FIU FLORIDA INTERNATIONAL UNIVERSITY

Partnership for International Research and Education
A Global Living Laboratory for Cyberinfrastructure Application Enablement

LAGrid Latin American Grid

Project Title: Computing Object Similarity Using MapReduce

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National Science Foundation

I. Research Overview and Outcome

Object Similarity MapReduce Template

- Given:
  - An object α of type γ
  - A collection β of n datasets $\beta_1,\ldots,\beta_n$
    - Each β_i contains a list of j objects $\beta_{i,1}$ to $\beta_{i,j}$ of type γ
  - A similarity function $\delta(o_1, o_2)$ that determines the similarity between o_1 and o_2 of type γ
- Find the level of similarity between α and every object in β using δ.
- Output the results organized by key based on, for example, level of similarity.
  - i.e. {0-30% Similar, γ[]Objects},{31-60% Similar, γ[]Objects},{etc}

Some Possible Applications

- Social Network Profiles
  - Given a profile α and its corresponding friend list F_α
  - Return all friends that have an 80% similarity based on musical taste.
- Spatial Objects
  - Given a search point α and an unsorted dataset of all McDonalds restaurants
  - Return all McDonalds within 6-10 miles of α that have a "Play Place"
- Plagiarism Detection
  - Given a document α and a corpus of documents β
  - Find if there is a member β_i of β with a level of similarity to α greater than 50%

Traditional Implementation

- for(int i = 0; i < n; i++)
  - Read dataset β_i
  - for(int j = 0; j < β_i.numRecords; j++)
    - Read object $\beta_{i,j}$
    - similarityMeasure = $\delta(\alpha, \beta_{i,j})$
    - Place $\beta_{i,j}$ in appropriate "bucket" based on similarityMeasure
- Sequential
- Bottlenecks to one object comparison at a time
- Data is in one central location
- Requires a write to file each time an additional result is obtained

Why the need to cope with heterogeneous datasets?

- The availability of linked open data (LOD) and other heterogeneous data allows us to dynamically add functionality to our applications
- Our GPS navigation system may not have a list of all McDonalds restaurants but, if we tell it where to find a the information then a method such as IBM's Midas can help us extract the data and we can instantly provide new functionality.
- MapReduce allows us to focus less on efficiency and more on dreaming up new content avenues we can open
- Once we see a consistent need for the functionality we can proceed to develop an efficient non-mapReduce solution.
- MapReduce allows us to provide the functionality right away without significant effort and development

Unsorted Spatial Data Example

- Given a point α, a set of keywords ε, and a collection of datasets β
- Return a list of objects in β that contain some or all ε_i aggregated by "distance range".
  - Given
    - α= (80.98, -127.356)
    - ε = {McDonalds}
  - Result:
    - List of
      - All McDonalds between 0-5 miles of α
      - All McDonalds between 6-10 miles of α
      - All McDonalds between 11-20 miles of α
      - All McDonalds 21 miles or more away from α
- Paradigm can be tuned quite easily for many different domains!

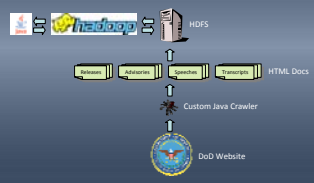
MapReduce Implementation

- Input to Mapper <β_i, $\beta_{i,j}$>
  - similarityMeasure = $\delta(\alpha, \beta_{i,j})$
  - κ = whichBucket(similarityMeasure)
  - outputIntermittentKeyValue(κ, $\beta_{i,j}$)
- Intermediate Output <key κ, Object $\beta_{i,j}$>
- Combiner will combine these by key
- Input into Reducer <key κ, < γ > ObjectIterator>
- Reducer Output <key κ, γ [] Object>
  - In the case of the described spatial application the result is simple a concatenated file of all of the objects in the ObjectIterator
  - The result can be in any format we specify; array, iterator, string, etc.

U.S. DEPARTMENT OF DEFENSE

A DoD Publications Archive Search Tool Using MapReduce

Overview



Data

- Approximately 4,000 HTML files in each of the 4 categories.
  - New files are added daily
- Size ranges from 34k to 500k
- Data was duplicated to reach Hadoop file quantity limit.
- Mapper will process entire file as record
  - Attempt will be made to adapt code to read one line at a time as well and output aggregate counts.
    - i.e. How many speeches were made on July 4, 1996?

MapReduce Paradigm

- Each file is processed as a record <k1, v1>
  - <NullWritable, BytesWritable fileContents>
- *Who*, *What*, *When* is extracted and emitted <k2, v2>
  - <Text *Who*, Text *When*>
  - <Text *When*, Text *What*>
  - <Text *When*, Text *Who*>
- Three Possibilities for Reduction:
  - Reducer aggregates based on *Who* and returns a list of *Whens*
    - <Text *Who*, BytesWritable *Whens*>
  - Reducer aggregates based on *When* and returns a list of *Whats*
    - <Text *When*, BytesWritable *Whats*>
  - Reducer aggregates based on *When* and returns a list of *Whos*
    - <Text *When*, BytesWritable *Whos*>

Result

- A searchable data structure containing information about all DoD publications since 1994.
- Query front end can easily be developed
- Information discovery and data mining possibilities will exist.

Sample Application

- Find all speeches and transcripts of President Bush in 1995
- Find any press advisories about Saudi Arabia that were issued at most 5 days before a speech given by Donald Rumsfeld that mentions Saudi Arabia.

II. PIRE Experiences

- **Received guidance from leading researchers on:**
  - IBM's systemT, JAQL, and Midas
  - MapReduce using Hadoop
  - JSON, DB2, and more!
- **Immersed myself in Bay Area and Catalonian culture.**
- **Used the knowledge gained to propose a data driven outcome prediction system.**
- **Extracted the US government organizational chart from PDF files using systemT, JAQL, JSON, and Hadoop!**
- **Gained intimate knowledge of US government agencies encouraging my pursuit of civil service careers.**
- **Made friends from Silicon Valley, China, Spain, Italy, and more!**

III. Acknowledgement

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