COP 5536 Spring 2020

Project Report

Shantanu Ghosh
UF Id: 4311 – 4360
shantanughosh@ufl.edu

Problem description

A system is implemented to find the n most popular hashtags that appear on social media such as Facebook or Twitter. For the scope of this project hashtags will be given from an input file. Basic idea for the implementation is to use a max priority structure to find out the most popular hashtags.

Assumption: There will be a large number of hashtags appearing in the stream and I need to perform increase key operation many times. Max Fibonacci heap is recommended because it has an amortized complexity of O(1) for the increase key operation. I have implemented all Fibonacci heap functions discussed in class. For the hash table, existing implementation of Hashtable in the java.util package has been used.

Programming Environment

This project is implemented in Java version 13.

Implementation:

1. **Max Fibonacci heap**: Fibonacci heap is a data structure which is primarily used for priority queue operations. It has better amortized complexity than normal Binary heap and Binomial heap. The amortized time complexity for find_minimum, insert, decrese_key operations are constant. For a heap size of n, the amortized complexity of deleting an element is O(logn).

In this project, Fibonacci heap is used to keep track of the frequencies of hashtags.

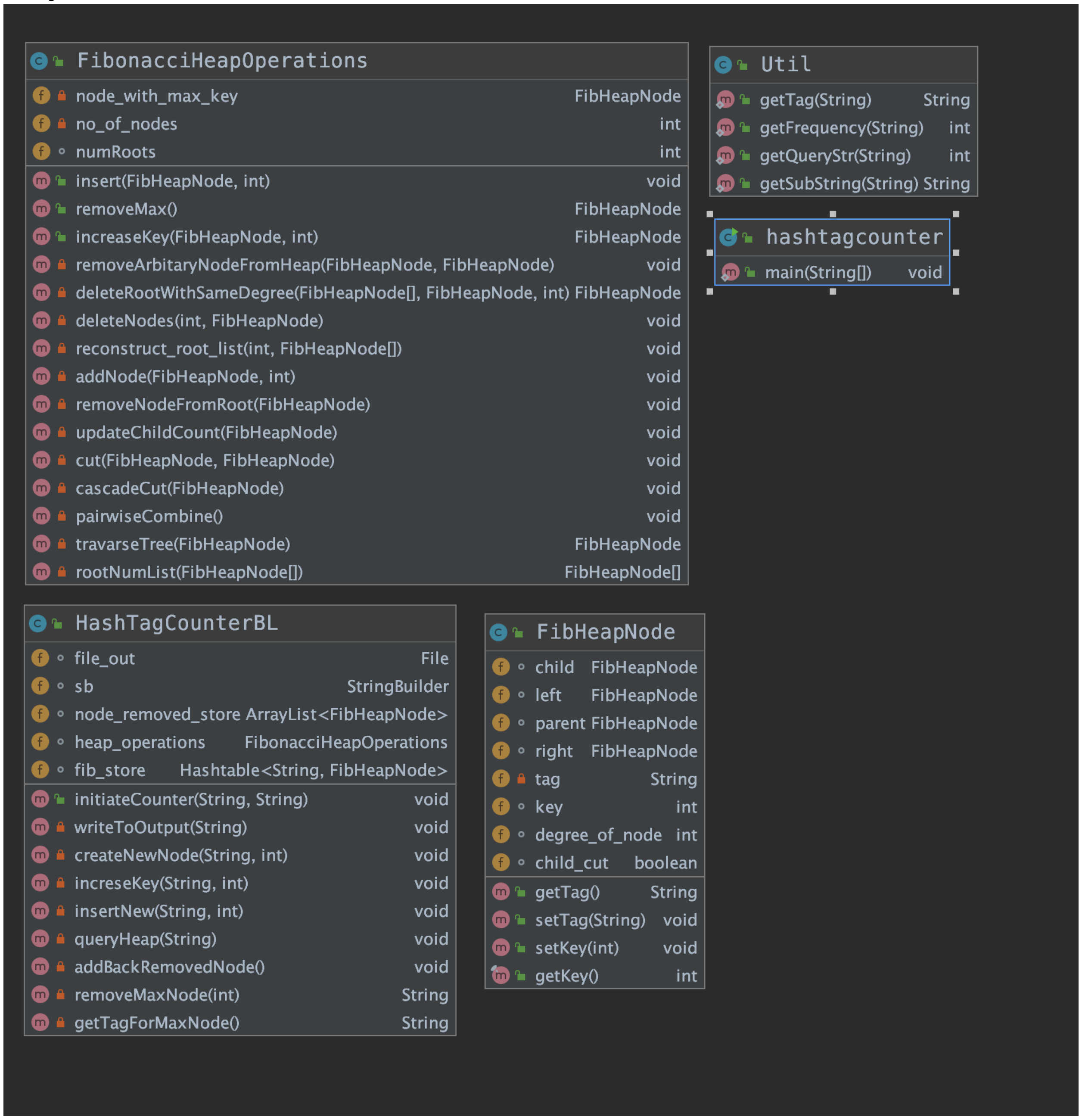
2. **Hash table:** The key for the hash table is the hashtag, and the value is the pointer to the corresponding node in the Fibonacci heap.

Execution:

Following are the required steps to execute the project:

- Unzip the project
- Paste the input file into the project folder
- make
- java hashtagcounter <input_file_name> <output_file_name>
- If output file name is mentioned, view the output in the output file, else view the output in the output_file.txt

Project Structure:



FibonacciHeapOperations	
node_with_max_key	FibHeapNode
no_of_nodes	int
numRoots	int
insert(FibHeapNode, int)	void
removeMax()	FibHeapNode
increaseKey(FibHeapNode, int)	FibHeapNode
removeArbitaryNodeFromHeap(FibHeapNode, FibHeapNode)	void
deleteRootWithSameDegree(FibHeapNode[], FibHeapNode, int)	FibHeapNode
deleteNodes(int, FibHeapNode)	void
reconstruct_root_list(int, FibHeapNode[])	void
addNode(FibHeapNode, int)	void
removeNodeFromRoot(FibHeapNode)	void
updateChildCount(FibHeapNode)	void
cut(FibHeapNode, FibHeapNode)	void
cascadeCut(FibHeapNode)	void
pairwiseCombine()	void
travarseTree(FibHeapNode)	FibHeapNode
rootNumList(FibHeapNode[])	FibHeapNode[]

Util	
getTag(String)	String
getFrequency(String)	int
getQueryStr(String)	int
getSubString(String)	String

hashtagcounter	
main(String[])	void

HashTagCounterBL	
file_out	File
sb	StringBuilder
node_removed_store	ArrayList<FibHeapNode>
heap_operations	FibonacciHeapOperations
fib_store	Hashtable<String, FibHeapNode>
initiateCounter(String, String)	void
writeToOutput(String)	void
createNewNode(String, int)	void
increseKey(String, int)	void
insertNew(String, int)	void
queryHeap(String)	void
addBackRemovedNode()	void
removeMaxNode(int)	String
getTagForMaxNode()	String

FibHeapNode	
child	FibHeapNode
left	FibHeapNode
parent	FibHeapNode
right	FibHeapNode
tag	String
key	int
degree_of_node	int
child_cut	boolean
getTag()	String
setTag(String)	void
setKey(int)	void
getKey()	int

FibHeapNode: This is class contains the basic node structure of the Fibonacci Heap

FibonacciHeapOperations: This class consists of all methods which implements the different operations of Fibonacci Heap Data structure.

HashtagCounterBL: This class implements the business logic of the problem statement to find n most popular hashtags

Shantanu Ghosh
UFID: 4311 - 4360

Util: This is a utility class which consists of utility methods that has been used by HasTagConterBL Class.
hashtagcounter: This class contains the main method which is entry point of this project.

Detailed description of the Methods of the classes will be mentioned below.

Project Documentation:
1. Class Name - FibHeapNode:

Return Type	**Member Type**	**Member Name**	**Purpose**
FibHeapNode	Variable	child	Child node given a parent
FibHeapNode	Variable	left	Left node of a child given a parent
FibHeapNode	Variable	parent	Parent node
FibHeapNode	Variable	right	Right node of a child given a parent
String	Variable	tag	Hashtag
Integer	Variable	key	Key of stored at the node
Integer	Variable	degree_of_node	The no of children of a node
Boolean	Variable	child_cut	• **True** if node has lost a child since it became a child of its current parent. • Set to **false** by remove min, which is the only operation that makes one node a child of another. • **Undefined** for a root node
String	Method	getTag	Getter method to retrieve the Hashtag
void	Method	setTag	Setter method to set the Hashtag
void	Method	setKey	Setter method to set the Key
String	Method	getKey	Getter method to retrieve the Key

2. Class Name - hashtagcounter:

Return Type	**Member Type**	**Member Name**	**Purpose**
void	Method	main	Entry point of the project

3. Class Name – Util:

Return Type	**Member Type**	**Member Name**	**Purpose**
FibHeapNode	Variable	child	Child node given a parent
FibHeapNode	Variable	left	Left node of a child given a parent
FibHeapNode	Variable	parent	Parent node

4. Class Name – HashTagCounterBL:

Return Type	**Member Type**	**Member Name**	**Purpose**
File	Variable	file_out	Output file Name
StringBuilder	Variable	sb	Temporary placeholder to hold the contents of the output file
ArrayList	Variable	node_removed_store	Hold the removed nodes ftom the heap
FibonacciHeapOperations	Variable	heap_operations	Object of the class FibonacciHeapOperations which contains all the implementation of operations performed in Fibonacci Heap.
Hashtable	Variable	fib_store	Object of the Hashtable
void	Method	initiateCounter	Entry point of the business logic which redirects to appropriate methods where operations on a Fibonacci heap is performed and to the method which query the Fibonacci heap
void	Method	writeToOutput	Writes the output to the output file
void	Method	createNewNode	• Creates a new node in the Fibonacci heap

			• Update the frequency and add the node with update frequency to the tree.
void	Method	increseKey	Update the frequency count for a given node
void	Method	insertNew	Insert a new node in the Fibonacci Heap
void	Method	queryHeap	Query the Fibonacci heap with the given frequency of a hashtag
void	Method	addBackRemovedNode	Remove the node to update the frequency and add with updated frequency
String	Method	removeMaxNode	Remove the node with max frequency
String	Method	getTagForMaxNode	Get the tag for the node to be deleted with max key

5. Class Name – FibonacciHeapOperations:

Return Type	**Member Type**	**Member Name**	**Purpose**
FibHeapNode	Variable	node_with_max_key	node with the maximum key
int	Variable	no_of_nodes	Total no of nodes of the Fibonacci heap
void	Method	insert	Insert a new node in the Fibonacci Heap
FibHeapNode	Method	removeMax	Remove the node with maximum key
FibHeapNode	Method	increaseKey	Increase the key of a node with updated frequency
void	Method	removeArbitaryNodeFromHeap	Remove any node from Fibonacci heap
FibHeapNode	Method	deleteRootWithSameDegree	Delete node with same degree
void	Method	deleteNodes	Perform delete nodes

void	Method	reconstruct_root_list	Reconstruct nodes during pairwise combine
void	Method	addNode	Add given node during insertion operation of Fibbonacci Heap
void	Method	removeNodeFromRoot	Perform removal of node from Fibonacci heap
void	Method	updateChildCount	Update the degree of the child during removeMax operation of Fibonacci Heap
void	Method	cut	Cut the child
void	Method	cascadeCut	Performs the cascade cut operation
void	Method	pairwiseCombine	pairwise combine min trees whose roots have equal degree.
void	Method	travarseTree	Traverse the Fibonacci Heap
FibHeapNode[]	Method	rootNumList	Uitlity method used by the method to remove a node with same degree

References:

- https://en.wikipedia.org/wiki/Fibonacci_heap
- https://www.geeksforgeeks.org/fibonacci-heap-set-1-introduction/
- Introduction to Algorithms – CLRS
- https://www.cise.ufl.edu/~sahni/cop5536/index.html