Interactive Data Exploration and Analytics

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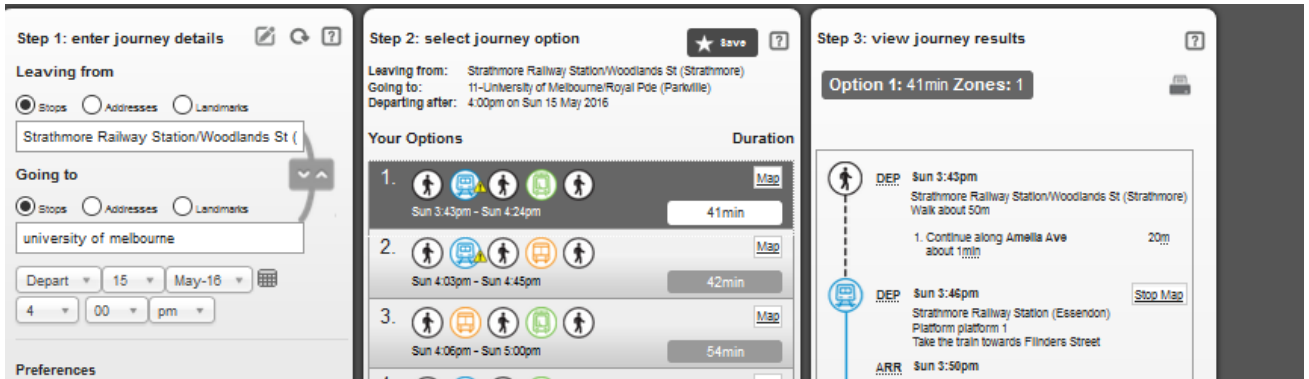
Problem Background

- Massive amount of data i.e. Big Data and the need to gain knowledge from it.
  - Marketing purposes – targeted advertising based on trends and buying patterns
  - Scientific discoveries
  - Improved emergency services
- "Knowledge is power" – Francis Bacon
- What is the best way to make use of big data?
- Traditionally:
  - finite data within a database
  - Users have good knowledge of database schemas
  - Specific requirement for what the output needs to be
- This method WILL NOT work for big data.
- Need for an efficient method to explore big data in order to find interesting patterns or make new discoveries. Hence, "interactive data exploration and analytics"

Interactive Data Exploration and Analytics

- Enables the extraction of interesting patterns or knowledge from big data without knowing beforehand what is being sought for
- It involves continual analysis of a dataset, often one that typically exceeds the processing power of conventional databases, i.e. big data
- As defined by Idreos: *"to allow for instant access to the data, i.e. , without expensive initialisation steps , while at the same time, allowing the user to extract knowledge from the data by selectively and interactively investigating only parts of the data."*
- It is useful to researchers, scientists, policy administrators, charitable organisations, and just about any organisation interested in acquiring information from unprocessed data.
- Everyday examples:
  - Google Maps, PTV Journey Planner



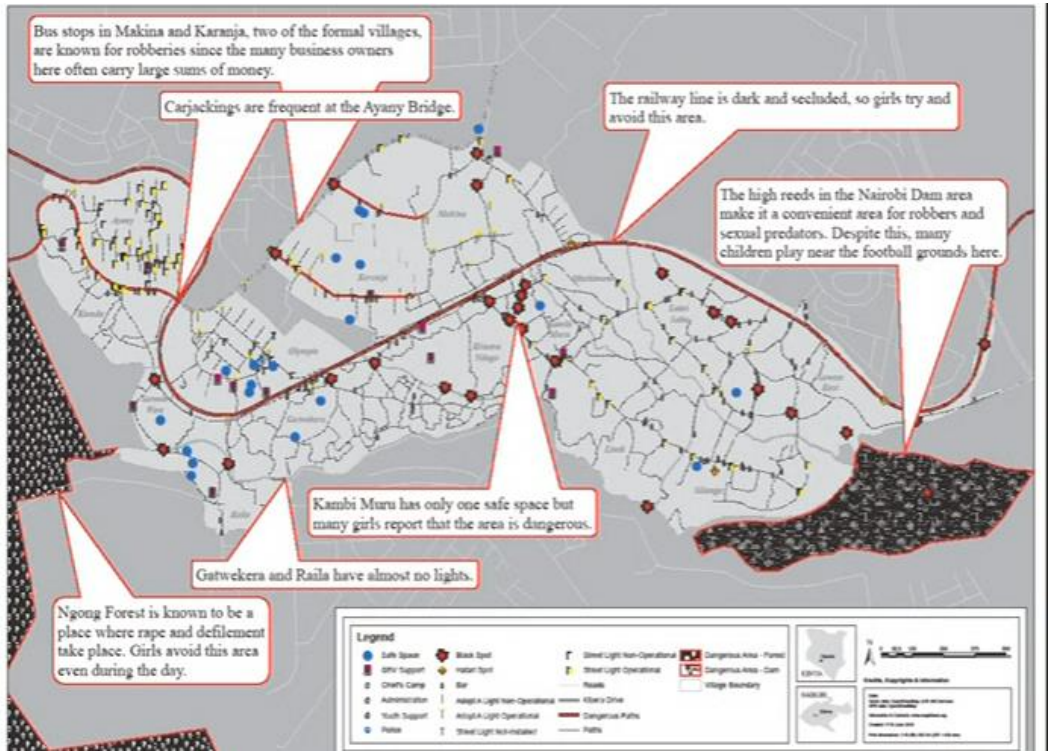
Facets of Data Exploration

- Visualisation Tools
  - Presenting data in a graphical form assists in gaining new insights and hypothesis about the data
- Exploration interfaces for user interaction
  - Facilitate user interaction with underlying data
  - Query Result Visualisation
  - Exploration Interfaces
    - Automate the process by discovering relevant data objects
    - Assist formation of queries

- Middleware
  - How can the performance of the data exploration task be improved?
  - Data Prefetching
    - Reduce overall exploration time
    - Challenge: Identifying promising data sets
  - Query Approximation
    - Approximate results improve response time
    - Query execution over subsets of data
- Database engine
  - Redesigning the database system architecture
  - Adaptive Indexing
  - Adaptive Loading

Advanced Projects/Applications

- Open Street maps(left) and iSpark(right)



- Applications allowing interactive data exploration can be useful for emergency services and humanitarian relief organisations as well

Building the application?

- The first and foremost stage before the whole data exploration and analysis process

- Data collection and manual data analysis
  - Selection of data sets critical for completeness, performance later
  - Involves web crawling or retrieving historical data from reputable sources
  - Human analysis of samples of underlying data, to determine features to start with
- Machine learning to organise and identify patterns
  - Algorithms vary widely according to applications
  - Include: Statistical Regression, K-Clustering, Neural Networks
- Caching the data

Vinem – A Data Mining Platform

- Visual Interactive Neighbourhood Mining on High Dimensional Data
- Purpose: Finds sub-space clusters over HD data i.e. finds sub-groups of objects that are related to each other
- Principle: Sometimes unsupervised methods of machine learning are more suitable for data exploration when little is known about the data in advance (particularly that which is usually raw or dirty)

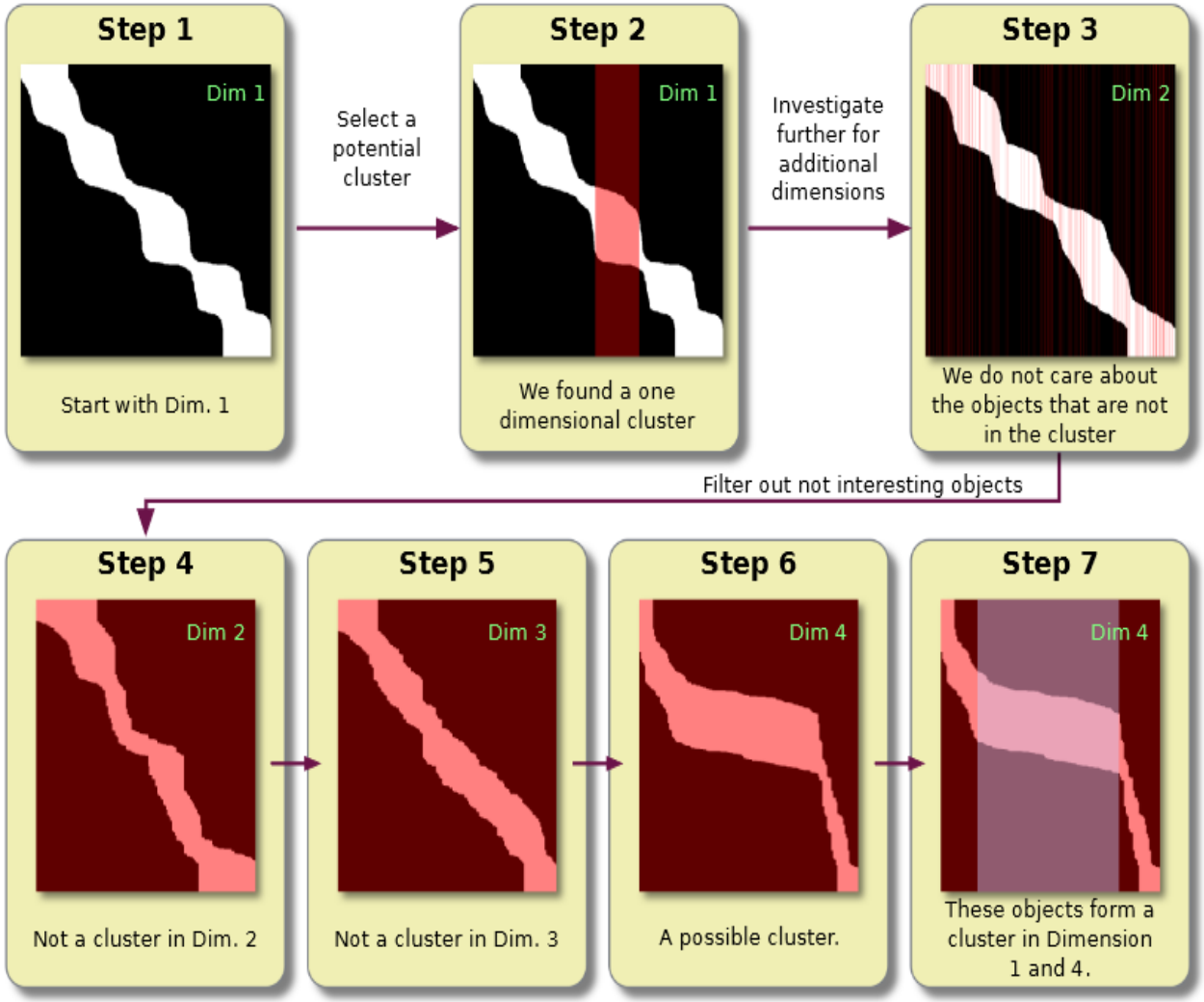
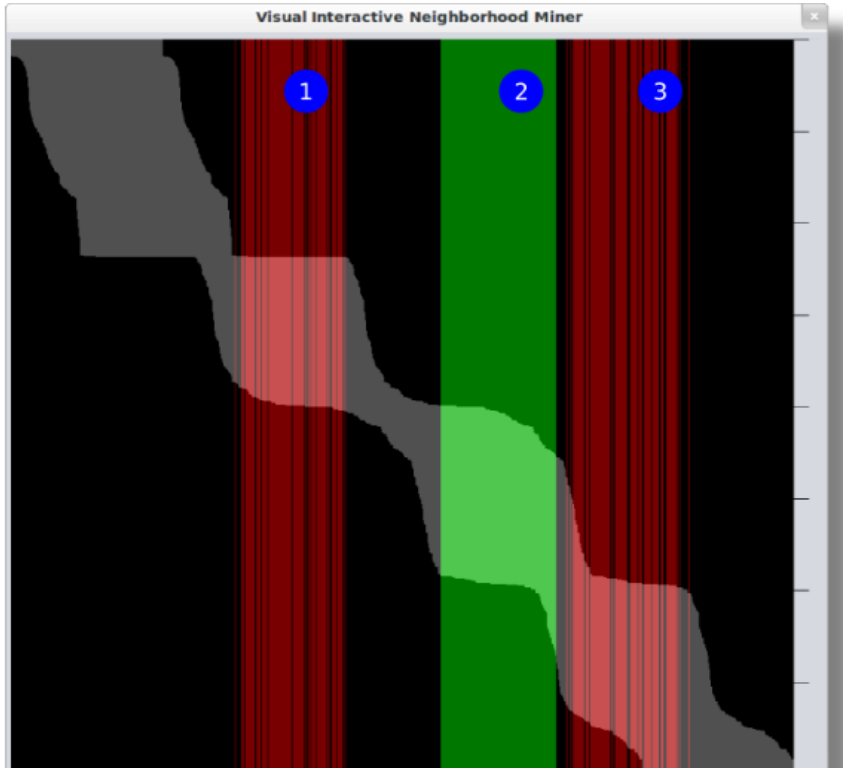
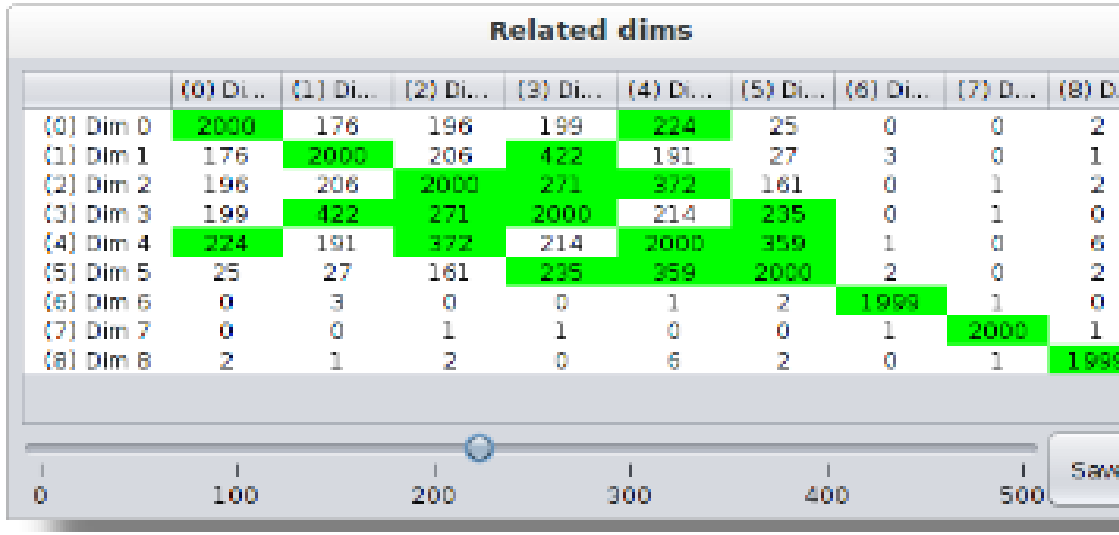


Fig: Data Mining Process in Vinem

Vinem – Visual Results

- In the visual interface users have control over:
  - the data sets to be included parameter selection
  - The type of neighbourhood (k-nearest of euclidean)
  - The mining method to focus on (fast or sampler.)
  - The required support weighting for individual attributes.
- There are different views available for displaying the results:
  - object neighbourhoods
  - member objects per cluster and the relevant attributes that were used for grouping them together.
  - E.g. right (Neighbourhood matrix, relevancy score of dimensions)





Text Data Exploration

Current Event Detection Practices

- *Detection of bioterrorism:* monitoring of health data such as sales of OTC medicines to detect events related to disease outbreaks like epidemics.
- *Detection of health related issues:* Monitoring of daily data feeds of 20,000 hospitals, pharmacies, medicine sales both temporally and geographically.
- **Shortcomings:** These applications lack the ability to handle text corpora which has the potential to include rich information.

Leadline Introduction

- The content of news*(CNN News)* and online social media *(Twitter microblogs)* embody important insights regarding the important events happening everyday.
- ***LeadLine***, added the capability of connecting topical themes with associating events on top of existing text data exploration tools.
- ***Leadline*** used 4W's approach which is What, Who, Where, When:
  1. Topical Modelling
  2. Early Event Detection
  3. Named Entity Recognition

- **Challenge:** An important obstacle is to keep the valuable information lost through the massive influx of text data and extract information in an event-driven approach.
- **Event Formulation:** In this context an event will be described with the tag *<Topic, Time, People, Location>*

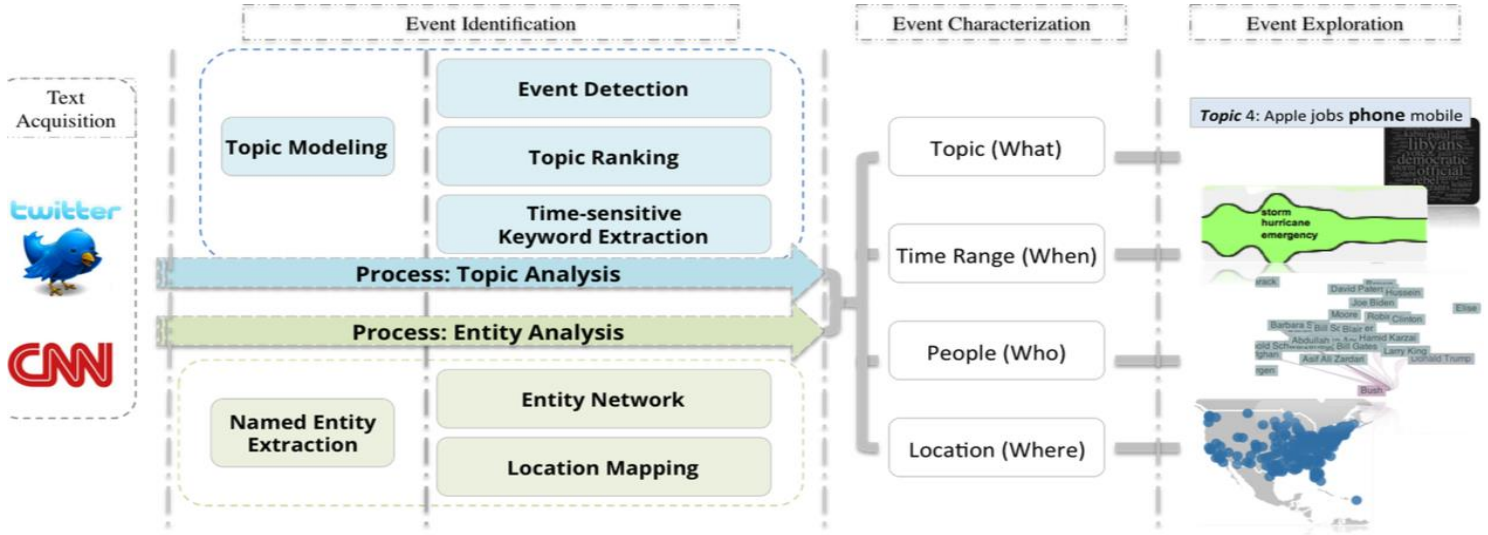
Leadline

Functionality of Leadline

- Leadline's main focus is to extract events from the text corpora.
- The text data is first organised into topical streams over time by *Latent Dirichlet Allocation (LDA)*.
- In order to detect the **"burstyness"** and the length of the events in temporal(time) scale an *Early Event Detection Algorithm* is used.
- *Named Entity Recognition* is used in order to discover the event's related People and Location attributes.

Leadline Visual Interface

- The visual interface provides the effective exploration of the events with related People and Location attributes of the events.
- It is used for building up the narratives of the event sequences in temporal(time) scale.
- It enables users to report their findings and provides capabilities for further analysis.



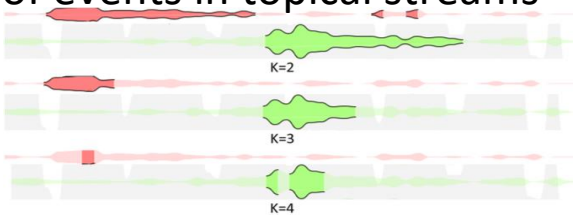
Leadline (contd.)

Data Acquisition

- There are no readily available datasets for CNN news and Twitter microblogs.
- So *web crawler bots* are used in order to acquire required data.
- The data acquisition process for *CNN News:*
  1. crawl the entire web domain
  2. download the pages,
  3. extract, parse and normalise the text articles, remove HTML formatting and noise from the text.
- For *Twitter microblogs*, Online Social Media(OSN) graph based web crawling technique is used. (Users as nodes, connections as edges)
- In total **5 billion** *Twitter microblogs* and **100K** *CNN news articles* are extracted over the course of 3 months.

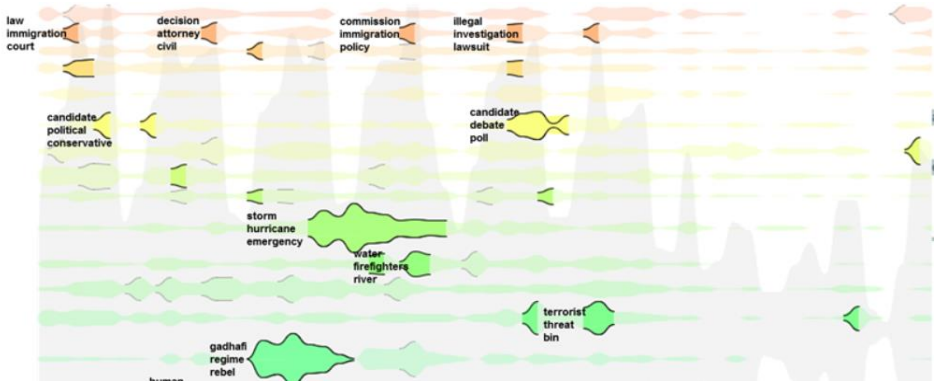
Leadline Introduction

- *Topical Level Event Detection Algorithm*: Find the "burstyness" of events in topical streams



- *Topic Ranking*: To visualise the related topics close to each other in topical stream visualisation

- *Time Sensitive Keyword Extraction*: To find what the event is actually about by using related keywords



Leadline (contd.)

Narratives

- *Leadline interactive system* uses attributes of events **(People, Place, Topic, Time)** to extend explorative capability of the user.
- *WordCloud* is used to summarise related events of Entities(People and Place).
- *Topic Streams* are used to visualise the Events on a river-like topical stream.
- *Geolocation Filtering* is used to extract meaningful information about the events.

Limitations and Improvements

- Limitations arise from the performance of the algorithms used such as *Topical Modelling* algorithm and *Entity Recognition* algorithm.
- *Entity Recognition Algorithm* gives results with uncertainty so the user should be noted.
- The system does not take into account inter-topic related events.
- If several bursts occur at the same time and same related entities, it can be assumed they are triggered by the same event.

Wrap Up

- Why Data Exploration is important?
  - People make decisions not computer, knowledge is power.
  - Big data surpasses conventional databases.
- Overview of Data Exploration facets such as User Interaction, Middleware, Database Engine
- How data exploration systems are built?
  - Data collection.
  - Selection of relevant attributes.
  - Machine learning algorithms.
- Vinem – a data mining platform
- Leadline - Event driven text data exploration tool

Questions

- Explain some ways that explorative data analytics is different from querying traditional databases.
- Discuss why data exploration and analytics is important.
- Give an outline of some steps involved in making an interactive data exploration application.

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