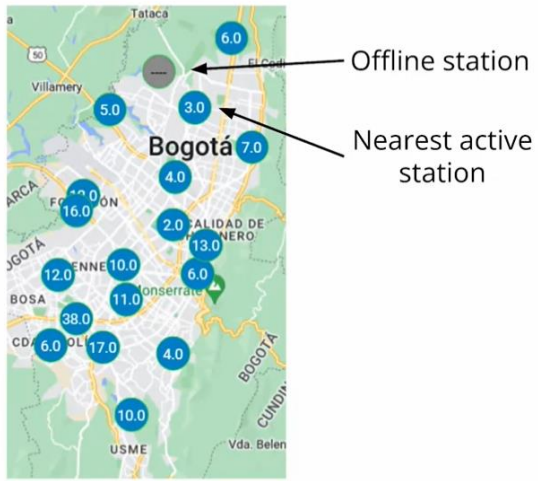
AI for Good framework

Explore

1. Engage stakeholders
2. Define the problem
3. Determine if AI could add value

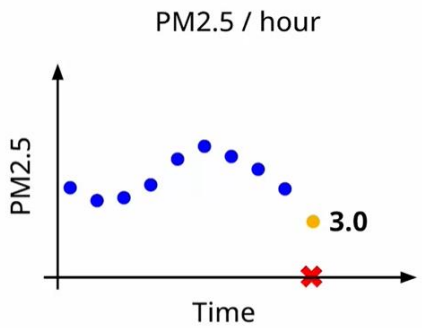
"Public health professionals working with the city of Bogotá need to be able to provide **real time estimates of air quality** throughout the city so that citizens can be aware of any health risks due to poor air quality and plan their outdoor activities accordingly."

Baseline model: Nearest station

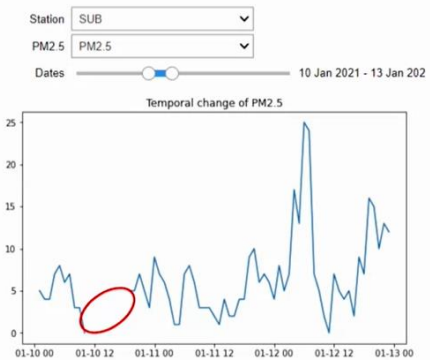


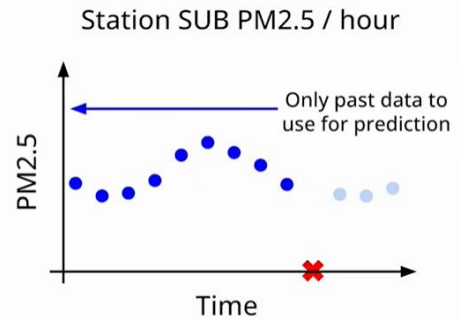
Offline station

Nearest active station



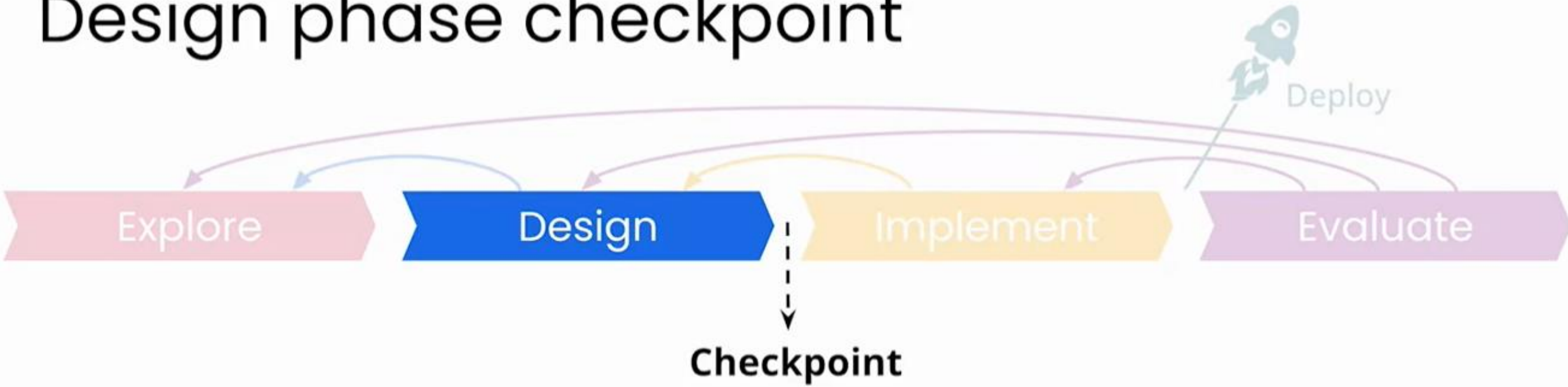
Baseline model: Last value





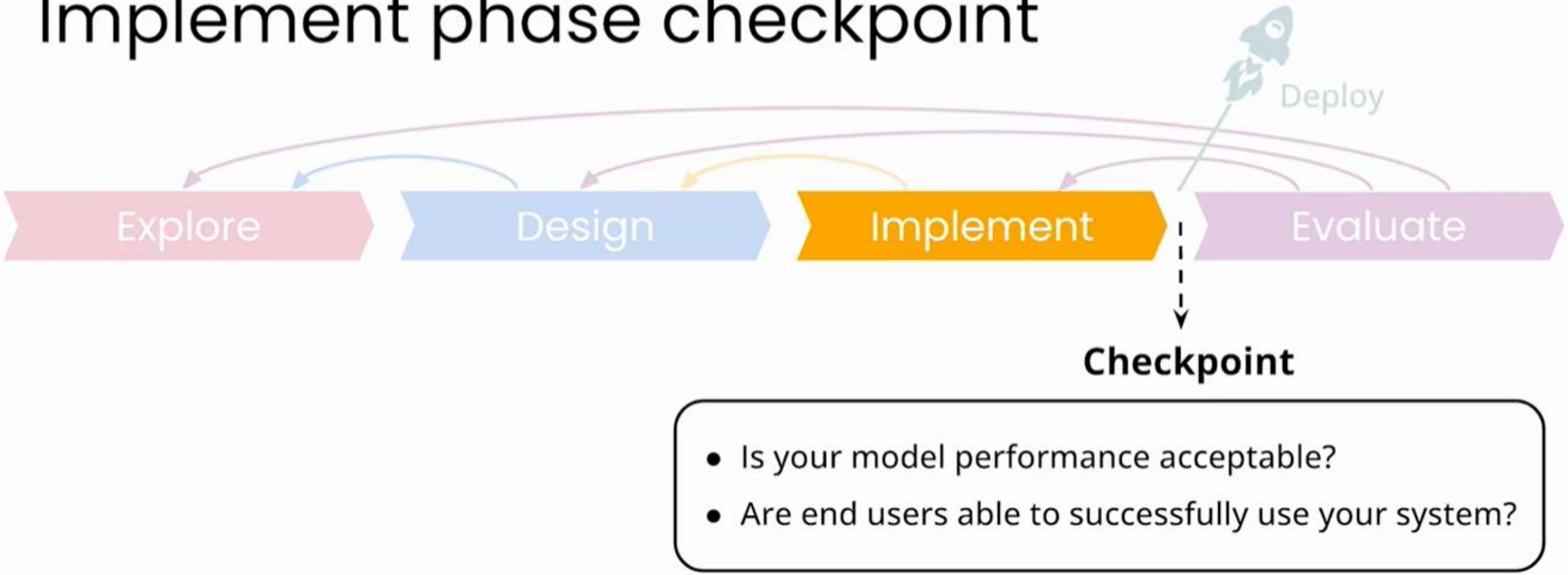
Air Quality - Establish a Baseline

Design phase checkpoint



- How will you address issues with imbalances, biases, privacy, or other concerns with your data?
- What kind of model will you implement, and how will you measure its performance?
- How will your design address the problem you set out to work on?
- How will the end user interact with your system?

Implement phase checkpoint



Air pollution

6.7 million premature deaths annually

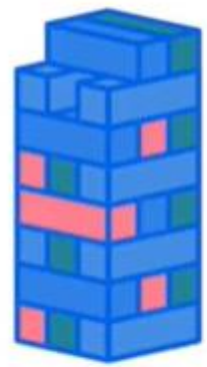
98% of urban areas don't meet accepted quality standards

1$ invested
=
30$ benefit

Guidelines for success

1. **Could AI add value? Where and how specifically?**

2. **Build on existing Infrastructure**



3. **Collaborate for success**