

Interactive Poster: Progressive Information Presentation

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ABSTRACT

An important aim of information visualization is the communication of characteristics of the data. Beside the exploration of relevant aspects, presentation of the findings is crucial. Due to the increasingly large data volumes, however, new strategies to avoid cluttered displays are necessary. Our approach makes use of *progressive refinement* to deskew information temporally. Moreover, we also apply its beneficial properties to enhance the communication of data characteristics by a pre-defined *Tour-through-the-data* and to simplify the *adaptation to different viewing devices*.

Keywords: Clutter reduction, progressive refinement, information presentation, smart environments.

Index Terms: H.5.m [Information Systems]: Information Interfaces and Presentation—Miscellaneous; I.3.6 [Computing Methodologies]: Computer Graphics—Methodology and Techniques

1 MOTIVATION

An important part of information visualization is about gaining insight into data through its visual presentation. The fact that many data sources are multi-variate and increasingly large, however, lets this become a rather difficult task. This problem is not new, and numerous approaches and techniques try to solve the related issues. Due to the mass of data, any technology, however, needs to adopt strategies for dealing with overloaded displays. There is simply too much data on too small screens resulting in visual clutter and in turn to a significantly diminished expressiveness. Although many solutions for this problem have been proposed, a final answer is still missing [1]. Thus, it is eligible to explore new ways to make comprehension of knowledge as easy and enriching as possible.

Our proposal for the presentation of massive information sets is the application of *progressive refinement*. The *progression* feature is an already accepted principle in computer graphics to overcome computing power, bandwidth, or memory constraints [2, 5]. However, its inherent property to show multiple successive views to the data opens up for further application fields. As we will point out by providing fundamentals and case studies, progression is able to reduce overloaded presentations by temporal deskewing. Additionally, it further allows for an accentuation of important data items, regions, or characteristics and is, due to its inherent support of scalability, able to simplify the adaptation to the viewing device.

2 PRINCIPLES AND REQUIREMENTS OF PROGRESSION

By talking about *progressive refinement* the reader might be instantly reminded on the early days of the World Wide Web, when limited bandwidth was a real issue. To shorten the long latency times during the loading of contents, the proposal of dynamically

refining image previews was a real relief – with little data received, first conclusions can already be drawn. To achieve this, the image content is scalably and efficiently encoded. Although, the thereby applied basics are still valid, they must be generalized and enhanced by new findings to apply the principle to other graphical contents and application fields. This has yet not been discussed in literature. The following points summarize the main requirements of progression to achieve meaningful and sophisticated content refinements:

Scalability Progressive presentations show abstractions of the data in multiple previews with increasing *Level of Detail (LoD)*. This requires scalability of the data and its representation.

Unambitious interpretation All previews should provide an *easy interpretable and unambitious view* to the data in order to avoid drawing wrong conclusions.

Random access To allow for temporal prioritization, single data values and their abstractions must be independently accessed and attributed by concepts like *Regions of Interest* [6], *Geometry of Interest*, or *Item of Interest* [4].

Encoding To avoid problems in transmission and storage, huge data volumes require efficient encoding. For scalable representations it is meaningful to add only an increment in order to increase detail of single or multiple data items.

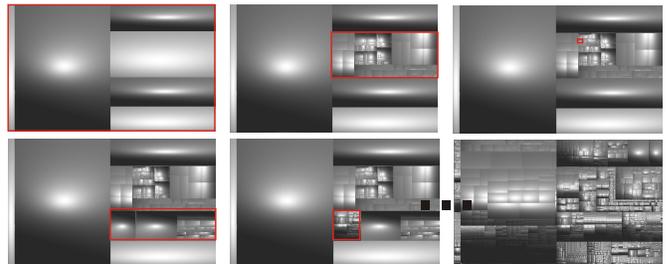


Figure 1: A *Progressive Treemap* designed to communicate position and context of certain data items (red marks indicate refined data).

Although not mandatory, progressive approaches typically assume a Client/Server environment with a server-side creation of the progressive data-stream and its flexible display at different clients. *Created once by an author and served multiple times*, this implements the paradigm – *encode once, decode many ways* [6] – and thus countervails the additional efforts required for including progression. This, however, can easily be achieved by a slight enhancement of the visualization pipeline.

3 ENHANCED INFORMATION PRESENTATION

Progression allows for a completely novel kind of information display and can be seen as a presentation approach rather than a visual analysis method. It provides multiple uncluttered views to the data, whereby each subsequent view adds detail to the display. This

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results in a successive buildup of knowledge about the data and its characteristics. This is an important difference to related approaches based on animation [1]. Due to the fact each view is well-designed by the author distributing the data items and their different LoDs throughout the presentation, specific data characteristics may easily be highlighted. Thus, the thereby applied paradigm – *progression instead of selection* – allows for the extension of the traditional interactive data exploration by a progressive presentation in terms of a *Tour-through-the-data*. If the presentation has not already been finished, visual clutter appears not until the intended characteristics have already been communicated to the viewer. This is illustrated by the following two case studies:

Progressive Treemap: With the goal to highlight certain parts of the data, Fig. 1 illustrates the proposed application of progression within the treemap technique. In order to keep structural dependencies and relations of the data and to fulfill the well-accepted principle *overview before detail*, the progressive presentation starts with the first level of the data hierarchy (Fig. 1/top-left). Now only incremental data to the region to highlight is transmitted and processed. This leads to its local refinement (Fig. 1/top-middle and right). The fact that this data also refines surrounding regions provides further context information and is a general advantage of the progressive proceeding. Once the region is displayed in the desired LoD the processing stops or continues with the handling of other regions. Thereby, the viewer might interact with the presentation by changing the refined region or its LoD at any time. This is illustrated at Fig. 1/bottom-left and middle by a larger region shown at low LoD only. If all information to the data has been communicated, the viewer may finish the presentation at any time. The example, however, continues until all available data is displayed (cf. Fig. 1/bottom-right).

Progressive Parallel Coordinates: The second case study is concerned with Parallel Coordinates (cf. to Fig. 2 and 3). As this technique has been developed to visualize abstract data, scalability must externally be included. This is often not a simple task strongly depending on multiple criteria [3, 4]. However, eligible solutions are current topic of different research areas and may simply be included as a modular part of a progressive system. Here, we want to focus on the presentation part only. As shown in the figures even with little data, a coarse preview of certain data characteristics can be given. Thereby, the previews shown in Fig. 2 strive to abstract the final representation of all data. Contrary, the presentation illustrated in Fig. 3 has been designed to communicate the general data distribution by interval subdivision and median representation. Highlighting of single or multiple items is also possible.

Beside the communication aspects, progressive presentations offers even more benefits. One advantage especially useful for resource-limited devices and environments is the significantly decreased efforts during storage, transmission, and processing. This is due to the tight coupling of presentation and encoding not available in traditional animations.



Figure 2: The inherent scalability of a progressive representation (here: *Progressive Parallel Coordinates*) allows for an uncomplex adaptation to multiple viewing devices.

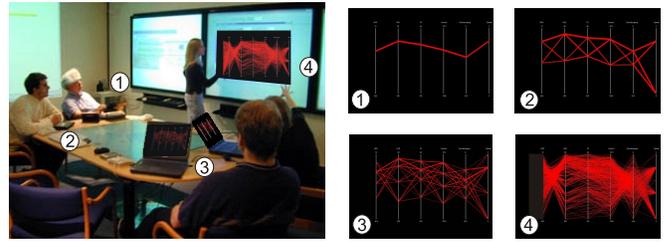


Figure 3: Simple adaptation to different viewing devices is an inherent feature of progressive presentations and allows for further benefits in group work.

4 ADAPTATION TO THE VIEWING DEVICE

Progressive presentations allow for the uncomplex adaptation to the available screen space. This beneficial property is of high relevance in *smart environments*. These environments consist of different cooperative devices with strongly varying properties (cf. to Fig. 3/left). If the demands of a presentation exceed the available resources, the user is confronted with long response rates or visual clutter. There is still no general solution to these problems.

By taking advantage of the modular and scalable data, progressive presentations are able to adapt to both the provided computational resources as well as screen size. Our proposal for an on-the-fly adaptation without prior knowledge to data, visualization technique, or device requires only a progressive presentation and is applicable to any viewing device. The strategy is simple and effective – the previews are piece-wise presented as long as the device is able to provide the required resources. If it is estimated that the consumption of one resource exceeds the capabilities of the device, e.g. by measuring response rates or clutter [1], the presentation does not continue. In streams with well-designed scalability and data distribution, this leads to a highly adapted visual representation whereby only essential data is processed and transmitted. Although for devices with strong limitations the presentation might be short, previews on the final representation of all data still allow for a rough overview (cf. to Fig. 2). The viewer might also switch its view to another device, whenever the presentation on his actual device is finished. Due to the fact different devices stop at different presentation stages, smart environments also allow for a later comparison of previews and the extraction of further knowledge from the refinement process. It is worth noting that in any case only a single presentation stream serving multiple devices is required.

Overall, progression is a means to declutter the presentation of large data sets over time. Within a predefined *Tour-through-the-data* designed to convey certain data characteristics, abstractions of the data provide a first *overview* and are successively refined in *detail*. Progressive information presentations are scalable to both the users interests as well as the viewing device.

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