深度学习与自然语言处理

以软件仓库挖掘为例

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智能服務與軟件工程中心
Center for Intelligent Services and Software Engineering

A.自然语言处理发展历程

B.深度学习与自然语言处理

C.自然语言处理与软件仓库挖掘

自然语言处理

第一阶段：20世纪50年代到70年代

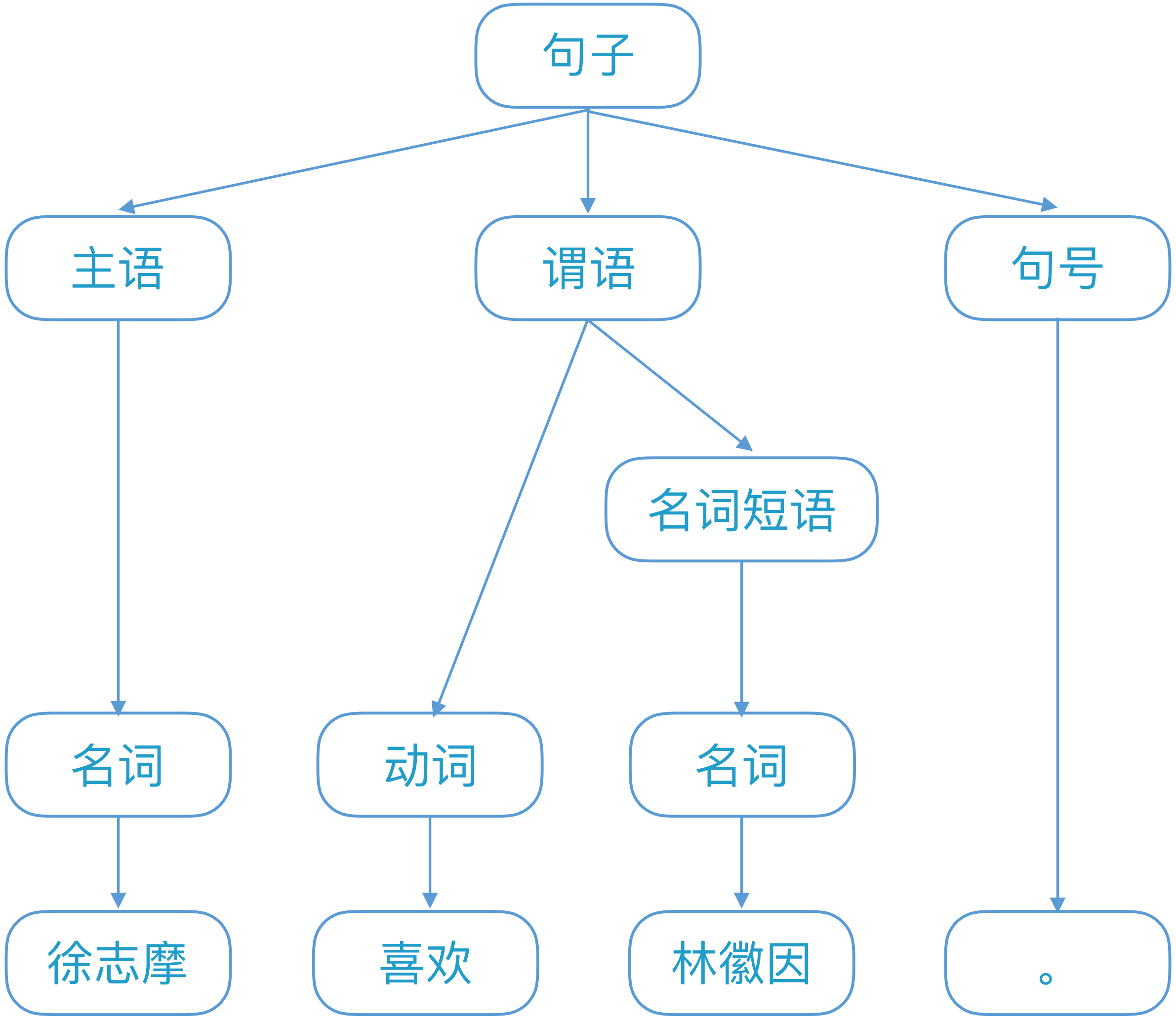
要让机器完成翻译或者语音识别等只有人来才能做的事情

1.就必须先让计算机理解自然语言

2.而做到这一点就必须让计算机拥有类似我们人类这样的智能

第一阶段：20世纪50年代到70年代

徐志摩喜欢林徽因



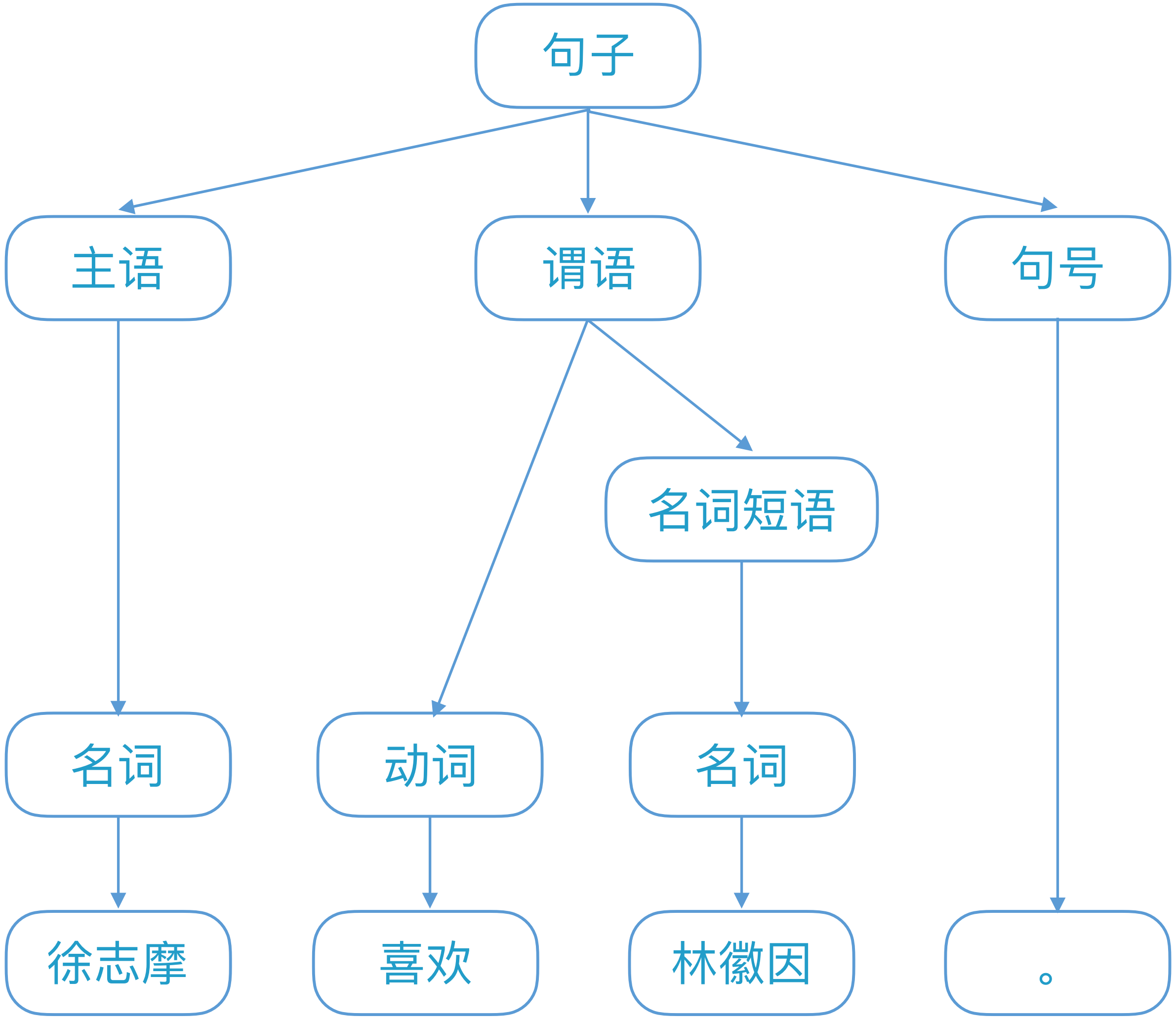
A

自然语言处理

第一阶段：20世纪50年代到70年代

徐志摩喜欢林徽因

美联储主席本-伯南克昨天告诉媒体7000亿美元的救助资金将借给上百家银行、保险公司和汽车公司。 ?



A 自然语言处理

第一阶段：20世纪50年代到70年代

The pen is in the box → 笔在盒子里

The box is in the pen → 盒子在笔里 ？

A 自然语言处理

第一阶段：20世纪50年代到70年代

The pen is in the box → 笔在盒子里

The box is in the pen → 盒子在笔里 ?

盒子在围栏里 !

第二阶段：20世纪70年代以后
从规则到统计

弗里德里克.贾里尼克

IBM华生实验室

Frederick Jelinek (18 November 1932 – 14 September 2010)

A

自然语言处理

第二阶段：20世纪70年代以后
从规则到统计

1.美联储主席本-伯南克昨天告诉媒体7000亿美元的救助资金将借给上百家银行、保险公司和汽车公司。

2.本-伯南克美联储主席昨天7000亿美元的救助资金告诉媒体将借给银行、保险公司和汽车公司上百家。

3.联储美主席南克告助资金将借本-伯给上司和汽车公司昨天诉媒体7000亿百家美元的救银行、保险公。

A

自然语言处理

第二阶段：20世纪70年代以后 从规则到统计

一个句子是否合理，就看它的可能性大小如何

1.美联储主席本-伯南克昨天告诉媒体7000亿美元的救助资金将借给上百家银行、保险公司和汽车公司。 10^{-20}

2.本-伯南克美联储主席昨天7000亿美元的救助资金告诉媒体将借给银行、保险公司和汽车公司上百家。 10^{-25}

3.联储美主席南克告助资金将借本-伯给上司和汽车公司昨天诉媒体7000亿百家美元的救银行、保险公。 10^{-70}

第二阶段：20世纪70年代以后
从规则到统计

一个句子是否合理，就看它的可能性大小如何

假定S表示一个有意义的句子

$S = (w_1, w_2, w_3, w_4, w_5, w_6 \ldots\ldots w_n)$

n为句子长度

$$P(S) = P(w_1, w_2, w_3, w_4, w_5, w_6 \ldots\ldots w_n)$$

↓

$$P(S) = P(w_1)P(w_2|w_1)P(w_3|w_1,w_2) \ldots\ldots P(w_n,|w_1,w_2,w_3,\ldots w_{n-1})$$

第二阶段：20世纪70年代以后
从规则到统计

一个句子是否合理，就看它的可能性大小如何

俄国数学家马尔可夫(Andrey Markov)

马尔可夫假设:

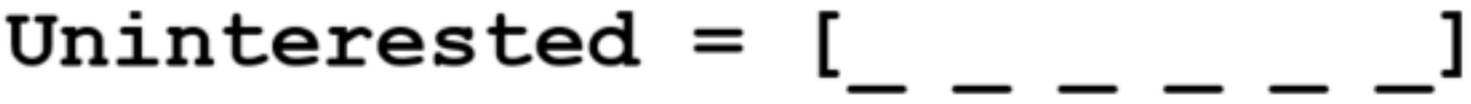
假设任意一个词w_i出现的概率只同它前面的词w_{i-1}有关

$$P(S)=P(w_1)P(w_1|w_2)P(w_3|w_2)\ldots P(w_n|w_{n-1})$$

深度学习与自然语言处理

深度学习，从基本的层面来说是表征学习

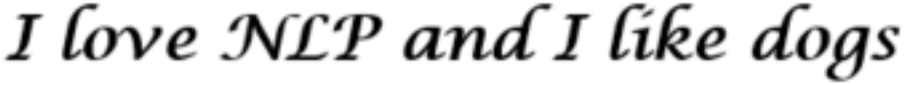
我们要将每一个单词都表征为一个d维向量



Uninterested = [_ _ _ _ _ _]

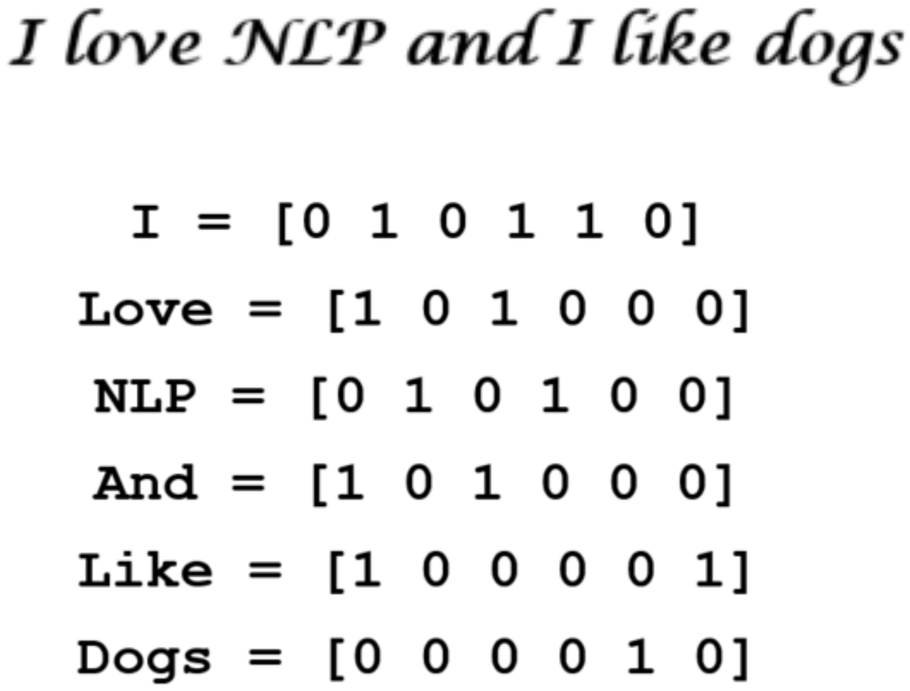
我们希望通过填写值的方式可以让向量表征词，以及词的语境、意思或者语音

建立一个共生矩阵(concurrence matrix)



I love NLP and I like dogs

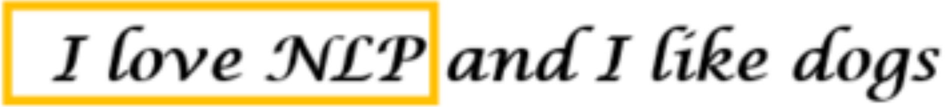
建立一个共生矩阵(concurrence matrix)



I love NLP and I like dogs

```
   I  = [0 1 0 1 1 0]
 Love = [1 0 1 0 0 0]
 NLP  = [0 1 0 1 0 0]
 And  = [1 0 1 0 0 0]
 Like = [1 0 0 0 0 1]
 Dogs = [0 0 0 0 1 0]
```

建立一个共生矩阵(concurrence matrix)



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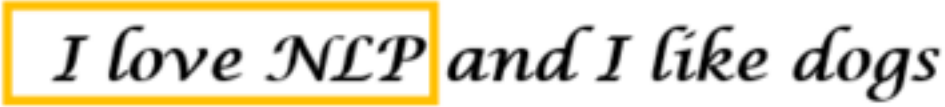
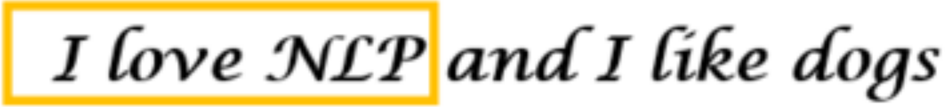


I love NLP and I like dogs

$$J(\theta) = \frac{1}{T}\sum_{t=1}^{T}\sum_{-m\leq j\leq m, j\neq 0} \log p(w_{t+j}|w_t)$$

Word2Vec

建立一个共生矩阵(concurrence matrix)



I love NLP and I like dogs

$$X_{shirt} - X_{clothing} \approx X_{chair} - X_{furniture}$$

$$X_{king} - X_{man} \approx X_{queen} - X_{woman}$$

循环神经网络(RNN)

循环神经网络(RNN) Why?

循环神经网络(RNN) Why?

Finding Structure in Time

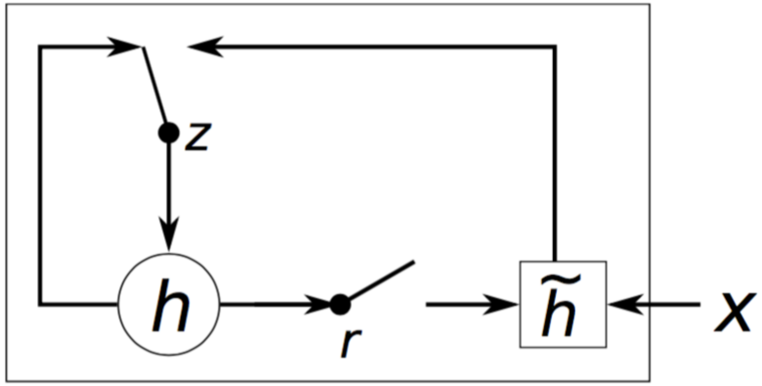
循环神经网络(RNN) Why?

- Finding Structure in Time

Other NNs’ drawbacks

- The input should be presented all at once
- The input layer must provide for the longest possible pattern

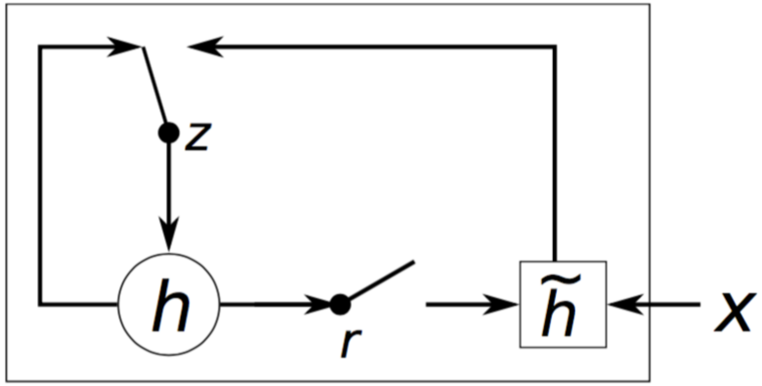
循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)



传统RNN中
隐藏状态向量是通过该公式计算的

$$h_t = f\left(W^{(hh)}h_{t-1} + W^{(hx)}x_t\right)$$

循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)



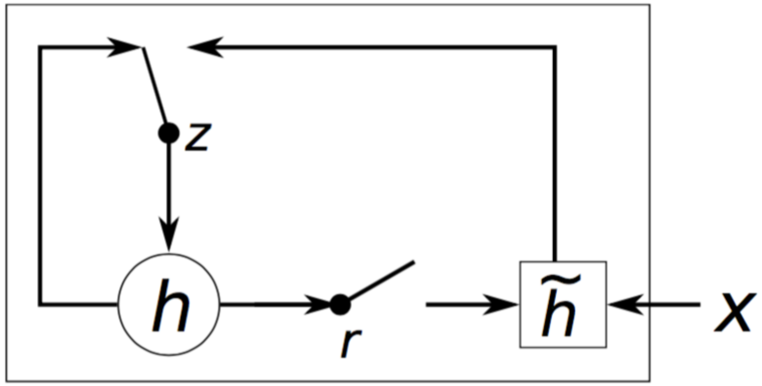
GRU提供

一个更新门(update gate) — z

一个重置门(reset gate) — r

一个新的记忆存储器(memory container) — h’

循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)

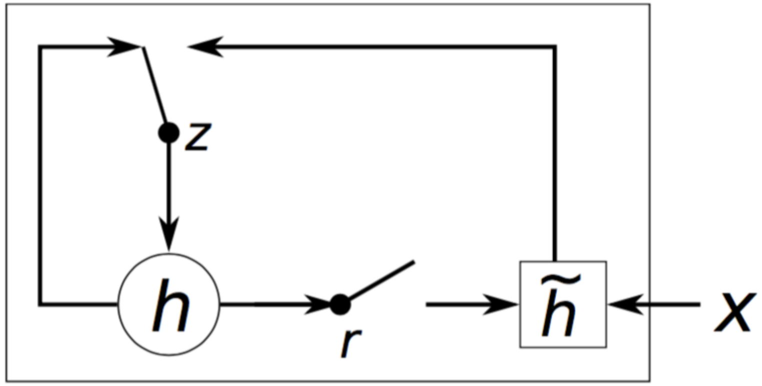


$$z_t = \sigma\left(W^{(z)}x_t + U^{(z)}h_{t-1}\right)$$

$$r_t = \sigma\left(W^{(r)}x_t + U^{(r)}h_{t-1}\right)$$

$$\tilde{h}_t = \tanh\left(Wx_t + r_t \circ Uh_{t-1}\right)$$

循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)

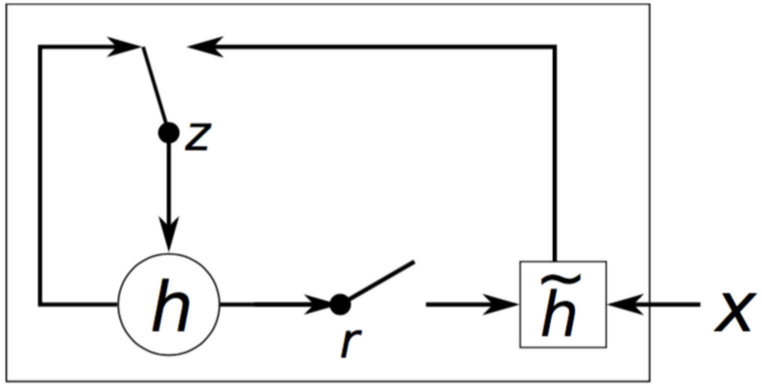


$$h_t = f\left(W^{(hh)}h_{t-1} + W^{(hx)}x_t\right)$$

$$\Downarrow$$

$$h_t = z_t \circ h_{t-1} + (1 - z_t) \circ \tilde{h}_t$$

循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)



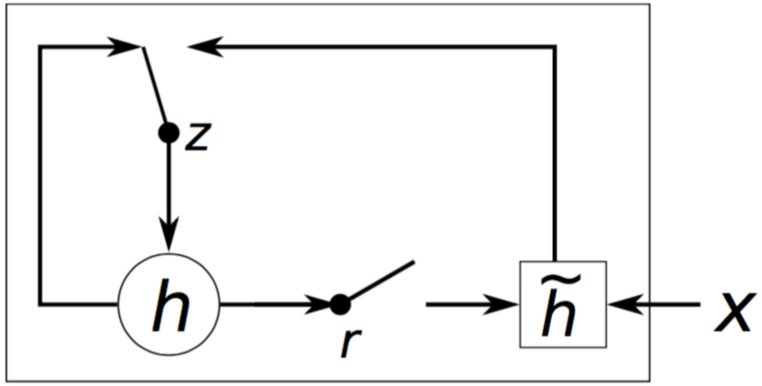
$$h_t = z_t \circ h_{t-1} + (1 - z_t) \circ \tilde{h}_t$$

更新门

如果zt趋向于1，ht就完全忽略现在的词向量，仅仅是复制前隐藏状态。

如果zt趋向于0，ht就完全忽略前一时间步骤的隐藏状态，仅仅只依赖于新的记忆存储器。

循环神经网络(RNN)
门控循环单元(gated recurrent unit / GRU)



$$h_t = z_t \circ h_{t-1} + (1 - z_t) \circ \tilde{h}_t$$

重置门

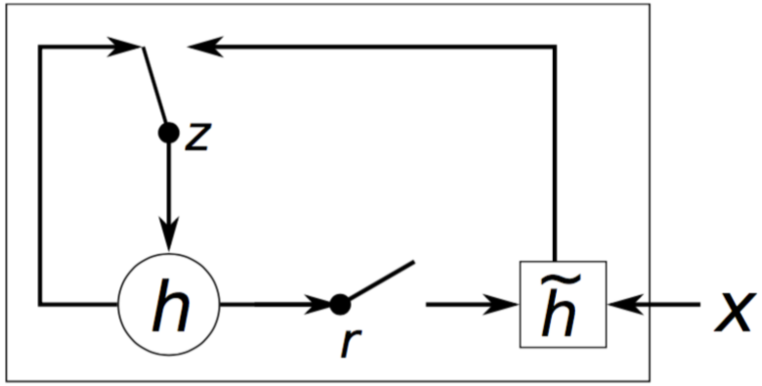
如果rt趋向于1，记忆存储器将保持前一隐藏状态的信息。

如果rt趋向于0，记忆存储器将忽略前一隐藏状态的信息。

此门控能允许模型丢弃一些对未来不相干的信息。

循环神经网络(RNN)

RNN Encoder-Decoder



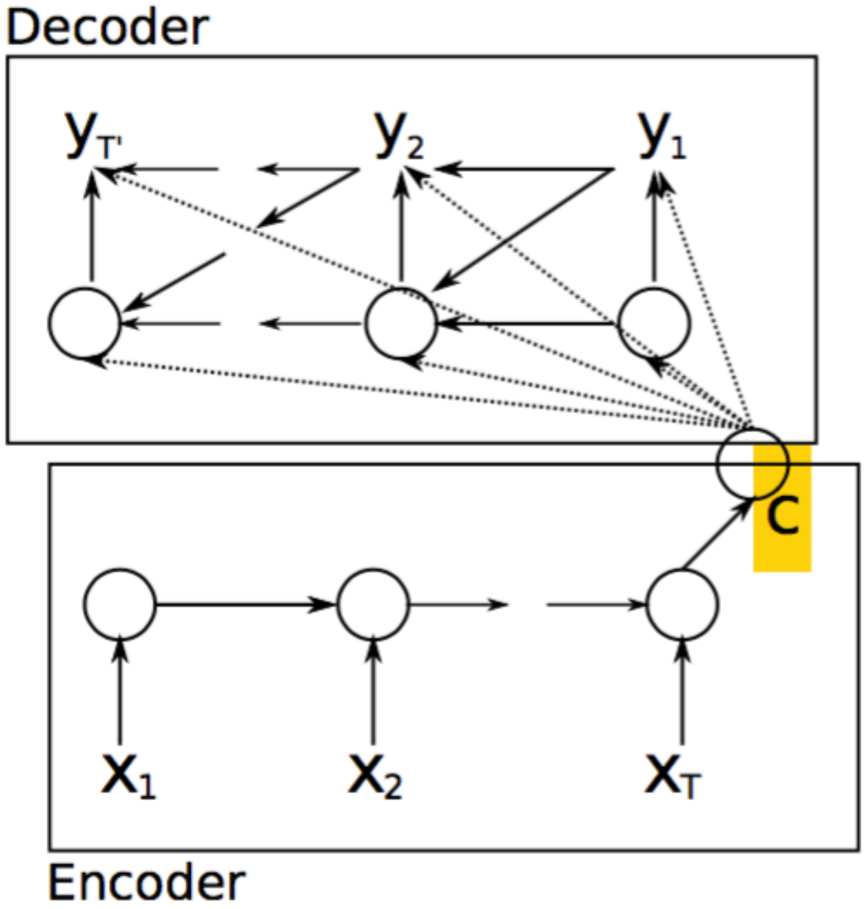
$$h_t = z_t \circ h_{t-1} + (1 - z_t) \circ \tilde{h}_t$$

Those units that learn to capture *short-term* dependencies will tend to have *reset gates* that are frequently active.

But those that capture *longer-term* dependencies will have *update gates* that are mostly active.

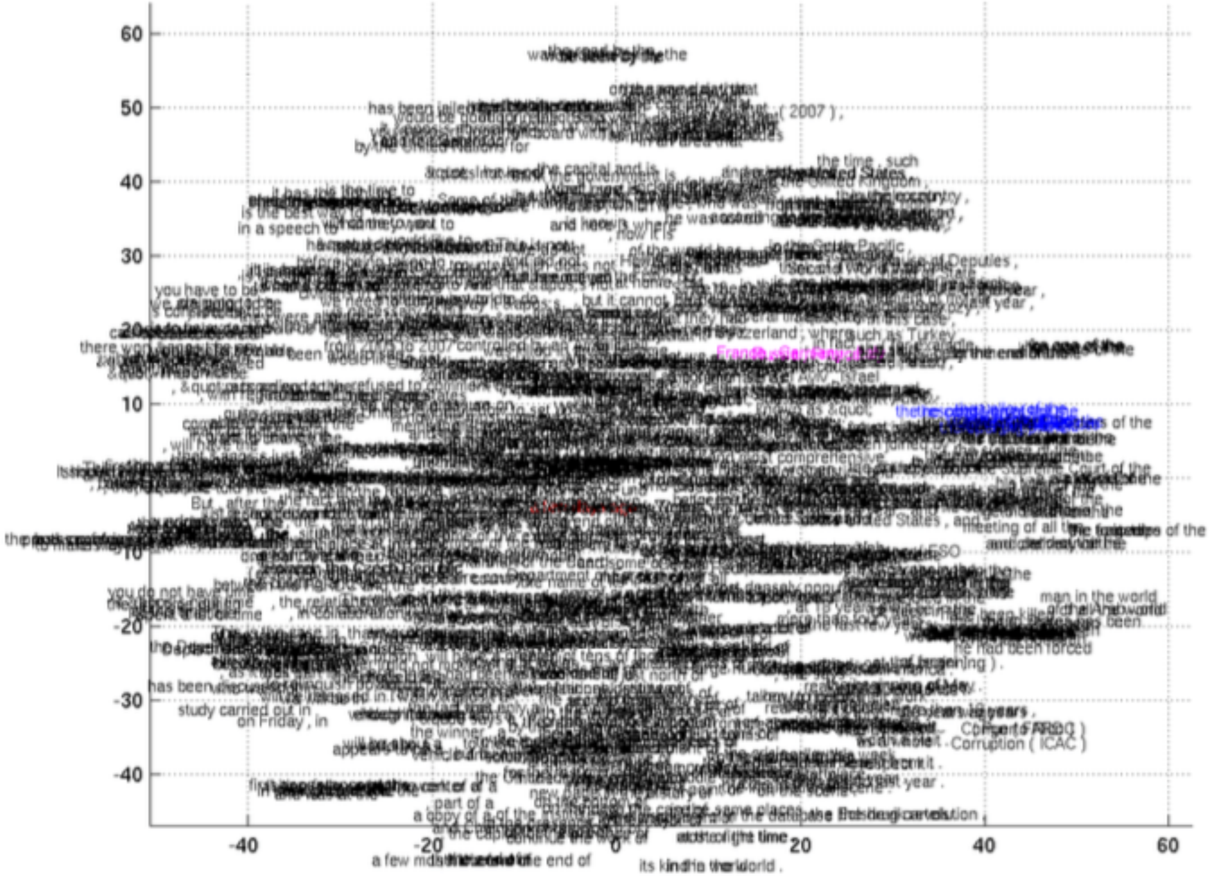
循环神经网络(RNN)
RNN Encoder-Decoder

It learns to encode a variable-length sequence into a fixed-length vector representation and to decode a given fixed-length vector representation back into a variable-length sequence.



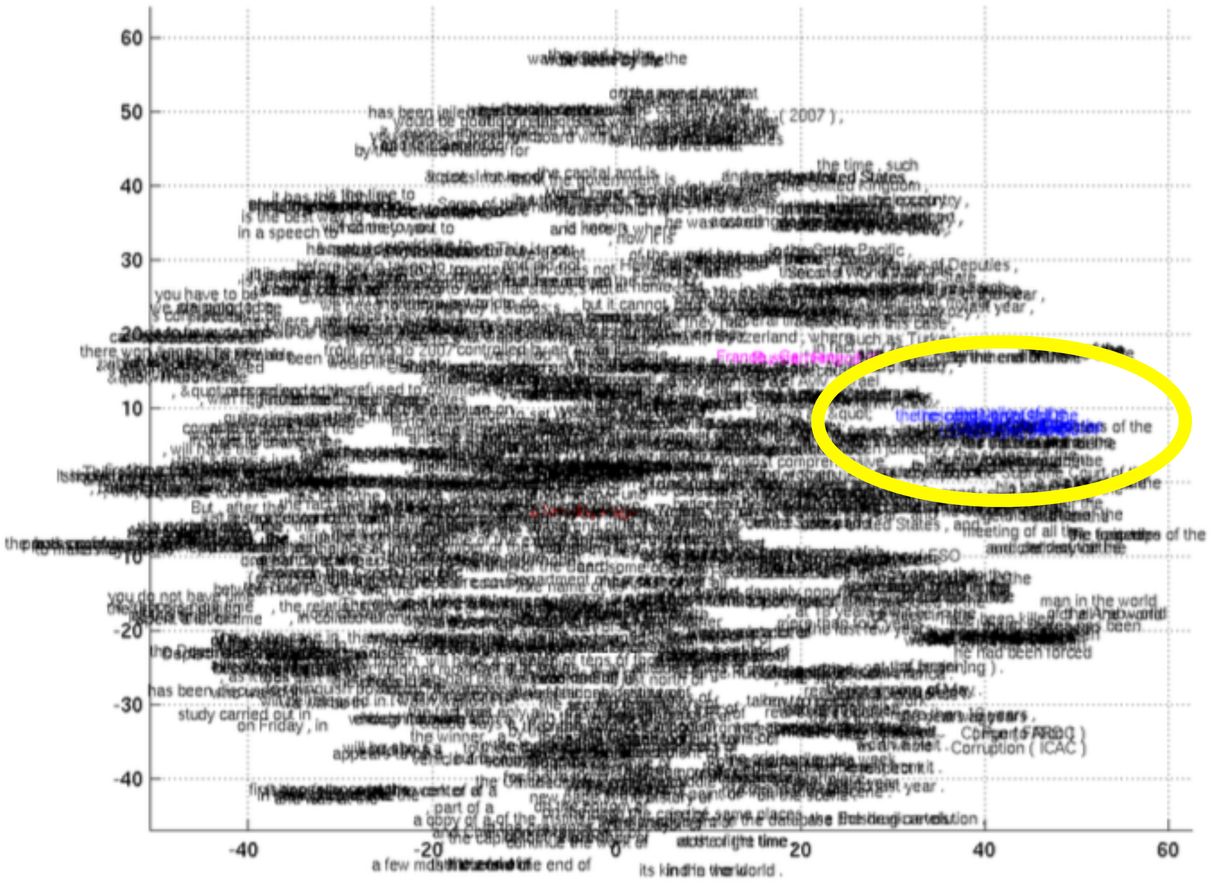
B

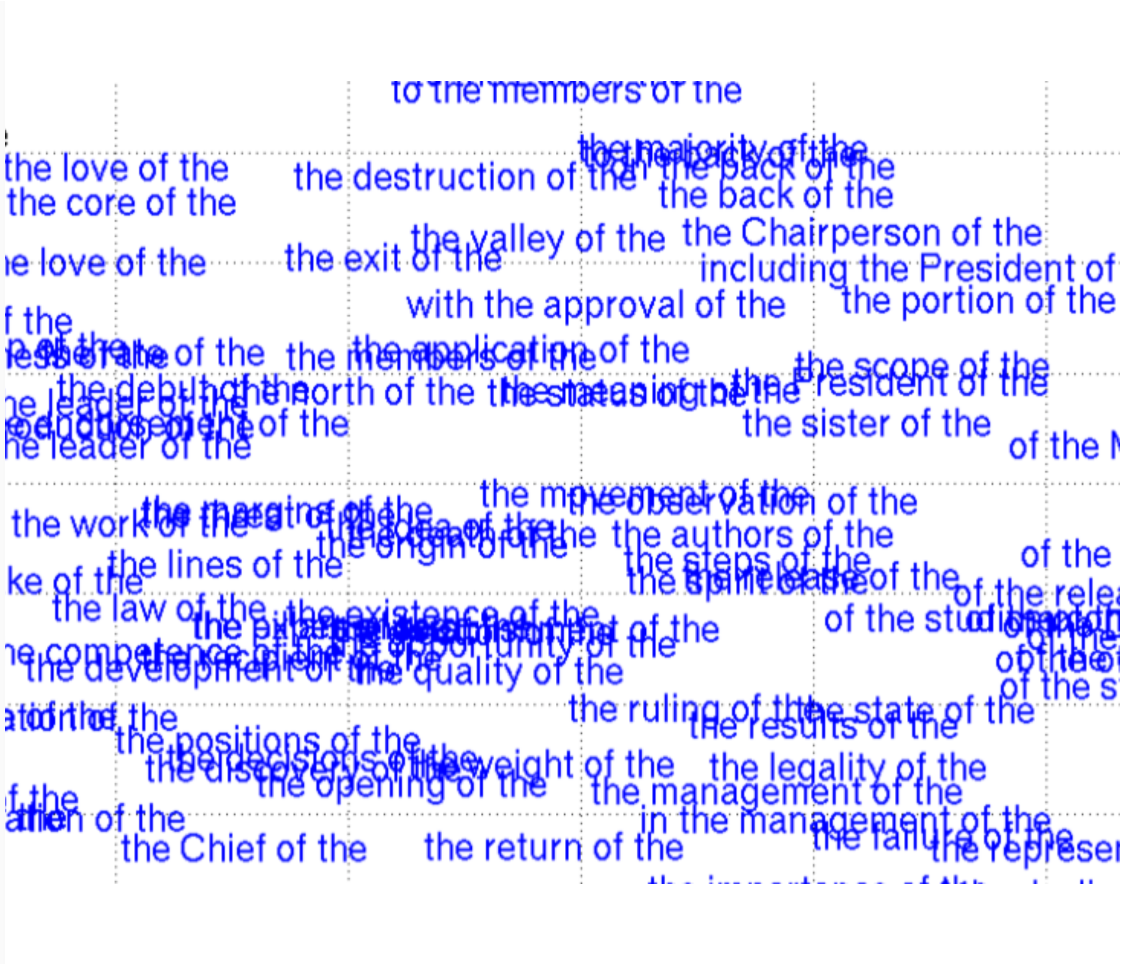
深度学习与自然语言处理



B

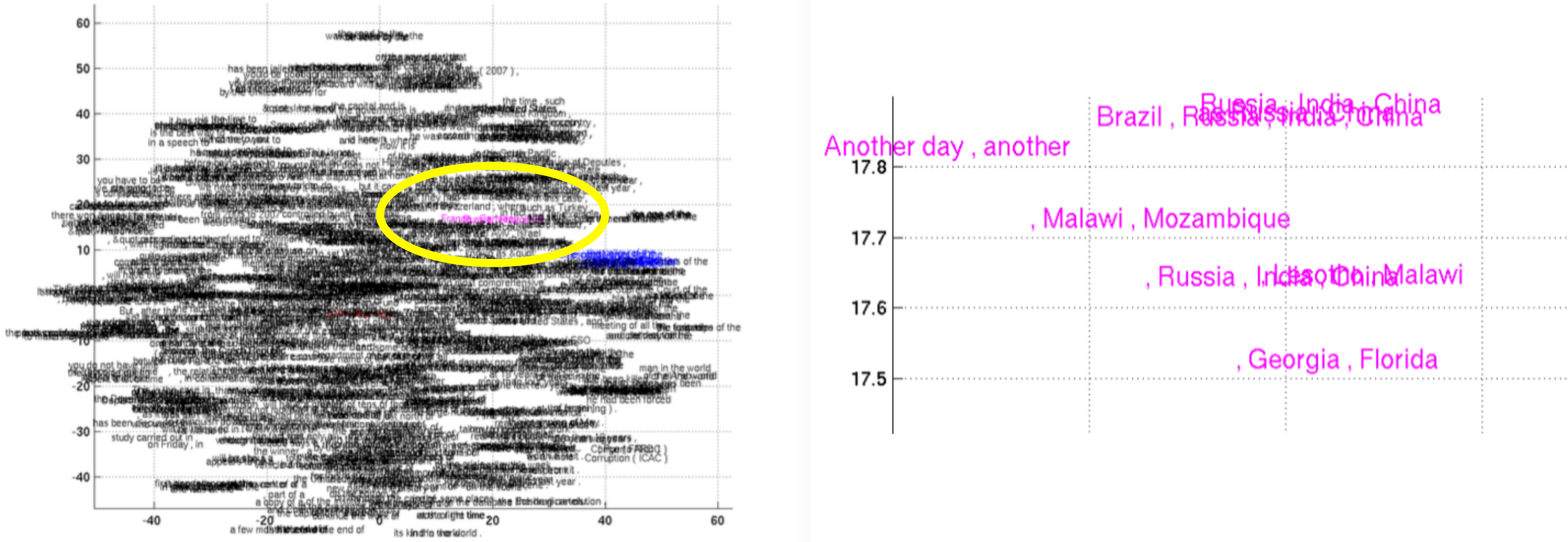
深度学习与自然语言处理





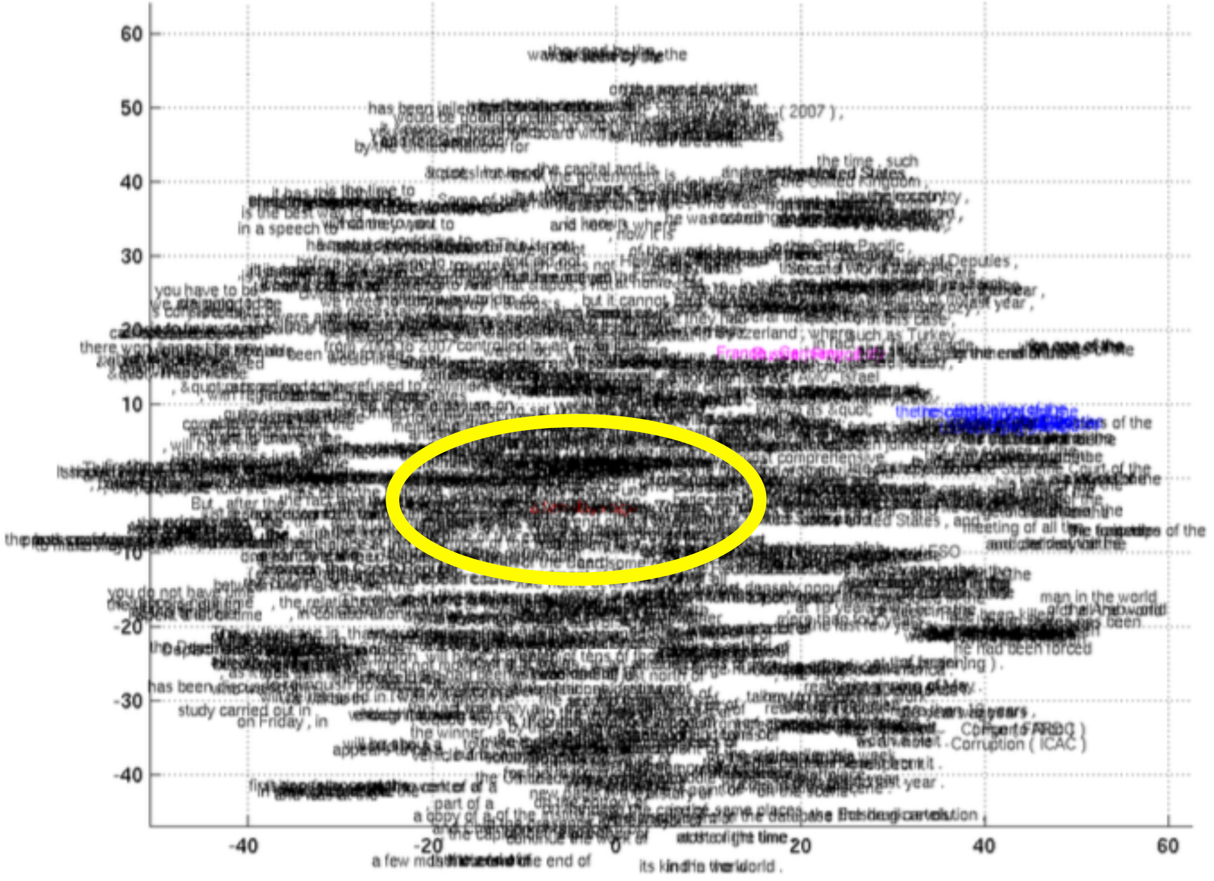
B

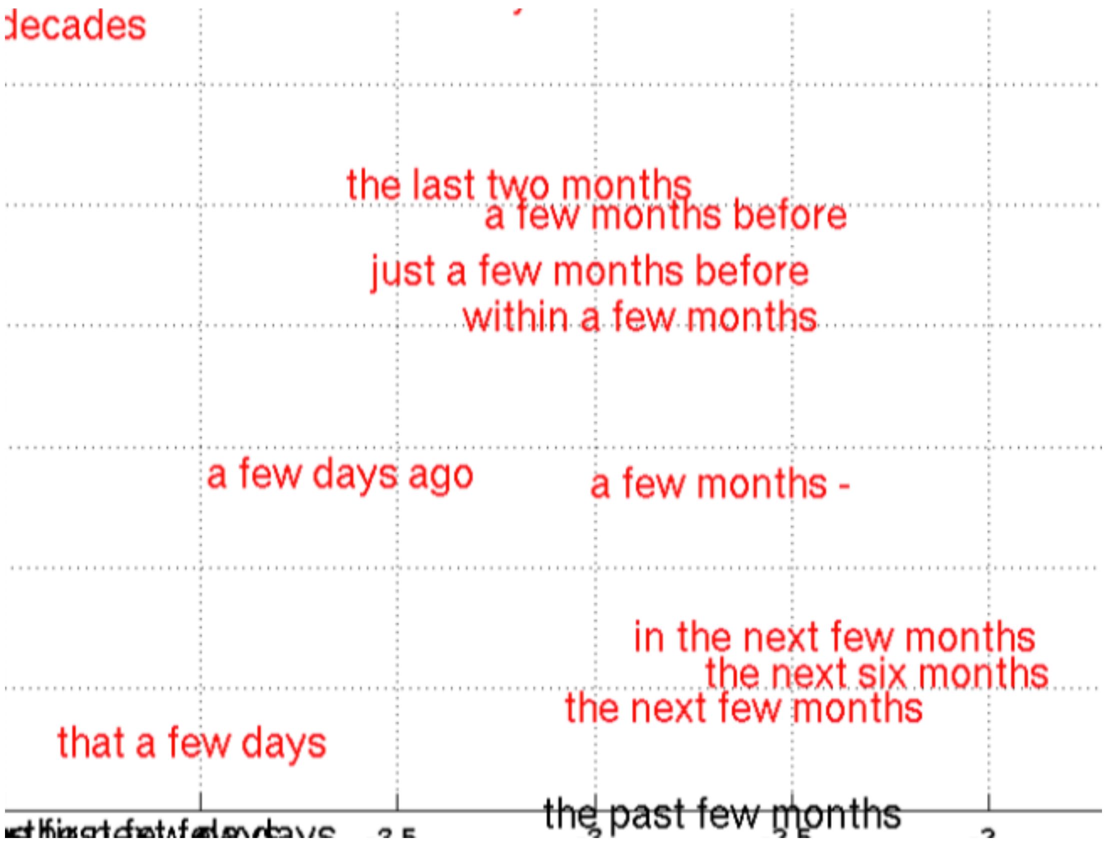
深度学习与自然语言处理



B

深度学习与自然语言处理



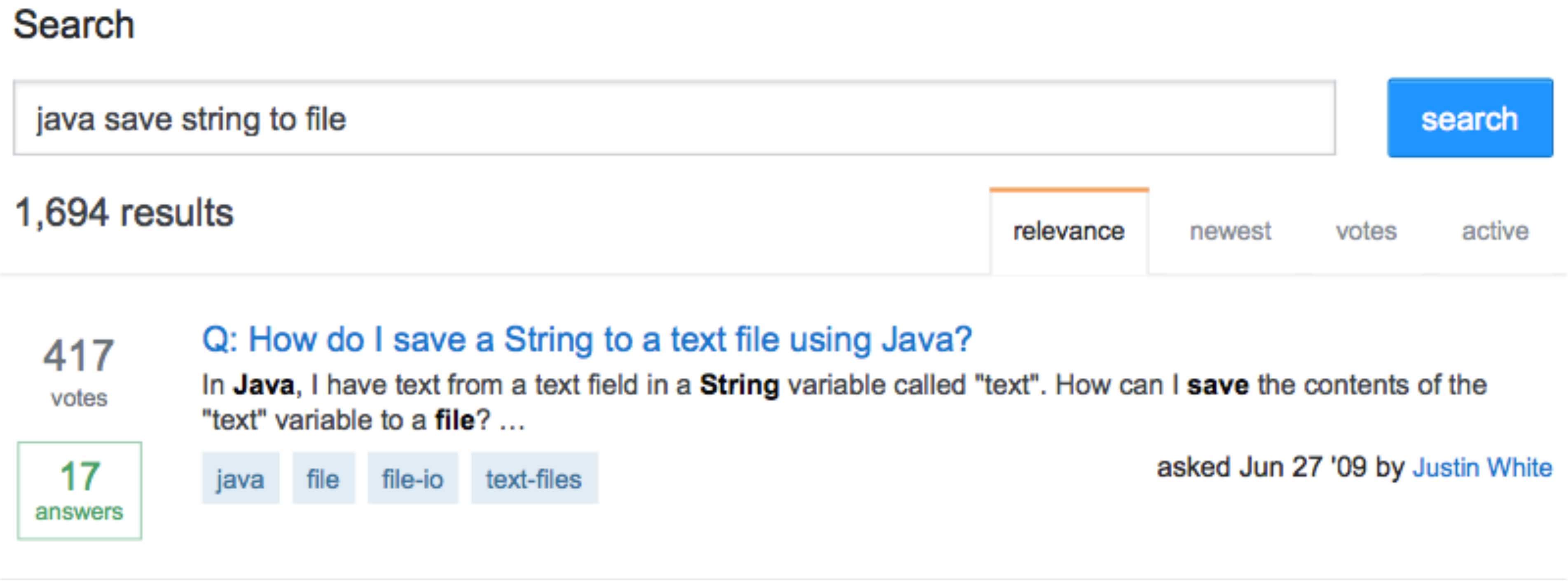


软件仓库挖掘

API Learning

C

软件仓库挖掘—API Learning



Search

java save string to file

1,694 results

417 votes

17 answers

Q: How do I save a String to a text file using Java?

In **Java**, I have text from a text field in a **String** variable called "text". How can I **save** the contents of the "text" variable to a **file**? ...

java file file-io text-files

asked Jun 27 '09 by Justin White

C

软件仓库挖掘—API Learning

Search engines based on keyword matching

common places to discover APIs and their usage sequences:

Google, Bing, Baidu

Stack Overflow, GitHub

Search engines based on keyword matching

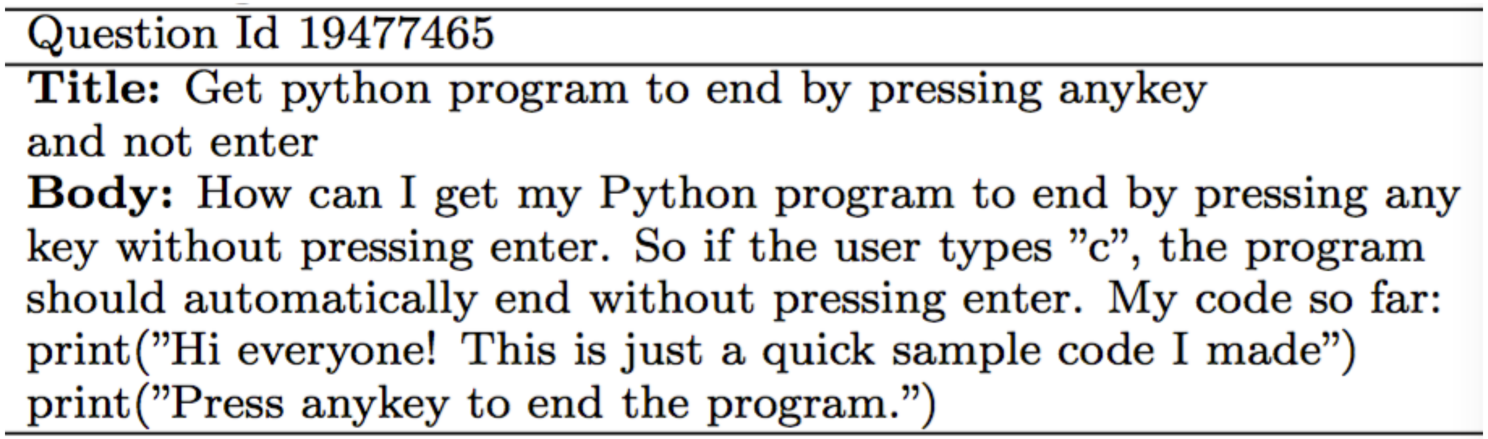
Drawbacks: Inefficient and inaccurate for programming tasks

Need to manually examine many web pages

Ignore the semantics of natural language queries.

C

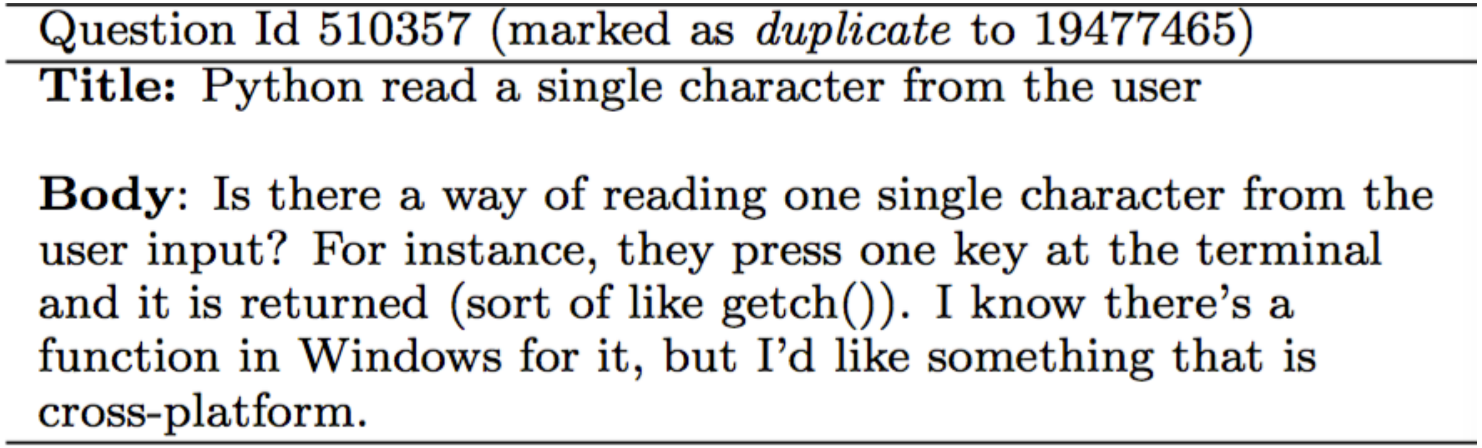
软件仓库挖掘—API Learning



Question Id 19477465

Title: Get python program to end by pressing anykey and not enter

Body: How can I get my Python program to end by pressing any key without pressing enter. So if the user types ”c”, the program should automatically end without pressing enter. My code so far:
print(”Hi everyone! This is just a quick sample code I made”)
print(”Press anykey to end the program.”)



Question Id 510357 (marked as *duplicate* to 19477465)

Title: Python read a single character from the user

Body: Is there a way of reading one single character from the user input? For instance, they press one key at the terminal and it is returned (sort of like getch()). I know there’s a function in Windows for it, but I’d like something that is cross-platform.

Code Search

McMillan retrieves and visualise relevant functions and their usages

W.-K.Chan model API invocations as an API graph
find an connected subgraph that has high textual similarity with the query phrases

Mining API Usage Patterns

Xie et al. proposed MAPO, which represents source code as call sequences and clusters them according to similarity heuristics such as method names

Fowkes Proposed a probabilistic algorithm for mining the most informative and parameter-free API call patterns

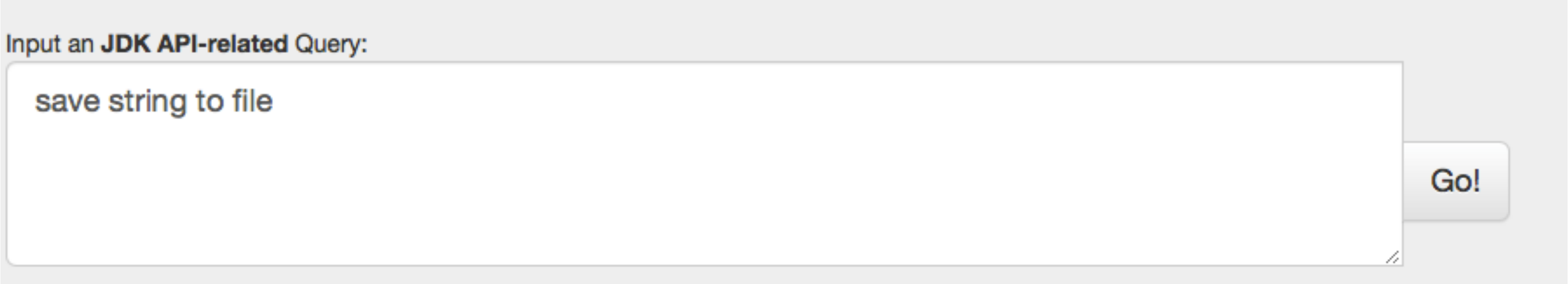
Deep API Learning

It does not rely on information retrieval techniques and can understand word sequences and query semantics.

It constructs a neural language model to learn usage patterns.

C

Deep API Learning

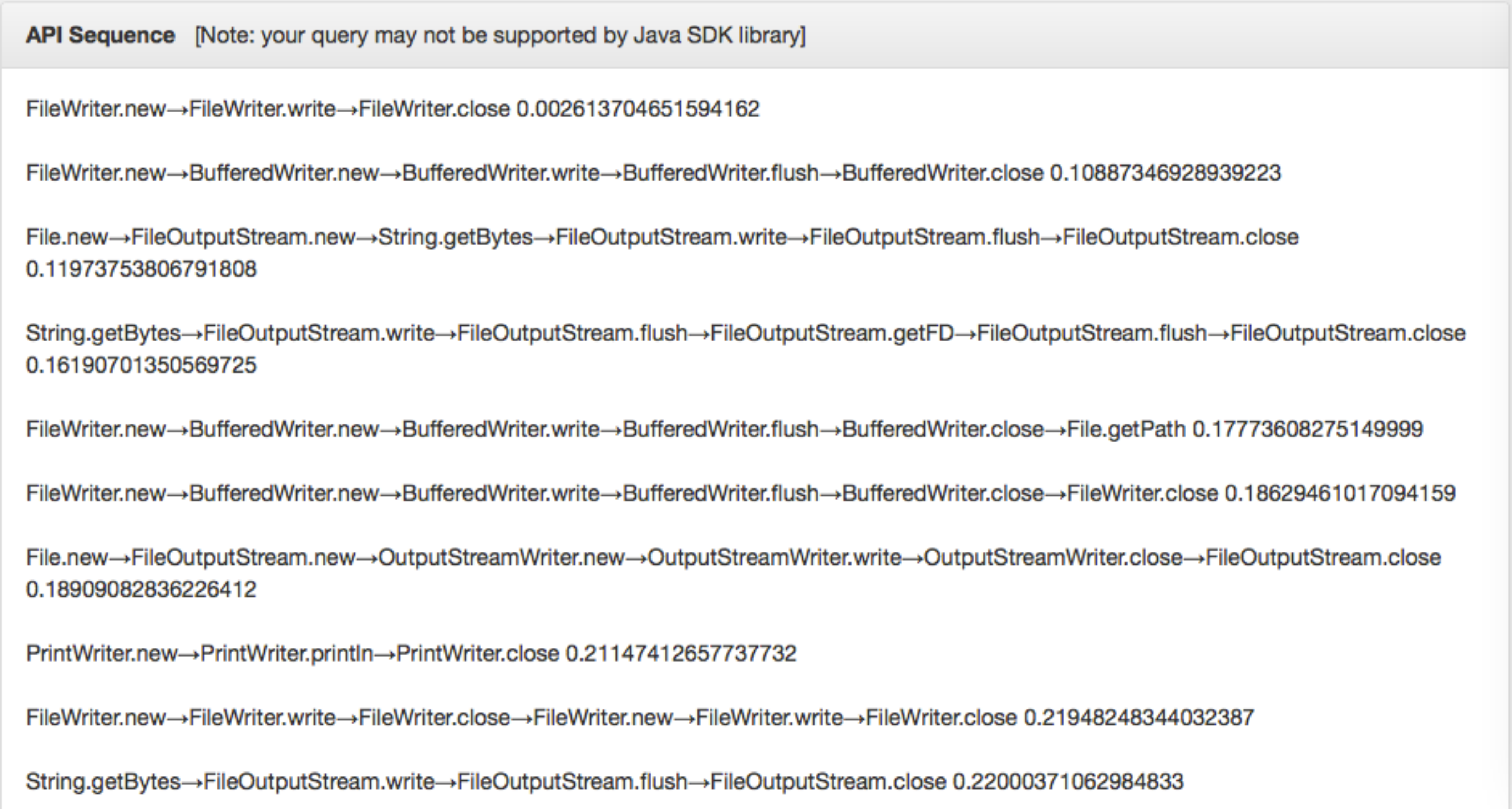


Input an **JDK API-related** Query:

save string to file

C

软件仓库挖掘—API Learning



API Sequence [Note: your query may not be supported by Java SDK library]

FileWriter.new→FileWriter.write→FileWriter.close 0.002613704651594162

FileWriter.new→BufferedWriter.new→BufferedWriter.write→BufferedWriter.flush→BufferedWriter.close 0.10887346928939223

File.new→FileOutputStream.new→String.getBytes→FileOutputStream.write→FileOutputStream.flush→FileOutputStream.close 0.11973753806791808

String.getBytes→FileOutputStream.write→FileOutputStream.flush→FileOutputStream.getFD→FileOutputStream.flush→FileOutputStream.close 0.16190701350569725

FileWriter.new→BufferedWriter.new→BufferedWriter.write→BufferedWriter.flush→BufferedWriter.close→File.getPath 0.17773608275149999

FileWriter.new→BufferedWriter.new→BufferedWriter.write→BufferedWriter.flush→BufferedWriter.close→FileWriter.close 0.18629461017094159

File.new→FileOutputStream.new→OutputStreamWriter.new→OutputStreamWriter.write→OutputStreamWriter.close→FileOutputStream.close 0.18909082836226412

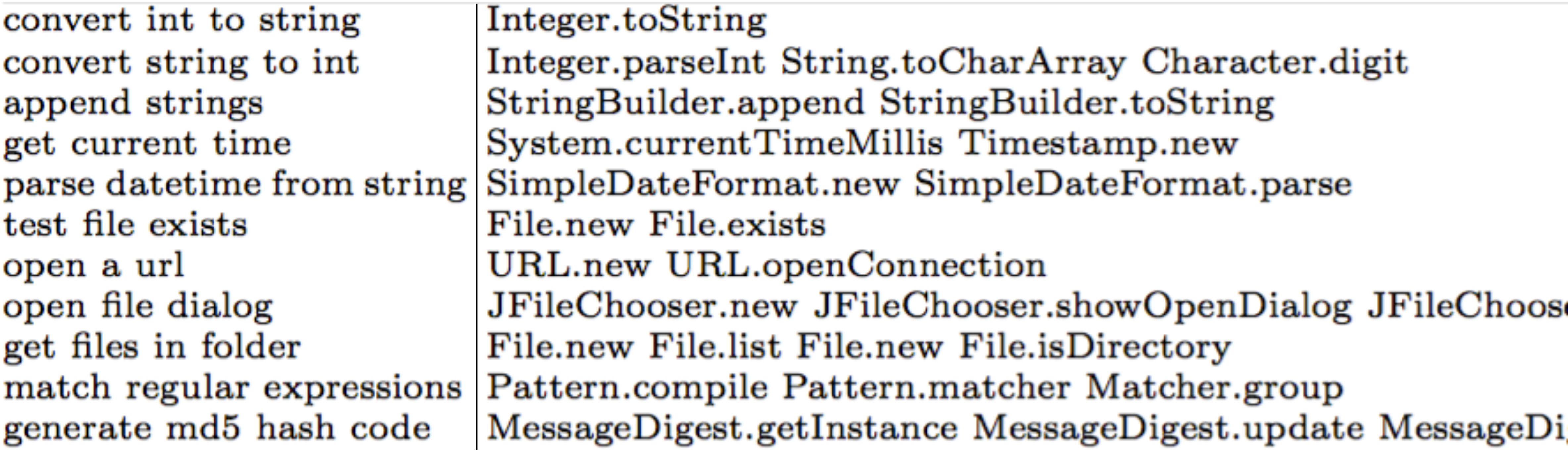
PrintWriter.new→PrintWriter.println→PrintWriter.close 0.21147412657737732

FileWriter.new→FileWriter.write→FileWriter.close→FileWriter.new→FileWriter.write→FileWriter.close 0.21948248344032387

String.getBytes→FileOutputStream.write→FileOutputStream.flush→FileOutputStream.close 0.22000371062984833

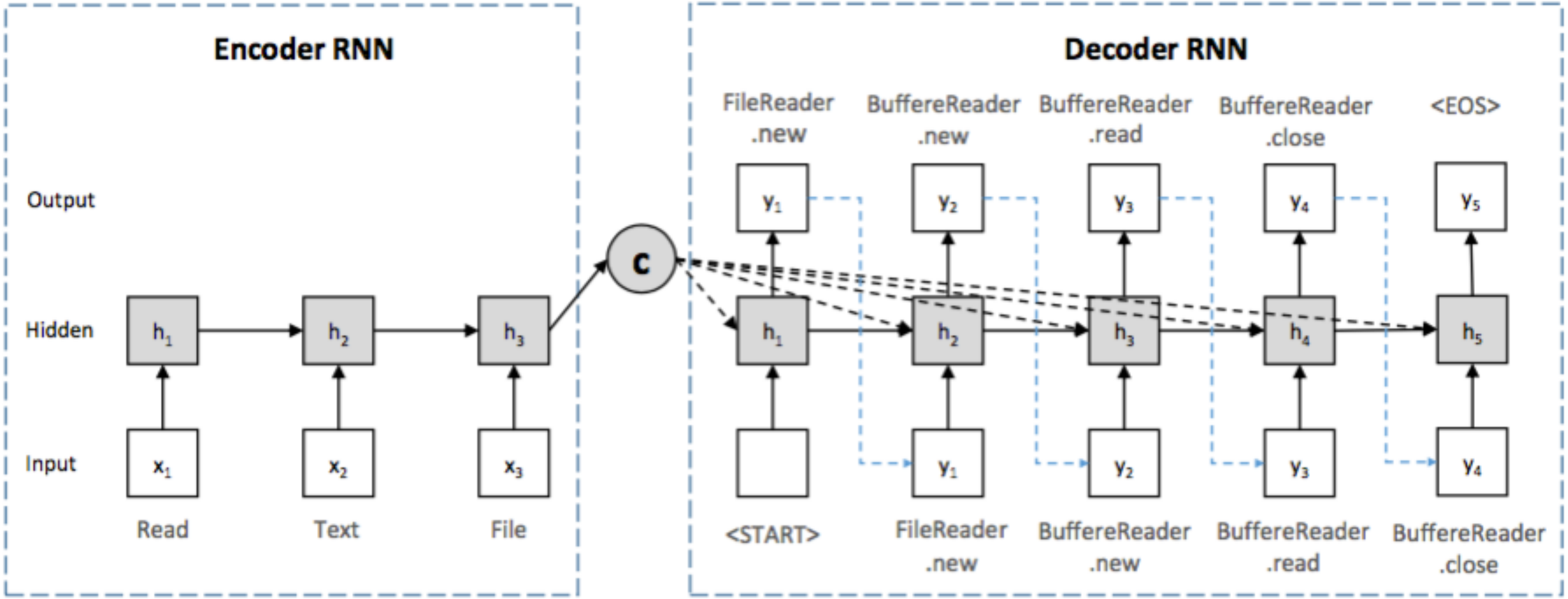
C

软件仓库挖掘—API Learning



convert int to string	Integer.toString
convert string to int	Integer.parseInt String.toCharArray Character.digit
append strings	StringBuilder.append StringBuilder.toString
get current time	System.currentTimeMillis Timestamp.new
parse datetime from string	SimpleDateFormat.new SimpleDateFormat.parse
test file exists	File.new File.exists
open a url	URL.new URL.openConnection
open file dialog	JFileChooser.new JFileChooser.showOpenDialog JFileChoose
get files in folder	File.new File.list File.new File.isDirectory
match regular expressions	Pattern.compile Pattern.matcher Matcher.group
generate md5 hash code	MessageDigest.getInstance MessageDigest.update MessageDi

Deep API Learning



Deep API Learning

INPUT → Natural Language

OUTPUT → Natural Language

Deep API Learning

INPUT → API sequences with corresponding NL annotation

OUTPUT → API sequences

Deep API Learning   Extracting API Usage Sequences

```
new C()

o.m()

o1.m1(o2.m2(), o3.m3())

stmt1; stmt2; …; stmt

if(stmt1) {stmt2;} else {stmt3;}

while(stmt1) {stmt2; }
```

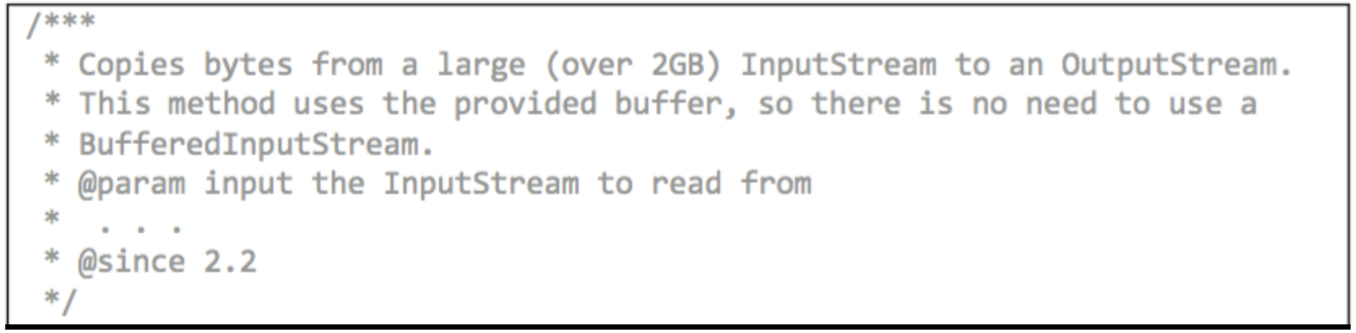
Deep API Learning　Extracting API Usage Sequences

new C()	C.new
o.m()	c.m
o1.m1(o2.m2(), o3.m3())	C2.m2-C3.m3-C1.m1
stmt1; stmt2; …; stmt	s1-s2-…-st
if(stmt1) {stmt2;} else {stmt3;}	s1-s2-s3
while(stmt1) {stmt2; }	s1-s2

C

软件仓库挖掘—API Learning

Deep API Learning   Extracting Annotations

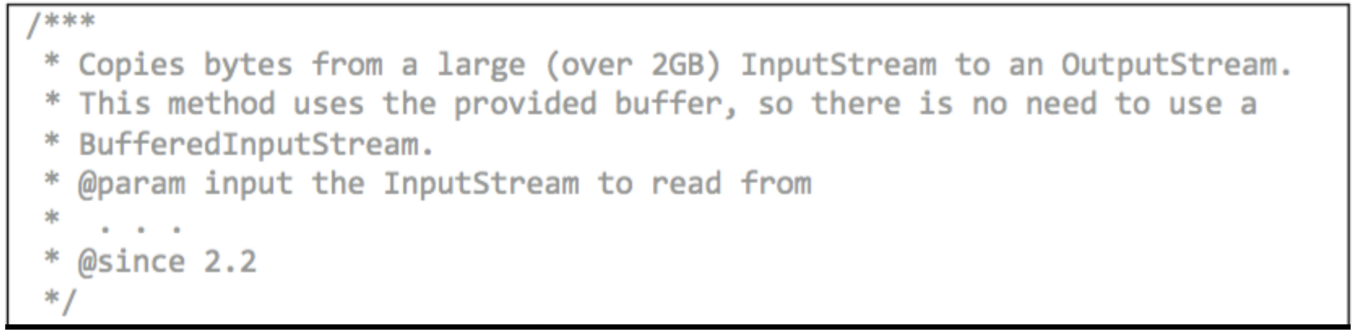


```
/***
 * Copies bytes from a large (over 2GB) InputStream to an OutputStream.
 * This method uses the provided buffer, so there is no need to use a
 * BufferedInputStream.
 * @param input the InputStream to read from
 *  . . .
 * @since 2.2
 */
```

C

软件仓库挖掘—API Learning

Deep API Learning   Extracting Annotations



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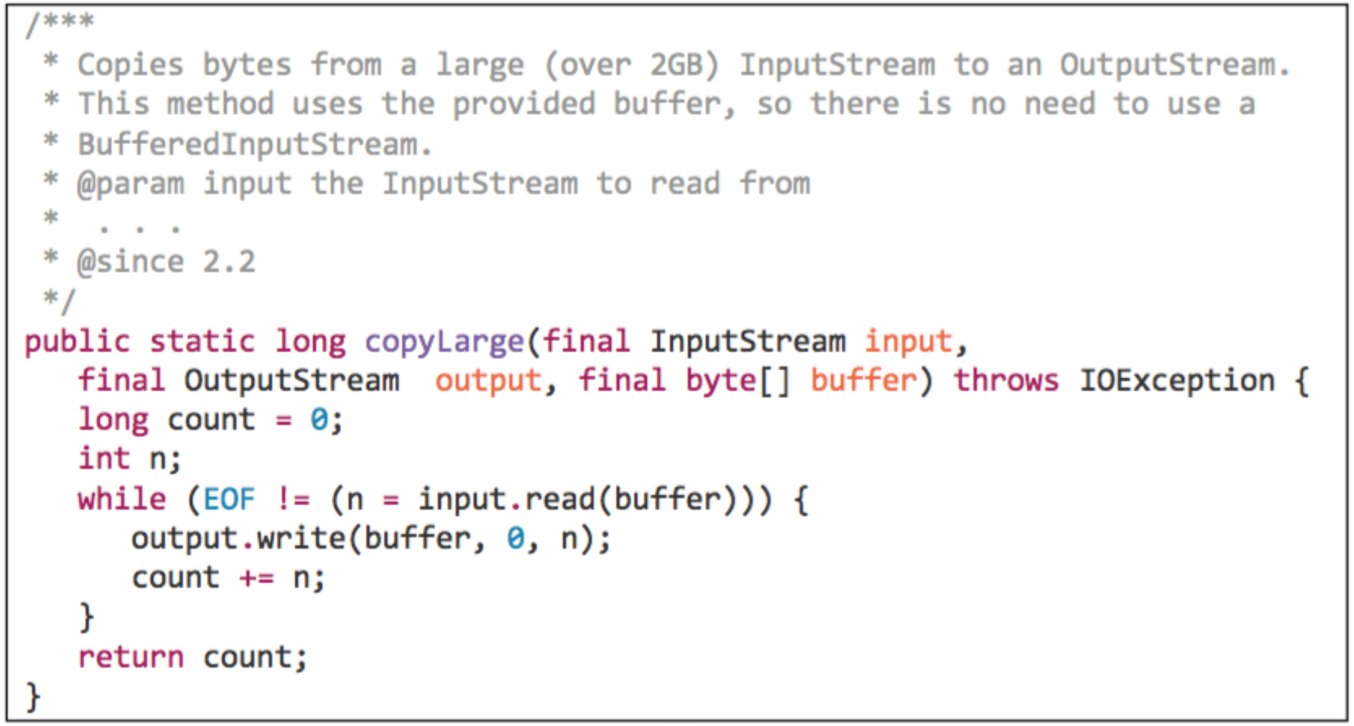
 *   . . .
 * @since 2.2
 */
```

↓

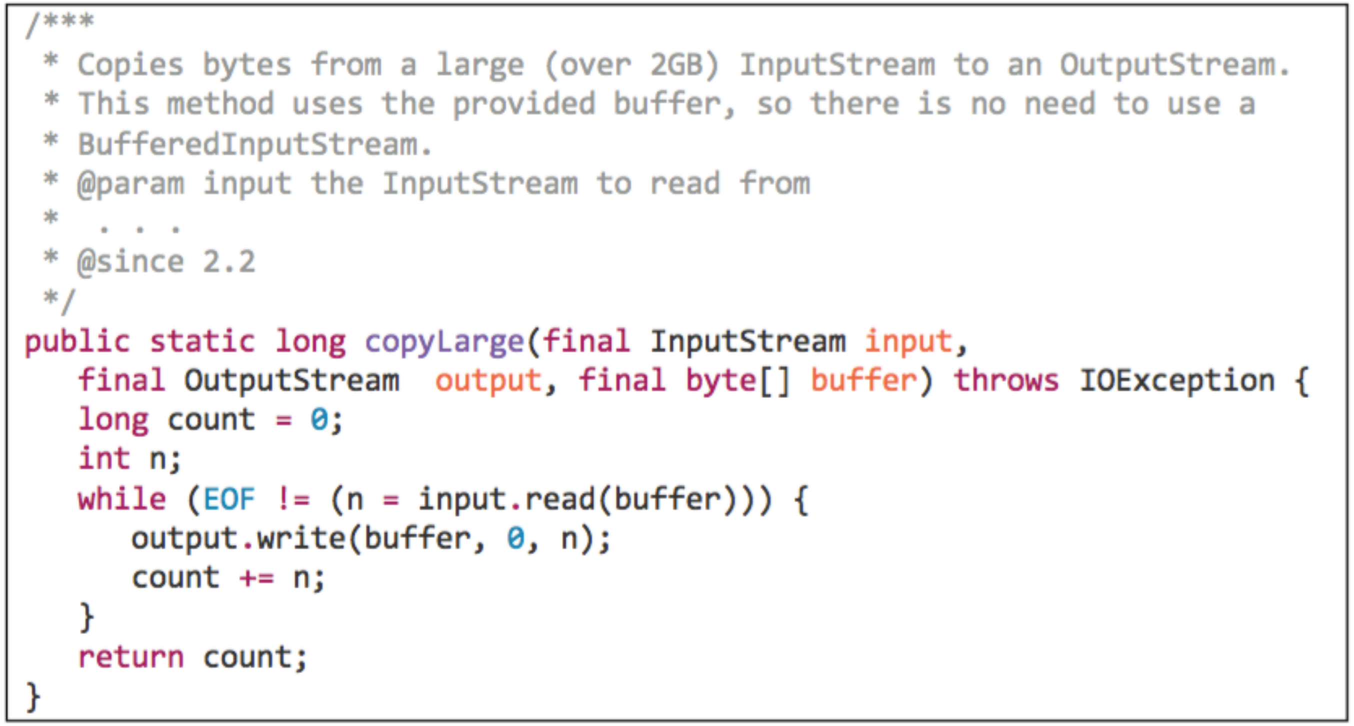
Copies bytes from a large (over 2GB) InputStream to an OutputStream

Deep API Learning



```java
/***
 * Copies bytes from a large (over 2GB) InputStream to an OutputStream.
 * This method uses the provided buffer, so there is no need to use a
 * BufferedInputStream.
 * @param input the InputStream to read from
 *   . . .
 * @since 2.2
 */
public static long copyLarge(final InputStream input,
   final OutputStream  output, final byte[] buffer) throws IOException {
   long count = 0;
   int n;
   while (EOF != (n = input.read(buffer))) {
      output.write(buffer, 0, n);
      count += n;
   }
   return count;
}
```

Deep API Learning



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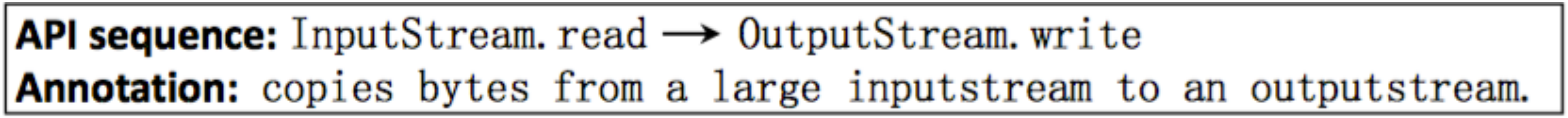
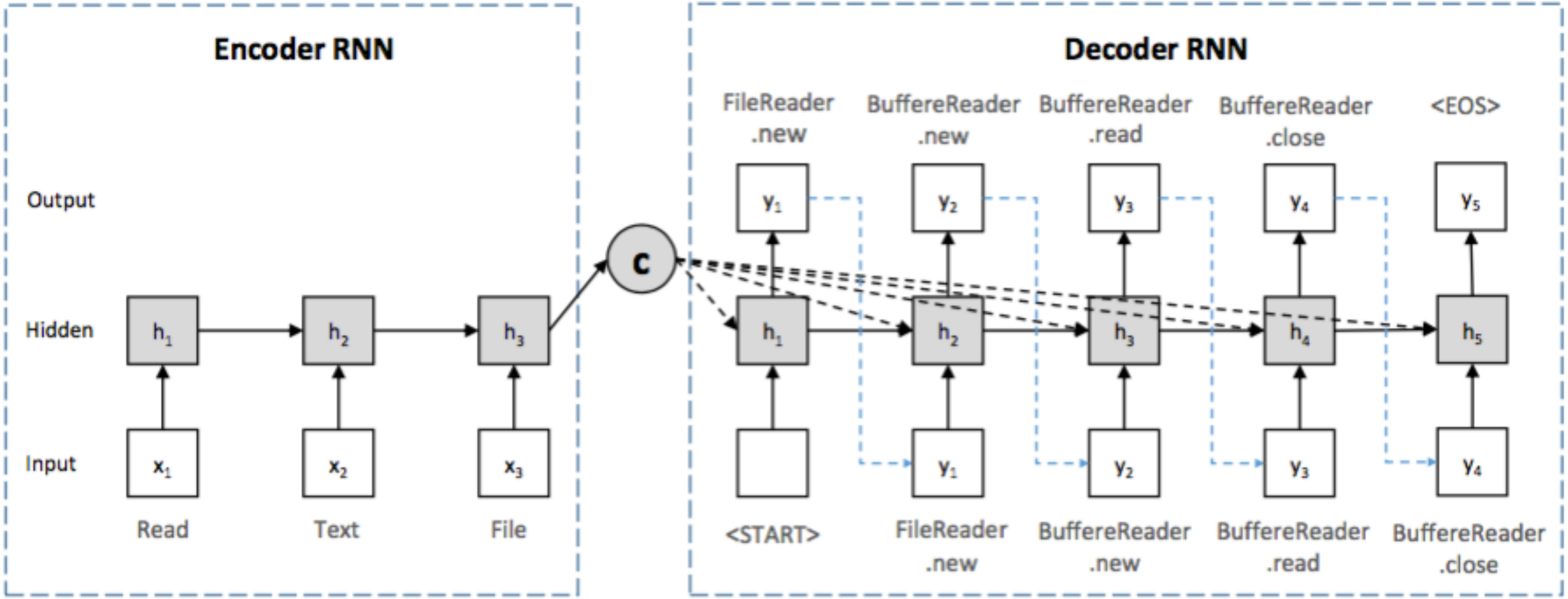


API sequence: InputStream.read → OutputStream.write

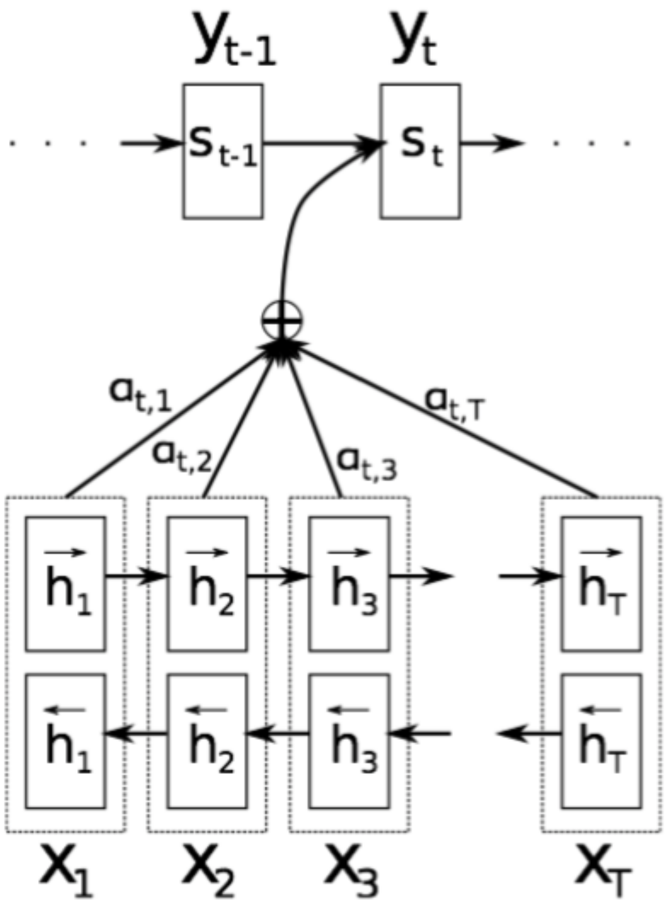
Annotation: copies bytes from a large inputstream to an outputstream.

Deep API Learning



Deep API Learning

Two RNNs for encoder

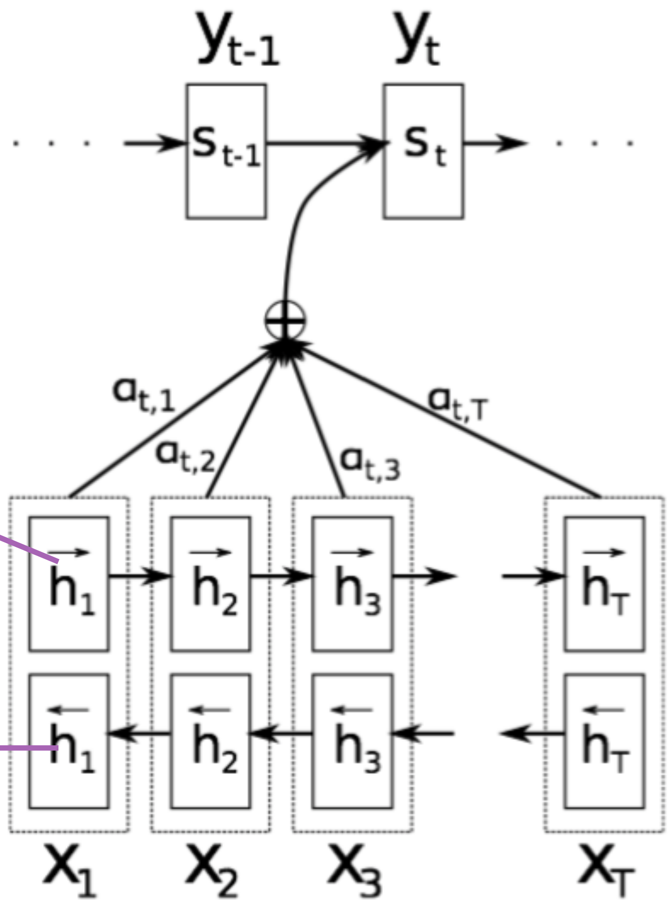


Deep API Learning

Two RNNs for encoder

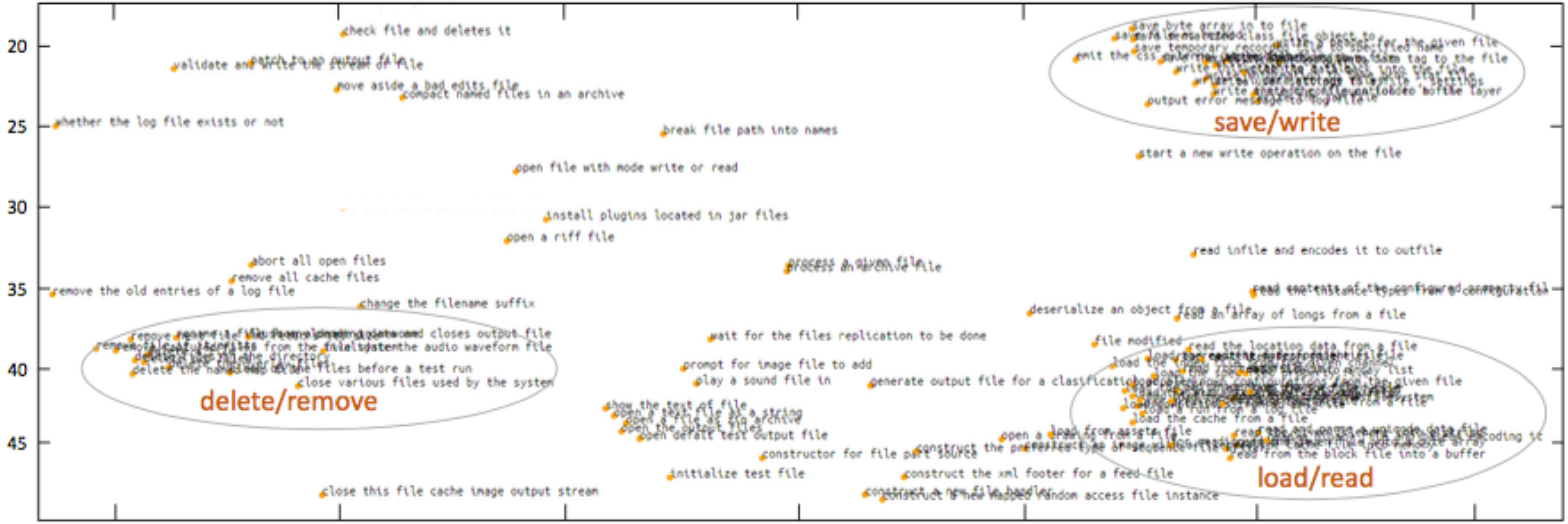
a forward RNN directly encodes the sources sentences

a backward RNN encodes the reversed source sentences

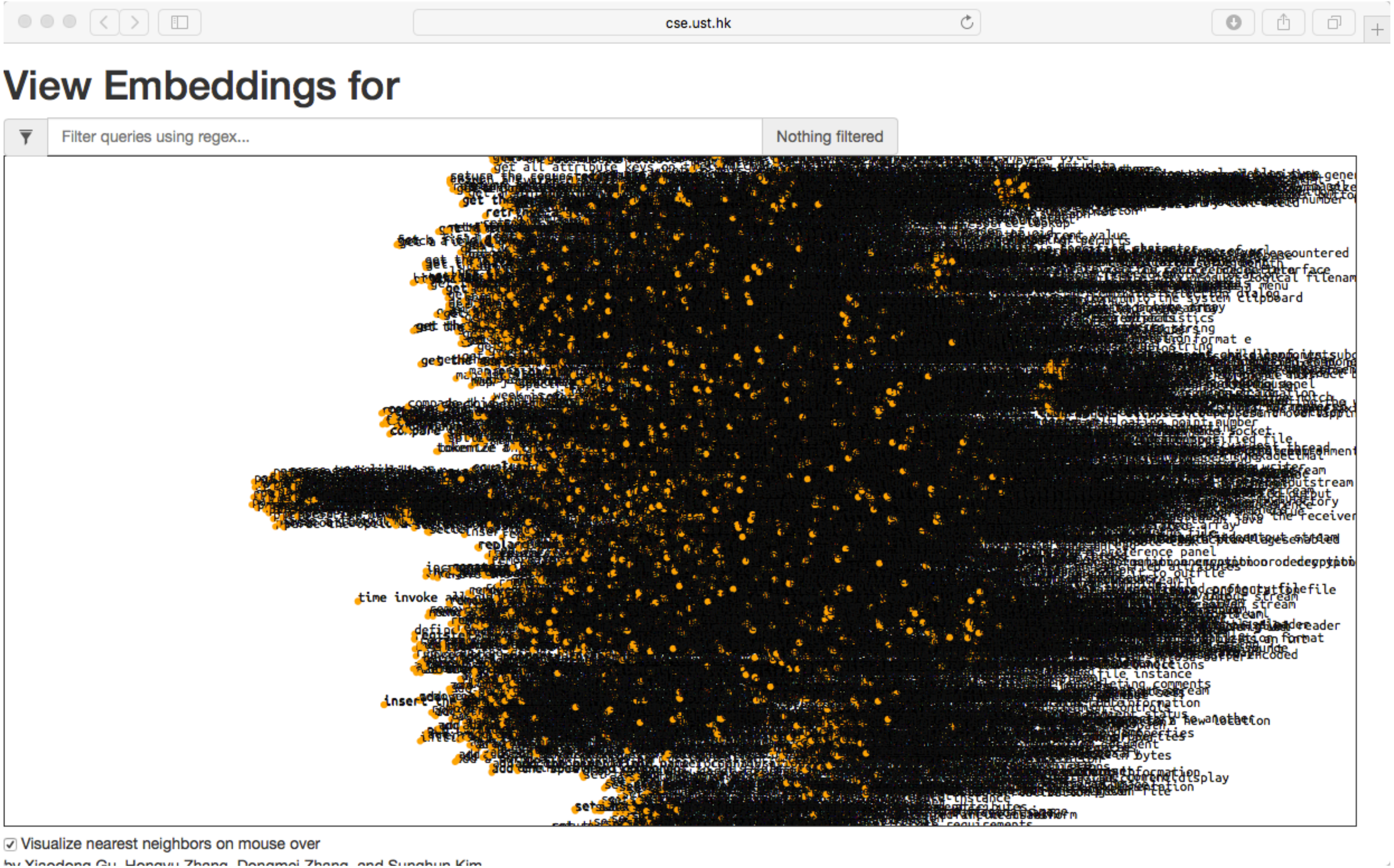


C

Deep API Learning



C



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View Embeddings for

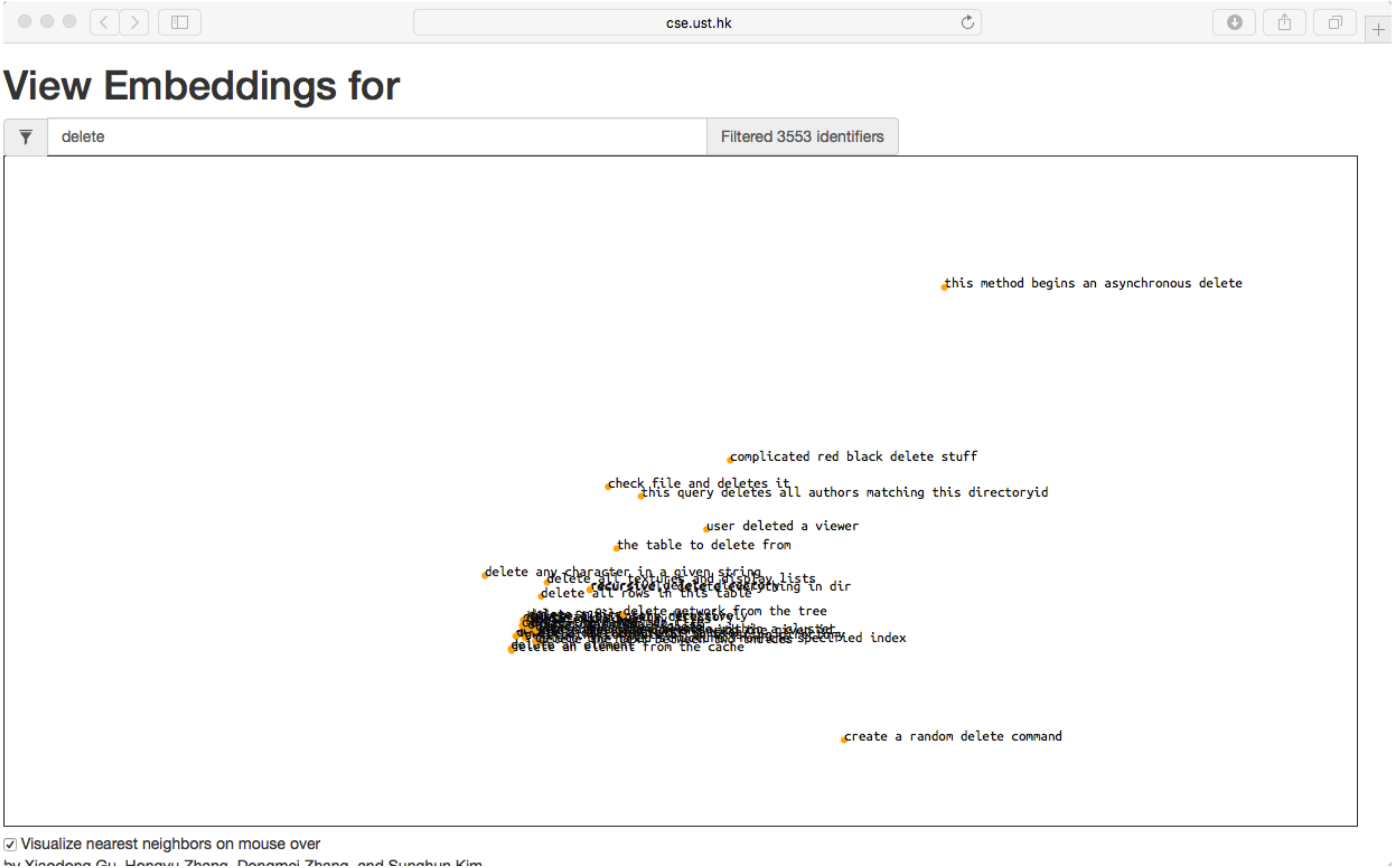
Filter queries using regex...

Nothing filtered

☑ Visualize nearest neighbors on mouse over

by Xiaodong Gu, Hongyu Zhang, Dongmei Zhang, and Sunghun Kim

C



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View Embeddings for

delete

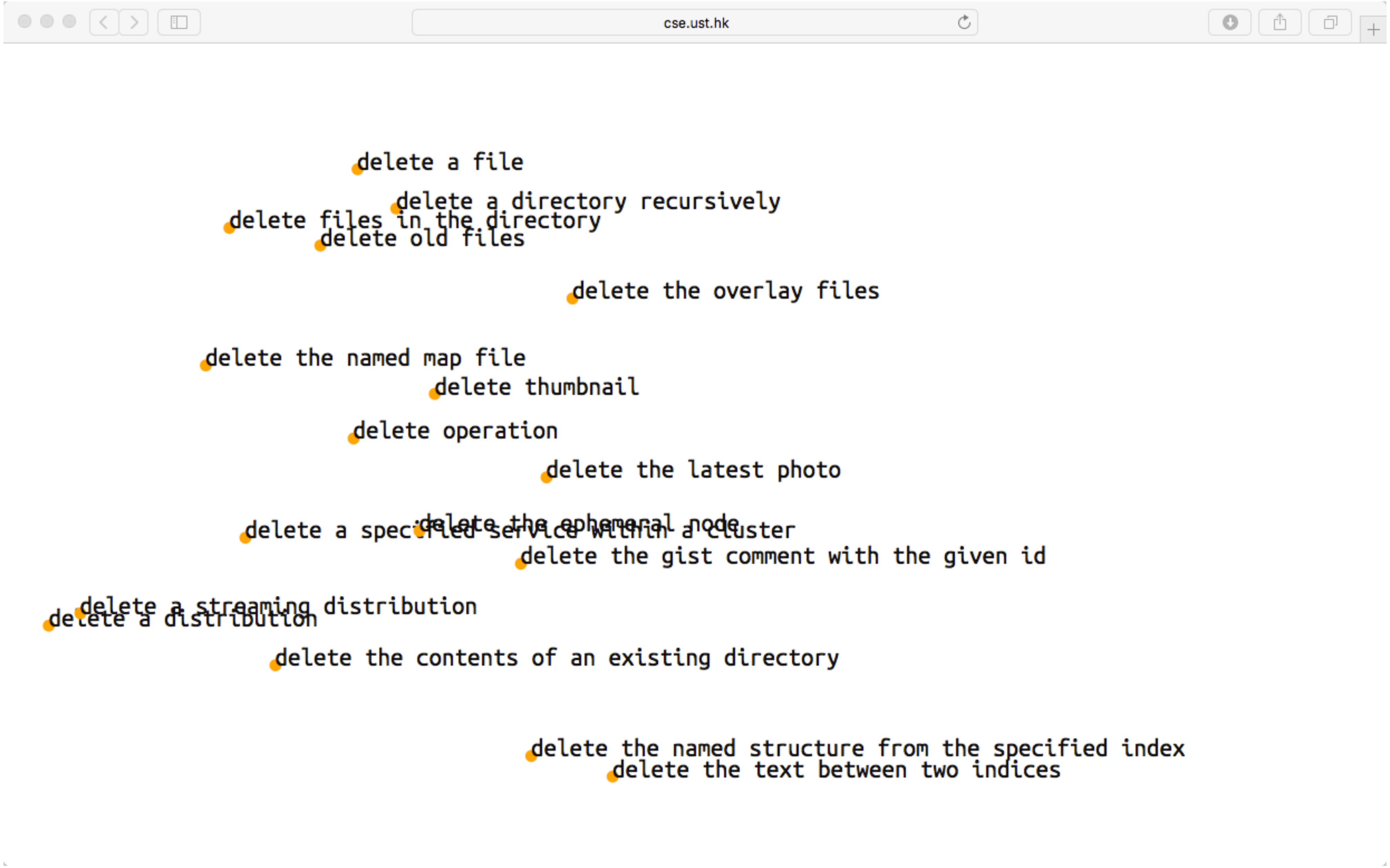
Filtered 3553 identifiers

this method begins an asynchronous delete
complicated red black delete stuff
check file and deletes it
this query deletes all authors matching this directoryid
user deleted a viewer
the table to delete from
delete any character in a given string
delete all textures and display lists
recursively delete everything in dir
delete all rows in this table
delete network from the tree
specified index
delete an element from the cache
create a random delete command

☑ Visualize nearest neighbors on mouse over

by Xiaodong Gu, Hongyu Zhang, Dongmei Zhang, and Sunghun Kim

C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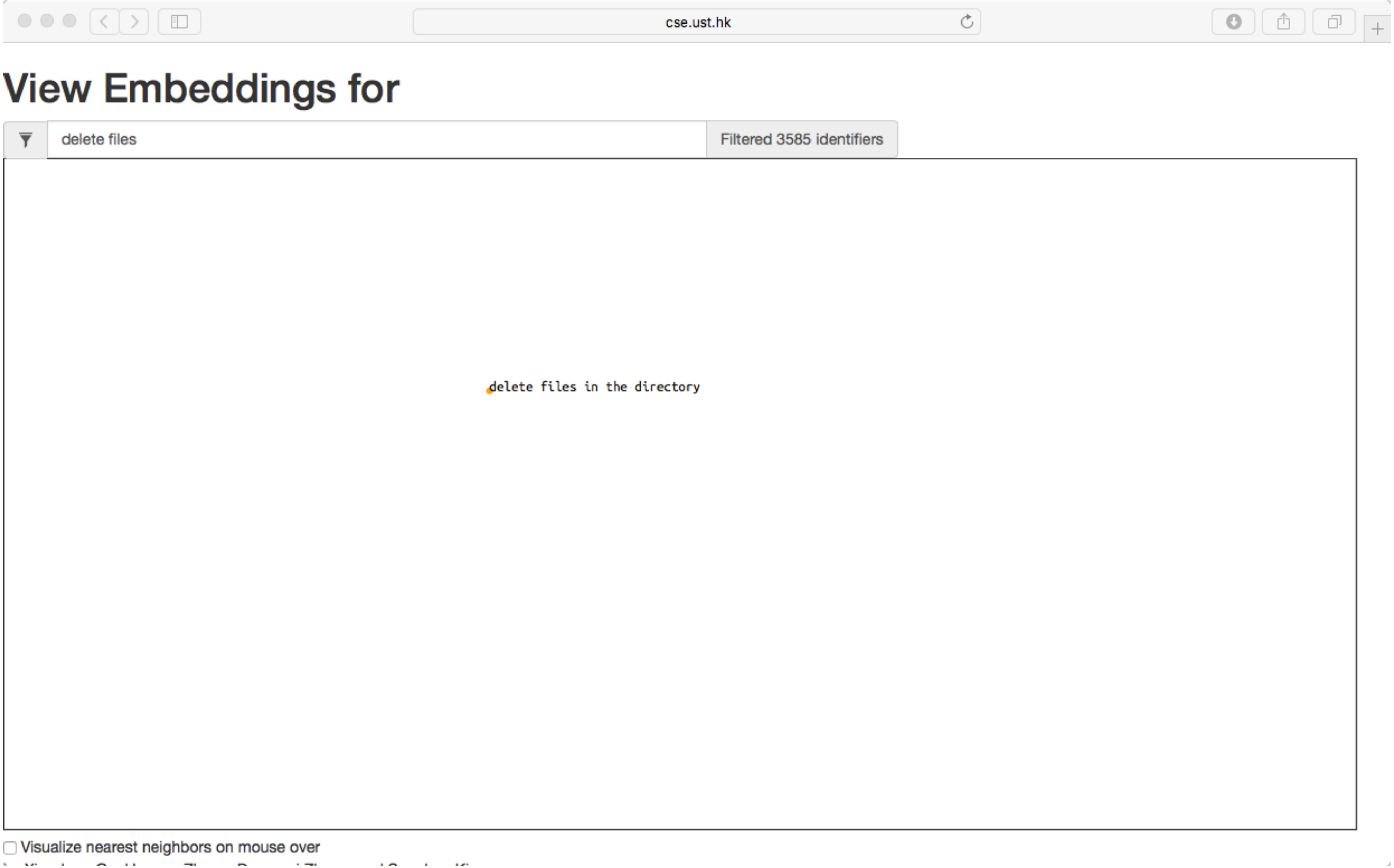
delete a file
delete a directory recursively
delete files in the directory
delete old files
delete the overlay files
delete the named map file
delete thumbnail
delete operation
delete the latest photo
delete the ephemeral node
delete a specified service within a cluster
delete the gist comment with the given id
delete a streaming distribution
delete a distribution
delete the contents of an existing directory
delete the named structure from the specified index
delete the text between two indices

C



View Embeddings for

delete files

Filtered 3585 identifiers

delete files in the directory

☐ Visualize nearest neighbors on mouse over

结论

自然语言处理	语法语义 → 概率统计
深度学习网络	表征学习、RNN、Encoder-Decoder
软件仓库挖掘	RNN Encoder-Decoder、API sequences

END

THANKS