Using eSlide for virtual microscopy practicals

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Background to eSlide software, how to write your own practicals in eSlide, and how to deploy eSlide to a class of students

The important bit: If you want to use eSlide in teaching you have the option of using a built-in exercise or creating you own. To use a built-in exercise, simply follow the link below and explore the options. You can upload eSlide to your own web server or you can run it from the link below.

https://www.staff.ncl.ac.uk/stephen.juggins/eSlide/eSlide.html

If you want to create your own exercise read this guide on how to modify the Excel exercise template file. Also decide if you also want to create your own help files to go with the exercise. If you don't want custom help files, then you can simply distribute the Excel template to students and they can open it in the app to run the exercise. If you do want to add custom help files or do not want the hassle of distributing the Excel exercise file then the help and exercise files have to be bundled into the app on the web server. This is easy and quick but currently has to be done by me, so get in touch.

1. eSlide software

eSlide is written in C++ using the QT cross-platform GUI toolkit and compiled as a web app using Emscripten. It can be installed and run locally as a native Windows or macOS app but it is more convenient to run it as a web app, as students can access it from any modern browser on PC, Mac, Chromebook, or iOS or Android tablet (although there issues of screen size and ability to save results that need to be resolved before it can be recommended on tablets).

A practical in eSlide is called an exercise, and needs the app, a set of images, help files, and an exercise file that defines the list of taxa, number of slides, the composition of each slide, and other interface settings. eSlide uses a technology called Webassembly to run as a web app. The app, help files and images have to be bundled together into a single Webassembly file and can be hosted on any webserver (it is currently run from my personal pages on our University web server). Starting the app for the first time the browser will download the complete Webassembly app+data bundle (about 40Mb) and compile it. This may take a few seconds depending on the speed of the computer. Subsequently it will start much more quickly as the browser caches the complied app. Once running the app does not need a connection to the server so slow / poor internet connections should not be a problem.

Running eSlide as a web app does create some specific constraints. First, as it runs in a browser, the app has limited access to the host computer for security reasons. This means that the normal File Open / Save are actually upload and download operations, although this distinction is hidden from the user as much as possible. The main difference here for the user is that Save operations appear as Download in the File menu, and files are saved to

the download folder. Other limitations of running in a browser are limited use of pop-up dialog boxes, and the possibility of losing work if students hit the browser back or refresh button. I'm working on a fix for the latter but at the moment you need to warn students not to click these buttons!

2. Image datasets

Currently there is a single image dataset of 50 images each of 39 common UK pollen types developed by Jane Bunting (list of taxa below). We are currently working on adding images to enable exercises an acid lake diatoms, Australian pollen and tephra, and will hopefully have these ready by early Feb.

Adding your own images: Current pollen images are 320x320 pixels in size, with the subject in the centre. This seems about the right resolution for clean images, e.g. from type slides, with a single object of interest. This is the image that appears in the top left panel which shows the currently selected image. The software automatically crops these images to generate thumbnails that appear in the "slide view" and "list of images" for each slide. The amount of crop can be set in the template file. Larger images can be used. For example, The Australian pollen images are captures from core material and contain a lot a debris. Here the task is to find the pollen grain amongst the background of debris well as identify it. Trials so far suggest an image size of c. 500x500 is suitable for this material. The size of the displayed image is set in the Excel exercise file and can be different from the original image size, so a 500x500 image could be displayed at a smaller size, though currently I have not used this option.



Original image captures from a microscope-attached camera are usually much larger than 320 or 500 pixels. Original images can be batch resized, cropped to square if needed, and converted to jpg format using Image Magick software so don't spend time doing this manually! Images should be named 000.jpg, 001.jpg etc. for each type, and each type should be stored in a subfolder with the name of the type.

3. Help files

eSlide has several types of help that is displayed in the bottom right window.

- i. Generic help on eSlide. This is "built-in" and invoked using the Help button at the topright of the help window.
- ii. Help on a specific exercise. If supplied, this file is automatically loaded when the exercise starts and should contain instructions to guide the students through the exercise. Clicking Home at the top of the help window returns to this help page.
- iii. Help on a type / taxon. This help is loaded when the ? button on the taxon counter is clicked and provides a description / image of the selected type. This help is optional and can be turned off in the Excel template.
- iv. Help on a particular slide. This help can provide custom help or guidance on working through a particular slide. Currently it is only used to provide taxon descriptions for type slides.

Help files are simple html files and can be generated by converting a Word file to html using pandoc software. The html viewer in eSlide can only display basic html markup, so keep the help files simple with just text and images, and use Word's styles for the headings: Heading 1 for the main title, and Heading 2 for sub-sections.

4. Using eSlide

eSlide has 2 main modes: *Browse* and *Identification*. In *Browse mode* (see figure below) the image list shows the name alongside the thumbnail and the button counter hidden. Browse mode is used to allow student to browse through type sides or other slides to simply view and take notes on a range of images. It might be the first exercise you set for a beginner class.

Exercise title List of images on current slide selector	Slide-specific nelp
R) eShde) eShdebarduet.xlor	- D X
File Options Help	
Browse and describe major pollen types Alnus ?	Home Back
Current selected image Advantations Advantations Advantations Advantati	Almus Polen Work - Almus glutinosa A famed out you think if you way with 4 or (none tupically) 3 zone pores linked by strongly connel bands or ans of networks trickering terms unlike to them.
Tere Inter. Tere Teres Personal Control of C	
SLIDE panel	COUNTER / HELP panel

In *Identification mode*, In Identification mode (see figure in section 2) the right-hand panel now displays a button counter. There are two styles of counter, one with images (shown above) and one without (see below). These can be changed during a session, or can be specified in the project file (e.g. to show counter with images in an initial practical, but without images in a test). Names are not initially displayed in the list of images. Students attempt to identify images, working down the list or by clicking on the images in the virtual slide. Feedback can be given after a set number of images have been identified. Feedback can be either a tick/cross to indicate correct /incorrect identification and challenge the student to go back and correct errors, or the correct identification can be given for students to check their work. The feedback threshold is set in the Excel template. Setting it to zero shows feedback immediately, setting it to a high number never shows feedback (i.e. if using for a test / exam).

Work can be saved by clicking File > Download results. The downloaded file is simply the original exercise template file with an additional tab added with results. This file can be reopened to continue a count.

Instructors can define their own exercise and distribute the Excel template file to students or use one of the bult-in exercises, or ask for their custom exercise to be added to the list of those built-in.

5. Built-in Exercises

There are several built-in exercises. At Newcastle we used the following 4, starting with viewing some types slides to give students an initial introduction to what pollen looks likes, then attempt some trial counts with feedback after 20 identifications so they can learn from mistakes, then a count of 100 grains from one of 5 slides from an interglacial sequence.

• **Type slides**: Browse mode setup with 15 single-taxon slides created with randomised images.

- Identification with correct name feedback: 16 taxa and 1 slides with 200 images per slide representing a mix of taxa from an interglacial pollen sequence. Full name feedback is given after 20 identifications.
- **Identification with error feedback**: As above but feedback 20 identifications only indicated correct / incorrect identification (student must correct).
- **Identification with error feedback**: As above but student given 1 of 5 slides to count and no feedback given. Students must count 100 grains and submit results.

Students then emailed results to me and I compiled them for the whole class using a simple R script to produce a composite diagram students then discussed. I'm working on a simple web page where students can upload their results and download the aggregated data to save the email step.

6. Creating your own exercise

Exercise are created by describing the slides, taxon list and elements of the user interface in a simple Excel template file. The template has three tabs:

Title	Exercise 4: Interglacial slides Title for the exercise: Shown at top of app (maximum of 30 characters)			
DataPath	./Pollen/ Path to images			
HelpPath	/Pollen/help/			
StartupHelpFile	/GEO2136.html Path or URL to startup help			
Mode	2	Program mode (1=browse images, 2=feedback errors, 3=feedback answei		
пТаха	15	Number of taxa, including unknown and any other special categories		
nSlides	5	Number of slides in exercise		
ImageType	gqį	Image file type		
StartupSlide	1	Start app with this slide (slide number)		
MoveToNext	1	Move to next item after ID (1=yes, 0=no)		
ImageSize	320	Image height in pixels (width will be set automatically)		
UseMosaicImages	0	UseMosaicImages (1=yes, 0=no)		
MosaicCols	5 MosaicCols			
MosaicRows	10 MosaicRows			
ShowScaleBar	1 Show scale bar on image (can be turned off in app)			
CountSheetThumbna	50			
SlideThumbnailSize	50	Height of thumbnail image on "slide" (width will be set automatically)		
ImageCanReflect	0 (1=yes, 0=no)			
ImageCanRotate	0 (1=yes, 0=no)			
Density	20	Percentage of slide occupied by thumbnails (5 - 50)		
ThumbnailOverlap	0	Allow overlap (in pixels)		
ShowTaxonHelp	0	Show help page for a taxon (1=yes, 0=no)		
ShowTaxonHelpButte	1	(1=yes, 0=no)		
CropThumbnailX	80			
CropThumbnailY	80			
HelpThreshold	0			
FeedbackThreshold	1000			
seed	100	seed for random coordinates		

Tab 1: Setup

Most of the entries are self-explanatory and can be left at their default value. The key ones to change are the number of slides (nSlides) and taxa (nTaxa), Feedback threshold, and Mode.

Tab 2: Slides

Taxon folder name	Taxon name in app	Status	Number of images	Scale (in pixels per 10 microi	1	2	3	4
Abies	Abies	Normal	5	4	48	0	0	0
Alnus	Alnus	Normal	50	5.664	12	0	0	57
Artemisia	Artemisia	Normal	50	5.664	0	0	8	0
Betula	Betula	Normal	50	5.664	1	2	11	0
Calluna	Calluna	Normal	50	5.664	0	25	0	0
Corylus	Corylus	Normal	50	5.664	1	10	0	6
Carex	Cyperaceae	Normal	50	5.664	17	8	31	9
Erica	Erica	Normal	50	5.664	0	53	0	0
Pinus	Pinus	Normal	50	5.664	14	1	2	1
Poaceae	Poaceae	Normal	50	5.664	3	0	27	6
Quercus	Quercus	Normal	50	5.664	1	1	0	16
Salix	Salix	Normal	50	5.664	1	0	21	0
Tilia	Tilia	Normal	50	5.664	0	0	0	4
Ulmus	Ulmus	Normal	50	5.664	2	0	0	1
Unknown	Unknown	Special	0	5.664	0	0	0	0

This tab list the composition of each slide:

Taxon folder name: name of the folder on disk

Taxon name in app: name displayed in the button counter

Status: *normal* appear as blue buttons in the button counter, *special* are green appear at bottom, and is used to separate types such as unknow, charcoal etc.

Include the list of taxa for the slides you wish to create. Buttons in the counter appear in the order of the taxa in the list. Columns labeled 1, 2, 3 etc on the right define the slides, with entries in the table indicating the relative frequency of teach taxon in each simulated slide. Assemblages will be created with a random allocation of images according to these frequencies.

Tab 3: Slide Info

Slide nu	Slide name	nCount	seed
1	Slide 1	200	1
2	Slide 2	200	2
3	Slide 3	200	3
4	Slide 4	200	4
5	Slide 5	200	1

For each slide, a list giving the slide name (that appears in the slide selector) and the number of images to create for each slide (ignore seed for now).

You can test your exercise by opening it in the app using the link at the start of this document. There is currently only limited error checking of the template, so it may crash if, for example, you specify 20 taxa but only list 19.