Technical documentation

Contents

1 Lumen Geoguesser

1.1 Notices:

Although you might be reading this documentation in the form of a PDF file, **we strongly recommend that you open the README.md file in a markdown editor** (GitHub, VSCode, PyCharm, IDE...). As for the API documentation, after setting up the environment, we recommend you run the server with the `python3 src/app/main.py` command after which you can inspect API endpoints in a browser (and execute them too!). Essentially, the technical documentation PDF is rendered from the README.md markdown file and concatenated with the PDF API documentation.

A few more notes:

- the documentation assumes you are located at the `.lumen-geoguesser` directory when running Python scripts
- all global variables are defined in `src/config.py` and `src/paths.py`
- other directories have their own `README.md` files which hopefully will come in handy
- you can run most python files with the `python3 program.py -h` command to get a sense of which arguments you can/must send and what the script actually does

1.2 Directory Structure

Directory	Description
data	dataset, csvs, country shapefiles
docs	documentation
figures	figures
models	model checkpoints, model metadata
references	research papers and competition guidelines
reports	model checkpoints and model metadata
src	python source code

1.3 Setup

1.3.1 Virtual Environment

Create and populate the virtual environment. Simply put, the virtual environment allows you to install Python packages for this project only (which you can easily delete later). This way, we won't clutter your global Python packages.

Step 1: Execute the following command: - the command will initialize the `venv` if it doesn't exist yet

```
[ ! -d "venv" ] && (echo "Creating python3 virtual environment"; python3 -m venv venv)
. venv/bin/activate
pip install -r requirements.txt
```

1.3.2 Dataset Setup

This project allows for the usage multiple datasets, therefore, multiple dataset directories can usually be sent to `*.py` programs

Step 1: If needed, rename directory `data` (which contains uuid subdirectories) to `images` - The original dataset structure has a directory `data` (e.g `dataset_original_subset/data`) which contains subdirectories with uuids of locations (`dataset_original_subset/data/6bde8efe-a565-4f05-8c60-ae2ffb32ee9b`).

Dataset structure should look like this:

```
dataset_original_subset/
├── images
│   ├── 6bde8efe-a565-4f05-8c60-ae2ffb32ee9b
│   │   ├── 0.jpg
│   │   ├── 180.jpg
│   │   ├── 270.jpg
│   │   └── 90.jpg
│   ├── 6c0ed2ea-b31b-4cfd-9828-4aec22bc0b37
│   │   ├── 0.jpg
│   │   ├── 180.jpg
│   │   ...
│   ...
└── data.csv


dataset_external_subset/
├── images
│   ├── e61b6e5f-db0d-4f57-bbe3-4d31f16c5bc3
│   │   ├── 0.jpg
│   │   ├── 180.jpg
│   │   ...
│   ...
└── data.csv
```

Step 2: Setup datasets with `src/preprocess_setup_datasets.py` - Before running other scripts, you have to properly setup a new dataset structure using the `src/preprocess_setup_datasets.py` file. It's important to note that this file accepts multiple dataset directories as an argument and it will make sure to merge the datasets correctly. No changes will be done to your original directories.

```
python3 src/preprocess_setup_datasets.py -h

usage: preprocess_setup_datasets.py [-h] [--dataset-dirs dir [dir ...]] [--out-dir dir] [--copy-images] [--spacing SPACING

optional arguments:
  -h, --help            show this help message and exit
  --dataset-dirs dir [dir ...]
                        Dataset root directories that will be transformed into a single dataset
  --out-dir dir         Directory where the complete dataset will be placed
  --copy-images         Copy images from dataset directories to the new complete directory.
                        You don't need to do this as later on you will be able to pass multiple dataset directories to vari
  --spacing SPACING
                        Spacing that will be used to create a grid of polygons.
                        Different spacings generate a different number of classes
                        0.7 spacing => ~31 classes
                        0.5 spacing => ~55 classes
                        0.4 spacing => ~75 classes
                        0.3 spacing => ~115 classes
```

Example of running the initial setup script:

```
python3 src/preprocess_setup_datasets.py \
--dataset-dirs data/dataset_original_subset data/dataset_external_subset \
--out-dir data/dataset_complete_subset
```

`preprocess_setup_datasets.py` does all the necessary preprocessing. However, underneath the hood it calls other preprocessing scripts. What happens when you run this script?

1. a directory for the new (complete) dataset is created, images are copied if `--copy-images` flag was passed
2. `preprocess_csv_concat.main()` is called, which concatenates multiple `data.csv` s into a single `data.csv`
3. this new (complete) `data.csv` is enriched by `preprocess_csv_create_rich_static.main()` . Here, regions (future classes) and their information (centroids, crs centroids ...) are attached to each location. Enriched data is saved to a *Rich static CSV* file created called `data_rich_static__spacing_<float>_classes_<int>` .
4. Directory `images` in all directories (including the `complete` one) will be split into `train` , `val` and `test` directories. Note: directory `images` won't be deleted.

New dataset structure:

```
dataset_complete_subset/
├── data.csv
├── images <= exists if the --copy-images flag was passed
└── data_rich_static__spacing_0.5_classes_55.csv


dataset_original_subset/
├── data.csv
├── images
├── test
│   ├── c4a74f0d-7f30-4966-9b92-f63279139d68
│   │   ├── 0.jpg
│   │   ├── 180.jpg
│   │   ...
│   ...
├── train
└── val


dataset_external_subset/
├── data.csv
├── images
├── test
├── train
└── val
```

1.4 Training

After you prepared that new dataset structure, you can start the *quick version* of training:

```
python3 src/train.py --dataset-dirs data/dataset_external_subset/ data/dataset_original_subset/ \
--csv-rich-static data/dataset_complete_subset/data_rich_static__spacing_0.7_classes_31.csv \
--quick
```

You can stop the training anytime with `Ctrl + C` . Pressing it once will gracefully shutdown the training (and perform the testing phase). Pressing it twice shows more aggression, which will stop the training immediately.

`--csv-rich-static` can be left out which forces the *Rich static CSV* creation during runtime (this will somewhat slow down the initial setup). You can perform the full training by removing the `--quick` flag. Some additional interesting arguments are listed below. Run the `python src/train.py -h` command to see all supported arguments.

```
--image-size
--num-workers
--lr
```

```
--dataset-dirs [dir1, dir2, ...]
--csv-rich-static
--unfreeze-blocks
--pretrained
--quick
--batch-size
--optimizer
--regression
```

Example of production training (in our case):

```
python3 src/train.py \
--accelerator gpu --devices 1 --num-workers 32 \
--dataset-dir data/raw/ data/external/ \
--csv-rich-static data/complete/data_huge_spacing_0.21_num_class_211.csv \
--batch-size 8 --image-size 224 --lr 0.00002 \
--unfreeze-at-epoch 1 --scheduler plateau
```

During the training, a few things will occur in the `reports/` directory:

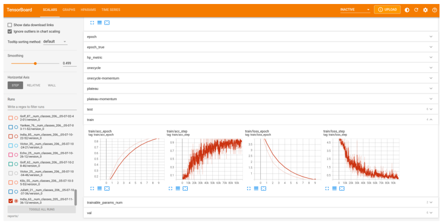
1. `reports/train_*.txt` files will be created which log everything that's outputted to the standard output
2. subdirectory `reports/<model_name>` will be created in which:
    1. `data_runtime.csv` will be created, serves as backup
    2. `version/0` directory which contains:
        1. `hparams.yaml` : details of hyperparameters
        2. `events.out.tfevents*` : log file which tensorboard consumes
        3. `checkpoints` : the most important subdirectory, contains model checkpoints (trained models)

```
reports/<model_name>/
├── data_runtime.csv
└── version_0
    ├── checkpoints
    │   ├── mymodel_checkpoint1.ckpt
    │   └── mymodel_checkpoint2.ckpt
    ├── events.out.tfevents.*
    └── hparams.yaml
```

1.5 Logs - Tensorboard

Tensorboard logging is enabled by default. To see training and validation logs, run the command bellow. Logs should be available in a browser at `http://localhost:6006/` . For more options, check `tensorboard -h` .

```
tensorboard --port 6006 --logdir reports/
```


TensorBoard
SCALARS
GRAPHS
HPARAMS
TIME SERIES
INACTIVE
UPLOAD
Show data download links
Ignore outliers in chart scaling
Tooltip sorting method: default
Smoothing
0.499
Horizontal Axis
STEP
RELATIVE
WALL
Runs
Write a regex to filter runs
Golf_87__num_classes_206__05-07-02-42-01/version_0
Yankee_76__num_classes_206__05-07-03-11-52/version_0
India_85__num_classes_206__05-07-10-22-52/version_0
Victor_35__num_classes_206__05-07-10-24-21/version_0
Echo_25__num_classes_206__05-07-10-26-12/version_0
Golf_62__num_classes_206__05-07-10-28-46/version_0
Victor_25__num_classes_206__05-07-10-34-46/version_0
Kilo_55__num_classes_206__05-07-10-35-53/version_0
Juliett_21__num_classes_206__05-07-10-37-36/version_0
India_63__num_classes_205__05-07-11-36-13/version_0
TOGGLE ALL RUNS
reports/
epoch
epoch_true
hp_metric
onecycle
onecycle-momentum
plateau
plateau-momentum
test
train
train/acc_epoch
tag: train/acc_epoch
train/acc_step
tag: train/acc_step
train/loss_epoch
tag: train/loss_epoch
train/loss_step
tag: train/loss_step
trainable_params_num
val

1.6 Local Server

A local server is useful when you are trying to do inference on a trained model. The sever code and config live in the `src/app` directory.

Before running the sever, set the variable `MODEL_DIRECTORY` in `src/app/.env` to a directory which contains (or will contain) model checkpoints (`.ckpt`). Models outside of this directory can't be used for inference via endpoints. We recommend creating a new directory called `models` and copying model checkpoint files (e.g. `reports/<model_name>/version_0/checkpoints/mymodel.ckpt`) to this directory.

Step 1. copy model checkpoints to /models/

```
mkdir models
cp -r reports/<model_name>/version_0/checkpoints/* models/
```

Step 1.1. ensure that the `MODEL_DIRECTORY` variable is set in `src/app/.env` file:

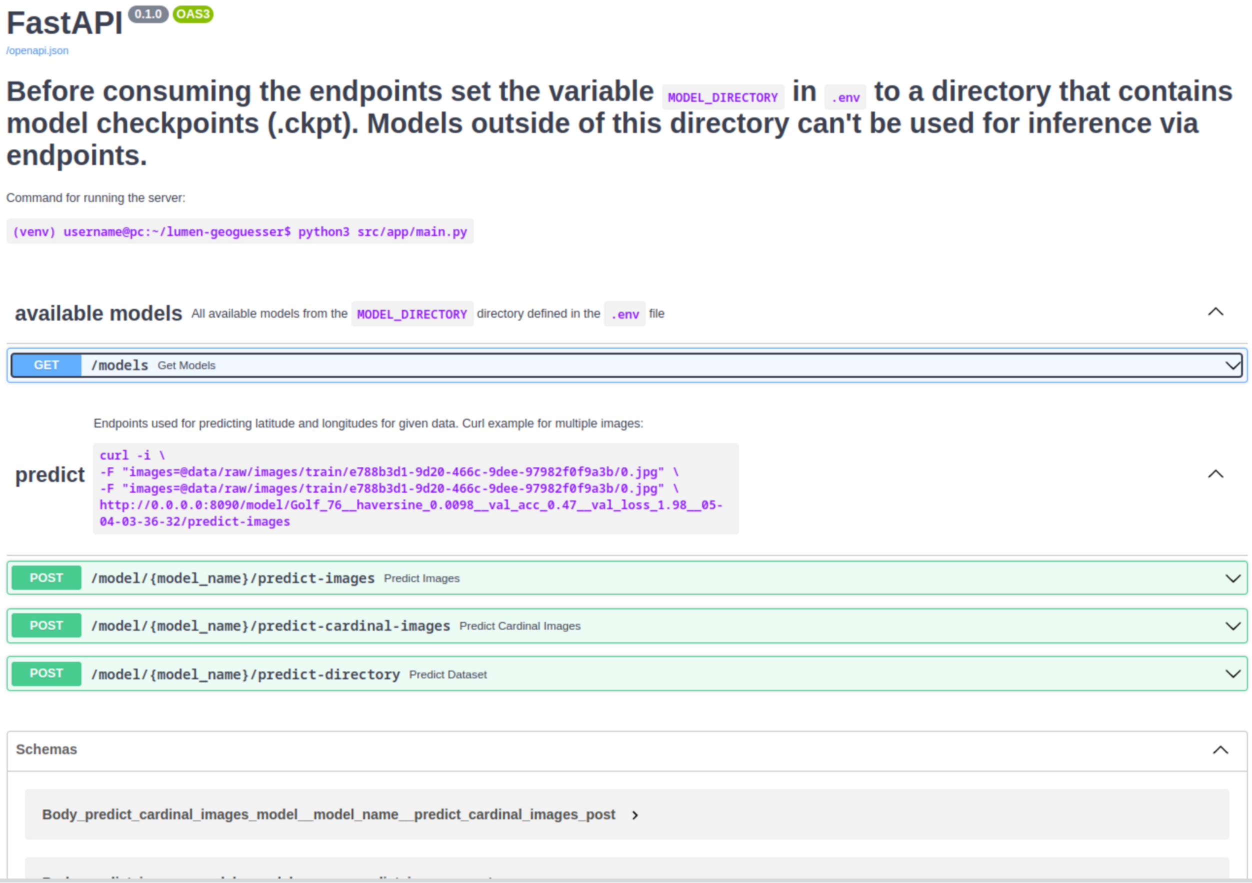
```
cat src/app/.env
```

Output:

```
MODEL_DIRECTORY = "models"  # relative to the lumen-geoguesser directory
MODEL_EXTENSION = "ckpt"
PREDICT_BATCH_SIZE = 16
HOST = "localhost"
PORT = 8090
HOT_RELOAD = 0  # please don't enable hot reloading as it's unstable
```

Step 2. run the server:

```
python3 src/app/main.py
```



FastAPI 0.1.0 OAS3

/openapi.json

Before consuming the endpoints set the variable `MODEL_DIRECTORY` in `.env` to a directory that contains model checkpoints (.ckpt). Models outside of this directory can't be used for inference via endpoints.

Command for running the server:

```
(venv) username@pc:~/lumen-geoguesser$ python3 src/app/main.py
```

available models All available models from the `MODEL_DIRECTORY` directory defined in the `.env` file

GET /models Get Models

predict

Endpoints used for predicting latitude and longitudes for given data. Curl example for multiple images:

```
curl -i \
-F "images=@data/raw/images/train/e788b3d1-9d20-466c-9dee-97982f0f9a3b/0.jpg" \
-F "images=@data/raw/images/train/e788b3d1-9d20-466c-9dee-97982f0f9a3b/0.jpg" \
http://0.0.0.0:8090/model/Golf_76__haversine_0.0098__val_acc_0.47__val_loss_1.98__05-04-03-36-32/predict-images
```

POST /model/{model_name}/predict-images Predict Images

POST /model/{model_name}/predict-cardinal-images Predict Cardinal Images

POST /model/{model_name}/predict-directory Predict Dataset

Schemas

Body_predict_cardinal_images_model__model_name__predict_cardinal_images_post ›