Abstract. Camera traps (aka trail / game / remote cameras) are field-deployable cameras placed at strategic locations, where they automatically take images (and even videos) at either regular intervals (e.g., every 5 minutes, every hour), or when motion is detected (e.g., an animal or person moving through the scene). Scientists use camera traps for many purposes: to track and count entities (such as people and wildlife) and to track conditions that occur in a particular place over time (such as weather and visibility). A technician usually retrieves the camera's card (e.g., after several months), and organizes the captured images into one or more computer folders as an image set (the set of images and videos captured by that camera). An analyst then visually examines each image and video for features of interest to their project, and encodes data describing those features.

The two tools described in this manual simplify this last visual examination and encoding step. In brief, the project manager uses the TIMELAPSE TEMPLATE EDITOR to create a custom template that defines the project-specific data that he or she wants an analyst to encode. An analyst then uses TIMELAPSE to open that template and one or more folders containing images and/or videos (the image set). TIMELAPSE automatically goes through all images and extracts information from them (e.g., file name, date and time taken). The TIMELAPSE interface then displays a series of fill-in fields corresponding to the desired data as specified in the template, along with the image or video. The analyst then goes through each image and video, where he or she encodes data by typing into fields, by selecting from menus, or (for counting) simply clicking on entities seen in the image.

Because much data entry is repetitive, TIMELAPSE includes various means to copy encoded data over a group of images and videos. Because the analyst may have to find and identify small details in an image or video, TIMELAPSE includes a magnifying glass, pan and zoom capabilities (where switching images will keep the same pan/zoom levels), and image enhancement methods. The analyst can also examine and encode multiple images at the same time via an overview. Because the project manager may use other software to analyzed the data (Excel, databases, statistical packages, R), data is stored in a standard SQLite database, which can be exported as a CSV file readable by most spreadsheet packages. TIMELAPSE has many other features that are described in this manual.
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Part 1. TIMELAPSE

Don’t Panic!

The length of this tutorial manual may give the impression that using TIMELAPSE is difficult. It isn’t. The tutorial is long only because it provides step by step details (and lots of images). It also includes several parts that may not be relevant to all readers.

Part 1 explains and provides a tutorial on how to use TIMELAPSE. This is the tool used by the analyst (the person analyzing images). The analyst is usually provided with one or more folders containing the images and/or videos to analyze (collectively called an image set), and a template that defines the project-specific data to be encoded. The analyst begins by using TIMELAPSE to open the template and folder(s).

Part 2 explains and provides a tutorial on how to use the TIMELAPSETEMPLATEEDITOR. This tool is used by the project manager to create a custom template that defines the project-specific data that he or she wants the analyst to encode.

The remaining parts is likely relevant to a small number of users.

Part 3 explains how 3rd party image recognition data can be imported and used. This is only of interest if you have a partnership with an agency that produces recognition data, which is currently limited to Microsoft.

Part 4 explains the internal structure of the SQLite database tables created by TIMELAPSE. This is only of interest if you want to access the data directly from the database rather than from the exported CSV spreadsheet.

Part 5 is of interest only to those who have used the considerably older TIMELAPSE1 system, and who need to migrate their files to work with TIMELAPSE. It explains how to convert old-style CodeTemplate.xml and ImageData.xml files to the new format.

Note. What you see when you run the TIMELAPSE program may not exactly match the screen images in this manual, due to updates made in the program after the screen images were taken. These are mostly minor visual differences, and / or added features that should not affect your general understanding.
1 Getting Ready
You will need to do several things to get ready for this tutorial.

- have a computer running Microsoft Windows,
- download the TIMELAPSE software,
- download a sample folder containing various images and videos and other necessary files.

Your Computer

**Hardware.** Timelapse does not require any specialized computer hardware. However, it will perform best on a fast modern computer with a reasonable amount of memory. Because you will be reviewing many images, it’s best to have them stored on a (fast) local hard drive rather than a slow network drive.

**Mouse with a scroll wheel.** Some interactions (such as zooming) are operated by the mouse scroll wheel.

**Microsoft Windows.** TIMELAPSE runs within most versions of Microsoft Windows. It should run on an Apple computer running a Windows emulator. It does not run on Apple OS/X.

**Good quality screen.** In our experience, the larger your screen and the better its resolution, the easier it will be for you to examine your images, especially if you are looking for small details in the image.

**Software License.** Timelapse is licensed under the Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license. See the Timelapse web site for license details.

**Technical Note.** TIMELAPSE requires Microsoft’s .Net framework 4.5. If you’ve kept up with Microsoft updates, it is likely already installed on your computer.

However, if you find TIMELAPSE ‘crashing’ on startup, it is likely because the correct .Net framework isn’t installed. The TIMELAPSE download page on the TIMELAPSE website provides links that will let you install the .Net framework (this just involves a few button presses – no technical knowledge needed). Alternately, if your machine is managed by an IT person (and likely locked down), you can ask them to install .Net 4.5 if it is missing.

Downloading the TIMELAPSE Software

Download the software should be straightforward.

   You will see a Download & Install link on the left side of that page.
2. Select the **Download & Install** link. You should see something like this section on that page. Follow those instructions closely. Download and uncompress the software and put it in a location of your choosing.

3. Briefly test the software. Start **TIMELAPSE** by double-clicking its icon within the download folder, or by clicking its shortcut (if you created one). You should see something like this.

4. If you don’t see the above screen or if the system crashes, follow the instructions in the ‘Potential problems’ section on that download page, as illustrated below.

**Tip: Updating TIMELAPSE.** Whenever you start **TIMELAPSE**, it checks if an update is available. If so, it tells you and directs you to the **TIMELAPSE** download page. To update, delete the old Timelapse folder, and repeat the above steps to download and install the new version.

**Tip: Join the Timelapse Mailing list** (via the Help menu). You will receive email when a new version is available.
Downloading the Sample Image Folder and Template

To help you follow this tutorial, you should download the tutorial image set. This folder contains the set of images, videos and other necessary files as used in this tutorial.

1. Return to the TIMELAPSE download page. Select Tutorial User Guide from the sidebar. You will see something like this.

2. Follow the instructions to:
   - View or download the Timelapse User Guide (this document)
   - Download and unzip the Tutorial Image Set and Template zip file. That folder will contain:
     - a file called TimelapseTemplate.tdb.
     - three sub-folders, each with a small sequence of jpg image files and avi video files.

How should you name your image files?

By default, TIMELAPSE adds images alphabetically, based on the subfolder path and file name. Your folder and file names can reflect the order that your images were taken, but only if you use a good alphabetic naming scheme. The best practice is to have your naming scheme reflect the time order. Its not strictly necessary, as you can also ask TIMELAPSE to sort your files by subfolder and then by date/time and/or other criteria (see §Menus: Sort menu).

Alphabetic ordering works reasonably well, as long as you understand its limitations. In particular, most cameras name images and videos by some common text at the beginning, and then by adding a sequence number (padded with leading 0's) at the end.

- IMG_0001.jpg, IMG_0002.jpg, …
- image (00912).jpg, image (00913).jpg, …
- 001.JPG, 002.jpg, ….

However, alphabetic ordering can be confusing in cases where image numbering does not contain leading 0's. For example, consider the sequence:


The alphabetic ordering of the above sequence is actually

- image1.jpg, image10.jpg, image11.jpg, image2.jpg, image3.jpg… image9.jpg, which is not what you want

Leading 0s circumvent this problem, i.e., the files should end in 0001, 0002… 0010 rather than 1,2,… 10

Various off-the-shelf photo software include facilities to rename your photos. For example, the TIMELAPSE download page includes a link to 3rd party software called ‘Renamer’.
2  Timelapse Files and Folders Explained.

TIMELAPSE requires and/or creates various files and folders, organized in a certain manner, as summarized below. While some of this may be a bit unclear for you right now, it should become clearer as you read this tutorial.

File and Folder Types

**Root folder:** the folder that contains all your files that you want to analyze collectively. In the tutorial, the root folder is named TutorialImageSet.

**Image set** are all the images (.jpg) and/or videos (.avi and .mp4) you will be examining. They are normally located in one or more subfolders within the root folder, or directly in the root folder. In the tutorial, the image set comprises three subfolders: Site1-08.14, Site1-08.15, and Site1-09.09.

**Template file (.tdb)** is the template database file located in your root folder. This template file defines your project-specific data needs (aka schema). It is normally created by the project manager (see Part 2), who then provides it to the analyzers. This file is used by TIMELAPSE to specify the fill-in data fields that appear in the TIMELAPSE window, and how your data fields are named and saved. While its default name is TimelapseTemplate.tdb (as in this tutorial), you can rename it as long as you keep the .tdb suffix.

**Data file (.ddb)** is the data database file created and updated by TIMELAPSE as you load and analyze your image set. This file stores all the data that you entered. Part 4 describes this file’s database format in case you want to access your data directly from its data tables rather than from a .csv (spreadsheet) file. While its default name is TimelapseData.ddb, you can rename it as long as you keep the .ddb suffix. Don’t delete this file, unless you want to delete all your work!

**Comma separated value file (.csv)** are files that can be opened and/or imported by most spreadsheet packages, databases, and statistical analysis tools (e.g., Excel). TIMELAPSE lets you export all your data into a .csv file. It normally has the same name as your data file, except it has a .csv suffix (e.g., TimelapseData.csv). You can also edit your .csv file (albeit with restrictions) and import it back into TIMELAPSE: the edits will be applied to update your data and the .ddb file.

*Note:* CSV files separate columns by a ','. If your data includes any commas, the package reading the csv file can misread that as a column separator.

**Backups** is a folder created in your root folder as you use TIMELAPSE. Every time you start TIMELAPSE, TIMELAPSE creates a time-stamped backup of your .ddb file within that folder (e.g., TimelapseData.2017-05-01.18-04-55.ddb was backed up on May 1, 2017 at time 18:04:55). Similarly, it backs up any existing .csv file whenever you export a new one. To conserve space, TIMELAPSE deletes older backups as new ones are created (around 8 backups of each file type are maintained).

**DeletedFiles** is a folder that may be created in your root folder. If you ask TIMELAPSE to delete any of your images or videos, TIMELAPSE will back up those files by moving them into the DeletedFiles folder just in case. Using *Options / Preferences*, you can configure when TIMELAPSE actually deletes those files.
Best Practices for Organizing your Files and Folders

Organizing your project

Many projects contain millions of images, and these need to be carefully organized. For example, projects often use multiple cameras, each located at different areas, where each area can contain different camera sites. Image sequences representing a particular time period are usually retrieved from each camera’s SD card over time.

Consider organizing your folders and sub-folders using something similar to the following the structure.

- ProjectName
  - AreaName
    - CameraSites
      - ImageSequence
        - images.jpg

To illustrate, this path is to an example image, where each subfolders reflects the above naming scheme: WolverineStudy/BigHornCounty/Site5/2019-01/image0001.jpg

Choosing where to use Timelapse

The next question is, how should you use Timelapse on these folders? In our experience, running Timelapse on the primary root project folder – especially if it is extremely large - should be avoided for these and other reasons:

- certain Timelapse operations are slow when run over millions of images,
- if your data gets corrupted, you would lose everything (unlikely, but...),
- only one person can analyze the images at a time, as otherwise database conflicts could occur.

Instead, we recommend the best practice of running Timelapse on a smaller sub-folders, such as at the CameraSite or even the ImageSequence level because:

- most timelapse operations are fast when done on tens or even a few hundred thousand images,
- different people can analyze images concurrently, as long as they work on different folders.

For example, if you want to run Timelapse at the CameraSite level, you would copy your template into each sub-folder representing a camera site, and run Timelapse from there. This will generate a Timelapse .ddb database file in each of those sub-folders.

Note. The downside of running Timelapse within different sub-folders is that Timelapse will produce a different database in each of them. However, you can merge that data (or exported csv files) later with other software.
The Timelapse subfolder organization

When you run Timelapse in a sub-folder, your image files will normally be organized in one of two ways, as illustrated below. Both methods keep your image set and all other necessary files within a single root sub-folder. While you can intermix these two methods if you wish, it could lead to poorer overall file organization.

Option 1. The Hierarchical Image Set.
Your root subfolder contains a Timelapse template, and one or more subfolders containing images and videos. This works if you have categorized your images and videos into subsets, or plan to add additional images and videos into your image set over time. The example below illustrates three sub-folders, each based on a retrieved camera card sequence.

Option 2. The Flat Image Set.
Your root folder contains the Timelapse template, and all your images and videos. This works if you have no need to add images and videos at a later time. The example below illustrates Timelapse running on a single retrieved camera card sequence, where all images are in the single folder.

Note: The Tutorial Image Set uses the hierarchical organization.
3 The Beginning and End

Before You Begin

You should have two folders:

1. **TIMELAPSE** software folder containing the downloaded TIMELAPSE software

2. A root folder containing:
   a. **Your images and/or videos**, located either directly in the root folder or organized in one or more sub-folders,
   b. A ‘template’.tdb file – by default named **TimelapseTemplate.tdb** – which defines information specific to your project. This file is usually copied into a folder that contains your images or your image folder(s). It will normally be given to you by your project manager. If you don’t have a project manager, you can make your own custom template file as described in Part 2.

The software and example root folder (including a template) matching those in this tutorial are available on the download page, found at [http://saul.cpsc.ucalgary.ca/timelapse/](http://saul.cpsc.ucalgary.ca/timelapse/) (see §Getting Ready). We strongly recommend that the reader walk through the exercises by using that root folder.

The TutorialImageSet folder is organized as shown below, left.

### Before processing with TIMELAPSE

- 4 items

### After processing with TIMELAPSE

- 8 items

After You are Done

When you are done your analysis, you will see several new files and folders in your image folder (above right).

- The .ddb file that stores your data, by default named **TimelapseData.ddb**.
- A .csv file that can be opened with a spreadsheet, by default named **TimelapseData.csv**. It is created only if you exported your data
- The **Backups folder** containing a backup of various files
- A **DeletedImages folder** containing deleted images. It is created only if you delete an image.
4 The Tutorial Scenario

The Images and Video

The images and videos used in this tutorial were obtained from a project manager who had set up a camera trap to capture human and wildlife usage near a mountain pass. The camera was configured to take an image every 5 minutes, 24 hours a day. Thus images\(^1\) include both day and night time shots, generating tens of thousands of images. The biologist organized images into folders, with each folder containing a day’s worth of images. She named the folders to indicate the camera’s site number and the date they were taken. For example, Site1-08-14 contains images taken at Site1 on August 14.

For our tutorial purposes we’ve included three folders reflecting three days (August 14, August 15 and September 9), where each folder only includes a small number of images. Each folder includes a few night-time (dark) shots as well as a video that summarizes the entire day. The Site1-09-15 folder also includes a ‘corrupted’ (non-readable) image.

**Tip.** The above organization of images and naming of folders is idiosyncratic to the needs of this particular biologist. As mentioned earlier, consider our recommended best practices for organizing and naming your folders and images.

**Note:** Your images may be quite different from the ones shown here. We deliberately chose images that have wildlife in the distance and that include night-time shots to illustrate particular TIMELAPSE features.

The Data of Interest

TIMELAPSE automatically encodes and makes available the following data for each image.

- **File:** name of the image or video,
- **Folder:** name of the root folder
- **Relative Folder:** name of the subfolder containing the image
- **Date and Time:** the image was taken
- **Image quality:** whether the image is ok or dark.
- **Delete?** allows the user to mark images for deletion

The biologist is also interested in additional data as follows.

- **Goats:** number of goats present
- **Hikers:** number of hikers present
- **Weather:** one of sunny, cloudy, foggy, raining or snowing
- **Temperature:** in °C, which will be extracted from the metadata found in each image,
- **Analyst:** the name of the person analyzing images
- **Comments:** additional comments made by the analyst after examining the image
- **Publicity?** images considered interesting enough to be used for publicity purposes

\(^1\) For brevity, the term ‘images’ as used in this manual includes pictures (.jpg files) and videos (.avi and .mpg files).
Your project manager has provided you with a ‘TimelapseTemplate.tdb’ template file that specifies the above data fields and how they appear in the use interface (see Part 2). That template is included in the tutorial image folder. Your task is to examine each image and fill in these fields as needed.

5 Analyzing Images and Videos

Loading your image set for the first time

Begin by loading the template and your images. TIMELAPSE will then examine each image to extract data from it. It shows its progress by briefly displaying the occasional image.

Tip. Pre-processing takes time if there are many images. Be patient: pre-processing only occurs during this initial load. Subsequent openings of this image set will be much faster. Load them over-night if you have a massive number of images (e.g., millions, but see Section 2)

1. Start the TIMELAPSE software through its icon or shortcut. You will see an opening screen with brief documentation. Read this, as it is a reminder of how to use the main features of TIMELAPSE. You can revisit this documentation at any time by selecting the Instructions tab at the top.

2. (optional) Expand the window to the full size of your screen. The larger the window and the bigger and better your monitor, the easier it will be to see details in each image.

3. Load the Template.
   - Select File | Load template, images, and video files... Navigate to the tutorial image folder (which will be the root folder), and select the TimelapseTemplate.tdb file.

Tip. If you plan to add new image sub-folders later, you will be able to add those by selecting File | Add image and video files to this image set...
4. **Watch the software pre-process the images.** Timelapse will search the root folder and each sub-folder for image and video files, and will load all of them. Timelapse will process all images found, where it will show its progress by briefly displaying the occasional image.

**Tip.** By default, Timelapse loads and then orders images in sub-folder/filename alphabetic order.
The basic TIMELAPSE controls are annotated in the figure below. These will be explained shortly.

5. Examine the control area to see what the software automatically filled in for you. We’ve annotated each of those fields to explain them.
Note on dates and times. Timelapse tries to read meta-data from each image to get its date and time. If the meta-data isn’t there (as its inclusion is camera-specific), Timelapse uses the file modified time. Videos don’t have date metadata, so the file modified time is always used. The problem is that the file modified time is not guaranteed to be the same as the date the image was taken. Check a small sample of images and videos to make sure that the date and time are correct. If the date appears correct for those, then it is likely fine for all files.

A second possible problem is that some cameras record date information ambiguously within its image metadata. For example, consider the date recorded as 12/02/10. Is it Feb 12, 2010 (month/day order) or December 2, 2010 (day/month order)? Timelapse tries its best in these cases. If it is unsure about the month/day order of images, it may raise a dialog box informing you, where you can verify if Timelapse’s date interpretation is correct.

Tip. If the date/time order is wrong, you can correct that by selecting Edit | Date Correction | …which includes various methods for correcting dates. These will be discussed later.

6. Use the slider, or the File Player, or the left/right arrow keys on your keyboard to navigate between your images.

7. (Optional) Click the Data Table tab (circled in red below) to reveal a table that shows, row by row, every image and the current set of values associated with that image. The currently selected image is highlighted in light grey. From this view, you can:
   - click the Image set tab to return to the view of the image, or
   - click on any row to navigate to and view that row’s image, or
   - use the left/right arrow keys to navigate between images, where that image’s data is shown in the Data entry pane at the top.

8. Export and Preview the Data as a Spreadsheet. From the File menu, select Export data for this image set as CVS File and Preview in Excel. If you have Excel installed, something like the following will appear. Notice that it contains various headers (top row), and that it has populated the cells with
the data that the software has already pre-processed. Each column represents one of the fill-in data fields shown at the top of the TIMELAPSE window. As the actual column names and their order are specified in the template .tdb file (§Part 2), the column names and order may not exactly correspond with what you see in the TIMELAPSE interface.

Notes.
- **The .csv file is re-created and over-written** every time you export your data. A backup of the previously created .csv file can be found in the **Backups** folder.
- You can edit the .csv file and import a limited number of changes back into TIMELAPSE. A later section will describe how this is done.

9. If you open the TutorialImageFolder, you will now see two new files and one additional folder.
   a. **TimelapseData.ddb** is the database created and used by TIMELAPSE to store all the information about this image set. If you quit TIMELAPSE and restart, TIMELAPSE will open this file so you can continue where you left off.
   b. **TimelapseData.csv** is the .csv file generated when you exported your data in the above step.
   c. **Backups** is a folder that TIMELAPSE uses to create backups of data files that you could manually restore if needed. When you open TIMELAPSE, it copies your .ddb file into this subfolder, where it adds a timestamp to the file names. A similar backup of your old .csv file is created whenever you export your data to a .csv file. If something really screws up during your analysis, you can always rename and copy that file back to your root folder.

Later in this tutorial, you will see another new folder called **DeletedFiles**, which TIMELAPSE creates only when you delete an image or video. Backups of deleted images or videos are located here.

That’s it – you are now ready to analyze your images. Of course, TIMELAPSE has many features that will help you analyze your images efficiently. Read on...

**Note. If you change your folder names and try to reload your images.** Timelapse records the folder location (RelativePath) and name of your files, and associates any data you enter with that name. If you change the names of the folder or your files any time after your images have been loaded for the first time, Timelapse will no longer be able to display those renamed file as it will not know where they are. A place-holder image will be displayed instead. However, any previously entered data concerning that file will have been saved.
6 Timelapse Interface Basics

Before showing you how to analyze your images, we will explain a few basic things about the Timelapse interface, just so we won’t have to explain it later. Have Timelapse running and displaying images so that you can try out some of these features. The subsequent section will show you how to use these features as part of your work flow.

Navigating through files

You will frequently navigate through the files in your image set. You can do this in various ways.

1. The slider lets you scroll through your files through various methods.
   - Clicking on the left / right side of the slider’s thumb goes to the previous or next file
   - Sliding the thumb is good for making large jumps
   - Clicking and holding on the left / right side of the slider’s thumb rapidly moves through all your files one at a time.

2. Keyboard navigation via left/right arrow keys lets you move back and forth through the files in a sequence
   - Holding the keys down continually moves through multiple images.
   - View | View previous/next file menu options and the PageUp/PageDown keys do the same thing.

Tip. If a date, note or counter data-entry control has the input focus (because you selected it), that control will use the left/right arrow keys to move through its text rather than to navigate to the previous / next image.

Use <Shift> left/right arrow in these cases (or in fact, at any time) to move back and forth through the files instead...
3. **The Overview**, explained fully in §Overview, lets you view and navigate through multiple images at a time. To summarize, you can:

- **switch** between the single file view and the overview by zooming in and out using the scrollwheel, the <> keys, or the zoom menu option,
- **view an image’s data** by selecting it,
- **navigate to a particular image** by double clicking it
- **select one or more images**, where you can enter data for them all at once.

4. **File Player**, found at the right of the slider, has multiple controls that let you navigate your files, or review your files by automatically playing them one after the other.

   a. If you are in the *single image view* (which displays a single image or video file), the File Player controls let you:
      - **step through** your files backwards or forwards,
      - **play** files backwards or forwards at different speeds
      - **go to** the first or last file.

   **Note.** You can set your preferred playback speed via Options | Adjust FilePlayer playback speeds…
b. If you are in the overview (which displays a page containing rows of multiple images, as illustrated on the right), the four play controls are replaced by navigational controls that let you view the:
   - **next or previous row** of files
     (also activated with the \[up\] keys),
   - **next or previous page** of files
     (also activated with the page down/up keys).

5. **Find image** is invoked by
   - **Edit|Find image** menu, or
   - pressing \[control\]-f

Find image lets you
- enter a search term
- use the \[<\] \[<\] \[<\] \[<\] buttons or enter to find the next or previous image whose file name contains that search term.

**Note:** search terms are case-insensitive. This means you don’t have to worry about capitalization.

For example, in the illustration above, the analyst has typed ‘33’ and pressed enter (or ‘>’), which searches for and displays the next file name in the sequence (if any) that contains the text ‘33’. In this case, IMG_0033.JPG is found and displayed. If the analyst presses enter two more times, it displays IMG_0133.JPG and then IMG_0233.JPG. On the next enter, no subsequent matches are found, so it restarts from the first image in your selection, where it finds and displays IMG_0033.JPG.

**Tip.** if the image set had video files scattered in the sequence, doing successive finds on the search term ‘avi’ will progress through each video that has an .avi or .AVI suffix.
Status Bar Feedback

The Status bar displays feedback in several areas.

- **File:** indicates the file number and the total number of files in the current image set. The total number is affected by your selection from the Select menu, described shortly.
- **Select:** indicates your current selection i.e., what subset of images you are viewing. See Select menu, described shortly.
- **Sorted by:** indicates the current criteria used to sort the order that files are presented to you. This is affected by the sort criteria specified via the Sort menu, described shortly.
- **Message area** provides occasional feedback of what you are doing as you are doing it.

Dialog Boxes

**Dialog Boxes** will appear as you use the system. Depending on the circumstances, they may display feedback, offer instructions and suggestions about choices you can make, request information from you, or inform you about any issues that arise.

Certain dialog boxes let you control whether or not they will be displayed in the future. This is done in one of two ways.

- Select the **Don’t show this message again** that appears at the bottom of the dialog box.
- Select from the menu **Options | Show or hide various informational dialogs**, which lets you select which dialog boxes to show or hide (via another dialog box, as illustrated on the right).
Fill in Fields

There are five different types of fill-in data fields: notes, choices, counters, flags, and date-time.

1. **Note field**: enter any text by typing. Tutorial examples are the Temperature, Analyst, and Comments fields above. The top row shows other special Notes filled in by the system during pre-processing. Some cannot be edited and are shown outlined in light blue (e.g., File, Relative Path, and Folder).

   Analyst: Saul

   Tip: Notes use auto-completion, where they predict the rest of the word you are typing based on previous note entries. Predictions appear highlighted. Accept the prediction by hitting return or tab. Ignore it by continuing typing.

2. **Choice field**: select from a predefined list of choices. Choices are selected from a pull-down menu raised by clicking the field. Alternately, you can type a choice’s first letter to select it, and/or use the down/up arrow keys to navigate through the choices. For example,
   - Weather’s menu shows six selectable values that you can select from (the last item is an ‘empty’ choice that lets you clear the field). The selected item will then appear in the text box.
   - Image Quality is a system-supplied field. Its initial values are automatically filled in by TIMELAPSE when you first load your images, but you can over-ride those values.
3. **Counter field**: count the things you see in your image by one of three ways:
   - **Type in a number** directly into the count field.
   - **Click the up/down arrows** to increment or decrement the count.
   - **Count by clicking and marking**. The left side of the Counter is a toggle button. Select it to activate it (which turns it blue). You can then click on the things you see in the image to increment the count and to leave a marker on the image to show what has been counted. This is explain later.
   - The *Goats* and *Hikers* fields above are both counters. The Goat radio button is selected and activated.

4. **Flag field**: sets a value to *true* or *false* by clicking on a checkbox.
   - *Publicity?* is shown below as selected (true).
   - *Delete?* is a system-supplied flag. When selected, it marks an image for later deletion. This is explain later.

5. **DateTime field**: let you set the current date and/or time. This is a system-supplied field that Timelapse automatically fills in with the date and time the image or video was taken. If it gets it wrong, you can change this by one of two ways.
   - **Select a portion of the field** (e.g., the year) and change with with the up down arrows (left image).
   - **Raise a calendar** (right image) by click the down-arrow on the far right to. Then select a new date from that calendar, or change the time with the various arrow keys at its bottom.

6. **All controls - Tooltips**. Tooltips provide additional detail about each field. They appear when you hover your mouse cursor over a field.
Methods for copying repetitive data

TIMELAPSE includes several methods to simply repetitive data entry. These are briefly explained here, and illustrated later in this tutorial. QuickPaste, described later, is yet another method worth trying.

1. **Copy Previous Values Button**, when selected, copies a subset of data from the previous image to the current image. This is a very handy way to encode repetitive data. As illustrated below, when you hold your cursor over the Copy button, the fields whose values will be copied from the previous image are highlighted in green, where they include a preview of what values will be pasted into those fields (in this case *Weather, Analyst, and Comments*). Pressing the ‘C’ shortcut key while the cursor is on the image has the same effect. The fields will flash briefly to indicate that they have been copied. Whether a field is copyable or not copyable is defined in the template.

2. Most fields include a context menu for copying data across images. This menu appears when you right-click on a field’s label. Its menu items let you copy data found in one image field to corresponding fields in other images in various ways.

   - *Propagate from the last non-empty value to here* will copy the last non-empty value you entered (e.g., several files back in the sequence) from that file up to the current file.
   - *Copy forward to end* will copy the current field’s value to all subsequent files in the sequence
   - *Copy to all* will copy the current field’s value to all files in the sequence.

3. Use the Overview to select and enter data for multiple images at a time. In this example, the user has selected only the dark images, and is setting the ImageQuality for them in one shot.

   §Overview explains this in greater detail.
Magnifying, zooming and panning

1. **The magnifying glass** magnifies the area under your mouse cursor as you move over the image. You can control its appearance through the Options | Magnifying Glass menu or through typing the following keyboard shortcuts:
   - **M** – (for Magnifier) while the cursor is on the image toggles its visibility on and off.
   - **U** – increases the magnification **Up**
   - **D** – decreases the magnification **Down**

The images below show the magnifying glass set at two different magnification levels. Here, the analyst is taking a closer look at a white blob that could be a goat. Normally, you will set the magnification to something that makes sense for your image set, and likely leave it there.

2. **Zoom into the image** by rotating the **scroll wheel** on your mouse or via selecting View | Zoom in. You can zoom back out by rotating the scroll wheel in the other direction or via selecting View | Zoom out. For example, compare the zoomed-out image on the left with the zoomed in image on the right.

Note.
- **You can customize the maximum zoom level** through the Options | Preferences menu. One of the options there will let you increase or decrease the maximum zoom level.
3. **Pan** (scroll) to different regions of a zoomed image by *clicking and dragging* across the image. That is, hold the left mouse button down and move the cursor, as illustrated on the left image. As you do this, the image will scroll to its new position. In the images below, the analyst is panning the image rightwards. If the image is zoomed out all the way, nothing will happen.

Before panning        After panning

4. **The Zoom Bookmark** remembers your last zoomed-in region, where it can be applied to any image. The keyboard shortcuts do the following actions, with equivalent commands available through the View menu.

   - B   creates a zoom bookmark of that region
   - +   zooms to the region saved by the bookmark
   - –   zooms out all the way to see the entire image

5. **Zoom out to an Overview**, which displays a page containing rows of multiple images. Zoom out by rotating the *scroll wheel* on your mouse or via selecting View | Zoom out. You can zoom back in again to the single image view by rotating the scroll wheel in the other direction or via selecting View | Zoom in. You can zoom out through three overview levels, each showing more images at smaller sizes. The number of images displayed will depend on your computer’s display resolution.

   Zoom level 1        Zoom level 2        Zoom level 3

**Note.**
- Using the overview, you can select multiple images. Any data entered is then applied to all those selected images. See §Overview for details.
- **The File Player controls** let you navigate to the next or previous row of images, or the next or previous page of images. See §File Player for details.
The Menus

There are seven pull down menus, whose purpose is summarized below. Each menu item also has a tooltip to remind you of its purpose. Tooltips appear when you hover the mouse over the menu item.

**File menu**

1. **Load template, images, and video files**... asks you to select the Timelapse Template .tdb file from the root folder. On first use, it will load every image it can find in your root folder and sub-folders. If you invoke it again, it will rescan your folders, where it will add any new images it can find (skipping ones that have been previously loaded).
2. **Load a recently used image set** displays a submenu listing the last few Template .tdb file you had opened, in recency order. Select one to reopen that image set.
3. **Add images and video files to image set**... lets you add images and videos found in a specific sub-folder of an existing image set. This is useful if you add folders to an existing image set and want to include them (its faster than reloading everything).
4. **Export data for this image set as a CSV file**... exports the data for the currently selected files as a comma-separated value .csv file that can then be opened in a spreadsheet or analytics package such as Excel or R.
5. **Export data for this image set as a CSV file and preview in Excel** is similar, but it will also try to open the .csv file in Excel (assuming you have Excel installed) for you to view and/or edit.

**Definition: Currently selected files.** Timelapse lets you select a subset of your files to view and work on via the Select menu. Many Timelapse operations – such as export data above – restrict their actions to only those currently selected files.

6. **Export the current image or video file**... lets you save a copy of the current image or video to a folder of your choosing. The original is kept intact.
7. **Import data from a CSV file**... imports data from a comma-separated value (.csv) file. For example, you can export your data to a .csv file, and then edit some of the values in that file using Excel. You can then import the edited .csv file back into TIMELAPSE, which will update the data accordingly. However, many restrictions apply. Columns cannot be altered or renamed. Edits must adhere to the type of items being edited. Flags can only have true/false values. Choices can only have changes that exactly match the text in the choice menu. Counts can only be positive integers or zero.
8. **Import recognition data for this image set**... is only visible if you have turned on Detections. See Part 3: Automatic Image Recognition.
9. **Rename the data file**... lets you rename your .ddb file.
10. **Close image set** closes the current image set, where you can then load another image set if desired.
11. **Exit** quits the program.

**Note.** There is no **Save** menu item: TIMELAPSE automatically saves all data as you perform your actions.
**Edit menu**

1. **Find Image** finds the next or previous image that contains the case-insensitive text.

2. **Show QuickPaste Window...** displays the QuickPaste window, which lets you bulk-paste previously copied data. Use the window to create, select, edit, delete QuickPaste items and paste them as desired.

3. **Import QuickPaste Items from .ddb file...** lets you retrieve and add quick paste items that were created for another image set, and saved in that image set’s .ddb file.

4. **Copy Previous Values** performs the same action as the Copy Previous Values button.

5. **Populate a field with metadata...** raises a dialog box allowing you to: inspect the metadata included in your images, select a metadata field of interest; select a Note field to hold that metadata; then populate that Note field for all your images with that metadata found in those images.

6. **Delete** opens a sub-menu with several options. All delete operations raise a dialog box that displays the images to be deleted, and asks for confirmation. Operations are performed on the currently selected files only.
   - **The current image or video file** deletes the currently displayed image or video, but not the data associated with it.
   - **The current image or video file and its data** is similar, except it also deletes the data associated with the current image or video.
   - **All selected images or video files in the current filter marked for deletion** deletes all images and videos that have the Delete? flag checked.
   - **All selected image or video files in the current filter marked for deletion and their data** is similar, except it also deletes the data associated with the images and videos that have the Delete? flag checked.

   **Note.** The Delete operation does not actually delete the images. Rather, it moves those images into a sub-folder titled Backups. You can delete the images within that (or the entire folder) at your leisure. However, any deleted data is permanently deleted.

7. **Date Correction** opens a sub-menu with several options. Operations are performed on the currently selected files only.
   - **Re-read dates and times from files...** displays a dialog box that will let you re-read the original dates and times from your image and video files. This is useful if you altered some dates or times, and want to revert back to the original ones.
   - **Correct for standard and daylight savings time changes...** displays a dialog box that lets you adjust the date to account for the extra / lost hour during time changes. This is useful for cameras that do not handle time changes automatically.
   - **Correct for cameras not set to the right date and time...** displays a dialog box that will let you adjust all dates and times. This is useful if your camera was not initialized to the correct date/time. All you have to do is supply the correct date/time for the first image, and all others image dates/times will be adjusted accordingly.
   - **Correct for cameras whose clock runs fast or slow...** displays a dialog box that will let you correct for clock drift, i.e., cameras whose clocks run slow or fast. All you have to do is to supply the correct date and time for the last image, and all other dates and times will be proportionally adjusted.
- **Check and correct for ambiguous dates...** displays a dialog box that examines the first image of each day to see if its date is ambiguous, i.e., uncertainties about whether certain dates are in day/month or month/day order. You can then selectively swap the day/month order for images taken on those days, or swap all ambiguous dates.

- **Set Time Zone... this option is not active in this version of Timelapse.**

8. **Classify dark files now...** Timelapse uses thresholds for determining whether an image is light or dark, which in turn is used to set image’s ImageQuality to Ok or Dark. You can fine-tune how Timelapse does this, and have Timelapse examine your images as Ok or dark. Operations are performed on the currently selected files only.

9. **Edit notes for this image set** allows you to edit and save notes that are associated with this image set, e.g., comments as a whole, your own ‘to do’ list, messages to other analysts who may go through these images, etc. Timelapse will also insert various messages in here about particular actions you asked it to do.
Options menu

This menu lets you adjust a few settings on the fly.

1. **Audio feedback** toggles audio on and off. TIMELAPSE uses audio to give you feedback of the counts you make while counting (more on counting later). While it can prevent errors, it can be annoying.

2. **Magnifying Glass** provides a sub-menu that triggers the same magnifying actions as previously described, i.e., turning the magnifying glass on and off, and increasing or decreasing the magnification level.

3. **Adjust File Player playback speeds** raises a dialog box that lets you adjust how many images per second you would prefer to see when using the play forward/backwards buttons on the File Player. Note that your computer may not be able to keep up with really fast speeds, especially if you have large images. This feature is really useful for letting you review images rapidly, but you should experiment with the speed to find a setting suitable for you.

4. **Show episode information.** Timelapse identifies images as belonging together in an *episode*, i.e., a sequence of images separated by a short time duration. An episode, for example, can group together the multiple images taken of an animal moving through a scene. Episode information is shown as a text overlay atop the image. See §Episodes later in this manual.

5. **Adjust episode time threshold** raises a dialog box allowing you to adjust the time threshold for determining whether images belong together in an episode.

6. **Show or hide various informational dialogs** raises a dialog box that gives you a list of other dialog boxes that you can optionally show or hide.

7. **Preferences** is a dialog allowing you to set various options. These can affect how TIMELAPSE behaves. The default settings are reasonable, so make sure you know what you are doing.
   
i. **How deleted files are managed.** When you delete files within TIMELAPSE, TIMELAPSE actually moves them into a 'DeletedFiles' sub-folder so you can recover them if needed. The options included direct TIMELAPSE on how to manage your DeletedFiles folder, e.g., to keep them there, to ask you if you want to delete them, or to delete them automatically on exit.

   ii. **Zooming within the Main Image.** When you zoom into the image, TIMELAPSE will stop zooming when it reaches a particular zoom setting. You can increase or decrease the maximum zoom allowable through this control. Note that really high zooms be of little value for low-resolution images, as you will just see a bunch of blurry pixels.

   iii. **Image Differencing Threshold.** When performing image differencing (discussed later), TIMELAPSE uses a particular threshold to determine if the difference spotted between images should be displayed or ignored. You can adjust this threshold if you wish. However, if you set it really low, TIMELAPSE will likely display many unimportant differences. If you set it to high, Timelapse may not display some differences that you would have judged as important. Your best setting will likely depend on the kinds of images you take.

   iv. **Adjusting performance.** Timelapse displays successive images when loading images for the first time, and when you rapidly scroll your images. Yet older machines and older Windows versions...
may have problems showing image quickly, leading to image skipping, stuttering, freezing and perhaps even a system crash. You can tweak the performance by

- Adjusting whether Timelapse should display fewer images (i.e., how many images it should skip displaying)
- For fast machines, you can tell it to try to display as many images as possible when loading.
- If you don’t see stuttering or stalling, try displaying more images. Otherwise try fewer ones.

**v. Detections.** Timelapse can import image recognition files produced by a third party (see Part III).

- *Turn on detection controls* exposes the menu controls that will let you import and use detections.
- *Display detection bounding boxes* will display rectangles around the detected entity when it exceed a particular detection confidence threshold
View menu

1. **View Next file / Previous file** navigates to the next and previous image. They perform the same action as using the left/right arrow keys on your keyboard.

2. **Zoom In / Zoom out** zooms into and out of the image and/or the overview. They perform the same action as using the scroll wheel on your mouse.

3. **Bookmark Current Region / Zoom to Bookmarked Region / Zoom Out All The Way** allows you to ‘bookmark’ your current zoomed in region, then return to that zoomed-in region, or zoom out all the way. They perform the same action as using the ‘B’, ‘+’ and ‘-’ keys on your keyboard as previously explained.

4. **Cycle Through Image Differences / View Combined Image Differences** visually displays an image that shows the differences between the current image and / or the previous and next image. It is useful for spotting small visual changes that you could easily miss. It will be explained in detail later.
**Select menu**

This menu lets you selectively show only a subset of the images from your image set, where selection operations are applied to select (i.e., filter) which images will be displayed. Note that the subset of images you select will be displayed by the sort order as specified in the Sort menu. Most will also show how many files match that selection.

1. **All files** display every single image and video.

2. **By Image Quality...** lets you select the subset of images that are considered
   i. **Okay files** are all files that are not classified as dark.
   ii. **Dark files** include only those images whose ImageQuality field is set to Dark. While ImageQuality can be set manually, its best done by having Timelapse automatically dark-classify your images via *Edit | Classify dark files now*...
   iii. **Missing files** displays only those files that are no longer present, i.e., where the file is missing. Missing files are usually those that have been deleted or moved, but where the data still exists

3. **By Folders...** selects all images in a particular folder.

4. **Files marked for deletion** displays all files that have the Delete? flag checked. This lets you review those files before you actually delete them.

5. **Custom selection** displays a query form that allows you to precisely specify the properties of only those images that should be displayed.
   
   **Tip. Custom Selection** is an extremely powerful work aid, and can help you speed up your workflow hugely. See Section 11: Custom Selection.

6. **Refresh the selection** will re-select the files based on the current values of your selection filters. This may be useful if you entered data on the currently selected files that changes whether it fits within the selection criteria.
Sort menu

This menu lets you set the criteria for how your files should be sorted, i.e., the order of files from first to last. Note that images shown will be of the files you selected in the Select menu.

Note. Sorting is alphabetic except for DateTime (which sorts by – you guessed it, Date and Time) and counters (which sorts numerically).

1. By Date/Time ↑. Files are sorted by date and time in ascending ↑ order. That is, the first file in the sequence of images will be the one with the earliest date.

2. By File Path ↑. Files are sorted alphabetically in ascending order by the file path, that is, a combination of the relative path (if you are storing images in subfolders) and the file name.
   - If you have no sub-folders, it will just sort by the filename
   - If you store your images in a sub-folder, the filepath would be something like Set1/image001.jpg, Set1/image002.jpg ... Set2/image001.jpg...). It will sort alphabetically on the combined path/filename

3. By Id ↑. As files are first added to Timelapse, they are given a sequential ID number. Thus sorting by Id sorts by the same order you added files to Timelapse.

4. Custom sort raises a dialog box that lets you sort in ascending or descending order on any two terms i.e., the data fields that appear in Timelapse. Using the Tutorial example, lets say you had three analysts working on the image set, where each had put their name in the Analyst box. Sorting by Analyst (ascending) and DateTime (descending) will group each analyst’s images together, where the their subset of images with show the one with the latest date first.

5. Refresh the sort will re-sort on the current values of your sort filters – this may be useful if you entered data that changes where particular images appear in the sorted list.
Window menu

This menu lets you selectively rearrange the various panels and windows that comprise Timelapse.

The first three adjust where the Data Entry pane appears relative to the Timelapse Window. You can fine tune the pane size by dragging its grey border.

1. **Data Entry On Top.** The data entry pane is tiled at the top of the current Timelapse window.
2. **Data Entry On Side.** The data entry pane is tiled at the right side of the current Timelapse window.
3. **Data Entry Floating.** The data entry pane is configured as a separate ‘floating’ window atop the current Timelapse window.

![Data Entry On Top, Data Entry On Side, Data Entry Floating](image)

The next two items lets you save the current layout (including position and size), and load them back any time you want. §Tabs and the Data Pane describes how you can rearrange your tabs and data panes manually, which you can then save for later reuse.

4. **Restore a Saved Window Layout.** Choose and load one of your previously saved layouts.
5. **Save the Current Window Layout.** Saves the current layout in one of several custom settings.

![An example of a manually arranged layout that can be saved and loaded](image)

The last two items lets you quickly restore your layout, which is useful if things get mucked up.

6. **Reset to Default.** Restores the layout to the system default (i.e., Data Entry On Top)
7. **Reset to Initial Layout.** Restores the layout to the initial layout of the current Timelapse session
Help menu

1. **The Timelapse Web Page** will display the main TIMELAPSE web page in your browser.

2. **Tutorial Manual** will display the TIMELAPSE Tutorial Manual (a PDF file) in your browser. Note: This is a large file, so it may take some time to load. You need to be connected to the internet.

3. **Download Sample Tutorial Images** will download the sample images that accompany the TIMELAPSE Tutorial Manual. You can use these images to practice on as you follow the manual’s instructions.

4. **Timelapse Mailing List – Join it** will let you join the Timelapse mailing list, which will keep you informed of software updates and occasional news. Mailings are fairly infrequent. All emails are moderated, so spam is highly unlikely. We highly recommend you join, as otherwise you can easily miss updates and bug fixes.

5. **Timelapse Mailing List – Send Email** will let you send email to the mailing list.

6. **About** gives information about the software (such as its version number) as well as how to contact the Timelapse team if you have issues, problems, or questions. We truly value your feedback! It also lets you check to see if a newer version of TIMELAPSE is available.
Markers

In some image sets (such as the one used in this tutorial) counting things can be difficult if:

- there are many entities to count (as it is easy to lose track of what is counted and what wasn’t)
- there are different entities to count (as it is easy to mis-categorize counted items)
- the entities you want to count are visually small (as it is easy to miss things)
- you (or another analyst) want to review the image later to verify the correctness of what has been counted and what hasn’t been counted.

Markers present an alternative to simply entering a number in a Counter. You count by clicking a Counter’s radio button, and then clicking over the entities of that type in the image. This also creates a visual marker indicating the location of those entities in the image.

- **Activate a Counter** by clicking its radio, which turns it blue.
- **Create a marker** by left clicking atop the thing you want to count on the image. Note that you must have a Counter selected (selected Counter buttons have blue radio buttons)
- **Highlight markers** by moving your mouse cursor over any Counter
- **Delete a marker** by right clicking on it.

You can de-activated a counter by clicking it again, or by selecting another counter to activate that one instead.

The image to the right illustrates this. The analyst activated the *Goat* counter by clicking its radio button (now in blue). Using the magnifying glass and zoom feature, the analyst scanned the image, identified four goats, and clicked on them. The count automatically increases to 4, and four blue markers now appear atop the goats. Hovering over a marker raises a tooltip describing its type (i.e, that it is a goat marker).

Markers matching an activated (blue) counter appear in blue. Other markers representing other entities are in yellow (matching the yellow color of the other unselected counter buttons).
Videos

TIMELAPSE can display both image (.jpg) and video (.mp4 and .avi) files. When you navigate to a video file, Timelapse will show various video player controls to play or pause the video at the bottom of the screen. The spacebar can also be used to play or pause the video.

Videos have several limitations
- TIMELAPSE may not be able to read the video’s correct date. Always check the dates on videos!
- Counter markers and zooming in/out are disabled.
- Videos are somewhat slower to load.
- Videos may initially display a ‘black’ frame before showing its content. This can introduce annoying flickering when navigating through multiple videos, or just seeing black if you navigate through them quickly.
The Overview

As mentioned in §Magnifying, zooming and panning, you can zoom out to an Overview, which displays a page containing rows of multiple images. You can zoom out through three overview levels, each showing successively more images at smaller sizes. Zooming in and out of the overview is done via the scroll wheel, the ‘<’ or ‘>’ shortcut keys, or via the zoom in/out menu.

**Note.** Some functions are disabled in the overview. These include a handful of menu options, the Copy Previous Values button, the magnifying glass, and marking.

1. **Displaying a single image’s data.** When initially zooming into the overview, the top-left image is automatically selected and its data displayed.

The first image and its data are normally displayed after switching to the overview.

A single click on any other image will display the data for that image. For example, the user has selected the third image (in this case IMG_0003.JPG) and its data is now shown.
2. **Zooming out to a selected image.** If you double click any image, it will return to the single image view, where it will navigate to the selected image and display it.

3. **Navigating to other images.** The file player controls navigation. Alternately, you can use these shortcut keys:
   - →← arrow keys advance to the next/previous image,
   - ↓↑ display the next/previous row of images,
   - Page Down/Page Up keys display the next/previous page of images. Navigation always resets the selections to the first image on the page.

4. **Selecting and entering data for multiple images at a time.** The overview is a convenient way to enter data common to multiple images.

   You can select multiple images similar to how Windows lets you select multiple files,
   - **Click and drag to select a range of images:** Click and drag from one image to another image will select all images between the two.
   - **Control-click an unselected image** to add that image to the set of selected images.
   - **Control-click a selected image** to remove that image from the set of selected images.
   - **Shift-click an image** will extend the selection from the previous selected image to the current image. If there is no previously selected image, it will extend the selection to the next selected image.

When multiple images are selected, data is displayed only if it is common to all selected images. If data differs, an ellipses ‘...’ will be displayed instead.

For the example at the right, the user has selected several images. Those selected images all have a Hikers value of 0. However, the same images don’t have a common value for the Goats count, as it displays ‘...’.
Any data entered will then be applied to all selected images. To illustrate, the example below shows a user setting the weather.

She selects all sunny images on this page (all but the last two, which she leaves unselected) and sets the weather to Sunny.

She then selects the last two images on this page and sets their weather to Cloudy.

She then clicks the next page button on the File player to show the next page of image files. All but one are cloudy, so she selects those and sets them to Cloudy.

She continues this process to enter the weather for all other images.
Window Tab Panes and the Data Pane

TIMELAPSE provides its major informational components within one data pane and three tabs.

The three window tab panes are:
- Instructions tab contains a brief summary of how to use TIMELAPSE.
- Image set tab displays the current image or video
- Data grid tab displays a grid that lists all you files in rows, and all the current data values as columns

The data pane
- contains all the fill-in data fields associated with the image being displayed.

You can re-arrange the window tabs and data pane on the display to best fit your working style and screen size. This includes adjusting how they appear within the main window, or popping some of them out as a separate floating window. For example. The image below shows the data pane arranged as a separate movable and resizable window.

A popped-out data pane appears in its own movable and resizable window.
You can save arrangement at any time via the **Windows->Save a Custom Layout** menu item. You can then restore that arrangement at a later time via the **Windows->Load a Custom Layout** menu item.

**Window Tab Pane rearrangement**

Window tabs can be rearranged as follows.

- **Switch between tabs** by clicking the tab header.

- **Pop out the instructions or data grid tab** by selecting and dragging the tab header out of the window.

- **Place a popped-out Window tab pane back into the window by:**
  
  - **recommended**: reverse the above, by dragging its title bar back into the tab headers
  
  - **alternate, not recommended**: drag its title bar over the icon that will appear at the center of the window (see below), which splits the current tab window into two (not advised, as the image set tab will then become quite small)
**Data Entry Pane**

The data entry pane can be re-arranged as follows

- **Resize the data entry pane** by dragging and moving the grey splitter bar that separates it from the Window tab pane, or by selecting one of the window arrangements on the Windows menu.

- **Pop out the data entry pane** by selecting and dragging the data pane header out of the window (similar what was illustrated for tabs)

- **Relocate the data entry pane on different sides of the window.** Select and drag the data entry pane’s title header out of the main window. Icons will appear at the left/right/top/bottom sides of the main window. Drop the data entry pane onto the icon on your desired side.

  Example: The following action moves the data pane from top (upper left image) to the right side (lower left image) of your main window. Select the data entry pane title and drag it over the icon that appears on the right side of the window (see right image). Note that you may have to resize the data pane afterwards.
7 Entering Data via Tabbing

You can select data fields for input by clicking on them with the cursor or by tabbing between fields. With tabbing you can enter your data using the keyboard instead of (or as well as) the mouse. While it takes some getting used to, you may find tabbing a very handy way to enter data quickly.

**Note.** The term **Focus** indicates which data field or user interface control is currently accepting text input.

To begin, press the tab key or select any data field to give it the focus.

- Read-only data fields (e.g. File) are outlined in thick light blue.
- Editable data fields (e.g. Goats) are outlined in thick dark blue.

**Tab** goes forward to the next **editable** data field in your Data Entry pane. **Shift-Tab** goes backwards to the previous **editable** data field in your Data Entry pane.

**Note.** Tabbing normally skips over **DateTime**, **ImageQuality**, and **Delete?** data fields, as these fields are rarely edited. However, you can include these fields in the tab order by selecting **Options|Preferences**...

When you reach the end of the data fields,

- **Tab** to go to the **Copy previous values** button.
- **Tab** again to go to the first editable data field in your Data Entry pane. **Or**
- **Shift-Tab** to go back to the last editable data field

Particular keyboard actions / shortcuts work over the particular controls that have the focus.

- **All controls:**
  - **Shift left/right arrow** or **shift page up/down**: navigate to the previous/next image
- **Notes:**
  - **Type** to enter or edit the data.
  - **Left/right arrow**: character navigation as expected.
- **Counters:**
  - **Type** to enter or edit the data
  - **Up/down arrow**: increment/decrement the value.
  - **Left/right arrow**: character navigation as expected.
- **Choice menus:**
  - When you type a letter, the first menu entry that matches that letter is selected.
  - **Up/Down arrow**: cycle through the menu items.
  - **Left/right arrow**: navigate to the previous/next image
- **Flag checkboxes:**
  - **Space**: toggle the checkbox.
  - **Left/right arrow**: navigate to the previous/next image
- **DateTime:**
  - **Up/down arrow**: increment/decrement the values.
  - **Left/right arrow**: move between year/month/day fields,
- **Copy Previous Values button**
  - **C** activates the button as if you pressed it
  - **Left/right arrow**: navigate to the previous/next image
8 Entering Data via QuickPaste

Let’s face it. Entering data is tedious, especially when you enter the same data into the same data fields repeatedly. Using our tutorial data fields as an example, imagine if you were the analyst where you found yourself re-enter these data patterns over and over again on many images:

- Goat:1, Weather: Sunny, Analyst: Fred, Publicity?:True, Comment: Nice close-up shot
- Weather: Sunny, Analyst: Fred
- Weather: Raining, Analyst: Fred, Comment: Poor visibility
- Comment: Another species spotted in image

QuickPaste minimizes this pain, where you enter a data pattern with a single button click.

The Quick Paste Editor:

You create a QuickPaste Entry with the QuickPasteEditor, where you indicate

- a name for that entry (optional)
- which data fields you want to QuickPaste into, and
- the values to be pasted.

For example, let’s say you had just entered the first pattern above into your data fields.

To create a QuickPaste entry based on that pattern:

1. Select Edit| Show QuickPaste Window (or type ‘Q’) to raise the QuickPaste window (shown at the right).
2. Click the New QuickPaste... button. The QuickPaste Editor window will appear (see next page).
3. Examine the contents. The editor pre-fills the fields with the values from your current image. It also pre-selects (via the checkboxes) all the fields marked ‘Copyable’ in the template, where those fields will be pasted into your data when you use QuickPaste.
4. **Edit as needed.** Reconfigure the above to what you want. You can easily edit the above by:

   replacing the default *Title* with one that is meaningful to you; changing the check-marks to indicate which fields you want pasted, and entering new values.

   For example, the right image below was edited to change *Title* to ‘One goat publicity shot’, and to check Goats to make it a pastable item.

   When you click Okay, the *QuickPaste* window will appear with a new button on it representing the *QuickPaste* Entry you just created (see left image below).

5. **Create/edit other *QuickPaste* buttons** at your leisure. For example, the four *QuickPaste* buttons below are based on the example data patterns described earlier (right image below).
**Using the Quick Paste Buttons**

**Previewing what QuickPaste will do.** When you hover you mouse over a button, the data controls that would be affected are highlit in green, where they show an italicized preview of the data that would be pasted into them.

**Doing a QuickPaste.**

- **Using the mouse:** Click the *QuickPaste* button to paste the data into the fields.
- **Using shortcut keys:** Each Quickpaste button is automatically assigned a shortcut key, displayed next to its name, e.g., ctrl-1, ctrl-2 as seen below.

Press Control and the desired number key to activate that *QuickPaste* button.

The data fields will flash briefly to indicate that they have been updated.

**Other QuickPaste button operations.**

The tooltip summarizes values that would be pasted into the corresponding data fields. Right-click raises the context menu, which lets you re-edit the button’s entry or delete it. QuickPaste also works with multiple images: the selected images get those values.
Importing Quick Paste Entries from another Image Set

Timelapse remembers your QuickPaste Entries in your image set’s database (.ddb) file. This means that when you re-open that image set, your QuickPaste Entries will be there for you to use again.

When you open a new image set (or perhaps an old image set with no QuickPaste Entries), you can – if you wish - import QuickPaste Entries created in another image set and saved to its .ddb file. To do this:

1. Select Edit | Import QuickPaste Items from .ddb file...
2. From the file dialog box that appears, navigate to the image set folder that contains the database (.ddb) file holding the desired QuickPaste Entries.
3. The QuickPaste Window will appear with those entries.

**Note 1.** Importing over-writes any QuickPaste entries you may have already created.

**Note 2.** Timelapse always checks the imported QuickPaste entries against your data fields, where it will adjust the imported entries as needed to make sure they will work against your data.
9 Episodes

An episode is a sequence of images related to each other over time, such as by animal moving through the scene. As described below, Timelapse can try to identify episodes for you.

Why episodes?

Some analysts need to group images together as an ‘episode’ in order to analyze them. For example, consider the analyst has to count the number of hikers using a trail. Yet a single hiker may appear on several images over time, perhaps due to motion triggering (where the camera automatically takes several snapshots after motion is detected), or because the hiker is milling about in front of the camera. To avoid double-counting, the analyst would only count the hiker once in this series.

Yet identifying a series of images as an episodes is tedious and time-consuming. The analyst may examine various cues: distinctive features of the hiker or animal, and the direction of movement of the entity across the scene. The analyst may also check the date/time of the images: if images are separated by a short time interval, it is reasonable to assume that those images are related. The catch is that checking times is both tedious and time-consuming.

How Timelapse determines episodes

Timelapse uses time differences to determine what images belong in an episode. It compares the time difference between successive images against a time threshold: if the time difference is less than the threshold, it adds that image to the episode.

To illustrate, consider these image times, and a time threshold of 2 minutes.

<table>
<thead>
<tr>
<th>Name</th>
<th>Image1</th>
<th>Image2</th>
<th>Image3</th>
<th>Image4</th>
<th>Image5</th>
<th>Image6</th>
<th>Image7</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time (hh:mm)</td>
<td>8:45</td>
<td>8:46</td>
<td>8:48</td>
<td>9:30</td>
<td>9:32</td>
<td>10:00</td>
<td>10:05</td>
</tr>
<tr>
<td>Time difference from previous image (minutes)</td>
<td>1</td>
<td>2</td>
<td>42</td>
<td>2</td>
<td>28</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Episode (image # / total)</td>
<td>1/3</td>
<td>2/3</td>
<td>3/3</td>
<td>1/2</td>
<td>2/2</td>
<td>1/1</td>
<td>...</td>
</tr>
</tbody>
</table>

- The first 3 images form one episode as the time difference between them is 2 minutes or less.
- A new episode begins on Image4, as it was taken 42 minutes after Image3
- Image4 and Image5 are an episode as their time difference 2 minutes
- For the same reasons, Image6 is an episode with only 1 image as the time differences between it and the surrounding images is more than 2 minutes.

How Timelapse displays episodes

Select Options | Show episode information, or press the shortcut key ‘E’ to show episode information. as illustrated below.

Viewing a single image: text is overlaid on the top left corner of the image, identifying the image number in sequence / total number in sequence. The text is colored red if it’s the first image in the sequence, otherwise black. For example, the images below show the 1st and 2nd images in a sequence of 3 images. If there is only one image in an episode, it is labelled as ‘single’.
Viewing multiple images is similar, except the image name and the image time are also overlaid on the right side of the image.

Note. If a relatively large number of images belong to a single episode, Timelapse will just display an $\infty$ (infinity) symbol.
Setting a time threshold for determining episodes

The time threshold determines whether images belong together in an episode. However, using time to delimit episodes is just a heuristic: it may be reasonably accurate, but it is still just a best guess.

Timelapse allows you to set the time threshold via the Options | Adjust episode time threshold... dialog, where it can be set very short (e.g., 15 seconds) or somewhat long (e.g., 10 minutes). We suggest examining a few of your images to determine what time threshold works best for your image set. Alternately, experiment with different threshold values and see how the episode groupings change.

Note. Episodes only make sense when your images are in some kind of date/time order. For example, when you use episodes you may first want to select:

- Sort | by Date/Time if all your images are from one camera, or
- Sort | Custom Sort and then by File Path and Date/Time if you have images from different cameras and/or different sites organized into sub-folders (as otherwise their times may be intermixed)
10 The TIMELAPSE Workflow

Image analysis can be tedious and error-prone. To maximize efficiency and minimize errors, this section details a basic workflow sequence that affords best practices.

The basic steps are:

- Populate the fields that are common to all images, or to large subsets of images
- Manage Dark and Corrupt images (if any)
- Analyze your remaining images one by one

We will discuss each in turn.

Note. Your particular workflow will vary from what is described below. Particular workflow steps required may depending upon various factors.

- **How your images were taken.** Cameras set to timelapse mode (images taken at regular time intervals) tend to produce many images. As only a few images contain something of interest, the analyst will tend to run through many images quickly. In contrast, cameras set to motion triggering tend to produce a flurry of images when motion is detected. Here, the analyst needs to examine each image to identify a sequence and to see if that sequence contains something of interest, or if triggering occurred as a result of vegetation motion due to wind.

- **Details of interest.** Some cameras are positioned to capture entities immediately in front of it, such as animals that are a few meters from the camera. These images display large entities of interest visible at a glance. Other cameras are positioned to capture entities far away (e.g., animals or people travelling across a meadow several hundred meters from the camera). These images display very small entities of interest that likely requires careful visual search to find them.

- **Your particular project needs.** Some projects only require you to code a few things in your image, such as the type of animal or person in the scene. Others may require considerable detail for each image, which is much more time-intensive.

- **Accuracy.** Some projects may require highly accurate image analysis, where data entries must be scrutinized carefully and perhaps double-checked by others. Others may just require estimates, where occasional errors due to mis-categorizations, false positives, or false negatives are tolerable.

Populate the Fields Common to All Images

Some of the fields associated with each image may contain a value that is identical across all images. For example, the analyst (you) will be the only one analyzing this image set, so all images would have the Analyst field set to your name.

You could, of course, enter your name one by one in the Analyst field, but this is tedious indeed. Fortunately, the TIMELAPSE tool lets you copy a value to all images. Let’s use the Analyst field as an example.

1. Make sure you are looking at All Files (Select / All files). This is because copying only works over the particular subset of images you are currently viewing. Filters will be explained later.
2. Navigate to the first image.
3. Type in your name in the Analyst field.
4. Right click on the Analyzer label to raise the context menu.
5. Select Copy to all. A dialog box will detail the changes that will be made, and will ask you to confirm this action. After you accept, all images i will have its Analyst field set to whatever you typed into it.
6. Test it.
   a. **Navigate to any other image.** You should see that they all contain the same value for the Sampler.
   b. **Examine the database.** At any time, you can view your entire data by either selecting View / Export as CVS and Preview in Excel, or by switching to the Data grid tab. Both the Excel spreadsheet or the Data Table tab (both shown below) will show the Analyst column filled in with the same value.
Populate the Fields Common to a Subset of Images

You can also populate a subset of images with a common data value. To illustrate, we will set the weather for images that appear to be daytime shots.

1. Filter the image set to show only light images (i.e., no nighttime shots or corrupt images). You do this by selecting View / Light files.

2. Start at the first image. Since it shows a sunny scene, set the Weather field to ‘Sunny’ (see left image below).

   ![Image](image1.png)

3. Use the slider, arrow keys, or FilePlayer to scan successive images until there is a significant change in weather, or until you see a video (which we will analyze later). In this case, all images show sunny weather until the video VID_0015.avi. Back up to the last image IMG_013.JPG.

4. Right click on the Weather field label to raise the context menu (see right image below). Select Propagate from the last non-empty value to here. Since the last non-empty value was ‘Sunny’, all the images in-between the two images will be filled in with the value ‘Sunny’.

   ![Image](image2.png)

5. Examine the image after the video (IMG_0101.JPG). Since it is sunny, set its Weather field to ‘Sunny’. If you keep on navigating, you will see that subsequent images are sunny until a video taken at dusk (IMG_0118.JPG). As before, back up one image to IMG_0116.JPG and use the Propagate from the last non-empty value to here to set the previous images to sunny.

6. Keep going through subsequent images and repeat this process. You will likely identify then next set of images as ‘Cloudy’.

7. Test it. Filter the image set to show ‘All images’. Check your data as before. You should see that most images (excluding videos which you skipped) will have their weather field set. Dark and corrupted images will not have their Weather field set, as those were not present since you were working in the ‘Light files’ filter.

8. Alternate approach: use the Overview to set data for multiple images at a time. This works well for cases when small-sized images suffice for determining its data. See §Overview for details.
Populating a Field with Metadata

Some cameras store metadata about your image that may be useful to your project. For example, you may have noticed that this particular camera model (an HC600 Convert) includes the temperature in the top right part of the image. It would be nice to have that somehow included in your data.

Your project manager included a ‘Temperature’ Note field, which needs to be filled in to show this temperature. While you could do this by typing in the temperature for each image, this would be quite tedious. Instead, we will check the metadata available for a typical image in your image set to see if there is one that records this temperature.

1. **Navigate to a typical image**, where that image is not missing or corrupt.
2. **Select Edit / Populated a field with metadata...** A dialog box will appear that shows you:
   - the metadata available for the current image, including its name and actual value
   - a list of Note data fields
Select the Ambient Temperature metadata and the Temperature Note field. The listed metadata includes two fields called Ambient Temperature and Ambient Temperature Fahrenheit. You want to assign the Ambient Temperature metadata (the temperature in Celsius) to the Temperature Note field.

a. Select Ambient Temperature by clicking on it.
b. Select the Temperature Note field by clicking it.
c. Click Populate. A dialog box similar to the one seen below will display all the changes it made. Note that the feedback also informs you about those images that do not have the Ambient Temperature metadata embedded in it (e.g., scroll the list to see that the video files and the missing files do not have any temperature metadata).

3. **Test it. You** should see the temperature has been filled in for all applicable images.

**Note.** While there have been attempts by the industry to standardize what metadata is embedded in an image, the actual metadata included by a particular camera can vary considerably. Some information (such as the size of the image) is fairly standard across most cameras. Other information (such as the current temperature) may be recorded only by particular cameras. Videos are even worse. The only way to know what metadata is actually embedded in an image is by examining a particular image.
Manage Dark and Missing Images: Filters and Deletion

If your image set has many night-time shots, you may want to deal with them in a uniform way. The same thing goes for corrupted images (hopefully, your camera won’t have any of them, but we include one in our test set). We will use Selections to do this. Typical things you may want to do are to delete the images (to save disk space), or delete them entirely (so they don’t clutter your work), or add comments about them.

**Tip.** If you set your camera to take images taken periodically (e.g., every hour in timelapse mode), you will likely collect many night-time shots that you will want to manage collectively. However, if you set your camera on motion detection, you will likely want to examine each image by itself.

A *Selection* lets you look at a subset of all your images. You can choose a selection by selecting one from the *Select* menu. Several stock filters are displayed in that menu, as well as a *Custom Select* option where you can create your own filter. As previously explained:

- **All files** display every single image.
- **By Image Quality | Ok files / Dark files** display images whose image quality field is set to Ok or Dark respectively. 
  Selecting *Edit | Classify dark files now*... will automatically classify dark images such as night-time shots as Dark.
- **By Image Quality | Missing files** display only those images that are no longer present.
- **By folder...** will display images in the chosen folder
- **Files marked for deletion** displays all images that have the Delete? flag checked.
- **Custom filter** lets you create your own filter using various fields, and will be described separately.

Now let’s use these view filters to manage the dark night-time images.

1. **Select Image Quality | Dark files.** The first dark image will be displayed. This assuming you have already classified your images by selecting *Edit | Classify dark files now...*. You will also see that the image number / image count at the bottom left says that this is the 1st image of the 3 dark images found in this image set. (If this were a full image that represents images taken over regular intervals, there could be hundreds of such images). The Date Pane title at the top also shows that dark files are selected.
2. **Check that all images are, indeed, dark.** This should be the case, but it never hurts to check. Quickly scroll through them to verify this using the slider or arrow keys.

3. **Change any fields** that are applicable to only the dark images.
   a. Set the **Comment** field text to ‘Night time’ in the first image,
   b. Do a **Copy to All** to propagate that comment to the other dark images.

4. **Delete the Dark images, but leave the data intact.** Your project manager has asked you to delete dark images in order to save disk space, but to leave the data associated with those images intact.
   a. Select the **Delete?** flag for the three images, or use Copy All after flagging one image).
   b. Select **Edit | Delete | All files in the current filter marked for deletion ...**

   A dialog box appears (see below) that displays thumbnails of the images to delete.

   ![Dialog Box](Image)

   After you confirm deletion, TIMELAPSE will
   - **show a placeholder** for these images as illustrated below.
   - **changes the ImageQuality** of those images to **Missing**.
   - **backup the deleted images** for added safety: TIMELAPSE doesn’t really delete these images. Instead, it copies them to the **DeletedImages** sub-folder. Check that folder to see if they are there are there. You can permanently delete those image files if you wish.
We will now use another view filter to manage corrupted images.

5. **Deleting corrupted images and associated data.** Select *Filter* / *Corrupted files*. Because the image file is corrupted, a placeholder image is shown instead stating that the image appears to be corrupted.

Because corrupted images are not usable, you have been instructed to delete not only the corrupted file, but any data associated with it. Since there is only one corrupted file:

a. Select *Edit* / *Delete* / *The current image or video file and its data* ...
   A dialog box appears (see below) that displays thumbnails of the images to delete.
  
b. Click the *Confirm deletion of images, videos and data* at the bottom checkbox at the bottom of the dialog box.

  c. A message telling you that the filter is being changed to All files, as there are no more corrupted images to show in the *Corrupted Files* filter.

![Delete image and data dialog box](image)

6. **Test it.** Preview your data using the spreadsheet or database view. You will see that the nighttime images (IMG_0014.JPG, IMG_0118.JPG, and IMG_0222.JPG) have their *ImageQuality* field set to missing, and the comment field set to Night time. You will also see that IMG_0117.JPG (the corrupted image) is no longer listed as its data has been deleted.

**Analyze your remaining images**

This ‘final’ step is where you do most of your detailed work, as you will be visually scanning and entering data for individual images.

As mentioned previously, different projects will require different levels of visual inspection. For example, projects with motion-activated camera traps usually capture large wildlife, which are easy to detect and count. In contrast, camera traps in our tutorial take timelapse images over a very large area, where the entities of interest (goats and hikers) are distant and thus quite small. We focus on this later case for now, i.e., how to use TIMELAPSE to help find and count small entities.

**The typical workflow per image** is summarized below, and will be illustrated shortly.

1. **Copy repetitive values** that were entered in the previous image.
2. Fill in all remaining fields excepting the count fields to match what you see in this image.
3. **Scan the image for the entities you want to count.** Sometimes the entities are hard to see, perhaps because the light is bad, or the things you are counting are far away and thus very small. Typical strategies include:
   a. Look at common places you expect those entities to be.
   b. Rapidly switch between the current and surrounding images by using the left/right arrow keys. Your eye will be drawn to things that change between them.
   c. Use the magnifying glass and / or the zoom facilities to see details in high-probability places.
   d. Magnify or zoom into possible entities to scrutinize them, e.g., if you see something that may be of interest, use the magnifying glass to see details.
   e. Combine steps b and d: if you see something in the magnifying glass but are unsure if it is actually something of interest, try using the left/right arrow keys to see if it’s the same across images (suggesting it is not something that moves), or if it is no longer there (and thus likely something of interest).
   f. Use the image differencing enhancers via the up / down arrow keys (we will explain this shortly).

4. **Select the counter type, and click on each entity of that type.** A visual marker – a blue circle – appears where you clicked (the currently selected counter is also blue), and the current counter will be incremented.

5. **Create QuickPaste** entries as needed that let you paste in multiple data values in a single click.

   **Tip.** If you clicked accidentally or in the wrong spot, you can remove the marker and decrement the count by left-clicking that marker.

We will now illustrate this workflow across various images by example.

To begin, set your filter to *Light Images* and go to the first image. There is no point looking at the other images, as you have already dealt with them. We will go through each image in turn, where we will emphasise various ways to analyze these images efficiently with TIMELAPSE. Along the way, we will introduce additional features available in TIMELAPSE.

**Get an overview of the images and videos.**

It’s always helpful to get a sense of the images and videos in your video set. Use the file player controls to go to the first image (if you are not already on it), and then play your images at high speed.
Introducing scanning, zooming, and rapid switching.

Image 1 (IMG_0001.JPG).

1. Enter any desired data into all but the counter fields. For this image, there seems to be little to add.

2. **Scan the image for goats and hikers.** In this particular image set we would do the following.
   - **Examine common places** you expect them to be. In this scene, goats would likely congregate on the meadow or on the rocky open slopes. You were also told that there is a hiking trail directly in front of the camera, so you would expect hikers to appear there.
   - **Use the magnifying glass** and/or Pan and Zoom to examine details in high-probability places, and/or suspected entities.
     - No goats appear to be present in the meadow or rocky slope. To check, place your cursor over the meadow and quickly zoom into it using the scroll wheel. Since you don’t see anything, zoom out again. Repeat this for the rocky slope (or use the magnifying glass).
     - You notice a blue blob at the bottom of the image, which could be a hiker (see left image below). Place your magnifying glass over it to inspect it. It appears to be a hiker wearing a blue hat and black shirt.

   **Tip.** While you can increase or decrease the magnification (the U key), the actual image resolution and quality – not its magnification – will limit the detail seen. Find a reasonable balance.

   - **Rapidly switch between this and surrounding images by using the left/right arrow keys.** You won’t be able to go left, as you are on the first image. If you rapidly switch between this and the next image, you’ll see that the blue blob is not there (right image below). This confirms your belief that there was a hiker on the first image, who has since moved. Note that if you keep the magnifying glass over that spot, you will be able to see the magnified changes between images (if any) within it.

   ![Image 1 (IMG_0001.JPG): Hiker present](image1.png) ![Image 2 (IMG_0002.JPG): Hiker absent](image2.png)
3. **Count the hiker. First**, click on the *Hikers* counter label to activate it. Then click just next to the hiker in the image. This creates a blue marker next to the hiker, and increments the count.

At this point, we are fairly satisfied that there is nothing else in image 1, so we are ready to move to the next image.

**Tip.** If the entities you are counting are small, it is better to click just next to that entity (as done with the hiker) so that the marker doesn’t occlude it.

**Tip.** Markers are persistent. If you quit and reopen this image set, or go to another image and then return to this one, the markers will still be there. This means you can check (and change) your counts at any time. It also means that another person can examine what you did and double-check that you correctly identified and counted all entities.

**Tip.** If you accidentally click on the image and introduce a marker and ‘count’ when you shouldn’t have, simply right-click over that marker in the image. This will remove the marker and decrement the count.
Images 2 and 3 (IMG_0002.JPG and IMG_0003.JPG)

1. Repeat the above process. In these images, the hiker is absent. However, when examining IMG_0002.JPG you see a white blob on the rocky slope which could be a goat (left image below). Using the magnifying glass, you suspect it’s a rock. If you use the navigation keys to rapidly cycle to the next and/or previous image (middle and left image below), you see that it hasn’t moved i.e., it is indeed a rock. Since there is nothing else of interest, you don’t change any of the data fields. Similarly, IMG_0003.JPG doesn’t seem to have anything of interest in it.

Introducing image differencing

Image 4 (IMG_0004.JPG).

TIMELAPSE includes three image enhancers that may help you spot small, easily missed entities by highlighting visual changes between the current image and the previous/next images. All are activated using the up/down arrow keys. All methods also work at all image zoom levels.

1. While you don’t immediately spot anything of interest in IMG_0004.JPG, you decide to double check this via image differencing.
2. The combined image difference. If you hit the down arrow key once, you will see something like the image below.
Timelapse creates this combined difference image view by comparing the current image with the next and previous image, and highlighting significant differences between them. Some of these differences may be due to lighting and shadow changes, slight movements of the camera, and wind effects. For example, the dull white shown in the upper left is due to wind effects on the tree. However, people and animals that move in the scene may also become visible, as they appear in different locations (or may leave) across the compared images.

3. **Examine suspect white areas with the magnifying glass.** There appears to be 3 white blobs in an otherwise unchanging portion of the image, which seems uncharacteristic (outlined in red in the above image). When we examine this with the magnifying glass, we see that they could indeed be goats.

Verify by zooming and rapidly switching between images. Zoom into that area (shown below), and use the down-arrow key to examine the combined differences (left) with the original image (middle): three goats do seem to be present. If you then rapidly switch between the current image and surrounding image (right), we see that the white blobs are no longer present, which confirms that they are indeed goats.

4. **Count the three goats by clicking on each of them** (make sure the Goats counter is still activated).

5. **Add a comment.** Type in ‘Sequence #1’ in the comment box, which indicates the beginning of a sequence of images that may contain goats in it (this comment is not really that meaningful, but we include it for illustrative purposes).

**Note.** Image differencing isn’t always effective: if there are large visual changes between images (e.g., due to wind effects), too many differences will be highlighted.

**Tip:** You can use the up-arrow key to compare the current image with only the previous image. If you press it again, it will compare it to only the next image. A third press will display the original image. Try these to see if you can spot any other things of interest.

**Why there are three different image differencing methods.** The next and previous differences create a composite of the difference between the current image and the next (or previous) one. This means that if an entity (e.g., a goat) appears in 1 image, and that entity moves to a different position in the next image, you will likely see 2 entities in the differenced image. That is, it’s a union of the differences. You would then use the magnifying glass to check which of those actually appears in the current image.
In contrast, the combined differences will only show those things that appears in the current image and that does not appear in either of the surrounding images. Thus if you see something there, it is likely only in the current image. You should still check with the magnifying glass.

The utility of a particular differenced image depends highly on how the surrounding images differ from the current one. If visual differences are large, then the differenced image would have quite a bit of ‘white noise’ and thus are of little value. While the surrounding differenced image usually works best, there is no guarantee that any of the differenced images will be useful. Still, it is a quick operation to cycle between all of them.

If you unclear as to what this all means, don’t worry. Let the visuals attract your attention, and then use the magnifying glass, zooming, flip backing to the normal image, and comparing what you see to surrounding images to check what is there.

**Introducing Copy Previous Values**

Image 5 (IMG_0005.JPG).

1. Repeat the above process. One of the goats is just visible in the same area, so mark that. The earlier comment (Sequence 1) still applies, but that field is not yet filled in on this image. We could fill it in by retyping, but this will become tedious to do.

2. Instead, use the **Copy Previous Values** button on the right.
   - Hover your cursor over the Copy Previous Values button. Various fields change their color to green to match the button’s color. These are the fields that are copyable. For example, we see that the ‘Weather’, ‘Analyst’, and ‘Comments’ are in green, but that the other fields (including the counters) are not.

   ![Copy Previous Values button](https://example.com/image)

   - Press the Copy Previous Values button. This copies the contents of all the green fields in the previous image to the green fields in this image. In this case, only the Comment field will appear to be different (i.e., from empty to ‘Sequence #1’), as the other fields in this image were already the same as those in the previous image.
The Copy Previous Values button is useful because - most of the time - there is very little difference between one image and the next in a sequence. You may find yourself using this button frequently. If there is something that you want to be different, you can always change that. For example, if everything but the ‘Weather’ field was identical between images, you can press the Copy button, and then change the ‘Weather’ field to the value you really want.

**Keyboard shortcut:** The C key will also activate Copy Previous Values.

**Introducing Propagating Values**

Images 6 - 13 (IMG_0006.JPG – IMG_0013.JPG).

1. **Repeat the above process** for the next 8 images. However, don’t use the Copy Previous Values as we will show you a different way to copy repetitive fields.

2. **Identify and count the goats.** As before, try rapidly switching back and forth between images, as well as using image enhancement. You should see a herd of goats move down the hillside into the meadow and surrounding trees, and then move up the hillside again near the end.

3. **Mark Image_0010.JPG as a possible publicity shot.** I counted 9 goats in Image_0010.JPG, which makes this a reasonable candidate. Click on Publicity?, which will set its data value to true.

4. **Use ‘Propagate…’ to back-fill the Comments field.** The final image in this sequence is IMG_0013.JPG. Since we didn’t use the Copy Previous Values button, the comment fields from IMG_0007.JPG to IMG_0013.JPG fields are empty. Instead, right click on the Comments field label, and choose ‘Propagate from last non-empty value to here’.
Tip. The basic idea of the ‘Propagate From…’ feature is that you can fill in a field on one image, and then keep going through subsequent images until the last one that should have that field’s value. You can then ‘backfill’ the entries in your filtered view. However, this only works if those inbetween images have nothing in that field.

Alternately, you can use ‘Copy Forward…’. Again, you can fill in a field on one image. In this case, however, doing a Copy Forward will copy the value in that field, and overwrite it for all subsequent images in the filtered view. You then navigate the subsequent photos until you find something different. You enter the new value on that image and copy forward again. Repeat until you have gone through all images. Of course, you have to be careful not to over-write existing values (if you didn’t fill things in in sequence) and you have to be diligent in this practice, as otherwise you may have filled in fields that you didn’t really want to fill in.

In practice, you may use a combination of all these menu items along with the Copy Previous Value button to fill out these fields efficiently.

5. **Test it.** As before, scan through your images, and/or preview your data using the spreadsheet or database view.

**Introducing Videos**

**Video (VID_0015.avi).**

Various cameras take short videos (usually 5 – 30 seconds) whenever it detects movement. TIMELAPSE lets your analyze those videos as well as images. The sample set includes three videos that summarize an entire day’s activities. While these differ from the typical video produced by cameras, they suffice to illustrate how you can view videos within TIMELAPSE.

1. **Play the video.** Controls appear below the video. Pausing and playing the video is done via the video player buttons, or by hitting the space bar. Scrub through the video using the slider.
2. **Update the Weather field.** You can update any field while using the video player. For example, because the day is predominantly sunny, set the *Weather* field to Sunny.

**Notes:** Markers cannot be placed atop of videos. Also, check the date carefully – some cameras do not properly record a video’s date. Edit it if needed.

**Introducing QuickPaste**

As you go through your images, you may find that you are entering particular data patterns over and over again (e.g., 1 hiker, sunny). Creating QuickPaste entries for those patterns can significantly speed up the data entry process. See §QuickPaste.

**Remaining images and videos.**

Analyze the remaining images and videos, while at the same time exploring other features available through its menu.
Other Helpful Features

There are many other specialized features in Timelapse, not all of which are detailed in this manual. Most of those are well explained in the various dialog boxes that appear as you use Timelapse. However, the following are worth describing in detail.

Custom Selection

Overview

Selections allow you to view and work with a subset of your images. The stock selections available on the Selection menu mostly deal with image quality: whether images are light, dark, missing, corrupted, or marked as deleted.

Importantly, the Select | Custom selection menu option raises a dialog box that allows you to create a custom selection by composing a query. As illustrated below, the dialog lists most of your fields. You create a query by selecting one or more field (by clicking the checkbox on its left), selecting an expression from the menu, and entering a value on the right. If you select two or more fields, then you need to specify whether searches combine those queries using And vs. Or as explained shortly. Only those images whose fields match the selected queries will be shown.
Several example selections, starting from simple to more complex ones, are described below. If you have completed analyzing the sample tutorial set, you can use try these examples to your image set to see how they work.

**Querying on a single field**

1. **Show only images that are Publicity? shots.**
   
   ![Image Selection](image1.png)
   
   **Result:** Only images with the Publicity? field checked will be displayed.

2. **Show only images that have hikers in it.**
   
   ![Image Selection](image2.png)
   
   **Result:** Only images with at least one Hiker counted will be displayed.

3. **Show only images whose Weather field is not Sunny.**
   
   ![Image Selection](image3.png)
   
   **Result:** Only images where the contents of the Weather fields is anything but Sunny are displayed.

4. **Show only images within a sub-folder.**
   
   ![Image Selection](image4.png)
   
   **Result:** Only images where the contents of the RelativePath field matches the folder name will be displayed.

5. **Gotchas.** Only Counters (such as Hikers and Goats) are treated as numbers. For other fields, any comparisons are based on alphabetic ordering. This can lead to confusing results if you are not aware of it. For example, consider Temperature. Even though its contents may look like a number (e.g., 5 C, 12 C), it is treated as an alphabetic string. Thus the > and < expressions may not give you the results you expect.

   ![Image Selection](image5.png)
   
   **The unexpected result:** As temperature values whose first character is ≥2 match this query, your results will include temperatures of 2 C to 9 C, which is likely not what you wanted.

**Querying on a single field using GLOB pattern matching.**

One of the expressions available in the pull-down menu for some of your fields is ‘GLOB’. GLOB expressions lets you use ‘wildcards’ to match various character patterns as follow.
• * matches any number of characters
• ? matches any single character
• [abc] matches one character only if it is present within the brackets
• [a-z] matches one character only if it is within the range of indicated characters

1. Using Glob to reduce typing (e.g., to find particular comments).
   In the tutorial, you had entered a Comment called Sequence #1 for various images. You can use glob to minimize your typing (and possible typing errors as follows.

   ![Screenshot of glob usage](image)

   Result: Only images whose text begins with the characters ‘Seq’ will be displayed.

2. Finding Folders produce over two days using file names
   Our image folders for our tutorial follow a specific format: Site name-month-date. To find images in subfolders for both August 15th and 16, we can do the following.

   ![Screenshot of folder search](image)

   Result: Only images whose RelativePath fields begins Site1-08.1 and whose last character is a 5 or 6 will be displayed. That is, only Site1-08-16 and Site1-08.16 will match.

3. Finding a set of character matches.
   We previously saw that we cannot use ‘>’ or ‘<’ to filter reliably on Temperature, as it is considered an alphabetic rather than a numeric field. However, we can use GLOB to partially give us what we want. For example, to find Temperatures ≥ 10 C, we can construct the following query:

   ![Screenshot of temperature search](image)

   Result: Only Temperatures whose first character is 1 through 9, and whose second character is 0-9 will be displayed. Thus 10 C matches, as does 25 C, as does 100 C. However, 5 C won’t match as its second character is not a number.
**Querying on DateTime.**

The selection dialog box includes two *DateTime fields*.

The image set includes files taken on August 14 and 15th and on September 9.

1. **Find the file taken on August 14 at 19:50**
   
   To view only the files at an exact date and time, we can construct the following query.

   ![Query Example]

   **Result:** Only images taken on August 14, regardless of the time, will be displayed.

2. **Find all files after August 14**
   
   The image set includes files taken on August 14 and 15th and on September 9. To view only the files whose date is after August 14, we can construct the following query. Note that the time is set to 00:00:00, as we want to include everything from midnight onwards.

   ![Query Example]

   **Result:** Only images taken after August 14, regardless of the time, will be displayed.

3. **Gotchas**
   
   Remember that queries use both date and time. Thus `=` has to match both the date and time. Other operations apply not only to the indicated date, but to the indicated time included.

4. **Find all files taken on August 14**
   
   For this query, we need to use both DateTime controls to specify a range of dates between 00:00:00 and 11:59:59 on August 14.

   ![Query Example]

   **Result:** Only images taken on August 14 will be displayed.

5. **Find all files whose dates cannot be read.**
   
   On loading an image set for the first time, TIMELAPSE tries to read the date and time for each file. If it cannot read it, it just uses current date and time. Thus checking for all files taken after the last known date the images were taken (in this case after September 9th), would likely reveal the files those files.

   ![Query Example]

   **Result:** one image will be selected – in this case the corrupted file.
Multiple Queries using And vs. Or.

The Custom Selection allows you to specify several queries at the same time. Importantly, query results depend on whether they are combined using And vs. Or, as illustrated in the examples below.

**And:** The values in the image’s fields have to match each and every search query.

**Or:** The values in the image’s fields have to match at least one search query.

Note. When to DateTime fields are selected, they are always And’ed together regardless of whether And vs. Or are selected.

1. **Find all images that contain either counted goats, or counted hikers.**

   Result: All images that have any non-zero count in it, regardless of whether the count is of a hiker or a goat, will match the query.

2. **Find only those images that contain both a goat and a hiker in it.**

   Result: Only images that have at least one goat and one hiker in it will match the query.

3. **Find images with hikers present on rainy days.**

   Result: Only images where the weather is raining and where a hiker is counted will match the query.
Adjusting Thresholds for Determining Dark Images

When TIMELAPSE first loads your images, it tries to determine and mark those images that are dark (likely night-time) shots. This classification is particularly useful for cameras that are in timelapse mode (images taken at fixed time intervals), as it allows the analyst to later filter out (and possibly delete) many hundreds or thousands of images that are less than useful.

However, classifying dark images on loading is optional: turn this on by selecting the Options | Classifying dark images when first loading an image set menu item.

Instead, you can classify your dark images at any time via the Edit | Identify or reclassify dark files... menu option. This raises the following dialog. If you then click the Apply to selected files button, the files in the current selection will be classified.

![Classify dark images and videos dialog]

**What:** If dark image classification was skipped when the image set was loaded, you can perform it now by clicking ‘Apply...’. Or, to adjust and how dark vs. light images are determined, set various thresholds with the controls below, then ‘Apply’.

**Solution:** If you want to tune how classification is done, go to an image or video that you think is a typical ‘borderline’ dark versus ok case. The horizontal bar’s color reflects the current ‘dark pixel threshold’ (adjusted with the left slider), while the bar’s length shows how many pixels in the current image are below that threshold. The red line shows the ‘dark percentage threshold’ needed.
1. Drag the red line and the slider to adjust both thresholds, until satisfied with the classification.
2. Check other borderline images or videos to see if it improves classification. If not, repeat the above steps.
3. If it looks good, Apply those settings to all images and videos. Review and repeat if needed.
4. At any time, you can reset thresholds to their initial values or to the Carnassial defaults, and Apply them.

**Hint:** It helps to understand how Timelapse determines darkness through the following steps.
1. If it appears to be in color, then classify it as Ok (i.e., not dark).
2. Otherwise, count the number of pixels darker than a ‘grey color threshold’.
3. If the percentage of dark pixels is greater than the dark percentage threshold, then classify it as dark.
Alternately, you can use the above dialog to tweak how TIMELAPSE does the classification. But first we need to explain how TIMELAPSE does this classification. For each image, TIMELAPSE samples many of its pixels. It then classifies an image as ‘dark’ by:

- checking to see if the large majority of image pixels are grey-scale vs color;
- counting the number of grey-scale pixels that are darker than a grey-scale threshold;
- checking if the total ratio of dark pixels in the image exceeds a dark percentage threshold.

You can fine-tune how TIMELAPSE uses these two thresholds to determine which images are dark vs. light, and have Timelapse reclassify your images accordingly.

To illustrate this, the tutorial image set contains an image taken at dusk that TIMELAPSE classified as Ok (see above). However, perhaps you (as the analyst) would prefer to see this image classified as dark. For a single image, you could do this simply by changing the ImageQuality field to dark. However, this would be tedious indeed if you had other hundreds of similar images taken at dusk and twilight within your image set. To do this, you would use the controls as annotated below.
1. Select the Edit | Identify or reclassify dark files... menu option, which will display a dialog box similar to what is shown above.

2. Use the slider at the bottom to navigate to an image that you consider just on the edge of what should have been classified as a dark image (in your tutorial set, this would be IMG0118.JPG).

3. Examine the current threshold settings.
   - The dark pixel threshold slider determines how dark the pixel has to be before it is considered a ‘dark’ pixel. It is currently set to a grey-level of 60 (the actual color is used to color the bar at the right), which is currently a very dark grey.
   - The dark percentage threshold slider (the red vertical bar) determines how many pixels in the image have to be dark before the image is considered dark. It is currently set to 71%.

4. Examine the classification of the current image against these thresholds
   - The length of the bar indicates the actual percentage of dark pixels in this image, where the actual percentage is textually described below it (‘57% of the pixels are darker than the (grey color) threshold’).
   - Because the dark percentage threshold is 71%, the image is classified as Ok (also reflected in the text above).

5. Change the settings as follows. Note that this is somewhat done by trial and error.
   - Relax the dark pixel threshold, where somewhat lighter pixels should be classified as dark. This is useful for this particular image type, as the infrared flash has brightened the surround trees. As you move the grey color threshold slider to the right, you will see the bar getting lighter in color (to indicate the new dark pixel threshold), and longer (as more pixels are now classified as dark).
   - Decrease the dark percentage threshold values by moving the dark percentage threshold slider leftwards. As the slide meets the edge of the grey bar, you will see that your image classification will change from ‘Ok’ to ‘Dark’.

6. Examine other images to see how this classification works by using the navigation slider at the bottom. In particular, check for:
   - false positives (i.e., images you consider light that have been mis-classified as dark)
   - false negatives (i.e., images you consider dark that have been mis-classified as light)

   Readjust the thresholds as needed.

7. If you are happy with what you see, apply these thresholds to reclassify all your images. The image quality field for each image will be reset accordingly.

8. Timelapse saves these threshold settings, and will apply them to future image classifications. At any time, you can use the ‘Reset’ button to either:
   - revert to the default system settings
   - revert back to your own initial settings (e.g., if you made threshold changes in the dialog box that you did not like).
The Data Table

The Data Table view shows the current state of all your image set’s data. You can access it by clicking on the Data Table tab as shown below.

The Data Table looks somewhat similar to the spreadsheet that you can export from Timelapse, where each image’s data is shown in a row. It differs in that all data fields are displayed, including those not normally exported to the spreadsheet. Date information is also recorded in two formats: a Universal Time format in the DateTime and UtcOffset column, along with a more human-understandable Date and Time columns. Regardless of these differences, you can use the Data Table to inspect the data in your image set and to navigate to images.
The Data Table includes the following features.

- Pull out the Data Table into a separate window by dragging its title bar (show below)
- Navigate to a particular image by clicking a row
- Row highlighting indicates the currently viewed image, or the set of images currently selected in the overview (see below, where the first three images are selected and the corresponding rows highlighted)
- Sort the data by clicking the column title. For example, if you want to see which images have the most goats in it, clicking the ‘Goats’ column will sort the images by number.
Correcting Dates

Dates and times can be problematic for many reasons.

- The camera’s date and time setting may be wrong, so all images are ‘off’ by a given amount.
- Some cameras record dates ambiguously. For example, if your camera records the date as (say) 01/02/2016, this could be interpreted as January 2, 2016 or February 1, 2016.
- A change from daylight savings time to / from standard time may have occurred, which isn’t handled by your camera.
- The camera may keep time inaccurately, where times can drift (i.e., similar to a slow or fast watch)
- Even if time change is handled by your camera, your particular project may want all times to be recorded in Standard time vs. Daylight Savings Time.
- Cameras may be sited across different time zones, where – depending upon your particular project – you need to adjust the image times to account for that.

Because of these and other factors, TIMELAPSE provides various facilities to correct the date and time. You can do it individually via the DateTime control found in the interface. However, if the problem spans multiple images, you will probably want to correct all DateTime fields in bulk. Various date correction facilities are all found in the Edit / Date correction menu (a list of the Date correction menu options were described earlier). As they all work somewhat similarly, only one of these is described below: Edit / Date Correction / Correct for standard / daylight savings time Changes.

For illustrative purposes, lets pretend that the camera has been set to daylight savings time, and that daylight savings time changes to standard time on August 15 (even though the change time is actually in November). Your camera does not account for this. Your task is to correct the dates for your images from August 15 onwards by subtracting an hour.

1. Navigate to the first image that should have its time corrected. In your tutorial set, this would be IMG0101.JPG, taken on Aug-15 at 6:30 am).

2. Select Edit | Date Correction | Correct for Standard / Daylight Savings Time Changes, which will display a dialog box similar to what is shown here.
3. Click *Time Correction: Subtract an hour*, and *Propagate Correction: Forwards*. The adjusted date/time for this image will be shown below.

4. Click Okay. All images from this image onwards will have their time adjusted to decrease it by one hour. This includes changing the date if needed (e.g., if the original date of an image was a few minutes after midnight).

5. Click Okay. All images from this image onwards will have their time adjusted to decrease it by one hour. This includes changing the date if needed (e.g., if the original date of an image was a few minutes after midnight).

6. Check the dates. If something went wrong, you can re-read the original dates back from the image by selecting *Edit | Date Correction | Re-read dates from files...*
Understanding UTC Dates and Timezones

Feel free to skip this section if you are uninterested in time zone information.

In rare cases, you may want to view and edit time zone details about dates, or view dates and times using a ‘universal’ time rather than a local time. This is possible with Timelapse.

When Timelapse records a date, it assumes that the time zone you want to use is the one on your computer. Dates and Times are then recorded internally following UTC (aka Coordinated Universal Time) standard (e.g., see https://en.wikipedia.org/wiki/Coordinated_Universal_Time). This standard separates the time zone information from the date/time, where the time zone (including daylight savings time) is provided as an UTC offset (see below).

The Editor lets you configure the template to expose this UTC offset. When exposed, a Timelapse user will be able to view (but not edit) the UTC offset. In addition, data exported to the spreadsheet will include two new rows that contain the UTC DateTime and the UTC Offset. Adding the UTCOffset to the UTC DateTime will give the local time.

To configure the template to show the UTC offset, select View/Enable UTC Date Time Settings. This will expose a new UtcOffset row in the interface, as illustrated below. Then make that control Visible by checking the Visible checkbox. The resulting editor window will resemble the following. It now includes:

- A UtcOffset row in the editable grid
- If The UtcOffset control visibility is checked,
  - A new control called ‘UtcOffset’ in the simulated interface area
  - Two new columns called ‘DateTime’ and ‘UtcOffset’ in the spreadsheet area.
Now let's look at how this appears in the Timelapse window.

We see the DateTime recorded as the local time (i.e., it matches the date and time seen in the image). However, we also see that its UtcOffset from the UTC time is -6:00. That is, we would have to add 6 to get the real UTC time. This UtcOffset was calculated as follows.

1. Take the timezone from the local machine that created this image set. In this case, it was (UTC-7:00) Mountain Time (US & Canada)
2. Correct for Daylight Savings Time. As August is in daylight saving times, an hour was subtracted, giving a UtcOffset of this image of -6:00

Now let's export the data to a spreadsheet.
We see the Date and Time recorded in several columns.

1. **The DateTime** column records the **UTC time**, not the local time.
   - **Note**: the data field DateTime displayed in the Timelapse window is shown in local time.
2. The UtcOffset column records the **UTC offset**.
3. The **Date** column records the local **date**.
4. The Time column records the local **time**.

For example, in Row 1 the local time of 15:10:00 is calculated by adding the UTC offset to the UTC DateTime i.e., 21:10:00 – 6:00:00 = 15:10:00.

If it sounds complicated, don’t worry. You would likely only use UTC time if you really know all about UTC time standards, or if you want your spreadsheet to show date / time in the UTC format.
Changing the Name of your Image Folders

As described in the beginning of this manual, TIMELAPSE expects all your images to be located in your root folder (i.e., where your template is located), or in sub-folders of your root folder. The root folder name is stored in the *Folder* data field. If you use sub-folders, it stores the name of an image’s subfolder in the *RelativePath* data field along with the file name so it can find and display each image again.

**Case one. Changing your root folder name.** Let’s say you have already used TIMELAPSE on your images, but then decide to change the name of your root folder (or alternately, you may have moved all the files to a new folder location). To illustrate, consider an analyst who initially stored and analyzed images (along with the template) in a root folder named ‘toProcess’, but then later renames that folder to a more descriptive name, such as ‘2018-10-LakeMagenta’. When the analyst next loads the images in that folder, TIMELAPSE detects that the stored vs. actual root folder names differ. It will then raise the following dialog to ask the analyst if she wants to update the stored root folder name to match the name of the actual root folder currently containing the files.

Updating the name is optional, as the root folder name is stored only for informational purposes: TIMELAPSE does not need it to locate any of its files. For example, you may not want to update the root folder name if you moved (or copied) your files to a temporarily folder to work on them, and plan to move them back to their original location later.

**Case two. Changing your sub-folder name(s).** Let’s say you have already used TIMELAPSE on your images, but then decide to change the name of a sub-folder (e.g., perhaps to a more descriptive name). When you start TIMELAPSE afterwards, it will still be able to show each image’s previously analyzed data, but will be unable to display the image as it can no longer find the folder where that image is located.

TIMELAPSE does give you options in these cases. Whenever TIMELAPSE loads an image set’s data, it automatically checks to see that each sub-folder mentioned in that data exists. If it can’t find the sub-folder(s), it raises the following dialog to ask you to try to locate it, where you can point to its new name.
For this to work properly, the original images will still have to be located in the renamed folder under their original names, as otherwise TIMELAPSE will not be able to find those images. If it can't find an image, that image’s data is still displayed along with a placeholder ‘missing image’ instead of the original image.

**Note.** The renamed folder must still be a sub-folder of the root folder containing your template.
Dialog Boxes Arising from Changed Templates

TIMELAPSE uses the .tdb template file not only to create the interface, but to structure how it stores its data in an image set’s .ddb data file. Whenever a previously created image set is loaded with a template, Timelapse will examine the template for possible changes and will raise a dialog box notifying you if any of those changes will affect the data associated with your image set.

Case 1. Adding new control fields and associated data.

After various image sets have already been analyzed, your project manager may decide to add new control fields to the template, which in turn allows you to enter data in that field within TIMELAPSE. To illustrate, the project manager may have added

- a new Counter for Bears
- a new Counter for Moose

When you open an existing image set, Timelapse detects these changes and will ask for confirmation.

You are given two options:

- **Open using New Template**: Opens your image set with the new template you provided. The Timelapse interface will now include Bears and Moose counter controls, and Bear and Moose data columns are added to the database.
- **Open using Old Template**: Ignores the changes, and opens your image set using an internally stored old copy of the template. Your data is left unchanged, and the Bears and Moose counters will not appear in the Timelapse interface.
Case 2. Deleting existing control fields (which deletes any associated data).

In other cases, your project manager may decide that a particular field (and its associated data) are no longer needed. To illustrate, the project manager may delete from the template:

- Analyst field, after realizing that the analyst information isn’t particularly useful.

As before, when you open an existing image set, TIMELAPSE detects this deletion and will ask for confirmation.

**Important note.** Closely examine deletions, as deletions will delete any previously entered data associated with that field. You may want to check with the project manager who changed your template.

As an alternative to deleting a control field, the project manager could have made it invisible in template. This will retain any associated data.

Case 3. Renaming existing control fields (which retains any associated data).

Your project manager may decide to rename a particular field, which retains any associated data. Renaming is done by changing the data label associated with the control and your data (the data label is the text that appears atop the data column in your spreadsheet, which may differ from the name of the associated control displayed in the Timelapse interface). To illustrate, the project manager may rename the data labels for the two counters in the template:

- Goats is renamed GoatsCounter
- Hikers is renamed Hikers Counter

As before, when you open an existing image set, TIMELAPSE detects this change and will ask for confirmation. However, TIMELAPSE cannot tell the difference between a renamed control vs a control that has been added and another similar-type of control that has been deleted (e.g., deleting Goats and adding GoatCounter). Consequently, its confirmation dialog box will give you the option to differentiate between these two cases.

**Important note.** Differentiating between the two cases is important: Adding/Deleting will delete the original data, while Renaming will keep that data.

To specify that this is a Rename vs. a Delete/Add, click the ‘Rename to’ on both fields and choose the appropriate new names from the drop-down menu as follows:

![Control type and data label update action](image)
That’s it! If you spot any problems, or if you think of any ways that this tool should be improved, contact Saul Greenberg at saul.greenberg@ucalgary.ca.
Part 2. Creating Templates

Part 1 explained how to use the TIMELAPSE tool. That tool assumes that a template already exists and was included in the image set.

Part 2 explains and provides a tutorial on how to use the TIMELAPSETEMPLATEEDITOR. This is the tool that is usually used by the project manager to create a custom template that defines the project-specific data that he or she wants an analyst to encode.

Part 3 will explain the internal structure of the database tables created by TIMELAPSE. This is only of interest if you want to access the data directly rather than from a spreadsheet.

Part 4 is of interest only to those who used the older TIMELAPSE1 system, and who need to migrate their files to work with TIMELAPSE. It explains how to convert old-style CodeTemplate.xml and ImageData.xml files to the new format.

Note. What you see when you run the TIMELAPSETEMPLATEEDITOR may not exactly match the screen images in this manual, due to updates made in the program after the screen images were taken. These are mostly minor visual differences and/or added features that should not affect your general understanding.
Introduction to Templates

The kinds of information and things that you and/or your organization want to track and count will be specific to the kinds of images you want to analyze and the particular data you want to get out of it. This information will differ between organizations, and possibly between image sets and particular project managers. For example, a fisheries manager may want to count anglers on a shore and boats on a lake, while a wildlife manager may want to count large mammals.

The TIMELAPSETEMPLATEEDITOR (included with the Timelapse Software) allows you to create a template (a file) specifying the data you want to track. TIMELAPSE will use that template to create the fill-in data fields that appear at the top of the TIMELAPSE window. As described next, you create these templates by filling in a table, where each row of the table specifies the custom data you want.

You should give considerable thought to the information you want to capture and how it is structured. Essentially, you are creating a standard on how your images should be analyzed and – by extension – how you want your data named and recorded, perhaps added to a database via your spreadsheet, and (eventually) analyzed via statistics. We recommend you talk with others in your organization to see what their needs are, where you (perhaps) give them samples of the codes you want to use (or a sample image set with the code template file) to see if it matches their needs.

The tutorial assumes that you have read and tried out TIMELAPSE as described in Part I of this manual.

Important. Once you analyze an image set, you should not add new data fields or delete data fields in the template file used by that image set (i.e., the template stored in the image set folder). This is because the stored data will no longer match the information specified in the code template file. However, you are allowed to modify all but the DataLabel field.
1 Creating a Minimal Template

This tutorial will show you how to create the minimum template required by TIMELAPSE. Try it out by using either one of the sample image sets provided with TIMELAPSE, or by creating a folder with your own modest sample of images.

Creating the template

1. Start the TIMELAPSETEMPLATEEDITOR. It initially displays some brief instructional text.
2. Select the File | New menu item. It will ask you to select a location to save the template file.
3. Save it by its default name (TimelapseTemplate.tdb) in your test image set folder. The TIMELAPSETEMPLATEEDITOR should then display something like this:

You will see four main areas in this display.

- **Data field specification area** (top). Each row in this area specifies a single data field item and its attributes.
- **Data field appearance within TIMELAPSE** (lower middle) shows how the data will be displayed as fields in the TIMELAPSE user interface. You can drag those fields around to re-arrange their order.
- **Data columns in spreadsheet** (lower) roughly shows how the data will be displayed as columns in the spreadsheet generated by TIMELAPSE. You can also drag those columns around to re-arrange their order.
- **Row addition/deletion** (right) are buttons that let you add or remove particular types of rows into the table.

---

3 There may be differences between the version of the TimelapseTemplateEditor portrayed in this manual and the one you are currently using. Even so, the explanation provided should generally apply to all versions.
4. Quit the TimelapseTemplateEditor.

**Testing the template within TIMELAPSE**

1. Start Timelapse
2. Select *File | Load template, images, and video...* Navigate to the template created above.
3. TIMELAPSE should display something like this if you included any images in that folder.

If you compare the images above, you will see that the fields shown in TIMELAPSE (as well as their contents) directly mirrors each row in the data row area of the TIMELAPSETEMPLATEEDITOR.
2 Explaining the Minimal Template

Every TimelapseTemplate requires several mandatory data elements, which are automatically added when you create a new TimelapseTemplate. TIMELAPSE tries to fill in most of these data fields when you first process your images. As seen in the previous figure, these comprise several data Types, each present as a row in the data table:

- **File**: the name of the image file
- **Folder**: the name of the root folder containing the template
- **RelativePath**: the path from the root folder to the folder containing the image
- **DateTime**: the date and time the image was taken
- **ImageQuality**: System-determined image quality. One of
  i. Ok (if the image was ok);
  ii. Dark (if the image was mostly black, as in poor quality nighttime shots)
  iii. Corrupted (if the image cannot be read)
  iv. Missing (if the image is no longer available)
- **DeleteFlag**: allows you to ‘flag’ particular images for later deletion (see TIMELAPSE manual)

Each data element has several attributes, presented as columns in the data table, as follows.

- **Type**: the type of data. In addition to the above, types include
  i. **Counters** for counting specific entities in an image, e.g., number of goats)
  ii. **FixedChoices aka Choices** for choosing from a set of items presented in a menu
  iii. **Notes** free-form text
  iv. **Flags** for boolean true / false values
- **Default Value**: the initial value of that data (which may be left empty) when images are first loaded into TIMELAPSE.
- **Label**: how the data field should be labelled in the TIMELAPSE user interface
- **DataLabel**: how this field should appear as a column header in the .cvs spreadsheet file. DataLabels must be unique, and its text can only comprise a mix of alphanumeric letters and '_'.
- **Tooltip**: defines the text displayed whenever the analyst hovers over a field. This is handy to remind the analyst as to the meaning of the label.
- **Width**: defines the width of the textbox associated with item. While the units are somewhat arcane, you can see the resulting width in the lower area. Ideally, the width is just wide enough to fit expected values
- **Copyable**: Defines whether that field is affected by the Copy Previous Values button in the TIMELAPSE tool. When the Copy Previous Values button is pressed, only those fields marked as copyable will have its data copied from the previous image to the current image. Copyable field appear in yellow in TIMELAPSE when the user hovers over the Copy Previous Values button.
- **Visible**: defines whether the field should be displayed in the user interface, and should be set to either true or false. Invisible fields and their default values are still displayed in the spreadsheet. Reasons for having invisible items include:
  o **Reducing clutter** on the TIMELAPSE interface by hiding fields not used or not needed by the analyst.
  o **Creating fixed data that should always be present** but that the analyst does not need to see. As an example, each image may be associated with the name of the organization who owns it. To do this, a note could be labelled ‘Organization’ and its DefaultValue set to that organization’s name. if it is set to invisible, it won’t appear on the interface but it will appear on the spreadsheet.
• **List**: Choice fields have one additional property, called **List**. This contains a series of **Items**. The values of these items define the names of the items in the pull-down menu associated with each Choice. The image below show how a Choice list is displayed as a pull-down menu when using TIMELAPSE.

![Choice list example](image)

*Note.* The Default Value of a Choice row must be either empty, or must match an item in your Choice list. An warning dialog will appear if they don’t match.

• **Editable fields are displayed in white, while non-editable fields are in grey.**

  *Note.* You cannot delete required data rows (i.e. those whose types are colored grey). However, you can edit some of their properties, as will be shown shortly.

  Editable fields are displayed in white, while non-editable fields are in grey.
3 Modifying the Minimal Template

This exercise will show you several basic methods for editing and modifying the template. This exercise uses these methods to modify the minimum template created in Exercise 1.

To begin,

1. Start the TimelapseTemplateEditor.
2. Select the File / Open menu item. Select the location where you had previously saved the template file. Alternately, you can just create a new template and over-write the old one.
3. Save it by its default name (TimelapseTemplate.tdb) in your root folder.

The TIMELAPSETEMPLATEEDITOR should now appear, where it is identical to what you saw in Exercise 1.

Editing Fields.

We will modify the appearance of the File field, and make the RelativePath field invisible.

1. Modify the text for the File type by changing its Label from ‘File’ to ‘Image’, the Tooltip text, and by increasing its Width to 200
2. Also modify the RelativePath Field by deselecting its ‘Visible’ property.
3. Quit the TIMELAPSETEMPLATEEDITOR, and open TIMELAPSE with the ImageSet to see if the changes worked.

Here is my example below, where we compare it with what is now shown in TIMELAPSE. Note how the image field is now much wider than before.

Note. Not all fields are editable. Editable fields are displayed in white, while non-editable fields are in grey.
Changing the Order of Fields Displayed in TIMELAPSE.

We will change the sort order so that the Date and Time will appear first.

1. Open the TIMELAPSETEMPLATEEDITOR as before, with the same TimelapseTemplate.tdb file.
2. The middle region includes an area that shows how the fields will appear in TIMELAPSE. It should look like:

   ![Image](image.png)

3. Select the ‘Date’ label (not its text box), drag it over the ‘Image’ label, and drop it. The Date field should now be in front of the Image field.

4. Do the same for the ‘Time’ label. You should now see:

   ![Image](image.png)

5. Quit the editor and open TIMELAPSE. The order of those fields in TIMELAPSE should reflect what you have just done.

   ![Image](image.png)
Changing the Column Order Displayed in the Spreadsheet

The spreadsheet produced by TIMELAPSE displays the data as columns. We will change the sort order of those columns so that the Folder, Time, Data and File appear in that order.

1. Open the TIMELAPSETEMPLATEEDITOR as before, with the same TimelapseTemplate.tdb file.

   The bottom region includes an area that shows how the columns appear in TIMELAPSE. It should look like:

   ![The spreadsheet column order. Drag and drop columns to re-arrange their order to your preference]

   The spreadsheet column order. Drag and drop columns to re-arrange their order to your preference

   | File | Folder | Date | Time | ImageQuality | MarkForDeletion |

2. Select the ‘Folder’ text and drag/drop it to the left side of the ‘File’ text. The Folder column should now be the first one. Similarly, drag and drop the Time and Date items to their new positions. It should look like:

   ![The spreadsheet column order. Drag and drop columns to re-arrange their order to your preference]

   The spreadsheet column order. Drag and drop columns to re-arrange their order to your preference

   | Folder | Time | Date | File | RelativePath | ImageQuality | DeleteFlag |

3. Quit the editor and open TIMELAPSE. Using the File menu, preview the spreadsheet. The columns in Excel should reflect the above new ordering:

   ![Excel spreadsheet with columns ordered as Folder, Time, Date, File, RelativePath, ImageQuality, DeleteFlag]

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>File</th>
<th>RelativePath</th>
<th>Folder</th>
<th>ImageQuality</th>
<th>DeleteFlag</th>
</tr>
</thead>
<tbody>
<tr>
<td>14-Aug-10 15:10:00 IMG_0001.JPG</td>
<td>Site-1-08.14</td>
<td>TutorialImageSet</td>
<td>Ok</td>
<td>TRUE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-Aug-10 16:40:00 IMG_0002.JPG</td>
<td>Site-1-08.14</td>
<td>TutorialImageSet</td>
<td>Ok</td>
<td>TRUE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-Aug-10 16:45:00 IMG_0003.JPG</td>
<td>Site-1-08.14</td>
<td>TutorialImageSet</td>
<td>Ok</td>
<td>FALSE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14-Aug-10 16:50:00 IMG_0004.JPG</td>
<td>Site-1-08.14</td>
<td>TutorialImageSet</td>
<td>Ok</td>
<td>FALSE</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Adding New Data Fields as Rows

The power of using templates is that you can add data rows (i.e., new data fields) that are unique to your own projects. As explained earlier, these can be one of four types: count, note, choice, or a flag. This tutorial will show you how to create and modify those four types.

For this exercise, assume you are a biologist described in Part I of this tutorial, who wants to create a template that includes the following custom data fields. The type is most appropriate for that field is shown at the right.

- **Goats**: a count of how many goats appear in an image   -> **Counter**
- **Hikers**: a count of how many hikers appear in an image   -> **Counter**
- **Weather**: sunny, cloudy, foggy, raining or snowing   -> **FixedChoice**
- **Temperature**: the temperature in Celsius, to be extracted from image metadata   -> **Note**
- **Analyst**: name of the analyst analyzing the image   -> **Note**
- **Comments**: optional comments about the image   -> **Note**
- **Publicity?**: whether the image is useful for publicity purposes   -> **Flag**

At the end, the biologist want the interface in Timelapse and the spreadsheet to look something like the following.
Adding Data Fields as Rows

We begin afresh. Delete the old TimelapseTemplate.tdb file from your image set. Then start the TIMELAPSETEMPLATEEDITOR, and create a new template (as in Exercise 1). This will create a template with all its default fields present.

We need to create 2 Counters (Goats, Hikers), 1 Choice (Weather), 3 Notes (Temperature, Analyst and Comments), and 1 flag (Publicity?).

1. Click on Count twice (right side of display) to add a row. Each row defines a data field of the type Counter.
2. Similarly, click the Choice button to add a row defining 1 Choice field, the Note button to add 3 Note fields, and the Flag button to add a Flag field.

The display should be similar to what is shown below. The image annotates, by using red boxes, the way these new fields now appear in the various parts of the interface.
Editing Rows

Using the editing methods in the previous exercise, change the text in the various rows to make them more meaningful. An example is illustrated below. Note that the lower areas will change to reflect what is in the Data Table.

If you make a mistake, you can select a row and delete it using the ‘Remove’ button. Try it by adding a row and then deleting it.

Note that these modifications are important for creating a comprehensive system representing the data you are interested in, as described below.

- Specify an understandable Label and tooltip that will be presented in the interface
- Specify a (possibly different) Data Label used to label a column in the spreadsheet.
- Adjust the Width of some of the fields (e.g., wider for comments, smaller for counts as we don’t expect large numbers)
- Counters are usually not Copyable (as we expect counts to change between images)
- Change the Temperature counter to not Copyable (as we expect those values to be read in from image metadata)
- Provide a different Data Label (‘PublicityShot’) vs Label (‘Publicity?’). The label that will be displayed in the TIMELAPSE interface, while the Data Label will be displayed as the column header in the spreadsheet.
- Provide default values if needed.

Very Important Notes on Data Labels.
- The Data Label identifies your field within TIMELAPSE, as well as in the final spreadsheet.
- Data Labels must have unique names, and can only contain alphanumeric and the '_' character. No white space is allowed. TIMELAPSE will warn you if you enter non-unique names and/or problematic characters.
Adding Items to a Choice’s List

1. Add the three list items to the Weather row. To do this, click the ‘Define List’ button in the List Column. A popup window will appear allowing you to create and edit the items, with one item per line. Type in “Sunny”, “Raining” and “Snowing”, each on a separate line. You can edit these entries at any time, e.g., to add, modify or delete items, and to change their order.
   - If you want your analyst to be able to clear any fields, click the Include an ‘empty’ item checkbox at its bottom.
   - You can also specify a default setting in the Default Value column, as long as it’s identical to one of your entries on the choice menu.

2. Quit the editor and start TIMELAPSE. The interface should reflect what you specified, as illustrated below. The Weather pull-down menu is raised to illustrate its contents.

If you do all the above, then you should have reproduced the .tdb template that was included in the TutorialImageSet. You should have no problems creating your own custom Code Template file.
Other things to try

1. Try reordering a few of the fields to change how they appear in the interface and in the spreadsheet.
2. Try changing the visibility of the fields.
3. Add default values to various fields (e.g., set the Comment default text to ‘No comment’. Note that defaults are applied only when you first load images via TIMELAPSE.
4. Inspect the metadata available on the images you expect to use. Note that metadata is camera-specific, so you should inspect metadata for each camera model you have. To do this, choose View | Inspect Image Metadata and then click the Inspect Image button to navigate to a typical image. You will see something like the image below.
5. If you see metadata that you may want your analysts to include, create a Note field that will eventually hold that data. For example, the AmbientTemperature metadata includes the temperature in Celsius for each image taken with this particular camera model. In our example above, the project manager has done so by creating a field called Temperature.

![Inspect what metadata is available in an image of your choosing](image.png)
Changing the Template after the Fact

See Part 1: Dialog Boxes Arising from Changed Templates

TIMELAPSE uses the .tdb template file not only to create the interface, but to structure how it stores its data in an image set’s .ddb data file. In particular, it uses the Data Label to match the field described in the template .tdb to the data stored in the .ddb data file. This has implications and limits to how edits to the template are currently managed after a .ddb was created.

Consider the case where:

- an analyst has an image set with a TimelapseTemplate.tdb in it and has begun analyzing those images.
- The analyst (or perhaps someone else) then decides to change the template.
- The analyst tries to reopen the image set for further analysis using the modified template.

What happens next depends upon the changes that were made in the template.

Changing how controls appear in Timelapse and their order in the spreadsheet

Some changes only alters how controls appear in the Timelapse interface and/or the order that your data is shown in the spreadsheet. They do not affect how your existing and future data is stored and used. Consequently, these changes will be applied automatically when you reload an image set with a template modified as follows.

- edit and alter any field in any row **EXCEPT** the Data Label.
- change a field’s Copyable status and Visibility status.
- change the position of those fields in the interface
- change the position of those fields the spreadsheet
- add items to the Choice menu

Adding, Deleting and Renaming controls

Adding, deleting and renaming controls has implications to the data already stored in a previously created image set. Consequently, Timelapse will check your template against the data, and will notify you (via a dialog box) of the implications that will have on your stored data. At that point, you will be able to open your data using either the new template you provided, or with the template originally used to create your data (which is stored internally by Timelapse).

- **Adding a control:** Adding a row in the template editor defines a new control that will appear in the Timelapse interface, and a new data column in the database and spreadsheet (labeled with the control’s Data label).
- **Deleting a control:** Removing a row in the template editor means it will no longer appear in the Timelapse interface. Perhaps more importantly, any previously entered data associated with that control will be deleted as well from the database, and will not appear in the spreadsheet.

  Note. If you want to keep the data, then just uncheck the control's visibility field instead of deleting it.

- **Renaming a control:** Changing a row’s data label in the template editor has two possibilities, where it can be viewed as:
- deleting that row, and then adding a new row, which deletes the data associated with
  the original data label
- renaming that row, which retains and associates the data with the new data label.

As Timelapse cannot tell which possibility has occurred, it will raise a dialog box asking you to
decide which action to take.

For example, if you changed the Data label of ‘Temperature’ to ‘Temp’, Timelapse will warn you
and ask you what it should do. If you wanted to keep the data previously associated with
‘Temperature’ you would click on Rename to and select ‘Temp’ from the pull-down menu.

You try. Alter the template after you’ve created a.ddb file and then opening up TIMELAPSE again with that
image set. You’ll see what changes work and where TIMELAPSE gives you an error message.
5 UTC Offsets and Timezones
See §Understanding UTC Dates and Timezones in the Timelapse section of this manual.

6 Appendix – Technical details
Internally, the template .tdb file is maintained as an SQLite database, where the information you provide is saved as a database table called TemplateTable. However, you don’t have to know anything about SQL or databases to create these files. The TIMELAPSETEMPLATEEDITOR takes care of all the grotty technical details.

To see what the database stores, select View | Show All Columns. The window will now display several other non-editable extra columns that are stored in the database table that are not normally made visible.

Making these columns visible is useful for technical debugging purposes, but little else. These extra columns are:

- **ID**: The internal database ID of each row
- **Control order**: represents the sort order for displaying controls (which is used to construct the sample interface in the middle window)
- **Spreadsheet order**: represents the sort order for the spreadsheet columns (which is used to construct the sample interface in the middle window)
Part 3. Automatic Image Recognition

Part 3 explains how image recognition information can be imported from a 3rd party, and how it can be incorporated into the workflow.
Background

A ‘holy grail’ of camera trap analysis is automated image recognition, where a computer automatically inspects your images and identifies what is occurring within them. We will refer to two types of image recognition:

- A detector detects whether something is in an image, and assigns a coarse label to it (e.g., animal, person, vehicle). We will refer to “a thing the detector found in an image”, e.g. an animal or person, as “a detection”.

- A classifier identifies fine-grained object categories. In Timelapse workflows, these categories will typically be different species of animal (e.g., elk, wolf, bear, dog).

Timelapse does not do image recognition by itself. Rather, Timelapse imports image recognition data from a 3rd party, and provide facilities for the analyst to use that information to improve their workflow.

In particular, Microsoft’s AI for Earth program is developing both detectors and classifiers for camera trap images. Microsoft works with collaborators to run their camera trap images through these models, producing data files containing detection information (which images have animals or people in them?) and in some cases classification information (which species are in each image?). Timelapse can then import that data, allowing the user to view and operate on the recognition information, which you can use to streamline your workflow.

Note: We do expect other companies and agencies will develop their own image classification systems, and will produce similar files in the future. For now, using detection and classification data within Timelapse is limited to those agencies that are using the Microsoft system. Contact cameratraps@microsoft.com if you’re interested in experimenting with this system, or – if you’re a “DIY type” – visit their GitHub page to try these models directly.

In its current form, Timelapse focuses on using the detection information to improve workflows (incorporating classification information is still in progress). Specifically, Timelapse displays detection information when reviewing images, and – more importantly – lets you use the detection information in selecting images. This section will discuss how you can use these capabilities to accelerate your analysis.

Timelapse displays detection information as one or more colored boxes atop the image (red for animal, blue for person), where the color’s intensity depends on its confidence. Hovering over the box outline will display the detector information, along with the classification information (if any). The left image below, for example, shows a really good detection – high confidence, fairly clean. The right image, on the other hand, is much messier – while it correctly identified that there may be several people in the image, it show various possibilities of what it thinks is a person, and all at fairly low confidence.
Caveat. As mentioned, Timelapse currently lets you work with the detection data, but not the classification data (except to display it). This will change in later versions of Timelapse.

Detection is not a magic bullet. While it works reasonably well at high confidence levels, there are several types of errors. We will use the following terminology to refer to error types:

- **False positives**: it identifies something as being there when nothing is actually there.
- **False negatives**: it misses the presence of an animal or person in the scene.
- **Incorrect identifications**: it detects an entity, but incorrectly labels it (e.g. an animal instead of a person).
- **Ambiguity**: it detects several overlapping – and possibly conflicting – detections.

Because detection errors are a fact of life, you can’t blindly accept all detection results – unless you are very tolerant of errors. Instead, you should consider detections as information that can augment your workflow, as will be described shortly.

**Why use automatic image recognition?**

Image recognition will ease your image analysis task mostly by helping you rapidly identify images with animals in them, and eliminating images that do not require further analysis. In particular, it will help you:

- **Eliminate empty images** from any further inspection
- **Eliminate ambiguous images** such as those that may have something in them, but where the entity is not recognizable (e.g. a night-time blurry shot of an animal’s rump)
- **Identify images containing people**, which is especially important if your agency has a privacy policy that requires those images to handled somewhat differently from other images
- **Identify images containing animals**, where you will inspect those in detail, for example, to classify or count what animals are present.
Getting recognition data for your images

Microsoft is still experimenting with its MegaDetector, and thus partners directly with agencies who are collecting camera trap data for wildlife studies. If you are interested in working with the Microsoft team, contact cameratraps@microsoft.com.

The relevant models are also publicly available; if you are interested in trying these models directly, and/or you work with technical colleagues who can help you through the “nuts and bolts”, visit https://github.com/Microsoft/CameraTraps to download models and code samples.

Whether you worked with Microsoft directly or ran their models yourself, the remainder of this section will assume that you have an image recognition results file in the .json format used by the Microsoft system.

Turning recognition capabilities on

By default, the user interface allowing you to interact with recognition data is turned off, so it does not add clutter to those who aren’t using recognition. To turn on recognition capabilities, select Option | Preferences and check the ‘Turn on detection controls’ box.

Importing recognition files

As per above, once your images are processed (by you or by Microsoft), you will end up with one or more .json files containing recognition data. These files – which can be really large – contain information for every image. This includes the relative path of the image, and Timelapse will look for that image by its relative path. Thus it is important that your image files are placed in folders that correspond to the original folders given to Microsoft, as otherwise Timelapse may be unable to match the detection data with your images. To make sure recognition data is associated correctly with your images:

- Place the .json file into the same folder as your .tdb file.
- Make sure detection controls are turned on (see above).
- Import the .json file by selecting File | Import image recognition data for this image set.
Note. Large projects may have many different cameras located at different sites, where camera images may be retrieved periodically. These would then be stored hierarchically in folders and sub-folders. The example illustrated on the right organizes all images within a root folder called ‘WildlifeProject’, which in turn contains sub-folders identifying camera sites (e.g., Site01). Each site then contains sub-folders identifying particular date ranges from a camera card retrieved from the camera.

Most Timelapse users prefer to process images on a sub-folder level. For example, they may do it on a sub-folder containing images retrieved from a camera card for a certain date interval, where the .tdb file would be placed in that folder.

When you give Microsoft the WildlifeProject folder, by default they will create one .json file describing all images in the WildlifeProject. If you copy that into the sub-folder containing your .tdb file, Timelapse will try to make sense of the paths in there to identify where the actual images are located, but this will slow things down. Alternately, tell Microsoft that you want .json files to be split up, one for each one of the folders that will eventually contain the Timelapse .tdb file.

Selecting images that fit some detection criteria

As discussed in Section 1, Select | Custom Selection displays a dialog box that allows you to select a subset of your images to view according to some criteria. When detection controls are enabled and a recognition file has been imported, that dialog box will now includes a ‘Detections’ area, as illustrated below.

Checking the desired Select checkbox will filter images according to the detections contained in the recognition data. With the Categories drop-down menu, you can select images where ‘animal’ or ‘person’ or ‘empty’ was detected. By setting the Confidence interval, you can restrict those detections to only those matching that confidence interval.

In the example figure, the analyst has asked Timelapse to only display images where the detector has detected an animal with a confidence between .8 and 1 (i.e., the detector is pretty confidence that it found an animal).
Viewing bounding boxes

The detector associates a “bounding box” with each detection, i.e. the region of the image that it thinks may contain an object. Each detection is also associated with a confidence value: the detector may be more or less certain that this box really contains an object. You will almost always be viewing bounding boxes above some confidence level; i.e., it’s rarely helpful to look at bounding boxes that the detector is only 10% confident in. Consequently, Timelapse varies the intensity of the bounding box color with confidence, and you can direct Timelapse to show only bounding boxes that are above some threshold.

As previously mentioned, the Options|Preferences menu will raise a dialog box that includes the following detection settings. The slider at the bottom lets you set the threshold for displaying bounding boxes. For example, if you set it to .6, only detections with a confidence of .6 or higher will be displayed. Experiment with what setting is appropriate by reviewing your images. 0.7 is the default, and values from 0.6 to 0.9 are typical.

**Automated Image Recognition**

Timelapse can import image recognition files produced by a third party (see manual). If you have access to these files, expose the menu controls that will let you import and use recognition data.

- Turn on image recognition controls
- Display bounding boxes around detected objects when it exceeds this confidence threshold

**Bounding box confidence threshold: 0.70**

What does ‘confidence’ really mean?

Confidence is best seen as a rough measure of how likely it is that a detection corresponds to a real object. The reliability of this confidence value will vary from dataset to dataset, so the best way to judge a reasonable confidence level is by reviewing your images. Typically, a confidence of 1 is mostly correct, as is the range between 0.9 and 1. 0.8 to 0.9 is usually correct. Ranges below 0.8 are much more suspect, where you will begin to see many more false positives.

An example Timelapse recognition workflow

Our recommended workflow strategy depends upon you selecting a subset of your images to display (via Select / Custom Selection), inspecting those images, and setting data values for the images displayed. While it may seem like the following steps adds work, you will find that – depending on your images – you can quickly reduce the number of images you need to review for detailed classification. For example, with a sample image set of ~2000 images, it took about 10 minutes to catalog about 1500 images as empty, ~250 as containing people, and ~250 containing animals. I could then focus on classifying those 250 animal images.

**Getting ready**

1. In the Timelapse Template, create three flags called ‘Person’, ‘Animal’, and ‘Empty’. Note that these are not required and have no special meaning to Timelapse. We use these as just part of an example workflow to track what we’ve seen and what we’ve corrected.
2. Load in your images as in Section 1.

3. Move the appropriate .json detection file to the same folder as your template.

4. Select File | Import Detection data for this image set to import the .json file.

**Filtering out empty images**

Your goal in this step is to remove empty images from any further consideration.

5. Use the Custom Select to select the images where the detector thinks nothing is in them.
   - Select Category, with the value ‘Empty’.
   - Uncheck ‘Confidence’ as it doesn’t apply to empty images.
   - Click ‘Okay’.

![Image Recognition](image.png)

6. Tentatively indicate these images are all empty by setting the ‘Empty’ flag to true.
   - In your data entry area, check the ‘Empty’ flag.
   - Right-click that flag to raise the context menu, and select ‘Copy to all’.

![Empty? Checkmark](image.png)

7. Review those images until you are satisfied that the detector was reasonably accurate at identifying images without animals or people in it. You can do this efficiently by using one or both of these strategies:
   - Use the FilePlayer to automatically play the images at various speeds. See Options | Adjust File Player Speeds to control the playback speed.
   - Use the overview to display multiple images at a time, where you can use the FilePlayer control to scroll through pages of images.

**Note.** A custom selection will show the last image (or as close to it as it could get) that was previously selected. Remember to scroll back to the first image before reviewing them, as otherwise you will miss some of them.

8. If the detector is working well, the vast majority of images you see will be empty. If you do see images that contain animals or people (false negatives), you can uncheck the ‘Empty’ field for
those images. At the same time, you can broadly classify those by checking the ‘Person’ or ‘Animal’ field.

9. Depending on your tolerance for errors, you may want to review all images carefully and correct for false negatives, or just look for glaring errors and correct those. Alternately, you may want to stop reviewing empty images if you feel the detector’s accuracy was good enough.

**Marking the majority of images with animals in them**

Your goal in this step is to identify as many images as possible with animals in them for later classification.

10. Select the images where the detector has a high confidence that an animal is in them
   - In the custom selection dialog, select Category as ‘animal’ and Confidence from .9 to 1. Click Okay.

   ![Image Recognition](image)

   - **Image Recognition**
     - **Select**
     - **Criteria**
     - **Value**
     - **Category**
     - **animal**
     - **Confidence**
     - **from** .90
     - **to** 1.00

11. Similar to before, tentatively indicate an animal is present in these images by setting the ‘Animals’ flag to true for all images in the current selection.

   ![Animals?](image)

12. Use the FilePlayer and/or the Overview to review these images.
   - If you see an image that does not contain animals (false positives) click on the ‘Animal’ flag to clear it. If the image is empty, click the ‘Empty’ flag.
   - As before, depending on your tolerance for errors, you may want to review all images carefully and correct for false positives, or just look for glaring errors and correct those. Or, you may want to stop reviewing the images if you feel the detector’s accuracy was good enough. As you’ve previously set them all to ‘animals’, you don’t have to do anything more.

   **Note.** When reviewing images, you may want to use the FilePlayer to rapidly scan images with high detection confidence (as there will be few errors to correct). However, at lower confidence levels you may opt to use the Overview, or even go through every image manually, as you may want to individually select and categorize particular images.
13. Repeat the above, but this time by setting the confidence from .8 to .9, then between .7 and .8, and so on.
   • When you begin to see that the detector is getting things more wrong than right, don’t set the animal flag via ‘Copy to All’. Rather, review the images and click only on the ones with an animal in it.
   • At some point, again depending on your tolerance for errors, you may decide to stop reviewing images below a certain confidence threshold.
   • Note: a range including 0 (e.g., 0 - 0.1) includes all empty images.

Marking the majority of images with people in them

Some organizations require, usually due to privacy policies, that images with people in it be identified and even discarded. Alternately, you may be counting people in your images, or you may not be interested in images with people in the context a wildlife survey. In any of these scenarios, it’s useful to rapidly identify the subset of images that contain people.

14. As with animals, select the images where the detector has a high confidence that a person is in them. Repeat the same steps described above for animals, but this time for people.

Double-checking

15. If desired, review the final results for errors, again using the custom selection dialog. You should unselect the Detection checkboxes, and select the data checkboxes as needed. To double-check:
   • ...whether you missed any images, uncheck the Person, Animals, and Empty checkboxes
   • ...your empty images, select and checkmark the Empty checkbox only
   • ...your person images, select and checkmark the Person checkbox only
   • ...your animal images, select and checkmark the Animals checkbox only

For example, to review only the images you’ve marked as containing animals:

<table>
<thead>
<tr>
<th>Animals?</th>
<th>Person?</th>
<th>Empty?</th>
<th>Animals = true</th>
</tr>
</thead>
<tbody>
<tr>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>✔️</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Detailed classification

16. To classify your animals by species and/or to count them, select and checkmark the Animals checkbox. All other images (which could be a considerable number) will now be filtered from view.

17. Similarly, to classify and/or count people, select and checkmark the Person checkbox. All other images (which could be a considerable number) will now be filtered from view.

18. To discard empty images (if desired)
   • Select the Empty checkbox
   • In your data entry area, checkmark the ‘Delete?’ flag (you may have to set it as ‘Visible’ in the template .tdb file)
   • Right-click that flag to raise the context menu, and select ‘Copy to all’.
• Use the *Delete* menu to delete all those files (and optionally its data)

19. To discard people images (if desired), repeat the process above except with ‘People’ selected

**Note.** You may not need the ‘empty’ flag, as an image that does not flag the presence of a person or an animal is, by definition, empty. However, using all three flags are useful for error management and checking.
Part 4. The Timelapse Database

Part 4 explains the internal structure of the database tables created by TIMELAPSE. This is only of interest if you want to access the data directly from the database rather than from the .csv file.
Timelapse saves all your data (as well as other information) in a file called TimelapseData.ddb, which is an SQLite database. If you want to access the database directly (rather than the exported spreadsheet), read on. Otherwise you can ignore this section.

You can directly access the TimelapseData.ddb database using software of your choice. For example:

- **R** is often used to access the database and perform statistical analysis of that data.
- **SQLite database editors.** There are myriads of free tools available that will let you view SQLite database files, query them, and even modify their entries (e.g., SQLite Browser [http://sqlitebrowser.org/](http://sqlitebrowser.org/), SQLiteAdmin [http://sqliteadmin.orbmu2k.de/](http://sqliteadmin.orbmu2k.de/)).

Be aware that altering the database files (e.g., by adding or deleting columns to it) can compromise Timelapse’s ability to read those files. Make sure to back up those files before you do any modifications.

The TimelapseData.ddb file contains four tables, as described below.

## DataTable

The DataTable is the one of most interest to you, as it contains all the data entered by the analyzer.

The figure below illustrates an example DataTable as held by the database (and as viewed within SQLite Administrator). Each column corresponds to the DataLabel as specified in the TimelapseTemplate file. Each row’s ID should correspond to the original order that the images were read in. If the analyst had deleted an image and its data, that row would no longer appear (i.e., the Id column would appear to skip a number). Note that a UTCOffset and DateTime field is present regardless of how you set the UTC option in your template. See §UTCOffset/DateTime to understand how those values are combined to get the local time.

![Example DataTable](image)

## TemplateTable

The TemplateTable is a copy of the template that was originally read from the TimelapseTemplate.tdb file when the image set was first analyzed. It is kept as a fall back if, for some reason, there are inconsistencies in the TimelapseTemplate.tdb file and the way the data is stored. An example is illustrated below. Note that the List (used to create the choice menu) has each entry that defines the menu item separated by a ‘|’.

When Timelapse reads in the TimelapseTemplate.tdb file, it tries to match its datalabels with those stored in the DataTable. If it can’t (e.g., because you added or deleted columns or changed the DataLabel names), it will use the internal copy instead. If you understand database tables, you may be able to fiddle with both the DataTable and TemplateTable to allow for new template structures (e.g., by

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adding or deleting columns, by changing DataLabel names), but be careful! Backup the file just in case. Future versions of Timelapse will allow for such modifications.

Although we suspect you will not need to access this table, it may be of interest if you want to retrieve the information associated with each field.

![SQL Query Result](image)

**Note:** two new rows have been introduced in recent versions of Timelapse as shown above: **DateTime** and **UtcOffset**. See *Understanding UTC Dates and Timezones* in the Timelapse section of this manual.

**ImageSetTable**

The ImageSetTable is likely of no interest to you. It records information about the entire image set, which in turn is used to restore state information when you restart Timelapse. **TLog:** the contents of the notes Timelapse lets you add through the Edit / ‘Edit Notes for this Image Set’ menu item.

- **Magnifier:** whether the magnifying glass is visible
- **Row:** The last image the user was viewing
- **WhiteSpaceTrimmed:** used internally by Timelapse to maintain backwards compatibility
- **Timezone:** The global timezone of the user’s computer. Used internally to store date information.
- **VersionCompatability:** The last version of Timelapse used to open this database.
- **SortCriteria:** The last used criteria used to sort the images
- **QuickPasteXML:** used internally by Timelapse to save/restore the QuickPaste information.
The MarkersTable is likely of no interest to you. It records the position of the visual markers that are used to mark counts. Positions are $x,y$ ratios reflecting their relative positions on the image. The figure below illustrates the DataTable as held by the database before the analyst actually entered any data. Multiple markers are separated by a ‘$|$’

<table>
<thead>
<tr>
<th>Id</th>
<th>Sheep</th>
<th>Hikers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.359,0.882</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.674,0.291</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.722,0.223</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.584,0.428</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Part 5. Migrating from **TIMELAPSE 1** to **TIMELAPSE 2**
1 Introduction

The previous and now quite old version of TIMELAPSE1 (version 1) used a different file structure to store both the template and the data. If you have used TIMELAPSE1 and want to migrate your template and/or data to TIMELAPSE, the following is for you. However, if you do not have any old templates or data files, you can ignore this section.

The template and data files also have different names across these versions, as listed below.

<table>
<thead>
<tr>
<th></th>
<th>TIMELAPSE (version 1)</th>
<th>TIMELAPSE (version 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Template file</strong></td>
<td>CodeTemplate.xml</td>
<td>TimelapseTemplate.tdb, or a file with a .tdb suffix.</td>
</tr>
<tr>
<td><strong>Data file</strong></td>
<td>ImageData.xml</td>
<td>TimelapseData.ddb, or a file with a .ddb suffix.</td>
</tr>
</tbody>
</table>

The tutorial User Guide page on the Timelapse web site also contains a downloadable zip file MigrationImageSet.zip that contains:

- a variety of images
- a sample CodeTemplate.xml file,
- an ImageData.xml file created by running Timelapse1 using the above CodeTemplate.xml file and images.

To follow this tutorial, download and uncompress the MigrationImageSet.zip folder to a location of your choosing.

**Warning.** Converting templates should be fairly seamless, with one major exception. New templates require that Data Labels be comprised of alphanumeric characters, with the only other allowable character being an '_'. In addition, the Data Label cannot match one of various reserved words.

If your old template used Data Labels with other characters, or if it matched a reserved word, the conversion process will detect that. It will offer alternative Data Labels (e.g., similar labels with the disallowed characters deleted), or a reserved word label modified to include an ' _ ' at its end.) You can also change the Data Label to a new label of your choosing.

However, if you use other software that is based on those old labels (e.g., your own database, or custom program, or statistical analysis tool), that software will have to be modified to these new names.
2 Converting Templates

The TIMELAPSETEMPLATEEDITOR includes a facility that transforms an old CodeTemplate.xml file into a TimelapseTemplate.tdb. For this example, consider a CodeTemplate.xml that defines the following fields:

- the standard fields (File, Folder, Date, Time, ImageQuality etc)
- Counters for Goats and Hikers
- A Note called Comment
- A Choice called Weather

As RelativePath and DeleteFlag did not exist in TIMELAPSE1, there is no equivalent RelativePath, DeleteFlag fields. Similarly, there are not controls of the type Flag.

Converting this CodeTemplate.xml file

1. Open the TimelapseTemplateEditor.

2. Select ‘Convert’ from the File menu,

   ![Image of File menu with Convert selected]

   A sequence of dialog boxes will ask you to:
   
   - Locate the CodeTemplate.xml file that you wish to convert
   - Locate the location for the new TimelapseTemplate.tdb file, where you will also have the option to rename it if you wish.

3. The TIMELAPSETEMPLATEEDITOR then converts the file. If it finds an error, it notifies you.

   In the image below, for example, we see that the TIMELAPSETEMPLATEEDITOR has raised a dialog box saying that:
   
   - an illicit character appeared in ‘Weather?’
   - it has changed the Data Label to ‘Weather’.
4. At this point, you can accept the template as is, and then modify it as you wish. However, if you want to use data created from that old template, you should hold off modifying it until you read the next section.
3 Converting Data

If you have an old ImageData.xml file, you may want to convert it to the new TimelapseData.tdb format. This will allow you to continue processing it.

However, there are pre-conditions for conversion. Most importantly:

1. You need to have your original image folder that contains:
   - the original images
   - the original CodeTemplate.xml file
   - the ImageData.xml file created by TIMELAPSE1 when using that CodeTemplate.xml file to analyze the images in this folder.

2. You will need to convert the CodeTemplate.xml file into the new TimelapseTemplate.tdb format. However, you are restricted in the modifications you can make to the TimelapseTemplate.tdb format, as detailed below. Otherwise the new template will not be able to read the old data, or may read it incorrectly.

Converting the CodeTemplate.xml file

1. Following the instructions in the previous section, convert the CodeTemplate.xml file in your old image set folder into the new TimelapseTemplate.tdb format, which should be saved in the same image set folder.

2. You can modify the new template in any way you wish, EXCEPT:
   - Do not add any new fields
   - Do not delete any existing fields
   - Do not change any of the Data Labels.

Converting the ImageData.xml file

3. Start TIMELAPSE and load the image set using the new TimelapseTemplate.tdb file. It will scan and read all your images as if they had never been previously analyzed.

4. At the end of scanning new images, Timelapse automatically checks to see if there is an old-style ImageData.xml file in that folder set. If there is, it asks you if you want to import the data already stored in the ImageData.xml file:
5. Select ‘Use Old Data’. Timelapse will then try to incorporate values of your old data.
   - Values are copied from your old ImageData.xml file from the following fields:
     - Date
     - Time
     - All other fields
     - Visual markers indicating where you had clicked for Counter fields are also copied over
       - The following values are **not** copied from your old ImageData.xml file fields
     - File (as these should not have changed)
     - Folder (in case the folder has been moved to a new place)
     - ImageQuality (as these have changed somewhat in the new system)
     - Delete? (as this did not exist in the previous version).

6. Check your data by one or all of:
   - navigating through images
   - examining the spreadsheet
   - selecting Options / Show Filtered Database Contents.