

Automated Assistance in Evaluating the Design of On-screen Presentations

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Abstract: Oral presentations can profit decisively from high-quality layout of the accompanying on-screen presentation. Many oral talks fail to reach their audience due to overloaded slides, drawings with insufficient contrast, and other layout issues. In the area of web design, assistant systems are available nowadays which automatically check layout and style of web pages. In this paper, we introduce a tool whose application can help non-experts as well as presentation professionals to automatically evaluate important aspects of the layout and design of on-screen presentations. The system informs the user about layout-rule violation in a self-explanatory manner, if needed with supplementary visualizations. The paper describes a prototype that checks important general guidelines and standards for effective presentations. We believe that the system exemplifies a high-potential new application area for human-computer interaction and expert-assistance systems.

1 INTRODUCTION

At the onset of their oral presentations, speakers sometimes apologize for the potentially suboptimal quality of the accompanying visual slides¹. They wonder whether the audience can see presented curves although the contrast between foreground and background is poor, e.g., yellow on white background, or whether the people in the back can read 10pt fonts well enough. These and similar questions are meant to be rhetorical—the audience often perceives them as cynical.

Could assistant systems inspect slides while the talk and the accompanying audiovisual aids are being prepared? In many areas of human-computer interaction, such as web-site design, assistant systems are available nowadays but, to our knowledge, not in the area of audiovisual presentations. The present paper describes a prototype that automatically checks various general guidelines and standards for effective audiovisual presentations.

In our system, short traffic-light-style bars inform the user about the evaluation result—supplemented on demand by more elaborate explanations. In the list of preferences, the user can deselect features s/he is

¹Although true “slide” projection is hardly in use anymore, the term *slide* has survived the transition from physical to virtual overheads.

not interested in along with personalized values overwriting the system’s defaults. For instance, the slides may contain more information in an academic lecture than in a business talk. In this paper, we focus on visualization of feedback by a system that has detected violations of presentation rules and standards. We describe measures taken to facilitate system use by novices as well as experts. The implementation of algorithms such as calculating the density of a slide or detecting insufficient contrast levels is not discussed here.

The paper is organized as follows. In the next section, we sketch the state of the art in assistant systems. In Section 3, we specify important to-be-evaluated criteria in the area of (audio)visual presentation design. The current prototype is discussed in Section 4. In the final section, we draw some conclusions and address future work.

2 STATE OF THE ART IN ASSISTANT SYSTEMS

Automated assistance in user-interface design is a relatively young but dynamic field. Goal is to countervail the proliferation of poorly designed interfaces—a development spawned by easy-to-use tools for imple-

menting dialogue systems. An important early step in this direction constitutes the DON framework (Kim and Foley, 1993), which uses rules from a knowledge base to provide expert assistance in user-dialogue design. It can generate layout variants in a consistent manner. Subsequent development of such assistant systems proceeded in two main directions—graphic art (printing) and web—and has already given rise to expert-assistant systems with commercial applications.

In the graphic-arts industry, quality control before printing plays a crucial role by reducing the costs of reprinting. The process has been dubbed “*preflight*”. This term usually designates the process of preparing a digital document for final output as print or plate, or for export to other digital document formats. The first commercial application was “FlightCheck”² described in a paper entitled “*Device and method for examining, verifying, correcting and approving electronic documents prior to printing, transmission or recording*” (Crandall and Marchese, 1999). Recent products in the area provide integrated preflight functionality (see, e.g., Adobe InDesign³ and Adobe Acrobat⁴). The main objective of these instruments is to reveal possible technical problems of the document. Accordingly, they work with the following primary checklist: (1) Fonts are accessible, compatible and intact; (2) Media formats and resolution are conforming; (3) Inspection of colors (detection of incorrect/spot colors, transparent areas); (4) Page information, margins and document size.

According to Montero, Vanderdonck & Lozano (2005), the abundance of web pages with poor usability is largely due to shortage of technical experts in the field of web design. Ivory, Mancoff & Le (2003) present an overview of systems that are capable of analyzing various aspects of the web pages. Historically different browsers have different views on the implementation of web standards (see, e.g., Windrum, 2004), with as a consequence that the same web page may look differently in different web browsers. The above criteria have led to the situation that tools for web-page analysis focus primarily on technical and marketing aspects of the pages. Current web analysis tools primarily check:

- W3C⁵ DOM, HTML and CSS standards;

²FlightCheck (Preflight for Print), <http://markzware.com/products/flightcheck> (Nov. 11, 2015).

³Adobe InDesign CC, <http://www.adobe.com/products/in-design> (Nov. 11, 2015).

⁴Adobe Acrobat, <https://acrobat.adobe.com> (Nov. 11, 2015).

⁵World Wide Web Consortium (W3C), <http://www.w3.org> (Nov. 11, 2015).

- Search engine optimization (SEO) aspects;
- Web page performance and rendering speed;
- Content, media and script sizes;
- Accessibility of various devices.

Despite the emphasis on purely technical aspects, several publications report on systems assisting users on other aspects of web design (e.g., Tobar et al., 2008). Some state-of-the-art systems (see, e.g., Nagy, 2013) advise on visible content prioritizing, check the size of control elements (e.g., some dialogue items may be too small for using on mobile devices), and distances between the visible elements of a web page.

An essential question concerns whether or not assistant systems should react directly/online, in a daemon-like fashion, to any undesirable user action (maybe even forbidding and overruling user actions), or should become active only on demand. The majority of systems mentioned above prefer the on-demand dialogue. Basically, the decision depends on the aspect evaluated. For instance, if the system cannot react to a user action such as saving a file in the current format, the implication should be brought to the user’s attention. The online alternative is appropriate if no ill-formed result can be produced at all (e.g., automatic typo correction during SMS typing, which avoids unknown words). However, this mode may cause the user to feel patronized. As a consequence, users tend to switch off such components. The second alternative of giving advice on demand offers the user more freedom (e.g., new words can be typed). In design, the user even might intentionally violate rules as a stylistic matter (cf. provocative design).

3 PRESENTATION RULES

Here we summarize well-known standards for user-interface design in general, which also apply to the design of on-screen presentations. Additionally, we list rules of thumb specifically for presentation design in particular. Due to space limitations, we cannot give a comprehensive overview of such rules and standards, and instead focus on the type of rules that our system checks automatically.

Many user-interface design rules (cf. the EN ISO 9241 norm) can be applied to slide presentations as well: use only few different colors; avoid high color saturation levels; give sufficient contrast to the colors used; group related elements together, potentially with a frame around them, and/or make sure there is sufficient spacing between non-related items (cf. the *Gestalt* laws; see Wertheimer’s work reprinted in

2012); do not make the interface too crowded; distribute objects such that the virtually assumed grid lines are minimized (i.e. make the interface—in our case, the slides—look balanced and sophisticated; cf. Galitz, 2007). The recommendation not to overtax the short-term memory of the user in interface design also holds for a slide: it restricts the number of presented items to 7 ± 2 per slide (cf. *Miller's rule*; Miller, 1956). In total, no more than 30% to 40% of a slide's surface should be occupied (cf. the screen density suggestion by Galitz, 2007).

For *consistency* reasons (cf. Shneiderman and Plaisant, 2004), font, size, position and color of the slides should remain the same in publishing media. This holds in particular for the title. Moreover, the latter's position should remain the same on each slide. Often a predefined frame is assumed for a user interface (cf. the *slide master* in PowerPoint⁶ for the adaptation to visual presentations).

Specific rules for visual-presentation design are discussed in many books. A wide variety of books focuses on different user needs such as presentation for beginning or professional presenters in business. For instance, for non-designers, Robin Williams (2015) cites four principles of visual presentation design: (1) Contrast, (2) Repetition, (3) Alignment, and (4) Proximity.

We focus on the following rules of thumb that, we assume, hold for business presentations. They represent the defaults of our prototype:

- (1) Do not use more than two font types in a presentation⁷;
- (2) Do not use fonts smaller than 18pt;
- (3) Do not use more than three colors;
- (4) Avoid saturated colors (threshold 30%);
- (5) Provide sufficient contrast for chosen colors/gray values (threshold 10%);
- (6) Provide sufficient distance between unrelated objects (as opposed to related objects which should be closer together due to *Gestalt* law effects; horizontal = .8cm, vertical = .8cm⁸);
- (7) Provide a balanced distribution of elements (maximum number of grid lines = 20 with unified distance of .3cm);

⁶See PowerPoint, <http://products.office.com/powerpoint> (Nov. 12, 2015).

⁷An extended version also checks whether dispreferred fonts are being used (e.g. Antiqua; for pros and cons of various fonts, see, e.g., Williams, 2015). Our default list is based on Schildt and Kürsteiner (2006). The user can edit this list (as s/he can modify any default parameter of the system).

⁸These values can also be calculated automatically using the font size used in the currently considered text box (cf. Galitz, 2007).

- (8) Slides should not be too full (threshold for overall slide density = 30%).
- (9) For convenience of the audience, provide automatic print versions without images, and/or with inversion of dark to white background and automatic conversion of the foreground colors to black or a user-defined value. This mode is not discussed here for reasons of space.

As will be outlined in the next section, the above mentioned features are first checked for each slide separately, using the default or user-defined parameter settings. The per-slide evaluation reports are subsequently inspected for overall consistency of the entire presentation.

4 SEAP TOOL: A PRESENTATION ASSISTANT SYSTEM

The nick name *SEAP* stands for *Software-Ergonomic Analysis of Presentations*. First, we describe SEAP tool's system design, e.g., its input and output structures. Then, we focus on the inspection per slide. In Section 4.3, we elaborate on the preferences the user can express for any feature in any particular slide. Section 4.4 indicates how the contents of the per-slide evaluation report are used for checking the overall consistency of the presentation.

4.1 System Design

Our prototype is implemented in Java 8⁹. As the main input format, we use Portable Document Format (PDF), being the de facto standard for fixed-format electronic documents (cf. ISO 32000-1:2008¹⁰). Hence, the system can analyze any presentation that is exportable as PDF, irrespective of the slide preparation program or the operating system under which the presentation was created.

The PDF format also permits access to the presentation's internal content stored as text, as raster or vector graphics, or as multimedia objects. If available, we use this information in the subsequent slide analyses. However, an analyzed slide may consist of only a picture, without any text information (e.g., when the entire slide is a screenshot). In this case, or when graphical elements on the slide display text, we

⁹Java Software, <https://www.oracle.com/java/index.html> (Nov. 12, 2015).

¹⁰See http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber=51502 (Nov. 12, 2015).

use the computer vision library OpenCV¹¹ to identify the objects. Obviously, this variant is computationally more complex and more time consuming. This will be reflected in lower processing speed, especially when producing evaluation reports on larger input files. However, the system thus gains independence from the actual representation format of the content of the slide. In the following, we do not elaborate on implementation details of the two different methods to obtain an evaluation result. (See Dünnebier, 2015; this paper also discusses quality estimates of the evaluation algorithms applied in SEAP. Without going into details, we assume that the evaluation results to be discussed below can be calculated automatically.)

Given the decision to inspect a PDF file of the presentation, the way SEAP tool provides the output is also determined. As mentioned in Section 2, an assistant system can evaluate *online during* the design process, or produce a review *on demand*. The latter (also SEAP's) mode has the advantage of avoiding disturbing the user, especially during stages where the focus is on content rather than form. However, this decision has a drawback: information that would be immediately at hand online (e.g.: Which areas belong to the master slide? Which text box is meant to be the title?) has to be recomputed.

We target different user groups: not only novices but also presentation professionals. Basically, the report aims at easily understandable comments (e.g., visualizations rather than technical terms in case of novice users). Professionals receive short traffic-light-style comments only.

Moreover, the personal settings for all parameters of the individual evaluation algorithms allow different levels of detail. Inexperienced users see intuitive labels, professional users can operate an "Advanced" button to enter exact values (e.g., see Figure 6 in Section 4.3 for the interface enabling personalization of the grid inspection parameters).

In the next paragraph, we outline the evaluation of individual slides, focusing on user preferences.

4.2 Report Generation per Slide

In reports on the evaluation of specific features, a green or red background indicates successful or failing compliance with the relevant rules. This traffic-light-style information helps professional users to speed up reading—on the assumption they search for red bars only (cf. Figure 1). It also supports users who are unfamiliar with presentation rules. They can read

¹¹OpenCV (Open Source Computer Vision), <http://opencv.org> (Nov. 12, 2015).

the traffic-light colors as hints whether they are on the right track or not. Moreover, we present informative visualizations whenever possible. If desired, the report can become personalized in two respects:

- (1) The user has the option to define *personal preferences* overruling the default settings used by the underlying algorithms.
- (2) Additionally, the system offers the choice between concise or elaborate reporting.

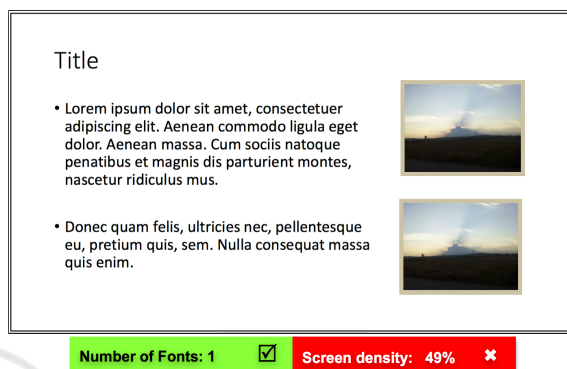


Figure 1: Concise analysis report. The user has asked the system to check the number of used fonts and the screen density only: Positive feedback for used fonts is displayed against a green background, negative feedback on crowdedness against a red background.

In the following, we focus on the elaborate reporting mode. On each slide, SEAP tool counts the number of different fonts and compares it against the threshold (whose default value is two). It also checks the occurrence of user-defined but generally dispreferred fonts. Figure 2 illustrates the most elaborate version of a font warning generated by SEAP tool. Color saturation warnings and warning for too many different colors on the same slide look similar. For reasons of space, we skip details here.



Figure 2: Elaborate font information based on the yellow rule of thumb in the right panel.

Whenever possible, visualizations are used to inform the user in a self-explanatory manner so that professional as well as non-professional presenters can use the system. For instance, the system exemplifies whether closely neighboring objects are likely perceived as belonging together according to the *Gestalt* laws. The system groups such objects in one abstract box¹², in line with the default or user-defined thresh-

¹²In this figure, we use black as the color denoting such boxes because this yields better interpretability of the

old (cf. Figure 3¹³ corresponding to the slide depicted in Figure 1). Notice that, here, the system does not attempt to warn against errors but merely visualizes the grouping most likely perceived by the audience. Therefore, only the user—not the system—can adapt the slide to the intended content. The example depicted in the figure also illustrates the difference between PDF-based and image-based inspections. In the PDF file, the two text items are shown in one box (see the green text boxes in the grid representation of Figure 4: they reflect the predefined settings for highlighting text compared to images, as outlined in Figure 6 in the next subsection). However, given the current threshold settings, an image analysis of the slide would interpret the text items as two independent boxes. Consequently, the user might feel inclined to improve the slide by positioning the two text items closer together. In SEAP tool, we currently take the PDF information about text to determine text boxes. Thus, no conflict needs to be resolved.



Figure 3: Recognition of object groupings for a threshold bigger than the distance between the text box with the two items and the two images but smaller than the distance between the two images.

In a similar manner, the system can visualize whether the spatial distribution of objects is balanced giving the impression that the user has immersed in the presentation design. Such visualizations display the virtual grid based on a threshold determining which distance is assumed to be one unit. For instance, on the slide in Figure 1, the two images are not fully vertically aligned (cf. Footnote 13). A very exact threshold (e.g., .1cm) would show two vertical grid lines to the left, and two vertical grid lines to the

scaled-down image. In SEAP tool, the user can select any color and any level of transparency.

¹³The obvious grid violation of an exact vertical alignment of the two images is intentional here. We will use the same image for the purpose of illustrating the virtual grid calculation later on in the section. One can see that the default parameter for grid inspection can be considerably high. Obviously, the original slide as presented in Figure 1 looks balanced.

right of the images. If the threshold would be set to a more lenient (higher) value, only one grid line will be calculated. Figure 4 depicts the result when an exact threshold is used: this illustrates the power of the automatic calculation. As holds for all preferences of SEAP tool, the color of boxes and lines serving to highlight the meta information on a slide can be chosen by the user. Thus, object colors and background colors on the slide can be clearly distinguished from colors added by SEAP tool in the the evaluation information.

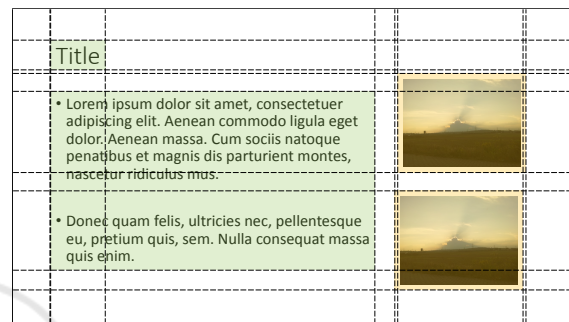


Figure 4: Visualization of the grid lines of objects illustrating whether the order of objects is reduced or not.

As for contrast evaluation against a given threshold, in the current SEAP tool version, each slide is translated into a grayscale version by applying a black-and-white filter, e.g., a dithering algorithm¹⁴. The concise report can issue warnings that information with too low contrast has disappeared. Too close similarities between colors can also be detected if the threshold is refined. In the elaborate report version, slide areas with “missing information” are highlighted, so that the user does not easily overlook missed details. Currently, we run experiments with measured contrast levels indicated directly on the original slide, without applying a black-and-white filter. Additionally, new evaluation rules should be added enabling the detection of colors invisible to color-blind users.

In the next paragraph, we discuss how user-defined preferences are entered. Here, it is important to use terminology that any kind of user understands—not only experts.

4.3 User-specific Preference-dialogues for Individual Slide Inspection

In this section, we introduce parameter settings for the

¹⁴For an easily understandable and nicely visually supported description see <http://www.tannerhelland.com/4660/dithering-eleven-algorithms-source-code/> (Nov. 12, 2015).

inspection of individual slides. The user can define slide-specific defaults as well as presentation-general ones. The latter ones are discussed in the separate Section 4.4 because checks of overall consistency are based on the per-slide reports. Moreover, the preference menu includes a separate submenu for the overall presentation parameters. This submenu also allows skipping the final overall evaluation when the user is not interested in this inspection, or when s/he is finalizing the presentation.

For each individual slide, the user can select which features to evaluate. This can speed up the process considerably¹⁵. Moreover, the user may be interested in specific feedback only. In that case, s/he is presented with the list of options mentioned in Section 3, and invited to select or deselect one or more items. Deselected items are grayed out and move to the end of the list. This behavior should elicit another user-option available in this window: The user can change the ordering of the sections in the evaluation report. In the top of the window, the user is informed that the list can be re-ordered if desired. In Figure 5, the window is depicted in the original order. However, the figure illustrates a state where the user has deselected the last five items (cf. gray color). Of course, any choice and ordering can be revised before being applied. Pushing the “Abort” button means staying with the previous settings. Pushing the preselected “Apply” button adapts the evaluation report according to the user’s preferences.

After the user has left the window either by pushing the “Apply” or the “Abort” button, s/he can opt for a concise or an elaborate report on each of the remaining items, to be displayed in the subsequent window. This window contains a choice button enabling reversal of the default assumed at the start. The default is to provide an elaborate report, for we assume that, in the beginning, the user—irrespective whether s/he is a novice or a professional presenter—will take the time to get familiar with SEAP tool’s feedback behavior. For reasons of space, we will not discuss this window here.

Besides the dialogue about the overall order and level of detail of the report, the user can overwrite the default parameter setting of any feature chosen to be checked in the report. Menu items referring to deselected evaluation features remain inactive (depicted in gray). We always display these menu items in the same order irrespective to the report order cho-

¹⁵Notice that the evaluation report also contains a section for the overall presentation checking (see next section). If the user wants many general consistency features to be checked according to personal preferences, the system obviously can not speed up very much.

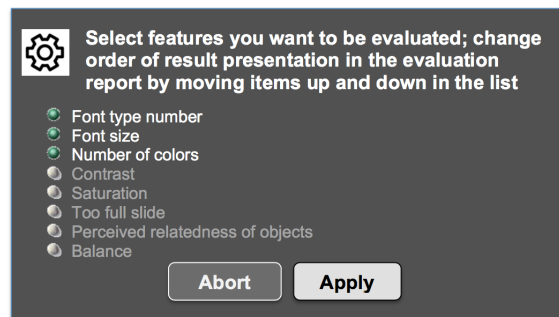


Figure 5: Personalization of features to be evaluated along with the option to personalize the order of results presented in the report.

sen by the user, because we assume search in a fixed-order menu is faster. Figure 6 shows an example that avoids changing exact numbers—which we assume to be the desired mode for novices. The example illustrates how inexperienced presenters can work with the SEAP tool in an intuitive fashion. Abstract terms instead of exact values are shown to allow the user to make a meaningful choice. Experts probably prefer a window where they can change the default values directly. The current prototype is not able to present the full set of possible menus for all features. We are currently revising and extending these dialogues considerably for the next version of SEAP tool.

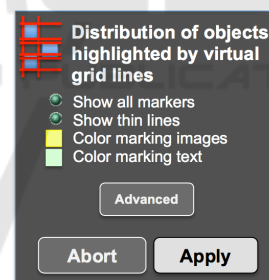


Figure 6: Upper part of the dialogue window: Setting of the grid evaluation parameter in the preferences list in a manner that allows inexperienced users to make a meaningful choice. Lower part: The button labeled “Advanced” located above the final choice “Abort/Apply” opens a window presenting detailed numerical settings, intended to be used by experts.

All defaults mentioned in Section 3 can be overwritten. Furthermore, the list of non-accepted fonts can be modified. For reasons of space, we do not elaborate on the fact that there are predefined forbidden values (e.g., using no more than zero different fonts). Of course, the algorithms activated during the evaluation process first check explicitly whether the ranges set by the user are acceptable. Otherwise, the system would crash unexpectedly.

Based on all these settings, the user gets a review

per slide in his/her personal style (e.g., a brief traffic-light-style coding for some selected features only). In its most elaborate mode, the report sums up positive and negative evaluation results for all inspected features. Additionally, it can provide hints on why/how the slide should be changed.

In the next section, we describe how the per-slide evaluation reports are consulted in order to detect overall consistency violations

4.4 Evaluation of Overall Consistency

In this section we discuss features that can be checked for consistency across the entire set of slides—e.g. whether or not the same fonts have been used throughout the presentation. The user can switch this evaluation on/off in the same manner as the features to be checked per slide.

If the user wants a consistency check, the user gets an overview of slides exhibiting rule/standard violations. The visible and invisible information in the per-slide evaluation reports enables the system to produce such a report automatically. However, the system needs additional information about the presentation in order to perform more advanced jobs, such as the following. SEAP tool should know about facts such as a predefined title position. Although this is known at design time, it is not accessible in the PDF file serving as input. The system assumes as default a margin area of 1cm around the presentation area. SEAP tool does not presuppose a specific, dedicated title area preset by the system, because warnings about any violation would irritate users who have no idea where the system assumes the title to be—there are no user expectations the system can take for granted. These (minimal) default settings avoid an obligatory dialogue with the user before running the system.

As holds for any preference in SEAP tool, the user can change these defaults in special windows. Here, the user can also define areas that the system should inspect for identity vs. leave uninspected for identity¹⁶. Figure 7 illustrates the assembly of a slide master. This example corresponds to the slide in Figure 1 where only margins as slide master is assumed—to be identical/ignored over all slides. The individual margin areas can be varied as indicated by the red arrows shown in the middle of each 1cm default margin. The inspection method carries out an identity check by de-

fault. We omit the dialogue to select between the options of ignoring an area vs. matching it throughout the presentation. This choice window pops up when activating the red arrow in an area or when double-clicking on the area. As a consequence, the color of the region changes. Blue means “check exactly”, whereas red means “ignore the content completely”. Preliminary experiments show handiness of the concept in the right vertical periphery—as is depicted as desired personalized setting in Figure 7. This setting allows the user to violate the right margin supposed to be identical with the master slide intentionally due to longer lines.

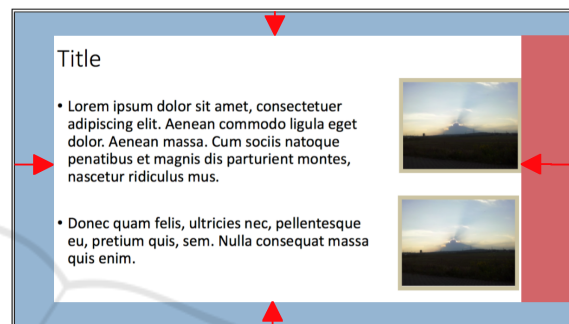


Figure 7: User interface enabling the user to determine the master-slide area in the presentation by varying the default area to be matched exactly on all slides or to be ignored on all slides. The areas in blue reflect the wish for an exact match and the ones in red, for ignoring any difference in the chosen rectangle.

The title area can be specified in a similar interactive window. Of course, title checks need not be exact: The user can determine which features should be checked (defaults are font type, font size and color). The same type of dialogue window opens if the user wants to have additional areas checked for consistency (e.g., slide numbers). In these windows, the blue areas need unique field labels to be used in the evaluation report for these areas. The same parameterized procedure inspects the title area as well as the user-defined areas (parameters: name, coordinates and features to be checked throughout the presentation). These inspections are based on information contained in the elaborate form of the per-slide evaluation reports.

Finally, SEAP tool draws up the consistency-check summary and presents it to the user. It results from a final review of all internal entries in the per-slide evaluation reports for each feature the user wants to be checked globally. For instance, the system can generate warnings in the final summary such as ‘*Attention, on slide 4, the font of the title is inconsistent. Please change from Times to Arial*’.

¹⁶The current version of SEAP tool applies an exact match algorithm. However, we are aware of the fact that the match should be less exact, e.g. in order to license slide numbers or small color/size variation serving to highlight parts of the currently active content. These and other similar differences should not count as non-identical.

5 CONCLUSIONS

We have sketched the prototype of an assistant system for layout and design evaluation of on-screen presentations. We have illustrated the diversity of topics automatically checked by our system. Such a system seems desirable as a tool to improve the quality of (audio)visual presentations in science and business given the often poor quality of presentations in science and business.

Our system, called SEAP tool, evaluates visual presentations against well-known rules and standards. It takes the PDF file of a presentation as input, thus making it independent from the software used to create the presentation. SEAP tool performs specific inspections on the PDF format, but other analyses are based on an image representation of each slide. Based on these results, the system draws up an evaluation report for each slide in a personalized manner. The user can determine which features should be evaluated, and in which order the results should be reported. In addition, the various parameters for the evaluation calculations can be personalized, along with the levels of detail of the reports. At the end, the user can activate an overall consistency check of the entire presentation.

As for future work, we plan to implement additional rules of presentation design and layout. For instance, as announced in Section 4.2, a facility for color-blind proof-reading of slides should be available. Furthermore, the image analysis techniques deployed by SEAP tool need further improvement. Moreover, the existing components such as the color checks that currently work with a translation into a grayscale will have to be improved.

Most important are user studies with novices and professionals, helping us to obtain better assessments of user needs and appreciations, and to optimize the user interface. We paid attention to the fact that the dialogues are easily comprehended even by novices. In this regard, we supported text with intuitive visualizations. However, only an empirical user study can provide clear insights into how the user interface can be optimized, and which to-be-evaluated features they value most.

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