

PhotoSpread: A Spreadsheet for Managing Photos

(Keynote Talk)

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The goal of the BioACT Project at Stanford is to help biodiversity researchers Acquire digital materials in the field, manage these online holdings (Curate), and Transfer the knowledge (or disseminate) to other researchers, museums, and the public. We are developing three sets of tools: (i) tools for speedy data entry and small-group collaboration in the field, (ii) tools for large scale collaboration in distributed collection curation, and (iii) tools for semidirected search and browsing of digital biodiversity materials.

One of our BioACT partners is Stanford University's Jasper Ridge Biological Preserve. The preserve is a 1,200 acre area in the foothills of the Santa Cruz mountains, just outside the Stanford campus. The area has been a Preserve for the past 30 years, but scientists have studied the region since 1891. Biologists at the Preserve record changes in the local climate, vegetation and fauna, and have studied the relationship between biodiversity and the intensity and type of neighboring urban development. In particular, biologists at the preserve are tracking animals using outdoor camera traps (remotely triggered photographic equipment), generating thousands of photographs. Each photo is automatically tagged with the date, the temperature, the location of the trap, and other metadata. In addition, biologists manually add tags describing the animal species, the identity of the individual animal (if known), and other facts. Biologists analyze these photos to discover trends and anomalies. For instance, they need to select groups of photos by their characteristics; groups of photos must be compared side-by-side; the scientists need to compute various statistics for particular sets of photos (e.g., average temperature), and so on. In addition, the biologists need to continuously edit the metadata, to correct errors or to enter additional facts they discover related to given photos.

Currently, the biologists use spreadsheets to analyze the photos. Each photograph is represented by a row in the spreadsheet. One column gives the file name where the photo is stored, and the other columns give the metadata (date, species, etc.). Once the data is in the spreadsheet, they can select and group photos of interest and compute relevant statistics.

To help the biologists in their analysis tasks, we have designed and implemented PhotoSpread, a spreadsheet tool where photos and groups of photos are first class citizens. To illustrate, Figure 1 shows a typical PhotoSpread sheet. Like any spreadsheet tool, PhotoSpread displays an array of

cells, but in addition to atomic data values, like strings and integers, groups of photos can be displayed within any cell. For example, the `load` command populated cell A1 with a set of photos from an external source. These photos are from camera traps at Jasper Ridge Nature Preserve. PhotoSpread decides how best to utilize the given real estate in the cell to display all or a subset of the photos. Users can change cell dimensions by dragging the grid lines. The size and number of the photos in the cells are automatically adjusted.

Anchored to the right of the spreadsheet grid is a *workarea*. This "big cell" shows the contents of the currently active cell—in this case C3—for better viewing. The metadata for a particular photo can be viewed via the blue rollover tooltip window, and can be edited in the workarea (not shown in this figure). If the current cell contains a formula, the formula is shown, and can be edited, in the formula window at the top of the workarea. Keep in mind that Figure 1 shows our interface in a small area. On a large display, the photos, especially those in the workarea, can be much better appreciated.

Say we want to organize these photos along two dimensions: the species and the age of each animal. To keep this example simple, we limit ourselves to two species, `bobcat` and `deer`, and two age groups, `adult` and `juvenile`. Figure 1 shows how we have arranged these values into a grid.

Cell C3 corresponds to adult (B3) bobcats (C2), so we enter the formula `=A1[species = C2 & age = B3]`. (As in Excel, dollar signs \$ could be added to control how a formula is copied into other cells.) As soon as the formula is entered, the appropriate photos from A1 are displayed in C3. When we copy the formula into the other three grid cells, we populate our display as desired. Our biologist collaborators tell us that this type of photo array (concurrently displaying the results of multiple queries) is critical for visually identifying patterns or anomalies, and is not available in any tools they use.

Cells E3 and E4 show the average temperature across the adult and juvenile rows. For instance, the average for adults (in E3) is computed as `=average(C3:D3.temp)`. Here, `C3:D3` is a range of cells containing the adult photos, and the `.temp` component extracts their temperature tag. As mentioned earlier, such metadata computations are important for biologists as they analyze their photos.

In addition to using formulas to organize and view photos and other data, PhotoSpread introduces a novel way of entering or updating metadata. Say for example that we see in our grid



Fig. 1. PhotoSpread Interface (image retouched for clarity).

a photo that is misclassified, e.g., the photo appears in the cell for adult deer, but it is really an adult bobcat. We can simply drag the photo from cell D3 to the cell for adult bobcats C3, and this action *forces* the metadata to change, so that the photo complies with the formula of its new cell. Later in this paper we present other semantics for dragging, so that a new copy of the photo is made, or so that the metadata is not changed but instead the underlying formula of the receiving cell is automatically changed to cover the new photo. In addition, strings can be moved to cells with photos (or vice versa) to tag photos. All these simple and intuitive drag-and-drop actions give the user a number of options for adding or changing the metadata of photos, as the photos are being analyzed and studied. Again, our biologist collaborators tell us that this type of re-tagging is very common, and that tagging by moving photos is preferable to using traditional editors.

In summary, PhotoSpread introduces two important extensions to common spreadsheet systems:

- *Tagged sets are first class objects.* Sets of objects, and in particular, sets of photos, can reside and be displayed in any cell. The objects—photos and other data types—can be conveniently tagged. A powerful formula language can select and manipulate objects, referring to tags in expressions. The language builds on widespread knowledge of standard spreadsheet formulas.
- *Drag-and-Drop (Re)Organization.* Simple actions on photos and strings change metadata and formulas. Tagging photos through direct drag/drop manipulation has been found to be effective for tagging data, and PhotoSpread allows the user to configure such manipulations to his needs.

Similar photo analysis needs arise in other domains. For

example, a journalist needing photos for an article, may need to examine, filter or group photos of relevant events. An astronomer looking for patterns may need to examine large numbers of photos related to a particular area of the sky. Museums have digitized significant parts of their collections, both for preservation and for wider dissemination. These vast digital archives must be curated, which requires analysis and organization of materials. Last but not least, an amateur photographer may also want to organize and analyze his travel or family photos.

In the full paper [1], we describe Photospread in more detail. We discuss the supported formula language, and we describe how drag-and-drop actions work. We also compare Photospread to other photo browsing and analysis tools.

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REFERENCES

- [1] Sean Kandel, Eric Abelson, Hector Garcia-Molina, Andreas Paepcke, Martin Theobald. PhotoSpread: A Spreadsheet for Managing Photos. Preprint available at <http://dbpubs.stanford.edu/pub/2007-28> (to appear ACM CHI 2008).