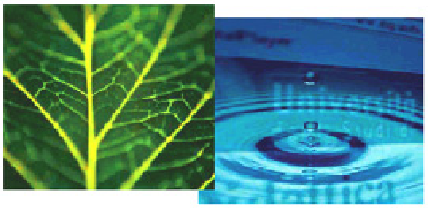
PhD Dissertation



International Doctorate School in Information and Communication Technology

DISI - University of Trento

A User Centric Interface for the Management of Past, Present and Future Events

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Abstract

Events have been categorized, modeled and recorded by researchers and practitioners for many centuries. Life and events are always being the philosopher's topic of debate. For us, event is any happening worth of remembering. This thesis makes an in-depth philological query of the nature of events and their intricate relationship to other events in the tapestry of complex social structures. We tried to understand our life events from grainy to vast in nature and size. Causation and effects are investigated and a simplified model is proposed for a user centric personal event management system which is fundamentally different from any existing system. Facts as a priori and stories as a posteriori has been separated by formal definition. Novel visualization and interaction is proposed to meet every individual's needs. The concept of lifelines has been introduced for the organizational requirements of a single person's life events that made it possible to distinguish from being the part of an event and being the witness of an event. This visualization model made it easier to manage causal relationships between events. Rich and intuitive interaction has been developed and proposed through the user-centric design process.

Keywords

Temporal data visualization, Minimalist Metadata visualization, Automatic and semi-automatic Metadata generation, Event organization and management.

Contributions and publications

This work has been developed in collaboration with Prof. Fausto Giunchiglia. For this work, diversified areas of thought have been studied and integrated ranging from philosophy to technical hands on experiences.

This dissertation makes the following contributions:

- Modeling life events taking different perspectives of human experience. *The river metaphor* is one of the notable integration of two different areas of knowledge that made possible modeling and visualizing complex events.

- A content rich interrelated timeline visualization has been proposed that resolves complicated issues like overlapped, nested and parallel events in the personal event management system.

- A novel User Interface layout method has been introduced that binds the interface properties and behavior together with data and action controls coherently.

- Minimalist metadata visualization for entity recognition has been investigated through user studies and valuable findings and directions are being reported.

- An extended data visualization reference model has been proposed for simultaneous multi-granular data visualization from same data set.

Part of this thesis had been published in the following paper -

Tabin Hasan and Anthony Jameson. *Bridging the Motivation Gap for Individual Annotators: What Can We Learn From Photo Annotation Systems?* In 1st Workshop on Incentives for the Semantic Web (INSEMTIVE2008) at the 7th International Semantic Web Conference (ISWC2008), Karlsruhe, Germany, October 2008.

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This work is dedicated to my mother *Khandaker Hashima Islam* who is been long waiting for my return back to home.

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Chapter 1

Introduction

1.1 The Context

Life is the most intriguing word in human vocabulary. Probably human is the only life form on earth that questions *life*. Men have defined the meaning of life in many different perspectives with one undeniable accord - event lends color to life. From birth to death, a life is full of events, small or big, happy or unhappy. Each life is the reminiscence of *past* and the author of *future*; bridging them is a nebulous time called the *present*.

One life contained in one line of time, no branch, no parallel. It has one start point and one end point. No matter how small is the length, its excellence prevails over all human experiences. It includes birth and death - the most formidable of all events. Historians keep account of historical events, none to keep account of events that happen everyday in our lives. *The first kiss in life* could be more worth of remembering than caring for how many stars born today. What is *important* to us may not lie in the line of historical account, but there is a need for individual to keep record of and maintain them with affordable cost. In recent years, number of systems had been developed, from event calendar to life logging, to help capture, organize and remember our memories. But events are not always something that involve one person, rather the intersections in the tapestry of a society. We tried to look deep into its structural nature both from a philosophical as well as technical perspective and found a need for solution coherent with real life experience.

More detailed accounts on event in life are discussed in chapter 3.

1.2 The Problem

One particular proposition is very clear from the above context that whatever view we take toward the meaning of life, even a small event in life could be far more meaningful than an event of a cosmic magnitude, thus making it more difficult to put life events in a single management system. Karl Wilhelm von Humboldt has given a different perspective on event - *I am more and more convinced that our happiness or our unhappiness depends far more on the way we meet the events of life than on the nature of those events themselves.*

Taking all considerations above, my personal view to the meaning of life is the existence of a mind that minds the world around and within itself. Herein, the discourse of event is viewed by different mind at different time in a single life adding more complexity of how to deal with them. The idea of life events are further complicated by its implication in social context, whether we take individual's life or life of a group.

However, the scope of this thesis is limited by user centric view of life event management rather than its philosophical nature that goes beyond common user's practice. Therefore, we define the problems in following points -

1. The very challenging issues are to define what events are important to human life that keeps log of a life long drama from minor to major and positive to negative (colors of life).

2. What are the correlations between events that happen within their

temporal, spatial and sociocultural boundaries.

3. How events of one life are related to the events of another life.

4. How other entities play their roles in an event such as digital and physical objects.

5. Finally, how the interface supports visualizing the events reckoning the above issues and facilitate a instinctive and intuitive user interactions for performing various operations on them.

1.3 The Solution

Numerous literatures had been studied, from the areas of philosophy, psychology, chronology, cartography, information visualization, user interface design and usability, in order to understand what would be a time sustaining solution to address the above issues. With the support of SWeb[1] semantic machineries, we could concentrate on user specific needs for developing such a system. Our approach to the solution started with understanding the problem from both from the bottom and from the top the problem domain. The solution is proposed in the steps.

- A formal definition has been proposed for the life events along with other relevant entities.
- River metaphor is used to model correlations between events. Other forms of complex events, like parallel events, are also investigated and put into the model.
- A visualization framework work has been developed and visualization of complex historical data has been proposed extending state of the

[1]The research described in this paper is being conducted in the context of the project KnowDive and SWeb is the Semantic Web platform developed under this project.

art works.

- A user-centric approach has been taken in the development of the user interface leveraging the delicacy of the visualizations.

- A usability evaluation on the early prototype has been performed to find necessary areas of improvement.

1.4 Organization of the Thesis

Following is the preview of what can be found in this thesis.

Chapter 1, *Introduction*, describes the context of the work, defines the problem and proposes the solution. This chapter includes the organization of the thesis reflexively.

Chapter 2, *Related Works*, highlights the related works from century old to state of the art knowledge in three categories, e.g., (1) temporal data management frameworks, (2) temporal data visualization and (3) timeline visualization of temporal data in chronological order.

Chapter 3, *Events in Life*, talks about *life* and *events* from philosophical perspective giving an insight of the nature of the problem. From geography, *river* metaphor is discussed with its analogy to life and events.

Chapter 4, *Entity Definition*, provides the semantics and the formal definition of event and some related entities.

Chapter 5, *Visualization of Events*, provides a detailed account of visualization principles and describes the proposed solution for the complex time-oriented data, more specifically events, visualization.

Chapter 6, *Metadata visualization*, addresses fundamental issues of minimalist metadata visualization that make an entity identifiable by human inspection. A survey result is presented revealing interesting facts differing our common understanding and practice of metadata visualization.

Chapter 7, *User Interface*, various methods and principles of user interface design has been thoughtfully discussed. Upon the foundation principles, the design and development of UI has been detailed in this chapter.

Chapter 8, *Usability Evaluation*, various evaluation techniques has been briefly discussed and usability evaluation result of the system has been reported in this chapter.

Chapter 9, Future Works, addresses the unfinished and possible extensions of the work being presented in this thesis.

Chapter 10, Conclusion, summarizes the overall achievements and failure of the work being intended and being done.

1.5 Conclusion

There exists multiple solutions, as we will see in the next chapter, for visualization and interactions of each problem being mentioned. We have carefully avoided metaphysical nature of events to put into the problems domain to be addressed. A plain view of events that occur in our everyday life and to be logged, viewed and shared between the people of interest with right perspective is an essential discrimination for our system.

Chapter 2

Related Works

Vannevar Bush's vision of Memory Index (Memex) in 1945 has come across a long way paving numerous fields of applications. Surprising enough was the use of the term *memory*. I wonder why wasn't it any other form of recorded knowledge other than memory! *Memories* of oneself does not go around the time, but along the time, though still erratic when we try to remember them.

A lexical definition of *Chronology* is the science of arranging events in time by their order of occurrence. It was not until 1583 when the modern science of chronology was introduced by Joseph Scaliger [82] in his famous book *De emendatione temporum*. However, the visualization of chronology was not in its infancy in those early time.

Shoshani and Kawagoe in 1986 [92] described a framework for the management of temporal data. The work introduced the concept of *time sequence* for representing the semantics of temporal data. Time-value pair, basically a two dimensional *time sequence array (TSA)*, stored in the databases were to be extracted, sequenced and represented with the semantics of time. Later, Rotem and Segev [87] proposed a multi-dimensional partitioning scheme in 1987. These works leveraged the necessary frameworks for the organization and management of time-oriented data.

The *related works* chapter is organized in (1) temporal data management, (2) visualization of temporal data, and (3) timeline visualization. Event centric works are not been discussed separately since they essentially come as historical or temporal data in one way or the other.

2.1 Management of temporal data

The temporal property of an object has successive meaningful and recorded values [8]. Values of temporal properties are histories, i.e., functions from a finite set of instances observed from certain granularity. They have both temporal and structural domains [30]. Eric Freeman and David Gelernter [37] materialized the organization of user collections in the line of time, having the objects being temporally characterized. The work was first proposed by David Gelernter [40] and described in [36]. This organizational metaphor subsumes many desktop metaphor cumulating in a single application (Figure 2.1). The documents are arranged in a time-oriented stream. Features are being fasciated by using colors and animations. The borders of unread documents are made red while the writable ones are being made thicker. Open documents are slid out to left of the stream. Newly created documents are popped from the top pushing back the the stream by one document. They used the concept of *substreams*, virtual directories created upon user search queries that provide an organizational framework for finding information.

Rekimoto's work in [81] went another step toward a time-centric approach for the information environment. This work leads to the concept of *time machine computing (TMC)* that allows user visit past and future state of computing through the time dimension. The system, called TimeScape desktop (Figure 2.2), is a combination of temporal calendar and timeline for automatically archived user content by their temporal properties. MyLifeBits [41], a project from Microsoft research aimed to fulfill

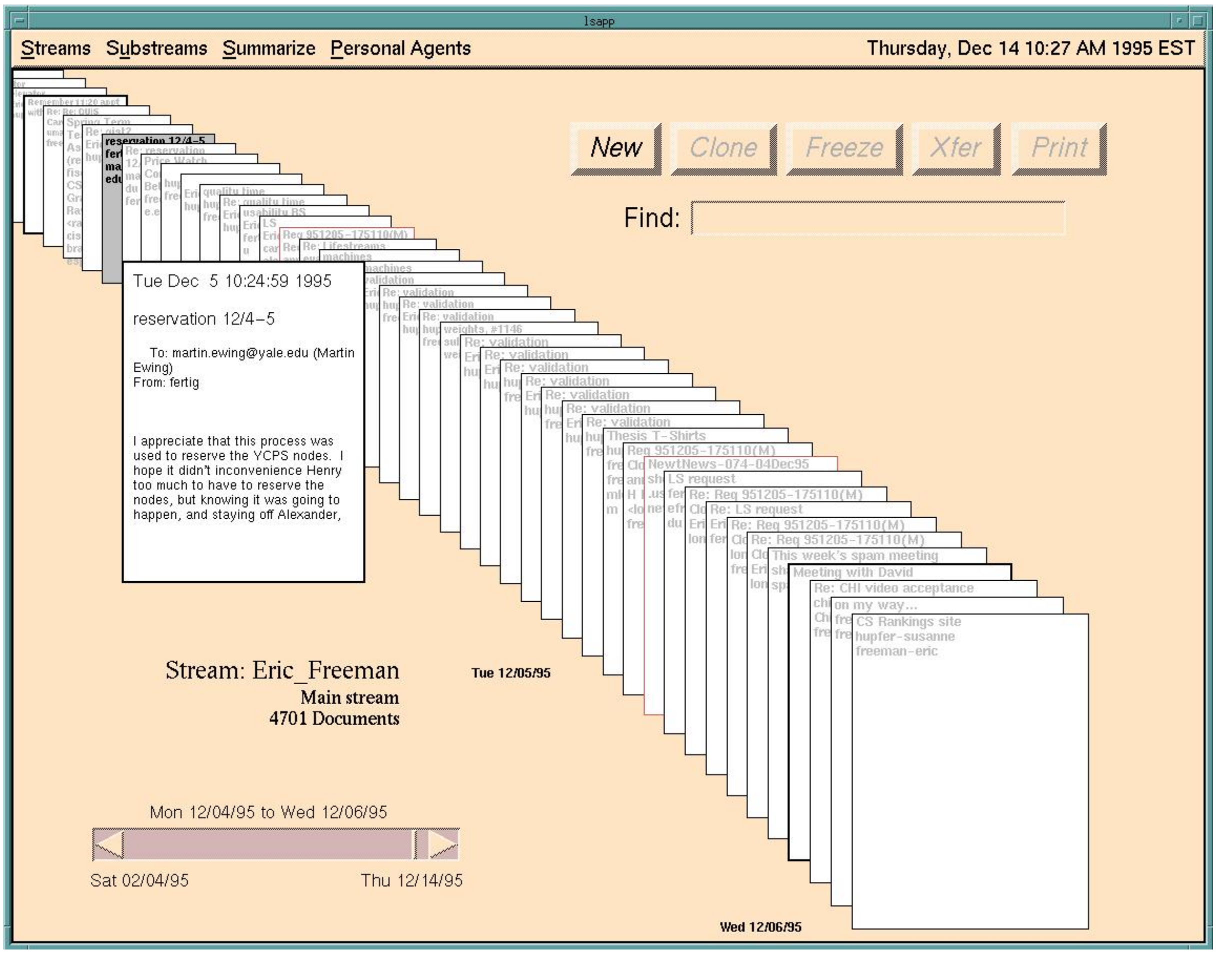


Figure 2.1: Lifestream interface.

Memex vision in total terms. The four principles it adopted was (1) a non-hierarchical organization of collection and search, (2) multi-dimensional visualization support, (3) easy annotations for non-text media, and (4) transclusion of authoring. This is one step forward to digital mechanism that Bush did not foresee. However, annotations and links, the two fundamental features, were not overlooked by Bush. Hierarchical organizations are too constraining and allows no reference to other forms of query [76] [37]. As an extension from Bush's trail, they argued the use of user constructed story that is laid out in time and space. Apart from aspect, they argued for multi-faceted organization of contents by user annotations.

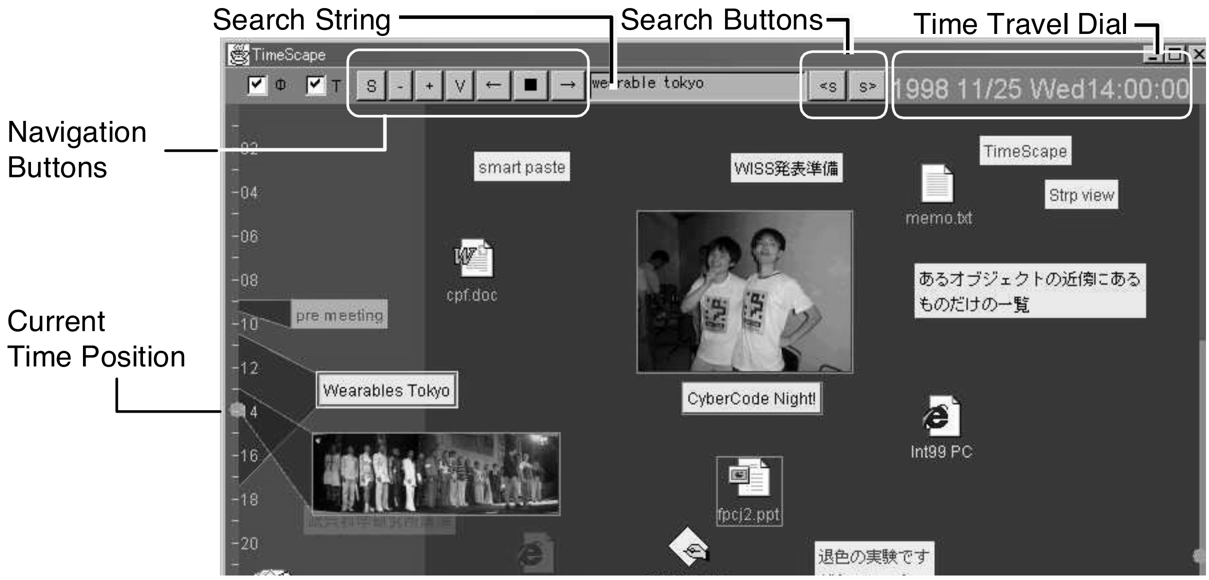


Figure 2.2: TimeScape desktop interface.

Events are basically time-oriented happenings or historical data that includes other contextual information. There are other structural domains that describes the events. We examine different cases of time-oriented information visualizations as they provide the foundation of interaction framework in a user centric application. We have dedicated one separate section for *timeline* visualization that inspired our work in adopting and advancing the best paradigm.

2.2 Visualization of temporal data

. There are many visualization techniques proposed in the applications domain like clinical data [90], geographic data [3], hydrometric data [97] and personal history [78]. The visualization techniques differ in two fundamental ways, e.g., (1) timeline view and (2) calendar view, therefore, the navigation is exploited in either way provided by the visualization framework.

While calendar is conventionally and extensively used in many applications for accessing temporal information, J. Mackinlay *et al* [62] proposed a 3D spiral calendar view for temporal data visualization with interactive animations. Time relationships among the schedules of groups is supported through the use of time lattice. A planar spiral technique has been used in [15] for the visualization of periodic patterns of serial data (Figure 2.3). Daniel A. Keim proposed pixel-oriented arrangements in circle segments

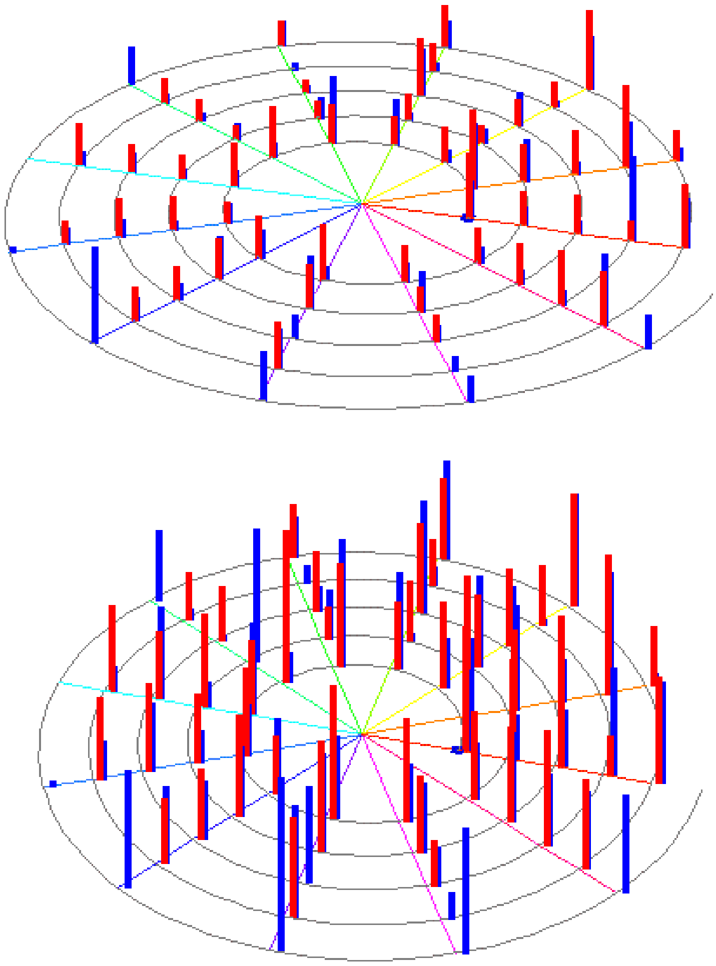


Figure 2.3: Spiral visualization of serial data.

for visualizing large amount of data on multi-dimension scale [9]. This technique used value to screen pixel correspondings for the visualization (Figure 2.4).

Kullberg [57] proposed a 3D timeline visualization technique for histor-

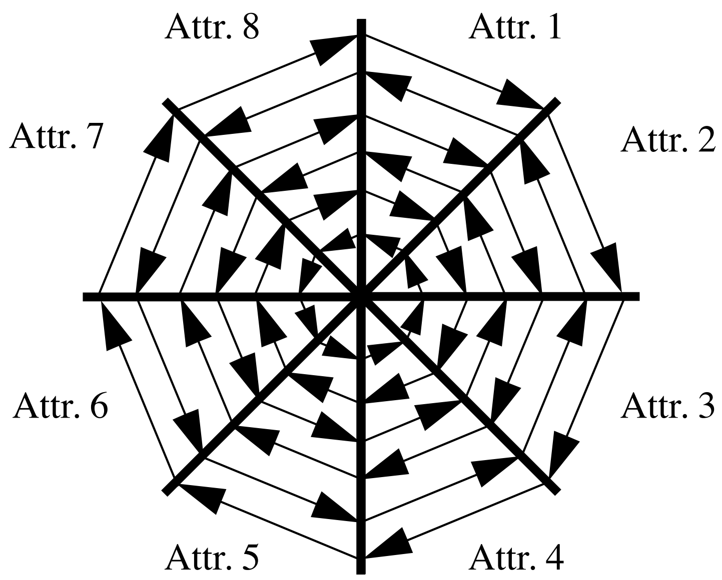


Figure 2.4: Circle segmented techniques for multi-dimension data visualization.

ical photo visualization. TimeSlider, a time navigation technique used for specifying time points in non-linear time scale is a different approach [56]. This was an early version for time machine computing developed in NEC, while the TMC [81] was later developed in Sony Corp.

The visual display of time-oriented patient data in [23] addressed two fundamental issues, e.g., (1) granularity problem and (2) calendar mapping problem. This is very different from LifeStream [37] which was not characterized with these issues. Patient's events are laid out on timeline facilitating the operations - slice, filter, overlay, new and add. They also have provided a formal definition of timeline that would hold the events by offsetting from a null event. Scale, align and mark are seen to be very prominent features in the visualization scheme. Similar work had been done in LifeLines [78] by using the concept of stream lining the access details. The data are presented in multi-timeline.

However, most of the proposed solutions [55], [75], [58], [78], [4], as we found, are timeline visualization of temporal data. This is more natural and intuitive for human to apprehend. From the Chronopsychological point of view, our mental action is not instantaneous but requires a finite state of time [14] and its behavior stays tuned to sequential contingencies afforded by its environment [65]. In many ways we seem to perceive time, though we don't have a genuine sense of time and this gave rise to the question what exactly we call the perception of time [70]. We have considered this cognitive approach of the perception of time in developing our visualization scheme with the concept of arranging events in the line of time as a series of sequences. Therefore, we move into more detail on timeline visualization in the following section.

2.3 Timeline visualization

2.3.1 A brief history

Cartography, by definition, is the study and practice of making maps. Though initially it meant to be spatial data, later it found its way out to the representation of historical data dated back from 1450 [86]. Joseph Priestly in 1765 [79] developed the idea of describing the life span of famous people (1200 BC to 1750 AD) by using horizontal lines along the time scale detailed in the *Chart of Biography* (Figure 2.5). This was a very similar work to modern horizontal bar type timeline charts.

This is apparent that Playfair's introduction of time series charts and bar charts were influenced by the work of Priestly [39]. Playfair's creation of the chart of trade between England and Ireland from 1700 to 1800 is still a classic historical example (Figure 2.6). The data was not only temporally aligned, but also the trade volume was shown.

Charles Minard in 1869 published the map of Nepolian's advance and retreat from Moscow during 1812-1813 campaign (Figure 2.7). The map reflected several variables of the campaign laid on 2D image, e.g., spatial distribution of army along the capaign, the size of the army as it progressed

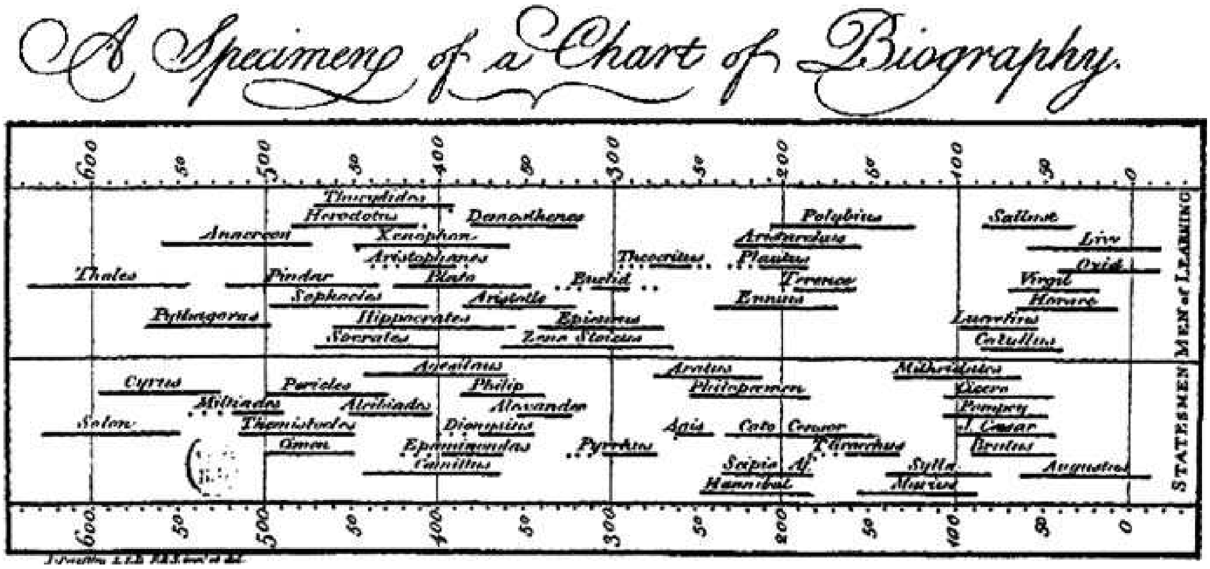


Figure 2.5: Timeline cartography in *Chart of Biography.* Source: Priestly, 1765 [38].

through time and space and variations in temperature [88]. Though scale of time is compromised, the map is termed as *gem of information graphics* and was nominated as the *World's Champion Graph* by Howard Wainer [101].

Emma Willard in 1846 published the famous *Temple of Time* in [104], rendering a three dimensional representation of events with respect to space and time (Figure 2.8). The relations with other constituents provides a full context of knowledge for any given point of time.

2.3.2 Current state

Several works have already been discussed in the previous section where timeline bars as visualization elements have been used, e.g., [78], [81]. A survey by Silva and Catarci [93] described a detailed account of visualization of linear time oriented data. They tried to address the gap between visual techniques and historical data that includes 2D and 3D representations. Plaisant *et al* further extended their work of *LifeLInes* again using

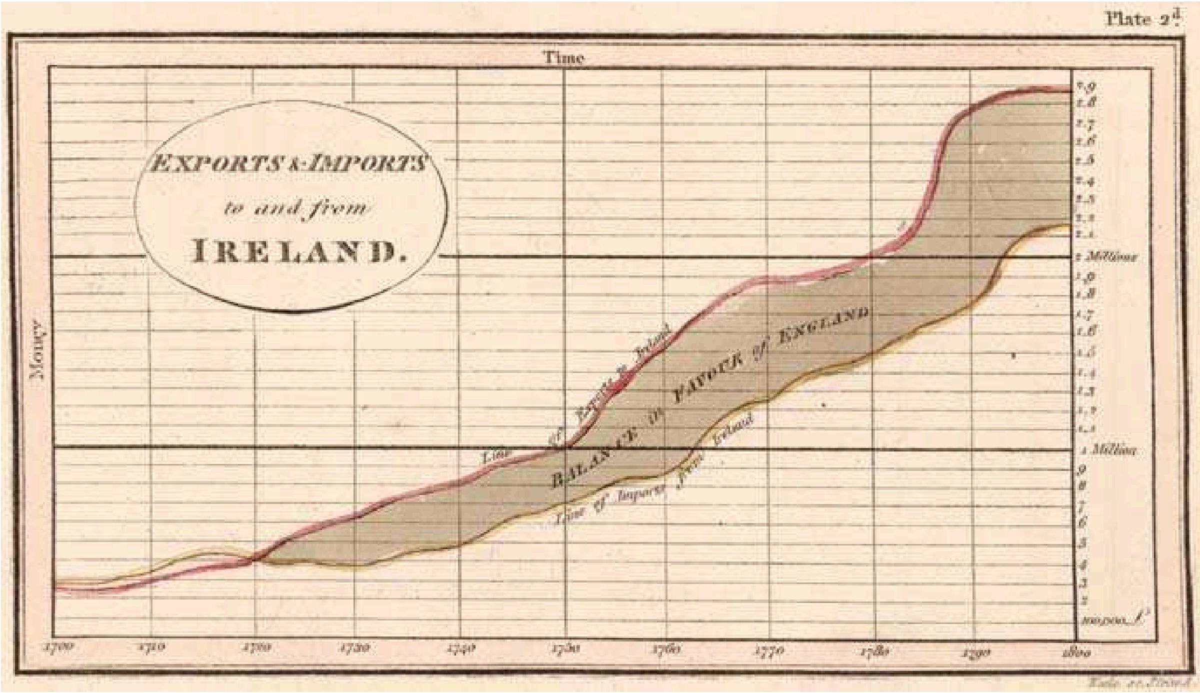


Figure 2.6: The trade between England and Ireland from 1700 to 1800. Source: Antony Unwin [99].

timeline visualization technique [77]. This is agreed, in [5], that timelines are best understood in the context of other timelines and essentially events are better represented with timelines for their temporal ordering.

SIMILE Timeline, a Web based widget is now available for the use of event management and visualization [1]. *SIMILE* is a joint project conducted by the MIT Libraries and MIT Computer Science and Artificial Intelligence Laboratory. As the project objective described in [59], it seeks to enhance interoperability among digital assets, schemata/vocabularies/ontology, metadata and services.

SIMILE Timeline provides the interface (Figure 2.9) as well as the event management framework. It has drawn much of the researchers attention and is being used in many state of the art works for chronological data in different applications. Omar Alonso *et al* used SIMILE Timelines for exploratory search [6], and timeline visualization for search results [7]. The

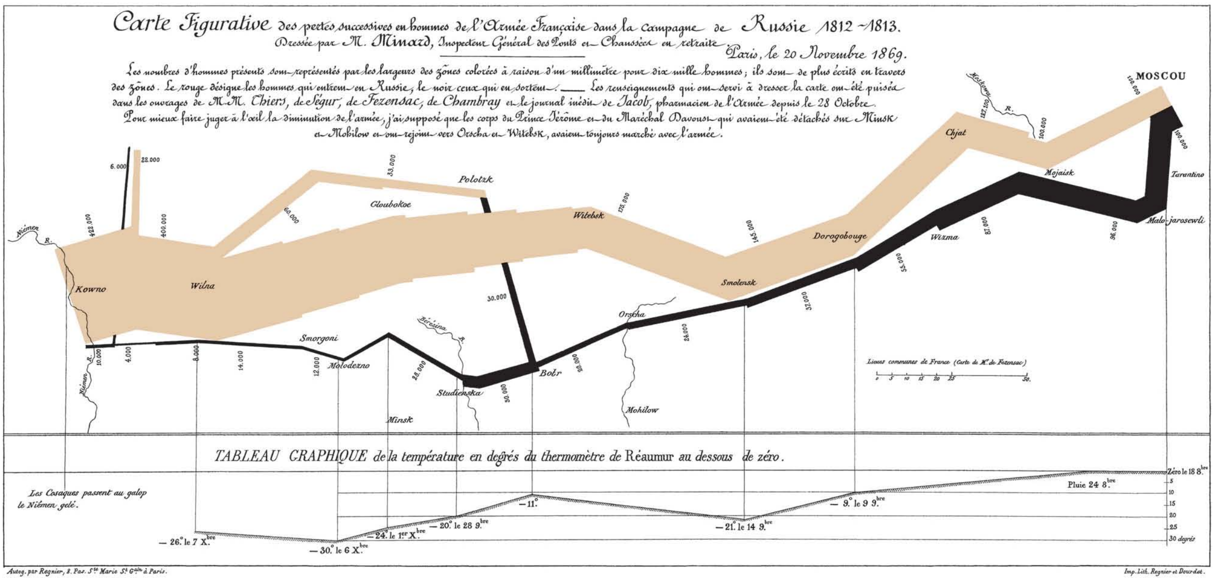


Figure 2.7: Nepolian's Russian campaign during 1812 to 1813 presented by Minard. Source: Internet

interface is the same as presented in Figure 2.9. A recent work in [8] addressed the interrelation issues between the events and proposed a coherent user interface facilitating the visualization and the interaction for end users (Figure 2.10). This work has some interesting features like sub-events, e.g., *battles of a war*, and being presented as collection of interrelated events maintaining their discrete form in the line of time. *Continuum*, as it is being termed, enables hierarchical relationship between temporal data.

As we move through the next chapter (3), we will see how complex the events can appear in life than what have been thought of in the area of *human computer interaction*. This year, 2011, R B Allen put forward the issues of *causation* in history in [83] and provided the schema for visualization. Though with much limitations, he tried to focus on the tapestry of historical events (Figure 2.11). Associated geo-spatial view is also supported by the interface.

This is, however, not an indigenous point where we started our quest for understanding the events in life, instead we tried to make a philosophical

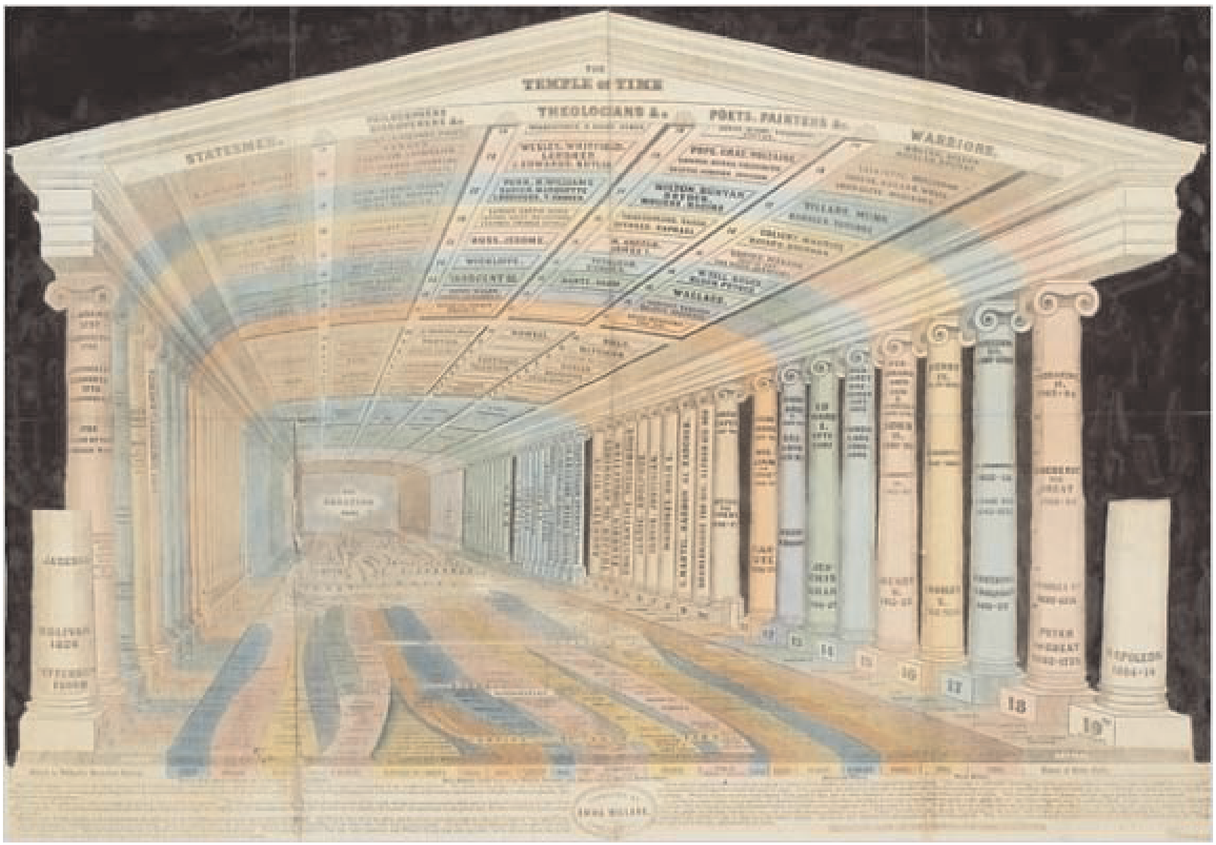


Figure 2.8: *Temple of Time* by Emma Willard. Source: Internet

inquiry on the subject first, then logically proceeded toward the understanding of events that are amenable to life.

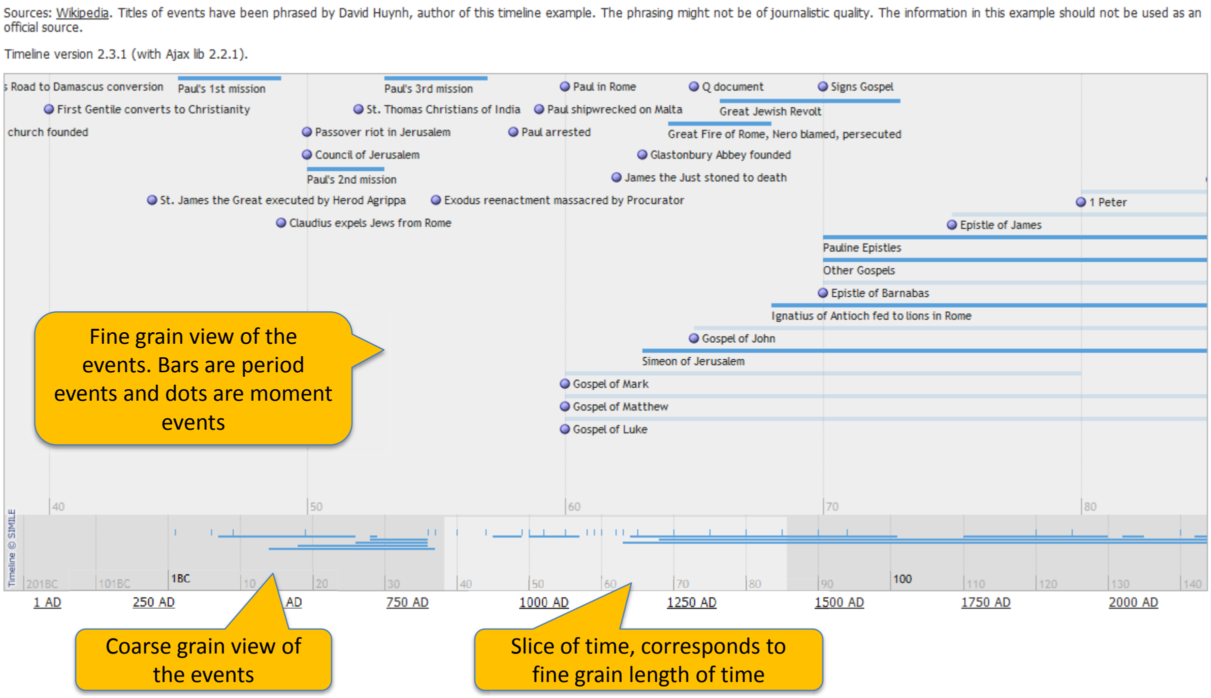


Figure 2.9: *History of Christianity*, an example with SIMILE Timeline. Source: SIMILE online Timeline example.

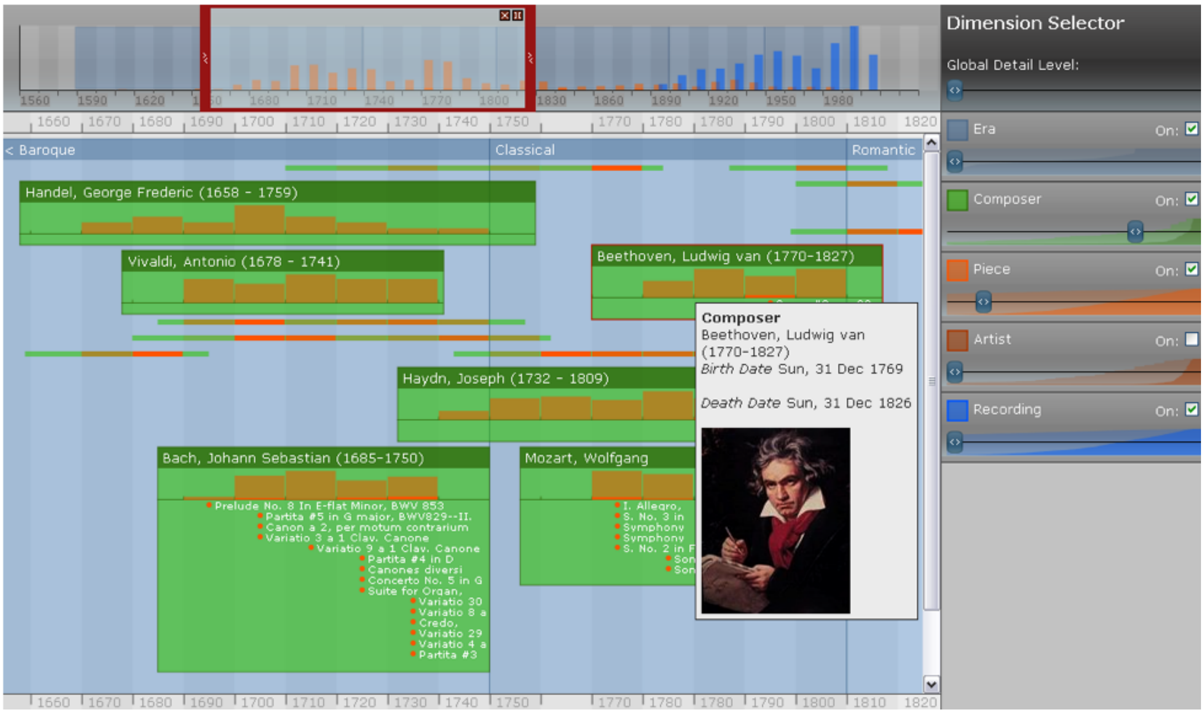


Figure 2.10: *Continuum*, a timeline visualization tool for inter-related faceted temporal data.

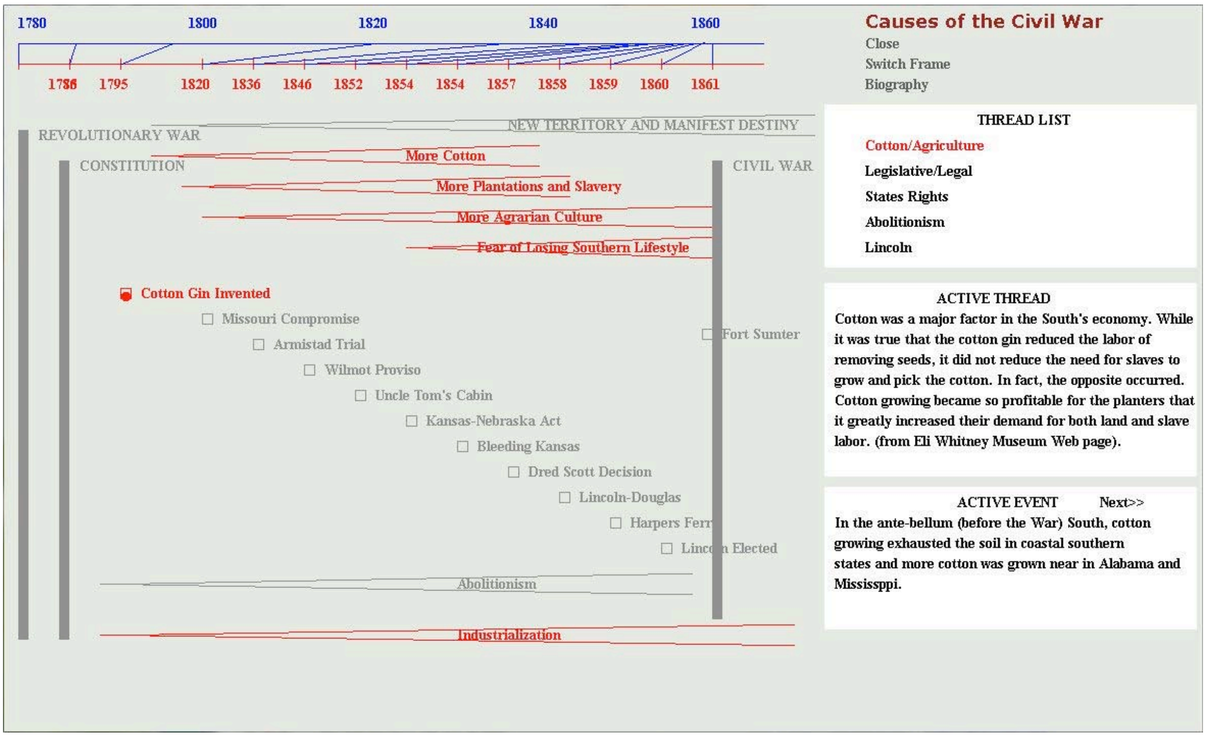


Figure 2.11: *Causes of the American Civil War* illustrated in the initial prototype.

Chapter 3

Events in Life

There are several articulations and evaluations of what makes life meaningful and discussed in several categories provided by major historical figures in philosophy [64]. This section attempts a brief discussion on the Meaning of Life as *a priori*. This is very hard to designate e narrow category under which events in life can be defined and articulated. However, some inspiring accounts are to be mentioned to find which perspective we take to orchestrate our life events.

Supernaturalism has both *God centric* and *Soul Centric* Views [105], [10]. Most authoritative God centric account is the existence of God and our life is created on purpose. Freedom is an discretional choice between good and evil, therefore, events in life are more obvious play of God than a choice. Leo Tolstoy (1884) is much in favor of a Soul centric view profusely reflected in his literatures [48], [69], [24]. By his argument for life to be meaningful, something must be worth doing, that nothing is worth doing if the one does make a permanent difference to the world, and that doing so requires having an immortal, spiritual self. Many of course question whether having an infinite effect is necessary for meaning [10].

Naturalism comes in *Subjectivism* and *Objectivism*, devoid of spiritual realm. The debate goes around two things: the extent to which human mind constitutes the meaning and whether there are any standards for meaning that are invariant among human beings. Subjectivism suggests that meaning in life varies from person to person, depending on each one's variable mental states. Recent influential subjectivism states that the relevant mental state is caring and loving, i.e., life is meaningful just to the extent that one cares about or loves something [33], [34], [35]. Pragmatism, positivism, existentialism, noncognitivism, and Humeanism were quite influential in much of the 20thy century [51], [12], [89]. Objectivism maintains that meaning is constituted by something physical independent of the mind about which we can have correct or incorrect beliefs. A hybrid view of Susan Wolf states *Meaning arises when subjective attraction meets objective attractiveness* [106].

Nihilism is another perspective that takes strait forward rationale by combining supernaturalism and atheism. Some nihilists claims that our lives lack meaning because we are invariably dissatisfied; either we have not yet obtained what we seek, or we have obtained it and are bored [63]! In reply, critics suggest that at least a number of human life do have a requisite amount of satisfaction required for meaning [13].

In my personal view, *life is an experience determined by the function of belief and wisdom. Which way we see it, is the way it is we experience life.* We experience every event through the passage of *a posteriori*, while the fact that happened is *a priori*. *Supernaturalism* and *Naturalism* both fits into this observation. Our system allows individual's experience to log as narratives.

Discussing the meaning of life does not have a ready admittance in this work, rather a recall to reach a common acceptable view of the meaning of event that is required to make a competent management policy for events in human life.

3.1 Events

Events are things that happens, such things are births and deaths, swimming and singing, meeting and dating. The perspectives that manifest the meaning of life establishes the individual's view of assimilating an event as it happens. We do not argue that any of the perspective questions whether some thing happened or not. The way a happening is perceived by individual commits story than fact. Whether such things are from a metaphysical category, there is little question that human perception, action, language, and thought manifest at least a *prima facie* commitment to entities of this sort [16]:

- Pre-linguistic infants seem to be able to seperate and count events. The content of auditory realm in adult perception, endorses the discrimination and recognition *as events* of some aspects of the perceived scene.

- Humans, and arguably other animals, as being observed, form the intention to plan and execute actions, and to bring about changes in the world.

- Dedicated linguistic devices, e.g., verb tenses and aspects, nominalization of some verbs, certain proper names, are adjusted for events and event structures, as opposed to entities and structures of other sorts.

- Thinking about the temporal, causal, and intentional aspects of the world appears to require parsing those aspects in terms of events and their descriptions.

However, the extent of the four commitments are not clear whether they are an integrated phenomenon or independent dispositions, although there seem to exist significant signs of convergence, for instance, the events that are perceived appear to be categorically homogeneous with those that are talked about or thought of in causal explanations [50].

Events have very exquisite relationship with other objects and categories. We would like take the advantage to mention few of them.

3.1.1 Event vs. Objects

The observable difference between event and object are in mode of being material (chairs, books, etc.) that said to *exist* and said to occur or take place [Hacker 1982a]. Another way they make difference is their relation to space and time. Most objects have clear spatial boundaries and unclear temporal boundaries, where, events have relatively clear temporal boundaries and unclear spatial boundaries. Objects do not co-exist in their spatial location, while events tolerate co-location [80], [47]. Therefore, given a temporal location, multiple objects can participate in a single event and given a spatial location, multiple event may take place.

3.1.2 Event vs. Facts and Stories.

Event and object both can be counted, quantified over, referred to and described and re-described in various way. But events conceived as facts are fine-grained entities that cannot be freely re-described or re-identified under different conceptualizations. Here facts are characterized the properties of event itself. "Caeser died in Rome in 44 BC" corresponds to a fact that cannot be re-identified otherwise, while "Caeser died brutally" corresponds to a story from a different perspective by individual [19].

3.1.3 Events vs. Properties

Sometimes event contrasts with properties. Events are individuals, therefore are on properties, for properties are normally constructed as universals. Individuals occur whereas universals recur. But some events do recur, such as *the sun rises everyday* and can be treated as properties, e.g., as properties of moments or intervals of time [67]. In our life, such events are anniversaries. A persons birth day is a recurring event and thus a property of that person. This is a very strong proposition that we have used for automatic event creation in our interaction design.

3.1.4 Event vs. Time

Time is the property of event can also be fleshed out as *event being the property of time*. "this morning's sun rising" is identified by an ordered pair $\langle i, \varphi \rangle$ where i is the relevant time period and φ is the sentence "The sun rises". Of course this treatment do not justify some intuitions underlying *prima facie* commitments to events, for instance, events can be perceived but time cannot [42]. Such accounts are especially attractive from a reductionist perspective because of the availability of fully developed theories of intervals along with fully developed interval-based semantics [25], [29]. It has been suggested that the mathematical connection between the way events are perceived to be ordered and the underlying temporal dimension is essentially that of a free construction (in the category-theoretic sense) of linear orderings from event orderings, induced by the binary relation x wholly precedes y [98].

3.2 Life, event and river metaphor

River is the most widely metaphor in literature and philosophy. This old philosophical query has no explanation that is logical as well as convincing which was formulated by philosophers to bring out the ceaseless dynamism of the natural phenomena [28]. Like every life, river has a beginning and an end, and has turns, twist and creeping waves of events. Rivers cannot plan the future, a major exception from human life. We have used the river metaphor toward a pragmatic approach in deriving the visualization of complex interrelated events. The concept works even better when we try to model interrelations between the events form different individuals. In this section, we present useful attributes of rivers [68] and their analogy to life events.

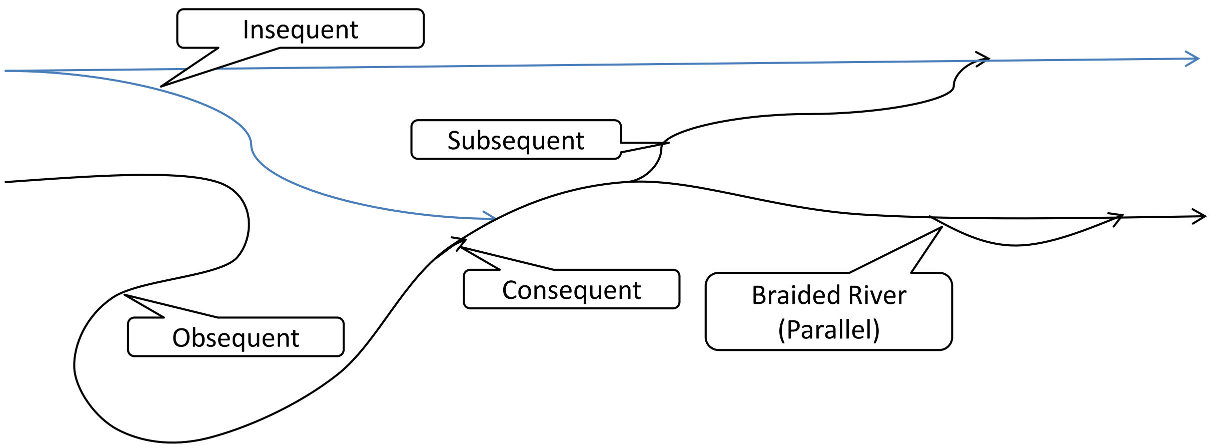


Figure 3.1: Rivers, the metaphor of life.

- River: A stream having a beginning point at some point on land and ends at lake, sea or ocean.
  Analogy: This is the life of an individual. In our visualization and interaction model, this happens to be the main lifeline of an user marked distinctly in the timeline. User have full controls over his/her own lifeline except the cases where some sort of dependency is in

place. For example, *John gets married to Jenny* is an event which is characterized by mutual as well dependent to both person's life.

- **Consequent:** Or *consequent streams* are the streams that formed as a direct consequence of the main stream.
  Analogy: In terms of events, these are consequences directly being occurred from a causal event. Often they are adjacent by occurrence, but in many cases, evidence of a causation may take place after a long time. John *fell off the cliff* at Cognola Park and *broke his leg*, exemplifies the causation (fell of the cliff) and the consequence (broke his leg), at least for what literally understood. There could have been some other reason other than the fall that contributed to the breakage of his leg.

- **Subsequent:** Or *subsequent streams* are those streams weakly branches out from a main stream river.
  Analogy: This analogy refers to the events of one individual branches out of his/her life causing impact to the life of another individual. The custodian of Cognola Park *forgot to put a warning sign* at the cliff where John fell off. The action made by the custodian contributed to John's misfortune (probably) made him/her suffer no immediate consequences but John. This action is a *subsequent* offset for at some point of John's life.

- **Insequent:** Or *insequent streams* are the tributaries branched out from another streams.
  Analogy: This is exactly the opposite of a *subsequent* where events from the life of other individual attributes causation to the life of the person being in focus. From the above example, we can say that the action of the custodian was an *insequent* to John's life event. Here, we regard the person using the system constitutes the main

stream experience the event caused by the action of another person. This is interesting to observe that the *insequent* in one lifeline is the *subsequent* of other's lifeline. These are the input that influence the way our life flows.

- **Obsequent:** Is the stream when the main stream takes an opposite turn in its course due a direct consequent of a confrontation of an unpassable landscape.
  Analogy: In time consistent notion of life, it never happens, but it happens when we fail a necessary accomplishment or achievement and have to start again, For example, you put rice on the oven for your dinner and start a long phone conversation. The rice burnt by the time you returned. You may either accept the consequence with the cost of starving which a consequent or you may start it over with the cost of time which is an obsequent. In our model, we haven't included obsequent because os its complex relation with time and action.

- **Braided Streams (Parallel):** These are basically the network of streams that eventually ends up with the main stream.
  Analogy: Such happenings are arbitrary parallel events with respect to time, though theoretically impossible. Dinning and talking with friends is a typical example which would be impractical separate in a model by minute fractions of time. Nested sub-events may well fit into this category.

In conjunction with *river metaphor*, other common cases of events are also considered under following premises.

- **Future events:** These are usually plans and agenda, a meeting for example that is anticipated to take place at some period in future. This is a very common practice in human life to anticipate or plan something in advance being prepared minded animal and our system is very smart in dealing this kind of events.

- **Periodic events:** Are those events known to occur periodically. This could be an anniversary like a birthday or a festival or a weekly event like prayer day. The prerecorded events of this kind of user's interest give the opportunity for automatic event creation and enrichments.

- **On going event:** This is the event either started some time in past or starts now and the duration is unknown or undeterminable until the event ends by some means, i.e. the start time is at some point in past or present and the event continues with the progress of time without any known point of time. *The forest caught fire yesterday*, is therefore, an ongoing event if it is still happening and end time is not known.

Given the analogy and facts above, we believe, we are now at an adequately acceptable level to model event for the user centric application allowing any ordinary user to log, share and remember their life activities. The *causal* relationship is hold by an attribute R in the formal definition of event (details in section 4.2.2).

Chapter 4

Entity Definition

In this chapter, we define the model for attribute definitions, entity types, entity type lattice, entities and other related objects.

Event is being described in the previous chapter 3 from different perspective with its relations to other entities and time. Here we take the required approach of defining and encoding them in formal languages that can implemented in our system. Along with the necessary entity definition, our user centric design of past, present and future event management heavily relies on the SWeb[1] semantic engines and other tools. The following two sections will describe EType (Entity type) Theory and EType Specifications , en essential guideline for defining an entity developed internally in our group. In our scenario, we have exemplified event, time, place and person entity types.

4.1 Semantics of Entities

4.1.1 EType Theory

Etype theory lights on various aspects of entities related to the definition of kinds of object properties used for ontological modeling of entities.

[1]The research described in this thesis is being conducted in the context of the KnowDive project.

Meta-properties

Meta-properties characterize properties (seen as unary predicates) used in ontological modeling. Based on the state-of-the-art [44] [45] [46] and [102], we summarize this section as follows -

- Essence: A property of an entity is *essential* to that if it must be true for it in every possible world, i.e. if it necessarily holds for that entity. For example, the property of having wings is essential birds, therefore, every birds must have wings.

- Rigidity: Rigidity is a special form of essentiality; a property is *rigid* if it is essential to all its possible instances; an instance of a rigid property cannot stop being an instance of that property in a different world. If x is an instance of a PERSON, it must be an instance of PERSON in every possible world, taking PERSON as rigid, while the property of being an STUDENT is not rigid in every possible world.

- Identity: Identity is related to the problem of distinguishing a specific instance of a certain class from other instances of that class by means of a characteristic property, which is unique for it (the whole instance). One of the distinctions mentioned OntoClean [46] is between properties that carry an identity criterion (IC) and properties that do not. Since criteria of identity are inherited along property subsumption hierarchies, a further distinction is made to mark those properties that supply their "own" identity criteria, which are not inherited from the subsuming properties.

- Unity: Unity is the second notion extremely useful in ontological analysis. Unity refers to the problem of describing the parts and boundaries of objects, that is, in general gives the idea the parts that forms an object as a whole.

- Dependence: Dependence in ontology may involve many different relations like those exist between the persons and their parents, an event and its consequences. In our case, we focus on a notion of dependence as applied to properties. We also distinguish between *intrinsic* and *extrinsic* properties that depends on whether they depend on other objects besides their own.

EType Model

We have delimited the following criteria for modeling EType -

- User friendliness: We assume that a large portion of data/metadata will be generated by users, therefore, the model should not be too expressive or too restrictive.
- System friendliness: While relative freedom is endorsed for the users, the model should take into accounts the system-oriented requirements such as the availability of constructs for basic operations like *semantic search*
- Performance: The data structures of the model and the model oriented operations should not be too time-space demanding and should optimally guarantee real-time performance.

Premitive notion

The definitions given in this paper are based on some primitive notions.

- Concept: A **concept** is defined as a set of individuals, also called the extension of the concept. Each concept has a unique identifier and a natural language name that describes the concept.
- System data types: The data types supported by the state of the art database management system and programming languages. This

includes range of HTTP URLs.

Attributes

An attribute is composed by its definition and its instance and the the instance is the name-value pair. The definition is deduced from the real world semantics that defines an entity. Within the boundaries of a system, this is assumed not to have multiple attribute definitions with same concept.

Entity Types and Entities

Instantiated attributes are characterized for certain objects which defines the context for the temporal validity of instantiated attributes; isMarried is instantiated to *false* from the moment a child is born. Through instantiated attributes, an entity type describes instances of a particular class by defining the attributes describing common properties of these instances; and entities are instances of the concept(s) associated with the Etype(s) of these entities. For example, instances of class EVENT can be described with attributes like NAME, PLACE, TIME and PARTICIPANT(S).

4.1.2 EType Specifications

This section briefly describes the data management framework implemented in our SWeb platform.

Data Types

A data type defines all the possible values for that type, its semantics and the set of operations that are allowed on those values. It defines the upper bound on the domain of possible values. Along with well known conventional data types, e.g., number, boolean, etc., the types are further categorized in sematic and semanticless types. Along with the standard data types, we used special data types in order to hold semantic values which have predefined concepts. This extension enabled our system to assign both quantitative and computable qualitative values.

By definition the following categories of attributes are being used.

- **Descriptive (Textual):** It's an attribute in which its values cannot be codified as a single entity and/or atomic concept. They are given in input from a user as a simple sequence of characters on which a process of entity/concept recognition can be applied. Descriptive attributes are those whose data type is semantic string.
- **Entity (Relational):** It's an attribute in which its value points to an entity (or an entity set) and that creates a (semantic) link between the entity owning the attribute and the target entity (the value of the attribute). It encodes a semantic relation where the name of the attribute definition encodes the relation existing between the source (the entity instantiating the attribute) and the target (the value). Relational attributes are those whose values are of data type Entity, examples can be "Birth Place" and "Father".
- **Concept (Attributive)**: It's an attribute in which its value carries an implicit semantic (E.g. the date of birth of a person), basically all the attributes whose data type is not semantic (less) strings or entity can be considered as attributive.

4.2 Event

Jaegwon Kim described event as $\langle x, P, t\rangle$, where x is Object(s), P is Properties of objects and t is time. Time is non-qualitative measuring component used to measure sequence of events and may have semi-temporal location and has constructive property [85]. In Donald Davidson's theory, event is "cause and effect" defined as ⟨space, time, object⟩ [27]. The *cause and effect* constitutes a very complex hierarchy of events and we provided adequate support for both theories.

This section describes the SWeb model for event EType as discussed in chapter 3. This event model is inspired by the framework presented in [103] and the *causal* relationship described in 3.2. This framework describes a common **event model** in order to allow integration and syndication of events and media from largely isolated data sources, making possible novel cross-application and cross-data source multimedia services. The event, specially that takes place in human life has described sufficiently in chapter 3. Here, we first discuss the aspects of events that is necessary in describing SWeb model of events.

4.2.1 Aspects of Events

The aspects of event are shortly described bellow with that counted for our event model.

- **Temporal** The temporal aspect concerns the time association of an event in different ways of capturing the aspect. The main ingredient that classifies time into two major group is *number*. In our event model we used *geological time scale* that seems more convenient for general understanding of time for an end user.
  - *Relative Time (Chronostatic):* This is a numberless reference to time. There is no date or quantitative measure for this class of time, e.g., yesterday, tomorrow, evening.
  - *Absolute Time (Chronometric):* A quantitative measure of time expressed in numbers. Such time class follows relevant type of

calendar. For us, this is a Gregorian calendar that is being used internationally for common usage.

- **Spatial** Spatial aspect concerns the location where the event takes place contained in an event description. There are different ways of capturing the spatial aspect:
  - P*hysical Location:* the geographical place where the event takes place. A physical location is characterized by GPS coordinates, city and country specifications, etc. For example, the soccer match takes place at the Olympic Stadium of Rome.
  - *Logical Location:* refers to a spatial domain concept (e.g., the match takes place in a stadium).
- **Informational** Informational aspect concerns information about the event. They can include the event type (e.g., soccer match), the event description (e.g., the Inter-Juve soccer match of the Champions League), the entities (agent and artifacts) involved (e.g., players and ball), the role of such entities (e.g., forward, goalkeeper, ball), other parameters (e.g., current score, number of players, etc.), the event "mode", that is, how the event takes place: it could be an online event or a physical event.
- **Experiential** Experiential to augment the exploration and experience of an event, a media-aware component should be associated to it. A set of media (e.g., images, videos, audios, etc.) should thus documents how a (past) event evolved.
- **Structural** Structural aspect concerns the decomposition of high-level events into low-level events. Sub-events can be aggregated so to form more composite events (e.g., a set of matches forms a season). Knowledge on subevents can give useful hints on the composite event.

- **Causal** Causal this aspect concerns the discovering of a chain of events which led to the event in question. Given an event, there should be an explicit representation of such cause-events chain.

4.2.2 Event Relationships

The last two aspects (Structural and Causal) put in relation more events. Here comes the issue of devising relationship between events. Some types of relationship are listed below:

- **Structural:** connect two events by expliciting a ”part-of” relationship, described as *sub-events* in 3.2
- **Causal:** connect two events by expliciting a sort of ”caused-by” relationship
- **Temporal:** connect two events by expliciting a temporal relationship (e.g., event A occurred ”during” event B), a type of parallel event.
- **Spatial:** connect two events by expliciting a topological relation (e.g., event A takes place in the ”same place” of event B)

SWeb Event Model

SWeb event model is defined from the idea that any happening might be important to us, significant to one and insignificant to others. And the model is capable of capturing them all and provides the means for visualization and interactions. As defined earlier, event emerges as a non-persistent temporal occurrences. The model also complies with the Dublin Core metadata (red). Following are the list of aspects of an event that will have a direct correspondence to attributes.

- Time-period: The interval in which the event occurred.
- Location: Where the event took place.
- A single entity corresponding to the main object in the event (e.g., Abraham Lincoln, Gettysburg, Pennsylvania)
- Type: The type of event (e.g. conference, anniversaries, etc.)
- Topic: Identifies the content of the event (e.g., music, dinning, presentation, etc.)
- Participants: A set of entities significantly involved in the event (e.g., players, chairs, soccer, referee, etc.)

Formally an event EV can be represented as

$$EV = \langle evid,\ T,\ L,\ Ie, R\rangle, \text{ where:}$$

- evid is the unique identifier for an event (e.g., SWeb id)
- T, defines the temporal collocation of an event, i.e., the interval or moment.
- L, defines the spatial collocation of an event, i.e., its location.
- Ie, describes the informational aspect of an event, e.g., type, actions, states, participants, etc.
- R, defines the relation to other event(s), i.e., whether a causal event, sub or discrete event.

This model supports the complex form of events with the support of R that holds relation to other events as described in chapter 3. Therefore,

$$R = \langle EV^R,\ r\rangle$$

Where:

- **EV**^{R} is the event being related to the eliciting event EV and the definition of EV^R is same as EV.
- **r** refers to the type of relation by which two events are bound. For example, if EV^1 is a super event of EV^2, then EV^2 is a sub-event of EV^1. The same way it can be used for causal and consequence events. This relation attribute R allows nesting of events to virtually unlimited depth. This relation holds as long as the event does not become independent.

The relations are temporally both forward and backward, i.e., they connect to events past or ahead of time. Table 4.1 shows relations with inverse and temporal direction.

Table 4.1: Relations, inverse relations and temporal directions

Realtion	**Inverse Relation**	**Direction**
Consequent, Subsequent	Causal, Insequent	Forward
Causal, Insequent	Consequent, Subsequent	Backward

Note that, if EV^R is the causal event for EV, EV must be either a consequent or an insequent of EV^R.

T describes concept of time, interval or moment. Interval is a length of time having a start and an end point of time, where moment is a single instance of time of zero length. Therefore, we define

$$T = \langle st,\ et,\ du,\ lu,\ ca \rangle$$

Here, st = start time,
et = end time and
lu = length unit, for intervals only
du = *duration of interval*
ca = calendar type, e.g., Julian, Gregorian or Geological Calendar

The temporal collocation of general event may be a set of time. UN general assembly is identified by a set of intervals and periods (breaks).

L describes the concept of location where the event takes place. This concept is described as

$$L = \langle name\_label,\ lat,\ lon \rangle$$

where
$name\_label$ = location name or address in text, lat = latitude and lon = longitude

This is important to note that where a disambiguated name label/address exist, precision of lat/lon plays less important role. However, at higher precision, specific name may not be obtainable.

Le describes the informational aspects of the event and can be defined with following tuples -

$$Le = \langle focus,\ type,\ Cx \rangle$$

Where:
focus is the main entity involved,
type is the type of event, e.g., weeding, anniversary, conference.
Cx is the the set of representing information associated with the context of event and the participating entities. These information refers to properties of participants, roles, actions being performed (e.g., playing, talking and so on) that explicitly characterizes the event.
The set *Cx* defines the context of an event at element *mode* that can be described as follows -

$$Cx = \langle eid,\ Ro,\ Pr \rangle$$

Where:
eid is the identifier of a participant entity
Ro is the role taken by the participants, e.g., speaker, player, etc.
Pr is the set of properties held by the participant entity E identified by *eid*
The property Pr is defined in attribute definition as a name-value pair.

4.3 Location

The unlimited expanse in which everything is located is called the *space* [31] and when space is occupied or allocated to person(s) or object(s), it becomes a *place*. Space and place are often considered synonymous in popular discourse with terms including region, area and landscape. What is a location then? *Geography has meant different things to different people at different times and in different places* [61]. However, we take the general approach in geography, where location is a position or point in physical space that something occupies on the Earth's surface or area in the Solar System, or mankind's physically reachable universe (Wiki). This could be either of two types -

- An absolute pair of latitude and longitude, a Cartesian coordinate grid (e.g.,a Spherical coordinate system). Such locations are referred by geo-coordinates, a pair of latitude and longitude. Theoretically, this is a maneless reference which an essential attribute of location type entity that has a name.

- A relative location is the location of a place or area in relation to another site, i.e. "9 miles north of Trento".

Yi-Fu Tuan asserted that people do not live in a framework of geometric relationship but a world of meaning [107], therefore, a location described with coordinates contributes no value to human experience of space. SWeb took inputs from different research fields such as Information Extraction (IE), Geographic Ontology and Geographic Information System (GIS). An objects (or entities) such as regions, cities, boundaries, parcels of land, water-bodies, roads, buildings, bridges are regarded as geographic objects, because of their spatial nature of occupying space [94]. Furthermore, parts and aggregates of all of these objects are geographic entities themselves.

In mane cases, locations are cultural as well as socioeconomic and there is no straight forward approach to model geographic entities. The following table by H. Counclelis [22] provides some dimensions in classifying the space.

Table 4.2: Different Kinds of Spaces Analyzed by Human Geographers.

Absolute Space: *Mathematical Space*	**Relative Space:** *Socioeconomic Space*	**Relative Space** *Experiential/ Cultural Space*	**Cognitive Space:** *Behavioral Space*
Points	Sites	Places	Landmarks
Lines	Situations	Ways	Paths
Areas	Routes	Territories	Districts
Planes	Regions	Domains	Environments
Configurations	Distributions	Worlds	Spatial Layouts

There are also issues of parts and aggregates. However, the study in [94] has taken a different view with following three sets of components.

- Entities which can be easily recognized as objects of physical sort: rivers, forests, bridges, etc.

- Entities like bays and promontories, which partly belong to the physical world but which exist only in virtue of demarcations induced by human cognition and action.

- Entities (geopolitical objects) like nations and neighborhoods which are more than merely physical, and which exist only as the hybrid spatial products of human cognition and action.

SWeb entity type is orientated toward ontological perspective taking into account the work done in Information Extraction (IE) for entity type categorization and the result of a Named Entity Recognizers (NERs). On the other side, more insights on the GIS domain are useful when modeling geographical entities.

4.4 Person

The term person in common usage means an individual human being. Most of the signature of a person are unique like the being itself and still we need a set of common usage properties to identify a person in real world. In our system, a person is defined by an EType with with different categories of properties for convenience. An instance of a person, Abraham Lincoln for example, can be uniquely identified by his date and place of birth and so on. Persons are the key participants in an event in our model and need a careful verification of the person's identity in order to resolve issues like same person participating more than one event at same time but different place in physical reality.
The following categories are proposed for the organization of person EType properties:

- Basic information
- Personal Information
- Contact information
- Career Information
- Personal preferences
- Social Relations

The concept of minimalist visualization of a person entity allows picking properties from different categories depending on the context of use. The following two tables exemplifies the sets of basic and personal information properties. See Appendix A for attribute examples of person EType.

4.5 Image

An image is a visual representation (of an object or scene or person or abstraction) produced on a surface [66]. This can be a permanent imprint on a physical surface (e.g., printed images on paper, transparency, metal, etc.) or an electronically produced impermanent impression (e.g., CRT, LCD, Plasma or LED monitor). Images are the most profusely available evidence of and around an event in recent days and today's images are abundantly produced by digital devices. Since our system considers images in its digital form, image EType is also defined accordingly. Following subsections define the ontology and attributes of different specifications that describes a digital image.

4.5.1 Ontology for Media Resources 1.0

Ontology for Media Resource is a specification that defines ontology for metadata integration of different standards related to media resources [60]. Ontology determines mapping between its set of attributes (Appendix B, Table B.2) and elements from some existing standards (Appendix B Table B.1).

4.5.2 EXchangeable Image Format

EXIF (EXchangeable Image Format) is an image file format for digital still cameras. The format sets the standard for images, sounds and tags for digital cameras and other systems that handle and use them. Much of the EXIF metadata can be machine processed at low level, while others are used for automated reasoning for search and organization. EXIF specifies the following items -

- Structure of image data files

- Tags used
- Definition and management of format versions

EXIF metadata are embedded by the digital cameras during the capture of the image. Some metadata describes the technical characteristics under which the image is taken (e.g., camera model, exposer details, etc.). Example of a typical metadata set associated with EXIF header are mentioned in AppendixB, Table B.3.

The format also allows geo-coordinates for location stamping.

4.5.3 DIG35

Unlike EXIF, the main aim of the DIG35 initiative is to determine a standard set of metadata for digital images that can improve the semantic interoperability between devices, services and software [32].
DIG35 metadata is grouped into 5 logical blocks:

- **Basic Image Parameter:** This is a file header information, that contains essential information for reading the image from different formats and using compression methods.
- **Image Creation:** Image Creation metadata specify "how" an image was created. The metadata contains device capture condition attributes and information about the device (the camera or scanner model, the lens model).
- **Content Description:** This block of metadata defines the descriptive information of "who", "what", "when" and "where" aspect of the image. This info is mainly added by humans.
- **History:** This is information about how the image has got to the present state. For example, history may include certain processing steps that have been applied to the image.

- **Intelectual Property Rights:** This block defines metadata about rights held in and over the resource.

There are other image metadata specifications such as IPTC and XMP that deserves to be mentioned. SWeb image metadata set is derived form various set including SWeb semantic attribute set.

Chapter 5

Visualization of Events

It took the world almost 70 years to acknowledge the elegance of Beck's design of London subway map [11]. Information visualization is a graphical representation of data meant to reveal complex information at a glance. Successful visualizations are beautiful not only for their aesthetic design, but also the elegant layers of detail that efficiently cumulate insight and new understanding [96]. There are two notable perspective of information visualization -

- Colin Wares perspective: Seeing through eyes and understanding with mind is the fundamentals for humans perception of the world. This influences how we should work in building virtual (digital) environments [21].
- Robert Spences perspective: When experiencing the world we build cognitive maps (mental models) that guide our understanding and knowledge of this world. This influences how we should work with creating representation of complex data, diagrams, graphical user interfaces, etcetera, in computers [84].

A beautiful visualization is the perfect orchestration of visual element organization with naturally representing colors, shapes and textures. In fact, this is how our nature is organized and exactly this is why it's so beautiful. This might also be true at same degree that our cognitive model of visual apprehension is evolved and harmonized with the way nature is perceived to be beautiful and meaningful as well. In either case, the most graceful design is often captured by the subtle minds from the profusion of nature.

5.1 Design methodology and principles

In the early 20th century, a group of German psychologists tried to determine how human visual perception works. Many important visual phenomena were catalogued by those people. One of the basic form of them was that human vision is holistic, i.e., *Our visual system automatically imposes structure on visual input and is wired to perceive whole shapes, figures, and objects rather than disconnected edges, lines, and areas. The German word for shape or figure is Gestalt, so these theories became known as the Gestalt principles of visual perception* [54].

5.1.1 Gestalt Priciples

The Gestalt principles are supported by neurophysiologists. The observations basically address the perception of the *whole* formed with discrete visual elements and serves as a useful guideline for graphical user interface design. We take the opportunity to discuss the principles in brief.

Proximity

Proximity is the relative distance between objects that affect our perception of whether they form a group. Objects nearer to each other appeared to be a group where the distant ones are not. Based on this principle, buttons for example, can be organized having close functionalities.

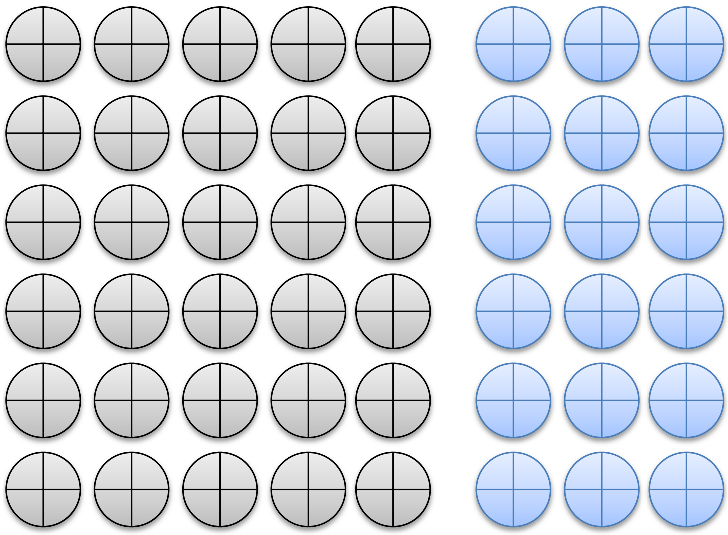


Figure 5.1: Two groups are being formed by a small separation.

Similarity

Objects looking similar appear to be a group. Shape is predominant in this perception along with size and color. This principle was widely considered during the development of event visualization as well as user interface design.

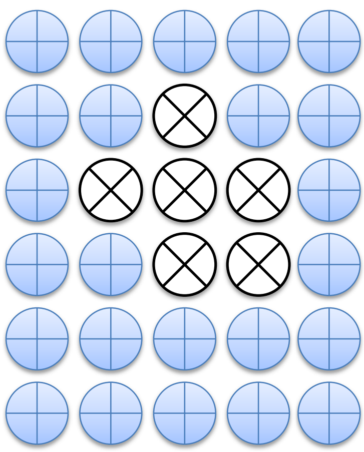


Figure 5.2: Objects appearing more similar than the others are perceived as a group.

Continuity

Our visual system has an intrinsic tendency to solve ambiguity or fill missing elements in such that we can perceive a broken chunk of visual information as a whole. However, the principle has not been used intentionally in the design.

Figure 5.3: Human perception of vision tries to add missing data to see a continuum.

Closure

This principle states that our visual system automatically closes open figures to perceive them as a whole. This is somewhat related to *similarity principle* and we considered the phenomena as an undesired effect that may misrepresent the intended message when a visual scheme yields many elements.

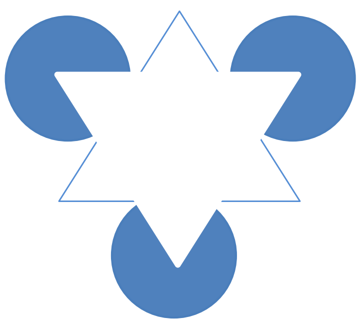


Figure 5.4: We are biased to see whole objects even when they are discontinued at some points.

Symmetry

The Gestalt principle of symmetry states our tendency to parse scene in a simpler form. This is our tendency of rejecting cognitive load by forming a simpler pattern in the brain. On the other hand, a visual design supported by this principle improves the visual clarity and reduces visual complexity dramatically.

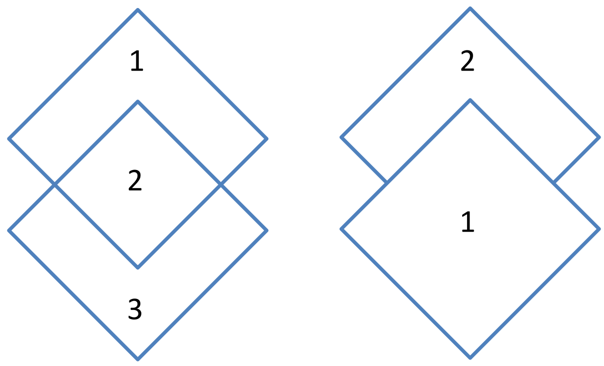


Figure 5.5: We reduce our focus to either 1, 2 or 3 of the figure to the left or 1 or 2 of the figure to the right.

Figure/Ground

This is a very interesting observation that when a smaller object overlaps a bigger object, the bigger one appears as ground while the smaller one as figure. This principle was a key consideration in nested visual element design and not to be mistakenly used where the similar message was not intended. However, there are situations when it is hard to distinguish between a figure and a ground.

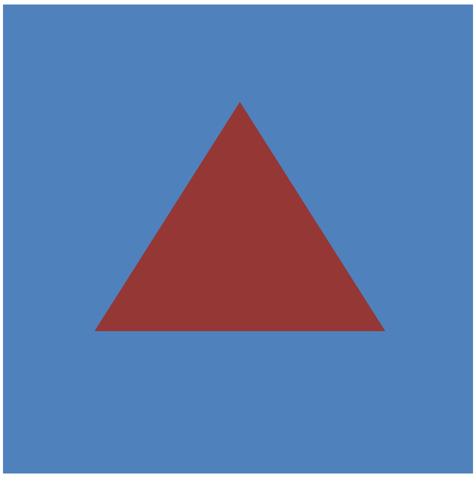


Figure 5.6: This is a common case where our eyes see the triangle as the figure and rectangle as the ground.

Common fate

Unlike the previously mentioned principles, this principle concerns with the moving objects and is related to *proximity* and *similarity* principles. It states that the objects that move together are perceived as a group. Since we haven't used animation or animated visual effects, this principle was never taken into account.

Combined

In a real-world scenario, Gestalt principles work with combined effect. In a static world, first six principles are in effect, while in a dynamic world, the seventh principle's participation is almost obvious.

5.1.2 Meaning of Colors

Psychologists have tried to understand the impact of colors in human mind and have reached some general definition from a psychological point of view. This section briefly discusses psychological effects of color on human mind. The samples are rather vernacular than any standard scientific reference to broad color spectrum, Munsell Color System [20] for instance. The meaning of color have changed over time and space, yet researchers have generally determined the following colors to be accurate [53]

-

♣ **Black:** Black is said to be the color of authority and power. It is stylish and timeless and also implies submission.

♣ **White:** White symbolizes innocence and purity. It is light and neutral and goes with everything.

♣ **Red:** Red is the most emotionally intense color. It stimulates a faster heart bit and breathing. It is also considered the color of love, probably because heart and red rose symbolizes love or vice versa. The most romantic color *pink* is close to red. On the other hand, this extreme color is also used for attention.

♣ **Blue:** The color of ocean and sky. Blue is one of the most popular colors and symbolizes immensity, causing opposite reaction to red. Peaceful, tranquil blue causes calming chemicals production in body. Blue is also the color of coldness and depression.

♣ **Green:** The symbol of nature and the easiest color on eye that can improve the vision. It is calming and refreshing; hospitals often use green wall color because it relaxes patients. It symbolizes fertility, while dark green is masculine, conservative, and implies wealth.

♣ **Yellow:** Yellow is the symbol of optimism, but it causes people to loose temper on long exposer. It is the most difficult color for the eye to take in, so it can be overpowering if overused.

♣ **Purple:** Purple is the color of royalty, luxury, wealth, and sophistication. It is also feminine and romantic.

♣ **Brown:** Solid and reliable brown is the color of earth. Light brown implies genuineness. Brown is also sad and wistful, while men tends to like it.

In our work, we did not make use of all colors mentioned above, while some colors being used left upon developers choice for first pass.

5.2 Visualization model

Chi [18] proposed a data state reference model, a taxonomy for information visualization. Previous attempts by the researchers provided solutions fairly difficult for the implementers of how to apply them. Chi proposed the visualization process in four steps, e.g., (1) data, (2) point of view on data, (3) visualization space and (4) point of view on visualization space. Chi's work contributed a *data to view* transformation process which is highly flexible in nature (Figure 5.7).

This reference model was later extended by Daassi [26] for temporal data

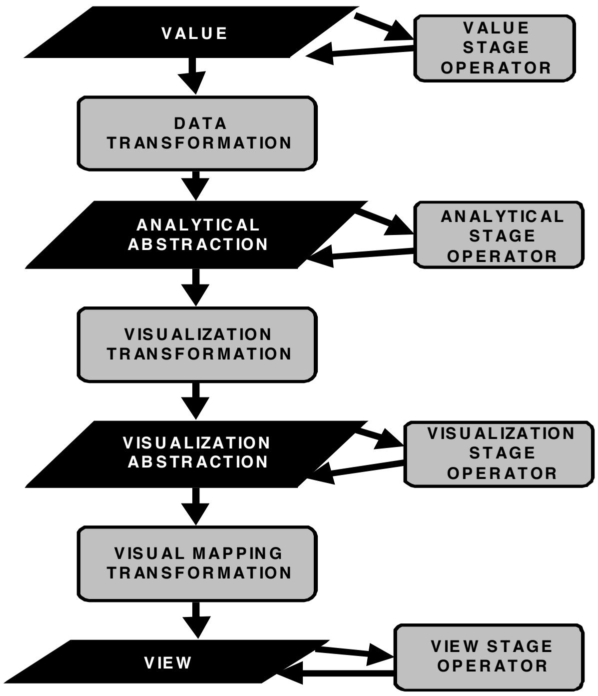


Figure 5.7: Chi's *data state reference model* for information visualization.

visualization. We have used similar technique in our visualization model with extra considerations. Though in both cases, data are dynamic, but our interface holds subset of a set/subset for different view port at different granularity, such as events and event clusters. Hence, we have extended the temporal data visualization model as shown in Figure 5.8

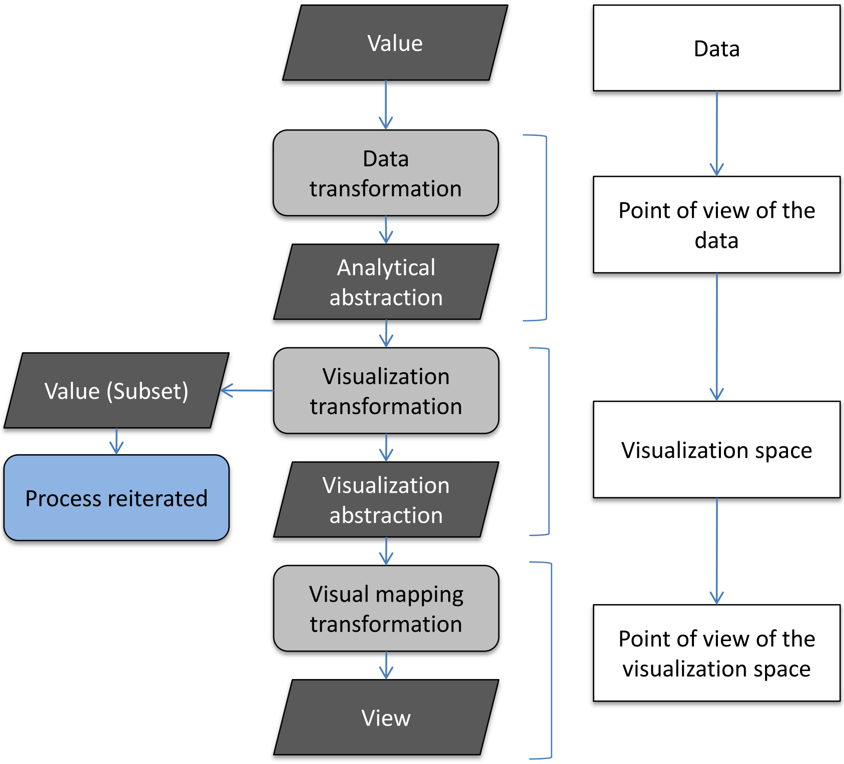


Figure 5.8: Data visualization model allowing data subset from the time slice of coarse grain view to corresponding fine grain view.

5.3 Visualizing data elements

For our work, we have considered laying out event as spots (for moment events) and horizontal bars (for intervals) on a linear absolute time scale i.e. a timeline visualization. To facilitate quick navigation, the granularity of the scale is divided in three bands. The lower band is a coarse grain time scale that contains mostly clusters of events, the middle band is a semi-fine grain contains series of events and the upper band is the fine grain contains events showing the interior of the events. All bands are zoomable.

A calendar view is also available for quick selection and navigation of a bigger to smaller time frame accommodating the user experience with calendars. This options replaces the coarse grain timeline in the lower band.

5.3.1 Basic visual elements

The top element to be visualized on Timeline is event aligned along a single lifeline and anything else goes in it. The user's own life events are discretionally colored *black*, the color of *authority*. The level of zoom determines if the contents are displayed clustered or discrete and of course it will depend on the algorithm and its granularity being set. There are many complex questions surround this visualization, therefore, for simplicity; we divide visual elements in four groups -

- Cluster of events.
- Events (there are also sub events and breaks which will be defined later).
- Cluster of entities other than events.
- Entities.

The proposed visualization is illustrated in Figure 5.9 at different zoom levels -

Cluster of events

Cluster of events visualized on a single horizontal level with temporal distribution. The width of a cluster is the enclosed length of time and height is

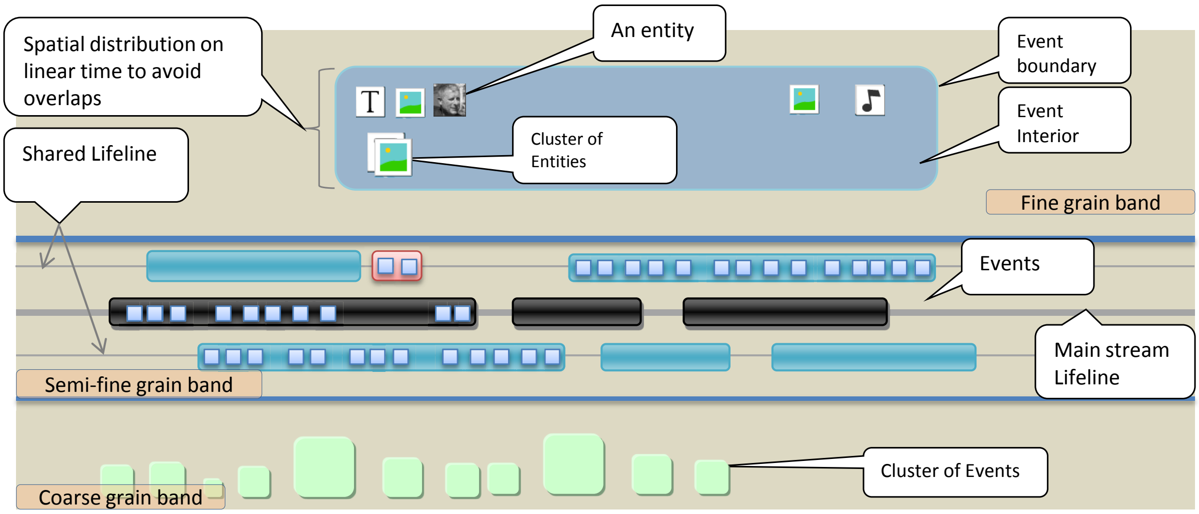


Figure 5.9: The basic visualization of elements.

the number of events within the time frame that includes the shared events.

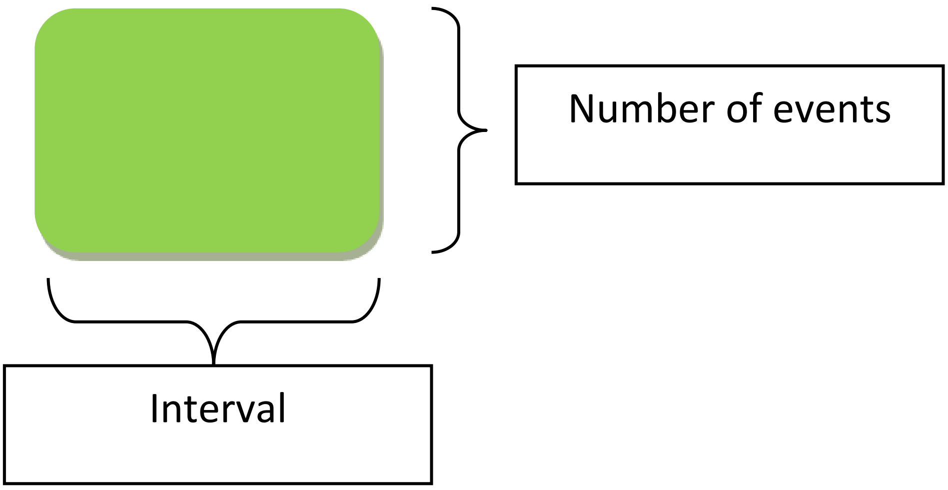


Figure 5.10: A cluster of events. Height is defined by the number of events and width is defined by time length of the events inside the cluster.

Events

At minimum zoom level, events are the rounded rectangle with a fixed height and variable length. At this level, event contents and content group are shown as small rectangles that hold their temporal and content type property.

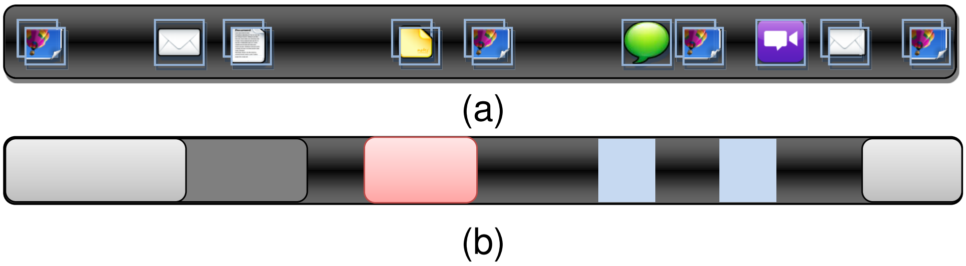


Figure 5.11: (a) A simple event with contents and content collections. (b) A nested event with conflicting parallel event (red) and breaks (blue).

There are two types of events being visualized by ownership type:

1. User events (the main stream), run through the center of the navigation band.
2. Shared events (in blue color), evenly spaced vertically above or below the user events. The spatial relation with the main stream event is yet to be decided.

Main stream user events are categorized as Simple Discrete Events in four different forms.

Simple discrete events

By examining the basic concept of events that happened in the past past, occur at present and are planed for future in our daily life, we developed the visual model on the following considerations.

1. Discrete events: a single event that has a beginning and an end, and may have breaks (periods) in them (see Figure 5.11 (b)). Any event marked as a moment (shooting a bird, for instance) cannot contain another event. Events of this type are shown as small circles.

2. Parallel events: a discrete event that falls within the interval of another larger event apparently shares partly a common length of time, but has no relation with that event. This type of events is distinct by color.

3. Sub-events: the events that are part of and within greater event(s). The visualization is a gradual increase in brightness from outer to inner (see Figure 5.11 (b)).

4. Overlapped events: events that have time overlaps but the owner has participated in his/her sequence (see Figure 5.13). The visualization uses the z-axis (depth) to cascade them. The distribution criterion along the axis is the developers priority at the moment.

More details and other categories are discussed in 3, section 3.2

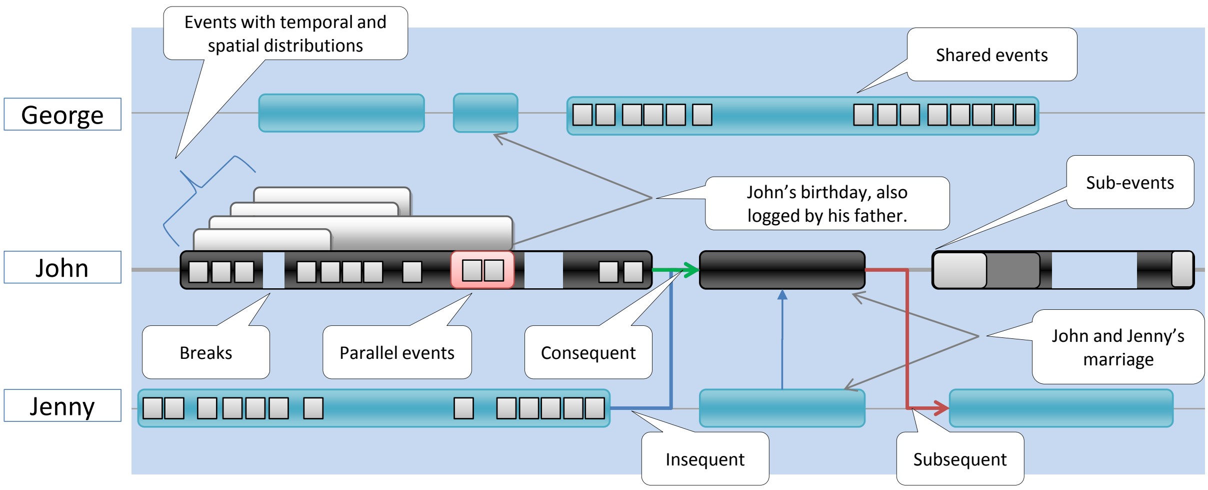


Figure 5.12: Lifelines.

5.3.2 Complex form of events: consequent, insequent and subsequent

As we have already described in section 3.2 the following correlations are defined in Figure 5.12

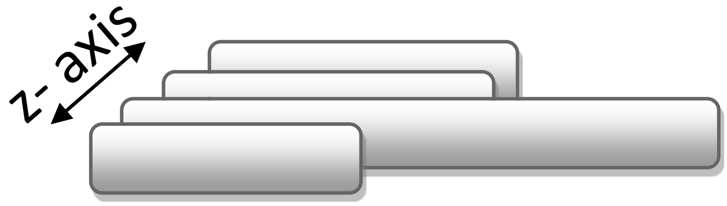


Figure 5.13: Overlapped events.

- Consequents: A determinable consequence of event(s), i.e., for some events there exist one or more causal events in the main stream events are to be shown with explicit relations.

- Insequents: one or more causal shared events impacting a main stream event are to be shown with corresponding relations.

- Subsequents: A resulting shared event from a causal main stream event is to be shown with corresponding relations.

Note that most events may have *consequents* or *causation(s)* and often have *insequents* and *subsequents*, but user may not log them either because they are indeterminable or trivial. Relations 2 and 3 are exemplified in Figure 5.12.

Chapter 6

Metadata Visualization

The relation between data and metadata remains always the same while the information being presented depends on the level we seek them. This chapter treats entity for data and property for metadata. Set of properties being associated with each entity is not completely intended for human comprehension, rather only a part of it is to be visualized. Both Appendix A and B demonstrates how much metadata can be attributed to each entity. Putting onto surface all of the should be disastrous. There is a need for quick preview of entity properties. This can be accommodated in a tooltip or a popup box with minimalist view of entity properties. Another important aspect of the design is to determine order of their arrangement i.e. setting the order of precedence of metadata visualization. In order to reduce user's cognitive load, we have conducted a user study for *minimalist metadata visualization*. There are three fundamental questions we had to encounter -

- What are the metadata to be visualized to make an entity identifiable by human inspection?
- How much is sufficient? and
- In which order?

Answering these questions is not a trivial task, therefore, no simple solution exists. For each entity, there exists numerous context where the answers varies.

6.1 Who, what, where, when

Context is formed out of all above entities. Basically it answers *who*, *what*, *when* and *where* [2]. The question *who* applies only to a context where people are explicitly associated. Furthermore, *which* is the question that essentially comes in play when an answer is incomplete or given in more general term. For instance, if an answer is *Joe is standing beside the car parking*, then the obvious question may come to mind - *which car parking?*, if there are many around. If there is only one car parking area in the context and it is relatively large, then another "*which*" may come to place. The word *which* is substitutive and replaced with the appropriate interrogation. This semantic gap can be sketched as a c*ontext boundary* and the following illustration shows how recursively it runs till the desired result is found -
Person X asks Person Y *where are you?*
Person Y replies *At the car parking*

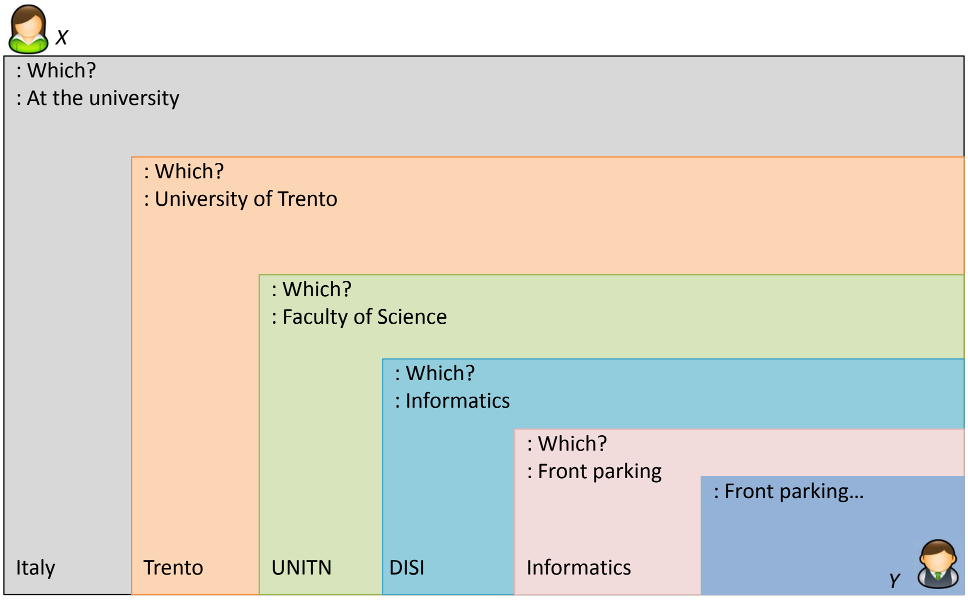


Figure 6.1: The less number of context boundary, the less semantic gap is.

If X were somewhere near the Y's position, then no more information would have been necessary to find Y. This context boundary is the essence of making metadata visualization decision. A prior knowledge of the information seeker determines how much information would be necessary to find an answer. This is not however says in which order they are to be visualized.

6.1.1 Context Query

The definition of context, as plainly as it is seen, is not so plain. In many occasions, it may raise more questions than it answers like answering the questions to a child. If we consider a scenario where two persons are involved and want to see what exactly happening there, a finite number of inquiry (for known subject) or an infinite number of inquiry (for partially known subject) will arise. If the context boundary is reduced as answering to a person already familiar with the scenario, it will end up soon with completeness. However, describing to someone else far outside the context would result in a recursive query.

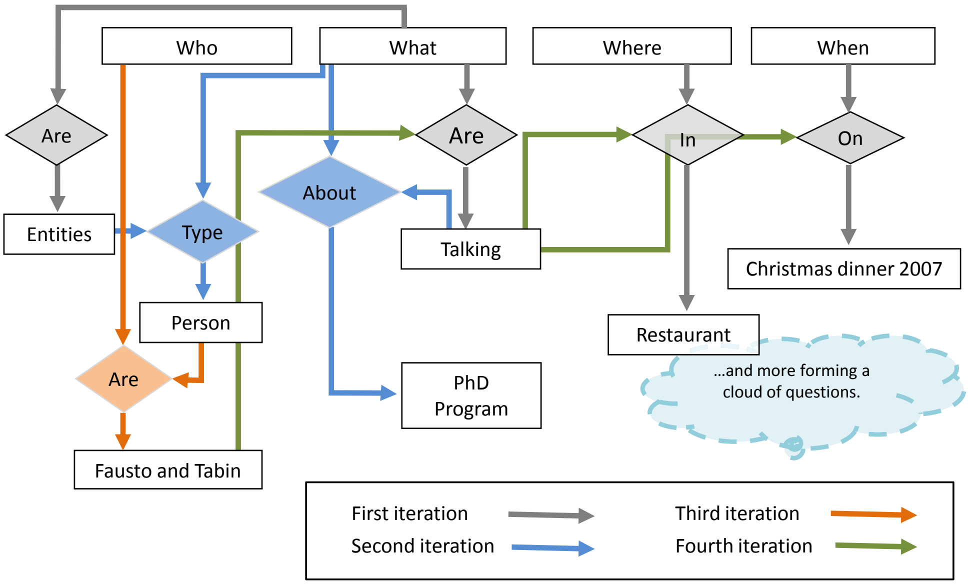


Figure 6.2: Questions are iterated demanding more answers if context boundary increases and goes on until a desired state is reached.

Understanding the right context for both the user and the subject is sought for provides some knowledge of what information should come first, i.e., *who is asking for what.*

6.2 User study

Minimalist metadata visualization for each entity type is subject to the context of use. We, therefore, tried to understand the need for required types, amount and order of metadata in different context. The study took one entity type with five different contexts to illustrate how variant the user response in such understanding of requirements. There were 40 participants in the study seeking for a person in five different contexts given a set of properties (metadata) presented to them. We used online survey tool to perform the study. There were eight common properties while the ninth one was subjectively different. The participants had the freedom to add properties of their own choice. Only one participant came up with an addition *affiliation* in few occurrences. They were -

1. Picture of the person
2. Full Name
3. Nick name
4. Current location
5. Profession
6. Date of birth
7. Hometown
8. Nationality

We will discuss about the ninth one in appropriate passage.

6.2.1 The types and amount of metadata

We perceived five scenarios for five contexts and asked in a form of questions with predefined answers (mentioned in the previous section). The questions were as follows -

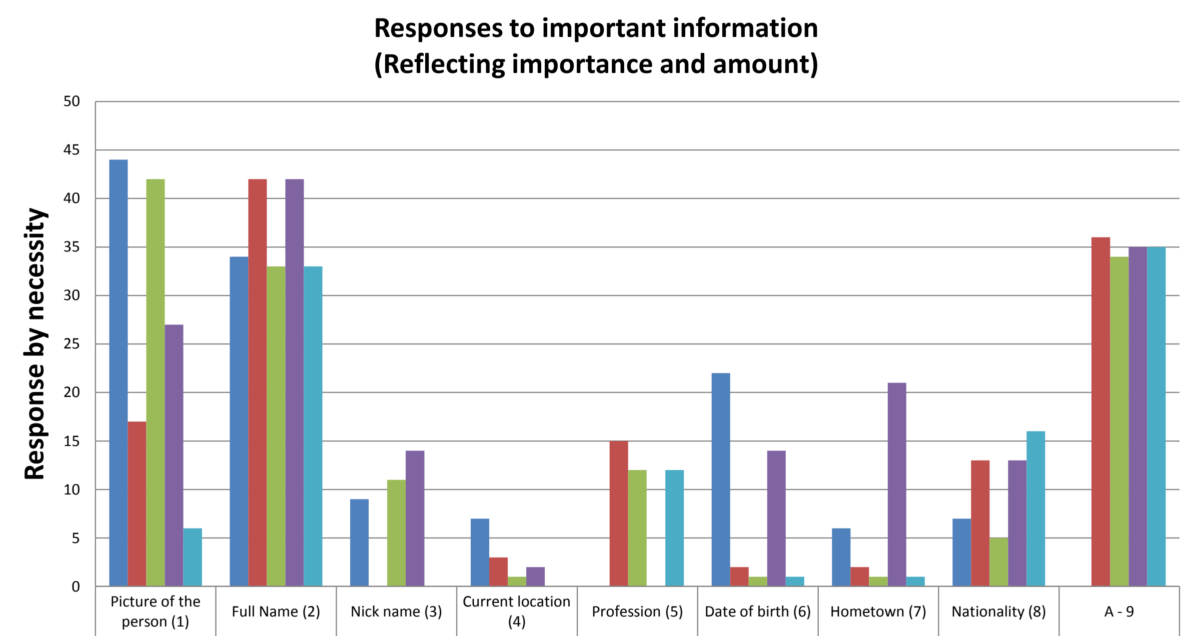
1. You are looking for your younger brother/sister (who happens to reside at the same home) on the net, what are the information sufficient to identify him/her from a search result? (Minimum context boundary)
2. You are looking for your favorite author on the net, what are the information can help you to find him/her from a search result? (Medium context boundary)

3. You are looking for your favorite actor/actress on the net, what are the information would you think sufficient to identify him/her from a list of people? (Medium context boundary)

4. You are looking for your childhood school friend after 15 years of disconnection on the net, what are the information would you think necessary to identify him/her? (High context boundary)

5. You are looking for the author of a famous quote (you know it partially), what are the information would you think sufficient to identify him/her from a list of people? (Higher context boundary)

What usually thought to be more or less close was profoundly different from each other when users responded with their opinion. Here is the summarized table with graph showing the result.



	Picture of the person (1)	Full Name (2)	Nick name (3)	Current location (4)	Profession (5)	Date of birth (6)	Hometown (7)	Nationality (8)	A - 9
Q - 1	44	34	9	7	0	22	6	7	
Q - 2	17	42	0	3	15	2	2	13	36
Q - 3	42	33	11	1	12	1	1	5	34
Q - 4	27	42	14	2	0	14	21	13	35
Q - 5	6	33	0	0	12	1	1	16	35

Figure 6.3: Responses to required metadata in five different contexts.

For question 1, picture, full name, date of birth ranked high respectively. Others being dwarfed, can be considered less relevant or necessary. There was no ninth property for this question. Should only this three pieces of information are enough for this context? If yes, then we are probably very close to a minimalist view of entity properties.

The result is similar for the third context (question) where still the picture and the full name dominate with one addition of the ninth - *List of movies that s/he acted in.* Note that another issue came to surface about the size of the list! We are not sure at this point how big the list could be since it may demand another study in its own right.

Other than contexts one and four, people hardly cared for date of birth and this is surprisingly true for the fifth context that an image is not necessary.

For context four, full name, List of schools s/he attended (ninth property) and a picture appear to be sufficient with the date of birth could help in some situations.

For question two, picture and profession followed by the full name and the list of literatures (ninth property) and for five, the full name and the list of similar quotes (ninth property) are towering high in the graph.

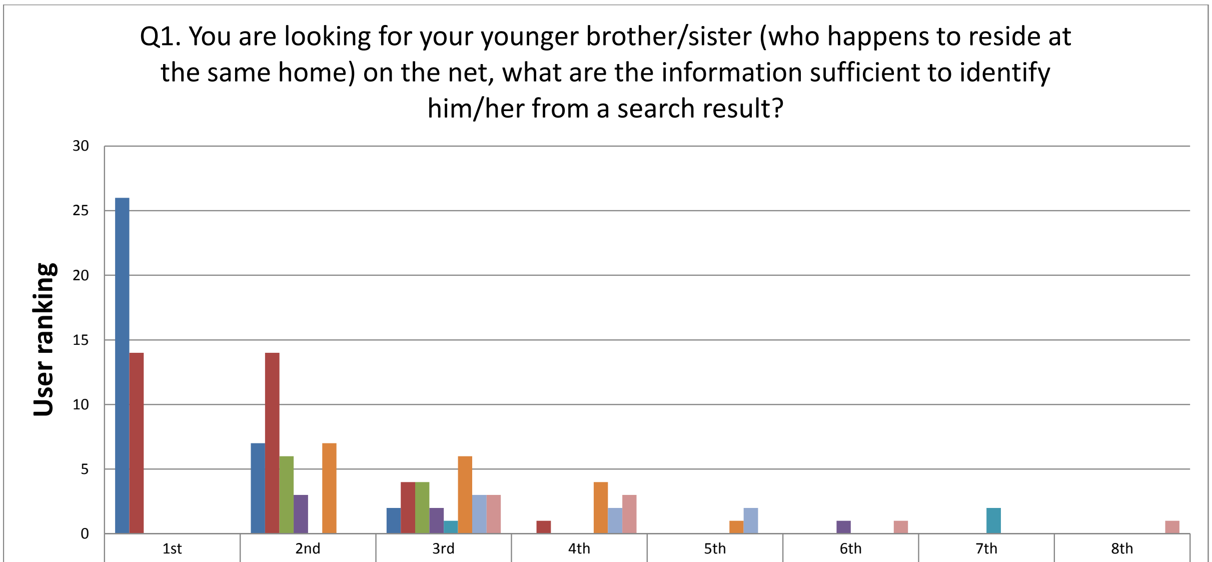
If we now have a quick look on the landscape, not much metadata is really needed given a specific context.

6.2.2 The order of precedence

Now we look at the order of precedence for the given contexts. There is a tradeoff between the natural order and the user's choice. Our contemplation counted both for achieving correctness and completeness.

Context 1: The person is very well known to the user

A user looking for his/her brother/sister on the net provides the context of minimum context boundary. Here is how people responded.



	1st	2nd	3rd	4th	5th	6th	7th	8th
A - 1	26	7	2	0	0	0	0	0
A - 2	14	14	4	1	0	0	0	0
A - 3	0	6	4	0	0	0	0	0
A - 4	0	3	2	0	0	1	0	0
A - 5	0	0	1	0	0	0	2	0
A - 6	0	7	6	4	1	0	0	0
A - 7	0	0	3	2	2	0	0	0
A - 8	0	0	3	3	0	1	0	1

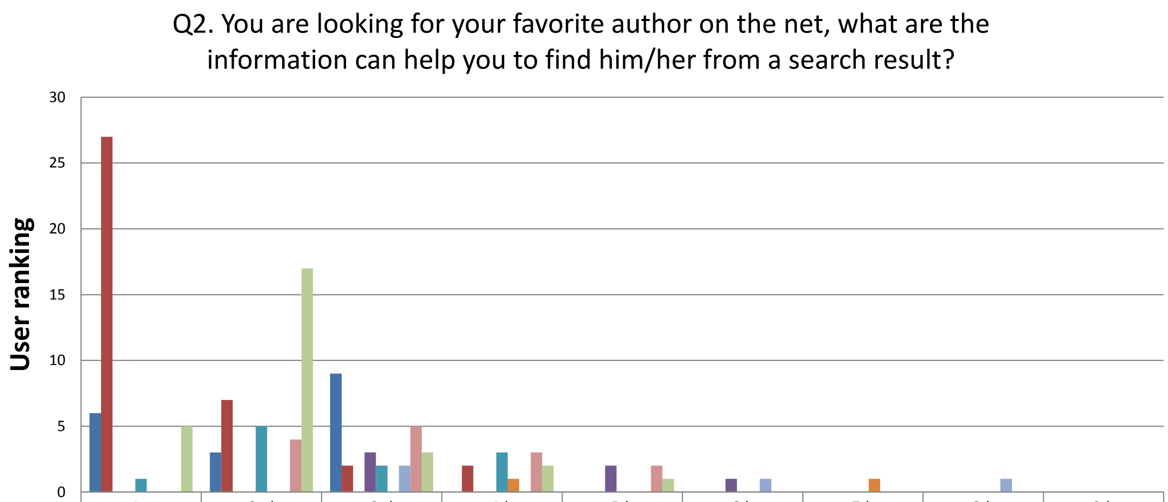
Figure 6.4: The picture should have sufficed though name is a necessity.

Yes, this is the picture that tops all when we know the person with maximum possible details. Some participants ranked full name first to be ordered while others put it at the second position. No other metadata came at the first position.

The picture and the name both are voted, but in some cases name comes above the picture. Though the reason not clearly understood, we conceived from the common paradigm of metadata visualization, we always put picture above the name label, should they come together.

Context 2: The person is known by his/her name and work

We really didn't understand what makes the picture go on the top where an author is mostly remembered by his/her name! In the quest of truth, it's better not read people's mind from another planet. Consider the ordering by picture first, then the list of literature and name at the last, in reality it may appear little weird. Therefore, again the picture-name pair stays at the top followed by the list in order to maintain the convention as long as it does not conflict with the goal.

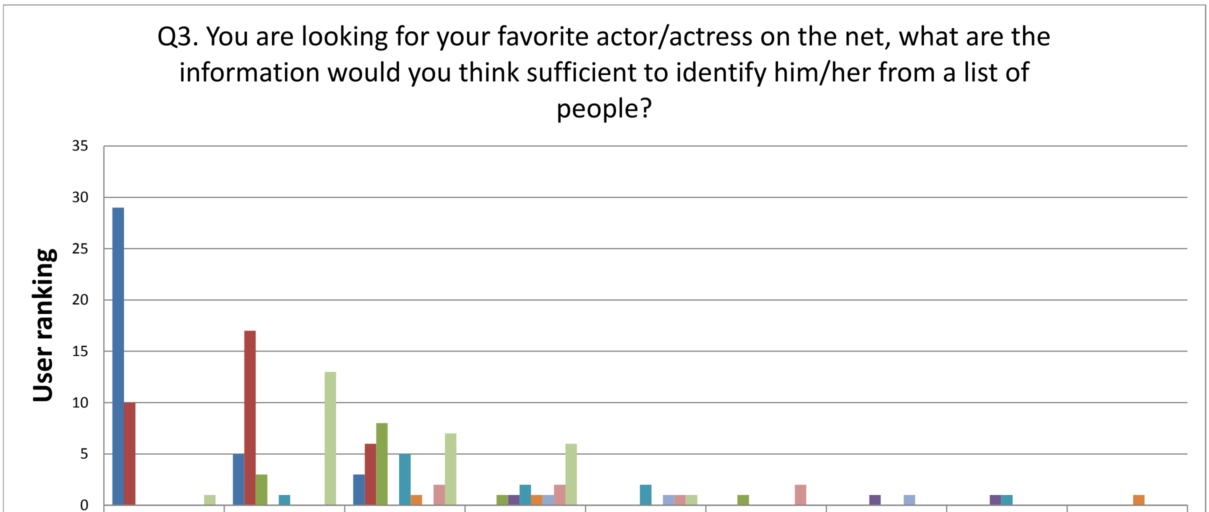


	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
A - 1	6	3	9	0	0	0	0	0	0
A - 2	27	7	2	2	0	0	0	0	0
A - 3	0	0	0	0	0	0	0	0	0
A - 4	0	0	3	0	2	1	0	0	0
A - 5	1	5	2	3	0	0	0	0	0
A - 6	0	0	0	1	0	0	1	0	0
A - 7	0	0	2	0	0	1	0	1	0
A - 8	0	4	5	3	2	0	0	0	0
A - 9	5	17	3	2	1	0	0	0	0

Figure 6.5: Our favorite author is known by his/her name though people ranked picture at the top.

Context 3: The person is known by his/her face and work

We are looking for our favorite actor/actress, the picture and the name pair alone makes the entity identifiable. Surprisingly, the anticipation did not work when participants put their opinion. It's the name first followed by the picture and the list of movies.



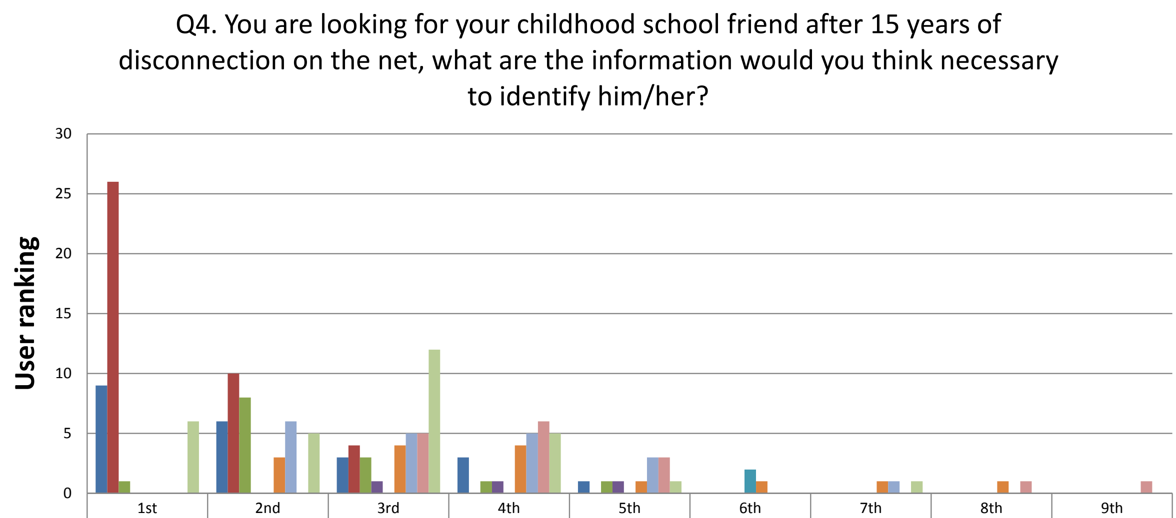
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
A - 1	29	5	3	0	0	0	0	0	0
A - 2	10	17	6	0	0	0	0	0	0
A - 3	0	3	8	1	0	1	0	0	0
A - 4	0	0	0	1	0	0	1	1	0
A - 5	0	1	5	2	2	0	0	1	0
A - 6	0	0	1	1	0	0	0	0	1
A - 7	0	0	0	1	1	0	1	0	0
A - 8	0	0	2	2	1	2	0	0	0
A - 9	1	13	7	6	1	0	0	0	0

Figure 6.6: Our favorite actor/actress is known by appearance and identified by his/her name and picture.

Context 4: The person is remembered from childhood memories

"Monica!!! Is that you!!!"

The thirst of eyes is to see the person comes next after the name is being inspected. Twenty six participants ranked name at the top followed by the list of schools s/he attended and the name. Nick name also has significance right with the picture.

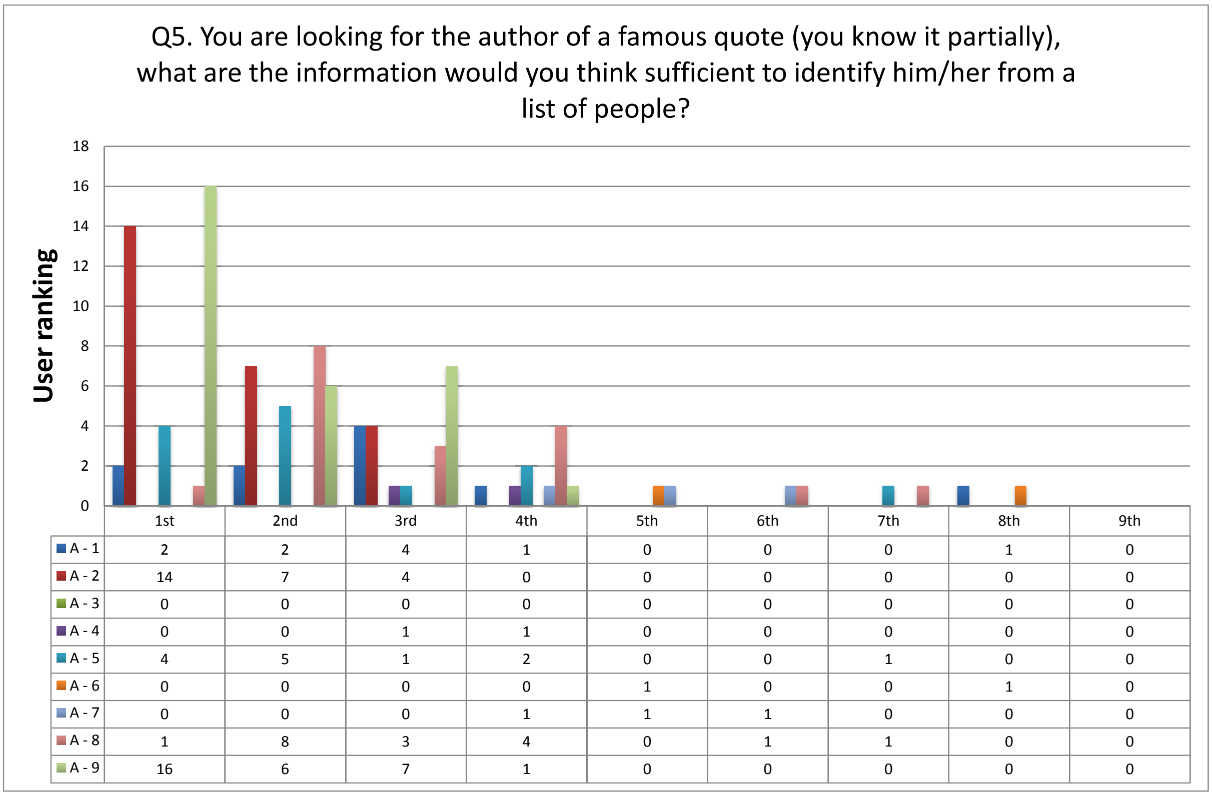


	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
A - 1	9	6	3	3	1	0	0	0	0
A - 2	26	10	4	0	0	0	0	0	0
A - 3	1	8	3	1	1	0	0	0	0
A - 4	0	0	1	1	1	0	0	0	0
A - 5	0	0	0	0	0	2	0	0	0
A - 6	0	3	4	4	1	1	1	1	0
A - 7	0	6	5	5	3	0	1	0	0
A - 8	0	0	5	6	3	0	0	1	1
A - 9	6	5	12	5	1	0	1	0	0

Figure 6.7: No matter what 15 years mean to make a big difference, people wanted to see the picture first.

Context 5: The person is not known, but a few of his/her words

One of the participants suggested to treat this context differently as the person is search by the *quote* not by any prime properties of a person. Therefore, consider this totally a different context than the previous four. The person can only be identified by matching quotes as appears in the graph and can be learnt with other metadata. The contest between *similar quotes* and *name* could have occurred due to the chances that the person is known, but not with relation to the given quotation.



	1st	2nd	3rd	4th	5th	6th	7th	8th	9th
A - 1	2	2	4	1	0	0	0	1	0
A - 2	14	7	4	0	0	0	0	0	0
A - 3	0	0	0	0	0	0	0	0	0
A - 4	0	0	1	1	0	0	0	0	0
A - 5	4	5	1	2	0	0	1	0	0
A - 6	0	0	0	0	1	0	0	1	0
A - 7	0	0	0	1	1	1	0	0	0
A - 8	1	8	3	4	0	1	1	0	0
A - 9	16	6	7	1	0	0	0	0	0

Figure 6.8: Other properties may help learn about the person if found correctly.

For all five contexts, different opinions exist. For the values being smaller, we put them aside from discussion. However, those less relevant but ranked metadata are considered for extended view when necessary.

6.2.3 Visual metadata

Images, static or motion, are usually embedded with metadata that describe the objects in them. These are visual metadata that eliminate the need for character encoding. The fundamental visual metadata are -

- Shape
- Color and
- Texture

Depending on the degree of clarity, shape alone can help identifying an entity. Here, we do not consider the primitive geometric shapes to be entities, rather they are constituents of entities. Following is the shape of a circle, once with a little bit distortion, the primitive shape appears to be a known object.

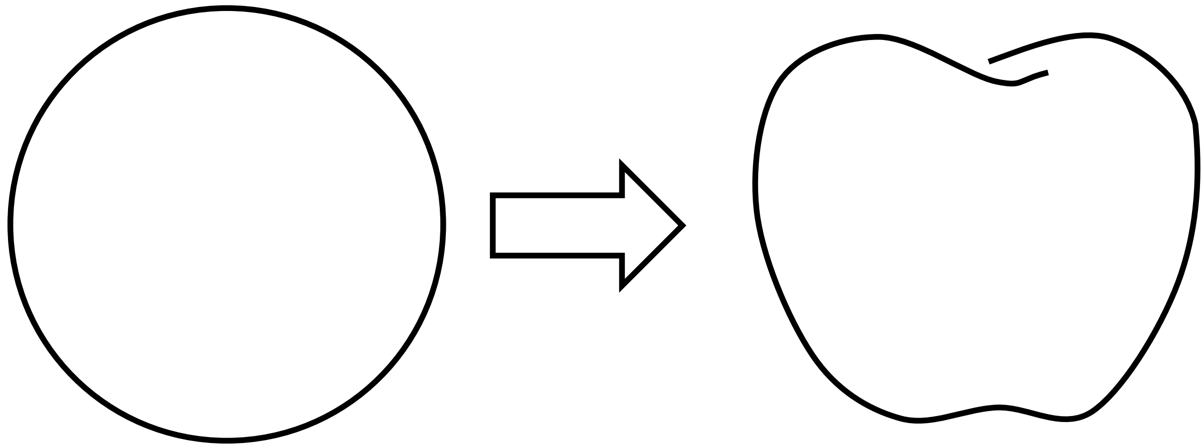


Figure 6.9: If we see an apple, only the shape probable served the purpose.

Again, we try to apply just the texture without any distortion of the shape. The shape is still primitive, but the object is known.

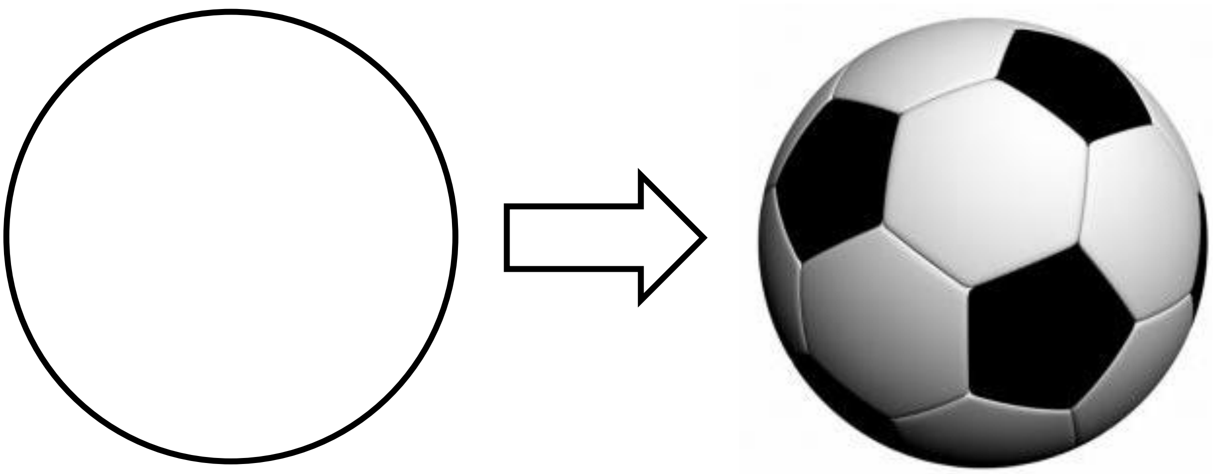


Figure 6.10: Texture is often necessary to distinguish objects.

The role color is another foremost visual metadata that may work without a shape. The following example does not need an expert eye to recognize the object as soon as the color is applied.

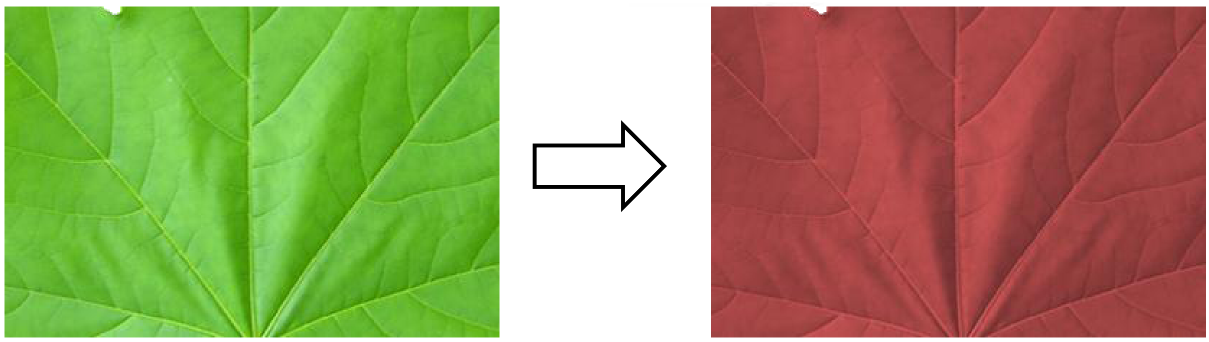


Figure 6.11: If the right side image confirms a maple leaf, then color has served its purpose.

This is important to understand from the above examples, that textual description are not always a necessary criteria to make an object identifiable. By reducing the textual metadata, an iconic or minimalist visualization is possible.

But still there are issues of information feed. We must not take it guaranteed that every user has familiarity with the object, therefore, this is wise to put always a label with an image. This help to achieve two things - (a)identity and (b)intention.

Identity confirms what exactly the image is representing and this should be done by accompanying its name label; somebody may need this extra little piece of information to learn. This apparently funny image of a South African airliner Kulula's plane may have extreme values for curious minds.

Figure 6.12: Designed to inform, a practice well beyond convention. (Source: Internet)

The intension can be changed just by adding or removing information. While one piece of information makes an identity clear, adding another piece makes the intention clear. Here is an example -

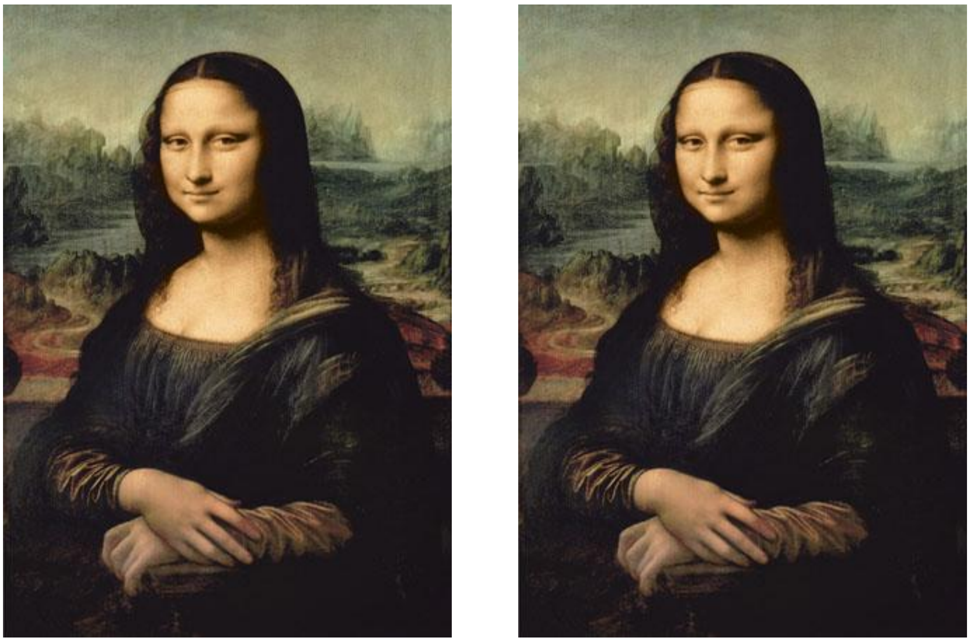


Figure 6.13: The intention is changed from image (a) to image (b). (Source: Internet)

This should be clear by now, how many aspects have to be explicated while specifying a minimalist metadata visualization.

6.3 Minimalist visualization of event metadata

We have followed the same principle derived from the study in minimalist view of event and other associated entities. Although, similar study has not yet been performed for all of them taking different contexts, the solution, for now, comes from empirical study of contemporary practice and natural ordering of meta-information. Events are recognized and/or remembered under various cultural, social and individual's mind settings. Defining a context-aware practical minimalist visualization of event information surmounts a study on bigger scale. Following two proposals exemplifies the minimalist view of metadata - *minimal* and *expanded* for event recognition.

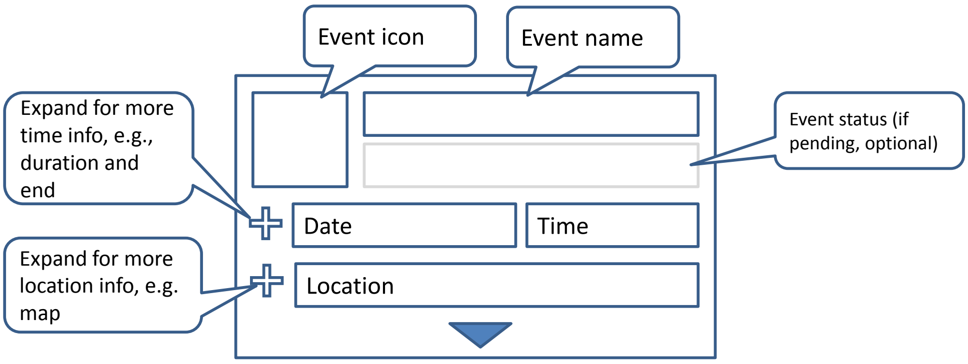


Figure 6.14: A minimalist view of event metadata that gives basic knowledge about the event.

The highest ranking metadata are placed in the minimalist view, while the rest of the user ranked metadata is served on demand in an expanded view. Both examples are generalized for all context.

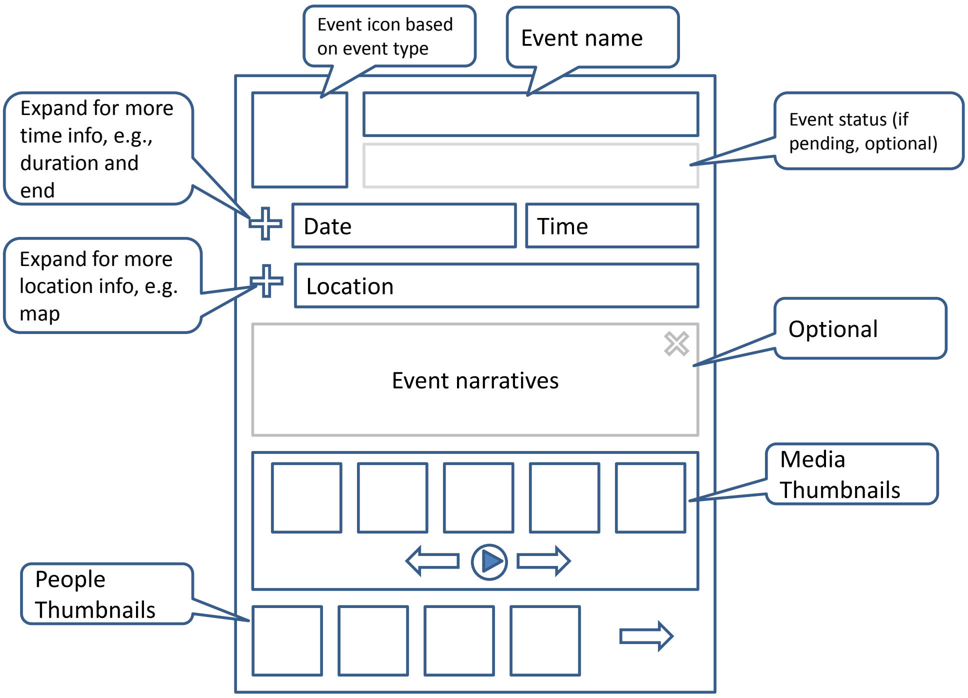


Figure 6.15: Expanded view of event metadata that enables access to associated services and entities.

Chapter 7

User Interface

While designing a system, we very often forget to perform a match between the system and the real world. The cognitive state of the developers mind overlaps only in few occasion with that of users perspective. What designers consider to be an innovation could be in turn the worst nightmare for the users. It is reported in a survey [100] undertaken by 350 US companies on over 8000 projects revealed that one third of the projects were never completed and one half succeeded only partially, that is, with partial functionalities, major cost overruns, or significant delays (Standish Group, 95). Managers identified poor requirements as the major source of problems (about half of the responses) - more specifically, the lack of user involvement (13%), requirements incompleteness (12%), changing requirements (11%), unrealistic expectations (6%), and unclear objectives (5%) . This summed up 47% of failure is due to the absence of Methodology of Interaction Design which spruces up from the field of *Human Computer Interaction* (HCI), more generally called *Human Machine Interactions.*

This chapter describes cumulative development of user interface and interactions. We have explored several novel principles as well as the state of the art techniques that dominate today. An early guideline proposed by Cheriton dates back to 1976 for time-shared computer system [17]. Donald Norman [73], [74] presented the design rules based on human cognition including cognitive errors. A more comprehensive set of user inteface design guide is provided by Smith and Mosier (1986) [95]. There are more to be mentioned, but the best known ones came from Shneiderman [91], and Nielsen and Molich [71]. Following both guidelines, the design progressed with an user centric approach.

7.1 Design methodology and principles

The success of an application does not only depend on its functional capabilities, that the application does, but also profoundly depends on how these capabilities are used.

Ben Shneiderman has defined eight rules that are very effective guidelines for the developers in order to design and develop usable applications for the end users [91]. Whenever design of interface and interaction come to account, we would like to mention the Eight Golden Rules of Schneiderman for interface design. These rules are derived heuristically from experience and applicable in most interactive systems after being properly refined, extended, and interpreted. To improve the usability of an application it is important to have a well designed interface. Shneiderman's *Eight Golden Rules of Interface Design* are a guide to good interaction design.

1. Strive for consistency
   Consistent sequences of actions should be applied in similar situations, such as identical terminology should be used in prompts, menus, and help screens, and consistent commands should be used throughout the interactions.

2. Enable frequent users to use shortcuts

With the increase of use frequency, user's desires to reduce the number of interactions and to increase the pace of interaction do increase. Abbreviations, function keys, hidden commands and macro facilities are very helpful to an expert user.

3. Offer informative feedback
   There should be some system or relevance feedback for every operator action. For frequent and minor actions, the response can be modest, while for infrequent and major actions, the response should be more attentive.

4. Design dialog to yield closure
   Sequences of actions is necessary to be organized into groups with a beginning, middle, and end. The informative feedback at the completion of a group of actions gives the operators the satisfaction of accomplishment. This in turn provides a sense of relief, the signal to drop contingency plans and options from their minds. This indicates that the way is clear to prepare for the next group of actions.

5. Offer simple error handling
   Restrict the possibility of making errors as much as possible. Design the system so the user cannot make a serious error. If an error is made, the system should be able to detect it and offer simple, comprehensible mechanisms for handling the error.

6. Permit easy reversal of actions
   This feature relieves anxiety, since the user knows that errors can be undone. It thus encourages exploration of undiscovered features. The units of reversibility may be a single action, a data entry or modification, or a complete group of actions.

7. Support internal locus of control

Experienced users strongly desire the sense that they are in charge of the system and that the system responds to their actions. Design the system to make users the initiators of actions instead becoming the responders.

8. Reduce short-term memory load
   Human short term memory has certain limitations for information processing. Short-term memory requires that displays be kept simple, multiple page displays be consolidated, window-motion frequency be reduced, and sufficient training time be allotted for codes, mnemonics, and sequences of actions.

Considering user's knowledge in the head and knowledge in the world, our design should contain the basic elements of interactive computing that users are familiar for decades. Following is the brief overview of Nielsen and Molich's rules for UI design.

- Consistency and standards
- Visibility of system status
- Match between system and real world
- User control and freedom
- Error prevention
- Recognition rather than recall
- Flexibility and efficiency of use
- Aesthetic and minimalist design
- Help users recognize, diagnose, and recover from errors
- Provide online documentation and help

Shneiderman's principles has also been adopted with fluid interaction, an illusive quality to measure during our usability evaluation test. On the other hand, Nielsen and Molich added aesthetic and minimalist design principles. To ensure we achieve maximum fluidity, we involved users from very beginning of the design process. Numerous scenarios had been developed to examine how each task can be performed uninterrupted with pleasure. In most cases, we offered either automatic or semi-automatic creation of events and later the process continued with the enrichment of event metadata.

In many cases, our perception of the world around us in not true depiction of what is actually there, but to a large extent what we expect to *perceive*. These expectations are biased by three factors [54] -

- **the past:** our experience
- **the present:** the current context
- **the future:** our goals

This would not be much to say that our design decision heavily biased by those experiences and the goal leaded us innovation to some extent.

7.2 Design Goals

As it comes to the necessity of visualizing data/metadata and performing operations on them intuitively, the fundamental rationale of the layout design was to allocate space to all visual elements. In this phase, we took object oriented approach of tree structured user interface where each of the node is assigned with data or control elements and its visual and behavioral properties. The data and metadata visualizations are described in Chapter

5 and 6 respectively in their own rights that provided the framework for designing the application interface.

As part of our consistent and progressive design work, the following goals were set for the application layout which are coherent with the UI design goals.

- Maximize content visualization area.
- Minimize UI component visualization overload.
- Allocate rational space and location for tools and components.
- Separate controls and data integration to visual space.
- Manifest real life experience of visual elements distribution in space.

7.3 Design and Prototyping

The units of UI are frames. Every frame is organized under the top frame or the application console that itself does not contain any data or control. These frames can inherit *look and feel* properties from parents making the theme management easier.

7.3.1 Dependency Hierarchy Graph

The hierarchy dependency graph (Figure 7.1) drawn from the requirements analysis for data to be visualized and manipulated by the end users. We tried to keep frames that would hold the data/metadata and operations menu under common parents in order to maintain integrity of visualizations and interactions.

Figure 7.2 shows the corresponding tree map drawn from the dependency hierarchy graph which is similar to a UI layout.

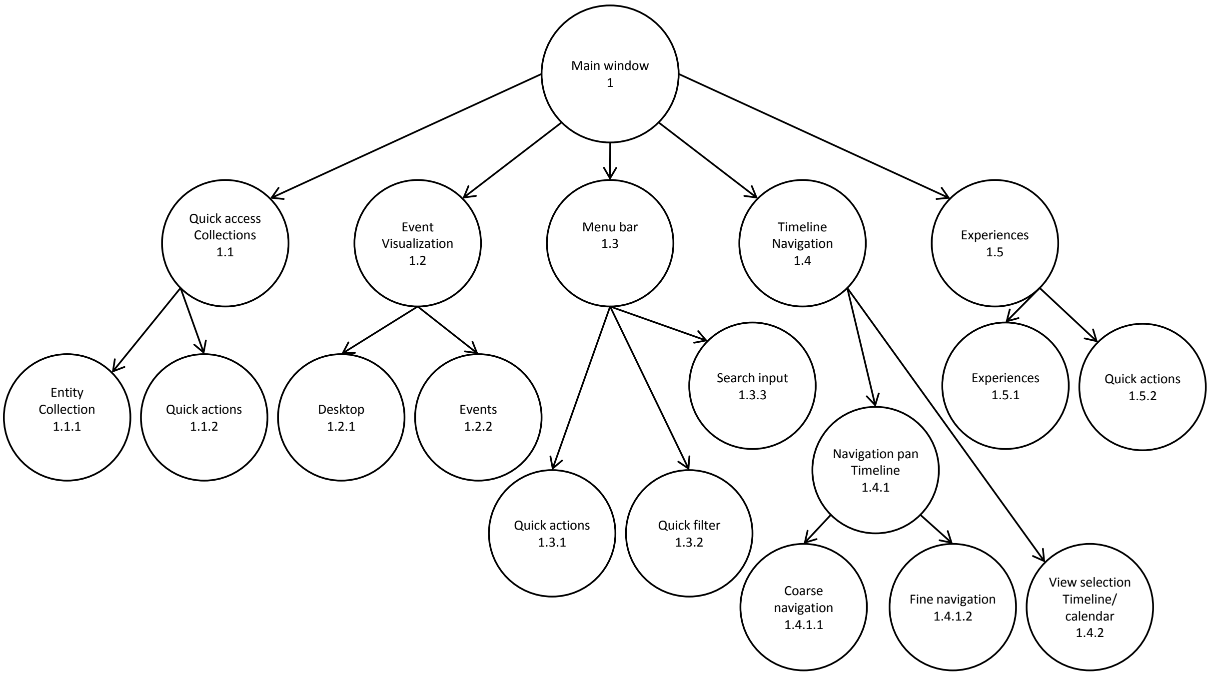


Figure 7.1: UI frame hierarchy dependency graph.

7.3.2 Mid-fidelity prototype

This section describes the mid-fidelity prototype which is being developed from dependency hierarchy graph. This prototype eventually leads to the high fidelity phototype.

Property allocation rules

We define two types of properties, e.g., (a)Private and (b)Public, that can be applied to each node/frame.

1. Private properties are those properties that cannot be inherited by the descendants, such as data/metadata and operation controls (menu/buttons). This is also mandatory to maintain that source data/metadata set cannot be changed once assigned at any phase of development.

2. Public properties intended to be inherited unless otherwise over ridden. These are the properties that controls the appearance and be-

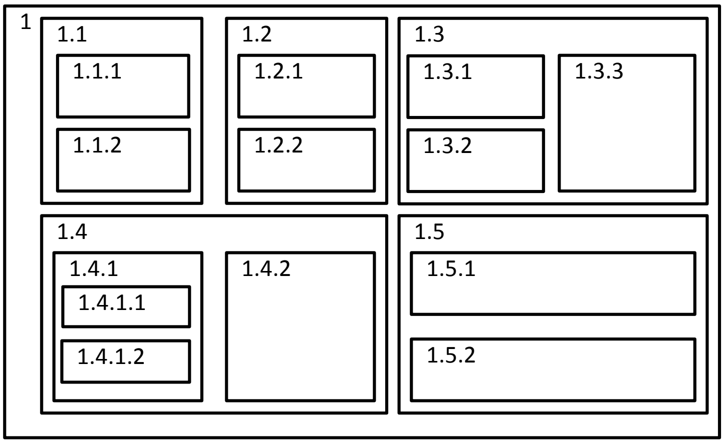


Figure 7.2: Corresponding tree map from dependency graph.

havior of the frame.

Following are the rules for the allocation of properties to each node.

- Each node should contain its set of properties.
- Properties (public) of a node can be inherited throughout the sub-tree under the node.
- Some properties can be over ridden with the nodes private properties.
- New properties can be defined as the nodes private properties.
- However, there are restriction on property values
  - Properties like size, height and width cannot over run the value of its parent node.
  - For every node, those properties are always relative.
- Content of each node should be defined as its property, e.g., whether it contains navigation items, data, image, or metadata.

User Interface prototype

With the initial design at hand, we moved forward with real users again for assigning the properties to each visualization pane. After properties being applied and nodes being indexed, the final layout (Figure 7.4) emerges from the graph in Figure 7.3

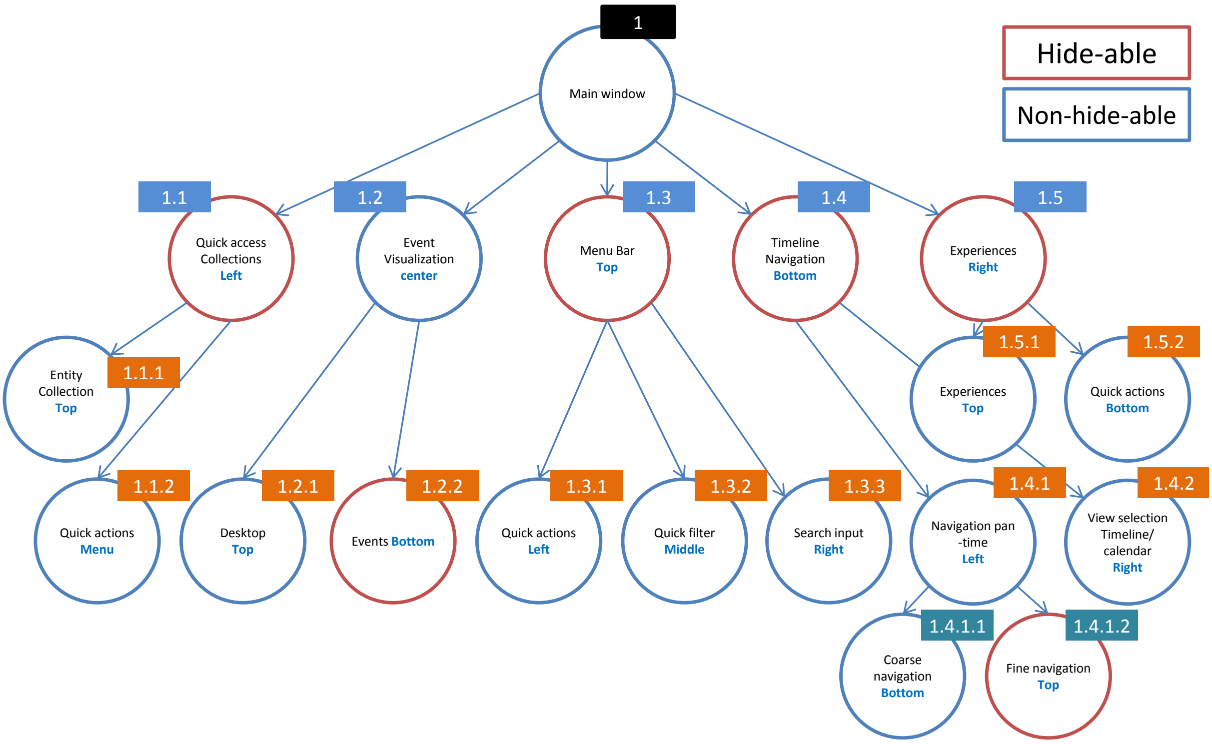


Figure 7.3: Frame hierarchy dependency graph, basic properties being applied.

7.4 Capturing and manipulating the events

In this section, we describe the various means and methods of performing operations. The five basic operations are -

- Navigate
- Create

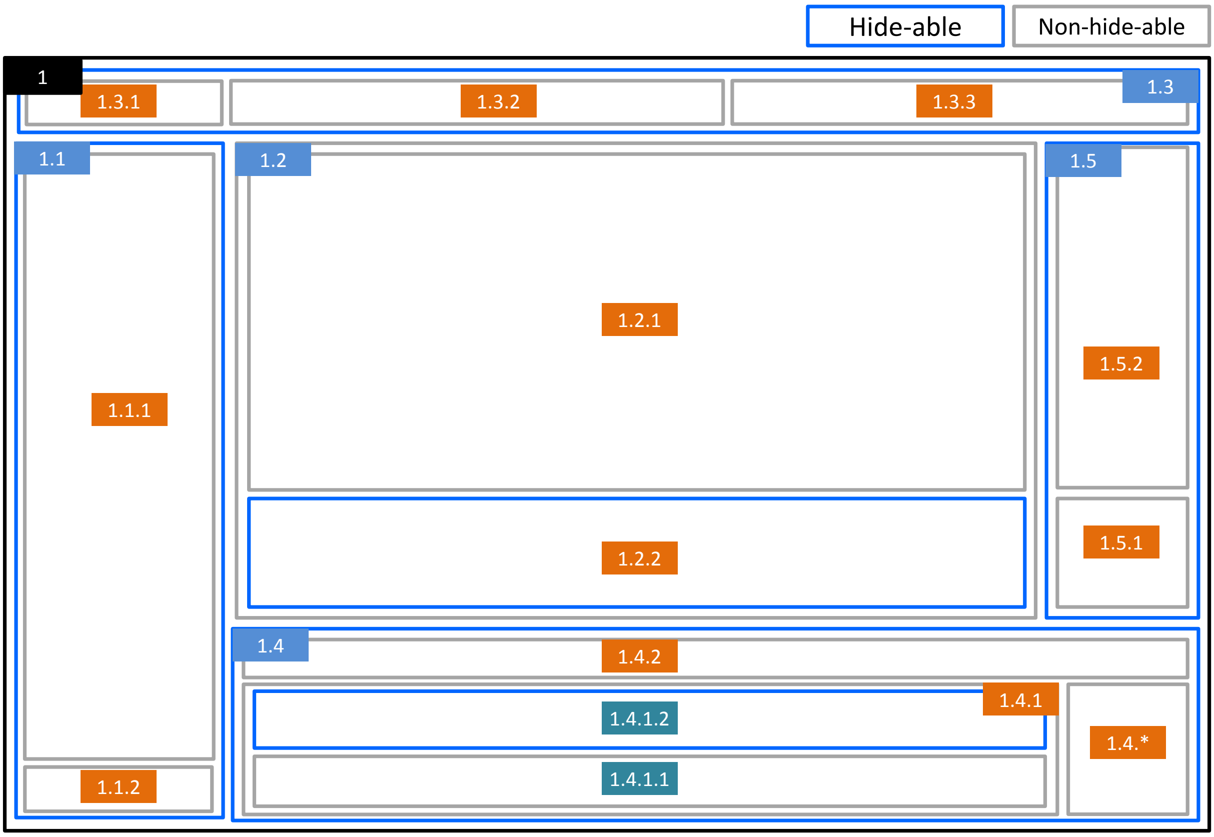


Figure 7.4: User interface layout form the frame hierarchy dependency graph. Spatial properties are being applied.

- Update
- Search
- Delete

7.4.1 Navigation

Timeline provides support for navigation, create, update of events of individual. This section focuses on event navigation over timeline which is the foundation of other operations. Note that all elements at navigation mode is locked with the timeline and cane be unlocked -

1. Automatically by dropping entities from desktop to timeline or

2. Explicitly by lock/unlock toggle button at the left of timeline bar. There should be other tools to perform different operations arranged vertically e.g. lock/unlock, edit, delete, etc.

In [56], time slider has been used to have point access to the time. On the other hand, our design incorporates three simultaneous level of granularity with the use of time slice. This provides greater flexibility of navigating timeline (Figure 7.5).

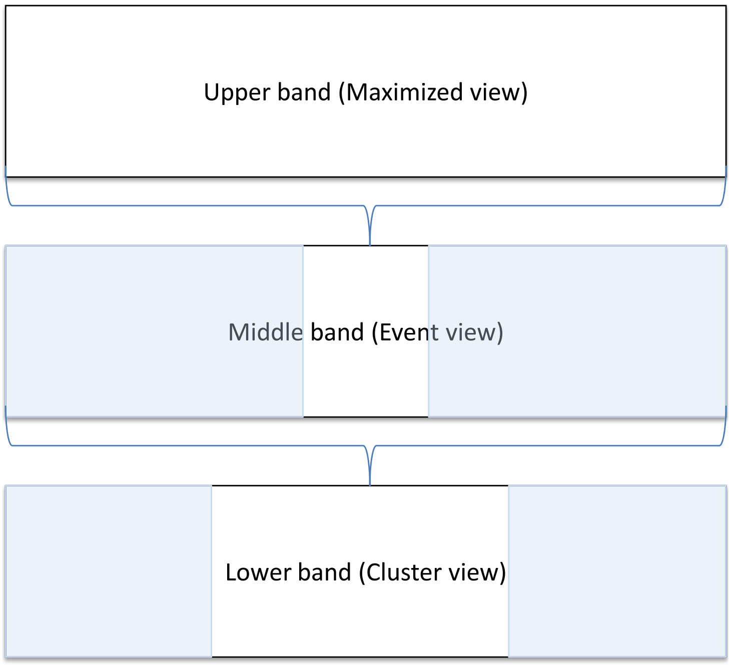


Figure 7.5: Retractible time slice in middle and lower band of timeline.

We have two modes for time navigation in the system-

1. Timeline mode
2. Calendar mode

Although the above two modes share some common characteristics, there are some distinct interaction behaviors that make them different. To avoid repetitions, the modes are not discussed here. We describe the behavior and interaction details in the following sections.

7.4.2 Timeline Mode

1. All three time bands can be panned and zoomed in/out by default actions.

2. Time skewed for lower band is $a*log(x)+b$, where a is the softening factor factor per action and b is the adjustment.

3. The effect of default Double Click (DC) action on empty area of band/slice is *zoom in* and *Ctrl + DC* is *zoom out*. Mouse wheel is the alternative modality to perform zoom actions.

4. Per DC, effect is set by the equation $f(x) = 2x.a$, where x starts with 1 at zoom min and $x = 1,2,3,$. This is an acceleration upon user intention.

5. Zoom out follows the reverse order of the equation that is $f(x) = 1/2x.a$, where x starts with 1 at zoom max 1 and $x = 1,2,3,$. This is an zoom out acceleration on user's intention.

6. Zoom level is stored in m and can be saved to restore the state on return. x is reset to start with 1 at any instance user takes a reverse turn in zooming, series continues as long as the zooming direction remains unchanged. In both equations, a is a softening factor.

7. Position of DC centers the point of the pane.

8. The effects of default DC action on content cluster in any band are -

    - Centering the cluster in the slice.
    - Decompose the cluster into sub-clusters or contents occupying the whole slice length and propagate the effect to upper band while the slice of the upper band remains intact by position and ratio.

9. The effects of default DC action on content or content cluster in upper band are -
   - If on a single content, it opens up with entity visualization window.
   - If on a cluster of contents, it opens up in entity preview window.
10. The effects of panning and/or resizing slice has its immediate effect on all subsequent bands above, i.e.
    - Panning the slice on the lower band shall change the period of middle band and upper band.
    - The slices of middle and upper bands will hold their respective position and ratio.
    - Similar effect is expected for resizing and this effect is bottom up and non-reversible.
11. The effects of panning any time band has its immediate effect on all subsequent band above or below, e.g., panning the middle time band -
    - Will move the corresponding slice on bottom time band to its respective position.
    - Will bring new contents in own time slice.
    - Will update the upper time band.
    - This effect is proportional and dispersive.
12. The effect of zooming in/out any time band has its immediate effect on all subsequent band above or below, e.g., zooming in the middle time band -

- Will proportionally zoom in the lower band while retaining the size and position of the slice.
- Or, will reduce the size of the corresponding slice on the lower band.
- Will update it.
- Will proportionally zoom in the upper band while retaining the size and position of its slice.
- For all first options, the effect is proportional and dispersive.
- If any band is positioned to center of double click, corresponding effect must be observed on both upper and lower bands.

13. Months above 24 should turn to 3 years. Pixel to time ratio has to be maintained with respect to the corresponding month when each vertical bar or time segment presents a month, e.g. for February (leap year), the ratio is number of pixel/29.

14. Years above 24 should turn to decade for each bar and the pane should initially have tree bars. We can go further from decade to half a century and then to century for each bar. Maximum 24 bars can be allowed with any given granularity.

15. At year per bar zoom level, pixel to month ratio is left as programmers challenge.

In this design timeline should demonstrate three behavioral modes -

- Read only mode that allows all interactions on timeline defined in previous points. This is the default mode.
- Edit mode, an especial lock/unlock icon placed bellow/above the right arrow of the timeline/calendar band that would allow to operation (b) in *explicit update* to be performed.

- Proactive mode that automatically switch to edit mode by any of the actions by the user from Explicit update (c), and Implicit update (b and c).

7.4.3 Calendar Mode

1. The lower band contains calendar of six months.

2. Year of the calendar is current year by default.

3. We need a horizontal bar above the calendar that enables selection of year, d/w/m as illustrated in Figure 7.7

4. By default Jan to Jun appears on the calendar band when year is selected and can be quickly changed between either half of the year. Note that panning of months on the calendar should be considered as intuitive feature.

5. The relevance feedback in the illustrations for *t* on hover, and *t1* to *t2* on drag can also be alternatively done on mouse tooltip.

6. Selection of year centers the 6 month calendar initially, i.e., months from Apr to Sep.

7. The lower band can be panned left-right, meaning months of two adjacent years can be visualized at max.

8. Selection of day divides middle band in 24 hours in vertical bars.

9. At day selection, the zoom in/out range is 6 to 24 hours by a factor of 2. Still panning left-right is possible. That means hours of two adjacent days can be viewed simultaneously.

10. At middle band, if hours are presented as vertical bars, pixels in each block width presents minutes by as *1 min = (int) total pixels in a block/60.*

11. Selection of week divides middle band in seven days and the zoom in/out range is 3 to 24 days by a factor of 2. Still panning left-right is possible. That means days of two adjacent weeks/months can be viewed simultaneously. In case 9 and 11, corresponding day(s) are shown selected in the calendar.

12. At middle band, if blocks jump unto days, *1 hour = (int) total pixels in a block/24*. The idea is same as previous illustration. There could be a problem with fractions, for instance, we may get 1 min or 3 min, but never 2 at a certain zoom level. This happens in Photoshop selection at lower zoom level.

13. At month selection, middle band should show up to 5 weeks with respect to the month. Only zoom into the week and into day and into hours should be allowed.

14. On exit, system saves the last state of navigation.

15. Behavior of middle and upper band is more discussed in Timeline mode (section 7.4.2).

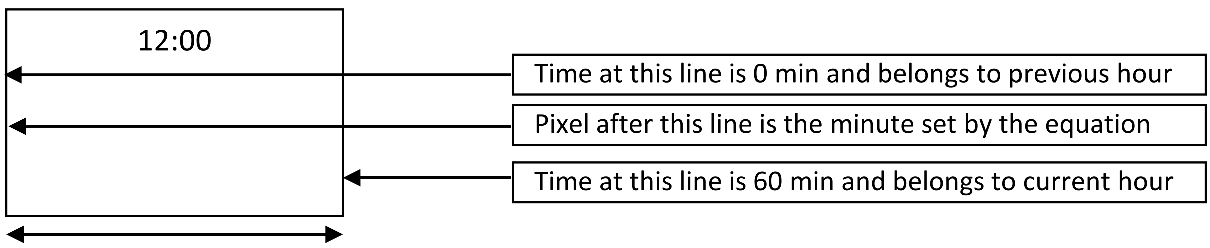


Figure 7.6: Pixel to time mapping.

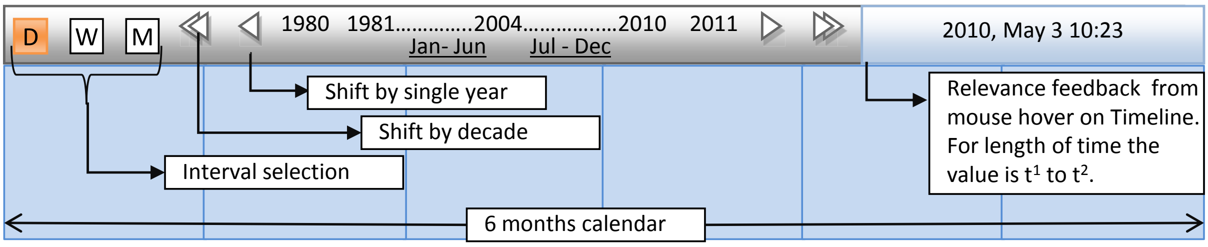


Figure 7.7: Navigation with calendar mode.

7.5 Operations on entities and timeline

This sections addresses the allowed operations that can be performed on entities and timeline. Each action is characterized by its type and effect. The operations for Create, Update, Navigate and Delete are described refereing this section. Drag and drop is classified into five primary scenarios, but all of them have multiple possibilities of actions and events. Therefore, our focus of design addresses the interaction modalities to provide one or more predefined actions to be chosen on single drag/drop operations. First, we note the scenarios and the interactions.

1. Actions for each scenario are to be defined later.

   (a) Entity(s) or entity cluster(s) from desktop dropped on timeline and vice a versa. Described in previous section.

   (b) Entity dropped on entity (for both homogenous and heterogeneous).

   (c) Entity dropped on entity cluster and vice a versa.

   (d) Entity cluster dropped on entity cluster (for both homogenous and heterogeneous).

   (e) Operations b, c, d from desktop to timeline and vice a versa.

2. Taking the scenario of a person being dropped over another person, following considerations are to be made -

   (a) User chooses one of multiple options.

   (b) User chooses more than one of multiple options.

3. The radial contextual menu is proposed in two different modalities.

   (a) The menu appears at right click or long press (for touch screen).

   (b) Drag and drop. This menu appears on drag over, after releasing the button.

      i. The circle appears around the entity icon with options in radial menu for specific action (Figure 7.8).

      ii. On hover, action area gets highlighted.

      iii. On click, action is performed.

      iv. Clicking outside the entity icon cancels user action.

Figure 7.8: Nested radial context menu.

7.5.1 Drag and drop

7.6 Event creation

We should distinguish between the terms "add event" and "create event". Add event is putting an event that exists in some form somewhere. While creating an event starts from the scratch of the process. Therefore, all descriptions in this section are subject to event creation. We can create event by -

- Explicit user actions
- Implicit user actions

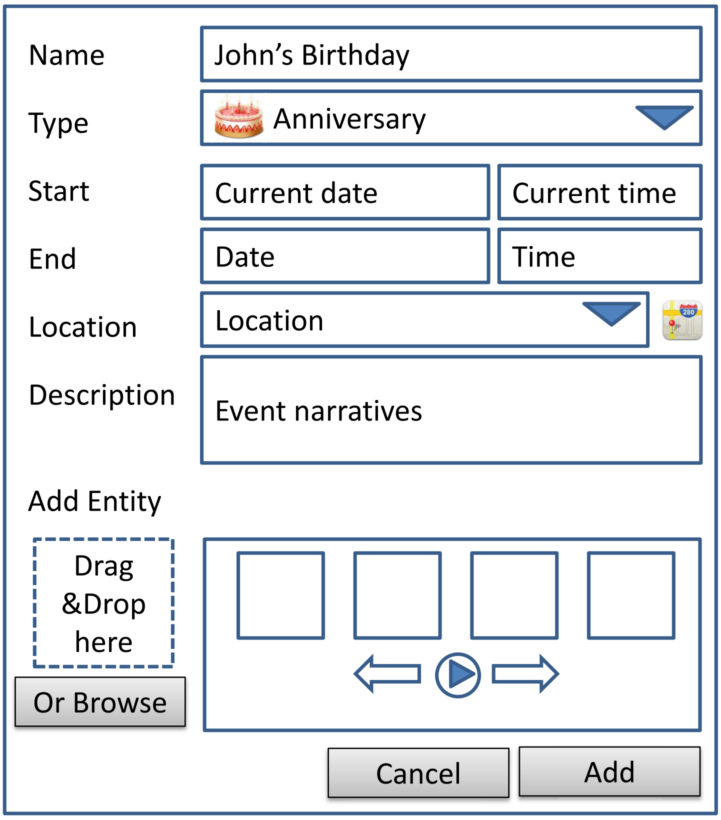


Figure 7.9: Event creation dialog.

7.6.1 By explicit user actions

We provided multiple options for explicit user action. The goal is to minimize effort. Two clicks are required to create an event without a single key stroke. This basic and undefined event may lack vital metadata, but once created it can be updated and perfected either by later user actions or by automatic system inference. We have discussed automatic and semi-automatic metadata generation in section 7.6.2 in more detail.

From menu

1. User clicks **Create Event**
2. The dialog appears with event name filled *Event(n)* being selected
3. The start date/time is current date/time as being selected
4. The end date/time is current date/time as being selected
5. User may press OK without providing additional information and an anonymous event is created on current date/time.
6. User may provide more information that identifies the event for the user that are asked in the event creation console.
7. If user provides an event name, this could possible to infer the event type by semantic engine.
8. An event will remain with '**?**' as long as complete information is missing.
9. All events are open for future update explained in section 7.7.

From Timeline

1. User right clicks on the timeline (a), or on an event on the timeline (b), or on a event cluster on the timeline (c), a popup menu appears providing option to chose "Create Event" for case (a) and (c).

2. The same dialogue appears as from the menu to take necessary user input if right clicked on empty space of the timeline.

3. Here again, the preselected event name is *Event(n)*.

4. If user provides an event name, this could possible to infer the event type by semantic engine.

5. Preselected event date/time is exactly where the timeline right click being performed. The time precision is determined by the zoom level.

6. If right clicked on another event, popup menu provides two options -

   (a) "Create new event", which would be parallel or overlapped event as shown in Figure 5.12 and Figure 5.13.

   (b) Or "Create sub event", which would be the child the event being right-clicked (See Figure 5.12).

7. Event name, preselected *Event(n)*.

8. The start date/time is current date/time as being selected.

9. The end date/time is current date/time as being selected

10. If right clicked on event cluster, a new event will be allowed to create as of from point 1 to 5.

11. User double clicks empty space of timeline in *edit mode* should allow same *create* operation.

7.6.2 By implicit user actions

An event has association with other entities e.g., people, photos, documents (stories). Here we take affordance of situation to create event with very little input from the user but from entities.

Drag and drop person(s)

1. While browsing people from any console, desktop for instance, drag and drop one person on the empty space of the timeline should instantiate the creation of an event. If any date/time from person's attributes (e.g., birthday, marriage day, etc) has a close match to current date/time, system can automatically create a specific event with event type inferred, an event name generated and the person being associated. Then system asks user for relevance feedback and updates accordingly.

2. If a number of people being dragged and dropped on the empty space of the timeline, system first performs the same task on same logic in point 1for all people in the group and comes up with the closest match for relevance feedback. Otherwise, it could be a meeting of past, present or future. User updates detail for later user actions.

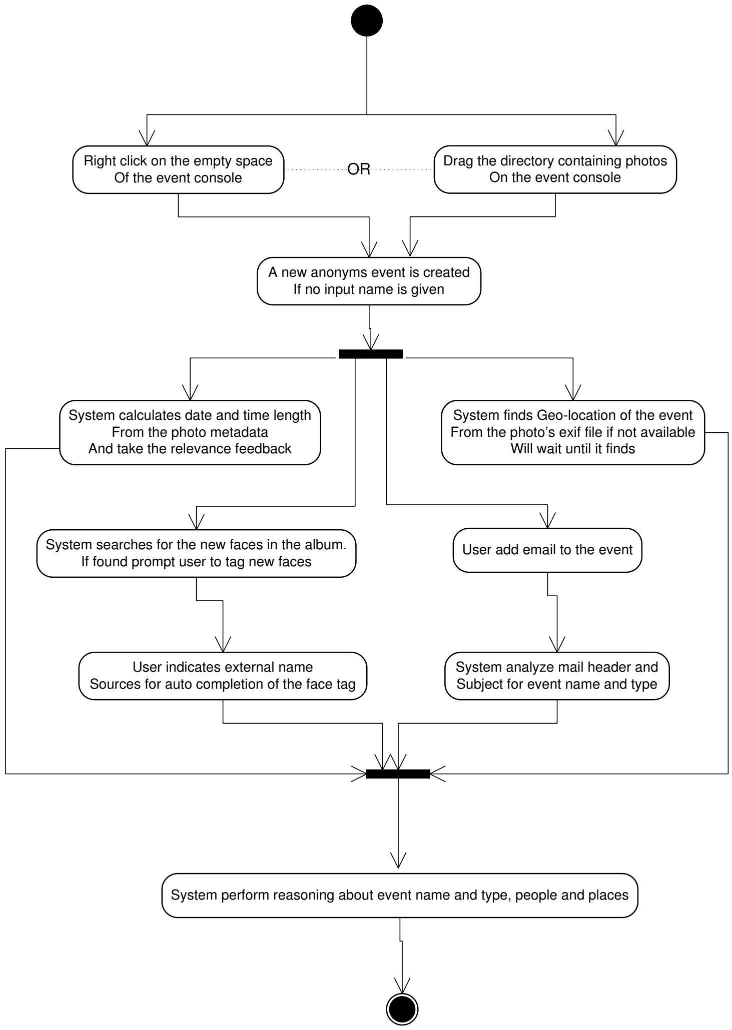


Figure 7.10: Action diagram for implicit user interaction.

Drag and drop photo(s)

1. While browsing photos from any console, desktop for instance, drag and drop one photo on the empty space of the timeline should instantiate the creation of an event. If we have an image processing engine at the back, this is possible to make assumption of the event type, a vacation for instance. If geo-tag and photo date/time is found in the image EXIF data, event start date and location can be inferred and user feedback could be taken for correctness (Figure 7.10).

2. If a bunch of photos are dragged and dropped, the above scenario applies with more accuracy with a possible end date/time suggestion from first taken photo and the last taken photo that gives the length of the event. Relevance feedback from the user could be taken for correctness and completeness of event metadata.

Drag and drop other entities

This part has not yet being fully explored, but mail sender, recipient, header and body could well be processed in automatic event creation, with user feedback for correctness.

7.6.3 Proactive Event creation

From people list: While metadata available about people's various periodic events, system may auto-suggest user if s/he wants to create an event, e.g., on the day of John's birth date, system prompt to know if the user wants create an event on John's birthday. **From photo collection (Proactive):** A background process can be run for the photos to group in temporal clusters and similarity matching, a reasonable suggestion can be made for semi-automatic event creation.

7.7 Event Modification

There are two modes for update -

7.7.1 By Explicit User Actions

- Providing input in the edit panel. This panel also allows the user to browse and add other entities.
- By interactively resizing or repositioning the event bar on the timeline.

- By adding other relevant entities with drag and drop operations.

7.7.2 By Implicit User Actions

- An anonymous or incomplete event can be updated by adding people in the event. Specification in section 7.6.2 applies here.
- Adding more photos readjust the start/end date/time as specified in section 7.6.2.
- Similarly adding other entities can contribute in enriching event metadata, but more study requires figuring out the extent.

7.8 Interactions for event metadata enrichment

7.8.1 Motivating annotations

Figure 7.11 summarizes a number of the ideas that have emerged from recent work on interfaces that help users to add such metadata. Before discussing these points individually and illustrating them with reference to recent research, we will comment on them briefly [49].

In terms of motivation, the overall approach taken in annotation systems for individuals is not based on external incentives or social mechanisms but rather on the provision of an intrinsically motivating experience for the individual user. Somewhat more concretely, the strategy is to optimize the relationship between (a) the cost to the user in terms of work done (in particular, tedious work) and; (b) the benefits in terms of enjoyable experiences, successful task performance, and visible improvements to the collection of items.

In some ways, the most straightforward approach is to exploit external resources (see the bottom left-hand corner of the figure) that can straightforwardly generate new metadata on the basis of existing metadata (e.g., supplying the name of a town on the basis of GPS coordinates). But external resources may also serve as input to sophisticated algorithms that analyze the content of items, either suggesting metadata or at least grouping together items that appear (to the system) to belong in the same category. Since such algorithms do not in general perform perfectly, there is generally a user interface that is designed to enable the user to supply the necessary manual input with minimal effort and maximal enjoyment. The user input itself can be seen as a valuable resource, which includes both explicit annotation actions and naturally occurring actions that provide useful information although the user does not perform them specifically for the purpose of adding metadata.

Finally, some systems take into account and exploit the affordances of situations, taking into account the fact that people use their event management systems in a variety of situations, each of which offers certain possibilities and limitations in terms of metadata generation.

As we will see in the next sections, these five contributors to metadata generation do not contribute independently in an additive manner. Often, a favorable combination of two or three contributors is required to achieve good results. For example, a classification algorithm may work well only on the basis of information in an external database; and its output may be manageable only with a cleverly designed user interface that elicits the necessary user input with minimal effort in an especially favorable situation. One objective of this section is to encourage this holistic view of the various contributing factors, whereas most of the primary research literature understandably focuses on one or two factors.

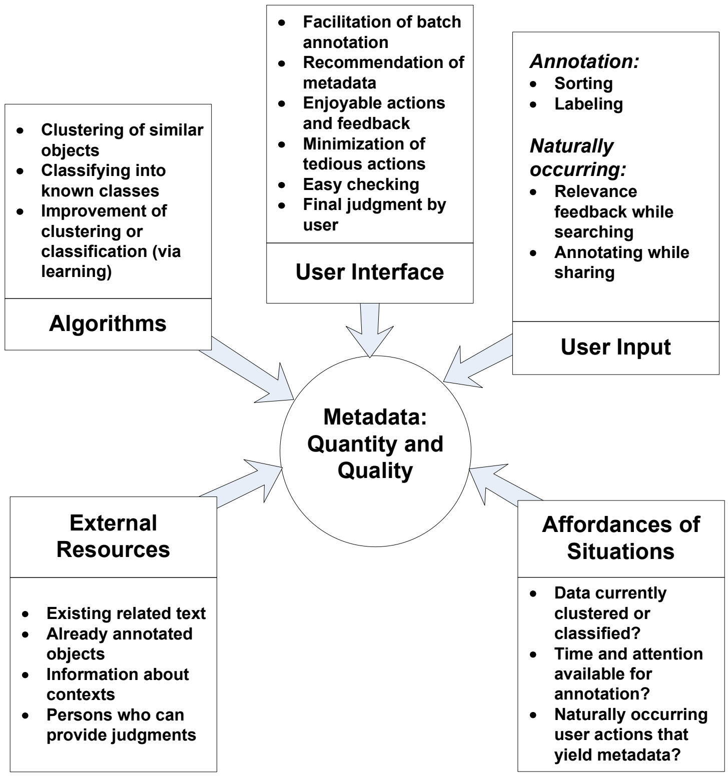


Figure 7.11: Overview of factors that can contribute to the quality and quantity of metadata added in a sophisticated system for the individual annotation of resources.

7.9 Search

The system is already supported with *lucen syntax* for advanced search. Free text search is a default feature. Semantic search is proposed in the following section.

7.9.1 Semantic search

Semantic search makes use of SWeb semantic engine and allows users to select appropriate concept on the fly. This feature works in conjunction with popular auto-completion. Following is the sequence of actions for semantic search.

1. When user start typing an auto completion list will appear.

2. User can select from this list or complete by himself.

3. With each suggestions, a right arrow indicates available semantics (Figure 7.12).

4. User can navigate either by mouse or KB to select suggestion and senses.

5. User may ignore any of these proactive behaviors.

Figure 7.12: User types a search query, system prompts auto-completion. An arrow at right indicates semantics are available.

User can select semantic input just placing his cursor/mouse-pointer on any concept of from the list . A list of possible semantics of that word/phrase will appear. User can select his preferred sense from the list for that particular word. During or after typing the query, user can also set the semantic of his/her query if wants. User can set semantic just by placing the cursor /mouse-pointer on any particular word. Following interactions occurs if user place the cursor on word -

1. A dropdown list of possible semantics of that word will appear.

2. System will also show by highlighting the sense that has chosen by the system which might have been inferred from previous history.

3. User can also select his preferred semantic from the list for that particular word.

4. Multiple selection allowed (Figure 7.13).

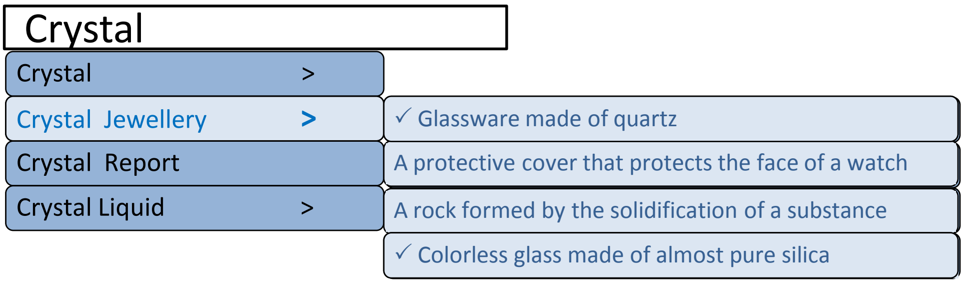


Figure 7.13: Multiple concepts can be chosen.

7.10 Early prototype

Figure is the screen shot of the first functional prototype which lacks may features described in the visualization and interaction design specifications. The interface is more or less the exact reflection illustrated in Figure 7.4.

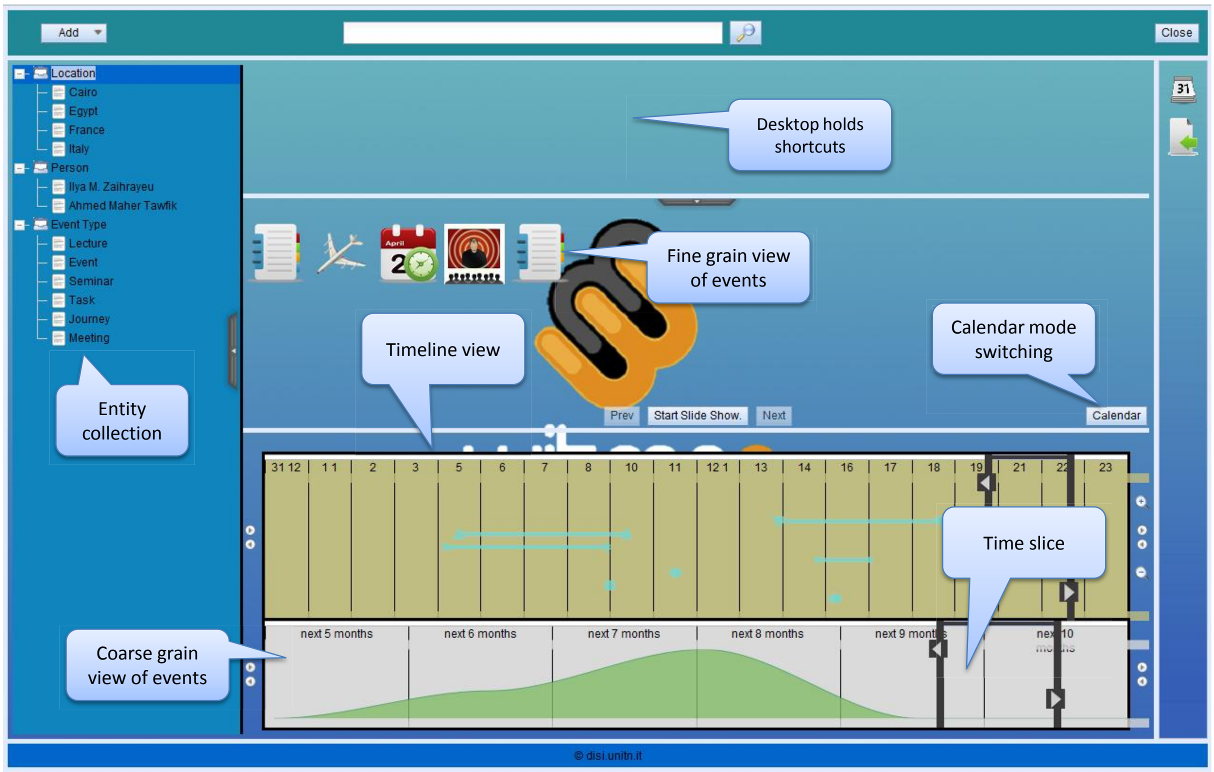


Figure 7.14: Version 0 prototype of the proposed system.

In the lower band, instead of recommended event clustering, simple area graph is implemented. Other visual elements have also been compromised for quick implementation and functional evaluation of the system. UI elements are described with the dialogs in the figure.

Chapter 8

Usability Evaluation

8.1 Methodology

In *human computer interaction*, usability evaluation appears to be a non-trivial issue in the whole design and development process. Sometime, evaluation is performed even with a paper prototype in a user-centric design. Usability evaluation is not only to find what does not work and why, but also makes proper judgements on why something works that had not been considered during the design requirement analysis. There are several many evaluation process in practice with positive and negative features, but in most cases design methodology determines which method is most suitable in a particular case. R. Jeffries *et al* [52] performed and reported an in-depth comparison of four widely used evaluation method. The comparison was done using pre-release version of software product. Table (8.1) shows the comparative data of different methods.

The development and definition of *usability evaluation methods* had been changing dynamically over time. There are evolving issues of *ethnomethodology* that determines how we interact with new artifacts, more futuristic and more abstract. In [43], a comparative study is provided indicating various dynamics of evaluation methods. Our early prototype being in its infancy, we considered both *cognitive walkthrough* and *feature inspec-*

Table 8.1: Problems found by problem type and evaluation techniques.

	Heuristic evaluation	**Usability**	**Guidelines**	**Cognitive WT**	**Total**
Total	152	38	38	40	268
Underlying System	15	3	3	0	21
Evaluator Error	7	0	0	3	10
Non-repeatable	6	3	0	2	11
Other	3	0	0	0	3
Core	121	32	35	35	223
Core, no duplicates	105	31	35	35	206

tion for our evaluation involving one male user of age 26 not familiar with our system. [72].

8.2 Evaluation process

The first step of evaluation was to let the user explore the system to see how intuitive the interface can reveal itself. Then we asked the user to perform some tasks without any guidance. There are several ways of performing a task, an event creation from menu or from mouse right click on the timeline for example. We tried to to examine in how many ways he could perform the same task.

The second step was to perform specific task following a task package scenario that describes how to perform the task and we recorded the task completion time. The bench mark time was set by one of us who is actively involved in the development process.

Finally, we provided a questionnaire to evaluate the user satisfaction on various design and interaction aspects. Color blindness test was not been performed with the prototype.

8.2.1 Feature inspection (Discovery)

The user was left alone without providing any prior knowledge of how the system works and what features the system offers. Only information we provided that the system is intended for personal historical data management. It would be impractical to think that user would discover all the features in a single sessions, but at list it gave some idea how much previous user experience were thought of during design process and much being exposed in the prototype. Though discovery time was recorded, but had little value in making any statistical conclusion. Table 8.2 illustrates the user discovery and the available list of features.

The user spent a total of 10:40.71 (mm:ss.0) on a unguided exploration of the system and discovered 6 out of 13 basic features being offered. This is a fair reflection of common design paradigm that needs no previous experience to use the new system. Next, we moved to the evaluation and made comparison with the bench mark time that we have set.

8.2.2 Task completion analysis

The task package scenario was composed of following seven primitive tasks for the user to perform. The list of tasks were kept minimum as the system was not fully featured during the time evaluation.

1. Create an event of type "Anniversary" from menu
2. Create event of type "Dating" drag and drop from entity collection
3. Create event of type "Dating" by Drag/drop type, person and location from entity collection
4. Save "Anniversary" event to desktop

5. Create event from saved desktop event

6. Update dating event using context menu

7. Update dating event using Drag/drop

Each task has been described with a set of parameters that were to put where necessary, e.g., beginning and end date/time of a event, persons, location, etc. The graph in Figure 8.1 demonstrates an acceptable task completion time by the user. This is interesting to see that the user struggled to performed the easiest task of saving the event from timeline to desktop. In fact, the desktop being developed is not fully identical that we use for everyday computing on today's PC.

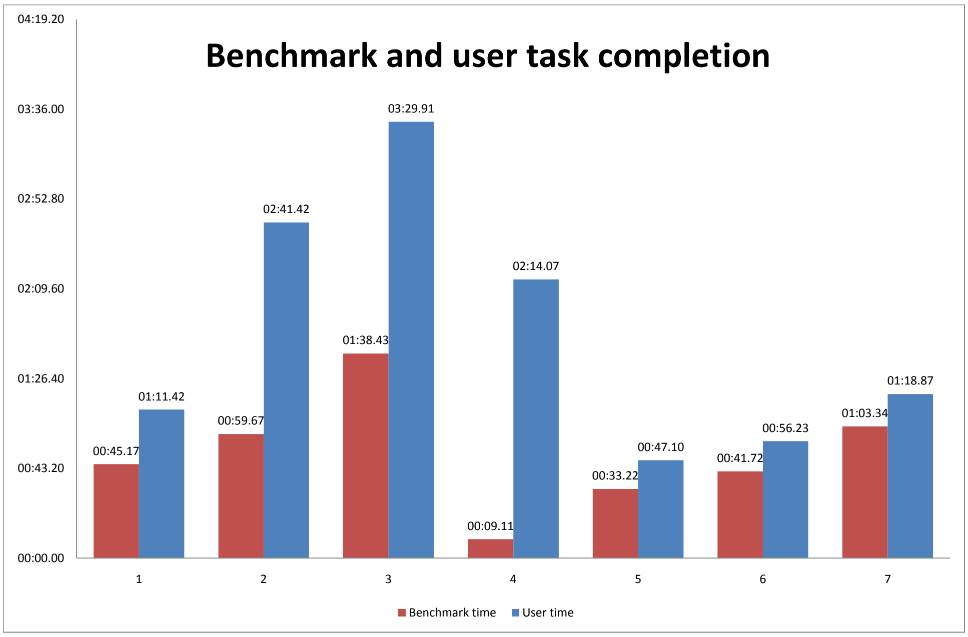


Figure 8.1: The comparison between benchmark time and user time.

The following graph shows the ratio between benchmark time and user time.

Tasks 2 and 3 took more double the required time, while surprisingly task 4 stands towering.

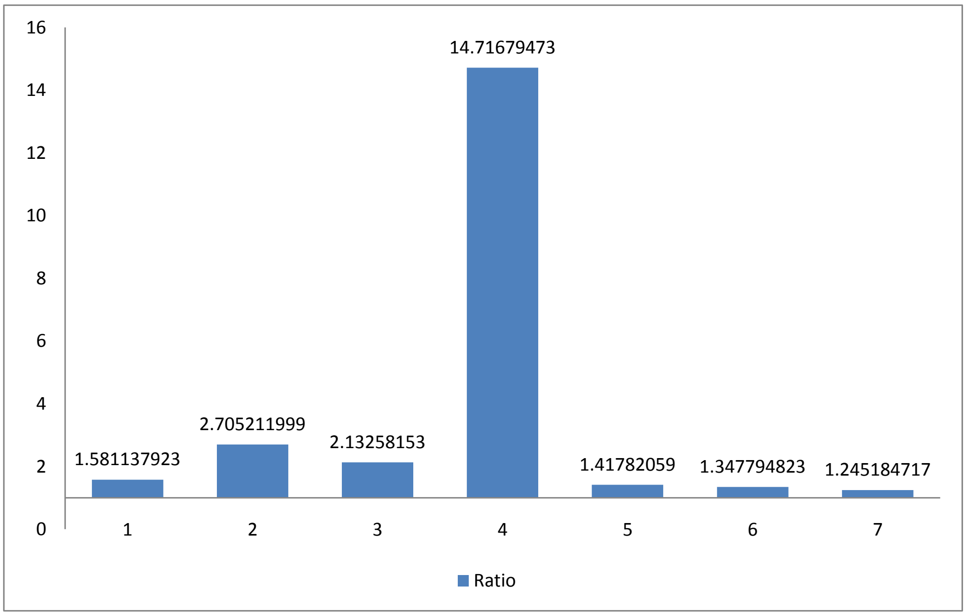


Figure 8.2: Ratio between benchmark time and user time.

The evaluation of exact interaction has not been performed at this stage of development. We, therefore, went on for Nielsen's heuristics for satisfaction evaluation.

Table 8.3 is a strong indication that the system needs more improvement in terms of visualization and user interface. However, the system is still under work and waiting to be declared for a usable prototype. On completion of first prototype, we are hoping to launch a multi-dimension user-oriented evaluation.

Table 8.2: The offered features vs the user discovery.

Available features	**Discovered**	**Time** (mm:ss.oo)
Left panel (Entity collection), Bottom panel (Timeline and Calendar), Upper panel (Desktop)	Left panel (Entity collection), Bottom panel (Timeline)	1:57.03
Create		
From Menu	Meeting created	2:38.42
Drag/drop single entity from left panel	Created dating	2:17.41
Drag/drop multiple entity from left panel	Not found	
Drag/drop existing event from desktop	Not found	
Right click on timeline	Not found	
Navigate		
From timeline	Not found	
From calendar	Meeting found	2:19.29
From calendar	Dating found	1:05.24
From search	Not found	
Update		
By drag/drop	Not found	
From menu	not found	
From context menu	Updated meeting	0:23.35

Table 8.3: User satisfaction on used features.

Features	**Rating** (1 to 5)
Event creation from menu	3
Event creation by drag/drop	4
Event creation from existing event	3
Timeline navigation	2
Calendar navigation	3
Event update from context menu	3
Event update from timeline	2

Chapter 9

Future work

There are many ideas left behind, considering unreachable with the given frame of time for the thesis.

Event types such as activities, states, achievements and accomplishments have not been considered in our work due to their ambiguous nature from the general user's point of view. *John is running* describes an *activity* while *running John* could be inferred as a *state* giving a perturbation in deciding only due to its linguistic expression. Furthermore, what is an achievement and whether it could be considered as an accomplishment also varies from person to person. These issues are left out for challenging future works.

Timeline navigation of linear temporal data was a natural choice, while navigating through relative time could have been a different experience. Such feature would have allowed organizing and navigating events by semantic relations to human memory, *during my marriage* - for example, instead of sequentially organized *date of my marriage*.

Geographic and cultural context of event visualization have left unexplored in this work. Events in specific geographic location or cultural interest should provide added dimension in a personal event management system. These issues are left open for further research.

Chapter 10

Conclusion

The system has been designed and developed with elegance in mind. It started form a nebulous conceptual level to a fine grain details like a mouse click. We tried to explore every possible area that could contribute in our design process, though time and satisfaction never tend to incline to same point. Our effort was to develop a system that portrays a life, sustains over time, stays as the strongest remembrance for the generations to come. Fair enough to say, not everything we could scope in the system. Navigation through causal links has not been specified in this work. The specifications for sharing events as participant or as witness has not been provided. Visualization and interaction has not been fully implemented, as a result, the evaluation of the system remains calamitous. Much of the innovative solutions left untested, so does the validation of our claims. However, the ground work of understanding and modeling *events in life* should stay there to live, opening wider areas of applications. The development of the current version is still under progress. Once being stabilized, we are looking forward for extending the system with the features being described in the future works.

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Appendix A

Person metadata

Table A.1: Exemplified list of basic information.

Name	**Datatype**	**Description**	**Example(NL)**
ID	URL¡N¿	ID number of an identification card, e.g passport number	SSN: 568-47-0008
Name	Semantic String	Given name.	Homer. J. Simpson
First name	Semantic less string		Homer
Middle Name	Semantic less string		J.
Last name	Semantic less string		Simpson
Description	Semantic string		
Nickname	Semantic less string	Nickname	Homer

Primary EMail	Semantic less string	A valid Email address	Homer@...

Table A.2: Exemplified list of personal information.

Name	**Datatype**	**Description**	**Example(NL)**
National Identifier	Semantic less string		691018-3414
Date of Birth	Date	Date of birth.	05/12/1956
Anniversary	Date		26/03/1971
Gender	Enumeration ⟨Formula⟩	Her sexual intention[Male, Femail, Other].	male
Nationality	Semantic String[]	Homeland, sometimes more than one.	USA
Hometown	Geo-entity	Where the person grew up	Springfield
Home	Geo-entity	Where the person currently lives	Springfield
Photo	Photo-entity	Photo(s) of a person.	`http://...`
Title	Semantic String		Mr.
Date of death	Date		
Blog	URL[]	Personal blog.	`http://my-personal-blog.com`

Homepage	URL[]	Homepage of the person	`http://my-personal-page.com`
Online Status	Semantic String	Gives the current position of the person	Bored
Ethnicity	Semantic String	Ethnic identification	Caucasian
Current location	Geo-entity	Gives the current position of the person	742 Evergreen Terrace, Springfield
Language	Semantic String[]	The languages the person speaks and/or understands	English, Italian, Spanish. Russian

Appendix B

Image Meatadata

Table B.1: Image metadata standards specifications.

Format	References
CableLabs 1.1	http://www.cablelabs.com/specifications/MD-SP-VOD-CONTENT1.1-I05-060831.pdf
CableLabs 2.0	http://www.cablelabs.com/specifications/MD-SP-VOD-CONTENT2.0-I02-070105.pdf
DIG35	http://www.bgbm.org/TDWG/acc/Documents/DIG35-v1.1WD-010416.pdf
Dublin Core	http://dublincore.org/documents/2008/01/14/dcmi-terms/
EBUCore	http://tech.ebu.ch/docs/tech/tech3293-2008.pdf
EBU P-Meta	http://tech.ebu.ch/docs/tech/tech3295v2.pdf
EXIF 2.2	http://www.exif.org/Exif2-2.PDF
ID3	http://www.id3.org/Developer_Information

IPTC	http://www.iptc.org/std/photometadata/2008/specification/IPTC-PhotoMetadata-2008.pdf
iTunes Metadata Specification	http://connect.apple.com/
LOM 2.1	http://ltsc.ieee.org/wg12/files/LOM_1484_12_1_v1_Final_Draft.pdf
Media RDF	http://digitalbazaar.com/media/video
Media RSS	http://video.search.yahoo.com/mrss
METS	http://www.loc.gov/standards/mets/
MPEG-7	http://www.chiariglione.org/mpeg/working$_$documents/mpeg-07/schema$_$def/cd.zip
NISO MIX	http://www.loc.gov/standards/mix/
Quicktime	http://developer.apple.com/documentation/QuickTime/QTFF/QTFFChap2/qtff2.html#//apple_ref/doc/uid/TP40000939-CH204-BBCCFFGD
SearchMonkey Media	http://developer.yahoo.com/searchmonkey/smguide/searchmonkey-media-details.html
DMS-1	http://www.smpte.org/standards
TXFeed	http://clearerchannel.org/docs/tx_metadata_standard_0_9.pdf
VRA Core 4.0	http://www.vraweb.org/projects/vracore4/index.html
XMP	http://www.w3.org/TR/xmlschema-2/
YouTube Data API Protocol	http://code.google.com/intl/en/apis/youtube/2.0/reference.html

Table B.2: List of core properties which is used in Ontology for Media Resource.

Name	Description
ma:contributor	A pair identifying the contributor and the nature of the contribution. E.g. actor, cameraman, director, singer, author, artist (Note: subject see addition of contributor type)
ma:creator	The authors of the resource (listed in order of precedence, if significant)
ma:description	A textual description of the content of the resource
ma:format	MIME type of the resource (wrapper, bucket media types)
ma:identifier	A URI identifies a resource; which can be either a "Resource" (abstract concept) or a "Representation" (instance/file).
ma:language	Specify a language used in the resource.
ma:publisher	Examples of a Publisher include a person, an organization, or a service. Typically, the name of a Publisher should be used to indicate the resource
ma:relation	A pair identifying the resource and the nature of the relationship. E.g. transcript, original work
ma:keyword	An unordered array of descriptive phrases or keywords that specify the topic of the content of the resource
ma:title	The title of the document, or the name given to the resource
ma:genre	Genre of the resource

ma:createDate	The date and time the resource was originally created. (for commercial purpose there might be an annotation of publication date)
ma:rating	A pair identifying the rating person or organization and the rating (real value)
ma:collection	A name of the collection from which the resources originates
ma:duration	The actual duration of the resource
ma:copyright	The copyright statement. Identification of the copyrights holder (DRM is out of scope for MAWG)
ma:location	A location associated with the resource. Can be the depicted location or shot location
ma:compression	Compression type used, e.g. H264.
ma:frameSize	The frame size. For example: w:720, h: 480
ma:targetAudience	A pair identifying the issuer of the classification (agency) and the classification. E.g. parental guide, targeted geographical region
ma:locator	A URI at which the resource can be accessed (e.g. a URL, or a DVB URI)

Table B.3: An example of EXIF attributes and values.

Attribute Name	**Attribute Value**
Make	Canon
Model	Canon DIGITAL IXUS 70
Orientation	Top left
XResolution	180
YResolution	180

ResolutionUnit	Inch
DateTime	2009:04:12 17:23:03
YCbCrPositioning	Centered
ExifOffset	196
ExposureTime	1/160 seconds
FNumber	8.00
ISOSpeedRatings	400
ExifVersion	0220
DateTimeOriginal	2009:04:12 17:23:03
DateTimeDigitized	2009:04:12 17:23:03
ComponentsConfiguration	YCbCr

Table B.4: Basic quantitative information mostly processed by machine.

Name	**Datatype**	**Description**	**Example(NL)**
Width	Integer	The horizontal size of an image in pixels	1268
Height	Integer	The vertical size of an image in pixels	756
Byte per pixel	Integer	The number of bits per single pixel used to represent the color of the pixel.	2

Color representation	Enumeration ⟨Formula⟩	The abstract mathematical model that describes the way of color representation. [YCbCr, RGB, CMYK, CIE XYZ, HSV, HSL, RG CHROMATICITY]	RGB

Table B.5: Geo data Information.

Name	**Datatype**	**Ref**	**Description**	**Example(NL)**
GPS VersionID	Float	EXIF	Indicates the version of GPS Info	2.2
GPS Latitude Ref	Enumerator ⟨Formula⟩	EXIF	Indicates whether the latitude is north or south latitude. [north, south]	"North"
GPS Latitude	?	EXIF	Indicates the latitude. The latitude is expressed as three float values giving the degrees, minutes, and seconds, respectively.	

GPS Longitude Ref	Enumerator ⟨Formula⟩	EXIF	Indicates whether the longitude is east or west longitude. [west, east]	"East"
GPS Longitude	?	EXIF	Indicates the longitude. The longitude is expressed as three float values giving the degrees, minutes, and seconds, respectively.	
GPS Altitude Ref	Boolean	EXIF	Indicates the altitude used as the reference altitude. False = above sea level. True =below sea level. The reference unit is meters.	"below sea level"
GPS Altitude	Float	EXIF	Indicates the altitude based on the reference in GPS Altitude Ref. The reference unit is meters.	20

GPS Time Stamp	Date	EXIF	Indicates the time as UTC (Coordinated Universal Time).	Fri Apr 17 06:58:00 EDT 2009
GPS Status	Enumerator ⟨Formula⟩	EXIF	A' means measurement is in progress, and 'V' means the measurement is Interoperability. [A,V]	"A"
GPS Measure Mode	Enumerator ⟨Integer⟩	EXIF	Indicates the GPS measurement mode. '2' means two-dimensional measurement and '3' means three-dimensional measurement is in progress.[2,3]	2