Estimating Obesity Levels in Individuals Using Classification Methods

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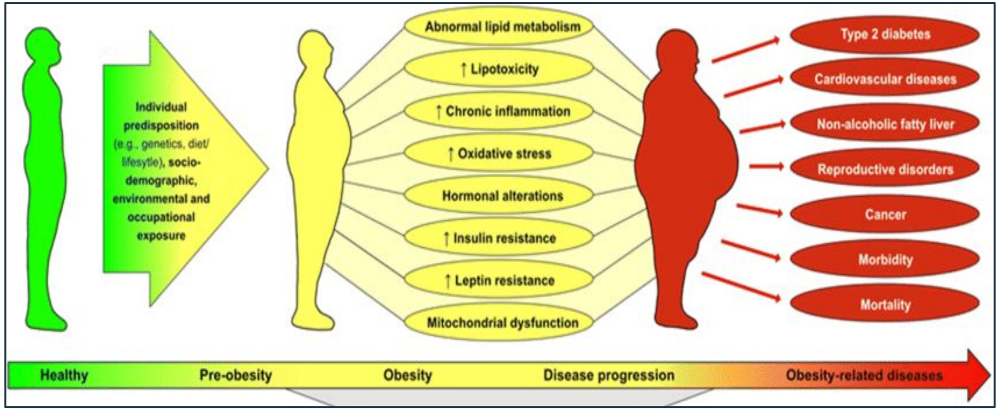
Overview

- Introduction
- Machine Learning Benefits
- Related Work
- Approach
- Dataset
- Preprocessing
- Experimental Methods
- Baseline Methods
- Evaluation

Introduction

- 1 in 8 are obese worldwide
- Potential health complications
- Strain on healthcare systems



'"Omics" platforms in obesity research' (2024)

How can machine learning classification techniques aid in alleviating pressure on healthcare systems?

- Predict obesity of the patients through datasets
- Helps doctors analyze contributing factors to obesity
- Determine the most at-risk individuals
- Lessen burden on healthcare facilities

Related Work

Visualization obesity risk prediction system based on machine learning

Jinsong Du, Sijia Yang, Yijun Zeng, Chunhong Ye, Xiao Chang & Shan Wu

Scientific Reports **14**, Article number: 22424 (2024) | Cite this article

1465 Accesses | **3** Altmetric | Metrics

- A visualized obesity risk prediction system based on machine learning techniques
- Uses largely medical data and measurement as features
- They use multiple models which each score AUC values of around 0.95:
    - Random Forest, **XGBoost**, LGBoost, Gradient-Boosted Trees, Back Propagation Neural Network, Linear Regression
- Hip circumference, Chest circumference, Body fat mass, Diet and Triglycerides were the most important features in determining risk
- Creates a visualization of the risk for each patient
- Various works from other groups:
    - **"Age-specific risk factors for the prediction of obesity using a machine learning approach"** (Front Public Health. 2023 Jan 17;10:998782. doi: 10.3389/fpubh.2022.998782)
    - **"Machine learning model to predict obesity using gut metabolite and brain microstructure data"** (Osadchiy, V., Bal, R., Mayer, E.A. et al. Machine learning model to predict obesity using gut metabolite and brain microstructure data. Sci Rep 13, 5488 (2023). https://doi.org/10.1038/s41598-023-32713-2)

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Approach

- **6 Classifier Models:**
  - Weighted k-Nearest Neighbours (kNN)
  - Decision Tree
  - Logistic Regression
  - Gaussian Naive Bayes
  - Random Forest
  - Support Vector Machine (SVM)
- Measured through Accuracy and Precision scores
- Ensure that the most accurate model is used
- Implementation: sklearn API and libraries

Implementation Overview

Dataset

Continuous	Categorical	Binary	Integer
• Age • Height • Weight • How many main meals do you eat daily? • How much water do you drink daily? • How often do you have physical activity?	• Gender • Do you eat any food between meals? • How often do you drink alcohol? • Which transportation do you usually use?	• Has a family member suffered or suffers from being overweight? • Do you eat high caloric food frequently? • Do you smoke? • Do you monitor the calories you eat daily?	• Do you usually eat vegetables in your meals? • How much time do you use technological devices, such as phones or computers?

Target:

Insufficient Weight	Normal Weight	Overweight Level I	Overweight Level II	Obesity Type I	Obesity Type II	Obesity Type III

Preprocessing

Data Preprocessing Pipeline

- Confirmed no missing values in the dataset
- Detected and removed outliers in numerical features (Age, Height, Weight) using the IQR method

Encoding & Transformation

- Applied one-hot encoding to categorical variables (e.g., family obesity history)
- Simplified target variable to binary classification (obesity: true/false)

Feature Selection

- Identified key predictive features: Height, Weight, Physical Activity Frequency, Transportation Modes, and Encoded Binary Features

Experimental Methods

- **Models Implemented**
  - kNN algorithm and Decision Tree Classifier
- **Evaluation Metrics**
  - **kNN**:
    - Evaluated with Manhattan & Euclidean distances using 10-fold cross-validation
    - Accuracy: **94.6%**, Precision: **94.7%**
  - **Decision Tree Classifier**:
    - Trained on 80-20 train-test split
    - Accuracy: **96.9%**, Precision: **99.4%**
- **Reliability Indicators**
  - Confusion matrix visualization highlighted Decision Tree's robustness in handling mixed features and complex data relationships
  - Models effectively classified individuals into "Obese" and "Not Obese" categories, validating their reliability for the task

Baseline Methods

Logistic Regression

- **Pros**: Simple, interpretable for feature relationships.
- **Cons**: Struggles with complex feature-target patterns.

Naive Bayes

- **Pros**: Efficient with categorical data.
- **Cons**: Assumes unrealistic feature independence.

Random Forest

- **Pros**: Handles mixed data types, resists overfitting.
- **Cons**: Computationally intensive with multiple trees.

Baseline Methods

Support Vector Machines (SVM)

- **Pros**: Effective for clear class boundaries, models non-linear relationships
- **Cons**: Can underperform with large datasets

Weighted kNN

- **Pros**: Emphasizes closer neighbors for improved classification

Evaluation Metrics

The following metrics were used:

- **Accuracy:** Percentage of correctly classified obesity levels
- **Precision:** Proportion of true positive predictions out of all positive predictions
- **Recall:** Proportion of true positive predictions out of all actual positive cases
- **F1-Score:** Harmonic mean of precision and recall, balancing false positives and false negatives
- **ROC-AUC:** Measures model ability to distinguish between classes

Model	Accuracy	Precision
K-Nearest Neighbors (kNN)	0.9375	0.9521
Decision Tree	0.9643	0.9937
Random Forest	0.9509	0.9873
Support Vector Machines (SVM)	0.9464	0.9581
Logistic Regression	0.9732	0.9877
Naive Bayes	0.8661	0.9592

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Q&A