

Semistatic Animations - Integrating Past, Present and Future in Map Animations

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1. Introduction

Map animations possess the ability to visualize temporal information in an appealing way to the user. However, there are several unresolved issues with animations which need to be addressed. Often map animations are compared with their static counterparts in order to assess the performance of each (Tversky et al. 2002, Midtbø and Larsen 2005). Tversky et al. (2002) reports that animations are not necessarily better than static maps. Several issues associated with map animations are of concern, such as split attention often related to the temporal legend (Midtbø et al. 2007) and disappearance (Harrower 2009, Tversky et al. 2002). The static counterpart is often used as a means of avoiding these issues. One example of this is the static small multiple maps (Fabrikant et al. 2008) which extract the key frames of the animation and display several static maps instead of one seamless animation.

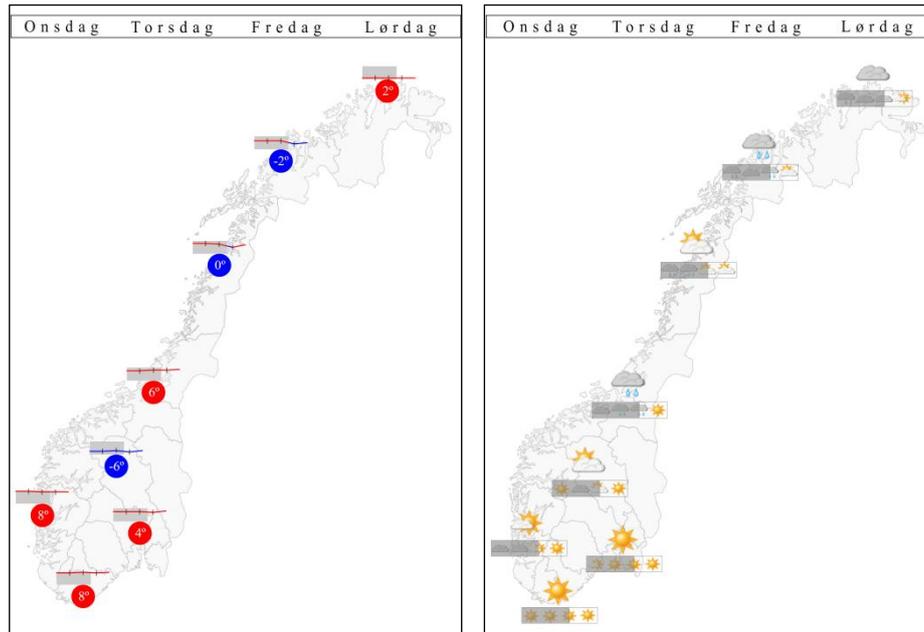
This research presents a new concept of map animation; semistatic animations, where each frame visualizes all key frames of the whole animation, thus integrating the temporal information. The concept explicitly tries to address the above mentioned challenges of disappearance and split attention. A web experiment has been conducted on two different types of semistatic animations. Results indicate better performance on several specific tasks compared to a traditional animation.

2. Semistatic animations

The semistatic animations address primarily two issues associated with today's animations; *disappearance* (Harrower 2009) and *split attention* (Harrower 2008). Disappearance occurs when the user misses information portrayed in the animation, for instance in the situation where the user starts watching in the middle of an animation's time span. Split attention occurs when the user is deliberately focusing on particular areas of the animation, such as a temporal legend and is not able to perceive the necessary information. In addition to these issues, map animations are often made in order to support knowledge creation. The limited cognitive memory of the user is important to support through the animation. This should support better the knowledge creation process and also enable "at a glance" usage of the animation.

Adding interactivity could meet several of the challenges. However, in broadcast mediums, such as television or public presentations, this is not suitable. Additionally this could potentially decrease the user's optimal perception of the information (Fabrikant et al. 2008).

Semistatic animations approach the issues through an extension of the symbols found in map animations. The most important extension is the "history view" which integrates both past, present and future information in every single frame of the animation - thus enabling better transparency of the information. In addition to this component, the temporal legend is integrated in the history view in order to address split attention and better support perception of the temporal reference.



(a) Temperature map animation (b) Weather map animation

Figure 1: Proof of concept implementation of the semistatic concept. Animations available at: <http://geomatikk.ntnu.no/projects/semistatic/>

To illustrate the concept of semistatic animations and evaluate its performance, a proof of concept implementation has been made and evaluated. The implementation focuses on weather and temperature forecast maps commonly used on television and the internet. Weather and temperature maps usually represent the information using pictograms, however, the information they portray have distinctly different properties. The information in the temperature map is essentially numbers, while for the weather map the information is of a textual kind. Figure 1(a) illustrates the proof of concept implementation, where the “history view” consists of a line graph illustrating the complete temperature information for the whole animation. Similarly figure 1(b) illustrates the weather map where the “history view” consists only of symbols. For both map animations, the temporal legend is integrated in the “history view” as a horizontal moving bar, although retaining the reference to the temporal scale at the top of the map.

3. Experimental evaluation

Three user tasks are focused on for comparing the performance of the semistatic to the traditional animations; Trend on one location, trend over space and time and memory task. Each of these tasks is influenced by the previously mentioned issues with animations. From this, two hypotheses for the outcome are defined:

1. Semistatic weather map animation performs better at all three tasks than the traditional weather map animation.
2. Semistatic temperature map performs better at trend on one location than the traditional temperature map animation and equally well for the memory and trend over space and time tasks.

In order to investigate these hypotheses, a web-experiment was conducted. The experiment was sent out to about 2000 students at the Norwegian University of Science and Technology. In total the experiment received 132 participants for the weather map animations and 133 participants for the temperature map animations.

Each participant watched both the semistatic and traditional animations in different sequences and relating to one of the above mentioned tasks. For each task and animation, an answer was given which in turn was coded as either correct or wrong.

Results from the experiment were analyzed using chi-square hypothesis tests on the different animation types as well as for each particular task. Chi-square tables and related chi-square values from the hypothesis tests are found in Table 1.

Table 1. Chi-square tables and values for each hypothesis test.

Hypothesis test	Animation type	Correct answers	Wrong answers	Chi-square value
Weather map overall	Semistatic	104	28	18.459
	Traditional	71	61	
Weather map trend one location	Semistatic	42	1	22.744
	Traditional	23	20	
Weather map trend space/time	Semistatic	19	24	1.163 (!)
	Traditional	24	19	
Weather map memory task	Semistatic	43	3	19.828
	Traditional	24	22	
Temperature map overall	Semistatic	97	36	6.647
	Traditional	77	56	
Temperature map trend one location	Semistatic	23	22	0.72 (!)
	Traditional	27	18	
Temperature map trend space/time	Semistatic	41	2	9.771
	Traditional	30	13	
Temperature map memory task	Semistatic	33	12	7.756
	Traditional	20	25	

The results relating to the weather map animation showed that in general the semistatic performed significantly better than the traditional animation at a 99% confidence interval. However, the most interesting result is the performance on the different tasks. For both the trend on one location task and the memory task, the results showed that the semistatic performed significantly better than the traditional map animations at a 99% confidence interval. The results were different for the trend over space and time task where the semistatic did not perform significantly differently than the traditional map animation, even at a 90% confidence interval. These initial results indicate strongly that the semistatic approach to symbols in map animations performs better at both memory task and trend on one location. It is believed this is a result of a

leveraged effect of split attention due to the integrated temporal legend and also better support of cognitive memory due to the integration of the complete information.

Results for the Temperature map animations were different than expected. For the overall performance the semistatic performed significantly better than the traditional at a 99% confidence interval (table: 6,635 chi-square value: 6,647). Although the overall results indicate a good performance of the semistatic animations, analyzing each of the tasks reveals that the performance is very task dependent. Results for the trend on one location task yields that there is no significant difference between the traditional and semistatic animations. Analyzing the answer distribution in Table 1 indicates that the traditional is performing slightly better than the semistatic animation - however, not significantly. For the trend over space and time, the semistatic actually performs significantly better than the traditional animation at a 99% confidence interval - although both animation types perform quite well. Semistatic animations also perform significantly better at the memory task than the traditional animation, at a 99% confidence interval. It was not expected that the semistatic animation would not increase performance for the trend on one location task, as this was the primary task it intended to support through the line graph in the history view.

4. Conclusions and further work

The results from the web experiments show that the proof of concept implementation of the semistatic concept performs better than the traditional map animations. This is evident particularly for the memory task where the semistatic performs better than the traditional animations for both temperature and weather map animations. Trend on one location is well supported in the semistatic weather animation, however not in the semistatic temperature animation. For the task; trend over space and time, the results are opposite, where semistatic temperature animation performs better than the traditional map animation.

By its nature, the web experiment can not give indications nor answers to why semistatic and traditional animations perform differently on different tasks and approaches. Leverage of split attention and support of cognitive memory are the two most prominent theories. Applying more sophisticated evaluation methods is needed in order to further elicit the map users' perception during the animations.

The design of the semistatic animations should be improved further. Suggested for the semistatic temperature animation is the application of spark lines (Tufte 2006) in the history view - as well as to aim at a more explicit representation of the discrete numbers.

An inherent problem of the proof of concept implementation is the symbol size. Further work should focus on limiting the space needed, for instance using a "fisheye", or a "carousel", approach to the history view symbols.

The author is currently in the process of addressing several of these challenges, as well as evaluating the current implementation using eye-tracking technology. Results from this will increase the insight into the map users' viewing behavior of the semistatic as well as the traditional animations.

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