GENSEQ: A Personal Sequence Flow Generator

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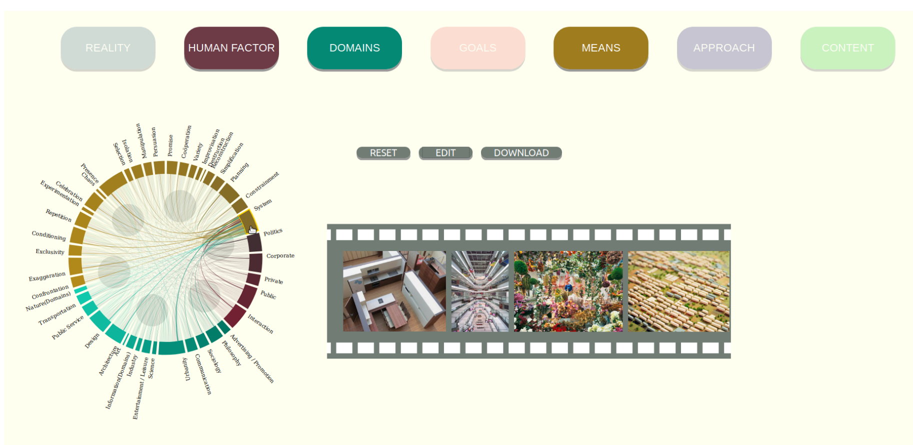
Abstract. Personalization has been of high attention within many fields of the digital domain. As generalizing power of traditional cluster mechanisms cannot be extended to domains such as art taste, the need arises for a personalised sequence generator. This work proposes GENSEQ, as a solution for creating personalised products from complex data. The system is applied to the NOWHERE photo exhibition, and explained in the view of different Information Visualisation models.

Keywords: Flows, Generator, Sequence, Exhibition, Art, Personalization

Fig. 1: GENSEQ system



Introduction

In the first decades of the 21st century we have witnessed a major movement towards a digitalized world. Products and processes which moved from the analog into the digital domain are flooded with new kinds of information. Digital actions are possible to chase, store, share and analyse. Never before this amount of user information could be obtained. Competing for market share, many services started to adjust their products for different users, utilising knowledge of different preferences over groups of people. This personalization ranges from social feeds to search results, advertisements and entertainment suggestions. The innovation became the norm, and slowly but surely digital users start expecting a personalised view within a system, aiming for time efficient experiences.

As impressive as these innovations work within domains such as marketing, in other domains personalization has remained a challenging problem. One of these domains is the experience of art. The appreciation and taste held by people is hardly measurable, let alone possible to generalize using statistical models. In our opinion, machine clustering for personalization in this area is undesired, and everyone should have their artistic self stay in control over their taste of art. To enable this, the need comes in for a method in which users can control the personalization of their experience. To this end we present GENSEQ: a *Gen*erator of *Seq*uences, brought into application for the NOWHERE photo exhibition.

This novel sequence flow generator makes use of meta information on the objects of interest. In the case of the NOWHERE set, this is assigned affiliation of pictures with a set of content labels. The generator enables the user to show attribute relations and select objects based on this. The user becomes able to create a personalized photo stream according to their interests, delivering a personalised route through the exhibition. This information visualization has potential to be applied in numerous domains in which traditional personalization by clustering falls short.

First we will review previous work aiming at a similar visualization design or including similar visual elements. Second, the visual elements will be discussed and presented. Third, we discuss the interaction design between the user and the interface. Next, we address a hypothetical evaluation design describing a method to best evaluate our system. Finally we discuss the limitations of our system and how it could be extended to work with the full visual analytics paradigm.

1 Previous Work

The current work relates to achieving insight in a complex dataset using a Visual Analytics approach, a topic elaborated on in numerous studies. [4] [3] The build application operates in the artistic domain. Hinrichs et al. (2008) [1] focus on the intersection of information visualization and the artistic display of the museum. A number of challenges are described, such as the shifting priority from functionality to appeal, the fit of expressed data within the concerned museum context and the design for the interaction, display and representation.

More distinctively, the current work aims to create something. Besides knowledge and insight, there is an actual product being generated and outputted by the system. Although different in the output result, a close related work is provided by Viégas et al. (2004) [7]. In this work, a stacked visualization of image material from the present is created, which can be obtained as a souvenir.

2 Positioning and Novelty of GENSEQ

To design and validate our visualization, the nested block model is used as guide line for implementation and for reflection after the implementation. The nested block model was proposed by Meyer in 2013, and consist of four different levels. The Domain level, Abstraction level, technique level and algorithm level. [2] The block model is shown in full in figure 2, and each of the levels is elaborated on in the following paragraphs. The composition of the system is shown in figure 1.

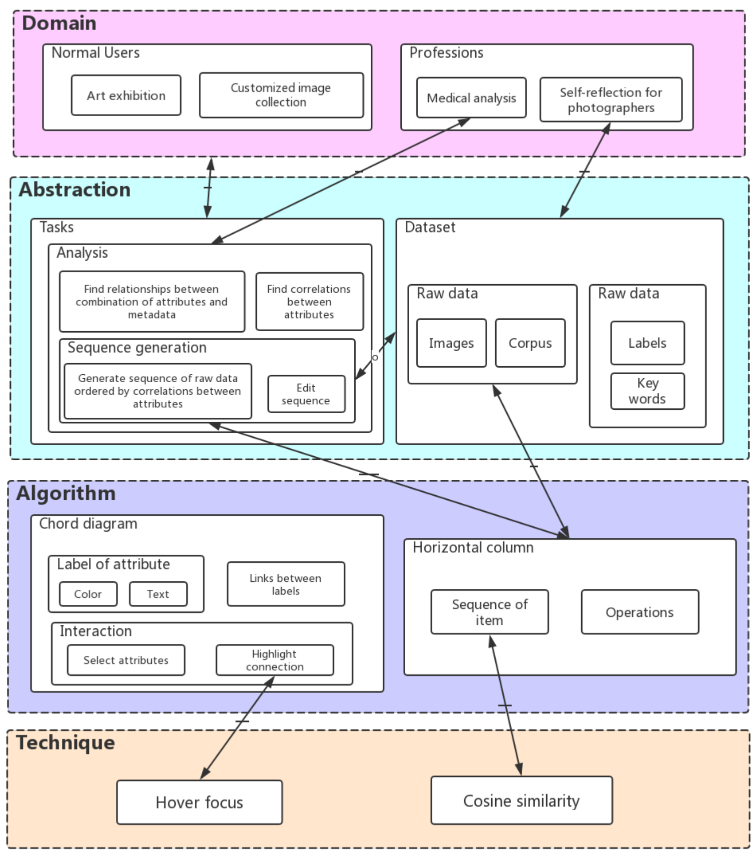


Fig. 2: Nested Block Model

2.1 Domain level

In this level, the situations will be presented in which target users, fields and data are included. We classified our target users into two groups normal users and professionals. For each of them, we present two typical scenarios to show the fields our system can be applied to.

For normal users, the main function is to generate customized collections of items for instance images and videos. Therefore this visualization can be used for art exhibition, which is the background of our data set, to help visitors to get an unique experience with the customized sequence of images. Similarly, users can generate a customized image/video collection with specific topics.

For professionals, the main idea is to get insight in the relationship between the combination of attributes and specific phenomenon which is hard to be encoded into numeric features. For photographers,they can get the insight from an unique angel which is different to usual methods like simple categorization statistic analysis and so on. What's more, the visualization can be applied to medical analysis as well. It can be applied with the way that particular diagnoses/scanned images can be popped out with selected key words/attributes.

2.2 Abstraction level

Within this level, the tasks and datasets will be specified. They are related to the type of target users and field.

The visualization can be of help to perform analysis and sequence generation tasks. In detail, for analysis users can find connection between certain combination of attributes and particular patterns hidden in generated items, or the correlations among attributes based on the features shown on items. Or, users can use this system to create their own sequence of items with different combinations of attributes.

The applied data are formed into two kinds, raw data and corresponded metadata. Raw data here is the data that need to be presented or hard to be encoded, like images and corpus (set of reports/diagnosis). The metadata consists of the set of attributes (labels/keywords) with relevance weights for all picture attribute combinations.

2.3 Technique level

There is two main techniques used for the visualization, the first is a Chord diagram, the second is a horizontal column in which the image sequence shows. The combination of these two elements has visual similarity with an analog film roll which is being rolled out into this sequence. This creates the unconscious feeling of being familiar with the system, as the movements in design coincide with the users natural expectations.

The Chord diagram is the generator part of the system. Along the outer edge of the diagram, the attributes are listed. Between these attributes, arcs depict the relations. When two attributes have more pictures with a strong relevance in common, this relation is stronger and the according arc has increased width. By selecting pairs of labels, pictures are generated onto the sequence, ordered in decreasing relevance to the selected combination.

These generated pictures roll out of the diagram onto the stretched film roll, which is the horizontal column. To keep the visualization clean, the column only shows as much as fits on the screen, and buttons allow the user to inspect other parts of the sequence. In order to further express ones preferences, the column has an edit function by which pictures can be individually removed from the sequence. A satisfied user can use the download option to obtain the personalized exhibition sequence.

2.4 Algorithm

In order to generate the right images per relation, a cosine similarity of attribute vectors is used. This way, the pictures can be ranked according to relation between attributes. Within the Chord diagram a Hover focus is used in order to guide to user focus when exploring the relation space.

The novelty of the system comes mainly from the generative capability for personalized experiences. By combining existing visual technologies the GENSEQ brings solution to the problem of personalisation in non-trivial domains.

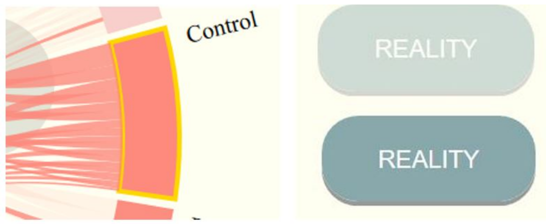
3 Interaction design

3.1 User intents

In order to understand the mechanism of interaction of our system, we address the user intents to perform certain actions with our system in terms of the 7 categories described in [9]. Alongside, the explanation is supported by visual screenshots from the system.

Select The select interaction technique provides the user with the possibility to mark items of interest to keep track of them. In our system there are several parts where the user is able to perform this interaction. Initially, when starting interaction with the system, the user is able to select one of the 7 domain groups of attributes which are represented as 7 buttons stacked vertically in the upper part of the screen. An example of a selected and unselected button is displayed in figure 3. Once the user clicks a button, the colour of the button gets dark until it is deselected again. This interaction technique works as a preceding action to the subsequent action of selecting attributes positioned on the arcs of the chord diagram. Once an arc is clicked, a golden or red border appears around it to indicate that this label is selected until it is deselected. A screen capture of this interaction feature is displayed in figure 3.

Fig. 3: Left: Example of selected arc attributed box. Right: Example of unselected (up) and selected (down) group button.



Explore The user is only able to see a limited number of attribute relations at a time due to perceptual and cognitive limitations in human information processing. Therefore, the user has the possibility to examine a subset of photo attribute labels to gain understanding and insight and then move on to view some other combination of labels. This is realized in our visualization as the user can first decide which of the 7 main domains he is interested in (and even chose multiple of them) and then dive down and select either inter domain attribute relations or across domain attribute relations. Those will in turn be expressed on the photos outputted by the flow generator such that the user can visually explore the results of his selection.

Filter The user can freely select among the 7 domain group buttons. When a new button is clicked, the labels corresponding to this group are added to the chord diagram. The other labels which are not selected are hidden from the display. The perspective on the data is not changed just specifying conditions on which data are shown. The user can manually remove picture from the generated sequence by using the edit button, see figure 4.

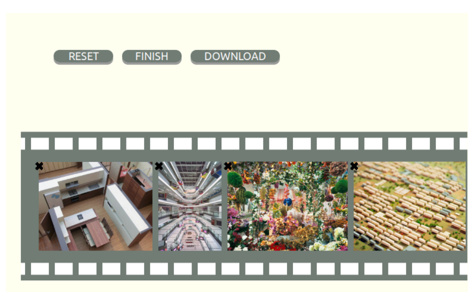


Fig. 4: Remove elements

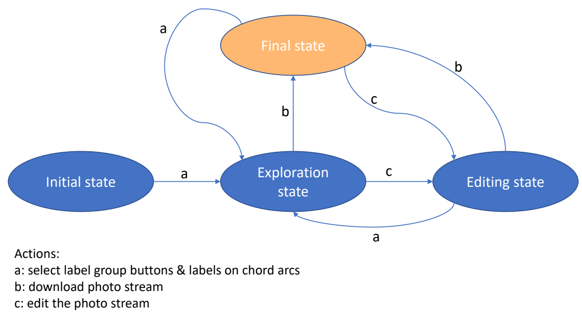


Fig. 5: Interaction model

Connect When hovering over an arc, the chords representing the relationship to other labels inside the diagram are highlighted.

3.2 User Interaction model

The interaction state machine model in figure 5 displays how the different states a user can be in are connected by the interaction techniques explained in the previous section. In the initial state the user is presented the seven main domain group buttons. Once the user selects one of the groups, the user is in the "Exploration state" where he/she can select more groups to be added to the chord diagram or selects labels on the arcs of the chord diagram to create a personalized photo exhibition. The latter action in turn will generate a photo stream which the user can either or edit. Downloading can be done by clicking on the download button and lead the user to the final state. The editing state is entered by selecting the edit button either while still exploring or when the user has already downloaded the photos. Here the user can delete photos from the personalized exhibition. From the editing state the user can either go back to the exploration state by selecting more labels and thus add more photos to the exhibition or he/she can download the photos and end up in the final state. Similarly, the user can go back to the exploration state after downloading the photos.

4 Evaluation design

As Jarke J. van Wijks recommendation [6], we know that Searching for and enumerating possible actions of users after they have used your tools, if such actions cannot be found or defined, the value of the visualization is in doubt. Considering the users' needs, we evaluate our demo from the following aspects:

Usability and aesthetics

Our interface consists of complex ideas communicated with clarity, precision, and efficiency. We list seven domain labels when we open the interface and make them be highlighted when we hover them. We also add borders to chord diagram labels when the mouse hovers on it. Through highlighted effects, we make sure the user could know what domains they are exploring now and which stage they stay in with clarity. Also, multivariate selection gives user the freedom to customize the photo flow under the relationship between selected labels.

Quality of the result

The picture flow generator imitates the film machine so it will give users vibrant views. We also consider add questionnaire to allow scaling reflection.

User efforts

Interaction cost and perception cost are controlled in a acceptable level. Among the interaction process, we hide the unnecessary sections and only present user manipulation modules so that the interaction will not be too overwhelming visually. Through highlighted style, we could also guide the users in the interaction process. Perception cost would be fine since the imitation of film machine has already given self explanatory reasons for photo flows. The shaded labels such as reset, edit and download are also plain.

Value of visualization

The sequence generator could be extended to multiple areas which need to know the relations between multiple factors and show the results as a sequence of photos. For example, medical diagnosis images according to the relationship between viruses.

Insight gained

Complex Insight is complex, involving all or large amounts of the given data in a synergistic way, not simply individual data values. We measure the relationship between different labels based on cosine similarity of the labels which involves all useful data points.

Deep Insight builds up over time, accumulating and building on itself to create depth often generating further questions and, hence, further insight. The generator give users freedom to customize photo flows according to their own interests to have deeper exploration.

Unexpected Insight is often unpredictable, serendipitous, and creative. As we don't know what film machine will project for next second, our generator can also raise the similar attraction for users and urge them to investigate more.

Relevant Insight is deeply embedded in the data domain, connecting the data to existing domain knowledge and giving it relevant meaning going beyond dry data analysis, to relevant domain impact. The generator is based on a chord diagram which is a fine way present asymmetrical relationships. Also, multiple choice pairs can increase the length of photo flows while we also present relevant label relations at parallel.

Qualitative Insight is not exact, can be uncertain and subjective, and can have multiple levels of resolution. All the settings about domains selection and photo flows edition would satisfy the users' qualitative needs and subjective exploration.

5 Visual Analytics design

In this section, we describe our system and identify limitations in terms of knowledge generation model [5] for visual analytics.

5.1 Actions

Data preparation is supported. Our system has seven buttons representing seven domains. Users can choose some domains and load the subset of the data. After parsing and loading a set of data, it is also possible for users to cancel a selection or add a new domain.

Model building and model usage is done automatically. Our system measure cosine similarity of each two labels and calculate the top three related images of them. These processes is implicit. Users cannot change or adjust anything of our system model, such as parameters and algorithms.

Visual-mapping is partly supported. In terms of images visualizations, the user can create customized images sequence, including adding and deleting images. However, the visualization of the metadata is pre-defined. A domain or a label is mapped to a color which the user cannot set by their preferences.

Model-visual mapping is available in our system, but only at a basic level. Our system mainly use the chord diagram to present our model. The link between two labels is wider, these two labels have stronger relationship. There are possibilities of adding or deleting a set of relations by choosing different domains, but the users cannot remove one relation or filter relations by a parameter.

Visualization manipulation is used to highlight the chosen relation and related three images. In the chord diagram, when the mouse hover on a label, the label will be highlighted with golden border and the connections with this label to all others are displayed while other connections are transparent. After selected two labels, one with golden border and the other with red-orange border, the horizontal column will be appended three new images. In order to emphasize these images, our system always add these images from the left side of the column, which means these images will be shown in the center of the screen and previous images in the column will be moved to the right side or may out of screen.

5.2 Knowledge Generation

Exploration loop describes how users interact with our system in order to get an insight of the data set and generate a customized images sequence. The users can get an overview of relations in some topics or domains. For each relation, our system will generate top three related images and present them in the horizontal column. It is also possible for users to explore the column, such as removing images and visiting the previous images. Finally, the users can capture the findings about labels relations and related images and download the sequence.

Verification loop is not fully supported. A domains is connected to a set of labels and a relation of two labels is linked to three images. To find evidence for these facts, our system will highlight the chosen domains and selected relations. However, these facts are verified by users themselves. For example, when users select "public" and "building", the content of the images shown in the column should be public buildings. It may present some "wrong" images, but our system cannot automatically verify it.

Knowledge generation loop are weak in our system. The process from insights to knowledge or from knowledge to new hypotheses entirely relies on users themselves. In additions, users' knowledge of understanding images' attributes play an important role, which is hard to incorporate.

In order to extend our system to work with the full visual analytics paradigm, we can enhance interactions with users. For example, in the model building process, parameters or the method used to measure similarity can be defined by the users. Another way is to provide more perspectives of the data [5].This makes it possible for users to collect different types of evidence and increases their trust in findings or insights.

6 Story telling design

To enhance the story telling design of our visualization we made use of some simple but yet effective design rules which will be outlined in the following paragraphs.

Visual Cues Consistent fontsize of text belonging to the same visual element (e.g. text on the arcs of chord diagram, button text) is used. A selected attribute arc on chord diagram is framed with a red stroke which distinguishes between selected and unselected labels.

Proximity & Similarity The button boxes are perceived as a group of elements even if they are not connected due to their similar shape and their vertical alignment.

Color Scheme The buttons for the main domain groups receive a color scheme which are also reflected inside the chord diagram. The chords and their arcs belonging to one attribute group receive the same color scheme to bring out which labels belong to the same group and distinguish labels from different groups. The horizontal column element is designed after a film roll such that it is colored grey.

Animation When the two labels are selected photos are generated in the photo stream, the wheel inside the chord diagram spins, as to resemble the effect of a spinning film roll.

Attention Steering All the above mentioned techniques contribute in steering the attention of the user which is also elaborated in detail in the interaction design section.

7 Visual thinking Design

We can think of this process of seeing as the execution of a continuous stream of visual queries on the environment. Depending on the task at hand the brain constructs a visual query and we execute a visual search to satisfy that query.

The three component model illustrated in figure 6 [8] is a useful simplification illustrating the different visual subsystems involved. At the lowest level information is processed through massively parallel feature finding mechanisms. Pattern finding occurs in the mid level; patterns are constructed from low level features according to the top down demands of attention operating in the context of a temporary store called visual working memory.

Queries are executed by means of eye movements and a focusing of attention on task-relevant patterns so that patterns are held briefly in working memory.

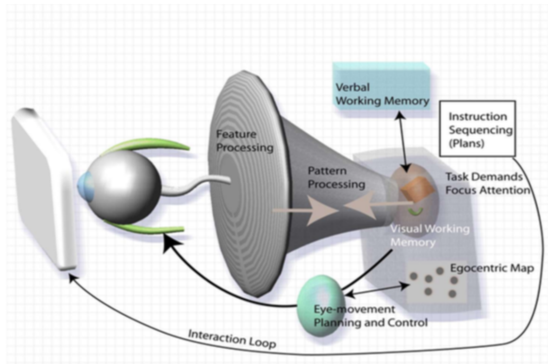


Fig. 6: Visual Thinking Design

When we implement our interface, we considered that user needs and interests when they first encounter our generator. In order to avoid giving them overwhelming Feature processing tasks. We only show them the seven domain information. Then the visual thinking comes out. Visual thinking is synonymous with pattern finding. In many cases, visual working memory gives us tasks to search certain patterns and the feature processing process reads a lot of competing patterns. The pattern processing module performs as a filter to allow corresponding patterns into our visual working memory.

We pay attention to guiding process by adding domain labels, attribute labels, highlighted effects, Photo flow edition buttons and use benefits of chord diagram. And present them all step by step to make sure self explanatory as much as possible.

8 Conclusion

In a digitalized era, personalization of products and experiences is becoming a user demand. Although clustering algorithms pave the road for personalization in many cases, it does not suffice in domains as art taste. To empower the user in guiding the personalization process in such cases, GENSEQ is proposed in this work. The system lets a user generate an information sequence based on personal interest and demands. In this work the system is applied to the NOWHERE photo exhibition, in order to generate tailored photo sequences. The work is positioned in the field by using the Nested Block model, from which the novelty shows of being a system able to create. Besides, the work is described from a variety of information visualisation models, including an Interaction design, Evaluation design, Visual Analytics design, Storytelling design and Visual Thinking design. GENSEQ proves to be a valuable contribution within the field of Information Visualisation, in special for generating personalized sequences from complex data. Delivering applications in domains other than the arts seems like a direction of future research with high potential.

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