ANEXO A

Functions of the Developed Framework

Author: Robson Rogério Dutra Pereira

The functions, operation modes, and variables of the developed framework are listed in Figura 76, Figura 77, Figura 78, Figura 79, Figura 80, Figura 81, Figura 82, and Figura 83, defined as `SMAxx_10_BCKns.py`.

The framework can be configured and initialized in three ways: through the framework code, by command lines in the terminal (prompt), and by a remote Python code defined as `SMAxx_10_BCKns_Main.py`, which is listed in Figura 84 and Figura 85.

Tabela 4 contains the variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`. The column prefix **"Module Variable"** is `modules."Module Variable"`. The equation for calculating the argument `overlapVAR` to obtain the overlap in pixel values between the patches is in Equation (2).

$$\text{round}\left(\frac{\text{module.patch\_sizeVAR} \times \text{module.overlapVARPerc}}{100}\right) \tag{2}$$

SMAxx_10_BCKns.py > ...

```
1   ##################################################################################################################
2   """
3   SMAxx_10_BCKns.py
4
5   Created by: Robson Rogério Dutra Pereira on 01.Sep.2023
6   Last Modified: rrdpereira
7
8   Description: Add backbones_index, With Adam CHECK, DATETIME CHECK, DEFAULTS VALUES VARIABLES, and 3 ways to insert data configuration. This is sequential python scr
9               and realize the training and validation with standard data according to RGB images patch
10              size and high resolution RGB images.
11
12  E-mail: robsondutra.pereira@outlook.com
13  """
14  ##################################################################################################################
15  set_rootOut = [0,0,0]
16  TDTDis00 = 0.5 # 5.0
17  TDTDis01 = 0.5 # 10.0
18  selected_classesVAR = [2, 3]
19  ##################################################################################################################
20  import sys, time, os, datetime, glob, re···
27  print(tf.version.VERSION)
28
29  import segmentation_models as sm
30  sm.set_framework('tf.keras')
31  sm.framework()
32
33  import tifffile as tiff···
50  print(f"(Sys version) :|: {sys.version} :|:")
51  os.system("which python")
52  print(f"(Python version) :#: {python_version()} :#:")
53  print("--------------------------->>> os.path.dirname(sys.executable):#: {0}".format(os.path.dirname(sys.executable)))
54  print("--------------------------->>> re.__version__:#: {0}".format(re.__version__))
55  print("--------------------------->>> sys.executable:#: {0}".format(sys.executable))
56  """···
67  ##################################################################################################################
68  # Allow GPU memory growth
69  physical_devices = tf.config.experimental.list_physical_devices('GPU')
70  print("--------------------------->>> physical_devices = {0}".format(physical_devices))
71  if physical_devices:···
74  ##################################################################################################################
75  # Check for available GPUs
76  gpu_available = 0 # 0: initial value; 1: GPU available; 2: GPU not available
77  gpus = tf.config.experimental.list_physical_devices('GPU')
78  print("--------------------------->>> gpus = {0}".format(gpus))
79  print("--------------------------->>> len(gpus) = {0}".format(len(gpus)))
80  if len(gpus) == 1:···
91  elif len(gpus) == 0:···
95
96  print("--------------------------->>> STATUS gpu_available = {0}".format(gpu_available))
97  ##################################################################################################################
98  models_inib = [ # Comment non used models to run "One Saved Model"···
112 models_inib_loop = [ # Comment non used models to run "One Saved Model"···
126 ##################################################################################################################
127 PLTShowChck = 0 # plt.show() ---> 0: OFF; 1: ON
128 PLTShowTempPause = 0 # plt.show(temporary pause) --->  0: OFF; 1: ON; 2: PNG inference paused way
129 TESTImgNumberChck = 0 # 0: random; 1: fixed
```

Figura 76 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (Part 1/8).

Tabela 4 – Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.PLTShowChck	0:off; 1:on	Enable and disable the matplotlib.pyplot.show functions
.PLTShowTempPause	0:off; 1:on; 2:pause during inference	If `PLTShowChck` is on, you can enable and disable temporary visualization of matplotlib.pyplot.show, and also enable pause during inference in validation

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.TESTImgNumberChck	0:random; 1:fixed	Determines whether the inference in validation will be on the same sample for all trainings or random for each training
.TESTImgNumberVAR	0 to size of validation set	Value of the fixed sample in validation
.UNetNormaChck	UNetNormaChckM	The `UNetNormaChckM` argument can have the value 0:off; 1:on for BatchNormalization of U-Net or whether it will be 2:mlp_nn, 3:FCN_atrous; 4:IFCN_atrous; 5:deep_lab
.metricsChck	1:metricsIOUFS; 2:metricsJac	Determines whether the metric will be Intersection of Union + F1 Score or Jaccard Index
.UshuffleChck	False:off; True:on	Enable and disable shuffle mode for model.fit
.mixed_precisionChck	0:off; 1:on	Enable and disable tensorflow keras mixed_precision
.date_timeChck	0:off; 1:on	Enable and disable date and time in Model Checkpoint
.split_loaded_dataChck	1:numpy split; 2:sklearn train test split; 3:random sample	Selects the dataset split mode into training and validation
.rootModChck	1:metricsIOUFS; 2:metricsJac	Configured according to the HDF5 model metric, by Intersection of Union + F1 Score or Jaccard Index
.mt_mont_Chck	mt_mont_ChckM	The `UNetNormaChckM` argument for training can be 1:mt function, 2:mont function, and 3:mlp_nn

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.patch_size_startVAR	0	The initial value of the Patch size
.patch_sizeVAR	patch_sizeVARM	The `patch_sizeVARM` argument is the Patch size of the image at the neural network input, which can be 128 px or 256 px for U-Net and backbones, and 384 px for PSPNet
.overlapVARPerc	overlapVARPercM	The `overlapVARPercM` argument determines the percentage of overlap between Patches with data augmentation
.overlapVAR	Equation (2)	Calculates the overlap between Patches in pixels
.patience_VVAR	patience_VVARM	The `patience_VVARM` argument determines the number of epochs if there is no change in the training values for Early Stopping
.batch_size_VVAR	batch_size _VVARM	The `batch_size_VVARM` argument determines the number of samples that will be propagated through the neural network and used in training before updating the weights of the trained variables, which in this case can be Batch size of 4, 8, 16, 32, and 64
.epochs_VVAR	epochs_VVARM	The `epochs_VVARM` argument determines the maximum number of epochs during training

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.activationVAR	activationVARM	The `activationVARM` argument defines the activation layer of the output, which can be softmax: multi-class segmentation without overlap of class masks; and sigmoid: binary segmentation or multi-class segmentation with independent overlap or without overlap of class masks
.LRVAR	LRVAR_M	The `LRVAR_M` argument defines the learning rate for training
.restart_loss_thresholdVAR	0 to 1	Defines the threshold value to trigger the training restart trigger with the `mont` function
.max_consecutive_epochsVAR	1 to 10	Defines the maximum number of consecutive epochs, in the `max_consecutive_epochs` variable of the `mont` function in the framework, with the `loss` value during training above the value defined in `restart_loss_thresholdVAR`, before restarting training

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.consecutive_epochsVAR	0	Defines the initial value of the `consecutive_epochs` variable in the `mont` function of the framework, whose value will increment based on the trained epochs. If the `loss` value is greater than `restart_loss_thresholdVAR`, and the current value of `consecutive_epochs` is equal to `max_consecutive_epochsVAR`, training is restarted
.max_restart_attemptsVAR	1 to 10	Defines the maximum number of training restart attempts, in the `max_restart_attempts` variable of the `mont` function in the framework
.restart_attemptsVAR	0	Defines the initial value in the `restart_attempts` variable of the `mont` function in the framework, with the purpose of recording the quantities of restarts
.optimizerUChck	1:Adam(LR) and 2:'adam'	Defines the optimizer compilation form in the U-Net model, whether it will be Adam based on Learning Rate (LR) 1:optim = Adam(LR), or whether it will be Adam without LR 2:'adam'

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.optimizerBChck	1:Adam(LR) and 2:'adam'	Defines the optimizer compilation form in the U-Net model together with Backbone, whether it will be Adam based on Learning Rate (LR) 1:optim = Adam(LR), or whether it will be Adam without LR 2:'adam'
.TestSplittVAR	0.10 to 0.50	Defines the percentage of the `test` set split in a normal training
.TestSplittFVAR	0.10 to 0.50	Defines the percentage of the `test` set split in a fast training
.high_resoution_imgChckEACHI	0:off; 1:on	Enables or disables the execution of inference on high-resolution images not seen by the trained model, and saves the output in individual files
.high_resoution_imgChckHOALL	0:off; 1:on	Enables or disables the execution of inference on high-resolution images not seen by the trained model, and saves the output in a single file
.modelnetChck	1:Unet; 2:FPN; 3:Linknet; 4:PSPNet	Defines the architecture of the neural network model used in training, which can be according to the one defined in `patch_sizeVARM` for 1:U-Net, 2:FPN, 3:Linknet; If it is 4:PSPNet, `patch_sizeVARM` should be changed to 384 px.
.encoderweightsChck	1 and 2	Defines whether the initial values of the model's encoder weights are 1: encoder_weights='imagenet' or 2: encoder_weights=None

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.encoderfreezeChck	0:off; 1:on	Enables or disables random initialization of the decoder to avoid corrupting the weights of the trained encoders, in this case 0: encoder_freeze off and 1: encoder_freeze = on
.asinputChck	0:off; 1:on	MAIN asinput: Enables or disables the use of the remote Python file `SMAxx_10_BCKns_Main.py`, or only the Python file of the framework `SMAxx_10_BCKns.py`, following the following combination —> asinputChck=1 + asinputChckIN=0 `SMAxx_10_BCKns_Main.py` + `SMAxx_10_BCKns.py`; asinputChck=1 + asinputChckIN=1 and asinputChck=0 + asinputChckIN=0 `SMAxx_10_BCKns.py`

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Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.asinputChckIN	0:off; 1:on	MAIN asinput terminal: Enables or disables the use of the remote Python file `SMAxx_10_BCKns_Main.py`, or only the Python file of the framework `SMAxx_10_BCKns.py`, following the following combination —> asinputChck=1 + asinputChckIN=0 `SMAxx_10_BCKns_Main.py` + `SMAxx_10_BCKns.py`; asinputChck=1 + asinputChckIN=1 and asinputChck=0 + asinputChckIN=0 `SMAxx_10_BCKns.py`
.prebckb_input1	backbones_in[i]	Defines the pre-compilation of backbone 1 of the ensemble according to the indices of the list `backbones_in[i]`, where i starts from 0 to the last item in the list
.prebckb_input2	backbones_in[i]	Defines the pre-compilation of backbone 2 of the ensemble according to the indices of the list `backbones_in[i]`, where i starts from 0 to the last item in the list
.prebckb_input3	backbones_in[i]	Defines the pre-compilation of backbone 3 of the ensemble according to the indices of the list `backbones_in[i]`, where i starts from 0 to the last item in the list

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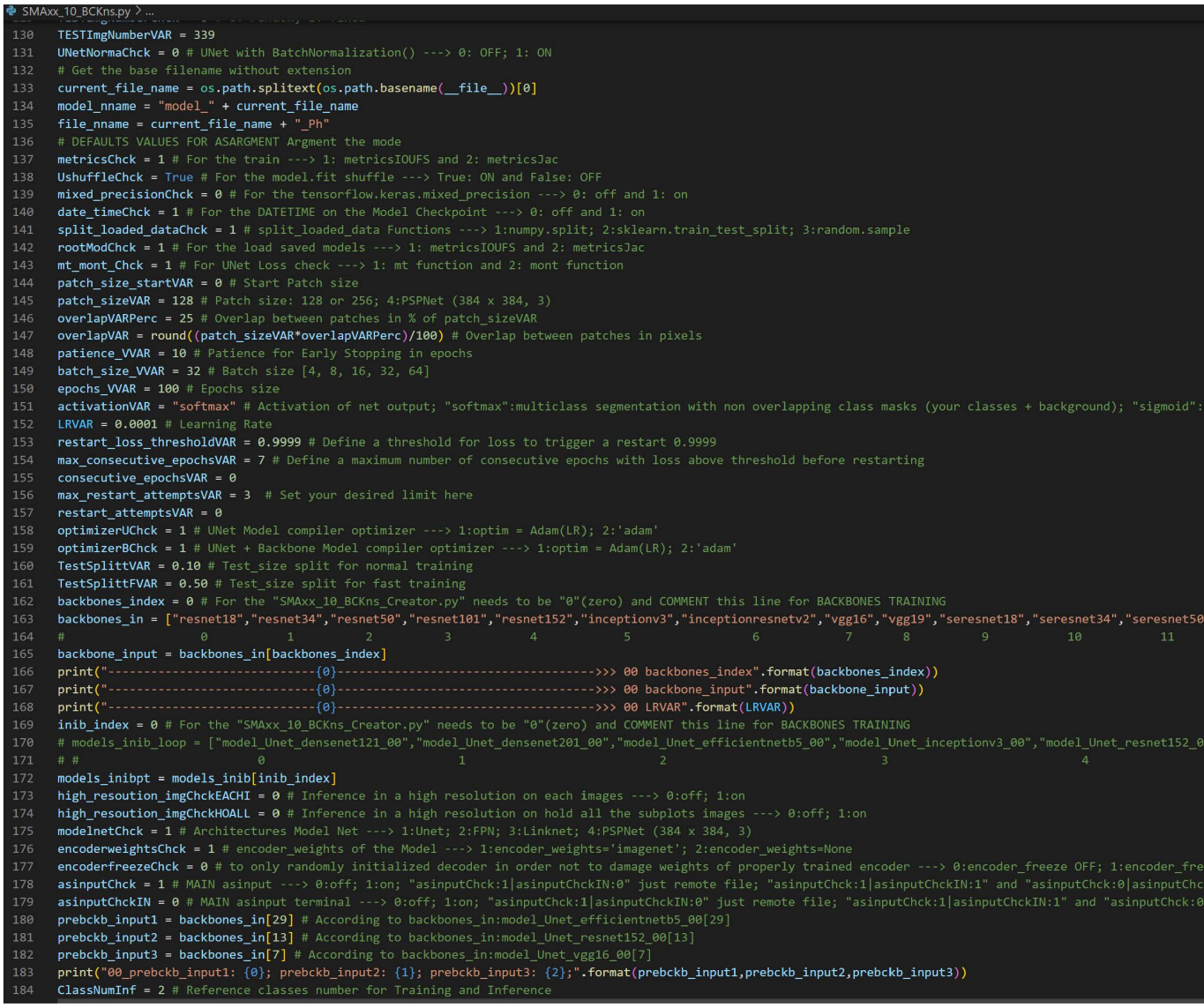
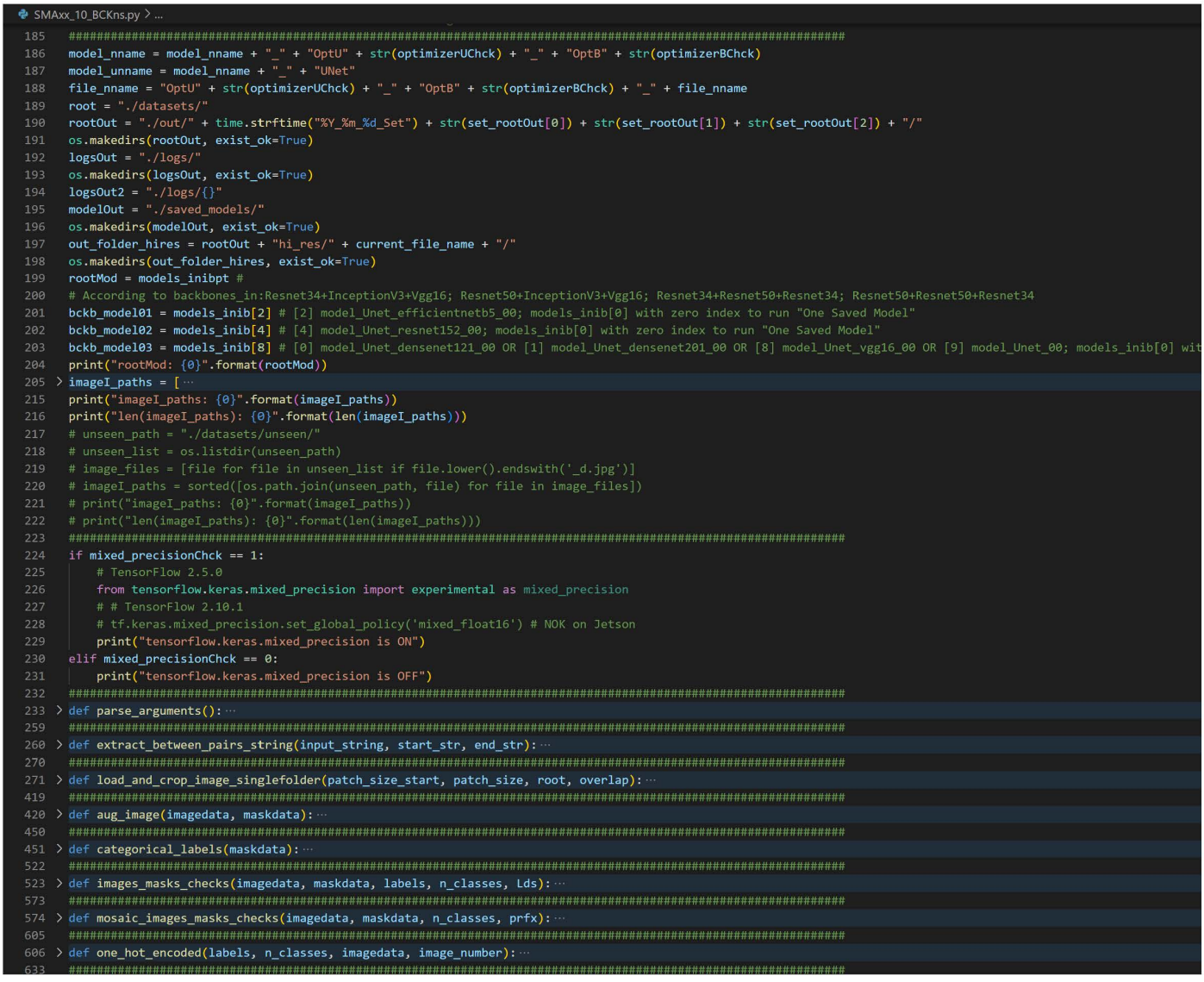
Tabela 4 – *(Continued)* Variables of the `run_modules` function after checking the initialization flags in the remote code `SMAxx_10_BCKns_Main.py`

Module Variable	Values	Description
.bckb_model01	models_inib[j]	Defines the HDF5 model 1 for the ensemble that is indexed in the list models_inib[j], where j starts from 0 to the last item in the list
.bckb_model02	models_inib[j]	Defines the HDF5 model 2 for the ensemble that is indexed in the list models_inib[j], where j starts from 0 to the last item in the list
.bckb_model03	models_inib[j]	Defines the HDF5 model 3 for the ensemble that is indexed in the list models_inib[j], where j starts from 0 to the last item in the list
.ClassNumInf	less than the number of classes	Defines the value of **ClassNumInf** to be used for the sample selection algorithm, `number of classes - ClassNumInf = reference value for sampling`. The objective is to return a sample containing masks with more than 2 classes
.mainIN(argument)	argument	This is the argument that links the `mainIN` function to the `main` call of the framework `SMAxx_10_BCKns.py`. The value of `argument` can be the texts 'mt', 'mti', 'mi', 'mta', 'mtia','mia', 'mien' and 'miaen'. These texts define the operation modes of the framework that are defined in the `mainIN` function



```
SMAxx_10_BCKns.py > ...
130  TESTImgNumberVAR = 339
131  UNetNormaChck = 0 # UNet with BatchNormalization() ---> 0: OFF; 1: ON
132  # Get the base filename without extension
133  current_file_name = os.path.splitext(os.path.basename(__file__))[0]
134  model_nname = "model_" + current_file_name
135  file_nname = current_file_name + "_Ph"
136  # DEFAULTS VALUES FOR ASARGMENT Argment the mode
137  metricsChck = 1 # For the train ---> 1: metricsIOUFS and 2: metricsJac
138  UshuffleChck = True # For the model.fit shuffle ---> True: ON and False: OFF
139  mixed_precisionChck = 0 # For the tensorflow.keras.mixed_precision ---> 0: off and 1: on
140  date_timeChck = 1 # For the DATETIME on the Model Checkpoint ---> 0: off and 1: on
141  split_loaded_dataChck = 1 # split_loaded_data Functions ---> 1:numpy.split; 2:sklearn.train_test_split; 3:random.sample
142  rootModChck = 1 # For the load saved models ---> 1: metricsIOUFS and 2: metricsJac
143  mt_mont_Chck = 1 # For UNet Loss check ---> 1: mt function and 2: mont function
144  patch_size_startVAR = 0 # Start Patch size
145  patch_sizeVAR = 128 # Patch size: 128 or 256; 4:PSPNet (384 x 384, 3)
146  overlapVARPerc = 25 # Overlap between patches in % of patch_sizeVAR
147  overlapVAR = round((patch_sizeVAR*overlapVARPerc)/100) # Overlap between patches in pixels
148  patience_VVAR = 10 # Patience for Early Stopping in epochs
149  batch_size_VVAR = 32 # Batch size [4, 8, 16, 32, 64]
150  epochs_VVAR = 100 # Epochs size
151  activationVAR = "softmax" # Activation of net output; "softmax":multiclass segmentation with non overlapping class masks (your classes + background); "sigmoid":
152  LRVAR = 0.0001 # Learning Rate
153  restart_loss_thresholdVAR = 0.9999 # Define a threshold for loss to trigger a restart 0.9999
154  max_consecutive_epochsVAR = 7 # Define a maximum number of consecutive epochs with loss above threshold before restarting
155  consecutive_epochsVAR = 0
156  max_restart_attemptsVAR = 3  # Set your desired limit here
157  restart_attemptsVAR = 0
158  optimizerUChck = 1 # UNet Model compiler optimizer ---> 1:optim = Adam(LR); 2:'adam'
159  optimizerBChck = 1 # UNet + Backbone Model compiler optimizer ---> 1:optim = Adam(LR); 2:'adam'
160  TestSplittVAR = 0.10 # Test_size split for normal training
161  TestSplittFVAR = 0.50 # Test_size split for fast training
162  backbones_index = 0 # For the "SMAxx_10_BCKns_Creator.py" needs to be "0"(zero) and COMMENT this line for BACKBONES TRAINING
163  backbones_in = ["resnet18","resnet34","resnet50","resnet101","resnet152","inceptionv3","inceptionresnetv2","vgg16","vgg19","seresnet18","seresnet34","seresnet50
164  #                 0          1          2          3          4           5                6           7       8          9           10           11
165  backbone_input = backbones_in[backbones_index]
166  print("----------------------------{0}---------------------------------->>> 00 backbones_index".format(backbones_index))
167  print("----------------------------{0}---------------------------------->>> 00 backbone_input".format(backbone_input))
168  print("----------------------------{0}---------------------------------->>> 00 LRVAR".format(LRVAR))
169  inib_index = 0 # For the "SMAxx_10_BCKns_Creator.py" needs to be "0"(zero) and COMMENT this line for BACKBONES TRAINING
170  # models_inib_loop = ["model_Unet_densenet121_00","model_Unet_densenet201_00","model_Unet_efficientnetb5_00","model_Unet_inceptionv3_00","model_Unet_resnet152_0
171  # #                       0                          1                          2                            3                           4
172  models_inibpt = models_inib[inib_index]
173  high_resoution_imgChckEACHI = 0 # Inference in a high resolution on each images ---> 0:off; 1:on
174  high_resoution_imgChckHOALL = 0 # Inference in a high resolution on hold all the subplots images ---> 0:off; 1:on
175  modelnetChck = 1 # Architectures Model Net ---> 1:Unet; 2:FPN; 3:Linknet; 4:PSPNet (384 x 384, 3)
176  encoderweightsChck = 1 # encoder_weights of the Model ---> 1:encoder_weights='imagenet'; 2:encoder_weights=None
177  encoderfreezeChck = 0 # to only randomly initialized decoder in order not to damage weights of properly trained encoder ---> 0:encoder_freeze OFF; 1:encoder_fre
178  asinputChck = 1 # MAIN asinput ---> 0:off; 1:on; "asinputChck:1|asinputChckIN:0" just remote file; "asinputChck:1|asinputChckIN:1" and "asinputChck:0|asinputChc
179  asinputChckIN = 0 # MAIN asinput terminal ---> 0:off; 1:on; "asinputChck:1|asinputChckIN:0" just remote file; "asinputChck:1|asinputChckIN:1" and "asinputChck:0
180  prebckb_input1 = backbones_in[29] # According to backbones_in:model_Unet_efficientnetb5_00[29]
181  prebckb_input2 = backbones_in[13] # According to backbones_in:model_Unet_resnet152_00[13]
182  prebckb_input3 = backbones_in[7] # According to backbones_in:model_Unet_vgg16_00[7]
183  print("00_prebckb_input1: {0}; prebckb_input2: {1}; prebckb_input3: {2};".format(prebckb_input1,prebckb_input2,prebckb_input3))
184  ClassNumInf = 2 # Reference classes number for Training and Inference
```

Figura 77 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (Part 2/8).



```
SMAxx_10_BCKns.py > ...
185  ##########################################################################################################
186  model_nname = model_nname + "_" + "OptU" + str(optimizerUChck) + "_" + "OptB" + str(optimizerBChck)
187  model_unname = model_nname + "_" + "UNet"
188  file_nname = "OptU" + str(optimizerUChck) + "_" + "OptB" + str(optimizerBChck) + "_" + file_nname
189  root = "./datasets/"
190  rootOut = "./out/" + time.strftime("%Y_%m_%d_Set") + str(set_rootOut[0]) + str(set_rootOut[1]) + str(set_rootOut[2]) + "/"
191  os.makedirs(rootOut, exist_ok=True)
192  logsOut = "./logs/"
193  os.makedirs(logsOut, exist_ok=True)
194  logsOut2 = "./logs/{}"
195  modelOut = "./saved_models/"
196  os.makedirs(modelOut, exist_ok=True)
197  out_folder_hires = rootOut + "hi_res/" + current_file_name + "/"
198  os.makedirs(out_folder_hires, exist_ok=True)
199  rootMod = models_inibpt #
200  # According to backbones_in:Resnet34+InceptionV3+Vgg16; Resnet50+InceptionV3+Vgg16; Resnet34+Resnet50+Resnet34; Resnet50+Resnet50+Resnet34
201  bckb_model01 = models_inib[2] # [2] model_Unet_efficientnetb5_00; models_inib[0] with zero index to run "One Saved Model"
202  bckb_model02 = models_inib[4] # [4] model_Unet_resnet152_00; models_inib[0] with zero index to run "One Saved Model"
203  bckb_model03 = models_inib[8] # [0] model_Unet_densenet121_00 OR [1] model_Unet_densenet201_00 OR [8] model_Unet_vgg16_00 OR [9] model_Unet_00; models_inib[0] wit
204  print("rootMod: {0}".format(rootMod))
205  imageI_paths = [···
215  print("imageI_paths: {0}".format(imageI_paths))
216  print("len(imageI_paths): {0}".format(len(imageI_paths)))
217  # unseen_path = "./datasets/unseen/"
218  # unseen_list = os.listdir(unseen_path)
219  # image_files = [file for file in unseen_list if file.lower().endswith('_d.jpg')]
220  # imageI_paths = sorted([os.path.join(unseen_path, file) for file in image_files])
221  # print("imageI_paths: {0}".format(imageI_paths))
222  # print("len(imageI_paths): {0}".format(len(imageI_paths)))
223  ##########################################################################################################
224  if mixed_precisionChck == 1:
225      # TensorFlow 2.5.0
226      from tensorflow.keras.mixed_precision import experimental as mixed_precision
227      # # TensorFlow 2.10.1
228      # tf.keras.mixed_precision.set_global_policy('mixed_float16') # NOK on Jetson
229      print("tensorflow.keras.mixed_precision is ON")
230  elif mixed_precisionChck == 0:
231      print("tensorflow.keras.mixed_precision is OFF")
232  ##########################################################################################################
233  def parse_arguments():···
259  ##########################################################################################################
260  def extract_between_pairs_string(input_string, start_str, end_str):···
270  ##########################################################################################################
271  def load_and_crop_image_singlefolder(patch_size_start, patch_size, root, overlap):···
419  ##########################################################################################################
420  def aug_image(imagedata, maskdata):···
450  ##########################################################################################################
451  def categorical_labels(maskdata):···
522  ##########################################################################################################
523  def images_masks_checks(imagedata, maskdata, labels, n_classes, Lds):···
573  ##########################################################################################################
574  def mosaic_images_masks_checks(imagedata, maskdata, n_classes, prfx):···
605  ##########################################################################################################
606  def one_hot_encoded(labels, n_classes, imagedata, image_number):···
633  ##########################################################################################################
```

Figura 78 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 3/8`).

Figura 79 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 4/8`).

Figura 80 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 5/8`).

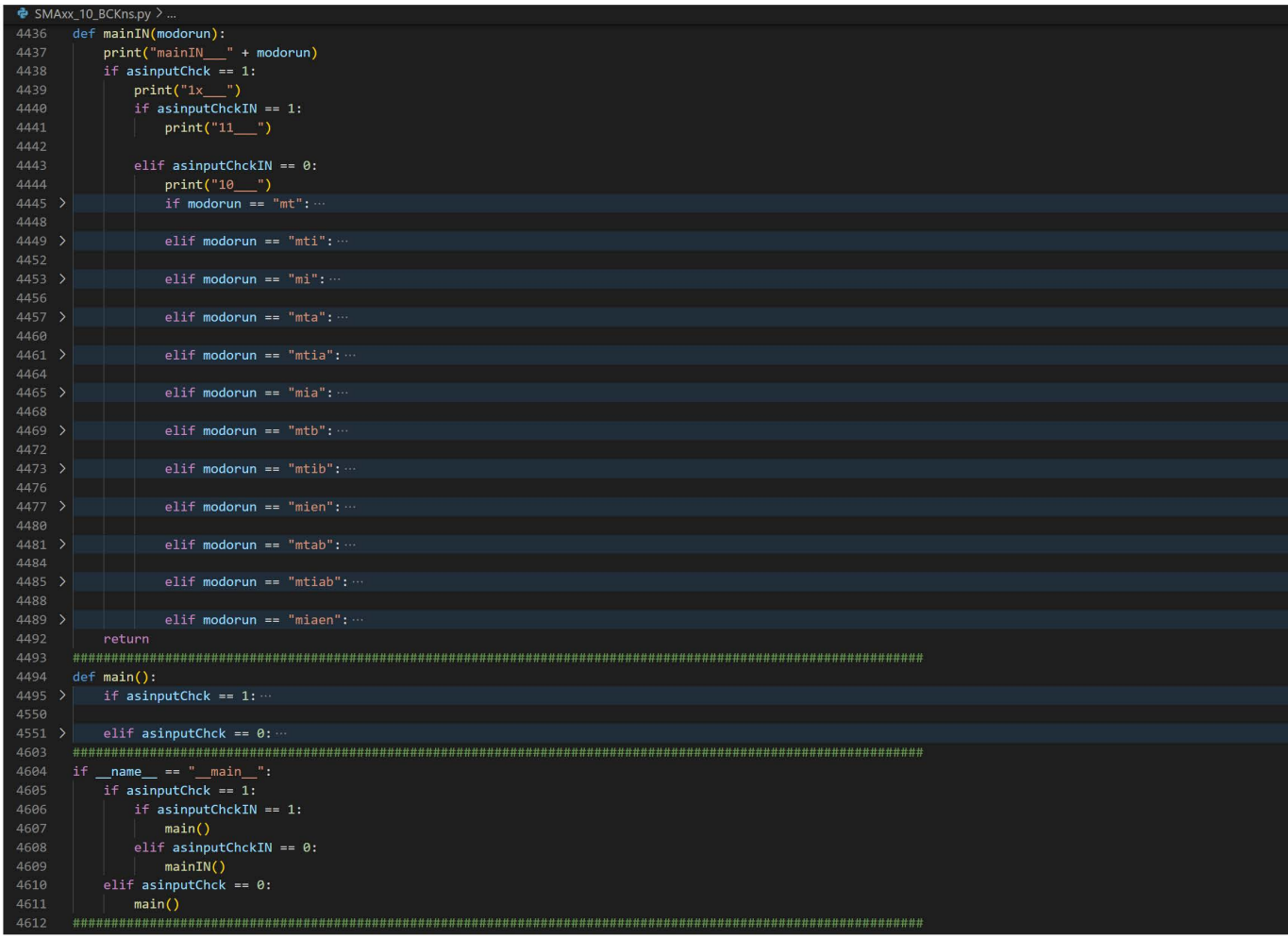
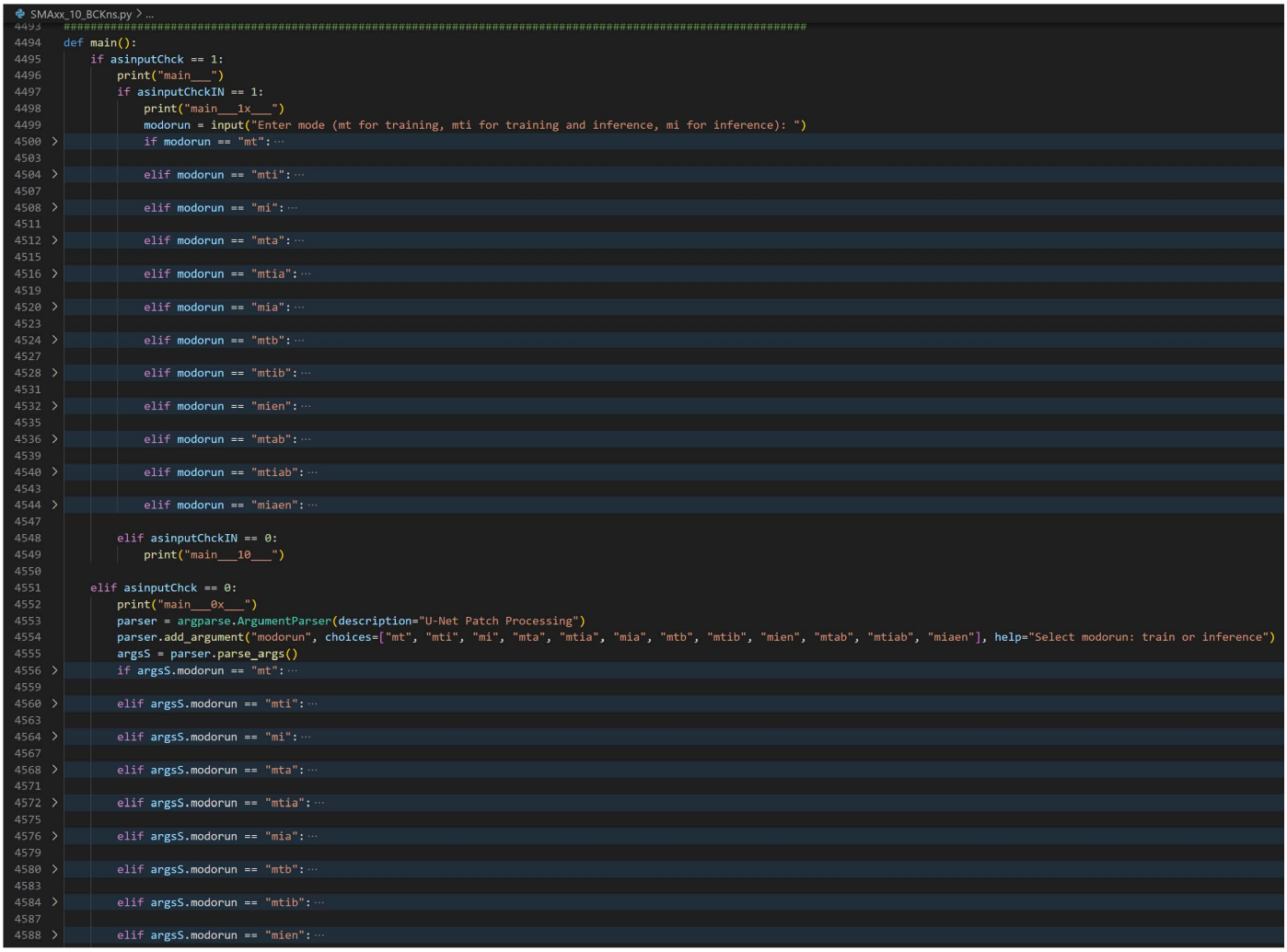


Figura 81 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 6/8`).



```
SMAxx_10_BCKns.py > ...
4493  ##########################################################################################################################
4494  def main():
4495      if asinputChck == 1:
4496          print("main___")
4497          if asinputChckIN == 1:
4498              print("main___1x___")
4499              modorun = input("Enter mode (mt for training, mti for training and inference, mi for inference): ")
4500              if modorun == "mt": ···
4503
4504              elif modorun == "mti": ···
4507
4508              elif modorun == "mi": ···
4511
4512              elif modorun == "mta": ···
4515
4516              elif modorun == "mtia": ···
4519
4520              elif modorun == "mia": ···
4523
4524              elif modorun == "mtb": ···
4527
4528              elif modorun == "mtib": ···
4531
4532              elif modorun == "mien": ···
4535
4536              elif modorun == "mtab": ···
4539
4540              elif modorun == "mtiab": ···
4543
4544              elif modorun == "miaen": ···
4547
4548          elif asinputChckIN == 0:
4549              print("main___10___")
4550
4551      elif asinputChck == 0:
4552          print("main___0x___")
4553          parser = argparse.ArgumentParser(description="U-Net Patch Processing")
4554          parser.add_argument("modorun", choices=["mt", "mti", "mi", "mta", "mtia", "mia", "mtb", "mtib", "mien", "mtab", "mtiab", "miaen"], help="Select modorun: train or inference")
4555          argsS = parser.parse_args()
4556          if argsS.modorun == "mt": ···
4559
4560          elif argsS.modorun == "mti": ···
4563
4564          elif argsS.modorun == "mi": ···
4567
4568          elif argsS.modorun == "mta": ···
4571
4572          elif argsS.modorun == "mtia": ···
4575
4576          elif argsS.modorun == "mia": ···
4579
4580          elif argsS.modorun == "mtb": ···
4583
4584          elif argsS.modorun == "mtib": ···
4587
4588          elif argsS.modorun == "mien": ···
```

Figura 82 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 7/8`).

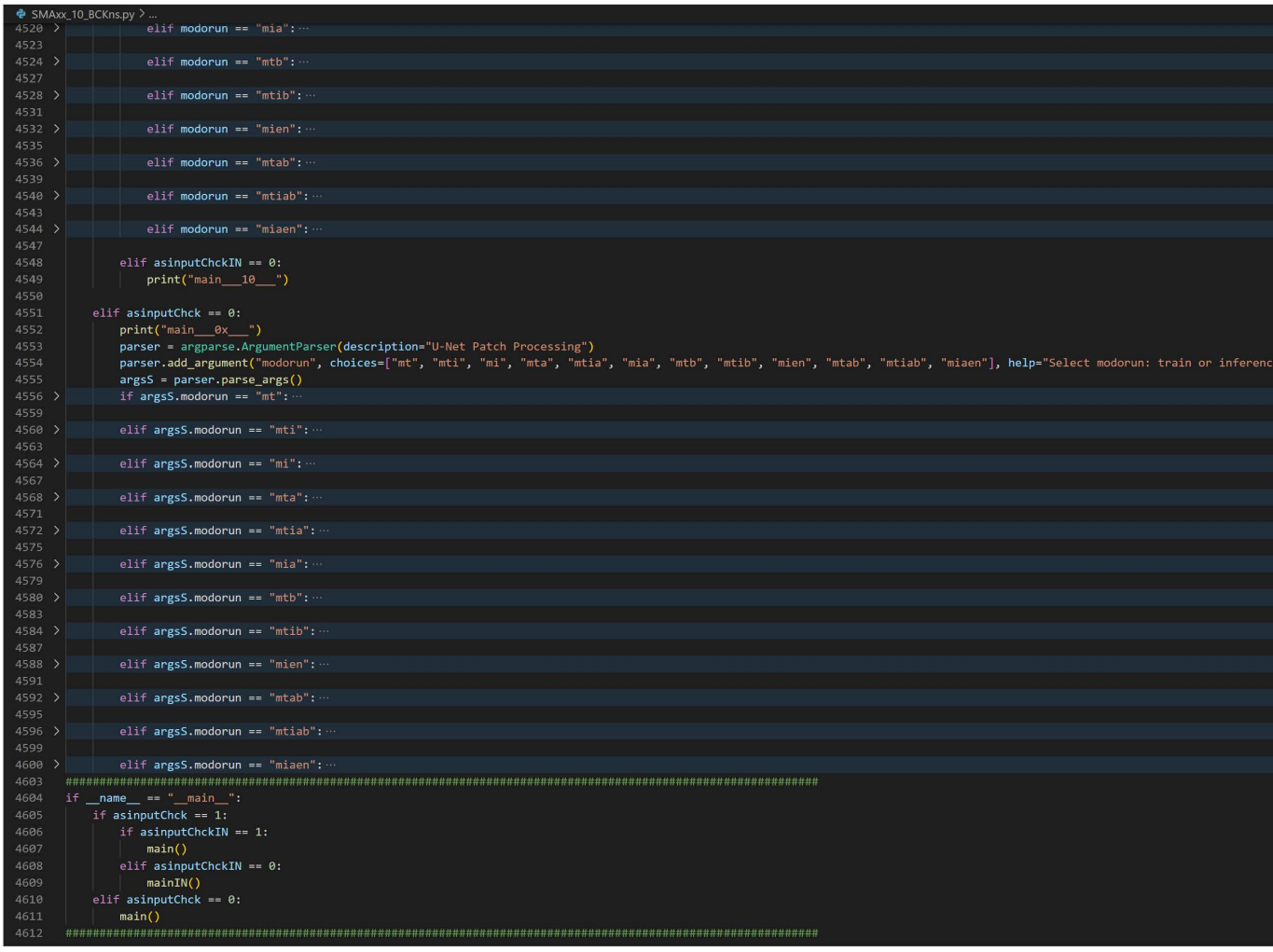
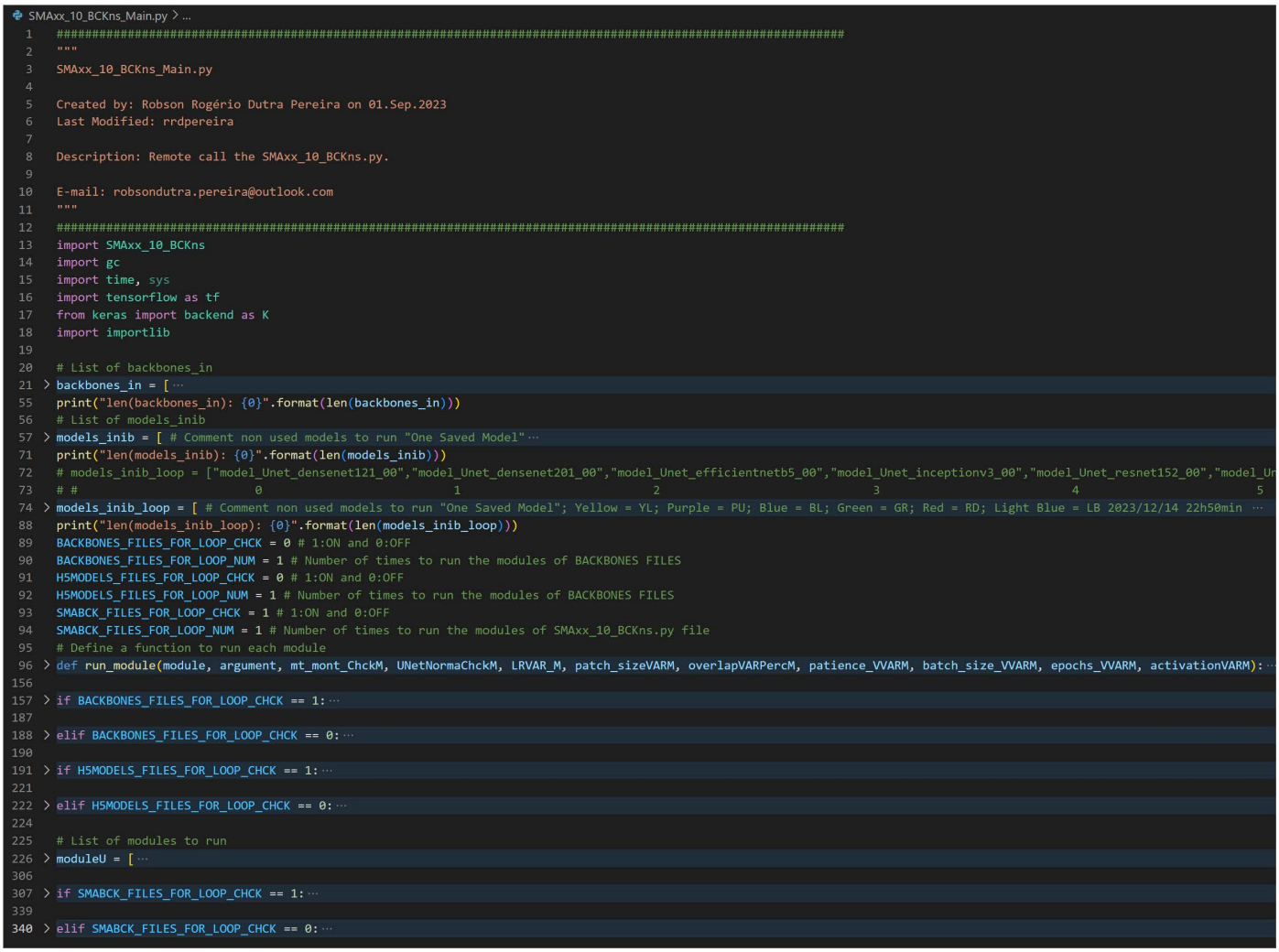


Figura 83 – Overview of the developed framework SMAxx_10_BCKns.py. Source: Robson Rogério Dutra Pereira. (`Part 8/8`).



```
SMAxx_10_BCKns_Main.py > ...
1   ##################################################################################################################
2   """
3   SMAxx_10_BCKns_Main.py
4
5   Created by: Robson Rogério Dutra Pereira on 01.Sep.2023
6   Last Modified: rrdpereira
7
8   Description: Remote call the SMAxx_10_BCKns.py.
9
10  E-mail: robsondutra.pereira@outlook.com
11  """
12  ##################################################################################################################
13  import SMAxx_10_BCKns
14  import gc
15  import time, sys
16  import tensorflow as tf
17  from keras import backend as K
18  import importlib
19
20  # List of backbones_in
21  backbones_in = [···
55  print("len(backbones_in): {0}".format(len(backbones_in)))
56  # List of models_inib
57  models_inib = [ # Comment non used models to run "One Saved Model"···
71  print("len(models_inib): {0}".format(len(models_inib)))
72  # models_inib_loop = ["model_Unet_densenet121_00","model_Unet_densenet201_00","model_Unet_efficientnetb5_00","model_Unet_inceptionv3_00","model_Unet_resnet152_00","model_Ur
73  # #                      0                          1                          2                          3                          4                          5
74  models_inib_loop = [ # Comment non used models to run "One Saved Model"; Yellow = YL; Purple = PU; Blue = BL; Green = GR; Red = RD; Light Blue = LB 2023/12/14 22h50min ···
88  print("len(models_inib_loop): {0}".format(len(models_inib_loop)))
89  BACKBONES_FILES_FOR_LOOP_CHCK = 0 # 1:ON and 0:OFF
90  BACKBONES_FILES_FOR_LOOP_NUM = 1 # Number of times to run the modules of BACKBONES FILES
91  H5MODELS_FILES_FOR_LOOP_CHCK = 0 # 1:ON and 0:OFF
92  H5MODELS_FILES_FOR_LOOP_NUM = 1 # Number of times to run the modules of BACKBONES FILES
93  SMABCK_FILES_FOR_LOOP_CHCK = 1 # 1:ON and 0:OFF
94  SMABCK_FILES_FOR_LOOP_NUM = 1 # Number of times to run the modules of SMAxx_10_BCKns.py file
95  # Define a function to run each module
96  def run_module(module, argument, mt_mont_ChckM, UNetNormaChckM, LRVAR_M, patch_sizeVARM, overlapVARPercM, patience_VVARM, batch_size_VVARM, epochs_VVARM, activationVARM):···
156
157 if BACKBONES_FILES_FOR_LOOP_CHCK == 1:···
187
188 elif BACKBONES_FILES_FOR_LOOP_CHCK == 0:···
190
191 if H5MODELS_FILES_FOR_LOOP_CHCK == 1:···
221
222 elif H5MODELS_FILES_FOR_LOOP_CHCK == 0:···
224
225 # List of modules to run
226 moduleU = [···
306
307 if SMABCK_FILES_FOR_LOOP_CHCK == 1:···
339
340 elif SMABCK_FILES_FOR_LOOP_CHCK == 0:···
```

Figura 84 – Overview of the developed remote code SMAxx_10_BCKns_Main.py. Source: Robson Rogério Dutra Pereira. (`Part 1/2`).

SMAxx_10_BCKns_Main.py > ...

```
96  def run_module(module, argument, mt_mont_ChckM, UNetNormaChckM, LRVAR_M, patch_sizeVARM, overlapVARPercM, patience_VVARM, batch_size_VVARM, epochs_VVARM, activationVARM)
97      # Your module-specific configuration here
98      module.PLTShowChck = 0 # plt.show() ---> 0: OFF; 1: ON
99      module.PLTShowTempPause = 2 # plt.show(temporary pause) --->  0: OFF; 1: ON; 2: PNG inference paused way
100     module.TESTImgNumberChck = 1 # 0: random; 1: fixed
101     module.TESTImgNumberVAR = 338
102     module.UNetNormaChck = UNetNormaChckM # UNet with BatchNormalization() ---> 0: OFF; 1: ON | 0: NBatNorm; 1: YBatNorm; 2: mlp_nn; 3: FCN_atrous; 4: IFCN_atrous; 5: de
103     module.metricsChck = 1 # For the train ---> 1: metricsIOUFS and 2: metricsJac
104     module.UshuffleChck = True # For the model.fit shuffle ---> True: ON and False: OFF
105     module.mixed_precisionChck = 0 # For the tensorflow.keras.mixed_precision ---> 0: off and 1: on
106     module.date_timeChck = 1 # For the DATETIME on the Model Checkpoint ---> 0: off and 1: on
107     module.split_loaded_dataChck = 1 # split_loaded_data Functions ---> 1:numpy.split; 2:sklearn.train_test_split; 3:random.sample
108     module.rootModChck = 1 # For the load saved models ---> 1: metricsIOUFS and 2: metricsJac
109     module.mt_mont_Chck = mt_mont_ChckM # For UNet Loss check ---> 1: mt function, 2: mont function and 3: mlp_nn
110     module.patch_size_startVAR = 0 # Start Patch size
111     module.patch_sizeVAR = patch_sizeVARM # Patch size: 128 or 256; 4:PSPNet (384 x 384, 3)
112     module.overlapVARPerc = overlapVARPercM # Overlap between patches in % of patch_sizeVAR
113     module.overlapVAR = round((module.patch_sizeVAR*module.overlapVARPerc)/100) # Overlap between patches in pixelss
114     module.patience_VVAR = patience_VVARM # Patience for Early Stopping in epochs
115     module.batch_size_VVAR = batch_size_VVARM # Batch size [4, 8, 16, 32, 64]
116     module.epochs_VVAR = epochs_VVARM # Epochs size
117     module.activationVAR = activationVARM #"softmax" # Activation of net output; "softmax":multiclass segmentation with non overlapping class masks (your classes + backg
118     module.LRVAR = LRVAR_M # 0.001 # Learning Rate
119     module.restart_loss_thresholdVAR = 0.9999 # Define a threshold for loss to trigger a restart
120     module.max_consecutive_epochsVAR = 7 # Define a maximum number of consecutive epochs with loss above threshold before restarting
121     module.consecutive_epochsVAR = 0
122     module.max_restart_attemptsVAR = 5  # Set your desired limit here
123     module.restart_attemptsVAR = 0
124     module.optimizerUChck = 1 # UNet Model compiler optimizer ---> 1:optim = Adam(LR); 2:'adam'
125     module.optimizerBChck = 1 # UNet + Backbone Model compiler optimizer ---> 1:optim = Adam(LR); 2:'adam'
126     module.TestSplittVAR = 0.10 # Test_size split for normal training
127     module.TestSplittFVAR = 0.50 # Test_size split for fast training
128     # module.backbones_index = 0 # For the "SMAxx_10_BCKns_Creator.py" needs to be "0"(zero) and COMMENT this line for BACKBONES TRAINING
129     # module.backbone_input = backbones_in[module.backbones_index]
130     module.inib_index = 0 # For the "SMAxx_10_BCKns_ibCreator.py" needs to be "0"(zero) and COMMENT this line for BACKBONES TRAINING
131     module.models_inibpt = models_inib[module.inib_index]
132     module.high_resoution_imgChckEACHI = 1 # Inference in a high resolution on each images ---> 0:off; 1:on
133     module.high_resoution_imgChckHOALL = 0 # Inference in a high resolution on hold all the subplots images ---> 0:off; 1:on
134     module.modelnetChck = 1 # Architectures Model Net ---> 1:Unet; 2:FPN; 3:Linknet; 4:PSPNet (384 x 384, 3)
135     module.encoderweightsChck = 1 # encoder_weights of the Model ---> 1:encoder_weights='imagenet'; 2:encoder_weights=None
136     module.encoderfreezeChck = 0 # to only randomly initialized decoder in order not to damage weights of properly trained encoder ---> 0:encoder_freeze OFF; 1:encoder_f
137     module.asinputChck = 1 # MAIN asinput ---> 0:off; 1:on; "asinputChck:1|asinputChckIN:0" just remote file; "asinputChck:1|asinputChckIN:1" and "asinputChck:0|asinputC
138     module.asinputChckIN = 0 # MAIN asinput terminal ---> 0:off; 1:on; "asinputChck:1|asinputChckIN:0" just remote file; "asinputChck:1|asinputChckIN:1" and "asinputChck
139     module.prebckb_input1 = backbones_in[0] # According to backbones_in:model_Unet_efficientnetb5_00[29]
140     module.prebckb_input2 = backbones_in[0] # According to backbones_in:model_Unet_resnet152_00[13]
141     module.prebckb_input3 = backbones_in[0] # According to backbones_in:model_Unet_vgg16_00[7]
142     module.bckb_model01 = models_inib[2] # [2] model_Unet_efficientnetb5_00; models_inib[0] with zero index to run "One Saved Model"
143     module.bckb_model02 = models_inib[4] # [4] model_Unet_resnet152_00; models_inib[0] with zero index to run "One Saved Model"
144     module.bckb_model03 = models_inib[7] # [0] model_Unet_densenet121_00 OR [1] model_Unet_densenet201_00 OR [8] model_Unet_vgg16_00 OR [9] model_Unet_00; models_inib[0]
145     module.ClassNumInf = 2
146     # Run mainIN(argument) of SMAxx_10_BCKns.py
147     module.mainIN(argument)
148     # Delays and clean commands
149     time.sleep(5)
150     gc.collect()
151     tf.keras.backend.clear_session()
```

Figura 85 – Overview of the developed remote code SMAxx_10_BCKns_Main.py. Source: Robson Rogério Dutra Pereira. (Part 2/2).