International Journal of Modern Achievement in Science, Engineering and Technology (IJSET)
ISSN 3023-459X
DOI: 10.63053/ijset.102

Determination and classification of human blood type using maching learning image processing and support vector machine (SVM) methods

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ARTICLE INFO

Keywords:
Blood Group Classification, Machine Learning, Image Processing, Support Vector Machine SVM

ABSTRACT

The importance of blood grouping in various medical and health fields is important. Also, the problems in blood group identification and the need to use artificial intelligence methods for more accurate blood group prediction are discussed in this section. The use of machine learning algorithms, especially deep learning and support vector machines, is examined for this purpose. The use of algorithms such as SVM, deep neural networks, decision tree machines, and reinforcement learning are mentioned. Various articles in the fields of biometrics or genetics have also addressed this topic.
. Support Vector Machine SVM The SVM model is a powerful algorithm for data classification that separates data by creating a decision line between categories.
- In this paper, SVM is used to predict the blood group of individuals based on various features (such as age, gender, and genetic data). Choosing a suitable kernel such as linear kernel or radical basis kernel (RBF) to improve the prediction accuracy will be one of the important parts of the paper.
The main methods and techniques used in the paper for blood group prediction are explained. These methods are usually divided into two categories: deep learning and support vector machine (SVM).
In an operational environment, images of new blood samples are collected and preprocessed, features are extracted and fed to the SVM model to determine the blood group. By following these steps and using machine learning tools and libraries such as scikit-learn in Python, an efficient system for determining human blood type can be created using machine learning and SVM. c) Statement of the main research problem: Pre-transfusion tests are necessary for blood transfusion. Although the donor is universal, if the blood types are not similar, blood transfusion reactions can occur. Various systems have been developed to automate these tests, but none of them have the ability to perform timely analysis for emergency situations. One of the new methods used in the field of classification and diagnosis of human blood types is image processing and the use of artificial intelligence techniques, which leads to increased detection accuracy and increased detection performance. To determine ABO and Rh blood types, using existing techniques, it is necessary to use some identifiers. To evaluate the performance of this proposed system, a microarray database is used, which includes breast cancer, leukemia, and bone marrow and lymphoid cancers from the Stanford University microarray database. For this purpose, this system is based on the plate test method. It is small in size and easy to carry.

1. Introduction

To determine human blood type using machine learning, specifically Support Vector Machine (SVM), there are several steps involved:

1. Data Collection: High-quality microscopic images of blood samples must be obtained. These images should have appropriate resolution. Additionally, data regarding the blood types of each sample (A, B, AB, O) and the Rh factor (positive or negative) must be collected. This data will serve as labels for training the model.
2. Image Preprocessing: This involves improving image quality using image processing techniques such as noise removal, contrast adjustment, and brightness enhancement, as well as segmenting the images to isolate blood cells from the background.
3. Feature Extraction: Features from the blood cell images need to be extracted. These features may include color, shape, texture, and other morphological characteristics.
4. Feature Selection: Selecting the most important features to reduce data dimensionality and increase model accuracy. This can be done using feature selection methods such as Principal Component Analysis (PCA) or feature importance-based methods.
5. Data Preparation for Model Training: The data is divided into two parts: the training set and the testing set. Typically, 70-80% of the data is used for training and 20-30% for testing.
6. Normalization: Features are scaled to a specific range (e.g., between 0 and 1) to prevent large values from affecting the model.
7. Training the SVM Model: Choosing the appropriate kernel type for SVM. Common kernels include linear, polynomial, and radial basis function (RBF). The choice of kernel depends on the type of data and the complexity of the problem.
8. Tuning SVM Model Parameters: This includes adjusting the C parameter (which determines the penalty for errors) and parameters related to the kernel (such as gamma for the RBF kernel).
9. Training the Model: The model is trained using the training set.
10. Model Evaluation: The testing set is used to evaluate the model's performance. Evaluation metrics such as accuracy, precision, recall, and F1-Score are calculated.
11. Model Optimization: If necessary, parameters may be readjusted or the kernel type changed to improve performance. Cross-validation techniques can be used for a more stable evaluation of model performance.
12. Implementation: After achieving satisfactory performance, the model can be used to determine the blood type of new samples. In a practical environment, images of new blood samples are collected and preprocessed, features are extracted, and fed into the SVM model to determine the blood type.

Data Quality: The quality of the data (images and labels) significantly impacts model performance. Therefore, accuracy in data collection and labeling is crucial.
Feature Selection: Choosing appropriate features can significantly enhance model accuracy.
Tuning SVM Model Parameters: Optimal tuning requires experience and experimentation.
By following these steps and utilizing machine learning tools and libraries such as scikit-learn in Python, an efficient system for determining human blood type using machine learning and SVM can be developed.
Improving image quality using image processing techniques such as noise removal, contrast adjustment, and brightness is essential for segmenting images to separate blood cells from the background. Feature extraction from blood cell images can include color, shape, texture, and other morphological characteristics. Feature selection involves choosing the most important features to reduce data dimensions and increase model accuracy. This can be done using feature selection methods such as Principal Component Analysis (PCA) or feature importance-based methods.
Data preparation for model training involves splitting the data into two parts: the training set and the test set. If necessary, model parameters can be adjusted or the kernel type changed to improve performance. Using cross-validation techniques provides a more stable evaluation of model performance. After achieving optimal performance, the model can be used to determine the blood

type of new samples. In a practical environment, images of new blood samples are collected and pre-processed, features are extracted, and fed into the SVM model to determine the blood type. The quality of the data (images and labels) significantly impacts model performance; therefore, accuracy in data collection and labeling is crucial.
Choosing appropriate features can significantly enhance model accuracy. Optimally tuning SVM model parameters requires experience and experimentation. By following these steps and utilizing machine learning tools and libraries such as scikit-learn in Python, an efficient system for determining human blood type using machine learning and SVM can be created.

The fundamental problem statement of the research is that conducting tests before blood transfusions is necessary for performing the transfusion procedure. Although there is a global donor pool, if blood types do not match, transfusion reactions can occur. Various systems have been developed to automate these tests, but none can perform timely analysis for emergency situations. One of the new methods used in classifying and detecting human blood type is image processing and the use of artificial intelligence techniques, which leads to increased detection accuracy and speed of performance.

To determine the ABO and Rh blood types, it is necessary to use certain indicators with existing techniques. To evaluate the performance of this proposed system, a microarray database is utilized, which includes breast cancer, leukemia, and lymphatic bone marrow data from Stanford University's microarray database. For this purpose, the system is based on a plate test method and is compact and easy to carry. Additionally, data extraction is based on image processing techniques to obtain results and has been developed using the C# programming language. The user interface was developed with XAML programming language due to the requirements of usability and compatibility with various operating systems, including computers, tablets, and smartphones.
Initially, the visual disk in the approach is discovered using thresholding and three geographic features of the spotted area, and the bright structures of the retina are detected using an accurate edge detector. Several existing methods in the dataset have been examined, and the precise method for classification has been identified as the most important feature.

c) Statement of the Basic Problem

Conducting tests prior to blood transfusion is essential for the execution of the transfusion process. Through these tests, it is determined whether the blood characteristics of the donor match those of the recipient. In specific emergency cases, there is not enough time to perform the necessary tests with existing commercial systems, and as a result, O negative blood is injected. This blood type is recognized as a universal donor in the context of transfusion, as it has a lower risk of incompatibility. However, despite being a universal donor, if blood types do not match, transfusion reactions can occur. These incompatibilities can lead to the patient's death, depending on the severity of their health condition. Determining and classifying blood type before transfusion, especially in emergency situations, is necessary and essential. Currently, these tests are performed manually by technicians, which can lead to human errors. Various systems have been developed to automate these tests, but none have the capability to perform timely analysis for emergency situations. One of the new methods used in the classification and identification of human blood types is image processing and the use of artificial intelligence techniques, which lead to increased accuracy and speed of diagnosis. Therefore, in this research, we aim to present a new method using image processing techniques and support vector machines to identify and classify human blood types.

d) Importance and Necessity of Conducting Research

Before performing a blood transfusion, several compatibility tests must be conducted on the blood recipient, including: determining the ABO group and Rh factor, identifying rare antigens in the blood, and screening for antibodies. These tests are used to assess compatibility between the patient's blood and the donor's blood—the goal is to select a compatible blood sample for the recipient. Several techniques are available for conducting the testing procedure, such as plate tests, tube tests, microplate tests, and ID card tests, with the tube test being considered the reference. The plate test is very suitable for emergency situations, allowing for rapid results, lower costs, and easy automation. However, manual tests can introduce human errors during the procedure as well as during the recording and interpretation of results. Therefore, although this method provides rapid results with good sensitivity, it is currently not used in hospital laboratories. To determine the ABO and Rh blood types using existing techniques, certain reagents must be used. These reagents combine with antibodies, especially Anti-A, Anti-B, Anti-AB, and Anti-D, which can react or not react when in contact with the patient's blood. This reaction is called agglutination and occurs when the antibodies present in the reagents match the antigens in the patient's blood. A table presents the antigens and antibodies present in different blood groups; it also indicates whether there is an agglutination/non-agglutination reaction in the blood. Based on the aforementioned content, we realize that timely and accurate blood type diagnosis is very necessary and essential. Therefore, in this research, we aim to improve and increase the accuracy of blood type diagnosis with the proposed new method.

h) Background of Research

This section examines the research conducted in the field of image processing using various methods.

Khalilabad and colleagues (2017) investigated and analyzed microarray image data for cancer disease detection. The proposed system consists of three main stages: classification through labeling, information extraction, and disease detection. The image processing stage involves tasks such as adjusting image rotation, correcting image orientation, constraining the image structure (determining the location for genes), and extracting raw information from images, which includes normalizing the extracted data and selecting the most effective genes. Ultimately, cancer cells are identified through the extracted information. To evaluate the performance of this proposed system, a microarray database is utilized, which includes breast cancer, leukemia, and lymphatic bone

marrow data from the Stanford University microarray database. The results indicate that the proposed system can identify the type of cancer with an accuracy rate of 95.45%, 94.11%, and 100% respectively based on the obtained data.

Sarikhan and colleagues (2017) attempted to classify vehicles in dedicated lanes using image processing techniques and machine learning techniques. Images containing the side profile specifications of vehicles are created using a commercial light curtain. This capability enhances the results against variations in operational and environmental conditions. A time jump is applied to compensate for speed changes in traffic. Features such as windows and hollow areas are extracted to distinguish motorcycles from cars. Circular values and skeleton complexity are used as classifying features. K-nearest neighbors and decision trees are selected as classification models. The proposed method is evaluated on a public highway, yielding promising classification results.

Faraz and colleagues (2017) presented an electronic system and an interface program that can quickly and easily perform all pre-blood transfusion tests safely and reliably, even in remote locations. For this purpose, the system is based on a plate testing method and is compact for easy transport. Another advantage of this system is its low cost, which can be a competitive factor in the market. Additionally, data extraction is based on image processing techniques to obtain results and is developed using the C# programming language. The user interface is developed with the XAML programming language, as the requirements for usability and compatibility with various operating systems, including computers, tablets, and smartphones, have imposed this necessity.

Zou and colleagues (2014) focused on the application of image processing and ultrasound imaging in sonography for identifying cardiovascular changes. Specifically, they concentrated on advanced signal/image processing technologies and related topics such as texture features, image segmentation, device tracking, and multi-functional registration. The results of this research indicate that imaging content within the body faces more challenges than traditional external ultrasound imaging, especially concerning cardiac dynamics. We must strive for new solutions that provide more consistent, reliable, and accurate analysis results to better support clinical decision-making.

Gogamurti and colleagues (2014) presented a new method for the intelligent diagnosis of eye diseases. The ARMD detection method is an intelligent approach discussed in this article. Initially, the optic disc is detected using thresholding and three geographic features of the macular region, and the bright structures of the retina are detected using an accurate edge detector. Several existing methods in the dataset have been examined, and a precise method for classification has been identified as the most important feature. The executed features were then tested using another dataset, achieving an accuracy of 92%. The main features and important requirements identified have been developed. However, there are some limitations in this product, which are listed below: images taken with older generation fundus cameras cannot be supported by the system due to lack of quality. Only intermediate retinal fundus images can be supported by the system.

Ravandinar and colleagues (2017) focused on determining and classifying blood types using various image processing methods. Determining blood groups in emergency situations before blood transfusion is very important. Currently, these tests are performed manually by technicians, which can lead to human errors. It is essential to determine blood types in a short time and without human errors. A method based on processing images obtained during the slide test has been developed. Image processing techniques such as thresholding and morphological operations are used. The test slide images from the pathology laboratory are processed, and the occurrence of agglutination is evaluated. Therefore, the developed automated method determines the blood type using image processing techniques. The developed method is useful in emergency situations for determining blood type without human error.

Waznik and colleagues (2018) attempted to identify and detect objects using image processing. We

present a recognition method based on analyzing a number of point clusters that are combined with a convolutional neural network as a final classifier. The proposed method detects point clusters based on a combination of graphical processes modeled with fuzzy logic. The proposed architecture for detection and classification has been tested and compared with other methods in this field to demonstrate the efficiency of this method and to draw conclusions for future development. The results of this research indicate that the proposed method has a desirable performance.

Zagal and colleagues (2020) presented a method for detecting melanoma skin cancer based on image processing. The aim of this paper is to develop a simple method capable of detecting and classifying skin lesions using dermoscopic images based on ABCD rules. The proposed method follows four stages: 1) The preprocessing stage includes filtering algorithms and contrast enhancement. 2) The segmentation stage aims to identify the lesion. 3) The feature extraction stage is based on calculating four parameters: asymmetry, border irregularity, color, and diameter. 4) The classification stage calculates the total dermoscopic value (TDV) based on the sum of the four extracted parameters multiplied by their weights. Thus, the lesion is classified into two categories: benign, suspicious, or malignant. The proposed method was implemented in MATLAB and tested based on the PH2 database containing suspicious melanoma skin cancer.

Jotilakshmi and colleagues (2020) presented a method for lung cancer detection using machine learning techniques and image processing. In this paper, they aimed to identify and diagnose lung cancer by processing the information obtained from the patient's CT scan. In this method, the patient's CT scan images are classified into normal and abnormal categories. Abnormal images are subjected to segmentation to focus on the tumor area. Classification is performed based on features extracted from the dataset. An efficient method for the successful detection of lung cancer and its stages, as well as the goal of having more accurate responses using SVM methods and image processing, is proposed. The results of this research indicate that the proposed method has a desirable performance and significantly increases the ability to detect lung cancer. [13].

Dio and colleagues (2020) presented a new method for liver cancer detection using image processing. Liver cancer is generally diagnosed through three different tests, including blood tests, imaging tests, and biopsies. To simplify the process, a more efficient and effective method for liver cancer detection is adopted. In this research, an image processing system for liver cancer detection is presented. The proposed diagnostic method uses MRI and CT. The region growing technique is used for segmenting images to register the area of interest. Later, wavelet transformation is considered to calculate the threshold values of the area of interest. After processing and measurement, the results yield correct outcomes in an efficient time frame. The results of this research indicate that the proposed method has a desirable performance in liver cancer detection. [14].

Regarding the novelty and innovation in the research

So far, numerous studies have been conducted in the field of blood group detection, each having its own advantages and disadvantages. However, there has not been any research that uses image processing techniques and support vector machines to detect and classify human blood groups. Therefore, this research aims to present a new method for blood group detection and classification that has a better performance compared to the existing methods. Initially, the research conducted in the field of blood group detection using various methods will be reviewed, and then the strengths and weaknesses of the proposed methods will be analyzed. Finally, using image processing techniques and support vector machines, an attempt will be made to detect and classify human blood groups in a way that demonstrates better performance compared to other studies.

Objectives of the Research

•To examine and analyze the methods of blood type detection and classification and identify the

strengths and weaknesses of the proposed methods.
•To utilize image processing for identifying blood groups.
•To analyze and evaluate the image processing technique and support vector machine for blood type identification.

Research Hypotheses
•Have the methods for detecting blood types been useful and effective so far?
•Does image analysis improve blood type detection?
•Does the use of image processing techniques and support vector machines increase the accuracy of human blood type detection and classification?

Definition of Technical Terms and Concepts

Image processing refers to digital image processing, which is a branch of signal processing that deals with digital signals representing images captured by digital cameras or scanned by scanners. Image processing has two main branches: image enhancement and machine vision. Image enhancement includes methods such as using blurring filters and contrast enhancement to improve the visual quality of images and ensure their correct display in the destination environment (such as printers or computer monitors), while machine vision deals with methods that allow understanding the meaning and content of images for applications in robotics and image-centric tasks. In its specific sense, image processing refers to any type of signal processing where the input is an image, such as a photo or a scene from a video. The output of an image processor can be an image or a set of special indicators or variables (mathematical) related to the image. Most image processing techniques involve treating the image as a two-dimensional signal and applying standard signal processing techniques to it. Image processing often refers to digital image processing, but optical processing and analog photography also exist. This article discusses the general techniques applicable to all of them.

Research Methodology:

A - Complete description of the research method based on objectives, types of data, and execution methods (including materials, equipment, and standards used in the implementation stages of the research separately):
In this research, we first review past studies in the field of blood type detection. We then analyze and evaluate the advantages and disadvantages of the proposed methods. Finally, we use image processing techniques and support vector machines to detect and classify human blood types.
b- The variables under investigation in the form of a conceptual model and the description of how to examine and measure the variables:

The main variables for determining blood type ABO and Rh, using existing techniques, require the use of certain indicators. These indicators combine with antibodies, especially Anti-A, Anti-B, Anti-AB, and Anti-D, which can react or not react when in contact with the patient's blood. Additionally, the antigens and antibodies present in blood groups are also research variables.

c- A complete description of the method (field, library) and tools (observation and testing, questionnaire, interview, data extraction, etc.) for data collection:
In this study, library resources will be used to collect data and research information. These resources include:
- Studying and reviewing reputable scientific articles published in recognized scientific databases such as Elsevier, IEEE, and other reputable scientific journals.
- Studying theses and research of other students and professors in the country.

d- Statistical population, sampling method, and sample size (if available and possible):

In this study, to obtain the necessary information and data, we will utilize 100 samples available in the hospital for blood group identification.

e- Methods and tools for data analysis:
Data analysis will be conducted in MATLAB and Excel software. We will attempt to test the proposed algorithm by providing sample images and creating a database of other images.
General process steps:

Data collection
- We need a dataset that includes information about individuals and their blood types. This information may include various characteristics such as age, gender, genetic factors, etc.

Data preprocessing
- Cleaning the data (removing missing data, standardizing values, normalizing data)
- Splitting the data into training and testing sets (usually 70-30 or 80-20)
- Encoding categorical data such as blood groups (A, B, AB, O)

Training the SVM model:
- Using an SVM model to train on the training dataset.
- Selecting an appropriate kernel (such as linear, radial, or polynomial) for the model based on the type of data.

Model evaluation
- Evaluating the model using the test data and measuring its performance with metrics such as accuracy, F1-score, and confusion matrix.

Predicting new blood types:
After training the model, it can be used to predict the blood type of new individuals based on their characteristics.

Blood Group Determination Tests

Hematology

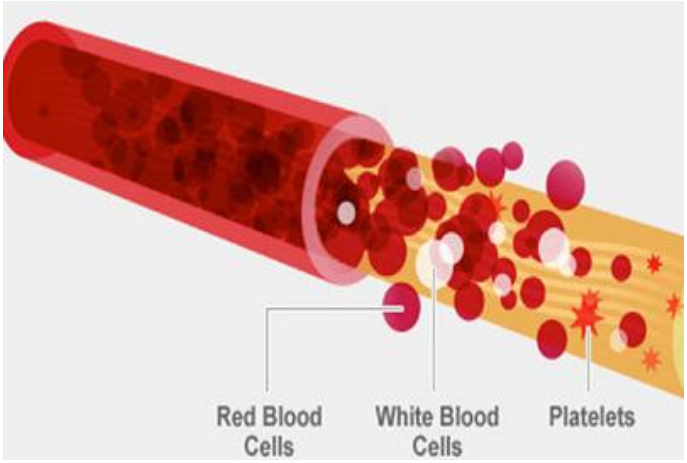
Blood group is one of the simple yet very sensitive tests that are frequently requested in laboratories.

An adult human has about 4-6 liters of blood circulating throughout their body. Blood performs important functions, but its most crucial role is the transportation of oxygen to various parts of the body. Blood is composed of several types of floating cells and a liquid called plasma.

Red blood cells, also known as RBCs, contain hemoglobin. This protein binds to oxygen, and red blood cells deliver oxygen to the body's tissues while removing carbon dioxide from their environment.

White blood cells, or WBCs, fight against infectious agents.

Platelets help in blood clotting. For example, when a part of our body is cut, they facilitate blood clotting to prevent severe bleeding.
Plasma contains various salts and proteins.



Different blood types are which ones

The difference in various blood types is defined by the presence or absence of antigens A, B, or both on the surface of human red blood cells. Antigens are located on the surface of red blood cells, and antibodies are found in the blood plasma. Different individuals have different types and combinations of these molecules. Your blood type depends on what you inherited from your parents. Today, there are more than 20 different blood group classification systems. However, the ABO and Rh systems are the most important ones used for blood transfusions.

Importance of blood type

The importance of determining blood types lies in blood transfusions and fetal erythroblastosis, which can lead to miscarriage. Not all blood types are incompatible with each other. Mixing incompatible blood types leads to agglutination (clumping) of blood, which can be very dangerous and fatal if incompatible blood is transfused into a person.

Discovery of blood types

Blood transfusions or components of blood from one person to another have been performed for hundreds of years. Many patients died after blood transfusions until in 1901, an Australian doctor named Karl Landsteiner discovered human blood types. Since then, blood transfusions have become safer. Landsteiner's work made it possible to determine blood types and allowed us to perform blood transfusions with greater confidence. He was awarded the Nobel Prize in Physiology or Medicine in 1930 for this significant discovery. Mixing the blood of two individuals can lead to the clumping of blood components together. In this case, the blood appears "clumped." Red blood cells that have gathered together can cause dangerous reactions in the body. These reactions can have fatal consequences. Landsteiner discovered that blood clumping occurs when the recipient of the blood has antibodies against the donor's red blood cells in their blood.

ABO System

According to this method of blood group determination, there are four types of blood groups: A, B, AB, or O.

Blood group A: If your blood group is A, you have antigen A on the surface of your red blood cells and antibody B in your plasma.

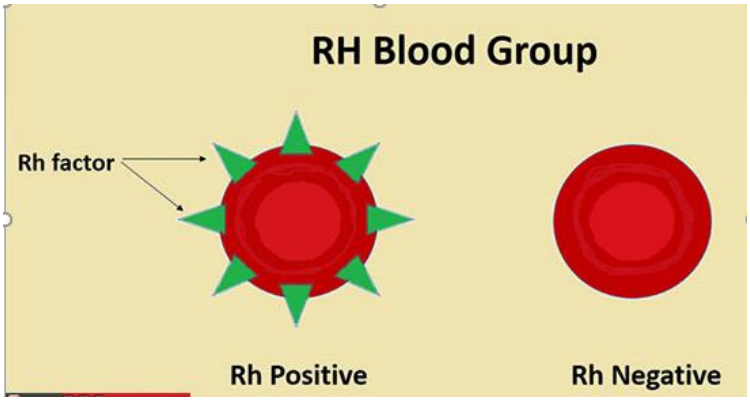
Blood group B: If your blood group is B, you have antigen B on the surface of your red blood cells and antibody A in your plasma.

Blood group AB: If your blood group is AB, you have both antigen A and antigen B on the surface of your red blood cells, and there are no antibodies A or B in your blood plasma.

Blood group O: If your blood group is O, you have neither antigen A nor antigen B on the surface of your red blood cells, and both antibody A and antibody B are present in your blood plasma.

Rh System

Many people also have the Rh factor on the surface of their red blood cells. Rh is an antigen that anyone who has it is considered +Rh. Those who do not have this antigen are considered -Rh. A person who is -Rh does not naturally have Rh antibodies in their blood plasma (but they can have antibodies A or B). However, if a -Rh person receives +Rh blood, they will produce Rh antibodies against it, which will appear in their blood plasma. A +Rh individual can receive blood from a -Rh individual without any issues.



According to the ABO blood group system explained above, you may belong to one of the following blood groups.

O+	AB+	B+	A+
O-	AB-	B-	A-

Rare Blood Types

Human blood types are not limited to groups such as A, AB, B, and O. These groups should be referred to as the main blood groups. There are 360 recognized blood types for humans. In defining a rare blood type, it can be said that individuals whose blood type is not shared by five to ten thousand other people have a rare blood type.

Among approximately 80 million Iranians, about 40 people have been identified with a blood type called Bombay. Individuals with Bombay blood type lack the H antigen.

Chalano is another rare blood type that until recently had about eight individuals identified in Iran with this blood type.

The RH NULL blood type should also be considered another rare blood type, as besides one brother and sister in our country, no one else has been identified with this blood type.

Additionally, another blood type called Luthern B negative has also been identified in the country.

The KPB negative blood type should be regarded as the rarest blood type in our country.

Identifying Rare Blood Types

These individuals may not even realize the rarity of their blood type when visiting a laboratory. Usually, these individuals discover their rare blood type when they need a blood transfusion and undergo additional tests. The Blood Transfusion Organization also identifies individuals with rare blood types by testing the blood of those who come to donate blood to this organization.

How Rare Blood Types Arise

Genetic changes resulting from consanguineous marriages or environmental changes that arise from specific geographical conditions can lead to an increase in rare blood types within a family and a race. For example, in some islands of East Asia, all individuals have blood type O, or in some regions of Latin America, there are tribes that only have blood type A. The reason for the emergence of the Bombay blood type is also due to these conditions and genetic changes. This blood type is essentially O negative or positive but lacks the H antigen. The reason for this naming is that the first person observed with this blood type was a resident of Bombay**.**

Principles of Blood Group Testing

As mentioned, the principles of ABO blood group testing are based on the presence or absence of A, B, or both antigens on human red blood cells. In this system, antibodies are naturally present against A and B antigens in the serum of individuals who lack either of these antigens.

Antibodies regularly present in the serum	Antigenes present on the red blood cells	Blood group
Anti-A & Anti-B	Neither A nor B	O
Anti-B	A	A
Anti-A	B	B
None	A & B	AB

AB, B, A antibodies

Anti-A, anti-B and anti-AB monoclonal antibodies (AB reagent is supplied separately) are IgM class antibodies secreted by mouse hybridoma cell lines. Anti-AB solution is a mixture of anti-A and anti-B monoclonal antibodies. The monoclonal antibodies mentioned were selected for their ability to specifically agglutinate human red blood cells containing A and B antigens in direct agglutination tests (slide, microplate and tube tests). These antibodies do not cause any non-specific agglutination.

Anti-D Blend

Anti-D Blend is a mixture of two human monoclonal antibodies of the IgG and IgM classes. This antigen can be used to detect Rh (positive or negative). This combined anti-D antibody can also be used in the indirect antiglobulin test (Combs test) due to the presence of IgG antibody (incomplete antibody). This combined monoclonal antibody has been prepared to identify weak types of antigen D. This combination does not cause any cross-reaction and does not cause a non-specific agglutination reaction with D-negative red blood cells.

Caution

Antibodies A, B, D, AB are produced in the Biotechnology Science Branch, so due to the fact that materials of animal origin (fetal cell serum) are used in the production process of these products, necessary precautions should be taken.

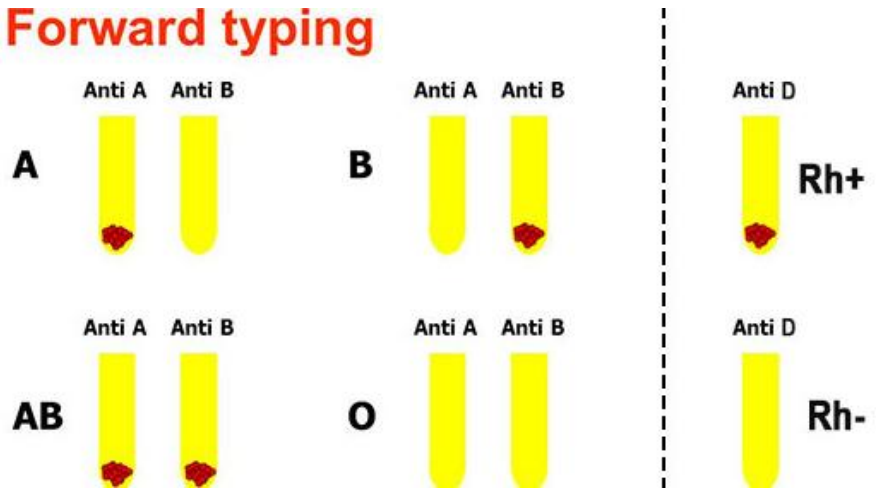
These antibodies contain preservatives (0.1% sodium azide), so avoid contact with skin and mucous membranes and wash with plenty of water in case of contact.

Blood group test method

Blood group tests can be performed in two general methods: Cell Typing or Forward Typing and Back Typing or Reverse Typing.

In the cell typing method, we will determine the blood group based on the antigen on the surface of the red blood cells, and in the back typing method, we will determine the blood group using the

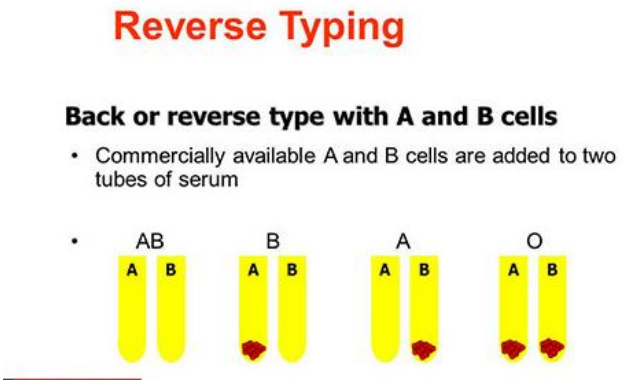
individual's serum and the antibodies in the serum. Each method has its advantages.
The cell typing method itself is divided into two categories: slide and tube. First, we will discuss the method of performing cell typing.
Cell Typing
Slide Methods
1. Pour each of the A, B, and D antibodies onto a clean slide (be careful not to mix these antibodies with each other when pouring).
2. Add one drop of 40% red blood cells to each of the antibodies (suspension with a concentration higher than 40% in the slide method can result in a weak reaction).
3. Mix the blood and antibody mixture well with the applicator by rotating it. (Note that use a new applicator to mix each drop).
4. Read the agglutination result within 30 seconds to 2 minutes by rotating the slide
Use standard positive and negative A, B, and O cells as controls.
The observation of agglutination in each blood and antibody mixture indicates the presence of that antigen. For a better understanding, see the images below.
Cell typing
Tube Methods
1. Wash the red blood cells with saline (0.85%) three times. This will prepare a 2-5% suspension.
2. Prepare a 2-5% suspension of red blood cells in saline.
3. Designate three tubes for anti-A, anti-B, and anti-D.
4. Add one drop of each reagent to the tubes labeled in the previous step.
5. Add one drop of the cell suspension to each tube and mix well.
6. For rapid observation, centrifuge at 1000-1500 RPM for 10-20 seconds after mixing or leave at room temperature for 30 minutes.
7. Gently shake the tube to remove the sediment from the bottom of the tube.
.8Read the test result visually or under a microscope.
If the D tube test result is negative, an indirect Coombs test is performed to look for weak D antigens.



Back Typing Method

In this method, the serum of the individual is used for the presence of natural antibodies and to confirm the cell typing method. The importance of back typing is due to the presence of rare and subgroup blood groups.
First, select three tubes
1. First tube: Add 2-5% suspension of A Cell red blood cells. Note: Make sure that this A Cell suspension is used from the blood of at least two people because one person alone may have a small number of A antigenic sites (due to the presence of multiple A subgroups).

2. Second tube: B Cell suspension, which is used from a sample of at least two people (B subgroups are fewer).
3. Third tube: Suspension of at least one person with blood group O is sufficient (in the back typing method, the use of O cells is not required).
4. Then add 2 drops of unknown serum to each tube (make sure that the ratio of serum to suspension is 2 times because the serum sample may have fewer Ab).
5. Gently mix the contents of the tubes and then centrifuge for 10-20 seconds at 1000-1500 rpm.
6. Shake the tubes gently against the light and check for agglutination.
.7If the Back type and Cell type match, the blood group result can be reported.

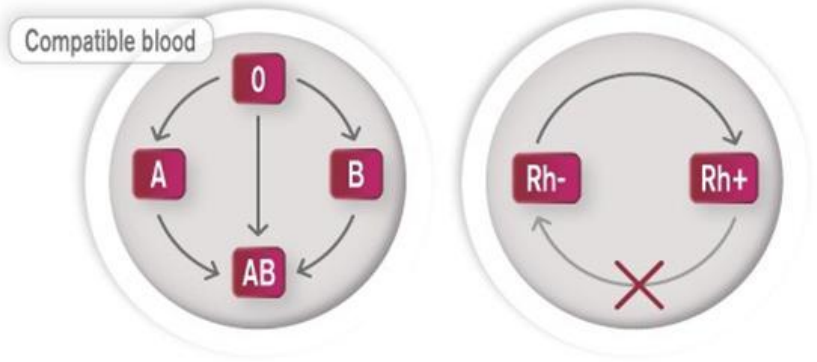


Important points of blood group testing
In infants less than 6 months old due to the natural deficiency of serum antibodies and in elderly people due to the weakness of these Ab, cell type is used.
Only cell type methods can be used to determine Rh because Rh antibodies are only found in the serum of people who have become sensitized against the Rh antigen and are of the IgG class, so they are determined only by examining the surface antigen using the cell type method.
For minor blood groups due to the weakening or absence of A or B antigens or both, it is better to use Back Type.
In the case of Bombay blood group, we also use Back Type due to the absence of Ag H and the presence of Anti H.
Technical factors causing test errors
The most common cause of errors and inconsistencies in cell and serum grouping are technical factors, the most common of which are:
1. Contamination of instruments (tubes, pipettes, etc.) and reagents (antiserum and cell suspension) that cause false positive and negative reactions.
2. Incompatibility of serum or antiserum with cell suspension (false negative reaction)
3. Failure to pay attention to the presence of hemolysis (false negative)
4. Attenuation or reduction of antiserum titer and aging of cell suspension which result in false negative reaction.
.5Personnel errors in identifying the patient or reagents, failure to use a microscope to confirm negative results.

Blood Transfusion
Who can receive blood from whom? You can give blood to a person with blood type A, blood to a person with blood type B, blood to a person with blood type B, and so on for other blood types. Of course, in some emergency cases, you can receive blood from a person with a different blood type or give blood to a person with a different blood type. If the person receiving the blood has a blood type that does not produce antibodies against the donor's blood type antigen, the blood transfusion can be successful. However, if the person who wants to receive the blood has antibodies that bind

to the donor's blood antigens, the donor's red blood cells will clot.

People with blood type O are called universal donors and people with blood type AB are called universal recipients. Note that, as mentioned earlier, there are no antibodies against the Rh antigen in the blood serum of Rh-negative people, but if a person with Rh- blood receives Rh+ blood, they will make Rh antibodies against it, which will appear in their blood plasma. An Rh+ person can receive blood from an Rh- person without any problems.



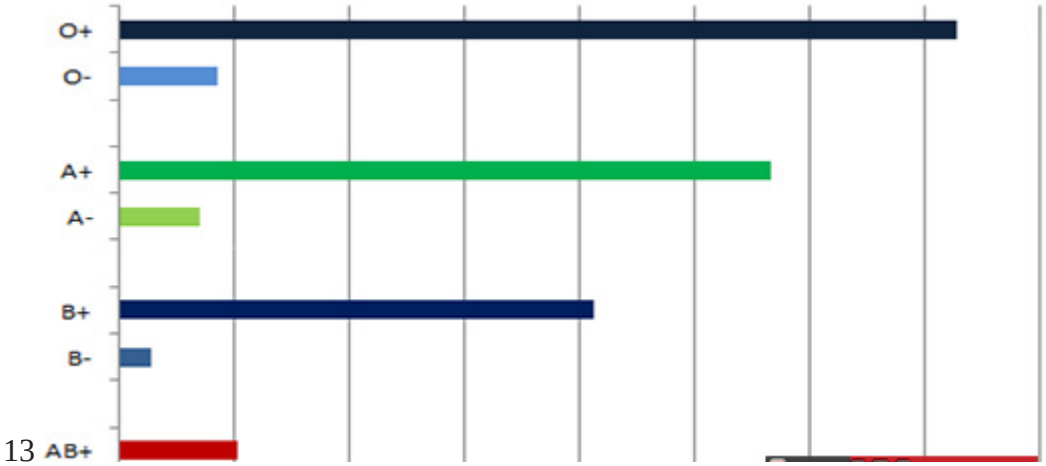
Important points about blood transfusion
Rare blood types for blood transfusion must be donated from the same rare group.
How blood type is inherited from parents
A person's blood type is inherited from their parents and is a bi-allelic phenotype that can be either heterozygous or homozygous depending on its genotype. What is determined in a blood type test is the phenotype. It is true that a blood type test cannot identify the true parents and children in all cases, but to some extent, knowing how blood type is inherited from parents to children can play a rol**e in determining the identity of parents or children.**

Mother's Blood Type	Father's Blood Type: A	B	AB	O	Child's Blood Type
A	A or O	A,B,AB or O	A,B,or AB	A or O	
B	A,B,AB or O	B or O	A,B,or AB	B or O	
AB	A,B,or AB	A,B,or AB	A,B,or AB	A or B	
O	A or O	B or O	A or B	O	

The above table shows what blood types a child of one parent can have.
Parent O + O = child O
Parent O + A = child O or A
Parent O + B = child O or B
Parent O + AB = child A or B
Parent A + A = child A or O
Parent A + B = child A or B or AB or O
Parent A + AB = child A or B or AB

Parent B + B = child B or O
Parent B + AB = child A or B or AB
Parent AB + AB = child A or B or AB

Both parents Rh- = child Rh-
Both parents Rh+ = child Rh+ or Rh-
One parent Rh+ and the other Rh- = child Rh+ or Rh-
Frequency of blood types
The frequency of blood types varies in different countries and even cities, but is approximately as shown in the diagram below.



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To determine blood group using machine learning and support vector machine (SVM), we first need data that contains features of individuals and their blood group. These features can include age, gender, blood type, and other parameters that may help identify blood group. Then, we use a machine learning model like support vector machine (SVM) for classification.

Example Python Code:
Here is a simple example of Python code to use SVM for blood group classification. Note that this code is for example and may require real data and proper preprocessing.


```python
import numpy as np
from sklearn.model_selection import train_test_split
from sklearn.svm import SVC
from sklearn.preprocessing import StandardScaler
from sklearn.metrics import accuracy_score

Suppose the data is a numpy array
Features in X and blood group label in y
X = np.array([[25, 1], [30, 0], [22, 1], [28, 0], [35, 1]]) Sample features
y = np.array(['A', 'B', 'A', 'O', 'AB']) Corresponding blood group
Splitting data into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_state=42)

Data standardization
scaler = StandardScaler()
X_train = scaler.fit_transform(X_train)
X_test = scaler.transform(X_test)
Create SVM model
model = SVC(kernel='linear') Linear kernel
model.fit(X_train, y_train)

Predict blood type
y_pred = model.predict(X_test)
```

Evaluate model performance
accuracy = accuracy_score(y_test, y_pred)
print (f"Accuracy: {accuracy * 100:.2f}%")
Explanation:
1Data (X, y) In this example, the features are numerical (such as age and gender) and the labels are blood type.
2 Training and testing: The data is divided into two parts, training and testing.
3SVM model We use SVC model with linear kernel for classification.
4Data scaling**: To improve the performance of SVM, the data is standardized.
5Evaluation: The accuracy of the model is calculated using the test data.

This is a simple example, and to have a more accurate model, we may need more complex data and model optimization settings.
A paper that discusses blood group classification using deep learning and support vector machines (SVM) usually includes an analysis of various machine learning methods and techniques for predicting blood group of individuals. In the following, I will explain the main structure of such a paper, which can be useful in similar contexts and for research uses.

Data Collection
This section explains where and how the data was collected. Typically, data used in such research may include:
- Biometric characteristics (such as age, gender, genetic evidence, and physical characteristics)
- Genetic information (for example, the types of different genes associated with blood types)
- Laboratory information (to identify blood type through specific tests)

Data may be collected from hospitals, laboratories, or genetic studies.

Data preprocessing

Data must be preprocessed before being used in machine learning models. This includes:
- Removing or replacing incomplete data
- Standardizing or normalizing features to improve model performance
- Encoding labels (for example, using numerical values for blood types such as A=0, B=1, AB=2, O=3)
- Splitting the data into two training and test sets to evaluate the model

Results and analysis

Future work:
The authors may make suggestions for further research. These suggestions could include:
Using more complex genetic data to improve accuracy Applying other machine learning techniques such as recurrent neural networks (RNN) or transfer learning Research on other features that may have a large impact on blood type prediction.

Overall Conclusion

A paper that discusses the use of deep learning support vector machine (SVM) for blood group classification can help researchers and medical professionals to make more accurate and effective predictions about blood group using medical and genetic data. The use of advanced machine learning models can help automated systems and improve the quality of medical diagnoses in the future. In this way, how deep learning or SVM model can help improve blood group prediction compared to traditional methods. Also, challenges and limitations in this research are mentioned, such as lack of data or difficulties in collecting accurate genetic data. The results of different models such as deep learning and SVM are compared. The criteria used to evaluate models usually include:
- Accuracy
- The accuracy of the model in recognizing each blood group (for example, Precision and Recall for each category)

- Error matrix to analyze false discrimination
- F1-Score to measure the balance of accuracy and coverage

If multiple models are used, their accuracy and performance are compared in different simulations.

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