Visual Trend Analytics in Digital Libraries

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The early awareness of upcoming trends in technology enables a more goal-directed and efficient way for deciding future strategic directions in enterprises and research. Possible sources for this valuable information are ubiquitously and freely available in the Web, e.g. news services, companies' reports, social media platforms and blog infrastructures. To support users in handling these information sources and to keep track of the newest developments, current information systems make intensively use of information retrieval methods that extract relevant information out of the mass amount of data. The related information systems are commonly focused on providing users with easy access to information of their interest and deal with the access to information items and resources [1], but they neither provide an overview of the content nor enable the exploration of emerging or decreasing trends for inferring possible future innovations. The gathering and analysis of this continuously increasing knowledge pool is a very tedious and time-consuming task and borders on the limits of manual feasibility. The interactive overview on data, the continuous changes in data, and the ability to explore data and gain insights are sufficiently supported by Visual Analytics and information visualization approaches, whereas the appliance of such approach in combination with trend analysis are rarely propagated. In fact, these so-called early signals require not only an analysis through machine learning techniques to identify emerging trends, but also human interaction and intervention to adapt the parameters used to their own needs [2]. There are two main aspects to consider in the analysis process: 1) which data reveal very early trends and 2) how can human be involved in the analysis process [3].

Scientific publications provide very early indicators for detecting new and economically important innovations and trends. These usually present technologies, approaches and methods years before a market launch. A noteworthy example is the work of Blei and colleagues [4], who developed an approach back in 2003 that uses statistical methods to extract topics from texts. For many years, the approach was not really considered and did not find its way into the real applications. Today, all providers of business intelligence (BI) and data analysis solutions use this approach. It has become a kind of standard in text analysis. Let us just assume that a company could detect through an early trend analytics system the potential of the approach and include it early in its portfolio. This company would have an essential advantage compared to its competitors. This is just one example that may illustrate the benefits of early detecting emerging technological developments through information retrieval and machine learning methods. However, a merely machine analysis is not always beneficial. It is far more

necessary to involve the human directly in the process of search, exploration and detection of trends. Humans are commonly not involved in the processes of machine learning and artificial intelligence, although they have a higher and above all broader intelligence than existing and widely used approaches of machine learning and artificial intelligence. Visual Analytics combines automatic analysis techniques with interactive visualizations to enable effective understanding (transparency), reasoning and decision-making [5]. Extended approaches enable in particular through visual representations, diagnostic (why something has happened?), predictive (what will probably happen in the future?) and prescriptive analytics approaches (which is probably the best decision or direction?).

We present a Visual Trend Analytics approach that builds upon our previous work on adaptive visualization [6]. According to our previous model, we subdivide the transformation process for visual trend analysis in digital libraries into the steps of (1) Data Enrichment, (2) Data Transformation, (3) Visual Mappings, and (4) Visual Orchestration. Data Enrichment gathers additional data from external repositories to enhance the quality of data and uses text analysis techniques to extract valuable information from these data. Data Transformation structures the data for a proper visualization. It detects relevance, amount and content of queried data and uses these features to create models revealing certain aspects of the data. Visual Mappings transforms the data models to appropriate visualizations. Visual Orchestration uses textual and visual information gathered in the previous transformation steps to create static and dynamic elements for human interaction.

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