Team Name: Destiny

Final Project Report

Chinese Word Segmentation

陈桢，李健达，袁全宁，刘柏辰

2013

Shanghai Jiao Tong University

Index

1) Overview

This is the final report for the project Chinese Word Segmentation of Computation Theory course at the Shanghai Jiao Tong University, by Professor Tianfang Yao. This report will explain the task, details in algorithm and the final result of our program in the following chapters.

a. System Function

Our task is to make an automatic Chinese Word Segmentation System which can separate a Chinese passage into sentences and sentences into words quickly and accurately especially for the articles on the EXPO website. The program should have the following parts:

- User Interface
- Text Input and Output
- Sentence Segmentation
- Word Segmentation
- Lexicon
- Rules

b. Running Environment

The running environment is recommended to be Microsoft Windows 7 with Python 3.2 to support its running.

c. Development Environment

The development environment is Microsoft Windows 7 with the development software PyScripter 2.5.3 and language Python 3.2.

2) Task Allocation

As the program contains many parts, each team member was required to finish one or more parts and then combined them together to test the whole process. The detail arrangement is shown as follows:

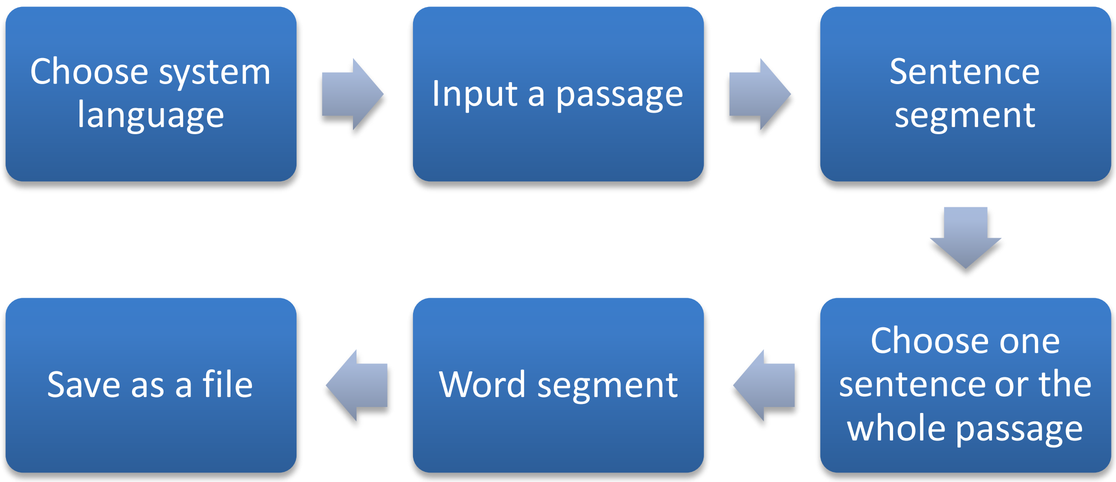
Chen Zhen: Design the algorithm for the sentence and word segmentation, then do the implementation and improve the performance.

Li Jianda: Design the user interface including the menu bar and the command buttons, then makes the text input and output function.

Yuan Quanning: Make the rule functions and debug the whole system, then use some articles on the EXPO website to test the program and improve the lexicon.

Liu Baichen: Find some information to build a lexicon for the system and make it reliable by deleting the unnecessary words in it.

3) System Architecture



a. User Interface Component

This program has both Chinese and English interface for users to choose. Users can add a word into the lexicon or delete it at any time, so does the rules. We have two text boxes. One is for users to input the passages; the other is for our program to output the results.

Next, we take the process of a passage being transformed into words as an example.

b. Process Component

First, we us some sentence punctuation as symbols to cut the passages into sentences. Then for each sentence, we have three procedures to make it into words. The first step, we find the numbers, spaces, English words, website address which can be symbols to help cut the sentence into small pieces. The second step, we use the main segment function to cut each piece into words. The last step, we use a function to find whether there are names in this sentence and combine names into a word. Finally, we use rules to rectify it and the work is done. You can choose the location to save the result into a txt file.

But how can we do this, how can we find the names accurately, please look the following chapter.

4) Algorithm Description

a. Input Dictionary Files

We have five dictionary files: main dictionary, blacklist, whitelist, single first name and double first name. In each file, we make one word one line so that we can get each word easily. But we should notice that at the end of each line, there is a "\n" which we have to neglect when we input the dictionary.

The related function source code is shown as follows:

```
def input_dic(a):
    dic=[]
    lex=open(a,"r")
    for line in lex:
        if line[-1]=="\n":
            dic.append(line[:-1])
        else:
            dic.append(line)
    lex.close()
    return dic

single_name=input_dic("lexicon/single.txt")
double_name=input_dic("lexicon/double.txt")
dic=input_dic("lexicon/dict.txt")
blacklist=input_dic("lexicon/blacklist.txt")
whitelist=input_dic("lexicon/whitelist.txt")
```

b. Sentence Segmentation

For a passage, we notice that some punctuation like “；。？！\n” can be symbol of a sentence except that these punctuation are followed by “’”　”. For punctuation like “：，”, sometimes they are symbols of a sentence but sometimes not. For example, when “：” is used as a part of time like “12：50”, then it cannot be separated. For “\n” and “\u3000”, we should neglect it when construct the new sentence. Finally, we should give each sentence a number except the empty sentence which has only “\n” or space so that users can choose which sentence he want to segment into words.

The related function source code is shown as follows:

```
def sentence_seg(a):
    n="1234567890１２３４５６７８９０"
    t=0
    new=[]
    for i in range(len(a)):
        if i==len(a)-1:
            new.append(a[t:i+1])
        elif i+1<len(a) and a[i] in "；。？！" and a[i+1] not in "”’　":
            new.append(a[t:i+1])
            t=i+1
        elif i+2<len(a) and a[i]+a[i+1]+a[i+2]=="。’”":
            new.append(a[t:i+3])
            t=i+3
        elif i+1<len(a) and a[i]+a[i+1] in ["。”","。’","","……"]:
            new.append(a[t:i+2])
            t=i+2
        elif a[i] in "，：" and i+1<len(a):
            if a[i+1] not in n or a[i-1] not in n:
                new.append(a[t:i+1])
                t=i+1
        elif a[i]=="\n" or a[i]=="\u3000":
            new.append(a[t:i])
            t=i+1
    s=""
    p=1
    for i in range(len(new)):
        t=""
        for j in range(len(new[i])):
            if new[i][j]!="\n":
                t=t+new[i][j]
        new[i]=t
        if new[i]!="" and new[i]!=" " and new[i]!="　":
            s=s+"{0}.{1}\n".format(p,new[i])
            p=p+1
    return new,s,p

(new,s,p)=sentence_seg(list_ch)
```

c. Choose a Sentence or the Whole Passage

We give two choices to the users. One is to segment only one sentence; the other is to segment the whole passage. So at this time, we have to accept the information from users and get the right sentence from the list. To be careful with the detail, if there is only one sentence, we will not ask the user to do the choice.

The related function source code is shown as follows:

```
def one(p,new):
    if p==0:
            return new
        else:
            t=0
            for i in range(len(new)):
                if new[i]!="" and new[i]!=" " and new[i]!="    ":
                    t=t+1
                if t==p:
                    return [new[i]]
        return new

    if p>2:
        p=int(input("Would you like to select one of the above sentences to
look at the result of word segmentation?\nIf yes, please input the indicated
sentence No.\nIf no, please input 0."))
    new=one(p,new)
```

d. Cut Sentence into Small Pieces

Some sentences can be very long which is hard for a program to cut it quickly, so we cut it into small pieces first and deal with some small problems at the same time.

The first thing we consider is the space. If we detect a space, we will report it to the user and ask whether the program should neglect the space. If the space is not neglected, it will be a separate symbol and the sentence becomes some short sentences.

The second thing we consider is the number. If we find a number in the sentence, the program will judge whether it is a day, month or year. Then the program can separate it. Having notice that some numbers are represented in the form of "123,456,789", so this kind of number should be separated into one part. The punctuation "，.” should be neglected when they are between numbers.

The third thing we consider is the English words and website address. We think such kind of things can be symbol for us to cut sentence into small pieces. Also, the punctuation "./" should be neglected when they are between English words.

The fourth thing we consider is the punctuation "、" which is commonly used in the name list. If we can use it to separate the sentence, it will be quite convenient for the following steps.

After we finish all of the above things, each sentence will become some short pieces and the following process can be pertinence.

The related function source code is shown as follows:

```
def first(new,sk):
    sp=0
    for i in range(len(new)):
        if " " in new[i]:# spaces
            j=0
            while j<len(new[i]):
                if sk==0:
                    if new[i][j]==" ":
                        new[i]=new[i][:j]+"|"+new[i][j+1:]
                        sp=1
                        j=j+1
                        while j<len(new[i]) and new[i][j]==" ":
                            new[i]=new[i][:j]+new[i][j+1:]
                else:
                    while j<len(new[i]) and new[i][j]==" ":
                        new[i]=new[i][:j]+new[i][j+1:]
                j=j+1
        j=0# number
        n="1234567890１２３４５６７８９０"
        m="年月日"
        p=",.:，：．　"
        while j<len(new[i]):
            if new[i][j] in n:
                t=j
                mark=0
                while new[i][j] in n:
                    j=j+1
                    if j==len(new[i]):
                        new[i]=new[i][:t]+"|"+new[i][t:j]+"|"
                        mark=1
                        break
                    if new[i][j] in m:

new[i]=new[i][:t]+"|"+new[i][t:j]+"|"+new[i][j]+"|"+new[i][j+1:]
                        mark=1
                        break
                    if new[i][j] in p:
```

```
                    j=j+1
                if mark==0:
                    new[i]=new[i][:t]+"|"+new[i][t:j]+"|"+new[i][j:]
            j=j+1
        j=0# website
        n=string.ascii_lowercase+"./"
        while j<len(new[i]):
            if new[i][j] in n:
                t=j
                mark=0
                while new[i][j] in n:
                    j=j+1
                    if j==len(new[i]):
                        new[i]=new[i][:t]+"|"+new[i][t:j]+"|"
                        mark=1
                        break
                if mark==0:
                    new[i]=new[i][:t]+"|"+new[i][t:j]+"|"+new[i][j:]
            j=j+1
        j=0# punctuation
        while j<len(new[i]):
            if new[i][j]=="、":
                new[i]=new[i][:j]+"|"+new[i][j]+"|"+new[i][j+1:]
                j=j+2
            j=j+1
        j=0# devide
        t=0
        k=[]
        if len(new[i])!=0:
            if new[i][-1]!="|":
                new[i]=new[i]+"|"
            while j<len(new[i]):
                if new[i][j]=="|":
                    k.append(new[i][t:j])
                    t=j+1
                j=j+1
            new[i]=k
        j=0# remove
        while j<len(new[i]):
            if new[i][j]=="":
                new[i][j:j+1]=[]
            j=j+1
    return(new,sp)
```

```
        backup=new[:]
        (new,sp)=first(new,0)
        if sp==1:
                if input("Space has been detected.\nDo you want to neglect the
space?\n(1=Yes,0=No)")!="0":
                        (new,sp)=first(backup,1)
```

e. Word Segmentation

For each small piece, if it is not started with the number, English words and punctuation, we use a main cut function to cut it into words. In this function, we use RMM method which means we take maximum match from right to left. If the word is in the dictionary, the program will cut it. Otherwise, the program will make the length smaller and match it again. During this procedure, we use recursion to write this function so that the function will be neat and easy to read.

The related function source code is shown as follows:

```
def cut(new,dic):
        n="1234567890１２３４５６７８９０"+string.ascii_lowercase
        for i in range(len(new)):
                j=0
                while j <len(new[i]):
                        if new[i][j][0] not in n and len(new[i][j])!=1:
                                (s,t)=rmm(new[i][j],new[i][j][-7:],dic,[])
                                t=t[::-1]
                                new[i][j:j+1]=[]
                                for k in range(len(t)):
                                        new[i][j:j]=[t[k]]
                                        j=j+1
                        else:
                                j=j+1
        return new

def rmm(s,s1,dic,t):
        if len(s)==0:
                return s,t
        else:
                if len(s1)==1 or s1=="……" or s1=="——" or s1 in dic:
                        t.append(s1)
                        s=s[:len(s)-len(s1)]
                        rmm(s,s[-7:],dic,t)
                        return s,t
                else:
                        return rmm(s,s1[1:],dic,t)

            new=cut(new,dic)
```

f. Name Segmentation

After the word segmentation, the names in sentence will be cut into one letter by one letter. So we use a first name dictionary to find whether there is a first name. If the program finds a first name, it will judge whether the following two parts of this letter is also a letter and not in the blacklist. If yes or the following part is in the whitelist, the program will consider it as a name and make these separated letters together.

The related function source code is shown as follows:

```
def final(new,single_name,double_name,blacklist,whitelist):
    for i in range(len(new)):
        j=0
        while j <len(new[i]):
            if new[i][j] in double_name or new[i][j] in single_name:
                t=j
                j=j+1
                m=0
                p=0
                while m<2 and j<len(new[i]):
                    if len(new[i][j])==1 and new[i][j] not in blacklist:
                        j=j+1
                    elif new[i][j] in whitelist:
                        p=1
                        m=m+1
                        new[i][t:j+1]=[new[i][t]+new[i][t+1]]
                    else:
                        break
                    m=m+1
                j=j-1
                if j-t==1 and p==0:
                    new[i][t:j+1]=new[i][t]+new[i][t+1]
                    if j-t==2 and p==0:
                        new[i][t:j+1]=new[i][t]+new[i][t+1]+new[i][t+2]
                        j=j-2
                j=j+1
        return new
    new=final(new,single_name,double_name,blacklist,whitelist)
```

g. Combine

Since all the sentences have been cut into words, we have to combine them into a string preparing for the output and rectify. This is really easy.

The related function source code is shown as follows:

```
def combine(new):
    s=""
    for i in range(len(new)):
        for j in range(len(new[i])):
            s=s+new[i][j]+"|"
        s=s+"\n"
    return s
```

h. Rules and Rectify

We have prepared three kinds of rules for users to create to rectify the segmentation result. These rules can make one word into two parts, two parts into one word or move the segmentation symbol.

The related function source code is shown as follows:

```
def concat(old_word,s):
    if old_word in s:
        new_word=""
        for word in old_word:
            if word!="|":
                new_word+=word
        s=s.replace(old_word,new_word)
    return s
```

```
def divide(old_word,position,s):
    if old_word in s:
        new_word=old_word[:position]+"|"+old_word[position:]
        s=s.replace(old_word,new_word)
    return s

def slide(old_word,direction,length,s):
    if old_word in s:
        if direction=="left":
            length=-length
        new_word=""
        for word in old_word:
            if word!="|":
                new_word+=word
        n=old_word.find("|")
        if 0<n+length<len(new_word):
            new_word=new_word[:n+length]+"|"+new_word[n+lengt
h:]
            s=s.replace(old_word,new_word)
        else:
            return s
    return s
```

5) Demo and Testing Result

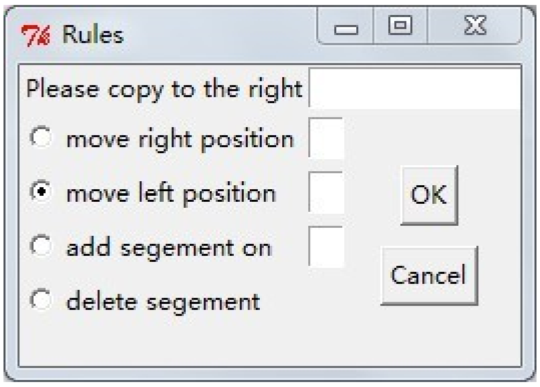
a. Testing

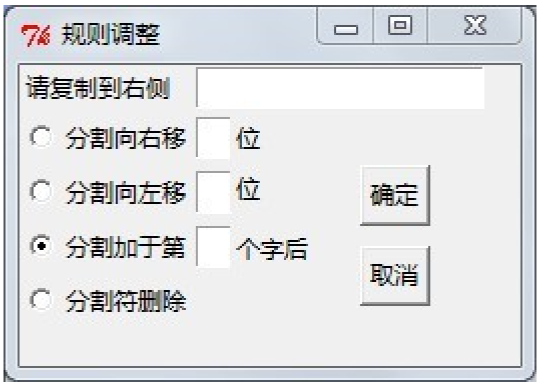
We use an article from Expo website to test our program. The result is shown as follows:

```
世博网|10|月|31|日|消息|：|
展现|城市|生活|美好|前景|，|
开启|人类|文明|崭新|篇章|。|
中国|2010|年|上海|世界|博览会|闭幕式|31|日|晚|在|上海|世博|文化|中心|隆重
|举行|。|
国务院|总理|温家宝|出席|闭幕式|并|宣布|上海|世博会|闭幕|。|
国际|展览局|主席|蓝峰|，|
来自|世界|各地|的|领导|人和|贵宾|出席|闭幕式|，|
共同|庆祝|上海|世博会|取得|圆满|成功|。|
上海|世博会|是|继|北京|奥运会|后|我国|举办|的|又|一|国际|盛会|，|
也是|第|一|次|在|发展中国家|举办|的|注册|类|世界|博览会|。|
本届|世博会|的|主题|是|“|城市|，|
让|生活|更|美好|”|。|
自|5|月|1|日|开幕|以来|，|
来自|246|个|国家|、|国际|组织|的|参展|方|，|
通过|展示|、|论坛|、|表演|等|形式|，|
一起|探讨|城市|未来|发展|前景|，|
共同|谱写|了|一|曲|人类|文明|和谐|共生|的|激情|乐章|，|
生动|诠释|了|“|理解|、|沟通|、|欢聚|、|合作|”|的|世博|理念|。|
浦江|两岸|灯火|璀璨|，|
申城|之|夜|流光溢彩|。|
造型|宛若|飞碟|的|上海|世博|文化|中心|内|，|
8000|多|名|观众|欢聚一堂|。|
当|时针|指向|20|时|，|
上|百|名|天真烂漫|的|少年|儿童|手|持|绚丽|的|花束|和|花环|走|上|舞台|中央
|，|
组成|喜庆|的|花坛|。|
两侧|台阶|上|，|
200|多|位|少女|手|执|世博会|参展|国家|和|国际|组织|的|旗帜|，|
整齐|站立|。|
舞台|旁|，|
中华人民共和国|国旗|和|国际|展览局|旗|、|上海|世博会|旗|高高|飘扬|。|
```

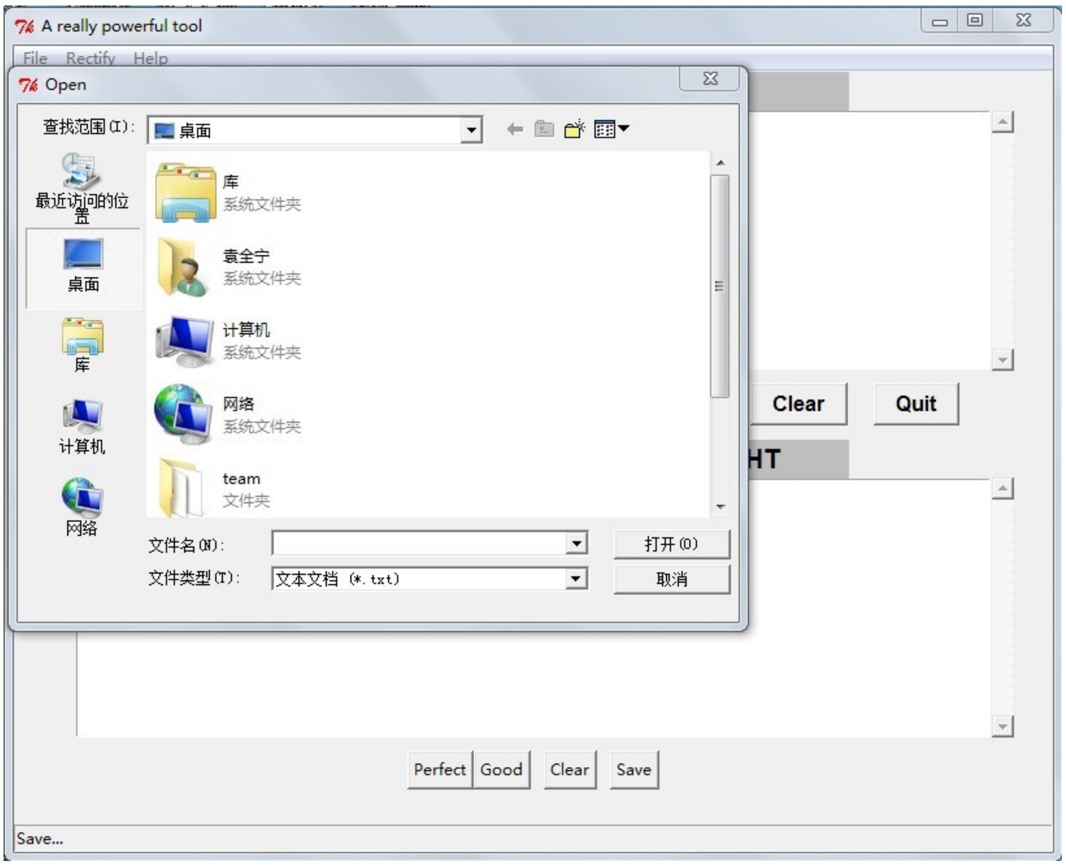
From this result, we can see that the names are be separated correctly such as “蓝峰” which doesn’t exist in the dictionary. So the name function does work and is really wonderful. Because of the incomplete lexicon, the “会旗” cannot be separated which leads a mistake. So we will keep refining the lexicon and make it complete.

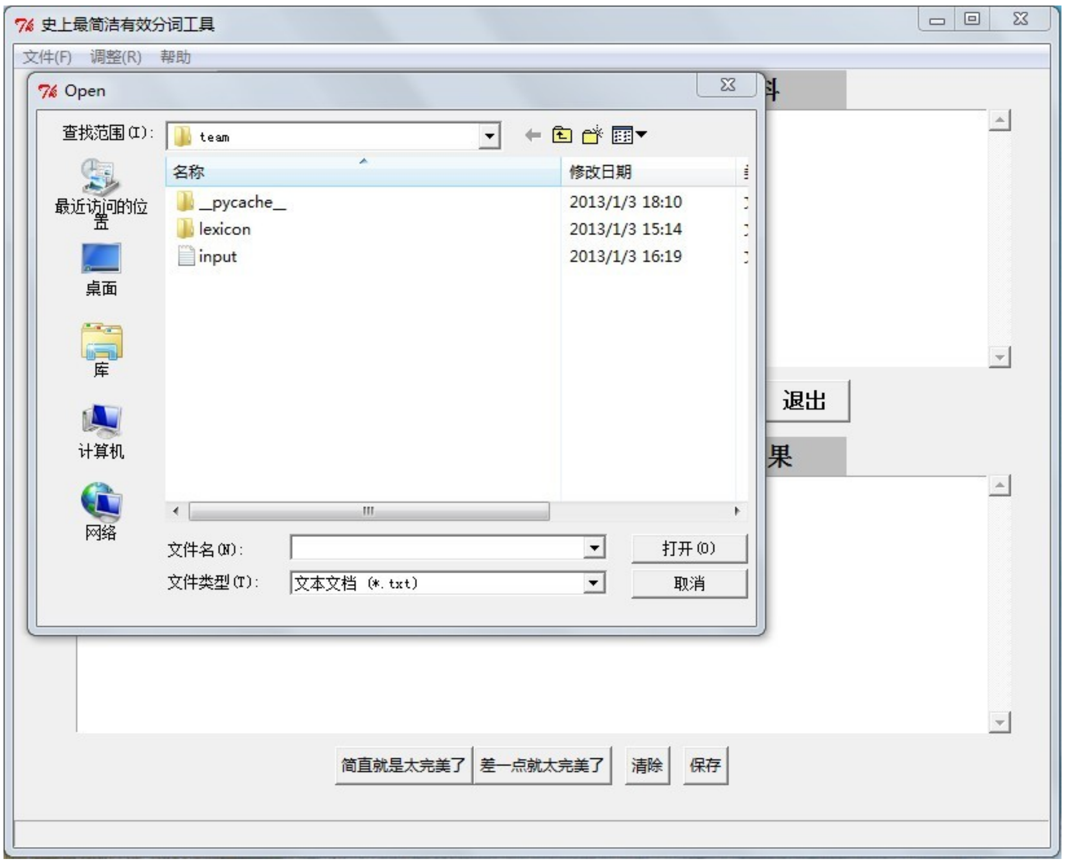
b. Screenshots


Rules
Please copy to the right
move right position
move left position
add segement on
delete segement
OK
Cancel

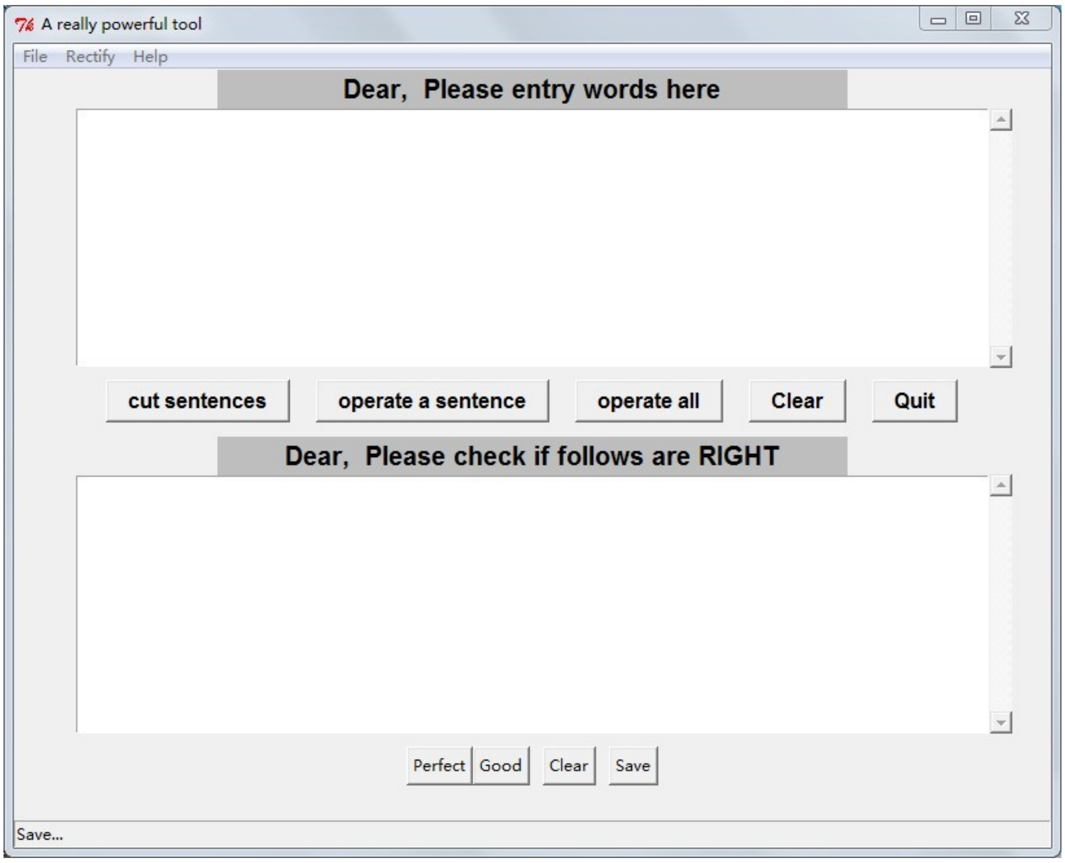

规则调整
请复制到右侧
分割向右移 位
分割向左移 位
分割加于第 个字后
分割符删除
确定
取消

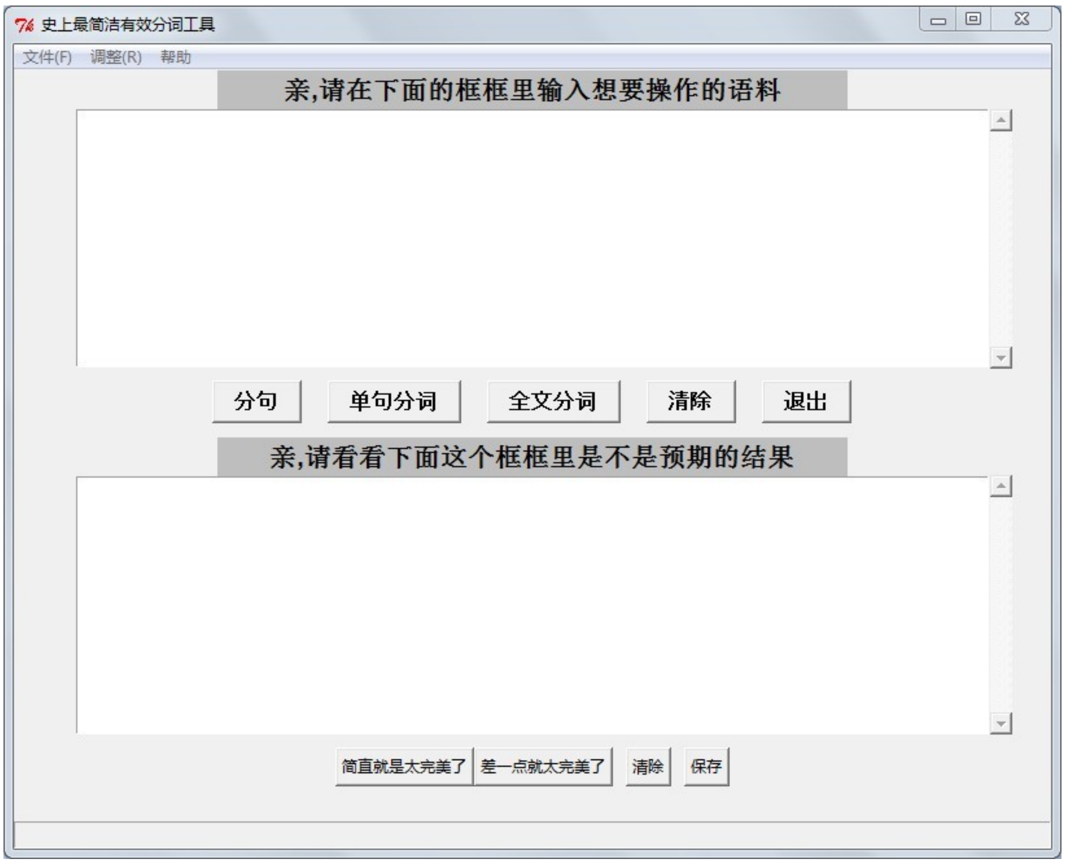
Add a rule


A really powerful tool
File Rectify Help
Open
查找范围(I): 桌面
最近访问的位置
桌面
库
计算机
网络
库 系统文件夹
袁全宁 系统文件夹
计算机 系统文件夹
网络 系统文件夹
team 文件夹
文件名(N):
文件类型(T): 文本文档 (*.txt)
打开(O)
取消
Clear
Quit
HT
Perfect
Good
Clear
Save
Save...

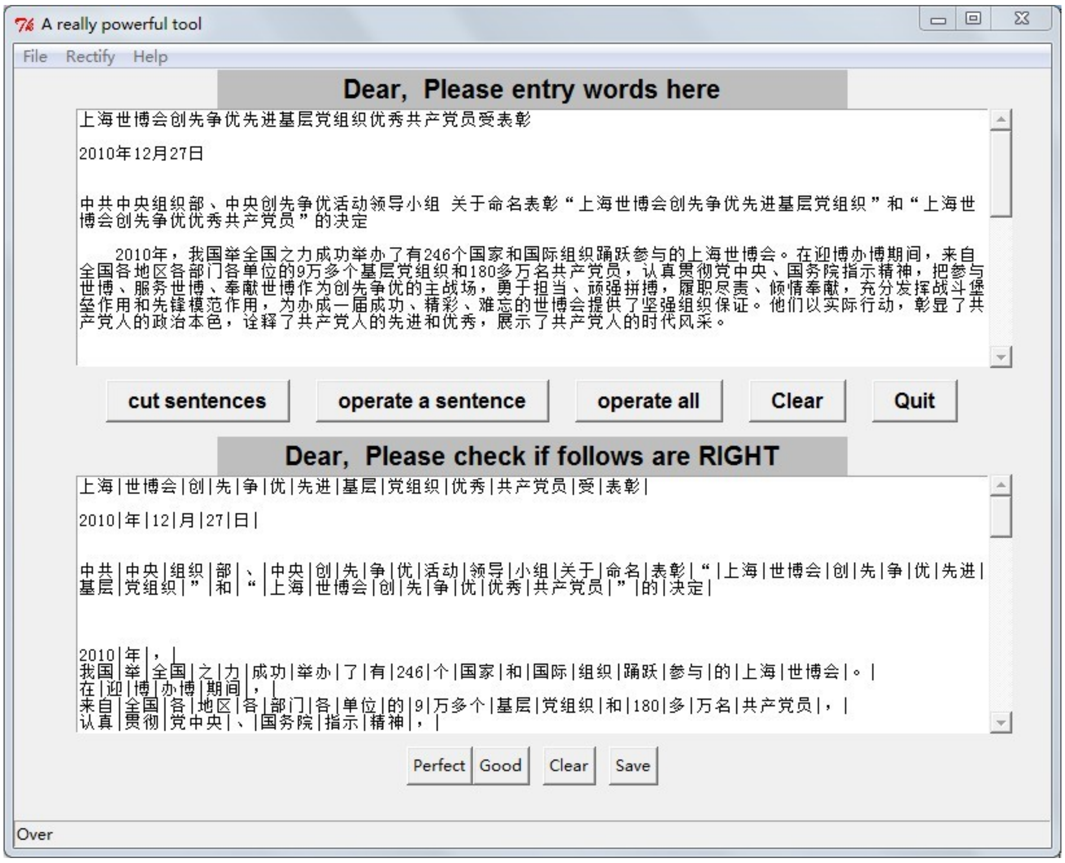

史上最简洁有效分词工具
文件(F) 调整(R) 帮助
Open
查找范围(I): team
名称 修改日期
__pycache__ 2013/1/3 18:10
lexicon 2013/1/3 15:14
input 2013/1/3 16:19
最近访问的位置
桌面
库
计算机
网络
文件名(N):
文件类型(T): 文本文档 (*.txt)
打开(O)
取消
退出
果
简直就是太完美了
差一点就太完美了
清除
保存

Load a file


A really powerful tool
File Rectify Help
Dear, Please entry words here
cut sentences
operate a sentence
operate all
Clear
Quit
Dear, Please check if follows are RIGHT
Perfect
Good
Clear
Save
Save...



The initial



上海世博会创先争优先进基层党组织优秀共产党员受表彰

2010年12月27日

中共中央组织部、中央创先争优活动领导小组 关于命名表彰“上海世博会创先争优先进基层党组织”和“上海世博会创先争优优秀共产党员”的决定

　　2010年，我国举全国之力成功举办了有246个国家和国际组织踊跃参与的上海世博会。在迎博办博期间，来自全国各地区各部门各单位的9万多个基层党组织和180多万名共产党员，认真贯彻党中央、国务院指示精神，把参与世博、服务世博、奉献世博作为创先争优的主战场，勇于担当、顽强拼搏，履职尽责、倾情奉献，充分发挥战斗堡垒作用和先锋模范作用，为办成一届成功、精彩、难忘的世博会提供了坚强组织保证。他们以实际行动，彰显了共产党人的政治本色，诠释了共产党人的先进和优秀，展示了共产党人的时代风采。

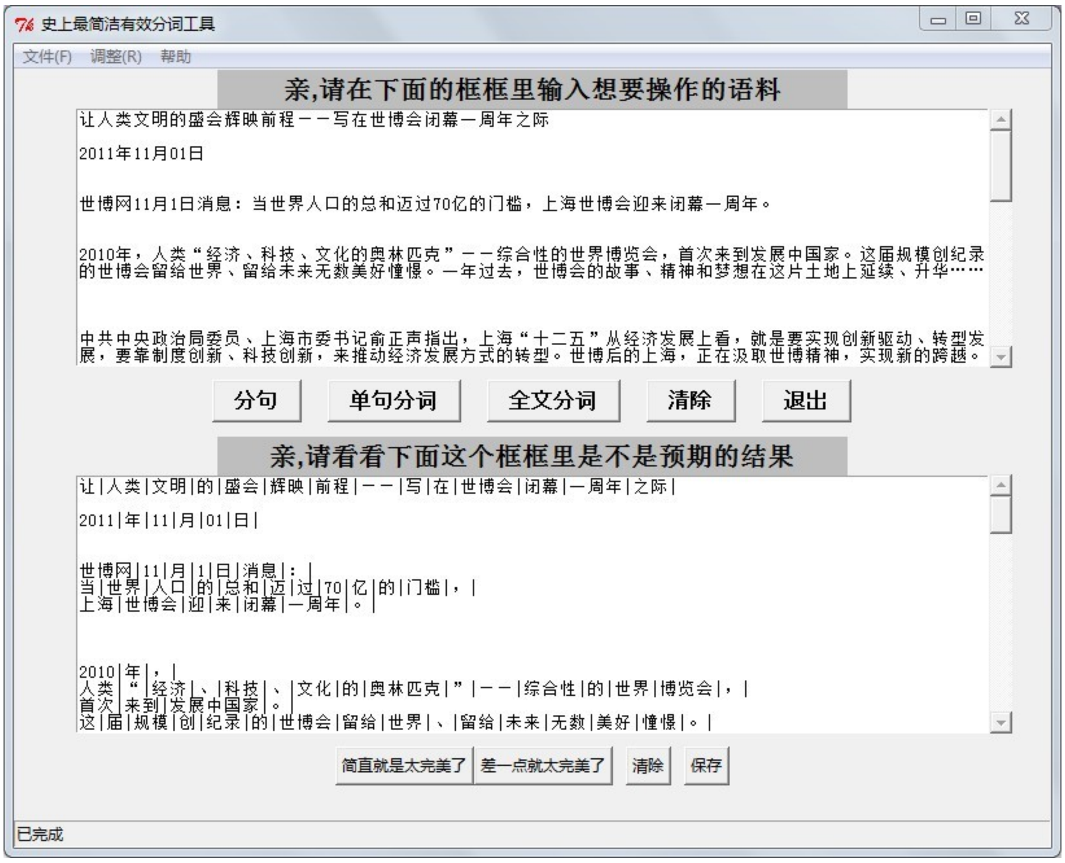
```
上海|世博会|创|先|争|优|先进|基层|党组织|优秀|共产党员|受|表彰|

2010|年|12|月|27|日|


中共|中央|组织|部|、|中央|创|先|争|优|活动|领导|小组|关于|命名|表彰|“|上海|世博会|创|先|争|优|先进|
基层|党组织|”|和|“|上海|世博会|创|先|争|优|优秀|共产党员|”|的|决定|



2010|年|，|
我国|举|全国|之|力|成功|举办|了|有|246|个|国家|和|国际|组织|踊跃|参与|的|上海|世博会|。|
在|迎|博|办博|期间|，|
来自|全国|各|地区|各|部门|各|单位|的|9|万多个|基层|党组织|和|180|多|万名|共产党员|，|
认真|贯彻|党中央|、|国务院|指示|精神|，|
```



```
让人类文明的盛会辉映前程——写在世博会闭幕一周年之际

2011年11月01日

世博网11月1日消息：当世界人口的总和迈过70亿的门槛，上海世博会迎来闭幕一周年。

2010年，人类“经济、科技、文化的奥林匹克”——综合性的世界博览会，首次来到发展中国家。这届规模创纪录
的世博会留给世界、留给未来无数美好憧憬。一年过去，世博会的故事、精神和梦想在这片土地上延续、升华……

中共中央政治局委员、上海市委书记俞正声指出，上海“十二五”从经济发展上看，就是要实现创新驱动、转型发
展，要靠制度创新、科技创新，来推动经济发展方式的转型。世博后的上海，正在汲取世博精神，实现新的跨越。
```

```
让|人类|文明|的|盛会|辉映|前程|——|写|在|世博会|闭幕|一周年|之际|

2011|年|11|月|01|日|

世博网|11|月|1|日|消息|：|
当|世界|人口|的|总和|迈|过|70|亿|的|门槛|，|
上海|世博会|迎|来|闭幕|一周年|。|

2010|年|，|
人类|“|经济|、|科技|、|文化|的|奥林匹克|”|——|综合性|的|世界|博览会|，|
首次|来到|发展中国家|。|
这|届|规模|创|纪录|的|世博会|留给|世界|、|留给|未来|无数|美好|憧憬|。|
```

The result

6) Conclusion and Comments

By three word segmentation procedures, we can get a good result and separate most of names right. This is what we most satisfied with. But how to improve the program to make it better is a little bit difficult. On one hand, a good lexicon is really important, so we have to keep refining it. On the other hand, we should consider the performance and try to make it run faster.

During making this program, we succeeded in almost everything except two things. One is multiprocessing; the other is packaging the program into exe file. Although we have learnt many knowledge from the Internet, that is not enough. When we tried to use multiprocessing to make our program faster, at the first time, we failed because we cannot terminate the new process which leaded the computer down; at the second time, we failed because we found that using multiprocessing is slower. So it shows that we still have much to learn.

a. From Chen Zhen

I’m the designer and the code writer of this program. This project really challenges my logical and algorithm designing ability which also improves my thinking method. At first, I thought name segmentation may be difficult. But at last, I just make it only with my brain. And as a team leader, I learn that distributing tasks to each team member and setting an appropriate deadline so that they will spend time working on the project is quite important. This team project is really meaningful.

b. From Yuan Quanning

In this project, I learn something important. In our team, we rely on each other and help each other. Though each of us has our independent task, we also solve some problems together. What's more, I practiced the knowledge that I learned in the class. We used many functions in the program, and I practiced using different of types of data. The most important is that I learned that we write a program is not only to solve a problem but also to let people use it conveniently. To think as a user is what we should notice and to be a good programmer is not to solve the problem but to serve the people.

c. From Li Jianda

In this team, I take charge of the interface part. By doing this, I learned not only the knowledge about Python Tkinter, but how to complete a program with a team as well. Solving a problem in team is nothing like doing it by oneself. In a team, communication is the most important thing. Without communication, we can’t combine what we have done respectively to a whole thing. I really enjoy the time working with my teammates. Thank you all for giving me such a wonderful experience.

d. From Liu Baichen

In the team project, I do the work about lexicon. The lexicon is easy to get but hard to optimize. I spend most time in optimizing the lexicon. I write some program to delete space blank, English words, numbers and punctuations. And then I check the words one after another to see whether it is appropriate. For instance, “踢球” should be separate, and “诚实守信” should be separate as “诚实” and “守信” . Maybe it is a physical work. But it is really tiring. Everyone has made a contribution to our team project. We are all really nice and we are confident in our team project!