

Human Centered Data Science SS 2024

Design & Implementation of an Explanation Interface for Maternal Health Care

Aditya Panchal
Mariana Steffens
Navya Reddy Tiyyagura
Se Yeon Kim

About the Project

- **Goal:** Create a comprehensive explanation interface using the techniques learned in class to help our target audience make informed decisions on maternal health.
- **Target Audience:** Medical staff in a maternity hospital, who work in the triage process in the emergency.



An expectant woman arrives in the emergency with symptoms of high blood pressure.

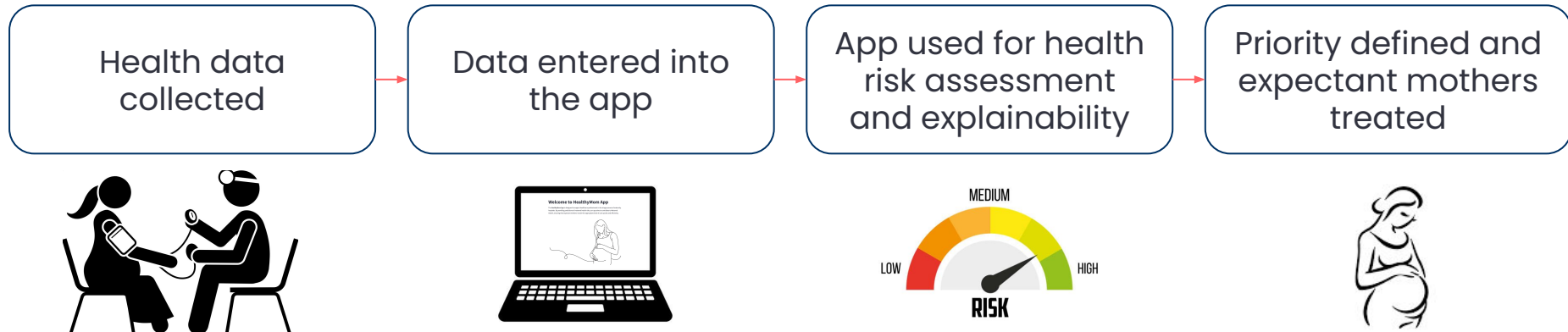
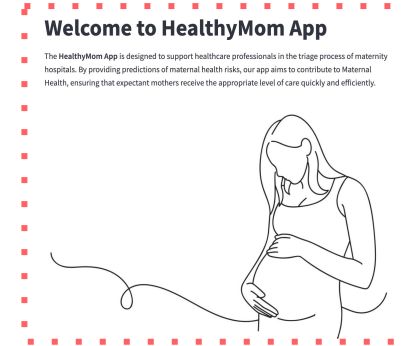
Many other expectant woman are in the waiting room.

How to determine the urgency of treatment for each patient?

How can we approach this problem?

About the Project

Our approach: integrate a **health risk classification App** in the emergency to ensure that mothers receive the **appropriate level of care** quickly and efficiently.



The Dataset

Maternal Health Risk Dataset

- Patient health data was collected using wearable sensor devices, and risk levels were classified with the help of medical experts and literature review.

Attribute Name	Role	Type	Description	Missing Values
Age	Feature	Integer	Any ages in years when a women during pregnant.	no
SystolicBP	Feature	Integer	Upper value of Blood Pressure in mmHg, another significant attribute during pregnar	no
DiastolicBP	Feature	Integer	Lower value of Blood Pressure in mmHg, another significant attribute during pregnar	no
BS	Feature	Integer	Blood glucose levels is in terms of a molar concentration (mmol/L)	no
BodyTemp	Feature	Integer	Body Temperature (F)	no
HeartRate	Feature	Integer	A normal resting heart rate (bpm)	no
RiskLevel	Target	Categorical	Predicted Risk Intensity Level during pregnancy considering the previous attribute.	no

Ahmed, Marzia et al. "Review and Analysis of Risk Factor of Maternal Health in Remote Area Using the Internet of Things (IoT)." (2020).

Main Questions

App Page Structure

#1
How each feature
contributed to the prediction
of the mother_id 31?

Home
Welcomes users and describes the app's purpose.

Individual Prediction
Allows user to select a mother ID and view the health risk
prediction.

#2
How would the prediction
change if we change the
feature inputs for the
mother_id 31?

Prediction Simulator
Enables users to modify input feature values and observe how
predictions change

#3
How was the
data collected?

About the Dataset
Provides comprehensive information about the dataset,
including data collection, labeling, and attribute distribution.

#4
What are the main
features of the
classification model?

About the Model
Offers details about the model used and its performance,
intended for both medical staff and data scientists.

#5
What is the uncertainty
in the prediction?

Key Takeaways
Summarizes our reflections on appropriate and inappropriate
use cases for the model.

Key Design Choices



Key Design Choices

"Select mother_id"

Important warning of when NOT to use the app

How has each feature contributed to the prediction?

Individual Prediction

Maternal Health Risk Prediction

This page enables the examination of the prediction and the contribution of each feature to the prediction for an individual sample.

Select the *mother_id* from the sidebar to see the prediction health risk for the mother and prediction contribution.

⚠ If the mother presents a significant symptom not considered by the model (e.g., stroke symptoms), disregard the model's prediction and base the urgency purely on medical judgment.

👤 Selected *mother_id*: 3

Predicted class: low risk (class 1)

Age (y)	SystolicBP (m...)	DiastolicBP (m...	BS (mmol/L)	BodyTemp (°F)	HeartRate (bpm)
17	90	63	7.5	101.0	70

Contributions Table

How has each feature contributed to the prediction?

Reason	Effect
Average of population	40.31%
BS = 7.5	+35.82%

Contributions Plot

How has each feature contributed to the prediction?

Contribution to prediction probability = 79.7%



Use traffic light colors to highlight main info (health risk)

Key Design Choices

Select bars on the sidebar to change the input features

Reset button to return to original values



Home
Individual Prediction
Prediction Simulator
About the Dataset
About the Model
Key Takeaways

Select a *mother_id* to view and modify
31

Change attribute values here:

Age
10 70
22

SystolicBP
70 160
91

DiastolicBP
49 100
69

BS
6.00 19.00
8.00

BodyTemp
98.00 103.00
98.00

HeartRate
7 95
80

Reset

Prediction Simulator

Maternal Health Risk Prediction

This page allows you to explore the model's predictions by simulating different values.

⚠️ If the mother presents a significant symptom not considered by the model (e.g., stroke symptoms), disregard the model's prediction and base the urgency purely on medical judgment.

What if... ?

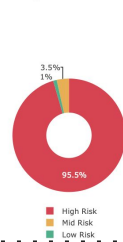
Select a *mother_id* from the sidebar and change the values for the measurements to simulate the health risk prediction. The model prediction will be updated accordingly.

The new sample values are displayed below, along with the change from the original sample values. (they can be reset to original values by clicking the **Reset** button in the sidebar)

👤 Selected *mother_id*: 31

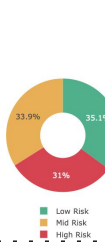
Age (y)	SystolicBP (mm...)	DiastolicBP (mm...)	BS (mmol/L)	BodyTemp (°F)	HeartRate (bpm)
22	91	60	8.0	98.0	80
↑ 0.0	↓ -29.0	↑ 0.0	↓ -7.0	↑ 0.0	↑ 0.0

Original Prediction



Predicted class: high risk (class 0)

New Prediction



Predicted class: low risk (class 1)

One can see how the output class probabilities change as the attribute values are modified.

2 Pie Charts to compare original vs modified prediction

Use traffic light colors to highlight the health risk

Key Design Choices

Short description about the data and its collection

Prediction Simulator

About the Dataset

About the Model

Key Takeaways

Selection Options

Select an attribute

Age

Filter Options

Filter Age values

10 70

About the Dataset

Maternal Health Risk Data

This page offers comprehensive details about the dataset, such as the method of data collection.

Data was collected from five hospitals and one maternity clinic in Dhaka. It was collected using wearable sensor devices, and risk levels were classified by experts and literature review.

[doi: 10.3389/fcomp.2021.734559](https://doi.org/10.3389/fcomp.2021.734559)

Author: Marzia Ahmed

Dataset donated on: 14.08.2023

The Dataset

Below you can find the dataset used in this application. You can filter the data using the Selection & Filter Options on the sidebar.

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate	RiskLevel
0	25	130	80	15	98	86	high risk
1	35	140	90	13	98	70	high risk
2	29	90	70	8	100	80	high risk
3	30	140	85	7	98	70	high risk
4	35	120	60	6.1	98	76	low risk
5	23	140	80	7.01	98	70	high risk
6	23	130	70	7.01	98	78	mid risk
7	35	85	60	11	102	86	high risk
8	32	120	90	6.9	98	70	mid risk
9	42	130	80	18	98	70	high risk

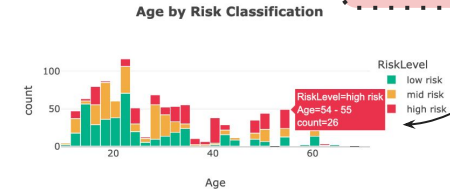
Dataset DOI, Author, date of donation

Attribute distribution

In the sidebar, select the attribute for which you want to see the distribution.

You can also filter the data based on the attribute values.

The graph shows the distribution of the selected filtered attribute values.



Attribute Distribution

Attribute Information

This table provides detailed information about each variable in the dataset.

- Attribute Name:** The name of the variable.
- Role:** Whether the variable is a feature (used for prediction) or the target (the outcome we are predicting).
- Type:** The data type of the variable (e.g., Integer, Categorical).
- Description:** A brief explanation of what the variable represents.
- Missing Values:** Indicates if there are any missing values for the variable.

Attribute Name	Role	Type	Description
----------------	------	------	-------------



Key Design Choices

Confusion Matrix

Home
Individual Prediction
Prediction Simulator
About the Dataset
About the Model
Key Takeaways

About the Model

Maternal Health Risk Prediction

This page provides information about the model used for prediction, its performance, and the feature importance alongwith information regarding the model's fairness.

[Model Training and Evaluation](#) [Model Fairness](#)

Model: [Random Forest](#)

 Hyperparameters ▾

Training on 811 samples and using 203 samples for validation.

Training time: 0.16 seconds

Model Performance

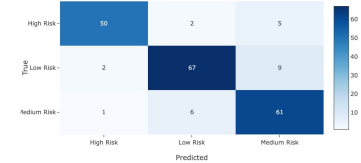
Accuracy:

Split	Accuracy	# samples
Train	92.73%	811
Test	87.68%	203

Model Accuracy and number of samples used for training / test

Feature Importance

Confusion Matrix



By looking at the confusion matrix, we can see that our model does a good job in reducing the number of false positives i.e. if the actual is **High Risk**, only a few instances are predicted as **Low Risk** or **Medium Risk**.

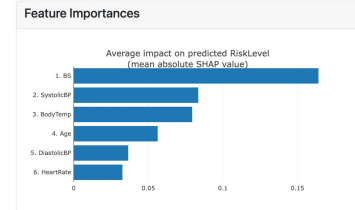
This is important because in the context of maternal health, we want to minimize the number of false positives as much as possible i.e. a **High Risk** and **Medium Risk** should not be predicted as **Low Risk** as much as possible.

The inverse, a false negative, is okay i.e. if a **Low Risk** is predicted as **Medium Risk** or **High Risk**, it is not as bad as the former case.

[Click here to know more about the confusion matrix...](#)

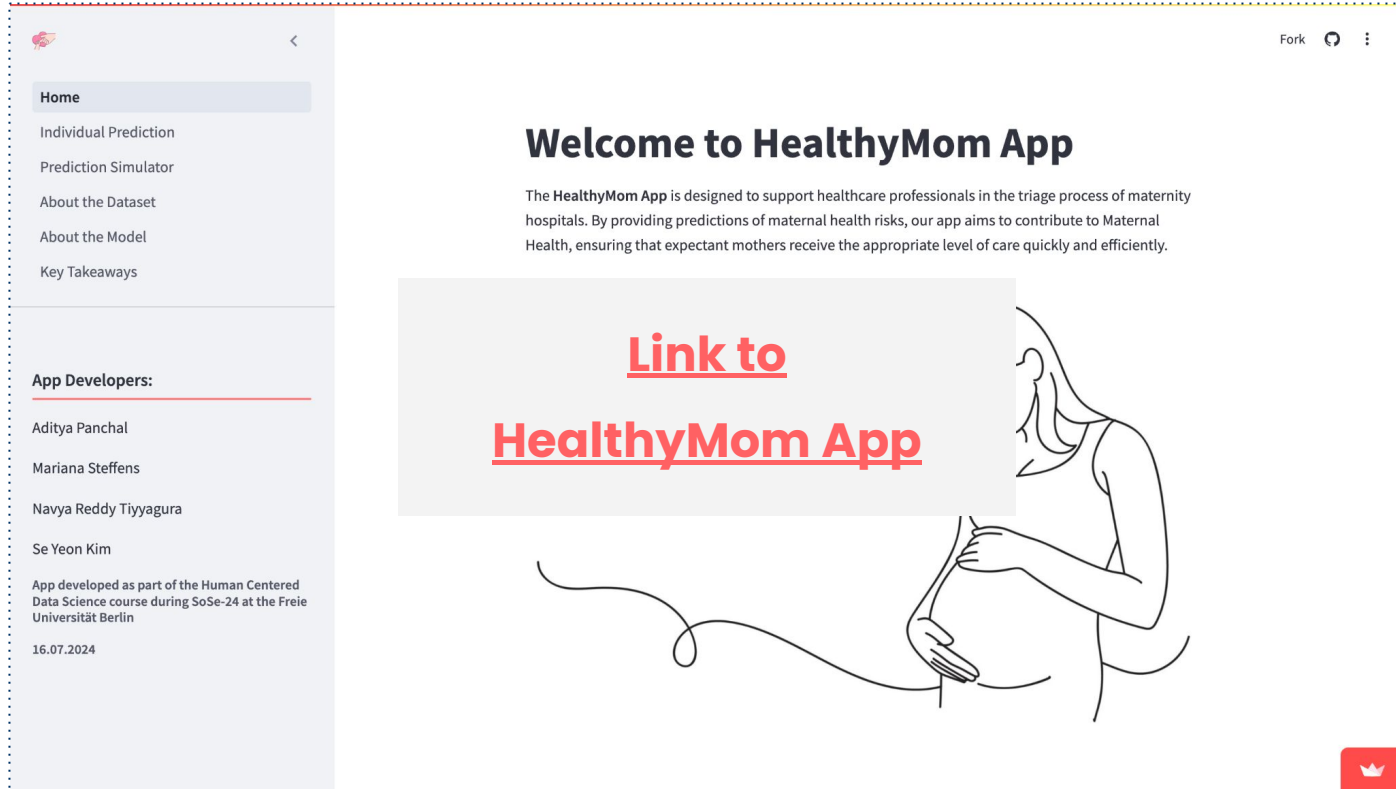
Feature Importances

Using [ExplainerDashboard](#) for our model, we visualize feature importances.



From the plot above, we can see that the most prominent feature for the model in its decision making is **BS** i.e blood sugar levels

This gives an overview of the model's decision making process. However, if one wants to see the contributions for a single sample, click on 'Individual Prediction' in the sidebar.



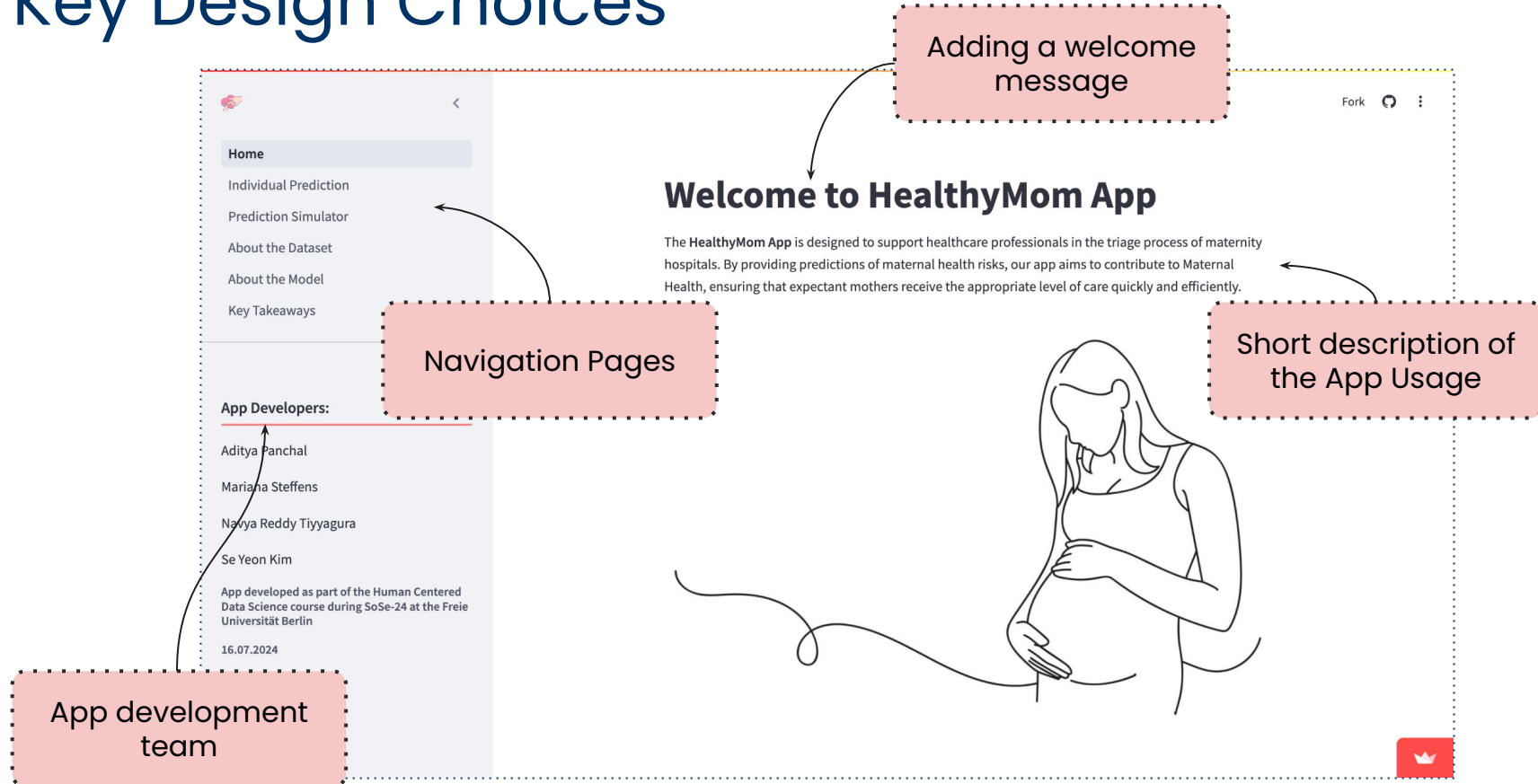
Discussion

- Reflection on ethical aspects of data science practice.
- Reflection on the design process of a explainability user interface.
- User Think Aloud test was essential to identify problems on the app.
- Limitations of the app.

Backup Slides

Pages with more details on Design Choices

Key Design Choices



Key Design Choices

"Select mother_id"

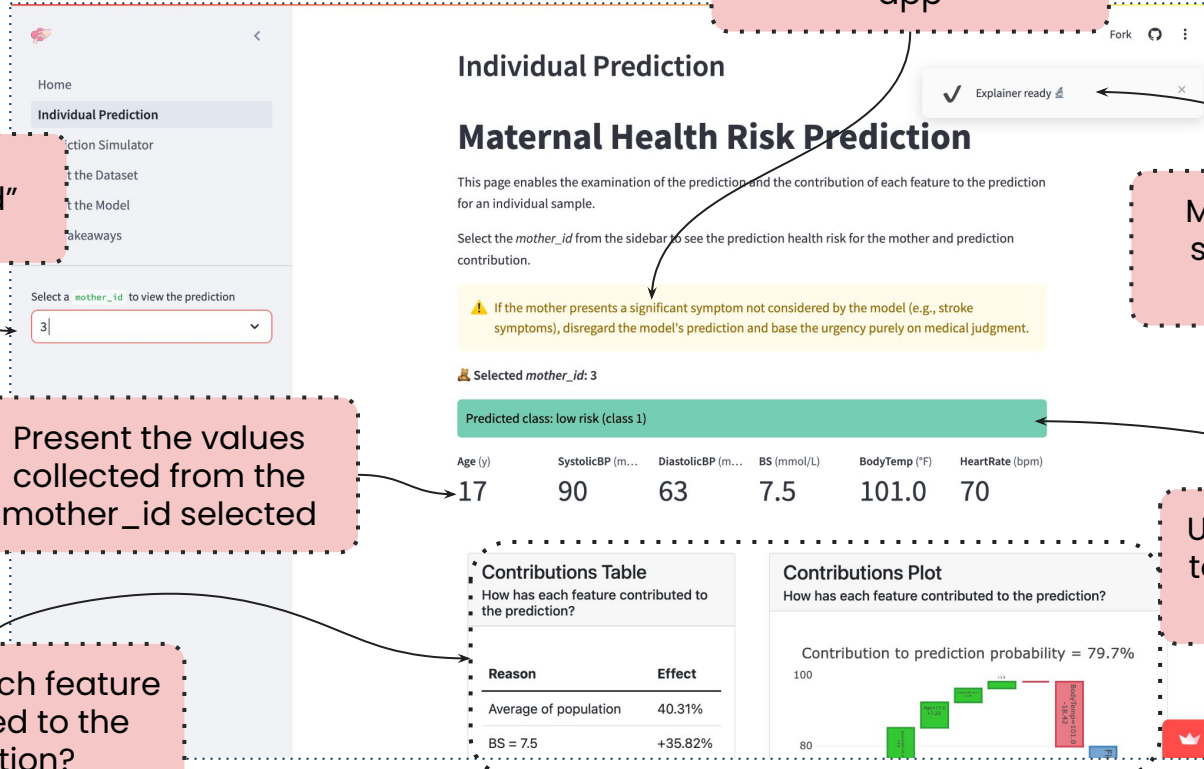
Present the values collected from the mother_id selected

How has each feature contributed to the prediction?

Important warning of when NOT to use the app

Message from the system "Explainer ready"

Use traffic light colors to highlight main info (health risk)



Key Design Choices

Select bars on the sidebar to change the input features

Reset button to return to original values



Home
Individual Prediction
Prediction Simulator
About the Dataset
About the Model
Key Takeaways

Select a *mother_id* to view and modify
31

Change attribute values here:

Age
10 70
22

SystolicBP
70 160
91

DiastolicBP
49 100
69

BS
6.00 19.00
8.00

BodyTemp
98.00 103.00
98.00

HeartRate
7 95
80

Reset

Prediction Simulator

Maternal Health Risk Prediction

This page allows you to explore the model's predictions by simulating different values.

⚠️ If the mother presents a significant symptom not considered by the model (e.g., stroke symptoms), disregard the model's prediction and base the urgency purely on medical judgment.

What if... ?

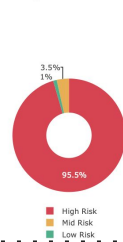
Select a *mother_id* from the sidebar and change the values for the measurements to simulate the health risk prediction. The model prediction will be updated accordingly.

The new sample values are displayed below, along with the change from the original sample values. (they can be reset to original values by clicking the **Reset** button in the sidebar)

👤 Selected *mother_id*: 31

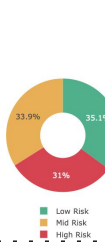
Age (y)	SystolicBP (mm...)	DiastolicBP (mm...)	BS (mmol/L)	BodyTemp (°F)	HeartRate (bpm)
22	91	60	8.0	98.0	80
↑ 0.0	↓ -29.0	↑ 0.0	↓ -7.0	↑ 0.0	↑ 0.0

Original Prediction



Predicted class: high risk (class 0)

New Prediction



Predicted class: low risk (class 1)

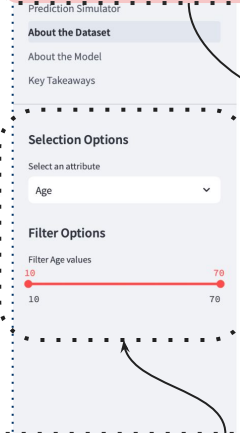
One can see how the output class probabilities change as the attribute values are modified.

2 Pie Charts to compare original vs modified prediction

Use traffic light colors to highlight the health risk

Key Design Choices

Short description about the data and its collection



Selection & Filter options to explore the dataset and the attribute to visualize

About the Dataset

Maternal Health Risk Data

This page offers comprehensive details about the dataset, such as the method of data collection.

Data was collected from five hospitals and one maternity clinic in Dhaka. Data was collected using wearable sensor devices, and risk levels were classified by experts and literature review.

[doi: 10.3389/fcomp.2021.734559](https://doi.org/10.3389/fcomp.2021.734559)

Author: Marzia Ahmed

Dataset donated on: 14.08.2023

The Dataset

Below you can find the dataset used in this application. You can filter the data using the Selection & Filter Options on the sidebar.

	Age	SystolicBP	DiastolicBP	BS	BodyTemp	HeartRate	RiskLevel
0	25	130	80	15	98	86	high risk
1	35	140	90	13	98	70	high risk
2	29	90	70	8	100	80	high risk
3	30	140	85	7	98	70	high risk
4	120	60	6.1	98	76		low risk
5	140	80	7.01	98	70		high risk
6	130	70	7.01	98	78		mid risk
7	85	60	11	102	86		high risk
8	120	90	6.9	98	70		mid risk
9	130	80	18	98	70		high risk

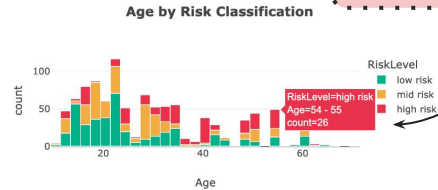
Dataset DOI, Author, date of donation

Attribute distribution

In the sidebar, select the attribute for which you want to see the distribution.

You can also filter the data based on the attribute values.

The graph shows the distribution of the selected filtered attribute values.



Attribute Distribution

Attribute Information

This table provides detailed information about each variable in the dataset.

- Attribute Name:** The name of the variable.
- Role:** Whether the variable is a feature (used for prediction) or a target (used for predicting).
- Type:** The data type of the variable (e.g., Integer, Categorical).
- Description:** A brief explanation of what the variable represents.
- Missing Values:** Indicates if there are any missing values for the variable.

Attribute Name	Role	Type	Description
----------------	------	------	-------------

Attribute Information

Key Design Choices

- Home
- Individual Prediction
- Prediction Simulator

Links to provide extra information

About the Model

Maternal Health Risk Prediction

This page provides information about the model used for prediction, its performance, and the feature importance alongwith information regarding the model's fairness.

[Model Training and Evaluation](#) [Model Fairness](#)

Model: [Random Forest](#)

[Hyperparameters](#) ▾

Training on 811 samples and using 203 samples for validation.

Training time: 0.16 seconds

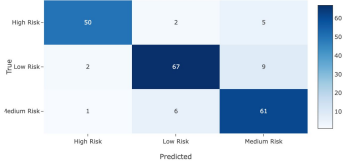
Model Performance

Accuracy:

Split	Accuracy	# samples
Train	92.73%	811
Test	87.68%	203

Model Accuracy and number of samples used for training / test

Confusion Matrix



Confusion Matrix

	High Risk	Low Risk	Medium Risk
High Risk	50	2	5
Low Risk	2	67	9
Medium Risk	1	6	61

By looking at the confusion matrix, we can see that our model does a good job in reducing the number of false positives i.e. if the actual is **High Risk**, only a few instances are predicted as **Low Risk** or **Medium Risk**. This is important because in the context of maternal health, we want to minimize the number of false positives as much as possible i.e. a **High Risk** and **Medium Risk** should not be predicted as **Low Risk** as much as possible. The inverse, a false negative, is okay i.e. if a **Low Risk** is predicted as **Medium Risk** or **High Risk**, it is not as bad as the former case.

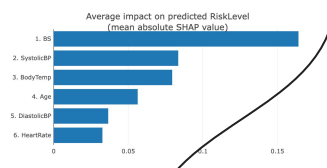
[Click here to know more about the confusion matrix...](#)

Model Fairness Tab

Expand/collapse boxes to provide more information

Feature Importances

Using [ExplainerDashboard](#) for our model, we visual



Feature Importances

Average Impact on predicted RiskLevel (mean absolute SHAP value)

Feature	Average Impact
1. BS	~0.14
2. SystolicBP	~0.11
3. BodyTemp	~0.10
4. Age	~0.08
5. DiastolicBP	~0.06
6. HeartRate	~0.05

From the plot above, we can see that the most prominent feature for the model in its decision making is **BS** i.e blood sugar levels

This gives an overview of the model's decision making process. However, if one wants to see the contributions of single samples click on individual prediction in the sidebar.

General Note ▾

What are SHAP values? ▾

Feature Importance

Key Design Choices

