HealthShield

Your Smart Doctor

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Introduction

Motivation and goal of our work

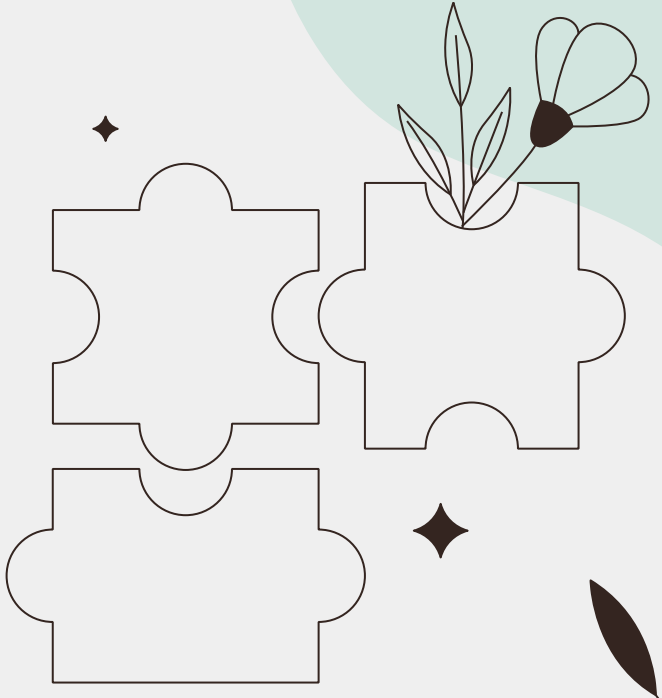
Background of Diabete

Top 5 death cause

in Taiwan (2024)

Increase 30%

adults aged 20–40 (2015–2020)



Motivation

01

Delayed Diagnosis

Diabetes is often diagnosed at a late stage.

02

Early Risk Prediction

Early risk prediction is needed to support prevention.

03

Cloud-based ML Solution

Develop a cloud-based machine learning system for diabetes risk prediction that can be accessed by more users.

Problem Definition

01 — **Input Data** — Basic information, body measurements, medical history, lifestyle habits,blood pressure, and blood test.

02 — **Method** — Machine learning models with SHAP-based interpretability.

03 — **Output** — Personalized diabetes risk prediction and explanations. (HealthShield)

Novelty

Adds more feature categories

Combines lifestyle habits, blood pressure, and blood test data.
Allows “I don’t know” for selected variables

SHAP visual explanations

Provides individual-level and global feature importance visualizations.

End-to-end cloud-based system

A modular cloud architecture separates frontend, backend, and model inference services.

02
Data

Dataset and data preprocessing

Data Source

NHANES

Introduction

A nationally representative health survey by the U.S. NCHS.

Years

2007–2018

Samples

56,463 samples
22 features

Variables

Feature Categories	Variables Names
Target	**Diabetes**
Basic Information	Age, Gender
Body Measurements	Height, Weight, BMI, Waist
Family History & Lifestyle	family_diabetes, ever_smoked, alcohol_drinks, Sleep_Hours vigorous_activity, moderate_activity, general_health
Blood Pressure	systolic_1/2/3, diastolic_1/2/3
Blood Test Results	fasting_glucose, insulin, HbA1c, total_cholesterol, HDL, LDL, triglycerides

Data Splitting

Data Preprocessing - Missing Values

Variables	Method
Target, Age	Remove missing target or age = 0
height, weight, BMI	Use bmi formula if one is missing; otherwise median imputation
systolic_1/2/3, diastolic_1/2/3	Average into systolic_avg/diastolic_avg; otherwise median imputation.
waist, fasting glucose, insulin, HbA1c, cholesterol (total, HDL, LDL), triglycerides, general_health, sleep_hours, alcohol_drinks	Median imputation (alcohol_drinks age < 20, impute 0)
ever_smoked, vigorous_activity, moderate_activity, family_diabetes	Add “Missing” category. (ever_smoked age < 20, impute “No”)

Data Preprocessing -Scaling and Encoding

Min-Max normalization

age, height, weight, bmi, waist, fasting_glucose, insulin, HbA1c, total_cholesterol, HDL, LDL, triglycerides, alcohol_drinks, general_health, systolic_avg, diastolic_avg, Sleep_Hours

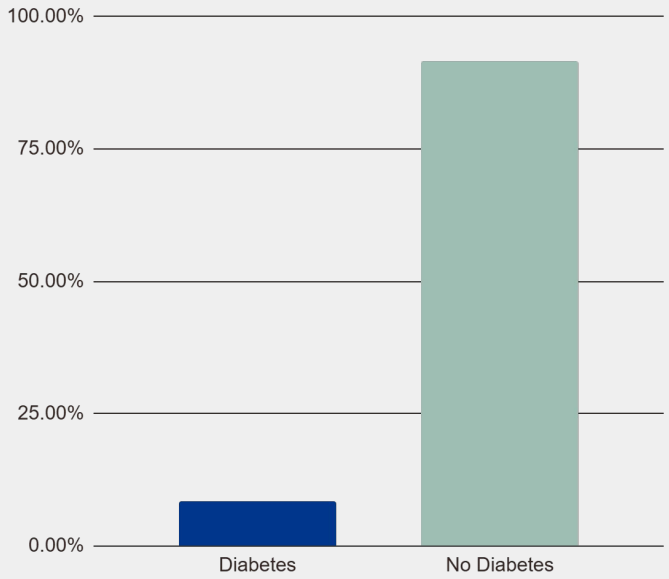
One-hot encoding

gender, ever_smoked,vigorous_activity, moderate_activity, family_diabetes

03
Methods

Measured criteria and fitted models

Selection of Criteria



Distribution of Target Classes

Diabetes
Diagnose to have diabetes

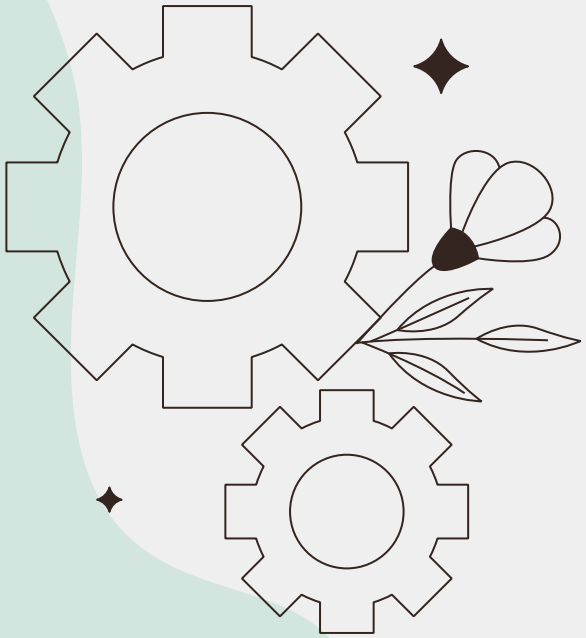
8.34%

No Diabetes
Not diagnose to have diabetes

91.66%

Imbalanced!
Adopt **Balanced Accuracy**

Fitted Models - Binary Classification Problem



Logistic Regression

Basic baseline that provides interpretable risk probabilities

SVM

Find the optimal boundary between healthy and at-risk patients

Random Forest

Ensemble of decision trees s.t. being more stable on imbalanced data

XGBoost

Iteratively corrects errors and offers built-in paras to maximize sensitivity for rare cases

04
Results

Performance of each model

Performance

Model	CV-Training				CV-Validation				Testing			
	BA	Sens	Spec	Acc	BA	Sens	Spec	Acc	BA	Sens	Spec	Acc
LR-L2	0.8894	0.8877	0.8910	0.8907	0.8881	0.8854	0.8909	0.8904	0.8954	0.9002	0.8906	0.8914
SVM	0.9000	0.9041	0.8959	0.8966	0.8915	0.8883	0.8948	0.8942	0.8945	0.8938	0.8952	0.8951
RF	0.9082	0.9183	0.8981	0.8998	0.8958	0.8949	0.8966	0.8965	0.8939	0.8970	0.8907	0.8913
XGB	0.9140	0.9203	0.9077	0.9087	0.9015	0.8970	0.9060	0.9052	0.9028	0.9023	0.9033	0.9032

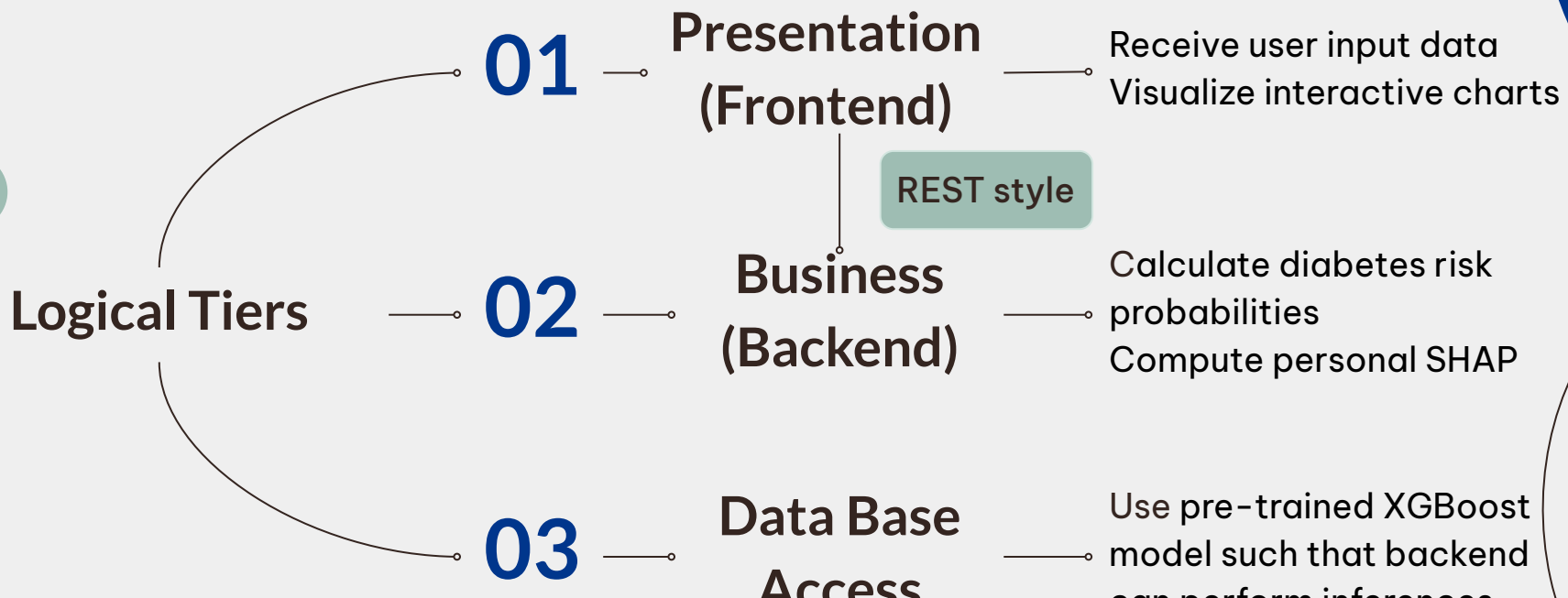
05

Demo

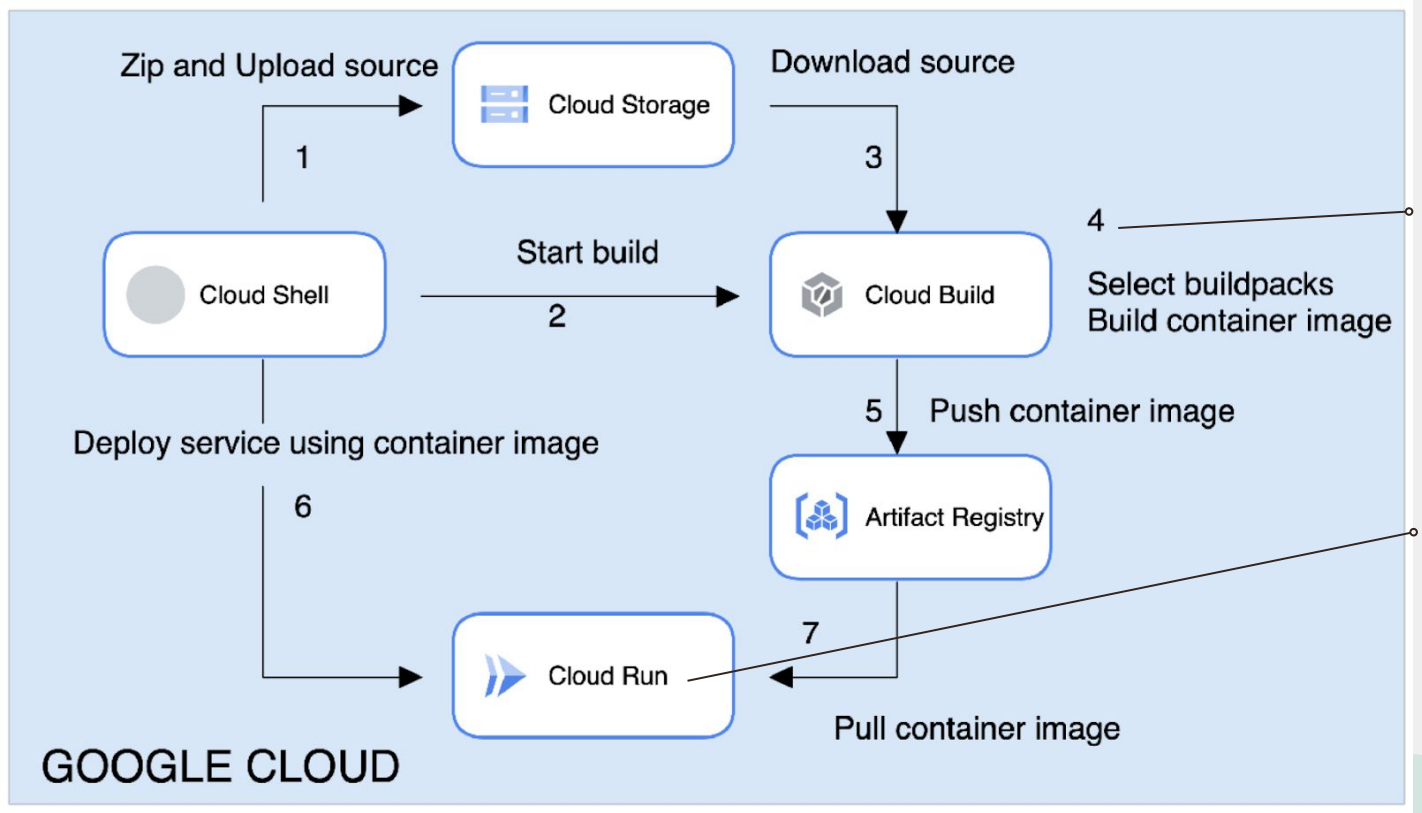
Introduce cloud architecture and demo web

HealthShield

3 Logical Tiers of Our Work



CI/CD Pipeline of Google Cloud Run



OS-level virtualization:
Dockerfile to define an isolated execution environment

PaaS:
focus on develop application codes

User Interface

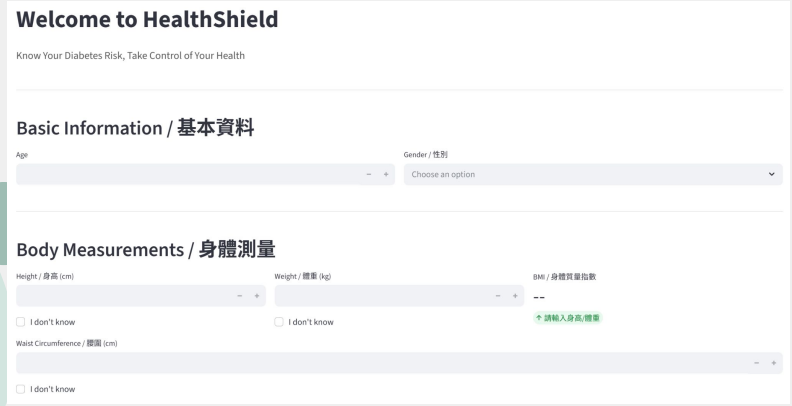
User Data Input Page

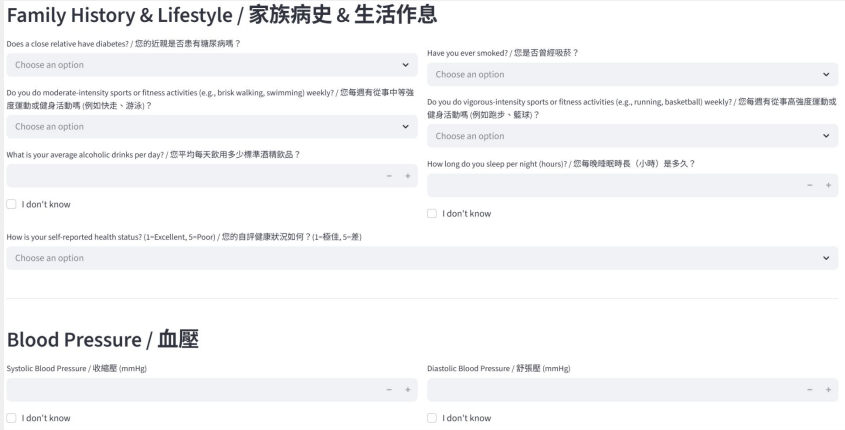
Users can enter their personal health information required for diabetes risk prediction

Prediction Page

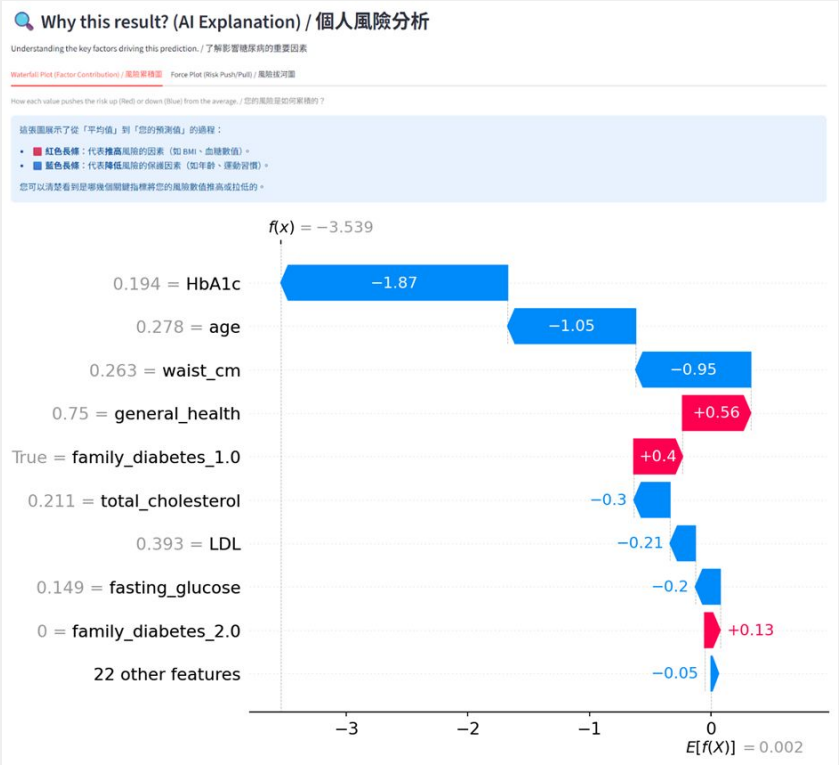
Present the diabetes risk prediction generated by the machine learning model.

User Data Input Page

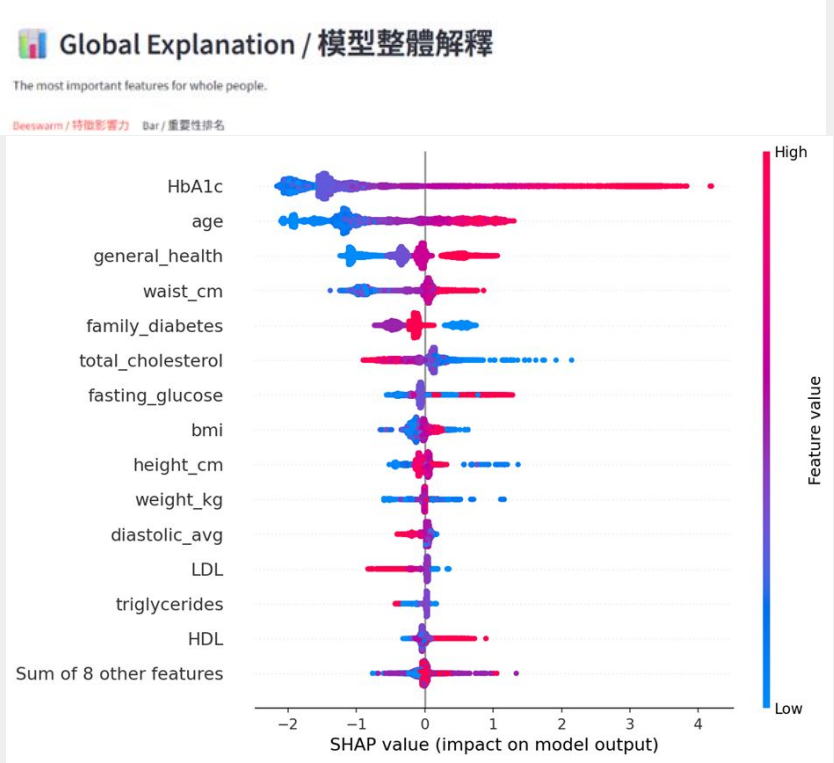


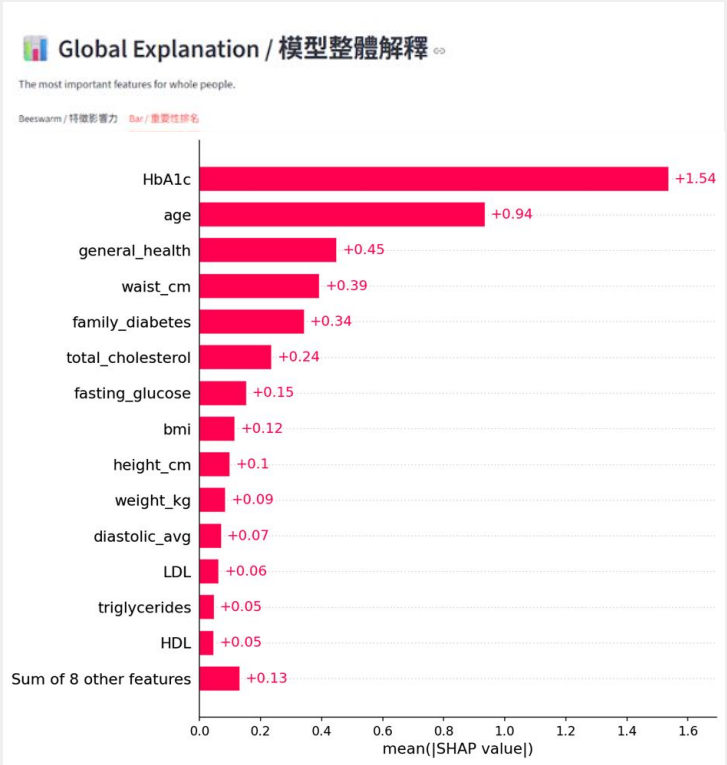


Prediction Page - Personal



Prediction Page - Global





Thank you for your listening!