

# KiEV: A Tool for Visualization of Reading and Writing Processes in Translation of Text

Oleg Špakov & Kari-Jouko Rähä  
Human-Computer Interaction Unit  
Department of Computer Sciences  
FIN-33014 University of Tampere, Finland  
{oleg, kjr}@cs.uta.fi

## Abstract

The increase in usage of eye-tracking technology to study text translation processes has revealed the need for effective tools for visualization of the data collected. We propose a new method for gaze and keystroke data visualization. The visualization utilizes the preprocessed gaze data, where detected fixations are linked to the corresponding word in the text. The blocks of reading and typing processes are shown in parallel with details for each word presented in word bars. Reading or typing sequences provide insight into the temporal distribution of the subject's activity, and highlighting pops up the unusual or attention-requiring data and events.

**CR Categories:** H.5.2 [Information Interfaces and Presentation]: User Interfaces – Evaluation/methodology; Input devices and strategies

**Keywords:** gaze data analysis, gaze and keystroke data visualization, gaze-to-word mapping, eye tracking, translation analysis

## 1 Introduction

As eye-tracking technologies became more affordable and accurate, the number of scientific disciplines using eye movement data for analysis has increased rapidly [Duchowski 2002]. Researchers who study processes in translation from one language to another are not left out: the analysis of eye movements of subjects who read text for translation and the text they produce themselves can reveal many important details [O'Brien 2006]. The analysis of such processes consists of analysis of reading of the text in source language L2 (supplied by the test supervisor), analysis of reading of text written in target language L1 (produced by the subject), and analysis of the dynamics of the subject's keystrokes.

Thus far, researchers have been able to perform highly detailed analysis of keystrokes only by using special tools like Translog [Jakobsen 1999] or ScriptLog [Strömqvist & Karlsson 2000]. The analysis of eye movements has remained a very tedious job, with manual gaze-to-word mapping required for each trial before the data for further analysis could be ready. It was possible to do this via tools that superimpose gaze points over stimuli (like ClearView by Tobii Technologies), but this was still took much longer than the actual recording. Even with the list of words given focus in hand, the numeric-data representation of the focusing statistics is not the best for determining the subject's behavior during translation.

The ScriptLog tool developed by researchers at the University of Lund can record both eye movements and keystrokes for later visualization of the temporal behavior of a subject translating the text presented onscreen [Andersson et al. 2006]. ScriptLog shows the time spent observing areas of interest (AOIs), which can be defined by an inspector. On a graph with a common timeline, each AOI is presented as a horizontal (or vertical) bar. The time a subject spent observing an AOI is presented as a colored part of the corresponding bar. Thus, only one bar representing an AOI can be colored at any given moment. In addition to the AOI bars, other bars represent events occurring in parallel: keystrokes, mouse clicks, etc. This kind of visualization gives a clear picture of how the observation of AOIs is distributed over time and how it correlates with keystrokes. The typical AOIs are stimuli (in the area with text for translation), the rest of the screen, and a keyboard.

Despite the clear usefulness of this tool, it does not answer the question that is as important as the temporal distribution of observation areas and correlation with keystrokes: how does the reading occur during an experiment? Our tool was developed to answer this question. We present here the functionality of the tool and discuss the cases where it might be useful.

## 2 Design

The requirements for the gaze and keystrokes visualization tool were collected during a discussion with researchers into translation processes from Copenhagen Business School. The main conclusions from these discussions concerned the need to a) quickly inspect temporal relations between gazing and typing events, b) highlight any data (related to reading or typing) differing from the data treated as a "smooth" ("normal") translation process, and c) obtain the most important statistics for reading/writing events. Since visualizations that employ a timeline to present a gaze data distribution in time between AOIs of a stimulus have been used successfully by other researchers too [Aula, Majaranta, & Rähä 2005], it was decided to choose this visualization format for the target tool.

The KiEV tool was developed on the basis of these requirements. It provides the associated functionality and proposes a solution for the problems mentioned in the introduction to the paper. The tool uses the data collected in log files by the Translog and GWM tools. The Translog tool presents text for translation and logs all keystrokes (and some other system and task-related events) produced by a subject. The GWM tool, integrated into Translog, uses an eye-tracking device to map gaze onto words in the text and logs all events related to word-focusing (e.g., a fixation's timestamp and duration, the total duration of observation of the word in focus, and the number of fixations and reading direction). Detailed description of these tools is available on the Web [EYE-to-IT project 2007].

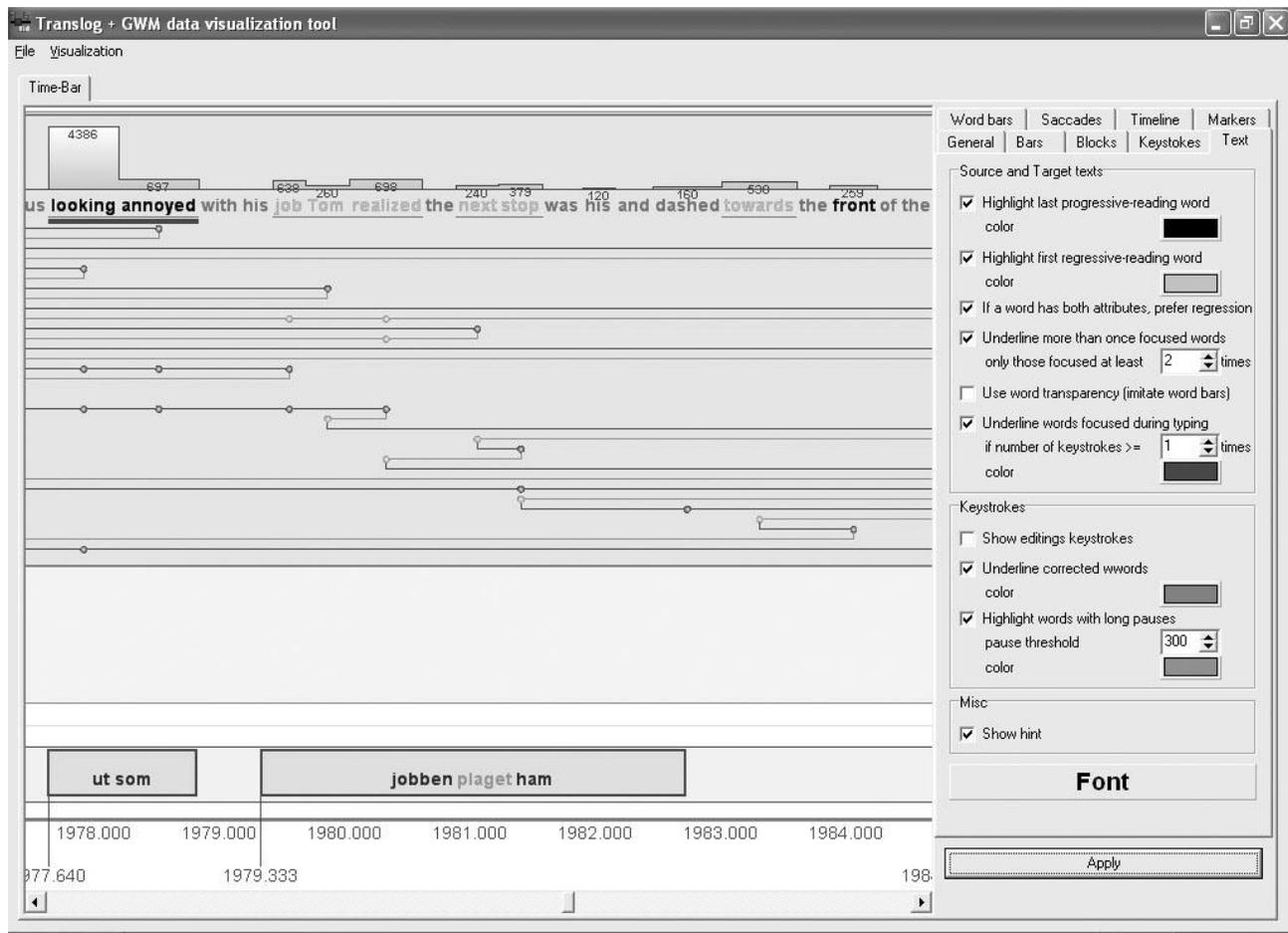


Figure 1: Screenshot of the KiEV tool.

The KiEV tool creates a visualization with three horizontal bars on the same timeline to present events of focusing on words in the source text and in the target (translated) text, as well as progress in typing the target text (see Figure 1: top, middle, and bottom bar, respectively). Each bar contains blocks that represent a collection of uninterrupted events. Each block starts when the first event occurred within this block and ends at the time when its last event ended. Obviously, the blocks of events in the source and target text bars cannot overlap. Each block of a source or target text bar consists of text, word bars above it, and the reading progress below it.

Creation of blocks within a source or target text bar is performed in one of two ways: a) all consecutive fixations that are mapped onto words of the same text form a block, or b) all consecutive fixations mapped onto words of the same text or not mapped at all are a block. The latter block creation method is more useful when accuracy in gaze direction detection is poor and many fixations thus are left unmapped to a word in the text.

The data illustrated in Figure 2 give a good example of such a case: the last word has been given focus only twice, but the gaze data for last focus were grouped by a fixation detection algorithm into three fixations, of which only two, the first and the last, were mapped onto the word, with the second fixation left unmapped. Therefore, the last focusing is shown as split into

two parts, and the last part is highlighted to indicate the presence of a preceding unmapped fixation.

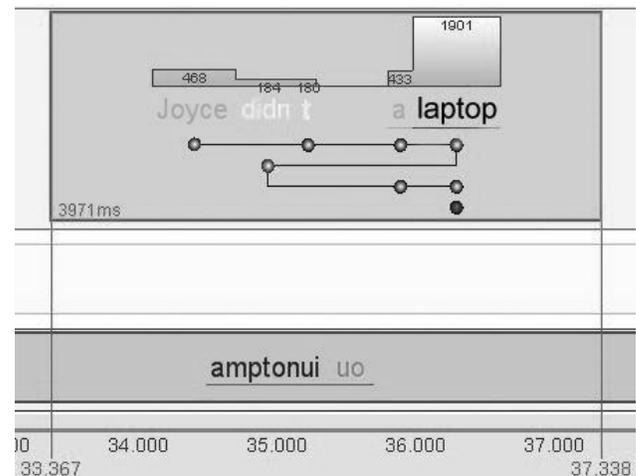


Figure 2: Details of the visualization.

The word bars may present either the total observation duration for each word (as in Figure 2) or only the duration of the first fixation landing on the corresponding word. The scaling of the



block when the block is too long – e.g. when the text read in a short time is longer than can be rendered in the space reserved for such a time span. The current solution provides two ways to address this problem: 1) decreasing the font size to make the text small enough and 2) having users increase the number of pixels used per second of the timeline so that all blocks are wide enough for their text. Applying both of these approaches usually yields a satisfactory result, but sometimes the text in some blocks becomes too small or the timeline appears enormous.

#### 4 Conclusions

The KiEV tool for visualization of gaze and keystroke data collected during text translation has been designed and implemented. It uses high-level preprocessed data providing links from fixations detected to words of the text being read.

The main benefit of the tool lies in the organization of the information presentation: the text-reading process is shown in detail and in parallel with the text-typing process. The word bars and reading sequence show the key aspects of the reading statistics and events. Highlighting is used widely to pop up unusual or attention-requiring data and events.

It is expected that, after careful examination and testing, the tool will be improved by increasing the number of variables used to create the word bars.

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