Part 8 – Trends in UID and HCI

We Shall Discuss

- Multimodal Interfaces
- Adaptive User Interfaces
- Web Usability
- Information Visualization
- Listen in to this talk by Peter Smart from Fantancy Interactive
  https://www.youtube.com/watch?v=m1zk4r6NWBc

Multimodal Interfaces

Multimodal systems

Existing types of multimodal interfaces

Advantages of multimodal interfaces

Multimodal interfaces vs. GUIs

Multimodal user interface design

Multimodal Systems

- We normally interact with the world through the five human senses: sight, sound, touch, taste and smell
- Multimodal systems process two or more combined user input channels (e.g. speech, pen, touch, manual gestures, gaze, and head and body movements) in a coordinated manner with a multimedia system output
- A multimodal system relies on the use of multiple human communication channels. Each different channel for the user is referred to as a modality of interaction
- Note that genuine multimodal interfaces rely to a great extent on simultaneous coordinated use of multiple communication channels

Multimodal Systems

- Some drivers of research and development in multimodal interfaces:
  - Improved and new recognition-based technologies and devices are becoming much more available e.g., speech-enabled devices, stylus-enabled devices, text-to-speech, VoiceXML, etc.
  - Increased demand and responsibility e.g., disabled, semi-illiterate using devices
- Future adaptive multimodal interfaces therefore have the potential to support new functionality, to achieve unparalleled robustness, and to perform flexibly as a multifunctional and personalized ubiquitous system

Existing types of multimodal interfaces

- The past two decades have seen a rapid development of multimodal systems
- In particular, what developments/changes have been witnessed?
  - Underlying support and techniques: There have been major developments in the hardware and software needed to support key component technologies incorporated within multimodal systems, as well as in techniques for integrating parallel input channels/modalities.
  - New modality combinations: Multimodal systems also have diversified to include new modality combinations, including speech and pen input, speech and lip movements, speech and manual gesturing, and gaze tracking and manual input.
  - More multimodal applications: In addition, the array of multimodal applications has expanded rapidly, and presently ranges from map-based and virtual reality systems for simulation and training, to person identification/verification systems for security purposes, to medical and web-based transaction systems that eventually will transform our daily lives.

Existing types of multimodal interfaces

- As **speech recognition technology** matured during the late 1980s and 1990s, multimodal systems added *spoken input* as an alternative to *text* entry via the keyboard. Among the many examples of this type of multimodal interface are CUBRICON and Shoptalk.

- More recent multimodal systems have moved away from processing simple mouse or touch-pad pointing, and have begun designing systems based on multiple parallel input streams that each are capable of conveying rich semantic information. For instance:
  - speech and pen input e.g. QuickSet system
  - speech and lip movements e.g. the classic work by Petajan (Automatic Lipreading to Enhance Speech Recognition)

The speech and pen & speech and lip constitute some of the most mature areas within the field of multimodal research. In both cases, the keyboard & mouse have been abandoned

Existing types of multimodal interfaces

- Vision-based technologies
  - There is growing interest in designing multimodal interfaces that incorporate vision-based technologies, such as interpretation of gaze, facial expressions, and manual gesturing
  - These technologies unobtrusively or passively monitor user behavior and need not require explicit and direct issuance of user commands. This contrasts with active input modes, such as speech or pen, which the user deploys intentionally as a command issued to the system

Advantages of Multimodal Interfaces

- **Flexibility** - multimodal interfaces permit flexible use of input modes
  - the choice of which modality to use
  - to use combined input modes, or
  - to alternate between modes at any time
- **Contextual adaptability** - Multimodal interfaces provide the adaptability that is needed to accommodate the continuously changing conditions of use
  - For instance: speech or touch input are appropriate in mobile conditions; speech input is more appropriate than gaze or keyboard input in an in-vehicle application
- **User satisfaction and preference** - A large body of literature indicates that multimodal interfaces satisfy higher levels of user preference than with unimodal interfaces

Advantages of Multimodal Interfaces

- **Efficiency** - They provide the ability to process input modes in parallel/simultaneously
- **Error handling and robustness** - The flexibility or alternation between modes in a multimodal interface also can be effective in preventing overuse and physical damage to any single modality, especially during extended periods of computer use (i.e. improved robustness)
- **Natural interaction** - Multimodal interfaces have the potential to support relatively more natural, transparent, and powerfully expressive means of human-computer interaction. For instance: speech, gestures, gaze, etc.
  - User interaction with a multimodal system therefore tends to bear more resemblance to the way the user naturally interacts with and in the real-world

//Multimodal interfaces vs. GUIs

- GUIs typically assume that there is a single event stream that controls the underlying event loop, with any processing sequential in nature. Multimodal interfaces typically can process continuous and simultaneous input from parallel incoming streams.
- GUIs assume that the basic interface actions, such as selection of an item, are atomic and unambiguous events. Multimodal systems process input modes using recognition-based technologies, which are designed to handle uncertainty and entail probabilistic methods of processing.
- GUIs often are built to be separable from the application software that they control, although the interface components usually reside centrally on one machine. Recognition-based user interfaces typically have larger computational and memory requirements, which often makes it desirable to distribute the interface over a network so that separate machines can handle different recognizers or databases e.g., cell phones and other networked devices may extract features from speech input, but transmit them to a recognizer that resides on a server.
- Multimodal interfaces that process two or more recognition-based input streams require time-stamping of input, and the development of temporal constraints on mode fusion operations. In this regard, they involve uniquely time-sensitive architectures.

Multimodal User Interface Design

Guidelines for multimodal user interface design

- Requirements specification
- Multimodal input and output
- Adaptivity
- Consistency
- Feedback
- Error prevention and handling

Guideline for Multimodal User Interface Design

Requirements specification

- Design for broadest range of users (level of experience, physical attributes, cultural background) and contexts of use (task, domain, environment)
- Address privacy and security issues

Multimodal input and output

- Maximize human cognitive and physical abilities (e.g. avoid unnecessarily presenting information in two different modalities in cases where the user must simultaneously attend to both sources, etc)
- Integrate modalities in a manner compatible with user preferences, context, and system functionality (e.g. ensure system output modalities are well synchronized)

Guideline for Multimodal User Interface Design

Adaptivity

- Multimodal interfaces should adapt to the needs and abilities of different users, and to different contexts of use (e.g. allowing gestures to augment or replace speech input in noisy environments, adapting the quantity and method of information presentation to both the user and display device).

Consistency

- This should be reflected in the input prompts, output, and across modalities.
- In terms of terminology, interaction features, etc.

Multimodal User Interface Design

System status and feedback

- Users should be aware of the current system status (e.g. current connectivity, modalities available to them, current processing, etc); system should also evidently respond to user's interaction and commands.

Error prevention and handling

- For instance, by providing clearly marked exits, allowing users to undo/reverse actions, supporting mutual disambiguation of input signals, etc.

Reading Assignment

- Application Areas of multimodal interfaces

Multimodal User Interface Design

- The future of computing is multimodal

Adaptive user interfaces

What are AUIs?

Advantages and disadvantages of AUIs

Application Areas of AUIs

Adaptive User Interfaces

- **Adaptive User Interfaces** (AUIs)belong to a class of intelligent interactive systems and are user interfaces that assist users accomplish tasks when using an application while they construct a model of the user's preferences so as to serve them better in the future
- It changes its design, controls, information and other elements according to the user' needs

Adaptive User Interfaces

- Emerged due to the growth of revolutionary technologies such as the Graphical User Interface (GUI) and Artificial Intelligence (AI)
- AUIs have the ability to adapt to changing needs of individuals who need data presented to them in a manner that allows the data to be easily interpreted.
- AUIs also take into consideration the uniqueness of their users and allow them to easily understand and use data presented to them with minimal training.

Advantages of AUIs

- The primary advantage of adaptive user interfaces is their ability to adapt to the user's needs
  - An AUI shows only relevant information based on the current user and this creates less confusion for less experienced users
- Another advantage of adaptive user interfaces is security
  - Since they only show information that's relevant or essential to the user, there's a lower risk of data breach

Disadvantages of AUIs

- Designing them, for example, is a more time-consuming and methodical process than other, non-adaptive user interfaces
- Subsequently, this increases the cost of adaptive user interfaces
- Requires knowing and understanding users' unique needs and a user's goals in order to most efficiently adapt
  - the AUI therefore must be designed with varying levels of implementation in mind, and be coupled with a way to measure any particular users needs

Application Areas of AUIs

- Medical systems for both doctors and patients
- eLearning Systems

Web Usability

Definition

Navigation

Supporting Web Usability

ISO Guidance on WWW User Interfaces

Web Usability

- Web usability is the application of usability in those domains where web browsing, and web search, or web navigation in general, can be considered as the general paradigm for constructing interactive web-based applications.

- In order to achieve web usability, the website development process should ideally adopt the user-centered design methodology

Navigation

- Navigation is primarily concerned with finding out about, and moving through, an environment.
- Design of navigation in information spaces:
  - Signage
  - Maps and guides
  - Environmental cues and social navigation

Navigation

- **Signage** - Good, clear and unambiguous signposting of spaces is critical in the design of spaces
  - There are three primary types of signs that designers can use:
    - informational signs
    - directional signs
    - warning and reassurance signs
- **Maps and guides** - Maps can be used to provide navigational information.
  - When maps are supplemented with additional detail about objects in the environment, they become guides
- **Environmental cues and social navigation** - Even in a well-designed environment, people will often turn to other people for information on navigation. We may use cues like observing the behaviour of other people and what they do
  - This is often supported using online social media features such as forums, blogs, chats,

Supporting Web Usability

1. Site Structure and Content
   - Structure information so that it is meaningful to the user
   - Determine what information content the user needs at what level of detail.
   - Use terminology familiar to the user.
   - Consider how users read content – they rarely read web pages word by word - they tend to scan pages to find the information they want
   - Determine what information content the user needs at what level of detail
2. Support Navigation:
   - Help users find their way
   - Tell users what to expect
   - Highlight important links
3. Page Design:
   - Design an effective home page
   - Design for efficiency and minimize download time
   - Make text easy to read and use
   - Support different browser environments

ISO 9241-151:2008 Guidance on WWW User Interfaces

- This standard provides guidance on the human-centred design of software Web user interfaces with the aim of increasing usability
- The standard covers five areas:
- **High-level design decisions and design strategy:** These include deciding on the purpose of the site and how this is communicated to users; who the intended users are and what they are trying to get from the site (their goals).
- **Content design:** This includes the conceptual model underlying the site; how it is organized and how issues such as privacy and personalization are addressed.
- **Navigation:** This includes how the content can be organized to help users navigate the site easily; and also how search is organized.
- **Content presentation:** This includes how pages and links should be designed to help users achieve their information goals.
- **General design aspects**: This includes issues such as internationalization, how to provide usable help and building in error-tolerance (what download times are acceptable).

Reading Assignment

- Find out whether the standard also handles:
  - Mobile Web user interfaces and/or smart user interfaces.
  - Non-conventional designs such as aesthetic and affective design.

Information Visualization and Visual Analytics

Information Visualization

Visual Analytics

Drivers in the fields of infovis and visual analytics

Types of visualization

Examples of information visualization

Information Visualization (infovis)

- **Visualization** is "the act or process of interpreting in visual terms or of putting into visible form." [Webster]
- **Information visualization** is the process of transforming abstract data into an interactive, visual form that will assist or trigger users to use their natural capabilities, mental and visual, thereby gaining insight and understanding of that data.
- Infovis allows information to be derived from data
- Importance of information visualization:
  - reduces the search space
  - increases the resources that are available to the user (e.g. working memory)
  - enhances detection and recognition of pattern
  - delivers a perceptual advantage, in terms of inference and monitoring
  - represents information in a manner that facilitates interactivity

Visual Analytics

- **Visual analytics** is defined as the science of analytical reasoning facilitated by visual interactive interfaces
- Visual analytics combines info with computational analysis approaches
- Visual analytics is therefore concerned with coupling interactive visual representations with underlying computational analytical processes (e.g., statistical procedures, data mining and machine learning techniques) such that high-level, complex activities can be effectively performed (e.g., sense making, reasoning, decision making).

Drivers in the fields of infovis and visual analytics

- Major technological advances have led to:
  - Reductions in memory cost and speed
    - encouraging data storage in business, government, …
  - Increases in computation speed & power
    - supporting rapid selection of data to display & allowing interactive computation of views
  - High-resolution graphical displays
    - allowing views that match the power and characteristics of human perception & cognition

Types of visualization

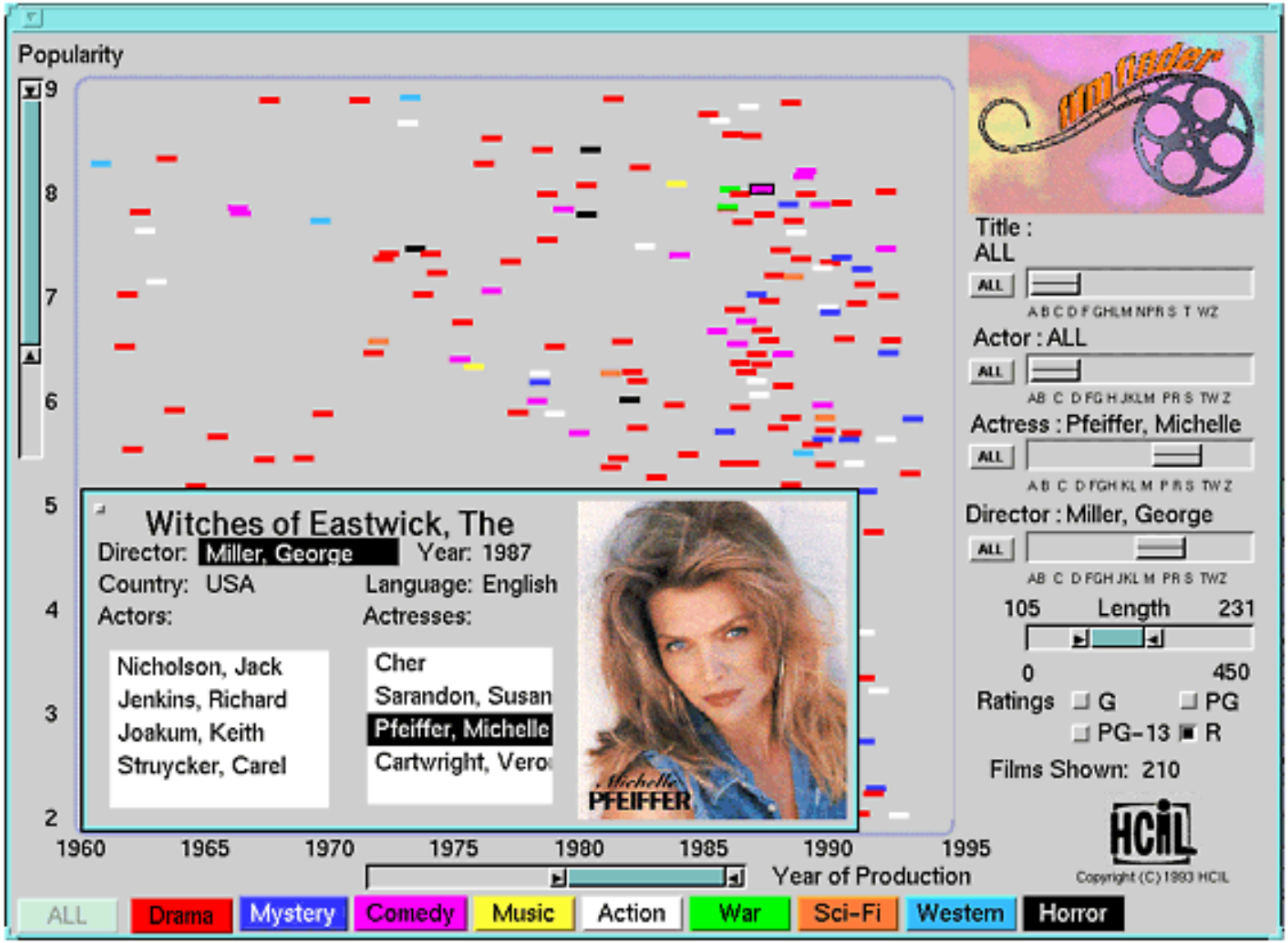
Visualization design highly depends on the underlying data and the specific application.

- **Graph visualization**
  - For graph-like data, analysts are usually interested in patterns related to topological structures. For example, friendship relations between a group of people can be represented as a graph. When exploring the relations, analysts often use visualization to keep them aware of the structure context.
- **Text visualization**
  - To visualize textual data, the semantic meanings in the content attract the most attention. For example, various visualization techniques have been developed to help analysts understand the theme or major topics in a large collection of documents.

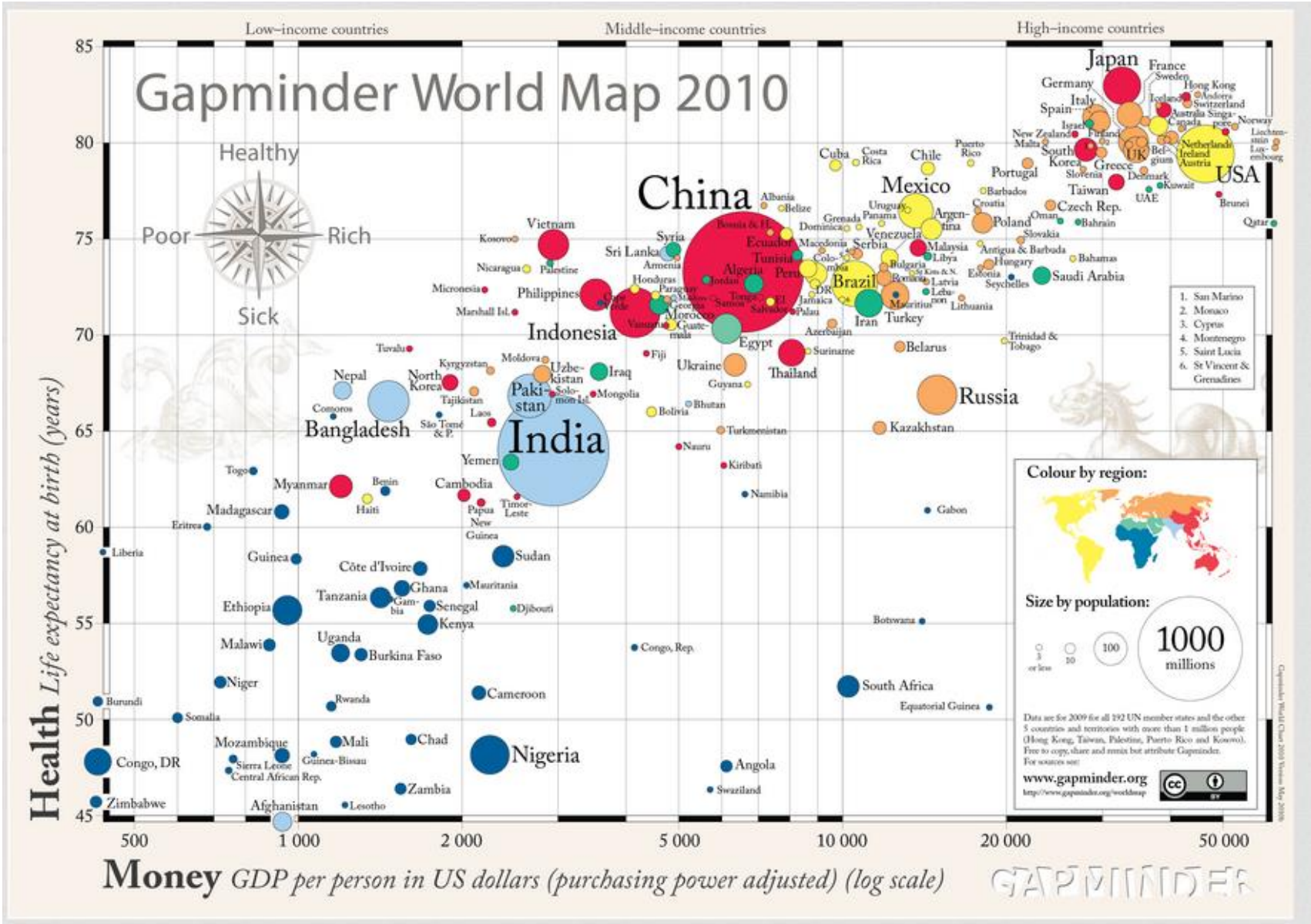
Types of visualization

- **Spatial/map visualization**
  - When dealing with geographic data, understanding the spatial distribution of information is usually the key to solving many problems. For example, to reveal patterns in trajectory data, one common approach is directly visualize them on the map.
- **Multivariate data visualization**
  - Multivariate data, as a most general data type, exists in various fields, but one common goal is to explore the inter-relationships between different dimensions. Targeting at the inter-relationships, various visualization techniques have emerged to help analysts identify, locate, distinguish, categorize, cluster, rank, compare, associate, or correlate the underlying multivariate data

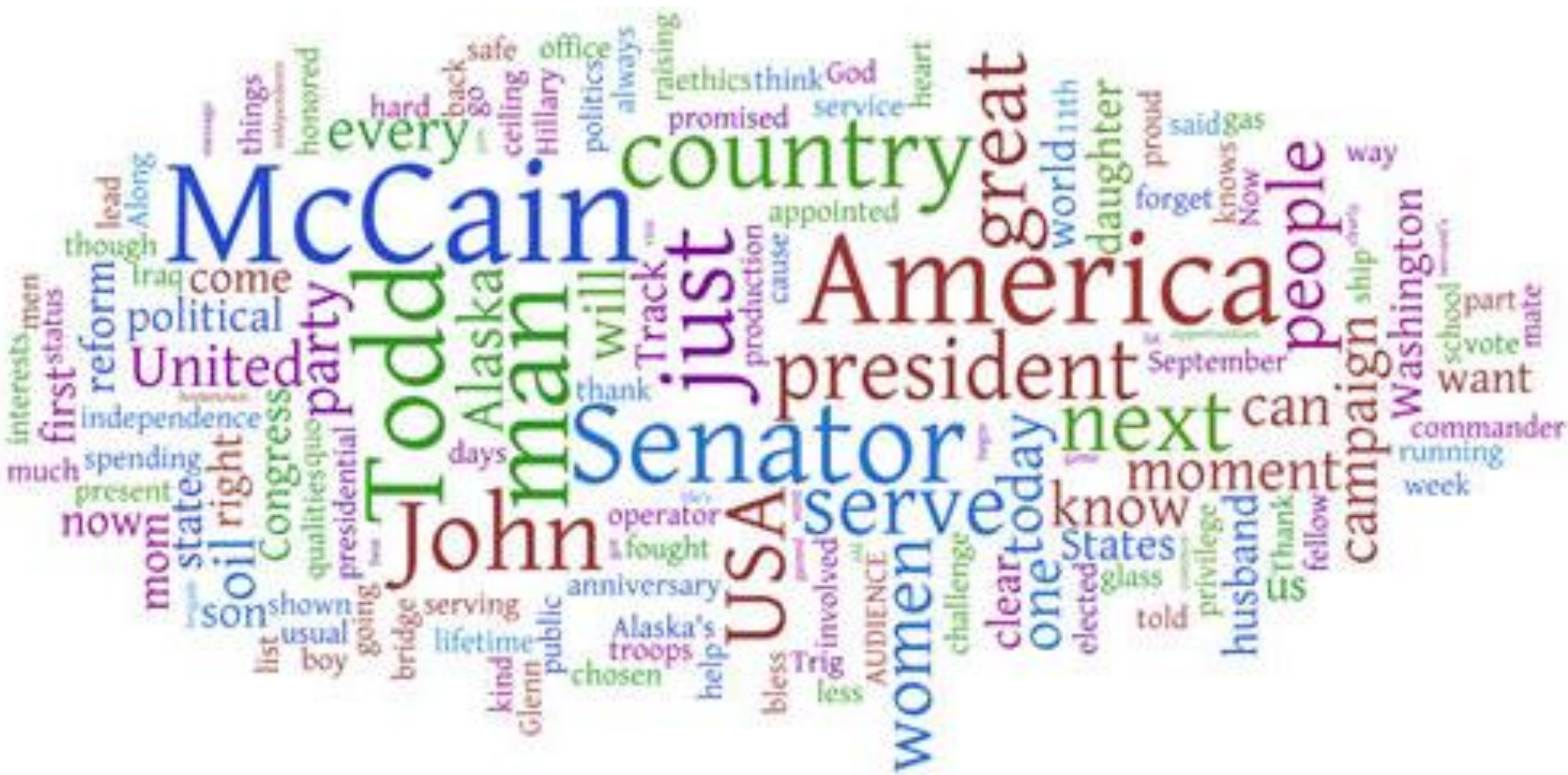
Examples of information visualization



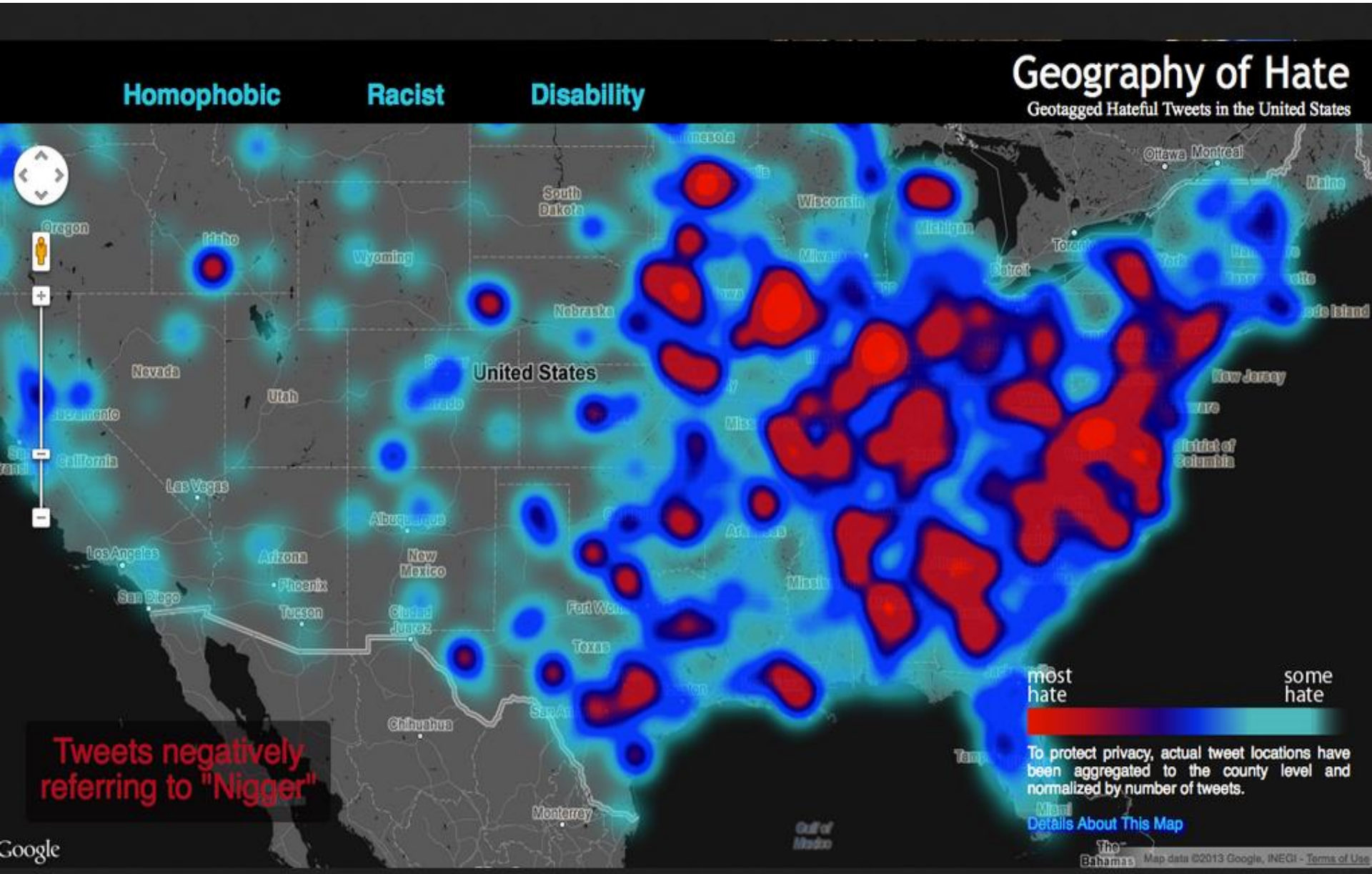
Examples of information visualization



Examples of information visualization



Examples of information visualization



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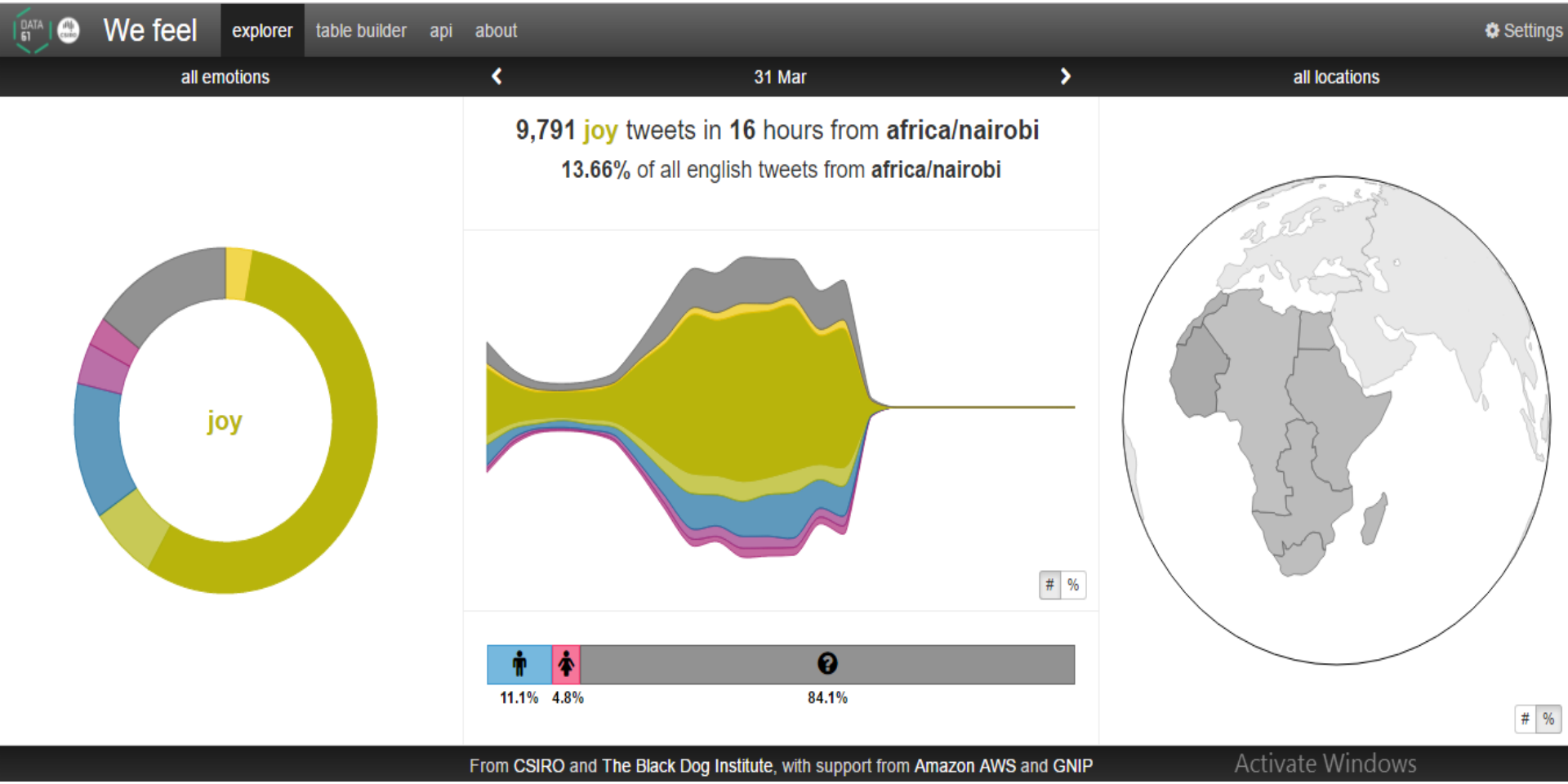

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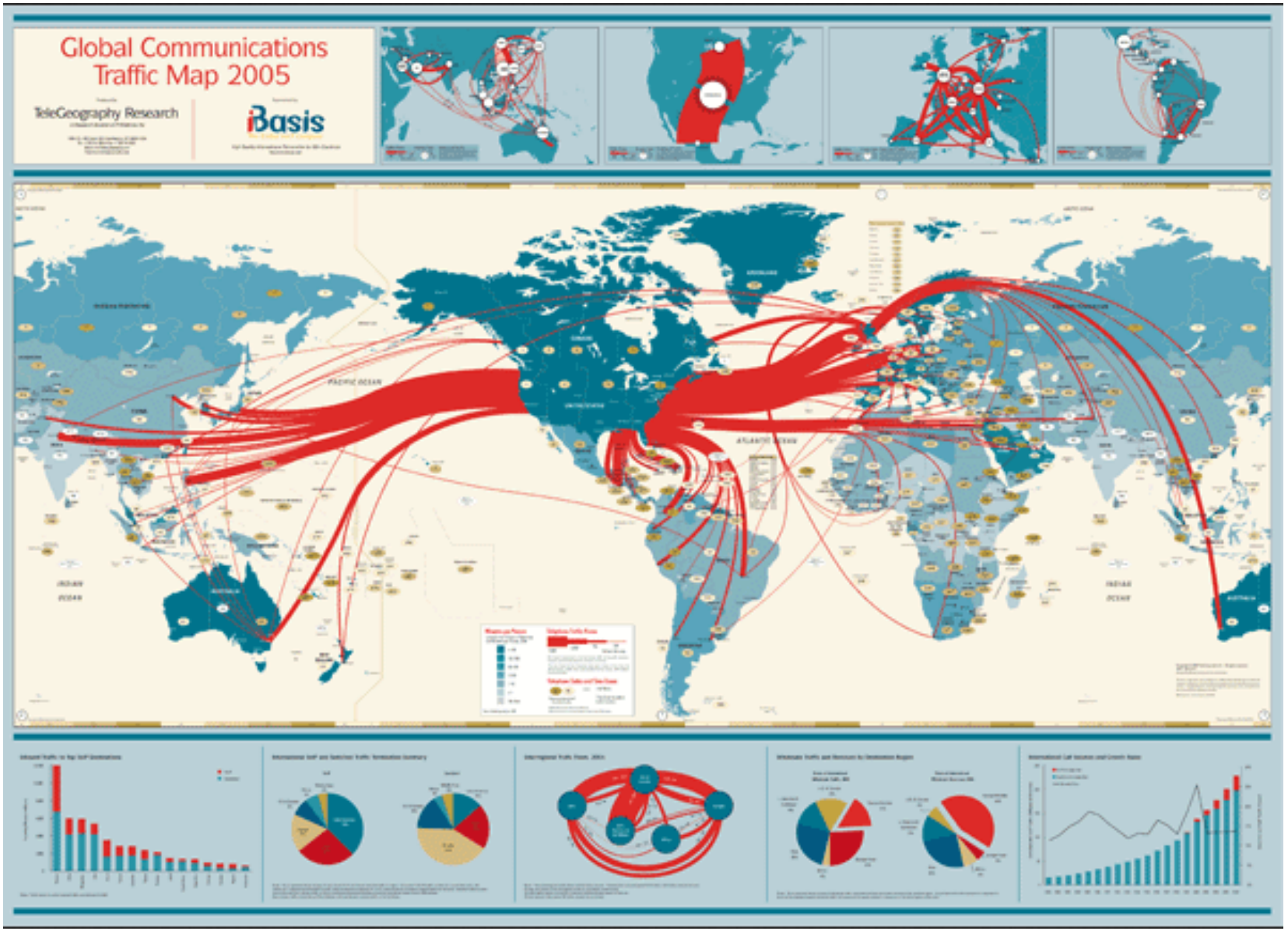
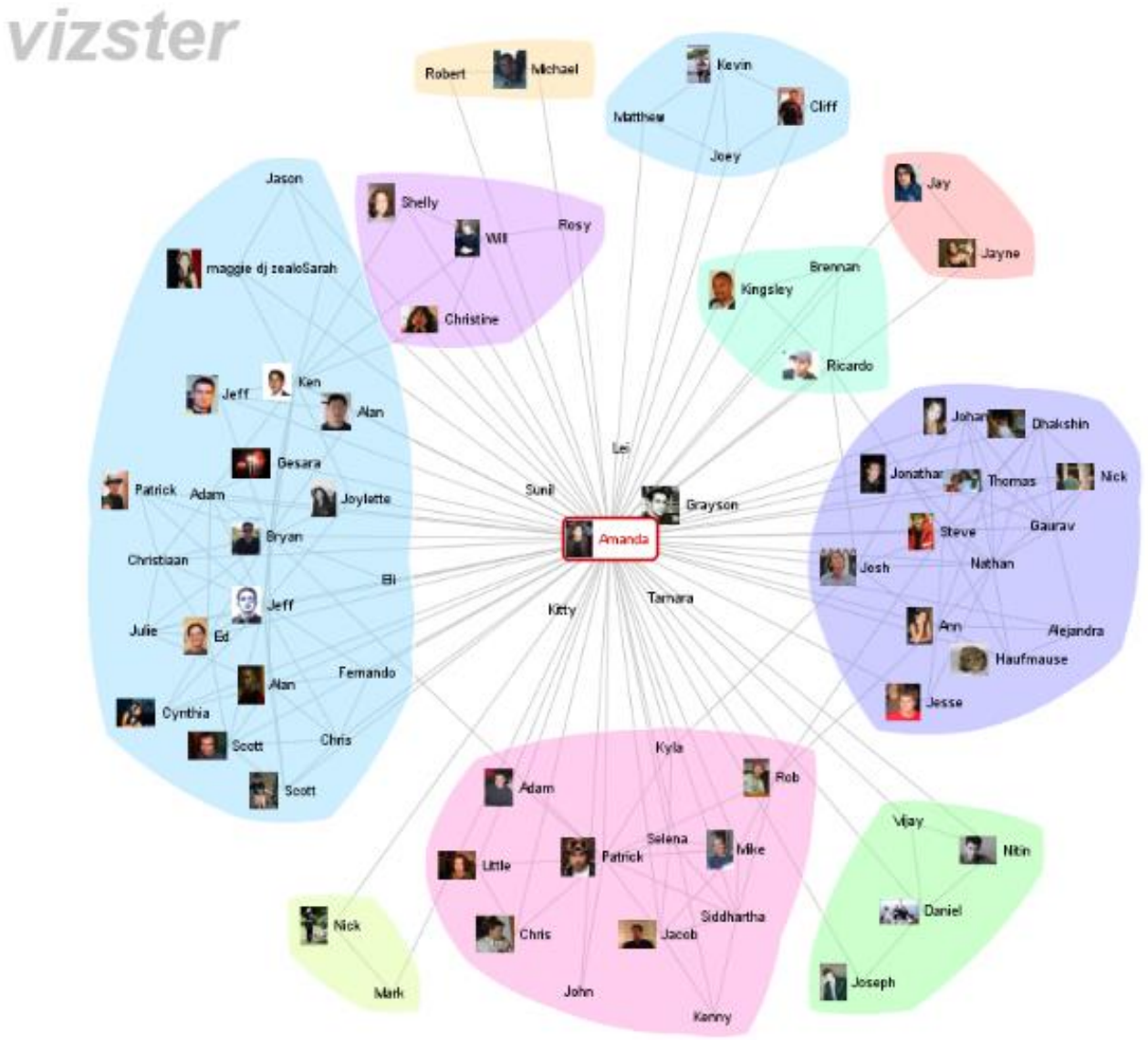


Examples of information visualization



Reading Assignment

- Describe the following:
  - What is Mobile UX (mUX)?
  - What are the Elements of mUX?
  - What are the best Practices for Designing for mUX ?
  - What are Computer mediated interactions?
  - What is Computer-supported cooperative work (CSCW)?
  - What is social computing?
  - What are the application areas of social computing?
  - What tools are used for social computing?
  - What is Affective computing?
  - What is affective communication?
  - What are the applications of affective computing?