

A Research on User Behavior Sequence Analysis Based on Social Networking Service Use-Case Model¹

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Abstract

This paper will put forward a use-case model of social networking service, which reflects the application requirements of social networking service for different roles. Based on data, information and behavior in this model, which have been released, collected and preprocessed by different roles in social networking service, the author will mainly analyze user behavior sequence using Web sequence mode mining algorithm improved. The experimental results show that implementation of this analysis process based on Struts2 technology not only provides a reference example for the data analysis of the network application service based on the mainstream framework technology, but also provides a technical platform condition for formulating the business decisions of social networking service.

Keywords: *User Behavior Sequence Analysis; Social Networking Service; Use-Case Model; Struts2*

1. Introduction

Human social activities have stimulated the rapid development of network technology and produced certain influence on a variety of services based on Web application, Web application platforms based on the mainstream technology not only save a lot of manpower and material resources for all types of service processes, but also provide corresponding personalized services for all types of user groups. Social Networking Service not only embodies the close relationship among social, network and services, but also reflects the high degree characteristics of self-organization and distribution contained in human social relationship [1]. This paper will put forward a use-case model of social networking service, based on data, information and behavior in this model, the author will mainly analyze user behavior sequence using Web sequence mode mining algorithm improved, in order to provide a reference example for the Web data analysis and formulate the business decisions of network application service.

2. Related Work

In recent years, some scholars have conducted certain research for the social networking service. For example, Zhai Hongsheng and others surveyed researches on locations acquisition, users understanding, locations understanding, information sharing and disseminating, locations privacy in location-based online social networking in the literature [2], and provided a summary for future research issues. Song Fei and others proposed a construction approach oriented intelligent communication platform of social networking in the literature [3], which can be used among smart handheld terminals for urgent communication scenarios and range setting by adopting layering structure, when

¹This work was supported by the National Natural Science Foundation of China under Grant Nos.71271209, the project of science and technology plan of Beijing Education Committee under Grant Nos.KM201311417011, and the project of training outstanding talents of Beijing under Grant Nos.2012D005022000013.

Internet access point is unavailable or unstable. Gong XiuWen and others proposed a new PageRank-based propagation model in the literature [4] and employed the Greedy algorithm to solve the influence maximization problem, those works were related research and application directions of social networking service.

In the process of designing and realizing network application platform, many scholars have also studied Struts framework technology in different fields of application and achieved certain results. For example, in order to solve the interoperability difficulty between mobile Agent and Web application, Yang Li and others proposed a new Aglet Struts2 integrated development framework based on mobile Agent in the literature [5], which has been applied to the remote monitoring system of gas production data. Gan Wenli and others described in detail three kinds of input validation usage based on instances in the literature [6], which was supported by Struts2 framework, and represented the process of input calibration. With teacher online training system as the application demand, Sheng Xu and others studied Struts framework based on MVC in the literature [7], those works were related research on the experimental direction of Struts technology.

Based on the analysis of the related research on social networking service and experimental technology, experts and scholars have studied on two directions respectively, but the user behavior sequence analysis of social networking service based on the simulating experiment using Struts2 technology are less. Therefore, this paper will mainly analyze user behavior sequence using Web sequence mode mining algorithm improved based on data, information and behavior released, collected and preprocessed in use-case model.

3. Related Experimental Technology

In the process of validating user behavior sequence analysis, this paper will use three-tier structural mode based on Browser/Server^[8]. In this mode, the presentation layer will partly display information analyzed and analysis results by the mean of pages, users can send service requests to the application service layer based on the role authorities and wait for the results of the requested service. The application service layer will complete the function of handling and analyzing information, according to the service requests send by the presentation layer, it will do the access operation of the business data via the data services layer, then return the results to the presentation layer. The data services layer will complete the definition, organization, storage, manipulation and management tasks of business data, the operational management, protection, maintenance and network communication tasks of database, then use the stored procedure to process business data, which have been submitted from application service layer, and return its result. In the interactive process between the presentation layer and application service layer that has been described above, this paper will adopt Struts2 technology, which has implemented MVC design pattern.

3.1 The design pattern of MVC

The implement of Model, View and Controller design pattern can logically divide social networking service functions [9], enhance extendibility of modules, improve efficiency of managing and maintaining modules, and embody effective separation of business logic, representation logic and control logic [10]. Model can process business logic based on JavaBean technology corresponding to the application service layer of three-tier architecture, View can display dynamic Web pages of social networking service based on JSP technology corresponding to the presentation layer of three-tier architecture, Controller plays the important role in the interactive process of presentation layer and application service layer, which can turn application service request over to corresponding model based on Servlet technology, the processed results will reflect to presentation layer by the mean of views, the working process that has been described above is shown in

Figure 1.

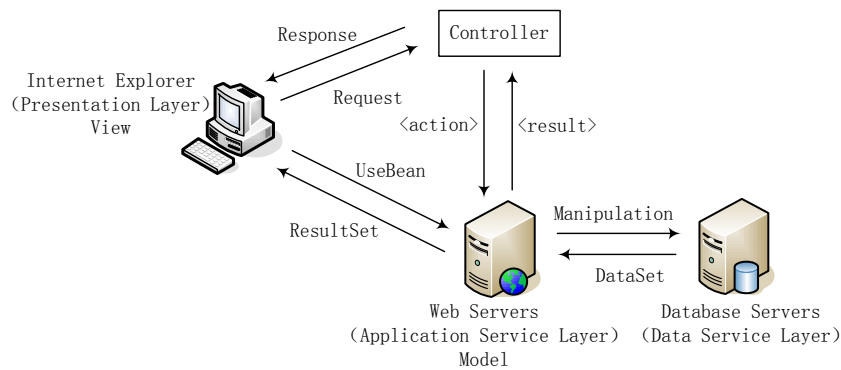


Figure 1. The Working Process of MVC Design Pattern

3.2. The Technology of Struts2

Struts2 technology fully integrates with Struts 1.X and the advantage of WebWork, improves Struts 1.X tag library [11], supports multiple types of return value and reduces the coupling between components of framework using plain old Java objects [12], which will bring great convenience for continued module testing work, also bring a better experience for the design and development of social networking service.

In the design process of social networking service, this paper will build application framework using MyEclipse tool. The author selects the command of adding Struts capabilities, Struts specification and Struts2 libraries in the wizard, which can generate the configuration file of struts.xml. In the business process of social networking service, it will turn service requests submitted over to the different action controllers using Struts2 technology, the business processing classes and controller mapping relationship can be set in this configuration file of struts.xml, which is shown as follows.

```
<action name="Action Name" class="Package Name.Class Name">
    <result name="Business Process State One">Turn to JSP Page One</result>
    <result name="Business Process State Two">Turn to JSP Page Two</result>
    .....
    <result name="Business Process State N-1">Turn to JSP Page N-1</result>
    <result name="Business Process State N">Turn to JSP Page N</result>
</action>
```

4. The Use-Case Model of Social Networking Service

With the continuous development of network information technology, users are enjoying convenient, fast, and a variety of network services. The social networking service originated in the United States, which can guide the user to establish the social networking relationship, reflects the Web 2.0 applications thinking^[13], which takes user demands as the core and focus on personalized and interactive characteristics. The statistics, which are recently released by China's Internet Data Center, show that the access amount of the social networking services has become a new driving force. The network users in China are also taking advantage of social networking services to communicate, social networking services have become the space of the sharing all kinds of experience for users, as this paper can observe in many dimensions, such as the total user access amount, the proportion of respondents in unit time, the dynamic changes of the user access amount, average daily number of sites that have been visited and average number of users that have daily visited the sites in the social networking industry.

The development direction of the social networking service, which takes user-leading as core feature, has reflected the Customer to Business e-commerce mode [14]. This paper

will make full use of the integration advantages of social networking services and C2B e-commerce mode to handle information and analyze user behavior [15], which not only can attract more user groups, but also offer the reference examples for exploring business modes of social networking service in-depth. There are three important roles in social networking service, including common users, business users, and website administrators, this paper puts forward a use-case model of the social networking service based on three roles.

4.1. The Use-Case Model of Common User Role

In the use-case model of social networking service, which is shown as Figure 2, the common user role has the authorities, including registering personal information, modifying personal information, browsing service information, searching service information, releasing service information, adding friends, searching friends, releasing personal comment, managing personal email, online games, managing personal log, manage personal album and so on, which reflects the application requirements of social networking service for common users.

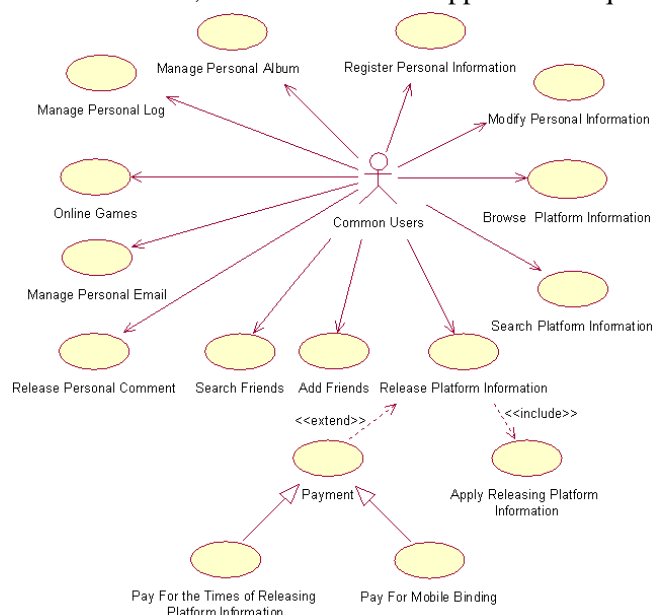


Figure 2. The Use-Case Model of the Social Networking Service for Common Users

In the use-case of common user role, the service information, which can be browsed and searched, contains the requirement information released by users, supply information released by enterprises, comment and log released by users, the album shared by the users and the information registered successfully by enterprises. The use-case of managing personal log has functions on adding, modifying, releasing, searching, and deleting them. The use-case of managing personal album has functions on adding, modifying, sharing, searching, and deleting them. <<extend>> shows the extended relationship between two use-cases, which contain payment and releasing service information, if the times of releasing service information for users have run out, then the model will prompt the common user pay firstly, and release information. <<include>> shows the existed using relationship between two use-cases, which contain releasing service information and applying to release them, while releasing service information, users should submit the

form for applying to release them, and wait for passing the administrator's check. In addition, there are two implementation use-cases of paying the cost, which contain paying the times of releasing service information and cost of mobile binding.

4.2. The Use-Case Model of Business User Role

In the use-case model of social networking service, which is shown as Figure 3, the business user role has the authorities, including browsing service information, searching service information, releasing service information, registering enterprise information, modifying enterprise information, managing enterprise email and so on, which reflects the application requirements of social networking service for business users.

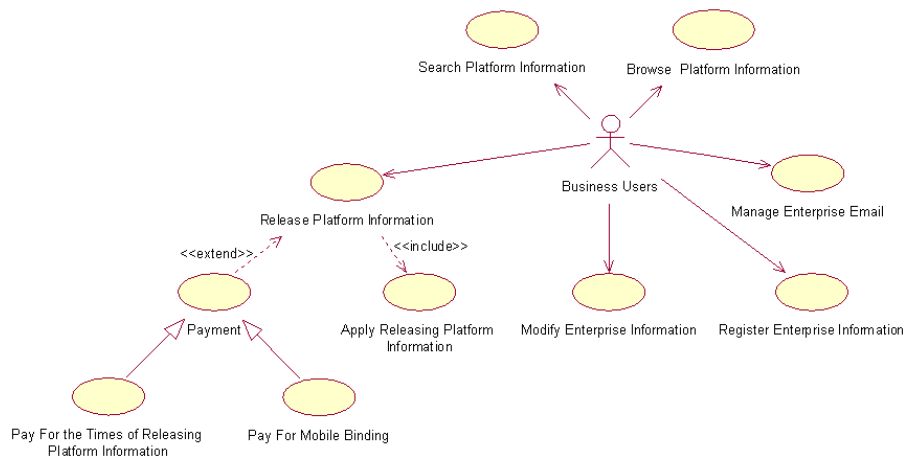


Figure 3. The Use-Case Model of the Social Networking Service for Business Users

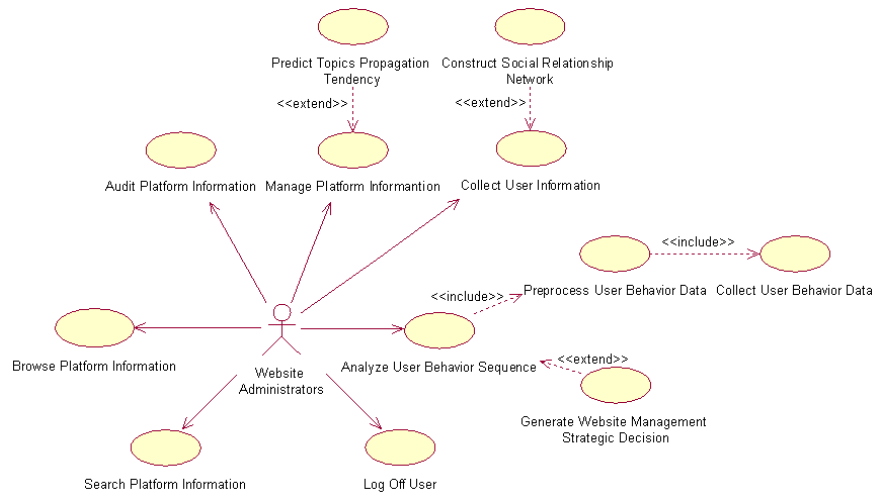
In the use-case of business user role, the service information, which can be browsed and searched, contains the requirement information released by users, supply information released by enterprises, comment and log released by users, the album shared by the users and the information registered successfully by enterprises. <<extend>> shows the extended relationship between two use-cases, which contain payment and releasing service information, if the times of releasing service information for enterprises have run out, then the model will prompt the enterprise user pay firstly, and release information. <<include>> shows the existed using relationship between two use-cases, which contain releasing service information and applying to release service information, while releasing service information, enterprises should submit the form for applying to release service information, and wait for passing the administrator's check. In addition, there are two implementation use-cases of paying the cost, which contain paying the times of releasing service information and cost of mobile binding.

4.3. The Use-Case Model of Website Administrator Role

In the use-case model of social networking service, which is shown as Figure 4, the website administrator role has the authorities, including browsing service information, searching service information, auditing service information, managing service information, collecting user information, analyzing user behavior sequence, logging off users and so on, which reflects the application requirements of social networking service for website administrators.

In the use-case of website administrator role, the service information, which can be browsed and searched, contains the log released by users, the album shared by the users

and so on, the service information, which can be audited, contains the applied release information proposed for individual demand and enterprise supply, the applied registration information proposed for users and enterprises, the service information, which can be managed, contains the personal requirement information released, the enterprise supply information released and personal comments, the collected user information contains individual, enterprise and their friends information. <<extend>> shows the extended relationship between two use-cases, which contain predicting topics propagation tendency and managing service information, constructing social relationship network and



collecting user information, analyzing user behavior sequence and generating website management strategic decision. <<include>> shows the existed using relationship between two use-cases, which contain analyzing user behavior sequence and preprocessing user behavior data, preprocessing user behavior data and collecting user behavior data.

Figure 4. The Use-Case Model of the Social Networking Service for Website Administrators

5. The Description of User Behavior Sequence Analysis Algorithm

In social networking service based on use-case model, there are several user behaviors, such as releasing comments, adding friends, online games, searching friends, releasing

information and so on. Firstly, this section will describe the process of generating user behavior taking releasing service information as an example, secondly, this section will mainly describe the algorithm of user behavior sequence analysis.

5.1. Generating User Behavior of Releasing Service Information

In the process of generating user behavior of releasing service information for users, this use-case will adopt JavaBean technology to realize the process of business logical execution. In the process of designing instance methods, first of all, it should judge times of releasing service information that users own, if the attributable value of releasing information times is zero in user account information table, then should turn the state of "reCharge" over to the control logic and provide two kinds of choices for users in the page, whether paying fee of releasing service information times, or to pay fee of mobile phone binding, if the attributable value of releasing information times is more than zero in user account information table, then should submit service information released, turn the state of "toExamine" over to the control logic and provide specifications for users in the page, which shows that administrator is checking the service information submitted that will be released at some time, the description of business logical processing procedure is shown as follows.

```
public interface Action { //Define Struts2 behavior interface
    public static String RECHARGE="reCharge"; //Encapsulate the sign of
    paying fee
    public static String TOEXAMINE="toExamine";
    //Encapsulate the sign of checking information
    public String execute() throws Exception;
    //Encapsulate the methods of executing business logical process
}
//Define Struts2 behavior class
public class PubInfoAction extends ActionSupport implements Action {
    private TreeSet tree; //Encapsulate the objects of ordered set
    public TreeSet getTree() { //Get the objects of ordered set
        return tree;
    }
    public void setTree(TreeSet tree) { //Set the objects of ordered set
        this.tree = tree;
    }
}
//Realize business logical processing methods of releasing service information for
users
public String execute() throws Exception {
    //Create model objects by using construct parameters that encapsulate users in
tree
    CountCheck countcheck= new CountCheck(tree);
    /*Call the method in model object to determine the released service
information times what the users have owned.*/
    if(countcheck.judge_count()==0) {
        /*If the attributable value of releasing information times is zero for
users, then add attribute judge in the request scope, and attributable value should be set
false.*/
        ServletActionContext.getRequest().setAttribute("judge", "false");
        return "reCharge"; //Return the sign of paying fee
    } else if(countcheck.judge_count()>0){
        /*If the attributable value of releasing information times is more than
zero for users, then add attribute judge in the request scope, and attributable value should
be set true.*/
```

```
        ServletActionContext.getRequest().setAttribute("judge", "true");
        countcheck.submit_info();//Submit information released to background
for users
        return "toExamine";//Return the sign of checking information
    }
}
```

When users fill out the service information released and submit requests, Web server should design the filter, which has chain function, before receiving client request. This use-case designs the Chinese code conversion filter to improve the Chinese recognition of model and performance of code reuse by implementing the Filter interface, which is described as follows.

```
public class ChineseFilter implements Filter{
//Define filter class and implement Filter interface
    private String chinese_encoding;//Encapsulate object of encoding type
//Realize the method of initializing to set encoding type
    public void init(FilterConfig fc) throws ServletException{
        this.chinese_encoding =fc.getInitParameter("encoding");
    }
//Realize the filtering function of requesting and responding Chinese information
    public void doFilter(ServletRequest request, ServletResponse response,
FilterChain chain) throws IOException,ServletException {
        request.setCharacterEncoding(this.chinese_encoding);
        response.setCharacterEncoding(this.chinese_encoding);
        chain.doFilter(request,response);
    }
}
```

In the development of MyEclipse enterprise version, Web Deployment Descriptor's Design can configure the filter, which is in response to Chinese code conversion. This model should add Filter in the child nodes of web.xml Filters, set the Filter-Name to ChineseFilter and set the Filter-Class to myfilter.ChineseFilter. This model should set Param-Name to encoding, set Param-Value to GBK in Init-Params, add Filter Mappings in the child nodes of web.xml Filters, set Filter-Name to ChineseFilter and set URL-Pattern to /*, which shows that this model can filter all resources of social networking service, the description of filter configuration is shown as follows in the document of web.xml.

```
<filter>
    <filter-name>ChineseFilter</filter-name>
    <filter-class>myfilter.ChineseFilter</filter-class>
    <init-param>
        <param-name>encoding</param-name>
        <param-value>GBK</param-value>
    </init-param>
</filter>
<filter-mapping>
    <filter-name>ChineseFilter</filter-name>
    <url-pattern>/*</url-pattern>
</filter-mapping>
```

When the Controller receives the service request from releasing service information for users, struts.xml, which is a configuration file, will turn it over to the corresponding model of publishInfo and receive the service information released from the service request form, which is described as follows.

```
<action name="publishInfo" class="bl.PliAction">
    <result name="reCharge">/pli_recharge.jsp</result>
```



```
<result name="toExamine">/pli_toexamine.jsp</result>
</action>
```

According to realizable description of business logical processing procedure, through calling business logical processing method of class PliAction and stored procedure, which has been designed in database, this model should handle the service request, in the end, according to the returned business processing state of "reCharge" or "toExamine", turn HTTP request over to the corresponding JSP page of "pli_recharge" or "pli_toexamine" and send the response to the browser.

/*This stored procedure is used to determine the times of releasing service information what users have owned.*/

```
CREATE PROCEDURE judge_count --Create stored procedure
@username varchar(10) as inputparam
--The user account of releasing service information is an input parameter.
@flag int as output
--The times of releasing service information is an output parameter for users.
AS
BEGIN
--Select times of releasing service information from the data table for users.
SELECT count into @flag FROM <Data Table Name>
WHERE username=@username
/*Return the times of releasing service information for users to the position, where stored
procedure is called by method of model instance.*/
return @flag
END
```

5.2. Analyzing User Behavior Sequence

In the process of analyzing user behavior sequence for website administrators, firstly, this model should collect user behavior data and store results in the user behavior database, which is shown as Table 1, secondly, this model should preprocess information collected, such as cleaning out, user identification, session identification, transaction identification and so on, and store results in the user behavior database, which is shown as Table 2, thirdly, this model should complete sequence pattern mining for preprocessed information and store results in the user behavior database, which is shown as following algorithm, finally, according to the user behavior frequent sequences mined and the adjustment of sequence mode support parameters, this model should generate the description of website management decision, which is shown as Table 3.

Table 1. User Behavior Data Collected

User ID	Time	Event ID	Event	User IP
DYJD204534	MAY 31, 2013, 0:27:34 AM	07	Release Comments	10.200.0.24
CNHC2013341	MAY 31, 2013, 5:12:44 AM	03	Release Information	61.105.43.99
CNHC2013341	MAY 31, 2013, 19:07:12 PM	04	Online Games	61.105.43.99
GLNB652678	MAY 31, 2013, 15:33:57 PM	01	Search Friends	211.305.0.18
GLNB652678	MAY 31, 2013, 14:57:43 PM	05	Add Friends	211.305.0.18
...
FLTW100272	MAY 31, 2013, 15:35:16 PM	03	Release Information	10.266.0.13

Table 2. User Behavior Sequence

User ID	User Behavior Sequence
DYJD204534	S<(07,05),04>

CNHC2013341	S<(03,07),(05,02)>
GLNB652678	S<(09),(05,01)>
AWEH568342	S<(03,07),(04,02)>
...	...
FLTW100272	S<(05,01),(03,02)>

```

public interface Action { //Define Struts2 behavior interface
    public static String DATASL="dataSelection";//The encapsulation of collecting
user behavior sign
    public static String DATAPP="dataPreprocess";
//The encapsulation of preprocessing user behavior sign
    public static String DATAM="dataMining";
//The encapsulation of mining user behavior sequence sign
    public static String DATAS="dataStrategy";
//The encapsulation of generating decision support sign
    public String execute()throws Exception;
//The encapsulation of executing business logical process method
}
//Define Struts2 behavior class members
private ResultSet rs;//Encapsulate the record set of user behavior sequence database
public ResultSet getRs() { //Get the object of record set
    return rs;
}
public void setRs(ResultSet rs) { //Set the object of record set
    this.rs = rs;
}
//Implement the business logical process method of analyzing user behavior
sequence
public String execute() throws Exception {
    double minsupport=0.4;//Set the minimum support in sequence mode
    while(rs.next())
    {
        String sequence=rs.getString("Sequence");
        Candidatek=GSPGenerate(sequence);//Generate the candidate set of
frequent sequences
        For each sequence s in the DataBase Do
            if(s contains Candidatek)
                Increase the count of Candidatek;
        End For
        Lk=Candidates in Candidatek with minsupport;
    }
    StoredData(Lk);//Store the set of frequent sequences
    return "dataMining";//Return the sign of mining user behavior sequence
}
    
```

Table 3. The Description User Behavior Decision

The Sequence Mode's Support up to 40%
S<(05,07),01>
S<01,05>
S<(04,05)>
...

When the Controller receives the service request from analyzing user behavior sequence for website administrators, struts.xml, which is a configuration file, will turn it over to the corresponding model, which is described as follows.

```
<action name="action name" class="bll.UserBehaviorAction">
  <result name="dataSelection">/userBehavior_dataselection.jsp</result>
  <result name="dataPreprocess">/userBehavior_datapreprocess.jsp</result>
  <result name="dataMining">/userBehavior_datamining.jsp</result>
  <result name="dataStrategy">/userBehavior_datastrategy.jsp</result>
</action>
```

According to realizable description of business logical processing procedure, through calling business logical processing method of class UserBehaviorAction, this model can execute user behavior analysis process of collecting user behavior data, preprocessing the acquisition data, performing sequential pattern mining for data preprocessed, generating website management decision and so on. According to the returned business processing state, this model can turn HTTP request over to the corresponding JSP page and send the response to the browser, in order to display the results of collecting user behavior, preprocessing user behavior data, mining user behavior sequential pattern and the description of website management decision.

6. Experimental Results

The physical components of social networking service based on Struts2 technology will be divided into the general components, foreground components and background components. The general components, which are called login components, can be used by common users, business users and website administrators, the foreground components can be used by common users and business users, the background components can be used by website administrators, who can access management background after entering the experimental platform.

In the foreground components, taking the use-case realization process of generating user behavior of releasing service information for users as an example, this experimental platform designs the pages, which have the functions, such as editing service information released by users, allowing users to select payment means of releasing service information and auditing releasing service information. This experimental platform imports into UI tag library supported by Struts2 using compile command, which is `<%@taglib prefix="s" uri="/struts-tags"%>`, and continually joins UI tags required by page body design in Struts2 form after joining `<s:form action="publishInfo">` tag in the page design or source code, such as `<s:textfield>`, `<s:textarea>`, `<s:file>`, `<s:select>`, `<s:checkboxlist>`, `<s:radio>`, `<s:submit>`, `<s:reset>` and so on. In Struts2 form of foreground components, when editing service information released, users can click the reset button to fill in information, also click the submit button to release information.

When users have not clicked the submit button to release information, this experimental platform will adopt Ajax technology to realize the browser checking process, in order to filter information edited by users. This experimental platform will call methods of instances encapsulated in JavaScript to display the filtering effect of page information based on DWR and Dojo framework, and add the validation rules in the configuration file, which is shown as follows.

```
<validator type="requiredstring"><!--The service information must be edited.-->
  <!--The theme information must be edited.-->
  <param name="fieldName">mytheme</param>
  <param name="trim">true</param>
  <message> The theme of releasing information must be
imported.</message>
</validator>
<validator type="regex">
  <!--The service information edited must be checked using regular
expressions.-->
```

```

    <param name="fieldName">mytheme</param>
    <!--The theme length of releasing information must be controlled between 5 and
    30 characters.-->
    <param name="expression"><![CDATA[(\w{5,30})]]></param>
    <message>The theme length must be controlled between 5 and 30
    characters.</message>
    </validator>
    
```

Figure 5. The Experimental Result of Releasing Service Information

In the background components, taking the use-case realization process of analyzing user behavior sequence for website administrators as an example, this experimental platform designs the pages, which contain collecting user behavior data, preprocessing user behavior data, analyzing user behavior sequence and generating website management strategic decision. Through importing UI tag library provided by Struts2 and adding <s:form action="action name"> label in the page design or source code, this experimental platform can continually add other UI tags required by the design of page body in Struts2 form. This use-case implementation process can complete user behavior analysis in social networking services by the means of module guidance, in order to display user behavior data and sequence by the application of paging technology [16].

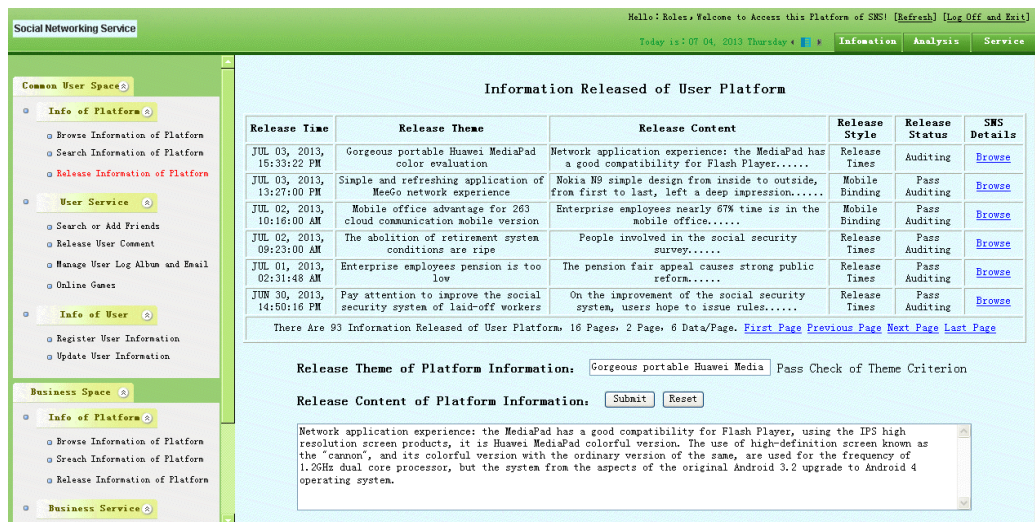
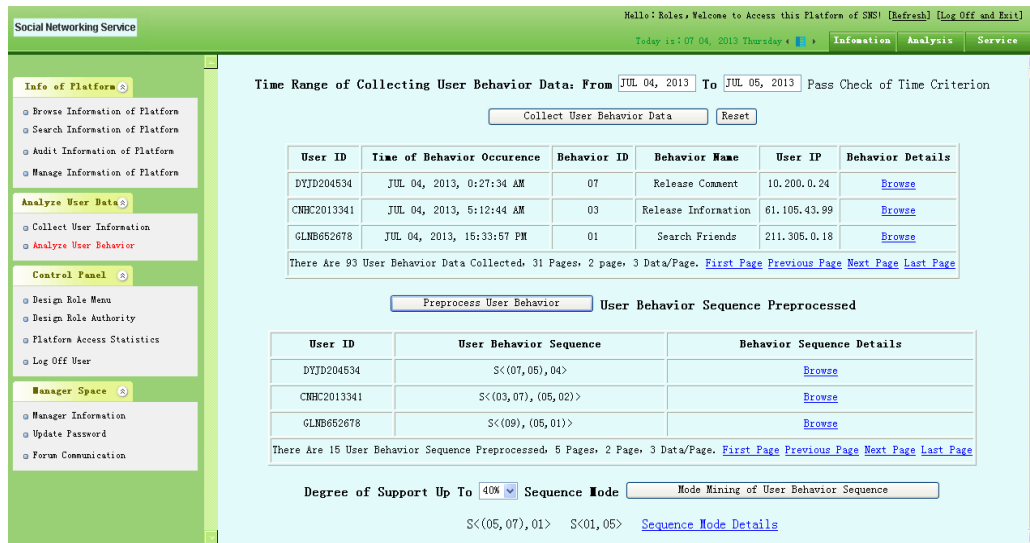


Figure 6. The Experimental Result of Analyzing User Behavior Sequence



7. Conclusion

This paper has proposed a model of social networking service, the author has also elaborated and analyzed related work, related experimental technology and use-case model in detail. The proposal of user behavior sequence analysis algorithm further reflects flexibility and reusability of object-oriented programming, completes clear logical division for experimental platform structure, which has model layer, view layer and control layer, performs effective separation of business logic, display logic and control logic, when this experimental platform can meet application complexity and security of the enterprise level, and fully embodies that the analysis idea of network application service based on Struts2 technology has become a mainstream development trend.

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