

# README

## Return to Bali

version 1.1      March 2021

*Towards AI in Ethnobotany*

## Introduction

Return to Bali's goal is to facilitate the creation of under-represented knowledge in machine learning. Return to Bali applies various machine learning procedures to the study of Ethnobotany on the island of Bali where Mead and Bateson, of second order cybernetics fame, collected field data for the book *Balinese Character: A Photographic Analysis* (1942).

While Bali has been subject to numerous exploitative practices, this project aims to bend machine learning to collect data responsibly and to assess if machine learning might help maintain the body of local ecological knowledge that has been documented as declining specifically amongst Balinese youth.

Return to Bali includes a dataset, bali-26, produced from field videos documenting 26 ethnobotanically significant plants of South East Asia, several of which are indigenous to the island of Bali. The videos show the plants in multiple stages of growth and include fruits, leaves, branches and bark where applicable, from multiple locations within the field study site of Central Bali and under varying lighting conditions.

The high definition mobile phone video files shot by data collectors in the field were converted to labeled images with the Catch & Release software package: <https://github.com/realtechsupport/c-plus-r>

The software modules included here allow one to parse text from video interviews and to experiment with image classification approaches on the bali-26 data set, the first small collection of ethnobotanically significant plants of South East Asia made amenable to neural network based image classification. The project demonstrates that even the best machine learning algorithms struggle to understand the visual complexity contained in this image set.

Additional Documentation: [http://www.realtechsupport.org/new\\_works/return2bali.html](http://www.realtechsupport.org/new_works/return2bali.html)

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Cite this software project as follows: 'Return to Bali version1.1'

## Context

Return to Bali runs on Linux and Mac OS under Python3 and Flask with Chromium or Firefox.

The software uses the PyTorch framework to train and test image classifiers and connects to the Google Speech API (free) for speech processing. Library versions and dependencies are given in the requirements file.

The software has been tested on a desktop (i7-4770 CPU with 16GB of memory) and a laptop (i7-3667 CPU with 8GB of memory) under Ubuntu (20.04 LTS and 18.04 TLS under kernels 5.2.8 and 5.3.0 ) and under Mac OS (Catalina) with images sourced from .mp4 and .webm video (HD [1920 x 1080] at 30f/s; .mp4 H.264 encoded) from multiple (android OS) mobile phones and GoPro Hero 6 action cameras.

## Browser Installation

Recommended browser: Chromium.

Install Chromium on Ubuntu:

```
sudo apt install -y chromium-browser
```

Install Chromium on Mac OS:

<https://apple.stackexchange.com/questions/78805/chromium-builds-for-mac-os-x/215426#215426>

(Currently recommended method)

Install the free Classic Cache Killer:

<https://chrome.google.com/webstore/detail/classic-cache-killer/kkmknnnjiniefekpicbaaobdnjjikfp?hl=en>

## Software Installation

Clone the Return to Bali repository on GitHub

Open a terminal window and type:

```
git clone https://github.com/realtechsupport/ai-ethnobotany.git
```

Cd to the project directory and run the following commands to update the python environment:

```
chmod +x basics.sh
```

```
sudo sh basics.sh
```

(This script just updates your Ubuntu installation and requires sudo to do so.)

Create a virtual environment:

```
python3 -m venv env
```

Activate the environment:

```
source ./env/bin/activate
```

Cd to to the project directory again. Install Requirements and Dependencies.

(This may take about 30 minutes.)

```
pip3 install -r requirements.txt
```

## Generate an STT key (optional)

While there are multiple providers of Speech to Text services, the most effective offering with the widest range of languages is at this moment provided by Google. If you want to make use of the text from video extraction you should obtain an access key to the Google Speech API. Creation of this key is free of charge and you can use it in this software at no cost as AIE operates within free limits of the API. However, you do require a google account in order to create the key. If that is not palatable, skip the section that makes use of the Speech API.

Instructions to generate a key (<https://cloud.google.com/text-to-speech/docs/quickstart-protocol>):

1. In the Cloud Console, go to the **Create service account key** page.
2. From the **Service account** list, select **New service account**.
3. In the **Service account name** field, enter a name.
4. Don't select a value from the **Role** list. No role is required to access this service.
5. Click **Create**.
6. Click **Create without role**. A JSON file that contains your key downloads to your computer.
7. Save the JSON file to the project folder.

## Enable the virtual environment

Activate the virtual environment:

```
source ./env/bin/activate
```

## Start

(in the project directory):

```
python3 main.py ubuntu firefox debug          or  
python3 main.py mac chromium no-debug
```

Specify all three items: OS, browser and debug mode. Supported OS: Ubuntu and Mac OS. Supported browsers: Chromium and Firefox (less stable). To run in debug mode replace 'no-debug' with 'debug'.

The terminal window will display comments. You should see the launch screen in a browser window:

Return to Bali

ctrl + / ctrl - increase / decrease zoom factor.

## Stop

Stop the app from the terminal:

```
ctrl-c
```

## Errors

If you see browser errors .. clear the browsing history:

```
ctrl-H - clear browsing data - clear data
```

## Description of the individual modules

### The bali-26 dataset

This module describes the plants contained in the bali-26 dataset. The descriptions include typical uses as well as the locations in which field videos of the plants were collected.

### Weather and satellite views

This module depicts rainfall, temperature data, a satellite image view and the current weather conditions of the field study site. The weather data was compiled by the Bali Botanical Gardens, and the view here (top diagram) shows the data for 2018 to 2019. Current temperature and rainfall is superimposed upon this map (red and green dots).

### Climate, flora and rituals

This module aligns the weather patterns mentioned above with Balinese rituals of significance to Ethnobotany as well as the flowering seasons of the plants contained in the Bali26 dataset.

### Informal integrated agriculture

This module contains a short video with Made Darmajan, one of our data collectors and a rich source of informal knowledge on local flora.

### Train image classifiers on a subset of the bali-26 dataset

This module allows one to create a fully functional - albeit low dimensional - convolutional neural network from one of several sample image sets. This module offers some insights into the impact of parameter settings on network training and performance.

Altering the parameters will impact training time and classifier performance. For example, reduced epochs and fewer images per category will shorten the training time but may compromise accuracy.

Two networks available: a simple (vanilla) CNN and the Alexnet architecture. The ore-trained option is available for the Alexnet architecture and usually improves performance – but does not allow control over pre-training and thus the logics with which your system is primed. This may be undesirable when networks are pre-trained on ImageNet or other biased image collections. You can select the normalization. A set of image normalization parameters have been calculated from the bali-26image collection (support local image logic!) and work well with the samples provided, which include:

<i>bali-3</i>	<i>Cacao, Passiflora and Aroid/Suweg</i>
<i>bali-3C</i>	<i>Durian, Nilam and Snakefruit</i>
<i>bali-3D</i>	<i>Coffee Arabica, Papaya, Sugarpalm</i>

Unless you have a GPU enabled computer, training on your home device is a slow process.(55 min for 3 categories with 1200 images trained for 20 epochs with Alexnet model on an Intel i7-4770 CPU @3.4GHz with 16GB RAM).Click ‘train-network’ once you make your choices and go for a walk. Training on generic computers will take an hour or more. When all is done, the training results and Top-1 errors per category.

## **Evaluate image classifiers on the bali-26 dataset**

This module loads one of several deep neural net classifiers trained on the bali-26 dataset and allows you to select an image from the validation set to test the selected classifier performance. The best prediction and the confidence level are listed as are the top 3 possibilities (two alternates to the first choice). These results are calculated in real time on your local computer. Left click to select a single image from the image gallery, then click 'classify image' to obtain the results. The first time you run AIE, the selected trained model will be downloaded from pCloud automatically. The gallery will only load once. To inspect additional images, left click to select a new image, then click 'classify image' again, and repeat.

## **General procedures**

The 'Context' button gives you pertinent information on what the individual functions perform. The next sections describe the individual modules.

## **Prepare field videos**

This module allows one to chunk a long field video into smaller parts for processing. Supported formats are .mp4 and .webm. Select the video and choose the chunk size. It is suggested that segments do not exceed 3 minutes.

Chunked segments are saved to the AIE /tmp directory, and are deleted if you go back to start or exit the program. You can also download some sample videos to process and experiment with. When you have some data ready, continue either onto the text extraction or the video voice-over modules.

## **Capture text from field video**

Use this module to extract text from a field video. First load a field video to locate a section you want to extract text from, then reload to capture the text. This module requires an access code for the Google Speech API (key for capture text). If you add a search term, text from video sections that contain that term will be listed separately. If the video is shorter than 1 minute, reduce chunk length.

Reducing the confidence level to below 0.9 increases detection chances and false positives.

This module may take several minutes to complete. It is best to limit the difference between start and end times to a few minutes.

## **Label images from field video**

Use this module to create labels from field videos or from your voice-over additions. Load the video to check, just in case. Label all images in the video with a given term (bulk label).

All images generated from a chosen video will be bulk labeled with a given category / folder name. Set the frame rate (number of images to be extracted per second). When the process has completed, click 'check the results' to open the subsequent module.

## **Quality control and archiving**

This module allows you to control the quality of the images created from the field videos (both images created by bulk labeling and by audio label). The purpose of this module is to combine automated and human quality control, to remove out of context and low quality images and retain only high quality images for subsequent classification. High quality images will enable better classifier training and performance. Sharpness is important, but poorly chosen backgrounds and offensive content might not matter for the classifier. The human image organizer plays a significant role in the compilation of these image sets. (This is a new field of design.)

The following options are available in this module:

*Remove-selected:*

Manually select images for removal. Select (multiple) images with a left click, confirm and then click 'remove-selected'

*Remove-divergent:*

Select a single image as reference with left click, confirm, and then click 'remove-selected'.

Hit <enter> to update the page after the removal process has completed. Images that deviate from this selected reference in luminosity beyond the set min /max levels (under and overexposure) will be deleted. Other images that deviate structurally (different visual contexts or blurry images) beyond the set similarity measure will be deleted.

*Add to collection:*

Once the image set has been reviewed you can add the resultant set to the collection. Once you have several collections / categories, you can archive the collection (compress the data sets) or, if something is amiss, delete everything and start again.

*Archive:*

The final archived (compressed) collection will be the input to the classification procedures as described in the next module.