**A REPORT**

**ON**

**Graph Data Digest Document Format (GDF)**

BY

Vipin Baswan 2017A7PS0429P

Suyash Raj 2017A7PS0191P

Yashdeep Gupta 2017A7PS0114P

Abhinava Arsada 2017A7PS0028P

Sreyas Ravichandran 2017A7PSP

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**Homi Bhabha Centre for Science Education (HBCSE)**

A Practice School-1 station of



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**Submitted to:**

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**Abstract**

Graph databases have always been a promising tool in increasing the querying efficiency on datasets. Hence, the prospect of data digest document format such as GDF seems very promising in today’s world where datasets interact in a complex manner and quick information retrieval is of prime import.

Our project deals with developing a format called GDF and the method to convert any document format into GDF. This will assist us in quick merging of different files as graphs can be merged easily. On completion of our project, we will be able to convert any file format into GDF and also view any file data in the form of graphs (only nodes and edges)! This format is essentially NoSQL type format since there are no tables.

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**INTRODUCTION**

*The aim of our project is to develop a Data Digest Format which can be used to convert and represent information of any format.* The format is graph based, hence the name.

The scope of our project is to:

1. Decide the format of GDF
2. Write methods to convert a text file into GDF
3. Create meta-data in the GDF format from the meta-data in the text format
4. Develop a query language (based on SPARQL) for information retrieval

Since the idea of GDF is pretty innovative and unique in itself (Credit: Nagarjuna G.), not much literature is available to us for this exact format. But a similar data format called *Resource Description Format* (RDF) already exists. It is also graph based data format. Hence, we have gone through the literatures regarding RDF (links of the online resources have been given in the References section). Also, we have generated the sample data (for testing our code) using a python code but later we will collect more data from *DBPedia* (an online platform to get 3-column formatted data for various Wikipedia pages). Also, the query language for our format is based on *SPARQL*. We are referring to the official literature available on *SPARQL* (link for the same has been provided in References Section) for building our querying engine.

We wanted to limit the dependency of our code on various platforms. Hence, we have used BASH Scripting to write our code.

Due to time constraints, we will not be able to create our own renderer but we will be using already existing D3.js renderer.

The report initially gives a basic background information on Graph based database formats. Then, the *7-column format* has been discussed in detail. Since, the format is graph based, we also need to define nodes and edges of the graph. This is done through generating the meta-data file. The format of meta-data file is also discussed in detail. After this, the report explains the flow of the project (from text to Graph) through a flow chart. Since we have limited time to complete the project, we have also stated the current progress and what we have to achieve in two separate sections. The relevant code and readMe files have been attached in the appendix. The links of various resources we referred to have been given in the references section. Few important jargons have been defined in the glossary at the end.

**MAIN TEXT**

1. **BACKGROUND**

This data format can be said to be loosely inspired from the RDF format, additionally making use of the seven-column format, which has been described below. In both of these formats, data is stored in the form of graphs i.e. nodes as well as edges for easier and more efficient querying of data. We also decided to additionally generate unique IDs for each one of the tuples generated as well as each entity uniquely specified by the edges and nodes. The last addition to this data format is that we shall implement a constantly self-updating metadata section of our data which cannot be accessed by the users and contains information about the type of entities stored in our data which reduces our query time to a very large extent despite requiring a very large amount of storage space.

1. **7-COLUMN FORMAT**

Each tuple in the input file (can be in any format) can be viewed as an entity with a Subject, Object and a Predicate. For instance, in “*Yashdeep likes to eat ice-cream*”, ‘Yashdeep’ is the Subject, ‘ice-cream’ is the Object and ‘likes to eat’ is the Predicate.

Let’s see the graph given below:



*Fig.1: A graph representing the sentence “Yashdeep like to eat ice-cream”*

Here are the observations:

1. Both subject and object are represented by the nodes of the graph
2. Predicate is represented by the edge of the graph
3. Both nodes and edges have some text associated with them (like ‘Yashdeep’ and ‘Ice-cream’ associated with nodes and ‘Likes to eat’ associated with edge)
4. The edge originates from Subject and terminates at Object. Thus, the graph we get is always a directed graph
5. Subject, Objects and Predicates can also have ‘qualifiers’ associated with them. For example, in above graph, Subject Qualifier can be ‘Person’, Object Qualifier can be ‘Dessert’ and Predicate Qualifier can be ‘Preferences’. In short, a qualifier gives more information about the subject/object/predicate.

The above graph corresponds to a single tuple of the GDF file. This graph is represented by a 7-column format in our GDF File. The format is:

UID | Subject | Subject\_Qualifier | Predicate | Predicate\_Qualifier | Object | Object\_Qualifier

Hence, above graph will be represented by the following tuple in our GDF File:

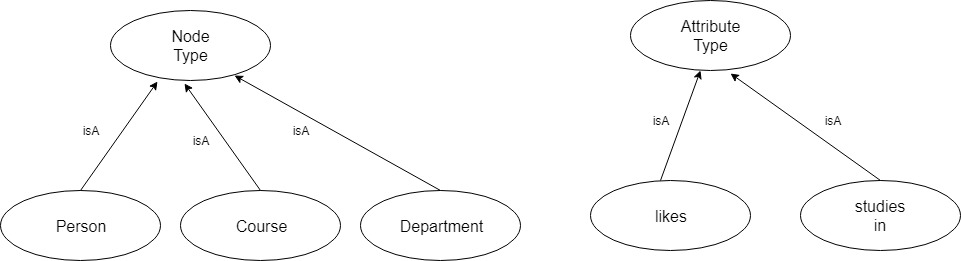
1242353353|Yashdeep|Person|LikesToEat|Preferences|Ice-cream|Dessert

The UID is generated by taking the hash of Subject, Object and Predicate (appended and delimited by space). We have used inbuilt ‘md5sum’ hash of the bash. For each tuple in the input file, a tuple is generated in the GDF file. Finally, the output will contain a file with .gdf extension.

The code for the conversion of text into GDF file is attached in the appendices section along with the ReadMe file for the code. For complete detailed explanation on how the code works and what 7-column format is, please refer to the ReadMe file.

1. **META-DATA FORMAT**

Along with the GDF file a meta-data GDF file is also created. For creating this file, the user has to give the meta-data text file as the input. The meta-data file will also have a Graph based file format. For instance, see the graph below:



*Fig. 2: An example Node and Attribute types for meta-data.gdf file*

The meta-data contains two basic entities: Node type and Attribute/Predicate type. This is used to define the nodes and edges within the graph.

In the example discussed previously, “*Yashdeep likes to eat ice-cream*”, Yashdeep is a Person and hence Yashdeep is a Member of Person Node type. This information can also be conveyed through the 7-column format:

UID | Subject | Subject\_Qualifier | memberOf | | Node\_Type

Predicate | Predicate\_Qualifier | memberOf | | Attribute\_Type

Object | Object\_Qualifier | memberOf | | Node\_Type

In our example,

1243453453 | Yashdeep | | memberOf | | Person

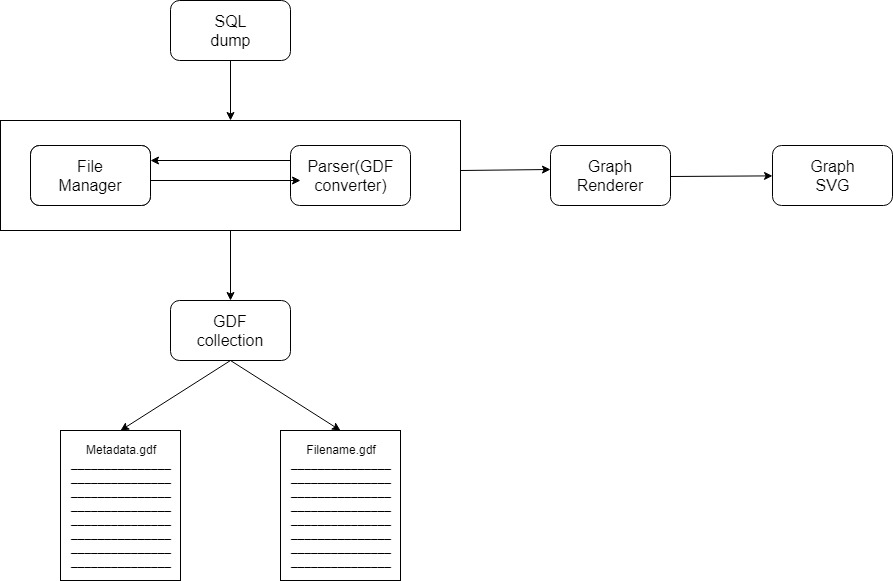
1453456564 | Ice-cream | | memberOf | | Food-items

2434536456 | Likes to eat | | memberOf | | likes

Hence, for each subject/object/predicate, our meta-data.gdf file will contain a tuple in it.

1. **TEXT TO GRAPH CONVERSION**

The conversion of input text file into Graph database can be represented by the following chart:



*Fig. 3: Processing of input file to get an interactive Graph SVG*

The sequence of steps has been explained below:

1. We will receive input from the user in the form of a table (called SQL Dump in the above chart). Mostly, user will also provide the corresponding meta-data file as another input file.
2. The parser will parse the input file and generate the GDF file along with the meta-data.gdf file. The availability of meta-data.gdf rests upon the availability of meta-data.txt file as the input from user.
3. We need to convert the GDF file into the JSON objects and then render these JSON objects in the form of Graph SVGs. This will be done by the Graph Renderer. It will read our GDF file and generate the corresponding graph database.
4. **OUR PROGRESS**

Till now, we have completed the following:

1. Creation of GDF Convertor to convert a text file into 7-column format
2. Creation of meta-data.gdf file from meta-data.txt file
3. Reading SPARQL

We will also start working on the querying engine within this week.

Everything that we have done has been committed to the GIT remote repository (<https://github.com/Sreyas-108/GDF>). Also, the code and readMe files have been attached in the Appendix section.

1. **FUTURE PROSPECTS**

We plan to complete the following objectives:

1. Conversion of our GDF file into JSON objects
2. Understand the working of D3.js renderer and use it to generate graph SVGs from the JSON objects generated from (a)
3. Complete the building of querying engine (based on SPARQL)

**CONCLUSION**

To sum up, our project is to convert any file into GDF format and to render the file using D3.js renderer. We are using 7-column format for making GDF file. The same format is also followed to produce meta-data.gdf file. Later, we will also write code to get JSON objects corresponding to tuples in the GDF file. We will use D3.js to get graph SVGs from JSON objects.

**APPENDIX**

*NOTE: The code attached here is already present on GitHub (*[*https://github.com/Sreyas-108/GDF*](https://github.com/Sreyas-108/GDF)*). Also, for sample input data and corresponding GDF file, please refer to the GitHub link.*

**Python code to generate sample input data:**

|  |  |
| --- | --- |
|  | import random  import numpy as np |
|  | students=['Yashdeep','Vipin','Suyash','Sreyas','Abhinava','Ayush','Sid','Anirudh','Arvind','Ravi','Kavi','Isha','Ritu','Jaya','Kapil','Divya','Pankaj','Sashan','Sushakt','Pratik','Saksham','Rachit','Shivam','Shalvi','Akriti','Bhoomi','Kavya','Sahil','Sargun','Swadesh','Kshitij','Anshuman','Samir'] |
|  | teachers=['Ashish','Shan','Geeta','Ashu','Nago','Pogo','Sanjay','Sunita','Kalpana','GN','Mukesh','Suresh','Rohil','Ramesh','Manoj','Raman','Kannan','Sundar','Vishal','Amit','Kamlesh','Jenny'] |
|  | fooditems=['Dosa','Pavbhaji','VadaPav','AlooParatha','BreadButter','BreadJam','BhelPuri','PaneerTikka','ShahiPaneer','Kadhi','Biryani','FriedRice','Pizza','Burger','Sandwich'] |
|  | people=students+teachers |
|  | courses=['DSA','DBS','MuP','DD','POE','POM','DISCO','OOP','PAVA','CP','ES','TRW','MeOW','Thermo','M1','M2','M3','PnS','Bio','PPL','CompArch','DAA'] |
|  |  |
|  |  |
|  | def createCrossData(list1,list2): |
|  | cross=[] |
|  | for l1 in list1: |
|  | for l2 in list2: |
|  | if random.randint(0,1)==1: |
|  | cross.append((l1,l2)) |
|  | return cross |
|  |  |
|  | def createTripletStrings(crossTable,predName): |
|  | tripletList=[] |
|  | for l1,l2 in crossTable: |
|  | tripletList.append(l1+'|'+predName+'|'+l2) |
|  | return tripletList |
|  |  |
|  | def printStringListToFile(stringList,filename): |
|  | file = open(filename,'w') |
|  | for string in stringList: |
|  | file.write(string) |
|  | file.write('\n') |
|  |  |
|  | teaches=createCrossData(teachers,students) |
|  | eats=createCrossData(people,fooditems) |
|  | registeredIn=createCrossData(students,courses) |
|  |  |
|  | tripTeaches=createTripletStrings(teaches,'teaches') |
|  | tripEats=createTripletStrings(eats,'likesToEat') |
|  | tripReg=createTripletStrings(registeredIn,'registeredIn') |
|  |  |
|  | tripAll=tripTeaches+tripReg+tripEats |
|  |  |
|  | printStringListToFile(tripAll,filename='sampleData.txt') |

**Code (Shell script) to convert text file to GDF file**

|  |
| --- |
|  |
|  |  |
|  | #!/bin/bash  function xtoGDF { |
|  | filename=$1 |
|  |  |
|  | outname='' |
|  |  |
|  | udi='' |
|  |  |
|  | #code to extract the primary name of the file |
|  | IFS='.' |
|  | fileArr=() |
|  | read -ra fileArr <<< "$filename" |
|  | outname="${fileArr[0]}.gdf" |
|  |  |
|  | IFS='|' |
|  |  |
|  | count=0 |
|  | while IFS= read -r line |
|  | do |
|  | array=() |
|  | uidArr=() |
|  |  |
|  | ############ Code to create 7 column format ############## |
|  | read -ra array <<< "$line" |
|  |  |
|  | cum="${array[0]} ${array[1]} ${array[2]}" |
|  | uid=$(echo "$cum" | md5sum) |
|  |  |
|  | IFS=' ' |
|  | read -ra uidArr <<< "$uid" |
|  | IFS='|' |
|  |  |
|  | uid=${uidArr[0]} |
|  |  |
|  | ############# Code to append data to GDF file ############# |
|  | toWrite="$uid|${array[0]}|${array[3]}|${array[1]}|${array[4]}|${array[2]}|${array[5]}" |
|  | if [[ $count -eq 0 ]] |
|  | then |
|  | echo "$toWrite" > "$outname" |
|  | else |
|  | echo "$toWrite" >> "$outname" |
|  |  |
|  | fi |
|  |  |
|  | let count=$count+1 |
|  | done < "$1" |
|  |  |
|  | #set the IFS back to default |
|  | IFS=' ' |
|  | } |
|  |  |
|  | xtoGDF $@ |

**ReadMe file for the above code**

|  |  |
| --- | --- |
|  | SUBJECT: Text to GDF Convertor  ------------------------------------------------------------------------------------ |
|  | RELATED FUNCTIONS: |
|  | xtoGDF() : Requires filename of the text file as the only command line argument |
|  | ------------------------------------------------------------------------------------ |
|  | OUTPUT: |
|  | The command is a silent command. A new file with the same name as the input file (but with .gdf extension) will be generated containing the GDF format |
|  | ------------------------------------------------------------------------------------ |
|  | SYNOPSIS: |
|  |  |
|  | Section 1: TEXT FILE FORMAT |
|  |  |
|  | The text file must be formtted by the following rules: |
|  |  |
|  | a) Each line must have only one entry |
|  | b) Multiple enteries (i.e. lines) must be seperated by a newline (\n) character |
|  | 1. Each line should have the following format:   Subject\_Name|Predicate\_Name|Object\_Name|Subject\_Qualifier|Predicate\_Qualifier|Object\_Qualifier |
|  |  |
|  |  |
|  |  |
|  | NOTE: |
|  | c.1) All or any entries can be omitted |
|  |  |
|  | c.2) If an entry from the middle of the format is omitted, even then the delimiters (i.e. |) must be kept |
|  | Eg: Yash|likes|IceCream|Intelligent||Chocolate |
|  |  |
|  | But if the entry omitted is not in the middle of the format, then successive entries can be omitted too |
|  | Eg: Yash|likes|IceCream |
|  |  |
|  | c.3) If a line doesn't contain any entry, GDF format will be : UID|||||| |
|  | ------------------------------------------------------------------------------------ |
|  | Section 2: THE GDF FORMAT |
|  |  |
|  | The output file has the following format: |
|  |  |
|  | a) Corresponding to each entry(i.e. line) of the text file, an entry is written in .gdf file |
|  | b) Multiple enteries are separated by newline character |
|  | 1. Each line has the following format:   UID|Subject\_Name|Subject\_Qualifier|Predicate\_Name|Predicate\_Qualifier|Object\_Name|Object\_Qualifier |
|  |  |
|  |  |
|  |  |
|  | NOTE: |
|  | c.1) UID is generated as the md5sum hash of (SubjectName' 'Predicate\_Name' 'ObjectName). Here ' ' indicates a space |
|  |  |
|  | c.2) Based on the input, each entry can have any or all enteries omitted. But delimiter '|' would still be present |
|  | ------------------------------------------------------------------------------------ |
|  |  |

**About( ) : Function to create a file that contains the names of all the unique subjects**

|  |
| --- |
| #!/bin/bash |
|  |  |
|  | function about { |
|  | filename=$1 |
|  | IFS='.' |
|  |  |
|  | fileArr=() |
|  | read -ra fileArr <<< "$filename" |
|  |  |
|  | tmpname1=${fileArr[0]}\_tmp1.gdf |
|  |  |
|  | count=0 |
|  |  |
|  | while IFS= read -r line |
|  | do |
|  | if [[ $count -eq 0 ]] |
|  | then |
|  | echo "$line" > "$tmpname1" |
|  | else |
|  | echo "$line" >> "$tmpname1" |
|  | fi |
|  | let count=$count+1 |
|  | done < "$1" |
|  |  |
|  |  |
|  | tmpname2=${fileArr[0]}\_tmp2.gdf |
|  | sort -k 2,2 --field-separator='|' "$tmpname1" > "$tmpname2" |
|  |  |
|  | IFS='|' |
|  |  |
|  | tmpname3=${fileArr[0]}\_tmp3.gdf |
|  |  |
|  | count=0 |
|  | while IFS= read -r line |
|  | do |
|  | IFS='|' |
|  | segment=() |
|  | read -ra segment <<< "$line" |
|  |  |
|  | if [[ $count -eq 0 ]] |
|  | then |
|  | echo "${segment[1]}" > $tmpname3 |
|  | else |
|  | echo "${segment[1]}" >> $tmpname3 |
|  | fi |
|  | let count=$count+1 |
|  | done < "$tmpname2" |
|  |  |
|  | aboutFile=${fileArr[0]}\_about.gdf |
|  | uniq "$tmpname3" > "$aboutFile" |
|  | rm $tmpname1 $tmpname2 $tmpname3 |
|  | IFS=' ' |
|  | } |
|  |  |
|  | about $@ |
|  |  |

**separateBySub( ): Function to create a separate file for each subject having all information of that subject**

|  |
| --- |
| #!/bin/bash |
|  | function separateBySub |
|  | { |
|  | filename=$1 |
|  | outname='' |
|  | rel=(NaN NaN NaN NaN NaN NaN NaN) |
|  | IFS=$'\n' |
|  | while read line #Loop to go through each relation in a gdf file |
|  | do |
|  | IFS='|' read -r -a rel<<<"$line" #Reading the line into array 'rel' separated by '|' |
|  | local outfile=${rel[1]}.gdf |
|  | flag=$(ls | grep $outfile) #Flag to check for existence of the filename |
|  | if [[ -z $flag ]] |
|  | then |
|  | touch $outfile #Creating the file from subject's name if it doesn't exist |
|  | fi |
|  | echo $line >> $outfile #Appending the relation |
|  | IFS=$'\n' |
|  | done < $filename |
|  | } |
|  |  |
|  | separateBySub $@ #calling the function |

**REFERENCES**

1. <https://github.com/Sreyas-108/GDF> : Link to the GIT repository having all our work
2. <https://www.w3.org/TR/rdf-concepts/> : Official documentation for RDF
3. <https://www.w3.org/TR/rdf-sparql-query/> : Official documentation for SPARQL (Query language for RDF)
4. <https://d3js.org/> : Official website of D3.js, the renderer we are using
5. <https://wiki.dbpedia.org/> : Link to DBPedia – the site from where we will collect 3-column formatted data

**GLOSSARY**

**RDF:** Stands for Resource Description Framework. It is a graph-based database system (NoSQL)

**SPARQL:** The query language for RDF

**Meta-Data:** The data about data

**JSON:** Stands for Java Script Object Notation. It is a lightweight format for storing and transporting data.

**Renderer:** It is a software to read a data file. In context of our project, renderer will read the JSON objects generated from the GDF file and generate Graph SVG.

**SVG:** Stands for Scalable Vector Graphics. It is an XML based vector image format that supports interactivity and animation.

**D3.js:** JavaScript library for manipulating documents based on data. This is the renderer we are using in our project.