Scripting in LIFEx

LITO - team meeting
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Why Scripting ?

What are the benefits ?

- ✓ to automate the tasks if there are many patients
- ✓ to recalculate the data by guaranteeing the reproducibility
- ✓ to ensure traceability in case of doubtful results

Operations

Format conversion
Spatial resampling
Filtering
Thresholding

Format conversion

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_v7.6.0.pdf => section 3.3

⚠ **numbering starts at 0**

- Save anonymous series in DICOM format (only if loaded series is in DICOM format too):
  LIFEx.Patient0.Series0.Operation0=**Save anonymous dcm**
- Save series in DICOM format (only if loaded series is in DICOM format too):
  LIFEx.Patient0.Series0.Operation0=**Save dcm**
- Save series in nrrd format:
  LIFEx.Patient0.Series0.Operation0=**Save nrrd**
- Save series in nifti format (float 32 bits):
  LIFEx.Patient0.Series0.Operation0=**Save nii float32**
- Save series in nifti format (uint 16 bits) (2 posibilities):
  LIFEx.Patient0.Series0.Operation0=**Save nii uint16**
  LIFEx.Patient0.Series0.Operation0=**Save nii**

In the example below

```
##############################################
#LIFEx script: convert image from DCM to NIFTI
##############################################

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/Images/P1_PT_SUV.dcm
LIFEx.Patient0.Series0.Operation0=Save nii uint16
LIFEx.Patient0.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_1/Images/

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/Images/P2_PT_SUV.dcm
LIFEx.Patient1.Series0.Operation0=Save nii uint16
LIFEx.Patient1.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_2/Images/
```

if the image is not a single dicom file => set the name of the folder containing .dcm files

Spatial resampling

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_v7.6.0.pdf => section 3.3

```
#####################################
#LIFEx script: image resampling
#####################################

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/Images/P1_PT_SUV.nii.gz
LIFEx.Patient0.Series0.Operation0=ResampleRescaling,4,4,4|Save nii
LIFEx.Patient0.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_1/Images/

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/Images/P2_PT_SUV.nii.gz
LIFEx.Patient1.Series0.Operation0=ResampleRescaling,4,4,4|Save nii
LIFEx.Patient1.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_2/Images/
```

Filtering

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_ v7.6.0.pdf => section 3.3

LIFEx.Patient0.Series0.Operation0=**GaussianFilter,SigmaX,SigmaY,SigmaZ, CalculationDimension,WholeBody,PaddingMethod**
Example with Sigma (x=2 mm, y=2mm, z=2mm), 3d calculation dimension, wholebody enable and reflect padding method:
LIFEx.Patient0.Series0.Operation0=GaussianFilter,2,2,2,3d,true,reflect
- float value Sigma is the FWHM/2 of kernels size in millimeter.
- 3d calculation dimension is between [2d, 3d]
- wholebody is always true in script
- padding method is between [reflect, periodic, edge, zero]

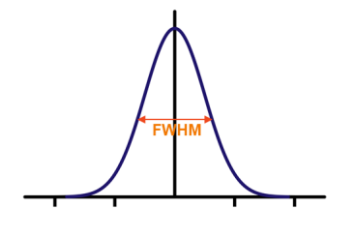
```
#####################################
#LIFEx script: image filtering
#####################################

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/Images/P1_PT_SUV.nii.gz
LIFEx.Patient0.Series0.Operation0=GaussianFilter,2,2,2,3d,true,reflect|Save nii
LIFEx.Patient0.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_1/Images/

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/Images/P2_PT_SUV.nii.gz
LIFEx.Patient1.Series0.Operation0=GaussianFilter,2,2,2,3d,true,reflect|Save nii
LIFEx.Patient1.Series0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_2/Images/
```

other spatial filters ?
LaplacianOfGaussianFilter
LawFilter
MeanFilter
WaveletFilter

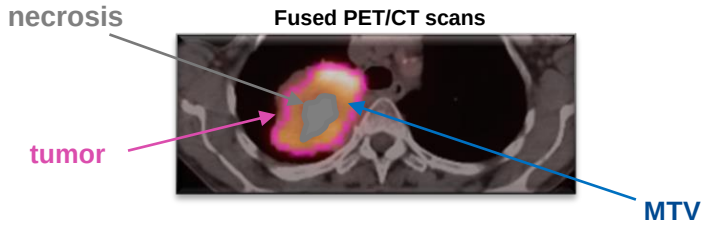
⚠ **sigma equal to FWHM/2**



vocabulary elsewhere…
4mm Gaussian filter = Gaussian filter with 2mm sigma

Thresholding

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_ v7.6.0.pdf => section 4.2



in the example below

- Absolute threshold:
  LIFEx.Patient0.Roi0.Operation0=**n,ValueOfMinThreshold,ValueOfMaxThreshold**
- Percent threshold:
  LIFEx.Patient0.Roi0.Operation0=**n%,ValueOfPercentThreshold**
- 40 Percent threshold:
  LIFEx.Patient0.Roi0.Operation0=**40%**
- 70 Percent threshold:
  LIFEx.Patient0.Roi0.Operation0=**70%**
- Peak:
  LIFEx.Patient0.Roi0.Operation0=**Peak**
- Nestle threshold:
  LIFEx.Patient0.Roi0.Operation0=**Nestle,ValueOfThreshold**
- PERCIST threshold (need to have previously loaded a ROI named Liver)
  LIFEx.Patient0.Roi0.Operation0=**PERCIST**

```
########################################
#LIFEx script: ROI thresholding
########################################

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/Images/P1_PT_SUV.nii.gz
LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs_original
LIFEx.Patient0.Roi0.Operation0=n,4,50|Save nii
LIFEx.Patient0.Roi0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs_threshold

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/Images/P2_PT_SUV.nii.gz
LIFEx.Patient1.Roi0=E:/Project/…/Database_1/Patient_2/Segmentations/VOIs_original
LIFEx.Patient1.Roi0.Operation0=n,4,50|Save nii
LIFEx.Patient1.Roi0.Operation0.Output.Directory=E:/Project/…/Database_1/Patient_2/Segmentations/VOIs_threshold
```

this folder may contain several VOIs

4 < SUV < 50

CT ? => 100 < HU < 300 => soft tissue

destination folder automatically created with the specified name

Extraction

Texture protocol

MTV protocol

…

Resampling

Filtering

Feature extraction

Color legend:
Information / Parameters
Non Discretized values
Non Discretized values
Discretized values

Texture protocol

MTV protocol

TEXTURE_ROI_Results.csv

INFORMATION
- INFO_*

PARAMETERS
- PARAMS_*
- CHECK_TEXTURE_*

FEATURE RESULTS
- MORPHOLOGICAL_*
- INTENSITY-BASED_*
- LOCAL_INTENSITY_BASED_*
- INTENSITY-BASED-RIM_*
- INTENSITY-HISTOGRAM_*
- LOCAL_INTENSITY_HISTOGRAM_*
- INTENSITY-HISTOGRAM-RIM
- GLCM_*
- GLRLM_*
- NGTDM_*
- GLSZM_*

MTV_ROI_Results.csv

- MORPHOLOGICAL_*
- INTENSITY-BASED_*
- LOCAL_INTENSITY_BASED_*
- INTENSITY-BASED-RIM_*

MTV_SUMMARY_Results.csv

- SUMMARY_Bulk*
- SUMMARY_Smallest*
- SUMMARY_Dmax
- SUMMARY_*Diff*
- SUMMARY_Min*
- SUMMARY_Mean*
- SUMMARY_Max*
- SUMMARY_TLG
- SUMMARY_RoiCentroidCoor-*
- SUMMARY_AllRoiCentroidCoor-*
- SUMMARY_RoiWCentroidCoor-*
- SUMMARY_AllRoiWCentroidCoor-*
- SUMMARY_TL/TR/BL/BR*

-need to extract advanced features (textural analysis) and don’t need calculating whole-body biomarkers => use Texture protocol
-need to extract advanced features and whole-body biomarkers => use both protocols
-need to extract standard features (non textural analysis) and whole-body biomarkers => use MTV protocol

Extraction ● Texture protocol

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_ v7.6.0.pdf => section 5.1.4

template: LIFEx.Patient0.Series0.Operation0=**Texture,**
KeepTheLargestCluster,Check,isEnabledRoiUnion
DistanceWithNeighbours,DimensionProcessing,
Absolute,BinSize,NbGreyLevels, MinBound,MaxBound

example: LIFEx.Patient0.Series0.Operation0=**Texture,true,false,false,1,3D,Absolute,0,64,0,20**
Texture with KeepTheLargestCluster=true
and with check=false
and with isEnabledRoiUnion=false
and with DistanceWithNeighbours=1 and with DimensionProcessing=3D
and with Absolute discretization
and with BinSize=0
and with NbGreyLevels=64
and with MinBound=0
and with MaxBound=20

```
########################################
#LIFEx script: extraction with Texture protocol
########################################

#Common
LIFEx.guiUpdate=false
LIFEx.seriesRoiGuiUpdate=false
LIFEx.messagesGuiUpdate=false

#Result file
LIFEx.Output.Directory=E:/Project/…/Database_1/Results_extract_Texture

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz
LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs
LIFEx.Patient0.Series0.Operation0=Texture,false,false,false,1,3D,Absolute,0,64,0,20

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/P2_PT_SUV.nii.gz
LIFEx.Patient1.Roi0=E:/Project/…/Database_1/Patient_2/Segmentations/VOIs
LIFEx.Patient1.Series0.Operation0=Texture,false,false,false,1,3D,Absolute,0,64,0,20
```

if false…
faster calculation

results file
TEXTURE_ROI_Results.csv
inside the specified folder

other discretization methods ?
RelativeMinMax
RelativeMeanSd

⚠ **discretization…**
mandatory for
feature extraction
with Texture protocol

Extraction ● MTV protocol

More information can be found on the LIFEx's website
https://www.lifexsoft.org/.../Documentation/.../LIFExScripts_ v7.6.0.pdf => section 5.2.2

```
#######################################
#LIFEx script: extraction with MTV protocol
#######################################

#Common
LIFEx.guiUpdate=false
LIFEx.seriesRoiGuiUpdate=false
LIFEx.messagesGuiUpdate=false

#Result file
LIFEx.Output.Directory=E:/Project/…/Database_1/Results_extract_MTV

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz
LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs
LIFEx.Patient0.Series0.Operation0=MTV,false

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/P2_PT_SUV.nii.gz
LIFEx.Patient1.Roi0=E:/Project/…/Database_1/Patient_2/Segmentations/VOIs
LIFEx.Patient1.Series0.Operation0=MTV,false
```

results files
MTV_ROI_Results.csv
MTV_SUMMARY_Results.csv
inside the specified folder

Combination of operations…

For example: **Spatial resampling** + **Filtering** + **Discretization** **within extraction with** **Texture protocol**

…

LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz

LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs

LIFEx.Patient0.Series0.Operation0=ResampleRescaling,2,2,2|GaussianFilter,4,4,4,3d,true,reflect|Texture,false,false,false,1,3D,Absolute,0,64,0,60

…

Combination of operations…

For example: **Spatial resampling** + **Filtering** **within extraction with** **MTV protocol**

…

LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz

LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs

LIFEx.Patient0.Series0.Operation0=ResampleRescaling,2,2,2|GaussianFilter,4,4,4,3d,true,reflect|MTV,false

…

Combination of protocols…

…

LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz

LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs

LIFEx.Patient0.Series0.Operation0=ResampleRescaling,2,2,2|MTV,false|Texture,false,false,false,1,3D,Absolute,0,64,0,60

…

PET/CT…

…

LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_CT_HU.nii.gz

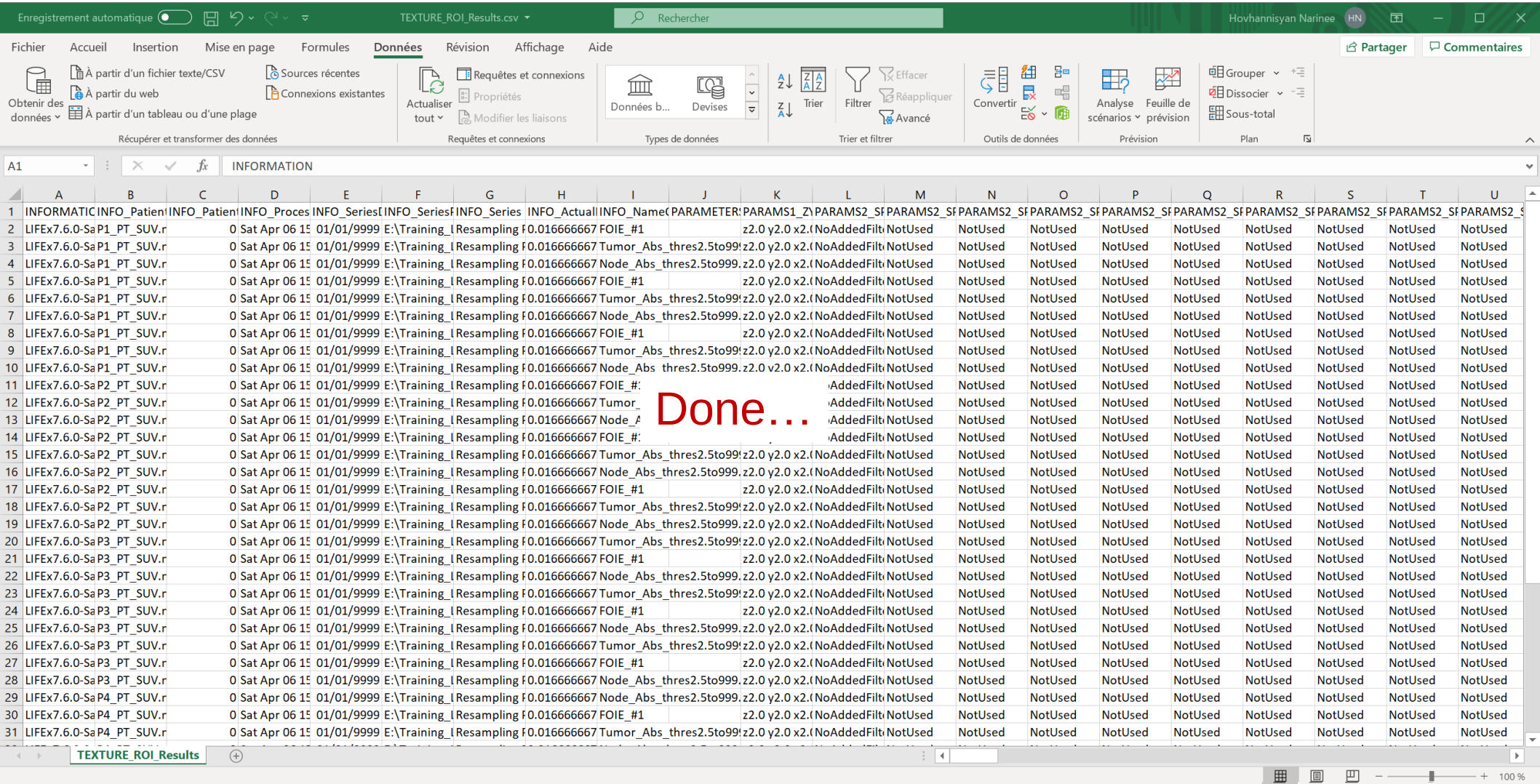
LIFEx.Patient0.Series1=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz

LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs

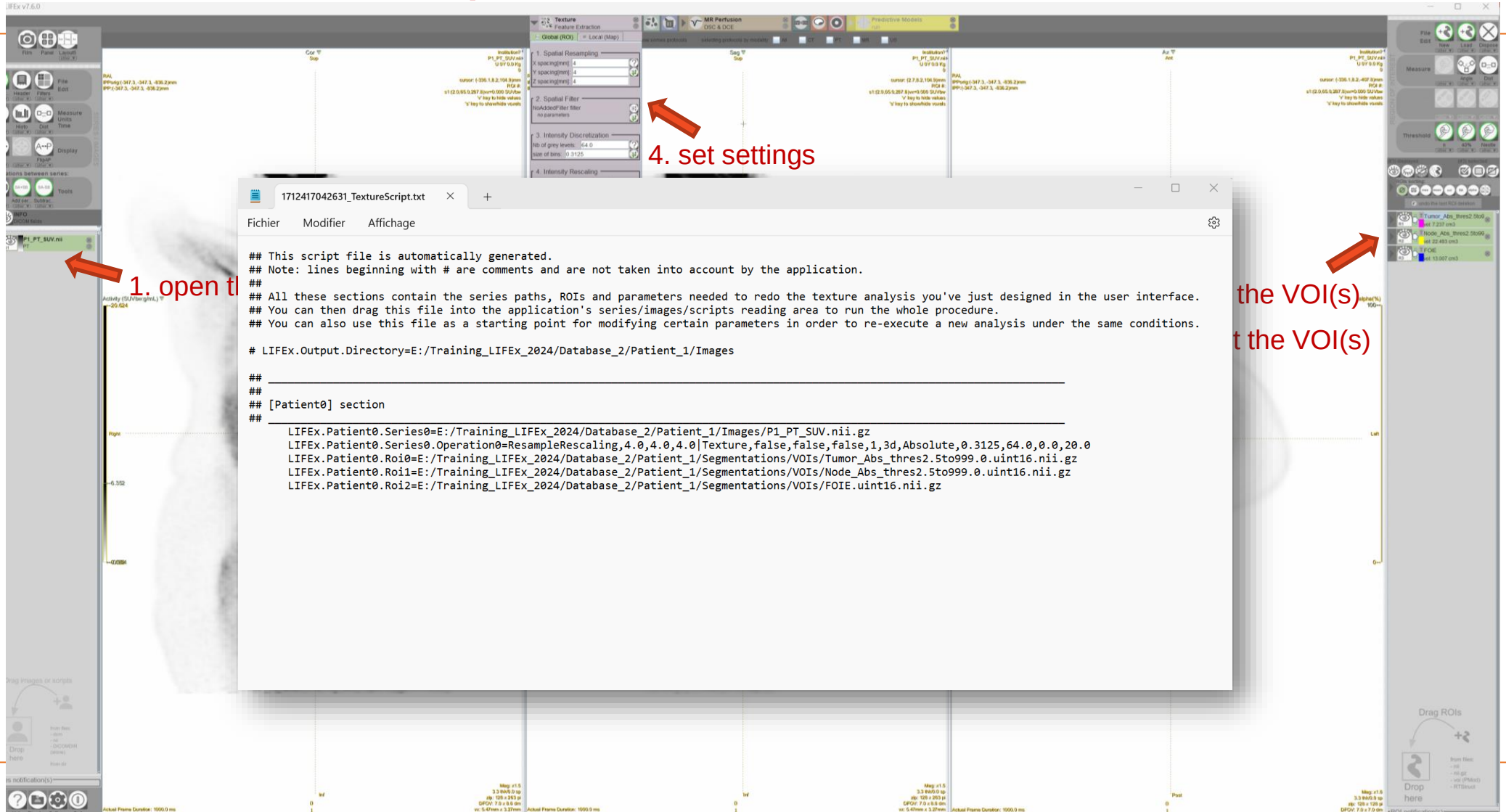
LIFEx.Patient0.Series1.Operation0=ResampleRescaling,2,2,2|Texture,false,false,false,1,3D,Absolute,0,64,0,60

…

More: Opening the resulting .csv file



More: create a macro script



More: Python in automatic script creation for LIFEx

jupyter Script_python_enter-data-script-lifex Dernière Sauvegarde : il y a quelques secondes (a

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Automatic script creation for LIFEx

Entrée [1]:
```
# NOTE HERE the path to the folder in which the PET scans are stored
path = 'D:/Project/Patients/'
```

Entrée [2]:
```
# We scan all visible folders at the location indicated in the previous cell
import os
list_of_folders = sorted(os.listdir(path))

# The result is a list:
for i,folder in enumerate(list_of_folders):
    print(i, folder, sep='\t', end='\n')
```

```
0	P_AAAA1112
1	P_AAAA1113
2	P_AAAA1114
3	P_AAAA1115
4	P_AAAA1116
5	P_AAAA1117
6	P_AAAA1118
7	P_AAAA1119
8	P_AAAA1120
9	P_AAAA1121
10	P_AAAA1122
11	P_AAAA1123
12	P_AAAA1125
13	P_AAAA1127
14	P_AAAA1128
15	P_AAAA1131
16	P_AAAA1132
17	P_AAAA1133
18	P_AAAA1134
19	P_AAAA1136
20	P_AAAA1137
21	P_AAAA1139
22	P_AAAA1140
23	P_AAAA1142
24	P_AAAA1145
25	P_AAAA1148
26	P_AAAA1149
27	P_AAAA1150
28	P_AAAA1153
29	P_AAAA1156
30	P_AAAA1161
31	P_AAAA1188
32	P_AAAA1192
33	P_AAAA1193
34	P_AAAA1194
35	P_AAAA1195
36	P_AAAA1199
37	P_AAAA1205
38	P_AAAA1206
39	P_AAAA1207
40	P_AAAA1208
41	P_AAAA1209
42	P_AAAA1210
43	P_AAAA1211
44	P_AAAA1213
45	P_AAAA1214
46	P_AAAA1215
47	P_AAAA1229
48	P_AAAA1233
49	P_AAAA1234
50	P_AAAA1253
51	P_AAAA1258
52	P_AAAA1259
```

Entrée [6]:
```
# NOTE HERE the Location and name of the script to be created (or overwritten)
script_path = 'D:/Projet/script_lifex_extract.txt'

with open(script_path, 'w') as f:
    f.write("""
##########################################
# Common
##########################################
# fixed information on script
LIFEx.guiUpdate=false
LIFEx.seriesRoiGuiUpdate=false
LIFEx.messagesGuiUpdate=false


#Result file
LIFEx.Output.Directory=E:/Project/Databes_1/Results_extract_Texture


#####################################################################
# Patients / ROI                                                    #
#####################################################################\n\n""")
    for i,folder in enumerate(list_of_folders):
        f.write('LIFEx.Patient'+str(i)+'.Series0='+path+folder+'/PET_SUV.nii.gz'+'\n')
        f.write('LIFEx.Patient'+str(i)+'.Roi0='+path+folder+'/Segmentations'+'\n')
        f.write('LIFEx.Patient'+str(i)+'.Series0.Operation0=ResampleRescaling,2,2,2|Texture,false,false,false,1,3D,Absolute,0,192

        f.write('\n \n')

    f.write('# End')
```

.txt file

```
###################################
#LIFEx script: extraction with Texture protocol
###################################

#Common
LIFEx.guiUpdate=false
LIFEx.seriesRoiGuiUpdate=false
LIFEx.messagesGuiUpdate=false

#Result file
LIFEx.Output.Directory=E:/Project/Databes_1/Results_extract_Texture

#Patients
LIFEx.Patient0.Series0=E:/Project/…/Database_1/Patient_1/P1_PT_SUV.nii.gz
LIFEx.Patient0.Roi0=E:/Project/…/Database_1/Patient_1/Segmentations/VOIs
LIFEx.Patient0.Series0.Operation1=ResampleRescaling,2,2,2|Texture,false,false,false,1,3D,Absolute,0,192,0,60

LIFEx.Patient1.Series0=E:/Project/…/Database_1/Patient_2/P2_PT_SUV.nii.gz
LIFEx.Patient1.Roi0=  E:/Project/…/Database_1/Patient_2/Segmentations/VOIs
LIFEx.Patient1.Series0.Operation1=ResampleRescaling,2,2,2|Texture,false,false,false,1,3D,Absolute,0,192,0,60
```

Thank you !

The templates of all introduced scripts are in the folder « Scripts_TakeHome »

Scripts_TakeHome

- Script_lifex_1_format-conversion.txt
- Script_lifex_2_spatial-resampling.txt
- Script_lifex_3_filtering.txt
- Script_lifex_4_thresholding.txt
- Script_lifex_5_extract-Texture.txt
- Script_lifex_6_extract-MTV.txt
- Script_python_enter-data-script-lifex.ipynb
- Opening the resulting csv file.pdf