

System Project

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System Project

1-Find a regular expression that accepts the language and implement it

The language $\{w \in \Sigma^* \mid w \text{ contains exactly one double letter}\}$. For example, **baaba** has exactly one double letter, but **baaaba** has two double letters.

Answer:

Regular expression

$$[((ab)^* \cup b \cup \varepsilon) aa (b \cup (ba)^* \cup \varepsilon)] \cup [((ba)^* \cup a \cup \varepsilon) bb ((ab)^* \cup a \cup \varepsilon)]$$

Code:

```
package system.project;

import java.util.Scanner;
import java.util.regex.Matcher;
import java.util.regex.Pattern;

public class SystemProject {

    public static void main(String[] args) {

        Scanner sc = new Scanner (System.in);
        String A = sc.next();

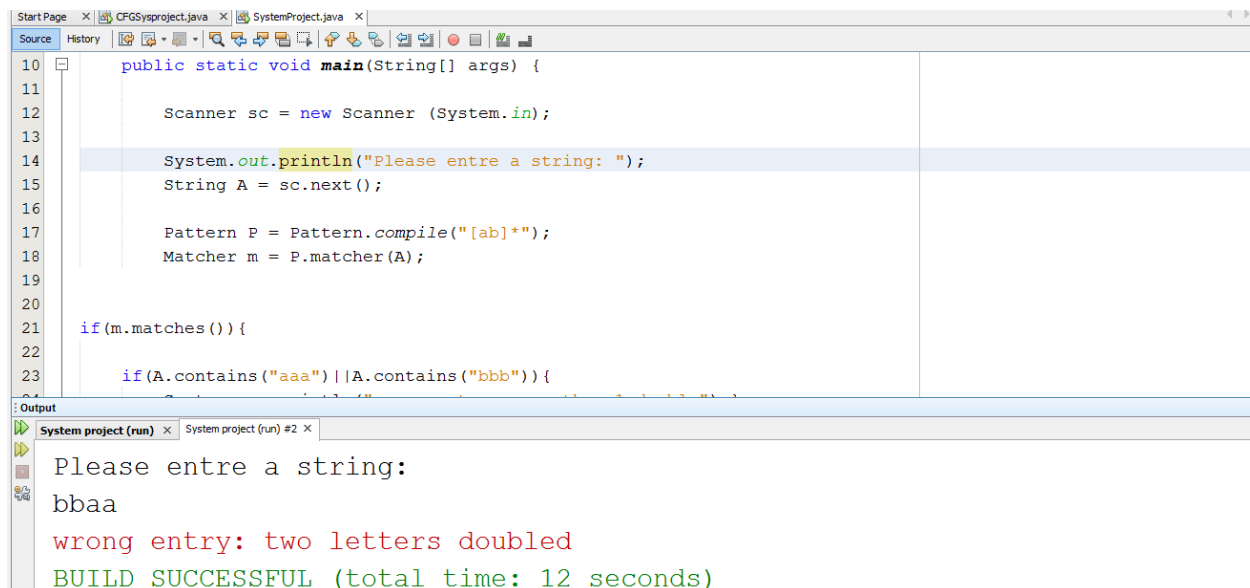
        Pattern P = Pattern.compile("[ab]*");
        Matcher m = P.matcher(A);
```

System Project

```
if(m.matches()){  
  
    if(A.contains("aaa")||A.contains("bbb")){  
        System.err.println("wrong entry: more than 1 double");}  
    else if(A.contains("aa")&&A.contains("bb")){  
        System.err.println("wrong entry: two letters doubled");  
    }else if(!A.contains("aa")&&!A.contains("bb")){  
        System.err.println("wrong entry: does not contain double letters");  
    }  
    else{ System.out.println("Accepted");  
    }  
}else  
    System.err.println("wrong entry: letters not a or b");  
}}}
```

Out put:-

-RE 2 letter doubled

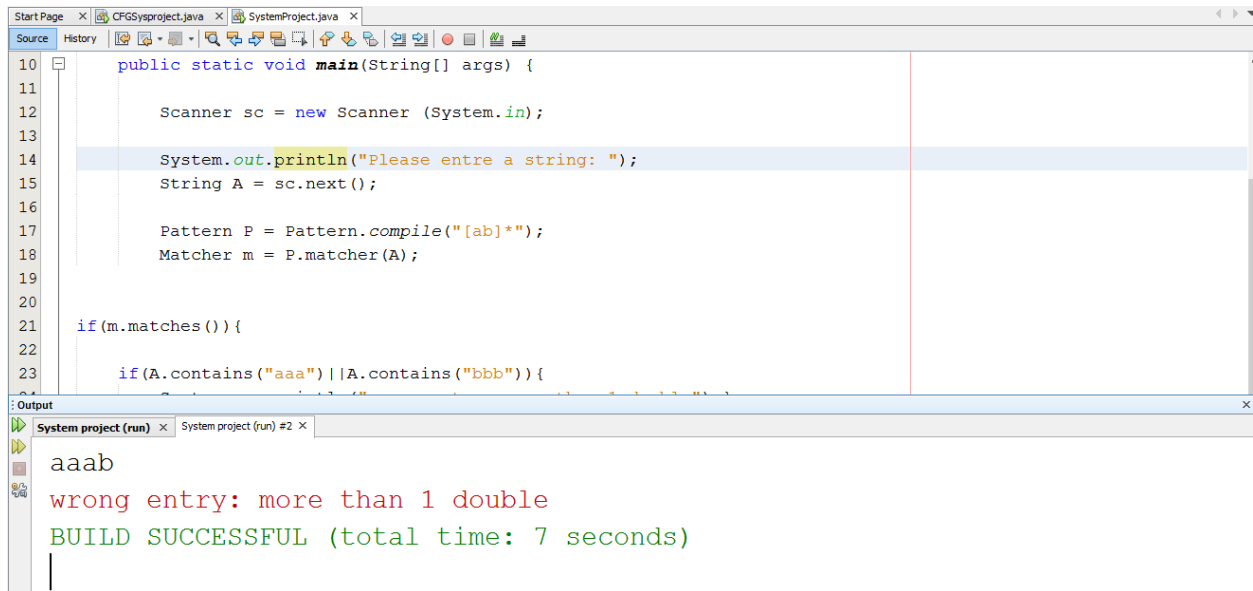


The screenshot shows an IDE with a Java file named 'SystemProject.java'. The code defines a 'main' method that uses a 'Scanner' to read a string 'A' from the user. It then uses a regular expression pattern '[ab]+' to check if the string contains one or more 'a' or 'b' characters. If the string contains more than one 'a' or 'b', it prints an error message. If it contains exactly one 'a' and one 'b', it prints 'Accepted'. Otherwise, it prints an error message. The output window shows the following text:

```
Please entre a string:  
bbaa  
wrong entry: two letters doubled  
BUILD SUCCESSFUL (total time: 12 seconds)
```

System Project

-RE letter is more than doubled



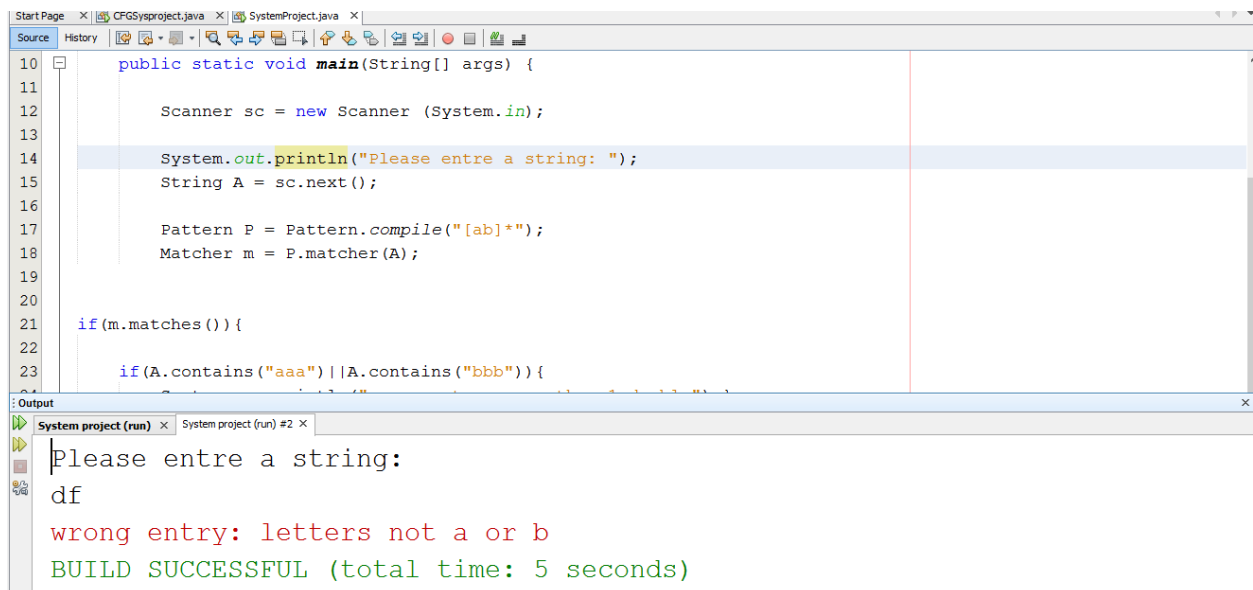
The screenshot shows an IDE with a Java file named `SystemProject.java`. The code defines a `main` method that uses a `Scanner` to read a string from the user. It then compiles a regular expression `[ab]*` and uses a `Matcher` to check if the input string matches. The code also checks if the string contains "aaa" or "bbb". The output window shows the program running, with the input "aaab" and the message "wrong entry: more than 1 double". The build was successful, taking 7 seconds.

```
10 public static void main(String[] args) {
11
12     Scanner sc = new Scanner (System.in);
13
14     System.out.println("Please entre a string: ");
15     String A = sc.next();
16
17     Pattern P = Pattern.compile("[ab]*");
18     Matcher m = P.matcher(A);
19
20
21     if(m.matches()) {
22
23         if(A.contains("aaa") || A.contains("bbb")) {
```

Output

```
System project (run) x System project (run) #2 x
aaab
wrong entry: more than 1 double
BUILD SUCCESSFUL (total time: 7 seconds)
```

-RE not ab



The screenshot shows the same IDE and Java code as the previous image. The output window shows the program running, with the input "df" and the message "wrong entry: letters not a or b". The build was successful, taking 5 seconds.

```
10 public static void main(String[] args) {
11
12     Scanner sc = new Scanner (System.in);
13
14     System.out.println("Please entre a string: ");
15     String A = sc.next();
16
17     Pattern P = Pattern.compile("[ab]*");
18     Matcher m = P.matcher(A);
19
20
21     if(m.matches()) {
22
23         if(A.contains("aaa") || A.contains("bbb")) {
```

Output

```
System project (run) x System project (run) #2 x
Please entre a string:
df
wrong entry: letters not a or b
BUILD SUCCESSFUL (total time: 5 seconds)
```

System Project

-RE accept

```
Matcher m = P.matcher(A);

if(m.matches()){

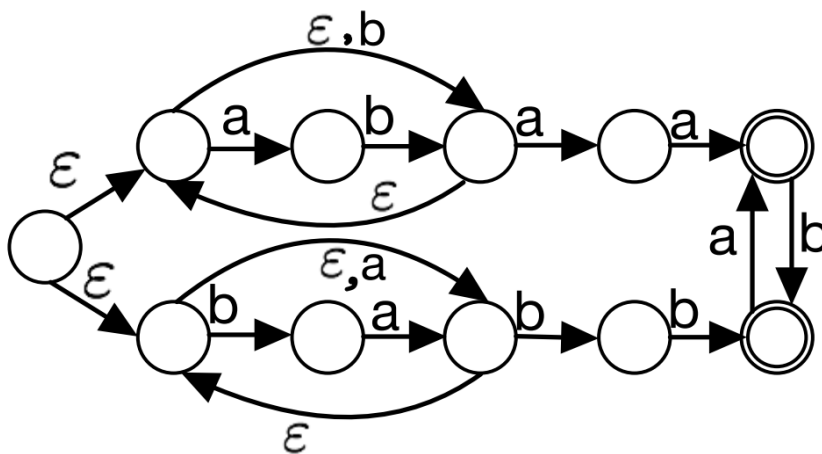
    if(A.contains("aaa")||A.contains("bbb")){
        System.err.println("wrong entry: more than 1 double");
    }
    else if(A.contains("aa")&&A.contains("bb")){
        System.err.println("wrong entry: two letters doubled");
    }
    }else if(!A.contains("aa")&&!A.contains("bb")){
        System.err.println("wrong entry: does not contain double letters");
    }
    else{ System.out.println("Accepted");
    }
}
```

ut - System project (run)

Please entre a string:
babababaa
Accepted
BUILD SUCCESSFUL (total time: 3 seconds)

2. Find the corresponding NFA for the Regular expression in question

1, then implement it.



System Project

Code:

```
#include <bits/stdc++.h>
using namespace std;

int transition(int state, char ch, string s, char ch2)
{
    if(s[0] == 'a' && s[2] == 'a' || s[0] == 'b' && s[2] == 'a' || s[0] == 'a' && s[1] == 'a')
    {
        if(state == 1)
        {
            if(ch == 'a' && ch2 == 'a')
                return 4;
            else if(ch == 'a' && ch2 == 'b')
                return 2;
            else if(ch == 'b' && ch2 == 'a')
                return 3;
        }
        else if(state == 2 && ch == 'b')
            return 3;
        else if(state == 3)
        {
            if(ch == 'a' && ch2 == 'a')
                return 4;
            else
                return 1;
        }
        else if(state == 4 && ch == 'a')
            return 5;
        else if(state == 5 && ch == 'b')
            return 6;
        else if(state == 6 && ch == 'a')
            return 5;
        else
            return 0;
    }
    else
```

System Project

```
else
{
    if(state == 1)
    {
        if(ch == 'b' && ch2 == 'b')
            return 4;
        else if(ch == 'b' && ch2 == 'a')
            return 2;
        else if(ch == 'a' && ch2 == 'b')
            return 3;
    }
    else if(state == 2 && ch == 'a')
        return 3;
    else if(state == 3)
    {
        if(ch == 'b' && ch2 == 'b')
            return 4;
        else
            return 1;
    }
    else if(state == 4 && ch == 'b')
        return 6;
    else if(state == 6 && ch == 'a')
        return 5;
    else if(state == 5 && ch == 'b')
        return 6;
    else
        return 0;
}
```

System Project

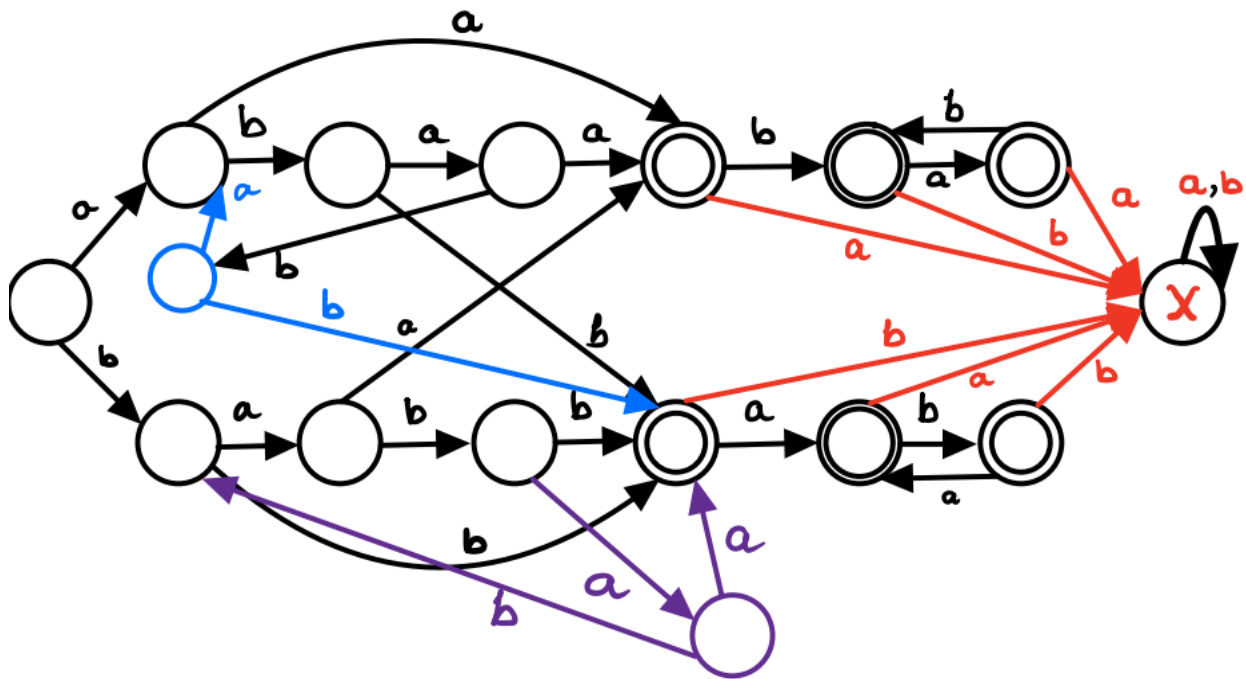
```
}

int accept(int state)
{
    if(state == 5 || state == 6)
        return 1;
    else
        return 0;
}

int main()
{
    string s;
    int state=1;
    cin>>s;
    for(int i = 1; i<=s.length(); i++)
    {
        int newstate = transition(state, s[i-1], s, s[i]);
        state = newstate;
    }
    if(accept(state))
        cout<<"Accept"<<endl;
    else
        cout<<"Reject"<<endl;
}
```

3. Convert the NFA to DFA, then implement it

System Project



Code:

System Project

```
#include <bits/stdc++.h>
using namespace std;

int transition(int state, char ch) {
    if(state == 1 && ch == 'a')
        return 2;
    else if(state == 1 && ch == 'b')
        return 9;
    else if(state == 2 && ch == 'a')
        return 5;
    else if(state == 2 && ch == 'b')
        return 3;
    else if(state == 3 && ch=='a')
        return 4;
    else if(state == 3 && ch=='b')
        return 12;
    else if(state == 4 && ch == 'a')
        return 5;
    else if(state == 4 && ch == 'b')
        return 8;
    else if(state == 5 && ch == 'b')
        return 6;
    else if(state == 5 && ch == 'a')
        return 0;
    else if(state == 6 && ch == 'a')
        return 7;
    else if(state == 6 && ch == 'b')
        return 0;
    else if(state == 7 && ch=='a')
        return 0;
    else if(state == 7 && ch == 'b')
        return 6;
    else if(state == 8 && ch == 'a')
        return 2;
```

System Project

```
else if(state == 8 && ch == 'a')
|     return 2;
else if(state == 8 && ch == 'b')
|     return 12;
else if(state == 9 && ch == 'a')
|     return 10;
else if(state == 9 && ch == 'b')
|     return 12;
else if(state == 10 && ch == 'a')
|     return 5;
else if(state == 10 && ch == 'b')
|     return 11;
else if(state == 11 && ch == 'a')
|     return 15;
else if(state == 11 && ch == 'b')
|     return 12;
else if(state == 12 && ch == 'a')
|     return 13;
else if(state == 12 && ch == 'b')
|     return 0;
else if(state == 13 && ch == 'a')
|     return 0;
else if(state == 13 && ch == 'b')
|     return 14;
else if(state == 14 && ch == 'a')
|     return 13;
else if(state == 14 && ch == 'b')
|     return 0;
else if(state == 15 && ch == 'a')
|     return 12;
else if(state == 15 && ch == 'b')
|     return 9;
}
```

System Project

```
int accept(int state)
{
    if(state == 5 || state == 6 || state == 7 || state == 12 || state == 13 || state == 14)
        return 1;
    else
        return 0;
}

int main()
{
    cin.tie(0)->sync_with_stdio(0);
    string s;
    int state=1;
    cin>>s;
    for(int i=0; i<s.size(); i++)
    {
        int newstate = transition(state, s[i]);
        state = newstate;
    }
    if(accept(state))
        cout<<"Accept"<<endl;
    else
        cout<<"Reject"<<endl;
}
```

4. Find the corresponding CFG for the Regular expression in question

1, then implement it

Context free grammar

$$\begin{aligned} S &\longrightarrow Aaa B \mid BbbA \mid Ab \mid aA \mid Ba \mid bB \mid AB \mid BA \\ A &\longrightarrow abA \mid \varepsilon \\ B &\longrightarrow baB \mid \varepsilon \end{aligned}$$

Code:

System Project

```
package cfg.sysproject;

import java.util.Random;
import java.util.Scanner;

public class CFGSysproject {

    public static void main(String[] args) {

        Scanner sc = new Scanner(System.in);
        System.out.println("would you like to double the a or the b? true = a , false = b ");
        Boolean choice = sc.nextBoolean();

        int min1 = 0;
        int max1 = 10;
        int length_of_string = (int) Math.floor(Math.random() * (max1 - min1 + 1) + min1);
        int before_double = (int) Math.floor(Math.random() * (max1 - min1 + 1) + min1);
        int after_double = Math.abs(length_of_string - (2 + before_double));
```

```
        if(choice==true){
            char[] c = new char[before_double];
            for(int i = before_double-1; i>0; i=i-2){
                c[i]='b';
                c[i-1]='a';
            }
            String A = String.valueOf(c)+"aa";
            // System.out.println(A);

            char[] d = new char[after_double+1];
            for(int i=0; i<after_double; i=i+2){
                d[i]='b';
                d[i+1]='a';
            }
            String B = String.valueOf(d);
            // System.out.println(B);

            String fullstring = A+B;
            System.out.println(fullstring);
        }
    }
}
```

System Project

```
else{
    char[] c = new char[before_double];
    for(int i = before_double-1;i>0;i=i-2){
        c[i]='a';
        c[i-1]='b';
    }
    String A = String.valueOf(c)+"bb";
    //
    System.out.println(A);

    char[] d = new char[after_double+1];
    for(int i=0; i<after_double;i=i+2){
        d[i]='a';
        d[i+1]='b';
    }
    String B = String.valueOf(d);
    //
    System.out.println(B);

    String fullstring = A+B;
    System.out.println(fullstring);
}
```

Out put:-

-CFG double a

```
char[] c = new char[before_double];
for(int i = before_double-1;i>0;i=i-2){
    c[i]='a';
    c[i-1]='b';
}
String A = String.valueOf(c)+"bb";
//
System.out.println(A);

char[] d = new char[before_double];
for(int i=0; i<after_double;i=i+2){
    d[i]='a';
    d[i+1]='b';
}
String B = String.valueOf(d);
```

```
ut - CFG Sysproject (run)
would you like to double the a or the b? true = a , false = b
true
ababababaabababa
BUILD SUCCESSFUL (total time: 4 seconds)
```

System Project

- CFG double b

```
char[] c = new char[before_double];
for(int i = before_double-1; i>0; i=i-2){
    c[i]='a';
    c[i-1]='b';
}
String A = String.valueOf(c)+"bb";
//      System.out.println(A);

char[] d = new char[before_double];
for(int i=0; i<after_double; i=i+2){
    d[i]='a';
    d[i+1]='b';
}
String B = String.valueOf(d);
```

run:

would you like to double the a or the b? true = a , false = b

false

bababababbab

BUILD SUCCESSFUL (total time: 4 seconds)

System Project

Another answer:

```
#include <bits/stdc++.h>
using namespace std;

int main()
{
    cin.tie(0)->sync_with_stdio(0);
    string s;
    char news[100];
    int x=0, n=0, A=0, aa=0, B=0, bb=0, Ab=0, aA=0, Ba=0, bB=0;
    cin>>s;
    n=s.length();

    for(int i=0; i<n; i+=2)
    {
        if(s[i] == 'a' && s[i+1] == 'b' && s[i+2] == 'b' && s[i+3] != 'b')
        {
            news[x]='A';
            news[++x]='b';
            i++;
        }
        else if(s[i] == 'a' && s[i+1] == 'a' && s[i+2] == 'b' && s[i+3] != 'b')
        {
            news[x]='a';
            news[++x]='A';
            i++;
        }
        else if(s[i] == 'b' && s[i+1] == 'a' && s[i+2] == 'a' && s[i+3] != 'a')
        {
            news[x]='B';
            news[++x]='a';
            i++;
        }
    }
}
```


System Project

```
else if(s[i] == 'b' && s[i+1] == 'b' && s[i+2] == 'a' && s[i+3] != 'a')
{
    news[x]='b';
    news[++x]='B';
    i++;
}
else if(s[i]=='a' && s[i+1] == 'b')
{
    news[x]='A';
    news[++x]='A';
}
else if( s[i-1] != 'a' && s[i]=='a' && s[i+1] == 'a' && s[i+2] != 'a')
{
    news[x]='a';
    news[++x]='a';
}
else if(s[i-1] != 'b' && s[i]=='b' && s[i+1] == 'b' && s[i+2] != 'ba')
{
    news[x]='b';
    news[++x]='b';
}
else if(s[i]=='b' && s[i+1] == 'a')
{
    news[x]='B';
    news[++x]='B';
}
x++;
}
```

System Project

```
for(int i=0; i<x; i+=2)
{
    if(news[i]=='A' && news[i+1]=='b')
        Ab+=1;
    else if(news[i]=='a' && news[i+1]=='A')
        aA+=1;
    else if(news[i]=='B' && news[i+1]=='a')
        Ba+=1;
    else if(news[i]=='b' && news[i+1]=='B')
        bB+=1;
    else if(news[i]=='A' && news[i+1]=='A')
        A+=1;
    else if(news[i]=='B' && news[i+1]=='B')
        B+=1;
    else if(news[i]=='a' && news[i+1]=='a')
        aa+=1;
    else if(news[i]=='b' && news[i+1]=='b')
        bb+=1;
}

if(Ab == 1 && A >= 0 && B == 0 && aa == 0 && bb == 0 && aA == 0 && Ba == 0 && bB == 0)
    cout<<"Accept"<<endl;
else if(Ab == 0 && A >= 0 && B == 0 && aa == 0 && bb == 0 && aA == 1 && Ba == 0 && bB == 0)
    cout<<"Accept"<<endl;
else if(Ab == 0 && A >= 0 && B >= 0 && aa == 0 && bb == 0 && aA == 0 && Ba == 1 && bB == 0)
    cout<<"Accept"<<endl;
else if(Ab == 0 && A >= 0 && B >= 0 && aa == 0 && bb == 0 && aA == 0 && Ba == 0 && bB == 1)
    cout<<"Accept"<<endl;
else if(Ab == 0 && A >= 0 && B >= 0 && aa == 0 && bb == 1 && aA == 0 && Ba == 0 && bB == 0)
    cout<<"Accept"<<endl;
else if(Ab == 0 && A >= 0 && B >= 0 && aa == 1 && bb == 0 && aA == 0 && Ba == 0 && bB == 0)
    cout<<"Accept"<<endl;
else
    cout<<"Reject"<<endl;
}
```